Lawrence Lake
Aquatic Plant Management Plan

2005

Aron & Associates
30910 Royal Hill Rd.
Burlington, WI 53105
262-514-3234

TABLE OF CONTENTS

Chapter I
INTRODUCTION

Lawrence Lake is a 220 acre lake located in the Town of Westfield, Marquette County, Wisconsin. The lake has a maximum depth of 14 feet and 6.87 miles of shoreline.

The Lawrence Lake P & R District (District) was formed in the mid-80's to accept ownership and repair the dam at the outlet of the lake.

In 1989 the State of Wisconsin enacted the Lake Management Planning Grant program. The program was designed to provide cost-sharing assistance and incentives to local communities because they are the front line for lake management activities. The District received a grant to assist with the development of this Aquatic Plant Management Plan. This Plan is but one part of the continued effort by local residents to improve Lawrence Lake.

An important element in the development of the plant management plan was public input and historical records. Comments and information were solicited from residents and board members, lake users, WDNR resource managers, and WDNR records.

GOALS & OBJECTIVES

The difficult task facing those who attempt to manage their lake is that user needs often conflict. Fish and wildlife need aquatic plants to thrive. Boaters and swimmers desire relief from nuisance aquatic plants. Those depending on the lake for “aesthetic viewing” desire an undisturbed lake surface.

The goals of the District, that is, broad statements of long range desires, are outlined below. The goals are followed by objectives to be used to accomplish each of the goals.

The District's goals are to responsibly work toward the preservation of aquatic systems including water quality, fisheries, and wildlife while minimizing the conditions resulting from aquatic nuisances and to preserve and maintain recreational uses of Lawrence Lake. To achieve the goal, the development of this plan is one component of an effort that may eventually include water quality monitoring, community surveys, aquatic vegetation surveys, wetland inventories, shoreline stabilization, educational lake fairs, and watershed improvement activities.

The District desires to:

- Restore native plant communities.
  —Encouraging landowners to protect native species.
  —Use chemical treatments in shoreline areas if needed.
  —Minimize fragments of aquatic plants.
  —Aggressively respond to re-infestations of exotic species.
- Preserve and enhance the natural lake environment by:
  —Educating landowners and lake users in lake ecology.
- Work with the Town, County and State governments to:
  —Continue to improve the watershed to protect Lawrence Lake.
  —Identify and expand local educational efforts to improve the public's understanding of lake issues
  —Encourage community participation in lake management activities.
  —Participate in the newly formed Montello River Watershed Task Force.
- Conduct in-lake management activities with the long-range goal of minimizing management to the extent possible by:
  —Conducting year-end evaluations as to the success of plant management activities and the community reaction to the activities.
  —Tracking annual progress of lake management activities.
  —Conducting water quality monitoring to assist in the documentation of results.

Chapter II

BACKGROUND

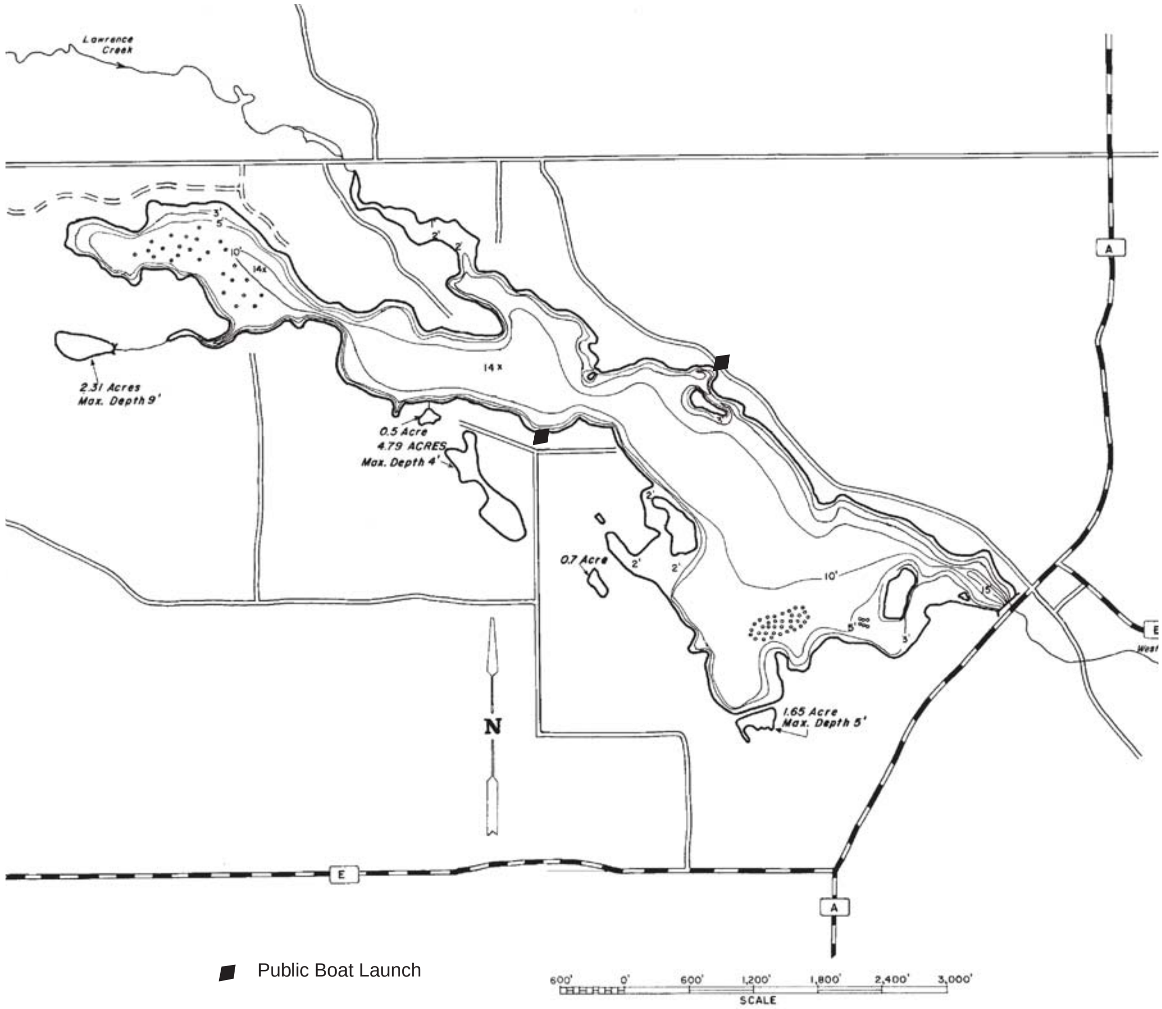
PHYSICAL DESCRIPTION

Lawrence Lake was created by impounding Lawrence Creek. A dam on the Southeast shore maintains the current lake elevation. Lawrence Lake is in the Montello River subwatershed in the Upper Fox River watershed.

Table 1 Hydrography and Morphology of Lawrence Lake
Marquette County, Wisconsin, 2004

Area = 220 acres
Shore length = 6.87 miles
Maximum depth = 14 feet
Mean depth = 8 feet
Volume = 1686 acre feet
Percent of area less than 3 feet deep = 14%
Percent of area greater than 20 feet deep = 0%

Sources: WDNR



Aron & Associates 2004

Figure 1 Lawrence Lake, 2004

The watershed of Lawrence Lake is gently sloping and ranges from well-drained to poorly-drained. The Lawrence Lake watershed is relatively undeveloped. This drainage lake[1] has a direct inlet (Lawrence Creek). The drainage area to Lawrence Lake is predominately rural land use (89%). Residential and commercial lands make up 11% of the watershed area. Most of the residential lands are found immediately adjacent to Lawrence Lake.

1. Drainage lakes have both an inlet and an outlet. Lawrence Lake's inlet enters the lake on the Northwest shore. The dam is located on the Southeast shore.

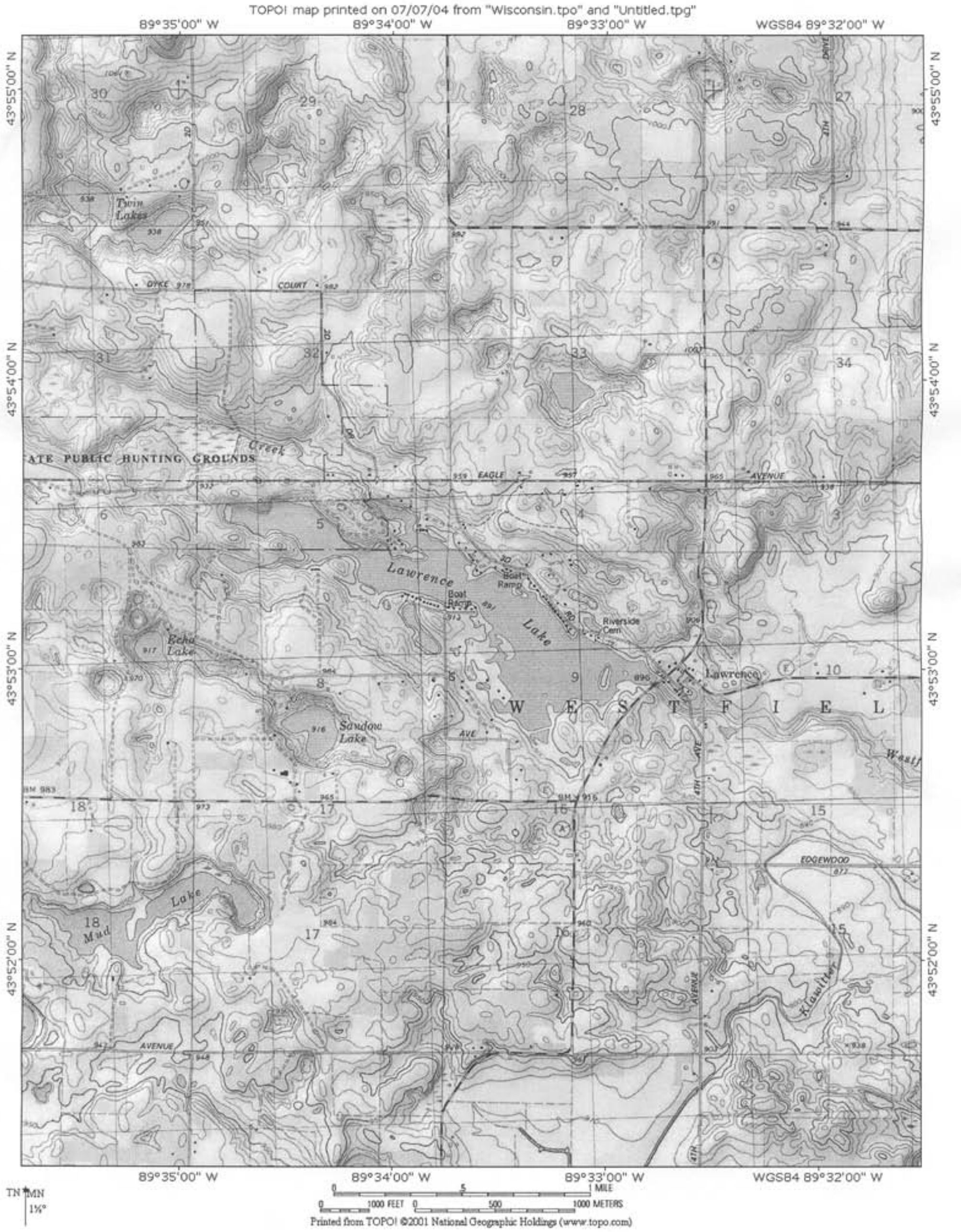


Figure 2 Location of Lawrence Lake. Source, USGS.

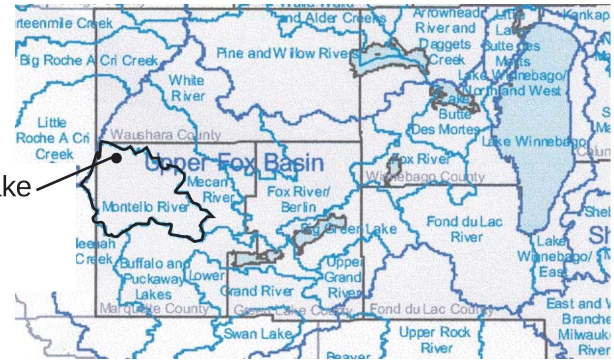


Figure 3 Lawrence Lake, Montello River Subwatershed of the Upper Fox Basin. Source ECWRPC.

Land use activities can directly affect the chemical and biological components of a lake, as well as plant growth patterns in a lake. To see this affect, it is helpful to look at lakes with storm drain outlets or inlet areas, where it is possible to see the more concentrated effects of rural and urban impacts. Often, the lakebed area near storm drains and inlets have different plant and sediment characteristics than other areas of the lake bottom. The runoff from individual homesites, development, and agricultural lands adds to the nutrients and sediments in a lake. That in turn increases the plant growth, sometimes to nuisance conditions. Nutrients, sediments and other materials entering the lake can severely impact the plants, fish and wildlife. Lower oxygen levels, fish kills, and sedimentation of spawning beds can result. Lake use activities on Lawrence Lake, such as motorboating, that are conducted in areas of the lake with insufficient depths, can result in the disruption of sediments. Education of the general public, especially the lake front property owners and landowners in the watershed, should focus on activities to minimize impact on the lake.

Civil Divisions

Lawrence Lake is entirely within the Town of Westfield, in Marquette County. The Town owns and operates two boat launches, one on the West shore, and one on the East shore Figure 1). The lake district boundaries include all lakefront property.

Watershed

Lawrence Lake is in the Montello River watershed, a subwatershed of the Upper Fox River Watershed Figure 3. The direct watershed is primarily forested, with little agricultural land. Lawrence Creek, a Class 1 trout stream, enters Lawrence Lake on the Northwest**.** There are two point source discharges in the watershed, both of which are below, and therefore do not impact, Lawrence Lake.

The direct watershed to Lawrence Creek is approximately 50% agricultural land. Wetlands and woods protect the Creek from direct agricultural impacts.

Soils

The soils are generally sandy soils found on the pitted outwash plains. The area is undulating with rolling hills. The soils in this region consist of the following soil associations: Plainfield-Gotham, Loamy-Sand; Delton-Briggsville-Mundelein, Silty Clay, Silty Clay Loam, Houghton-Adrian, Peat.

SHORELINE DEVELOPMENT & AESTHETIC FEATURES

The Lawrence Lake shoreline is predominantly open space and residential. Most of the homes are located in the center areas of Lawrence Lake and along the Northeastern shoreline. Large expanses of natural shoreline protect the quality of habitat on the lake, and provide a quiet respite from the developed areas.

HISTORICAL CONDITIONS

Determining what plants are present in a lake can be done a number of different ways. One way, including transect and point-intercept surveys, is to measure the species composition, frequency, and densities of aquatic plants at a number of points around a lake. Another, called a general survey, is to traverse the area of the lake that is available for plant growth, called the littoral zone, covering all the depths and as much of the littoral zone as possible, to develop a species composition list.

According to the WDNR, no historical plant data exist for Lawrence Lake.

Chemical treatment of Eurasian watermilfoil (*Myriophyllum spicatum*), an exotic plant, started in 2002. It is not known how long Eurasian watermilfoil or curly-leaf pondweed have been present in the lake. Dense beds of native plants, primarily waterweed, naiads, and pondweeds, have been chemically treated to provide riparian access for a number of years.

SENSITIVE AREAS

The level of development around lakes and the amount of recreational use lakes receive severely restricts the value of the resources to fish and wildlife. Often, people tend to underestimate the affect they have on their environment. But their affect can be significant. Wildlife will avoid areas frequented by boats and noisy lake users. Waves from the continuous use of watercraft can erode shorelines and drive furbearers from their nests. Neatly manicured urban lawns do not protect shorelines from the corrosive action of waves, nor do they provide shelter or shade for wildlife. Retaining walls do not provide areas for small invertebrates to hide, an essential element in the food supply for fish. Spawning areas can be disrupted by propellers or personal watercraft. Migrating birds and waterfowl seek quiet resting places or nesting areas.

In March 1989, the State enacted legislation to protect special or "Sensitive" lake areas from some negative impacts. The WDNR was charged to administer an aquatic nuisance control program which includes Sensitive Area Designation. Administrative Code NR 107 and NR 109 provide the guidance used to administer the WDNR's aquatic plant management (APM) program. The APM program seeks to protect native vegetation that is important to fish and wildlife. The WDNR may restrict activities that would prove detrimental to the native plants. These restricted activities may include dredging, filling, shoreline alterations or sand blankets.

Many plant management activities are now regulated by the state. Legislation that was recently passed requires permits for activities including chemical treatment, aquatic plant harvesting, native species re-introductions, among others.

The WDNR has not conducted a Sensitive Area designation on Lawrence Lake**.** Figure 4 shows the areas of the lake that may be considered environmentally valuable. The native species and habitat in these areas are extremely important to the long term health of the fisheries and vegetation diversity on Lawrence Lake and should be protected.

Residents should be encouraged to naturalize their shorelines. Aquatic vegetation in the nearshore areas stabilize soft sediments, preventing the sediments from becoming re-suspended into the water column because of wind or boating. The shallow areas of native aquatic plants should be preserved as much as possible.

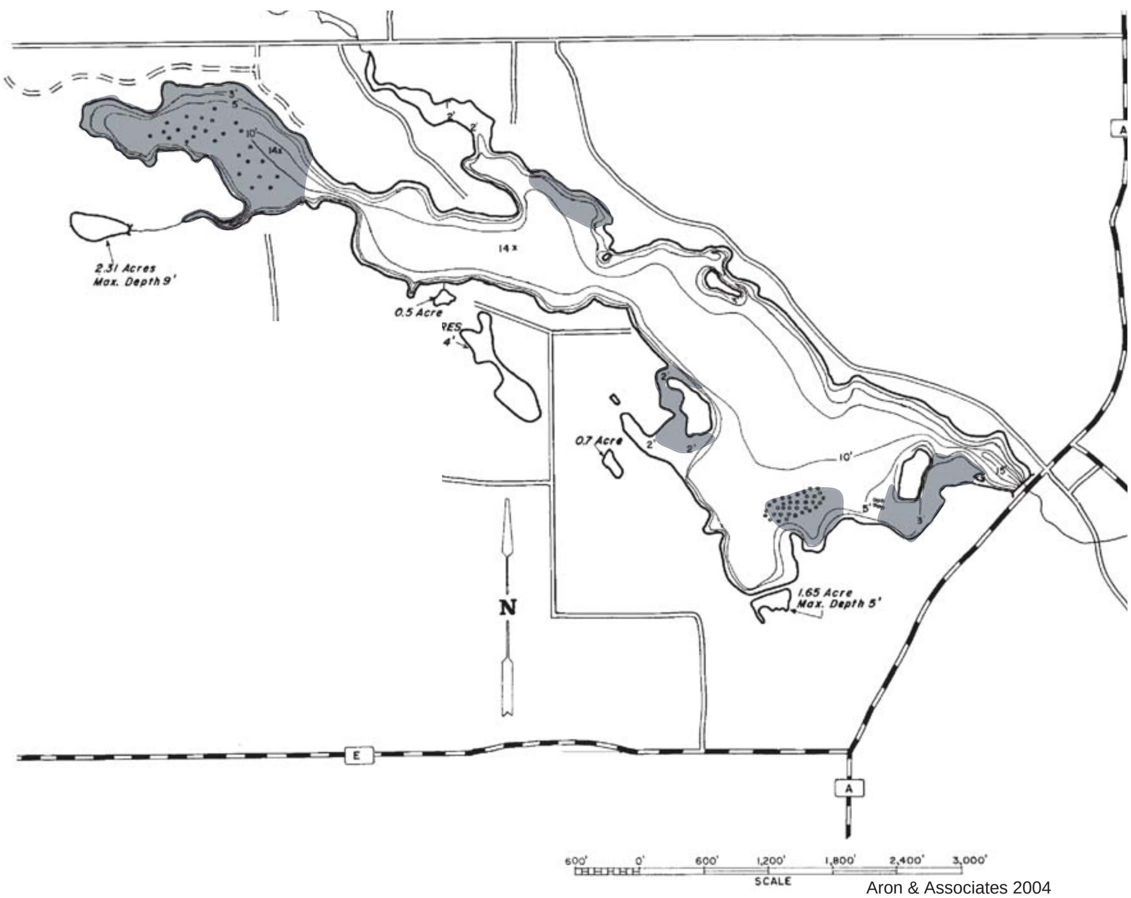


Figure 4 Environmentally Valuable Areas, Lawrence Lake, 2004.

FISH AND WILDLIFE

Lawrence Creek is a Class 1 trout stream. Lawrence Lake has northern pike, panfish, largemouth bass, and walleye. In 2003, 2,500 walleye were stocked in Lawrence Lake. Carp are present in the system. Efforts to remove carp have resulted in over 8,400 lbs removed to date, with 936 removed in 2003.

Because of the undeveloped nature of the surrounding area, the lake is an important resource for wildlife. Protection of native aquatic plant species, and protection of natural shorelines are considered important for the long term protection of fish and wildlife. Undeveloped areas, with natural shorelines should be protected. Landowners with mowed lawns to the lakeshore should be encouraged to naturalize their shoreline areas. This will provide valuable shelter for wildlife. Native aquatic plants in the nearshore zone should be protected to protect fish habitat and prevent invasion of exotic species.

WATER QUALITY

Water quality studies on Lawrence Lake have been limited. A few results are available on the WDNR website. The data may be accessed on the WDNR website by going to: www.dnr.state.wi.us/org/water/fhp/lakes/index.htm. Once there select '"Lake Data". Contact WDNR water resources staff for more information.

The WDNR report, "The State of the Upper Fox River Basin, 2001" lists Lawrence Lake as mesotrophic, based on secchi disk readings. The report documents Lawrence Lake as being less responsive to changes in phosphorus loading.

Anecdotal reports from the lake community indicate that the clarity of Lawrence Lake has improved since the bottom-draw dam has been discharging nutrient-rich bottom waters.

Collection of water quality data is a very important tool for lake managers. The information is critical to document changes in the lake over time, the impact of ongoing management activities, and the planning of future management actions.

EXOTIC SPECIES

During the aquatic plant survey, Lawrence Lake was evaluated for exotic species. Eurasian watermilfoil and curly-leaf pondweed are exotic plant species present in the lake. Exotic plant species do not provide the benefits the native plant species provide. Exotic plant species tend to be more dense, and often grow to the surface where they interfere with recreational uses. Some exotic plant species will create 'canopies' that prevent light from reaching native plants underneath. These canopies also raise the temperature of the water beneath the canopies.

No zebra mussels have been found in Lawrence Lake to date (WDNR website, 2003). Because zebra mussels are in a number of lakes in Wisconsin, educational programs should focus on the preventative actions that can be taken by lake users to prevent the introduction of invasive, exotic species. This can include newsletters and boat launch signage and programs that explain how exotics are transferred from lake to lake and what actions can be undertaken by individuals to prevent infestation.

LAKE USE

Lawrence Lake receives a moderate, though increasing, level of recreational pressure. The majority of recreational uses are scenic viewing, swimming and fishing.

BOATING ORDINANCE

Lawrence Lake has a slow-no-wake area within 200 feet of shore. No tow sports, including skiing, tubing are allowed, nor wave runners. In addition to the local ordinances, state laws are in effect on the lake and are enforced by the Conservation Wardens. The District is working with the various entities to resolve the question of enforcement of local boating regulations.

ACCESS LOCATIONS

Lawrence Lake meets the WDNR standards for public access to an inland lake. The Town of Westfield owns two boat launches (Map 1) on Lawrence Lake.

Chapter III

AQUATIC PLANTS

BACKGROUND

Aquatic plants are very important to the health of a lake. They provide food and cover for fish and wildlife. They also contribute to dissolved oxygen production. Invertebrates which fish depend on for food, spend much of their life cycle on or near plants. Young fish and wildlife use plants for shelter and protection from predators. Plants also stabilize sediments, helping control shoreline erosion, and turbidity. Without plants, nutrients in the water column are readily available to fuel algae blooms. Native plant beds rarely experience oxygen or pH problems that are often associated with exotic species. An aquatic plant monitoring program may also provide an early warning signal that the lake is reacting to negative impacts from the watershed. Loss of diversity or an increase in nuisance species can signal the existence of watershed problems.

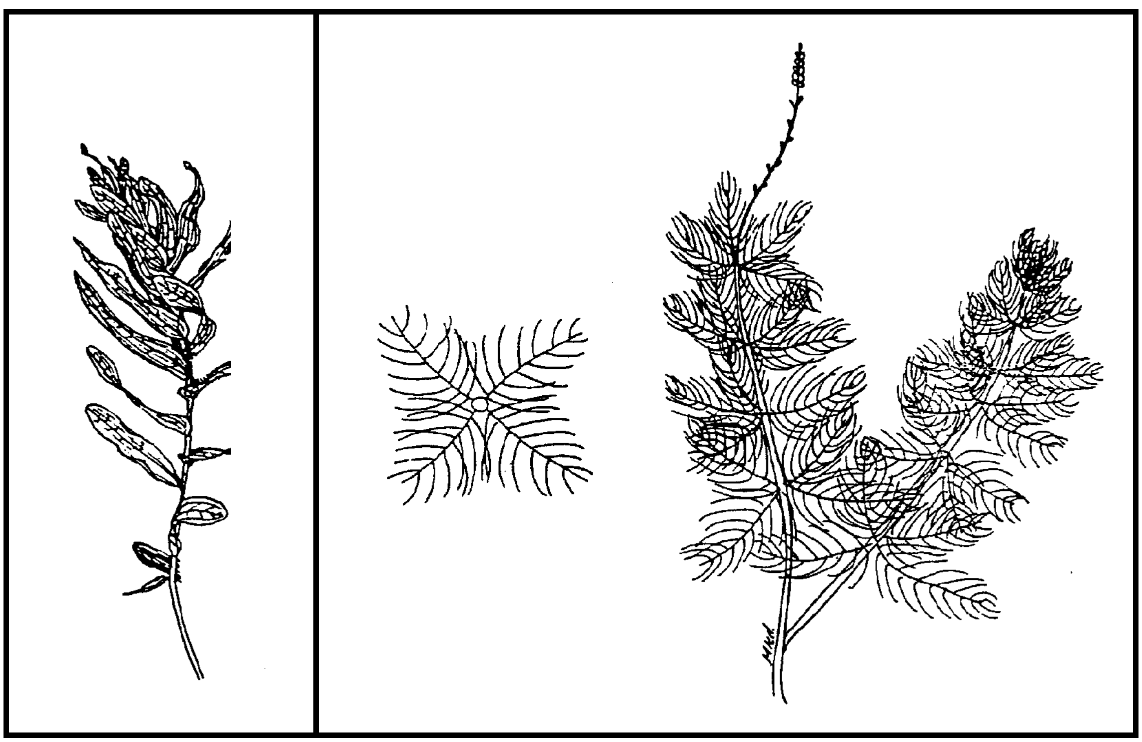


Figure 5 Curly-leaf Pondweed and Eurasian Watermilfoil, Two Exotic Species.

Many aquatic plants are important food sources for waterfowl. Others provide habitat, spawning and shelter areas for fish and amphibians. Exotic plant species do not provide these benefits as well as the native plant species. Exotic plant species tend to grow more densely, and often grow to the surface where they interfere with recreational uses. Some exotic plant species will create "canopies" that prevent light from reaching native plants underneath, raising water temperatures, and stressing native plants. Protection of native species is important to help reduce problems from exotic species. Just as crabgrass and dandelions are the first plant to invade a disturbed area of a backyard, Eurasian watermilfoil is one of the first to invade disturbed sediments in a lake.

Types of Aquatic Plants

There are four types of aquatic plants: emergents, floating-leaved, submergents, and freely-floating. Emergent plants are rooted in the lakebed with the tops of the plant extending out of the water. The sediments are either submersed or partially inundated with water. Common emergent species include bulrushes, cattails, and reeds. Floating-leaved plants are rooted in the lakebed and the leaves float on the waters surface. Floating-leaved plants usually have larger rhizomes. The most common of these plants are waterlilies. Floating-leaved plants are usually found in quieter, protected areas of a lake. Submergent plants grow completely submersed under the water, although flowering or seed portions may extend out of the water. These plants include pondweeds, Eurasian watermilfoil, muskgrass, and others. Submersed plants are affected by the amount of light that can penetrate the water. Freely-floating plant species are entirely dependent on the water movement in a lake. These plants include coontail and duckweed. Freely-floating plants are found where ever the winds and water current take them.

Littoral Zone

The term littoral zone is commonly used to describe the area of the lake from the shore out to the depth where plants no longer grow. This area receives sufficient light to grow vegetation, with coarse sediments and fluctuating water temperatures.

Plants within the littoral zone are affected by a number of factors. Steeply sloping lake bed areas do not support the vegetation that flatter lakebed areas support. Soft sediments usually support more plants than hard sand or gravel areas. Exotic plants tend to favor soft sediments. Wind and wave action impacts plant growth.

Even the shape of the shoreline impacts plant growth. Interior bay areas of the shoreline collect sediments and debris, creating soft sediments that support abundant amounts of vegetation; while jutting shoreline areas tend to erode, sending their sediments into bays and depressional areas.

PLANT DESCRIPTIONS

Pondweeds

Pondweeds are important species of plants for a lake. Pondweeds do not grow as quickly or as dense as exotic species. They do not create a dense canopy like exotic species such as Eurasian watermilfoil. Pondweeds support food and provide cover for fish. Most pondweeds provide good to excellent food for waterfowl. Different species of pondweeds become important at different times of the year. Pondweeds support much greater populations of macroinvertebrates than exotic plant species such as Eurasian watermilfoil. Plant management on lakes should focus on protection and enhancement of the pondweeds, while controlling nuisance species.

The Wisconsin Legislature sought to protect native pondweeds in 1989 with the passage of NR107. That legislation names 12 aquatic plant species that should be protected and enhanced. The protected plants that are found in Lawrence Lake are flat-stem pondweed (*Potamogeton Richardsonii)*, white-stem pondweed (*P. praelongus)*, Illinois pondweed (P. Illinoensis), sago pondweed (*Stuckenia pectinata),* and horned pondweed *(Zannichellia palustris)*. Other high value species in Lawrence Lake include Fries pondweed (*P. friess), small pondweed (P. pusillis), P. oblongus, waterweed (Elodea canadensis),* and common water nymph (*Najas guadalupensis)*.

Curly-leaf Pondweed (*Potamogeton crispus*)

Curly-leaf pondweed is an exotic plant species. It gains an advantage over native plants by becoming established very early in the season. Curly-leaf pondweed tends to be more dominant in early summer, dying off in mid-July and August. Curly-leaf pondweed produces dormant structures called turions by the end of June and early July. The turions rest on the bottom until fall, when they begin to germinate and produce small plants. The fall growth over-winters in a green condition (Nichols and Shaw, 1990). In spring, when water temperatures and light intensities increase, Curly-leaf is ready to grow, out-competing other plants that must germinate from seeds or re-establish rootstocks. Curly-leaf reaches the peak of its life-cycle in June and July. Then it dies back in mid-July when other plants are beginning their peak growth periods. If curly-leaf pondweed dominates the plant community in a lake, the die-off can create algae blooms when the decaying plants release the nutrients. Curly-leaf pondweed provides a good food source for waterfowl, especially as an invertebrate substrate, which is also used by fish. Curly-leaf pondweed may provide good cover for fish as long as densities do not reach nuisance levels.

Curly-leaf pondweed is present in Lawrence Lake. Aside from chemical treatment, two of the most effective means of controlling curly-leaf pondweed is to protect the native plants and to prevent turion production on the curly-leaf plants. This would mean conducting plant management activities prior to the formation of the turions. Early season, low-dose chemical treatments is one option, harvesting the plants is another option. Exercise caution when determining which plant management technique should be used because native pondweeds may be impacted by some management techniques that target curly-leaf pondweed.

Eurasian Watermilfoil (*Myriophyllum spicatum*)

Eurasian watermilfoil is an exotic plant that quickly takes advantage of opportunities for growth. In many lakes it can become a severe nuisance, creating dense plants with large canopies on the surface that shade out other more desirable plant species. Fishing and boating is impaired or restricted and swimming becomes dangerous in the long, stringy plants. Eurasian watermilfoil can contribute to stunted panfish populations by providing too much protection from predator fish (WDNR, 1988). Eurasian watermilfoil stands have been found to support fewer macro invertebrates than comparable stands of pondweeds and wild celery (Smith and Barko, 1990). This in turn affects the fisheries that can be supported by the plants. Eurasian watermilfoil has been thought to spread primarily by fragmentation, however, there is now evidence that seeds play a much more important role than previously believed (Aron, 2002).

Eurasian watermilfoil is found in Lawrence Lake. Non-management of Eurasian watermilfoil may lead to a decline in the density and frequency of native plants and a loss of species diversity.

Muskgrass
Muskgrass (*Chara* sp.) is actually an algae, but is usually included in discussions of aquatic plant management. Muskgrass is low growing and can help prevent or reduce the growth of Eurasian watermilfoil. It can also protect lake sediments from the effects of boaters. Muskgrass will not thrive in lakes with high turbidity problems. Muskgrass is an excellent producer of fish food for large and small mouth bass (Fassett, 1985). Nitella (Nitella sp) is similar to muskgrass.

Muskgrass and nitella are present in Lawrence Lake and in most circumstances should be protected to help reduce infestations of other potential nuisances such as Eurasian watermilfoil. Muskgrass can be a problem for some lakes, becoming very dense with large mats lifting off the lakebed and up into the boating areas.

Coontail
Coontail (*Ceratophyllum demersum*) is a somewhat bushy plant that prefers soft sediments. The plants do not have a root system and float in the water column. The seeds and foliage are used by waterfowl as a source of food. Coontail also provides good spawning habitat and cover for young fish. Coontail provides a source of food either directly or by supporting fish food fauna. Coontail is able to draw nutrients from the water column. Coontail may grow to nuisance conditions. Coontail is occasionally mistaken for Eurasian watermilfoil.

Coontail is present in Lawrence Lake.

Sago Pondweed
Sago pondweed (*Stuckenia pectinata*, formerly known as *Potamogeton pectinatus*) is an excellent food source, and cover, for fish. Sago pondweed has narrow leaves that create an open structure, reducing the likelihood of becoming a nuisance. The plant has the ability to survive in low light conditions. Because of its value to wildlife, sago is often planted in ponds and shallow lakes.

Sago pondweed was is present in Lawrence Lake.

SURVEY METHODOLOGY

General Survey
A preliminary survey of the lake was made by boat. An attempt was made to locate all plant communities on the lake by region. Nomenclature follows Crow & Hellquist (2000). Plant samples were collected, preserved, and mounted. The maximum rooting depth on Lawrence Lake in 2004 was determined to be 14 feet, the maximum depth of the lake.

Line Transect Survey
The methodology for the line transect survey follows the protocol used by the WDNR Water Resources in the Ambient Lakes Monitoring Program. Transects were established

around the shoreline. Global positioning satellite (GPS) coordinates were obtained for each sampling point along the transects.

Twenty transects were established around the lake, Map 6. Actual samples points along each transect were located using a 2004 Garmin GPS LMS330 with an LGC-2000 Receiver. Four rake tows were conducted at each sample point. Each plant species retrieved was recorded and given a density rating in accordance with the WDNR criteria, between 1 and 5.

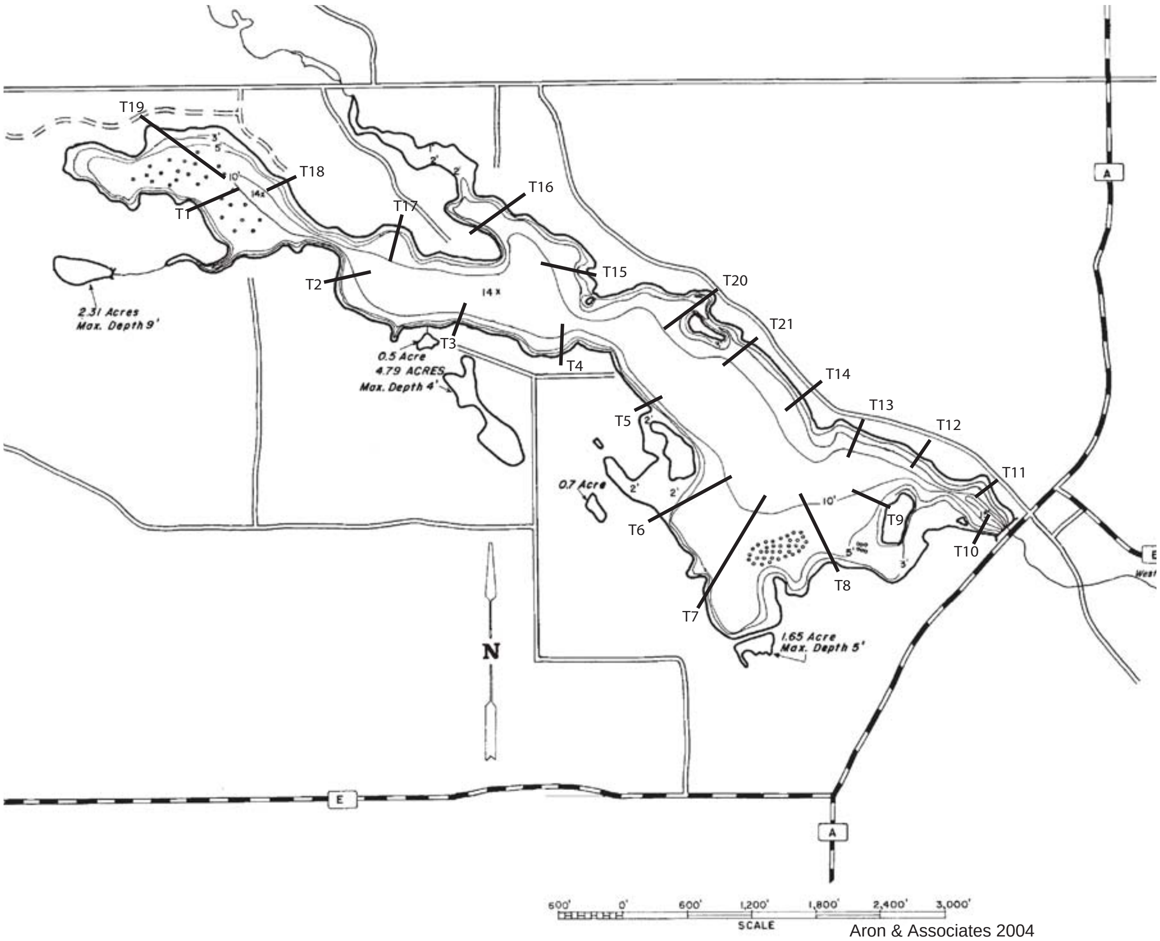


Figure 6 Transect Locations on Lawrence Lake, 2004

The data collected were then used to calculate the mean density and percent of frequency for each species. Lake depth at each sample point was determined by using the Garmin after calibration in the field. That data are provided at the end of this report.

The abundance of each species was determined using four estimates:

1) The frequency is the rating of how often a species occurs in the sample points.
2) The average density rating, or the average density of a species in the sample point where it occurred.
3) The relative density rating, or the average density of a species averaged over all sample points whether or not any species were present.
4) The relative density rating averaged over all sample points in which any species occurred.

LAWRENCE LAKE AQUATIC PLANTS - 2004

An aquatic plant survey was conducted by Aron & Associates the week of July 5, 2004. The aquatic macrophytes observed in Lawrence Lake during the survey are listed in Table 3. A total of 25 species were observed, two of which, yellow water lily (*Nuphar* sp.) and Nitella (*Nitella* sp.) were only found in the general survey. The aquatic macrophyte population of Lawrence Lake is dominated primarily by native plants: muskgrass, coontail, flat-stem pondweed, waterweed, and sago pondweed. The maximum rooting depth was determined to be 14 feet. The entire lake was available for aquatic plant growth in Lawrence Lake in 2004. Muskgrass, elodea, coontail, flat-stem pondweed, and sago pondweed dominated the plant populations at depths of seven feet or less. Muskgrass, sago, coontail, and flat-stem pondweeds dominated the deeper areas (7 to 14 feet) of the lake.

Figure 7 shows the areas on Lawrence Lake where Eurasian watermilfoil and curly-leaf pondweed have been located.

Other areas that have been problems for Lawrence Lake residents are shoreline areas with dense native aquatic plants, that limit access. Figure 8 shows those areas.

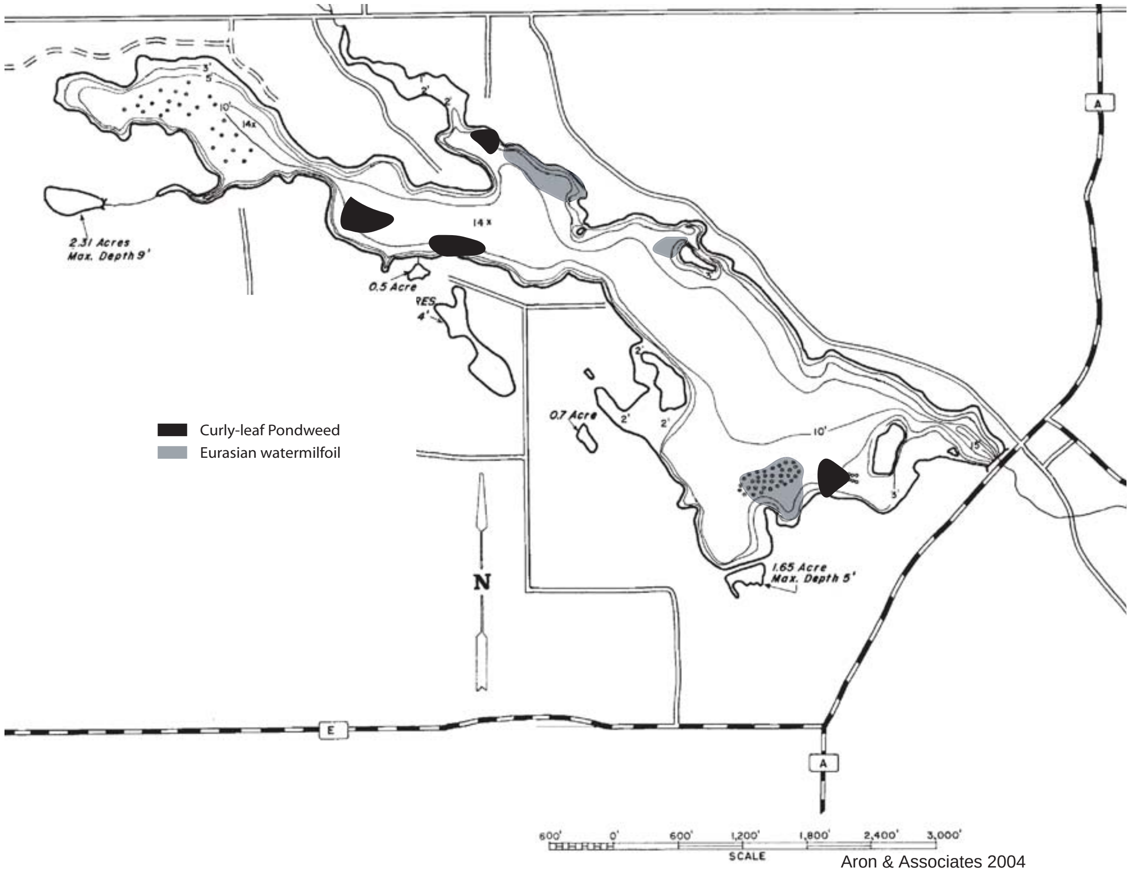


Figure 7 Areas of Lawrence Lake With Eurasian Watermilfoil and Curly-leaf Pondweed

During the general survey plants were inspected for signs of the "milfoil weevil" (*Euhrychiopsis lecontei*). Damaged, blackened stems, and stressed plants were not located. Random bucket tests of milfoil were also done, but no weevils were found. The “milfoil weevil” was not found in Lawrence Lake during the 2004 aquatic plant survey.

General Conclusions

- Lawrence Lake has good aquatic plant diversity.
- Eurasian watermilfoil and curly-leaf pondweed are problems in the lake.
- Current aquatic plant management activities appear they are barely able to manage the nuisance plant conditions.

Table 2 List of Plant Species in Lawrence Lake, 2004

Scientific Name	Common Name
Ceratophyllum demersum	Coontail
Chara sp.	Muskgrass
Elodea canadensis	Elodea
Lemna minor	Small Duckweed
Myriophyllum sibiricum	Northern Water Milfoil
Myriophyllum spicatum	Eurasian Water Milfoil
Najas guadalupensis	Common Water Nymph
Nitella sp.*	Nitella
Nuphar sp.*	Yellow Water Lily
Nymphaea sp.	White Water Lily
Polygonum amphibium	Smartweed
Potamogeton crispus	Curly-leaf Pondweed
P. friess	Fries Pondweed
P. Illinoensis	Illinois Pondweed
P. oblongus	
P. praelongus	White-stem Pondweed
P. pusillis	
P. Richardsonii	Richardsons Pondweed
P. zosterformis	Flat-stem Pondweed
Ranunculus longirostris	White Water Crowfoot
Stuckenia pectinata	Sago Pondweed
Utricularia vulgaris	Bladderwort
Wolffia sp.	Watermeal
Zannichellia palustris	Horned Pondweed
Zosterella dubia	Water Stargrass

*Found only during the general survey.

Chapter IV

PROBLEMS

Lawrence Lake is considered a quality water resource, however, its waters and sediments contain sufficient amounts of nutrients to promote aquatic plant and algae growth. Phosphorus and nitrogen have been determined to be the most critical components that drive aquatic plant growth. Phosphorus is likely that limiting nutrient in Lawrence Lake.

Dense plant beds clog boat motors and pier areas, impairing boat traffic. Dense weeds limit swimming along shorelines and create unsafe conditions for lake users. It also contributes to stunted panfish populations by reducing opportunities for grazing by predators. Additionally, the excessive plants mar the aesthetic value of a lake when surface weeds collect algae and debris and become odoriferous.

Plants in Lawrence Lake grow to the maximum depth of the lake. The fertile soils in the region contribute to the excessive plant problems in Lawrence Lake. Recreational use can also create problems in the lake, disrupting game fish spawning areas, suspending sediments, reducing water clarity, and negatively impacting the aquatic plant conditions.

Recent publications also point to the role of various lake-side living activities as a significant source of nutrients. Maintenance of golf course-type lawns, with high doses of fertilizers and pesticides are a big contributor of nutrients to lakes. A recent USGS publication, USGS Water-Resources Investigation Report 02-4130, cites a study conducted on Lauderdale Lakes in Walworth County. In that study, the quality of runoff from the use of no-phosphorus fertilized areas was nearly identical to that from non-fertilized areas, indicating the advantages of limiting phosphorus application. In addition, nitrogen also plays an important role in plant growth and should also be avoided. Other human activities that negatively impact water quality include the excess use of salt in winter, pet waste, and discharges from automobiles.

Recreational use, coupled with the dense plant beds contribute to plants cut by boats, known as floaters, that wash up on shorelines and re-root. Parts of plants broken by wind and wave action, or by motors (even electric ones), float around the lake, create shoreline debris, and reroot into new areas. Also, swimming perils can exist in long Eurasian watermilfoil and curly-leaf pondweed strands.

Excessive curly-leaf pondweed can contribute to poor water clarity and algal problems, when the plants begin to die off in early summer, releasing nutrients into the water column.

Eurasian watermilfoil and curly-leaf pondweed are the exotic plants species needing control on Lawrence Lake. Dense native plants, specifically waterweed and flat-stem pondweed, obstruct boating lanes, requiring control to maintain access.

It is important to remember that it is far cheaper to prevent a problem than it is to correct a problem. A cars' oil change costs only $20 but a new engine costs over $1000. The same holds true for lakes. Public information efforts to prevent problems and the cost of annual monitoring programs are much cheaper than major lake restoration projects. Stopping erosion and nutrients from entering the lake is much more cost effective than attempting to dredge or correct plant and algae problems.

Chapter V

HISTORICAL PLANT MANAGEMENT

In recent years, Lawrence Lake residents have used chemical treatment to control aquatic nuisances.

CHEMICAL TREATMENT

Chemical treatment conducted on Lawrence Lake for the past 4 years is shown in Table 3.

HARVESTING

No aquatic plant harvesting is conducted on Lawrence Lake.

Table 3 - Chemical Treatment on Lawrence Lake, 2001 - 2004

Year	Chemical	Amount Used	Target Plant	Acres Treated acres/depth
2001	Reward	13 gals	Milfoil	10.6 / 3-4
2001	Cutrine Plus	13 gals	Flat-stem pondweed	10.6 / 3-4
2001	Aquathol-K	15 gals	Naiad, Elodea	10.6 / 3-4
2002	Cutrine Plus	2 gals	Elodea	1 / 3-4
2002	Reward	2 gals	Elodea	1 / 3-4
2002	Cutrine Plus	1 gal	Chara	.25 / 3
2002	Weedar 64	40 gals	Milfoil	8 / 3.5
2002	Aquathol K	.5 gal	Pondweed	.25 / 3
2003	Weedar 64	18.75 gals	Milfoil, Coontail	3 / 3
2003	Aquathol K	1.5 gals	Pondweed	.3 / 2
2003	Cutrine Plus	2.5 gals	Elodea	1.2 / 5
2003	Reward	2.5 gals	Elodea	1.2 / 5
2004	Cutrine Plus	8.25 gals	Algae	5 / 3
2004	Aquathol K	2.75 gals	Pondweeds	1 / 3
2004	Reward	6 gals	Elodea	4 / 3
2004	Weedar 64	11 gals	Milfoil	2.7 / 3-5

Chapter VI

PLANT MANAGEMENT ALTERNATIVES

Control of exotic or nuisance plant species is an uphill battle. The very nature of all aquatic plant species survival provides the means to spread. For instance, wild celery can spread by releasing from the sediments and floating to new areas in late summer and fall. With exotic or nuisance plants, the growth and spread of the plants is more prolific. Fragmentation is important for Eurasian watermilfoil. It is now suspected that Eurasian watermilfoil can spread significantly through seeds as well as fragments (Aron, 2002). The recent documentation of hybrid species of milfoil confirms the importance of seeds in its reproduction. Curly-leaf pondweed spreads by creating turions from which new plants grow.

Realistic expectations are important in aquatic plant management. It is unlikely that exotic plants species can ever be completely removed from a lake. It is more likely that a combination of lake management techniques, along with public education, are most effective in minimizing the long-term impact of exotic plant species in a lake.

A discussion of a variety of plant management alternatives follows.

NO MANAGEMENT

Nuisance levels of aquatic plants can be left to do what they will with no active management from people. Under this alternative, it should be expected that Eurasian watermilfoil and curly-leaf pondweed will continue to expand their range in Lawrence Lake. While the firm, sandy shorelines will not see much Eurasian watermilfoil growth, the soft sediment portions of the lake will likely see expanded areas of Eurasian watermilfoil. The downside of this is that the more shading from Eurasian watermilfoil, the less light can reach the native understory, further increasing water temperatures and reducing the native plant community, allowing Eurasian watermilfoil even more opportunity for growth. Expanded areas of Eurasian watermilfoil may impact the fisheries, increasing the areas for small panfish to hide from predators. While the short term cost of the No Management option is nothing, the long term cost may be higher than if even minimal management occurred. Once seed beds are established, and the nuisance plants shade out the natives, it may take aggressive, costly activities to re-establish a balanced plant population.

***Conclusion*—**Although No Management of exotic species is technically feasible for Lawrence Lake, it should not be considered in the best, long term interest of the water resource. However, No Management of native species is in the best interest of Lawrence Lake.

DRAWDOWN

Drawdown can be used to control some plant growth. Use of this method entails dropping the lake X number of feet for a period of time. This exposes the plants to extreme temperatures, drying and freezing. Some plants respond very favorably to drawdown, while other plants react negatively, or unpredictably. The success of drawdowns for aquatic plant control depends upon the timing of the drawdown. The drawdown must begin early enough in the season to allow plants to germinate and to allow hibernating species to adapt and avoid freeze-out. Reaching the target elevation by October 1 is prefered, with refill occuring in late April. Eurasian water milfoil and coontail react unpredictably to drawdown (Nichols 1991). Locally, Big Muskego Lake was drawn down for a lake restoration plan. While Eurasian watermilfoil was reduced for a while, the plant returned to a level requiring aggressive management. Other lakes have had good success with extended drawdowns that thoroughly freeze the lakebed, especially those areas with soft sediments in shallow shoreline areas.

A source of water to refill the lake, and a means to draw the lake down, are also important considerations. Some valuable plants can be destroyed while more nuisance plants can be encouraged. Time is also a factor in drawdowns. Usually a lake is drawn down for 4 to 6 months and often needs to be repeated for maximum effectiveness. Drawdown also reduces the recreational opportunities on the lake. Timing of a drawdown can have a negative impact on fisheries if spawning areas are no longer accessible to fish. Turtles and frogs hibernate in shoreline muds and can also be affected by drawdowns.

Costs associated with drawdowns depend on the outlet control structure. Pumping to lower the lake requires costs for equipment, electricity and staff. Costs can be minimal if the lake can be lowered by opening a gate.

Conclusion— Because of the high recreational demands on the lake, because the exotic species are found throughout the lake (especially in the deep water areas), and because it is not effective for controlling milfoil, drawdown for the purpose of aquatic plant control on Lawrence Lake is not recommended.

NUTRIENT INACTIVATION

Nutrient inactivation is used to control the release of nutrients, primarily phosphorus, from the sediments. One of the most common substances used is aluminum sulfate, or alum. The alum treatment creates a floc formation covering the bottom sediments, preventing phosphorus from being released into the water. Nonpoint source pollution controls must be implemented prior to the use of alum, or the floc will be covered with newer nutrients.

This treatment will not prevent plant growth but will reduce problems from algae growth. Improved water clarity from an alum treatment may increase aquatic plant densities. Water chemistry information must be collected prior to use to ensure sufficient buffering exists to prevent acidification and aluminum toxicity. Waters deeper than five feet are usually treated with alum to prevent re-suspension of the alum. WDNR approval is required. Many of the areas with the existing nuisance conditions would not be treated with alum, so localized problems would not be corrected and in fact may be increased.

Conclusion—Little surface water quality data are available for Lawrence Lake. Lawrence Lake has only a small area near the dam that is weakly stratified. Considering the flow through the lake, and without additional water quality data, nutrient inactivation is not recommended at this time.

DREDGING FOR AQUATIC PLANT CONTROL

Dredging is most often used to increase depths for navigation in shallow waters, especially for channels, rivers, and harbors. Dredging for the sole purpose of plant control has met with mixed success. To be considered successful for aquatic plant control, dredging would need to bring the lake bed to depths beyond 15 feet deep, the maximum rooting depth in the lake. Eurasian watermilfoil prefers soft sediments. To minimize rapid re-infestation of the remaining sediments, dredging would need to be done to a hard pan layer. Dredging is the most costly form of plant management control. Costs range from $5.00 per cubic yard up to $20.00 or more per cubic yard depending on site conditions, method used and disposal costs. A WDNR permit is required.

The availability disposal sites often restrict the size and scope of dredging projects. Dredging projects have been discussed for specific areas of the lake.

Conclusion—Dredging for the purpose of aquatic plant control would not be considered a viable alternative for Lawrence Lake because of the very high cost, its considerable disruption to the aquatic environment, and the unlikelihood of being able to dredge below 13 feet in depth.

AERATION

Aeration entails installation, operation and maintenance of a system to artificially pump oxygen into the lake depths. Artificial aeration has been used to correct oxygen deficiency problems in lakes that produce numerous algae blooms and subsequent fish kills. Aeration is used when internal nutrient sources are high compared to external sources, if nuisance algae conditions exist, or if low oxygen levels are a problem. It is most useful on lakes with low dissolved oxygen levels and large internal releases of phosphorus.

Aeration is an expensive lake management technique. Initial capital costs for a lake this size is approximately $125,000 to $200,000 and an annual maintenance and operational cost of approximately $15,000. Problems may result with improperly sized aeration systems so initial planning and engineering must be done carefully to prevent creating greater problems. Annual operational problems and costs are difficult for small lake organization budgets and staff.

There has been no documented effect of aeration on plant growth. WDNR approval is required.

Conclusion—Unless Lawrence Lake shows depleted oxygen levels to be a problem, aeration should not be considered at this time.

SCREENS

Light screens are similar to window screens that are placed on the lake bottom to control plant growth. Screens come in rolls that are spread out along the bottom and anchored by stakes, rods, or other weights.

Screens create little environmental disturbance if confined to small areas that are not important fish or wildlife habitat. Although they are relatively easy to install over small areas, installation in deep water may require SCUBA. Screens must be removed each fall and reinstalled in spring. Care must be taken to use screens where sufficient water depth exists, reducing the opportunity for damage by outboard motors. Screens cost approximately $300 for a 700 sq. ft. roll. Screens may be used by individual home owners along their shorelines or piers to create swimming areas. A negative impact of using screens is that all plant species are affected by the installation of screens, even native plants. WDNR permit is required.

Conclusion—Screens may be a viable alternative for the limited applications by individual property owners to improve conditions in swimming areas, however, they are contradictory to the WDNR's stated goal of protecting native plants. They are not viable for use on Lawrence Lake.

BIOMANIPULATION

The use of biological controls for aquatic plant management purposes is currently limited to the grass carp and a few species of insects. Most of these controls are theoretically possible, however they have limited application. Non-native biological controls are risky: there are a number of instances where the solution caused new problems when a non-target organism was preferred. Biological controls also produce slower, less reliable, and less complete control than mechanical or chemical control activities.

Grass Carp (*Ctenopharyngodon idella* Val.) is an exotic species originally imported from Malaysia. It is considered to be a voracious eater of aquatic plants and prefers elodea, pondweeds and hydrilla. Studies have shown that Grass Carp can reduce or eliminate vegetation at low densities. Grass Carp generally will graze on more beneficial plants before going after Eurasian watermilfoil, thereby compounding nuisance problems. Overstocking can eliminate all plants. In the United States, only a few states allow the use of a sterile form of Grass Carp. Grass Carp are illegal in the State of Wisconsin and are not an option on Lawrence Lake.

In British Columbia, Canada, the larval stage of two aquatic insects, the caddisfly (*Triaenodes tarda* Milne.) and the chironomid larvae (*Cricotopus* sp.) have been observed to graze on Milfoil plants. These two insect species are currently being studied as forms of biological controls.

Recently, a naturally occurring fungus (*Mycoleptodiscus terredtris*) has been observed to effectively control a species of Milfoil in New Hampshire.

A weevil (*Eurhychiopsis lecontei*) has been found to help control Eurasian watermilfoil in some lakes in Wisconsin and Illinois. The weevil does major damage to the milfoil plant as it is closely associated with it during its entire life cycle. The adult female lays eggs on the tips of the milfoil. When the larvae hatch, they feed in the growing tips and then burrow into the stem. Pupation (when the larvae changes to an adult) occurs in the stem. In fall, adult weevils burrow into the shoreline litter and remain until spring. Weevils mature from egg to adult within 30 days and reproduce from May through September. Lakes with intensive management using harvesters or chemicals are less likely to support good populations of the weevil. Weevils do not usually like other plants so it does not affect other plant species. Weevils are now available commercially. Although the weevils can dramatically impact milfoil beds, it may not be enough to control the nuisance. In Wind Lake in Racine County, the milfoil beds frequently reach the surface by mid-June, but the weevils' life-cycle on the lake does not begin to drop the milfoil until the beginning of July. This time lag can negatively affect the riparians acceptance of the weevil as a management technique.

Other efforts to introduce the weevil into new lakes has not been successful enough to justify the expense of the weevils ($1.00 per weevil). Additional research is needed before many of the biomanipulation techniques can be commonly implemented in lake management. Of greatest importance is the need to establish whether a given biological control organism will not become a nuisance itself.

***Conclusion*—**Neither the Grass Carp, insects, nor fungus are viable alternatives for Lawrence Lake. No signs of the weevils were found during a 2004 survey. Because Eurasian watermilfoil is not a primary plant species in Lawrence Lake, stocking the weevils is not recommended.

NATIVE SPECIES REINTRODUCTION-SHORELINE EDGES AND ADJACENT UPLANDS

Native plants are being re-introduced into lakes to try to diminish the spread of exotics and to try to reduce the need for other, more costly, plant management tools. Native plants are usually less of a management problem because they tend to grow in less dense populations and are more often low-growing. Native plants also provide better food and habitat for fish and wildlife.

Careful consideration of the species introduced needs to be given to avoid creating another problem.

Native species re-introduction or expansion has very limited application as a plant management alternative for Lawrence Lake. Small, isolated destruction or removal of Eurasian watermilfoil beds could be combined with planting or transplanting Chara, water lilies or a number of different pondweeds. The planting of native emergent plant species such as bulrushes and associated upland plantings along developed shorelines could be considered in areas where there are none. The emergent plant species would provide a buffer zone between the water and shoreline thereby reducing the effects of wave action upon the shore, and erosion. The emergent plants would also provide important habitat for fish and macro invertebrates as well as increase the aesthetic value of Lawrence Lake. Emergent plants should blend into shoreline buffer zones to further enhance their environmental value.

Costs to conduct plantings vary with the number and type of plants, and whether volunteers or paid staff do the work. Successful plantings can be affected by a number of factors, including health of the new plants, weather, timing, bottom substrate, water clarity, and waterfowl grazing. The WDNR should be consulted before conducting any planting activities to ensure the protection of the resource, the necessity for a permit, and the likelihood of success.

Conclusion—Shoreline plantings and upland restoration may be considered by the District or individual landowners. Landowners with lawns to the shoreline should be encouraged to allow the upland shoreline edge to re-vegetate into a stable buffer zone. This could be done as simply as not mowing. This, along with supplemental plantings of native upland plants, would provide habitat for birds, turtles, frogs, and other wildlife, while helping to filter out nutrients and sediments. This will indirectly help with the in-lake nuisance aquatic plants by reducing the nutrients in the lake used by the plants, and by creating a more stable near-shore area. Natural shoreline vegetation also provides a natural barrier that Canadian geese avoid. Although an established buffer will require less work than a lawn, there will be maintenance required. This may include cutting, mowing, or elimination of exotic species such as purple loosestrife. Landowners should consult with a professional to determine specific maintenance requirements and scheduling for their shoreline buffers. Permits will be needed for aquatic plantings and the County should be consulted for the need for upland restoration permits.

HAND CONTROLS

A method of aquatic plant control on a small scale is hand or manual control. These can consist of hand pulling or raking plants. A rake with a rope attached is thrown out into the water and dragged back into shore. Plants are then removed and disposed of. Skimmers or nets can be used to scrape filamentous algae or duckweed off the lake surface. These methods are more labor intensive and should be used by individuals to deal with localized plant problems such as those found around individual piers and swimming areas. Hand controls are very inexpensive when compared to other techniques. Various rakes and cutters are available for under $100. However, hand control is labor intensive and cutters pose risks to users because of their extreme sharpness.

NR 109 allows riparian landowners to remove Eurasian watermilfoil and curly-leaf pondweed plants within their “riparian zone” without permit. Residents may remove plants in a single area that is not more than 30 feet wide, including any swimming and pier areas, as long as the area is not a WDNR Sensitive Area. It is illegal to remove native plants outside the 30-foot wide area without a permit.

Conclusion—Hand controls may be used by individual landowners to clear swimming areas. Landowners should be encouraged to be selective in their clearing, again focusing on Eurasian watermilfoil or curly-leaf pondweed. Landowners should maintain a natural area of vegetation both on their shoreline and in the water. The District may consider acquiring some rakes and cutters to loan out to property owners.

Riparian landowners may remove Eurasian watermilfoil and curly-leaf pondweed plants within their “riparian zone” without permit. Residents may remove plants in a single area that is not more than 30 feet wide, including any swimming and pier areas, as long as the area is not a WDNR Sensitive Area. However, because of the ease with which Eurasian watermilfoil spreads, landowners should not attempt to remove native plants. Doing so will create a far worse condition when Eurasian watermilfoil fills the void created by removing the native plants. Consult WDNR regarding any permits needed for removal of plants.

CHEMICAL TREATMENT

Chemical treatment for the control of aquatic plants is one of the more controversial methods of aquatic plant control. Debate over the toxicity and long term effects of chemicals continues in many communities. A WDNR permit is required prior to any chemical treatment.

With chemical treatments, the plant material impacted by the treatment dies and contributes to the sediment accumulation on the lake bed. When treated, the decaying process of the plants uses oxygen. Depending on the chemical used, if too much plant material is treated at once, oxygen depletion may occur, stressing or killing fish.

Identification of the target species is very important. Different chemicals should be used for different plant species. Dosage also affects the results. Too little chemical may stunt growth but not kill the plant. Too much chemical may negatively impact fish, amphibians, or invertebrates. If native plant communities are destroyed by chemicals, the areas may be invaded by exotic plants such as Eurasian watermilfoil and curly-leaf pondweed. The formulation of the chemical, whether liquid or granular, is a factor to consider. Another factor to consider is the contact period the chemical would have with the vegetation.

Chemical treatment has the advantage of being more selective than harvesting. Chemical treatment may also be more appropriate in some situations, especially where mono-typic stands of exotics exist in shallow water where harvesters cannot work, such as in marina areas. It may also be the method of choice to treat early infestations of Eurasian watermilfoil when hand-pulling cannot be used. Another advantage of the use of chemical control is that it is economical and very effective.

Modern herbicides have been tested extensively to be sure they can be used safely. Tests include determining toxicity levels to be sure that humans, animals and fish are not affected. Test results must also show that the herbicides do not bioaccumulate in fish or other organisms and that their persistence in the environment is low. Product labels contain the requirements for use. Material safety data sheets are available for all herbicides approved for use in Wisconsin. Chemicals must be used according to the approved use applications listed on the labels. Application rates, as well as any use restrictions, are indicated on the product labels. Licensed applicators must follow the label requirements.

Shoreline treatments will likely need to be repeated at least annually. A single season shoreline treatment will not permanently eliminate the nuisance. Unless the entire lake is treated, invasive plant material will quickly re-enter the area. Whole-lake treatments have been successfully used to eliminate Eurasian watermilfoil from a lake for at least three years. Whole-lake treatments have also been used to dramatically reduce curly-leaf pondweed problems. Whole-lake treatments are not however, appropriate for all lakes. Lakes with short hydraulic residence times are poor candidates, as are lakes with a large variety of native plants that are susceptible to fluridone.

Although “mail order” chemicals can be purchased, their use is strongly discouraged and cannot be used without a permit from WDNR. They may be completely ineffective if they are used to try to treat the wrong plant species. Unregulated, uneducated use may result in overuse of a chemical and cause damage to the “good” weeds, fish and wildlife, and humans.

Prior to any chemical treatment, a permit is required from WDNR. Only Wisconsin and EPA approved herbicides may be used, following all label directions and restrictions. In most situations, herbicides may only be applied by applicators certified in aquatic application by the Wisconsin Department of Agriculture, Trade, and Consumer Protection. Proper handling and application techniques must be followed, including those to protect the applicators. All applications must comply with current laws in the State of Wisconsin.

Systemic Herbicides — Systemic herbicides are translocated throughout the entire plant, including the roots. Examples of systemic herbicides are 2,4-D, Fluridone, and trichlopyr. 2,4-D and trichlopyr are used to control Eurasian watermilfoil in localized areas. Fluridone is primarily used to control Eurasian watermilfoil in whole-lake, or large area situations.

Contact Herbicides — Contact herbicides kill the exposed portions of the plant that they come into contact with. They are not translocated to roots and will only rarely kill entire plants. Herbicides with the active ingredients of diquat and endothall are common contact herbicides. Contact herbicides are frequently used to provides short-term nuisance relief.

Copper Compounds — Copper sulfate is used for the control of algae. Cutrine Plus is an herbicide that uses copper as its active ingredient. This is used to control various types of algae. Although it can sometimes control Chara (also known as muskgrass), a more desirable algae, it is more commonly used to control filamentous, green and blue-green algae. Liquid formulations, especially the chopper chelated products (those combined with other compounds that help prevent the loss of active copper from the water) are more effective. These tend to remain in solution longer, allowing more contact time between soluble copper and the algae cells.

Aquathol — Super K is a formulation containing the active ingredient endothall. This is a contact herbicide that prevents certain plants from producing needed proteins for growth. It is used to control certain pondweeds, coontail, and Eurasian watermilfoil. The timing of an application affects what plants are impacted.

Reward — Reward, previously known as Diquat, is a non-selective contact herbicide that is used to control a wide variety of plants. It is absorbed by plants and damages cell tissues. Reward kills the parts of the plants that it comes into contact with directly. Reward loses its effectiveness in muddy, silt-laden waters. If too much plant material is killed in an area, the decomposing vegetation may result in very low oxygen levels that may be harmful or fatal to fish. Areas that are treated with Reward cannot be used for activities requiring full or partial body contact for at least 24 hours after treatment. Animal consumption, irrigation, and other domestic uses require waiting at least 14 days after treatment. Reward works quickly, with results usually seen in 6 to 10 days.

2,4-D (2,4-dichlorophenoxyacetic acid) — 2,4-D is a systemic herbicide which interferes with normal cell growth and division. Plants begin to die within a few days of liquid formulation treatments, and within a week to 10 days when granular formulations are used. The aquatic formulations of 2,4-D are only effective on certain species of aquatic plants. It is most commonly used to treat Eurasian watermilfoil. The timing and the dosage rate of an application is important to avoid impacting native plant species. Because it also impacts several desirable species including bladderwort, water lilies, and watershield, care should be taken to ensure that only the target nuisance plant species are present before treatment or that the dosage is low enough to protect natives.

Fluridone — Fluridone is an herbicide that inhibits the plant's ability to make food. Without that ability, the plant dies. The visual symptom of the effects of fluridone is bleaching of the terminal buds, or growing points, on the plant. This herbicide takes at least 30 to 45 days of contact time to kill the plant. This prevents problems with low dissolved oxygen in treated areas. Fluridone is rapidly diluted and best used in larger treatment areas, generally 5 acres or more in size, preferably on a whole-lake basis. Prior to treatment there should be good flow data for the proposed treatment area. Rates of inflow, outflows, and ground water sources should be known prior to treatment. Without this information, applied material can be quickly flushed from a system or rendered ineffective. Fluridone can be used for a range of plant control, from species specific control to general control. Fluridone achieves its selectivity by the use of varying dosages. High treatment dosages control a wide variety of aquatic plants, while low dosages maintained over long periods of time have been used to control Eurasian watermilfoil with minimal impact on native plants.

Trichlopyr — Trichlopyr is a newly-approved herbicide which kills the entire plant, and is effective at treating Eurasian watermilfoil. Trichlopyr is more suited to moving water applications than slow-acting herbicides such as fluridone.

Conclusion— Chemical treatment may be conducted on Lawrence Lake. Treatments may be undertaken by individuals or the district. Native aquatic plant beds should not be chemically treated without a thorough review of the existing conditions. Changing plant conditions that create new shoreline nuisances may warrant chemical treatment of exotics.

- Lawrence Lake is not a good candidate for a whole-lake treatment.
- Eurasian watermilfoil and curly-leaf pondweed should be treated with the appropriate herbicides. Chemical treatment of the remaining plant communities should be limited to providing navigational access. It should be remembered that destruction of any native plant species populations will increase potential problems from the spread of Eurasian watermilfoil.
- Treatments should be planned to treat early in the season to eliminate the nuisance with the least amount of herbicide and before the native plants have been impacted by dense growths of nuisance plants.
- Proposed chemical treatments should be developed based on the current nuisance conditions.
- When conducted, curly-leaf pondweed treatments should be planned to try to prevent the production of turions, an important method of reproduction for the plant. These treatments would allow native plants a better opportunity for growth in the area.

HARVESTING

Harvesting is another lake management tool that is frequently used to control aquatic plants. Plants are cut off about five feet below the surface and conveyed to shore where they are then trucked to a disposal site. Harvesting aquatic plants removes biomass from the lake as well as nutrients. In the past, the presumption was that eventually plant growth in a lake with harvesting would cease to be a problem when nutrients have been removed. However, a lack of plant growth after harvesting will not normally be seen because incoming nutrients from the watershed will usually offset any nutrients removed during harvesting (Engel, 1990). The remaining plant material, that material below the cutting depth, will continue its life cycle. The decomposing material will contribute to the sedimentation in the lake, however, wind and wave action will move the material into deposition zones: usually the deep hole.

Harvesting should only be done in waters deeper than three feet. Harvesting should not be done in shallower areas because it will increase damage to the equipment, will disrupt bottom sediments and plants, and will open up lake sediments to invasion by exotic plant species.

Shoreline pickup programs can help control floating plant material (floaters) and plant debris, however, they are labor, and time intensive. They are very difficult to eliminate once the residents are used to the pickups. Debris that includes rocks, sticks, gravel, or other such material will damage the equipment. When plant debris is on shore, the equipment must go up to shore to retrieve it, disrupting the sediments and rooted plants in the process. Harvesters are very large pieces of equipment that are highly susceptible to wind and waves, and are difficult to maneuver. This increases the chances for damage to riparians' piers and boats. If a shoreline pickup program continues to be used, plant debris should be placed on the ends of piers whenever possible.

Harvesting of fish lanes can open up areas so game fish can feed upon panfish. It also helps increase the size of panfish that remain, and can increase the size of the predator fish (Nichols, 1988).

Harvesting can reduce the recreational boating's impact on aquatic plants by opening navigation lanes and lessening the amount of plants that are cut off by boating activities.

Recreational use in dense milfoil beds, winds, and waves can create large amounts of “floaters" that can increase the spread of milfoil. Collection of the floaters as part of a harvesting program can help minimize the spread of the nuisance. Plant fragments that are not removed from a lake can settle into new areas and spread the problem. This creates a greater problem on lakes which do not conduct chemical shoreline treatments for Eurasian watermilfoil.

Harvesting can also cause problems if it is not done properly. Machines that are not properly maintained can discharge gas, oils and grease into lakes. Cutting too close to shore or into the bottom sediments can disrupt fish spawning and nursery areas. The sediments are also very damaging to the harvesting equipment and will increase maintenance costs significantly. Attempting to operate the equipment in shallow water (less than three feet deep) will disrupt the sediments and aquatic plants.

Harvesting is non-selective, that is, it harvests all plants in its path. Areas with native plants should be avoided whenever possible. In an area with a mix of plant species, including Eurasian watermilfoil, harvesting favors the species that grow quickly. Because this is usually Eurasian watermilfoil, it leads to re-harvesting areas often over the summer season. Harvesting also removes fish, turtles and invertebrates.

In a mixed plant bed with both Eurasian watermilfoil and natives, cutting above the native plants will open up more sunlight to the understory, will encourage the native plant growth, and will remove any flowering portions of the Eurasian watermilfoil.

Because of the increasing concern of the role seeds play in the spread of Eurasian watermilfoil, areas dominated by Eurasian watermilfoil should be harvested early enough to prevent seed development.

Harvesting is a very costly management alternative. Purchase of equipment can exceed $120,000 in capital costs. State grants are eligible to lakes which harvest a minimum of 30 acres, and have adequate public access.

Conclusion—Harvesting on Lawrence Lake would be a costly management tool. It has limited application because of the diverse, dominant native plant community. Harvesting should not be used to control Eurasian watermilfoil because of fragmentation and flows in the lake. Harvesting may have limited applications for harvesting native plants, only to provide navigational access.

LOCAL ORDINANCES AND USE RESTRICTIONS

Lake use ordinances have long been used to control activities on lakes. Local communities may adopt ordinances to protect public health, safety and welfare. Any proposed ordinances are sent to the DNR for review to be sure they comply with State Statutes. Ordinances must address issues that threaten public health, safety and welfare. Once approved by DNR, communities may then finalize and enforce the ordinances.

Historically, public health, safety and welfare was interpreted to mean peoples' physical issues associated with using the lake. Speeding and reckless use endanger lives and are usually controlled through local ordinances.

Recently there has been a growing realization that the lake's health has a bearing on public welfare. Lake use activities conducted in inappropriate areas of lakes can be very damaging to the lake ecosystem. Spawning habitat can be destroyed. Wildlife can be chased away. Aquatic plant communities can be disrupted, shifting the communities to plants less beneficial than the original.

With the state's acceptance of the environmental health premise, communities are looking at lake use zoning. Some have shoreline zones that are no slow wake. Others have restricted some or all of the lake to no-motors. Protection of specific species or valuable areas can be achieved by developing an ordinance to minimize intrusions.

Costs associated with ordinance development depends upon the problem, potential solutions, municipal cooperation, and municipal legal reviews. Grants are available through the WDNR to assist with the cost of developing ordinances.

It is important to keep in mind the following in the development of ordinances:

- Any proposed ordinance must have prior review by the WDNR.
- An ordinance must not discriminate on a particular craft, ie, if motors damage an area, all motors should be restricted not just ski boats.
- An ordinance must be clearly understood and posted. Buoys (which must also be approved by the DNR) should warn boaters of areas to avoid.
- Any ordinance should address a particular problem. If boating damages a sensitive area of the lake, allowing boats in the area on alternating days does not achieve the protection sought.
- An ordinance must be reasonable and realistic. An ordinance that creates a slow no wake zone that affects all of the lake area less than three feet deep may not be enforceable. The general public could not know the extent of that area. A more reasonable approach would be to review the desired area and develop a plan based on a specific distance from shore. Buoys could then be used to identify that area.
- Any proposed ordinance should be studied to ensure that it does not aggravate a different problem. For example, many communities have shoreline slow no wake zones that exceed that of state law. On a small lake, enlarging that shoreline zone may provide more resource protection. It may also further concentrate other lake use activities such as skiing into an area too small to be safe.
- Any attempts to restrict lake use should be weighed along with the social and economic impacts. It is well documented that those most involved with lakes and lake protection are those same people who spend the most time on or around lakes. They either live on or have easy access to a lake. It is very difficult to convince outsiders that lake quality is a concern or that funds should be spent because they do not have a personal involvement. They have other priorities. Reducing public use of a lake will have a direct affect on their involvement and possibly their social and economic concern about a lake.
- Lake ordinances should be developed to protect health or safety, not to restrict a specific user group.
- Ordinances should reference, not duplicate state laws.

Conclusion—Lake use ordinances may be considered for Lawrence Lake, however, they should be carefully developed and studied to ensure that they address the problems without undue restrictions and that they will actually be enforced.

Chapter VII

PLANT MANAGEMENT PLAN

GOALS AND OBJECTIVES

The goals of the District, that is, broad statements of long range desires, are outlined below. The goals are followed by objectives to be used to accomplish each of the goals.

The District's goal is to optimize the preservation of aquatic systems that includes water quality, fisheries, and wildlife while minimizing the conditions resulting from aquatic nuisances and to preserve and maintain recreational uses of Lawrence Lake. To achieve the goal, the development of this plan is one component of an effort that has included water quality monitoring, community surveys, aquatic vegetation surveys, wetland inventories, shoreline stabilization, educational lake fairs, and watershed improvement activities.

The District desires to:

- Restore native plant communities.
  - —Encouraging landowners to protect native species.
  - —Use chemical treatments in shoreline areas if needed.
  - —Minimize fragments of aquatic plants.
  - —Aggressively respond to re-infestations of exotic species.
- Preserve and enhance the natural lake environment by:
  - —Educating landowners and lake users in lake ecology.
- Work with the Town, County and State governments to:
  - —Continue to improve the watershed to protect Lawrence Lake.
  - —Identify and expand local educational efforts to improve the public's understanding of lake issues
  - —Encouraging community participation in lake management activities.
  - —Participate in the newly formed Montello River Watershed Task Force.
- Conduct in-lake management activities with the long-range goal of minimizing management to the extent possible by:
  - —Conducting year-end evaluations as to the success of plant management activities and the community reaction to the activities.
  - —Tracking annual progress of lake management activities.
  - —Conduct water quality monitoring efforts to assist in the documentation of results.

RECOMMENDATIONS

All management activities should focus on minimizing the activities needed over the long haul. This may mean short-term inconveniences, but long-term success.

Chemical Treatment

- The District may continue to use chemicals to control nuisance plants in the shoreline areas. Treatments should minimize the effects on non-target plants. Care should be taken to avoid treating too much plant material at a time. Earlier, rather than later season treatments will accomplish this. Waiting until there are high densities to treat could place undue stress on the fish community by reducing oxygen concentrations post-treatment.
- Target species for chemical treatment include: Eurasian watermilfoil and curly-leaf pondweed. Curly-leaf pondweed treatments should be conducted very early in the season.
- Native treatments should be conducted only to provide navigational access.

WDNR Administrative Rule NR 107 should be consulted for the specific requirements for conducting a treatment. The following are some of the steps that should be followed by the District when preparing to conduct chemical treatments.

- Complete and submit the WDNR permit application forms. Include treatment map, area sizes and name and addresses of all affected riparian landowners.
- Contact a licensed firm to coordinate proposed treatment.
- When treatment areas will be greater than 10 acres, a public notice should be placed in the local paper informing the public about the proposed treatment. This will also inform those who may be using the public beaches.
- Provide a copy of the WDNR application to any riparian landowner who is adjacent to the proposed treatment areas. This may be done by newsletter, or box drops.
- At the time of treatment, WDNR-approved yellow posting signs must be posted in and adjacent to treatment areas, at least every 300 feet. The signs must indicate what chemical has been used, and any use restrictions and must remain posted for at least the time of any restrictions.
- Current administrative codes should be reviewed annually to ensure compliance.

Hand Controls

Riparians should be encouraged to use the least intensive method to remove nuisance vegetation. This could include minimal raking and pulling. NR109 allows landowners to remove plants from an area up to 30 feet wide without a permit. The 30-foot area includes the swimming and pier areas. Landowners may remove Eurasian watermilfoil and curly-leaf pondweed from the remainder of their shorelines without a permit. Removal of native plants beyond that allowed in the 30-foot area, will require a WDNR permit. If screens are considered by individuals, a WDNR permit will be required.

Riparians should be encouraged to allow native plants to remain. This will help prevent infestation of the areas by Eurasian watermilfoil or curly-leaf pondweed. The native plants will also help stabilize the sediments.

The District should encourage landowners to use hand controls to manage the aquatic nuisances. Small swimming areas can be manually cleared without damaging the resource. The District may wish to consider acquiring rakes and cutters to loan to lake residents. Another idea the District may consider is to match energetic teens seeking summer help with those physically unable to do hand clearing.

The District should inform landowners about the importance of keeping their shorelines free of floating plant debris. Wave action can carry plant fragments into new areas, possibly aggravating nuisance conditions. Plant debris can be used in mulch piles or gardens.

Education and Information

The District should take steps to educate property owners regarding their activities and how they may affect the plant community in Lawrence Lake. Informational material should be distributed regularly to residents, landowners, and lake users and local government officials. A newsletter to landowners and residents should be part of the annual plant management budget. Topics should include information relating to lake use impacts, importance and value of aquatic plants, land use impacts, etc. Information on shoreline restoration and plantings can be provided. Publications are available that list sources of plants and methods of creating buffers. Other issues that should be addressed may include landscape practices, fertilizer use, and erosion control. Existing materials are available through the WDNR and the UWEX. Other materials should be developed as needed.

The District should also enlist the participation of the local schools. The schools could use Lawrence Lake as the base for their environmental education programs. Some schools have a mandatory community service requirement that may be tapped to assist with lake management activities. Regular communication with residents will improve their understanding of the lake ecosystem and should lead to long term protection.

The District should inform residents about the lake management activities that are undertaken and the reasons behind the activities.

Water Quality Monitoring

The District should begin a water quality monitoring program on Lawrence Lake. At a minimum, a volunteer monitor should also collect secchi disk readings at least every two weeks. Ideally, the District would participate in the US Geological Survey water quality program, or similar program to determine the nutrient concentrations in Lawrence Lake.

Watershed Controls

The District should work to improve the quality of water runoff into Lawrence Lake, especially with the redevelopment of residential areas. All areas of the watershed should be toured regularly for identification of new problems.

The District should work with the Town officials to encourage rigid enforcement of erosion control in the watershed and consideration of lake-friendly methods of development and road construction. The District should participate in the Montello River Watershed Task Force.

Land Use Planning

The District should take an active role in land use planning decisions in the Town. Development proposals should be analyzed with the lake in mind and revised if necessary to protect the lake from damaging runoff. Long range planning should also involve the District to ensure that future development includes lake protection.

Storm Water Planning

The District should review any new development proposals to ensure that the lake will not be damaged by changes in flows or quality of stormwater. The District may consider applying for grants to assist with land use and storm water planning. The District may assist the County and Town to develop and implement storm water ordinances. Residents should consider the use of phosphorus-free or no phosphorus fertilizers. It is preferable to avoid the use of all fertilizers because of the impact of nitrogen on the growth of some plants. Some communities are considering fertilizer restrictions to protect their lakes.

Ordinances

The District may consider the development of ordinances, working with the Town to implements and enforce. It should be noted that passing an ordinance does not in and of itself, correct a problem. Enforcement is a key component of any ordinance development.

Contingency Plans

The District should be prepared for changing aquatic plant conditions that may fall outside the recommendations in this Plant Management Plan. While the final determination will be permitted by WDNR, developing local consensus on possible solutions is often needed. In evaluating whether to treat or harvest a “new” nuisance condition, the following should be considered:

- ***Are the plants native or exotic species?***

  If unsure, consult WDNR or an aquatic plant specialist to determine the species.

- ***Is the area in shallow or deep water?***

  This quickly limits some of the options. Harvesting, for instance, cannot be used in water less than 3 feet deep.

- ***Is the condition impeding or preventing recreational use, or is something else a factor?***

  Access channels may be created either by harvesting or chemical treatment. However, if water depth prevents access during a drought, chemical treatment will not open up boating access. In this instance chemical treatment may eliminate a filamentous algae that is causing odor problems.

- ***Is the situation creating unsafe conditions?***

  Dense, stringy weeds in a beach area, for instance, could create dangerous conditions for young swimmers.

- ***Will the considered option improve the situation long term, short term, or both?***

  The short term solution may eliminate the problem this summer, but make it worse in future years, while the long term solution may be the best over the long haul.

- ***Is the considered option detrimental to fish, wildlife, or humans?***

  If it is, maybe there are other options to solve the problem that would be safer.

- ***Will the considered option increase invasion by other nuisance species?***

  Consider whether the option will create “bare” lakebed that will quickly be invaded by weedy species, or whether the option will protect desirable vegetation while removing the nuisance.

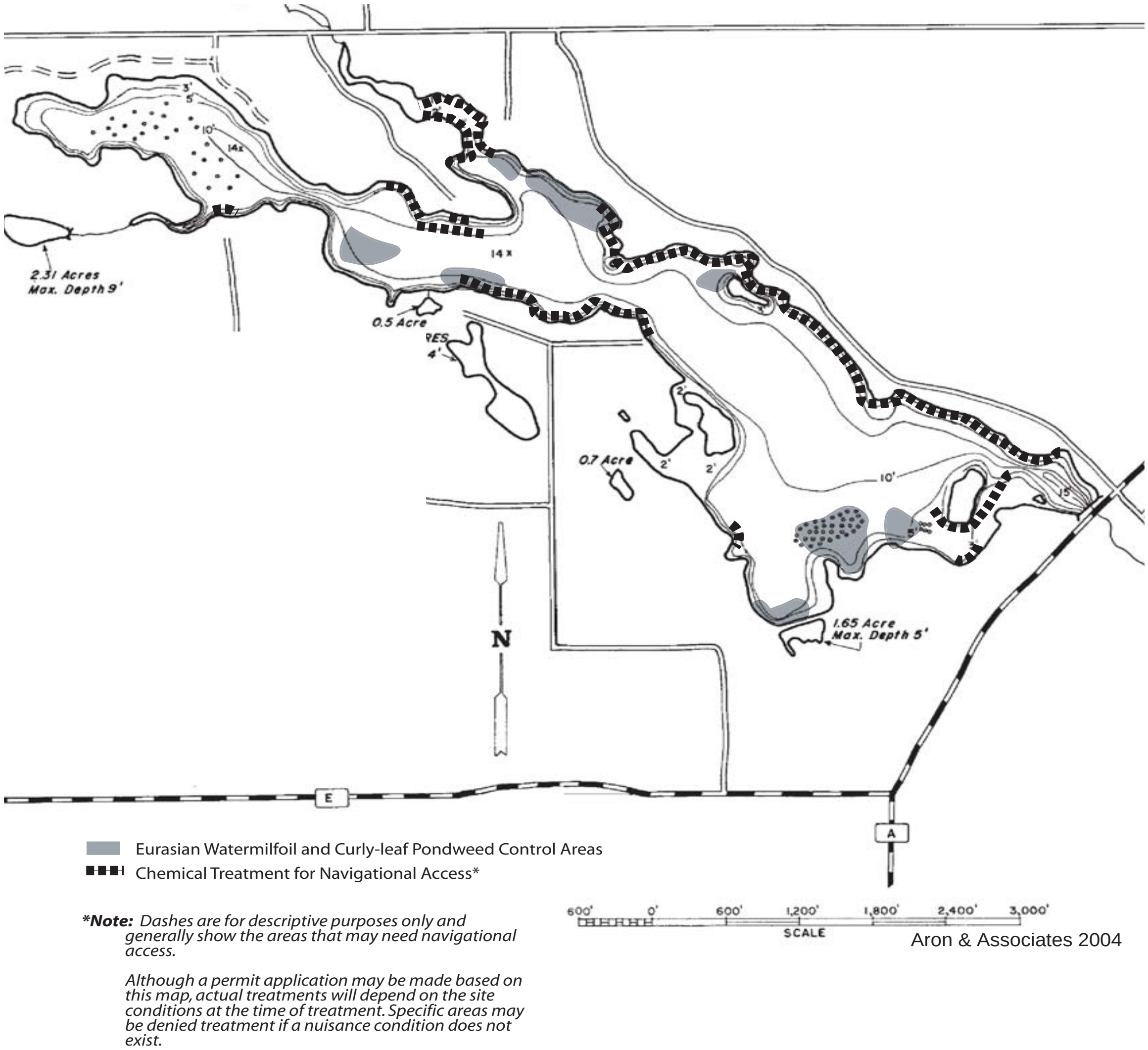


Figure 8 Aquatic Plant Management Plan, Lawrence Lake, 2004

Chapter VIII

FUNDING

The District taxing authority provides funds to conduct management activities, including any cost-shared requirements of a state grant.

The District may seek funds to assist with the aquatic plant management. Sources of funding and their uses are shown in Table 4. Check with WDNR to determine grant applicability of potential projects.

Table 4 Funding Sources for Aquatic Plant Management

Grant Program	Potential Uses	Percent Available
Wisconsin Waterways Commission	Eurasian watermilfoil treatment, non-riparian	50%
Aquatic Invasive Species Grant	Exotic species prevention and removal projects	50%
Lake Planning Grants	Plant Plans, Whole-lake treatment plans	75%
Wisconsin Waterways Commission	Harvesting equipment	50%

Chapter IX

PLAN EVALUATION AND REASSESSMENT

This plant management plan provides options for plant management from which the community may select to accomplish their goals.

Future evaluation of the effectiveness of this plant management plan and the subsequent implementation efforts undertaken by the District, should be based on whether the lake is in "better condition" from an aquatic plant nuisance situation:

- Have native aquatic plants increased in densities and diversity;
- Have nuisance species decreased in densities and coverage;
- Has water quality improved;
- Does the general public, and more specifically, do the District residents, have a better understanding of the lake, its environment, and the impacts on the resource;
- Do the District residents support the plant management activities of the District;
- Has the District been able to prevent exotic species invasions;
- Are there ongoing public education efforts such as newsletters, websites, public meetings, etc; and are they being used by the public.

The District should quantitatively review or contract to review, the plant populations of Lawrence Lake every three to five years. This will provide necessary data that can be used to document the success of management activities that are undertaken.

A summary of the past years management activities should be developed annually to facilitate comprehensive review of the entire program and effectiveness. The District should then review the Plant Management Plan every three to five years to ensure its appropriateness to the changing conditions.

Chapter X

SUMMARY

General

- The management of aquatic plants on Lawrence Lake should focus on management of nuisance species.
- The District should work with landowners' to encourage protection of natural shorelines and emergent plant species such as sedges and rushes and floating leaf species like waterlilies.
- The District should provide landowners with information on erosion control.
- The District should conduct a quantitative aquatic plant survey and plant management plan reassessment every 3 to 5 years.

Chemical Treatment

- The District may elect to use chemical treatment to control nuisances in shallow near shore areas.
- Property owners should restrict the use of hand controls and bottom barriers to control Eurasian watermilfoil and curly-leaf pondweed only and should minimize the size of any areas that are cleared.

GLOSSARY

acid

Corrosive substances with a pH of less than 7.0.

acid rain

A polluting rain in which sulfur oxides from fossil fuels react with water vapor in the environment to form sulfuric acid.

adaptation

Any structure, the means an organism has to make them more likely to survive.

aerobic

Processes requiring oxygen.

algae

Microscopic organisms/aquatic plants that use sunlight as an energy source (e.g., diatoms, kelp, seaweed). One-celled (phytoplankton) or multicellular plants either suspended in water (Plankton) or attached to rocks and other substrates (periphyton). Their abundance, as measured by the amount of chlorophyll a (green pigment) in an open water sample, is commonly used to classify the trophic status of a lake. Algae are an essential part of the lake ecosystem and provides the food base for most lake organisms, including fish.

algal bloom

Population explosion of algae in surface waters. This may be caused by an increase in nutrients.

alkalinity

The ability of water, or other substances, to absorb high concentrations of hydrogen ions. Substances with a pH greater than 7.0 are considered alkaline. Low alkalinity is the main indicator of susceptibility to acid rain.

ammonia

A form of nitrogen found in organic materials and many fertilizers.

anaerobic

Living or occurring without air or free oxygen.

annual

A plant that completes its life cycle in one year or one season.

annual turnover

This is when the lake mixes entirely from top to bottom.

aquatic

Organisms that live in or frequent water.

aquatic invertebrates

Aquatic animals without an internal skeletal structure such as insects, mollusks, and crayfish.

aquatic plants

Plants that grow and live in water. They may be floating, submerged or emergent.

asexual

Reproducing by fragmentation, turions, tubers, and/or other vegetative structures.

benthic zone

The bottom zone of a lake.

benthos

Organisms living on, or in, the bottom material of lakes and streams.

biomass

The total quantity of plants and animals in a lake. It indicates the degree of a lakes system's eutrophication or productivity.

blue-green algae

Algae that are associated with problem blooms in lakes. Some produce chemicals toxic to other organisms.

bog

An area characterized by soft, water-logged soil with mosses and other vegetation as the dominant plants.

calcium (Ca++)

The most abundant cation found in Wisconsin lakes. Its abundance is related to the presence of calcium-bearing minerals in the lake watershed. Reported as milligrams per liter (mg/l) as calcium carbonate (CaCO3), or milligrams per liter as calcium ion (Ca++).

cation

This refers to chemical ions that carry a positive charge. Some cations present in lakes are calcium (Ca++), magnesium (Mg++), potassium (K+), sodium (Na+), ammonium (NH4+), ferric iron (Fe+++) or ferrous iron (Fe++), manganese (Mn++), and hydrogen (H+).

chloride (Cl-)

Is considered an indicator of human activity. Agricultural chemicals, human and animal wastes, and road salt are the major sources of chloride in lake water.

chlorophyll

A green pigment found in plants that is necessary for the process of photosynthesis.

clarity

Secchi disc is an 9-inch diameter plate with black and white painted sections that is used to measure water clarity (light penetration). The disc is lowered into water until it disappears from view. It is then raised until just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi disc reading. The readings should be taken on sunny, calm days.

conductivity (specific conductance)

Is the waters ability to conduct an electric current.

cultural eutrophication

Eutrophication that happens as a result of human activities when increased nutrients in runoff water drains into lakes.

decompose

Breakdown of organic materials to inorganic materials.

dissolved oxygen (DO)

The amount of free oxygen absorbed by the water and available to aquatic organisms for respiration.

diversity

Number of species in a particular community or habitat.

drainage basin

The total land area that drains toward the lake.

drainage lakes

Lakes fed primarily by streams and with outlets into streams or rivers. They are more subject to surface runoff problems but generally have shorter residence times than seepage lakes. Watershed protection is usually needed to manage lake water quality.

ecosystem

A system formed by the interaction of a community of organisms.

epilimnion

The epilimnion is the warm upper layer of a lake when the denser, colder water is on the bottom during stratification.

erosion

Movement of soil by water and wind.

eutrophication

The process by which lakes and streams are enriched by nutrients which results in increased plant and algae growth.

exotic

A non-native species of plant or animal that has been introduced.

filamentous algae

Algae that forms filaments or mats attached to sediment, weeds, piers, etc.

food chain

An arrangement of the organisms in an ecological community according to the order of predation in which each uses the next, usually lower, member as food source.

groundcover

Plants grown to keep soil from eroding.

habitat

The place where an animal or plant lives; its living and non-living surroundings.

herbicides

Chemicals designed to kill a variety of undesired plant species.

hydrologic (water) cycle

The process by which the earth's water is recycled. Atmospheric water vapor condenses into the liquid or solid form and falls as precipitation to the ground surface. This water moves along or into the ground surface and finally returns to the atmosphere through transpiration and evaporation.

hydrology

Study of the distribution, circulation, and properties of water.

hypolimnion

The lower, more dense, colder waters on the bottom of stratified lakes is the hypolimnion.

impervious surface

Ground cover that does not allow for infiltration of water, such as roads and parking lots, and increases the volume and speed of runoff after a rainfall or snow melt.

limiting factor

The nutrient or condition in shortest supply relative to plant growth requirements. Plants will grow until stopped by this limitation; for example, phosphorus in summer, temperature or light in fall or winter.

limnology

The study of inland lakes and waters.

littoral

The near shore shallow water zone of a lake, where aquatic plants grow.

macrophytes

Refers to plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects.

marl

White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate (CaCO3) in hard water lakes. Marl may contain many snail and clam shells, which are also calcium carbonate. While it gradually fills in lakes, marl also precipitates phosphorus, resulting in low algae populations and good water clarity.

metalimnion

This is the thin layer in a stratified lake that lies between the hypolimnion and the epilimnion.

non-point source

A source of pollution that comes from a variety of sources instead of a pipe.

nutrients

Elements or substances such as nitrogen and phosphorus that are necessary for plant growth. Large amounts of these substances promote excessive plant growth.

pH

The numerical value used to indicate how acid or alkaline a solution is. The number refers to the number of hydrogen ions in the solution. The pH scale ranges from 1 to 14 with 7.0 being neutral. Acid ranges from 0 to 6. Alkaline ranges from 8 to 14.

phosphorus

Key nutrient influencing plant growth in more than 80% of Wisconsin lakes. Soluble reactive phosphorus is the amount of phosphorus in solution that is available to plants. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form.

photosynthesis

The process by which green plants create food and oxygen.

phytoplankton

Microscopic plants and algae found in the water.

plankton

A small plant organisms and animal organisms that float or swim weakly through the water.

point source pollution

Air or water pollutants entering the environment from a specific point such as a pipe.

pollution

The contamination of water and other natural resources by the release of harmful substances into the environment.

ppm

Parts per million.

retention time

(Turnover rate or flushing rate) The average length of time water resides in a lake. This can range from several days in small impoundments to many years in large seepage lakes.

runoff

The portion of rainfall, melted snow, or irrigation water that flows across the land surface or through pipes and eventually runs into lakes and streams.

seepage lakes

Lakes without a significant inlet or outlet, fed by rainfall and groundwater. Seepage lakes lose water through evaporation and groundwater moving on a down gradient. Lakes with little groundwater inflow tend to be naturally acidic and most susceptible to the effects of acid rain. Seepage lakes often have long residence times and lake levels fluctuate with local ground water levels. Water quality is affected by groundwater quality and the use of land on the shoreline.

thermocline

Stratification is the layering of water due to differences in density. Water's greatest density occurs at 39 ×F (4 ×C). As water warms during the summer, it remains near the surface while colder water remains near the bottom. Wind mixing determines the thickness of the warm surface water layer (epilimnion), which usually extends to a depth of about 20 feet. The narrow transition zone between the epilimnion and cold bottom water hypolimnion) is called the metalimnion or thermocline.

trophic state

Eutrophication is the process by which lakes are enriched with nutrients, increasing the production of rooted aquatic plants and algae. The extent to which this process has occurred is reflected in a lakes trophic classification or state: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile).

turbidity

Degree to which light is blocked because water is muddy or cloudy.

turnover

Fall cooling and spring warming of surface water increases density, and gradually makes temperature and density uniform from top to bottom. This allows wind and wave action to mix the entire lake. Mixing allows bottom waters to contact the atmosphere, raising the water's oxygen content. However, warming may occur too rapidly in the spring for mixing to be effective, especially in small sheltered kettle lakes.

watershed

The land area draining into a specific stream, river, lake or other body of water. These areas are divided by ridges of high land.

wetlands

Low-lying lands in which the soil is saturated with water at some time during the year.

zooplankton

Microscopic or barely visible animals that eat algae. These suspended plankton are an important component of the lake food chain and ecosystem. They are the primary source of food for many fish.

REFERENCES

Borman, S., B. Korth and J. Tempte, 1997. Through the Looking Glass. Wisconsin Department of Natural Resources, 248 pp.

Crow, G. and C. Hellquist, 2000. Aquatic and Wetland Plants, Vols 1 and 2. University of Wisconsin Press.

Engel, S., 1989. Lake Use Planning in Local Efforts to Manage Lakes, Wisconsin Department of Natural Resources, 5 pp.

East Central Wisconsin Regional Planning Commission. 2002. Comprehensive Plan, 2030.

Fassett, N.C., 1969. A Manual of Aquatic Plants. University of Wisconsin Press, Madison, 405pp.

Garn, H, 2002. Effects of Lawn Fertilizer on Nutrient Concentration in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin. USGS Water-Resources Investigations Report 02-4130.

Gleason, H.A., 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. Hafner Press, 483 pp.

Hoyer, M.V. and D. E. Canfield Jr., eds. 1997. Aquatic Plant Management in Lakes and Reservoirs. Prepared by the North American Lake Management Society and the Aquatic Plant Management Society for the US Environmental Protection Agency. 103 pp.

Nichols, S.A. and J. G. Vennie, 1991. Attributes of Wisconsin Lake Plants. University of Wisconsin-Extension Geological and Natural History Survey, 19 pp.

Nichols, S. A. and Byron M. Shaw, 1986. Ecological Life Histories of the Three Aquatic Nuisance Plants, Myriophyllum spicatum, Potamogeton crispus, and Elodea canadensis. Hydrobiologia 131, 3-21.

Province of British Colombia, Informational Bulletin, A summary of Biological Research on Eurasian Water Milfoil in British Colombia. vol. XI, 18 pp.

Pullman, G. 1992, The Management of Eurasian Water Milfoil in Michigan. Midwest Aquatic Plant Management Society. 30 pp.

SePRO. No date. Sonar Guide To Aquatic Habitat Management. SePRO Corporation, 23 pp.

Smith, C.S. and J. W. Barko, 1990, Ecology of Eurasian Watermilfoil. Journal of Aquatic Plant Management.

Smith, G.M., 1950, The Fresh-Water Algae of the United States. McGraw-Hill Book Company

Wagner, Kenneth, 1990, Assessing Impacts of Motorized Watercraft on Lakes: Issues and Perceptions. North American Lake Management Society, 17pp.

Wisconsin Department of Natural Resources, 2001. The State of the Upper Fox River Basin, WT-665-2001. Wisconsin Department of Natural Resources, 120 pp.

Wisconsin Department of Natural Resources, 1992, Eurasian Water Milfoil in Wisconsin: A Report to the Legislature. Wisconsin Department of Natural Resources, 19 pp.

Wisconsin Department of Natural Resources, 1991. Wisconsin Lakes. Wisconsin Department of Natural Resources, 174 pp.

Wisconsin Department of Natural Resources, 1988. Environmental Assessment Aquatic Nuisance Control (NR 107) Program. Wisconsin Department of Natural Resources, 218 pp.

Wisconsin Department of Natural Resources, 1985. Aquatic Community Interactions of Submerged Macrophytes. Technical Bulletin No. 156, Wisconsin Department of Natural Resources, 79 pp.