Eagle Lake
Aquatic Plant Management Plan

Second Reassessment, 2005

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Chapter I
INTRODUCTION

Eagle Lake is a 520 acre lake located in the Town of Dover, Racine County, Wisconsin. The lake has a maximum depth of 13 feet and 4.75 miles of shoreline. Approximately 250 homes and condominiums are located in close proximity to the lake.

The Eagle Lake Property Owners Improvement Association (Association) was formed more than 40 years ago to protect and enhance the quality of Eagle Lake. The Association, working closely with County and Town representatives, enlisted the cooperation of the Wisconsin Department of Natural Resources (WDNR) in efforts to rehabilitate Eagle Lake. Rough fish had increased and dominated the fishery. The aquatic plant population was almost non-existent, while algae populations thrived. Clarity was very poor and the game fish populations, unable to sight feed, were suffering. In 1991 the WDNR conducted a lake-wide fish kill to begin efforts to restore the game fishery.

The Association anticipated that the lake would change significantly after the fish kill. It was expected that with reduced algae populations and improved clarity, aquatic plants would rebound, possibly to nuisance conditions. In 1992, the Association hired Aron & Associates to conduct an aquatic plant survey[1]. The Southeastern Wisconsin Regional Planning Commission (SEWRPC) also contributed by surveying the shoreland wetland zones[2] and participating in the aquatic plant general survey. Aron & Associates was then hired to develop a Plant Management Plan[3]. A Reassessment of the Plan[4] was done in 1998 in response to the increasing plant problem.

In-lake plant conditions have changed since the fish kill, going from a diverse, native population the first few years following the fish kill, to one that is now dominated by two exotic species, Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*).

The community created a lake protection district in 1995 when it was determined that the lake would require intensive harvesting. The Town of Dover assisted with the acquisition of new weed harvesting equipment until the new district, the Eagle Lake Management District (District) was established. The program and the equipment was then transferred to the District. After three years of harvesting Eagle Lake, weed growth on the lake required that additional equipment be used to harvest 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 Eagle Lake.

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1. Eagle Lake Aquatic Plant Survey-1992, Aron & Associates.
2. Preliminary Vegetation Survey Eagle Lake, 1992. Southeastern Wisconsin Regional Planning Commission.
3. Eagle Lake Plant Management Plan, 1995, Aron & Associates.
4. Eagle Lake Aquatic Plant Management Plan Reassessment, 1998, Aron & Associates.

PLAN REASSESSMENT

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, community surveys, WDNR resource managers, WDNR records, and SEWRPC records.

This reassessment will review the recommendations made in the earlier Plans, the current conditions on Eagle Lake, and will make modifications as necessary.

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 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 Eagle 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.
  - —Conduct whole-lake chemical treatment to eliminate exotic species.
  - —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.
  - —Harvest where necessary to maintain navigational areas.
- Preserve and enhance the natural lake environment by:
  - —Educating landowners and lake users in lake ecology.
- Work with the Association, Town, County and State governments to:
  - —Develop and enforce ordinances to protect Eagle Lake.
  - —Continue to improve the watershed to protect Eagle Lake.
  - —Identify and expand local educational efforts to improve the public's understanding of lake issues
  - —Encouraging community participation in lake management activities.
- 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.

Chapter II
BACKGROUND

PHYSICAL DESCRIPTION

Eagle Lake was formed during the Lake Michigan glacier as many as 13,000 years ago. A dam on the west shore maintains the current lake elevation and prevents rough fish from re-entering the lake. Hydrographic and morphologic data are provided in Table 1. Gravel and sand dominate the near shore lakebed where the lowest densities of aquatic vegetation are found. Eagle Lake is in the Middle Fox River watershed.

Table 1 Hydrography and Morphology of Eagle Lake
Racine County, Wisconsin, 2004

Area = 515 acres
Shore length = 4.37 miles
Shore development factor* = 1.37
Watershed area = 2910 acres
Ratio of watershed area to lake area = 5.7 to 1
Maximum depth = 13 feet
Mean depth = 6 feet
Volume = 3267.34 acre feet
Percent of area less than 3 feet deep = 13.9%
Percent of area greater than 20 feet deep = 0%

* Shore development factor is defined as the ratio of shoreline to the circumference of a circle with the same area as the lake.

Sources: SEWRPC, WDNR, and Aron & Associates

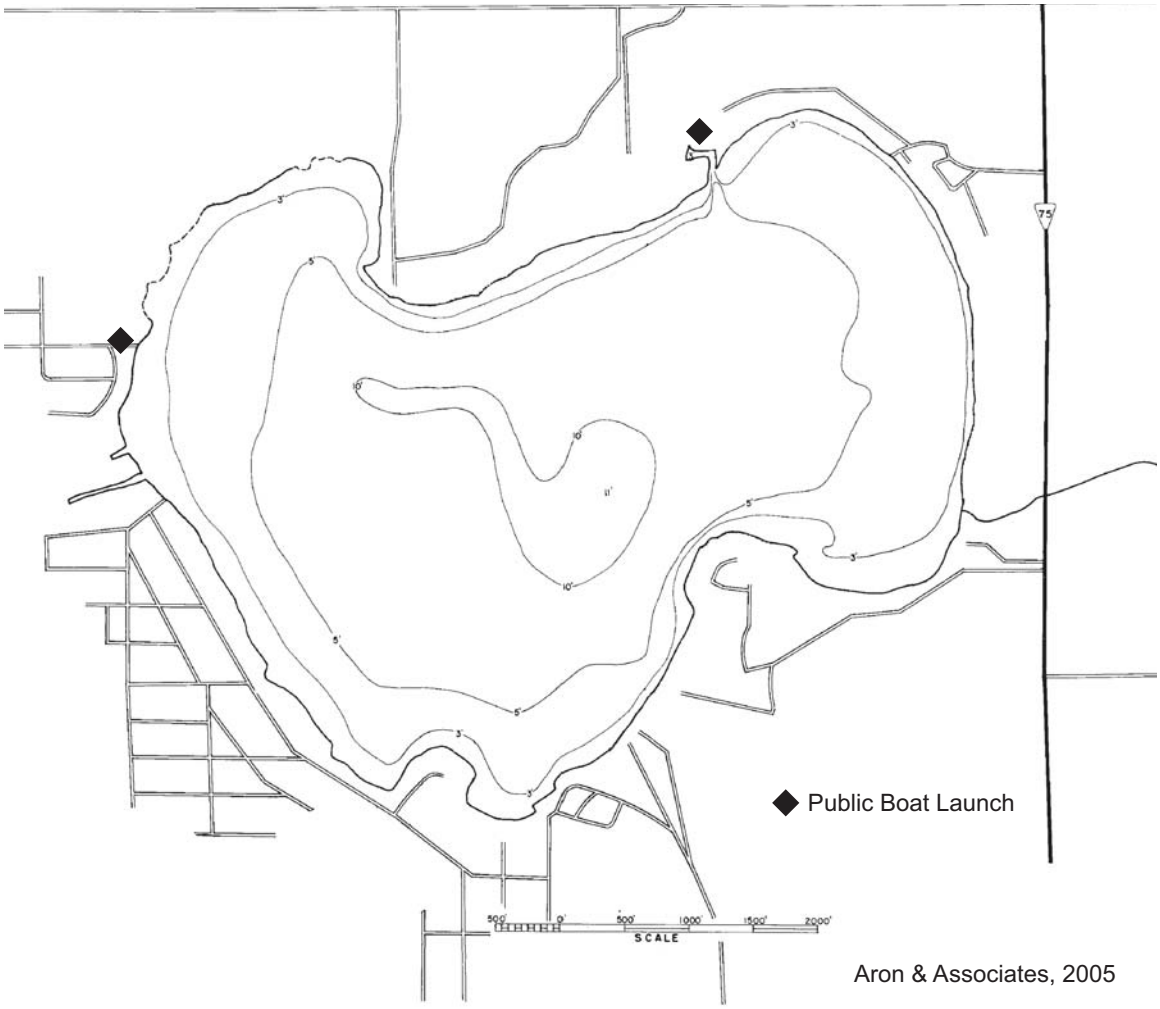


Figure 1 Eagle Lake, 2004

The watershed of Eagle Lake is gently sloping and ranges from well-drained to poorly-drained. The Eagle Lake watershed is relatively undeveloped. This drainage lake[5] has direct inlets and receives water from the 2910 acres that comprise its watershed. The drainage area to Eagle Lake is predominately agricultural (89%). Residential and commercial lands make up 11% of the watershed area. Most of the residential lands are found immediately adjacent to Eagle Lake. Approximately 168 acres of wetlands are adjacent to Eagle Lake (SEWRPC 1993).

5. Drainage lakes have both an inlet and an outlet. Eagle Lake's inlet enters the lake on the eastern shore. The dam is located on the northwestern shore.

The main tributary to Eagle Lake is on the east shore. It includes a network of manmade channels and ditches. The tributary also collects water from underground field tiles in the agricultural lands

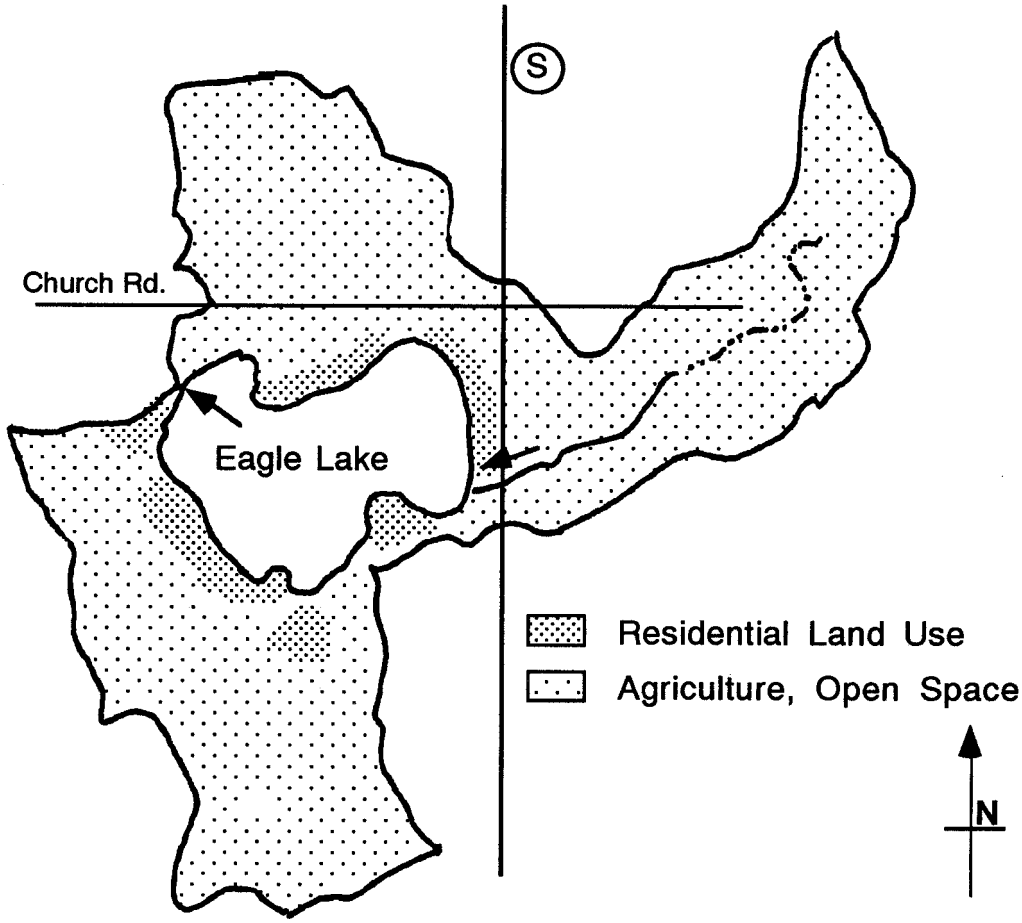


Figure 2 Eagle Lake

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, such as skiing and boating, that are conducted in areas of a lake with insufficient depths, can also 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

Eagle Lake is entirely within the Town of Dover in Racine County. The County owns and operates a park with a boat launch on the north shore. The Town owns and operates a boat launch on the west shore. The lake district boundaries include all lakefront property. The Association membership includes on and off-lake residents.

Watershed

The drainage area to Eagle Lake is predominately agricultural (89%). Residential and commercial lands make up 11% of the watershed area. Most of the residential lands are found immediately adjacent to Eagle Lake. Approximately 168 acres of wetlands are adjacent to Eagle Lake.

Soils

The predominant soil associations in the watershed are Varna-Elliot-Ashkum association and Hebron-Montgomery-Aztalan association. Slope and soil composition affects the rate, amount, and quality of the surface water runoff in the watershed.

SHORELINE DEVELOPMENT & AESTHETIC FEATURES

Eagle Lake shoreline is predominantly residential.

A large condominium complex is on the east shore with a long expanse of beach and mowed lawns. Canadian geese are often a nuisance on the property. The property also has a very large pier with mooring for the residents' boats.

Bays on the Northwest and Southeast sides of the lake offer quiet refuge for fish, wildlife and humans seeking an area for quiet reflection. The bays' association with adjacent wetlands increases their value.

Steeply-sloped lands along the north and southeast shoreline extend into the lakebeds. These steep shorelines can also contribute significant problems for the lake: disturbances by residents can result in serious erosion if preventive steps are not taken. The large expanses of agricultural lands protect the rural characteristic of the area, while contributing significant amounts of sediment and nutrients to the lake (SEWRPC 1978, Amerson 1997).

HISTORICAL CONDITIONS

In 1991, WDNR conducted a whole-lake fish kill to rid the lake of the rough fish that were negatively impacting the lake. Based on fish surveys, to date, there are no carp present in Eagle Lake.

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 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.

The conditions have changed since the fish kill. In earlier surveys in 1992 and 1993, curly-leaf pondweed and Eurasian watermilfoil were dominant in all areas deeper than four feet. Muskgrass dominated the shallower depths. In 1992 the shallow areas had good diversity of native plant species. However, by 1993, waterweed (*Elodea canadensis*) and sago pondweed (*Stuckenia. pectinata*) had declined dramatically in the lake.

Conditions in 1994 were similar to those seen in June 1993. The areas deeper than three feet were almost completely dominated by curly-leaf pondweed and Eurasian watermilfoil. One species, Fries pondweed (*Potamogeton friesii*), found in 1994, was not identified in earlier surveys. Overall, species diversity appears to have declined since 1992. Notable species that have not been found in sample points since 1992 include leafy pondweed (*P. foliosis*), long-leaf pondweed (*P. nodosus*), flat-stem pondweed (*P. zosterformis*) stiff water crowfoot (*Ranunculus longirostris*) and horned pondweed (*Zannichellia palustris*).

A general aquatic plant survey was conducted on Eagle Lake in August 1998. The secchi disk reading the day of the survey showed 2.5 foot water clarity. The lake was very turbid with planktonic algae. Plants were growing throughout most of the lake, with the maximum rooting depth at 10 feet. The dominant plant species were Eurasian watermilfoil, curly-leaf pondweed, and muskgrass.

A report written in 1947 by the predecessor of the DNR, the Wisconsin Conservation Department, A Biological Survey of Browns and Eagle Lake, Racine County Wisconsin, included a species list of plants found in Eagle Lake. Table 4 lists the species found in Eagle Lake in 1947, 1992, 1993, 1994 and 1998. In 1947 pickerel weed (*Pontederia cordata*) was not found. Coontail and wild celery were listed as abundant; although current densities would be described as sparse. Illinois pondweed (*P. illinoensis*) and floating-leaf pondweed (*P. natans*) were sparse in 1947 but were not found in the 1990's. According to the 1947 report, submerged vegetation was found up to the eight foot depths.

Table 2 Comparison of Aquatic Plant Species Found, 1947, 1992, 1993, 1994 & 1998.

Species	1947	1992	1993	1994	1998
Carex sp.*		X	X	X	X
Ceratophyllum demersum	X	X	X	X	X
Chara sp.	X	X	X	X	X
Elodea canadensis		X	X	X	X
Lemna minor	X	X	X		
Myriophyllum spicatum		X	X	X	X
*Najas flexilis**	X	X		X	
Nuphar sp.	X	X	X	X	X
Nymphaea sp.	X	X	X	X	X
*Pontedaria cordata**		X	X	X	X
Potamogeton crispus		X	X	X	X
P. foliosus		X			
P. friesii				X	
P. illinoensis	X				
P. natans	X				
P. nodosus		X			
P. zosterformis		X			
Ranunculus longirostris		X			
Stuckenia pectinata	X	X	X	X	X
Vallisneria americana	X	X	X		X
Zannichellia palustris		X			

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 detri-

mental 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 Eagle Lake. Figure 6 shows the areas of the lake that have the greatest aquatic plant diversity, one important component in the Sensitive Area program. The native species in these areas are extremely important to the long term health of the fisheries and vegetation diversity on Eagle Lake and should be protected.

With the exception of the two bays on the Northwest and Southeast areas of the lake, Eagle Lake has very limited areas of natural shoreline. 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.

FISH AND WILDLIFE

As previously discussed, in 1991, the WDNR conducted a fish kill on Eagle Lake to rid the lake system of the rough fish. In spring of 1992, the WDNR stocked game and panfish in the lake. After the treatment, the lake was closed to fishing to allow the fishery to become established.

According to the WDNR fish manager, Eagle Lake has a healthy fish population. Electrofishing surveys are done regularly to monitor the fish population. Eagle Lake has crappie, bluegill, walleye, northern pike, yellow perch, and large mouth bass. No carp are present in system, more than 14 years after the whole-lake fish kill to remove them. WDNR stocks Eagle Lake. In 2003 and 2004, 25,750 walleye were stocked each year.

Reduction of sediment and nutrients entering the lake is critical to the long term success of the fishery management programs. The natural shoreline areas and the adjacent wetlands enhance the spawning and nursery habitat for game fish. Native aquatic plants provide feeding and shelter areas for most of the fish species in Eagle Lake. The wetlands also provide refuge and cover for waterfowl. Birds and fur-bearers inhabit the natural shorelines for feeding shelter, rearing and nesting. Quiet wetland areas, such as the bay areas, are important resting points during migration.

A problem facing many lakes in Southeast Wisconsin is the non-migratory Canada goose. These geese are an entirely different species than the migratory geese and cause significant problems, both for residents and for the water quality of the lake. The non-migratory geese remain in an area year-round. They especially like mowed lawns and open water, making lakeshore areas prime targets. People often enjoy watching a few of these geese, but the problems arise as the numbers increase.

WATER QUALITY

Water quality studies on Eagle Lake have been limited. WNDR collected data during the WDNR Long Term Trend program until the mid-90s, and then in the Baseline Monitoring program from 2000 through 2004. 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. Figures 3 through 4 illustrate the data available for Eagle Lake. Note that the secchi data are not shown here because there are significant discrepancies between the volunteer data and the USGS data in the reported data.

Water quality has declined on Eagle Lake. The reasons for the decline are not clear, however, the decline may impact many aspects of the resource over time, including aquatic plants and the quality of the fisheries. As water quality declines, the diversity of aquatic plants declines, and sight-feeding game fish are at a distinct disadvantage.

An initial explanation for the changes in Eagle Lake may point to the watershed and an increase in runoff problems. However, it may not be as simple as that:

- The watershed remains primarily agricultural.
- Much of the inlet stream corridor has vegetated buffers.
- Agricultural landowners are now participating in nutrient and pest management programs, as well as other programs that improve the quality of runoff leaving the fields.
- The lakefront community has been actively working with landowners to restore shoreline buffers, improve public awareness, and minimize impacts to the lake.

Other factors may also contribute to the declining water quality:

- Nutrient contributions from the sediments (result of historical inputs).
- Release of nutrients during senescence of curly-leaf pondweed.
- Elevation of water temperatures under thick dense mats of Eurasian watermilfoil and filamentous algae.

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.

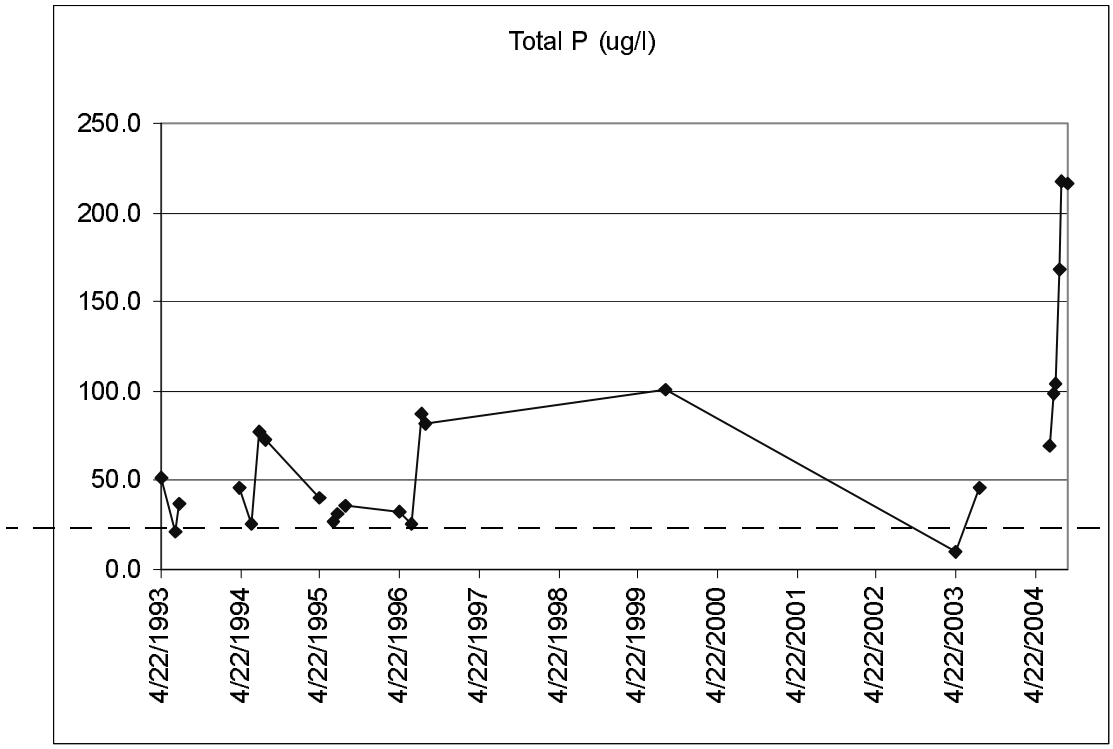


Figure 3 Total Phosphorus for Eagle Lake, Racine County Wisconsin

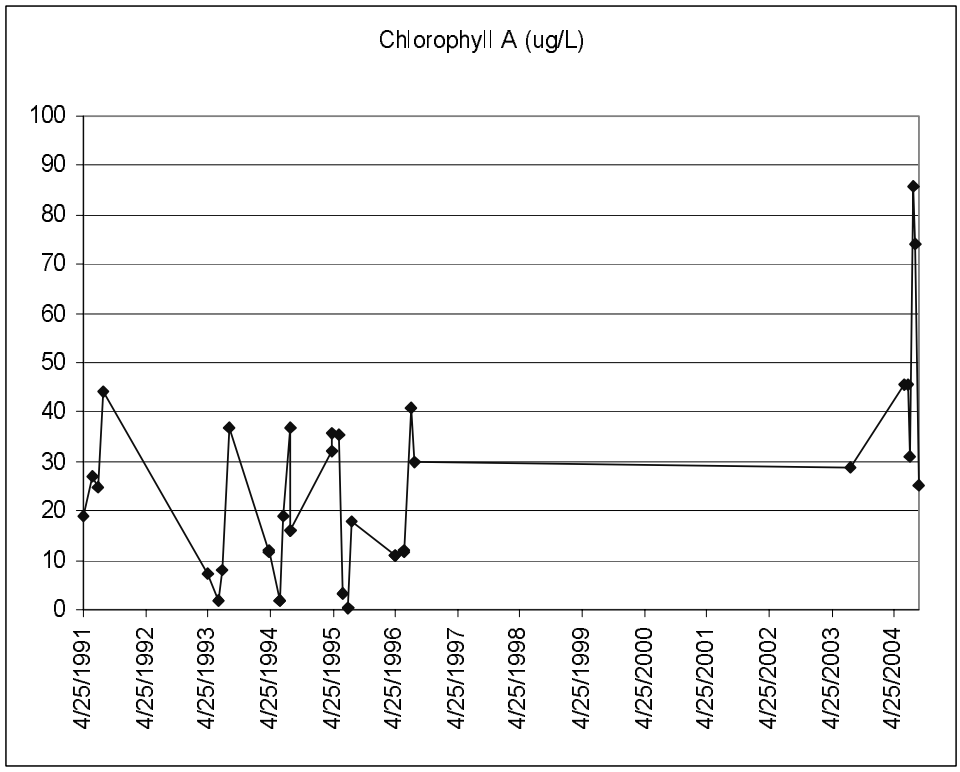


Figure 4 Chlorophyll A for Eagle Lake, Racine County Wisconsin

EXOTIC SPECIES

During the aquatic plant survey, Eagle 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 Eagle Lake to date (WDNR website, 2003). Because zebra mussels are in a number of nearby lakes, 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

Eagle Lake receives a high degree of recreational pressure. The majority of recreational uses are water-skiing, personal watercrafting, scenic viewing, swimming and fishing. In a community survey taken in fall 1991 (Losik et al, 1992) scenic viewing was the most popular activity. Fifty percent of the respondents indicated frequent or daily viewing. Walking (26%), boating (25%) and swimming (22%) were the next most important activities. The survey also reported only a moderate amount of concern expressed over boating behavior (such as excessive speeds and traffic) by 20 to 30% of the respondents.

If the survey were to be retaken now, the responses would likely be significantly different. The survey was conducted at a time when the lake had been dominated by rough fish and nuisance algae, producing poor clarity and odors. Under such conditions, lake uses requiring full or partial body contact are often reduced in direct proportion to worsening conditions.

Although the fisheries continues to improve, threats to the continued quality include exotic plant dominance and poor water clarity. Water clarity has been poor the past few years, which affects full-body contact uses.

As traffic on the lake increases, conflicts arise between those seeking a peaceful scenic vista and those desiring a speedy boating experience and those looking for game fish. Lake use levels are the highest on weekends and holidays.

BOATING ORDINANCE

The Town of Dover has a boating ordinance in effect on Eagle Lake. The local ordinances are occasionally reviewed and modified. A copy of the ordinance is included in the Appendix. In addition to the local ordinances, state laws are in effect on the lake and are enforced by the Conservation Wardens. The Town also operates a boat patrol on Eagle Lake. The lake patrol concentrates on high use times, primarily weekends and holidays.

ACCESS LOCATIONS

Eagle Lake meets the WDNR standards for public access to an inland lake. The primary access to the lake is provided by a County Park located on the north shore (Figure 1). The Park has a boat launch ramp, parking area and other improvements. The Town has a small access on the western shore that provides parking for 10 cars. There are also private accesses to the lake, one on the southern shore at the former Giovanni's and one on the eastern shore near the condominium development.

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.

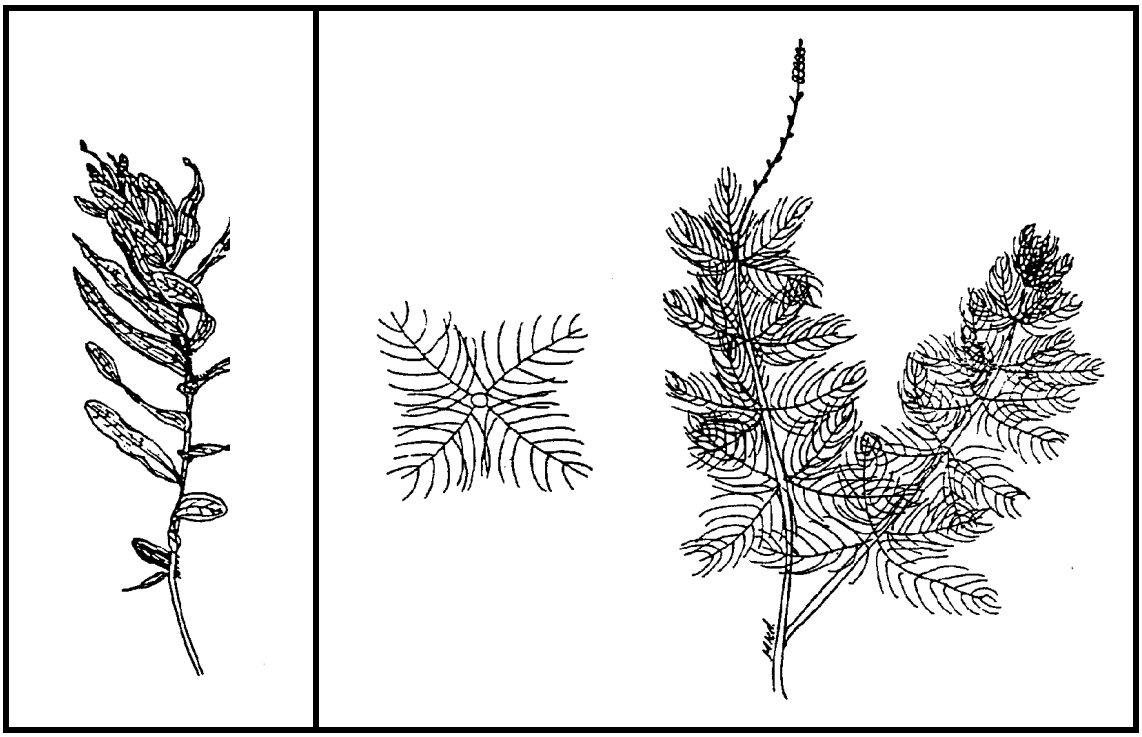


Figure 5 Curly-leaf Pondweed and Eurasian Watermilfoil, Two Exotic Species.

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 spe-

cies 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 laklebed 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 Eagle Lake are *Stuckenia pectinata* and *Vallisneria americana*. Other high value species in Eagle Lake include *P. foliosis* and *Najas flexilis*.

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 Eagle 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.

Curly-leaf pondweed is abundant in Eagle Lake.

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 abundant in Eagle Lake. Non-management of Eurasian watermilfoil will lead to a continued 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).

Muskgrass is common on Eagle 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 plant that was rarely found in 1992, but has increased in density since then. Historically, coontail was found in abundant densities (WDNR 1968). Coontail 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 present in Eagle Lake.

Wild Celery

Wild celery (*Vallisneria americana*) is a perennial plant that prefers hard substrates. The seeds and foliage are considered an excellent food source for waterfowl. Wild celery is a prime spawning habitat for northern pike. In late March to early April, the northern pike spawn on the wild celery that is left from the previous summers growth. Wild celery also provides cover for fish as well as supporting fauna that are utilized by fish for food. Wild celery may also grow to nuisance levels.

Wild celery was found only in the general survey on Eagle 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 rarely found on Eagle 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). No plant samples were collected and preserved since all species found had been collected during previous surveys. The maximum rooting depth on Eagle Lake in 2004 was determined to be 13 feet (4 m), the maximum depth of the lake.

Point Intercept Survey

The methodology for the point intercept survey was developed by the WDNR Bureau of Research for the state's Whole Lake Treatment Protocol. A grid and global positioning satellite (GPS) coordinates for sampling, were developed by WDNR and provided to Aron & Associates for use in the surveys on Eagle Lake.

The initial grid established 97 sample points, Map 8. Eleven sample points were determined to be on dry land. Samples points 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. An overall density rating and the dominant species at each sample point was also identified.

The data collected were then used to 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.

EAGLE LAKE AQUATIC PLANTS - 2004

An aquatic plant survey was conducted by Aron & Associates the week of June 28, 2004. The aquatic macrophytes observed in Eagle Lake during the survey are listed in Table 3. A total of 12 species were observed, five of which were only found in the general survey. The aquatic macrophyte population of Eagle Lake is dominated primarily by *Myriophyllum spicatum* (Eurasian Watermilfoil) and *Potamogeton crispus* (curly-leaf pondweed). The maximum rooting depth was determined to be 13 feet. The entire lake was available for aquatic plant growth in Eagle Lake in 2004. (Note: The lake map shows a maximum depth of 11 feet, however, the 13-foot depth was verified in the field.) Muskgrass and Eurasian watermilfoil dominated the plant populations at depths of five feet or less. Eurasian watermilfoil and curly-leaf pondweed, interspersed with occasional sago pondweed and coontail dominated the deeper areas of the lake. In significant contrast to earlier surveys, native plants were rarely found on Eagle Lake in 2004.

Figure 6 shows the areas with the greatest aquatic plant diversity on Eagle Lake.

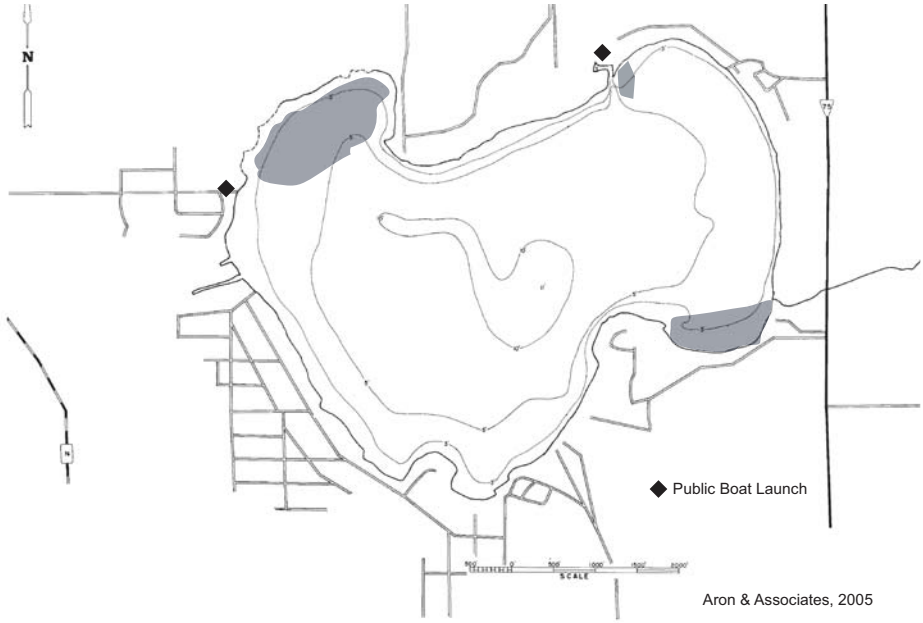


Figure 6 Areas on Eagle Lake with the Greatest Aquatic Plant Diversity

The North shore near the County boat launch was the only area where wild celery (*Vallisneria americana*) was found. The area also has muskgrass, Eurasian watermilfoil and curly-leaf pondweed.

The Southeast bay has water lilies, sago pondweed, coontail, muskgrass, and Eurasian watermilfoil.

The Northwest bay has the best diversity, with water lilies, sago pondweed, coontail, muskgrass, leafy pondweed, curly-leaf pondweed, and Eurasian watermilfoil.

Figure 7 shows the areas on Eagle Lake with the greatest problems with aquatic vegetation. The shaded areas were dominated by Eurasian watermilfoil, curly-leaf pondweed, and filamentous algae. Very frequently, plants in these areas had 10 to 15-foot long stems, much deeper than the lake depth. This creates a dense, tangled mess on the lake surface. It increased the water temperature and filamentos algae thrives in the tangled mats.

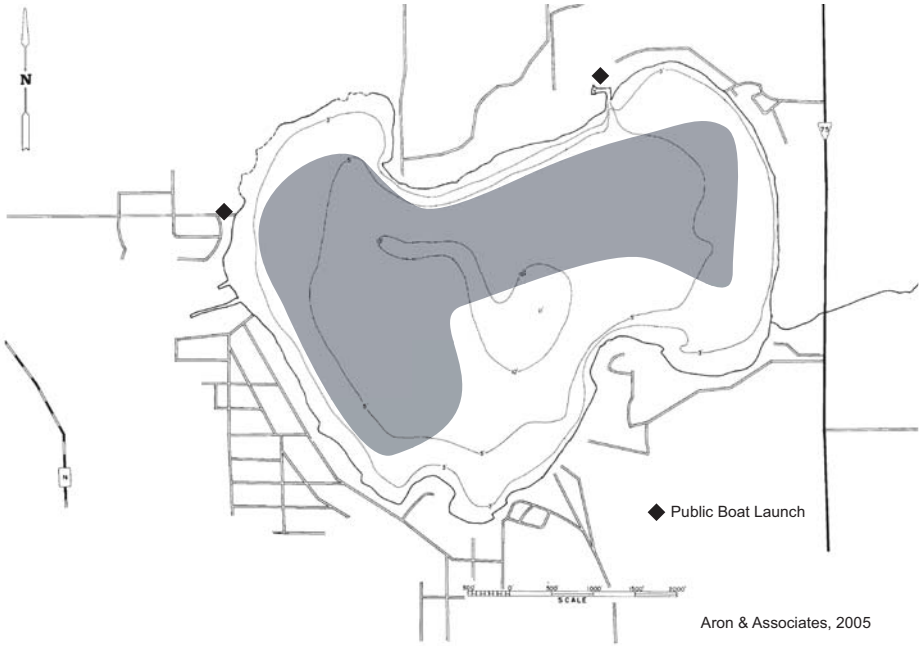


Figure 7 Areas of Eagle Lake With Eurasian Watermilfoil and Curly-leaf Pondweed to the Surface

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. Lakes with harvesting programs are not expected to support the weevil because harvesting removes the portions of the plant that the weevil needs for survival. The “milfoil weevil” was not found in Eagle Lake during the 2004 aquatic plant survey.

General Conclusions

- The area available for aquatic plant growth in Eagle Lake was greater than that seen in previous surveys, 13 feet, the maximum depth of the lake.
- Native aquatic plant diversity has declined since earlier surveys.
- Eurasian watermilfoil and curly-leaf pondweed are significant problems in the lake.
- Current aquatic plant management activities appear they are barely able to manage the nuisance plant conditions.

Table 3 List of Plant Species in Eagle Lake, 2004

Scientific Name	Common Name
Ceratophyllum demersum	Coontail
Chara sp.	Muskgrass
*Elodea canadensis**	Elodea
Lemna minor	Small duckweed
Myriophyllum spicatum	Eurasian Water Milfoil
Nuphar sp.*	Yellow Water Lily
Nymphaea sp.*	White Water Lily
Potamogeton crispus	Curly-leaf Pondweed
P. foliosis	Leafy Pondweed
*P. zosterformis**	Flat-stem Pondweed
Stuckenia pectinata	Sago Pondweed
*Vallisneria americana**	Water Celery, Eel Grass

*Found only in the general survey.

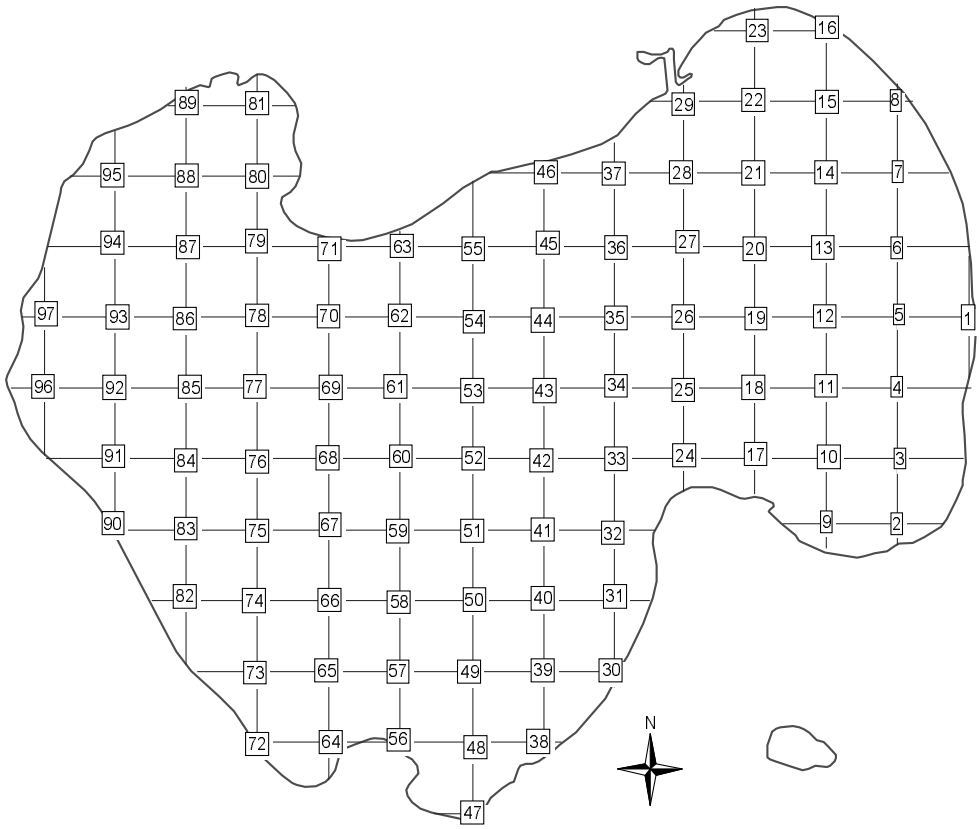


Figure 8 Aquatic Plant Survey Sample Points on Eagle Lake, 2004

Chapter IV
PROBLEMS

Although Eagle Lake is considered a quality water resource, 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 Eagle Lake.

Dense plant beds in the bays clog boat motors and pier areas, impairing boat traffic. Dense weeds impair swimming along shorelines and creates 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.

Eurasian watermilfoil, curly-leaf pondweed, planktonic algae, and filamentous algae are causing the nuisance problems in Eagle Lake.

In spite of poor water clarity, plants, primarily Eurasian watermilfoil, curly-leaf pondweed, and filamentous algae, were thriving in depths up to 13 feet. The fertile soils in the region contribute to the excessive plant problems in Eagle Lake. High levels of recreational use also create problems in the lake, disrupting game fish spawning areas, suspending sediments, reducing water clarity, and negatively impacting the aquatic plant conditions.

Although the Eagle Lake area is now sewered, for many years it was not, creating an additional contribution of nutrients which may have come from improperly maintained or malfunctioning individual septic systems. These nutrients remain in the lake for years. This is common in densely populated, older lake communities with historic use of septic systems.

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.

The high level of recreational use, coupled with the dense plant beds also contribute to plants cut by boats or harvesters, known as floaters, that wash up on shorelines and reroot. 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 exist in long Eurasian watermilfoil and curly-leaf pondweed strands.

Dense Eurasian watermilfoil bed can contribute to stunted panfish populations by reducing opportunities for grazing by predators. 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.

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.

Eurasian watermilfoil itself may be contributing to the nutrient problem, and resultant decline in clarity, in Eagle Lake. Eurasian watermilfoil may contribute as much as 2 mg/m2/day of phosphorus into the water column (S. Carpenter, 1981). For Eagle Lake this could mean as much as 1000 lbs per summer season, almost half the total annual phosphorus load from the watershed.

Another concern is a possible link between Eurasian watermilfoil and toxicity to planktivores. A recent study (E. Linden and M. Lehteniemi, 2005) found Eurasian watermilfoil was toxic to invertebrates, and caused the invertebrates to spend more time outside the plant beds, subjecting them to greater predation. This did not occur with native milfoil beds. This toxicity may explain why Eurasian watermilfoil supports fewer invertebrates and therefore provides fewer benefits to fisheries. It also raises concerns about the long term effect on a healthy fisheries population in lakes dominated by Eurasian watermilfoil.

Eurasian watermilfoil, curly-leaf pondweed, and filamentous algae are causing the aquatic plant nuisance problems in Eagle Lake.

Chapter V
HISTORICAL PLANT MANAGEMENT

In recent years, Eagle Lake residents have used a combination of chemical treatment and aquatic plant harvesting to control aquatic nuisances.

CHEMICAL TREATMENT

A DNR report in 1968 indicated that 16,600 pounds of copper sulfate was applied in Eagle Lake between 1957 and 1968 to treat algae. Until 2004, recent treatments have focused on plant control, rather than algae control.

Shoreline vegetation treatment has been conducted the past few years to improve conditions for residents that cannot be addressed by harvesting. Two treatments were conducted in 2004. On June 24, 2004, 38.6 acres were treated with 2,4-D to control Eurasian watermilfoil in the shoreline areas. On July 9, 2004, just over 1/2 acre was treated to control Eurasian watermilfoil and 5 acres were treated to control filamentous algae.

The District spent approximately $15,200 on shoreline chemical treatments in 2004.

HARVESTING

Eagle Lake has been harvested since 1996. According to the harvesting program supervisor, approximately 562 hours were spent on harvesting in 1996, and 602 hours in 1997. In 1999, the District purchased a second harvester.

Approximately 450 acres of the lake has been harvested for the past three years. Plant growth levels increased following the fish kill and have required the acquisition and use of a second harvester. The severity of the plant growth, along with the decline in water clarity, and the increase of filamentous algae problems, have led the District to consider another alternative for the lake.

Most of the lake, with the exception of the diverse plant areas, has been harvested. Two off-load sites are being used, one at the county park on the north and the other at the town access on the west.

The District also conducts a shoreline pickup program around the lake.

The annual budget for the harvesting program in 2004 was approximately $86,100.

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 Eagle 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 is technically feasible for Eagle Lake, it should not be considered in the best, long term interest of the water resource.

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. Eurasian water milfoil and coontail react unpredictably (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 draw-

downs 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. The procedure is rarely effective. 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 throughout the lake, and because it is not effective for controlling milfoil, drawdown for the purpose of aquatic plant control on Eagle 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. Based on the volume of the lake and the cost of alum, an alum treatment on Eagle Lake would cost approximately $50,000.

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. 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—Some surface water quality data are available for Eagle Lake. Planktonic algae and high phosphorus levels contribute to poor water clarity. An alum treatment may be considered following a whole-lake chemical treatment for exotic plants. This would minimize any potential shifts to an algal dominated system and would provide increased clarity for native aquatic plants. The life-span of an alum treatment is dependent upon the applied dosage and the amount of incoming sources of nutrients.

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—While dredging is being discussed for specific areas of Eagle Lake, dredging for the purpose of aquatic plant control would not be considered a viable alternative for Eagle 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 $300,000 to $400,000 and an annual maintenance and operational cost of approximately $25,000. 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—Eagle Lake should be monitored for dissolved oxygen levels to protect the fishery. Unless Eagle 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 not viable for use on Eagle 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 Eagle 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.

Weevils were introduced into Eagle Lake during a demonstration project approximately 8 years ago. The weevils were placed in specific areas in the Northwest bay. No signs of the weevils were found during the 2004 survey.

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 Eagle Lake. Milfoil weevil introductions do not appear to have been successful in Eagle Lake. Because of the intensive harvesting program of Eurasian watermilfoil, and the cost of the weevils, introduction of the milfoil weevil is not a feasible management option at this time.

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 Eagle Lake, unless natives fail to re-establish after intensive management of exotic species. 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. 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 Eagle 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 volun-

teers 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. The Association has worked with four different landowners to establish shoreline buffers and correct erosion problems, as part of a lake protection grant project. Landowners should be encouraged to allow the upland shoreline edge to revegetate 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.

Although “mail order” chemicals can be purchased, their use is strongly discouraged and should not 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.

Shoreline vs Whole-lake Treatments
Under current laws, standard chemical treatment permits are issued for the shoreline areas, 150 feet out. It is possible to get a permit to treat beyond the shoreline, however extra planning and preparation will be required. For instance, a whole-lake treatment will require a detailed plan that should include timing of treatment, dosage planned, pre- and post-treatment data collection, and a re-infestation plan.

Whole-lake treatments may not appropriate for all lakes:

- Lakes with high volume flows through the lakes would not be able to maintain the appropriate contact time for a whole-lake treatment.
- Lakes with exotic populations confined to a single or small area are likely to be better and more cost-effectively treated with 2,4-D.
- Lakes with large populations of highly susceptible native plants.

Whole-lake treatments may be appropriate for:

- Lakes with increasing populations of Eurasian watermilfoil.
- Lakes with exotic problems throughout the lake, minimizing the effectiveness of conventional management tools.
- Lakes with healthy, diverse native populations threatened by exotics.
- When the costs and effectiveness of conventional management tools is no longer sufficient to control the nuisance.
- When the diversity of native aquatic plants is declining because of the exotics.

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 Eagle 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. Swimming beaches may be treated with contact herbicides. **Any other chemical treatments conducted on Eagle Lake should only target exotic species, Eurasian watermilfoil, curly-leaf pondweed, and filamentous algae.**

- Swimming beaches (public and multiple-resident beaches) may be treated with contact herbicides to provide safe swimming conditions.
- There may be consideration given to treating Eurasian watermilfoil and curly-leaf pondweed with the appropriate herbicides. Chemical treatment of the remaining plant communities would not be advised on Eagle Lake. It should be remembered that destruction of any native plant species populations will increase potential problems from Eurasian watermilfoil.
- Treatments should be planned to treat early enough 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.
- If 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.
- Because of the decreasing diversity found on Eagle Lake in 2004, the lack of susceptible native species, and the continued increase of both Eurasian watermilfoil and curly-leaf pondweed, a whole-lake treatment may be considered.

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 pre-

vent 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 has been shown to be effective at improving recreational use by controlling nuisance species on Eagle Lake. Landowners should be encouraged to remove floaters from their shorelines. Material can be mulched, used in plant beds, or picked up during the shoreline pickup activities.

- Harvesting should be used to remove large stands of Eurasian watermilfoil and curly-leaf pondweed that have topped out.
- Harvesting may be used to cut boat lanes through dense vegetation to provide access.
- Harvesting should begin with the boat lanes to ensure access for riparians, then work should begin on large dense stands of exotic plants.
- The program should emphasize reducing nuisances rather than clear cutting.

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 Eagle 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 Eagle 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:
  - —Conduct whole-lake chemical treatment to eliminate exotic species.
  - —Encouraging landowners to protect native species.
  - —Use chemical treatments in shoreline areas.
  - —Minimize fragments of aquatic plants.
  - —Aggressively respond to re-infestations of exotic species.
  - —Harvest where necessary to maintain navigational areas.
- Preserve and enhance the natural lake environment by:
  - —Educating landowners and lake users in lake ecology.
- Work with the Association, Town, County and State governments to:
  - —Develop and enforce ordinances to protect Eagle Lake.
  - —Continue to improve the watershed to protect Eagle Lake.
  - —Identify and expand local educational efforts to improve the public's understanding of lake issues
  - —Encouraging community participation in lake management activities.
- 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

Many of the initial recommendations in the 1995 Plant Management Plan have been implemented. The community established a lake protection district to handle the funding and management of the harvesting program. The harvesting program has followed the guidelines in the Plan, avoiding diverse areas and concentrating on removal of Eurasian watermilfoil and curly-leaf pondweed. The Association continues to be very active, working on public education efforts and shoreline restoration projects.

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.
- Swimming beaches may be treated with non-selective, contact herbicides to provide safe swimming conditions.
- Target species for chemical treatment include: Eurasian watermilfoil, curly-leaf pondweed and filamentous algae. Curly-leaf pondweed treatments should be conducted very early in the season.
- Areas which are chemically treated should not be harvested. Harvesting shortly after chemical treatment will negate the affect of the chemical treatment. An early season chemical control may be followed by late season harvesting.
- Because of the nuisance conditions and the previous level of diversity of native plants, a whole-lake treatment may be conducted on Eagle Lake. Because Eagle lake has nuisance conditions of both curly-leaf pondweed and Eurasian watermilfoil, a very early spring treatment is preferable over a fall treatment. A spring treatment will eliminate the current seasons' growth of curly-leaf pondweed while eliminating the Eurasian watermilfoil. Such a treatment will require a whole-lake treatment plan be developed to accompany a permit request. The plan will detail all components of the proposed treatment.

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 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.

Harvesting

- The District may continue to use harvesting to provide relief from nuisance conditions, unless a whole-lake treatment is conducted.
- Harvesting should not be done in areas that are treated with herbicides, until later in the season.
- Any harvesting done should be carefully planned to avoid native plants as much as possible.
- No harvesting should be done in shallow waters less than three feet deep.
- Incidental cutting of native plants is allowed, however, large areas of primarily native plants should not be harvested.
- Eurasian watermilfoil areas should be “topped”, that is, the top 4 or 5 feet of plant material (or to the depth of the Eurasian watermilfoil canopy) should be harvested, cutting above any native plants. This will allow light to reach the natives and will encourage their growth.
- The District may continue shoreline pickup of plant debris, taking care to minimize lakebed disruption.
- Near-shore areas, especially those with fish spawning habitat, should not be harvested prior to June 1st of each year.
- Educational efforts should be developed to inform the public about the benefits of a comprehensive plant management program, that gives equal consideration to fish and wildlife, while reducing recreational nuisances and unsafe situations.

WDNR Administrative Rule NR 109 should be consulted for the specific requirements for conducting harvesting. The following are some of the steps that should be followed by the District when preparing to harvest.

- Complete WDNR permit application forms. Include map, area sizes and name and addresses of all affected riparian landowners.
- Current administrative codes should be reviewed annually to ensure compliance.
- The District should concentrate harvesting efforts on Eurasian watermilfoil, sago, and widgeon grass. Efforts should be made to eliminate “shading” of lower growing native plants and to reduce floaters.

- Daily records should be kept documenting loads, maintenance, downtime, and other pertinent information. The District should stress to the operators the importance of keeping accurate records.
- The District should provide operators with a copy of the harvesting permit and be sure it is read and understood, to ensure compliance with its provisions.
- Harvesting operators should be trained to identify target plant species. This would ensure the operators would know to avoid areas with high numbers of pondweeds that should not be cut.
- Operators should not cut plants in less than three feet of water.
- The District may continue its current harvesting schedule. Shoreline pick up may be done as needed.
- Any fish or turtles that may be harvested with the plants should be returned to the lake.
- Avoid areas with spawning fish.
- Disposal of cut plants may continue to be disposed of locally.
- The District should continue its practice of hiring experienced operators as well as the comprehensive training in equipment operation and maintenance.
- The District should summarize its harvesting records into an annual report.
- The District should review the plant management plan and operations every three to five years.
- The District should distribute informational materials to its members that include such topics as proper lawn and garden practices, land use impacts and the importance and value of aquatic plants.

General Recommendations

The District staff should continue to harvest areas of the lake on an as needed basis, prioritizing the areas as follows:

—Harvest main navigational channels.
—Harvest curly-leaf pondweed beds as early as possible to minimize turion production.
—Harvest to remove tops of Eurasian watermilfoil to prevent seed production and to open native understory to sunlight.
—Early in the season the focus should be on removing topped out Eurasian watermilfoil/curly-leaf pondweed beds. This should take precedence over shoreline pickup efforts.
—Shoreline pickup should be done only after topped-out areas have been cleared.

Emphasis of the program should be to harvest plants necessary to facilitate recreational use and remove unsafe conditions in topped out areas. Focus on removing topped out conditions and removing in bulk prior to "grooming" less dense areas.

Staff needs to make sure that cutter bars are kept out of the sediments and to cut at least one foot above the native plant beds, being especially careful where Muskgrass tends to dominate the plant community. Nuisance aquatic plants, especially Eurasian watermilfoil,

will likely expand their range if this recommendation is not followed.

Public acceptance and continual support are critical components to a successful program. Continue to harvest outside the piers to allow for satisfactory recreational use and public satisfaction. Harvesting should focus on removal of top portions of plants, approximately 3 feet down, or to the top of the native plants, which ever is less. This will allow light to reach the native understory. If chemical treatment is not used, harvesting may be used to relieve the nuisances up to the pier zone area as long as access is not restricted by depth.

Staff should concentrate harvesting efforts on the Eurasian watermilfoil areas (especially to help reduce the amount of floaters that may be caused by boaters). Eurasian watermilfoil should be harvested before a canopy begins to form if possible. No harvesting of areas that have desirable native plant species especially when native pondweeds are in seed.

Staff should continue an aggressive program to reduce the amount of “floaters” and if they do occur, should be removed immediately. Equipment should be operated so that cut plant material does not fall off the harvester. Deep water areas that need to be harvested for access purposes should be cut to depths between five and six feet to prevent boating activity from cutting plants.

Off-load areas should be kept free of plant debris. Any debris in the lake should be removed each time the harvester unloads.

Comprehensive and detailed records should continue to be kept documenting:

1. Date
2. Hours worked - including harvest and down time
3. Loads harvested - including plant types and densities
4. Areas harvested - located on a map
5. Weather conditions
6. Other relevant information

Schedule For Harvesting

The District should continue to follow their present schedule.A review of past harvesting records in conjunction with a pre-harvest survey should be conducted each spring to determine which areas need attention and which areas are undergoing a change from the previous year. If plants become a nuisance in mid-May begin harvesting but note previous recommendations, especially with regard to fish spawning areas. The current schedule of harvesting weekdays for approximately 8 hours a day should be sufficient. Shoreline pick-up may be continued. Near-shore areas, especially those with fish spawning habitat, should not be harvested prior to June 1st of each year.

Shoreline pickup should be second priority to clearing topped out exotic beds. This will help reduce the amount of plant material that floats to shore.

Staff and operator time not directed to harvesting could be routed to additional lake work, such as shoreline erosion prevention, monitoring, and documenting plant growth changes and educational programs.

Since most of the harvesting is done outside the pier zone, spawning habitat should not be impacted. Near-shore areas, especially those with fish spawning habitat, should not be harvested prior to June 1st of each year.

The productivity of the harvesting effort depends on the density of the plants, weather, operator skill, etc. A 450 cubic foot capacity harvester can be expected to harvest an acre in 2 1/2 to 5 hours.

Harvested Fish & Wildlife

Care should be given to returning any captured fish and turtles to the lake. If fish are caught in quantities of more than a few per area, the harvesting crew should take the following actions:

1. Reduce the operating speed of the harvester to give fish a chance to flee.
2. If that does not help, then reduce cutting depth and see if problem is resolved.
3. If fish are still being harvested, refrain from cutting area and consult with WDNR or private consultant for further recommendations.

Shoreline Pickup

A shoreline pickup program was instituted because of the large amount of plant debris. Shoreline pickup may be continued for homeowners assistance. This encourages landowners to keep their shorelines free of plant debris. Plant debris is raked onto the conveyor (cutter bars are removed for shoreline work). Any shoreline pickup should be avoided until after June 15th.

Off-Loading and Disposal Sites

Current disposal practices should continue. Care should be taken to keep lake areas adjacent to disposal sites clean of cut vegetation. Staff should be instructed to remove any vegetation debris immediately upon off-loading the harvester. Cut material should not be left on the conveyors overnight.

Operator Training

The District should try to hire experienced operators. The District should conduct comprehensive training in equipment operation, maintenance and safety. Employees should be trained in the identification of the plants in Eagle Lake. This will help protect beneficial plant beds and will ensure accurate documentation of changes that may occur in the aquatic plant community as a part of their daily program.

Maintenance Program & Downtime

Maintenance should continue as is currently done. The focus should continue to be on preventive methods, rather than reactive. The District should use synthetic, biodegradable hydraulic fluids in the harvester to reduce the adverse impacts to the lake from spills. In the event this is not possible, a small spill kit should be acquired to immediately and efficiently deal with any spills that may occur.

The District should follow the manufacturer's recommended equipment maintenance. To extend the life of the equipment, daily maintenance should include checking engine oil and pump fluid levels prior to use each day. Oil and filters should be changed weekly. A grease

gun should be kept on board each piece of equipment and operators should grease every 2 hours while running, taking extra care to grease areas below the water line.

Storage

The District has a storage facility to house the equipment when not on the lake.

Employee Safety

The District should regularly review safety measures with the staff. It is especially important that staff wear life preserves at all times while on the harvesters.

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 Eagle 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

Eagle 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 Eagle Lake. This will be required as part of a whole-lake treatment project. A volunteer monitor should also collect secchi disk readings at least every two weeks. This task could be included as a responsibility of a harvester operator. Ideally, the District would participate in the US Geological Survey water quality program to determine the nutrient concentrations in Eagle Lake.

Watershed Controls

The District should work to improve the quality of water runoff into Eagle 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.

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. Another option to consider is the use of phosphorus-free or no phosphorus fertilizers. 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.

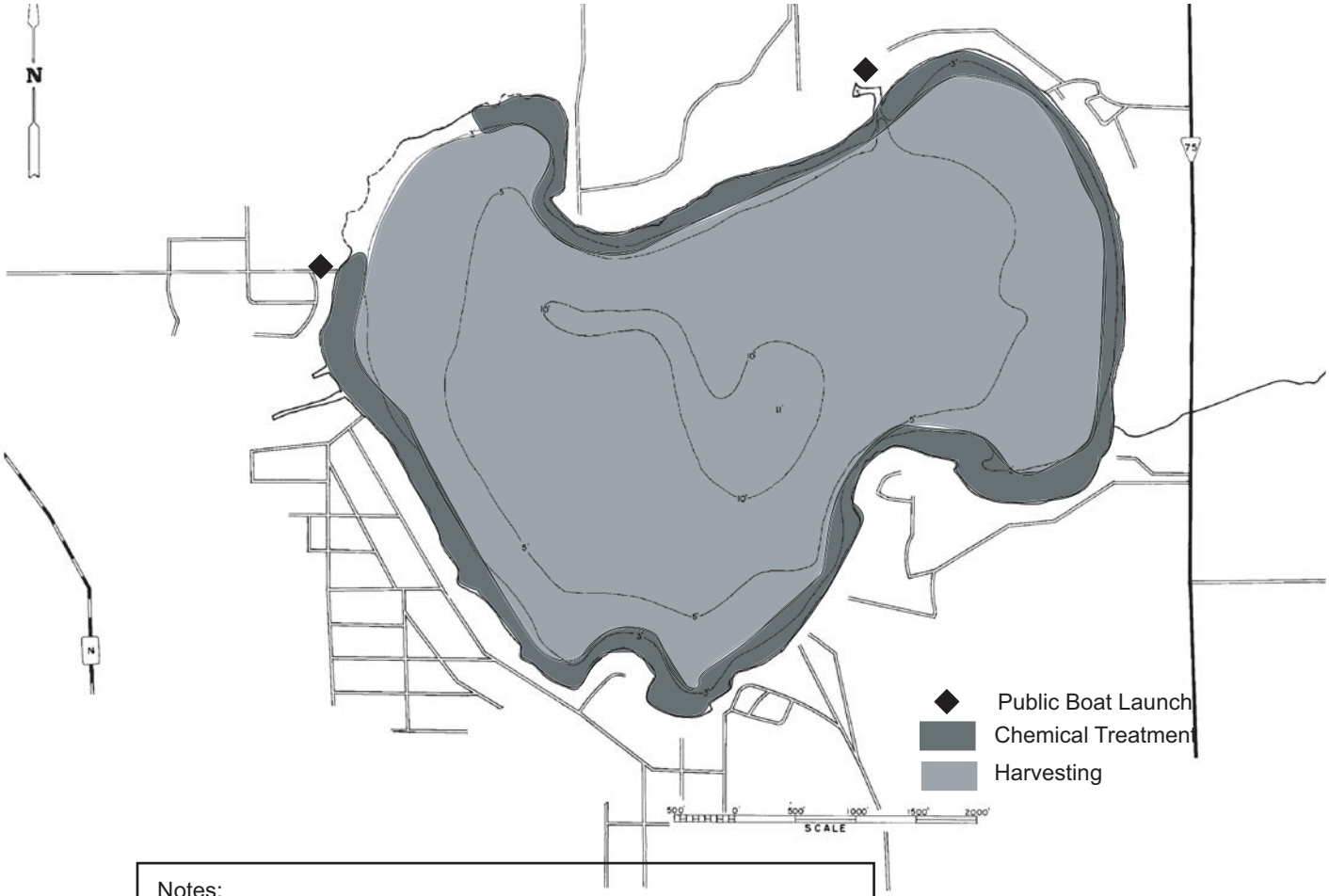
- ***Is the condition impeding or preventing recreational use, or is something else a factor?***
  Access channels may be created either by harvesting or chemical treatment. However, if water depth prevents access during a drought, chemical treatment will not open up boating access. In this instance 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.



Notes:
1. Chemical treatment for Eurasian watermilfoil, curly-leaf pondweed, and filamentous algae only.
2. Harvest topped-out areas first.
3. Harvest Eurasian watermilfoil and curly-leaf pondweed. Avoid native plants.
4. Do not harvest in water less than 3 feet deep.
5. Whole-lake chemical treatment to be done in early spring, targeting Eurasian watermilfoil and curly-leaf pondweed

Aron & Associates, 2005

Figure 9 Aquatic Plant Management Plan, Eagle Lake, 2004

Chapter VIII
EQUIPMENT - FUNDING

In light of the size and scope of the program, the current equipment is appropriately sized to provide the relief desired. The District should continue to maintain the equipment and replace equipment as necessary to ensure appropriate aquatic plant management on Eagle Lake.

FUNDING

The District taxing authority provides funds to purchase and maintain the equipment, 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	Harvesting equipment	50%
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%

FEASIBILITY

The District's program is a well-run, well-maintained program that manages the aquatic plant nuisances and improves conditions on Eagle Lake.

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 Eagle 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 Eagle 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, especially on the steeper shorelines on the North and East shores.
- 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.
- The District may conduct a whole-lake chemical treatment to eliminate Eurasian watermilfoil and reduce curly-leaf pondweed.

Harvesting

- The District may continue to use harvesting to manage exotics.
- Harvesting efforts should emphasize providing public access and safe recreational use.
- Staff should keep cutter bars and paddle wheels out of the sediments. Any harvested areas should have at least one foot of plant material remaining to stabilize the lake bottom.
- Harvesting operators should be trained to identify "good" plants. This will allow the operators to avoid areas with high numbers of pondweeds that should not be cut.
- Every effort should be made to reduce the amount of floating plant debris, especially milfoil fragments, in order to reduce opportunities for establishment in other areas.
- Comprehensive and detailed records should be kept detailing where harvesting takes place, number of loads, and types of plants being harvested, maintenance and downtime.
- Any harvested fish or other wildlife should be returned to the lake. If large numbers of fish are being harvested, the staff should take immediate steps to prevent the fish harvest.
- The District should distribute informational materials regularly to residents on such topics as proper lawn and garden practices, land use impacts and the importance and value of aquatic plants.
- Natural shorelines in environmentally valuable areas should not be harvested except to provide navigational access for riparian landowners.

- The District should maintain off-load sites and the surrounding lake areas in a clean, debris free manner.
- The District may continue the shoreline pickup program.
- Prior to June 15, harvesting should be confined to the primary harvest areas (water deeper than five feet) to protect the fisheries.
- 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.

LOCAL CONTACTS

RACINE COUNTY

County Web Site www.racineco.com

County Executive	Phone: 262-636-3273
Office of the County Clerk Racine Courthouse 730 Wisconsin Ave Racine, WI 53403	Phone: 262-636-3121
Clerk of Circuit Court	Phone: 262-632-3770
Human Resources Department	Phone: 262-638-6680
Public Works/Parks 14200 Washington Ave Sturtevant, WI 53177	Phone: 262-886-8440
Birth & Death Certificates, Marriage Records Register of Deeds	Phone: 262-636-3208
Racine/Kenosha UW Extension Service 14200 Washington Ave Sturtevant, WI 53177	Phone: 262-886-8470
Racine County Planning and Development 14200 Washington Ave Sturtevant, WI 53177	Phone: 262-886-8460
Racine County Historical Society 701 S Main St Racine, WI 53403	Phone: 262-636-3926

Wisconsin Department of Natural Resources

Water Resources	Craig Helker (262) 884-2357
Water Reg and Zoning	(262) 884-2356
Lake Planning Grant and Lake Protection Grant Applications	Heidi Bunk (262) 574-2130
Fisheries	Doug Welch (262) 884-2364

University of Wisconsin Stevens Point

Lake Specialists	Tiffany Lynden (715)295-8903 Bob Korth (715) 346-2192
Adopt-A-Lake	Mary Pardee (715) 346-4978
Invasive Species Coordinator	Laura Felda (715) 346-3366
UWEX Contact Information Web Site	http://www.uwsp.edu/cnr/uwexlakes/staff/default.asp

Wisconsin Association of Lakes	(608) 662-0923

REFERENCES

Amerson, F, et al, 1997. Eagle Lake Watershed Planning Project.

Aron, K., 1992. Aquatic Plant Survey, Eagle Lake. Aron & Associates.

Aron, K., 1995. Eagle Lake Plant Management Plan. Aron & Associates. 42 pp.

Aron, K., 1998. Eagle Lake Plant Management Plan Reassessment. Aron & Associates. 40 pp.

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

Carpenter, S. 1981. Submersed Vegetation: An Internal Factor In Lake Ecosystem Succession. Am. Nat. 1982. Vol 118, pp 372-383. The University of Chicago.

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.

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.

Linden, E. and M. Lehtiniemi, 2005. The Lethal and Sublethal Effects of the Aquatic Macrophye Myriophyllum spicatum on Baltic Littoral Planktivores. Limnology and Oceanography 50(2), 2005, pp 405 - 411.

Losik & Associates et al, 1992, Eagle Lake Lake Management Planning Grant. Michael J Losik & Associates.

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. 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

Southeastern Wisconsin Regional Planning Commission, 1978, Volume One, Inventory Findings, A Regional Water Quality Management Plan for Southeastern Wisconsin-2000.

Southeastern Wisconsin Regional Planning Commission, 1993, Correspondence to Town of Dover.

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

Wisconsin Department of Natural Resources, 1947. A Biological Survey of Browns and Eagle Lake, Racine County Wisconsin. Wisconsin Department of Natural Resources.

Wisconsin Department of Natural Resources, 1968. Report of Fish Kill on Eagle Lake. Wisconsin Department of Natural Resources.

Wisconsin Department of Natural Resources, 1985. Aquatic Community Interactions of Submerged Macrophytes. Technical Bulletin No. 156, Wisconsin Department of Natural Resources, 79 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, 1991. Wisconsin Lakes. Wisconsin Department of Natural Resources, 174 pp.

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