Twin Lakes, Marquette County
Aquatic Plant Management Plan

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CHAPTER 1

INTRODUCTION

Twin Lakes in the Town of Springfield in Marquette County, is a valuable resource in the area, providing significant natural recreational opportunities. The lake is negatively impacted by nuisance aquatic vegetation, primarily Eurasian watermilfoil (*Myriophyllum spicatum*). The community desires to work to improve the lake, enhancing the long term potential of the lake.

This plan presents a general inventory of the aquatic plant communities in Twin Lakes and discussions with respect to the various options for long term management of the aquatic plants. The plan is funded in part by a Wisconsin Department of Natural Resources Lake Planning Grant awarded to the Twin Lakes Conservancy under Wisconsin Administrative Code Chapter NR 190. This plan may also be used as a component of a comprehensive lake management plan.

The difficult task that often faces those who attempt to manage aquatic plants is that user needs often conflict. Fish and wildlife need aquatic plants to thrive. Boaters and swimmers desire relief from nuisance aquatic plants. Those using the lake for “aesthetic viewing” desire an undisturbed lake surface. Balancing all of these user needs takes a continuous effort.

Whispering Pines Estates Property Owners Association was founded in 1986 when the subdivision was built on the north shore of Twin Lakes. When the Association attempted to undertake lake planning work, it was learned the Association did not comply with State requirements to receive grants, so the Twin Lakes Conservancy was created. Twin Lakes Conservancy is relatively new organization, founded in 2001. The Conservancy’s stated purpose is to preserve the natural environment around Twin Lakes for the present and future generations. The group has been very active, already obtaining 2 planning grants for various projects.

The Conservancy desires to:

- Preserve native species within Twin Lakes and its watershed.
- Control exotic and nuisance plant species and protect sensitive areas.
- Lessen the negative ecological impacts of aquatic plant management while providing nuisance relief.

CHAPTER 2

BACKGROUND

Shoreline Development & Aesthetic Features

Twin Lakes is a 39 acre lake located in the Town Springfield, Marquette County, Wisconsin. The lake is actually two lakes connected by a narrow channel. East Twin Lake has a maximum depth of 10 feet, West Twin Lake has a maximum depth of 35 feet. Twin Lakes has a watershed area of 284 acres (Map 1). Lakes with low surface area to watershed ratios are typically found to have better than average water quality. This is because there is less opportunity for negative impacts from non-point source pollution problems.

Twin Lakes shoreline and it's watershed is relatively undeveloped. The south shore is wooded, undeveloped land, the north shore is formerly a Campfire girls camp. The drainage area to Twin Lakes is primarily agricultural and open lands. Residential land use accounts for only a small area of the watershed.

Land use activities can directly affect plant growth patterns in the lake. The runoff from individual homesites, development, and agricultural lands adds to the nutrients and sediments in a lake. That in turn contributes to the plant growth, sometimes to nuisance conditions. To see this affect, it is helpful to look at lakes with storm drain outlets to see the more concentrated effects of rural and urban impacts. Often, the lakebed area near storm drains has different plant and sediment characteristics than other areas of the lake bottom. Nutrients, sediments and other materials entering the lake can severely impact the plants, fish and wildlife. Some of the negative results can produce lower oxygen levels, fish kills and sediment filling in spawning beds and macro invertebrate habitat. Public and property owner education should focus on activities to minimize their impact on the lake.

Much of the shoreline of Twin Lakes is undeveloped, with large expanses of wooded and natural areas that are aesthetically pleasing to lake users.

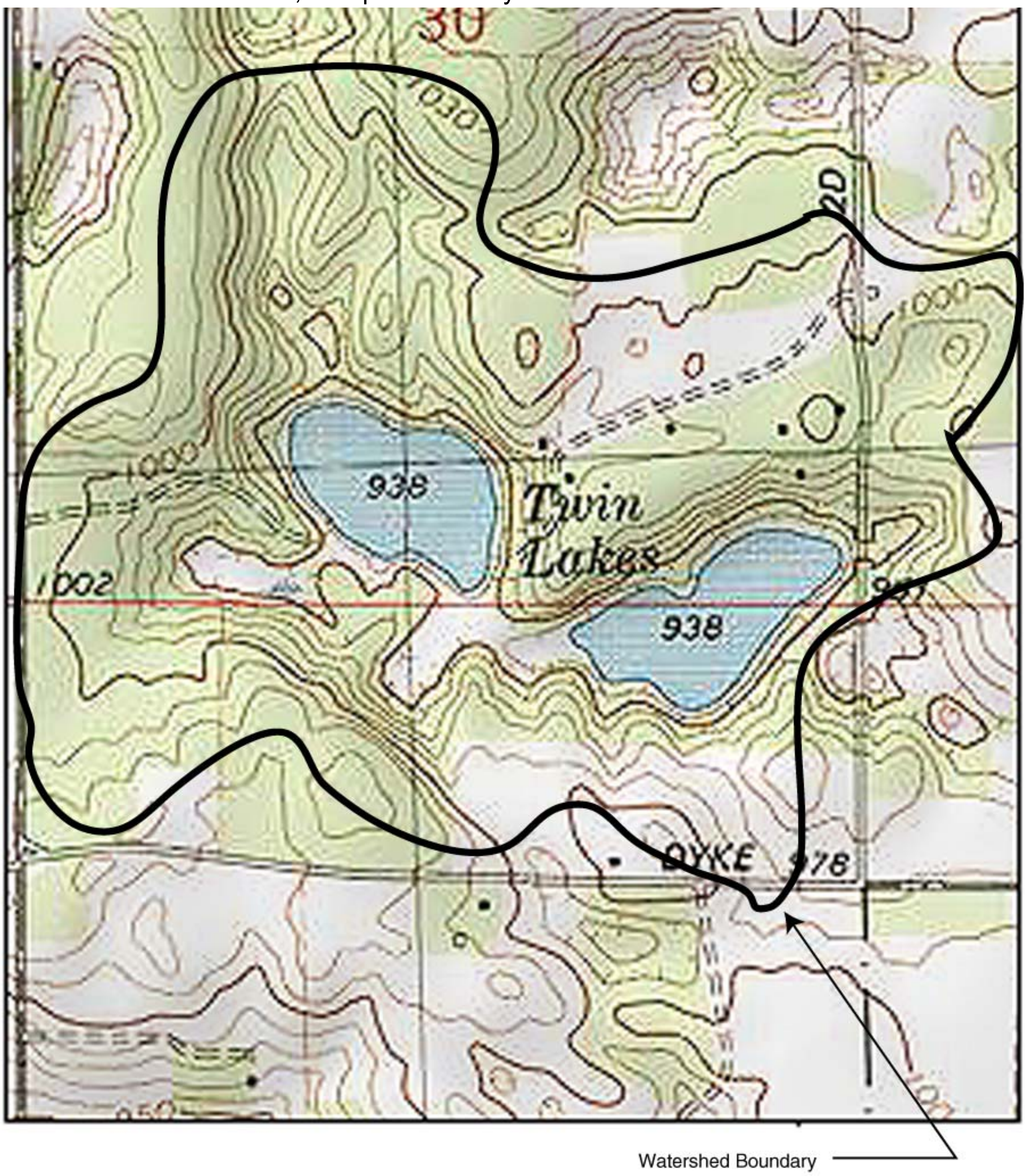
Access Locations

Twin Lakes meets the Wisconsin Department of Natural Resources (WDNR) standards for public access to an inland lake. There is a public access site on the east shore of Twin Lakes. Because of its small size, 39 acres, no motors are allowed on Twin Lakes.

Lake Morphology

The hydrographic and morphologic data for Twin Lakes is shown in Table 1. Twin Lakes is a seepage lake that has not inlet or outlet. Its principal source of water is precipitation and runoff. The lake has a surface area of 39 acres. The maximum depth is 35 feet.

Map 1 - Watershed of Twin Lakes, Marquette County.



Source: Marquette County LCD

Table 1

Hydrography and Morphology of Twin Lakes Marquette County, Wisconsin, 2002
Area = 39 acres
Shore length = 1.8 miles
Shore development factor* = 1.8
Maximum depth = 35 feet
Maximum length = approx. 1742 feet
Maximum width =approx. 845 feet
Watershed area = 284 acres
Ratio of watershed area to lake area = 7.3

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

Source: Wisconsin Department of Natural Resources and Aron & Associates.

Lake Use

Twin Lakes has limited amounts of lake use. The majority of recreational uses are scenic viewing, swimming, fishing, and non-motorized or electric motor boating. Internal combustion engines cannot be used on Twin Lakes.

Boating Ordinance

There are no local boating regulations on Twin Lakes, however, State Statutes do apply.

Water Quality

Twin Lakes has very limited data on water quality. A property owner participates in the volunteer monitoring program with DNR, collecting Secchi disk readings on the East and West Twin Lake. Clarity on East Twin Lake ranged from 5.5 feet in 2001 to a low of 4 feet in 2002 . Clarity on West Twin Lake ranged from a low of 5 feet in 2001 to a high of 6 feet in 2002. The Self-Help Monitoring Data can be viewed on the DNR website at www.dnr.state.wi.us/LakeSelfHelp/ViewData.

The US Geological Survey (USGS) conducted water quality tests on Twin Lakes in 2002. A copy of the preliminary report is included in the Appendix. Both the East and the West Twin Lakes are considered “Eutrophic” or fairly nutrient enriched. The differences in depths in the East and West lakes create different conditions in the water column. The water column of East Twin Lake was completely mixed during the sampling periods. Temperature throughout the depth was relatively uniform. The water column of West Twin Lake was thermally stratified. That means the upper warmer waters were separated from the cold lower waters by a thermocline. The bottom waters were void of oxygen (anoxic). The USGS report indicates that the Secchi depth is lower than would be suspected based on the nutrient levels in the lake. Reduced clarity may be a result of suspended solids in the water column.

A long term, ongoing program of water quality monitoring should be a priority of the Conservance. The information is crucial to developing and evaluating any lake management activity. Continued monitoring through USGS or the expanded Self-Help Monitoring program with DNR should be a priority.

Fishery

Twin Lakes has a good population of large mouth bass, as well as panfish (including perch), and walleye. Carp are present in the system. Carp disrupt bottom sediments and vegetation. This is turn reduces water clarity and encourages the spread of Eurasian watermilfoil. Because game fish are sight feeders, reductions in water clarity affect their ability to thrive. This can reduce the predation on carp eggs, creating a cycle that encourages the growth of carp, at the expense of the rest of the fisheries.

Wildlife

Twin Lakes shoreline is primarily undeveloped and is minimally impacted by humans. This creates a haven for mammals, including deer, otter, mink, muskrats; and amphibians, turtles, and frogs.

Sensitive Areas

Because the development around Twin Lakes is very limited and the amount of recreational use the lake receives is low, the potential value of the resource to fish and wildlife is high.

The WDNR administers a Sensitive Area Designation under NR 107 which guides their aquatic plant management program. The program seeks to protect native vegetation that is important to fish and wildlife. The WDNR may also request that other limitations be placed on activities that would prove detrimental to the native plants. These restricted activities may include dredging, filling, shoreline alterations or sand blankets.

A formal WDNR Sensitive Area Designation has not been done however, much of the diverse plant communities in the lake should be protected. The Conservancy may enter into discussions with WDNR staff to determine whether a Designation can be done for Twin Lakes.

CHAPTER 3

PROBLEMS

Twin Lakes is considered a quality water resource. However, its waters and sediments contain sufficient amounts of nutrients to promote nuisance aquatic plant and algae growth. Phosphorus is the limiting nutrient that affects aquatic plant growth.

Twin Lakes is a small lake with two distinct sides connected by a narrow channel. East Twin Lake has shallow depths while West Twin Lake is deeper. The good water clarity contributes to plants thriving in depths of 13 feet. The fertile soils in the region contribute to the excessive plant problems in Twin Lakes. Carp also present a problem in Twin Lakes, disrupting game fish spawning areas, suspending sediments, reducing water clarity, and negatively impact the aquatic plant conditions.

In non-sewered lake areas, an additional contribution of nutrients may come from improperly maintained or malfunctioning individual septic systems. This is more common is densely populated, older lake communities, than might be suspected in the Twin Lake area. However, improperly maintained septic systems will eventually contribute to increased nutrient levels in the lake.

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 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. However, 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.

When nuisance conditions exist, dense plant beds can limit non-motorized boating. Dense plant beds may also impair swimming and contribute to stunted panfish populations by reducing opportunities for grazing by predators. Also, the canopies created by Eurasian watermilfoil collect debris and are unsightly and sometimes odiferous, for those desiring a pleasing scenic view. 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 strands.

Eurasian watermilfoil is the plant species creating the nuisance conditions in Twin Lakes.

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 is only $20 but a new engine is over $1000. The same holds true for lakes. Public information efforts to prevent problems and the cost of annual monitoring programs are much cheaper than major lake restoration projects. Stopping erosion and nutrients from entering the lake is much more cost effective than attempting to dredge or correct plant and algae problems.

CHAPTER 4

AQUATIC PLANTS

Background

Aquatic plants are very important to the health of the lake. They provide food and cover for fish and wildlife as well as contributing to dissolved oxygen production. Invertebrates, upon which fish and wildlife depend 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 bind 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.

Many aquatic plants are important food sources for waterfowl. Others provide habitat, spawning and shelter areas for fish and amphibians. Exotic plants 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 the plants. Protection of native species is an important means of reducing 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 takes 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. Steeping sloping lake bed areas do not support the vegetation that flatter 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 also 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 dense and 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 like Eurasian watermilfoil. Plant management on lakes should focus on protection and enhancement of the pondweeds, while controlling nuisance species. Twin Lakes has three native pondweeds: variable pondweed, Illinois pondweed, and long-leaf pondweed. A fourth pondweed found on Twin Lakes is the exotic curly-leaf pondweed and is discussed further below.

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 plant that is found in Twin Lakes is Potamogeton illinoensis.

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 Twin Lakes, but is not present at nuisance levels. The most effective means of control of curly-leaf pondweed is to protect the native plants and secondly to prevent turion production. This means conducting plant management activities prior to the formation of the turions. Exercise caution when determining which plant management technique should be used because native pondweeds may be impacted.

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 (WND, 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 a dominant plant in Twin Lakes. Because it is unknown how long the plant has been in Twin Lakes, total removal is unlikely. However, management activities should focus on protection of native plants, and management of Eurasian watermilfoil to minimize the spread of the plant. Non-management of Eurasian watermilfoil on other lakes in Wisconsin has led to increased competition over native plants, and a decline in the density and frequency of native plants.

Twin Lake Aquatic Plants

A general aquatic plant survey was conducted by Aron & Associates in July of 2002. The survey consisted of using a boat and traversing the littoral zone, visually identifying plant species present. Rake casts were done randomly around the lake to verify the visual observations in shallow depths and to identify species present in deeper depths. Map 2 presents the general locations of plant species found.

The aquatic macrophytes observed in Twin Lakes during the survey are listed in Table 2. A total of 9 submersed and floating aquatic plant species were observed. In general, the aquatic macrophyte population of Twin Lakes is dominated by Eurasian watermilfoil (Myriophyllum spicatum). The maximum rooting depth was determined to be 13 feet in the west end and 10 feet (maximum lake depth) in the east end. Eurasian watermilfoil was most commonly found in depths of 8 to 13 feet. It was also dense in the channel between the two lakes. Eurasian watermilfoil was growing to the surface around the lake. Nearly all of the species found during the survey were observed to be sporadically interspersed within the Eurasian watermilfoil beds.

Property owners reported that water lilies used to be much more prominent on Twin Lakes. One area, the very shallow bay on the south shoreline, was an area reported to have large amounts of water lilies. The bottom sediments in this area have no “structure”, that is, they are highly fluid and easily disturbed. Plants may have been uprooted or damaged by predation. Another factor may be the very shallow nature of the bay. The plants may have been frozen out during winter. This bay did have some Eurasian watermilfoil, however, there were large areas with no vegetation present.

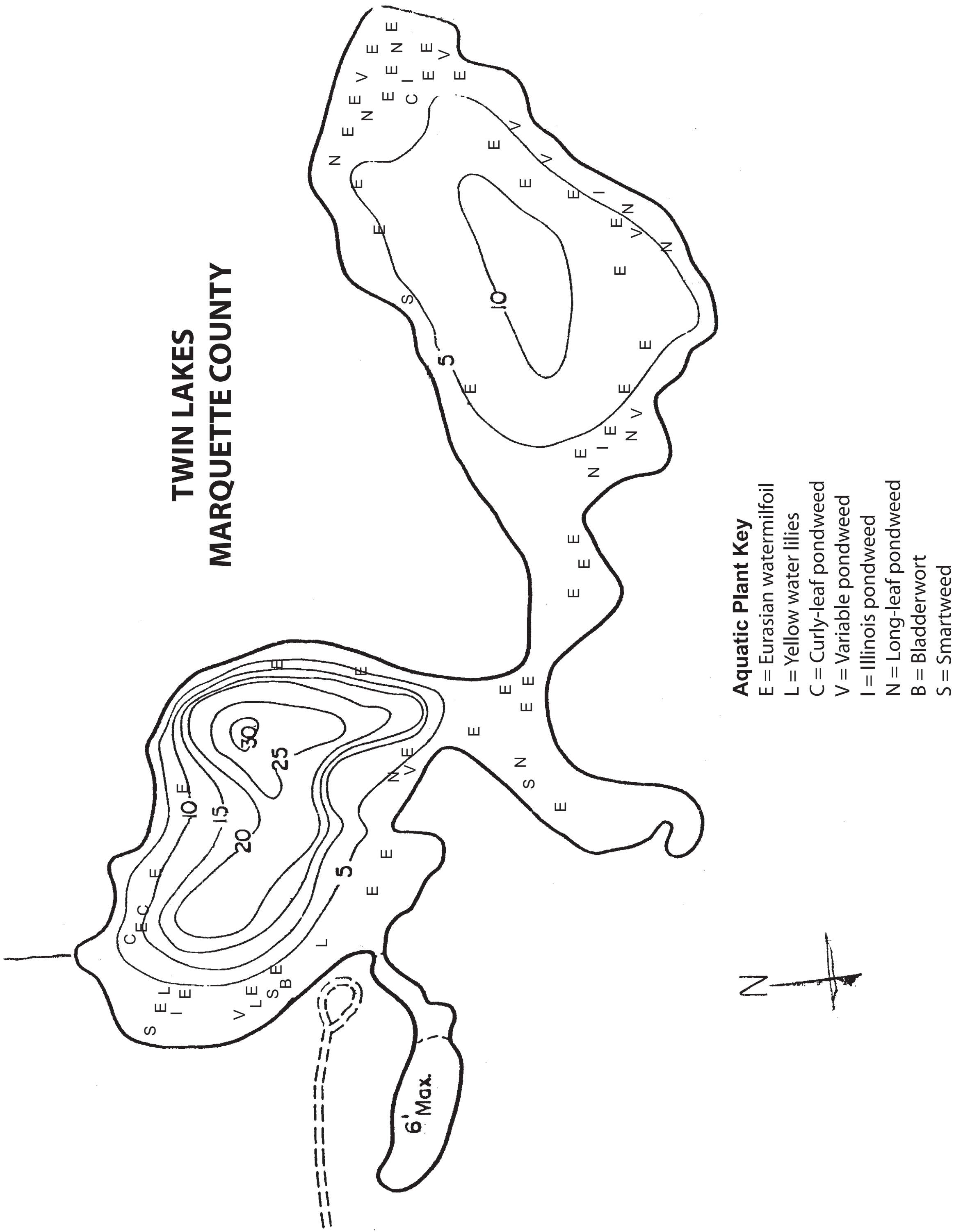
Sandy, firm bottom shoreline areas have primarily native plant species, including sedges, water smartweed and pondweeds.

The plant species list is relatively short. Most lakes surveyed by the author have more native plant species present. The lack of identification during the 2002 survey does not mean that additional plants are not present, it only means they were not identified in this survey. Unfortunately there is no historical data on plants identified in Twin lakes. Lack of resources, the small size of the lake and the large number of lakes in Wisconsin are just a few of the reasons the surveys have not been done previously. Without the historical information it is impossible to know whether more plants existed in Twin Lakes.

Table 2

List of Plant Species in Twin Lakes, 2002		
Scientific Name	**Common Name**	**Ecological Significance**
Brasenia Schreberi	Watershield	Muskrats love it. Roots eaten by beavers. Seeds eaten by waterfowl. Leaves provide harbor to insects, and shade and shelter for fish.
Myriophyllum spicatum	Eurasian Watermilfoil	A non-native, exotic plant species. No ecological significance known.
Nuphar sp.	Yellow Water Lily	Leaves, stems, and flowers are eaten by deer. Roots eaten by beavers. Seeds eaten by waterfowl. Leaves provide harbor to insects, and shade and shelter for fish.
Polygonum amphibian	Water smartweed	Important waterfowl food. Can be aquatic or terrestrial. Good shoreline plant for habitat.
Potamogeton crispus	Curly-leaf Pondweed	A non-native, exotic plant species. Provides food, shelter, and shade for some fish and waterfowl.
P. gramineus	Variable Pondweed	Fruits and tubers are used by waterfowl. Foliage and fuit provides food for muskrat, beaver, deer and moose. The branching of leaves provides habitat for invertebrates and foraging opportunity for fish.
P. illinoensis	Illinois Pondweed	Provides some food for waterfowl and shelter for fish.
P. nodosus	Long-leaf Pondweed	Fruits and tubers are used by waterfowl. Foliage and fuit provides food for muskrat, beaver, deer and moose. The branching of leaves provides habitat for invertebrates and foraging opportunity for fish.
Utricularia vulgaris	Bladderwort	Stems provide food and cover for fish.

Map 2 - Locations of Aquatic Plant Species - Twin Lakes, Marquette County, 2002.



CHAPTER 5

PLANT MANAGEMENT ALTERNATIVES

Control of exotic plant species is an uphill battle. The very nature of the plant species survival provides the means to spread rapidly. Fragmentation is important for Eurasian watermilfoil. Wild celery can spread by releasing from the sediments and floating to new areas in late summer and fall. Curly-leaf pondweed spreads by creating turions from which new plants grow. It is now suspected that Eurasian watermilfoil can spread significantly through seeds as well as fragments (Aron, 2002).

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. The first group of alternatives are the options that are appropriate for use on Twin Lakes. The second group of alternatives are not appropriate for a variety of reasons as presented in each section.

Options Appropriate for Use on Twin Lakes

Hand Controls

A method of aquatic plant control on a small scale is use of hand or manual controls. These 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 could 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.

Hand controls may be used by individual landowners to clear swimming areas. Landowners should be encouraged to minimize the area impacted and 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 the upland shoreline area and in the water. The Conservancy may wish to acquire some rakes and cutters to loan or sell to property owners. Landowners should be sure to collect all plant fragments to prevent spreading a nuisance problem.

Riparian landowners may remove Eurasian watermilfoil plants within their “riparian zone”. Residents may apply for a permit to remove native plants in a single area that is not more than 30 feet wide as long as the area is not a WDNR Sensitive Area. However, with 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.

Native Plant Species Re-introduction

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.

Due to the species diversity of aquatic plants in Twin Lakes, native species re-introduction or expansion has only limited application as a plant management alternative. Small, isolated destruction or removal of Eurasian watermilfoil beds could be combined with planting 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 surface area with native emergent species has declined over the years. The emergent plant species will provide a buffer zone between the water and shoreline thereby reducing the effects of wave action upon the shore, and therefore reducing erosion. The emergent plants also provide important habitat for fish and macro invertebrates as well as increase the aesthetic value of Twin Lakes. Emergent plants should blend into shoreline buffer zones to further enhance their environmental value.

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

Plantings may be considered by the Conservancy or individual landowners. Landowners should be encouraged to allow the shoreline edge to re-vegetate into a stable buffer zone. This could be done as simply as not mowing. This, along with supplemental plantings of native upland plants, would provide habitat for birds, turtles, frogs, and other wildlife, while helping to filter out nutrients and sediments. This will indirectly help with the in-lake nuisance aquatic plants by reducing the 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.

Chemical Treatment

Chemical treatment for the control of aquatic plants is a controversial method of aquatic plant control. Debate over the toxicity and long term effects of chemicals continues. 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. 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 must 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 another 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, or in shallow water where harvesters cannot work. It may also be the method of choice to treat early infestations of Eurasian watermilfoil when hand-pulling cannot be used.

Chemical must be used according to the approved use applications. Application rates, as well as any use restrictions, are indicated on the product labels. Licensed applicators must follow the label requirements.

Treatments need to be repeated at least annually. A single season treatment will not eliminate the nuisance. 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.

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 is can 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 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.

Discussion — 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. **Any chemical treatment conducted on Twin Lakes should only target the nuisance species.**

Prior to any 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. 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.

There may be consideration given to treating Eurasian watermilfoil with the appropriate herbicide. Chemical treatment of the remaining plant communities would not be advised on Twin Lakes. Destruction of any native plant species populations will increase potential problems from Eurasian watermilfoil.

Chemical treatment of Eurasian watermilfoil in Twin Lakes may be considered under a carefully controlled program that would include protection of native pondweeds. Early season application of a 2-4,D product will ensure Eurasian watermilfoil control without harming native species.

Carp Removal

Carp control has been included in this section because of the impact carp have on aquatic plants. As discussed earlier, carp disrupt the bottom sediments, dislodge native plants, and reduce water clarity. An important way to protect the native plant population is to remove carp whenever possible. This may be done by spearing, bow and arrow, or hook and line. Larger scale removal requires a permit from WDNR.

Carp removal is a viable management tool for Twin Lakes. Twin Lakes should develop a program to encourage landowners and lake users to remove carp. This might entail something as large as a Carp Tournament with a prize for the most removed, or individual removals by volunteers, i.e. a Carp Patrol.

Options Not Appropriate for Use on Twin Lakes

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 will continue to expand its range in Twin Lakes. 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-established a balanced plant population.

Although No Management is a possibility for Twin Lakes, it should not be considered for the 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 watermIlfoil and coontail react unpredictably (Nichols, 1991), and muskgrass reaction is not known. An adequate outlet control structure and a source of clean water to refill the lake 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 at least 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 reachable by fish. Turtles and frogs hibernate in shoreline muds and can also be affected, or killed, by a drawdown. Costs associated with a drawdown depend on the outlet control structure. Pumping to lower the lake raises the cost for equipment, electricity, and staff. Costs can be minimal if the lake can be lowered by opening a gate.

Twin Lakes does not have a structure to allow an efficient drawdown and because it is a seepage lake, receives much of its water from runoff from the immediate area and precipitation. Drawdown is not considered a viable alternative for plant management on Twin Lakes.

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 flock formation covering the bottom sediments, preventing phosphorus from being released into the water. Nonpoint source pollution controls must be implemented prior to the use of alum, or the floc will be covered with newer nutrients.

This treatment will not prevent plant growth but will reduce problems from algae growth. Improved water clarity from an alum treatment may increase aquatic plant densities. Water chemistry information must be collected prior to use to ensure sufficient buffering exists to prevent acidification and aluminum toxicity. Waters deeper than five feet are usually treated with Alum. WDNR approval is required.

The east portion of Twin Lakes does not stratify, and so does not release nutrients during anoxic conditions. Water quality sampling, similar to that currently being done by the USGS, would need to identify internal nutrient release from sediments as a problem before this could be considered a viable alternative for plant management on Twin Lakes.

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 the purpose of aquatic plant control, dredging would need to bring the lake bed to depths beyond 13 feet deep, the maximum rooting depth in the lake. Dredging is the most costly form of plant management control. WDNR approval is required. Costs range from $5 to $15 per cubic yard depending upon site conditions, method used, and disposal costs. A WDNR permit is required.

Dredging simply for aquatic plant control is not viable alternative for plant management on Twin Lakes. The cost would be prohibitive and the impact to the quality of the resource would be significant. Dredging may increase the spread of Eurasian watermilfoil by exposing near shore soft sediments.

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. Water quality problems may result from improperly sized aeration systems, so initial planning and engineering must be done carefully to prevent creating even greater problems. Annual maintenance and operational problems and costs are difficult for smaller lake organization budgets and staff. There has been no documented effect of aeration on plant growth. WDNR approval is required.

Twin Lakes has good water clarity. Aeration is not considered a viable alternative for plant management on Twin Lakes.

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 will reduce 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. A negative impact of screens is that all plant species are affected, even natives. WDNR approval is required.

Screens are a viable alternative for the limited applications by individuals on some lakes, however, they are contradictory to the WDNRs goal of protecting native plants. They are not viable for the management of plants on Twin Lakes.

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 have limited application.

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 Twin Lakes.

In British Columbia, Canada, the larval stage of two aquatic insects, the caddis fly (*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) 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 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.

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.

Neither the Grass Carp, insects, nor fungus are viable alternative in Twin Lakes. No signs of the weevil were identified in Twin Lakes in 2002.

Harvesting

Selective 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).

Harvesting must be done in waters deeper than three feet. Harvesting in shallower areas will increase damage to the equipment, 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. 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. 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, increases 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.

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 is 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 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.

Harvesting is a very costly management alternative. Purchase of equipment can exceed $100,000 in capital costs. State grants are only eligible to lakes which harvest a minimum of 30 acres, making Twin Lakes ineligible for a grant. Only two contract harvesters are known to operate in Wisconsin, charging approximately $125 per hour with a 40 hour minimum.

At this time, harvesting is not a viable alternative for aquatic plant management on Twin Lakes because of the cost and the size of the problem. Landowners should be encouraged to remove floaters from their shorelines. Material can be mulched or used in plant beds.

CHAPTER 6

HISTORICAL PLANT MANAGEMENT

There has been no permitted aquatic plant management on Twin Lakes.

CHAPTER 7

PLANT MANAGEMENT PLAN

Goals and Objectives

The goals of the aquatic plant management program are to:

- Preserve native species within Twin Lakes and its watershed.
- Control exotic and nuisance plant species, specifically Eurasian watermilfoil.
- Protect sensitive areas.
- Lessen the negative ecological impacts of aquatic plant management while providing nuisance relief.
- Eliminate carp.
- Develop an ongoing educational program.
- Eliminate the use of fertilizers on the shoreland.
- Develop a watershed watch program.

Discussion

Management efforts should be directed toward protection and maintenance of the resource with a primary focus on controlling Eurasian watermilfoil. Control of native plants is not an objective of the plan and will not be done. Chemical treatment, hand removal, carp removal, native plantings, and educational projects may be used to control Eurasian watermilfoil.

Chemical Treatment

Chemical treatment of Eurasian watermilfoil may be done using only 2-4,D products at a rate sufficient to kill the plants, without impacting native species. When susceptible plants (bladderwort, watershield and waterlilies) are in the treatment area, the product may only be used at a rate low enough to avoid impacting the native plants. If budget constraints limit the amount of treatments that can be done, chemical treatment should focus on the larger, monotypic stands (areas with few or no native plants) of Eurasian watermilfoil. Products that impact pondweeds (Reward, and Aquathol K) should not be used. Early season treatment, (in May) will minimize the impacts to natives, reduce the chemical needed, and will reduce the plant biomass that needs treatment. Map 3 may be used for a permit application to control Eurasian watermilfoil. Treatment should be done in May at 100 lbs per acre. Liquid or granular may be used.

Hand Removal

Hand removal of Eurasian watermilfoil should include removal of the root material. Take care to avoid native plants. Those conducting the hand removal should be trained to identify Eurasian watermilfoil to avoid confusion with similar native plants.

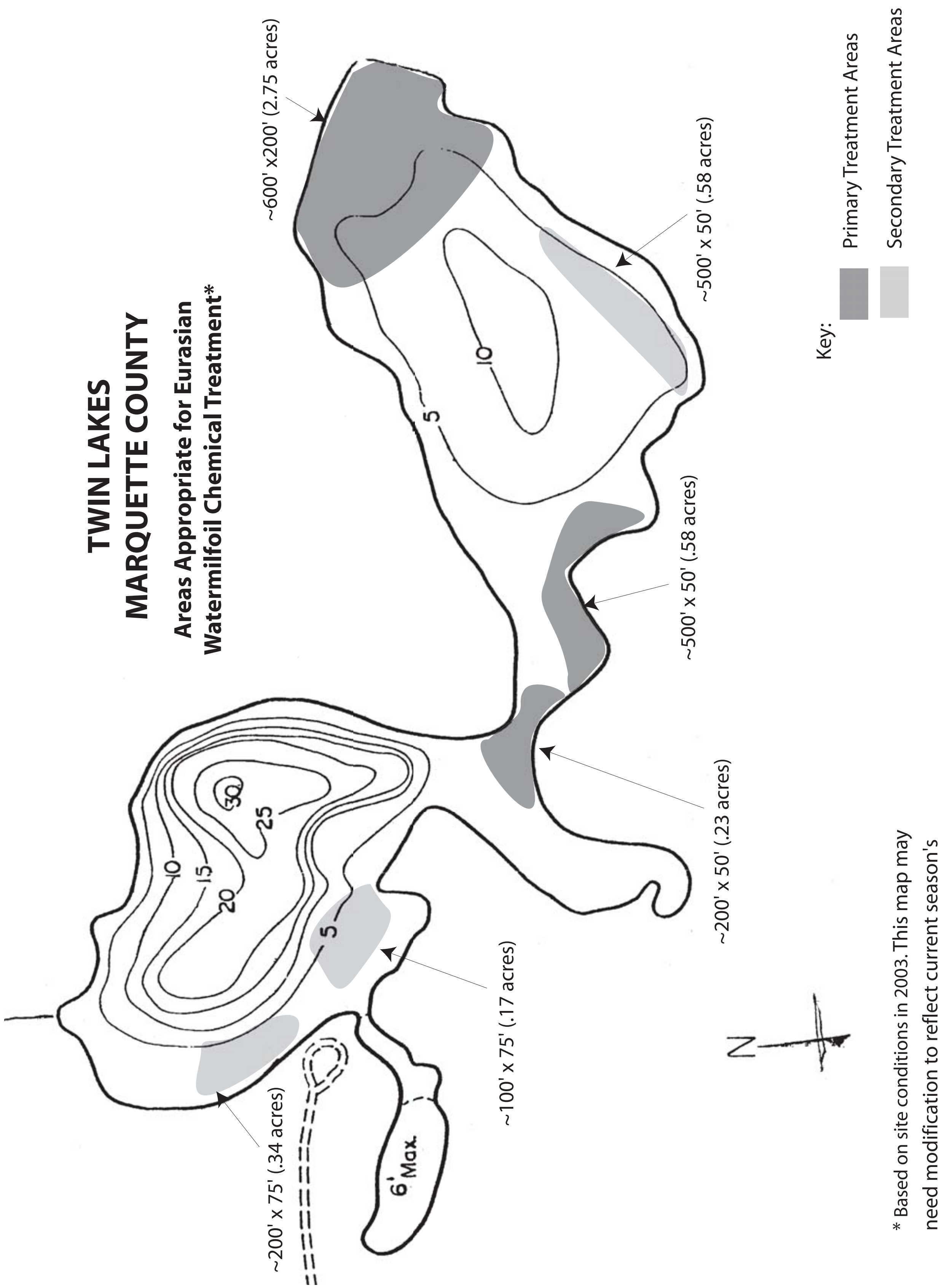
Hand removal of native plants should be avoided. In 2002, there did not appear to be any native plants creating a nuisance in the pier zone, so there should not be a need for individuals to remove native plants. Any removal of native plants requires a permit from WDNR.

Landowners should be encouraged to regularly clean floating plant debris from their shorelines. Debris should be mulched or placed in gardens or plant beds away from the shoreline.

Carp Removal

The Conservancy should consider the creation of a Carp Patrol. The Patrol can undertake projects to remove Carp from the system. T-shirts, badges, or other such items could identify the Patrol and advertise its purpose. Any carp removal will be of benefit to the resource.

Map 3


TWIN LAKES
MARQUETTE COUNTY
Areas Appropriate for Eurasian
Watermilfoil Chemical Treatment*
~600' x200' (2.75 acres)
~500' x 50' (.58 acres)
~500' x 50' (.58 acres)
~200' x 50' (.23 acres)
~100' x 75' (.17 acres)
~200' x 75' (.34 acres)
10
5
30
25
20
15
10
5
6' Max.
N
Key:
Primary Treatment Areas
Secondary Treatment Areas
* Based on site conditions in 2003. This map may
need modification to reflect current season's
.

Other Recommendations

Protect Native Habitat And Shorelines

Consideration should be given to protecting native aquatic plant species along undeveloped shorelines. Developed shorelines should be restored to more natural conditions. This will accomplish a number of management goals including but not limited to:

- Shoreline protection from wave action
- Provide valuable fish and wildlife habitat
- Improve the aesthetic value of Twin Lakes
- Prevent the spread of exotic plant species

The Conservancy may conduct plants or transplantings to encourage the spread of native plant species. The Conservancy should work with WDNR, or the LCC to develop projects and acquire any necessary permits. Projects can include:

—Planting of yellow water lilies. This may be done by transplanting small plants into new shallow areas, or by purchasing roots from an aquatic nursery. When purchased, the small tubers are weighted and can be tossed from shore or from a boat. These should be planted in shallow, near-shore areas.

—Transplanting sedges or water smartweed. Small plants may be removed from areas with many plants and placed into areas without them. The goal here is to encourage the spread of the plants without disrupting or harming existing plants.

—Planting Chara. Chara is actually an algae, but it is usually included in discussions of aquatic plant management. Chara has no roots but is very effective at stabilizing bottom sediments and reducing the opportunity for invasion from Eurasian watermilfoil. Chara can be purchased from an aquatic nursery. It comes in bushel-sizes, shipped in plastic bags. Chunks of Chara are pulled out, dropped into the lake (usually from a boat), and pushed down into the bottom sediments with a rake. The success of this type of planting may not be seen for a couple of years.

Transplanting should only be done if a well-populated host area is available. This will prevent damage to or loss of the existing plants.

Information and Education

The Lake Conservancy should take steps to educate property owners regarding the plant management activities and how people’s activities may affect the plant community as well as water quality in Twin Lakes. Informational material should be distributed regularly to district residents, landowners and lake users and local government officials. Topics should include information relating to lake use impacts, importance and value of aquatic plants, land use impacts, etc.

One important area that should be addressed is proper maintenance and upkeep of individual septic systems. Other issues that should be addressed include landscape practices, fertilizer use, and erosion control. Materials are available for distribution from WDNR and UWEX. Existing materials should be distributed as much as possible. Continued distribution of materials may seem redundant, but the Conservancy should remember that it takes multiple “hits” for information to be recognized and understood. Regular communication with residents will improve their understanding of the lake ecosystem and should lead to long term protection.

Another important educational effort should be developed to inform the public about the benefits of protecting native aquatic plants, giving equal consideration to fish and wildlife, while reducing recreational nuisances.

A watershed watch program should be considered. This group would serve as the local partner, along with WDNR and the County Land Conservationist to prevent problems, react quickly to new threats, and provide local feedback.

Changing Plant Conditions

In the event aquatic plant conditions on Twin Lakes changes, a plan amendment should be conducted. Without a plan amendment, treatment or removal of nuisance plants (Eurasian watermilfoil) may continue, but must be done without impacting native species. Products that impact pondweeds should not be used.

Grants

Funding for educational projects, water quality monitoring, and other lake planning and protection projects may be available from a variety of sources. Projects may be funded in whole or in part, or sponsored through programs with the Wisconsin Environmental Board, the County Land Conservation Committee, WDNR,USGS, or private foundations.

CHAPTER 8

PLAN REASSESSMENT

The Conservancy should re-survey the aquatic plant population at least every three to five years. This will provide necessary historical data, and will provide information on the success of the management activities that are undertaken. The Conservancy should then review the Plant Management Plan every three to five years to ensure its appropriateness to the changing conditions.

REFERENCES

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

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

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

Garn, H.S., 2002. Effects of Lawn Fertilizer on Nutrient Concentration in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin. USGS Water-Resources Investigations Report 02-4130. 6 pp.

Gleason, H. A., 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. Hafner Press, 482 pp.

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

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

Nichols, S. A. and Byron M. Shaw, 1986. Ecological Life Histories of the Three Aquatic Nuisance Plants, Myrophyllum 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. Douglas., 1992. The Management of Eurasian Water Milfoil in Michigan. The Midwest Aquatic Plant Management Society, 30 pp.

SePRO Corp, Sonar AS Specimen Label.

SePRO Corp, Sonar Material Data Safety Sheet.

SePRO Corp, Sonar Guide to Aquatic Habitat Management, SePRO Corp, 24 pp.

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

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, 219 pp.

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

APPENDIX

LOCAL CONTACTS

Marquette County

County Web Site **co.marquette.wi.us**

Administrative Coordinator Phone: 608-297-9136 ext. 281

Office of the County Clerk Phone: 608-297-9114 ext. 6
PO Box 186
Montello, WI 53949

Clerk of Circuit Court Phone: 608-297-9136 x203

County Sheriff Phone: 608-297-2115

Health Department Phone: 608-297-9116

Highway Department Phone: 608-297-9129

Office of the County Clerk Phone: 608-297-9114
County Parks
PO Box 186
Montello, WI 53949

Birth & Death Certificates, Marriage Records
Register of Deeds
PO Box 236
Montello, WI 53949 Phone: 608-297-9114 ext 232

UW Extension Service
PO Box 338
Montello, WI 53949-0338 Phone: 608-297-9153

Tourism, Relocation & Business Development
Montello Area Chamber of Commerce
PO Box 325
Montello, WI 53949-0325 Phone: 608-297-7420

Westfield Chamber of Commerce
PO Box 393
Westfield, WI 53964-0393 Phone: 608-296-4146

Historical and Genealogical Societies
Marquette County Historical Society
PO Box 172
Westfield, WI 53964 Phone: 608-981-2234

Wisconsin Department of Natural Resources

Water Resources and Chemical Permit Applications	Scott Provost	(920) 787-4686 ext 3017
Lake Planning Grant and Lake Protection Grant Applications	Mark Sesing	(920) 485-3023
Fisheries	Dave Bartz	(608) 297-7058

University of Wisconsin Stevens Point

Lake Specialists	Tamara Dudiak Bob Korth	(715) 346-4744 (715) 346-2192
Project WET Coordinator	Mary Pardee	(715) 346-4978
Adopt-A-Lake	Laura Felda	(715) 346-3366

Wisconsin Association of Lakes

(608) 662-0923

GLOSSARY

acid

Corrosive substances with a pH of less than 7.0.

acid rain

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

adaptation

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

aerobic

Processes requiring oxygen.

algae

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

algal bloom

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

alkalinity

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

ammonia

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

anaerobic

Living or occurring without air or free oxygen.

annual

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

annual turnover

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

aquatic

Organisms that live in or frequent water.

aquatic invertebrates

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

aquatic plants

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

asexual

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

basic

Alkaline.

benthic zone

The bottom zone of a lake.

benthos

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

biomass

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

blue-green algae

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

bog

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

calcium (Ca++)

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

cation

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

chloride (Cl-)

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

chlorophyll

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

clarity

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

conductivity (specific conductance)

Is the waters ability to conduct an electric current.

cultural eutrophication

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

decompose

Breakdown of organic materials to inorganic materials.

dissolved oxygen (DO)

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

diversity

Number of species in a particular community or habitat.

drainage basin

The total land area that drains toward the lake.

drainage lakes

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

ecosystem

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

epilimnion

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

erosion

Movement of soil by water and wind.

eutrophication

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

exotic

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

filamentous algae

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

food chain

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

groundcover

Plants grown to keep soil from eroding.

habitat

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

herbicides

Chemicals designed to kill a variety of undesired plant species.

hydrologic (water) cycle

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

hydrology

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

hypolimnion

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

impervious surface

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

limiting factor

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

limnology

The study of inland lakes and waters.

littoral

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

macrophytes

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

marl

White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate ($CaCO_3$) in hard water lakes. Marl may contain many snail and clam shells, which are also calcium carbonate. While it gradually fills in lakes, marl also precipitates phosphorus, resulting in low algae populations and good water clarity.

metalimnion

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

non-point source

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

nutrients

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

pH

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

phosphorus

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

photosynthesis

The process by which green plants create food and oxygen.

phytoplankton

Microscopic plants and algae found in the water.

plankton

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

point source pollution

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

pollution

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

ppm

Parts per million.

retention time

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

runoff

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

seepage lakes

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

thermocline

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

trophic state

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

turbidity

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

turnover

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

watershed

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

wetlands

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

zooplankton

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