Big Brower Lake

Lake Management Plan Update 2023

Recommendations 2024-2028

Submitted By:

Jaimee Desjardins, Environmental Scientist

Jason Broekstra, Biologist

PLM Lake & Land Management Corp.

PO Box 132 · Caledonia, Michigan 49316
phone 616.891.1294 · fax 616.891.0371
www.plmcorp.net

TABLE OF CONTENTS

Lake Management Plan Update

Introduction

This management plan examines current conditions in the lake and provides management recommendations for 2024-2028. The plan will detail an integrated approach to lake management including but not limited to exotic weed control, water quality monitoring and aquatic vegetation surveying.

Characteristics of the Lake

Big Brower Lake is an 85-acre lake located in Courtland Township, Kent County, Michigan. Big Brower Lake is within the Rogue River Watershed. The Rogue River is a major tributary of the Grand River. The watershed is 167,625 acres and includes portions of Kent, Montcalm, Muskegon, Newaygo, and Ottawa counties. The Rogue River is fed by wetlands, county drains, lakes, and both warm and cool-cold water tributaries. Rooted vegetation covers a substantial amount of the littoral zone of the lake.

A majority of the shoreline have been developed for single family year-round homes. The lake has a private boat launch, located on the east shore of the lake. An area of wetlands borders the northern end of the lake near the outlet. A formal lake-use survey was not included in this study, but observations made while working on the lake indicate that the lake is used for fishing, boating and swimming.

PLM's Integrated Plant Management Program

An Integrated Plant Management program should focus on preserving and protecting desirable plant life while controlling unwanted "weed" species through remediation services. In addition, these preventative programs should strive to keep the lake free of unwelcome plants that are known to be pests elsewhere in the region.

The first step of PLM's Integrated Plant Management Program is to *evaluate* and record current lake conditions and lake residents' goals. Next is to *prescribe* a lake specific management plan to control unwanted plant growth. *Implementation* of the agreed upon lake management plan is the final step of the program. After the program has been implemented, PLM will assess the results and use the information to modify and improve priorities, processes and plans – starting the cycle again. The key to a successful Plant Management Program is to minimize the total long-term impacts of noxious aquatic vegetation while preventing new infestations and protecting the aquatic environment.

Why Do Aquatic Plants Become a Nuisance?

In moderation, aquatic plants are good for the lake, providing habitat for fish and other organisms and stabilizing bottom sediments. Plants get to be a problem when their growth becomes excessive and interferes with the use of the lake. At high levels, even native plants can disrupt the balance and be viewed as "invasive". A number of factors can result in excessive growth of aquatic plants. In many, or perhaps most cases, several factors have combined to result in the problem.

Exotic plant species cause many of the most serious weed problems. Exotic plants are plants that are not native to this area, which have been brought to the area and released.

Because they often have few natural enemies (their pests, pathogens, etc. may not have come over with them), they grow out of control. When exotic aquatic plants such as Eurasian watermilfoil and Curlyleaf pondweed invade a lake, they often form extensive dense populations, crowd out native species and reduce the quality of habitat for other organisms.

Human activities also increase the input of nutrients and nutrient-rich sediments to the lake. Nutrients feed the growth of algae in the water and settle on the bottom, where they provide a rich substrate for aquatic plant growth.

Nutrient inputs increase the overall growth of all aquatic plants (exotic and native) and algae. Preventing excess nutrients from entering your lake is much less expensive than trying to fix the problems they cause.

Eurasian watermilfoil

EWM, an exotic species, is an extremely aggressive submerged aquatic plant that has the abilities to form a monoculture among vegetation. EWM spreads by fragmentation (every inch of plant can sprout new growth) and has a very strong root system. EWM forms a canopy above native plants, choking out the competition. EWM also has the ability to overwinter underneath the ice, allowing it to be present throughout the winter. This gives the plant a head starts in growing during the spring and chokes out native plants very quickly. EWM should be controlled as soon as it is found within a waterbody to prevent further infestation and loss of native plant diversity. NOTE: Once a native plant is lost in a lake, there is no guarantee it will return.

Curlyleaf pondweed

Curlyleaf pondweed, an exotic species, usually emerges early each spring, flowers and sets seed in the late spring and early summer, and then collapses by the first week in July. There are, however, exceptions to this pattern regarding juvenile plants, part of this re-growth community can occasionally be found in the late summer or early autumn. These small plants are capable of over-wintering below ice cover. Curlyleaf can be a severe nuisance during the early part of the peak recreational use season. Early control of this species is recommended so that the plant is not allowed to produce large quantities of biomass that die naturally and decompose in early July when water temperatures and the potential for oxygen stress are high. Early treatment/management is also encouraged to take place prior to seed production therefore, reducing the next generation of early pondweed growth.

Starry stonewort

Starry stonewort, an exotic species, looks like a rooted plant but it is actually an algae. The plant is native to Europe and Asia and was first discovered in the St. Lawrence River in 1978. In 1983, it was found in the Detroit River near Belle Isle and has since infested hundreds Michigan lakes. Starry stonewort resembles the native aquatic plant Chara. Unlike Chara, which is generally considered to be a beneficial plant, starry stonewort tends to colonize deeper portions of the lake and can form dense blankets several feet thick. These mats can severely impede navigation and limit growth of more beneficial plants. Starry stonewort anchors to the sediments through rhizoids (primitive root structures) which can also absorb nutrients. Like Chara, starry stonewort also absorbs nutrients from the water through its cell walls. Compared to many other aquatic plants, starry stonewort may begin growing later in the season and persist longer.

European Frog-bit

European frog-bit, an exotic plant, is a free-floating aquatic plant native to Europe, Asia and Africa. European frog-bit was first found in SE Michigan in 1996 but has recently made its way to west Michigan over the last 10 years. European frog-bit can form dense mats on the surface of slow-moving waters like bayous, backwaters and wetlands. Mats can impede boat traffic and alter food and habitat for ducks and fish. Prolific growth of European frog-bit can also reduce oxygen and light in the water column. The plant is spread by plant fragments or turions (seed pods)

transported on boats, trailers and recreational gear. Once established, drifting mats of vegetation spread to connected waters.

Algae

Algae are basically divided into planktonic, filamentous, and macroalgae forms. Planktonic algae are microscopic, free floating plants, often referred to as "water bloom". In large number, the algae can cause water to appear green, brown, yellow, or even red. Filamentous algae, commonly called "pond scum" can form raft-like masses over the water surface. Since they are vulnerable to winds and currents, they are generally restricted to bays, bayous, and sheltered shorelines. Filamentous algae can grow attached to the lake bottom, weeds and docks. The filamentous algae will frequently detach from the lake bottom and form floating mats. The macroalgae includes three types, chara, starry stonewort and nitella. Chara grows like a carpet on the bottom of the lake. It is nature's water filter and is excellent for fish bedding. Chara grows approximately one inch a week during the summer months.

An over abundance of algae is an indicator that there is an excess amount of nutrients within the water column/lake, causing the waterbody to become overly productive. Algae are very beneficial in a lake ecosystem and can be thought of as the base of the food chain. Therefore, some alga is required.

However, when an alga reaches the point of hindering the use of the lake, control measures are available. Firstly, actions should be taken within the watershed to promote a healthy lake ecosystem and decrease nutrient loading, etc. However, no immediate change will be seen with these actions. Therefore, many lakes opt to include limited algae control within their management program.

Management Goals for Big Brower Lake

- The primary goal of aquatic plant management in Big Brower Lake is the control of exotic aquatic plants, where found. The exotic plant species, Eurasian watermilfoil and Curlyleaf pondweed should be controlled throughout Big Brower Lake. The abundance of these species should be reduced to the maximum extent possible, and efforts should be made to reduce their recovery after treatment.
- Aquatic plant management should preserve species diversity and cover of native plants sufficient to provide habitat for fish and other aquatic organisms. Native plants should be managed to encourage the growth of plants that support the Big Brower Lake fishery (by creating structure and habitat) provided that they do not excessively interfere with recreational uses of the lake (e.g., swimming and fishing) in high-use areas. Where they must be managed, management techniques that reduce the stature of native plants without killing them (e.g., harvesting, contact herbicides) should be used whenever possible. Specific areas should be set aside where native plants will not be managed, to provide habitat for fish and other aquatic organisms. Muskgrass (*Chara*) should be allowed to grow throughout the lake, except in where it grows so tall as to interfere with boating and swimming.
- The species Starry stonewort should be actively controlled and managed, if found. Starry stonewort is in the same family as Muskgrass (Chara) but is considered to be an exotic invasive species. Starry stonewort, which looks very similar to the beneficial species Chara, is appearing in more and more lakes. Chara is a highly desired plant because it is typically low growing, keeps the water clear and can slow down the invasion of exotic weed species. Starry stonewort also forms dense mats, but unlike chara, it can grow from 5 to 7 feet tall. Starry stonewort can be very detrimental to a lake's ecosystem and has the ability to kill off native plants and have a negative impact on a lake's fisheries.

- The invasive terrestrial plant Phragmities should be controlled along the shoreline and adjacent wetlands where present. This species is exotic and has the ability to displace beneficial native vegetation. Phragmites (common reed) is a wetland grass that ranges in height from 6 to 15 feet tall. Phragmites quickly becomes the dominant feature in aquatic ecosystems, aggressively invading shorelines, wetlands, and ditches. This plant creates dense stands - walls of weeds crowding out beneficial native wetland vegetation and indigenous waterfowl habitats. Spreading by fragmentation and an extensive root system, Phragmites ultimately out-competes native plant life for sun, water and nutrients.
- Conditions in Big Brower Lake should not be allowed to deteriorate below present levels. Expansion of aquatic plant problems should trigger an adjustment in the aquatic vegetation management strategy. To support such responses, an annual record of vegetation and management should be maintained.
- Preventative measures that protect the lake from further nutrient enrichment should be identified and implemented.

Lake Management Activities 2017-2023

Planning/Evaluation

Vegetation surveys determine the locations of target and non-target plant species. The results of the surveys are used to determine the most appropriate management strategy. The vegetation surveys also document the success of the prescribed management program. An AVAS survey is the State of Michigan's method for conducting a complete aquatic vegetation survey. The Aquatic Vegetation Assessment Site (AVAS) survey divides the parts of the lake capable of growing plants (littoral zone) into subareas and records the cover of each aquatic plant found in each "site". This method of surveying considers not only the types of plant species present in the lake but also the densities of those species. AVAS surveys are also an excellent way to track plant species trends over time. A goal of invasive plant management is to have native plants increase while exotic plants decrease over time. The success of this goal can be illustrated through the use of the AVAS data collected over several years.

Aquatic Vegetation

A complete AVAS survey of Big Brower Lake to determine plant types, populations and aquatic problems is conducted every August/September. Big Brower Lake supports a fairly diverse community of aquatic plants. Fifteen species of aquatic plants were encountered in the August 2022 survey of the lake (Table 1). Rooted plant growth is low to moderate almost everywhere in the littoral zone (0 to 15 feet deep) of the lake.

All of the plants listed in Table 1 are native North American species, except for Eurasian watermilfoil, Starry stonewort, Cabomba and Purple loosestrife. These plants are non-indigenous aquatic nuisance species, i.e., plants from other places. These exotic plants cause considerably more problems than most native species. Eurasian watermilfoil can attain nuisance levels of growth at almost any time of year.

Table 1: Plant Species Found in Big Brower Lake – August 2022

AVAS Code	Common Name	Scientific Name
	Submerged- Exotic	
1	Eurasian watermilfoil	Myriophyllum spicatum
28	Cabomba	Cabomba caroliana
29	Starry stonewort	Nitellopsis obtusa
	Submerged- Native	
3	Muskgrass	Chara
4	Thinleaf pondweed	Potomageton spp
5	Flatstem pondweed	Potomageon zosteriformis
7	Variable pondweed	Potamageton gramineus
9	Richardson's pondweed	Potamageton richardsonii
15	Wild Celery	Vallisneria americana
20	Coontail	Ceratophyllum demersum
	Floating/Emergent- Native	
30	Water lily	Nymphaea odorata
31	Spatterdock	Nuphar variegata
37	Pickerelweed	Pontederia cordata
39	Cattail	Typha spp.
40	Bulrush	Scirpus spp.
	Floating/Emergent- Exotic	
43	Purple loosestrife	Lythrum salicaria

The native plant species benefit the lake, performing such functions as stabilizing sediments and providing habitat for fish and other aquatic organisms. Three species commonly found in higher densities on Big Brower Lake are Chara, Wild Celery and Variable pondweed.

Chara

Wild Celery

Variable pondweed

Aquatic Plant and Algae Control

Over the past five years, treatments for the exotic species Eurasian watermilfoil, Curlyleaf pondweed, Starry stonewort and Cabomba have been conducted throughout each summer. Spot treatments have also been conducted for the control of nuisance native plants and shoreline algae. Both contact and systemic herbicides have been used to control the plants.

A reflection of proper/successful management is stable water quality parameters and a good fishery, which have been verified through the water quality program and terrific fishing reports on the lake. Continued spot treatments for these exotic species will ensure a proper balanced aquatic ecosystem.

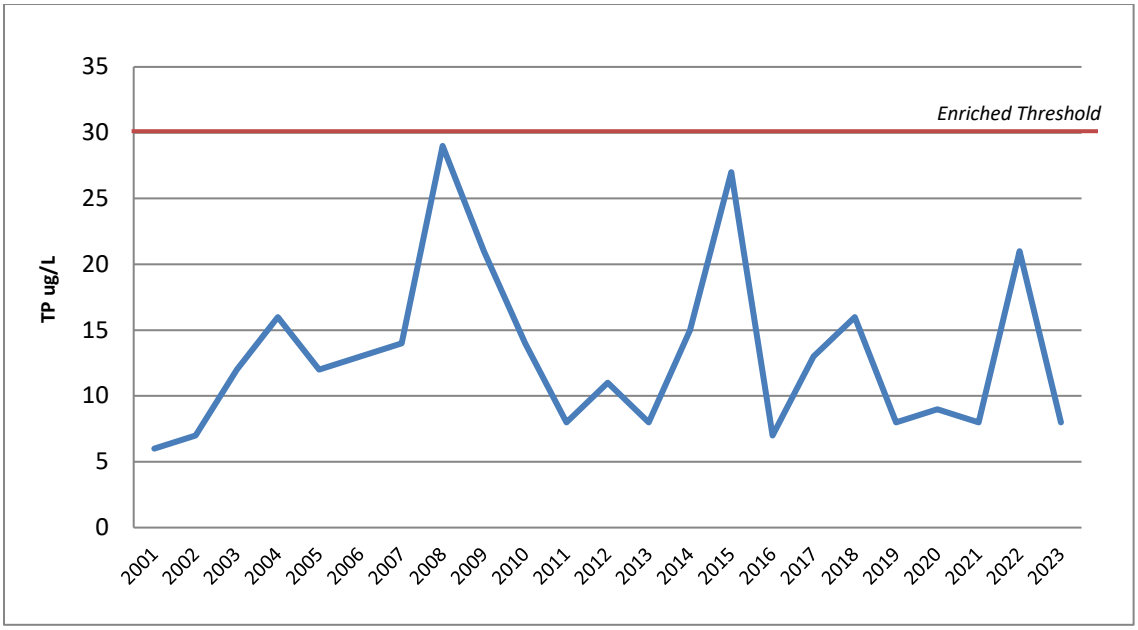
Successful exotic plant management has allowed the native plant populations on Big Brower Lake to flourish. Native plants provide many benefits to a lake, including but not limited to; food for many animals such as ducks and geese, habitat for aquatic insects and snails, cover for young fish and amphibians, and shoreline protection from erosion from wave action. Native plants provide oxygen to a lake as well and absorb nutrients and pollutants from the water column. Promoting native plants is a critical part of proper lake management.

Water Quality Program

Water quality monitoring is a critical part of lake management. Water quality monitoring provides an ongoing record of conditions in a waterbody. Changes in water quality can indicate threats from sources such as failed or inadequate septic systems, agricultural and lawn runoff, burgeoning development and erosion from construction site. Prompt identification of threats to water quality makes it possible to remedy them before irreversible harm has been done. Riparian's enjoyment of the water resource and the value of their property depend on maintaining water quality.

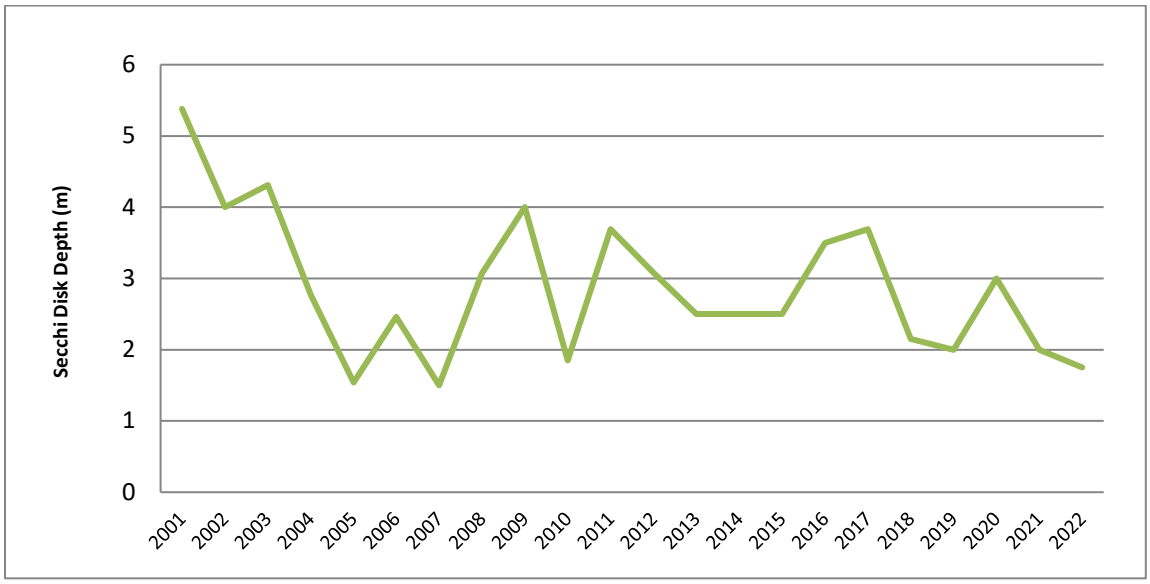
Water quality in the lake has been evaluated by PLM in the spring and late summer since the start of the program. On each occasion, a depth profile of water temperature and dissolved oxygen concentrations were measured at one-meter (approximately three foot) intervals and the Secchi disk depth was measured in the deepest part of the lake (Deep Hole Site). Samples for LakeCheck analysis were collected from the deep part of the lake (surface and bottom water). LakeCheck measures conductivity, total dissolved solids, pH, alkalinity, total phosphorus, and nitrates.

Graph 1: Total Phosphorus Deep Hole, Spring



Total Phosphorus over the last twenty years has remained within the "slight to moderately enriched" category in the surface water of Big Brower Lake. Spring rain events, lake stratification and turn-over can bring variance to the total phosphorus concentrations throughout the years.

Graph 2: Water Clarity Deep Hole, Fall

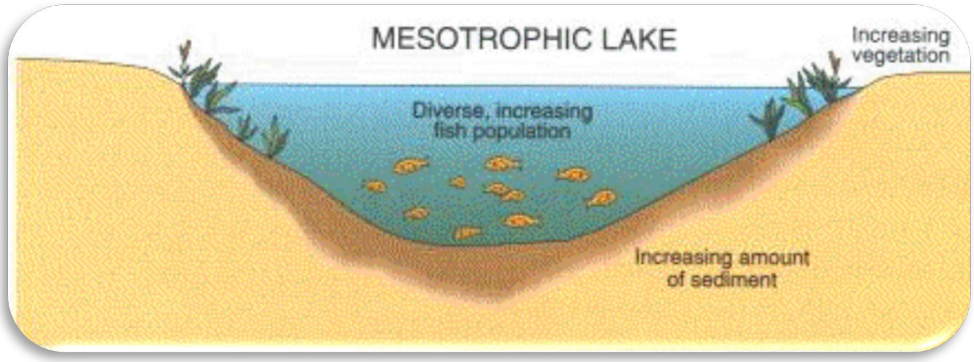


Graph 2 demonstrates the stability of Big Brower Lake over the last 20 years. Water clarity readings are fairly good for a developed lake, ranging from 5 to 17 feet. Water clarity can fluctuate from week to week depending on several environmental factors such as rain & algal production.

Evaluation of Trophic Status

Trophic status is a measure of nutrient richness and productivity (i.e. the ability to grow plants and animals). Trophic Status Index (TSI) values are used to describe the trophic status of lakes. Indices typically rank lakes from 1 to 100, based on such parameters as Sechhi disk depth and total phosphorus. Overall the TSI values for Big Brower Lake would categorize it as being Mesotrophic.

Mesotrophic lakes have moderate nutrient levels, clear water and moderate productivity. Rooted plants are commonly abundant and moderate dissolved oxygen in cooler waters allow for the survival of cold-water fish.



E.Coli Monitoring

E. Coli bacteria monitoring has also been conducted every summer. Coliform bacteria (E. Coli) are invisible. Contamination of surface water by *E. coli* and other bacteria poses a hazard to swimmers and to pets that drink the water. Contamination by fecal bacteria also indicates the potential for contamination by even more dangerous pathogens from animal digestive systems, including bacteria, protozoans (such as *Giardia* or *Cryptosporidium*) or viruses. Contamination can potentially be derived from a number of sources, including failed septic systems, agricultural runoff, or waterfowl or wildlife droppings. Big Brower Lake was sampled along the residential shoreline areas during the peak summer month of July. Sampling is best done in mid-summer when the water temperature is at its warmest and the bacteria have a perfect environment to populate. All sites sampled have always had very low levels of E.Coli and have always been below safe swimming standards.

Strategies for Achieving Lake Management Goals

Aquatic Plant Control Techniques

Areas of the lake that support vegetation will grow plants, despite intense efforts to remove them. Aquatic vegetation provides important benefits to a lake, including stabilizing sediments, providing habitat for fish and other aquatic organisms, and slowing the spread of exotic plant species. In general, native plants interfere less with recreation and other human activities than exotic species. The non-native plant species, Eurasian watermilfoil and curly leaf pondweed concentrate their biomass at the water surface where it strongly interferes with boating, swimming and other human activities. This growth form also allows exotic plants to displace native plants and form a monospecific (i.e., single species) plant community. The dense surface canopies of Eurasian watermilfoil and Curly leaf pondweed provide a lower quality habitat than that provided by a diverse community of native plants. Control of exotic plant species minimizes interference of plant growth with human activities and protects the native vegetation of the lake. The goal of environmentally responsible aquatic plant management, therefore, is not to remove all vegetation, but to control the types of plants that grow in the lake and the height of plants, to minimize interference with human activities.

It is important that control techniques meet the needs and expectations of lake users. Each technique has advantages and disadvantages. Many aquatic plants are relatively susceptible to some control measures but resistant to others. Too often, lake groups select a control technique before determining what their needs are.

Chemical control, or use of aquatic herbicides, is the most common strategy for controlling exotic plant species. Michigan Department of Environment, Great Lakes and Energy (EGLE) regulates the use of chemical control in lakes and ponds across Michigan. This highly restrictive practice uses federal and state approved herbicides and/or algaecides under permits for conrtrolling plants or algae. Dosage, timing, product, and location and among some factors restricted by the permit. Aquatic herbicides provide predictable results and there is extensive research and data regarding all the products approved for use. There are two types of herbicides, systemic or contact. Many of the aquatic herbicides available can be used to selectively control exotic species with minimal or no impact on native species.

Mechanical harvesting is best suited for native plant species. Most native plant species have a higher tolerance to aquatic herbicides and require higher dosage rates (higher cost and reduced selectivity). Mechanical harvesting can be used to provide relief from native plant species if they are causing a recreational nuisance. Harvesting does not kill the plants, but simply reduces it's stature, leaving lower growth for fish habitat and sedimnet stabilization. Mechanical harvesting of Eurasain watermilfoil is not recommended as it will expedite its spread throughout a lake through fragmentation.

Biological control options for nuisance aquatic vegetation are limited. Grass carp, which indiscriminately devour aquatic vegetation, have been restricted in many states because of their nonselective grazing and fear they may escape into nonintended waters. The use of the milfoil weevil (Euhrychipsis lecontei) to control Eurasian watermilfoil has been implemented in many Michigan lakes. PLM Lake & Land Management Corp has many years of experience paticapating in weevil stocking, evaluations and longterm observations related to their performance and sustainability. Although the milfoil weevils may impact EWM populations in certain situations, the use of this tool remains unpredictable.

Bacteria product formulations and application techiques has greatly improved in recent years. Granular bacteria products can be applied to specific shoreline areas to reduce organic muck that has acumulated over the years. As waterbodies age, organic sediment can build up due to excessive plant and algae growth. This process is called eutrohpication. Increasing native populations of bacteria can slow this process down. Reductions in the depth of muck may depend on many variables. Most importantly, the percent of sediment that is organic. The more organics in the sediment, the greater the potential for muck reduction via bacteria augmentation.

Aeration can be a beneficial tool to sustain ecological balance within an aquatic ecosystem. By maintaining sufficient oxygen levels throughout a waterbody, the entire eutrophication process can be slowed down, the health of the fishery can be maintained and overall water quality can be improved. The implementation of an aeration system to control rooted aquatic plant growth is not recommended. Rooted plants, such as Eurasian watermilfoil, will not be affected by aeration. Similar to the use of biological control, the impact of aeration on improving water quality and reducing organic sediment will vary greatly from site to site. Therefore, it is extremely important to thoroughly evaluate each site's conditions and expectations before implementing an aeration system.

Genetic Milfoil Testing advancements over the last decade have allowed milfoil stems to be analyzed to determine genetic makeup (i.e. Northern watermilfoil versus Eurasian watermilfoil versus Hybrid watermilfoil). This testing has confirmed that there are variances in the genetic makeup of different hybrid milfoils. Genetically testing milfoil can be helpful if treatments have shown unexpected results. PLM has been collaborating with Universities across the country in sampling and studying the genetic makeup of milfoil infestations across Michigan. Although this data is very helpful in researching milfoil, genetic testing is not a requirement for management.

Integrated Pest Management (IPM) approaches to aquatic plant control IPM emphasize spending more effort evaluating the problem, so that exactly the right control can be applied at just the right time to control the pest. IPM approaches minimize treatment costs and the use of chemicals. Lake management planning ensures the most appropriate, cost-effective treatment for your lake. Planning is an essential phase of Integrated Pest Management and includes lake vegetation surveys, water quality evaluation and a detailed, written lake management plan. Having the plan in place helps lake users know what to expect from lake management. Survey results provide a permanent record of conditions in the lake and the impact of management practices.

Exotic Plant Management

Aquatic herbicides currently represent the most reliable, effective, selective means for controlling Eurasian watermilfoil. There are currently six systemic herbicides, 2,4-D (Navigate), 2,4-D amine (Sculpin G), triclopyr (Renovate 3 & OTF), 2,4-D/Triclopyr combination (Renovate Max G), Florpyrauxifen-benzyl (ProcellaCOR) and fluridone (Sonar or Avast), which can be used to achieve long-term, selective control of Eurasian watermilfoil. Systemic herbicides are capable of killing the entire plant. Systemic herbicides control Eurasian watermilfoil with little or no impact on most native plant species. Under ideal conditions, several consecutive annual applications of these herbicides can reduce Eurasian watermilfoil to maintenance (low) abundance, such that only relatively small spot treatments are required to keep it under control. For this strategy to succeed, it is necessary to treat most of the Eurasian watermilfoil in the lake each time.

Several contact herbicides, including diquat can provide short-term control of Eurasian watermilfoil and Curlyleaf pondweed. These herbicides kill only the shoots of the plant, and plants regrow relatively rapidly from their unaffected below ground parts.

Harvesting of Eurasian watermilfoil is not recommended. This plant spreads by fragmentation and regrows significantly more rapidly than most native plant species; thus, continued harvesting of mixed plant beds typically leads to nearly complete domination of the aquatic vegetation by Eurasian watermilfoil.

Algae/Starry stonewort Management

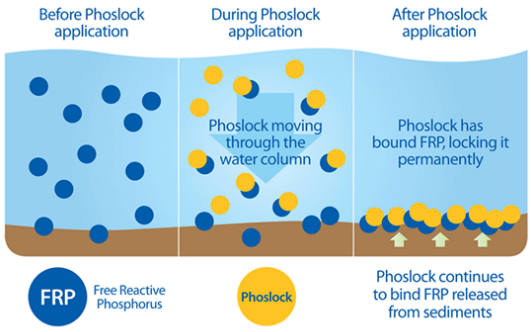
Areas of excessive filamentous algal growth or muskgrass (*Chara*) growth should be controlled using copper-based algaecides. Treatments should be confined to shallow areas where these algae can cause a serious interference with recreation. Muskgrass should only be controlled where it grows up to the surface. Even in these areas, muskgrass treatments should be designed to take off the top layers of growth without exposing bare sediments, so as to preserve the beneficial functions of this species.

The product SeClear should be used for algae management on the lake. SeClear is one of the first algaecide and water quality enhancers in one, designed to replace routine algaecide programs. SeClear provides effective control of a broad-range of algae species while reducing in-water phosphorus levels with each application. SeClear uses nutrient locking technology to bind phosphorus in the water, thus removing it from the water column. Once bound, it is unavailable for algae growth. It can therefore treat the symptoms and the root cause of algae growth.

Starry stonewort should be controlled to the maximum extent possible to keep the exotic plant from continuing to spread. Copper sulfate and/or SeClear G should be used on the lake in areas near shore with dense SSW growth.

Phosphorus Mitigation – Phoslock Treatments

Phoslock is a patented phosphorus locking technology to restore water quality in lakes and ponds. Phoslock is a bentonite clay product containing lanthanum, a naturally occurring low toxicity earth element. Phoslock has the ability to permanently and rapidly remove, "strip", phosphorus from the water column. Phoslock is environmentally friendly and is commonly used throughout the United States, Canada and many other countries throughout the world. Incorporating the use of Phoslock along shorelines that are prone to algae growth may decrease growth and need for management in the future.



Picture courtesy of SePRO Corporation

Emergent Vegetation Management

Purple loosestrife should also be addressed around the perimeter of the lake to prevent the further spread of this exotic species. The systemic herbicide, Renovate 3, is effective at selectively controlling Purple loosestrife. Since Renovate 3 is a systemic herbicide, the root system of the plant will be killed not just the foliage.

Native Plant Management

Native plants should be controlled primarily by harvesting. Unlike Eurasian watermilfoil, most native plants do not regrow rapidly after harvesting, and a single harvest is often sufficient to control them for the entire summer. Normally low-growing species should not be controlled unless unusually fertile growing conditions allow them to grow tall in areas of high recreational use. Contact herbicides applied at higher rates can be effective at controlling native plants that are causing a nuisance close to shore, in between docks.

Monitoring

It is important to maintain a record of lake conditions and management activities. Vegetation surveys monitor types and locations of plants in the lake, providing information that is essential to the administration of efficient, cost-effective control measures. Vegetation surveys also document the success or failure of management actions and the amount of native vegetation being maintained in the lake. Water quality monitoring can identify trends in water quality before conditions deteriorate to the point where remediation is prohibitively expensive or impossible. Records of past conditions and management activities also help to keep management consistent despite changes in the membership of the Lake Association. Records should include (at a minimum):

- Temperature, dissolved oxygen and Secchi disk depth should be measured in the lake. Temperature and dissolved oxygen profiles should be obtained in the deep hole, so as to monitor the timing and extent of oxygen depletion in the hypolimnion (i.e., bottom water).

- Total phosphorus and nitrates should be measured in the surface and bottom water at least two times per season (spring and late summer) to monitor nutrient accumulation in the hypolimnion.
- Lake vegetation should be surveyed on an annual basis (late-spring and/or late summer/early fall) to document the results of plant management efforts and provide information necessary for planning future management.

Natural Shoreline/Nutrient Loading Abatement

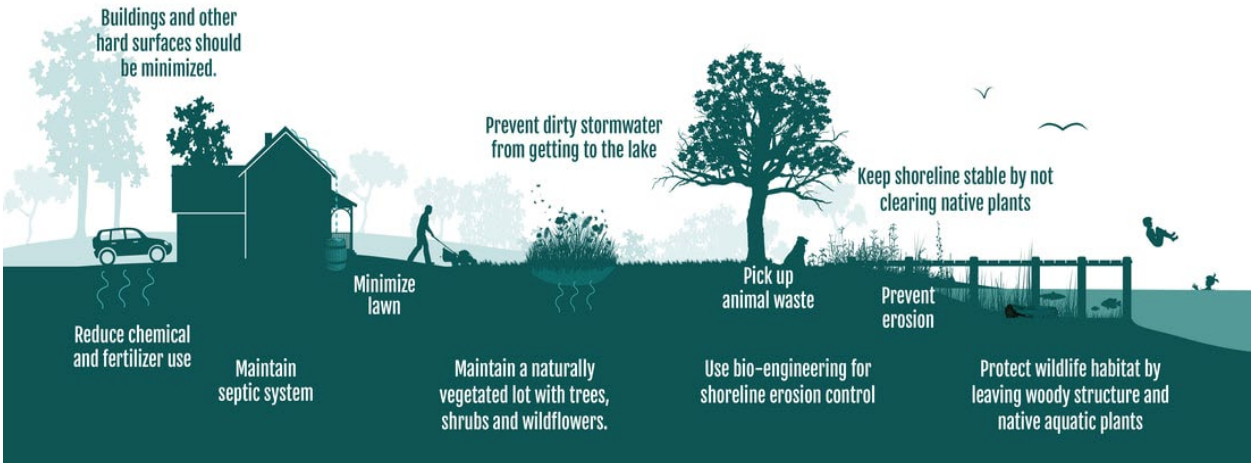
Lakeshore property owners should be encouraged to use phosphorus-free fertilizers on lawns and other areas that drain into Big Brower Lake or the adjacent wetlands. Lakeshore residents should also be encouraged to manage their waterside landscapes according to the recommendations outlined in publications on this topic available from the MSU Extension.

It is also important to remember that rooted plants derive most of their key nutrients from the sediments; thus, they respond slowly, if at all, to reductions in nutrient loading. In fact, if reductions in nutrient loading lead to improved water clarity, the growth of rooted plants will probably increase.

If organic material (muck) accumulates to undesirable levels in shoreline areas, bacterial treatments should be considered as a way to alleviate the buildup.

Shoreline development has led to habitat degradation and as lakes continue to become more and more developed, the impacts continue to be damaging to the lake ecosystem. From mowed grass and sandy beaches, to seawalls and riprap to wake boat waves and fertilizer, development has negatively impacted a lake in all ecological aspects. By working to reduce the human footprint around the lake, the health of the lake will be improved. Natural shoreline restoration is helpful from reducing nutrient loading and runoff to providing habitat for frogs and fish to naturally defending against Canadian geese congregating in your yard, it is important that action is taken to minimize development impact and restore natural features. Maintaining a natural shoreline can greatly aid in the overall health of the lake.

The implementation of natural shorelines should be encouraged around Big Brower Lake. Converting seawall shorelines, if applicable, back to natural vegetation; plants, trees and shrubs along the water's edge has many benefits for the lake. Some of benefits of having a natural shoreline are erosion control, nutrient and pollution absorption, increase in wildlife and fish habitat and reduction of nuisance geese on lawns. If seawall removal is not feasible there are other options residents can do to improve and protect the lake. Placing rip rap in front of a seawall will help reduce wave action thus reducing lake scour. Rip rap can also create a suitable shoreline for animals to access the land and provide places for aquatic insects and plants to grow. Also, native vegetation can be planted within the rip rap, creating a more natural shoreline. Adding rip rap is an easy, affordable and effective way to help the lake.



Picture courtesy of MI Natural Shoreline Partnership

Fishery

Big Brower Lake has a diverse fishery. Many of the fish species rely on vegetated areas to spawn, forage and seek refuge. A healthy native aquatic plant community offers favorable habitat for many species that benefit from the complexity of architectural diversity. Exotic invasive aquatic plant species, such as Eurasian watermilfoil and Starry Stonewort are known to displace native plant communities, reduce architectural diversity and have negative effects on fish populations. Managing exotic aquatic plant species while maintaining native plant communities promotes a healthy and stable fish community.

Restoration

Pending the level of a waterbody's impairment, specific activities such as phosphorus mitigation, native plantings, fish plantings, etc. can be recommended. As this varies tremendous on a site by site basis, it is generally best to work with healthy lake front living practices, early detection rapid response and education/outreach to prevent infestations and make improvements in the overall ecosystem.

In regards to nonnative plant infestations, it is best to control early. Controlling nonnative plants early is key to lowering the impact to the native plant communities. If and when a monoculture is formed, there is no guarantee that a native species will return. In most cases, once a nonnative plant has been controlled, native plants will naturally flourish in that area. If and when a planting is considered, it is important to only use native species as well as species that have a historical presence within that system. Even native species, once introduced into a new environment can cause negative impacts and have consequences (i.e. Wild Celery (*Vallisneria americana*)).

Prevention

Eurasian watermilfoil, Curlyleaf pondweed and Starry stonewort were most likely introduced to Big Brower Lake by plant fragments carried on boats and/or boat trailers. A variety of other troublesome exotic plants and animals that can be introduced to Big Brower Lake are also transported this way. Preventing their inadvertent introduction to Big Brower Lake can significantly lower the cost of future lake management. Education can be an effective preventative measure. Newsletter articles should alert lake residents to the threat from exotic nuisance plants and animals. Warning signs should be erected at any public boat access sites, if applicable, that encourage boaters to clean boats and trailers when launching or removing watercraft from the lake.

Big Brower Lake Management Recommendations for 2024-2028

Management options are dependent on many factors, including but not limited too, species abundance (density), species richness, species location and many lake characteristics. Whenever an exotic species is found within an aquatic environment, action needs to be taken to prevent long term ecological damage as well as recreational and aesthetic loss that will take place.

Submersed Aquatic Plants

Conventional Herbicide treatments

Systemic herbicides should be used in undeveloped and offshore areas of the lake, as well as any other area deemed appropriate. The treatment should take place once the plants are actively growing but before they are a recreational nuisance. Contact herbicides may be utilized tight to shore in developed shorelines for EWM control. The benefit of using a contact herbicide near shore is that it can target other nuisance vegetation, if needed, and

can also provide a quicker die-down of the plants. Multiple treatments will be required in both the developed and undeveloped areas of the lake throughout the growing season.

Starry stonewort, if found, should be controlled to the maximum extent possible to keep the exotic plant from spreading. Copper based products such as SeClear G are effective herbicides that can be used for control.

Native plant treatments with contact herbicides and algaecides in residential shoreline areas will minimize nuisance native vegetation and algae, if needed. The initial treatment will be scheduled in mid-June to allow for control prior to the Fourth of July holiday, depending upon growing conditions. Follow up treatments in August may be required to address re-growth.

The product SeClear will be used for algae management on the lake. SeClear is one of the first algaecide and water quality enhancers in one, designed to replace routine algaecide programs. SeClear provides effective control of a broad-range of algae species while reducing in-water phosphorus levels with each application. SeClear uses nutrient locking technology to bind phosphorus in the water, thus removing it from the water column. Once bound, it is unavailable for algae growth. It can therefore treat the symptoms and the root cause of algae growth.

Monitoring and Water Quality Testing

Aquatic vegetation will be monitored to document the condition of the lake and to provide warning of any changes in the condition of the lake that need to be addressed by additional lake management activities. Current water quality testing should continue to document overall health of the waterbody.

The Recommended Management Program for Big Brower Lake:

- A spring vegetation survey (to evaluate conditions in the lake and direct management efforts)
- Spring water quality sampling
- Early summer herbicide treatment (to control any Eurasian watermilfoil and/or curly leaf pondweed areas that are found)
- SSW treatments, as needed
- Algaecide/Chara treatments as needed, monthly
- Mid-summer herbicide treatment (to control any EWM areas that are found)
- Herbicide treatment of native plants in mid-late summer, if needed/requested
- Late summer herbicide treatment (to control any EWM areas that are found)
- Late summer water quality sampling
- A fall vegetation survey (AVAS)