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North Lake

Dexter and Lyndon Townships, Washtenaw County

Michigan

Management Opinion
2011

Executive Summary:

~ The primary goal of the North Lake aquatic plant management program is to suppress invasive, weedy species that interfere with recreation, reduce the plant biodiversity and habitat complexity, and destabilize essential ecosystem functions.

A special assessment district was established in 2008 for the purpose of securing the necessary funding to implement the programmatic elements of the North Lake Management Plan.

~ For decades, Eurasian watermilfoil and curly leaf pondweed were the dominant weeds in North Lake and nearly all plant control efforts were focused on the suppression of these two species. In fact, milfoil control was the practically the singular focus of lake management programs in most Michigan Lakes until the mid 2000's. Conditions have changed dramatically in Michigan inland lakes and management strategies have had to adjust to these new challenges. In recent years novel genetic strains of pondweed and milfoil hybrids have emerged as weeds in North Lake. Starry stonewort is a very aggressive and relatively recent invader of Michigan Lakes and is beginning to become a greater nuisance and threat to North Lake. A weedy genetic strain of wild celery was introduced to the upper Great Lakes Region in the mid 1960's and it appears that this plant has been found in North Lake and that it is spreading. These changes in the plant community require that the management program be adaptive and constantly refocused on emerging problems. Aggressive, but selective control is recommended all of these plants and any invasive species that may be introduced to the lake in the future.

Milfoil: Various genetic strains of watermilfoil have been a very big problem in North Lake for decades. Recently the dominant strains of the milfoil in North Lake have been more tolerant of all forms of selective treatment than the milfoil that was found in the lake in years past. It appears that this tolerance is related to a symbiotic relationship that has become established between the plant and the microbial community (biofilm) that covers the surface of the plant. Special management strategies have been developed that help to defeat the ecological mechanisms that confer what can be a significant degree of tolerance to weedy milfoil populations. A combination of contact herbicides is recommend for application to areas that are less than 5' deep. A selective systemic herbicide is recommended for use in deeper water. However testing completed on North Lake in the autumn of 2010 suggest that much higher dose rates of the herbicide will be needed to overcome herbicide tolerance mechanisms. Alternately, the same combination of aquatic herbicides that have proven to be successful for the suppression of weedy milfoil populations in the near shore areas is recommended for the deeper parts of the lake. This treatment strategy would require a variance in the normal permitting polices of the MIDNRE.

Weedy Pondweed: Decades of competition with invasive exotic species such as milfoil and the struggle to be productive in disturbed aquatic ecosystems appears to have contributed to the emergence of weedy, and invasive pondweeds that are probably hybrids of several native

pondweed species. There is one of these weedy pondweed types in North Lake and it is nearly as invasive as milfoil and has become a serious impediment to recreation. Selective control of most native pondweed species is nearly impossible; however, the weedy hybrid pondweeds may be easier to control. Currently, State regulations restrict the control of these plants to near shore shore areas and a combination of contact herbicides is recommended to selective suppress this plant and other nuisance invasive species from the near shore areas. This same combination of herbicides is also recommended for the control of nuisance milfoil populations.

Wild Celery: State agencies introduced a strain of wild celery, found in Arkansas, to lakes in the upper Great Lakes and upper Mississippi River regions when native regional populations crashed and threatened canvasback duck populations that were important resources in those areas. Wild celery is not usually considered to be a weedy species in most other parts of the world; however, it has become a very serious nuisance in parts of the North America where this strain of wild celery was introduced. When it grows to the surface, it becomes a very serious impediment to boating. It also produces a white, spiral shaped "flower stalk" that is very tough and can easily tangle and stop low horsepower boat motors. Perhaps one of the most annoying characteristics of wild celery is that it is commonly uprooted by water birds that feed on fleshy, potato-like structures that are produced by the roots of this species. It is also common for the plant to uproot "naturally" which seems to help to spread the plant to other areas of a lake. Between the natural uprooting phenomenon and the activities of water birds, large mats or rafts of wild celery vegetation can float to the water surface. Rafts of wild celery can be ushered to leeward shorelines by wind and create a very significant nuisance for shoreline residents when these mats accumulate to considerable depths and begin to decompose. They impair boat access, swimming, irrigation water intakes, and create an aesthetic and odiferous nuisance. Recent studies also have found that the bacteria that inhabit the decaying wild celery mats can contaminate public health agency samples and lead to the unnecessary closing of public swimming beaches.

Best management strategies have been sought for decades, but reliable wild celery control has been illusive, at best. Aquest Corporation is conducting a study on a Michigan Lake where a new and promising control strategy is being developed. The results of this study should be available in in late 2012. Until then, there are no known reliable control strategies that can be recommended for North Lake that can provide any assurance that the outcomes will meet anyone's expectations.

Starry Stonewort: Starry stonewort is certainly the most aggressive, invasive plant that inhabits North Lake. It is more aggressive than milfoil or any other common exotic invasive or invasive species found in Michigan Lakes. It is not a higher plant, but is an alga that can be easily and selectively controlled with the correct combination of algaecides. The spread of this plant appeared to have been constrained by the combination of herbicides that were used to control milfoil and weed pondweed in 2009; however, it has continued to spread from the east side of the lake in a westward direction. It was observed in most parts of the lake in 2011. It has become increasingly common to observe that native Chara species that closely resemble starry stonewort (both plants are part of the charoid algae family) begin to exhibit some of the same weedy characteristics of Starry Stonewort when both plants inhabit a lake. Weedy forms have chara have become a significant nuisance in the along the northwestern shore of the lake in the past 2 years. It has been necessary to control provide control of chara along these shorelines to provide access to the open water for the residents that are located adjacent to these areas.

Despite the significant threat to biodiversity and ecosystem stability that accompanies the invasion of lakes by starry stonewort, there are some possible benefits that can be associated with the aggressive growth of this plant. It is able to extirpate (outcompete and eliminate) nearly all species found in Michigan lakes, including milfoil and curly leaf pondweed. The need for large-scale milfoil treatment has been reduced in other lakes where starry stonewort has become more established because the milfoil is not able to compete with starry stonewort. Starry stonewort is

capable of growing to 8' tall; however, will generally cease to grow any taller than approximately 3' to 4' tall when the water is sufficiently clear to allow light penetration to the deeper parts of the lake. For a variety of reasons, starry stonewort dominated lakes are usually very clear. Desirable native plant species rarely grow in the deeper water of lakes where milfoil, curly leaf pondweed and starry stonewort grow. When starry stonewort displaces milfoil in the deeper waters of a lake it is generally considered to be the replacement of one weed species by another. Because starry stonewort does not normally grow to the water surface in clear water lakes and water depths greater than four feet recreational boating is not hindered as it would be if milfoil were the dominant plant in the deeper parts of the lake. Furthermore, the cost per acre to treat starry stonewort is less than half of the cost that is required to control an acre of higher plant weeds. The cost to manage wild celery is even greater than the cost to control other higher plant species. And, controls for wild celery are notoriously unreliable and rarely produce outcomes that meet the expectations of lake users. Starry stonewort appears to be suppressing the spread and degree of weediness that is associated with wild celery in North Lake. Until better controls are found for weedy wild celery populations, starry stonewort is considered to provide some benefits to the North Lake community.

Water Lilies: It is believed that most or all of the common water lily species found in Michigan Lakes are native types and genotypes. Water lilies are capable of growth on sediments that may not support other rooted aquatic plants. They are however, subject to wide annual fluctuations in area cover because they can be host to a wide range of herbivores and plant diseases. The area of lake that is covered by water lilies can vary considerably from year to year. Occasionally the area covered by water lilies can reach nuisance levels. There are a number of known methods to selectively control water lilies. If they are cut repeatedly and never allowed to produce floating leaves, they will eventually succumb to such efforts and die. They can also be controlled selectively with a number of herbicides and herbicide combinations. The most effective herbicide controls are applied in late August to early November.

~ Conditions need to be monitored to evaluate the outcome of future treatment programs, increasing impact of starry stonewort, and other emerging weed species and genotypes in North Lake. Monitoring is also needed to detect the invasion of several submersed plant species that have recently been found in nearby lakes. These species include, cylindro (blue green algae), hydrilla, invasive pondweed, and red ludwigia.

Prepared by:

G. Douglas Pullman, Ph.D.
Aquest Corporation
351 Channelside Walkway, 4104
Tampa, FL 33602
aquest@mac.com

North Lake

2011 Management Opinion

Purpose of Inquiry and Consideration:

To evaluate status of the submersed flora of North Lake and update lake management plan.

Introduction:

North Lake is located in Dexter and Lyndon Townships, Washtenaw County, Michigan. Regular surveys of the North Lake submersed vegetation community are conducted by resident volunteers, Washtenaw County and Aquest Corporation personnel, several times throughout the plant growing season The observations that are made during these surveys are critical to provide direction for the implementation of lake management plans and as a means of assessing the efficacy of lake management programs.

Administrative and Management Authority:

North Lake is managed under the authority of the Washtenaw County Board of Public Works, which has established a special assessment district to fund improvements to the lake.

Morphometric Data:

Lake Size:	246 acres
Maximum Depth	58 feet
Mean Depth	~ 10 feet
Nuisance Vegetation Management Area	~ 65 to 75 acres

Note: These data were approximated from a Institute for Fisheries Research/MI DNR map which was downloaded from the MI DNR website. These are only approximations.

Management Objectives Overview:

Lakes are complex. Aquatic ecosystems are comprised of number of independent but related systems similar to systems found in people or any other organisms. When considering human health we may focus on cardiac health (circulatory system), bone strength (skeletal system), or nervous or motor disorders (nervous system) and the impact of diet, environment, and genetics on all of those systems. Similarly some of the lake systems that must be considered in a lake management plan include the open water (limnetic) and near shore or bottom associated (littoral and pelagial, respectively) systems. Usually, nuisance conditions develop more rapidly when ecosystem disturbance(s) reaches a level that internal mechanisms in a lake are altered to make it easier for opportunistic or nuisance species to become established and flourish. Ecosystem functions are compromised by a wide range of conditions that are referred to as natural and cultural (man-made) disturbances. Common sources of cultural disturbance include shoreline development, recreation, changes in water levels, sediment loading, and essential plant nutrient equilibria, the introduction of invasive species.

Some of the more common biological problems found in Michigan Lakes include poor water clarity, blue green algae blooms, excessive rooted and vascular plant growth, invasive macroalgae (plant-like algae) growth, nuisance mats of filamentous algae, declining fisheries, and nuisance fish and wildlife. It is good practice to identify the root cause of lake problems, in order to implement the best-known remedies. However, causative agents can be difficult to identify and sometimes nearly impossible to correct. Consequently, lake management usually involves the implementation of strategies or technologies that help to mitigate against the impacts of pollution, invasive species introductions, and restore the stability and integrity of aquatic ecosystems.

When aquatic vegetation grows at nuisance levels, it is usually necessary to apply remedies to treat the symptoms of the problem rather than the source of the problem (see adjacent text box). Lake management plans are used to guide the decision making required to create a prescriptive course of action to remedy obvious problems or their symptoms and to recommend activities that will help to protect, preserve, or improve the resource. This must be done within the context of all available technology, current regulatory considerations, the sociological disposition of the shoreline community, and available financial resources. Fortunately, there are a variety of things that can be done to enhance and protect lakes. There are no simple cures for many lake problem but there are things that can be done year after year to improve conditions and remediate some of the consequences of ecosystem disturbance.

Disturbed lake ecosystems are typically characterized by low species diversity and habitat complexity. They are commonly described as not meeting the expectations of lake user groups from an aesthetic, utilitarian, or recreational perspective. For this reason, management plans must be multi-faceted and directed toward mitigating against disturbance while causing as little additional disturbance as possible. Compared to the wide variety methods, tools, and strategies used in terrestrial vegetation management practice and agriculture, there are relatively few aquatic plant management tools and strategies. There is no way to manipulate the aquatic environment to provide and sustain the wide range of conditions that are possible in terrestrial systems. Lakes that are geographically predisposed to a certain condition and must necessarily be managed within that context. It is not possible to sustain the conditions found in some relatively unproductive (clear, few weeds) upper great lakes regions lakes in most of the lakes in Michigan. Swimming pool conditions can be created but not sustained. Therefore, the North Lake Management plan is intended to foster the growth of plants that posses characteristics that are consistent with the expectations of lake users. This discourse forms the basis for the North Lake Improvement Plan.

Aquest TIP:

Aquatic Plant Myths and Misinformation

Rooted Plants and Phosphorus

Aquatic plants continue to be the source and subject of misunderstanding and misinformation. During the late 1960's, scientists identified phosphorus, a plant fertilizer and frequent pollutant, to be one of the principal reasons for declining water quality in lakes, reservoirs, rivers, and ponds. It was determined and has been confirmed repeatedly that phosphorus can stimulate suspended algae growth and lead to nuisance algae blooms, which can make water resources look like "pea soup". Unfortunately, technical bulletins and scores of publications glibly state that phosphorus pollution can lead to nuisance plant growth too. Actually the converse can be true. Available light and the depth of the water resources frequently limit the total area covered by nuisance plant growth. If phosphorus levels are not high enough to support nuisance suspended algae production, then the water will be clearer, there will be greater light penetration, and rooted aquatic plants can grow to greater depths. Rooted plants may become an even greater problem where they are already growing at nuisance levels. What about phosphorus and the potential to stimulate greater rooted plant growth? Rooted aquatic plants use their roots to extract phosphorus from the sediments. Most sediments contain more that enough phosphorus to support luxuriant aquatic plant growth. Other factors seem to be more important in limiting rooted plant growth, such as wind fetch and water flow, substrate type, nitrogen and light availability. The key here is that watershed management that focuses on phosphorus loading limits may help to reduce the intensity of algae blooms but may actually worsen rooted plant problems by improving the clarity of the water.

General Goals of the North Lake Management Plan

1. Preserve or enhance ecosystem stability by protecting species and habitat diversity. This is accomplished with the application of targeted, selective management of nuisance opportunistic plant species such as watermilfoil, curly leaf pondweed, weedy hybrid pondweed, wild celery and starry stonewort.

2. Monitor the resource to evaluate the effectiveness or outcome of any applied management efforts and to identify any species that might invade and proliferate and diminish biological and habitat diversity of the lake.

3. Enhance recreational options through the discrete and localized control of nuisance plants near critical use areas only. This will not include the maintenance of localized and specific problems that may exist in the water immediately adjacent to a very limited number of home sites. A balance shall be established between the maintenance of ecosystem stability and recreational use demands.

Aquest Tip:

Choosing the Right Tool

The growth of nuisance native species can be controlled by chemical, biological, or mechanical strategies. Once a lake has been invaded by an invasive aquatic plant or alga species, control efforts must be applied to that lake every year or the invasive species will return and over-take the lake again. It is absolutely critical that the proper strategy or range of management tools be applied to a given nuisance condition in a lake. Failure to apply the proper tool or to do nothing at all will result in further degradation of aquatic resources.

Aquatic herbicides algaecide can be applied to provide selective control of many, but not all nuisance plant and algae species in Michigan. Selective control is key for the improvement of plant community biodiversity and habitat complexity. Aquatic herbicides only provide relief or control of nuisance plant species for 6 weeks to 2 years, depending on the herbicide and the target species. The recent emergence of herbicide tolerant plant genotypes make it necessary to use different herbicides and combinations of herbicides to maintain the effectiveness of these management tools.

Mechanical harvesting is used to alleviate nuisance conditions but can create selective pressures that favor the growth and domination many of the most weedy and opportunistic plant species and depress the production of more desirable plants if it is improperly applied to a set of conditions. Like any management tool, harvesting can cause serious ecosystem damage if it is not used properly.

Currently, there are no independently proven biocontrol methods that can be used to protect or improve submersed aquatic plant community biodiversity. The milfoil weevil has not been proven to be an effective agent for attaining sustainable lake management goals by independent sources.

Fundamental Considerations of the Management Plan

North Lake is a 246 acre lake, located in Dexter and Lyndon Townships, Washtenaw County, Michigan. It is a kettle lake with a maximum depth of 58 ft. and a mean depth of 10 ft. that is oriented in a west to east plane. There are no major inlets. The outlet is on the southwest side of the lake. Nearly all of the area in the lake that is less than 5' deep appears to be suitable for the support of luxuriant plant growth and much of the area that is from 5' to 10' also appears to be capable of supporting rooted plant growth. There is a MI DNR public launch site on the eastern shore.

The organic content and fertility of the sediments in North Lake appear to be variable and range from very low fertility in some areas to highly enriched organic substrates in others. Nearly the entire bottom of the lake appears to be capable of the support of vegetation except for some shallow or sandy wave swept areas that are scattered around the lake. Contrary to popular opinion, research clearly demonstrates that the highly organic or mucky areas of lakes are not particularly favorable for submersed rooted aquatic plant growth. These areas are commonly dominated by floating leaf or aerial leaf species such as water lilies and wetland plants. Only the most opportunistic rooted plant species seem to be able to colonize these areas and many of these plants are considered to be weedy and undesirable. Plants that have no roots such as coontail, bladderwort, filamentous and charoid algae can sometimes grow to nuisance levels over muck sediments. The combination of opportunistic plant species and nuisance algae growth in areas dominated by organic sediments can cause these areas of lakes to be considered as unsightly or undesirable. Consequently, these areas may require more management effort and expense to be maintained as acceptable levels. North Lake contains several species that are capable of nuisance growth over all types of sediments, including muck sediments. The most important plants in this group are Eurasian or hybrid watermilfoil, curly leaf pondweed, weedy pondweed genotypes, wild celery and starry stonewort.

Cultural Use Considerations:

North Lake is classified as a "multi-use" or "multi-sports" lake. It is used for boating, power boating, skiing, swimming, fishing, wild life production, and lawn irrigation. Consequently, it is critical to manage the vegetation community to accommodate the requirements of a wide range of uses. Tall plants are needed to provide refuge and nursery for the fishery and create edge effect to improving fishing. Low growing plants should cover the bottom of the lake where boating and swimming occur.

Watershed Considerations:

Most of the North Lake shoreline has been developed for residential uses and most of the residences on North Lake appear to be "year round" or ""four season" dwellings. The Detroit Board of Education Maintains a camp on the north shore and the shorelines in that area are still in a natural state. Wetlands and wetland vegetation are located found in shallow areas around the southern and western shorelines of the lake. The North Lake watershed is characterized by mixed uses which includes agriculture, forested areas, some residential, and the afore mentioned wetland complexes. Waterside landscapes should be managed to minimize disturbance of the lake ecosystem.

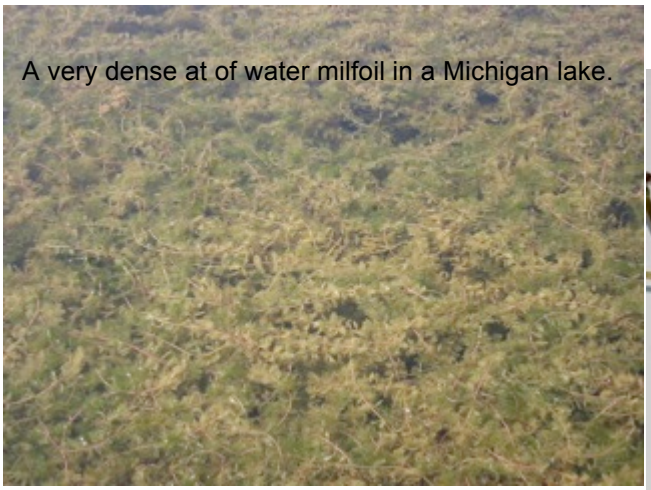
Biological Survey Overview:

Milfoil: The exotic plant species, watermilfoil has been recognized as a problem in North Lake for at least 20 years. Studies recently completed by University of Michigan - Flint and Aquest Corp. researchers have demonstrated that the exotic Eurasian watermilfoil and native northern watermilfoil have crossed and have produced a variety of hybrid genotypes. The milfoil hybrids possess varying degrees of characteristics inherited from the parental genotypes. There are also several Eurasian watermilfoil genotypes in Michigan lakes. The different milfoil genotypes appear to exhibit varying degrees of tolerance to common control strategies. There is some very limited evidence that some milfoil genotypes possess the physiological mechanisms that allow them to tolerate some specific aquatic herbicides. However, there is growing evidence that tolerance is related to the formation of symbiotic biofilm, microbial communities, that protect plants from a wide range of aquatic herbicides (and presumably, naturally occurring substances that may be harmful to the plant). The dominant milfoil genotype in North Lake is not known but it does appear that it could be one of the hybrid genotypes. It is impossible to make a definitive determination without genetic analysis. Anecdotal accounts from a previous herbicide contractor suggest that the milfoil population in North Lake is unusually tolerant of traditional control strategies.

Eurasian watermilfoil (*Myriophyllum spicatum* L.) or a milfoil hybrid has been found at varying densities and throughout the lake since 2008. Density levels have been greater in some years than others and the location of the milfoil beds also appears to change. Starry stonewort is expected to have an increasing impact on the density and distribution of milfoil and other plants in the lake as it continues to spread. However, it has yet to have significantly diminished the density or distribution of milfoil populations in the lake.

Historically, repeated systemic herbicide applications have resulted in the reduction of the density and distribution of milfoil populations with each year of successive use. The outcome of recent 2,4-D applications to North Lake have provided adequate control of milfoil but have not resulted in the longer-term reduction of the density and distribution of milfoil that could not be attributed to "normal" annual variation. A test was conducted in 2010 where twice the normal dose of 2,4-D was applied to selected areas of the lake. Milfoil was not found in the test treatment areas in 2011 and these observations suggest the milfoil genotypes in North Lake may be susceptible to longer-term control if higher 2,4-D doses are used. MIDNRE rules do not normally allow for the use of 2,4-D at these higher application rates. Consequently, it is recommended that the North Lake aquatic herbicide application contractor be instructed to seek a variance from the rules regarding the use of 2,4-D that would limit the use of this herbicide at concentrations at levels below 200 lbs. per acre.

Observations and LakeScan™ monitoring data collected from other Michigan lakes where a special combination of aquatic herbicides commonly referred to as the "triple play" has resulted in significant reductions of milfoil densities and distribution with successive annual applications of this special herbicide mixture. This mixture of aquatic herbicides includes diquat dibromide, Aquathol K, and Cutrine Ultra. It is strongly recommended that the North Lake Management Plan Program include the use of this "triple play" combination and that monitoring be conducted to assess the longer-term implication of the application of this herbicide mixture to the near shore areas of the lake. MIDNRE rules do not normally allow for the use of the triple play to deeper waters of the lake (depths greater than 5'). It is recommended that the North Lake aquatic herbicide application contractor be instructed to seek a variance from the rules regarding the use of the triple play herbicide combination in waters of greater depth than 5'.



A very dense at of water milfoil in a Michigan lake.

A Eurasian x Northern Milfoil Hybrid Plant.

Viable milfoil roots from plants that were treated with 2,4-D in North Lake, 2009.

Curly Leaf Pondweed: Curly leaf pondweed is another exotic invasive plant species, like milfoil. It is widespread and creates significant problems in many Michigan lakes prior to the Fourth of July holiday. It has all the same abilities to diminish plant community biodiversity and destabilize ecosystems, as does milfoil. It is; however, among the easiest plants to suppress being sensitive to a broad range of aquatic herbicides. The control agents that are used to suppress the growth of milfoil and weedy pondweed are also very effective for the control of the herbicide sensitive curly leaf pondweed. Curly leaf pondweed is not expected to be present at conspicuous levels in the future as long as the milfoil and weedy pondweed programs are properly implemented.

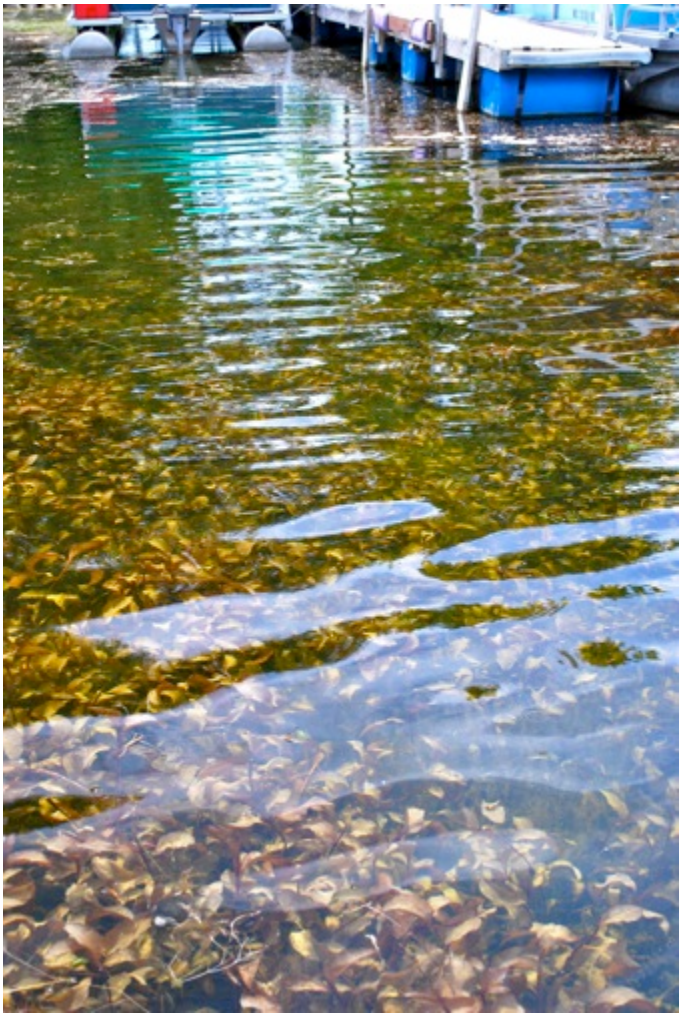
Starry Stonewort: Dr. Doug Pullman, Aquest Corporation was the first to identify starry stonewort in a Michigan inland lake in the early spring of 2006. Since that time it has been found in numerous lakes from Ludington to lakes throughout SE Michigan. This plant is actually an alga species that strongly resembles native Michigan charoid species. It appears that starry stonewort is more aggressive than any other plant currently found in Michigan lakes. Starry stonewort is a charoid species that is nearly impossible to distinguish from other native or endemic Michigan chara species during normal vegetation surveys. Endemic chara rarely grows taller than 6" but starry stonewort has been observed to grow 7' tall. Starry stonewort can crowd out even the most aggressive and opportunistic species such as milfoil and curly leaf pondweed. Once introduced into a lake, it can seriously diminish plant community biodiversity. It has also been found to blanket fish spawning areas and for this reason (and others) is currently believed to be a significant threat to the fisheries of inland Michigan Lakes. Fortunately, it is fairly easy and relatively inexpensive to control.

Chara: Chara is not normally considered to be a nuisance, or potential nuisance in Michigan lakes. In fact, chara is thought to be a particularly beneficial pant in Great Lakes regions lakes. However, it was observed to be growing at nuisance levels in North Lake and other area lakes since 2009. It appears that chara can become or grow to a nuisance that is very similar to the type of nuisance that is created by starry stonewort. This seems to occur when starry stonewort is also found in the water body. There are several explanations that might adequately or reasonably be used to describe the mechanisms that might lead to the creation of nuisance chara populations when starry stonewort is also found in the lake. However, it is critical that chara be recognized as growing to nuisance levels along the northwestern shoreline of the lake and that controls have been applied to those areas to ameliorate nuisance conditions that interfere with boat traffic and swimming. Like starry stonewort, chara is relatively easy to control.

Nuisance levels of starry stonewort and chara were identified in North Lake in 2008. The northwestern shore of the lake has been treated repeatedly with algaecides and the outcomes of those treatments have been considered to be effective. Charoid algae control (starry stonewort and weedy chara) must be a central consideration in the formulation of the annual revisions of the program elements of the North Lake management plan.

Pondweeds: Broadleaf pondweed species have also been recognized to be problematic by some North Lake residents. Nuisance plant growth of this type is generally subjected to discrete, contact herbicide, controls that are restricted to those areas where the pondweeds directly interfere with swimming and boat dock access. In contrast to the management of milfoil and other opportunistic species, mechanical harvesting can be used for native pondweed control without creating worse problems. It is important to remember that starry stonewort is likely to crowd out most native plant species, including the pondweeds. Any problems that may have occurred as a result of pondweed production is likely to diminish in the coming years as starry stonewort spreads and dominates North Lake.

Unfortunately, a broad leaf pondweed genotype was observed in North Lake in 2008 that was very weedy. It was co-dominant as a weedy plant type, with milfoil, during most of every year since it was first recognized as a problem. This plant is nearly as aggressive and invasive as milfoil and is referred to as weedy hybrid pondweed. It is easier to manage than most pondweeds; however, there are permit restriction on the control of this plant. The spread and functional characteristics of this plant must be monitored to create a case for management if an expanded control area is necessary to protect plant biodiversity and recreation.



Wild Celery: Weedy wild celery (a.k.a. celery, tape grass, val,), *Vallisneria americana Michaux*, is probably an exotic species in Michigan Lakes being a descendant of populations introduced to the State in the 1960's by the Michigan Department of Conservation. It has garnered the attention of aquatic plant scientists from around the world who are perplexed by the degree of nuisance that is produced by wild celery populations in some Michigan Lakes. Wild celery is beginning to spread in North Lake that is now considered to have reached a serious level of concern. Currently, the spread of this plant appears to have been impeded by the spread of starry stonewort. However, should starry stonewort populations crash in the late summer, it is possible that wild celery populations could rapidly become a dominant nuisance during the later part of the recreational season. Not only do the leaves and flowers of wild celery interfere with boating and simmers, but it also is easily uprooted by birds, boats, wave, and wind action and forms dense mats that collect on leeward shorelines. These stranded mats of vegetation are large and begin to decompose to create a significant aesthetic and odor problem. There are currently no effective or reliable controls known for weedy wild celery populations. Some of the strategies that have been used to control weedy wild celery in the past are VERY expensive and have failed to yield acceptable or reliably effective outcomes.

Management Recommendations

Management Objectives:

The introduction and evolution of invasive plant and animal species in Michigan's inland lakes coupled with the emergence in increasingly disturbance tolerant "native" or hybrid genotypes represents a significant threat to the stability and integrity of inland lake ecosystems. Consequently, the principal management objective of the North Lake vegetation management plan should be to suppress the production of invasive submersed plant species to the greatest degree possible.

Milfoil, Weedy Pondweeds:

The management of Eurasian watermilfoil, curly leaf pondweed, and weedy hybrid pondweed can be accomplished by the application of a species selective aquatic herbicides known as the triple play. A variance from normal MIDNRE rules would be required to apply this mixture of aquatic herbicides to obtain a permit to apply the triple play to areas of the lake that are deeper than 5'. Should such a variance not be granted, 2,4-D BEE is recommended for the management of nuisance deep water milfoil populations. An application rate of 200# per acre has been observed to provide multi-year control of the milfoil genotypes found in North Lake. A variance from normal MIDNRE rules would also be required to obtain a permit for the application of this strategy to water in North Lake.

Weedy Charoid Algae:

Chara and starry stonewort production is already considered to have reached nuisance levels in some areas of the lake. Best management practices for starry stonewort have advanced tremendously in the past years. It appears that selective starry stonewort is possible in North Lake. It will also be necessary to control the growth of starry stonewort and chara in some parts of the lake.

It is important to note that starry stonewort appears to have impeded the spread of weedy wild celery in North Lake. Because this weed is nearly impossible to control or suppress, it is recommended that the control of starry stonewort be strictly considered within the context of spreading wild celery problems. The indiscriminant control of starry stonewort is not advised at this time.

Water Lilies:

Water lily and spadderdock are common in North Lake. They can grow to nuisance level in North Lake. The total area of lake that is covered by waterlilies does vary considerably from year to year as a result of numerous naturally occurring factors. The MI DEQ will not permit the use of herbicides in some of the areas where the water lilies may be considered to be a significant nuisance but they will allow some limited control in some areas of the lake where lake access is impaired. Combinations of systemic herbicides are recommended for water lily control because they can provide significant long-term relief from nuisance conditions. Mechanical harvesting is not regulated by the MI DEQ and can be used to clear lanes through the water lilies in some parts of the lake.

Action Plan:

The application of contact herbicides and algaecides is recommended for the control of nuisance plant growth in North Lake because they are able to provide reasonably selective control of nuisance species. Aquatic herbicides and algaecides are currently the most effective methods that can be used to target nuisance plants and protect desirable species. They can be used in a manner that results in relatively low levels of ecosystem disturbance, which if not properly considered or controlled, can exacerbate conditions that lead to the establishment of other weedy species. There is an important place for mechanical and physical weed control strategies in lake management programs; however, it must be recognized that these strategies can impose far greater levels of disturbance on aquatic ecosystems than is normally associated with herbicide or algaecide applications.

PROPOSED TIMELINE OF EVENTS

The challenges to effective lake management in Michigan have increased exponentially in the past decade. New weed species and weedy genotypes of familiar species have emerged to demand that management programs be more adaptive and flexible. A singular focus on one or two weed species is no longer adequate to maintain acceptable conditions in lakes. It is impossible to establish a specific timeline for weed management because weather and other ecological disturbances can contribute to drastically different conditions in any given year. However, the following timetable is offered as a "generalized" description of key management program elements and when they might be implemented in a given year.

November or December

Application made to MIDNRE for variance from rules regulating the areas of allowed application for the "triple play" herbicide-algaecide combination and for a 2,4-D application rate of 200# per acre.

Early June

Application of the triple play herbicide combination, for the suppression of milfoil, curly leaf pondweed, and weedy pondweed to as large an area as permitted.

Application of 2,4-D at the highest possible rate, to deeper, milfoil infested parts of the lake.

Mid June

LakeScan™ aquatic vegetation assessment and survey.

Late June

Application of algaecides for the control of filamentous algae

Mid July

Carefully considered and discrete suppression of starry stonewort and weedy chara (nuisance charoid species).

Mid August

Carefully considered and discrete suppression of starry stonewort and weedy chara (nuisance charoid species).

Application of herbicides for the control of nuisance wild celery (if practical).

Early September

Water lily control on a revolving site, around the lake, basis as permitted by the MI DNRE.

LakeScan™ aquatic vegetation assessment and survey.

Early January

Issue of the LakeScan analysis and assessment report.

Further Reading

Aquest Corporation strives to create concise reports that are not bloated with "filler". Consequently, we have developed a number of narratives that help to understand some of the concepts and ideas used to develop the lake management plan. These are provided as "Aquest Tips" and are offered to assist the reader if they wish to gain a deeper understanding of the fundamentals of the management plan. Some are included in the report and identified in text boxes. Others are attached to the management plan update for those who wish to read and consider their content.

Aquest TIP:

Blue Green Algae Part 1:

Why All the Concern?

Blue green algae blooms are becoming increasingly common in Michigan. Blooms can appear as though green latex paint has been spilled on the water, or resemble an oil slick in enclosed bays or along leeward shores. Blue green algae blooms are usually temporal events and may disappear as rapidly as they appear. Blue green algae blooms are becoming more common for a variety of reasons; however, the spread and impact of the zebra mussels has been closely associated with blooms of blue green algae according to MSU researchers.

Blue green algae really a form of bacteria known as the cyanobacteria. They are becoming an important issue for lake managers, riparian property owners and lake users because studies have revealed that substances made and released into the water by some of these nuisance algae (cyanobacteria) can be toxic or carcinogenic. They are known to have negative impacts on aquatic ecosystems can potentially poison and sicken pets, livestock, and wildlife. Blue green algae and can have both direct and indirect negative impacts on fisheries. Persons can be exposed to the phytotoxins by ingestion or dermal absorption (through the skin). They can also be exposed to toxins by inhalation of aerosols created by overhead irrigation, strong winds, and boating activity. Studies are in progress to determine how serious the potential risks are to lake users and those exposed to blue green algae tainted water by other means.

An invasive, exotic blue green alga has recently been found in Michigan. Cylindro is also capable of producing phytotoxins and has been implicated in some public health incidents in Florida. Work groups in Indiana and Wisconsin have not reported similar incidents in their respective states. Unfortunately cylindro blooms are not obvious and the water must be sampled and analyzed to detect their presence.

It is estimated that approximately one half of obvious blue green algae blooms contain phytotoxins. Water resource managers and users are urged to not panic, but remain pre-cautious. Until studies are completed, it is recommended that persons not swim in waters where blue green algae blooms are conspicuously present. Specifically persons should avoid contact with water where blooms appear as though green latex paint has been spilled on the water, or where the water in enclosed bays appears to be covered by an "oil slick". Pets should be prevented from drinking from tainted water. Because the blue green algae toxins can enter the human body through the lungs as aerosols it is suggested that water where there are obvious blue green algae blooms not be used for irrigation of areas where persons may be exposed to the irrigation water. Blue green algae blooms are usually temporal events and may disappear as rapidly as they appear, so it is important to closely monitor lakes that contain occasional or persistent blue green algae blooms.

Fortunately, blue green algae can be easily controlled by a variety of methods. There is increasing evidence that the blue green algae can be targeted specifically with certain algaecides. These strategies could help lake managers to selectively manage and improve suspended algae communities. The MI DEQ does not permit these treatments, so lake users are advised to use caution when entering blue green tainted water.

Aquest TIP:

Blue Green Algae Part 2:

Why Do Blue Greens Become a Problem?

Blue Green Algae are probably not very good competitors with other, more desirable forms of algae. They typically bloom and become a nuisance when resources are limiting or when biotic conditions reach certain extremes. Some of the reasons that blue green algae can bloom and become noxious are listed below:

1. **TP and TN**

   The total phosphorus (TP) concentration in a water resource is usually positively correlated with the production of suspended algae (but not rooted plants, i.e. seaweed). Very small amounts of phosphorus may result in large algae blooms. If the ratio of total nitrogen (TN) to total phosphorus is low (<20), suspended algae production may become nitrogen limited and noxious blue green algae may dominate a system because they are able to "fix" their own nitrogen from atmospheric sources. Other common and desirable algae are not able to do this.

2. **Free Carbon Dioxide**

   All plants, including algae, use carbon dioxide in photosynthesis. Alkalinity, pH, temperature, and the availability of free carbon dioxide are all closely related and inter-regulated in what can be referred to as a lake water buffering system. Concentrations of these key water constituents will shift to keep pH relatively constant. Carbon dioxide is not very soluble (think about the bubbles of carbon dioxide that escape soda pop). The availability of this essential substance can be in short supply in lake water. Many blue green algae contain gas "bubble" that allow them to float upward in the water column toward the water surface where they can access carbon dioxide from the atmosphere. Consequently, blue green algae that can float have a competitive advantage in lakes where carbon dioxide is in low supply in the water. This is also why blooms form near the surface of the water.

3. **Biotic Factors**

   Zebra mussels and zooplankton (microscopic, free-floating, animals) are filter feeding organisms that strain algae and other substances out of the lake water for food. They already know about the blue green algae and find them unpalatable. Studies have shown that filter-feeding organisms often reject blue green algae and feed selectively on the good algae. Over time, and given enough filter feeding organisms, a lake will experience a net loss in "good" algae and a gain in "bad" blue green algae as the "good" algae are consumed and the "bad" algae are rejected and "spit" back into the water. This is one of the most disturbing factors association with the invasion and proliferation of the zebra mussel. Lakes that are full of zebra mussel may not support the production of "good" algae and experience a partial collapse of the system of "good" algae that are necessary to support the fishery.

Aquest Tip:

Rationale for Managing Aquatic Vegetation

Lake leaders and managers cringe when they hear someone say that "the lake has never been this bad before". Often the comment is made without accurate recollection of recent lake conditions; however, there is truth in the statement when lakes are considered within the context of the past several decades. When aquatic vegetation cover and biomass become sufficiently high to disrupt the natural balance of a lake and interfere with recreation people begin to seek solutions to the problems. Aquatic weeds are usually referred to as being a nuisance or invasive. The list of nuisance and invasive plants has grown much longer in the past three decades as weedy species have invaded North America from other continents and other species have become more problematic as they respond to human activity and the introduction of foreign species. Excessive aquatic plant growth interferes with nearly all forms of recreation and causes many biological problems. For example, dense plant growth at the water surface impedes exchange of gases between the air and water, thereby contributing to nighttime dissolved oxygen depletion and large daily pH fluctuations. Dense invasive species growth can cause the desirable plants to decline and can destroy the quality of spawning habitats. Production of desirable sport fish (e.g., largemouth bass) is maximized at intermediate levels of plant cover and biomass. Boaters and swimmer are usually satisfied with the conditions that support a good fishery. It is fortunate that there a number of things that can be done to improve or renovate aquatic plant communities to enhance recreation, improve fishery habitats, and make lakes more resilient to the invasion of new or emerging weeds.

The list of invasive plant species that create problems in Michigan lakes is expanding rapidly. Invasive species are often exotic, which are plants that do not naturally occur in the same geographical area but invade lakes after being introduced from other parts of the world. Invasive plants do not necessarily have to be exotic. Native species or hybrids can emerge as invasive plant genotypes that dominate parts of a lake in response to the selective pressures placed on aquatic vegetation communities as a result of human activity and invasion of other invasive species. Exotic and invasive plant genotypes typically form dense mono-specific (single species) plant beds that result in a loss of plant community diversity, habitat complexity, ecosystem stability, and resilience. Lake quality is seriously degraded unless interventions are applied and the offensive plant species are suppressed. It is not possible to reduce the total amount of aquatic plant biomass that is produced in a lake. And, it may not even be desirable to do that. Generally the problem is not really too much plant growth, but too much of the wrong kind of plant growth.

At moderate density levels, aquatic plants provide important benefits to the lake, including sediment stabilization, invertebrate habitat and cover for small fish. Thus, management of problem aquatic plant growth should be carried in such a way as to preserve desirable aquatic vegetation or preferred plant species. Most preferred species are characteristic of stable, undisturbed ecosystems and are not usually considered to be a nuisance. Effective aquatic plant management can preserve beneficial aquatic vegetation in a number of ways. Selective techniques control problem species with minimal effect on desirable ones. Limiting the application of control techniques to areas where they are needed can also preserve desirable vegetation. In general, areas in every lake should be set aside to support different types of plants. For example some of these areas may support plants that may interfere with boating, but create good "edge effect" for anglers. There are lower growing plant species that should be maintained in areas of the lake where boating is really important. Because invasive species fail to recognize the boundaries of the lake management plan proper vegetation management is a "whole lake proposition". It is certain that a lakes in Michigan will never have "been so bad" unless responsible lake communities take action to mitigate against the consequences of ecosystem disturbance and target invasive species for suppressive