# Iron Lake

**Manchester Township, Washtenaw County**

**Michigan**

## Management Opinion

**2007**

**Executive Summary:**

~ Milfoil and possibly curly leaf pondweed are expected to grow to moderate levels in Iron Lake. Starry stonewort may already be present or is likely to invade the lake in the future and become a nuisance. Aggressive, but selective control is recommended all of these plants.

~ Some discrete control of near-shore, native plants may be required to improve swimming and boat access near some residences.

~ Conditions need to be monitored to evaluate the outcome of future treatment program, and the possible impacts associated with the probable invasion of starry stonewort, and proliferation of harmful algae.

~ The lake must be monitored to detect the invasion of several submersed plant species that have recently been found in nearby lakes. These species include, starry stonewort, cylindro (blue green algae), hydrilla, invasive pondweed, and red ludwigia.

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# Iron Lake

## 2007 Management Opinion

**Purpose of Inquiry:**

To evaluate status of the submersed macrophytic flora of Iron Lake and develop a basis for a lake management plan.

**Introduction**:

Iron Lake is located in Manchester Township, Washtenaw County, Michigan. The submersed vegetation community was briefly surveyed by Washtenaw County and Aquest Corporation personnel during 2007 as part of a review of conditions that can be used to form the basis for a lake improvement and management plan. These kinds of data 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:**

The residents of Iron Lake have requested that the Washtenaw County Board of Public Works investigate the feasibility of establishing a special assessment district to administer a program to implement and fund improvements to the lake.

**Morphometric Data:**

| | |
|---|---|
| Lake Size: | 156 acres |
| Maximum Depth | 40 feet |
| Nuisance Vegetation Management Area | ~99 acres |

**Management Objectives Overview:**

Lakes are complex. Aquatic ecosystems are comprised of number of independent but related systems similar to systems found in humans or 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 which 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 (cyanobacteria) blooms, excessive rooted and non-rooted vascular plant growth, the over production of macro-algae (plant-like algae), 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.

Because there are only a limited selection of nuisance aquatic vegetation management tools, it is usually necessary to apply remedies to treat the symptoms of the problem rather than the source of the problem. 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 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 Iron 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 Iron 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. The total area covered by nuisance plant growth is frequently limited by available light and the depth of the water resources. 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 Lake Management Plan

1. Preserve or enhance ecosystem stability by protecting species diversity and habitat complexity, This is accomplished with the application of targeted, selective management of nuisance opportunistic plant species such as watermilfoil, curly leaf pondweed, starry stonewort, or any other opportunistic and invasive plant species that can be suppressed or controlled.

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

Iron Lake is comprised of 5 deep basins surrounded by shallows that are capable of supporting submersed plant growth. Approximately one half of the lake is less than 10' deep. Most of those areas of the lake that are less than 10' deep appear to support plant growth and some areas appear to be capable of supporting nuisance plant growth. There are few prominent inlets to the lake except for an influent stream on the southwestern shore. Water exits the lake over a control structure located on the northeastern shore. Water flows down Iron Creek to join the Raisin River. Most of the shoreline of Iron Lake is undeveloped. There is no public boat access to the lake; however, the residents of the lake do maintain a boat launch site on the north shore of the lake.

It appears that the organic content and fertility of the sediments in the south end of Iron Lake is a product of the adjacent wetlands. Contrary to popular opinion, studies clearly demonstrate 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 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. Iron Lake contains at least one species that is capable of nuisance growth over all types of sediments, including muck sediments. Milfoil (Eurasian watermilfoil or a milfoil hybrid) was found to have infested scattered areas of the lake where it was observed to grow at nuisance levels. It appears that Iron Lake could support the growth of other weedy species that are already known to be in Washtenaw County such as curly leaf pondweed and starry stonewort. It also appears that it could support the production of other invasive species that are known to be present in southeastern Michigan.

Cultural Use Considerations:

Iron Lake is classified as a "multi-use" or "multi-sports" lake. It is or can be used for boating, swimming, fishing, wild life production, and lawn irrigation. Consequently, it is critical to manage the vegetation community to accommodate the requirements of a moderately 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:

Relatively little of the Iron Lake shoreline has been developed for residential uses. All of the residences on Iron Lake appear to be "year round" dwellings. The Iron Lake watershed is dominated by forested area; however, there does appear to be some agricultural and residential utilization. Residents are urged to consider that waterside landscapes should be managed to minimize disturbance of the lake ecosystem.

**Biological Survey Overview:**

Milfoil: According to reports, the exotic plant species, Eurasian watermilfoil or a hybrid has been present in Iron Lake for several years. The lake community has not engaged in any coordinated and selective program to suppress milfoil in Iron Lake. The dominant milfoil genotype in Iron Lake is not known. The milfoil plants could be hybrid types, however, it is impossible to make a definitive determination without genetic analysis. It is generally distributed but is not a general nuisance in the lake.

Green/Variable Milfoil: There are two species of native or endemic milfoil in Michigan that are very similar in appearance and habit. Because they are so similar and because there is conflicting opinions among aquatic plant taxonomists, these two species are considered together for survey purposes. Green/variable milfoil was observed to grow at nuisance levels in Iron Lake. A hybrid water milfoil known as variable watermilfoil hybrid is a serious nuisance in New England. It has not been identified in Michigan, because no one has done the requisite genetic testing. The genetic identity of the green/variable milfoil in Iron Lake is not known; however, it is clear that it is invasive in the lake. It has come to dominate large areas and exclude the growth of other desirable plant species. MI DEQ permit restrictions will not allow for the management of this plant in most of the areas where it was observed to grow at nuisance levels, even though it may damage the ecosystem.

Curly Leaf Pondweed: Curly leaf pondweed is another exotic invasive plant species, like milfoil, that has the capacity to crowd out other more desirable species and cause ecosystem values to decline. It is widespread in the upper U.S. and creates significant problems in many Michigan lakes prior to the Fourth of July holiday. It is; however, among the easiest plants to suppress being highly sensitive to a broad range of aquatic herbicides. It was not identified in Iron Lake; however, it would not be expected to be present when the lake was surveyed (September).

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. It has been found in several

Washtenaw County lakes may have been identified in Iron Lake in 2007. Definitive identification was not possible at the time of the survey. Starry stonewort is a charoid species that is nearly impossible to distinguish from other native or endemic Michigan chara species. 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. It is easily transported from lake to lake by boats and water birds. If it is not already present in Iron Lake it is highly likely that the lake will be infested with this plant at some future time.

Pondweeds: Native broadleaf pondweed species were also observed to be mildly problematic in Iron Lake, particularly near-shore, adjacent to the developed areas of the lake. These areas could be benefited by discrete, contact herbicide applications. Treatments are recommended for those areas where the pondweeds 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. Starry stonewort is likely 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 when starry stonewort spreads and dominates Iron Lake.

Other Considerations. A suspicious looking and potentially hybrid watermilfoil was found in Lower Straits Lake in 1992 by Aquest and State regulatory personnel. The plant exhibited characteristics of both Eurasian watermilfoil and the native Northern Watermilfoil and was dubbed "norasian watermilfoil". Unfortunately, most North American aquatic plant biologists doubted that such a hybrid might exist. Genetic analysis of plant chlorophyll by University of Connecticut researchers in 2003 finally determined that a hybrid was indeed present in that lake and several others. Extensive studies related to herbicide tolerance are being conducted at the University of Michigan - Flint. It appears that there are several Eurasian watermilfoil and hybrid milfoil genotypes that are tolerant of a wide range of herbicide and biological controls. The strain of milfoil in Iron lake may tolerate some the common aquatic herbicides so it is important to monitor the outcome of any herbicide treatment program. Since the discovery of management tolerant strains of milfoil, Aquest scientists have worked with various aquatic herbicide applicators to develop effective means to manage a wide range of milfoil genotypes. For this reason, and in the interest of good management strategy stewardship, a combination of control agents are recommended to provide adequate and consistent control of milfoil in Iron Lake.

**Management Program Specifications**:

The density and distribution of the species present in Iron Lake suggest that the higher plant community appears to be in a reasonably stable condition. Stability appears to be the result of relatively little shoreline development and recreational utilization of the lake. Ecosystem stability will be compromised; however, if invasive species are not selectively managed in the lake and biodiversity and habitat complexity are allowed to decline. The invasive plant, milfoil is already present in nearly all areas of the lake and will continue to dominate the flora unless it is managed. Starry stonewort is present in nearby lakes and is expected to invade Iron Lake and destabilize the ecosystem and diminish the quality of the fishery. Current MI DEQ policies and permit conditions prohibit the effective management of starry stonewort for the protection of fisheries. Plant community monitoring is strongly indicated for 2008.

Blue green algae blooms were not conspicuously present in Iron Lake in 2007. Zebra mussels were not found in lake but they could invade the lake at some future time. The expansion of zebra mussel populations in lakes can lead to the development of conditions that would favor blue green algae production. Residents are advised to monitor the lake for the presence of zebra mussels and report any findings to County officials. Phytoplankton monitoring is also recommended for 2008.

Runoff from shoreline development and imprudent aquatic plant management could cause significant disturbances and exacerbate some problems in the lake. Dense shoreline vegetation, including turf

grass can serve to filter plant nutrients from runoff before it reaches the lake where it can fertilize suspended algae growth. Although there are many underlying causes of blue green algae blooms (see *Aquest Tip*), nutrient enriched runoff can help to support blue green algae production. Efforts need to be adopted to reduce nutrient loading to the lake. A ban on the use of phosphorus as a fertilizer should be enacted near the lake. Rooted aquatic plants derive their nutrients from the sediments and are not directly affected by nutrients in the water. See the included *Aquest Tip* for further explanation.

Native, invasive plant controls may be needed in discrete areas near the developed shoreline where they interfere recreation and utilitarian uses. Controls should still be strictly limited to only those areas where it is absolutely necessary. Milfoil, curly leaf pondweed and starry stonewort, when it invades the lake, all need to be aggressively managed. Starry stonewort management strategies are still in development but need to be adopted to protect the lake and fishery

**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 Iron Lake vegetation management plan should be to suppress the production of invasive submersed plant species to the greatest degree possible.

The management of Eurasian watermilfoil and curly leaf pondweed can be accomplished by the application species selective aquatic herbicides, and create little further disturbance of the ecosystem. Mechanical harvesting is not recommended for either of these two species because it provides a competitive advantage to these two weedy and opportunistic species that helps them to suppress other desirable species.

Although the management of native plant species (broad leaf pondweeds and thin leaf pondweeds) is not a primary objective of the lake management plan some of these plant species were observed to grow at a nuisance levels in 2007. It is anticipated that a discrete shoreline submersed vegetation management program will be necessary in some areas to alleviate nuisance conditions.

Chara production should be encouraged and supported to cover as much of the bottom of Iron Lake as possible. However, the management of starry stonewort will be required to protect chara populations and other species if it is present and spreads in the lake. Best management practices have not yet been determined for starry stonewort;however, it is important to plan to manage this plant before it has a significant negative impact on the submersed flora of Iron Lake.

Water lily and spadderdock are common in the lake and may be considered to be a nuisance by some residents. The MI DEQ will not permit the use of herbicides in some of the areas where the water lilies may be considered a nuisance. Mechanical harvesting is not regulated by the MI DEQ and can be used to clear lanes through the water lilies in regions of the lake where they impede boating.

*Action Plan*:

Michigan DEQ places restrictions on the use of aquatic herbicides and in turn have created a barrier to the use and implementation of strategies that would have the greatest benefit for Iron Lake. The application of contact herbicides and algaecides is recommended for the control of invasive nuisance plant growth in Iron Lake. Contact herbicides should be applied to the lake as soon as nuisance plant production and temperature permit the application of these agents. An initial herbicide/algaecide application, made in the early summer, should provide acceptable control of nuisance species through the Fourth of July Holiday. A midsummer contact herbicide application may be required to manage nuisance native pondweed and milfoil production, depending upon the rate of regrowth. Representatives of the lake should make a thorough assessment or request the assistance of Aquest Corporation before herbicides are applied to the lake in midsummer. The control of nuisance pondweed production should be restricted to discrete applications to those areas plagued by excessive growth near boat docks and swimming areas. One or possibly two algaecide applications may be necessary for the control of nuisance algae and starry stonewort after it invades the lake. Lake

resident participation in this part of the management program is essential. The expected invasion, spread and proliferation of starry stonewort is likely to eliminate the need for mechanical harvesting in Iron Lake because it is expected to eliminate any nuisance rooted plant production from the middle of the lake where harvesting operations are normally concentrated. It is likely that starry stonewort will exclude the growth of green/variable milfoil and reduce the severity of nuisance conditions caused by this species or hybrid.

**Estimated Costs:**

The cost for weed control for the first year of treatment is estimated to be $16,850. This includes:

- Two herbicide applications (35 acres early summer, 10 acres midsummer),
- Discrete control of near-shore nuisance vegetation (with early summer application),
- Starry stonewort algae (45 acres, several applications during the course of the year).

The cost of the State of Michigan permit application fee is estimated to be $800.

Limnological monitoring, fisheries habitat assessment, and water quality testing are estimated to be $10,364.

The total cost of improvements and program management is estimated to be $30,492 for the first year of treatment.

The total cost of lake improvements and monitoring for 5 years is estimated and provided on the attached estimate form. There are no federal, State, or local grants available for invasive species management. Consequently, the costs of improvements are usually borne by those who are benefited by the actions of the proposed improvement program. An assessment formula can be devised by the Township and County with significant input from local residents that can equitably distribute the costs of the improvements according to relative benefits derived by those that reside or own property within the boundries of the special assessment district. It is recognized that there are relatively few residents located on Iron Lake and that the cost of the proposed improvement program would be higher than the average annual unit assessment as determined for lake improvement special assessment districts established elsewhere in the State of Michigan. Should the costs be prohibitive, it is recommended that a prioritized plan be developed with the Township and County officials and the residents of the proposed special assessment district.

# Iron Lake, Washtenaw County, MI

Estimated Budget Worksheet for:

## Year 1

**Lake Improvements**

Nuisance Control √ $16,850

| | TMT Area | EWM Control | TMT Area | CLP Control | TMT Area | Celery Contol | TMT Area | Other Nuisance Contol | TMT Area | Broad Spectrum | TMT Area | Chara Algae | TMT Area | Filament Algae | TMT Area | Plankton Algae |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Herbicides | 45 | $10,125 | | | | | 7 | $2,450 | | | 45 | $4,275 | | | | |
| Mechanical | | | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | | |

| **Professional Services** | | | **Administrative Services** | | | **Regulatory Costs** | | |
|---|---|---|---|---|---|---|---|---|
| Vegetation Monitoring | √ | $4,696 | Local Administration Costs | √ | $600 | Permit Fee | √ | $800 |
| WQ Monitoring | √ | $2,768 | Communications | √ | $630 | Special Permit Application Prep | | |
| Fishery Monitoring | √ | $2,900 | Contractor Bids | √ | $600 | Regulatory Study Requirements | | |
| Special Studies | | | SAD Hearings | √ | $648 | | | |

**TOTAL ESTIMATED COST** $30,492

## Year 2

Annual Inflation Rate 2%

**Lake Improvements**

Nuisance Control √ $17,187

| | TMT Area | EWM Control | TMT Area | CLP Control | TMT Area | Celery Contol | TMT Area | Other Nuisance Contol | TMT Area | Broad Spectrum | TMT Area | Chara Algae | TMT Area | Filament Algae | TMT Area | Plankton Algae |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Herbicides | 45 | $10,328 | | | | | 7 | $2,499 | | | 45 | $4,361 | | | | |
| Mechanical | | | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | | |

| **Professional Services** | | | **Administrative Services** | | | **Regulatory Costs** | | |
|---|---|---|---|---|---|---|---|---|
| Vegetation Monitoring | √ | $4,790 | Local Administration Costs | √ | $612 | Permit Fee | √ | $800 |
| WQ Monitoring | √ | $2,823 | Communications | √ | $643 | Special Permit Application Prep | √ | $1,836 |
| Fishery Monitoring | √ | $2,958 | Contractor Bids | | | Regulatory Study Requirements | | |
| Special Studies | | | SAD Hearings | | | | | |

**TOTAL ESTIMATED COST** $31,649

## Year 3

Annual Inflation Rate 2%

**Lake Improvements**

Nuisance Control √ $19,481

| | TMT Area | EWM Control | TMT Area | CLP Control | TMT Area | Celery Contol | TMT Area | Nuisance Contol | TMT Area | Broad Spectrum | TMT Area | Chara Algae | TMT Area | Filament Algae | TMT Area | Plankton Algae |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Herbicides | 45 | $10,534 | | | | | 11 | $4,006 | | | 50 | $4,942 | | | | |
| Mechanical | | | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | | |

| **Professional Services** | | | **Administrative Services** | | | **Regulatory Costs** | | |
|---|---|---|---|---|---|---|---|---|
| Vegetation Monitoring | √ | $4,886 | Local Administration Costs | √ | $624 | Permit Fee | √ | $800 |
| WQ Monitoring | √ | $2,880 | Communications | √ | $655 | Special Permit Application Prep | | |
| Fishery Monitoring | √ | $3,017 | Contractor Bids | | | Regulatory Study Requirements | | |
| Special Studies | | | SAD Hearings | | | | | |

**TOTAL ESTIMATED COST** $32,344

## Year 4

Annual Inflation Rate 2%

**Lake Improvements**

Nuisance Control √ $22,630

| | TMT Area | EWM Control | TMT Area | CLP Control | TMT Area | Celery Contol | TMT Area | Other Nuisance Contol | TMT Area | Broad Spectrum | TMT Area | Chara Algae | TMT Area | Filament Algae | TMT Area | Plankton Algae |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Herbicides | 55 | $13,132 | | | | | 12 | $4,457 | | | 50 | $5,041 | | | | |
| Mechanical | | | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | | |

| **Professional Services** | | | **Administrative Services** | | | **Regulatory Costs** | | |
|---|---|---|---|---|---|---|---|---|
| Vegetation Monitoring | √ | $4,983 | Local Administration Costs | √ | $637 | Permit Fee | √ | $800 |
| WQ Monitoring | √ | $2,937 | Communications | | | Special Permit Application Prep | | |
| Fishery Monitoring | √ | $3,078 | Contractor Bids | | | Regulatory Study Requirements | | |
| Special Studies | | | SAD Hearings | | | | | |

**TOTAL ESTIMATED COST** $35,065

## Year 5

Annual Inflation Rate 2%

**Lake Improvements**

Nuisance Control √ $23,083

| | TMT Area | EWM Control | TMT Area | CLP Control | TMT Area | Celery Contol | TMT Area | Other Nuisance Contol | TMT Area | Broad Spectrum | TMT Area | Chara Algae | TMT Area | Filament Algae | TMT Area | Plankton Algae |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Herbicides | 55 | $13,395 | | | | | 12 | $4,546 | | | 50 | $5,142 | | | | |
| Mechanical | | | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | | |

| **Professional Services** | | | **Administrative Services** | | | **Regulatory Costs** | | |
|---|---|---|---|---|---|---|---|---|
| Vegetation Monitoring | √ | $5,083 | Local Administration Costs | √ | $649 | Permit Fee | √ | $800 |
| WQ Monitoring | √ | $2,996 | Communications | √ | $682 | Special Permit Application Prep | | |
| Fishery Monitoring | √ | $3,139 | Contractor Bids | √ | $649 | Regulatory Study Requirements | | |
| Special Studies | | | SAD Hearings | √ | $701 | | | |

**TOTAL ESTIMATED COST** $37,783

**5 YEAR TOTAL COST ESTIMATE** **$167,334**

**ANNUAL AVERAGE COST** **$33,467**

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# 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 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 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. Desirable vegetation can also be preserved by limiting the application of control techniques to areas where they are needed. 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 management activity.