Indian Lake

Lake Management Plan 2015

Submitted By:

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Introduction

Purpose of the Update

This management plan documents past management activities, examines current conditions in the lake, and provides management recommendations for 2016. The plan will detail an integrated approach to lake management including but not limited to exotic weed control, water quality monitoring and aquatic vegetation surveying.

Characteristics of the Lake

Indian Lake is 256-acre lake located in Winfield Township, Montcalm County, Michigan (T12N R9W Sec 19). Indian Lake is within the Muskegon Watershed. The watershed flows through the counties of Muskegon, Newaygo, Mecosta, Osceola and Clare to name a few.

Rooted vegetation covers a good portion of the littoral zone of the lake. A majority of the shoreline has been developed for single family year-round homes. The lake has a history of aquatic plant and algae problems. A formal lake-use survey was not included in this study, but observations made while working on the lake indicate that the lake is used for fishing, boating (power & non-power), and swimming.

PLM's Integrated Plant Management Program

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

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

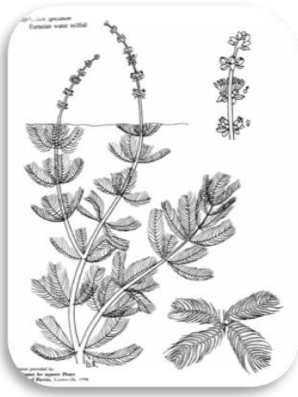
Why Do Aquatic Plants Become a Nuisance?

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

Exotic plant species cause many of the most serious weed problems. Exotic plants are plants that are not native to this area, which have been brought to the area and released. Because they often have few natural enemies (their pests, pathogens, etc. may not have come over with them), they grow out of control. When exotic aquatic plants such as Eurasian watermilfoil and Curlyleaf pondweed invade a lake, they often form extensive dense populations, crowd out native species and reduce the quality of habitat for other organisms.

Human activities also increase the input of nutrients and nutrient-rich sediments to the lake. Nutrients feed the growth of algae in the water and settle on the bottom, where they provide a rich substrate for aquatic plant growth. Nutrient inputs increase the overall growth of all aquatic plants (exotic and native) and algae. Preventing excess nutrients from entering your lake is much less expensive than trying to fix the problems they cause.

Eurasian watermilfoil



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

Curlyleaf pondweed

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

Starry stonewort - Not Currently Found

The species Starry stonewort should be actively controlled and managed. Starry stonewort is in the same family as Muskgrass (Chara) but is considered to be an exotic invasive species. Starry stonewort, which looks very similar to the beneficial species Chara, is appearing in more and more lakes. Chara is a highly desired plant because it is typically low growing, keeps the water clear and can slow down the invasion of exotic weed species. Starry stonewort also forms dense mats, but unlike chara, it can grow from 5 to 7 feet tall. Starry stonewort can be very detrimental to a lake's ecosystem and has the ability to kill off native plants and have a negative impact on a lake's fisheries.

Terrestrial Exotic Plants-

The invasive terrestrial plants, Purple loosestrife and Phragmities should be controlled along the shoreline and adjacent wetlands where present. Both species are exotic and have the ability to displace beneficial native vegetation. Purple loosestrife grows 2 -4 feet tall and is a vibrant magenta color. It is very aggressive and can quickly become the dominant wetland vegetaion. Phragmites (common reed) is a wetland grass that ranges in height from 6 to 15 feet tall. “Phrag” quickly becomes the dominant feature in aquatic ecosystems, aggressively invading shorelines, wetlands, and ditches. This plant creates dense “strands” - walls of weeds crowding out beneficial native wetland vegetation and indigenous waterfowl habitats. Spreading by fragmentation and an extensive root system, Phragmites ultimately out-competes native plant life for sun, water and nutrients.

Algae

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

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

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

Management Goals for Indian Lake

- The primary goal of aquatic plant management in Indian Lake is the control of exotic aquatic plants. The exotic plant species, Eurasian watermilfoil and Curlyleaf pondweed, should be controlled throughout Indian Lake. The abundance of these species should be reduced to the maximum extent possible, and efforts should be made to reduce their recovery after treatment. If the species, Starry stonewort or Phragmites were found, control should be immediately focused on treating these species.
- Aquatic plant management should preserve species diversity and cover of native plants sufficient to provide habitat for fish and other aquatic organisms. Native plants should be managed to encourage the growth of plants that support the Indian Lake fishery (by creating structure and habitat) provided that they do not excessively interfere with recreational uses of the lake (e.g., swimming and fishing) in high-use areas. Where they must be managed, management techniques that reduce the stature of native plants without killing them (e.g., harvesting, contact herbicides) should be used whenever possible. Specific areas should be set aside where native plants will not be managed, to provide habitat for fish and other aquatic organisms. Muskgrass (*Chara*) should be allowed to grow throughout the lake, except in where it grows so tall as to interfere with boating and swimming.
- Conditions in Indian Lake should not be allowed to deteriorate below present levels. Expansion of aquatic plant problems should trigger an adjustment in the aquatic vegetation management

strategy. To support such responses, an annual record of vegetation and management should be maintained.

- Preventative measures that protect the lake from further nutrient enrichment should be identified and implemented.

Past Lake Management Activities

Weed and Algae Treatments conducted in 2015

In 2015, Indian Lake was spot treated to target Eurasian watermilfoil and some native growth in the lake. In 2013, the EWM was treated lake wide using a systemic herbicide, Triclopyr. In years prior, numerous treatments took place for the control of EWM including Sonar (Fluridone), Triclopyr, 2,4-d and Diquat. The 2013 treatment was extremely successful in limiting the growth of the EWM. In the years following the 2013 treatment, only a few acres have been treated. It is likely that the EWM will resurge and preparations need to be made for that.

In addition to the focus on exotic species, treatments took place for native plants. Native plant control can be performed when plants hinder the recreational and navigational use of the lake.

Finally, algae treatments took place to treat both filamentous algae as well as macroalgae (Chara).

2015 Service Timeline:

Service	Date	Acres
Water Quality	May 7, 2015	-
Survey	May 14, 2015	-
Algae Treatment	May 14, 2015	17.25
Algae Treatment	June 3, 2015	7
Weed Treatment	June 25, 2015	2.1
Algae Treatment	June 25, 2015	22.5
Survey, Water Quality	July 15, 2015	-
Weed Treatment	July 22, 2015	24.2
Algae Treatment	July 22, 2015	25.75
Survey	August 12, 2015	-
Water Quality	September 4, 2015	-
Survey	September 22, 2015	-

Planning/Evaluation

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

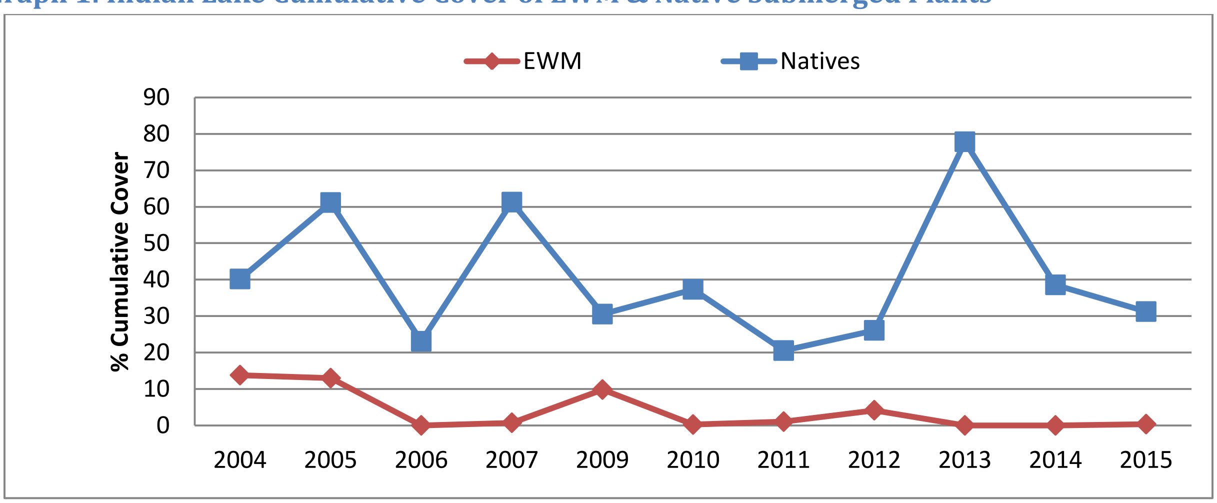
Table 1: Plant Species Found In Indian Lake – September 2015

AVAS Code	Common Name	*Scientific Name*	% Cumulative Cover Indian Lake
	Submerged- Exotic		
1	Eurasian watermilfoil	*Myriophyllum spicatum*	0.35
	Submerged- Native		
3	Muskgrass	*Chara*	13.87
4	Thinleaf pondweed	*Potomageton spp.*	0.31
5	Flatstem pondweed	*Potamageton zosteriformis*	0.09
7	Variable pondweed	*Potamageton vgramineus*	7.13
8	White stem pondweed	*Potamageton praelongus*	0.14
10	Illinois pondweed	*Potamageton illinoensis*	0.35
11	Largeleaf pondweed	*Potomageton amplifolius*	0.00
15	Wild Celery	*Vallisneria Americana*	6.99
25	Naiad	*Najas flexilis*	0.54
27	Sago pondweed	*Potamageton pectinatus*	1.81
	Emergent- Native		
37	Pickerelweed	*Pontederia cordata*	0.18
39	Cattail	*Typha spp.*	0.82
40	Bulrush	*Scirpus spp.*	0.83
	Emergent- Exotic		
43	Purple Loosestrife	Lythrum salicaria	0.14
	Total		**33.55**

Aquatic Plant/ Weed & Algae Control

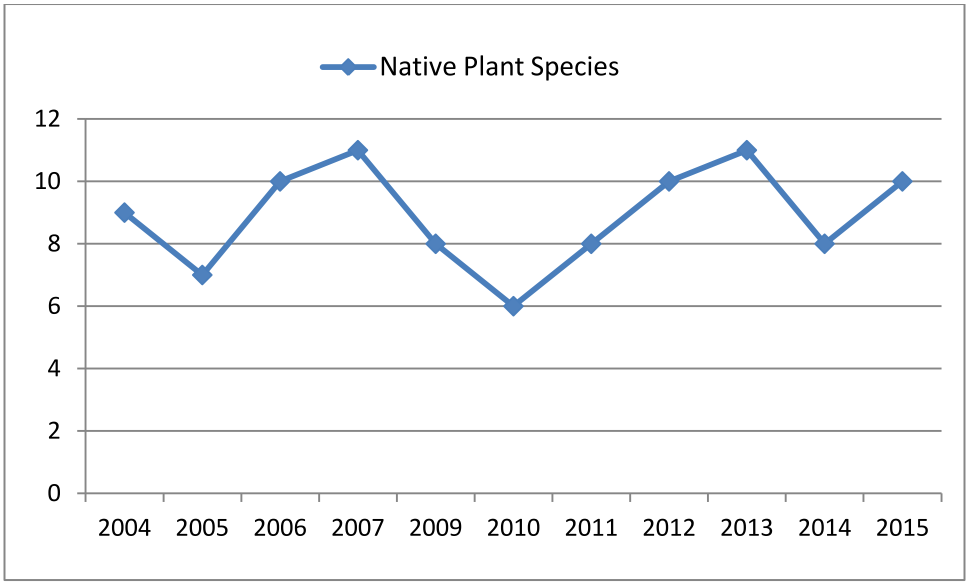
Over the past five years, treatments for the exotic species Eurasian watermilfoil has been conducted in the late spring/early summer of each season. Spot treatments have also been conducted for the control of nuisance native plants and shoreline algae. Both contact and systemic herbicides have been used over this timeframe to control the plants.

Graph 1: Indian Lake Cumulative Cover of EWM & Native Submerged Plants



Graph 1 illustrates the changes in plant cover over the last 11 seasons. EWM treamtents have effectively reduced the overall cover of this highly invasive plant. Native plant coverage has flucuated over the years, still maintaining a healthy coverage in the lake.

Graph 2: Indian Lake Native Plant Diversity



Graph 2 illustrates the stability of native plant diversity on Indian Lake over the past 11 years (Species number was determined based on AVAS data collected during August or September of each year). Graph 1 illustrates stability in the density of the native plants as Graph 2 illustrates a strengthening in the diversity of native plants. As much diversity has possible in plant biomass is ideal for a healthy aquatic ecosystem.

Water Quality Monitoring

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

Indian Lake has been participating in the PLM Water Quality Monitoring Program for many years. The water quality program consists of two samples, occurring in the spring, and late summer each season. Parameter such as secchi disc, pH, D.O., conductivity, alkalinity and nutrient sampling of nitrates and total phosphorus give PLM the ability to monitor lake trends more efficiently. This information enables PLM to calculate the tropic status of the waterbody. The program also tests the lake for Fecal bacteria (E. Coli), in mid-summer which can determine the condition of the lake and if the water is safe for swimming.

Dissolved Oxygen is a measure of the amount of oxygen dissolved in the water. Oxygen is needed by fish and other aquatic organisms to allow them to "breath" underwater. Plants and algae produce oxygen by photosynthesizing during the day and use oxygen for respiration at night.

Temperature provides information about the kinds of fish that can grow in a lake, information necessary for interpretation of other parameters, and information about the extent to which a lake is stratified into layers having water of different temperatures. If the lake is stratified, the thermocline depth tells how deep the surface layer of warm water is.

Secchi disk depth is a measure of water clarity, determined by measuring the depth to which a black and white disk can be seen from the surface. Larger numbers represent greater water clarity.

Secchi Disk

Conductivity and Total Dissolved Solids (TDS) measure the total amount of material dissolved in the water. Higher values indicate potentially richer, more productive water, whereas lower values indicate potentially cleaner, less productive water. Localized increases in conductivity and TDS may indicate inputs of groundwater or other nutrient-enriched water. [Note: Human activities that result in nutrient pollution (e.g., fertilizer runoff) can increase the productivity of algae and other organisms without raising conductivity/total dissolved solids very much. If nutrient pollution is occurring, the total phosphorus concentration is a much better indicator of potential productivity.]

pH describes the balance between acids and bases in the water. Neutral values of pH (between 6 and 9) are desirable. Low pH values typically result either from the growth of bog vegetation (such as peat moss), acid precipitation ("acid rain"), or acid runoff (as in acid mine drainage). Excessive growth of certain plants and algae can raise pH values above 9.0 or 10.0.

Alkalinity measures the concentration of carbonates and bicarbonates in the water. These compounds and other ions associated with them make water "hard". High alkalinity lakes are hardwater lakes, while low alkalinity lakes are softwater lakes. Different kinds of plants, algae, and other aquatic organisms live in hardwater than in softwater. Alkalinity also influences the effectiveness of some herbicides and algaecides. Alkalinity is a basic characteristic of water, but is neither inherently good nor bad.

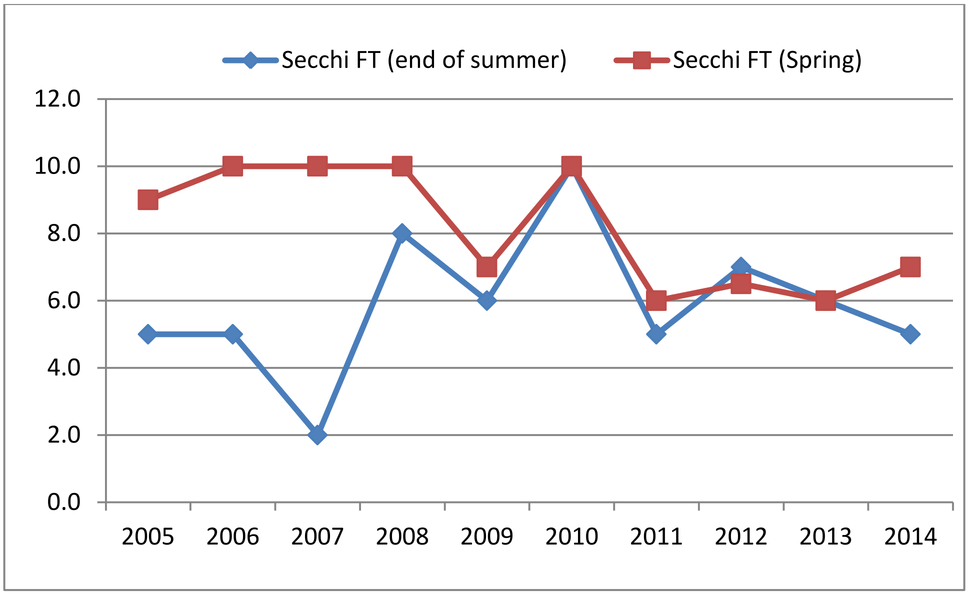
Total Phosphorus measures the total (organic and inorganic, dissolved and particulate) amount of phosphorus in the water. Phosphorus is usually the plant nutrient (i.e., fertilizer) that controls the amount of algal growth in lakes and ponds. Most Midwestern lakes have more phosphorus and more algae than is desirable, so lower values are generally better, though very unproductive water bodies typically support little fish production. Michigan law makers are considering a ban on all phosphorus in fertilizers. Since a majority of soils in Michigan have more than enough phosphorus naturally present to support a healthy lawn the need to fertilize yearly with phosphorus is not needed. This unnecessary fertilizing contributes to the nutrient loading and pollution of Michigan lakes and rivers.

Nitrates measure the total inorganic amount of nitrogen in the water. Nitrogen is the plant nutrient (i.e., fertilizer) most likely to control the amount of rooted plant growth in lakes and ponds. Most Midwestern lakes have more nitrogen and more rooted plant growth than is desirable, so lower values are generally considered better.

Fecal Indicator Bacteria (*E. coli*) measurements count the number of live fecal indicator bacteria in the sample. These bacteria are considered reliable indicators of fecal contamination—when they are found in a lake, it is very likely that the water is being contaminated by animal feces. Contamination can potentially be derived from a number of sources, including failed septic systems, agricultural runoff, or waterfowl or wildlife droppings.

Trophic State Indices calculate the trophic status of the waterbody. Waterbodies are classified as oligotrophic, mesotrophic, eutrophic or hypereutrophic depending on the overall amount of plants, algae and other organisms the waterbody supports. Lakes of different trophic states vary in a number of chemical characteristics and support different types of organisms. Thus the trophic state of a waterbody provides a wealth of information concerning the types of organisms living in the waterbody, the processes likely to occur there and the kinds of problems to be expected. Trophic State Index values can be calculated from a number of variables, including total phosphorus, Secchi disk depth and chlorophyll *a*.

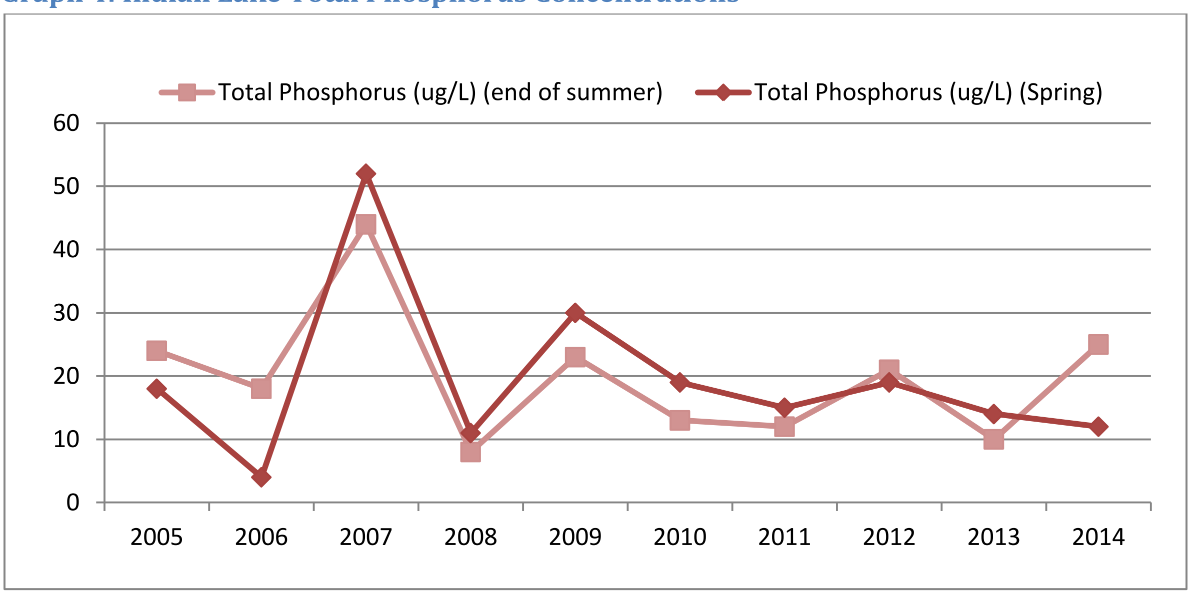
Graph 3: Indian Lake Water Clarity Measurement – Deep Hole



Secchi Disk depth was sampled from the Deep Hole of the lake.

Graph 3: The transparency on Indian Lake has fluctuated over the years, displaying less clarity in the end of the summer, typically. Looking at the trend, clarity has fluctuated but had similar readings at the end of the summer in 2015 and 2014.

Graph 4: Indian Lake Total Phosphorus Concentrations



Total Phosphorus was sampled from the Deep Hole of the lake.

Graph 4 shows a large spike in Total Phosphorus levels in 2007, but that levels lowered and have remained rather consistent over the last 11 years. The 2007 spike could have been due to flow, rain, or weather, winter snow fall, etc. Overall, the TP readings on Indian Lake are elevated which can lead to increased productivity.

Current Conditions in the Lake

Aquatic Vegetation

Indian Lake supports a fairly diverse community of aquatic plants. Ten native species of aquatic plants were encountered in the September 2015 survey of the lake (Table 1). Rooted plant growth is moderate almost everywhere in the littoral zone (0 to 10 feet deep) which comprises a majority of the waterbody.

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

The native plant species in Indian Lake benefit the lake, performing such functions as stabilizing sediments and providing habitat for fish and other aquatic organisms. In general, native species cause few problems, compared with those caused by exotic plants. Three species commonly found in higher densities on Indian Lake are Chara, Wild Celery, and Water lilies.


Chara


Water lily


Wild Celery

Water Quality Program

The water quality of the lake was tested in 2014. The Carlson Index or Trophic classification for Indian Lake in 2014 is Mesotrophic to eutrophic. Mesotrophic lakes have moderate nutrient levels, clear water and moderate productivity. Rooted plants are commonly abundant and moderate dissolved oxygen in cooler waters allow for the survival of cold water fish. Eutrophic lakes have high nutrient levels, turbid water and high productivity. Algal blooms are likely and plants abundant. Reducing nutrient loading in the lake will help decrease the aging of Indian Lake.

The surface dissolved oxygen level was adequate at both the spring and late summer sampling.

The correct balance of an aquatic ecosystem will result in great water quality, thriving fisheries, and a diverse native plant population. With the help of a proper lake management program, we can continue to make progress in improving Indian Lake.

Strategies for Achieving Lake Management Goals

Aquatic Plant Control Techniques

Areas of the lake that support vegetation will grow plants, despite intense efforts to remove them. Aquatic vegetation provides important benefits to a lake, including stabilizing sediments, providing habitat for fish and other aquatic organisms, and slowing the spread of exotic plant species. In general, native plants interfere less with recreation and other human activities than exotic species.

The non-native plant species, Eurasian watermilfoil concentrate their biomass at the water surface where it strongly interferes with boating, swimming and other human activities. This growth form also allows exotic plants to displace native plants and form a monospecific (i.e., single species) plant community. The dense surface canopies of Eurasian watermilfoil a lower quality habitat than that provided by a diverse community of native plants. Control of exotic plant species minimizes interference of plant growth with human activities and protects the native vegetation of the lake. The goal of environmentally responsible aquatic plant management, therefore, is not to remove all vegetation, but to control the types of plants that grow in the lake and the height of plants, to minimize interference with human activities.

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

Chemical control, or use of aquatic herbicides, is the most common strategy for controlling exotic plant species. Aquatic herbicides provide predictable results and there is a great deal of research and data regarding theses products. Many of the aquatic herbicides available can be used to selectively control exotic species with minimal or no impact on native species.

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

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

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

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

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

Exotic Plant Management

Aquatic herbicides currently represent the most reliable, effective, selective means for controlling Eurasian watermilfoil. There are currently five systemic herbicides, 2,4-D (Navigate), 2,4-D amine (Sculpin G), triclopyr (Renovate 3 & OTF), 2,4-D/Triclopyr combination (Renovate Max G) and fluridone (Sonar or Avast), which can be used to achieve long-term, selective control of Eurasian watermilfoil. Systemic herbicides are capable of killing the entire plant. Several contact herbicides, including diquat (Reward or Solera) can also provide short-term control of Eurasian watermilfoil. These herbicides kill only the shoots of the plant, and plants regrow relatively rapidly from their unaffected below ground parts.

Systemic herbicides control Eurasian watermilfoil with little or no impact on most native plant species. Under ideal conditions, several consecutive annual applications of these herbicides can reduce Eurasian watermilfoil to maintenance (low) abundance, such that only relatively small spot treatments are required to keep it under control. For this strategy to succeed, it is necessary to treat most of the Eurasian watermilfoil in the lake each time.

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

Purple loosestrife can be selectively controlled through the use of triclopyr (Renovate). Purple loosestrife is an exotic species, which is out competing native vegetation, destroying valuable wetlands and animal habitat and expanding in density along the Indian Lake. In past years our options to manage this nuisance weed has been extremely limited to prevention, manual removal or broad spectrum herbicide treatments, which not only killed the Purple Loosestrife but also the native vegetation remaining in the treatment areas.

Phragmites, can be selectively controlled through the use of glyphosate or imazapyr (Habitat) herbicides. Phragmites is an exotic species, which can out compete native vegetation, destroying valuable wetlands and animal habitat.

Native Plant Management

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

Algae Management

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

Monitoring

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

- Temperature, dissolved oxygen and Secchi disk depth should be measured in the lake. Temperature and dissolved oxygen profiles should be obtained in the deep hole, so as to monitor the timing and extent of oxygen depletion in the hypolimnion (i.e., bottom water).
- Total phosphorus and nitrates should be measured in the surface and bottom water at least two times per season (spring and late summer) to monitor nutrient accumulation in the hypolimnion.
- Lake vegetation should be surveyed on an annual basis (late-spring and/or late summer/early fall) to document the results of plant management efforts and provide information necessary for planning future management.

Nutrient Loading Abatement

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

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

If organic material (muck) accumulates to undesirable levels in shoreline areas, bacterial treatments should be considered as a way to alleviate the buildup. PLM MD (Muck Digestion) Pellets are a combination of natural beneficial bacteria, enzymes, and vitamins that stimulate the biological activity of the lake bottom. This stimulation allows the bacteria to feed on the organic sediment, therefore reducing the muck levels over time.

Prevention

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

Indian Lake Management Recommendations for 2016

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

Submersed Aquatic Plants

Treatments with the herbicides should be done if and when the Eurasian watermilfoil starts to bounce back in Indian Lake.

The herbicides Triclopyr and 2,4-D, control Eurasian watermilfoil with little or no impact on most native plant species. Since they are selective, systemic herbicides, they can actually kill Eurasian watermilfoil plants. Under ideal conditions, several consecutive annual applications of Renovate or 2,4-D can reduce Eurasian watermilfoil to a maintenance (low) abundance. For this strategy to succeed, it is necessary to treat all the Eurasian watermilfoil in the lake each time they are applied. Recent Michigan regulation restricting 2,4-D use in the vicinity of drinking water wells may result in the inability to apply 2,4-D near the shoreline of the lake.

Triclopyr is a systemic herbicide with selectivity very similar to 2,4-D. Triclopyr is not subject to the well setback restrictions that currently affect 2,4-D. Therefore, triclopyr can be used to control Eurasian watermilfoil in near shore areas. A combination of both systemic herbicides in Indian Lake could greatly reduce the growing Eurasian watermilfoil problem.

Several contact herbicides, including diquat (Reward) can also provide short-term control of Eurasian watermilfoil. These herbicides kill only the shoots of the plant, and plants regrow relatively rapidly from their unaffected belowground parts.

Curlyleaf pondweed if found, should be controlled. CLP is not controlled using other systemic herbicides but is controlled with contact herbicides (Diquat and Aquathol K). CLP should be controlled on an annual basis before the plant matures and produces additional turions.

Nuisance native plant management can also be incorporated into a lake management program with conventional herbicide treatments if needed. Native plant treatments are completed using only contact herbicides in beach areas. Contact herbicides will not target the root system of the plant. Based on the infestation of Thinleaf pondweed and Wild Celery throughout Indian Lake, it is recommended to use control efforts to reduce the stature of these plants.

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

Muck Control

Muck Control should be considered to help reduce muck in the lake, improve navigation and water depths. Muck naturally occurs with the breakdown of organic materials. Bacteria augmentation will help deplete muck and its use should be considered on an individual or lake wide program. Additional muck control aspects could be explored as well.

Monitoring Program

Aquatic vegetation and water quality will be monitored to document the condition of the lake and to provide warning of any changes in the condition of the lake that need to be addressed by additional lake management activities.

Final Recommendations

The recommended management program for 2015:

- A spring vegetation survey (to evaluate conditions in the lake and direct management efforts)
- Water quality evaluation should continue
- Herbicide treatments for exotic species and nuisance natives, if needed
- Algaecide treatments as needed
- Potential Purple Loosestrife treatment along shoreline
- A fall vegetation survey