A LIMNOLOGICAL AND MACROPHYTE SURVEY OF

NORTH LAKE

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INTRODUCTION

We were asked by Don Warren of the North Lake Association to do a macrophyte investigation of North Lake and address the question of the current status of Eurasian Water milfoil in the lake. We also performed some limnological tests to determine the current status of the lake since we were on the lake anyway. We also wanted to compare the previous data we collected on plant distribution and extent of Eurasian water milfoil in October 1988 with current information on the lake to determine if there has been and improvement in the plant diversity and abundance in the lake.

We would like to thank Jerry Loukatka for his excellent assistance, provision of a great platform for our work, and his skill in running the boat despite some nasty winds the day we did the survey. We are indebted to Jerry and Don and the residents should be appreciative that there are people on the lake who are very concerned about the current and future status of North Lake and are willing to give of their time and talents to help preserve its quality.

METHODS

Our study involves physical, chemical, and biological measurements and observations by professional aquatic biologists who have conducted lake management studies since 1972. We focused on the plant problems for our North Lake studies. We use specialized samplers and equipment designed to thoroughly examine all components of an aquatic ecosystem. Shallow water, deep water, sediments, animal and plant life as well as inlet and outlet streams are intensively sampled and analyzed at several key stations (sites on the lake). Our SCUBA divers examine aquatic plants, sediments, and fish and assist in some other data collections. Some samples are analyzed in the field, while the balance are transported to our laboratory for measurements and/or identification of organisms found in samples.

After the field study, we compile, analyze, summarize, and interpret data. We utilize a comprehensive library of limnological studies, and review all the latest management practices in constructing a management plan. All methods used are standard limnological procedures, and most chemical analyses are according to Standard Methods for the Examination of Water and Wastewater.

STATION LOCATIONS

During any study we choose a number of places (stations) where we do our sampling for each of the desired parameters. We strive to have a station in any unusual or important place, such as inlet and outlet streams, as well as in representative areas in the lake proper. One of these areas is always the deepest part of the lake. Here we check on the degree of thermal and chemical stratification, which is extremely important in characterizing the stage of eutrophication (nutrient enrichment), invertebrates present, and possible threats to fish due to production of toxic substances due to decomposition of the bottom sediments. The number and location of these stations for this study are noted in that section.

PHYSICAL PARAMETERS

Depth

Depth is measured in several areas with a sonic depth finder or a marked sounding line.

Acreage

Acreage figures, when desired, are derived from maps, by triangulation, and/or estimation. The percentage of lake surface area in shallow water (less than 10 feet) is an important factor. This zone (known as the littoral zone) is where light can penetrate with enough intensity to support rooted aquatic plants. Natural lakes usually have littoral zones around their perimeters. Man-made lakes and some reservoirs often have extensive areas of zone.

Sediments

Bottom accumulations give good histories of the lake. The depth, degree of compaction, and actual makeup of the sediments reveal much about the past. An Ekman grab or dredge sampler is used to sample bottom sediments for examination. It is lowered to the bottom, tripped with a weight , and it "grabs" a 1 square foot sample of the bottom. Artificial lakes often fill in more rapidly than natural lakes because disruption of natural drainage systems occurs when these lakes are built. Sediments are either organic (remains of plants and animals produced in the lake or washed in) or inorganic (non-living materials from wave erosion or erosion and run-off from the watershed).

Light Penetration

The clarity of the water in a lake determines how far sunlight can penetrate. This in turn has a basic relationship to the production of living phytoplankton (minute plants called algae) which are basic producers in the lake and the foundation of the food chain. We measure light penetration with a small circular black and white Secchi disc attached to a calibrated line. The depth at which this disc just disappears (amount of water transparency) will vary between lakes and in the same lake during different seasons, depending on degree of water clarity. This reference depth can be checked periodically and can reflect the presence of plankton blooms and turbidity caused by urban run-off, etc.

Temperature

This is a physical parameter but will be discussed in the chemistry section with dissolved oxygen. Thermal stratification is a critical process in lakes which helps control the production of algae, generation of various substances from the bottom, and dissolved oxygen depletion rates.

Stream Flows from Inlets and Outlets

Estimation of flows in and out of a lake give us information about ground water inputs, inputs of nutrients and toxic substances, and amount of water moving through the ecosystem. When tied to the chemical analyses described earlier, nutrient inputs and outputs can be calculated and amount of impact of these inputs evaluated.

CHEMICAL PARAMETERS

Water chemistry parameters are extremely useful measurements and can reveal considerable information about the type of lake and how nutrients are fluxing through the system. They are important in classifying lakes and can give valuable information about the kind of organisms that can be expected to exist under a certain chemical regime. All chemical parameters are a measure of a certain ion or ion complex in water. The most important elements--carbon (C), hydrogen

(H), and oxygen (O) are the basic units that comprise all life, so their importance is readily obvious. Other elements like phosphorus (P) and nitrogen (N) are extremely important because they are significant links in proteins and RNA/DNA chains. Since the latter two (P and N) are very important plant nutrients, and since phosphorus has been shown to be critical and often times a limiting nutrient in some systems, great attention is given to these two variables. Other micro-nutrients such as boron, silicon, sulfur, and vitamins can also be limiting under special circumstances. However, in most cases, phosphorus turns out to be the most important nutrient.

Temperature Stratification

Temperature governs the rate of biological processes. A series of temperature measurements from the surface to the bottom in a lake (temperature profile) is very useful in detecting stratification patterns. Stratification in early summer develops because the warm sun heats the surface layers of a lake. This water becomes less dense due to its heating, and "floats" on the colder, more dense waters below. Three layers of water are thus set up. The surface warm waters are called the epilimnion, the middle zone of rapid transition in temperatures is called the thermocline, and the cold bottom waters, usually around 39 F (temperature of maximum density), are termed the hypolimnion. As summer progresses, the lowest cold layer of water (hypolimnion) becomes more and more isolated from the upper layers because it is colder and more dense than surface waters.

When cooler weather returns in the fall, the warm upper waters (epilimnion) cool to about 39 F, and because water at this temperature is the most dense (heaviest), it begins to sink slowly to the bottom. This causes the lake to "turnover" or mix, and the temperature becomes a uniform 39 F top to bottom. Other chemical variables, such as dissolved oxygen, ammonia, etc. are also uniformly distributed throughout the lake.

As winter approaches, surface water cools even more. Because water is most dense at 39 F, the deep portions of the lake "fill" with this "heavy water". Water colder than 39 F is actually lighter and floats on the more dense water below, until it freezes at 32 F and seals the lake. During winter, decomposition on the bottom can warm bottom temperatures slightly.

In spring when the ice melts and surface water warms from 32 to 39 F, seasonal winds will mix the lake again (spring overturn), thus completing the yearly cycle. This represents a typical cycle, and many variations can exist, depending on the lake shape, size, depth, and location. Summer stratification is usually the most critical period in the cycle, since the hypolimnion may go anoxic (without oxygen--discussed next), we always try to schedule our sampling during this period of the year. Another critical time exists during late winter as oxygen can be depleted from the entire water column in certain lakes under conditions of prolonged snow cover.

Dissolved Oxygen

This dissolved gas is one of the most significant chemical substances in natural waters. It regulates the activity of the living aquatic community and serves as an indicator of lake conditions. Dissolved oxygen is measured using the Winkler method with the azide modification. Fixed samples are titrated with PAO (phenol arsene oxide) and results are expressed in mg/L (ppm) of oxygen, which can range normally from 0 to about 14 mg/L. Water samples for this and all other chemical determinations are collected using a device called a Kemmerer water sampler, which can be lowered to any desired depth and like the Ekman grab sampler, tripped using a messenger (weight) on a calibrated line. The messenger causes the cylinder to seal and the desired water sample is then removed after the Kemmerer is brought to the surface. Most oxygen in water is the result of the photosynthetic activities of plants, the algae and aquatic macrophytes. Some enters water through diffusion from air. Animals use this oxygen while giving off carbon dioxide during respiration. The interrelationships between these two communities determine the amount of productivity that occurs and the degree of eutrophication (lake aging) that exists.

A series of dissolved oxygen determinations can tell us a great deal about a lake, especially in summer. In many lakes in this area of Michigan, a summer stratification or stagnation period occurs (See previous thermal stratification discussion). This layering causes isolation of three water masses because of temperature-density relationships already discussed. In the spring turnover period dissolved oxygen concentrations are at saturation values from top to bottom. However, in these lakes by July or August some or all of the dissolved oxygen in the bottom layer is lost (used up by bacteria) to the decomposition process occurring in the bottom sediments. The richer the lake, the more sediment produced and the more oxygen used up. Since there is no way for oxygen to get down to these layers (there is not enough light for algae to photosynthesize), the hypolimnion becomes devoid of oxygen in rich lakes. In non-fertile (Oligotrophic) lakes there is very little decomposition, and therefore little or no dissolved oxygen depletion. Lack of oxygen in the lower waters (hypolimnion) prevents fish from living here and also changes basic chemical reactions in and near the sediment layer (from aerobic to anaerobic).

Stratification does not occur in all lakes. Shallow lakes are often well mixed throughout the year because of wind action. Some lakes or reservoirs have large flow-through so stratification never gets established.

Stratified lakes will mix in the fall because of cooler weather, and the dissolved oxygen content in the entire water column will be replenished. During winter the oxygen may again be depleted near the bottom by decomposition processes. As noted previously, winterkill of fish results when this condition is caused by early snows and a long period of ice cover when little sunlight can penetrate into the lake water. Thus no oxygen can be produced, and if the lake is severely eutrophic, so much decomposition occurs that all the dissolved oxygen in the lake is depleted.

In spring, with the melting of ice, oxygen is again injected into the hypolimnion during this mixing or "turnover" period. Summer again repeats the process of stratification and bottom depletion of dissolved oxygen.

One other aspect of dissolved oxygen (DO) cycles concerns the diel or 24-hour cycle. During the day in summer, plants photosynthesize and produce oxygen, while at night they join the animals in respiring (creating CO_2) and using up oxygen. This creates a diel cycle of high dissolved oxygen levels during the day and low levels at night. These dissolved oxygen sags have resulted in fish kills in lakes, particularly near large aquatic macrophyte beds on some of the hottest days of the year.

pH

The pH of most lakes in this area range from about 6 to 9. The pH value (measure of the acid or alkaline nature of water) is governed by the concentration of H (hydrogen) ions which are affected by the carbonate-bicarbonate buffer system, and the dissociation of carbonic acid (H_2CO_3) into H + ions and bicarbonate. During a daily cycle, pH varies as aquatic plants and algae utilize CO_2 from the carbonate-bicarbonate system. The pH will rise as a result. During evening hours, the pH will drop due to respiratory demands (production of carbon dioxide, which is acidic). This cycle is similar to the dissolved oxygen cycle already discussed and is caused by the same processes. Carbon dioxide causes a rise in pH so that as plants use CO_2 during the day in photosynthesis there is a drop in CO_2 concentration and a rise in pH values, sometimes far above the normal 7.4 to values approaching 9. During the night, as noted, both plants and animals respire (give off CO_2), thus causing a rise in CO_2 concentration and a concomitant decrease in pH toward a more acidic condition. We use pH as an indicator of plant activity as discussed above and for detecting any possible input of pollution which would cause deviations from expected values. pH is measured in the field with color comparators and in the laboratory with a Beckman pH meter.

Chlorides

Chlorides are unique in that they are not affected by physical or biological processes and accumulate in a lake, giving a history of past inputs of this substance. Chlorides (Cl^-) are transported into lakes from septic tank effluents and urban run-off from road salting and other sources. Chlorides are detected by titration using mercuric nitrate and an indicator. Results are expressed as mg/L as chloride. The effluent from septic tanks is high in chlorides. Dwellings around a lake having septic tanks contribute to the chloride content of the lake. Depending upon flow-through, chlorides may accumulate in concentrations considerably higher than in natural ground water. Likewise, urban run-off can transport chlorides from road salting operations and also bring in nutrients. The chloride "tag" is a simple way to detect possible nutrient additions and septic tank contamination. Ground water in this area averages 10-20 mg/L chlorides. Values above this are indicative of possible pollution.

<u>Phosphorus</u>

This element, as noted, is an important plant nutrient which in most aquatic situations is the limiting factor in plant growth. Thus if this nutrient can be controlled, many of the undesirable side effects of eutrophication (dense macrophyte growth and algae blooms) can be avoided. The addition of small amounts of phosphorus (P) can trigger these massive plant growths. Usually the other necessary elements (carbon, nitrogen, light, trace elements, etc.) are present in quantities sufficient to allow these excessive growths. Phosphorus usually is limiting (occasionally carbon or nitrogen may be limiting). Two forms of phosphorus are usually measured. Total phosphorus is the total amount of P in the sample expressed as mg/L or ppm as P, and soluble P or Ortho P is that phosphorus which is dissolved in the water and "available" to plants for uptake and growth. Both are valuable parameters useful in judging eutrophication problems.

<u>Nitrogen</u>

There are various forms of the plant nutrient nitrogen, which are measured in the laboratory using complicated methods. The most reduced form of nitrogen, ammonia (NH_3) is usually formed in the sediments in the absence of dissolved oxygen and from the breakdown of proteins (organic matter). Thus high concentrations are sometimes found on or near the bottom under stratified anoxic conditions. Ammonia is reported as mg/L as N and is toxic in high concentrations to fish and other sensitive invertebrates, particularly under high pHs. With turnover in the spring most ammonia is converted to nitrates ($NO_3=$) when exposed to the oxidizing effects of oxygen. Nitrite (NO_2-) is a brief form intermediate between ammonia and nitrates, which is sometimes measured. Nitrites are rapidly converted to nitrates when adequate dissolved oxygen is present. Nitrate is the commonly measured nutrient in limnological studies and gives a good indication of the amount of this element available for plant growth. It, with Total P, are useful parameters to measure in streams entering lakes to get an idea of the amount of nutrient input. Profiles in the deepest part of the lake can give important information about succession of algae species, which usually proceeds from diatoms, to green algae to blue-green algae. Blue-green algae (an undesirable species) can fix their own nitrogen (some members) and thus out-compete more desirable forms, when phosphorus becomes scarce in late summer.

BIOLOGICAL PARAMETERS

Algae

The algae are a heterogeneous group of plants which possess chlorophyll by which photosynthesis, the production of organic matter and oxygen using sunlight and carbon dioxide, occurs. They are the fundamental part of the food chain leading to fish in most aquatic environments.

There are a number of different phyla, including the undesirable blue-green algae, which contain many of the forms which cause serious problems in highly eutrophic lakes. These algae can fix their own nitrogen (a few forms cannot) and they usually have gas-filled vacuoles which allows them to float on the surface of the water. There is usually a seasonal succession of species which occurs depending on the dominant members of the algal population and the environmental changes which occur.

This usual seasonal succession starts with diatoms (brown algae) in the spring and after the supply of silica, used to construct their outside shells (frustrules), is exhausted, green algae take over. When nitrogen is depleted, blue-green algae are able to fix their own and become dominant in late summer.

The types of algae found in a lake serve as good indicators of the water quality of the lake. The algae are usually microscopic, free-floating single and multicellular organisms, which are responsible many times for the green or brownish color of water in which they are blooming. The filamentous forms, such as Spirogyra and Cladophora are usually associated with aquatic macrophytes, but often occur in huge mats by themselves. The last type, Chara, a green alga, looks like an aquatic macrophyte and grows on the bottom in the littoral zone, sometimes in massive beds. It is important to understand the different plant forms and how they interact, since plants and algae compete for nutrients present and can shade one another out depending on which has the competitive advantage. This knowledge is important in controlling them and formulating sensible management plans. Samples are collected using a No. 20 plankton net, preserved with 10% formaldehyde and examined microscopically in the laboratory.

Macrophytes

The aquatic plants (emergent and submersed) which are common in most aquatic environments are the other type of primary producer in the aquatic ecosystem. They only grow in the euphotic zone, which is usually the inshore littoral zone up to 6 ft., but in some lakes with good water clarity and with the introduced eurasian milfoil (Myriophyllum spicatum - See Appendix 2), growths have been observed in much deeper water. Plants are very important as habitat for insects, zooplankton, and fish, as well as their ability to produce oxygen. Plants have a seasonal growth pattern wherein over wintering roots or seeds germinate in the spring. Most growth occurs during early summer. Again plants respond to high levels of nutrients by growing in huge beds. They can extract required nutrients both from the water and the sediment. Phosphorus is a critical nutrient for them. The aquatic plants and algae are closely related, so that any control of one must be examined in light of what the other forms will do in response to the newly released nutrients and lack of competition. For example, killing all macrophytes may result in massive algae blooms which are even more difficult to control.

RESULTS

WATERSHED

North Lake is located in Washtenaw County (T1S R3-4E S13,16) and is 220 acres. The watershed of North Lake is mostly wooded with some agricultural activities. There are some-many houses around the perimeter of the lake, allowing a considerable amount of access and potential threats to the integrity of the lake from runoff. This runoff can be derived from pet droppings, lawn and garden fertilization, washing of cars in the driveway, eavestrough runoff, antifreeze, and similar sources. It cannot be stressed enough that each individual resident on the lake must take responsibility for the water quality of the runoff that traverses their piece of terrestrial habitat that is so intimate with the lake.

The local watershed, including those houses immediately on the lake, is very important also. Lawn fertilization and disturbance of the lake surface for new developments, etc., cause additional nutrients to be exported to the lake, and further speed the enrichment process. Lake front property owners should be made aware that each resident has responsibility for controlling and reducing nutrient and sediment inputs to North Lake, and that individuals do count in this battle against cultural eutrophication (See Appendix 1). Things that can be done to inhibit entry of undesirable and deleterious substances into the lake are planting greenbelts along the lake edge, reducing erosion where ever it occurs, reducing the use of fertilizers for lawns , cutting down on road salting operations, not feeding the geese or ducks, no leaf burning near the lake, prevention of leaves and other organic matter from entering the lake, no effluent pipes or drains which run directly into the lake, care in household use of such substances as fertilizers, detergents to wash cars and boats, pesticides, cleaners like ammonia, and vehicle fluids, such as oil, gas, and antifreeze, and elimination of willow trees around the lake which can add leaves and branches to an already over fertilized lake.

STATION LOCATION

We established 24 stations (numbers 1 to 24) on North Lake for determining the diversity and abundance of Eurasian milfoil during 1992. We used the same stations we used in our 1988 study to promote comparison among parameters. One water chemistry station (A) was set up in the deepest part of the lake (Fig. 1).

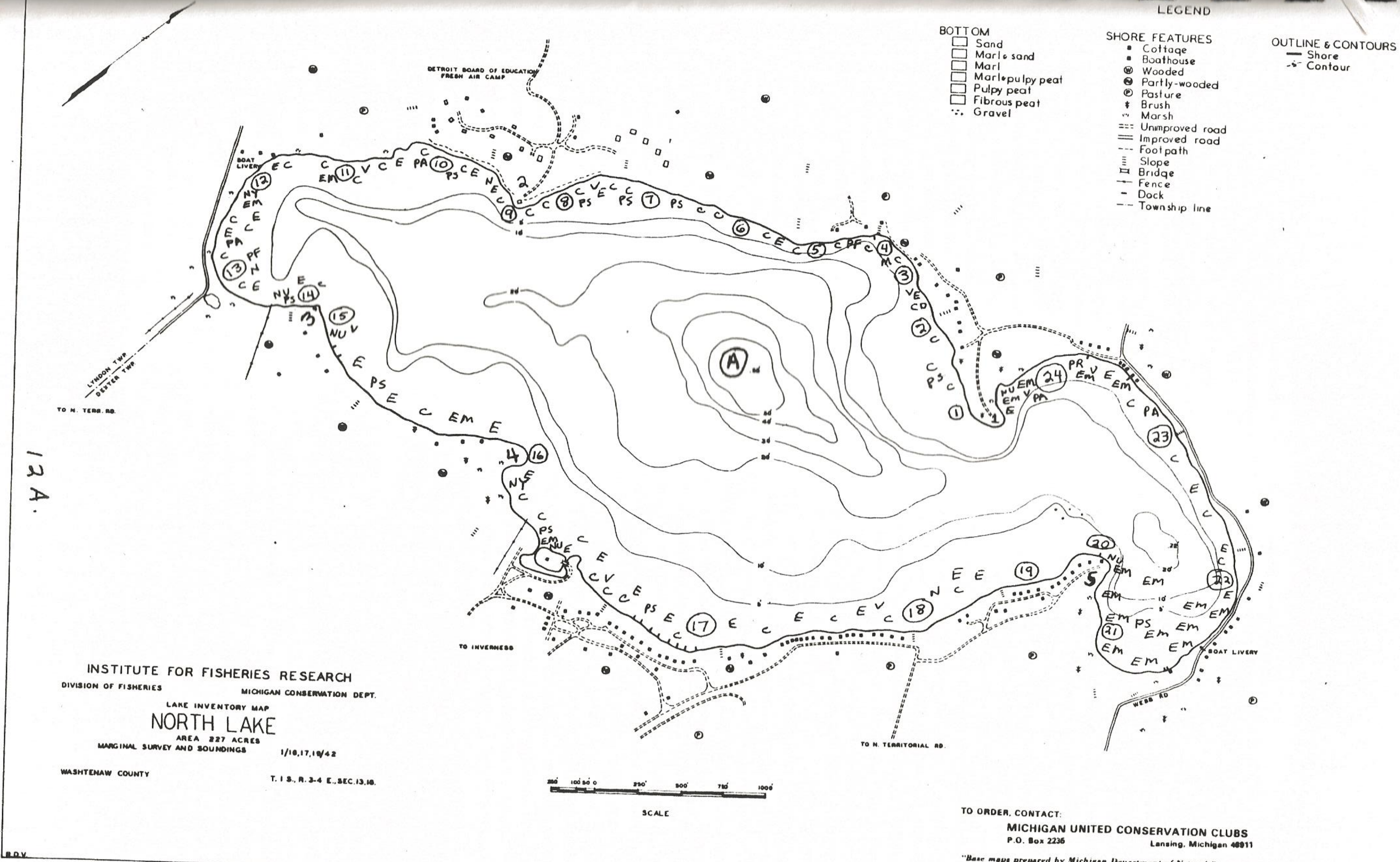


Figure 1. Map of North Lake.

Light Penetration

The secchi disc reading at station A was 12 feet. This is a reasonable good reading and indicates that their was not an extensive algal bloom in progress and that lake is not severely eutrophic (highly enriched). It would be classified as eutrophic based on the chemical, secchi disc reading, and abundance of macrophytes in the lake.

Temperature

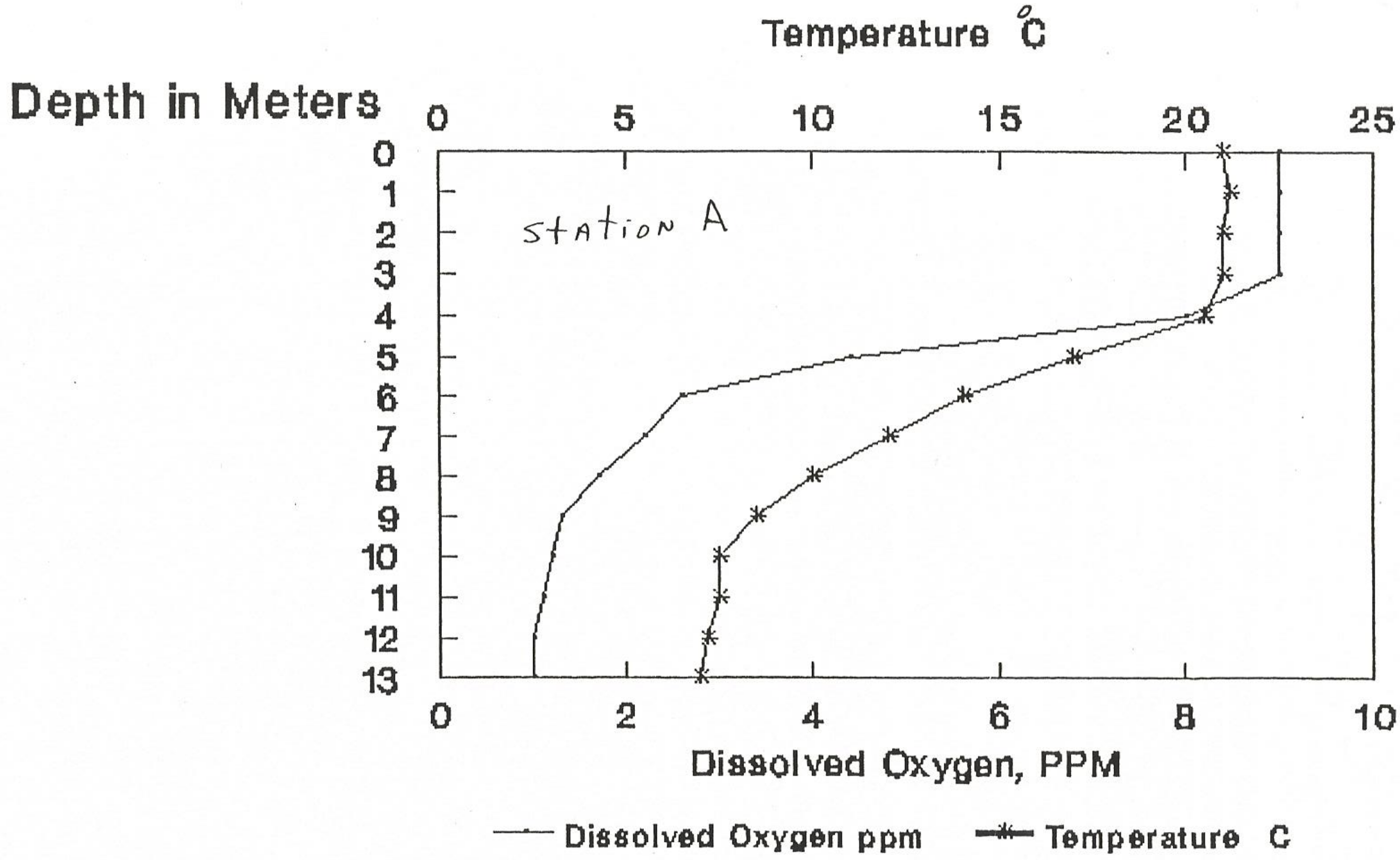
Water temperature is intimately associated with the dissolved oxygen profiles in a lake. North Lake was stratified in our 1992 studies (Fig. 2), but showed very little stratification in 1988 when we did our studies, which is to be expected since stratification is broken up in the fall (Table 2). Water temperatures were consistently 20-21 C at the surface in 1992 (Fig. 2). Bottom temperatures were 7.0 C and a typical pattern was observed.

CHEMICAL PARAMETERS

Dissolved Oxygen

The dissolved oxygen in North Lake was not stratified in 1988 as expected (fall data), while in 1992 it was stratified (July) and followed the same pattern as the temperature (Fig. 2, Table 1). In 1992, there was reduced dissolved oxygen on the bottom of the lake, but it was not anoxic (no dissolved oxygen). This is a positive feature of North Lake and should be verified during another summer, but does two things for the lake. First, it allows fish access to bottom waters, which is necessary for northern pike, and it allows fish access to food supplies derived from the bottom sediments. However, the levels measured are too low for prolonged residence by fish in these strata. Around 2-3 mg/L, coolwater fish species are stressed, so they will only be able to descend into these depths for short term bouts. Second, dissolved oxygen on the bottom prevents phosphorus from re-entering the water column, which occurs during anoxic conditions. Phosphorus is a plant nutrient which fuels algal and macrophyte growth.

FIGURE 2. Dissolved Oxygen/Temperature Profile
North Lake, 10July, 1992



1 meter = 3.3'

Table 1. Some physical and limnological parameters measured 23 August 1988 and 10 July 1992 on North Lake, Oakland County, Michigan. Units: mg/l = milligrams per liter or parts per million; SRP = soluble reactive phosphorus; Cond . = conductivity, units are micromhos (umhos); ND = non detectable. Surf=surface, Bott=bottom, Mid=mid-depth. Depth in meters.

Station-Depth		pH	Cond.	Secchi Disc (ft)
		10 July 1992		
A	Surf- 0 M	7.95	341	12
	Mid - 7 M	7.04	373	
	Bott-14 M	6.94	389	

Table 1. Continued.

Station/Depth	Ammonia (mg/L)	Nitrate (mg/L)	SRP (mg/L)	Silica (mg/L)	Chlorides (mg/L)
		23 October 1988			
A-SURF 0 M	0.057	0.008	0.003	0.11	42.17
A-MID 6 M	0.058	0.003	0.003	0.01	42.13
A-BOT 12 M	0.097	0.023	0.006	0.40	42.46
		10 July 1992			
A-SURF 0 M	0.016	0	0.001	no data	42.1
A-MID 6 M	0.024	0	0.001	no data	41.7
A-MID 13 M	0.339	0	0.001	no data	40.8

Table 1. Continued.

Sta	Depth	Temp.	Diss. Oxygen	Depth	Temp	Diss. Oxygen
	23 October 1988			10 July 1992		
A	0	11.0	10.8	0	21.0	9.0
A	1			1	21.2	9.0
A	2			2	21.0	9.0
A	3			3	21.0	9.0
A	4			4	20.5	8.0
A	5			5	17.0	4.4
A	6	11.0	10.8	6	14.0	2.6
A	7			7	12.0	2.2
A	8			8	10.0	1.7
A	9			9	8.5	1.3
A	10			10	7.5	1.2
A	11			11	7.5	1.1
A	12			12	7.2	1.0
A	13	10.8	10.8	13	7.0	1.0

pH

The pH (how acid or alkaline water is) data for North Lake, showed a typical pattern of high values in surface waters and a progressive decline in bottom waters in 1992. This again is expected as decomposition of sediments on the bottom releases large quantities of carbon dioxide which makes the water acidic.

Chlorides

Chloride data from in lake stations were around 41-42 mg/L (Table 1); this is a medium level of chlorides and indicates past contamination, probably from road salting operations. The important observation is that there was no change from 1988 to 1992 in chloride levels. This is an excellent sign that contamination inputs have been negligible over the last 5 years and bodes well for North Lake. We conclude that there is little input from the watershed of this indicator chemical over the last 5 years.

Phosphorus

Data on phosphorus at the in-lake stations (A - Table 1) show that soluble reactive phosphorus (SRP) was very low, from 0.001 to 0.006 mg/L on both dates, 1988 and 1992. Concentrations of 0.03 mg/L are high enough to cause an algal bloom, so all values are well below that. This is a another indication of the high water quality of North Lake and further proof that the dissolved oxygen on the bottom of the lake is preventing recycling of phosphorus from bottom sediments. It is not a excuse for lake residents to relax on lawn fertilization or attention to cleaning their septic tanks regularly, as these are important sources of nutrients to North Lake as well. In fact, these data mostly speak to bottom concentrations of phosphorus, since algae and aquatic plants probably take up most of the phosphorus discharged in the nearshore zone, and is responsible for the large growths of plants that are prevalent around the littoral zone of the lake.

Nitrates

Nitrate is very important since it is a critical plant nutrient. We found non-detectable levels in North Lake during 1992, which is another good sign. We expected to see higher than observed nutrient levels, speculating that the herbicide treatments might keep the plants depressed so that the nutrients would not be taken up. However, it appears that the aquatic plants are taking up large amounts of the nutrients. Therefore, great care should be taken before any wholesale destruction of aquatic plants is completed, since it may shift the flow of nutrients into the algae. We have seen *Chara*, a green alga, perform this same function in other lakes in your area.

Ammonia

Ammonia is also a plant nutrient, but it can be toxic in high concentrations to fish. It is formed by the decomposition of bottom sediments or can enter with runoff through the storm drains. Concentrations in North Lake on 23 October 1992 (Table 1) were low throughout the upper water column (0.01-0.02 mg/L), which is a good sign; however there was a high buildup in bottom waters (0.33 mg/L). This is not an alarmingly high level, but will be distributed throughout the lake next spring at turnover and contribute to plant growth during spring and summer. It is an indication of some plant decomposition on the bottom of the lake.

Hydrogen Sulfide

Hydrogen sulfide is a toxic substance produced under conditions of no dissolved oxygen from the decomposition of organic matter. We found no hydrogen sulfide on the bottom which is expected, since there was dissolved oxygen at the bottom of the lake at the in-lake stations.

Silica

Silica is an important component of some algae (diatoms). The deep in-lake station showed low levels of silica, from 0.01 to 0.40 mg/L (Table 1). We usually observe low quantities in surface waters (taken up by algae) and increasingly higher concentrations on the bottom, the pattern in North Lake also.

Conductivity

Conductivity is a measure of the ability of water to conduct current and is proportional to the dissolved solutes present. Conductivity was generally at expected levels in the lake proper, around 350-400 umhos from surface to bottom (Table 1) at station A in 1992.

BIOLOGICAL PARAMETERS

Aquatic Macrophytes

We qualitatively surveyed the aquatic plant (macrophyte) population in North Lake during 23 October 1988 and found the lake was dominated by Eurasian water milfoil (Freshwater Physicians, 1988 report on North Lake - included as Appendix 2). Eurasian milfoil covered over 10 acres of the lake bottom and grew in some thick clumps, some up to 3 feet deep in 1988. Eurasian Milfoil *Myriophyllum spicatum*, is a recent European exotic which has infested area lakes within the last 10-15 years. This plant is very insidious, since it can dominate native species, grows in very dense beds, and can grow in very deep water. We have seen it grow in 12+ feet of water. This species can also germinate from any fragments which become detached from the main plant. It can spread from lake to lake on the wheels, motors, boats and in the minnow buckets of people who fish or recreate on a number of different lakes within the state or the nation. Care should be taken to alert residents not to transplant this plant from any other lake to North Lake or from North Lake to other lakes they may visit.

Our general feeling about the aquatic plants in North Lake at the present time (see Appendix 3) is that the herbicide treatments have definitely depressed the abundance of Eurasian water milfoil to the point where we believe that no further treatment was necessary during 1992. There were some areas that spot treatment with 2,4-D next spring will probably be necessary to reduce some local densities, especially in the canals and in a few spots in bays. We recommend that you contact your plant control specialists and arrange for this spot treatment next spring. Remaining macrophytes were diverse, with over six species noted across the littoral zone of the lake. The past treatments have allowed native species to re-establish themselves and we are pleased to see a more balanced plant community than what was present in 1988 (See Appendix 4 for some discussion of plants). Under no circumstances would we recommend any further decimation of the current plant population, with the exception of the Eurasian milfoil, which will have to be monitored to insure it does not dominate again in this lake system.

RECOMMENDATIONS

INTRODUCTION

We have attempted to consolidate all the data collected in 1988 and 1992. These recommendations are based on the findings we made and of course are heavily biased by the conditions we observed at the time of sampling. We have tempered our 1992 observations with the information we generated in our 1988 report, but even so, some additional data may have to be collected at a future date so we can gather more data on other aspects of the lake that were not studied during this monitoring activity.

HERBICIDE TREATMENT OF PLANTS IN THE LAKE

We are aware that an aggressive program of treating the Eurasian milfoil in North Lake has been carried on routinely, especially in the last few years. We have no problem with a judicious use of herbicides to control obnoxious plants, but we do not advocate calling the calvary in every time a strand of milfoil or an algal bloom is spotted. The over-use of herbicides can also cause problems, but there is no evidence of that from what we have seen in North Lake.

EURASIAN MILFOIL

Be on the continual lookout for re-establishment of high densities of Eurasian milfoil. We recommend that a milfoil watch be conducted each year, probably in late summer, to determine whether densities have reached high enough levels to initiate treatment. The situation in 1992 can act as a benchmark for your observations; only a few spots need be treated with 2,4-D in 1992.* Along these same lines, someday there could be an infestation of zebra mussels. This species is easy to identify because of its "zebra stripes"; if found, watch the pumps for clogging. This species would also be introduced inadvertently from other water bodies in minnow buckets, attached to electric motors that were used in infested water, or even in with stocked fish.

RIPARIAN RESPONSIBILITY

The lake side residents can have an important impact on the water quality of North Lake. We urge residents to exercise common sense in the care and feeding of their lake (See Appendix 1). This includes no fertilization or if need be, only nitrogen-based fertilizer. Curtail any runoff from houses via pipes into the lake. Run them into a dry well in the ground. Don't burn leaves near the lake or anywhere they can be washed back into the lake freeing the nutrients for use by the algae and aquatic macrophytes. Don't wash cars, windows, etc. with high phosphate soaps, which can also end up in the lake. Remember 1 pound of phosphorus can produce 500 pounds of plants! Greenbelts will also go a long way toward thwarting nutrient input to North Lake.

* I THINK THEY MEANT 1993. (VLB)

Don't feed the geese or ducks; they can contribute too many nutrients to the lake. Willow trees along the lake are generally detrimental in that they shed too much debris, leading to nutrient enrichment. Alternative plantings are recommended.

Appendix 1.

, Guidelines for lakeshore property owners.

GUIDELINES FOR PROPERTY OWNERS:

CONTROLLING LOCAL NUTRIENT INPUT TO LAKES

It is especially important that the water quality in your lake be protected. Riparians and other users can and should have a positive influence on water quality. If the following steps are taken, definite benefits can result:

1. Eliminate or reduce lawn fertilization. Area wide soil testing should be instituted. Only use fertilizers that are necessary.

2. Establish a greenbelt of thick shrubby evergreens in a strip 10-20' along the lake edge.

3. Draw the lake down in the fall and require property owners to clean beach areas in front of their houses. Dispose of aquatic plants, muck, etc. far away from the lake edge, in gardens or landfills.

4. Require low or no phosphate detergents be used in <u>all</u> cleaning activities--inside <u>and</u> outside the house.

5. Allow no basement sumps or eavestrough drains to drain near or into the lake.

6. Rake all leaves away from the lake and compost them in gardens, etc.

7. Restrict direct inputs of urban runoff or storm water coming from within subdivisions or dwellings on the lake. If possible this water should either be re-routed to wetlands first or be diverted around the lake.

Appendix 2.

AQUATIC MACROPHYTE SURVEY OF NORTH LAKE, 23 OCTOBER 1988

Joseph L. Er vin

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313-227-6623

Report submitted: 10 December 1988

Revised : 15 January 1989

INTRODUCTION

We were asked by Virginia and Jerry Bachman as representatives of concerned lakeshore property owners to assess the current macrophyte population in North Lake, with special reference to identifying whether Eurasian milfoil (see Appendix 1) was present in the lake, and if it was present, to determine how abundant it was, where it was most concentrated, and prepare a brief recommendations section to address alternatives to control this exotic European species. We performed the survey on 23 October 1988 and we thank the Bachmans for their help in providing a vessel of opportunity to do the survey and the warmth of their hearth afterward. We found the lake to be a typical eutrophic inland Michigan lake, with a aquatic plant population that was not excessive or overly abundant. However, we did identify the presence of Eurasian milfoil, especially on the northeast side, where it covered over 10 acres in dense stands.

METHODS

We surveyed North Lake by traversing the entire shoreline and areas farther out where we could see aquatic plants for the species, abundances, and distribution of macrophytes. We traveled along the shoreline and established 23 stations or areas of relatively homogeneous distribution and abundance of plants (see Fig. 1) around the lakeshore. The results section is a description of what we observed as we went along the shoreline and they are keyed to these stations. We brought along a rake and sampled the plants on the bottom when we were not able to identify them from the surface and we also brought along an Ekman dredge or grab sampler to sample plants in deeper water. Information was transcribed onto waterproof paper and into a

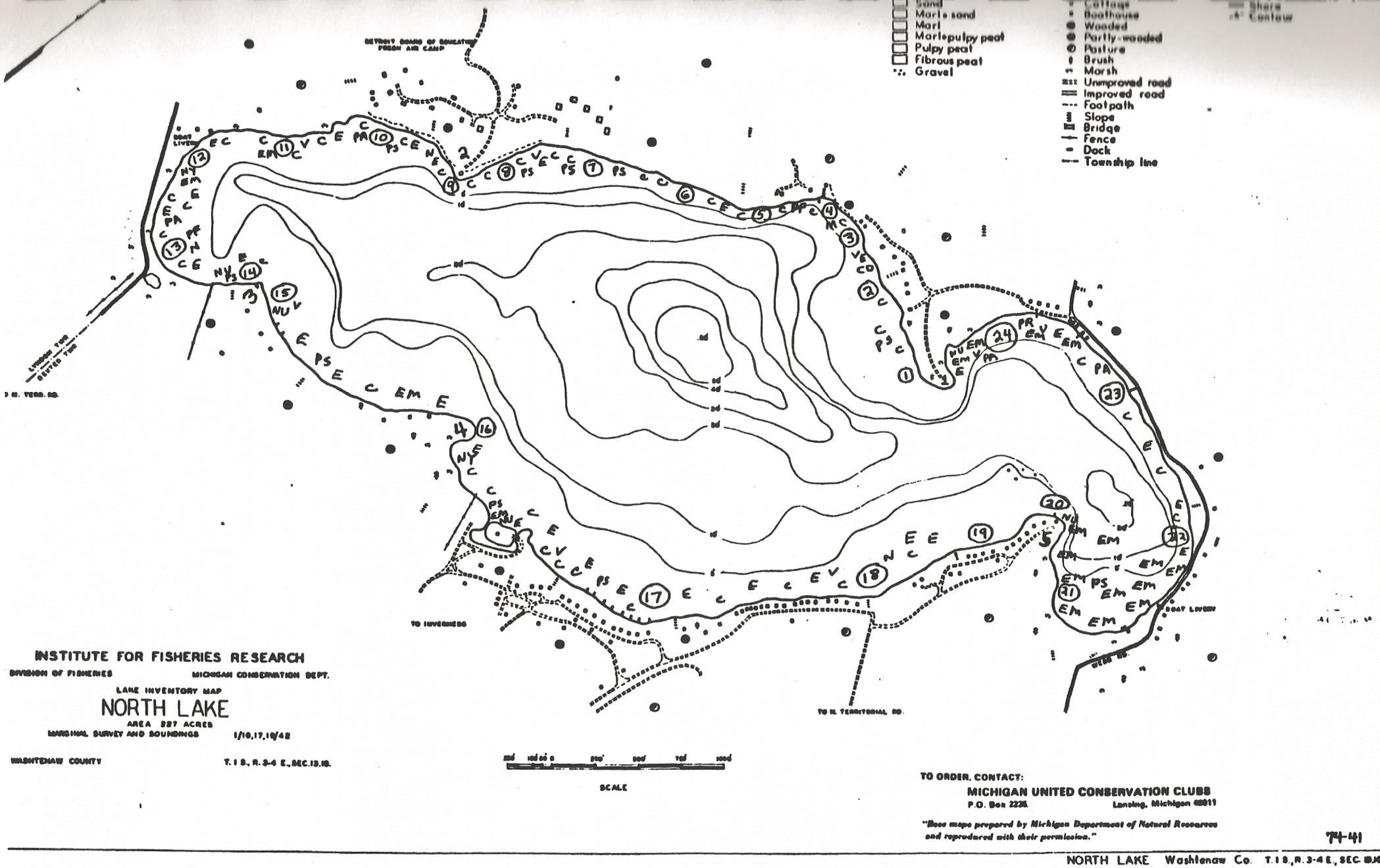


Figure 1. Map of North Lake, Washtenaw County, showing the distribution of aquatic macrophytes (two letter codes- see text for definitions) and stations (circled numbers- see text for description of station and plants found there) surveyed on 23 October 1988.

tape recorder and later entered into a computer and edited. The following species and their common names were seen or identified during our survey:

Common Name	Code	Scientific Name
wild celery or tape grass	V	Vallisenеria
green alga	C	Chara
coontail	CD	Ceratophyllum demersum
arrowroot	S	Sagittaria
water lily (yellow flowers)	NU	Nuphar
water lily (white flowers)	NY	Nymphea
waterweed	E	Elodea canadensis
pondweed	PS	Potamogeton spp.
sago pondweed	PP	P. pectinatus
large-leaf pondweed	PA	P. amplifolius
clasping-leaf pondweed	PR	P. richardsonii
pondweed	PF	P. filiformis
curly-leaf pondweed	PC	P. crispus
Eurasian milfoil	M	Myriophyllum spicatum
water milfoil	ME	M. exalbescens
bushy pondweed	N	Najas flexilis

RESULTS

NORTH LAKE AQUATIC PLANT SURVEY DESCRIPTIONS

Station 1

Station No. 1 is off point 1 (see Fig. 1) with the flag which is located on the north shore of the west basin of the lake. Stations were numbered starting here and proceeding counter-clockwise around the entire lake. . It is sandy here, no plants that we can see, a few leaves, it is shallow all the way out 50 yards from shore. We found some Potamogeton species and Chara, very sparse. We are proceeding toward the Bachmans now, we are in about 2 feet of water and probably a hundred yards down from Station 1 into the Station 2 area.

Station 2

The situation is pretty much the same, sandy bottom with some rocks. We cannot see any large accumulations of plants. There are a few patches as we get closer to shore, but very few. There are a few rocks, sand, and it is only about a foot and a half deep out here too. Rake samples showed modest amounts of Chara, so it looks like those patches of plants are Chara on the bottom, which would probably be expected. We found a few sprigs of coontail in the Station 2 area. We are moving down shore, we are about a hundred yards from Jerry Bachman's now.

Station 3

Station 3 is a hundred yards from the Bachman's. There are fairly high accumulations of plants: Valliseneria, Chara, and Elodea were found in the samples. There is some Potamogeton filiformis. We are about 50 yards from Jerry's house now. We see Elodea, lily pads near shore, fairly sparse, Eurasian milfoil, not too abundant, mostly Elodea, scattered Eurasian milfoil within a bed of Elodea, and some Chara too.

Station 4

Dead Elodea and Chara are very thick right at Jerry's dock, very common, and a few scattered Potamogeton amplifolius, and a Eurasian milfoil here and there. We are traveling now from Jerry's dock to the next dock. There are vast beds of Elodea that are all dead, some scattered Valliseneria is in very dense patches.

Station 5

Now, moving on to Station 5, we are now beyond the dock next to Jerry's, heading along the shoreline, there is more Chara here, a little bit reduced volume, pretty good coverage though, a little more sand here, Potamogeton filiformis, Chara right at the pontoon boat.

Station 6

We are at Station 6 beyond the double docks beyond the pontoon now. Chara and Elodea mixed. It seems like a lot less dense than it was, although some medium leafed Potamogeton spp exists. Moving along into a little bay, a little bay before another point, there is Chara, native milfoil, a lot sparser here, sandy bottom, predominated by Chara, fairly extensive, but nothing like we saw at the other stations.

Station 7

Station 7 has a log sticking out from shore here. We are running into a few scattered Potamogetons here past Station 7, a lot of plant cover all over, Chara and Potamogeton mixed together (could be amplifolius).

Station 8

We are going on to Station 8 which is sort of up to the point, there is a brown house or shed here at the point, looks like a lot of Chara on the bottom, not very high, covers the whole bottom, and a few other plant species too.

Chara with about 10% Potamogeton spp., some Valliseneria, very thick here, Chara, Elodea, some P. amplifolius. We are almost at the brown shed now, mostly Chara here, a few open spots, looks like sandy shore, no plants within 5-6 feet of the shoreline, but once you get from there on out it is covered, a lot of Chara, a lot of other different species here, including Potamogeton amplifolius. Now we are in an area that looks like a beach, which has been cleaned out; it is all sandy.

Station 9

We are going around the bend now from the beach, we are right at point 2 (Station 9), there is a little bay here, it is fairly sandy here, a few sprigs of Chara probably, very sparse in this area again, kind of like what we had at the other Station 1. We will call this Station 9. Going around the bend there are big beds of Elodea here and looks like a little bit of Najas here and there, lily pads along the shoreline, mucky bottom, some marl. We are about 20 yards from the point right now, looks like some Chara down here, it is fairly dense, although there are patches where it is not too dense. Mostly Chara with 20% Potamogeton. We are about 50 or 70 yards from the point, moving toward an oak tree buffer zone below the houses all along here; ahead about a hundred yards is a house right on the lake.

Station 10

Chara is common here along with a patch of lily pads, some P. crispus, ; Chara and Elodea are common on the bottom and beneath the lily pads. We haven't seen much Eurasian milfoil here. We are about 50 yards north of the house that's on the shoreline in this little bay. Looks like Chara and a few Potamogeton. We are right at the house now, we went through a few patches of algae at the house, a lot more sparse, wide open areas of sand, patches of Elodea and Chara. It is shallow (1.5 ft) here 20 yards offshore, plants are a lot more sparse here. Dead plants on the bottom, Chara, P. amplifolius, scattered, a few open spots of mud, plants are not too dense.

Station 11

We will call this Station 11, right out in front of a blue cabin. There are about 12 houses along the shore, then we are going to run into a road here soon. We are angling to the road, we are still at Station 11. Where the road would run into the lake we will call Station 12. At station 11, it there is some Eurasian milfoil, a few sprigs, it is not very abundant, also Chara, Elodea. It is a lot deeper out here, we are about 70 yards offshore, Valliseneria, Elodea, Chara, Eurasian milfoil right here. Eurasian milfoil is very common here, very heavy patches about 70 yards from shore. We are still in the Station 11 area, very common here. Now we are close to where the road touches the lake and there are not many plants on the bottom here, we are 70, 60, 50 yards offshore, it looks like Chara, sand, marl kind of substrate and very sparse plants here, very surprising compared to the fact that 50 yards behind us there are dense stands of Eurasian milfoil.

Station 12

We are running into a bed of Nuphar or lily pads right now, some cattails on the shore, it is about a foot and a half deep here, it is about 30 yards from shore, still similar stuff. We right at a catamaran now, still same kinds of plants, such as lily pads, marly sandy substrate, there is some Eurasian milfoil, a few scattered sprigs of Eurasian milfoil. We are moving past that spot where the road first touches the lake, looks like we are running into a big bed of lily pads here, cattails on the shoreline, plants are still sparse on the bottom, looks like some Elodea and Chara again. In the bed itself,there is a lot of Elodea and we found some Eurasian milfoil as well by the lily pad bed here.

Station 13

We are moving on now to where the road curves and if you drove straight you'd hit the lake. We are at that point right now and we'll call it Station 13. Moving past that point again we see a lot of dense plants on the bottom, probably Chara and Elodea. There is a lily pad bed, 2 or 3 lily pad beds. We are in a little bay and we are heading toward the point (Point 3) of this bay going around the other side of the lake now. Looks like some Potamogeton amplifolius, a lot of Chara, and probably Chara again, some spots of open area here, some Eurasian milfoil, a few strands of Eurasian milfoil in with the Potamogeton filiformis.

Station 14

We are getting very close to point 3 and there is a lily pad bed here. We will call that station 14, just before the point, a muskrat house here, some cattails, and arrowhead abundant along the shoreline. We just made contact with point 3, it is very shallow, about an inch deep here, very sandy, and we are going to have to go way around it to get around the point. We are rounding the point, we are on the other side now. It is fairly sparse with plants here, the same plants again, Elodea, some Chara probably. We are running into plant beds that are a little more dense now as we round the bend, we are about 30 yards around the bend coming in front of a house here. Looks like right along here the whole bottom is covered with plants, although we cannot tell how thick they are. Looks like Elodea and Chara again, no Potamogeton or Eurasian milfoil that we can see sticking out anywhere, just a whole blanket of plants down there on the bottom composed mostly of Chara and some Potamogeton species. We are out about 70 yards from shore and it all looks the same in through here. There is one little stand of Nuphar up here, and there is one about 40-50 yards around point 3 and another one about a hundred yards west of the point.

Station 15

We are moving up along the shoreline now. We'll call this Station 15 in the area beyond point 3 and point 4. There is actually another patch of lily pads along here, fairly common in this particular area, and we are moving on toward point 4. We are going right through the lily pad bed right now. We went through a little bit of Valliseneria, but it is fairly sparse in this particular section. We are about a hundred and fifty yards from the point 4 in the Station 15 area. Not much for plants on the bottom, there is marly substrate here. Here we are running into some Elodea or Chara, there is some Eurasian milfoil, a couple of sprigs of Eurasian milfoil here and there, thick beds now of Elodea. They're very abundant in through this area. Another sprig of Eurasian milfoil here, and about a hundred geese sitting out here. Some Najas here amongst the Elodea , looks like some Potamogeton spp. Now we are about 70 yards before coming to point 4, we are 40 yards from shore, there are a few patches of gray where there aren't any plants and out where we are there is Elodea. There are a few more areas here where there is no plants on the bottom, but big beds of Elodea in other spots.

Station 16

We are at point 4 now, we'll call this Station 16, we are going around the point. Plants are fairly sparse although there are areas that are covered a lot with Elodea. Now we are running into an area where it is pretty windswept, not much on the bottom. What is here is probably Chara, mostly mud and sand or marl, not many plants. It says private beach, members only here, so it might be treated with herbicides as well. This is a beach area just going around the point, there is a little bay around this point, it has a lot of lily pads in it, again this is all sandy area here, sandy or marly, not much for aquatic plants at all, from the point all the way around the bend here until we get around it there is lily pads. There is a channel right here, looks like a canal, a prime spot for Eurasian milfoil, although it looks to be fairly good so far here. We are going through the lily pads right now. There is a lot of Eurasian milfoil on the right hand side (west side) as we go into the canal in amongst the lily pads, looks like some on the bottom too, some Potamogeton. Again, the dominant surface plants are the lily pads. The canal seems to be fairly deep in here, like about 3-4 feet. Not much for plants that we can see, except for the lily pads. It looks like they did treat plants with herbicides here; everything looks dead. It goes on, it is pretty big. We are now out of the canal proceeding around the bend from the canals about a hundred yards, we went through a lily pad bed again, it is Elodea on the bottom. We are right next to another little canal system here and there is a rope hanging from a tree. There are fewer plants here, some more of that open sandy area with a few scattered beds of probably Chara and Elodea for a good part of this shoreline. This looks like a little park here. It says private beach, association members only. We went by a rocky point here past that little park. There is one sprig of Eurasian milfoil here. It is all pretty much open here, we are about 40 yards past that park now, going along the shore. It is not the kind of thick abundant plants we saw before, it is fairly sparse along here with some Chara in scattered spots. You can see a lot of exposed bottom here; sparse aquatic plant growth. We are moving along the shoreline now, we are quite a ways along this whole shoreline, at least close to shore where it is fairly shallow, it is sparsely populated with plants. Once you get out a little deeper then the Chara is a little more dense in about 3 or 4 feet of water. There are a few Valliseneria sticking up along here, some Potamogeton and Najas on occasion, but the whole bottom is covered with Elodea. We are getting close toward the other end of the lake. We just ran into some sandy shoreline along here.

Station_18

This station is a large area along this southern shore. It is amazing the dearth of plants here, it is very sparse, we see a little Chara on the bottom here and there, and there is nothing really near shore, we are out about 70-80 yards from shore right now and the deeper you go out the more abundant the plants become. For example, we are running into a little more dense growth on the bottom, but it is not very thick and it is mostly Elodea. So this whole shoreline along here looks like not much of a problem with regard to Eurasian milfoil. Call this whole area along here Station 18. There is a lot of houses along here and a few docks here and there, one diving raft is sticking out here. We are getting about 2 or 3 hundred yards approaching point 5, sort of the major point on the lake and the one that divides the lake into two lobes. We will call the intermediate area between where we've been (station 18) and Point 5 station 19.

Station 19

We are about 200 yards away from point 5 now. There is nothing around here, no plants at all. It is all sandy and nice, it is a beautiful spot right here, a lot of houses. We are about a hundred and fifty yards from point 5 now and it is sandy, no plants. We ran into a bed of Elodea here, it is just one little bed about ten feet thick, ten feet in diameter. We are approaching the point which is sandy, gravelly, no plants whatsoever. We are in about 2 feet of water, 40 yards from shore.

Station 20

Call the point station 20. It got deep off the point and looks like a few plants down there too. Around the bend from the point there is a little bay in here, there is a lot of Eurasian milfoil and lily pads in here. We are probably 40-50 yards around the point. A bit of Eurasian milfoil out in front of the lily pads. This is the most Eurasian milfoil we've seen, it is very abundant in here.

Station 21

There is a canal where we are right now where the Eurasian milfoil is just thicker than we have seen anywhere in the lake. It is just extremely abundant, covering the entire bay. It is right next to the canal, this is a tremendous area of infestation, probably about 50 yards by 25 yards at least, right by this canal. And it is out in real deep water as well. We'll call this Station 21, right by the canal. Our estimates are widening. It looks like this entire bay is infested with Eurasian milfoil. We are seeing acres instead of square yards of Eurasian milfoil here--we are almost cutting right straight across here over toward the other road that comes in here, looks like this whole bay is infested from one shore to the other. We are out in the middle about a hundred yards from all three shores here, and it is solid Eurasian milfoil. As we approach the other shore here it is either too deep or there isn't any, because we kind of ran out of it about 70 yards from shore. We are on the other shore now, right where the road along the lake goes up a little hill.

Station 22

At Station 22, which is adjacent to the road where it starts up the hill here we are running into sandy, gravelly substrate with very few plants on the bottom, nothing much to speak of, mostly Chara, probably some Elodea as well.

Station 23

We are approaching point 1 where we started, we are probably 150 yards from it, call it station 23. There are heavy growths of Potamogeton amplifolius, Chara on the bottom. Aquatic plants are fairly dense in here. Prior to this time, plants were fairly sparse and it was quite shallow.

Station 23

This station is the entire area of the bay just before point 1 (station 1 where the study was initiated we found Vallisceneria, Elodea, a couple of Potamogetons, and a few areas where there were no plants at all. Another big bed of Eurasian milfoil was recorded; Eurasian milfoil is fairly thick over here again, we are about a hundred yards from the point, there are lily pad beds here, lot of plants on the bottom, probably Elodea, a few spots where it is bare again, but there are a few areas of occurrence of P. amplifolius. We note here some more lily pads, a stand of Eurasian milfoil by the lily pads. We are right before the point, in this little bay, or at least this little indentation, it looks like another good spot for a lot of plant growth. We found Elodea, Potamogeton amplifolius, we are out about 70 yards from shore, there is some Eurasian milfoil, so it looks like Eurasian milfoil is sort of interspersed in here. It is not as abundant as it was at the other spot, but here and there, there is another big stand of it. We are getting close to the point now, more Eurasian milfoil, and the lily pads close to shore. We are right at the point now, and as might be expected this is that windswept point, similar to what we started out at at Station 1. It is shallow and sort of devoid of plants.

RECOMMENDATIONS

We discovered that North Lake is a typical eutrophic lake with a healthy growth of aquatic macrophytes along its shoreline. In some areas, there may be some excessively dense stands of aquatic plants that may restrict swimming beaches or other forms of recreation. The main area of abundant plants was in the northeastern part of the lake. Here there is an infestation of Eurasian milfoil (see Appendix 1), which was most likely brought in from the public access on a boat or trailer which had fragments of this plant on it from other contaminated lakes in Michigan. This is a common method for this plant to spread since any fragment or piece can sprout new growths. Since Eurasian milfoil is a threat to the recreational and fishery interests in a lake, it should be eradicated or it will take over more of the lake as it spreads to available habitat in other sections of the lake. Since it is able to outcompete native species, and grows in dense stands in up to 12 feet of water, this plant has gained a considerable amount of respect by lake managers in most of the US and Canada. We are of the opinion that Eurasian milfoil is the only plant causing a problem in North Lake; the other plants were not abundant nor dense enough to justify their extirpation, in all but the most serious cases where a swimming beach is desired.

Eurasian milfoil can be controlled in a number of ways (See Appendix 2). A drawdown, whereby the lake level is lowered exposing the plants and killing them by drying and freezing is one method. Treatment with 2,4-D is another highly recommended method which has provided some control in lakes we have worked on in past years. You should consult a reputable aquatic plant treatment specialist about advice on how best to attack this species and what chemicals they recommend. We estimate that there are about 10 acres of Eursain milfoil in the northeastern part of the lake, but to get a liberal estimate for obtaining costs of treatment, use 20-30 acres. Bear in mind that even with aggressive control using herbicides, Eurasian milfoil may remain in the lake and need to be controlled annually depending on the completeness on the control the year before and growth conditons in the year of concern.

In several cases, Eurasian milfoil has died off on its own, and biologists are still trying to find out why this occurred and discover some new ways to control this nuisance species. Harvesting is not recommended since as noted above, the plant fragments created by harvesting and cutting would contaminate other parts of North Lake that are currently uninfected. It would be a recommended method, if Eurasian milfoil had colonized all available habitat on the lake and it has been used on at least one lake we studied. However, residents were unhappy with the control, which was not unlike mowing a vast and dense lawn. Harvesting had to be ongoing at all times in the summer to just keep up with the milfoil growth.

FRESH WATER PHYSICIANS INC.

PROFESSIONAL

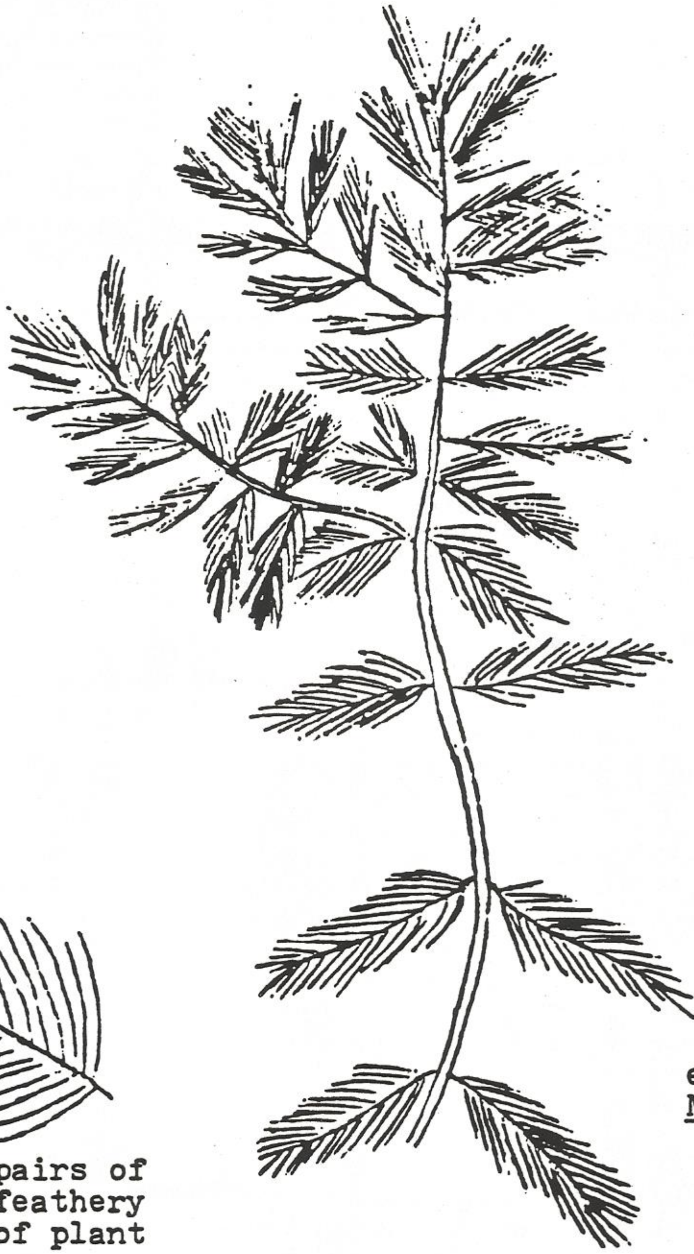
BIOLOGISTS

FOR

COMPLETE

AQUATIC

STUDIES



eurasian milfoil
Myriophyllum spicatum

Note 12-16 pairs of
leaves and feathery
appearance of plant

IMPACT STUDIES   LAKE MANAGEMENT

Preliminary Report, North Lake Water Quality/Macrophyte Survey
Freshwater Physicians, Inc., 10 July 1992.

Water samples were collected at North Lake to determine existing water quality and extent of stratification on 10 July 1992. In addition, a shoreline survey of aquatic vegetation was performed which duplicated a survey conducted on 23 October 1988. Preliminary results are as follows:

* As expected, the lake was thermally stratified in a typical pattern for southern Michigan lakes of this size. Maximum depth was nearly 60' (18 meters). Both temperature and dissolved oxygen were high at the lake surface, dropped rapidly through the thermocline, and reached lowest values near the lake bottom. As the dissolved oxygen falls below 2-3 ppm, fish become stressed and will avoid these areas (23' or 7 meters and deeper in North Lake at the time of measurement). The attached figure displays the temperature and dissolved oxygen in graphic form.

* Light penetration as measured by a secchi disk was 3.6 meters (12'). The is quite good for lakes in this area at this time of the year.

* Conductivity and pH showed expected values from top to bottom at the profile station (deepest part of the lake).

* The aquatic plant survey demonstrated a very much improved situation with respect to the most problematic species, eurasian milfoil. Although still present, the plant was scattered with no substantial beds noted. Channels and backwater areas showed the most milfoil, these areas may need treatment with 2,4-D. The balance of the aquatic plant population was very diverse, with 5 or 6 species represented. We saw no open water areas needing immediate treatment. We do recommend spot treatments of milfoil with 2,4-D as needed. However, treatments this time of the year are not too effective. We suggest consulting with a weed control specialists to discuss future treatments to keep the milfoil under control.

* Until the chemical analyses are completed on the samples we collected, we cannot issue a final report on the water quality of North Lake. The lake is eutrophic (enriched), but seems to be quite well balanced. The oxygen depletion is our biggest concern, as it is evidence of substantial enrichment. We will further discuss this issue in our final report.