Management of Aquatic Plants

Prepared By:
State of Michigan
Department of Environmental Quality
Water Bureau

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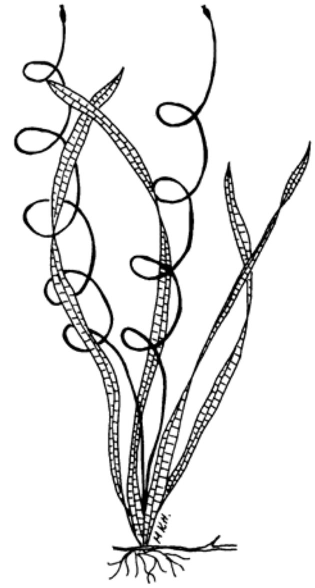
MANAGEMENT
OF
AQUATIC PLANTS



Introduction

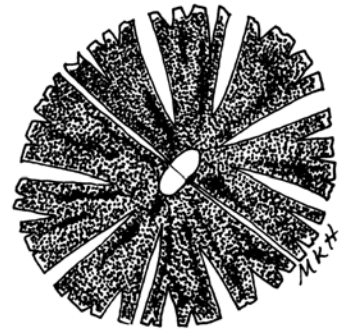
Aquatic plants are a vital part of any lake or pond. They convert sunlight and chemical elements into living plant tissue. Fish, waterfowl, insects, mammals, and microscopic animals use the plants for food. Plants also replenish the aquatic environment with oxygen, which is essential to aquatic animals. Additionally, rooted plants create a varied aquatic environment in which fish food organisms reside. They also provide cover for spawning fish, nesting waterfowl, shoreline mammals, and their young.

Although they are important to the aquatic environment, plants frequently conflict with recreational and economical interests. A need, therefore, exists for proper aquatic plant management to insure that the natural environment and human interests are mutually protected. The Department of Environmental Quality (DEQ), Inland Lakes and Remedial Action Unit (ILRAU), has developed this bulletin as a primer for those seeking information on aquatic plant management.

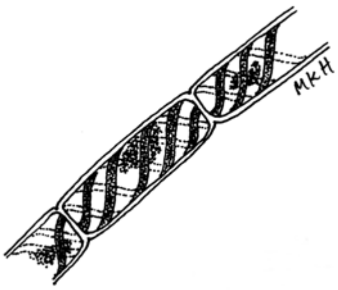
Aquatic Plant Types

The first step in any lake or pond management program should be to identify the aquatic plants present in that particular waterbody. The proper management of aquatic vegetation requires knowledge of the various plants that grow in lakes and ponds and their importance to the aquatic ecosystem. Although aquatic plants may be divided into many categories, a simple classification according to life forms and growth patterns divided them into only two categories: the algae and the macrophytes (rooted aquatic plants).

Algae



Algae are divided basically into planktonic, filamentous and macroalgae forms. Planktonic forms are microscopic, free floating plants often referred to as “water bloom”. In large numbers, these algae can cause water to appear green, brown, yellow or even red, depending upon the species present.

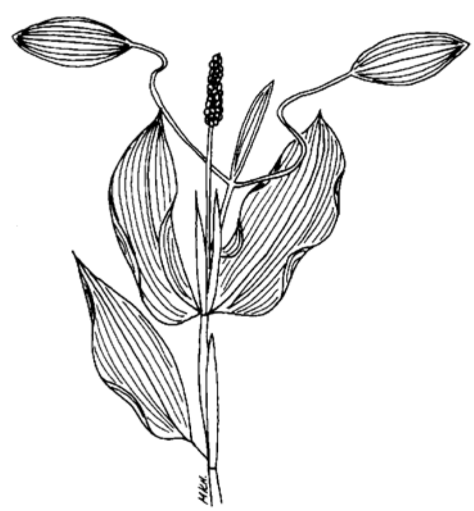


Filamentous algae, commonly called “pond scum”, can form raft-like masses over the water surface, but since they are vulnerable to winds and currents, they are generally restricted to bays, bayous and sheltered shorelines. Filamentous algae can also grow attached to the lake bottom, the macrophytes, or piers and docks. The filamentous algae will frequently detach from the substrate and form floating mats.

The macroalgae include the two types refered to as Chara and Nitella which are large and resemble macrophytes.

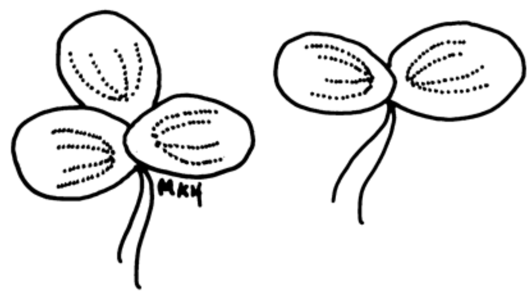
Macrophytes

The macrophytes are the rooted plants found in a lake or pond. They are usually large, easily seen plants; however, some are small enough that dozens of plants can be held in an individual’s hand. The macrophytes may be divided into three basic forms; submergent, emergent, and free-floating. Submergent macrophytes usually grow rooted to the bottom with stems and leaves below the water surface, except for some plants which may produce a few small floating or aerial leaves. Submergent plants provide food and cover for fish, waterfowl, and other aquatic life.



Emergent plants grow in shallow water, with most of the plant protruding above the water surface. Cattails, waterlilies, arrowhead, rushes, and reeds are examples of emergent plants and, like the submerged plants, are important as food and cover for fish, waterfowl and other shoreline animals.

The free-floating macrophytes in Michigan are the duckweeds. These tiny plants are not attached to any substrate, but float freely upon the water. They are subject to current and wind action which will concentrate them in certain portions of a lake. Some waterfowl utilize duckweed as food.



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For additional help in identification of plants refer to the drawings at the back of this booklet, or the bulletin "Common Aquatic Plants of Michigan." County extension agents, chemical companies dealing in aquatic herbicides, universities, and DEQ district offices may also provide assistance.

What Makes Aquatic Plants Grow?

The distribution and abundance of aquatic plants in a lake is dependent upon the lake's chemical and physical properties including:

1. the amount of light available,
2. water levels,
3. water temperatures,
4. type of lake bottom sediments,
5. current or wave action, and
6. the concentration of dissolved gases and nutrients.

In lakes, nutrients and light availability are most often the factors which limit plant growth. Nutrients are the chemicals such as nitrogen, phosphorus, carbon, potassium, etc., which plants require for their growth. These nutrients originate in the rocks and soils surrounding the lake. Natural processes at work within the lake's watershed continually carry some of these nutrients into the lake. A lake's watershed is the land around the lake from which water drains to the lake (Figure 1). Lake watersheds vary greatly in size, topographic relief and the means by which water moves through the watershed (stream flow, groundwater movement, surface runoff, etc.). The natural movement of nutrients to lakes is, therefore, dependent upon the characteristics of the watershed.

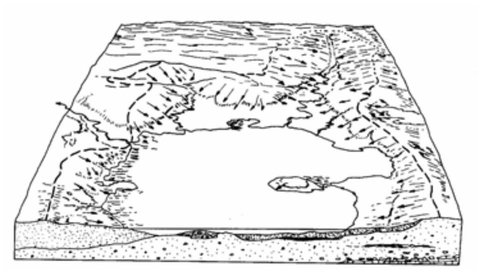


Figure 1. This diagram represents a lake and its watershed. The broken line represents the drainage divide of the watershed. The arrows depict the pattern of overland flow.

As nutrients enter lakes from the watersheds, lakes respond by producing aquatic plants and algae. Limnologists (lake scientists) have for many years grouped lakes by a classification system based upon their productivity or ability to produce plants. Lakes that are low in productivity are called oligotrophic, while lakes high in productivity are called eutrophic.

Oligotrophic lakes usually:

1. are deep,
2. have high oxygen concentrations in the deeper water,
3. are very clear,
4. have sparse populations of aquatic plants, and
5. are populated with cold water fishes such as trout and whitefish.

Eutrophic lakes usually:

1. are shallow,
2. have little oxygen in waters deeper than 30 feet,
3. have murky water,
4. have substantial growths of aquatic plants, and
5. are populated with warm water fishes such as bass, pike and bluegills.

The term mesotrophic is often used to describe a lake with characteristics between oligotrophic and eutrophic.

All lakes will become more productive or “age” with time. This aging process, commonly referred to as “eutrophication” is dependent upon the lake’s physical characteristics and upon the quantity of sediments and nutrients washed into the lake from its watershed. Without human influence, the natural aging process is extremely slow often taking thousands of years to result in any noticeable changes in lakes. Human activity on the watershed, however, may greatly accelerate the aging process by increasing the quantity of sediments and nutrients entering the lake. This fact emphasized the importance of proper watershed management, especially at the shoreline of lakes and streams. Figure 2 illustrates a preferred watershed management plan vs. poor management of the watershed.

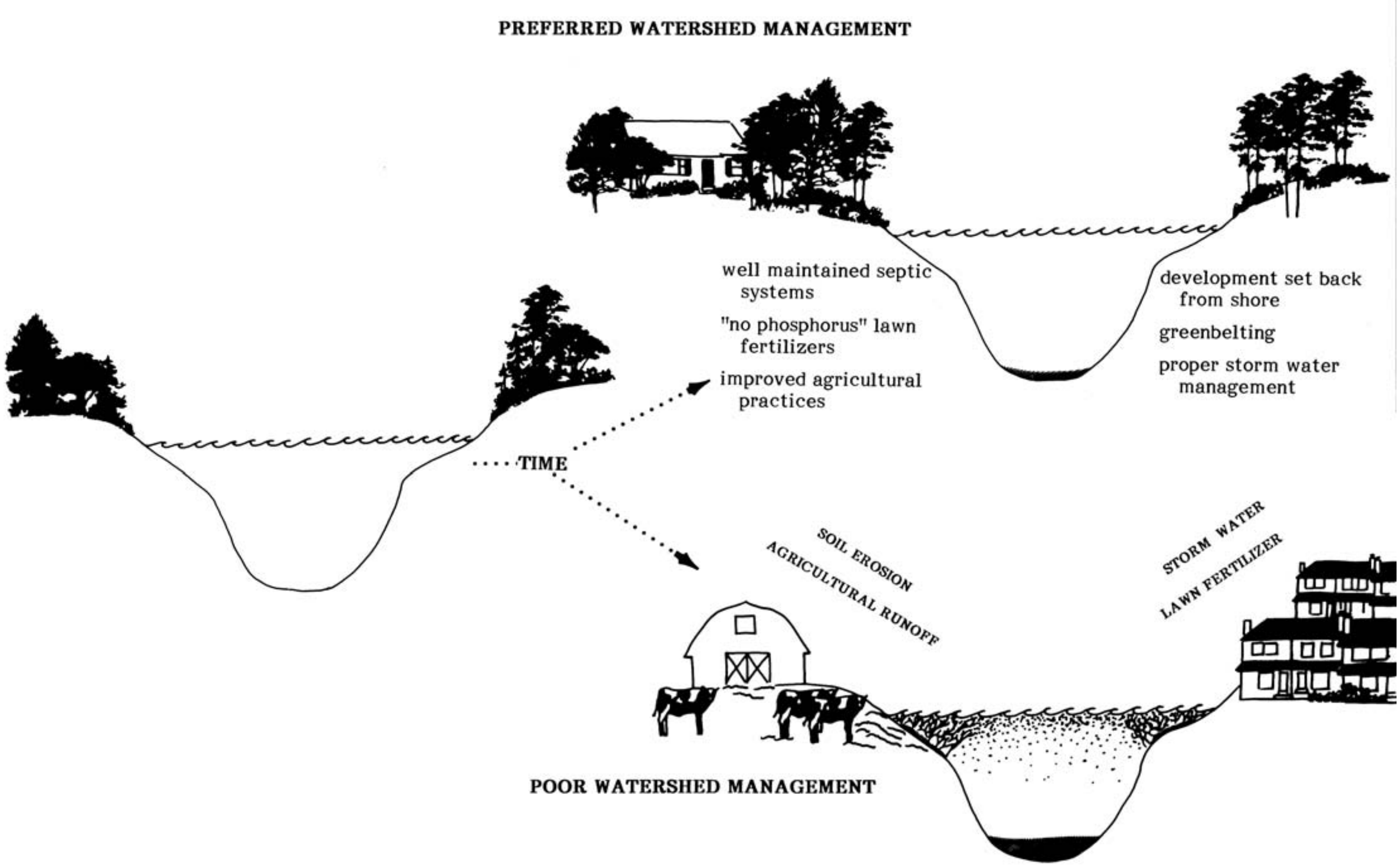


Figure 2. Preferred Watershed Management vs. Poor Watershed Management

The Aquatic Plant Management Program

The goal of any plant management program should be to maintain a proper balance of plants within a lake. Ideally, every aquatic plant management program will have two phases: (1) long-term management (nutrient control) and (2) short-term management (direct manipulation of macrophyte and algae populations). Short-term management is relatively easy to implement, but long-term management is more complicated. It requires considerable community involvement and cooperation, and results take years rather than days to develop.

The remainder of this bulletin will consider the principles and techniques of long-term and short-term aquatic plant management. Not every principle or technique presented will be applicable to every lake and even those that are should be evaluated carefully before using them. While economics must, of course, be considered, ecological values should receive prime consideration before any management technique is employed. Attention to ecological values may result in a program that is less costly over the period of a decade or two.

Long Term Management (Nutrient Control)

Aquatic plants require many nutrients for growth and reproduction. The nutrients most often considered to be in the shortest supply and, therefore, limiting plant growth are phosphorus and nitrogen. Since aquatic plant populations are directly dependent upon the amount of nutrients available, nuisance growths of plants are only symptoms of high nutrient levels. This is important because all too often aquatic plant control programs are directed only at the aquatic plants, and not at what causes the plants to grow (nutrients). An effective aquatic plant management program must give proper consideration to the amount of nutrients entering the lake. Aquatic plant management techniques designed only to "kill weeds" must be considered only temporary cosmetic measures to reduce the symptoms of high nutrient levels. It is wiser to control the movement of nutrients (and sediments) from the watershed, whenever possible, than to attempt remedial action after nutrients have entered the lake. The management of nutrient sources, over the long run can help reduce the rate of lake aging.

Limiting the movement of nutrients off the watershed and into lakes will require the management of nutrient sources. Some sources of nutrients, both natural and cultural are listed in Table 1. Natural sources of nutrients are those which would enter a lake, even without human influence. Most natural sources contain only very small amounts of nutrients. However, human sources of nutrients are usually in large volumes and high concentrations, which can greatly accelerate the rate of lake eutrophication.

Table 1. Natural and cultural (human) sources of plant nutrients (chemical elements) to the aquatic environment.

Natural	Cultural
wetland runoff	domestic and industrial wastewater
meadow land runoff	agricultural runoff (cropland & pasture)
forest runoff	agricultural wetland drainage
precipitation on the lake surface	managed forest runoff
soil erosion	urban stormwater runoff
aquatic bird and animal wastes	septic tank discharges
leaf, pollen and dust deposition	landfill drainage
groundwater influxes	construction activities
nitrogen fixation by plants	lake shore lawn runoff
sediment recycling	atmospheric fall-out of wind borne fertilizers from land and industry

(Modified from Shannon and Brezonik, 1972. Relationship between lake trophic state and nitrogen and phosphorus loading rates. Environ. Sci. Tech. 6:719-725).

All nutrient sources will have different levels of manageability. Some may be uncontrollable, while others may be controlled with little effort or cost. Ideally, it is desirable to know which sources are contributing nutrients to a lake and in what quantities. It is then possible to adjust funds and activities to control nutrient sources to most effectively reduce the amount of nutrients entering the lake. However, this approach in most situations will require an extensive study by a trained limnologist.

The best time to begin a nutrient control program is before aquatic plants have attained nuisance levels. The management of nutrient sources is an on-going responsibility, which must be intensified as development of the watershed continues. Methods of nutrient source management include:

1. proper land use,
2. wise consumer use of commercial products,
3. treatment of inflowing waters high in nutrients,
4. diversion of water high in nutrients, and
5. municipal and industrial wastewater treatment.

Proper Land Use

The importance of proper land use and watershed planning is beginning to stimulate many units of government, at all levels, to enact ordinances and laws to regulate land use. In Michigan, the State Legislature enacted the Soil Erosion and Sedimentation Control Act of 1972 (Act No. 347 of Public Acts of 1972) to limit the movement of sediments and associated nutrients into surface waters during earth moving activities (except agricultural tillage).

Minnesota, Wisconsin and Maine now require local government units to establish zoning ordinances for lake and stream front properties to protect the quality of these aquatic environments. Table 2 presents land use practices that should be considered in a nutrient control program.

Table 2. Examples of wise land use practices which can reduce the movement of nutrients from the watershed into lakes.

a. advocate sediment control from logging, agricultural activities and urban construction.

b. Preserve wetlands as no development areas.

c. Require or encourage greenbelting to preserve native vegetation along lake and stream banks.

d. Promote proper collection and disposal of or treatment of farm and feedlot animal wastes.

e. Encourage sound farm fertilization practices.

f. Urge community collection and disposal of leaves in urban areas adjacent to large recreational water systems.

g. Require routine inspection and maintenance of catch basins in city storm drains.

h. Limit or restrict the use of fertilizers on lawns adjacent to lakes and streams.

i. Prevent urban stormwater drainage, with its high nutrients, from directly entering a lake, rather encourage subdivision designs which maximize infiltration and groundwater recharge.

j. Regulate the size and use of lake and stream front lots and backlots to prevent over-development of the environment and its associated high nutrient loading.

k. Stipulate a minimum distance of at least 100 feet between the shoreline and installation of private septic systems and tile fields.

l. Prevent development in areas where the groundwater is high or soils are poor nutrient traps for private sewage-disposal systems.

m. Require an environmental impact statement for all development which could significantly degrade environmental quality.

Wise Consumer Use of Commercial Products

There are several commercial products, such as detergents and fertilizers, used for domestic and commercial purposes which can contribute significant amounts of nitrogen and phosphorus to natural waters. Curtailing or restricting the use of these products or substituting similar products of low nitrogen and phosphorus content would substantially reduce the loading of nutrients to natural waters.

Waterfront property owners should take special care in the use of detergents and fertilizers. To reduce phosphorus loading into waterways, high-phosphate detergents have been banned in Michigan and several surrounding states.

If lawns must be fertilized, soils should be tested to determine which chemical nutrients are needed. If the soil does not require phosphorus, a fertilizer with little or no phosphorus should be used. County cooperative extension agents can provide information on soil testing procedures and the best methods for applying fertilizers.

Treatment of Inflowing Waters High in Nutrients

In certain situations it may be possible or necessary to treat inflowing waters to reduce nutrient levels before they enter a lake. An inflowing stream or drain may carry substantial amounts of nutrients collected from many sources, such as agricultural drainage or urban stormwater drainage. In certain situations it may be more feasible to chemically or physically treat the inflowing water to reduce nutrients than to control the many diffuse nutrient sources draining into it.

Diversion of Waters High in Nutrients

Diversion is the rerouting of water high in nutrients around or away from a lake. The principle of diversion is applicable to most nutrient sources that can be physically contained or rerouted. The application of this nutrient control technique has been most frequently applied to the diversion of municipal wastewater, but the concept can apply to waters containing high nutrient levels derived from other sources as well.

In many cases where nutrient rich water has been diverted away from a lake, there has been a marked increase in water quality. It must be emphasized, however, that diversion is not a substitute for treatment or proper land management. The diversion of non-treated nutrient rich waters is only a transfer of nutrient control problems to downstream communities.

Municipal and Industrial Wastewater Treatment

Few Michigan inland lakes receive municipal wastewater discharge, but when present, it can be a major source of nutrients for aquatic plant growth. Several methods are now available to reduce the level of plant nutrients in wastewater. But even when these methods are used, a wastewater treatment plant discharging to a lake or its tributaries will contribute greatly to the loading of nutrients to a lake. Diversion of wastewater around lakes or land disposals are possible alternatives for eliminating completely the impact of this nutrient source upon lakes.

Industrial wastewater is highly variable in quality. Those that contain substantial amounts of plant nutrients or toxic materials must be considered in any lake management program.

Short Term Management of Aquatic Plants

Although the initial and continuing phase of aquatic plant management should be the control of nutrient sources, many lakes have such serious plant problems that short-term management techniques may be needed to maintain the recreational and economic interests in the lake. Also in cases where nutrient control is impractical, such as shallow reservoirs on major, agricultural or urbanized river systems, short-term management practices may have to be conducted annually. Even in such cases, however, under no circumstances should the complete eradication of aquatic plants be considered. This practice is environmentally unsound and could have very undesirable consequences. In some lakes it may be necessary to alter recreational activities somewhat to suit the lake's state of eutrophication, rather than attempt to change the lake to meet recreational demands. In situations where nutrient control is possible, short-term management techniques should be considered only as temporary measures, designed to replace nuisance plant species with plant species that conflict less with recreational and economic interests.

The short-term methods of managing aquatic plants include:

1. biological control,
2. mechanical harvesting,
3. environmental manipulation, and
4. use of herbicides.

These methods are directed primarily at the results (aquatic plants) of nutrients entering the lake and not at reducing the flow of nutrients. In some cases, however, nutrient levels with the water system may be reduced incidentally with certain techniques.

<u>Biological Control</u>

Biological control of aquatic vegetation is presently the least understood and utilized of the four short-term management techniques. Biological control normally includes the introduction of an organism that competes with, preys upon, inhibits the growth of, causes disease in or parasitizes a plant species which has created a problem.

The introduction and release of exotic, foreign or non-native insects, fish or other animals into Michigan without specific authorization is strictly forbidden by state laws (Act No. 286 of the Public Acts of 1929; Act No. 196 of the Public Acts of 1958). At the present time, there are two biological control techniques being applied in Michigan waters. These methods are not regulated by state agencies, therefore, if you are interested in these programs, please contact the program directly.

The Purple Loosestrife Program was initiated by Michigan State University and Michigan Sea Grant College Program as an ecologically-sound approach to the biological control of purple loosestrife, an exotic plant species native to Europe and Asia that inhabits wetland areas. This program introduces natural insect enemies, or biological control agents, to existing purple loosestrife populations. The biological control agents feed on the leaves, and stem and root tissue, causing defoliation and eventually plant death. For more information about this program, contact the Purple Loosestrife Project at 517-353-9568 or view http://www.msue.msu.edu/seagrant/pp.

The MiddFoil® Program is a biological control program for Eurasian watermilfoil, an exotic submerged plant species. MiddFoil® augments existing lake populations of a native insect (weevil) that feeds on watermilfoil plant tissue, causing the plant to lose buoyancy and fall to the bottom of the waterbody. For more information about this program, contact EnviroScience, Inc. at 800-940-4025 or view http://www.environscienceinc.com.

Mechanical Harvesting

Mechanical harvesting involves the pulling or cutting and removal of macrophytes from selected areas of a lake. It may employ hand tools or highly sophisticated motorized cutting or rotovating devices. The harvesting of algae from lakes appears presently to be economically infeasible primarily due to very high energy costs to remove the microscopic plants from water.

When large areas of aquatic plants are harvested, the cut material should be removed from the lake. If left in the lake, the cut plant parts will decompose, sometimes only partially, and contribute nutrients and organic material to the lake bottom. This, in turn, helps to nourish new plant growth. In addition, during biological decomposition of the cut plant material, dissolved oxygen levels may be lowered. This can affect the delicate balance between the water and sediment chemistry. Low oxygen levels also affect fish and fish-food organisms. Removing cut material from a lake may even improve water quality somewhat if the amount of nutrients removed (in plant material) is greater than the amount of nutrients entering the lake from the watershed.

Mechanical harvesting also has drawbacks which must be considered. It has a high initial investment if a specially manufactured harvester is purchased. Many of these machines are large, heavy, and can be damaged by obstructions (Logs, boulders, and debris) hidden below the lake surface. Additionally, harvesting could aid the spread of a plant problem, since fragments of certain plants could drift into unaffected areas, take root and grow.

Environmental Manipulation

The objective of environmental manipulation is to alter one or more physical or chemical factors (listed in “What Makes Aquatic Plants Grow?”) critical to plant reproduction and growth thus making the environment less suitable to the plant. Several techniques have been used with varying degrees of success. These methods may not be economically or environmentally practical in every lake. Even in practical situations, a technique should be employed only after the particular plant problem, and social and economic factors have been carefully considered. Environmental manipulation can provide some control of aquatic plants, but without reduction of nutrient inputs, any results achieved will be only temporary. Since most of these methods are somewhat technical, only a brief discussion of each is given below. Most of these activities require a permit from the Department of Environmental Quality.

Dredging reduces nuisance aquatic macrophytes by deepening the lake bottom below the depth of light penetration. Reduction of the size of the well lighted zone around the shore will reduce the total amount of macrophytes. The disadvantages of dredging include a temporary increase in silt suspended in the water, which on settling in non-dredged areas can smother bottom living animals. Additionally, a suitable upland site must be available for the disposal of dredge spoils.

Aeration is the introduction of air into the waters of a lake for the purpose of increasing the dissolved oxygen concentration of the water. Aeration is most effective in lakes which are devoid of oxygen in the deep water. Keeping oxygen in the bottom waters will prevent the release of nutrients from sediments. As long as nutrients remain chemically bound to the sediments in the deeper parts of the lake, they are less available for aquatic plant growth. Decreases in nuisance algal populations and a shift to more favorable species have been reported following aeration, but this result is not always observed. Control of aquatic plants by aeration has not been demonstrated. A possible disadvantage of aeration is that it can be detrimental to cold water fishes (trout) if warm surface waters are mixed with cool bottom waters making the total lake environment unsuitable for these fish species. There are methods of aerating only the deeper waters, however. The use of an aerator may also cause the re-suspension of bottom muds which may increase turbidity ("cloudiness" of the water).

Nutrient Inactivation is the application of a chemical to a lake that binds with and otherwise immobilizes nutrients necessary for plant growth. Once immobilized, the nutrients settle to the lake bottom. This method is appropriate for algae control, but has little effect on the growth of aquatic plants. The chemical substance used to immobilize and settle out the nutrients is usually a metal ion (iron, aluminum, calcium). The settling process may also reduce suspended solids and decrease turbidity and color, in addition to inactivating nutrients. This technique is expensive and may adversely affect the small animals that serve as fish food.

Drawdown or water level manipulation is a potential mechanism for controlling certain types of aquatic vegetation. In this technique, water levels are lowered for a period of time to expose shallow water areas. This dries out the exposed plants and kills them. Many submerged macrophytes are susceptible to this procedure, but certain emergent macrophytes actually benefit from it. In addition, this method does not control algae. A drawdown period of approximately two months is necessary for drying and freezing to be effective during winter drawdown.

Dilution or Displacement of low quality water with water of higher quality may lessen algae problems, but may not effect plant growth. A supply of higher quality replacement water must be available as well as an acceptable means of disposing of lower quality lake water.

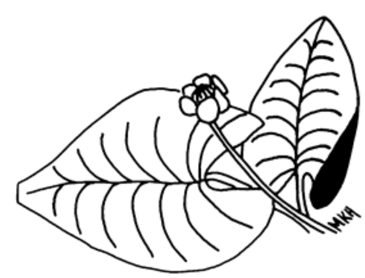
Shading for prolonged periods (4 weeks or longer) has been effective in reducing certain submerged macrophytes by light limitation. Light reduction through the use of water dyes has been tried with some success in ponds and small embayments in lakes. Black plastic sheeting has been used as a floating shade. Its success on small areas (swimming beaches) is good for certain submerged macrophytes and of limited control value for emergent vegetation. However, problems with wave action and currents limit the usefulness of a floating plastic shade primarily to small ponds. The plastic sheeting should be removed after five to six weeks of shading in the spring. This method does not effectively control the growth of algae.

Covering of Bottom Sediments with sheeting material (such as black plastic) and/or particulate material (sand, clay) can perform two functions in controlling aquatic plants. It can prevent the exchange of nutrients from the sediments to the overlying water and it can retard the establishment of rooted aquatic marcophytes. Disadvantages of this technique are that bottom dwelling animals are usually killed when the sediment is covered and often gas is produced under the plastic sheeting causing it to float to the surface. Sheetings are not available that have pores which allow gases to escape. Experience with this technique so far has resulted in good temporary control, however, macrophytes will gradually recolonize the area unless the sheeting is removed periodically and cleared of any growth.

Intensive Use and Periodic Manual Clearing of shoreline areas will in many instances prove to be an effective means of aquatic plant control in small beach areas. The rooted plants must produce sufficient food in their leaves to maintain their root systems. Frequent cutting of the leaves or their destruction by wading and swimming will eventually lead to death of the root system. This technique is particularly effective with emergent vegetation such as water lilies. Like weeding the garden, it is necessary to watch for the early development of potential problems and remove the plants as they become established and before they spread over large areas.

Use of Herbicides

Chemical control is another means of temporarily controlling aquatic plants and algae. There are a number of chemicals available which offer varying degrees of action time, persistence, cost, selectivity and safety to humans, other mammals and aquatic animal life.



When herbicides are part of an aquatic plant management program, special care must be taken to protect both the environment and individuals involved, since herbicides are potentially dangerous to both. To promote the proper use of aquatic herbicides Part 33, Aquatic Nuisance Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, has granted regulating authority over the application of these compounds to the Department of Environmental Quality (DEQ). A permit is required from the DEQ prior to any chemical treatment of a waterbody. The only exemption from this permit requirement is treatment of a pond which is less than ten (10) acres, does not have an outlet, and which is owned by only one person or corporation. Even in situations where a permit is not required, only herbicides registered for use in lakes and ponds may be used. A current list of these herbicides, and permit applications, are available from the DEQ, Water Bureau, Inland Lakes & Remedial Action Unit, P.O. Box 30273, Lansing, MI 48909-7773.

It is important that herbicides be used with extreme care. Herbicides require special handling such as protective clothing for application and posting of treated water so that innocent swimmers or fishermen are not exposed to potentially harmful chemicals. Before applying any chemical always read the product label completely and follow all instructions. Take special note of all warnings on the label to avoid any personal injury and dispose of all empty chemical containers as directed. The product label will also explain the best methods for using the product, as well as rate of application and a list of plants which may be controlled by the product.

If you do not have the proper training or equipment to apply herbicides, you may wish to contact a licensed aquatic herbicide applicator. A list of commercial applicators licensed by the Michigan Department of Agriculture (MDA) to apply herbicides to the aquatic environment is available at http://www.mda.state.mi.us/industry/pest/license/index.html, or from MDA at 800-292-3939. Additionally, the DEQ, ILRAU is available to answer questions which may arise concerning chemical control of aquatic plants or other aspects of inland lake management.

It is important to point out that the use of herbicides to control aquatic plants has certain drawbacks. Most herbicides control all forms of plant life to some extent. Beneficial aquatic plants may be killed along with the nuisance plants. It is also difficult to control the drift of herbicides under certain conditions. Consequently, plants may be killed over a much wider area than intended. Additionally, herbicides give only temporary control. In lakes where herbicides are used repeatedly on a large scale, dramatic shifts in plant populations can occur which may seriously alter the lake's ecology.

In calculating the proper amount of herbicide to use, the first step is to determine the surface area to be treated. In the case of small ponds, this can be done by direct measurement with a tape. For waterbodies of unusual shape, divide the surface into distinct areas, each of which is a shape with which you can deal. The surface area of each section can be calculated, and the areas added together to give the total area of the waterbody. In the case of man-made ponds, the engineer or surveyor who designed the pond may already have the surface area calculated. If the area has been calculated in square feet, divide the number of 43,560 square feet/acre to obtain the number of acres. Example: treatment area of 100 feet x 200 feet = 20,000 sq. ft.; 20,000 sq. ft ÷ 43,560 sq. ft./acre = .459 acre, or about one-half acre.

For some herbicides, the application rate is expressed as gallons or pounds per acre-foot. To calculate the acre-feet of a treatment area, multiply the surface are (in acres) by the average depth (in feet). If a depth contour map of the lake or pond is available, the average depth can be calculated from it. If not, the average depth can be measured through the use of a pole or sounding line (a calibrated cord with a weight at one end). Generally, in an area used for swimming or docking of boats, an average depth of 3-5 feet can be used.

If there are questions that you would like to ask, or if you simply need more information, contact:

Inland Lakes and Remedial Action Unit
Water Bureau
Michigan Department of Environmental Quality
PO Box 30273
Lansing, MI 48909-7773

Additional References:

Introduction to Freshwater Vegetation by Donald N. Riemer, Krieger Publishing Company, Melbourne, Florida, 1993 reprint (hardcover 218 pp.) 1-800-724-0025

A Manual of Aquatic Plants by N.C. Fassett, revision appendix by E.C. Ogden, University of Wisconsin Press, Madison , Wisconsin, 1969 (hardcover, 405 pp.)

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