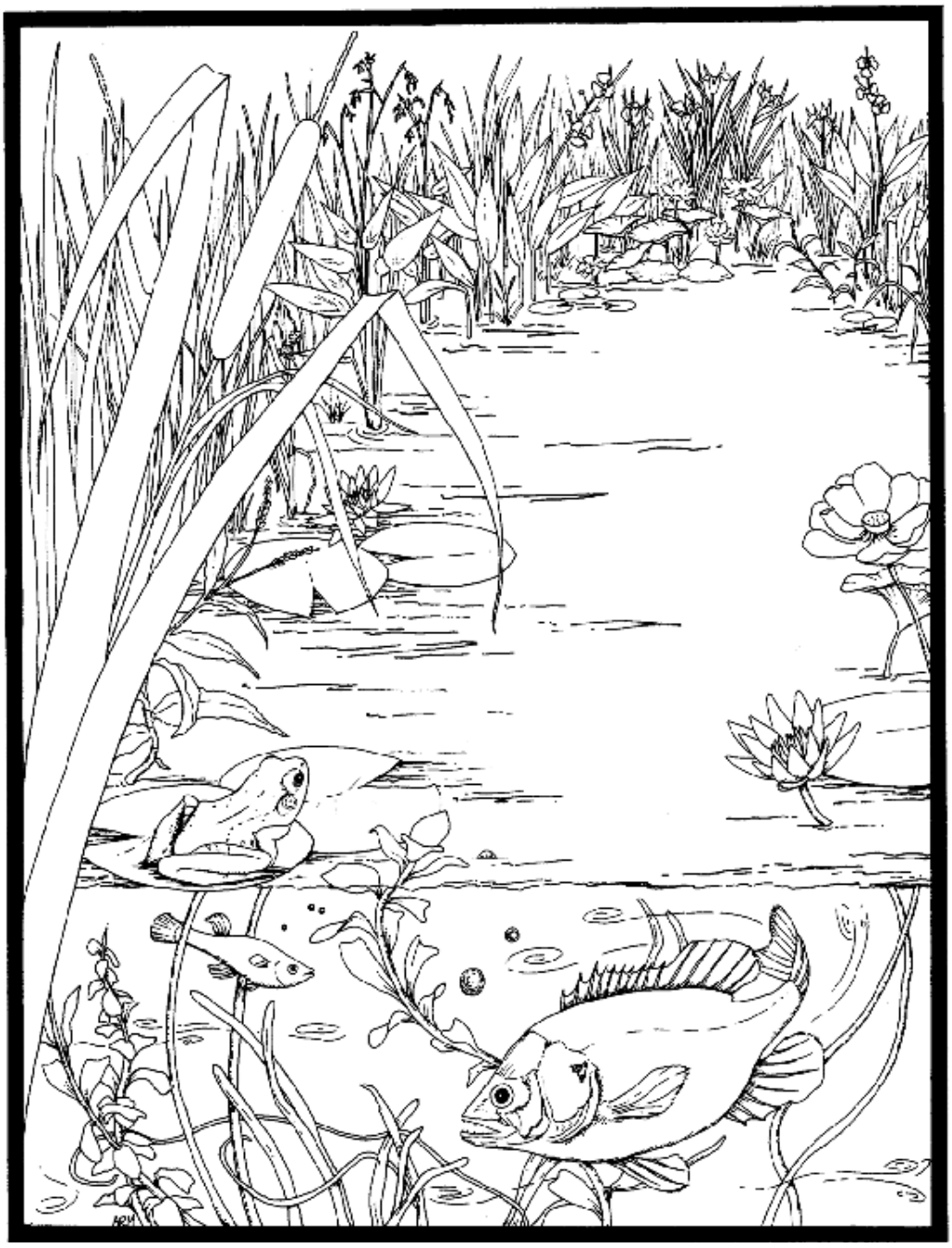
Aquatic Weeds: Nuisance and Necessity



Managing Waterweeds in Cayuga, Owasco and Seneca Lakes

July 6 2009

Cayuga Lake Watershed Network

www.cayugalake.org

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Introduction

Lakeshore property owners have concerns that most other landowners do not face. Mighty waves erode the shoreline, fluctuating water levels threaten drinking water wells, activities in the yard can have an immediate effect on water quality – and excessive water weeds can ruin the enjoyment of the property. An overabundance of aquatic plants can prevent swimming, foul boat propellers, stink as they rot along shorelines and reduce property values. Lakeshore residents expect reasonable access to, and use of, the lake. For many this includes the need for weed management, used here to mean activities intended to reduce the abundance or species of aquatic plants in a specific area.

Weed management requires knowledge, time, patience and money. There is no magic bullet that will eliminate excess weeds without continued effort and without harmful side affects. Some management attempts can even make the problem worse. A lake, after all, is not a swimming pool but a dynamic, complex system and expectations should be realistic.

Who Owns the Lake

The bottom, or beds, of Seneca, Cayuga and Owasco Lakes are state-owned, as is the case of most navigable water bodies in New York State. State Environmental Conservation Law gives the Department of Environmental Conservation (DEC) authority to regulate aquatic plant management and to require permits for certain activities.

State and county Departments of Health may be consulted in cases where permits are sought for waters that are public water supplies.

The people of New York also own all the water in lakes and streams. The owner of land that borders the lake is said to have riparian rights, which is the right to reasonable use of that water. Because other landowners, such as neighbors and those downstream, also have rights to the water it is unlawful to substantially diminish its quantity or quality.

The goal of this booklet is to support weed management in Seneca, Cayuga and Owasco Lakes that takes into account all of the lake's users, emphasizing a watershed approach. The Finger Lakes are important to a wide range of people including boaters, anglers and businesses that benefit from tourism as well as those who enjoy a lake view from afar. Fish, amphibians, aquatic insects, birds and other wildlife also depend on healthy lakes.

This publication will help frustrated lakeshore residents select from the management options provided and understand why some techniques are not allowed or not appropriate. The first section provides background information that is helpful when selecting management options including basic information about plant growth and the benefits of plants. The second section covers specific management practices. The cost estimates provided are intended only as a rough comparison among the different methods. The final section explains watershed-wide steps to take towards longer term solutions. The Appendices provide more information.

SECTION 1: Understanding Aquatic Plants

Why Are There Weeds In My Lake?

Life in a lake depends directly or indirectly on aquatic plants. Water weeds are a critical component of most elements of Central New York's important tourism industry: fishing and hunting, watching and photographing wildlife, swimming, boating and camping. The visual appeal of the lake often includes the flowers and leaves of lakeshore plants, such as water lilies, arrowhead, and pickerelweed. Often incorrectly called "seaweed", they are frequently undervalued and their diversity under-appreciated.

These unique plants provide food and habitat for many animals such as fish, frogs, birds, muskrats, turtles, insects, and snails. The lakeshore and near-shore waters form an important zone, called the littoral zone, in which eighty percent of all plants and animals live at least part of their lives. Excessive removal of plants in this zone interferes with the survival of fish and wildlife. The absence of plants may also increase shoreline erosion and cause disturbance that invites colonization by invasive plants. Plants not native to an area are called exotic. Species that move in and harm the environment by taking over an ecosystem are called invasive, giving rise to the term exotic invasive, or non-native invasive. They are even harder to control than most native species (see "Identifying the Enemy" below). Let's take a closer look at how aquatic plants are a natural and important part of lakes.

Aquatic plants provide important living space and shelter for fish and small animals called invertebrates, a group that includes aquatic insects, snails, and crustaceans. Did you know that:

- Bass, sunfish, and yellow perch nest in areas where plants are growing. Northern pike spawn in marshy and vegetated areas that flood in early spring.
- Young fish, frogs and salamanders hide from predatory fish and birds in aquatic plants. This, coupled with the abundant food supply, makes these important nursery areas.
- Many birds and mammals, including muskrats, use sturdy native plants like cattails and rushes for nest and den-building.

Areas with plants, especially diverse native species, produce more food for fish and waterfowl than unvegetated areas. Plants are the primary producers in the aquatic food chain, harnessing the energy of the sun and making it available to creatures such as insect larvae, snails, and other invertebrates that lack chlorophyll. Here are some ways plants support animal life:

- Ducks and geese eat the seeds, leaves and tubers of plants such as pondweeds, bulrushes, arrowhead, eel grass and duckweed. Songbirds consume the seeds of tall shoreline plants.
- Otters, brooding hens and migrating waterfowl feed on insect larvae, snails and freshwater shrimp that thrive in shoreline plant beds.

- Muskrats graze on cattails, water lilies, sedges, and grasses. They may occasionally eat mussels, shrimp, and small fish that lurk in the weedy shallows.
- Turtles munch on water lilies, cattails, Elodea, grasses and the small invertebrates that thrive in weed beds.
- Tadpoles feed on loose bits of plants (detritus) and algae. For adults, frog fare includes small aquatic invertebrates that find harbor in the weeds.
- Bluegill sunfish devour aquatic plants in addition to insects and crustaceans that flourish in the vegetation.
- Insects cling to leaves and stems using them as feeding stations, resting places and attachment for overwintering cocoons and eggs.

There's more! Water weeds reduce pollution and protect your property. Cattails, rushes and bulrushes absorb and break down polluting chemicals, improving water quality. These and other strongly rooted plants reinforce the shoreline and hold soil in place. Floating plants and those that rise above the water's surface dampen the force of waves and further reduce erosion. Plants improve water clarity in three ways. Leaves and stems act as filters that trap silt and organic particles. Underwater plants hold down sediment and reduce sediment re-suspended caused by wave action, motorboats and currents. They remove nutrients that could otherwise feed algae.

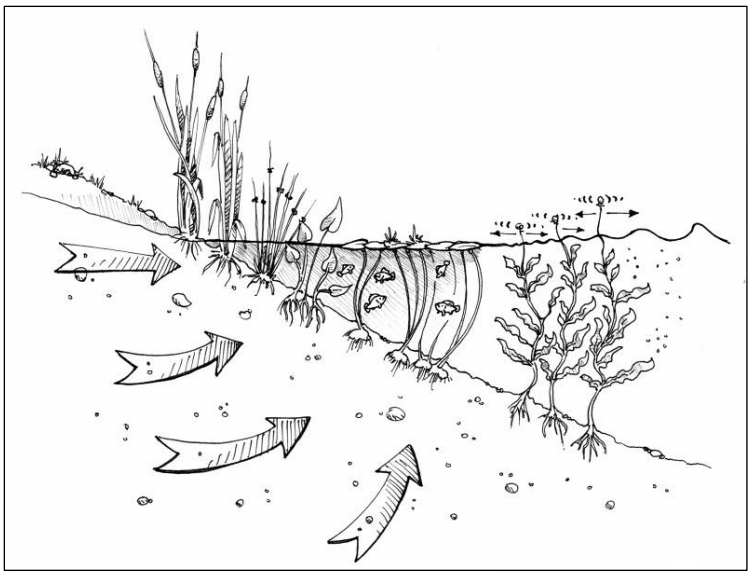

Fig. 1. Plants along the shore-line intercept pollutants, hold soil in place, dampen wave action and shelter fish. Credit: New York Federation of Lake Associations (NYFOLA).

Aquatic plants form a vital part of the complex system of chemical cycling in a waterbody. Plants invigorate the lake by increasing oxygen concentrations in the bottom sediments as well as in the water column. For example, eel grass pumps oxygen into the bottom sediments creating micro-habitats. Aquatic plants, particularly those with floating leaves, create shade below their leaves. The shade reduces water temperature, which allows the water to hold more of the dissolved oxygen that fish and many other underwater animals need.

What Makes Weeds Grow?

The amount, distribution and types of weeds can vary noticeably from year to year. There are many factors that affect how and where aquatic plants grow. All plants need light, nutrients and space, though different species need different amounts. Plant growth can be affected by water temperature and by the type of sediment. All of these factors naturally fluctuate, sometimes dramatically, from year to year.

Why Are There More (or Fewer) Weeds This Year?

It often remains a mystery why the weeds are more extensive one year or for a series of years, or in one part of the lake and not another. Here are some situations that could happen:

- Heavy spring rains dumped fresh soil at the mouth of a creek. Types of plants that were never noticed before dominate since they can thrive in disturbed soil. Delicate plants were smothered by the new sediment.
- An unusually sunny spring caused the shallow shoreline water to warm prematurely and an algae bloom resulted. This decreased the light getting to rooted plants, which were therefore less dense early in the season.
- Weeds piled up on shore are much worse than usual because strong winds broke the weakened stems of plants that were naturally dying back (different species of plants die back from early summer through the fall.)
- Increased water clarity, thanks to zebra and quagga mussels and less erosion, let light penetrate deeper into the water. With the additional light some plants stay well below the water's surface, through the weeds beds may reach further out into the lake.
- Two nearby septic systems failed and went unnoticed by the land owners, but not the weeds which grew lusher from the extra nutrients.
- As soon as lake levels were lowered for winter a cold snap hit. Insects that normally would overwinter in the shoreline mud and plants, now newly exposed, were killed. Vegetation flourished the next year with fewer insects feeding on it.

Sunlight

Plants get their energy from the sun through a process known as photosynthesis. Where the lake is deeper than the sunlight can reach, rooted plants cannot grow. Most aquatic weeds have true roots, stems and leaves and they look similar to plants that grow on land. These large plants are called macrophytes, a word that distinguishes them from most algae that are often microscopic. The littoral zone is the near-shore area where light penetrates to the bottom and rooted macrophytes grow. Many types of algae, also called phytoplankton, float in the water column. These microscopic plants are eaten by tiny animals called zooplankton, which are in turn eaten by fish.

Macrophytes are commonly divided into three groups based on where they grow. Emergent plants grow along the boundary of the water and dry land. A large portion of their stems and leaves grow above (emerging from) the water, even though they can inhabit shallow water up

to two feet deep. Submergent plants have most of their leaves and stems growing below (submerged) the water's surface. Sometimes the flowering parts will project above the surface. The majority of nuisance weeds are submergent. Plants in these first two groups, emergent and submergent, are either securely or loosely rooted in the lake bottom. The third group is the floating-leaf plants, which can be either rooted or free-floating.

Floating-leafed plants with roots, such as water lilies, are most often found just beyond the emergent plants in water that is anywhere from a few inches to eight feet deep. Free-floating plants, such as duckweed, are also found near-shore even though they are not rooted to the lake bottom. Algae float freely in the water but they do not have true roots, stems and leaves. They are simple, primitive plants that are usually quite small, even microscopic. Some algae form stringy colonies 3 feet or more in length and some even look like true, rooted plants (see Figure 2). Of the management techniques presented here, a watershed approach is best for reducing algal blooms (excessive algae). See Section 3, "Taking a Long-Term View: a Watershed Approach."

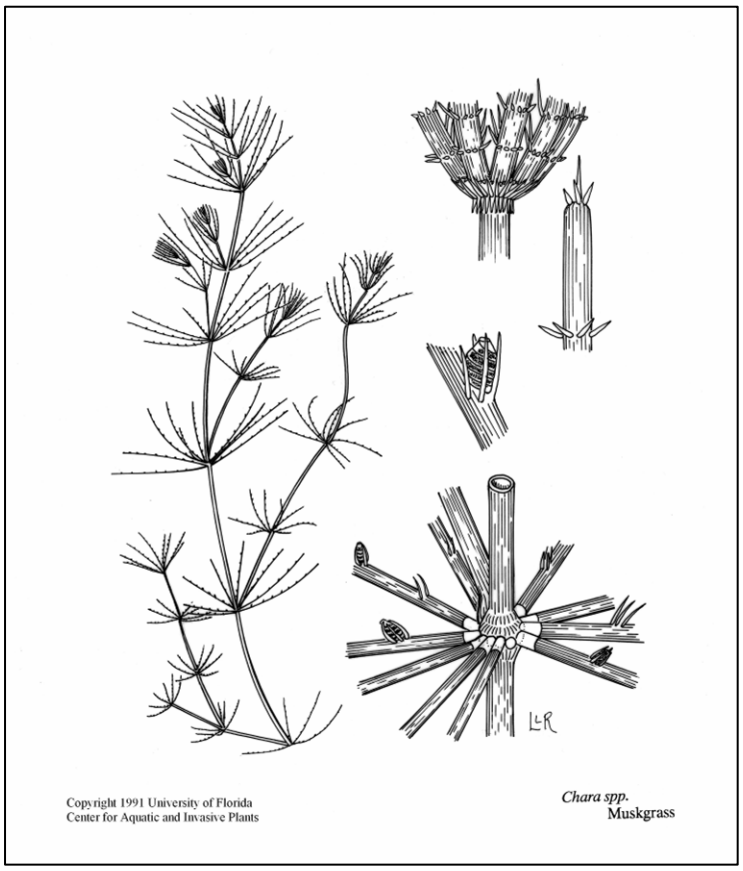

Fig. 2. Muskgrass (various species of *Chara)* are unusually large algae. Credit: University of Florida.

Light is important for all plants. The distribution of plants, especially submergent species, within a lake is generally limited by light availability, which is controlled by water clarity. The amount of light available to submergent plants is altered by anything that affects the clarity of the water, such as an algal bloom, soil washed

into the lake, or filtering by zebra and quagga mussels that make the water more clear. Underwater weeds respond to changes in light even more than land plants since plants submerged in fresh water proportionally require more energy than land plants. Their roots live in sediments that are usually low in oxygen and extra energy is expended by pumping needed oxygen into the oxygen deprived soil. This is balanced somewhat by the reduced need for energy to grow and maintain support tissues since water provides support to plants.

Water clarity is measured using a Secchi disk (see Figs. 3, 3a), a plate-sized disk with black and white sections that is lowered into the water until it can no longer be seen. The deeper the Secchi disk is lowered and still is visible, the clearer the water. As a general rule, the maximum depth to which plants grow is twice the midsummer Secchi depth.

Fig. 3. A Secchi disk is a simple tool commonly used to measure water transparency or clarity. When the disk is lowered into the water until it can no longer be seen, the resulting depth reading is called the Secchi depth. Credit: NYSFOLA.

	Seneca	Cayuga	Owasco
Average Secchi Depth in Meters	5.0 ± 1.6	4.2 ± 1.1	4.9 ± 1.2

Fig. 3a. These numbers are a snapshot of water clarity at a limited number of sampling locations, and are not intended to indicate lake-wide conditions. Finger Lake Institute data for 2007 taken from http://people.hws.edu/halfman/FL-Lim/2007AvgData/2007%20Data.htm

Nutrients and Bottom Conditions

Nutrients – nitrogen and phosphorus – act as fertilizers. Rooted plants get most of their nutrients from the bottom sediments and therefore thrive in nutrient-rich, dark soils, rather than sandy or rocky areas. Sediments to which phosphorus is attached are abundant at the mouth of many streams, which are prime areas for

weed growth since nutrients are continuously replenished. Often beds of decaying leaves or other aquatic plants (detritus) provide ample nutrients for promoting aquatic plant growth.

Some types of plants, such as free-floating duck weed and algae and some submerged plants, receive nutrients directly from the water. Nutrients come from a variety of sources, as discussed in “Taking a Long-term View” (Section 3). Limiting the inputs of sediment and phosphorus must be part of any serious campaign to control aquatic plants.

By examining the lake and lakeshore before you buy property, you can often tell how abundant aquatic vegetation will be. A muddy shoreline is a result of the topography and geology of the area, wave action and flow patterns. One edge of the lake might have a rich organic substrate (bottom material), while the opposite edge of the same lake could have a sandy substrate because wave action has washed away the organic material. It is a myth that if you remove vegetation a sandy beach will appear. Removing vegetation will create more mobile soils resulting in murkiness and turbidity.

During periods of heavy rainfall, increased runoff brings more nutrients into a lake. These additional nutrients may be released from flooded soils or carried into the lake attached to silt or clay particles. Excess nutrients often boost plant growth, particularly to algae and free-floating aquatic plants. If rainfall and water levels are normal, nutrient levels and plant growth tend to remain stable. Conversely, low water levels can promote plant growth, particularly that of rooted plants, by expanding the shallow-water areas available for growth. Water levels in Seneca, Cayuga and Owasco are adjusted seasonally according to a plan known as a “rule curve”. The New York State Canal Corporation is a key, though not the only, player in setting rule curves. Winter water levels are lowered to reduce the flooding risk when snow melts and spring rain falls. When the growing season begins the distribution and types of water plants may be different from the previous year if there is not adequate snow melt and rain to replenish the lake to summer levels.

Three Ways to Make More Plants

Seeds

We are all familiar with terrestrial plants that reproduce via seeds – acorns grow into oak trees and vegetable seeds planted in spring give us delicious fare in the summer. Similarly, aquatic plants that flower also produce seeds. Seeds that don’t germinate can overwinter for multiple years. When this happens the supply of seeds that builds up is called a seed bank. When the conditions are right the seeds can sprout, bringing forth new plants even if the parent plant had been dead or removed years ago. Water chestnut is an example of a nuisance plant that has seeds that can remain viable for 15 or more years.

Roots

Even plants that produce seeds may use other methods as their prime propagation method. Root systems that lead away from the parent plant are a very effective way to start new plants. Specialized types of roots called rhizomes, stolons, turions

and tubers can take advantage of exploring new locations while drawing nutrients from the parent plant root system. More than just runners, most of these structures also store food. A small piece of such a root may start a whole new plant if it is left behind during harvesting. Dormant buds may survive in the sediment for years before conditions trigger a new plant. Hydrilla and curly leaf pondweed are very successful at surviving as dormant root buds.

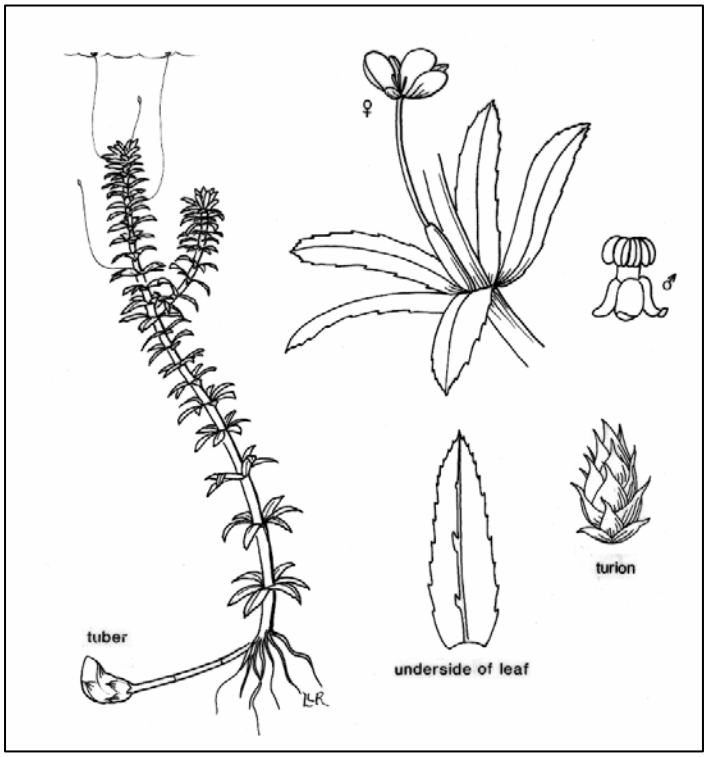

Fig. 4. Tubers are one way to both store food and survive winter's bitter cold. When conditions are right, a new Hydrilla plant will sprout from the tuber.
Credit: University of Florida.

Fragmentation

Some plants only need a small piece of stem with leaves to form a new plant. During most weed management methods it is easy for a portion of plant (fragment) to break off and be carried by wave or wind action to other areas in a lake. The fragment will grow roots and start a new colony. Fragments can also be transported by birds, animals and boats.

Identifying the Enemy

To a person annoyed by too many weeds, they may all be "seaweed". In reality there is incredible diversity among the plants in our lakes. It is helpful to know what plants are plaguing you before undertaking management. Many water weeds get nutrients primarily from the bottom sediments while others, such as coontail and bladderwort, absorb nutrients from the water column. Eurasian water milfoil is a perennial that spreads easily by plant fragments while water chestnut is an annual that reproduces primarily by seeds. American lotus is a native plant with an attractive flower and ornamental seed pod. Eel grass (also called water celery and tapegrass) is a favorite food for many water birds including 14 species of wild

ducks. Recognizing an exotic invasive plant before it is well established gives the best chance for eradication. Also, control techniques that require permits are more likely to be acceptable when exotic invasives are the concern. Information like this should be factored into management choices.

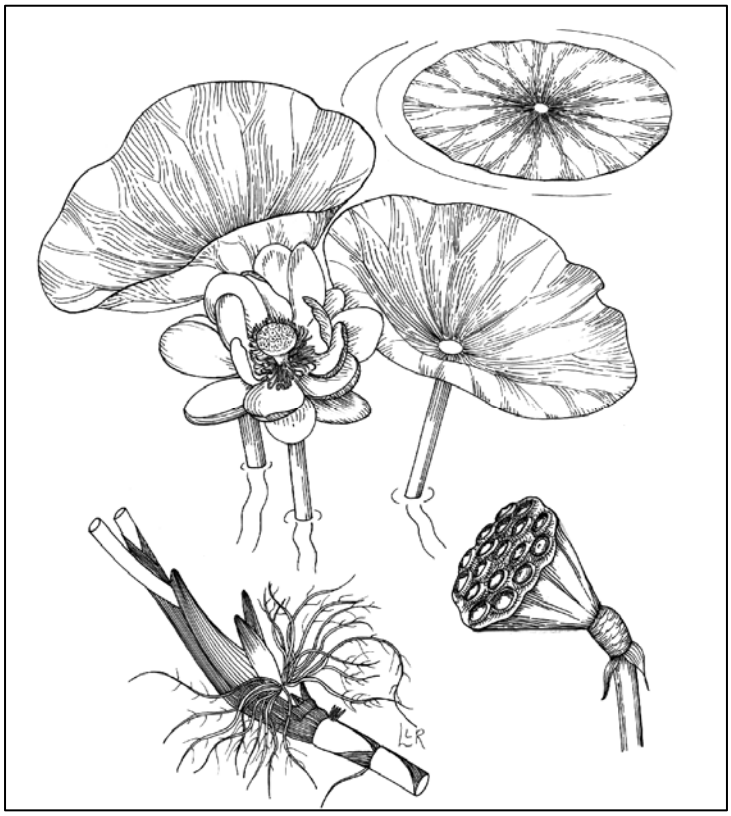

Fig. 5. American lotus (*Nelumbo lutea*). Credit: University of Florida.

Alien Invaders

Alien and exotic are two words used when plants are not native to an area. When such plants are aggressive to the extent that they out-compete native plants and disrupt the ecological balance, they are called invasive. These problem plants are spread and introduced into lakes by various methods. One of the fastest and most common ways invasive weeds spread is by hitching a ride on boats as they move between water bodies, such as those traveling along the interconnected Erie Canal system. In addition, plants are introduced into new waterbodies by boat trailers, bait buckets and fishing tackle. Some exotic invasives have been introduced unintentionally when they are used in gardens and landscaping near a waterway. Additionally, when people dispose of aquatic plants by emptying their aquariums into a nearby waterway, non-native nuisance plants (and sometimes fish) are introduced into the region. Stopping the spread of invasive weeds is essential to the health of the Finger Lakes.

Prevention is crucial, and can be accomplished if everyone cleans their boats and equipment on dry land when leaving a waterbody. If an invasive weed does arrive in a new area, early detection and rapid response are both essential to prevent a large infestation from becoming established. There is an excellent publication, the

"Invasive Weed Identification Guide," developed specifically for proper identification and early detection of invasive water weeds in Central New York. It compares non-native plants with common native look-alikes. You can contact your local lake association or the Cayuga Lake Watershed Network for a copy, or it is available online at http://co.cayuga.ny.us/wqma/weedswatchout/resources/publications.htm .

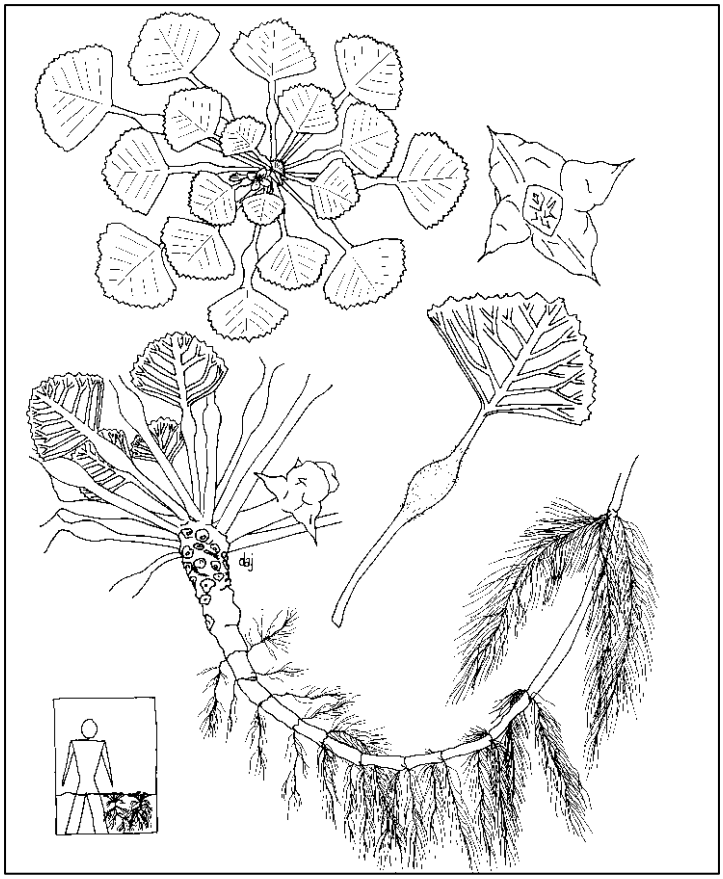

Fig. 6. Water chestnut is an invasive exotic that is growing in the Seneca River but not yet established in Seneca, Cayuga or Owasco Lakes. Learn to identify this and other threats so we can keep them out of our lakes. Credit: University of Florida.

SECTION 2: What Are My Options?

A range of methods – physical, mechanical, chemical, and biological – has been used in the battle with weeds. They vary in cost, effectiveness and environmental impacts. The possible harm to lake ecology from a poorly thought-out response to a weed problem can be significant and difficult to reverse. Some gadgets may look promising but are expensive and do not work. Sometimes inaction is the worst course, particularly when a new exotic invasive arrives on the scene.

This section provides information on the methods that are most likely to be useful to the private landowner. In addition to weighing the pros and cons, a plant manager should remember that the best strategy may be a combination of options. Some sections of shoreline can be left natural (no control); others can be allowed to have intermediate level of plant growth; while a few select areas, like the space used for swimming, may be kept virtually weed free. This approach balances recreational use of the lake with the ecological benefits plants provide.

When possible, discuss management options with neighbors to reduce conflicts. Even if both parties want fewer weeds, they may not agree on the method to be used or the amount of vegetation to remove. There is no sense in reducing one problem – nuisance weeds – with the new problem of a disgruntled neighbor. Aquatic weed management should not be taken lightly.

Disposing of Weeds

Harvested plants should be thoroughly removed and disposed of on land away from the lake to prevent fragments or seeds from re-entering the lake. Large fish nets are useful for gathering floating fragments.

The weeds are composed largely of water. They can be drained by piling them on pallets or on top of an old window screen placed on top of 2 x 2's that have been set up away from the shore.

Once drained, or dried, they can be added to a well-aerated compost bin (such as one made of welded wire) or windrow where they will decompose rapidly.

Wet weeds heaped into an enclosed compost container can become a slimy mass. Large quantities of weeds removed in a short time and dumped in a pile may stink as they dry and start to decompose.

In rural areas farmers may be willing to take water weeds as compost as long as they don't have to do the transporting.

Check with your local waste disposal contractor or facility to see if dried or partially dried weeds can be handled as yard wastes.

Hand Pulling

Hand pulling submerged weeds is one of the most common removal techniques. A spade or long knife is used to dig out the entire plant – stem and roots – for disposal on shore. It is a process akin to weeding a garden. If done well, control can last for an entire season or longer. This is especially true for plants that do not reproduce via plant fragments and if harvesting is done before seeds are produced. Plants return much more quickly if the roots are not fully removed (see "Hand Cutting" below). Since many water

weeds are anchored with runners and rhizomes, it can be hard to remove all of the roots. Water lilies, cattails and other plants with extensive roots systems are also hard to fully dislodge.

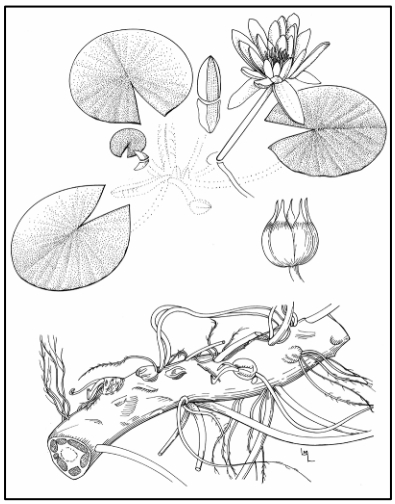

Fig. 7. The strong roots of water lilies will be harder to remove by hand pulling than the weaker roots of eel grass.
Credit: University of Florida.

Hand pulling works best for small areas and in shallow water of less than three feet. Snorkel or scuba gear is needed for deeper water (see “Diver-assisted Harvesting” below). Hand pulling can be done selectively. If the area has rare plants or particular plants that are valued for their flowers, these can be left and the less desirable plants removed. Small areas can be cleared of weeds and other areas can be left natural, thereby providing all the benefits mentioned above. This technique is very good for stopping new infestations of an exotic plant such as water chestnut. Other advantages are that the results are immediate, no permit is needed and it is easy to hand pull close to docks and other structures.

Hand pulling has virtually no monetary cost if labor is not hired. Typically a permit is not needed unless there are many neighbors that band together to do a large area or if a benthic barrier was being placed in a wetland. Time and physical effort are the costs and limit the usefulness of this method.

Hand Cutting

This manual technique differs from hand pulling in that the roots are not removed. Scythes, rakes or other implements are used to cut off the stems and leaves below the water surface. This temporarily opens up areas for swimming and boating but the benefits last less than one growing season. This is akin to mowing a lawn in that the plants re-grow. As with hand pulling, the weed debris is removed from the lake and disposed of on shore.

Both hand pulling and hand cutting are useful for controlling water chestnut. For a homeowner, water chestnut can be pulled out easily. Cutting is effective if the plants are cut before the seeds (nutlets) mature and fall. Water chestnuts are an annual, meaning they die back every year and do not re-grow from the roots. Without a seed bank of nutlets, hand cutting can wipe out even sizable infestations.

The monetary cost is minimal if labor is not hired and specialized equipment is not purchased. The physical effort for one harvest is less than with hand pulling but the harvesting will have to be repeated more frequently. This method does not allow for selectively leaving individual plants, but it can be used to clear some areas and leave others in a natural state.

Generally, a permit is not required when manual techniques are used. Use of specialized, motorized equipment may require a permit (see “Weed Sweeper and Rollers” and “Hydroraking and Rotovating” below).

Diver-assisted Hand Harvesting

In deep water, scuba divers can assist with either the hand pulling or cutting of weeds. Typically the plant remains are shoved into a mesh bag that is taken back to shore. More extensive diver-assisted harvesting uses a suction device after the plants are manually dislodged.

This method can be used in deeper water and slightly larger areas. Divers can maneuver around and among docks and other obstacles. Divers can selectively remove some plants and leave others. It is best used for localized infestations where plants are not very dense or where fragmentation must be minimized. This can be a good method for stopping the spread of newly arrived invasive plants, particularly if they are found in small but concentrated beds.

Diver-assisted harvesting is still labor intensive and is more costly due to the expense of hiring of a diver and possibly a dive tender (a member of a dive team that stays at the surface and works closely with the diver on the bottom). Prices range from $400 to $1000 per acre, or approximately $0.25 to $1.00 per plant. A full day of diver assistance ranges from $1100 to $2000 per day.

Using suction to remove plants, and inevitably some of the bottom soil, is also referred to as diver dredging or suction harvesting. A boat or small barge carries a suction device that aids with plant disposal once plants are freed using sharp tools. The suction device is kept at least 2 feet from the lake bottom which minimizes the amount of sediment that is disturbed or collected. Once on the barge, the plant parts are separated out and retained for later disposal on shore. The remaining water and minimal sediment is discharged back into the water. The potential for more extensive disturbance of the bottom when using a suction device shifts the technique into the realm of regulation and necessitates a permit. Consult with the permitting staff at your regional NY Department of Environmental Conservation (DEC) office (see Appendices).

Bottom Barriers

A fabric, rubber or synthetic blanket is placed on the lake bottom to physically smother weeds and to block out light. Rectangular barriers cover 150 to 250 square feet. The material is typically heavier than water, must be anchored securely to the bottom and ideally is permeable enough to allow for the escape of gases bubbling

up from the lake muck. Alternatively, holes can be punched through the fabric at 24-inch intervals.

Bottom barriers, also called benthic barriers or bottom screens, are best suited for suppression of all rooted-weed growth in a small area such as a boat lane or dock-side swimming area. They provide immediate relief and give season-long protection.

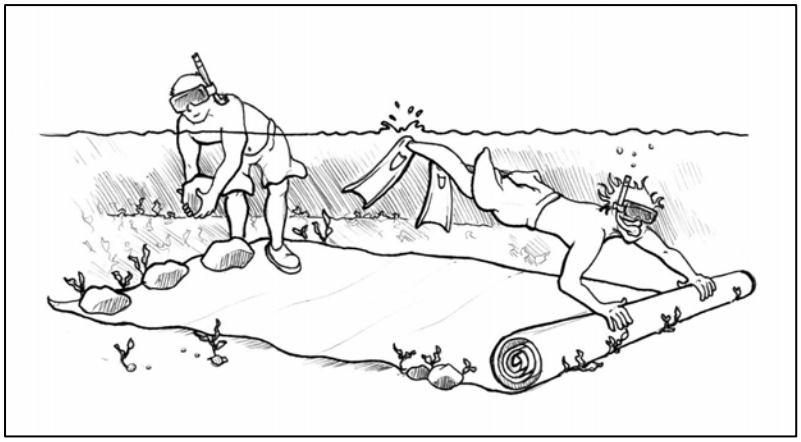

Fig. 8. Two to four people are needed to place a benthic barrier, which is then secured in place for one to two months. Credit: NYSFOLA.

It is easiest to apply the barrier in the early spring while plant growth is still minimal. That's a chilly undertaking in the Finger Lakes and should be done with adequate safety precautions. Several people, a small boat and divers may be needed depending on water depth. Stones, sandbags, stakes or other anchors that will not become a hazard are used to hold the barrier in place. Without good anchors even barriers made of permeable materials can capture gas bubbles that levitate the barrier causing a navigation hazard. A floating barrier is difficult to retrieve and control.

After weeds have been killed in one area, after typically 1 to 2 months, the barrier can be moved to a new location to clear additional space. Most of the barrier materials will last for several years if they are removed for cleaning and storage at the end of the season. In areas with heavy sedimentation and zebra mussel infestations, be prepared for the added weight and the need for interim cleaning. If the barriers are not removed, sediment and washed-in plant material will accumulate on top and provide a great surface for growing weeds in subsequent years. Permanent bottom smothering will also impact the bottom-dwelling organisms normally thriving within the weed beds. In areas where barriers are difficult to remove there have been reports of success from using burlap, which will survive in place 2-3 years before naturally decomposing.

In addition to the challenges of installation and removal, the cost can make benthic barriers undesirable to some. Commercial barriers can cost from $500 to $800 per 1,000 square feet, which may include installation. Commercial installation costs vary depending on sediment characteristics and type of bottom screen selected. Twelve by twelve foot homemade barriers have been made for as little as $0.25 per square foot. Instructions for a homemade bottom barrier are available online at

http://www.ecy.wa.gov/programs/wq/plants/management/aqua021.html . Also, you can contact the Cornell Cooperative Extension of Onondaga County at (315) 424-9485 for step by step instructions.

A permit may be required in order to use bottom barriers in some regions or lakes. Check with your regional DEC office.

Weed Rollers and Sweepers

Several products are commercially available to flatten, drag or sweep across weedy patches in order to remove aquatic plants and prevent re-growth. They require electricity to operate and typically must be attached to a dock or post that acts as a pivot point. These patented devices use rakes, rollers or chains to mechanically disturb the lake bottom along an adjustable arc of up to 270 degrees. Some models are easy enough to install that they can be used to keep multiple patches cleared and can be shared between neighbors.

Results are best when use is started in the spring before plant growth begins. Any plant fragments should be collected and properly disposed of on shore. Once plants are cleared from the area it can be kept clear by using the device for as little as once a week. This method is akin to keeping a worn path clear by frequently walking on it. However, repeated use can cause a depression in the area, especially where bottom sediments are soft or mucky.

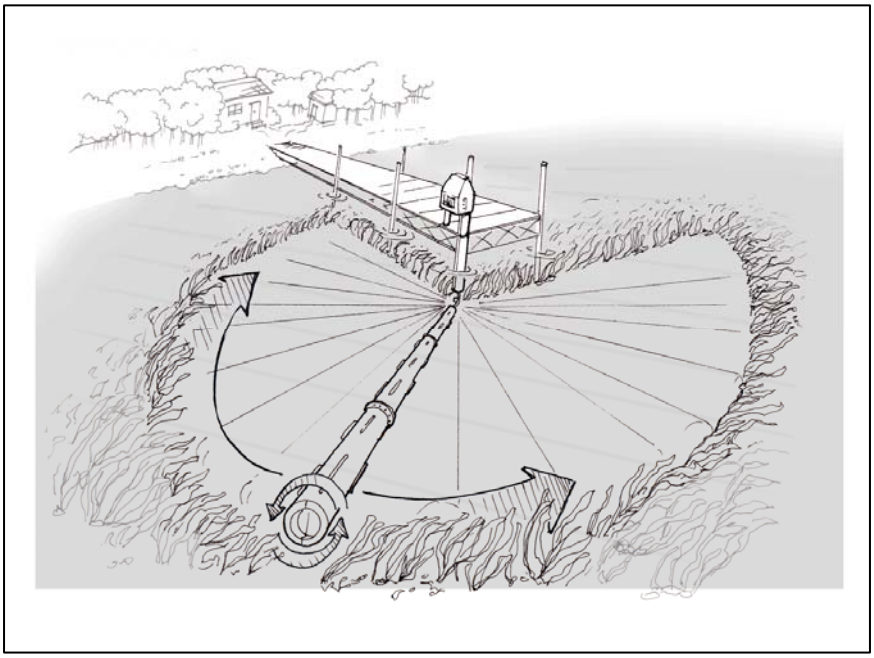

Fig. 9. Some weed rollers cover an area with a radius of up to 21 feet, taking up to an hour to make one pass before reversing direction.
Credit: Cayuga Lake Watershed Network.

One-time site preparation is done before use. This includes removing any sunken debris or obstacles in the path of the device, including the roots of water lilies, cattails and thick masses of dead weeds left from the previous year.

The purchase cost ranges from $1000 to $2100 with a small operating expense to run the motor. Equipment maintenance is usually minimal but the device must be removed in the winter.

Before purchasing a weed roller and sweeper, check with the local region DEC office since a permit may be required and there may be use restrictions during times of fish spawning. These devices have not been widely used in NYS and therefore there is little information on their effectiveness that does not come from the vendors who sell them.

Hydroraking and Rotovating

These methods are akin to rototilling a garden. With both these methods, a large rotating head tills the lake bottom to a depth of 4 to 6 inches in order to cut out the weeds, roots and all. Hydroraking has the added benefit of a mechanical rake that collects and removes some of the cut material. Bottom tillage and bottom de-rooting are other terms used for this type of process. These methods require a permit because of the extensive disruption of bottom sediment. Few permits have been issued in New York State.

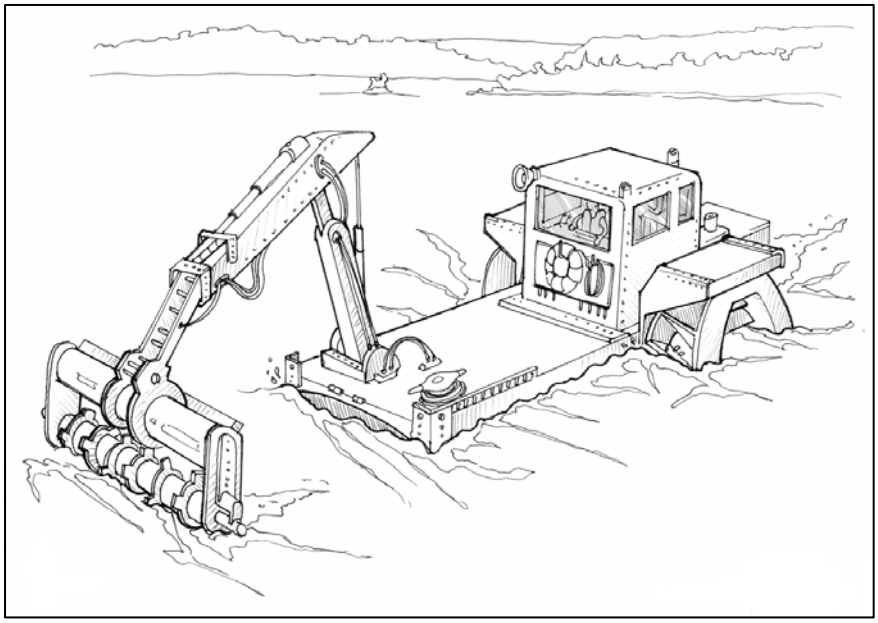

Fig. 10. Few permits to use rotovators have been given in New York State because of the extensive disruption of bottom sediment. Credit: NYSFOLA.

Bottom tillage is used in water depths of 1 ½ to 11 ½ feet using a barge-mounted rotating head that can cut a swath 6 to 10 feet wide. The benefits of rototilling can last for 2 to 3 years. The dramatic reduction in plant density may make other control methods feasible – such as hand harvesting – to keep weed growth suppressed in subsequent years. The technique is most effective when done in winter and spring when fish are not spawning and before recreational lake use is at its peak.

The main drawbacks of hydroraking and rotovating are 1) the tremendous amount of sediment that is stirred up 2) the cost and 3) permitting (mentioned above).

Bottom tillage is discouraged where bottom sediments store excessive nutrients, heavy metals or other contaminants since the disturbance can release these pollutants into the water. Capital cost range from $100,000 to $200,000 with an operating cost of $200-$300 per acre. Other areas of the country where this service is available for hire list the costs from $1,200 to $1,700 per acre.

Plants that are buoyant, such as milfoil, float to the surface and must be collected. Inevitably some pieces will drift away and can cause the spread of plants that reproduce by fragments. If such a weed is already widespread in the lake the fragmentation is insignificant. However, if a new invasive plant that reproduces vegetatively is present, this method should not be used.

Mechanical Harvesting

Weed harvesters are used in Seneca, Cayuga and Owasco Lakes thanks to the efforts of the county Soil and Water Conservation Districts. Mechanical harvesters cut off the upper portion of rooted weeds, harvest the plant fragments and transfer them to a barge that transports the organic matter to the shore for disposal. While some fragments inevitably escape they are probably fewer than the amount that boat traffic would dislodge if the weeds were not cut down.

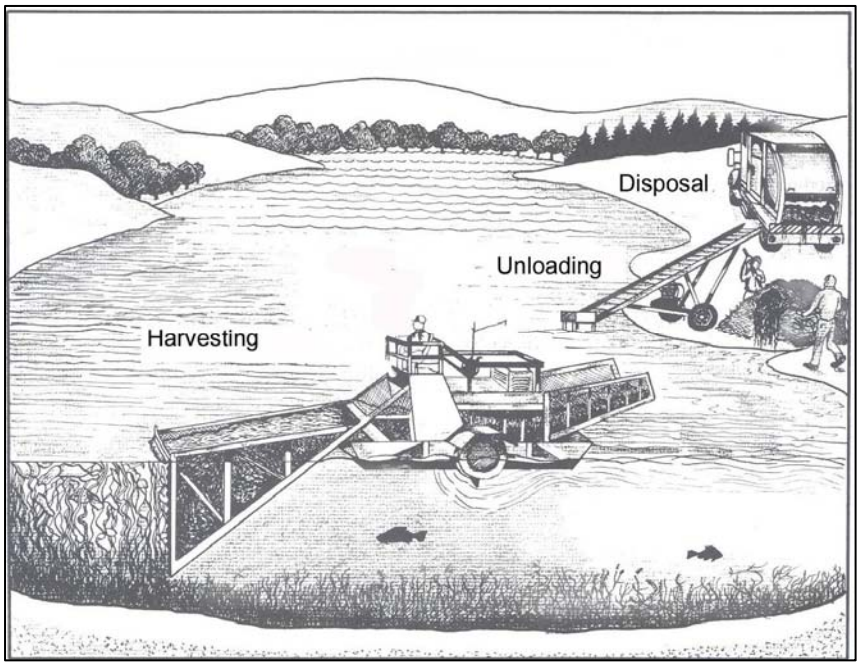

Fig. 11. Harvesting can provide an advantage to rapidly growing plants, altering which plants become dominant. Credit: NYSDEC.

Like hand cutting, mechanical harvesting is akin to mowing a lawn, the weeds will grow back again, and the cutting and harvesting must be done season after season, sometimes even more than once per season. This drawback is balanced with a benefit of leaving the lower portion of the plants to provide habitat and food for fish and other aquatic life.

Harvesters cut a swath six to twelve feet wide and six to eight feet deep, depending on the type of machine and how it is adjusted. The width of the equipment and

depth of water required means it cannot maneuver close to shore or in small spaces such as between docks. It is well suited for large areas such as navigation channels. Most healthy fish can out-swim a slow moving (two miles per hour) harvester and any fish and invertebrates caught are usually too small to wiggle out of plants.

Using large machinery has other limitations as well. Each machine is very expensive and the models used locally require a barge to collect and transport the weeds. The equipment is shared between lakes meaning that lake access big enough for large machinery is needed. Harvesting collects so much plant material that disposal sites are needed. These weeds are largely water making them heavy, and therefore expensive to transport. Fortunately farms accept the plant matter and use it as compost and green manure, decreasing disposal costs.

Why These Aren't Options for Weed Control in Large Lakes

Alum

Aluminum sulfate (alum) has long been used in the treatment of drinking water. More recently it has been used to reduce available phosphorus. The alum binds to the phosphorus and makes it unavailable to algae. Alum treatments are therefore also referred to as nutrient inactivation or nutrient precipitation.

Alum is primarily used where algae is a problem since algal growth responds readily to the amount of available phosphorus. This is less true of water weeds. Not only would the removal of phosphorus not suppress the growth of these larger plants, but some lake managers have found that when alum reduces the amount of algae and other particulates, sunlight penetrates more readily and the amount of weed growth actually increases. Even for algae control, alum only works if there are not further additions of phosphorus. In Seneca, Cayuga and Owasco Lakes, tributaries continue to be major and continuous sources of phosphorus.

Alum can be applied in sufficient quantities to seal the bottom and stop the release of phosphorus from the sediment. This is done only in small lakes since the aluminum levels must be kept low enough to not cause harm to aquatic life. For example, excess aluminum is toxic to fish as well as most aquatic invertebrates living on the bottom sediments.

Environmental Impact Statements are typically needed before alum treatments can be done, adding to the cost of application which ranges from $100 to $500 per acre. Alum is not registered for use as an aquatic herbicide or algaecide and therefore a pesticide permit is not issued. There is currently some uncertainty over how New York regulatory authorities will handle permitting for and application of alum, further reducing its value for algal control.

Biological Controls: Grass Carp and Insects

Grass Carp, also called triploid carp or white amur (*Ctenopharyngodon idella),* is a non-native fish that voraciously consumes aquatic plants and can increase in weight

by up to six pounds per year. They can be a good option for small lakes and ponds. Triploid grass carp cost approximately $20 each. This is not a spot treatment. The fish will not stay where they are stocked in a large lake and there is no way to contain them in a particular area. Without the addition of thousands of grass carp in a large lake, control would be ineffective. Stocking rates this high could locally impact the fisheries.

Permits to buy and stock these fish are only given where migration out of a pond can be prevented; usually this means a waterbody with no permanent outflow. If these fish escape from a pond, they can cause extensive damage since they often favor native plants over exotics. If native plants are removed then populations of unpalatable species such as Eurasian watermilfoil can explode.

Fig. 12. Grass Carp. Credit: US Fish & Wildlife Service.

The development and use of insects as effective biological controls is still in its infancy. A naturalized underwater moth (*Acentria ephemerella*) and a native weevil (*Euhrychiopsis lecontei)* that feed on Eurasian watermilfoil have been found in most New York lakes. The moth was discovered in Cayuga Lake in the early 1990s and is credited with the crash in the exotic invasive Eurasian watermilfoil. Together the indigenous moth and weevil control the growth of Eurasian watermilfoil in the shallow ends of Cayuga, Owasco and Seneca lakes. The moth limits the growth in all of Owasco Lake and at the north and south ends of Cayuga Lake.

Attempts to stock commercially-raised insects in other lakes have had uneven success. Use of commercial augmentation of insect is still considered experimental though in the future it may be a good choice for selective removal of plants. Early experiments are exploring other insects that may feast preferentially on water chestnuts and water lilies.

Dredging

Dredging has been used in the Finger Lakes to keep channels open and improve navigation. When this is done periodically, weed management may be a secondary

benefit. Water weeds are physically removed; the top, nutrient-rich layer of soil is removed; and water depth is increased, which reduces the sunlight reaching the bottom thereby reducing re-growth. Dredging projects are expensive, take a long time from conception to completion, and are often contentious especially when it comes to disposing of the dredge spoils (the material removed from the lake bottom). Permits must be obtained from multiple agencies. In short, dredging is not reasonable to undertake as a weed control strategy in these large lakes.

Herbicides

Herbicides are chemicals that are poisonous to or inhibit plant growth. Increasingly, newer herbicides work by disrupting growth processes that are specific to green plants, which reduces the potential harm to other life, at least in the short term. There is little information on the long-term effects of herbicides on humans, fish and wildlife. A few studies have linked herbicides to health problems in amphibians.

In New York State a permit from the Department of Environmental Conservation is required to be obtained by a commercial licensed applicator and few permits have been issued where lakes are used for drinking water or encompass wetlands. It is unlikely herbicides will be permitted for use in the Finger Lakes in the foreseeable future. Regardless, some additional information on herbicides is provided here.

Herbicides have been developed to be relatively selective (harming only certain species of plants) or to affect a broad spectrum of plants. Some herbicides are systemic, meaning they are absorbed by the plant and can kill the entire plant from the roots to the leaves. Others are referred to as contact herbicides because they kill only the parts of the plant the chemical contacts.

The effectiveness and safety of herbicide treatment depends on the lake conditions (temperature, pH), time of year and the plant's life cycle, and achieving the proper concentration for the prescribed amount of time. These toxic chemicals can harm fish, ruin drinking water, make water unfit for swimming and unsafe to apply to crops. The complexity of factors that influence success and the potential harm that can be done means that only licensed professionals can legally apply aquatic herbicides (with some exception for lakes that are smaller than one acre and meet other requirements).

All of the six aquatic herbicides registered for use in NYS have use-restrictions, meaning that after they are applied the water cannot be used for certain purposes for a set amount of time. This ranges from the suspension of swimming for 24 hours to prohibiting water use for irrigation for 30 days. Regulations state that "Permits shall be granted under such limitations as will protect to the greatest extent possible all terrestrial life, aquatic life other than aquatic vegetation intended to be controlled or eliminated, all public and domestic water supplies and irrigational, recreational, agricultural, and industrial water uses" (New York State Register and Official Compilation of Codes, Rules and Regulations of the State of New York, Part 327, available at http://www.dec.ny.gov/regs/4422.html).

The regulation recognizes that “the owners of lands through which water passes or which are bordered by waters have certain vested riparian rights to the use of these waters” and that the use of herbicides causes a temporary suspension of some of those rights. Therefore the permitting process includes notifying property owners and users who are likely to be affected. In lakes the size of Seneca, Cayuga and Owasco, such notification alone is a daunting task. Given the strong feeling some people have about adding chemicals to the lake, attempts at chemical control can be contentious.

Improper herbicide use is a violation of both Conservation and Public Health Law. It is a felony punishable by law.

Shading and Water-column Dyes

The unnatural blue color of some ponds results from the addition of a dye that blocks sunlight. This shading affect reduces the plant’s energy source and stunts or stops the growth of algae and weeds. Dyes cannot be used in drinking water supplies. Dyes work in small, shallow ponds without an outflow, where the dye concentration can be kept high. In large lakes like the Finger Lakes where there is a lot of water movement it is ineffective and at a cost of $50 per gallon, which can be used to treat one acre of water that is 4 feet deep, can you even imagine how much it would cost, even if it was permitted?

Water-level Drawdown

In water bodies where water level can be controlled, drastically lowering the water level exposes plants and their root systems to lethal freezing and drying conditions that are lethal. To be effective, the sediment must freeze to a depth of at least four inches and for at least four weeks. However, some species, such as Eurasian watermilfoil, are not susceptible to water drawdown.

Water drawdown is a useful technique in ponds and reservoirs but is not appropriate in the Finger Lakes. Given the depth of plant growth in all of these fairly clear lakes, drawdown to the depth of the deepest weed growth is not feasible or advisable. In addition, Seneca, Cayuga and Owasco have extensive shallow shelves that would require the release of huge amounts of water to expose all the area where plants grow. Equally massive quantities are necessary to replenish the water in the spring. Furthermore, these large lakes have complicated interconnections and varied uses and controls. Water drawdown could disrupt public drinking water facilities and private water wells and harm wildlife, such as frogs and turtles that burrow into lake-bottom mud for the winter.

SECTION 3: Taking a Long-term View: a Watershed Approach

Understanding what a watershed is helps us tackle lake problems. A watershed is all the land contributing rainfall to a given body of water. It is like a funnel with the water running downhill to the bottom, where the lake or stream is located. When rain falls it moves from higher ground to lower ground. Any water not quickly evaporated finds its way downstream through a system of road ditches, wetlands, creeks and overland flows, eventually reaching the lowest point of the watershed, in this case one of the Finger Lakes.

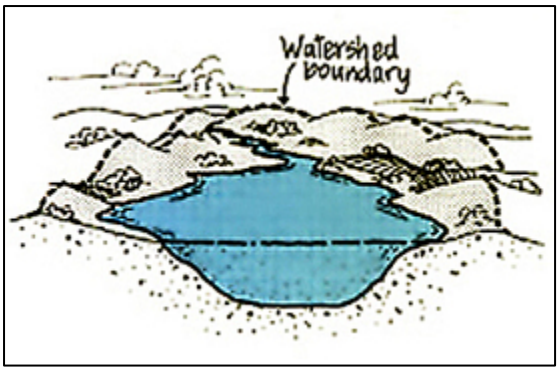

Fig. 13. Watershed diagram. Credit: Northeast Illinois Planning Commission.

Groundwater, water below the earth's surface, is also slowly moving towards the lowest point. The highest points of land between waterbodies form the watershed divide. For example, rain that falls just outside of the Cayuga Lake Watershed contributes to the watersheds of Seneca Lake, Seneca River, Owasco Lake or distant Chesapeake Bay.

What people do on the land – the way we live, work and play – affects the health of our lakes even if they are far away. Cayuga, Owasco and Seneca Lakes all have management plans, which outline steps to protect and restore lake health using a watershed approach. These are all available for viewing online at: www.cayugawatershed.org, www.co.cayuga.ny.us/wqma/finalplan.pdf and http://www.gflrpc.org/Publications/SenecaLakeWMP.htm/ .

Land Uses Affect Lake Water Quality

Any short-term weed management technique will be helped by reducing the conditions that foster plant growth, such as the excess nutrients that act as fertilizer to feed weeds, and freshly disturbed or deposited sediment that favors aggressive weeds and carries nutrients as it moves. Activities that take place on the land, often far away from the lake, may seem like they have little to do with weed problems yet they are frequently the root cause and weeds are merely a symptom. Altering household and yard care practices, agricultural and forestry best management practices and even construction and road maintenance practices make a difference. The changes in the lake may be slow but the use of best practices throughout the watershed is the most effective route to improving the long-term health of our lakes.

Weeds thrive in areas where soil is washed into the lake. Just like disturbed areas along a roadside, disturbed or newly deposited bottom sediment is ripe for weed colonization. For example, the non-native Eurasian watermilfoil gains a competitive edge since it will easily push through thick sediment that smothers native plants. In addition, sediment usually has phosphorus attached to it, providing plants with the nutrient they most need in order to thrive. One pound of phosphorus can generate thousands of pounds of biomass. In short, erosion = sediment = weeds.

Over the long-term, reducing the amount of phosphorus and soil washed into the lake is a key to controlling weeds. That is one reason why the watershed groups take a watershed approach to protecting the lake: it is the activities around the lake that most affect water quality and weed growth.

Long-term Solutions to Weeds

Like all nonpoint source pollution, there is no one source of phosphorus-laden silt but many small sources. The Cayuga Lake Watershed Network publication *Smart Steps for Clean Water* (see Resources in the Appendices) contains dozens of specific suggestions for reducing erosion and the amount of phosphorus available to move with the soil. In addition to encouraging good practices upstream, there are other things lakeshore property owners can do.

What is Nonpoint Source Pollution?

Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground.

As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. These pollutants include:

- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;
- Oil, grease, and toxic chemicals from urban runoff and energy production;
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks;
- Salt from irrigation practices and acid drainage from abandoned mines;
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems.

Atmospheric deposition and hydromodification are also sources of nonpoint source pollution.

US Environmental Protection Agency, Office of Water.
http://www.usepa.gov/owow/nps

Zones of Vegetation

Growing a lawn down to the water's edge is a common practice that is not lake-friendly. Replacing sections of lawn with taller attractive plants that leave open views and access to the lake will reduce the sediment and phosphorus that feeds weeds. Tall plants along a lakeshore and streamside add roughness, created by their stems and the plant debris that accumulates around them, that slows the water as it moves to the lake. When water slows, much of the sediment can drop out. These plants have deep roots allowing water to penetrate into the soil more readily. Compared to a grass, the

roots take up large quantities of water and more nutrients, such as phosphorus. Ideally, a buffer of taller plants should be 40 to 60 feet wide, meaning some of the buffer might be behind the house. The plants in front of the house, such as flowering shrubs, may be tall relative to grass but still short enough to allow views of the lake. Strategic placement of small trees can block unpleasant views.

Wonderful Wetlands

Wetlands perform similar functions to buffer strips, naturally slowing and cleaning water before it flows to the lake. In addition to protecting existing wetlands, previously existing wetlands can be restored and temporary wetlands known as vernal pools can be built to capture water during wet weather. Both vegetated buffer strips and wetlands, including vernal pools, have added benefits of attracting and supporting wildlife.

Ditches Dump Dirt to the Lake

Roadside ditches are necessary to protect roadways, be they public roads or private camp roads. However, they both carry and are a source of sediment and nutrients. Keep nearby ditches vegetated to minimize the amount of sediment they carry. While they can be mowed, taller plants are better sediment filters. Large stones can also protect soil from eroding from the side of ditches but have the drawback of absorbing large amounts of heat on hot sunny days that unnaturally warms the water flowing over them. For more information on roadside ditches, see the spring 2007 issue of the Cayuga Lake Watershed Network's *Network News,* available online at www.cayugalake.org .

Better Designs for Breakwalls

Smooth, straight breakwalls can increase erosion and remember, erosion = sediment = weeds. The magnified forces of waves hitting vertical breakwalls along the lakeshore can stir up the bottom sediment as the waves bounce off and travel back toward the lake with nearly equal force. Large stones, an angled breakwall or strongly rooted plants in front of the breakwall are better at breaking up and diffusing the wave energy. Watch how shoreline plants move back and forth when waves hit them. This motion takes energy that reduces the force of the wave before it hits the shore.

Please Don't Fertilize the Lake

Lakeshore property owners may be unwittingly adding nutrients to the lake. An inadequate septic system, pet wastes left on the ground and waterfowl droppings can all provide fertilizer to water weeds. A lawn down to the water's edge is a welcome mat to geese. Even a small buffer of taller plants can discourage geese, which prefer areas with a clear view and no places for predators to hide. In the remaining lawn area, according to new studies, proper care produces a lush lawn needing no added phosphorus, and can help reduce the movement of phosphorus. Have a soil test done every three years to determine how much, if any, fertilizer the lawn needs. Even when fertilizer is recommended, phosphorus is rarely called for. Look for phosphorus-free, lake-friendly lawn fertilizer and learn about lawn care practices that keep your lawn green and the lake blue.

Appendices

NY Department of Environmental Conservation (DEC) regional offices for the Finger Lakes

Region 7, Central New York: Oswego, Cayuga, Onondaga, Madison, Tompkins, Cortland, Chenango, Tioga and Broome counties. Main Office:
615 Erie Blvd. West
Syracuse, NY 13204
315-426-7400

Region 8, Rochester / Western Finger Lakes: Orleans, Monroe, Wayne, Genesee, Livingston, Ontario, Yates, Seneca, Steuben, Schuyler and Chemung counties. Main office:
6274 Avon-Lima Rd. (Rtes. 5 and 20)
Avon, NY 14414-9519
(585) 226-2466

More detail is available online at: http://www.dec.ny.gov/54.html .

Resources

Publications

CLWN. 2005. *Invasive Weed Identification Guide.* Available for free download at http://co.cayuga.ny.us/wqma/weedswatchout/documents/guide.pdf .

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Organizations

Cayuga County Water Quality Management Agency	www.co.cayuga.ny.us/wqma
Cayuga Lake Watershed Network	www.cayugalake.org
Finger Lakes-Lake Ontario Watershed Protection Alliance	www.fllowpa.org
Finger Lakes Institute	fli.hws.edu
New York State Federation of Lake Associations	www.nysfola.org
North American Lake Management Society	www.nalms.org
Owasco Lake Association	www.owla.org
Seneca Lake Pure Waters Association	www.senecalake.org
Seneca County Water Quality Committee	www.senecacountyswcd.org
Tompkins County Water Resources Council	www.tompkins-co.org/planning/committees/WRC