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AQUATIC PLANT MANAGEMENT

Identifying and Managing Aquatic Vegetation

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Vegetation is an important part of any aquatic system, but sometimes it can get out of control and create problems. This publication explains the benefits of aquatic plants and algae, describes the problems they can cause, identifies common species, and offers practices for effectively managing them.

The Benefits of Aquatic Vegetation

Although most readers of this guide probably want to reduce aquatic vegetation in a body of water, it's important to remember that aquatic plants are essential components of healthy aquatic systems. All plants — whether on land or in or around water — photosynthesize.

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They use sunlight, carbon dioxide, and water to grow and produce new plant tissue. They also produce oxygen through this process.

What does this mean in terms of the roles that aquatic plants play in the aquatic environment?

1. Microscopic plants (algae) form the base of the aquatic food chain. Also called "phytoplankton" (or, plant plankton), these plants are eaten by zooplankton (or, microscopic animal plankton). In turn, zooplankton are eaten by small fish, which are eaten by larger fish, and so on up the food chain to humans and other top predators.
2. Larger algae and flowering plants (macrophytes) provide habitat and shelter for fish, fish food organisms, waterfowl, and other wildlife.
3. Macrophytes provide food for insects, waterfowl, and mammals such as muskrats and beavers. However, bass, bluegill, and catfish do not, as a rule, eat macrophytic vegetation.
4. Since all plants, including those that grow underwater, produce oxygen as they photosynthesize, they are the major source of oxygen for aquatic animal life.
5. Rooted plants stabilize shorelines and bottom sediments. They absorb nutrients and filter pollutants from runoff, which improves water quality.
6. A diverse aquatic plant population adds beauty to a water body. Many people recognize and appreciate the aesthetic value of aquatic vegetation, whether in a backyard fishpond, around a retention pond, or along the shoreline of a large lake.

Because of these benefits, some aquatic plant growth is desirable. Eliminating native aquatic vegetation from a site should never be the goal of a management plan. Still, there are times when aquatic vegetation can pose problems.

The Problems of Excessive Aquatic Vegetation

We know that plants growing in a body of water can quickly get out of hand. In addition, certain non-native plant species are extremely aggressive (invasive) and can take over large areas of aquatic habitat.

Excessive aquatic plant growth can lead to several common problems:

1. Too much vegetation can impair recreational activities such as swimming, fishing, and boating.
2. Excessive plant growth can provide too much shelter for small fish and reduce predation. This leads to an overpopulation of prey fish.
3. An overabundance of aquatic plants and algae can reduce oxygen levels in the water, which can contribute to fish kills. Fish kills that are vegetation-related can occur in the summer or winter.

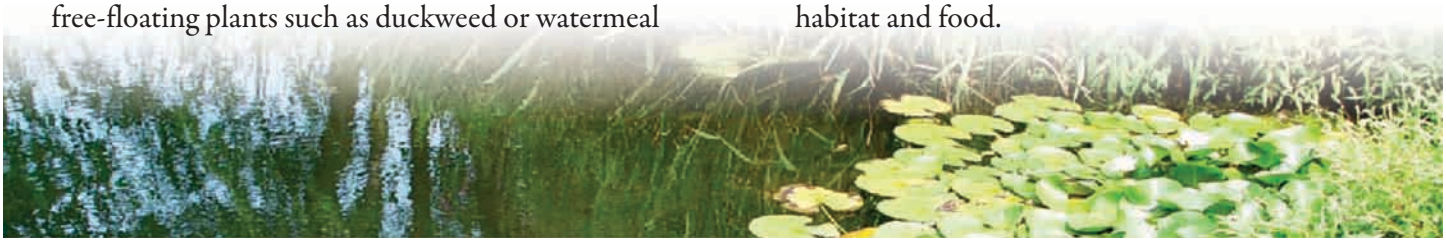
   During the day, plants produce oxygen through photosynthesis. At night (as well as day), they consume oxygen through respiration. If plant growth is excessive during the summer, they can use up most of the oxygen in the water at night. In fact, oxygen-stressed fish often come to the surface gasping for air and die just before dawn when oxygen levels are lowest.

   Decomposing algae and plants also contribute to oxygen depletion. When plants die, bacteria and fungi break down the decaying plant material. This process uses up the oxygen in the water. Plant death and decomposition can occur in midsummer under natural conditions. Unfortunately, these conditions are not well understood. We do know that herbicide treatments must be made carefully because if too much vegetation is killed at any one time, the decomposition could lead to oxygen depletion.

   Oxygen depletion can also occur when algae or free-floating plants such as duckweed or watermeal completely cover the water's surface. These surface growths reduce the amount of light that can penetrate the water, inhibiting photosynthesis (and oxygen production) of plants in deeper waters. Anything that stirs or brings these deoxygenated waters to the surface (such as a strong wind) can lower oxygen levels throughout the water column and cause a fish kill. Even if it doesn't kill the fish, prolonged exposure to low oxygen concentrations can weaken fish, making them susceptible to diseases and toxicants.

   Winter fish kills also occur, sometimes because decomposing plants that died in the fall deplete oxygen. But more often, winter fish kills are caused by snow accumulating on the ice that blocks sunlight and prevents photosynthesis and oxygen production. People may not notice winter fish kills because dead fish can decompose and disappear under the ice. It may not be until spring or early summer that people notice that fishing is not what it used to be.

   Many causes of fish kills are not plant-related, including natural stresses on fish as they come out of the winter and into the spawning season, pesticide runoff, ammonia leakage from storage tanks, and diseases.
4. Certain algae impart foul tastes and odors to water. This is an extremely important concern for the managers of municipal and private drinking water sources.
5. Excessive plant growth can impede water flow in drainage ditches, irrigation canals, and culverts and cause water to back up.
6. Excessive plant growth can trap sediment and debris, gradually filling in bodies of water. When the plants die and fall to the bottom, they accelerate this process.
7. Aquatic weed growth can provide the quiet water environment that is ideal for mosquito larvae development.
8. Excessive plant growth lessens aesthetic appeal and lowers property values.
9. Invasive plant species such as Eurasian watermilfoil and purple loosestrife can completely destroy stands of native vegetation. This can have adverse effects on the animals that depend on the native vegetation for habitat and food.



Aquatic Plant Identification

The plants that commonly lead to most problems can be divided into two botanical groups: algae and flowering plants.

This section identifies some of the most common species of these plants and how they can lead to problems if improperly managed. The descriptions here are necessarily brief and do not cover all possible types and species of aquatic plants.

Algae

Algae are usually very simple in structure, but some of them, such as Chara, can resemble flowering plants. There are three types of algae:

1. Microscopic algae (also called phytoplankton)
2. Mat-forming algae (also called filamentous algae)
3. Chara (also called stonewort)

Microscopic Algae

Microscopic algae (phytoplankton) color the water green or yellow-green. A phytoplankton population that colors the water is called a "bloom." In quiet water, blooms can produce surface scums as well as green, red, black, or oily streaks. When these algae die off, they can cause fish kills. The most troublesome type of this group are the blue-green algae.

A bloom of microscopic blue-green algae can cause a surface scum.

Blooms occur in waters that have abundant nutrients. These nutrients often come from nitrogen and phosphorus fertilizers that reach the water. The best practice for managing blooms of microscopic algae is to prevent nutrient-laden water from entering the water body.

Mat-forming Algae

Mat-forming algae form floating, mat-like growths that usually begin around the edges and bottoms of bodies of water in the spring. Often incorrectly called moss, this type of algae growth is the most common problem in ponds.

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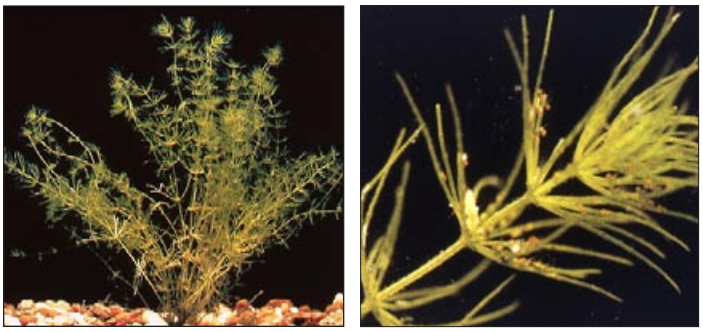
Often incorrectly called moss, mat-forming algae are a common problem on ponds.

Chara

Chara (also called stonewort) usually grows in very hard water and often is calcified and brittle. The plant is rooted, and its leaves are arranged along the stem in whorls. It is often confused with flowering plants, but it is an alga and should be managed as such.

The plant grows completely under water and has a very distinctive musky smell. In bodies of water where it is low-growing, Chara provides valuable habitat for fish and stabilizes sediments. Do not disturb Chara under these conditions. However, in shallow water some species of Chara can grow up to the surface and be troublesome.



(Left) Although Chara resembles flowering plants, it is an alga. (Right) Chara leaves are arranged along the stem in whorls.

Get the Right ID

Looking for an accurate plant identification? The following resources can help

In Indiana, contact your Purdue Extension county Educator
To find yours, visit www extension purdue edu/counties htm, or call (888) EXT-INFO

Submit plant specimens to the Purdue Plant & Pest Diagnostic Laboratory for accurate identification Submission guidelines and other details are available at www ppdl purdue edu

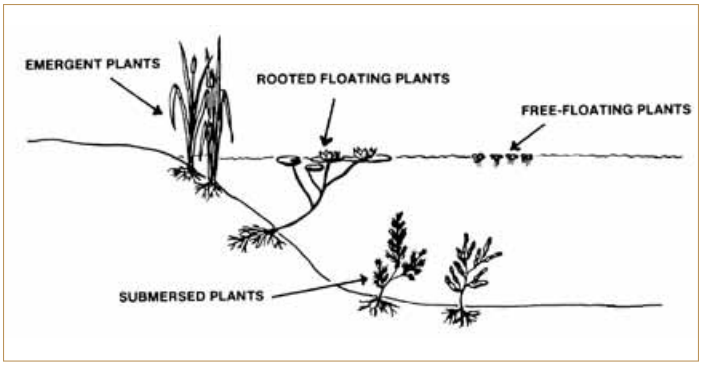
Other online resources include:

Minnesota Department of Natural Resources,
A Guide to Aquatic Plants-Identification and Management
www dnr state mn us/shorelandmgmt/apg/index html

Texas A&M University, AQUAPLANT
http://aquaplant tamu edu/database/index htm

University of Florida Extension Center for Aquatic and Invasive Plants
http://aquat1 ifas ufl edu

Clean Lakes, Inc , How to Identify and Control Water Weeds and Algae
www cleanlake com/aquatic_plant_id1 htm



The categories of flowering plants.

Flowering Plants

As their name suggests, flowering plants produce flowers. They also are more complex than algae because they have vascular tissues that algae lack. Vascular tissues allow plants to conduct nutrients, water, and other materials throughout the plant.

Flowering plants are grouped into four broad categories based on where they grow:

1. Submersed plants
2. Free-floating plants
3. Rooted floating plants
4. Emergent plants (also called shoreline or marginal plants)

Submersed Plants

Submersed plants are rooted at the bottom and grow up through the water. Flowers or flowering spikes often emerge above the water surface.

The main criteria for identifying these plants are:

- Their leaf arrangements — the number of leaves at a node (a node is the place on the stem where the leaves attach)
- The shapes of their leaves

The plants identified in this publication are some of the most common underwater weeds. However, within almost every one of these plant groups there are species that provide valuable fish or wildfowl habitat. For example, curly-leaf pondweed is an invasive weed, but beds of large-leaf pondweed provide good shelter for game fish. Eurasian watermilfoil is a very aggressive, non-native weed, but other milfoil species are beneficial natives.

Information beyond what this bulletin can provide may be necessary for complete aquatic plant identification.

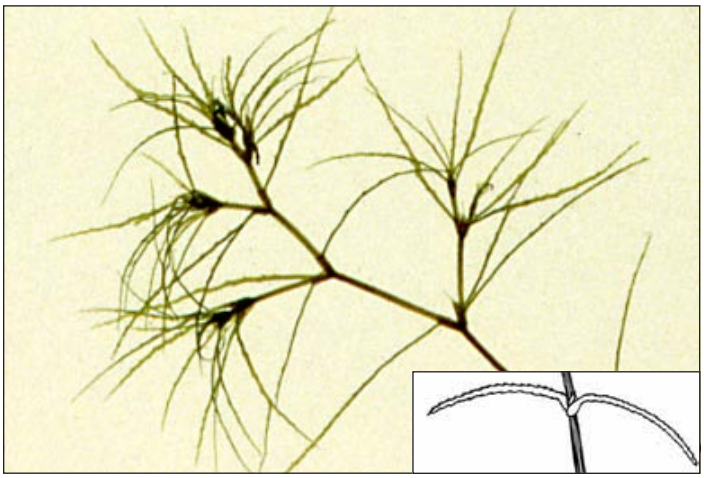
Submersed Plants, Alternate Leaf Arrangement (one leaf at a node)

(Top left) Curly-leaf pondweed grows best in the spring and tends to die out in summer. This invasive plant is found in lakes and ponds.

(Bottom left) Sago pondweed has very long, almost thread-like leaves that are 2 to 6 inches long. Individual leaves tend to be slightly curved. Although a weed in some situations, its seeds and underground tubers are valuable food for waterfowl.

(Above) Leafy pondweed is extremely common in ponds during the summer. It has very narrow leaves that are 1 to 2 inches long.

Submersed Plants, Opposite Leaf Arrangement (two leaves at a node)



(Left) Southern and slender naiads have leaves that are not visibly spined. They have two leaves at a node, but they sometimes appear to have three leaves per node.

(Above) Brittle naiad leaves are stiff, slightly spined, and sometimes clustered at the tips of the stems.

Submersed Plants, Whorled Leaf Arrangement (three or more leaves at a node)

Coontail leaves are branched and spined. This plant is very lightly rooted or floating in the water column. It is very common in shallow, marsh-like areas and in older ponds.

Eurasian watermilfoil is a serious and rapidly spreading invader. This plant typically has more than 10 leaflet pairs per leaf, whereas native milfoils have fewer than 10. There are four leaves per node.

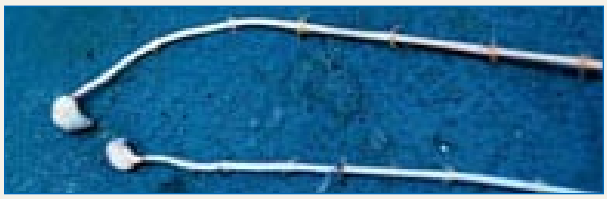
Inset diagrams show individual leaves.

Invasive Species Alert

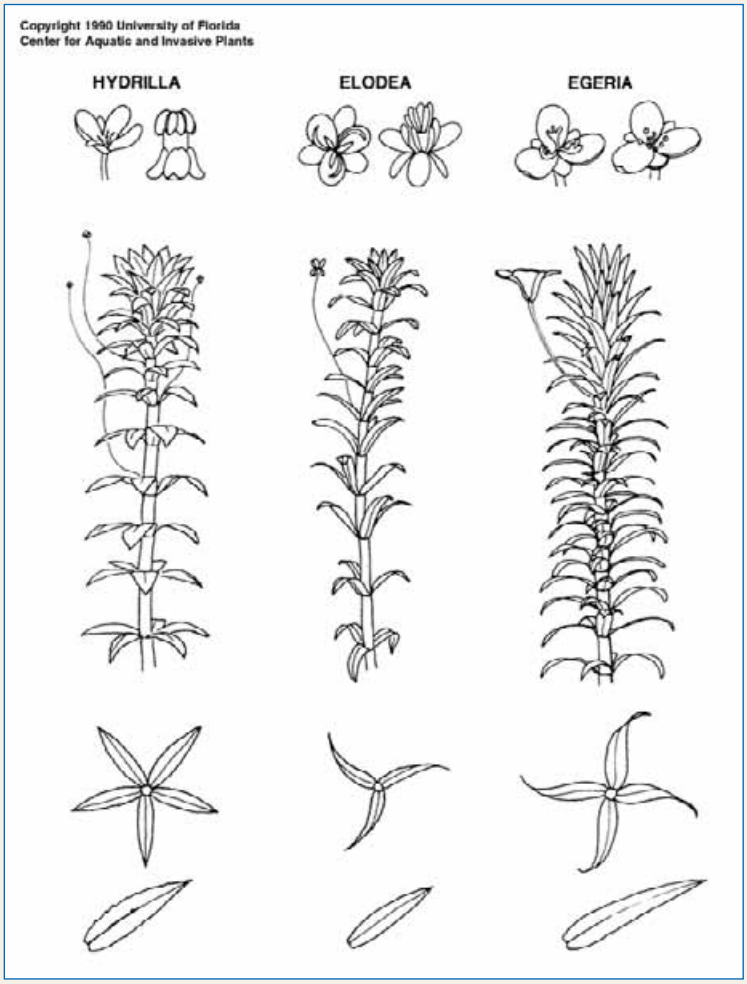
American elodea and its relatives are submersed plants with whorled leaf arrangements American elodea is a native plant that is sometimes weedy in shallow water Recently, two relatives of this plant, Brazilian elodea (Egeria) and hydrilla, were found in Indiana

Brazilian elodea and hydrilla are extremely invasive, and efforts are being made to eradicate them If you find plants that look like elodea but have more than three leaves at a node or have underground tubers (small potato-like structures, a characteristic of hydrilla), please report them at www invasivespecies in gov, or call the regional offices of the Indiana Division of Fish and Wildlife: in the north (260) 244-6805, in the south (812) 279-1215

American elodea is a native plant that can sometimes be weedy in shallow water.



These tubers are characteristic of hydrilla, an invasive species.



A comparison (from left) of hydrilla, native American elodea, and Brazilian elodea (Egeria).

Free-floating Plants

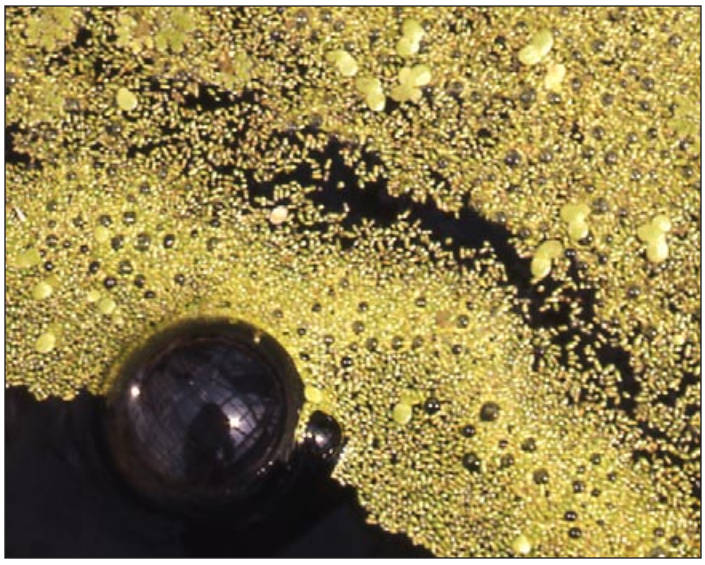
As their name suggests, free-floating plants are not rooted in the soil.

Free-floating plants such as duckweed and watermeal can completely cover the surface of a pond, shading out underwater plants, which depletes oxygen in the deeper waters.

These plants are extremely small — a duckweed plant is 1/8 to 1/4 inch in diameter and has a small root that hangs in the water; a watermeal plant has no roots and looks like a tiny green seed or green cornmeal.

These plants are found in nutrient-rich waters, so restricting nutrient inputs is helpful in management.

Note the roots hanging from these duckweed plants.



Most of these very tiny plants are watermeal. The larger plants are duckweed.

Watermeal plants look like tiny green seeds. The edge of a penny can be seen in the lower right corner.

A pond totally covered with watermeal.

Rooted-floating Plants

Rooted-floating plants have underground stems (rhizomes) from which new plants can sprout. Their leaves and flowers float on the water's surface. These plants are generally found in shallow water less than 4 or 5 feet deep.

Examples of these plants include spatterdock, waterlily, watershield, and American pondweed. Spatterdock has yellow flowers and is sometimes called yellow cow lily. Spatterdock and waterlilies provide valuable wildlife habitat and should be protected in natural lake and wetland areas. Watershield and American pondweed can be weedy in the shallow areas of ponds and lakes.

American pondweed leaves are 2 to 5 inches long (much smaller than waterlily or spatterdock leaves). The petiole is attached at the edge of the leaf. Note the long, horizontal, underground rhizome from which new plants are produced.

Spatterdock, also called yellow cow lily because of its yellow flowers, have leaves that stand erect from the water surface.

The floating leaves of American pondweed.

Waterlilies provide habitat for wildlife. Their leaves lie flat on the water surface.

Watershield leaves are 2 to 5 inches long (much smaller than waterlily or spatterdock leaves), and the petioles and undersides of the leaves tend to be slimy. Note how the petiole joins the leaf at the leaf's middle.

Emergent Plants

Emergent plants are also called shoreline plants or marginal plants due to their location. Most of the green vegetation of this group of rooted plants is above the water surface.

This group includes grass-like and broadleaved plants. Grass-like plants commonly include cattails, bulrushes, spikerushes, and reed canarygrass. Broadleaves include willow trees, creeping water primrose, and purple loosestrife (an invader of wetland areas). Many of these plants spread rapidly by underground rhizomes as well as by seed.

Spikerush plants usually are no more than 1 foot tall.

Cattails can grow 5 to 7 feet tall.

Phragmites (common reed) is a very tall grass (10 to 15 feet) that can spread rapidly along roadsides and around water bodies.

Purple loosestrife is a serious wetland invader. Its flowers are pink-purple.

Bulrush plants can grow 3 to 7 feet tall.

Creeping water primrose plants have reddish stems that extend through the water. By summer, most of its leaves are above the surface (top). The plant is rooted (middle), and produces yellow flowers (bottom).

Aquatic Plant Management Methods

The goal of managing any body of water should be to achieve balance, never to create a sterile, swimming pool effect. Native vegetation is part of that balance because it helps to maintain a healthy population of aquatic organisms.

When is control warranted?

Invasive plant species in all bodies of water should be controlled — and in some cases (such as hydrilla), eradicated. Excessive weed growth (whether by native or invasive plants) that causes problems in ponds or larger bodies of water should also be managed.

Just remember: never control vegetation in wetlands or state-owned bodies of water (such as public lakes) without first receiving a permit (application and information at www.in.gov/dnr/fishwild/7046.htm).

Effectively managing aquatic plants generally involves the careful use of one or more of these management methods:

- Preventive control
- Mechanical control
- Biological control
- Habitat alteration
- Chemical control

Preventive Control

Many aquatic weeds or their seeds are carried into a body of water by wind, birds, fish, boat trailers, fishermen, or other means. Even plant fragments less than an inch long can survive transfer to another body of water as long as they do not completely dry out.

Prevention starts by eliminating or reducing the sources of spreading. Discourage geese from visiting your water body, wash plant fragments off trailers and boats before leaving a site, and remove plant fragments from live wells and when moving fish or bait from one site to another.

Invasive species can be spread when non-native plants are purchased at aquarium and water garden stores. For example, Brazilian elodea is a popular aquarium plant (often sold as Anacharis). So do not dispose of aquarium plants where they can wash into a water body, and always check with vendors to determine if a water garden plant is invasive. It is unwise to introduce any plants from a water garden store into ponds and lakes.

The introduction or sale of purple loosestrife (seeds and plants), hydrilla, and Brazilian elodea is prohibited in Indiana and most surrounding states.

Find Out More

If you're not sure if a particular plant species is invasive, try searching for it on the Web Specific sites include:

Purdue Extension Indiana's "Most Unwanted" Invasive Plant Pests
http://extension entm purdue edu/CAPS

Indiana Department of Natural Resources Invasive Species page
www invasivespecies in gov

Mechanical Control

Mechanical control methods involve removing plants manually — for example, by hand pulling or raking plants.

Since most aquatic plants are perennial, they have underground portions that can resprout new shoots, so it is essential to harvest below-ground growth (roots and rhizomes) for effective control. With larger plants such as cattails, this can be difficult. Dealers specializing in aquatic or fisheries supplies do offer hand-held devices for cutting or pulling plants in small areas.

For larger bodies of water, motor-driven weed harvesters with underwater cutting blades are available. Such equipment is a major investment and may have to be operated several times during the season to effectively cut back the vegetation. The principle behind these harvesters is the same as mowing a lawn: the weeds will not be eliminated, but they can be prevented from growing to the surface and becoming a nuisance.

Mechanical harvesters can successfully cut channels through vegetation, allowing boat traffic to move to open water. When mechanically controlling aquatic plants, harvest the cut vegetation and dump it where it cannot reenter the water. Plant fragments left to float in the water can produce new plants.

Cattail rhizomes are difficult to dig out.

Know Your Local Laws

Some states require permits for mechanically harvesting vegetation on natural lakes States may also have requirements for releasing biological control agents Always check with state regulatory agencies before harvesting any plants or introducing any biological controls

Mechanical Control

In Indiana, the Indiana Department of Natural Resources (IDNR) requires a permit for mechanically harvesting vegetation in public waters if the area to be controlled is more than 25 feet along the shoreline, has a water depth of more than 6 feet, and has an area more than 625 square feet

Indiana residents do not require a permit to harvest vegetation on privately owned lakes, ponds, or drainage ditches

Biological Control

IDNR requires a permit before anyone can introduce biological control agents into public waters

Indiana residents can introduce grass carp in privately owned lakes and ponds, but there are some restrictions First, the land surrounding the pond or lake must be privately owned, and second, all precautions, such as constructing barriers at spillways or outflows, must be taken to prevent the grass carp from escaping

The type of grass carp legal for stocking in Indiana is the triploid grass carp, a form that will not reproduce In Indiana, triploid grass carp must be purchased from a dealer holding an Aquaculture Permit The permit holder must deliver and stock the fish, present the purchaser with a bill of sale, and provide a copy of triploid certification Purchasers must retain these documents for at least two years Triploid grass carp are also legal in Illinois and Ohio, but have not been approved for use in Michigan, Minnesota, and Wisconsin

For more information, visit the IDNR Web site, www in gov/dnr

Biological Control

Biological control methods involve using beneficial organisms to control pest organisms. Remember, always check with the appropriate state regulatory agency or fish and game agency before releasing a biological control agent.

Biological controls have received considerable publicity and research attention. For example, certain insects have been released in the Midwest to control Eurasian watermilfoil and purple loosestrife populations. Results with Eurasian watermilfoil have been mixed, and the insect introductions for purple loosestrife are part of a long-term management plan.

In addition to insects, waterfowl such as swans can keep small ponds weed-free, but they require husbandry and protection from predators.

The most widely used biological control agent is the grass carp (also known as the white amur). This fish is native to China and Russia and can live 15 to 20 years. Grass carp consume most submersed plants. However grass carp prefer certain plant species more than others, so they often consume native species (such as pondweeds) before feeding on truly troublesome weeds such as Eurasian watermilfoil or mat-forming algae. Grass carp are not effective on duckweed or watermeal.

Grass carp populations have the potential to denude a body of water of its underwater vegetation, so they must never be released in natural lakes and wetland areas where vegetation is critical to fish and wildlife.

The recommended stocking rates in Indiana are 15 or 30 fish per vegetated acre. The carp should be 10 to12 inches long — smaller fish will be rapidly removed by predators such as bass. Use the lower stocking rate for most ponds so that some vegetation remains for fish habitat. The higher stocking rate can be used where total vegetation control is desired for aesthetic purposes, such as golf course ponds.

Although grass carp can provide good aquatic vegetation control, it is not the solution for all ponds. Vegetation control may not be observed for a year or more, so it can be difficult to determine if enough fish are still present in the pond to be effective. After about five years, the fish slow their feeding rate, so more fish may be needed to maintain adequate vegetation control.

Habitat Alteration

As the name suggests, habitat alteration management strategies alter growing conditions to reduce aquatic plant growth.

The primary targets of habitat alteration are nutrients (primarily nitrogen and phosphorus) and light.

Nutrients

A good management plan for the watershed (the area that drains into the body of water) will help reduce nitrogen and phosphorus input. Surveying the watershed and reducing or eliminating obvious nutrient or sediment sources can be effective first steps.

The following measures will help prevent weed growth (particularly in newly constructed ponds) and reduce free-floating plants such as microscopic algae and duckweed in established ponds:

1. ***Do not fertilize your pond or lake.*** Most Midwestern waters are sufficiently rich in plankton and other food organisms to support fish without being fertilized.
2. ***Maintain a vegetation cover around the body of water, including areas that drain into the water.*** Although most people plant turfgrasses near bodies of water, native perennial species with longer roots (such as native grasses and sedges, sweetflag, arrowhead, and cardinal flower) can reduce soil erosion and absorb nutrients more effectively. These plants also offer a more natural look. Remember: always consult your plant supplier or check the Web to make sure you do not select an invasive species.
3. ***Do not apply fertilizers to any plants within 10 to 20 feet of the shoreline.***
4. ***Do not provide livestock with access to a pond.*** Animals in the water will increase turbidity and fertility, and tear down the banks.
5. ***Direct new septic drainage fields away from water.***
6. ***Do not permit runoff from chicken coops, feedlots, and similar operations to enter water.*** Check with your county board of health if you suspect this kind of runoff is occurring upstream from your site.
7. ***Establish a settling or retention pond or wetland area to receive and settle out nutrients before the flow reaches the main body of water.***

There are other measures to alter nutrients in the aquatic environment.

Adding alum (aluminum sulfate) clears up cloudy water and reduces phosphorus. It primarily helps reduce microscopic algae. It has no effect on larger weeds.

Aerating a body of water also can reduce phosphorus concentrations. Like adding alum, aeration may help reduce microscopic algae growth, but its impact on aquatic weeds and mat-forming algae is negligible. Aeration definitely benefits fish, helps prevent fish kills, and increases the breakdown of undecayed muck on the bottom. Fountains are not aerators. Aerators are specialized pieces of equipment that deliver air to the bottoms of ponds or lakes.

Light

Altering light in an aquatic habitat is usually done with dyes.

Products such as Aquashade® inhibit light penetration in the water. This blue dye can be applied right out of the bottle along the shoreline and mixes throughout the body of water within 24 hours. The dye intercepts the light that underwater plants normally use for photosynthesis. Dyes can only be effective if their concentrations in bodies of water are maintained.

Some general rules for dye products include:

1. ***Do not apply a dye where water outflow will reduce its concentration.***
2. ***Apply dyes in March or April before plants reach the water surface.*** Midsummer reapplications are usually necessary.
3. ***Only use dyes to control rooted underwater plants growing at depths greater than 2 to 3 feet.*** They are ineffective on other plants. If necessary, provide supplemental treatments of copper sulfate or other copper products for algae control.
4. ***Do not use in muddy water.***

Other Habitat Altering Methods

Other habitat alterations include riprapping shorelines and anchoring black plastic sheeting on bottom sediments to prevent rooting.

Drawing down the water level over the winter also can be an effective option. Exposing sediments in the shallow areas to freezing and thawing kills the underground structures of many aquatic plants, but its effectiveness depends on the severity of the winter. This method has been successful at controlling Eurasian watermilfoil and waterlily populations.

Chemical Control

When properly applied, herbicides control aquatic vegetation without harming fish and wildlife.

In some instances, herbicides can selectively control particular weed species without killing others. Aquatic herbicides also can fit into an aquatic plant management plan when it is desirable to treat some vegetated areas and leave others untreated. Herbicides are particularly effective for controlling invasive species such as Eurasian watermilfoil and Brazilian elodea.

The herbicides discussed here are registered with the United States Environmental Protection Agency (EPA) and, when used as directed on their labels, pose no significant threat to the environment or public health.

Always read and follow label directions regarding the correct use of a product and personal protective equipment. Misapplying chemicals to private or public waters is a violation of state and federal laws, and violators are responsible for any environmental damage. The appropriate state regulatory agency (in Indiana, the Office of Indiana State Chemist) also must approve EPA-registered herbicides.

Know Your Local Laws

The Indiana Department of Natural Resources (IDNR) requires permits for chemically treating vegetation in public waters if the area to be controlled exceeds more than 25 feet along the shoreline, has a water depth of more than 6 feet, and has an area more than 625 square feet

IDNR does not require permits for treating privately owned lakes, ponds, or drainage ditches

For more information, visit the IDNR Web site, www in gov/dnr

Find Out More

To learn more about the environmental and human health effects of aquatic herbicides, visit:

Why Aquatic Herbicides Affect Aquatic Plants and Not You!
www btny purdue edu/aquatic

Three major factors protect the environment from the adverse effects of EPA-registered algicides and aquatic herbicides:

1. They are used at extremely low doses in water
2. They do not persist very long in water (usually only a few days)
3. They do not bioaccumulate in the fatty tissues of humans or animals

Before Using Herbicides

Before you choose or use any herbicides, there are a number of important considerations, including:

1. ***Properly identify the weed.*** Certain herbicides will work only on some weeds, but not on others. To get help identifying the weeds, consult your county extension office, a pest diagnostic service, fisheries biologist, or aquatic herbicide dealer. Other resources are listed in Get the Right ID on page 4.
2. ***Never apply chemicals in or around water unless they are specifically labeled for aquatic use.*** Always read herbicide labels — they are the law. If labels do not provide information for aquatic use, it is illegal to use them in water. For example, Princep® and Karmex® are not approved for aquatic use.
3. ***Always follow any water use restrictions.*** Although most aquatic herbicides break down rapidly in water, most products have waiting periods before the treated water can be used. These restrictions — mostly for drinking water, livestock watering, or irrigation — dictate which herbicides will be appropriate for your lake or pond. None of the products listed in this publication currently have swimming or fishing restrictions.
4. ***Apply the correct dose.*** Never apply more herbicide than called for on a label. Some aquatic herbicide labels provide dosages based on acre-feet (a measure of water volume). To calculate acre-feet multiply the surface area by the average depth. For example, a pond with a surface area of half an acre and an average depth of 4 feet contains 2 acre-feet (0.5 acre X 4 feet = 2 acre-feet).
5. ***Make timely applications.*** Late spring — when plants are young, actively growing, and most susceptible to herbicides — is usually the best time to apply aquatic herbicides (exceptions are noted on individual chemical labels). If you wait until late summer to treat, you risk killing fish. By that time, vegetation is usually extensive and dense, the water is warm, and oxygen levels are low. Killing all vegetation at once under these conditions could seriously deplete oxygen levels in the water and cause a fish kill. If you must treat late in the summer (July or August), treat only a portion of the weed growth at a time so fish can move to other areas of the pond or lake.
6. ***Apply when the temperature is right.*** Herbicides do not affect aquatic plants when the water is too cold. The areas to be treated should have water temperatures

in the upper 60s. These water temperatures usually occur from late April to early June in Indiana. Also, (with the exception of fluridone) the target plants must be present at the time of treatment.

7. ***Know the difference between contact and translocated herbicides.*** Some herbicides work very quickly by killing the plant tissue that they contact. Use these contact herbicides for "spot" treatments; that is, apply them to burn down the green parts of plants. Contact herbicides include the copper algicides, endothall, and diquat.

   Other herbicides move into the plant through the leaf tissue and then move into and kill other plant parts, such as underground rhizomes or tubers. These translocated herbicides give a more permanent kill than the contact herbicides. They work more slowly; for example, fluridone cannot be used as a spot treatment because it may move away from the treated area before it can have an effect. Other translocated herbicides (2,4-D, triclopyr, and glyphosate) can be used as spot treatments, but remember, they work slowly.

8. ***Retreat areas as required.*** Adequate control may require more than one treatment a season, such as with copper sulfate on algae. Retreatment is usually required in succeeding years because plants can regenerate each spring from seeds, spores, and underground structures. Most aquatic herbicides have no effect on seeds and underground structures that lie dormant over the winter.

Algicide and Aquatic Herbicide Products

Algicides and herbicides approved for aquatic use are primarily sold as liquids or in dry forms (granules, pellets, etc.). The liquids usually are mixed with water and sprayed directly on the plants or delivered to the water according to label instructions. Granules are applied directly to the water, preferably with a seeder. For good control, it is critical to achieve even distribution of the chemical on or over the target plants.

The most common products and their formulations include:

1. ***Copper sulfate.*** These products are sold under various trade names, and are available in dry (crystal nugget and powder) forms.

   Copper sulfate is for algae control only, and is ineffective on other weed types. When purchased as copper sulfate pentahydrate (25 percent metallic copper), the recommended dosage is 2.7 pounds per acre-foot of water.

   Concentrate the application in the area where algae are growing. One method is to put the copper sulfate in a burlap sack and tow it by boat in the infested area until the product dissolves. Simply tossing the product into the water is not very effective because copper that lands on the sediment will be rapidly adsorbed by soil particles and will not be available for uptake into the algae. Tossing in crystals may be effective, however, against bottom algae, such as Chara, or against mats that have not risen to the surface as long as good contact with the vegetation is achieved.

   Apply the powder form by dissolving it in water and spraying the solution directly on algae mats and in the water around the mats.

   Copper sulfate is highly corrosive to metals, so use plastic, enameled, or copper-lined containers and fittings for mixing and applying it. Thoroughly clean and rinse out sprayers after every operation to prevent corrosion damage.

2. ***Copper chelates.*** Trade names for these products include Cutrine Plus®, Cutrine Ultra®, Algimycin®, Captain®, K-Tea®, and others. They are available in liquid form, and Cutrine Plus® also is available in granular form.

   Copper chelates are used primarily for algae control, particularly at sites where hard water may cause copper sulfate to precipitate out of the water, which reduces its effectiveness. Copper chelate products tend to be less corrosive to metals than copper sulfate. Mix liquid formulations with water in a container and spray or inject into the infested areas. Granular formulations can be broadcast into the water using a seeder. Both liquid and granular formulations can be used as spot treatments.

3. ***Non-copper algicides with the active ingredient sodium carbonate peroxyhydrate.*** Trade names for these products include GreenClean® and Phycomycin®. They are available as granules.

   These products kill algae rapidly. They are primarily used to control microscopic algae but may control some mat-formers. Unlike copper, they are readily broken down in the aquatic environment, so they do not persist as long. They may be suitable alternatives to copper products although more research is needed to determine where they work best.

4. ***Endothall.*** Trade names for endothall are Aquathol® and Hydrothol®, and they are available in liquid and granular forms.

   Aquathol® controls submersed flowering plants and, along with diquat, is a standard treatment for these plants. Mix liquid formulations with water in a container and spray or inject in infested areas. Granular formulations can be broadcast into the water using a seeder. Both formulations can be used as spot treatments.

   Hydrothol® liquid controls algae and submersed plants, but it is recommended for use only by certified applicators who have had special training in handling aquatic pesticides. It can kill small fish and burn skin.

5. ***Diquat.*** The trade name for this product is Reward®, and it is available only as a liquid.

   Diquat controls submersed weeds and, along with Aquathol®, is a standard treatment for these plants. Diquat should be mixed with a nonionic surfactant (wetting agent) when used for burndown treatments of duckweed and watermeal, although these plants usually recover.

   For in-water treatments, mix Reward® with water in a container and spray or inject in the infested area. Only use diquat as a spot treatment. Do not use diquat when the water is muddy because soil particles will remove it from the water.

6. ***Fluridone.*** Trade names of this product include Sonar® and Avast!®. Sonar® is available in AS (liquid solution), SRP (slow release pellet), PR (precision release), and Q (quick release pellet) formulations.

   Fluridone primarily controls submersed plants and duckweed, and can be particularly effective with watermeal. Use only the AS form for duckweed and watermeal. Mix the liquid product with water in a container and spray or inject in infested areas. The pelleted forms can be dispersed with a seeder.

   Fluridone is not effective as a spot treatment, so it must be applied to a pond's entire surface area. In lakes and reservoirs, apply fluridone to areas at least 5 acres in area to prevent dilution. Since the chemical must stay in contact with target plants for several weeks, it is not recommended for sites where there is a lot of water exchange.

   The chemical is slow acting, and it may take 30 to 90 days to see results. However, under optimal conditions, target plants may be controlled for two years or more. This chemical is effective at selectively removing the invasive species Eurasian watermilfoil, Brazilian elodea, and hydrilla from native plant stands.

7. ***2,4-D.*** Trade names of this product include Navigate® and Aquakleen®. Both are granular formulations. DMA 4 IVM® is a liquid formulation approved for in-water treatment.

   2,4-D is used for specific broadleaf plant species such as Eurasian watermilfoil, coontail, and waterlilies. Distribute granules and the liquid evenly over the infested area. Only amine formulations of 2,4-D liquid (such as DMA 4 IVM®) should be used for vegetation control around water — such as vegetation along drainage ditchbanks — but always read product labels to make sure products are registered for that use. Do not use liquid ester formulations because they are highly toxic to fish.

8. ***Triclopyr.*** The trade name of this product is Renovate®, and it is available in liquid and granular forms.

   This product is particularly effective on broadleaf weed species but can be used on selected grasses such as Phragmites. Its primary targets are Eurasian watermilfoil, purple loosestrife, and woody species.

9. ***Glyphosate.*** Trade names of this product include AquaMaster®, AquaPro®, and Shore-Klear®. Rodeo® may also be available. These products are available only as liquids, and require adding a nonionic surfactant (wetting agent) to the glyphosate and water mix. However, GlyphoMate 41® and Shore-Klear Plus® are products that already include an EPA-approved surfactant, so they do not require one to be added. It is illegal to use glyphosate products that are not specifically labeled for aquatic use.

   Glyphosate controls emergent vegetation such as cattails, grasses, and woody species. It does not work on plants under the water's surface. Spray glyphosate solutions directly on the foliage. With appropriate penetration into the tissue, the product translocates into the underground system and kills the weeds.

   The best time for treatment is late summer or early fall, before the first hard freeze. Glyphosate solution can be used as a spot treatment or a wipe-on application (applying with a sponge directly on the foliage of the target species) to kill only specific plants. Always wear protective gloves for wipe-on applications.

Algicide and Aquatic Herbicide Recommendations

This table shows the dosages, uses, and restrictions of the common algicides and aquatic herbicides approved for use in Indiana. The dosages shown here are only indications of the amounts to use and will vary according to target species, state restrictions, and other factors. Always read product labels to determine actual dosages.

Aquatic Weed	Herbicide	Typical Dose[1]	Restrictions[2]
Algae (microscopic, mat-forming, Chara)	copper sulfate (25% Cu)	2 7 lbs/A-ft	Do not use in trout- or koi-bearing waters
	copper chelates	Dose varies by formulation	Do not use in trout- or koi-bearing waters
	sodium carbonate peroxyhydrate (GreenClean®, Phycomycin®)	3-100 lbs/A-ft	None, but check specific labels
	endothall (Hydrothol 191®)		
	liquid form	0 6-18 pt/A-ft	I, L, D = 7-25 days
	granular form	3-81 lbs/A-ft	
Submersed plants (pondweeds, naiads, elodea)	endothall (Aquathol K®)		
	liquid form	0 6-3 2 gal/A-ft	I[3], L, D = 7-25 days
	granular form	2 2-22 lbs/A-ft	I, D = 7 days
	diquat (Reward®)	0 5-2 gal/SA	I = 1-5 days; D = 1-3 days; L = 1 day
	fluridone (Sonar®, Avast! ®)	Dose varies by formulation	I = 7-30 days Do not apply within a quarter mile of potable water intakes[4]
Submersed plants (Eurasian watermilfoil, coontail)	2,4-D		
	Navigate®	100-200 lbs/SA	I, D Note precautions on label
	DMA 4 IVM®	Up to 2 8 gal/A-ft	
	triclopyr (Renovate®)	0 7-2 3 gal/A-ft	D Note setbacks when applying near potable water intakes
	fluridone (Sonar®, Avast! ®)	Dose varies by formulation	I = 7-30 days Do not apply within a quarter mile of potable water intakes[4]
Free-floating plants (duckweed, watermeal)	diquat (Reward®)	1-2 gal/SA (add surfactant)	I = 1-5 days; D = 1-3 days; L = 1 day
	fluridone (Sonar AS®, Avast! ®)	0 12-0 24 qt/A-ft	I = 7-30 days Do not apply within a quarter mile of potable water intakes[4]
Rooted-floating plants (waterlilies, spatterdock)	Glyphosate (AquaMaster® and others plus surfactant, Glyphomate 41® without added surfactant)	Dose varies according to species Consult label	Do not apply within a quarter mile upstream of potable water intakes
Emergent plants (cattails, willows, grasses and other perennial plants)	Glyphosate (AquaMaster® and others plus surfactant, Glyphomate 41® without added surfactant)	Dose varies according to species Consult label	Do not apply within a quarter mile upstream of potable water intakes

[1]A-ft = acre-feet SA = surface acre

[2]D = drinking water for humans I = irrigation L = drinking water for livestock

Where a range of days is given (e g , 7-30 days), the waiting period depends on the dose
These restrictions apply to Indiana Other states may have additional restrictions
Always read product labels and check with local and state regulatory agencies

[3]Liquid formulation only: Treated water can be used immediately for sprinkling bent grass

[4]Doses less than 20 ppb can be used within a quarter mile of potable water intakes

Specific Control Strategies

Algae

The first step in effective algae control is reducing the runoff of nutrients (nitrogen and phosphorus) into a body of water. This is the best strategy for managing green water blooms caused by microscopic algae.

Grass carp do not consume microscopic algae. Young grass carp may eat mat-forming algae, but they generally prefer eating submersed flowering plants. Sun-blocking dye products are not very effective on algae, particularly in shallow water where light can penetrate. However, it may be useful to add dye after a copper treatment to prevent new growth from rising to the surface.

Mat-forming algae and Chara are mostly treated with copper-based products. The standard product is copper sulfate, but it can be ineffective in very hard (alkaline) waters. Copper sulfate provides poor control of some types of algae. If copper sulfate is ineffective, try a chelated copper product. Mix copper sulfate and copper chelate products in water and spray them directly on and around the algae mats. Good coverage of the mats is critical to good control. For some extremely copper-tolerant algae, repeated copper treatments over the summer may be necessary.

In ponds and lakes with a history of green water, prevent fish kills by treating algae with algaecides while the color is still light.

Chara can be difficult to control once it is established and has developed a heavy coating of calcium carbonate (limestone) around its body. Use copper compounds when the plants are still young and not heavily calcified. The granular forms of Cutrine® and Hydrothol®, which are dropped into the vegetation, can be effective.

Use Hydrothol® with caution to avoid killing fish — apply only as a spot treatment so that ample untreated fresh water is available for fish to move into. Sometimes, small fish will not move away from the treated area quickly enough and can be killed.

Submersed Plants

A number of methods can control submersed plants including the introduction of grass carp, mechanical harvesting, and the application of dyes. However, grass carp do not control Eurasian watermilfoil very effectively.

Aquathol® and Reward® are the most commonly used submersed weed control products. They can be tank-mixed with copper products to control both algae and submersed plants. They are effective as spot treatments, so they can control vegetation in one area while leaving other areas untreated. They act quickly, and burndown should be visible within a week of treatment.

Aquathol® and Reward® can burn down Eurasian watermilfoil, but 2,4-D (Navigate®, Aquakleen®), triclopyr (Renovate®), or fluridone (Sonar®, Avast!®) provide more effective, long-term control of this invasive plant. Although fluridone products are quite expensive, they can be used at extremely low dosages (parts per billion) to remove Eurasian watermilfoil from native plant stands.

Free-floating Plants

Duckweed and watermeal are difficult to control.

Grass carp do not consume them and mechanical removal is very difficult. Surface applications of Reward® plus a surfactant primarily burn the plants, but they tend to come back within a week or two. Therefore, continual treatments with Reward® are required throughout the season, starting as soon as plants appear on the water surface.

Sonar® or Avast!® can be more effective on duckweed than Reward® and, if used correctly, can sometimes provide control for more than a year. When using fluridone products, block pond outflow for at least 30 days because plants must be exposed to the chemical for at least this long.

Watermeal is harder to control than duckweed. The most effective strategy is to use the highest dose of fluridone (0.24 quarts per acre-foot) in a split application (two applications 10 to 14 days apart). Although fluridone usually provides successful control, there can be failures. Pond outflow must be reduced for at least 30 days, preferably longer.

Find Out More

For more information on watermeal and duckweed control, see Purdue Extension publication APM-2-W:
Aquatic Plant Management: Control of Duckweed and Watermeal
www extension purdue edu/extmedia/APM/APM-2-W pdf

Emergent Plants

Cutting or digging emergent plants can be extremely laborious because the underground rhizomes must also be removed for effective control. Grass carp do not feed on emergent plants.

Glyphosate products (AquaMaster® and others) plus a nonionic surfactant, or glyphosate products that come premixed with a surfactant (Glyphomate 41®, Shore Klear Plus ®) are effective as foliar spray or wipe-on treatments on almost all vegetation standing above the water surface. Surfactants can be purchased from the same dealers as herbicides.

Although Reward® also is labeled for emergent plant control, it primarily burns the foliage and does not move into the underground parts of the plant. Glyphosate, on the other hand, does move downward to kill the underground structures. This systemic action is essential for long-term control of the plant. Remember, glyphosate acts slowly, so its effect on vegetation may not be seen for several weeks.

Although glyphosate applications can be made as soon as vegetation appears in the spring, it is most effective when applied in the late summer or early fall before the first hard freeze. If the underground structures are successfully killed, the vegetation should not reappear in the spring.

Comments on Barley and Bacterial Products

Some people have promoted using barley straw to control algae. Although widely used in England and other countries, research results in the United States have been inconsistent.

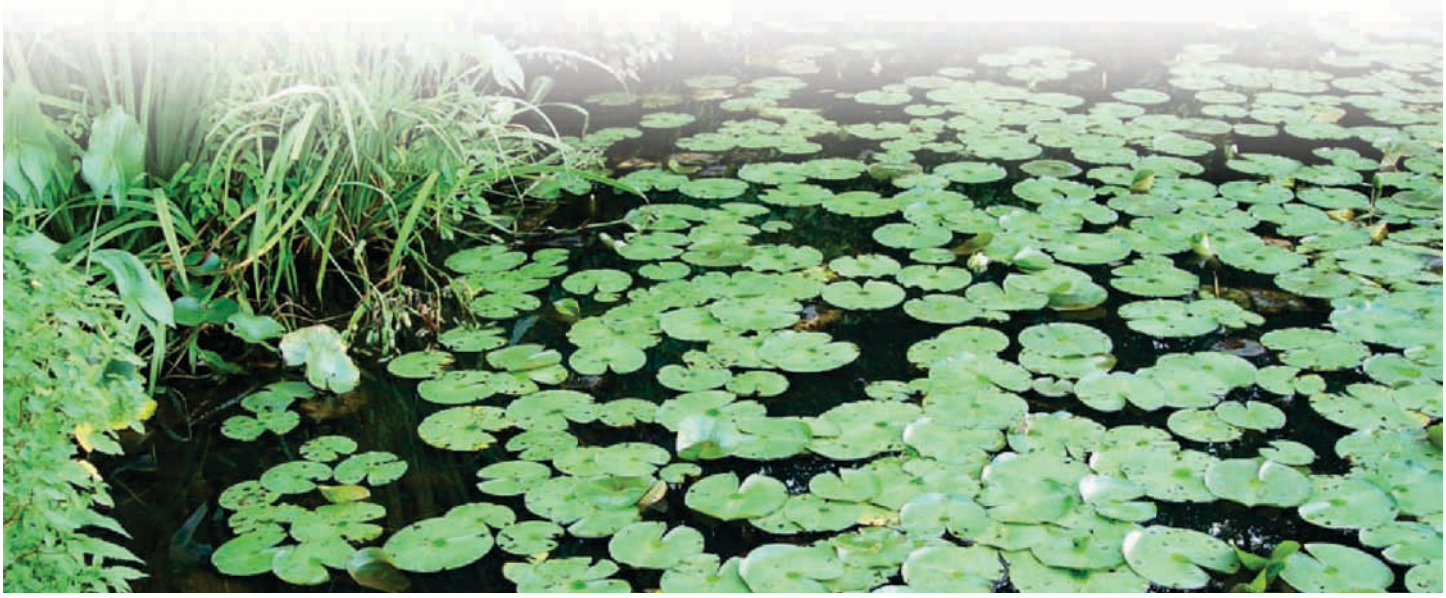
Various bacterial products are also on the market. These products generally claim to clarify the water or reduce organic compounds, and tend not to be specific about how they reduce algal growth, if at all. Very little research has been conducted on these products, and testimonials are mixed, so be aware that these products may have no effect on algae.

Find Out More

For more about barley for algae control, see Purdue Extension publication APM-1-W:
Aquatic Plant Management: Barley Straw for Algae Control
www btny purdue edu/Pubs/APM/APM-1-W pdf

Other Purdue Extension publications in the Aquatic Plant Management series are available from The Education Store:
www extension purdue edu/store

Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer. Always read and follow product labels.



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