UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE

Category 5
Training Manual
AQUATIC WEED CONTROL

Pesticide Safety Education Program
UK College of Agriculture

Specific requirements for commercial applicators in the Aquatic Pest Control category relate to a practical knowledge in four major areas-

- Water use situations
- Weed identification
- Weed management alternatives
- Principles of limited area application.

Effective management of aquatic pests requires an integrated approach that incorporates cultural, mechanical, biological, and chemical methods as appropriate.

Adapted from *North Central Regional Extension Publication No. 241, Carole A. Lembi, Aquatic Weed Specialist, Purdue University* and *Aquatic Pest Control, University of California Leaflet 2961*

CONTENTS

Why is aquatic weed control necessary?

Plants are natural and important components of the aquatic environment. Microscopic plants (algae) form the base of the aquatic food chain. Larger algae and plants provide habitat for fish and food organisms, and all plants produce oxygen as they photosynthesize during the daylight hours. However, excessive growths of these plants can have a detrimental effect on a body of water and its inhabitants. Many shallow, nutrient-rich ponds, lakes, and drainage ditches provide ideal conditions for abundant aquatic weed growth.

Some of the problems caused by aquatic weeds are as follows:

- Interfere with or prohibit recreational activities such as swimming, fishing, and boating.
- Detract from the aesthetic appeal of a body of water.
- Stunt or interfere with a balanced fish population.
- Fish kills due to removal of too much oxygen from the water. Oxygen depletion occurs when plants die and decompose. Photosynthetic production of oxygen ceases, and the bacteria, which break down the plant material, use oxygen in their own respiration. Fish kills in summer are frequently caused by die-offs of algae blooms. Fish kills in winter occur when snow accumulates on ice cover. Light is blocked thus preventing photosynthesis by any living plants or algae. Decomposition of plants that died in the fall causes further oxygen depletion. Fish kills also can be caused by insecticide runoff, ammonia runoff from feedlots, and diseases.
- Produce quiet water areas that are ideal for mosquito breeding.
- Certain algae can give water bad tastes and odors.
- Impede water flow in drainage ditches, irrigation canals, and culverts, causing water to back up.
- Deposition of weeds, sediment, and debris, can bodies of water to fill in.

Water Use Situations

The demand for water resources for recreation, agriculture, and industry is increasing. Many kinds of plant and animal aquatic pests can interfere with water uses. Control of aquatic pests must be done without harm to people and the environment.

Habitats for aquatic weeds involve various proportions of water and soil, including intermittently wet ditches, ditches which always hold standing water, streams, stock ponds, farm ponds, lakes, ornamental ponds, and intermediate habitats. This manual considers three types of water situations - static, limited flow impoundments, and moving water.

1) Static water is confined for considerable periods of the year, or totally confined within a known area, with no downstream movement. However, even totally enclosed bodies of water often have appreciable water movement because of wind and changes in water temperature. Weeds commonly grow in static water up to 12 feet deep. Weeds may grow in very clear water that is more than 20 feet deep. If a herbicide is applied for weed control, there is no reason to expect that any appreciable downstream effect may occur, unless there is overflow resulting from unusual storm conditions.

2) Limited -flow Water Impoundments Ditches may be intermittently wet or dry, depending upon climatic conditions. However, herbicides applied to these habitats may move downstream following an influx of water from surrounding areas. The purpose of the ditch is to drain the surrounding land area so considerable amounts of water must pass through it.

Many farm ponds may be characterized as having limited flow because there nearly always is an overflow pipe and an emergency overflow channel (spillway). The overflow pipe is designed to permit passage of a continuous and relatively well-defined amount of water at all times. The emergency spillway is provided to release from the pond when storms dump in excess amounts of water in a short time. In these situations, small amounts of pesti-

cides may be carried downstream from the application site. Larger amounts may be found downstream after sudden rain storms, which interrupt or come immediately after pesticide application.

3) Moving water is found in small streams, creeks, streams, and rivers where there is always some detectable downstream current. Applied pesticides may be found in downstream locations in varying amounts away from the area of original application. Such situations present the greatest potential for concern as an environmental hazard.

Aquatic Weed Identification

Identification is the first step in managing aquatic weeds. Most control methods are aimed at specific weeds or groups of weeds with similar growth habits. Aquatic weeds can be divided into two botanical groups; algae and flowering plants. Algae are usually very simple in structure with no apparent leaves or stems. However, some (for example, *Chara*) can resemble flowering plants. For effective chemical control, it is essential that you distinguish between algae and flowering plants.

Algae

Microscopic algae form scums and/or color the water green or yellow-green. Sometimes they cause red, black, or oily streaks in the water called "blooms." Blooms usually occur where abundant nutrients are reaching the water. They should be treated with chemicals before they cause a noticeable color but a sudden die-off of these algae can cause fish kills.

Filamentous algae (also known as moss) form floating, mat-like growths which usually begin around the edges and bottom of ponds in the early spring. Moss is probably the most common in lakes and ponds in the Midwest. Often, repeated chemical treatments during the summer season are necessary for effective control.

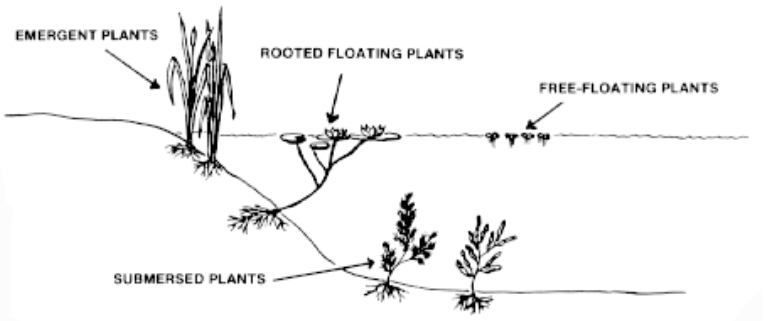
CHARA

Chara, or stonewort usually grows in very hard water and is often calcified and brittle. The plant is rooted, and leaves are arranged along the stem in whorls. It grows completely underwater and has a musky smell. *Chara* can be difficult to control once it has become established and has a heavy coating of calcium carbonate. Use contact herbicides when the plants are still young and not heavily calcified. Although this plant resembles some flowering plants, it is an alga.

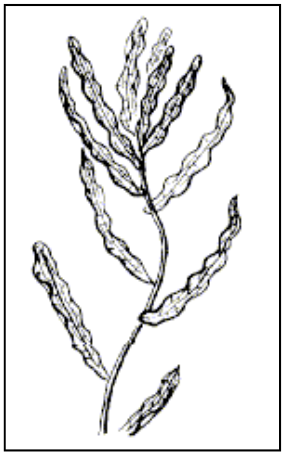
Flowering Plants

Flowering plants can be grouped into broad categories according to where they are found in a body of water.

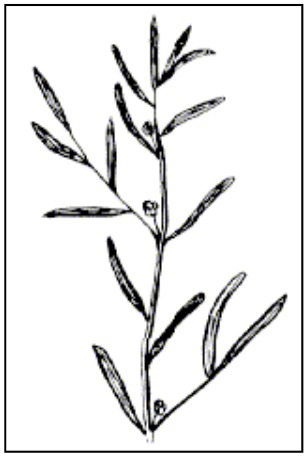
Submersed plants are rooted in the bottom sediments and grow up through the water. Flowers or flowering spikes sometimes emerge above the water surface. The main criteria for identification are leaf arrangement and leaf shape.



Common underwater weeds



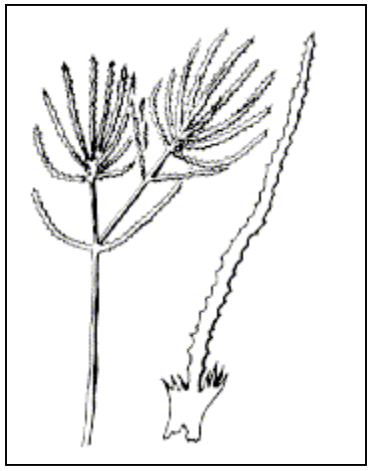
Curly-leaf pondweed has an alternate leaf arrangement. It grows best in the spring and tends to die out inthe summer. This weed is common in ponds, lakes, and ditches.



Leafy pondweed has very narrow leaves with an alternate arrangement. It is more common in ponds than in large lakes.

Waterthread pondweed, usually restricted to shallow water, has small floating leaves that are about 1" long. Leaves of other floating-leaved pond weeds (such as American pondweed) may be 4" to 5" long.

Coontail has branched, spined leaves in a whorled arrangement. This weed is very common in the Midwest.

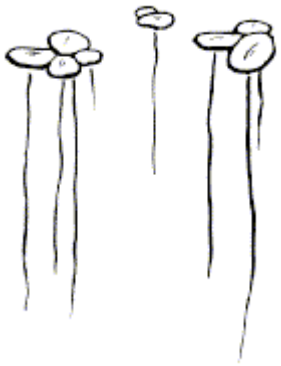


Brittle naiad, more common in the southern Midwest, has an opposite or whorled leaf arrangement.

Eurasian watermilfoil usually has four feather-like leaves at a node. This serious, rapidly spreading invader is found in lakes and ponds throughout the Midwest.

Floating weeds

FREE-FLOATING PLANTS



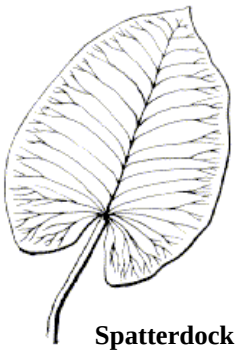
Duckweed

Watermeal

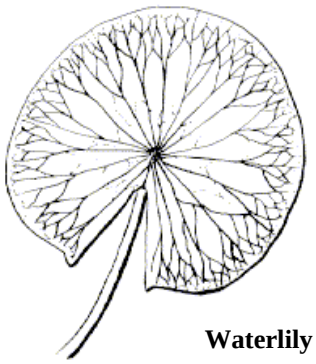
Free-floating plants, such as **duckweed** and **watermeal** are seed-bearing plants which float free on the water's surface. They never become rooted in the soil, and are propagated by sexual and asexual means. They can completely cover the surface of a pond. Both are extremely small. Duckweed is no more than 1/4 inch in diameter, and watermeal is even smaller. Both plants are found in nutrient-rich waters. Input of waste water from sources such as livestock feedlots and septic tank fields should be eliminated.

Rooted floating plants include water lily, spatterdock, and water lotus. **Spatterdock** is usually the weedier of the three and completely fill in shallow areas less than 3' or 4' deep. Spatterdock is a massive, difficult to kill underground rhizome from which new plants sprout. It differs from waterlily in having heart-shaped leaves that come above the surface of the water and a yellow flower. **Waterlily** has round leaves.

ROOTED FLOATING PLANTS



Spatterdock



Waterlily

EMERGENT PLANTS

Cattail

Bulrush

Spike Rush

Creeping Water Primrose

Emergent (shore or marginal) plants commonly include **cattails**, **bulrushes**, **spike rushes**, reed canarygrass, and other grass-like perennial plants. Broadleaves include willow trees and **creeping water primrose**.

Managing Aquatic Weeds

1. **Preventive measures** such as proper design and construction of ponds is an important factor in preventive control of weeds. Shallow water at the margins provides an ideal habitat for immersed weeds, such as cattails. These weeds can spread then to deeper water. Banks should be sloped steeply so that very little water is less than 2' to 3' deep.

   Proper design and construction of ditches and channels makes weed control easier in the future. If the banks are leveled and smoothed, hard-to-reach places will be eliminated. Lining canals will help to alleviate water weed problems, too.

2. **Mechanical control** may be needed if severe waterweed infestations develop in spite of preventive measures, many ponds still have severe waterweed infestations. In some cases, use of a herbicide may not be possible if the water is used for livestock, drinking, or fish. Hand-pulling the weeds or dredging the pond are possible methods of control. But often the infestation is so severe that these methods are impractical or uneconomical.

   Motor-driven underwater weed cutters are available and can be used for the control of such plants as waterlilies and watermilfoil. Some mowers simply cut the weeds loose beneath the water surface. Aquatic weed harvesters collect weeds for removal. Disposal of harvested weeds can be a problem. Most mechanical control methods fragment weeds. Many weed species can spread and reproduce from these pieces. Mechanical control is usually slower and more expensive than use of herbicides. Underwater weed cutting must be done continuously during the summer and usually represents a long term financial investment.

3. **Cultural control and habitat alteration** through certain methods of manipulating or altering the aquatic environment can be effective in controlling aquatic weeds. One of the more successful methods is the drawdown technique in which water levels are lowered over the winter. Exposure of the sediments in the shallow areas of a lake or pond to alternate freezing and thawing action will kill the underground rhizomes of many aquatic weeds (the majority of aquatic weeds are perennial and come from rhizomes).

   This method has been quite successful for the control of Eurasian watermilfoil and waterlilies, although the degree of control depends somewhat upon the severity of the winter. There are several advantages to a winter drawdown in addition to weed control. As the sediment dries, it is compacted, thereby increasing the depth of shallow areas. Drawdown also concentrates the fish which increases the predation of the smaller fish by the larger ones. Fishing quality can often be improved following a drawdown.

   Many aquatic weeds or their seeds are carried into a pond by wind birds, fish introduction, fishermen, etc. These weeds infest a pond only if the water conditions are just right. This usually means that nutrients are entering the pond from runoff or stream inflow. To help prevent serious weed infestations you can do the following things:

   - Most waters in Kentucky are sufficiently rich in plankton and other food organisms to support large fish without the need for supplemental fertilization.
   - Maintain a good sod and grass cover around your pond. This will help prevent runoff and erosion. Do not fertilize the turf directly around the pond.
   - Do not allow livestock access to a pond except under conditions of extreme heat. If the water is used for livestock, fence the pond and water the animals from a stock tank below and outside the fence. Animals will increase turbidity and fertility and tear down the banks.
   - Check septic tanks for possible leakage or seepage into the pond. Locate new septic drainage fields so that the nutrient-rich effluent will not reach your pond.
   - Do not permit runoff from chicken coops, feedlots. etc., to enter your pond. If this kind of runoff is occurring upstream from your pond, you should check with your county Board of Health to see if anything can be done about it.

All of these measures will help prevent weed growth, particularly in a new pond. In older ponds these measures will probably aid in reducing infestations of floating plants such as algae and duckweed.

Other types of habitat manipulation include riprapping shorelines and anchoring screens (e.g., Aquascreen) or black plastic sheets on the bottom sediments to prevent rooted plant establishment. Dyes such as Aquashade are used to inhibit light penetration through the water. This blue dye can be applied right out of the bottle along the shoreline. It mixes throughout the body of water within 24 hours. The dye intercepts light normally used for photosynthesis by underwater plants. The dye can only be effective if its concentration is maintained.

Some general rules for using Aquashade:

a. Do not apply where water outflow will reduce Aquashade concentration.
b. Apply in March or April before weeds reach the water surface. Midsummer reapplication is usually necessary. It is effective only on rooted underwater plants growing at depths greater than 2 to 3 feet. Supplemental treatments of copper sulfate might be needed for algae control.
c. Do not use in muddy water.

Aeration has been publicized as another method of weed control. Although aeration is definitely beneficial for fish life and can help prevent fish kills, there is no evidence that aeration inhibits weed growth.

4. **Biological controls** for aquatic vegetation have received considerable publicity. Several species of fish are herbivorous in that their principal diet is aquatic vegetation. One such species, the grass carp (also known as the white amur or Chinese carp), is being tested in various parts of the United States and is legal in several states. However, it is illegal to introduce these fish to the ponds, lakes, and streams of many states. Check with your local or state fisheries department for regulations regarding the grass carp.

5. **Chemicals** used in aquatic weed control are classified as herbicides. Herbicides used primarily to control algae may be called algicides, even though they also kill other aquatic plants. For most aquatic weed problems, properly-used herbicides control vegetation without harming the fish. Aquatic herbicides are effective and commonly used means of controlling aquatic vegetation.

Four zones of a body of water may be treated
Aquatic herbicides generally are available in sprayable or granular formulations.

Sprayable formulations- Most herbicide formulations must be mixed with water and applied so that they disperse evenly. These include-

- **WSP**- water soluble powders that dissolve and form true solutions in water.
- **WP**- wettable powders form suspensions in water. The particles do not dissolve.
- **EC**- emulsifiable concentrates form milky white "oil-in-water" emulsions
- **G—**granular formulations are small clay-based pellets that carry the active ingredient on or in the product. They are usually distributed by some sort of slinger-spreader and sink to the bottom. Slow-release granules or pellets release the pesticide active ingredient over an extended period of time.

Four zones of a body of water may be treated with herbicides

Surface	Generally, only 1/4 to 1/3 of the surface area of the water should be treated at a time. This helps to protect fish from a possible shortage of oxygen. Surface area (in acres) of a rectangular body of water equals length in feet times width divided by 43,560 (the number of square feet in an acre).
Total water volume	The whole body of water from the surface to the bottom is treated OR you can treat 1/4 to 1/3 of the water volume (based on surface area) at a time. Calculate the volume of the body of water and add chemical to obtain the required dilution. The concentration of chemical needed to control aquatic plants is often very small and is stated in parts per million (ppm). For example, if the toxic concentration for a particular plant is 2 ppm, then the chemical should be applied at the ration of 2 parts of active ingredient to one million parts of water (2:1,000,000) in the area to be treated. 1) Calculate the acre-feet of the body of water to be treated. Multiply the surface acres by the average depth in feet. An acre-foot of water weighs 2.7 million pounds (2,700,000). 2) 2.7 * ppm concentration wanted * acre-feet = pounds of active ingredient needed. The following calculation shows how to calculate the number of pounds of active ingredient needed to treat a body of water containing 10 acre feet at the rate of 0.5 ppm. 2.7 * 0.5 * 10 = 13.5 pounds of active ingredient
Bottom 1 to 3 foot layer of water	Treating the bottom 1 to 3 feet of water is especially useful in deep lakes where it is impractical to treat the entire volume of water. Treatments are generally made by attaching several flexible hoses at 3 to 5 foot intervals along a rigid, weighted boom. Each hose has a nozzle at the end. The herbicide is applied as a blanket in the lower 1 to 3 feet of water.
Bottom soil surface	Herbicide applications may be made to the bottom soil of a drained pond, lake, or channel.

Floating and immersed weeds can be killed with direct sprays on the foliage applied from a boat or the shore.

Submersed weeds and algae can be treated using sprays or granular formulations.
Sprays are applied as water surface treatments, particularly in shallow water. The herbicide is then dispersed by diffusion, thermal currents, and wave action. Good control depends upon good dispersion of the chemical.

Granules are used primarily to control algae or submersed weeds. They sink to the bottom and work about the same manner as bottom soil treatments. Application rates for granules are given as amount per unit of surface area or as a concentration in ppm. They must be broadcast evenly over the water surface for best results.

Advantages to granular formulations include

- treatment is confined to the bottom are where submersed weeds are
- slow-release formulations can provide extended control
- low concentrations of herbicides can be used
- toxicity to fish may be reduced

Weed Control in Large Impoundments

Herbicides that work well in small bodies of water may perform poorly in large impoundments because of much greater water movement by thermal currents and wave action. In these cases, weed control may be improved by

- using maximum recommended rates
- treating relatively large areas at one time
- apply when winds are at a minimum
- use bottom treatments in deep water
- select herbicides that are absorbed quickly by the plants

Weed Control in Limited-Flow Waterways

Flood drainage canals, sloughs, and drains are good examples of limited-flow waterways. Weed control methods in these systems are very similar to those for static water. Evaluate the possibility of contamination when planning herbicide use. In some areas, drainage water may flow onto crop land or into drinking water supplies.

Secondary and Environmental Effects of Aquatic Pesticide Applications

Incorrect applications of herbicides in water may pose serious hazards to humans, wildlife, fish, and desirable plant life. Select the correct herbicide and apply it at the proper rate. Follow all restrictions on the label. Water has many uses and herbicides will not always remain where they are applied.

Improper applications can kill fish directly or deplete the oxygen concentration excessively if the plants die too quickly. Decomposition of dead fish can contaminate downstream water supplies. Water may be unsuitable for humans, animals, or irrigation.

In static water- ponds, lakes, reservoirs

If application rates are too low in a static water situation, weed control may be unsatisfactory. Excessive application rates may kill fish or exclude livestock from use of the water for a period of time. Use of water supplies for irrigation may not be possible for an indefinite period of time. However, little effect would probably be observed as far as downstream hazards are concerned, since little or no outflow normally occurs.

In limited-flow water

Improper application rates could result in contamination of downstream water used by municipalities or communities for domestic water supplies. The hazardous condition would exist whether limited-flow water sources were treated with an application rate too low to accomplish a desired kill of vegetation or if the rate were excessive. Use of excessive rates might result in a fish kill that could affect downstream water supplies through bacteria from decay and decomposition of dead fish.

In moving water

Application of pesticides to moving waters may lead to at least temporary contamination of downstream water supplies which may be utilized for domestic consumption. In addition, the pesticide, though applied locally for pest control, is certain to move to other areas of the stream and affect various aquatic organisms.

Faulty Application

There are two major hazards involved in faulty application of pesticides: (1) damage to non-target organisms (2) unsatisfactory control. For example, it would be hopeless to apply granular herbicides in fast moving water, whereas they might work quite well in static water impoundments and even in limited-flow water situations. All currently registered herbicides employed for aquatic weed control are rated as slightly toxic, or non-toxic to fish, birds, insects, and other aquatic organisms so long as proper application rates and techniques are employed. Pesticide labels should be carefully observed to ensure that the aquatic environment is not contaminated during pest control efforts.

Limited Area Application

Aquatic weeds may occur in the whole body of water as submersed weeds, or may appear to cover the whole surface of the water as floating weeds. Conversely, the same weeds or other pests may occur only in limited areas within a body of water, whether it is a static, limited-flow, or moving body of water. "Limited area application" implies the advantage of improved safety to aquatic species, specifically the fish population. If pesticides that are potentially toxic to the fish population are applied to a limited area, the fish population can move to untreated water areas and escape potential toxic effects. Also implied in this concept is that a minimal amount of pesticide is applied. This tends to reduce the potential effect upon downstream environments in the event of spillover from the treated body of water.

What You Need to Know Before Using a Chemical

The most important considerations before buying and applying a herbicide for aquatic weed control are:

1. ***Identify the weed.*** This can save you a lot of money because certain chemicals will work only on certain weeds and not on others. Identification help can be obtained from your county Extension Service.

2. ***Restrictions on use of water treated with herbicides.*** Although most aquatic herbicides break down readily and rapidly in water and pose no threat to human or animal health, there are waiting periods on the use of water treated with most herbicides. These restrictions--usually on fishing, swimming, domestic use, livestock watering or irrigation--dictate which herbicides will be appropriate for your pond or lake. Always check the herbicide label for possible restrictions.

3. ***Dosage.*** Calculate carefully, and don't overdo it. Most aquatic herbicide labels give dosages on the basis of acre-feet (volume measurement). Acre-feet is calculated by multiplying the surface area by the average depth. For example, a pond with a surface acreage of l/2 acre and an average depth of 4 feet contains (4 feet x 1/2 acre) 2 acre-feet. The herbicide label can then be checked for the amount of chemical to apply per acre -foot.

4. ***Timing.*** Late spring is usually the best time to apply aquatic herbicides. The plants are young and actively growing and most susceptible to herbicides. Do not wait until July or August! If you wait until late summer to treat, you are running a serious risk of killing fish. By that time, the vegetation is usually extensive and thick. Also the water is warm and still. Killing all vegetation at once under these conditions could seriously deplete the water of its oxygen and cause a fish kill. If you must treat this late in the summer, treat only a portion of the weed growth at a time.

5. ***Temperature.*** Aquatic weeds are not affected by herbicides when the water is too cold. The water temperature should be in the 60's, preferably the upper 60's (in the area to be treated). These temperatures usually occur from late April to early June. This means that as soon as the plants are up and actively growing, and if the water temperature is right, the herbicide should be applied.

6. ***Retreatment.*** More than one treatment may be required for adequate control. Retreatment is usually required in succeeding years. Plants can regenerate each spring from seeds, spores, and underground rhizomes. These structures generally are not affected by aquatic herbicides. Also, new plants can sprout from seeds.