Aquatic Plants And Their Control

COOPERATIVE EXTENSION SERVICE
Kansas State University, Manhattan

Contents

Introduction

Plants have adapted to thrive in diverse habitats. They are most obvious in the terrestrial environment, but they also can inhabit many types of aquatic environments. Aquatic plants are more numerous in the warm, swampy areas of the southern United States, but numerous examples can also be found in Kansas.

Aquatic plants are a natural part of the aquatic ecosystem, used by many different animals either as food or as a hiding place. Many people find aquatic plants interesting and attractive. However, as with any naturally occurring organisms, they may interfere with people's activities either by their over-abundance or by their mere presence. When this occurs the plants are considered "weeds" and some control is desired.

Different problems occur in different types of waters. The main water types and their associated aquatic plant problems are as follows:

Impounded Waters (Ponds, Lakes, and Reservoirs)

The most common aquatic vegetation problems occur in impounded waters. Abundant vegetation affects the fish populations in these bodies of water. Small fish hide in the vegetation, making them unavailable to predators. This often results in overpopulation and stunting of certain species. Excessive vegetation interferes with fishing, swimming and boating, and dead, decaying vegetation produces offensive odors. A more serious problem results from the oxygen deficiency caused by the decaying vegetation. This can occur at almost any time of year, but the most common are in mid-summer and in mid-winter during ice cover. Summerkills usually occur after periods of hot, calm, cloudy weather. During these times the plants greatly reduce their photosynthesis, but continue to respire and often die and decompose. Winterkills occur during periods of ice and snow cover. Ice usually allows enough light penetration for photosynthesis, but a layer of snow can block out most light. This light blockage prevents oxygen production, but respiration and decomposition continue, resulting in an oxygen shortage.

Flowing Water (Rivers, Streams, and Canals)

Aquatic vegetation is seldom a problem in the rivers and streams of Kansas. In fact, vegetation along the banks is beneficial in that it protects the banks from erosion. Problems can occur in canals, however, which are designed to transport water. Plants growing along the edge, especially trees, can impede water flow.

Water Saturated Areas (Marshes, Seeps, and Drainage Ditches)

Aquatic plants usually are not a major problem in these areas. Encroaching vegetation may impede flow in drainage ditches. Marshes and seep areas usually cannot be used for conventional Kansas agriculture so the vegetation can be left alone for wildlife habitat. Weed problems can occur in cultivated fields that border these wet areas, especially in abnormally wet years. During these times the aquatic plants will invade the fields and cause special weed control problems.

Classification of Aquatic Plants

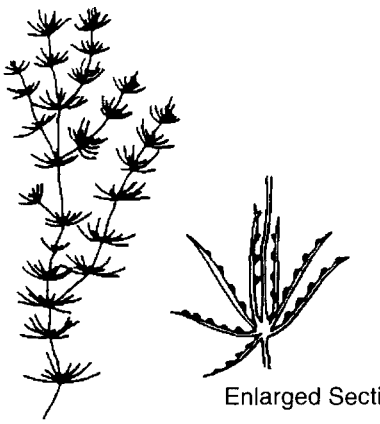
Problem weed species must be identified before an appropriate weed control practice can be selected. Aquatic plants are classified by a similar growth habit as: (1) algae, (2) floating plants, (3) submersed plants, (4) emersed plants, and (5) marginal plants.

Algae

Three major forms of fresh water algae are: (1) phytoplankton (planktonic), (2) filamentous, and (3) chara. Planktonic algae are usually beneficial unless water is used for human consumption. Planktonic and filamentous algae may clog filters in water treatment plants or produce undesirable tastes and odors in drinking water.

Filamentous algae interfere with irrigation systems by clinging to structures and concrete linings and clogging weirs and screens. Common filamentous algae are *Spirogyra* spp.—slimy and green; *Cladaphora* spp.—cotton mat type; and *Pithophora* spp.—horsehair clump type.

Nitella spp. and *Chara* spp. (also called muskgrass) are large green algae that are anchored to the bottom but do not extend above the surface. Stem-like, with thin, leaf-like structures, they are often confused with seed plants. When crushed, chara produces a musky odor.



Chara Enlarged Section

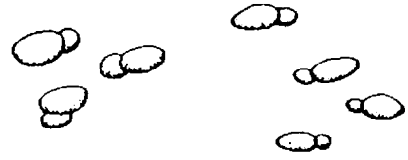
Floating Plants

Some plants are free-floating while others, rooted in the bottom, have floating leaves-that rise or fall with the water level. Many floating plants grow rapidly and are among the most troublesome aquatic plants. Duckweeds *(Lemna* spp.) and watermeal *(Wolffia* spp.) are true floating

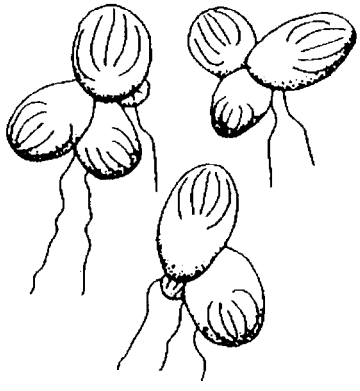
plants of this group whose roots feed from water rather than soil. Rooted plants with floating leaves include waterlilies *(Nymphaea* spp.) and American lotus *(Nelumbo* spp.). Many lotus leaves float, but some extend above the surface

Submersed Plants

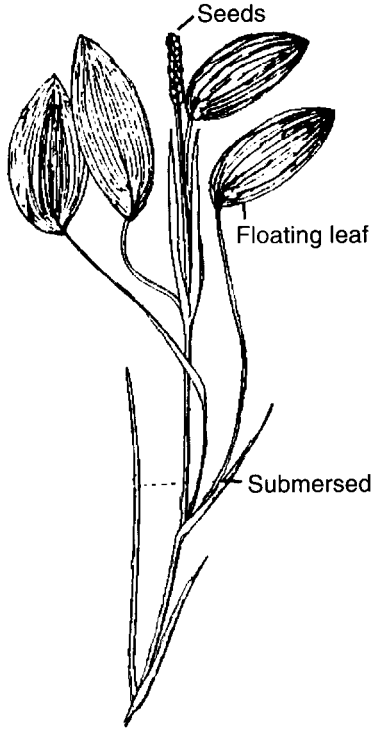
Submersed plants are true seed plants with roots, stems, and leaves. Rooted on the bottom, these plants grow chiefly below the surface although their flowers and seeds and a few leaves may extend above it. A depth of 10 to 12 feet in clear water is the limit habitat for most submersed plants. Important submersed plants include: pondweeds *(Potamogeton* spp.), elodea *(Elodea* spp.), watermilfoil *(Myriophyllum* spp.), coontail *(Ceratophyllum* spp.), naiads *(Najas* spp.), and bladderwort *(Utricularia* spp.).



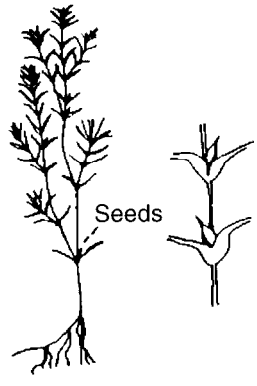
Watermeal (*Wolffia*)



Duckweed (*Lemna*)

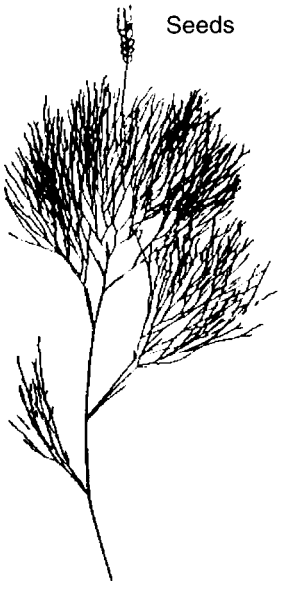


American Pondweed

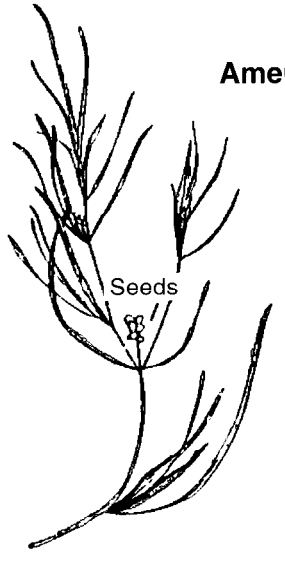


Naiad (*Najas*)

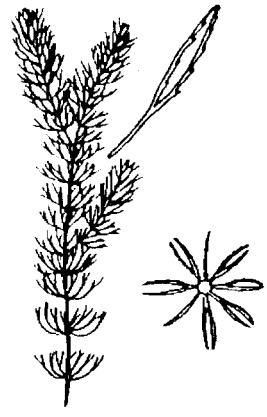
Pondweeds (*Potamogeton*)



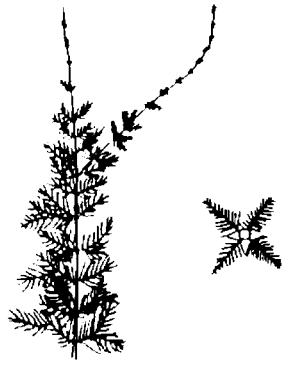
Sago Pondweed



Leafy Pondweed



Coontail (*Ceratophyllum*)



Watermilfoil (*Myriophyllum*)

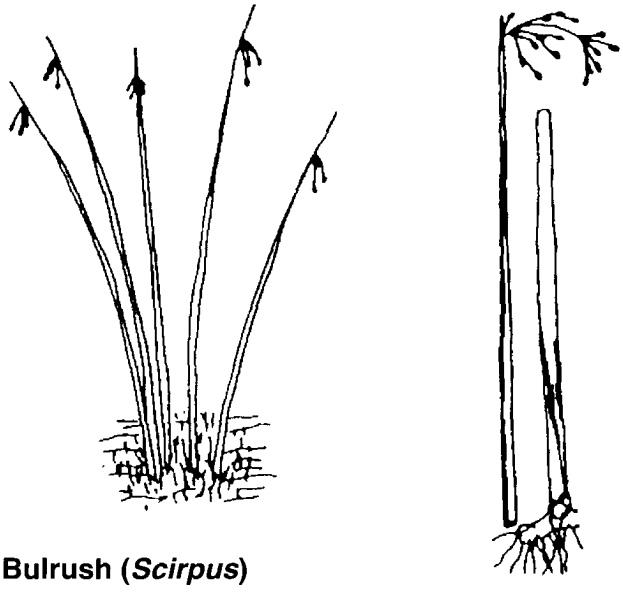
Emersed Plants

Emersed plants are rooted in the bottom and produce most of their leaves and flowers at or above the surface. Leaf shape, size and point of attachment are variable within this group. Leaves of emersed plants do not rise and fall with the water level as do those of attached floating plants. Important emersed plants include: watershield *(Brasenia* spp.), arrowhead *(Sagittaria* spp.), water primrose *(Ludwigia* spp.), and waterwillow *(Justicia* spp.).

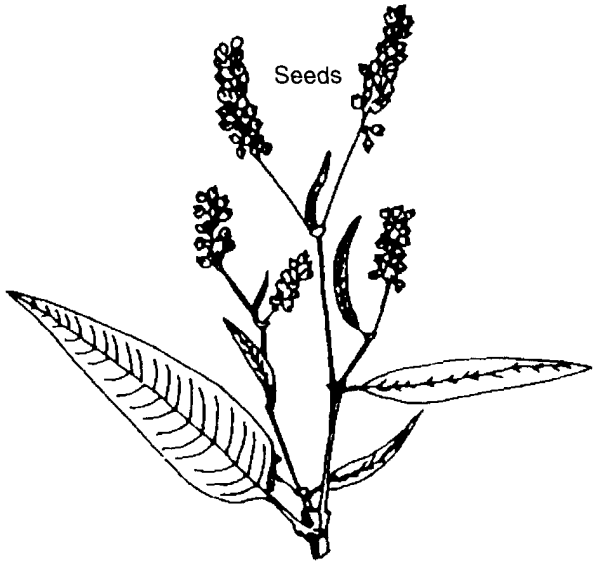
Arrowhead (*Sagittaria*)

Marginal Plants

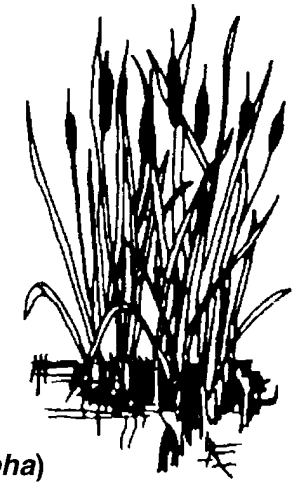
Marginal plants are emersed plants that grow on saturated soil beyond the water's edge. These plants vary in size, shape and habitat. They may be found growing in moist soils along shorelines into water up to 2 feet in depth. Important marginal weeds are: reeds *(Phragmites* spp.), sedge *(Carex* spp.), bulrush *(Scirpus* spp.), rush *(Juncus* spp.), cattails *(Typha* spp.), giant cutgrass *(Zizaniopsis* spp.), smartweeds *(Polygonum* spp.), purple loosestrife *(Lythrum* spp.), willow *(Salix* spp.), and cottonwood *(Populus* spp.).



Bulrush (*Scirpus*)



Smartweed (*Polygonum*)



Cattails (*Typha*)

Identification

Target weeds in the water-use area must be correctly identified so that appropriate control practices can be selected and applied. For identification of unfamiliar aquatic plants, take samples of entire plants (roots, stems, leaves and flowers if available) to your county Extension agent. The county agent can then send the aquatic plant(s) to the Herbarium, Division of Biology, Kansas State University, for proper identification. Request control information if you desire management practices for these unfamiliar aquatic plants. Herbicide recommendations based on the plant identification report can be provided by the Extension Weed Specialist.

Control

Control of aquatic weeds can be subdivided into four general categories: (1) prevention, (2) mechanical, (3) biological, and (4) herbicides. Often a combination of these practices is necessary for adequate control.

Prevention

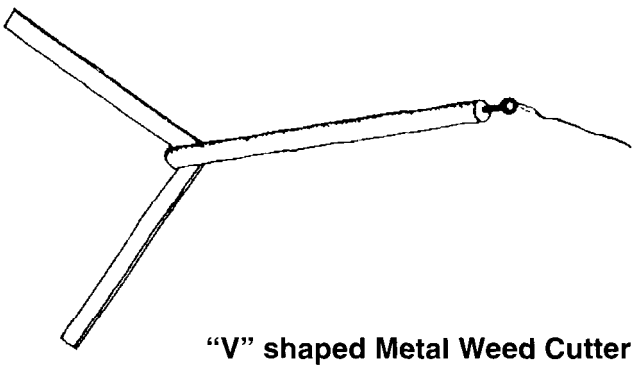
Effective planning and aquatic system management often eliminates or greatly reduces the need for costly and time consuming weed control practices. Aquatic weed problems typically occur in clear, shallow water high in nutrients. Ponds or lakes should be constructed so that shallow water areas are minimized by shaping the sides with a 3 to 1 slope (3 feet horizontal to 1 foot vertical drop) down to a depth of at least 3 feet. Existing ponds or lakes that have extensive shallow water areas can be dredged deeper, but a less expensive practice is to use a bulldozer to deepen shallow areas after the water level has receded below these areas.

Excessive nutrients should be prevented from getting into the water since they will stimulate rapid plant growth. Common sources of nutrients are runoff from livestock holding areas, septic tank drainage, and heavily fertilized fields.

Mechanical and Physical

Mechanical and physical control methods will be more effective in smaller bodies of water than in larger bodies of water. Pulling marginal plants by hand is an effective reduction practice to control cattails, willows, and cottonwood trees in small ponds. Small amounts of submersed plants can be pulled out or raked by hand. Larger amounts can be removed by pulling a long chain or cable across a pond between two tractors.

A device that is effective on submersed vegetation is a hand-pulled cutter, consisting of a "V" shaped flat metal piece sharpened on the outer edge. A rod is fastened to the point and a rope attached to this. The device is thrown out into the vegetation and pulled in with a jerking motion. This cuts off the vegetation so it can float to shore where it can be raked out.



"V" shaped Metal Weed Cutter

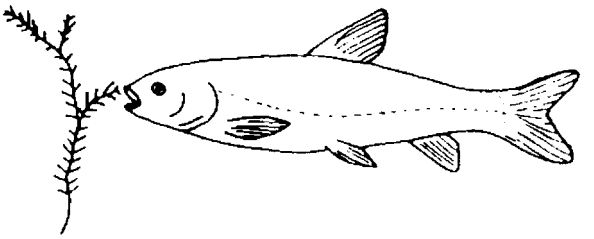
Submersed vegetation can also be controlled by shading it with fine meshed dark plastic screen similar to the type used to shade greenhouses. A large section of this material is place over the vegetation and weighted down with rocks. This compresses and shades the vegetation so it dies. After about two weeks the screen can be moved to another area. The advantage of this method is that fishing, swimming, and boating can take place over the screen.

Various types of weed harvesters have been used, including a cutting device on a floating barge. As the weeds are cut, they are brought up on a conveyor and deposited on the barge. Devices such as these are expensive and disposal of the wet, heavy plant material is a problem.

All mechanical and physical control methods are labor-intensive and give only short-term relief. They work best on small bodies of water that can be observed closely so control can take place before the problem gets too large. These methods are especially effective in home sewage lagoons. For more effective control, use mechanical and physical control practices in conjunction with biological or chemical control methods.

Biological

Herbivorous fish, the grass carp, sometimes called the white amur *(Ctenopharyngodon idella),* is the most effective biological method to control aquatic vegetation. A member of the minnow family, this fish is native to the large rivers of China and Siberia. It will not reproduce in ponds and lakes since it needs large, fast-flowing rivers for reproduction. The young grass carp feed on small crustaceans and insects, but as they grow larger, they shift their



diet almost completely to plant material. They prefer some plants over others, but will consume most species of floating and submerged plants found in Kansas. They will pull out and eat some of the emersed plants, but will not be able to control them. They have voracious appetites and grow rapidly until the plants are controlled and then their growth levels off. The amount of grass carp needed for control of submersed vegetation depends on the infestation of aquatic plants. Grass carp at the rate of 20 fish per acre are needed if at least half of the area is normally covered by vegetation. For vegetation in only a narrow belt around the edge, 5 to 10 fish per acre are sufficient. Control is achieved within one year at these stocking levels. At half these levels, control may take up to two years.

Stocking new, clear ponds and lakes at 3 to 5 grass carp per acre can prevent development of aquatic weed problems. Grass carp need to be at least 10–12 inches long to avoid predation if predatory fish such as bass are in the pond or lake. The initial stocking should be effective for at least several years since these are long-lived fish. A few replacement fish can be stocked if aquatic weed infestation increases.

Only a few problems are associated with grass carp. They do not reproduce in standing water nor do they seem to compete or interfere with the game fish. They may, however, cause some loss of clarity of the water. Clear weedy ponds when stocked with grass carp become less clear. As the grass carp eat the vegetation, the nutrients are excreted through wastes. These in turn stimulate the production of planktonic algae which decrease the clarity.

Grass carp are highly mobile and they will readily leave a pond or lake during periods of heavy flow over the spillway. Use of mesh fence across the spillway can prevent loss of these fish.

Some states have restrictions regarding the use of grass carp, but Kansas has none. Grass carp are readily available from most commercial fish growers at the current cost of about $4 to $8 per fish.

Fertilizers added to water have been used to control aquatic weeds. Fertilizers stimulate the growth of planktonic algae which in turn decreases the water clarity, and thus prevents growth of submersed vegetation. Although it appears to be a good practice it usually creates other problems. Additional nutrients may cause an increase of marginal vegetation and also filamentous algae. Increased infestation of algae and other vegetation may cause oxygen depletion as the plants die and decay. Fertilization is not recommended in Kansas since most waters in Kansas lakes and ponds contain sufficient nutrients.

Waterfowl have also been used to control aquatic plants. Ducks, geese and swans will eat aquatic vegetation. Many pond and lake owners enjoy waterfowl. However the large number of waterfowl needed for control of submersed and marginal plants results in a large amount of wastes, which fertilize the water. This often results in algae problems.

Herbicides

Herbicides may be used to control aquatic weeds but control may vary due to such factors as susceptibility of the aquatic weed(s) to the herbicide, stage of growth, rate of application; and the time of application. Some herbicides may also cause injury to fish if not applied properly. This publication provides information on alternative herbicides and their use for aquatic weed control.

Herbicides are frequently the preferred method for control of aquatic weeds in situations requiring fast results and control for several months. However, even chemical methods frequently must be combined with hand or mechanical weeding to remove remaining weeds and to prevent future spread by seed or other plant parts.

Additional information on proper use of registered herbicides for most effective aquatic pest control and least or no effect on non-target organisms or the environment can be obtained from: (1) County Extension offices, (2) Kansas Department of Wildlife and Parks, and (3) information from product labels and manufacturers of herbicides registered by the Environmental Protection Agency (EPA) for use in aquatic areas.

Herbicides and Their Use for Aquatic Plants

Improper Use

Improper application rates: Proper use of herbicides requires accurate application so that water, vegetation, or soil in an aquatic area is covered uniformly at the rate recommended on the product label. Properly functioning, accurately calibrated equipment is essential. Application of a herbicide below the rate recommended on the label can result in unsatisfactory control of target aquatic weeds. Herbicide application at a rate higher than the recommended rate for the product can result in greater residue and/or toxicity. Herbicides applied at rates exceeding the recommended rate can also create a hazard by contaminating water used for drinking, fish, livestock, other non-target organisms, irrigation, or other purposes.

Incorrect formulation: The use of an incorrect formulation can result in:

1. Use of a product that is not effective or safe.
2. Increased toxicity resulting in death or injury to fish and other non-target organisms.
3. Increased hazard to humans during application.
4. Increased hazard of injury to desirable non-target plants.

Faulty application: Faulty application can be the result of:

1. Improperly calibrated equipment.
2. Use of improper herbicide.
3. Use of improper rate of recommended formulation.
4. Application at improper stage of plant growth of target weeds.
5. Application of foliar-applied herbicides when weeds are not growing rapidly due to unfavorable growing conditions.
6. Application to plants, water, or areas not registered for treatment on product label.
7. Application during windy or other undesirable weather conditions.
8. Improper determination of volume of lake or pond to be treated.

Hazards that can result from faulty application are listed above under Improper Application Rates and Incorrect Formulations.

Proper Use of Herbicides

All chemicals used for aquatic pest control should be applied in accordance with the directions on the manufacturer's label, as registered under the Federal Insecticide, Fungicide and Rodenticide Act.

Table 1. Response of aquatic weeds to selected herbicides[1]

Classification of Aquatic Weeds	Aquatic Weed	Aquatic Herbicides (Trade Name)						
		Copper algaecides (several)	2,4-D (several)	Diquat (Reward, Weedtrine D)	Endothall (Aquathol, Hydrothol)	Fluridone (Sonar)	Fosamine (Krenite)	Glyphosate (Rodeo)
Algae	Chara	X			X [2]			
	Filamentous							
	Cladophora	X			X [2]			
	Pithophora	X			X [2]			
	Spirogyra	X			X [2]			
	Planktonic	X						
Floating Plants	Duckweed			X		X [3]		
Rooted Floating Plants	Waterlilies		X			X		X
Submersed Plants	Bladderwort		X	X		X		
	Coontail		X	X	X	X		
	Elodea			X	X [2]	X		
	Naiad			X	X	X		
	Pondweeds							
	American			X	X	X		
	Curly leaf			X	X	X		
	Horned			X	X	X		
	Leafy			X	X	X		
	Sago			X	X	X		
	Water thread			X	X	X		
	Watermilfoil		X	X	X	X		
Emersed Plants	Arrowhead		X					X
Marginal Plants	Cattails			X		X		X
	Smartweeds		X					X
	Willow		X				X	X
	Cottonwood		X				X	
	Purple Loosestrife		X					X

[1] X = Aquatic weeds controlled as shown on product labels of herbicides registered for aquatic weed control.
[2] Hydrothol formulation only.
[3] AS Formulation only.

Most herbicides have a low acute oral toxicity, but a few aquatic herbicides are poisonous to human beings, livestock, and other non-target organisms. Some herbicides are toxic to fish but most do not injure fish at concentrations required for weed control.

Proper use of herbicides will result in the most effective control of aquatic weeds and little or no effect on non-target organisms or the environment. Follow these rules:

1. Select the appropriate herbicide to control the identified target weeds. Refer to Table 1 for weed response to selected aquatic herbicides.
2. Consult with Kansas Department of Wildlife and Parks or the U.S. Fish and Wildlife Service for advice if a proposed herbicide application might endanger wildlife, fish, or their habitat.
3. Apply the herbicide in accordance with all directions, warnings, and precautions on the label. Refer to Table 2 for use restrictions of water treated with aquatic herbicides.
4. Store excess pesticides under lock and key–out of reach of children and animals–and away from food and feed.
5. Properly dispose of empty pesticide containers

Herbicides for Aquatic Use

Copper Algaecides

Copper Sulfate

Products and manufacturers: Copper Sulfate—Chem One Corp and Griffin.

Copper Sulfate use information: Do not exceed 4 ppm in potable water. Copper sulfate controls microscopic algae, single-filament algae and *Chara* (stonewort), but is not effective against submersed or emersed leafy waterweeds. Copper sulfate may be used in recommended concentrations without harm in waters for livestock and irrigation. Copper sulfate corrodes galvanized cans and most spraying equipment. Plastic sprinkling cans are convenient for applying copper sulfate.

Rate of application: Rates for algae control range from 0.67 to 5.32 pounds of copper sulfate per acre–foot of water. Four pounds of powder or crystals per acre–foot is generally strong enough to kill algae and stonewort in most waters. This concentration kills snails but does

not kill fish. In alkaline water, stronger concentrations may be necessary. Treatment is ineffective in waters with total alkalinity over 250 ppm. In moderate to high alkalinity waters (over 200 ppm), the copper chelated products are recommended. Use only 1.2 pounds of copper sulfate per acre–foot in very soft water as fish may be killed at the 4-pound rate.

How to apply: Copper sulfate is available in different crystal and granular grades depending on application needs. Crystals may be scattered by hand on the surface of small ponds or placed in a burlap bag and towed behind a boat. Crystals or powder can be dissolved in water and applied by spraying the water surface. If a heavy growth of algae is present treat only one-third or one-half of the pond at a time at weekly intervals. This prevents depleting the oxygen when the mass of dead organic matter decomposes. You may treat an isolated mass of stonewort or algae without treating the whole pond.

Caution: Residual copper is toxic to many aquatic animals. Frequent and continued use may result in the kill of a large part of the fish-food supply.

Copper Chelates

Products and manufacturer: Cutrine-Plus and Stocktrine II—Applied Biochemists, Inc. (basic producer), K-Tea and Komeen-Griffin, and others.

Herbicide use information: For use in lakes, private farm, fish and fire ponds; fish hatcheries; potable water reservoirs, irrigation systems, and stock tanks (Stocktrine). Apply to control algae including *Chara, Spirogyra,* and *Cladophora.* Chelates prevent precipitation of copper with carbonates or bicarbonates in the water. To avoid suffocation of fish due to lack of oxygen caused by decay of heavy infestations treat only 0.3 to 0.5 of the lake or pond at a time. Water treated with this product may be used for drinking, livestock watering, swimming or fishing immediately after treatment. Water treated with this product also may be used to irrigate turf, ornamental plants or crops immediately after treatment. Copper chelates may be toxic to trout and other species of fish in soft water (<50 ppm carbonate hardness).

2,4-D

2,4-D Low Volatile Ester Granules

Products and manufacturers: Aqua-Kleen—Rhone Poulenc; Navigate—Applied Biochemists, Inc.

Herbicide use Information: For use to control specified water weeds (refer to product labels) in ponds and lakes. Granules sink to bottom and release weed-killing chemical in the critical root zone area. Apply 100 to 200 pounds per acre by portable spreader or mechanical spreader. During growth season, weeds decompose in a 2- to 3-week period following treatment. Apply in spring and early summer during the time weeds start to grow. Do not apply to more than 0.3 to 0.5 of a lake or pond in any one month because of excess decaying vegetation which may deplete oxygen content of water, killing fish. Do not apply to waters used for irrigation, agricultural sprays, watering dairy animals, or domestic water supplies.

2,4-D Amine

Product and Manufacturer: Several

Herbicide use information: For use to control aquatic weeds and weeds adjacent to water. Apply for control of annual weeds, perennial weeds, and woody plants. Do not apply to more than 0.3 to 0.5 of a lake or pond in any one month because of excess decaying vegetation which may deplete oxygen content of water, killing fish. Do not apply to waters used for irrigation, agricultural sprays, watering dairy animals, or domestic water supplies.

Diquat

Products and manufacturers: Reward and Diquat—Zeneca and Weedtrine D—Applied Biochemists.

Herbicide use information: May be fatal if swallowed, inhaled or absorbed through skin. Skin contact will cause severe skin irritation. Do not get material on skin, eyes or clothing. Contact with skin may increase danger of absorption. For application only to ponds, lakes, and drainage ditches where there is little or no outflow of water and which are totally under control of product's user. Diquat is rapidly absorbed by aquatic plants and begins to work immediately upon contact. Plant tissue is destroyed, causing wilting and loss of foliage. Do not use treated water for animal consumption, spraying or irrigation for 14 days after treatment. Do not apply within 0.25 mile of any functioning potable water intake. Treatment of dense weed areas can result in oxygen loss from decomposition of dead weeds. Treat only 0.3 to 0.5 of the dense weed area at a time to avoid fish suffocation from oxygen loss and wait 10–14 days between treatments. *Do not apply to muddy water.* Apply diquat in early season to control submersed weeds before weed growth has reached surface. Diquat will control the following submersed weeds infesting still ponds, lakes and ditches: bladderwort, coontail, elodea, naiad, pondweeds, and watermilfoil. Other aquatic weeds controlled include duckweed, cattails and some filamentous algae.

Endothall

Products and manufacturers: Aquathol and Hydrothol 191—Elf Atochem

Herbicide use information: Aquathol and Hydrothol 191 are different formulations of endothall and are both available as granular or liquid formulations. Hydrothol controls most algae and submersed plants, but is toxic

to fish at dosages in excess of 0.3 ppm. Aquathol controls most submersed plants and is not toxic to fish, but does not control algae. Apply in late spring or early summer when weeds are actively growing. Do not use treated water for irrigation, agricultural sprays, livestock, or domestic purposes for at least 7 to 25 days after treatment.

Fluridone

Product and manufacturers: Sonar AS and Sonar SRP—SePRO

Sonar use information: For management of aquatic weeds in fresh water ponds, lakes, reservoirs, drainage canals and irrigation canals. Sonar is absorbed from water through leaves and shoots, and from hydrosoil by the roots. Sonar causes chlorosis at terminal bud or growing points of plant, then plants slowly deteriorate. Complete weed removal may require 30 to 90 days. Sonar AS is effective in controlling duckweed; certain emersed weeds including spatterdock and waterlily; certain submersed weeds including bladderwort, coontail, elodea, naiads, pondweeds, and watermilfoil; and certain shoreline grasses. Sonar provides partial control of certain vascular aquatic weeds including American lotus, arrowhead, cattail, rush, and smartweed. For best results, apply Sonar before initiation of weed growth or when weeds begin actively growing. **Users must consult their State Fish and Game Agency or the U.S. Fish and Wildlife Service before making applications.** Do not apply in lakes, ponds, or other bodies of water where crayfish farming is performed. There are no label restrictions against swimming or fishing in water treated with Sonar. There are no restrictions on consumption of treated water by humans, pets, and livestock.

Fosamine

Product and manufacturer: Krenite—Du Pont.

Krenite use information: For control of susceptible perennial weeds and brush species on non-cropland adjacent to and surrounding domestic water reservoirs, streams, lakes and ponds, as well as drainage ditchbanks. Krenite, a water-soluble liquid, is non-flammable and non-volatile. Brush controlled includes cottonwood and willow. Apply with surfactant and make a single foliar application during the period from July to first fall coloration. For control of only a portion of a plant, as in trimming, direct the spray to thoroughly cover only the section of the plant to be controlled. Do not apply Krenite directly to water.

Glyphosate

Product and manufacturer: Rodeo—Monsanto.

Rodeo use information: This product may be used in and around aquatic sites, including all bodies of fresh and brackish water, which may be flowing, non-flowing or transient. This includes lakes, rivers, streams, ponds, seeps, irrigation and drainage ditches, canals, reservoirs, and similar sites. There is no restriction on use of water for irrigation, recreation, or domestic purposes. Apply Rodeo plus nonionic surfactant approved for aquatic sites as directed on the label to control or partially control marginal weeds, woody brush and trees listed on the label. Aquatic plants controlled include cattails, annual and perennial smartweeds, spatterdock, and willow. Perennial plants generally are best controlled when treated during the flowering stage of growth. Do not apply this product within 0.5 mile upstream of potable water intakes, unless intake is turned off for a minimum of 48 hours after application.

Aquatic dyes

Product and manufacturer: Aquashade—Applied Biochemists.

Aquatic dye use information: These products are a mixture of blue and yellow dyes that intercept light penetration in water. Aquatic dyes do not directly control the plants through herbicidal activity, but limit growth of plants below the water surface through shading effect. Primarily for control of submersed, rooted weeds, and some algae. Should only be used in bodies of water with little or no through-flow, in order to maintain dye concentration. Products should be applied before foliage reaches the water surface. These products are nontoxic to fish, wildlife, livestock, humans, and turf. Do not use where water is used for human consumption. Safe for swimming after complete dispersal. May be undesirable to some individuals due to artificial appearance of water.

How to Calculate Area and Volume of a Body of Water

Area— Some chemicals are applied at a certain rate per surface area (square feet or acres). Area can be calculated by multiplying average length times average width. This is easy if the body of water is rectangular or oval in shape. If a more accurate estimate is desired, or if the body of water is an irregular shape, the graph paper method should be used. Length and width should be measured in several places. These measurements should then be transferred on to a sheet of graph paper according to a scale. Then the shoreline can be drawn in with the proper curvatures. The area can then be determined by counting the

Table 2. Aquatic-herbicide-treated-water use restrictions.

Herbicide	Human			Livestock		Irrigation	Agricultural Spray
	Drinking	Swimming	Fish Consumption	Dairy	Meat		
	Number of days after treatment before use[1]						
Copper Sulfate	0[2]	0	0	0	0	0	0
Copper Chelate	0[2]	0	0	0	0	0	0
2,4-D	----------(Varies with formulation. Consult the label) ----------						
Diquat	14	1	0	14	14	14	14
Endothall	7–25	1	3	7–25	0	7–25	
Fluridone	X[3]	0	0	0	0	7–30	30
Fosamine	----------(Do not apply directly to water) ----------						
Glyphosate	2	0	0	0	0	0	0
Aquatic dyes	X	0	0	0	0	0	0

[1] X = Do not use treated water for that purpose.

[2] Elemental copper concentration should not exceed 1.0 ppm if water is used for drinking.

[3] Do not apply within 0.25 mile of any functioning potable water intake.

squares and multiplying this by the scale area for each square. For example: if the scale is 1 square = 5 feet, then the area of 1 square = 5 x 5 or 25 square feet.

The area then can be expressed as square feet or acres. One acre = 43,560 square feet.

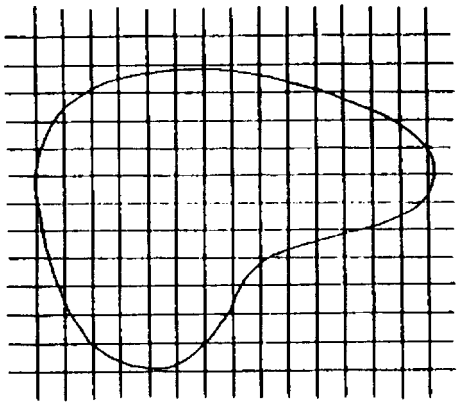
$$\text{Surface area of pond in acres} = \frac{\text{pond area in square feet}}{43{,}560}$$

Volume— Most herbicides are applied on the basis of volume as a certain number of parts per million (ppm) or as a certain amount per acre-foot (1 acre of surface water that is one foot deep). To find volume, the average depth must be determined. This is done by taking numerous evenly spaced depth measurements. The accuracy of the average depth estimate is increased as the number of depth measurements increases. Shallow measurements must also be included or the estimate will be too high. This calculated average depth is then multiplied by the surface area determined by the method described earlier. If all the measurements were made in feet, the calculated volume will be in cubic feet. This number can be used to calculate the amount of herbicide product recommended on the label. Aquatic herbicide application is often expressed on a per acre-foot basis.

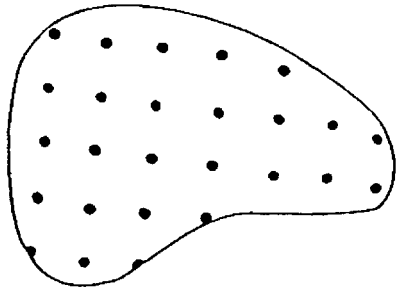
$$\text{Volume of pond in acre-feet} = \frac{\text{Pond volume in cubic feet}}{43{,}560}$$

$$= \frac{\text{Pond area in square feet} \times \text{average depth in feet}}{43{,}560}$$

$$= \text{Pond area in acres} \times \text{average depth in feet}$$



Area Determination



Depth Readings for Volume Determination

Table 3. Conversion units and equivalents

1 acre–foot = 1 acre of surface water 1 foot deep = 43,560 cubic feet of water = 2,718,144 pounds of water = 326,000 gallons of water
1 cubic foot = 7.5 gallons = 62.4 pounds of water = 28,355 grams of water
1 gallon = 8.34 pounds of water = 128 fluid ounces = 3,785 milliliters or cubic centimeters = 3,785 grams of water
1 cubic foot per second (cfs) = 7.5 gallons per second = 450 gallons per minute = 28.3 liters per second
1 quart = 946 milliliters or cubic centimeters = 946 grams of water
1 pound = 453.6 grams (454) = 16 ounces
1 ounce = 28.35 grams
1 part per million (ppm) requires— 2.7 pounds per acre foot 0.0038 grams per gallon 0.0283 grams per cubic foot 0.000062 pounds per cubic foot 1 milligram per liter

Additional Information

Additional information on aquatic plants and their control is available from the following resource personnel:

1. County Extension Agent
2. Extension Weed Specialist, Department of Agronomy, Kansas State University
3. Fisheries Biologist, Division of Biology, Kansas State University.
4. Kansas Department of Wildlife and Parks.

Dallas E. Peterson
Extension Specialist
Weed Science

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