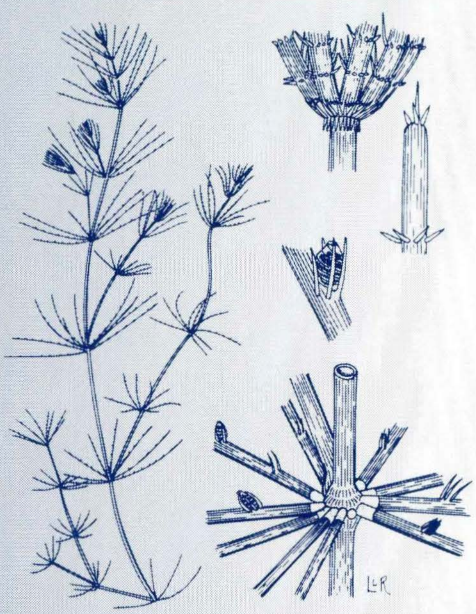
Iowa Commercial Pesticide Applicator Manual

Category

5



Aquatic Pest Control

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Iowa Commercial Pesticide Applicator Manual

Aquatic Pest Control

Category 5

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This manual is for individuals planning to become certified in commercial pesticide applicator Category 5, Aquatic Pest Control. This manual will supplement the general information in the *Iowa Core Manual* (IC-445), and should not be used for certification preparation without reference to the *Iowa Core Manual*.

Contents

Introduction

Plants are important components of the aquatic ecosystem. They provide food and shelter for a variety of wildlife and produce oxygen required for the survival of fish. However, in water where plant populations are extreme, they may restrict people's use of the water and lower water quality for fish. The amount of plant material that can be tolerated depends upon how that specific body of water is used.

This manual is intended to prepare individuals for the design and implementation of management procedures for aquatic plants that have reached undesirable levels. Pesticide applicators must have a thorough understanding of the aquatic ecosystem to avoid damaging a valuable natural resource.

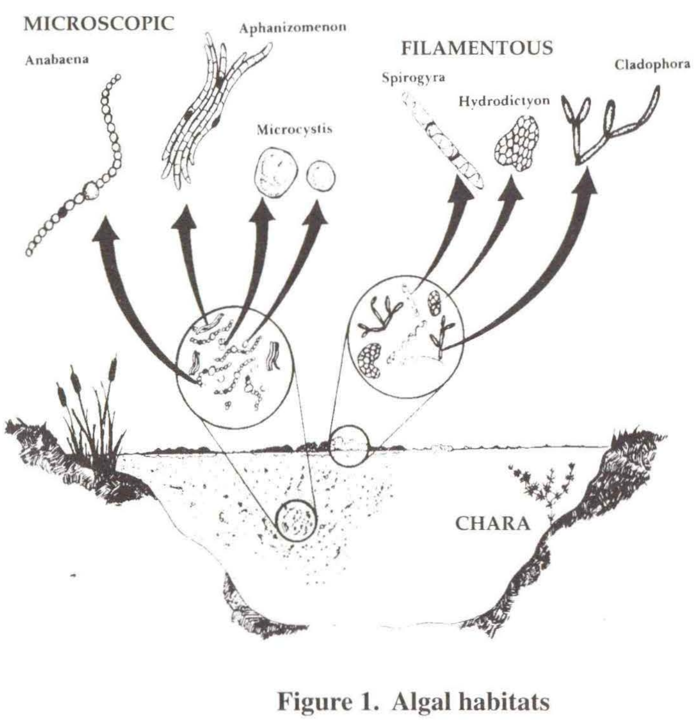

Figure 1. Algal habitats

Types of aquatic plants

Aquatic plants are grouped into four categories to facilitate their identification and to aid in the selection of appropriate control measures. These four categories are algae, submersed plants, free-floating plants, and emergent plants (Figures 1 and 2).

Algae

Algae are unicellular or multicellular plants that do not produce flowers or seeds. The three major types of algae are microscopic, filamentous, and stoneworts (*Nitella* and *Chara* spp.).

Microscopic algae are tiny plants common in almost all waters. Specific identification usually can only be done by an expert; however, exact identification often is not critical because most species of microscopic algae respond similarly to management measures. Green and blue-green algae are common microscopic algae. Although green algae generally are considered beneficial to a body of water (they produce the majority of oxygen present), occasional excessive blooms may occur that can give water a green, soupy appearance and create severe nighttime oxygen depletions and pH swings during the day. Blue-green algae often start out as gray mats on the pond bottom that come loose and float to the surface as the water temperature increases. Several species of blue-green algae may produce toxins that are harmful to animals.

Filamentous algae frequently cause problems in pond management. They normally begin growth on the pond bottom and later float to the surface, forming dense mats. These mats may hinder fish harvest and survival. As with microscopic algae, it is more important to recognize the general algal type rather than to identify a particular species. Control measures for filamentous algae will control all but a few species of these plants.

Stoneworts include species in the genera *Nitella* and *Chara*. They may be found in waters with high alkalinity. As with the other algae, large populations of stoneworts may cause aesthetic problems and reduce dissolved oxygen.

Stoneworts resemble flowering plants because they have leaflike structures arranged in a whorl around a hollow stem. Identifying these species as algae is critical in developing effective management strategies.

Submersed plants

Most submersed plants are rooted on the bottom of the water body with stems and leaves suspended below the water surface. These plants are dependent upon water for their support. Occasionally, seedheads or a few leaves are observed above the water surface. Important submersed weeds found in Iowa are the pondweeds (*Potamageton* spp.), elodea (*Elodea* spp.), coontail (*Ceratophyllum* spp.), and watermilfoil (*Myriophyllus* spp.). Correct identification is essential for successful management because susceptibility of the various species to aquatic herbicides is variable.

Free-floating plants

Certain species such as duckweed (*Lemna* spp.) and watermeal (*Wolfia* spp.) float freely, whereas others may be rooted on the bottom of the water body with their leaves floating on the water surface (rooted floating plants). Rooted floating plants include water lilies (*Nymphaea* spp.) and watershield (*Brasenia* spp.). As with the submersed plants, correct identification of free-floating plants is necessary for successful management of the weeds.

Emergent plants

Emergent plants normally grow near the shoreline with a portion of the plant extending above the water surface. Examples of emergent plants include cattails (*Typha* spp.), rushes (*Juncus* spp.), and arrowhead (*Sagittaria* spp.).

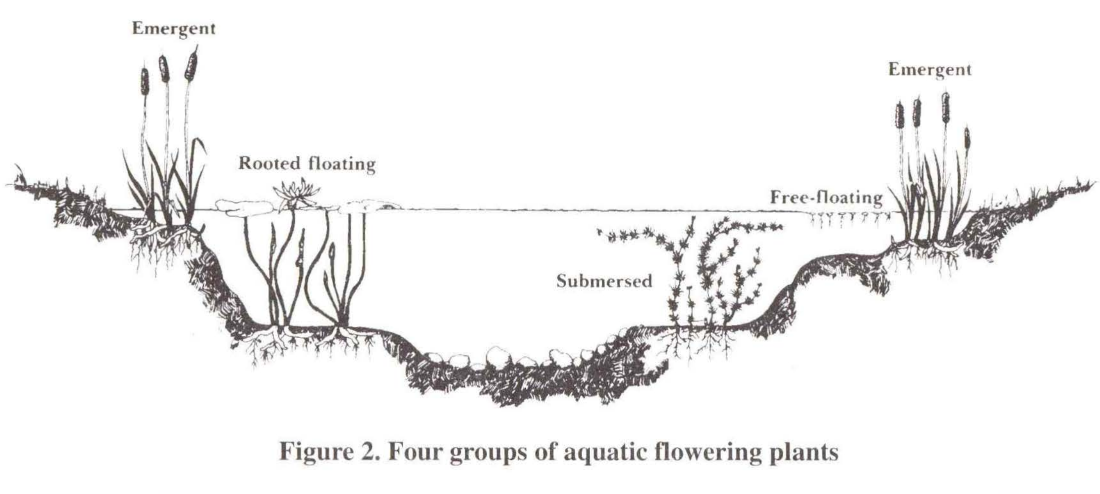

Figure 2. Four groups of aquatic flowering plants

Methods of aquatic weed control

When aquatic plants reach densities that interfere with people, wildlife, or fisheries activities, they are considered weeds. Methods of managing aquatic weeds include preventive measures, and mechanical, biological, and chemical control techniques.

Preventive measures

Preventive measures are designed to create an environment that is unfavorable for aquatic weed growth. The major cause of excessive aquatic plant growth is the movement of high levels of nutrients into the water, a process known as eutrophication. The largest source of nutrients is runoff from agricultural lands. Maintaining a sod bank around ponds can help reduce levels of nutrients entering the water. Preventing livestock access to farm ponds, whose hoofprints erode the sod bank, is critical for reducing aquatic weed problems.

Most aquatic weeds become established in water that is less than 2 feet in depth. Maintaining steep banks (at least 3:1 inside slopes) along the shoreline reduces the area in the pond that is suitable habitat for weed growth. Proper pond construction is important to reduce the habitat favorable for weeds.

Mechanical control

The use of hand rakes for removing aquatic weeds is frequently an effective means of controlling weeds in their early stages. This method of controlling submersed and emerged weeds is effective for small ponds or shoreline property. Several mechanical harvesters are available, but their cost often is prohibitive. A problem with mechanical removal is that many aquatic weeds have a large root system that is usually unaffected by mechanical procedures. In addition, many aquatic plants reproduce asexually via fragmentation and budding. Thus, aquatic plants are often only temporarily affected by mechanical harvesting techniques.

Dredging usually provides excellent results because it removes the entire plant and the nutrient-rich sediments from the bottom of the water body. Dredging also increases depth of shallow areas, which helps prevent plant reestablishment. However, costs for dredging may be substantial.

Biological control

The use of grass carp (white amur), an exotic fish from Asia, can effectively control aquatic vegetation, principally vascular plants. Algae are not the preferred food of grass carp. Stocking rates start at approximately five 6–9-inch fish per surface acre and may need to be increased in ponds that have a rich plant fauna; larger fish are needed in ponds with preexisting predators (e.g., largemouth bass). Additional fish will need to be stocked after 5 years because these fish do not reproduce in ponds.

Chemical control

The use of registered herbicides is often the most effective and economical means of controlling aquatic weeds. However, chemicals should not be substituted for sound aquatic management practices. These chemicals are safe and effective when applied according to the product label. Always carefully read and fully understand the label before purchasing and applying any pesticide. Follow these steps when using an aquatic herbicide:

(1) identification of weed,
(2) determination of surface area or water volume,
(3) consideration of uses of water area,
(4) selection of an appropriate herbicide,
(5) application of herbicide.

Failure to complete these steps properly can result in poor weed control or injury to fish, wildlife, or humans that use the water (Table 1).

Weed identification

No single herbicide is effective against all of the weed species found in aquatic systems. Thus, it is important to correctly identify the weed for selection of an appropriate herbicide. Fortunately, most algal species found in Iowa can be controlled effectively with similar herbicides. Vascular aquatic plants (submersed, free-floating, and emergent) have a wide range of susceptibility to herbicides. Contact your county extension director or other expert if you cannot identify a particular weed species.

Determining surface area and water volume

Proper calculation of the size of area to be treated is essential for effective weed control treatment. Most aquatic herbicide rates are determined by the surface area or water volume of the pond or lake. Mistakes in calculating the size of the area to be treated are common because of the irregular shape and variable depth of most water bodies. Emergent and free-floating plants usually are treated based on surface area, whereas water volume is typically used for determining the rate of herbicides for controlling algae and submersed plants.

Calculating surface area

The first step in calculating the surface area of a pond is to determine the general shape of the pond or other area to be treated. The formula used depends on the shape of the area.

Rectangular area

$$\text{acres} = \frac{\text{length (ft)} \times \text{width (ft)}}{43{,}560\ \text{ft}^2}$$

Circular area

$$\text{acres} = \frac{3.14 \times \text{radius (ft)}^2}{43{,}560\ \text{ft}^2}$$

Triangular area

$$\text{acres} = \frac{1/2\ \text{base (ft)} \times \text{height (ft)}}{43{,}560\ \text{ft}^2}$$

Note: 43,560 = number of square feet per acre

If the area to be treated is not a regular shape, divide the area into sections of standard geometric shapes, calculate the area of each section, and add them together.

If only the shoreline of a pond or lake is to be treated, it will be necessary to determine the length of the shoreline. The surface area then can be calculated by multiplying the length of the shoreline by the width of strip to be treated.

Calculating water volume

Several herbicides are applied according to water volume. To calculate volume, the applicator must determine the surface area in acres and the average depth of the pond. Water volume is calculated by multiplying surface area in acres by average depth.

In bodies of water with a uniform bottom slope, average depth can by estimated by dividing the maximum depth by two. A more accurate measurement can be obtained by taking a series of depth measurements at uniformly spaced intervals (Figure 3). Measuring can be done with a long pole, a chain, or a weighted rope marked off in feet. These values are added and the total is divided by the number of measurements to arrive at an average depth figure. For example, the average depth of a pond with depth readings of 2, 5, 8, 5, 2, and 0 ft is 22 divided by 6 or 3.66 feet.

The most common mistake that people make is that they think they know the maximum or average depth without taking measurements. Often they assume that the maximum depth is the same as when the lake or pond was first constructed. With sediment inflow and vegetation dieback over the years, however, most bodies of water gradually become shallower. For example, a pond that was 15 feet deep at the time of construction may only be 10 feet deep at the time of treatment. Using the 15-foot depth to estimate average depth would lead to an overdose of chemical, a possible fish kill, and a waste of money. Measurements always should be taken before treatment, even if the only measurement taken is maximum depth. On artificial ponds or lakes, the deepest portion is usually near the dam or outlet end.

The volume of the water is expressed in acre-feet and is calculated using the following formulas.

Acre-feet = surface area (acres) x average depth (ft)

Example: An artificial pond is roughly rectangular in outline with dimensions of 240 x 120 feet. Depth measurements taken at 20-foot intervals along two transects across the lake are 2, 3, 4, 6, 8, 9, 9, 8, 5, 3, 3, and 0 feet and 2, 4, 9, 5, 1, and 0 feet, respectively.

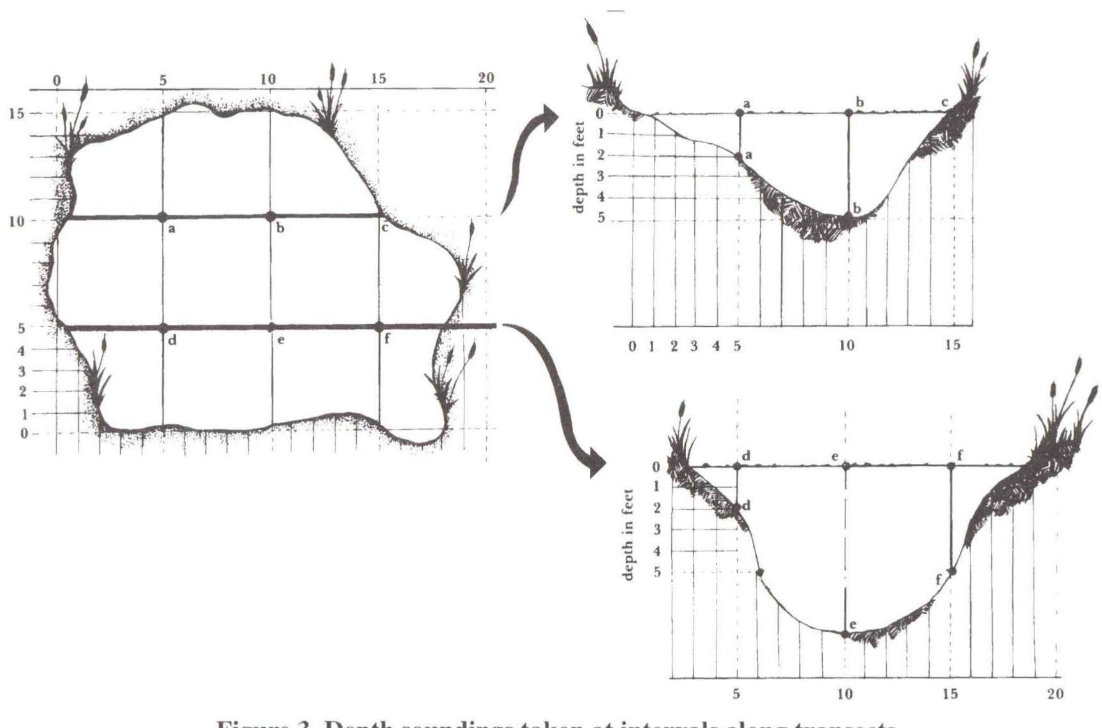

Figure 3. Depth soundings taken at intervals along transects

What is the volume of the pond in acre-feet?

Area = 240 ft x 120 ft/43,560 ft^2 = 0.66 acre

Average depth

2 + 3 + 4 + 6 + 8 + 9 + 9 + 8 + 5 + 3 + 3 + 0 = 60/12 = 5 ft

2 + 4 + 9 + 5 + 1 + 0 = 21/6 = 3.5 ft

5 ft + 3.5 ft = 8.5/2 = 4.25 ft

Volume = 0.66 acre x 4.25 ft = 2.8 acre ft

Determining dosage

The next step is to check the herbicide label for the dosage recommended for the weed species. Dosage is usually given in parts per million (ppm, or parts of active ingredient per 1,000,000 parts of water). Amounts of active ingredients in formulations are given on labels in pounds. Most labels also give dosage recommendations for spot or partial treatments.

Determining amount required

The correct amount of formulated herbicide to use per acre-foot of water to give the required parts per million is usually provided in a table on the herbicide label. The amount also can be calculated easily if the following relationship is used. Because an acre-foot of water weighs approximately 2.7 million (2,718,144) pounds, 2.7 pounds of any material dissolved in 1 acre-foot of water will equal 1 ppm by weight. Therefore,

Pounds required = 2.7 lb x ppm desired x acre-ft

Example 1. How much copper sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$) (CSP) is required to treat 2.8 acre-feet of water at a recommended dosage of 2 ppm?

Amount of CSP = 2.7 lb x 2 ppm x 2.8 acre-ft = 15.1 lb

It should be noted that dosage can be calculated on the basis of total chemical material or on the basis of active ingredients. For example, the active ingredient of CSP is copper, which represents only 25 percent of the total weight of the compound.

Example 2. If a recommendation calls for the treatment of 2.8 acre-feet with CSP of 2 ppm of copper (25 CSP is elemental copper), how much CSP is required to achieve a final concentration of 2 ppm of copper in water?

Amount of copper = 2.7 lb x 1 ppm x 2.8 acre-ft = 7.6 lb

Amount of CSP = 7.6 lb Cu/25% (or 0.25) Cu by weight = 30.4 lb

Example 3. Aquathol K liquid is labeled at a rate of 2 ppm of active ingredients for coontail control. Aquathol K contains 4.23 pounds of active ingredient (dipotassium endothall) per gallon. How many gallons of Aquathol K is required to treat 2.8 acre-feet at a rate of 2 ppm of active ingredient?

Pounds of active ingredient required = 2.7 lb x 2 ppm x 2.8 acre-ft = 15.1 lb

Gallons of Aquathol K = 15.1 lb a.i. required/4.23 lb a.i. per gal = 3.57

Water uses

Ponds and other water bodies may be used for sport fishing, fish culture, swimming, irrigation, watering livestock, and other purposes. The application of an aquatic herbicide may restrict the uses of the land or pond for a specific length of time following treatment. For example, water treated with Sonar cannot be used for irrigation for 30 days after the application. However, no restrictions are placed on fishing or swimming (4 hours after initial application) in treated areas.

Always carefully read the label for use restrictions on treated areas before applying any aquatic herbicide. If the pond is accessible to the public, post signs to alert the public of the restrictions.

Aquatic herbicides are best suited for ponds and lakes that normally have no movement of water to downstream locations. Pesticide applications to areas with a continuous water flow may result in contamination of areas downstream from the application site. Thus, the usefulness of aquatic herbicides in creeks, streams, and rivers is limited.

Herbicide selection

The most important considerations in selecting an aquatic herbicide are the species of weeds present and the uses of the water. However, other factors such as herbicide formulation, type of application equipment available, and cost need to be considered before a product is purchased. Herbicides cleared for use on aquatic weeds are listed in Table 2.

Herbicide application

Successful aquatic weed control is dependent upon selection of the correct herbicide and proper application of this chemical at the correct time and rate. Most aquatic herbicides should be applied in the spring or early summer while weeds are young and actively growing. Applications made in the late summer generally are less effective than early-season applications. Many situations require a second application of the herbicide to maintain season-long control. Algae reproduces very rapidly; thus, applications of an algicide need to be made at the first appearance of the problem.

If a pond is heavily infested with weeds, it is best to treat only 30 to 50 percent of the area at one time, waiting 2 or 3 weeks between applications. Treatment of the entire water body in a single application may result in a fish kill due to depletion of the water's oxygen supply by the resulting decomposition of aquatic plants. Applications made in the late spring while water temperatures are relatively cool reduce this risk; the cooler the water, the higher its oxygen content.

The technique used for applying aquatic herbicides depends on the type of weeds present and on the formulation of the herbicide.

Emergent weeds typically are controlled with foliar-applied herbicides. Thorough coverage of the foliage with the spray solution is critical for acceptable results. Plants generally are most susceptible to herbicides when environmental conditions (warm temperatures and adequate sunlight) are favorable for active growth.

Herbicides used to control algae must be evenly dispersed throughout the water column to achieve good control. Copper sulfate crystals may be placed in a burlap bag that is dragged behind a boat until the crystals dissolve. Alternative methods are to place the crystals in a floating structure, allowing them to slowly dissolve, or to make a concentrated copper sulfate solution that is sprayed onto the pond surface. Submersed weeds also are controlled with herbicides applied throughout the water. Most applications should be applied to the entire water body because the herbicide will be diluted if applied as a partial treatment.

Combination strategies

Maintenance of water quality is an ongoing task; a single application of a herbicide will not eliminate most weed problems. A combination of control strategies—preventative, mechanical, biological, and chemical—normally provides the best results.

The commercial applicator is responsible for proper selection and application of aquatic herbicides. The applicator must not only select an effective treatment but also one that will not cause undesirable damage to the aquatic ecosystem.

Aquatic herbicides

Copper sulfate (Bluestone, Blue Vitriol)

Copper salts are among the earliest known herbicides for both terrestrial and aquatic weed control. Copper sulfate was first used in 1904 for water treatments and today its use is widespread. It is one of the few herbicides that can be used for algal control in potable (i.e., suitable for drinking) water supplies.

Copper sulfate is strictly used for algal control; it has little or no effect on flowering plants at normal use rates. The copper is formulated as CSP. It may be used at a maximum dosage of 4 ppm of CSP (1 ppm of copper ion), but the normal rate is 1 ppm of CSP, or 2.7 pounds of CSP per acre-foot of water. There are no restrictions on the use of the water following treatment. Water can be used for drinking, swimming, or fishing immediately after treatment (Table 1), although it is desirable to wait 24 hours to let the metallic smell of the copper disappear from the water. However, sheep are noted for having a low tolerance for copper compounds and overexposure may be fatal.

The activity of copper sulfate is greatly affected by the carbonate alkalinity of the water. Copper combines with carbonates and other ions in water that has a high carbonate concentration (>250 ppm of $CaCO_3$). These copper complexes precipitate out of the water and thus prevent the copper from entering algal cells. Therefore, higher concentrations of CSP are usually necessary to control plants in hard, alkaline waters than in softer, acid waters. Precipitation explains the copper resistance sometimes observed in chara, which often grows in extremely hard, alkaline waters. In contrast, when carbonate alkalinity is low (<50 ppm of $CaCO_3$), most of the copper goes into solution in the water rather than precipitating. Although this solubility may be excellent for plant kill, fish kills also may occur (particularly among copper-sensitive species such as trout). Fortunately, the moderate amounts of alkalinity (from 50 to 250 ppm of $CaCO_3$) characteristic of many U.S. waters act to protect fish from lethal doses of copper, so that fish kills are relatively rare. Most fish kills following copper sulfate appear to result from heavy algal kill and accompanying oxygen depletion rather than from the algicide itself.

Copper sulfate is a contact herbicide, therefore, good distribution within the water where the plants are growing is essential. A standard method of applying copper sulfate is to place the crystals or granules in a burlap sack and dissolve them in the water by dragging the sack behind a boat. If free-floating mats of filamentous algae are present, powdered copper sulfate can be dissolved in water and sprayed directly on the surface mats as well as injected into the water. Copper sulfate solution is extremely corrosive to metals, thus spray equipment should be washed thoroughly after application. The least preferred application method for free-floating algae is to toss the crystals or granules into the water; with this method, the chemical sinks to the bottom rather than dispersing in the water. This type of treatment may be suitable for mats lying on the bottom and for chara control. Because light appears to enhance the activity of CSP, treatment should be made when light intensity is high.

Copper sulfate has a fairly short period of phytotoxicity. It is quickly adsorbed to soil, inorganic ions, and organic materials suspended in the water. When particles fall to the bottom sediments, the chemical is removed from the water. The rapid inactivation and the low mammalian toxicity of CSP when dissolved in water account for the lack of restrictions on water use after treatment.

Copper chelates (Cutrine-Plus)

The copper chelates (copper held in an organic molecule) are formulations that prevent copper from precipitating from the water. They should provide somewhat longer-lasting results than copper sulfate, particularly in alkaline water. Copper chelates are also slightly less toxic to fish than copper sulfate. Manufacturers of these products still caution against using them in waters of low alkalinity and in waters containing trout. Copper chelates can be formulated as liquids, granules, or powders and thus can be used in more types of application equipment than copper sulfate.

The copper chelates are used primarily for algal control, but some submersed flowering plants also are susceptible. Like copper sulfate, the copper chelates are contact materials and have no water use restrictions (Table 1) other than toxicity to trout . However, per unit of copper they are considerably more expensive than copper sulfate.

Endothall (Hydrothol, Aquathol)

Two salts of endothall are used in aquatic weed control. One is the amine salt of endothall; the other is the potassium salt. Even though the parent compound is the same, the two salt formulations differ appreciably in their control characteristics.

Fish respond differently to these two compounds. Fish are extremely sensitive to the amine salt (particularly the liquid formulation) but not to the potassium salt. The potential of the former compound to cause fish kills has greatly limited the use of an otherwise effective herbicide. When the amine salt is used, it should be applied as a partial or shoreline treatment so fish can escape to untreated water.

Both salts are contact herbicides and require reasonably good distribution to be effective. They are subject to rapid microbial breakdown and persist for only 15 to 16 days in the water. The restrictions on the use of treated water range from 24 hours for swimming to 7 to 14 days for irrigation on food crops, domestic uses, and livestock watering (Table 1). Both salts can be used in water for the immediate irrigation of turf. Both are available as a liquid or granular formulation.

Diquat (Diquat)

Optimal activity of Diquat depends on direct contact with the plant, either by complete dispersal in the water or by direct spraying on the plant.

Diquat is formulated as a bromine salt, but when added to water, Diquat dissociates to form the cation (positively charged ion). This property makes the compound extremely susceptible to adsorption to negatively charged clay and organic matter. Thus, Diquat should never be applied to water that is turbid from suspended soil particles or to plants covered with mud deposits. Diquat persists in water from 4 to 12 days. It is removed from the water by adsorption to suspended sediment and plant material, which then settles to the bottom.

Diquat is available only as a liquid. It is often used as a tank mix with the liquid forms of copper chelates and the dipotassium salt of endothall. This tank mix provides a broad spectrum of control for aquatic weeds as well as the convenience of working with liquid formulations.

2,4-D (various trade names)

In general 2,4-D is not as effective on aquatic plants as it is on terrestrial plants. An exception is the granular ester formulation 2,4-D, which is particularly effective on watermilfoil and coontail. The liquid formulations of 2,4-D are primarily limited to treatment of plants with aerial parts, for example, rooted floating plants and ditchbank growths of cattails, bulrushes (tules), and many broadleaf species. Restrictions on the compound vary, but in general, the herbicide should not be used in water intended for irrigation, domestic use, or watering dairy herds.

2,4-D is available in several formulations for aquatic use, including ester and amine salts. The liquid ester formulations, although more effective for plant kill than the amines, also are more toxic to fish and should not be used around water containing fish. The granular ester formulations are much less hazardous to fish than are the liquid ester formulations.

Glyphosate (Rodeo)

Glyphosate is labeled for control of rooted floating plants and emergent plants. Rodeo contains the same active ingredient as Roundup, but requires the addition of a surfactant to the spray solution. The surfactant found in Roundup can be toxic to fish, thus Roundup should not be used for aquatic weed control. Glyphosate moves systemically through the plant from the point of foliage contact into the root system, thus, it will not control plants that are completely submersed or have most of their foliage underwater. Extremely cool or cloudy weather following treatment may slow the activity of glyphosate. Avoid washing pesticide off sprayed foliage by spray from boats, recreational backwash, or rainfall within 6 hours of application.

Fluridone (Sonar)

Fluridone is a slow-acting herbicide, requiring between 4 and 10 weeks before a complete kill of susceptible weeds is obtained. Fluridone blocks synthesis of plant pigments, thus the growing points and new foliage of susceptible plants appear white approximately a week following exposure.

Sonar is available in a liquid or a pellet formulation. It should be applied soon after weeds initiate growth in the spring. Because fluridone is slow acting, it is important to maintain the maximum concentration in contact with weeds for as long as possible. Use of fluridone in areas with significant water flow may result in poor activity due to dilution of the herbicide.

Fluridone will control both submersed and emerged weeds, including cattails and other shoreline plants. Trees near treated water may be damaged if they have roots extending into the body of water.

Additional information

Additional information concerning aquatic herbicides may be found in the following Iowa State University Extension publications: Pm-1352a, *Managing Iowa Fisheries: Water Quality*; Pm-1352d, *Managing Iowa Fisheries: Calculations and Conversions for Fisheries*; Pm-1352i, *Managing Iowa Fisheries: Use of Copper Compounds in Aquatic Systems*; and Pm-1352j, *Managing Iowa Fisheries: Aquatic Plant Management* (source of Tables 1 and 2).

Table 1. General aquatic weed control water use restrictions[1] (number of days after treatment before use).

Common name	Human: drinking	Human: swimming	Human: fish consumption	Animal drinking: dairy	Animal drinking: livestock	Irrigation: turf	Irrigation: crops	Irrigation: agricultural sprays
copper sulfate[2]	0	0	0	0	0	0	0	0
copper complexes	0	0	0	0	0	0	0	0
2,4-D	*	*	*	*	*	*	*	*
diquat	*	*	*	*	*	*	*	*
endothall	7–14	1	3	7–14	7–14	7–14	7–14	7–14
fluridone[3]	0	0	0	0	0	30	30	30
glyphosate[4]	0	0	0	0	0	0	0	0

[1]Algal control may result in fish kill due to oxygen depletion if herbicides are applied to large areas if dissolved oxygen levels are low or if fast-acting contact herbicides are used (e.g., diquat, copper sulfate). Similar hazards exist when large masses of vascular plants or floating weeds are rapidly killed with herbicides.
[2]If water is used for drinking, the elemental copper concentration should not exceed 1.0 ppm (e.g., 4.0 ppm copper sulfate).
[3]Do not apply within 0.25 mile of any potable water intakes.
[4]Do not apply within 0.5 mile upstream of potable water intakes.
*Water restrictions vary with formulation and rate. Read the label.

Note: Labels change periodically. The end user must read the label at the time of purchase and before using the product.

Table 2. Response of common aquatic weeds to herbicides.

Aquatic group and weed	copper complexes, copper sulfate	2,4-D	diquat	endothall	fluridone	glyphosate
	Aquatic herbicides					
Algae						
planktonic	E	P	P	P	P	P
filamentous	E	P	E	G[1]	P	P
chara (musk grass, musk weed)	E	P	G	G[1]	P	P
nitella	E	P	G	G[1]	P	P
Floating Plants						
bladderwort	P	G[2]	E		E	
duckweeds	P	G[3]	G	P	E	
water hyacinth	P	E	E		P	G
watermeal	P	P	P-F		F-G	
Emergent Plants						
American lotus	P	E	P	P	F	G
arrowhead	P	E	G	G		E
buttonbush	P	E	F	P	P	G
cattails	P	G	G	P	F	E
water lily	P	E	P		E	E
maidencane	P	P	F		F	E
pickerelweed	P	G	G		P	F
pond edge annuals	P		G	P	F	E
sedges and rushes	P	F	F		P	G
slender spikerush	P		G		G	P
smartweed	P	E	F		F	E
spatterdock	P	E	P		E	G-E
watershield	P	E	P	P	G	G
water primrose	P	E	F	P	F	E
willows	P	E	F		P	E
Submersed Plants						
broadleaf water milfoil	P		E	E	E	P
coontail	P	G	E	E	E	P
elodea	P		E	F	E	P
eurasian water milfoil	P	E	E	E	E	P
fanwort	P	F	G	E	E	P
naiads	P	F	E	E	E	P
parrotfeather	P	E	E	E		F
pondweeds (*Potamogeton*)	P	P	G	E	E	P

E, excellent control; G, good control; F, fair control; P, poor control.
[1]Hydrothol formulations only.
[2]Granular 2,4-D formulations.
[3]Liquid ester formulations only.

Before Using Any Pesticide

STOP

READ THE LABEL

All pesticides can be harmful to health and environment if misused.

Read the label carefully and use only as directed.