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Southern Regional Aquaculture Center

SRAC Publication No. 360

Aquatic Weed Management

Control Methods

James L. Shelton and Tim R. Murphy *

Many different aquatic plants can be found in, on and around fish culture ponds. These plants range from microscopic organisms known as plankton algae which drift suspended in the water, to larger plants rooted in the pond bottom. Certain types of aquatic plants are essential for fish production. However, aquatic plants that interfere with commercial fish production are considered to be weeds.

Intensive fish production often involves adding large amounts of commercial feeds and inorganic fertilizers to ponds. Nutrients introduced into the water through feeds and fertilizers often create an ideal habitat for aquatic weed growth. Submersed aquatic weeds are particularly undesirable because fish harvesting seines will ride up over the weeds and allow fish to escape. Ponds with dense weed infestations can be impossible to harvest since the weight of the weeds accumulating in the seine can become too great to be pulled. Additionally, separating fish from weeds is a slow process and can severely stress the fish.

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Aquatic weeds

Aquatic plants that cause weed problems may be placed into four groups: algae, floating weeds, emersed weeds (foliage above water) and submersed weeds (majority of foliage below water) (Figure 1).

Algae are the most common group of weeds in aquaculture ponds. Shape and size vary from microscopic single- or multiple-celled plants to branched plants that resemble submersed aquatic weeds. Unlike other aquatic plants, algae do not produce flowers or seeds. Algae are divided into three groups: plankton algae, filamentous algae (pond moss) and the stoneworts (*Chara* spp. and *Nitella* spp.).

Plankton algae produce the majority of dissolved oxygen in the pond and are essential to fish survival. In the presence of sunlight, green plants release oxygen as a by-product of photosynthesis. At night, plants and other pond organisms consume oxygen. Because of this diurnal cycle, oxygen concentrations are the lowest at dawn and highest in the mid-afternoon. Cycle imbalances can lead to oxygen depletion and subsequent fish death.

In commercial fish ponds, excessive plankton algae may result from the high feeding rates necessary to produce large fish yields. In many cases, fish production rates are limited by the amount of feed that can be applied without plankton algae blooms becoming so dense that dissolved oxygen problems cannot be managed. The complexity of this cycle makes attempts to treat ponds with algicides to "thin out" excess algae growth very risky. Although spot treatments of plankton algae scums are effective,

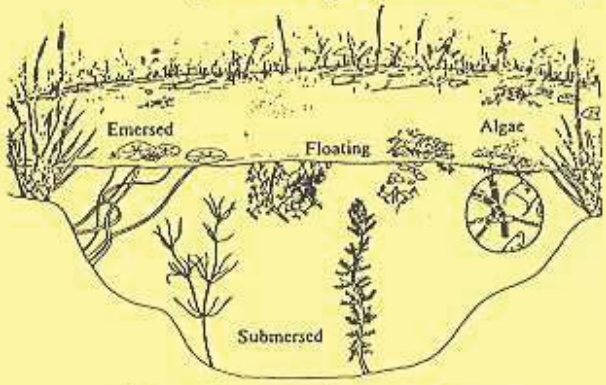

Figure 1 Aquatic Plant Groups

problems with low dissolved oxygen concentrations following algicide applications limit their use in fish culture primarily for the control of filamentous algae and stoneworts.

Certain types of algae produce compounds which cause a musty flavor or odor in fish flesh. These compounds are absorbed by the fish and can cause a highly offensive taste known as "off-flavor." This condition can be corrected within 3 to 10 days if fish are moved to water that does not contain these "off-flavor" compounds. There is no definitive evidence that thinning the plankton algae bloom with algicides reduces the incidence of "off-flavor."

Floating weeds float in or on the surface of the water and obtain their nutrients from water rather than soil. Duckweed (*Lemna minor* and *Spirodela polyrhiza*) and watermeal (*Wolffia* spp.) are examples of common floating weeds.

Emersed weeds are rooted to the bottom, but have stems, leaves and flowers which extend above the water surface. They primarily occur on the shoreline and in shallow water up to 10 feet deep. Common emersed weeds are waterlily (*Nymphaea* spp.) and alligatorweed (*Alternanthera philoxeroides*).

Submersed aquatic weeds grow under and up to the water surface. Most submersed weeds have flowers and seedheads that extend above the surface of the water. Examples of common submersed weeds include hydrilla (*Hydrilla verticillata*) and Brazilian elodea (*Egeria densa*).

Management methods

Aquatic weed control is a management plan that incorporates preventive methods such as proper pond construction and maintenance, biological methods such as the grass carp (*Ctenopharyngodon idella*) and the use of labeled aquatic herbicides. The development of an aquatic weed management plan is dependent upon correctly identifying the problem weed(s) and selecting control methods that are compatible with efficient fish culture procedures.

Basic methods used to control weeds include preventive, mechanical, biological and chemical techniques. Determining which of these techniques to use involves consideration of the target weed species, fish production objectives for the pond, secondary water uses and the cost of treatment options.

Preventive methods

It is easier and less costly to prevent weed problems than it is to control them once they develop. Careful pond site selection and proper pond construction practices are the first steps in preventing aquatic weed problems. Rooted aquatic weeds and algae usually begin growing in shallow water (< 2 feet). Edges of new and existing ponds should be deepened so shallow water areas are minimized. The USDA Soil Conservation Service provides technical assistance for pond construction and renovation.

Farm ponds are commonly fertilized to increase the fish production capacity of the pond. Fertilization is also an effective and economical way to prevent the growth of many aquatic weeds. Fertilization stimulates the growth of plankton algae. This algal growth is known as a bloom. The bloom blocks sunlight from reaching the pond bottom which limits the establishment of rooted aquatic weeds. The key to successful control of aquatic weeds with fertilization is to establish and maintain a bloom before rooted weeds begin spring growth.

Decreasing the pond water level exposes shallow areas to freezing temperatures and drying and can effectively limit certain types of submersed weeds. For a drawdown to be effective, the water level should be lowered in the late fall and not allowed to refill until the early spring. Some weeds, such as hydrilla and cattail (*Typha* spp.), are tolerant to drawdown and cannot be controlled by this method.

Biological control

The grass carp is a practical and economical way to control certain types of pond weeds. Grass carp effectively control weeds with tender succulent vegetation such as filamentous algae and duckweed, but are ineffective in controlling weeds that have tough, woody vegetation such as waterlily and cattail. Many states regulate the use of grass carp. Contact your Department of Natural Resources representaive for state regulations on the use of grass carp.

Mechanical methods

Various types of aquatic weed cutters and harvesters have been developed for canals and large reservoirs. Use of these machines is not practical in fish ponds. Early manual removal of weeds by seining or raking can prevent some weed problems.

Chemical control

Herbicides may be used to control weeds in commercial fish ponds. The first step in successful chemical control is accurate identification of the problem weed. Weed identification assistance is available through county Extension and Department of Natural Resources offices. After the weed has been identified, a herbicide that is labeled for commercial fish ponds may be selected. The herbicide label must be read and fully understood by the user prior to application to the pond. SRAC Publication No. 361, Aquatic Weed Management - Herbicides, contains information on commercial fish pond herbicides.

Integrated weed management

Herbicides should be considered as a temporary control method. Depending upon the herbicide selection and the weed species, duration of control can range from a few weeks to several months. Long-term weed control can be achieved by using a combination of recommended aquatic weed methods. For example, use of the proper herbicides followed by grass carp stocking will effectively control and prevent the reoccurrence of most submersed weed problems.

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Aquatic Weed Management

Herbicides

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Aquatic herbicides enable managers to quickly control problem weeds in commercial fish ponds. However, herbicides should be viewed as only one method that can be used for aquatic weed management. Other methods of aquatic weed control include (a) preventive methods such as proper pond site selection and construction, fertilization and drawdowns, (b) biological methods such as the grass carp (*Ctenopharyngodon idella*), and (c) mechanical methods such as seining and raking. A combination of these methods into a comprehensive plan will provide the most cost effective, environmentally safe means of aquatic weed management. SRAC Publication No. 360, Aquatic Weed Management - Control Methods, contains additional information on the various methods used to control weeds in fish ponds.

Herbicide selection

Aquatic herbicides vary in their weed control spectrum (Table 1). After the weed has been correctly identified, it is usually possible to select an appropriate herbicide. The herbicide selected must be labeled for food fish use. Most aquatic herbicides have water use restrictions that may prevent their use on a particular body of water (Table 2). Secondary water uses (i.e., swimming, livestock watering, irrigation, etc.) must be considered prior to herbicide selection and application.

Most aquatic weeds begin growth in the early spring months when water temperatures are 55° to 60° F. The spring months (March, April, May), when water temperatures are between 70° and 80° F, are an ideal time to apply herbicides to control aquatic weeds. At this time of the year weeds are small and are easier to control than during the hot summer months. Aquatic herbicides are not toxic to fish when applied according to label directions. Aquatic weeds that are killed by the herbicide undergo decomposition. The decomposition process consumes oxygen and can reduce the amount of oxygen available. If the oxygen level drops below the necessary level, fish kills due to oxygen depletion can occur. Treating only portions of the pond will minimize the risk of oxygen depletion problems due to weed decomposition. Fish should be observed for 1 week after treatment. Emergency aeration equipment should be available if oxygen depletion problems occur.

Treating the pond with herbicides during the hot summer months is risky. Oxygen levels tend to be lower at this time, and weed biomass levels tend to be higher. Treating only 1/4 to 1/3 of the total surface acreage of a pond at one time will minimize the risk of herbicide-induced oxygen depletion problems. However, in ponds with very low oxygen levels, even partial pond treatments with herbicides may be risky during the hot summer months.

Application methods

The application method is dependent upon the herbicide formulation and the target weed species. Many herbicides may be applied directly from the container (ready for use) while others need to be diluted with water before application.

Treatment of large areas requires the use of mechanical sprayers or spreaders and a power boat to ensure adequate distribution of the chemical. Sprayable herbicide formulations can be applied with hand-held or mechanical pressurized sprayers or a boat bailer. Injecting the chemical near the outboard motor propwash will aid in dispersion. Hand-operated or mechanical rotary spreaders can be used to

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Table 1. Response of common aquatic weeds to herbicides.

Aquatic group and weed	Aquatic Herbicides						
	copper complexes copper sulfate	2,4-D	diquat	endothall	fluridone	simazine	glyphosate
Algae							
planktonic	E					E	
filamentous	E		F	G[1]		E	
chara	E		G	G[1]		E	
nitella	E		G	G[1]		E	
Floating Weeds							
bladderwort			E		E		
duckweeds		G[2]	G		E	E	
water hyacinth		E	E				G
Emersed							
alders		E	F				E
alligatorweed					G		E
American lotus		E			F		G
arrowhead		E	G	G			E
buttonbush		E	F				G
cattails		G	G		F		E
fragrant & white waterlily		E			E		E
frogbit		E	E				
maidencane			F		F		E
pickerelweed		G					F
pond edge annuals					E		E
sedges & rushes		F	F				G
slender spikerush			G		G		
smartweed		E			F		E
spatterdock		E			E		G-E
southern watergrass					G		
torpedograss							G
watershield		E			G		G
water pennywort		G	G				G
water primrose		E	F		F		E
willows		E	F				E
Submersed Weeds							
broadleaf water milfoil			E	E	E	E	
coontail		G	E	E	E	E	
egeria			G	F	E		
elodea			E	F	E		
eurasian water- milfoil		E	E	E	E	G	
fanwort				E	E	G	
hydrilla	F		G	G	E		
naiads			E	E	E	E	
parrotfeather		E	E	E			
pondweeds (Potamogeton)			G	E	E	E	

E = excellent control; G = good control; F = fair control.

[1]Hydrothol formulations only.

[2]Ester formulations only.

Table 2. Aquatic Weed Control Water Use Restrictions[1] (Number of days after treatment before use).

	Human			Animal Drinking		Irrigation		Agricultural
Common Name	Drinking	Swimming	Fish Consumption	Dairy	Livestock	Turf	Crops	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	14	1	0	14	14	14	14	14
endothall	7-25	1	3	7-25	7-25	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
simazine	365	4hr	0	365	365	365	365	365

[1] Algae control may result in a fish kill due to oxygen depletion if herbicides are applied to large areas, or when dissolved oxygen levels are low, or if fast-acting contact herbicides are used (diquat, copper sulfate, etc). 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 (i.e., 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.

apply granular or pelleted formulations. Soluble crystals (copper sulfate) may be placed in burlap bags and dragged or suspended in the water until they dissolve.

Add surfactants according to individual product label directions. Surfactants enhance the spreading, wetting and penetration characteristics of selected foliar-applied herbicides (e.g., diquat, glyphosate). Use of surfactants is not recommended for submersed weed control treatments.

Herbicide dosage calculations

Aquatic herbicides are applied at labeled rates. Applying an excessive rate of a herbicide **does not** increase the level of weed control but does increase the cost of the treatment and may increase the risk of injury to fish. Conversely, applying less than the recommended rate usually does not control the weed.

In order to apply the recommended rate, the size and often the average water depth of the water body must be determined prior to herbicide application. Depending upon the chemical, herbicides are applied as a surface acre, bottom acre-foot or total water volume treatment.

Surface acre treatments:

The amount of herbicide needed for a surface acre treatment may be determined by the following formula:

$F = A \times R$

F = Amount of formulated herbicide product

A = Area of the water surface in acres

R = Recommended rate of product per surface acre

Acre-foot treatments:

Many aquatic herbicides list their application rates in terms of amount of product per acre-foot of water. An acre-foot of water is defined as one surface acre of water that is 1 foot deep. The number of acre-feet of water can be found by multiplying the number of surface acres times the average water depth. The amount of herbicide needed for an acre-foot treatment may be determined by the following formula:

$F = A \times D \times R$

F = Amount of formulated herbicide product

A = Area of water surface in acres

D = Average depth of water body in feet

R = Recommended rate of product per acre-foot

PPM treatments:

The treatment rate of certain aquatic herbicides may be listed as the final concentration of the chemical in the water body on a part per million weight (ppmw) basis. The amount of herbicide needed for a ppmw treatment may be determined by the following formula:

$F = (A \times D \times CF \times ECC) \div I$

F = Amount of formulated herbicide product

A = Area of the water surface in acres

D = Average depth of the water body in feet

CF = 2.72 lbs /acre-foot. The conversion factor (CF) when total water volume is expressed on an acre-foot basis.

2.72 lbs of a herbicide per acre-foot of water is equal to 1 ppmw.

ECC = Effective chemical concentration of the active ingredient of a herbicide needed in water to control the weed.

I = The total amount of active ingredient divided by the total amount of active and inert ingredients.

For liquid products I = pounds of active ingredient ÷ one gallon

For dry products I = percent active ingredient ÷ 100%

Aquatic herbicides

The herbicides discussed in this section are labeled for use in commercial fish production ponds. The herbicide label should be read and fully understood prior to pond application.

Copper sulfate
(Various trade names)

Copper sulfate is primarily used to control algae. It is a contact herbicide and quickly kills sensitive algal species. Copper can interfere with gill function and if improperly used can be toxic to fish. The majority of fish kills due to copper sulfate treatment are primarily caused by a massive algae kill and subsequent oxygen depletion problems.

The effectiveness and safety of copper sulfate is determined by alkalinity and water temperature. In waters with an alkalinity $\leq$ 50 ppm, the rate of copper sulfate needed to control algae can be toxic to fish. Treatment at water alkalinities of $\leq$ 20 ppm is extremely risky. In high alkalinity ($\geq$ 250 ppm) waters, copper sulfate quickly precipitates out and is not effective for algae control. The toxicity of copper sulfate to fish increases as water temperature increases. Avoid copper sulfate applications during hot summer months.

Chelated Copper
(Komeen, K-Tea, others)

Copper that is held in an organic complex is known as chelated copper. Chelated copper formulations do not readily precipitate in high alkalinity waters, but stay in solution and remain active longer than copper sulfate. Chelated copper is less corrosive to application equipment than copper sulfate. Due to its enhanced solubility, chelated copper is generally used at rates slightly lower than copper sulfate. Chelated copper formulations are slightly less toxic to fish than copper sulfate. However, in waters with low alkalinity ($\leq$ 20 ppm), or in water with an alkalinity of $\leq$ 50 ppm that contains trout, chelated copper use is extremely risky, particularly during the hot summer months.

Diquat
(Weedtrine-D, Diquat, Herbicide-H/A)

Diquat is a contact herbicide that can be used as a "pour-in" treatment for submersed weed and filamentous algae control or as a foliar application for duckweed (Lemna minor and Spirodela polyrhiza) control. An approved nonionic surfactant is required when diquat is used as a foliar application. Diquat is tightly bound to clay micelles and is not effective for weed control in muddy water. Diquat quickly kills plants and should be used as a partial pond treatment for dense vegetation.

Endothall
(Aquathol, Hydrothol)

Two salts of endothall are used for aquatic weed control. A dipotassium salt is available as a granular or liquid formulation by the trade name of Aquathol. Hydrothol is available as a liquid or granular formulation and is a mono-(N,N-dimethyl-alkylamine) salt of endothall. Aquathol and Hydrothol vary considerably in their safety to fish and weed control spectrum. Hydrothol is more toxic to fish so consequently, Aquathol is generally used in commercial ponds. Hydrothol controls algae (filamentous and stoneworts) and many submersed weeds. Aquathol controls many submersed weeds but is not effective for algae control. Both Aquathol and Hydrothol are contact herbicides and may be used on a spot or partial pond treatment basis.

Fluridone
(Sonar)

Fluridone controls most submersed and emersed weeds and is available as a liquid or pelleted formulation. Liquid formulations may also be used to control duckweed. Fluridone is a translocated herbicide that slowly kills plants over a 30- to 90-day period. The slow action of fluridone generally prevents the occurrence of weed decomposition- induced oxygen problems. Fluridone is not effective as a spot treatment. The entire pond must be treated to control the target weed species.

Glyphosate
(Rodeo, Pondmaster)

Glyphosate is a foliar applied, translocated herbicide that is used to control most shoreline vegetation and several emersed weeds such as spatterdock (Nuphar luteum) and alligatorweed (Alternanthera philoxeroides). Glyphosate translocates from the treated foliage to underground storage organs such as rhizomes. Applications at the flowering or fruiting stage of perennial plants are generally more effective than earlier applications due to better translocation to underground plant parts. An approved nonionic surfactant should be used with glyphosate (Rodeo formulations only). Rainfall occuring within 6 hours of application will reduce the effectiveness of glyphosate.

Simazine
(Aquazine)

Simazine is a translocated herbicide that is used to control algae (all types), duckweed, watermeal (Wolffia spp.) and most submersed weeds. Simazine has only minimal activity on emersed weeds. Simazine is available as wettable powder (WP) and water dispersible granule (WDG) formulations. Simazine can be applied by making a slurry in a small amount of water and dispensing the slurry at several locations in the pond. Simazine will become distributed throughout the body of water thus eliminating the need for a uniform application. Partial pond or spot treatments of simazine are not effective due to its propensity to spread throughout the entire water body. Fish ponds treated with simazine have shown reduced planktonic algae populations for an extended period after treatment. Consequently, oxygen concentrations tend to be low and feed conversion rates increase. Due to its extended persistence, using simazine to decrease or "thin" planktonic algae blooms is extremely risky.

2,4-D
(Various trade names)

2,4-D is a translocated herbicide that is available as a granular or liquid formulation. Granular 2,4-D controls submersed weeds such as coontail (Ceratophyllum demersum) and emersed weeds such as waterlily (Nymphaea spp.). Liquid formulations of 2,4-D are used to control floating weeds such as water hyacinth (Eichhornia crassipes) and several emersed weeds. 2,4-D is available as an ester or amine formulation, which is slightly better for aquatic applications. However the liquid ester formulation is more toxic to fish than the amine. The granular ester form is safer to use in aquatic applications. There are numerous uses for 2,4-D, but only those labeled for aquaculture use are legal.

The information and suggestions included in this publication reflect the opinions of Extension fisheries specialists based on field tests and use experience. Our management suggestions are a product of research and are believed to be reliable. However, it is impossible to eliminate all risk. Conditions or circumstances which are unforeseen or unexpected may lead to less than satisfactory results even when those suggestions are used. The Cooperative Agricultural Extension Service will not assume responsibility for such occurrences. Such risk shall be assumed by the USER of this publication.

Suggested herbicides must be registered and labeled for use by the Environmental Protection Agency and the Department of Agriculture. The status of herbicide label clearances is subject to change and may have changed since this publication was printed. County Extension agents and appropriate specialists are advised of changes as they occur.

The USER is always responsible for the effects of herbicide residues on livestock and crops, as well as problems that could arise from drift or movement of the herbicide from his property to that of others. Always read and follow carefully the instructions on the container label.

The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Cooperative Extension Service is implied.

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