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Methods for Controlling Aquatic Weeds *in* Fish Ponds *with* Emphasis *on* Use *of* Chemicals

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THE PRESENCE of aquatic plant growths in ponds, lakes, streams, and irrigation channels presents problems for persons using such bodies of water. Principal water uses at present include fish production, domestic and industrial water supplies, irrigation, stock watering, water-fowl habitat, and recreation. Obnoxious aquatic growths common to various waters and interfering with one or more of these uses come from the following groups: Plankton algae, filamentous algae, submerged rooted plants, emergent rooted plants, marginal rooted plants, and floating types of plants.

There have been and possibly still are those who advocate the need for aquatic weed growth in ponds, lakes, and streams. Some of the proposed advantages of aquatic weed growth in bodies of water are summarized by Hotchkiss (14), and included the following: (1) production of oxygen for use by the fishes; (2) additional space for attachment as well as food for aquatic invertebrate animals, which in turn serve as food for fishes; (3) shade for fishes; (4) hiding space for small fishes; (5) precipitation of colloidal clays and other suspended matter; and (6) beautification of ponds, lakes, and streams.

If new ponds are properly constructed and managed, problems of controlling water weeds are greatly reduced. Construction features, described by Lawrence (15), include deepening the pond edge to ensure minimum water depth of 18 inches, and building up and sodding the pond bank. Pond management practices include proper fertilization of the pond as recommended by Swingle and Smith (33). An efficient fertilization method utilizing platforms was described by Lawrence (16). It is becoming more evident each year that proper fertilization is essential for weed control and maximum fish production. Certainly, an economical weed control program must include adequate fertilization.

These practices are not followed in unmanaged ponds, and often well-managed ponds show some weed growth. This necessitates control measures to eliminate water weeds. The methods of control currently in use are either biological, mechanical, or chemical. Oftentimes all three are necessary for desired results. Summaries covering various aspects of these control methods have been given by Speirs (29), Surber (32), Crafts (7), and Stephens (30).

This report summarizes in tabular form by plant groups all pertinent information concerning control methods used for the more objectionable water weeds, with major emphasis on their application to fish ponds. Also included are summaries of toxic effects of chemicals on fish as well as on higher animal forms.

TABLE 1. BIOLOGICAL METHODS FOR CONTROL OF AQUATIC WEEDS IN PONDS

Biological method	Groups of plants responding to biological control				
	Filamentous algae	Submerged weeds	Emergent weeds	Marginal weeds	Floating weeds
Phytoplankton induced by fertilization	O	X	X	O	O
Crayfish	X	X	X	O	O
Ducks	O	O	O	O	X(?)
Geese	O	O	O	O	X(?)
Herbivorous fishes	X	X	X[1]	X[1]	X[1]

[1]No such species are known in the United States at present.

TABLE 2. MECHANICAL METHODS FOR TEMPORARY CONTROL OF AQUATIC WEEDS IN PONDS

Mechanical method	Groups of plants responding to mechanical control				
	Filamentous algae	Submerged weeds	Emergent weeds	Marginal weeds	Floating weeds
Draining and drying pond bottom	O	X	X	X	X
Draining plus burning	O	X	X	X	X
Draining plus discing	X	X	X	X	X
Draining, discing, and planting to dry land grain crop	X	X	X	X	X
Cutting and/or chaining	O	X	X	X	X
Raking	X	X	X	X	X
Seining	X	O	O	O	X
Digging out	O	O	O	X	O
Beating	X	O	O	O	O
Grazing	O	O	O	X	O
Mechanical agitation of pond bottom	X	X	X	O	O
Shading induced by:					
Dyes	X	X	X	O	O
Suspended clay colloids	X	X	X	O	O
Humic acids	X	X	X	O	O

TABLE 3. TOXICITY OF SELECTED ALGACIDES AND AQUATIC HERBICIDES TO FISH AND WARM-BLOODED ANIMALS

Chemicals	Concentration "safe" to fish	LD_{50} rats,[1]	Effects when included in diet[1]
	p.p.m.	*mg/kg*	
Copper sulphate	0.5 - 2.0	300	Less than 100 p.p.m. in drinking water safe for cattle. One gm. daily before toxicity becomes evident in larger animals.
2,4-D esters	3 - 5	500 (acid)	20 mg/kg daily toxic to dogs.
Oktone	1.9		
Roccal	1.9	234	0.25 per cent daily to rats and 0.12 per cent daily to dogs, no harmful effects.
Sodium arsenite	< 18	13	0.2 gm. lethal to man, 30 to 60 grains lethal to cow.
TCA	< 50	3,370	0.3 per cent daily for 4 months to rats, no mortality.
2,4,5-T	3	300 (acid)	10 mg/kg daily not lethal to dogs.
Amino triazole	1,470	14,700 - 25,000	100 mg/kg daily for 2 weeks depressed thyroid function in rats, but they recovered.
Ammate	10	3,900	0.5 pound in 5 days to sheep, no harmful effects.
Baron	5	1,000 - 3,500	
Dalapon	3,000	6,590 - 8,120	1 gm/kg daily for 10 days to cattle, no serious effects.
Delrad	0.5	850	33 p.p.m. in drinking water for 8 weeks to cattle, no effects.
Kuron (Silvex)	3	650	100 mg/kg daily for 15 days to steers, no effects.
Borascu (borax)	130 - 200	5,330	15 to 30 gm. lethal to man.
CMU	< 1.2	3,500	500 mg/kg daily for 10 days to rats, lost weight but no deaths.
Ferbam	0.5	4,000	0.1 per cent to rats for 30 days, no deaths.
2 methyl-4-chloro-phenoxyacetic acid	< 35	28 (lethal)	
Orthodichlorobenzene	< 3		1 to 3 gm. lethal to man.
Phygon XL	0.05 - 0.6	1,300	1,580 p.p.m. daily to rats for 2 years, no effects.
Potassium permanganate	3 - 5	500	
Tributyl phosphate	5	3,000	

< = Concentration less than.
[1] Information from selected references.

TABLE 4. HERBICIDE DILUTION TABLE

Per cent active ingredient	Units per 5 gallon mixture			Units per 100 gallon mixture					
	Concentration of mixture, per cent			Concentration of mixture, per cent					
	0.1	0.25	0.5	0.1		0.25		0.5	
	Pt. or lb.	*Pt. or lb.*	*Pt. or lb.*	*Qt.*	*Lb.*	*Qt.*	*Lb.*	*Qt.*	*Lb.*
20	0.20	0.50	1.00	2.00	4.00	5.0	10.0	10.0	20
40	0.10	0.25	0.50	1.00	2.00	2.5	5.0	5.0	10
60	0.07	0.17	0.34	0.75	1.25	2.0	3.4	3.8	7
80	0.05	0.12	0.25	0.50	1.00	1.3	2.5	2.5	5
100	0.04	0.10	0.20	0.40	0.80	1.0	2.0	2.0	4

Total pounds per acre of herbicide at recommended 200 gallon rate: 0.1 per cent solution, 1.6 pounds; 0.25 per cent solution, 4 pounds; 0.5 per cent solution, 8 pounds.
Liquid measures based on gallon weighing 8 pounds.

TABLE 5. CHEMICAL REQUIRED PER ACRE-FOOT TO GIVE A DEFINITE CONCENTRATION IN POND WATER

Per cent active ingredient	Amount per acre-foot for different concentration			
	0.2 p.p.m.	0.5 p.p.m.	1.0 p.p.m.	4.0 p.p.m.
	Lb.	*Lb.*	*Lb.*	*Lb.*
25	2.2	5.5	10.8	43.2
50	1.1	2.8	5.4	21.6
75	0.7	1.8	3.6	14.4
100	0.5	1.3	2.7	10.8

TABLE 6. CONCENTRATIONS OF SELECTED CHEMICALS THAT HAVE SHOWN PROMISING HERBICIDAL ACTIVITY ON AQUATIC PLANTS

CHEMICALS Note: Those in capital letters are recommended; those in caps and small caps are safe for use in ponds. Insufficient data available to evaluate others listed.	Effective treatment concentration in p.p.m. active ingredient[1]																		Effective spray concentration in per cent active ingredient[2]																							
	Plankton algae				Filamentous algae						Submerged weeds								Emergent weeds						Marginal weeds														Floating weeds			
	Microcystis	Anabaena	Oscillatoria		Spirogyra	Oedogonium	Pithophora	Hydrodictyon	Chara		Najas	Elodea	Coontail	Milfoil	Bladderwort	Potamogetons	Parrots feather		Water lilies	Lotus	Spatterdock	Watershield	Pennywort		Primrose willow	Sedges	Smartweeds	Cattails	Arrowhead	Pickerel weed	Bulrush	Spike rush	Knot grass	Southern water-grass	Needle rush		Duckweeds	Water hyacinth	
COPPER SULPHATE	.1-.5	.1-1.0			.1-1.0	.5-1.0		.33	.5-1.0																															
2,4-D ESTER[3] (BUTYL)											10[4]	5[4]				10[4]			.5	.5	.5	.5	.5		.5	.5	.25	.5	.25	.1	.5	.5	.5	.5	.5		.5	.05	
2,4-D ESTER[3] (ISOPROPYL)											10[4]					10[4]	1		.5	.5	.5	.5	.5		.5	.5	.25	.5	.25	.25	.5	.5	.5	.5	.5		.5	.05	
OKTONE[5]																																					.7		
ROCCAL					.2	.2	.5																																
SODIUM ARSENITE						4	4	4			4	4	2	4	4	2	4																						
TCA											10[4]					10[4]																								
2,4,5-T[3]												10[4]	3[4]			10[4]			.5	.5	.5	.5	.5			.3	.3	.3	.3	.1	.3	.3	.5	.5	.5		.5		
AMINO TRIAZOLE																			1.2			1.2					.6	.6			1.0	.5							
AMMATE																				5	5				5	5		5	5					5			5		
BARON (ERBON)[3]																									1.2	.7	.7	.7		.7	.7								
DALAPON																										.6	1.2				1.0	.6		1.0					
DELRAD	.3	.3			.3	.3	.4	.4	.4																														
KURAMINE[3]																										.7		.7	.7			.6							
KURON[3]																												.7			.7								
Benoclor 3C	2	2																																					
Borascu							12				350-650	350-650				350-650																							
Diuron	2						1.2				1.2					10												1.0			1.0	1.0							
Fermate					.5	.5	3																																
2 methyl-4-chlorophenoxyacetic acid												10				10																							
Monuron																10																						10	
Orthodichlorobenzene													10																								4		
Phygon XL	.01	.01			.15			.15						.7																									
Potassium permanganate													20			20																							

[1] One p.p.m. is 2.7 pounds per acre-foot. One acre-foot is 1 acre of water 1 foot deep.
[2] Spray rates are based on an application of 200 gallons of a given concentration per acre.
[3] For best results these chemicals should be mixed with diesel fuel. Such diesel fuel spray solutions may impart flavors to fish for 4 to 6 weeks after application.
[4] These concentrations are not recommended for use in ponds since they will kill fish as well as plants.
[5] This chemical must be applied in diesel fuel, with high pressure equipment, at rate not to exceed 20 gallons per acre.

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