

AQUATIC HERBICIDES

Using registered herbicides for aquatic plant control is a widely employed technique for both private and public waters. Treatments can be applied with a 1-gallon pump sprayer for a spot treatment, a helicopter or airboat for a whole lake treatment, or anything in-between. Treatment objectives could be the control of a single invasive plant species or a broad spectrum control of numerous species.

All herbicides listed have undergone EPA review and are approved for aquatic use in Arkansas, when used in accordance to the instructions included on the label. There are approximately 300 herbicides registered in the U.S., but only 16 of these are labeled for aquatic use.

Like all pesticides, herbicides have three names: a trade name, a common name and a chemical name. An example of this is the common herbicide Rodeo. Rodeo is the trade name, the common name is glyphosate and the chemical name is N-(phosphono-methyl) glycine, isopropylamine salt. In this publication, the common name will be used the majority of time.

All herbicides come with a label. Included on the label is the product form and instructions for safe handling and effective use. It cannot be stressed too strongly that the label is the law, and not using herbicides according to the labeled directions can have legal ramifications for the applicator.

Often included is a listing of species that are controlled by the chemical and sometimes the extent of the control. If the target species is not included on a particular label, the herbicide may still be used as long as the herbicide is labeled for use at the desired site of application, though effectiveness may be unknown.

Herbicide Types

Herbicides can be classified in several ways. One way is by their activity in the plant: systemic or contact. This classification refers to whether or not the herbicide is translocated, or moves within the plant. Whether the herbicide moves within a plant or not has implications on its effectiveness, application and how quickly it acts upon the plant.

Contact herbicides do not move and will cause death to only those parts of the plant they contact. Contact herbicides also tend to cause more rapid injury to treated plants, but require more complete spray coverage of all plant tissue during application. If a contact herbicide is used on submersed plants,

the chemical must remain in the treatment area long enough for the entire plant to be exposed to a lethal concentration. Since contact herbicides tend to cause rapid plant death, in areas with dense plant populations and warm water, the decomposing plant tissue can lead to a low dissolved oxygen fish kill. Care must be taken to treat only 33-50% of a pond or have supplemental aeration available.

Systemic herbicides are mobile in plant tissue and move through the plant's vascular tissue to their action site. This gives them the ability to affect all parts of the plant, not just those parts they contact. One implication is effects on the plant take longer to become apparent. Additionally, complete plant coverage may not be necessary to attain control. Finally, with correct timing, some herbicides will be stored within the plant's root tissues. The following season, as sugars move upward in the plant, the herbicide moves with it, leading to a second season of activity.

Adjuvants

Herbicides that are applied as a foliar treatment will include a recommendation to include an adjuvant. The two most common are a crop oil and some kind of nonionic surfactant. While different in chemistry, they serve the same function. Both of these reduce the surface tension of the herbicide solution and increase the herbicide coverage and penetration into plant stems and leaves. A third type of adjuvant often used in

Contact Herbicides	Systemic Herbicides
Copper and Copper products	2,4-D
Diquat*	Glyphosate
Endothall*	Fluridone
Carfentrazone	Triclopyr
Sodium Carbonate Peroxyhydrate	Imazapyr
Flumioxazin	Imazamox
	Penoxsulam
	Bispyribac Sodium
	Topramezone
	Florpyrauxifen

*Systemic herbicide that acts like a contact herbicide.

aquatic plant control acts as a "sinker" when added to a spray solution. When the solution is sprayed onto the water surface, the "sinker" will help carry the herbicide down through the water column, into the weeds growing on the pond bottom.

Why Treatments Fail

Oftentimes a herbicide treatment for a submersed plant will not have the desired results. Sometimes this results from inaccurate plant identification, leading to incorrect herbicide selection. Another cause is using the herbicide under sub-optimal conditions. For example, selecting diquat for a submersed plant in a muddy pond. Diquat binds with suspended particles, rendering it inactive. Water temperature can also affect effectiveness. As a general rule, most herbicides shouldn't be used when the water temperature is below 50-60°F. While still growing, reduced plant metabolism may prevent sufficient herbicide uptake.

However, the most common reason is some form of dilution. Every plant and herbicide has a unique concentration and exposure time relationship. If the exposure time is reduced or the concentration is lower than required, the treatment results will be suboptimal. Exposure time can be shortened by increased degradation due to bacteria, sunlight, high pH or a water current carrying the herbicide away, to list some examples. Inaccurately estimating a pond's volume can also reduce the herbicides' target concentration. The end result of these things is that plants are not exposed to a concentration of herbicide sufficient to lead to plant control. Please take the time to carefully read the label and correctly estimate the water body's size and conditions prior to an herbicide application.

Further Information

Like most weed control, the sooner the nuisance plants are treated, the better the results. With few exceptions, most aquatic plants start actively growing when water temperatures reach 50-60 F, and their growth increases with increasing temperatures until they begin die back or senesce in the fall. Also take into account the time a selected herbicide takes to reach maximum effectiveness. Consult the label for further information. Another source of relevant information is extension publications MP556 Aquatic Vegetation Control in Arkansas which can be found at <https://www.uaex.edu/MP556.pdf>.

WEED RESPONSE RATINGS FOR AQUATIC HERBICIDES¹

Aquatic Weed Group	Copper Sulfate and Copper Complexes	2,4-D	Diquat	Endothal	Fluridone	Glyphosate	Triclopyr	Imazapyr	Imazamox	Carfentrazone	Penoxsulam	Sodium Carbonate Peroxyhydrate	Flumioxazin	Bispyribac Sodium	Topramezone	Florpyrauxifen	Grass Carp
Algae																	
Planktonic	E	P	P	G	P	P	P	P				G-E					
Filamentous	E ²	P	G	P-G ³	P	P	P	P				G-E	G-E				F-P
Chara	E	P	P-G	P-G ³	P	P	P	P									E
Nitella	E	P	P-G	P-G ³	P	P	P	P									G
Free Floating Weeds																	
Bladderwort	P	P-G ⁴	E	F	G			G-E			G		G		G		E-G
Duckweed	P	F	G	P	E			G		G-E	E		E	E			P-F
Watermeal	P	P	F		G	P	P	P		G	G		E	E			
Azolla	P	F	G		G-E	F				E	E		E	E		G-E	P-F
Water hyacinth	P	E	E		P	F	E	E	E	G-E	E			E	E	G-E	P
Rooted Floating Weeds																	
American lotus	P	E	P	P	F	G	E	G	G						G	G-E	P
Water lily (fragrant and white)	P	E	P	P	E	E	E	E	G								P
Spatterdock	P	E	P	P	E	G		G									P
Watershield	P	E	P		G	G		E	G	G						G-E	F-P
Emerged Weeds																	
Alligator weed	P	F	P	P	G	E	E	E	G	G	G		E	E		G-E	P
Arrowhead	P	E	G	G		P		E	E		G				E		F-P
Buttonbush	P	E	F	P	P	G	G	G									
Cattails	P	G	G	P	F	E	P	E	E								
Common reed	P	F	F	P	F	E	G	E									
Ducksalad	P	E	G	P		E		E	G-E								P
Frogbit	P	E	E					E	E	G	E		E				P
Maidencane	P	P	F		F	E	P	E									F-P
Pickeralweed	P	G	G			P	E	E	E		G						P
Pond edge annuals	P		G		E	E		E									
Sedges and rushes	P	F	F	P		G	P	E									P
Slender spikerush	P		G		G	P	P	E			G					G-E	
Smartweed	P	G	F		F	E	E	E	E		G						P
Water pennywort	P	G	G	P	P	G	E	E			E		E	E		G-E	F-P
Water primrose	P	E	F-G		F	E	E	E	E	G			G-E			G-E	P
Willows	P	E	F	P	P	E	E	E									

¹ E = excellent control, G = good control, F = fair control, P = poor control.

² For Pithophora, only F-G control.

³ Hydrothol formulation only.

⁴ Granular 2,4-D formulation.

⁵ Copper complexes only (ex. Komeen, Captain, K-Tea).

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WEED RESPONSE RATINGS FOR AQUATIC HERBICIDES¹ [cont.]

Aquatic Weed Group	Copper Sulfate and Copper Complexes	2,4-D	Diquat	Endothal	Fluridone	Glyphosate	Triclopyr	Imazapyr	Imazamox	Carfentrazone	Penoxsulam	Sodium Carbonate Peroxyhydrate	Flumioxazin	Bispyribac Sodium	Topramezone	Florpyrauxifen	Grass Carp
Submersed Weeds																	
Coontail	P	G	E	E	E	P							E			G-E	G-F
Egeria	P-G ⁵	P	G	G	E	P		P			E						E
Elodea	P-G ⁵	G	E	F	E	P		P			E		E				E
Fanwort	P	F	G	E	E	P		P					E				E
Hydrilla	P-E ⁵	P	G	G	E	P		P	G		E		E	E	E	E	E
Naiads	P	F	E	E	E	P		P			G		E		G		E
Parrotfeather	P	E	E	E	E	F	F	G (when emerged)	G	E	G		E	E		G-E	F-P
Pondweeds	P-G ⁵	P	G	E	E	P		F	E		E		E	E	E		G-P
Water milfoil (broadleaf)	P		E	E	E	P	G	P	G	G	E						P
Water milfoil (Eurasian)	P	E	E	E	E	P	G	P	G	G-E	E		E	E	G		F-P

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GRASS CARP FOR AQUATIC WEED CONTROL

Grass carp (*Ctenopharyngodon idella*), or white amur, is a member of the minnow family native to Asia. They feed almost exclusively on aquatic plants. Their short digestive tract requires grass carp to feed almost continuously when water temperatures are above 68°F, which means they can eat two to three times their body weight each day. This makes them an excellent biological control of certain nuisance aquatic plants.

Grass carp are capable of fast growth and may gain 5 to 10 pounds per year, reaching their final size of 20 to 30 pounds within a few years, and can live for 10 to 15 years. Unfortunately, when they reach maturity, their rate of weed consumption declines, and restocking of additional fish is required every 3 to 5 years.

Grass carp have definite preferences of the type of vegetation they consume. They prefer tender, succulent vegetation that is under water. This makes them best suited for submerged vegetation, and they will not generally control tough, fibrous plants that grow up out of the water. The extent to which they are able to control a particular weed depends upon many factors, including their feeding preferences, the aquatic plant density, water temperature and the number and size of grass carp stocked. As more preferred vegetation becomes scarce, grass carp will eat less preferred types of

vegetation. Water chemistry can affect weed palatability. Grass carp will consume floating fish food as well as aquatic plants.

Grass carp are readily available in Arkansas, and the *Sport Fish Supplier List* provides a listing of the fish farms that sell grass carp. This publication is available at the county office or online at http://www.uapb.edu/sites/www/Uploads/SAFHS/sportsfish_suppliers.pdf. Unlike many states, Arkansas permits the stocking of either diploid (normal) or triploid (sterile) grass carp in ponds and lakes. Because grass carp require flowing water to reproduce, stocking fertile grass carp in your pond will not result in more grass carp. New ponds can be stocked with 2- to 6-inch grass carp, but if largemouth bass are present, the grass carp stocked should be 8 to 10 inches in length. The stocking rates can vary depending on the amount of weeds. A standard recommendation is 5 to 10 per acre, but if the pond has plant coverage of greater than 50 percent, a stocking rate of 20 or more per acre may be required.

As a biological control agent, they will not provide immediate results. Assuming the target plant is readily consumed by grass carp, 1 to 2 years are required for control. If the pond/lake owner wants quicker results, applying an

aquatic herbicide followed by stocking grass carp 2 to 3 weeks later may be the best solution. Stocking should take place after much of the dead plant material has had a chance to decompose.

Grass carp are natural inhabitants of rivers and readily escape ponds that overflow. Barriers on spillways are a good idea to prevent fish losses. Ponds with grass carp often develop a green or yellow color as grass carp promote greater phytoplankton growth in the water by the release of nutrients from the plants they eat.

After the grass carp reach maturity, the pond/lake owner may want to remove them. These large fish can be removed by snagging, bow fishing, spearing or angling. Their habit of hanging near the surface can make bow fishing especially simple. Because of their jumping ability, seining is often not effective. Their flesh is white, firm and not oily, but the muscle mass contains “Y” bones that can make cleaning more difficult. Their flesh is considered a delicacy by many seafood enthusiasts.

For more information, ask your county extension agent for Southern Regional Aquaculture Center (SRAC) Fact Sheet #3600, *Using Grass Carp in Aquaculture and Private Impoundments*, or it can be downloaded from <https://srac.tamu.edu/serveFactSheet/160>.

GOLDFISH (*CARASSIUS AURATUS*) FOR WATERMEAL AND DUCKWEED

Duckweed (*Lemna* spp.) and Watermeal (*Wolffia* spp.) are free-floating aquatic plants commonly found together. Watermeal is the smallest and simplest of flowering plants. It is rootless and tiny, usually less than 1 mm, and appears as little green pinheads floating on the surface. To the touch, it feels somewhat like dry grits. Duckweed is a little bigger but still very small, usually 1/8 to 1/4 of an inch across. The fronds tend to be elliptical, and a small root is present on the lower surface of each frond.

The growth of these plants is linked to high nutrient levels, which is why they are common in cattle ponds. Both of these plants tend to grow in dense colonies in quiet waters.

Individual plants stick readily to birds, animals and equipment that may be in ponds that have these plants. As a result, they spread easily from one pond to another. Once in a new pond, their growth can be quite explosive if the conditions are right. Both species can reproduce by budding and, in some cases, double their population every 24 hours.

Both watermeal and duckweed tend to disappear from the pond surface in the late fall. During the summer, the plants have buoyancy due to trapped oxygen from photosynthesis. In the fall, photosynthesis slows down, leading to less oxygen in the plant, and the accumulated starch from a season of growth

makes the plant heavier, so it sinks to the sediments. In the spring, the plants start photosynthesizing, accumulate oxygen and float to the surface again.

Under certain conditions, goldfish can provide a biological control option for watermeal. It is recommended that they be stocked into small ponds at a rate of 35 to 65 pounds per acre. Like any biological control, results take time and are not universal. In ponds where goldfish failed to control watermeal, it may have been due to predation from largemouth bass or some other factor. Stocking them is fairly inexpensive and will cause no harm, but success is not guaranteed.

AQUATIC DYES

Aquatic dyes are made from EPA registered non-toxic dyes (typically blue), that might control unwanted filamentous algae and submersed plants in natural and man-made lakes and ponds. They do not kill plants; they prevent growth by blocking light penetration, which reduces photosynthesis. They are less effective when plant growth is near the surface (2 ft or less). Aquatic dyes should only be applied to water bodies entirely within the control of the applicator, and only those with little or no outflow. If water is continuously released from the pond/lake, product is wasted and their effectiveness reduced. The effects on an aquatic dye typically last for up to 6 weeks.

Dye should be applied in the early spring before weed growth begins, or applied when weeds may be seen on the bottom of the pond. When applied to ice, it will melt a hole and disperse underneath. Additional applications will be necessary throughout the year to maintain an acceptable level of dye in the water. These dyes may be used at any time of the year.

Do not apply to water that will be used for human consumption. Water may be used for swimming after complete dispersal of the dye in water. Dyes are non-toxic to livestock.

At present, while there are many aquatic dye formulations available for purchase, only two dyes, Aquashade and Admiral, are registered with the EPA for aquatic plant control. As such, they are the only two that can make control claims. For the liquid formulations, the rate is typically 1 ppm, or one gallon/acre*ft. To restrict hydrilla growth, the rate should be doubled, due to its ability to grow at very low light levels. See label for rates.

**USE RESTRICTIONS FOR AQUATIC HERBICIDES
(Number of Days After Treatment and Before Use)**

Chemical	Active Ingredient Formulation	Withdrawal PPM	Drinking	Swimming	Eating Fish	Dairy	Other Stock	Withdrawal Crop Irrigation
Copper	Copper Sulfate Crystals, Copper Sulfate Solution, Copper Complexes		0	0	0	0	0	0
2,4-D	Amine, Ester, Acid formulation		(*a)	0	0	0	0	(*b)
Diquat			1-5 (*c)	0	0	1	1	5
Endothall	Dipotassium Salt		(*d)	0	0	7-25 (*e)	7-25 (*e)	0
Endothall	Mono (N,N-dimethylalkylamine) Salt		(*d)	0	0	7-25 (*e)	7-25 (*e)	0
Fluridone		0.15	0 (*f)	0	0	0	0	7-30 (*g)
Glyphosate		0.7	2 (*h)	0	0	0	0	0
Imazapyr			(*i)	0	0	0	0	120 or (*j)
Triclopyr			(*k)	0	0	0	0	120 or (*l)
Imazamox			(*m)	0	0	0	0	*n
Carfentrazone			0-1 (*o) (*m)	0	0	0-1 (*o)	0-1 (*o)	0-14 (*o)
Penoxsulam			0	0	0	0	0	(*p)
Sodium Carbonate Peroxyhydrate			0	0	0	0	0	0
Flumioxazin			0	0	0 (*q)	0	0	0-5 (*r)
Bispyribac-sodium			0	0	0 (*q)	(*s)	(*s)	(*s)
Topramezone			(*t)	0	0	0	0	(*u)
Florpyrauxifen			0	0	0	(*v)	(*v)	(*w)

- (*a) Read the label. Restrictions will vary based upon formulation.
- (*b) Read the label. Restrictions will be determined by rate, crop to be irrigated, intake setbacks, and may require an Assay.
- (*c) Withdrawal period will be determined by rate and formulation. An Assay may be required.
- (*d) Restrictions are to ensure treated water exceeding Maximum Concentration Level (MCL) of less than 0.1 ppm. 600 foot setback from potable water intake in Lakes, Ponds and Quiescent Water bodies. For flowing water bodies, if intakes can be closed, they must remain closed until tested levels are below 0.1 ppm. If intakes can't be closed, the application must be below intake.
- (*e) Withdrawal period is based upon application rate. If water is flowing, the water can be used immediately.
- (*f) Do not apply within ¼ mile of water intake at rates above 20 ppb.
- (*g) Withdrawal period may depend upon crop to be irrigated and soil type. FasTEST assay may be required prior to use as irrigation.
- (*h) Can't be applied within ½ mile upstream of active potable water intake. Water intakes must remain off for 48 hours if application made within ½ mile of intake, unless assay determines glyphosate level below 0.7 ppm.
- (*i) not apply within ½ mile of active potable water intake.
- (*j) Application to water used for irrigation that results in residues > 1.0 ppb must not be used for 120 days or until residue level is 1.0 ppb or less.

- (*k) Potable water intakes must be turned off till triclopyr levels are determined to be 0.4 ppm or less.
- (*l) Until residue is 1.0 ppb or less by assay.
- (*m) May be applied to potable water at concentrations up to 500 ppb to within ¼ mile of active intake. Within ¼ mile, water concentrations can't exceed 50 ppb.
- (*n) Restrictions based upon crop or location to be irrigated and rate used.
- (*o) Read label. Restrictions based upon surface area treated. Do not apply within ¼ mile of potable water intake. Water intake may be turned back on less than 24 hours if assay shows carfentrazone-ethyl and degradate levels are below 0.2 ppm.
- (*p) Treated water cannot be used for crop irrigation until below assay shows levels below 1 ppb, or 30 ppb if used to irrigate rice.
- (*q) Do not use for water applied to crayfish ponds
- (*r) Read label. Restriction determined by rate, water depth, and what is to be irrigated.
- (*s) Assay indicating concentration of less than or equal to 1ppb (30 ppb for St. Augustine grass).
- (*t) Application concentrations must be below 45 ppb.
- (*u) Residue concentration assay must be below 1 ppb.
- (*v) Do not allow livestock to drink treated water.
- (*w) Read label. Do not use for irrigation. For non-agricultural irrigation, waiting period depends upon treated water body area and rate.

USE OF COPPER SULFATE IN PONDS WITH FISH

Copper sulfate is a contact herbicide recommended for algae control. If improperly used, copper can be toxic to fish by interfering with gill function. Trout and koi are particularly sensitive to copper. However, most fish kills associated with copper sulfate treatments are related to oxygen depletions due to the decomposition of dead plant material or a massive phytoplankton kill.

The effectiveness and safety of copper sulfate treatments are mostly determined by water alkalinity. In water with an alkalinity below 40 ppm (mg/l), the amount of copper sulfate needed to control algae can be toxic to fish. Copper sulfate treatments at water alkalinities below 20 ppm are extremely risky and should be avoided. Low alkalinity water is considered “soft” water and can be very common in Arkansas fish ponds, especially watershed

ponds. In high alkalinity water (>250-300 ppm), copper sulfate quickly binds with carbonate and forms a precipitate that is not effective for algae control.

The toxicity of copper sulfate to fish also increases as water temperatures increase. It is best to try and avoid copper sulfate treatments during the summer months. In most cases, treat only one-third to one-half of the pond at a time.

To calculate a copper sulfate treatment, you will need to know your pond's alkalinity, surface area and depth. A good starting “Recommended Dose Rate” for copper sulfate is typically 0.5 to 1.0 ppm. To calculate a pond's volume, multiply the acreage by the average depth.

In suitable water, the effective copper sulfate dosage can be

calculated using the following formula:

$$\text{Maximum Safe Dose in ppm} = \text{Total Alkalinity (ppm)} / 100$$

$$\text{Amount copper sulfate needed (lb) = Max Safe Dose x Recommended Dose Rate (ppm) x Volume (in acre*ft) x 2.72}$$

To make a copper sulfate solution, mix 1½ lb of copper sulfate crystals with 1 gal of water.

For water testing and further recommendations, contact your county extension office or one of the UAPB Aquaculture/Fisheries extension specialists. The algaecides listed in the copper complexes section are formulated for safe use in ponds with soft water.

HERBICIDES APPROVED FOR AQUATIC USE

Below is a listing of herbicides currently approved for aquatic use by the Arkansas State Plant Board. This list may not be complete. Copies of all current labels can be downloaded from the Arkansas State Plant Board website at <https://aad-web-ser.agri.arkansas.gov/>.

Chemical	Active Ingredient Formulation	Trade Name(s) (list may be incomplete)
Copper	Copper Sulfate Crystals & Granules	AB Brand Copper Sulfate Crystals, Copper Sulfate Crystal Chem One Ltd., Quimag, Quimicos Aguila Copper Sulfate Crystals, Old Bridge Copper Sulfate Fine, Gordon's Pond Master Copper Sulfate Crystals, Crystal Blue Copper Sulfate Smart Crystals, Aqua Vet SeClear G, SePro Total Pond - Clear G
Copper	Copper Sulfate Solution	SCI-62 Algicide/Bactericide, Formula F-30 Algal Control, Agritec, Earthtec, Aqua Hawk Cu, Pond Champs Algae X Algaecide/Herbicide, Crystal Plex Algae Control, SeClear Algaecide, Gordon's Pond Master SeClear Algaecide & Water Quality Enhancer, Current, Aqua Vet Algae Control, Liquid Copper Sulfate by Brenntag, Brandt T.A.C., SePro Total Pond Clear, Main Stream 635
Copper	Copper Complexes (Copper Ethanolamin, Copper Carbonate, etc.)	Captain Liquid Copper Algaecide, Nautique Aquatic Herbicide, Captain XTR, Harpoon Aquatic Herbicide, Harpoon Granular Aquatic Herbicide, Alligare Argos, Komeen Crystal, Cutrine Plus Algaecide, Clearigate EC9 Algaecide/Herbicide/Cyanobactericide, Algimycin PWF, Stocktrine II Algaecide, Algi-Cure Algaecide, Clearigate, Gordon's Pond Master Aquatic Herbicide, K-Tea Algaecide, Komeen, Algae Defense, Alligare 8% Copper, Pond Oasis Algaecide, SePro Total Pond Rescue
2,4-D		AgriStar 2,4-D Amine Herbicide, Alligare 2,4-D Amine, Navigate, DMA 4 IVM, Helena 2,4-D Amine 4, Opti-Amine, Unison, WeedRhap A-4D, Hardball, Loveland Amine 4 2,4-D Weed Killer, Savage, Clean Amine, WeeDestroy AM-40 Amine Salt, UAP Timberland Platoon, Riverdale Solution Water Soluble, NuFarm Weeder 64, Sculpin G, Tenkoz Amine 4 2,4-D Herbicide, Hi-Yield 2,4-D Amine No. 4, Compare-N-Save 2,4-D 2,4-D Amine Salt, Defy Amine 4, Rugged Herbicide, Shredder Amine 4, GF-2654, Drexel De-Amine 4, Havoc Amine, United Suppliers 2,4-D Amine 4, Hardball Elite, Martin's 2,4-D Amine, Renovate MAX G Aquatic Herbicide (w/triclopyr), Aquasweep (w/triclopyr), Depth Charge (w/flumioxazin), Chinook (w/endothall)
Diquat dibromide		Aceto Diquat 2L Landscape & Aquatic Herbicide, Alligare Diquat, Weedtrine-D Aquatic Herbicide, Harvester Landscape and Aquatic Herbicide, NuFarm Diquat SPC 2L, Solera Diquat Landscape & Aquatic Herbicide, Reward Landscape and Aquatic, Eliminator, Tsunami DQ, Littora, Tribune Herbicide, RowRunner ATO, Liberator 711, AquaVet Landscape and Aquatic Herbicide, Ultra Pond Defense, Pond Oasis Aquatic Plant Control, Verdure-X-Herbicide, SePro Total Pond- React, Diborx Herbicide, DESSICASH L&A Landscape and Aquatic Herbicide, Quick Kill, AquaStrike (w/endothall)
Endothall	Dipotassium Salt of Endothall	Aquathol K, Aquathol Super K, Cascade Aquatic Herbicide, Aquastrike (w/diquat), Chinook (w/2,4-D)
Endothall	Mono(N,N-dimethylalkylamine) salt of endothall	Hydrothol 191 Aquatic, Hydrothol 191 Granular, Teton Aquatic Herbicide
Fluridone		Avast! SC, Sonar A.S., Sonar PR Precision Release, Sonar Q, SonarOne, Sonar RTU, Alligare Fluridone, Sonar Genesis, Alligare Fluridone RTU, Alligare Fluridone Granule, Sonar H4C Aquatic Herbicide, SePro Total Pond-Prevent, Spritflo Herbicide, Pond Logic Wipeout Pondweed Defense Aquatic Herbicide, Airmax Wipeout Pondweed Defense Aquatic Herbicide
Glyphosate		Aqua Star, Alligare Glyphosate 5.4, Shore-Klear Aquatic Herbicide, ShoreKlear-Plus Aquatic Herbicide, Rodeo, Cinco, AquaNeat Aquatic Herbicide, Gordon's Pro T&O Products GlyphoMate 41, Gordon's Pondmaster Surf & Shoreline Herbicide, Catt Plex Cattail Control, AquaPro, Tomahawk 5, Hi-Yield Killzall Aquatic Herbicide, Round Up Custom for Aquatic & Terrestrial Use, Drexel Imitator Aquatic Herbicide, Enforcer Weed Defeat, AquaVet Shoreline Weeds, Shoreline Defense, Buccaneer 5 Extra Herbicide, Pond Oasis Shoreline Plant Control, SePro Total Pond-Emerge, Farmworks Aquatic Herbicide, Foresters' Non-Selective Herbicide
Triclopyr		Alligare Triclopyr 3, Element 3A, Garlon 3A, Trycera, Platform, Tahoe 3A Herbicide, Renovate 3, Renovate OTF, Navitrol Landscape and Aquatic Herbicide, Navitrol DPF Aquatic, Agristar Triclopyr 3A, Aquasweep (w/2,4-D), Renovate MAX G Aquatic Herbicide (w/2,4-D)
Imazapyr		Alligare Imazapyr 2 SL, Alligare Ecomazapyr 2 SL, Arsenal Herbicide, Arsenal Applicators Concentrate, Habitat Herbicide - SePro, Habitat, Herbicide - BASF, NuFarm Polaris AC Complete Herbicide

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HERBICIDES APPROVED FOR AQUATIC USE [cont.]

Chemical	Active Ingredient Formulation	Trade Name(s) (list may be incomplete)
Imazamox		Clearcast, C, Alligare IMOX, Imazacast
Carfentrazone		Stingray
Penoxsulam		Galleon SC
Sodium Carbonate Peroxyhydrate		Ecoblast Contact Granular Algaecide, Green Clean Granular Algaecide, Phycomycin-SCP Algaecide/Cyanobacteriacide, Phycomycin SCP Algaecide and Oxidizer, Algae Remover, GreenClean Pro, PAK27 Algaecide, Algae Off Granular Herbicide
Flumioxazin		Clipper SC, Flumigard SC, Flumioxazin 51% WDG Herbicide - Noncrop, Pond-Klear, Semera 51% WDG Herbicide, Flumioxazin 51WDG Select, Alligare Flumigard SC, Depth Charge (w/2,4-D),
Bispyribac Sodium		Tradewind
Topramezone		Oasis
Florpyrauxifen		ProcellaCor SC
Aquatic Dyes		Admiral Liquid, Admiral WSP, SePRo Blue, Gordon's Pondmaster Blue, Aquashade, Aquashadow, others

APPLICATION NOTES

Active Ingredient	Rate	Application and Notes
Copper Sulfate Crystals	<p><u>Algae</u> Blue-Green, Filamentous and Planktonic 0.25-2ppm</p> <p>Chara, Nitella 1.5-2.0 ppm</p> <p><u>Submersed Weeds</u> 0.25-0.5ppm</p>	<ul style="list-style-type: none"> • Copper is toxic to fish. Please refer to "Use of Copper Sulfate in Ponds with Fish" in this section for more details and correct dose calculation. • If water alkalinity is above 250 ppm, use results will be unsatisfactory. The free copper ions precipitate before they can be effective. • Use can lead to dissolved oxygen problems when applied to ponds with water temperatures above 85°F. • To make a copper sulfate solution, mix 1½ lb of copper sulfate crystals with 1 gal of water. • For filamentous algae, copper can be tank mixed with diquat. • For submersed weeds, it can be tank mixed with endothall, diquat or fluridone.
Copper Sulfate Solution	See label.	<ul style="list-style-type: none"> • Copper solutions can be tank mixed with diquat, endothall and copper complexes. • See previous warning about copper toxicity to fish.
Copper Complexes	See label.	<ul style="list-style-type: none"> • Generally safe for use in soft water ponds. • If treated water is potable, rate cannot exceed 1 ppm. • Can be tank mixed with diquat and endothall. • Some formulations are labeled for hydrilla.
2,4-D	<p>Various and numerous. Formulations can be liquid or granular; ester, amine or acid. This impacts the amount of active ingredient that is applied and application method used.</p>	<ul style="list-style-type: none"> • Growth essential for uptake. • Please consult label thoroughly due to numerous formulations. • Due to local restrictions, use of 2,4-D may be prohibited at certain times of the year. • Plant roots absorb salt forms more readily than esters. • Esters more readily penetrate foliage. <p><u>Foliar</u></p> <ul style="list-style-type: none"> • Rate depends on species and water depth of emergent plant. • Apply early in season when weeds are small and growing actively before the bud stage. • Apply when biennial and perennial species are in the seedling stage and before flower stalks appear. • For liquid formulations, thorough wetting of foliage is essential for maximum control. • A pH above 8 reduces effectiveness. • Do not treat more than one-half pond at a time. • Do not apply within 600 to 2,400 feet of a potable water intake, depending on treatment rate. • 2,4-D may be more effective if applied after dark. <p><u>Submersed</u></p> <ul style="list-style-type: none"> • pH higher than 8 reduces effectiveness. • Do not treat more than one-half pond at a time. • Do not apply within 600 to 2,400 feet of a potable water intake, depending on treatment rate. • 4-hour contact time. • Low light intensity reduces ability of submersed plants to recover. • Can apply when water temperature is above 50°F if target plants are actively growing.

APPLICATION NOTES [cont.]

Active Ingredient	Rate	Application and Notes
Diquat dibromide	2-4 lb ai/acre (foliar) (ai = active ingredient) 0.09-0.37 ppm 0.25-1 lb ai/acre*ft (submersed)	<ul style="list-style-type: none"> • Rapid wilting, often within several hours. • Plant must be actively growing for uptake. <ul style="list-style-type: none"> – Use whenever plant is growing, even in winter. <p>Foliar</p> <ul style="list-style-type: none"> • For spot treatment, apply a 0.5% solution with approved adjuvant at 0.25-1%. • For broadcast treatment, apply at labeled rate with sufficient carrier (water), and approved adjuvant, to ensure sufficient plant coverage. • For best results, apply before flowering (cattail). • Repeat treatments may be necessary. • Diquat becomes rainfast (won't wash off) in 1 to 2 hours. • For floating and emergent plants, diquat requires a 30-minute contact time with foliage to be effective. • Do not tank mix with penoxsulam. <p>Submersed</p> <ul style="list-style-type: none"> • Treat only one-third to one-half of pond at one time to avoid oxygen depletion due to decomposing vegetation. • Wait 14 days between treatments. • Application to muddy/turbid water may reduce effectiveness. • For submersed plants, faster acting when combined with copper or endothall. • Water half-life < 48 hours. • Diquat is rapidly absorbed by submersed leaves but still requires a 24-hour contact time to be effective. Do not apply to flowing water. • Low light intensity reduces ability of submersed plants to recover. • Labels have rates as gallons per surface acre, assuming a 4-foot average pond depth.
Endothall (Dipotassium Salt)	0.5-5 ppm (concentration) 1.3-13.5 lb ai/acre*ft	<ul style="list-style-type: none"> • If plant infestation is heavy, treat sections 5 to 7 days apart. • Not for use in brackish or salt water. • Up to 24-hour exposure needed. • Active growth needed for plant uptake. <ul style="list-style-type: none"> – Late winter/early spring. • Rapid breakdown of product occurs at temperatures > 80°F, reducing effectiveness.
Endothall (Mono(N, N-dimethylalkylamine) Salt)	0.05-1.5 ppm (algae) 0.5-3 ppm 1.4-8 lb ai/acre*ft (submersed)	<ul style="list-style-type: none"> • May be mixed with copper sulfate, 1 gallon plus 5 pounds per surface acre. • Toxic to fish at rates higher than 0.3 ppm. Generally rates of 0.05-0.3 ppm are effective. • If rates higher than 0.3 ppm, should be applied by commercial applicator only. • Do not treat more than one-tenth of pond or lake with doses in excess of 1 ppm. • Up to 24-hour exposure needed. • Active growth needed for plant uptake. <ul style="list-style-type: none"> – Late winter/early spring. • Rapid breakdown of product occurs at temperatures > 80°F.
Fluridone	10-90 ppb (see label)	<ul style="list-style-type: none"> • Good to excellent control of duckweed, salvinia and bladderwort. • Poor control of water hyacinth and water lettuce. • Use "Lake" rate for water bodies over 5 surface acres. • Do not apply as a spot treatment. • Needs minimum of 45 days of contact. • May require 30 to 90 days to achieve weed control. • May be mixed with other herbicides and algaecides. • Greater potential for crop injury if treated water is applied to crops grown on low organic and sandy soil. • Thirty days may be insufficient restriction if pond water will be used to irrigate sensitive crops, such as tomatoes or peppers. • Absorbed from water by shoots and from hydrosol by roots. • Can be applied to water surface or subsurface. • Broken down by sunlight. • No issues related to pH, alkalinity.

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APPLICATION NOTES [cont.]

Active Ingredient	Rate	Application and Notes
Glyphosate	Up to 3 lb ai/acre	<ul style="list-style-type: none"> • Nonselective. • For foliar application only. • Use of nonionic surfactant is recommended or required, depending on formulation, read label (2 or more quarts/100 gallons water). • If applying by boat, take care to not create waves that may wash the herbicide off floating leaves. • Rainfall within 6 hours may reduce effectiveness. • Will not work in water. • No root absorption. • Vegetation must be on or above the surface for treatment to be effective.
Imazapyr	0.25-0.75 lb ai/acre (foliar)	<ul style="list-style-type: none"> • Mix with 100 gallons water to insure complete coverage. • Will not control plants completely or mostly submerged. • Treat one-half of pond surface area or less in a single operation. Do not exceed 6 pints/acre (1.5 ppb ai/acre). • Do not use on food crops. • Do not apply within one-half mile upstream of active potable water intake. • Rapid foliage absorption (< 24 hours), root absorption too. • Adjuvant can be nonionic surfactant, methylated seed oil or silicone based surfactant based on weed to be controlled. • Plant needs to be actively growing. • Will not work on submersed vegetation. • Can be mixed with glyphosate. • Do not mix with diquat or 2,4-D. • Not temperature or light sensitive. • Can be selectively used when nontarget plants are dormant.
Triclopyr	1.5-6 lb ai/acre (foliar) 2-6.8 lb ai/acre*ft (submersed)	<ul style="list-style-type: none"> • Can be tank mixed with 2,4-D amine. • Readily absorbed by roots. • No pH, alkalinity, temperature issues. <p><u>Foliar</u></p> <ul style="list-style-type: none"> • Apply when plants are actively growing. • Use higher rate when the weed mass is dense. • Thoroughly wet all foliage. • Use of nonionic surfactant is recommended. • Do not exceed 2.5 ppm ai triclopyr/year. Can repeat treatments as long as 2.5 ppm annual limit not exceeded. • Readily penetrates foliage (< 4 to 12 hours). <ul style="list-style-type: none"> – Rainfast in 2 hours <p><u>Submersed</u></p> <ul style="list-style-type: none"> • Setbacks from potable water intake based on amount of area treated and rate used. • Do not exceed 2.5 ppm ai triclopyr/year. Can repeat treatments as long as 2.5 ppm annual limit not exceeded. • Results can be unsatisfactory if pond has high water exchange.
Imazamox	0.125-0.5 lb ai/acre (foliar) 50-500 ppb (submersed)	<ul style="list-style-type: none"> • An approved adjuvant should be used for foliar applications. Consult label for appropriate type and rate. • A glyphosate herbicide can be added for quicker brownout. • Imazamox can be applied to the water targeting emergent vegetation. Rate is 17-173 ounces product/acre*ft. (50-500 ppb). • Do not exceed 500 ppb (173 oz/acre*ft) for water application or 2 quarts/acre for foliar application. • Spot application can use 5% rate. • Absorbed mostly by foliage. • Root absorption is slower. • Broken down by photolysis (14-day half life in water). • Low light intensity may reduce ability of submersed plants to recover.

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APPLICATION NOTES [cont.]

Active Ingredient	Rate	Application and Notes
Carfentrazone	0.05-0.2 lb ai/acre (foliar) 200 ppb (concentration) 0.5434 lb ai/acre*ft (submersed)	<ul style="list-style-type: none"> • Light dependent. • Best if applied to young actively growing plants. • Mixing with systemic herbicides can enhance effectiveness. • May be tank mixed with other herbicides (2,4-D, diquat, glyphosate, triclopyr, or imazapyr). • Single application will not control plants with high biomass. <p><u>Foliar</u></p> <ul style="list-style-type: none"> • For best results, use a methylated seed oil or non-ionic surfactant. • Dirty or muddy water for spray mixtures will reduce effectiveness. • Thorough wetting of foliage essential for maximum effectiveness. • Rapidly absorbed by foliage, rainfast in 15 minutes. – 1-2 hrs of contact for good activity. <p><u>Submersed</u></p> <ul style="list-style-type: none"> • Inject below the surface or use suitable polymer to rapidly sink spray mixture. • Do not apply within ¼ mile of potable water intake. • Treatment of dense weed mats may result in oxygen loss from dead weed decomposition. • Highly effective on broadleaved weeds. • Visible results in 24 to 48 hours. • pH 7 – half life 8.6 days, pH 9 – half life 3.6 hours.
Penoxsulam	0.03125-0.0875 lb ai/acre (foliar) 5-150 ppb (submersed)	<ul style="list-style-type: none"> • Absorbed by roots and foliage. <p><u>Foliar</u></p> <ul style="list-style-type: none"> • Use of surfactant required for best results. Surfactant should not be organosilicone surfactant. • Apply only to actively growing weeds (temperature > 50°F). • Can be applied as a pre-emergent at rates of 5.6-11.2 oz/acre. • Do not tank mix with Diquat. • Works faster for submersed weeds when mixed with endothall. <p><u>Submersed</u></p> <ul style="list-style-type: none"> • Single application rate 25-75 ppb. Sum of all applications must not exceed 150 ppb/year.
Sodium Carbonate Peroxyhydrate	0.3-10.2 ppm hydrogen peroxide	<ul style="list-style-type: none"> • SCP converts to hydrogen peroxide when applied to water which is the compound that causes plant death. • Active ingredient concentration based on hydrogen peroxide concentration that evolves from product application.
Flumioxazin	3.06-6.12 oz ai/surface acre (foliar)	<ul style="list-style-type: none"> • Target plant will determine whether to make a surface or subsurface application (check label). • Taken up by roots and foliage. • Need actively growing plants for uptake. • Mature plants might have carbohydrate reserves to recover. • Very sensitive to pH (pH 9 – half-life is minutes). <p><u>Foliar</u></p> <ul style="list-style-type: none"> • Tank mix with water having a pH of 5-7. Buffer spray solution to pH less than 7. Use nonionic surfactant with at least an 80% ai (perform jar test to determine compatibility). Apply in 5-10 gallons of water per acre to ensure coverage. Treat less than one-half of the pond at a time and wait 10 to 14 days before treating remaining area. Do not retreat same section within 28 days. • May be tank mixed with 2,4-D, diquat or other approved aquatic herbicide. • Evidence that duckweed and watermeal are susceptible regardless of pH. • Foliar contact causes rapid desiccation and necrosis of exposed plant tissue. • 1 to 2 hours contact time needed. • Floating plants – Better efficacy during cooler weather (late September/October and March/April). <p><u>Submersed</u></p> <ul style="list-style-type: none"> • Application in early morning might enhance effectiveness, due to rapid break down of product in water with pH 8.5 or greater. Pond pH tends to be lower in the morning but should be tested prior to application. • Tank mix with water having a pH of 5-7. • May be tank mixed with other approved herbicides. • 4-6 hour contact time needed.

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APPLICATION NOTES [cont.]

Active Ingredient	Rate	Application and Notes
Bispyribac-sodium	0.8-1.6 oz ai/acre (foliar) 20 to 45 ppb initial concentration (submersed)	<ul style="list-style-type: none"> Absorbed by roots and foliage. No pH or temperature issues. Need active growth. Late winter/early spring application best. <p><u>Foliar</u></p> <ul style="list-style-type: none"> Higher rate for more mature/denser vegetation. Min of 30 gallons water per acre to ensure coverage. No more than 8 oz per year. May be tank mixed with 2,4-D, diquat or other approved herbicide. Tank mix with a nonionic surfactant at the labeled rate. <p><u>Submersed</u></p> <ul style="list-style-type: none"> For optimum control, repeat applications 60 to 90 days to maintain desired concentration (not to exceed 45 ppb). Do not reapply within 14 days. No more than 4 applications per year. Tradewind can be tank mixed with other approved herbicides for enhanced Hydrilla control. Clear water and higher light intensity may increase control.
Topramezone	0.03125-0.0875 lb ai/acre (foliar) 5-150 ppb (submersed)	<ul style="list-style-type: none"> Can be applied directly to water or sprayed onto foliage of plants or exposed sediment after drawdown. Symptoms appear 7 to 10 days after treatment. Plant death occurs over 60 to 120 days period. Maximum initial application can't exceed 50 ppb. Do not exceed 150 ppb cumulative total. Do not irrigate crops if concentrations above 1 ppb. Use surfactant for foliar applications.
Florpyrauxifen	Foliar – Rate is 1 to 2 PDU (Prescription Dose Units) per acre Submersed – Rate is 1 to 5 PDU per acre*ft 1 PDU = 1.35 oz of product	Read label.

Useful Tank Mixes

- Imazapyr – glyphosate, triclopyr, carfentrazone
- Imazamox – penoxsulam, carfentrazone, endothall, fluridone
- Penoxsulam – imazamox, endothall (possible synergy), fluridone, flumioxazin, carfentrazone
- Bispyribac-sodium – endothall, flumioxazin
- Diquat – 2,4-D (emersed), endothall (submersed), copper (submersed),
- Carfentrazone – penoxsulam, glyphosate, 2,4-D, triclopyr, imazapyr, imazamox
- Flumioxazin – diquat, glyphosate, endothall, imazamox, copper, bispyribac-sodium (can use lower rates), penoxsulam
- Glyphosate – imazapyr, triclopyr, carfentrazone
- 2,4-D – diquat, triclopyr, carfentrazone
- Triclopyr – 2,4-D, glyphosate, imazapyr, carfentrazone
- Copper sulfate – diquat, endothall, flumioxazin (for algae),
- Endothall – penoxsulam, imazamox, bispyribac-sodium
- Fluridone – penoxsulam, imazamox

Aquatic Herbicide Toxicity to Some Fish

The 96-hour LC₅₀ is given in ppm columns. The lb column gives the pounds of active ingredient needed per acre*ft to reach the 96-hour LC₅₀

Herbicide	Bluegill		Channel Catfish		Rainbow Trout	
	ppm	lb	ppm	lb	ppm	lb
Endothall (Aquathol)	343	933	150	408	230	625.6
Endothall (Hydrothol)	1.0	2.72	0.5	1.4	1.7	4.6
Copper	Toxicity dependent upon alkalinity of water. The lower the alkalinity, the greater the toxicity.					
Diquat	14	38			15	41
Rotenone (a fish toxicant)	0.02	0.05	0.002	0.005	0.03	0.08
Glyphosate	25	68	13	35	28	76
2,4-D (Amine) Weedar 64, Weed Rhap A-4D, DMA 4 IVM	263	715	166	452	222	604
2,4-D (Ester) Navigate, Aqua-Kleen	2	5.4	1	2.7	1	2.7
Imazapyr	336	914	>100	>272	>100	>272
Triclopyr	681	1,852	446	1,213	400	1,088
Imazamox	119	324			122	332
Carfentrazone	2.0	5.4			16	44
Penoxsulam	103	280			102	277
Sodium Carbonate Peroxyhydrate	26(*a)	71(*b)	24(*a)	65(*b)	22(*a)	60(*b)
Flumioxazin	21	111.3			2.3	12.2
Florpyrauxifen	Practically non-toxic to fish at normal use rates.(LC50 > 100ppm)					
Bispyribac-sodium	>100	272			>100	>272
Topramezone					>100	>272

-The 96-hour LC₅₀ is the amount of material needed to kill 50% of a population within 96 hours.

-ppm values are for the amount of active ingredient.

(*a) - Toxicity as ppm Hydrogen Peroxide.

(*b) - Expressed as pounds Hydrogen Peroxide. User will need to calculate the amount of product this equals from label information.