

Aquatic Weed Control

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Several options, including hand removal, cultural, mechanical, biological, and chemical control techniques are available for the management of aquatic weeds. The applicator should choose the most efficacious, environmentally acceptable and cost-effective alternative that is available for a particular weed problem. The particular management strategy to use in a given situation will depend on the intended use of the body of water, fish, and wildlife populations that may be impacted, type of environment in which the weed problem occurs, and the particular weed species of concern. Before selecting your management strategy, **be sure to have the weed(s) of concern identified by a qualified individual.**

Assistance in weed identification is available from the Cooperative Extension center in your county. Additional information on management techniques also may be obtained from the county Extension center; ask for AG-437, *Weed Management in Small Ponds*; AG-438, *Weed Control in Irrigation Water Supplies*; and AG-449, *Hydrilla, A Rapidly Spreading Aquatic Weed in North Carolina*. Information on pond construction, stocking, and general pond management may be found in AG-424, *Pond Management Guide*. Additional information may be found on the Aquatic Weed Management Web site:

<http://www.weedscience.ncsu.edu/aquaticweeds>.

For the purpose of description and management, aquatic weeds may be grouped either on the basis of their botanical relationships or on the basis of their growth habits. Most plants in each group are managed similarly, with some exceptions.

Table 7-19A. Aquatic Weed Groups — Grouping of Aquatic Plants on the Basis of Botanical Relationships

Category and Description	Examples
<p><i>Algae</i> — These plants may be either microscopic or visible to the naked eye, exist as single cells or occur in clusters or filaments containing many cells, and may be either free floating (planktonic) or attached to the soil, rocks, or vegetation. Filamentous algae may be unbranched, slightly or highly branched, or net-like. Some planktonic algae are mobile. Certain types of algae (macroalgae) may be large, very coarse, and resemble submersed vascular plants. Most algae (except macroalgae) usually require magnification to be identified accurately. Algae do not contain vascular (water conducting) tissues, consequently all chemicals used for algae control have only contact activity. Algae reproduce by cell division, fragmentation, and sexually by spores.</p>	<p>Filamentous Algae Bluegreens or Cyanobacteria Giant <i>Lyngbya</i> Green algae <i>Oedogonium</i> <i>Hydrodictyon</i> (water net) <i>Spirogyra</i> <i>Pithophora</i></p> <p>Planktonic Algae Bluegreens or Cyanobacteria <i>Lyngbya</i> <i>Anabaena</i> <i>Oscillatoria</i> <i>Microcystis</i> Euglenoids (<i>Euglena</i>)</p> <p>Macroalgae Muskgrass (<i>Chara</i>) Stonewort (<i>Nitella</i>)</p>
<p><i>Mosses</i> — These plants are visible to the naked eye and resemble delicate, leafy submersed plants. The mosses lack vascular tissues or roots, but usually are attached to the soil. Mosses reproduce sexually by spore production.</p>	<p><i>Fontinalis</i> <i>Sphagnum</i> (peat moss)</p>
<p><i>Ferns</i> — These plants are visible to the naked eye, either free floating or rooted to the bottom, occasionally forming loosely consolidated floating mats. Ferns have vascular tissues and reproduce by vegetative propagation and sexually by spores.</p>	<p>Giant salvinia (<i>Salvinia molesta</i>) Mosquito fern (<i>Azolla</i> spp.) Water clover (<i>Marsilea quadrifolia</i>) Water spangles (<i>Salvinia minima</i>)</p>
<p><i>Vascular flowering plants</i> — These plants may be rooted or unrooted, free floating, submersed, floating-leaved, or emergent. Most reproduce vegetatively by means of rhizomes, stolons, and various other vegetative perennating structures including turions and tubers. Most also produce flowers and may set seeds. This group has a vascular system that shows varying degrees of development from rudimentary in the case of the duckweeds and submersed species to very complex and highly developed in emergent plants and includes annual and perennial herbaceous forms and several woody species.</p>	<p>Bald cypress (<i>Taxodium distichum</i>) Bladderwort (<i>Utricularia</i> spp.) Bulrushes (<i>Scirpus</i> spp.) Cattail (<i>Typha</i> spp.) Duckweed (<i>Lemna</i> spp. and <i>Spirodela</i> spp.) Hydrilla (<i>Hydrilla verticillata</i>) Naiads (<i>Najas</i> spp.) Pondweeds (<i>Potamogeton</i> spp.) Rushes (<i>Juncus</i> spp.) Spikerushes (<i>Eleocharis</i> spp.) Waterhyacinth (<i>Eichhornia crassipes</i>) Watermilfoils (<i>Myriophyllum</i> spp.)</p>
<p><i>Submersed plants</i> — Plants in this group grow beneath the surface of the water and may be rooted to the bottom or free floating, with or without roots. Flowers usually are produced above the surface of the water and occasionally may be supported by specialized floatation structures. Some species will produce emergent floral spikes that extend several inches above the surface of the water and are covered with bracts that resemble leaves. Submersed plants usually have poorly developed vascular systems and very limited structural tissue and depend on the water's buoyancy for support. Filamentous algae and macroalgae also could be considered submersed plants.</p>	<p>American elodea (<i>Elodea canadensis</i> and <i>E. nuttallii</i>) Bladderwort (<i>Utricularia</i> spp.) Brazilian elodea (<i>Egeria densa</i>) Brittle naiad (<i>Najas minor</i>) Coontail (<i>Ceratophyllum demersum</i>) Creeping rush (<i>Juncus repens</i>) Eurasian watermilfoil (<i>Myriophyllum spicatum</i>) Fanwort (<i>Cabomba caroliniana</i>) Hydrilla (<i>Hydrilla verticillata</i>) Parrotfeather (<i>Myriophyllum aquaticum</i>) Pondweeds (<i>Potamogeton</i> spp.) Proliferating spikerush (<i>Eleocharis baldwinii</i>) Southern naiad (<i>Najas guadalupensis</i>) Variable-leaf milfoil (<i>Myriophyllum heterophyllum</i>) Widgeongrass (<i>Ruppia maritima</i>) Wild celery (<i>Vallisneria spiralis</i>)</p>

Table 7-19B. Aquatic Weed Groups — Grouping of Aquatic Plants on the Basis of Growth Habit

NOTE: Some species have growth habits that overlap and may be listed more than once.

Category and Description	Examples
<p>Submersed plants — Plants in this group grow beneath the surface of the water and may be rooted to the bottom or free floating, with or without roots. Flowers usually are produced above the surface of the water and occasionally may be supported by specialized floatation structures. Some species will produce emergent floral spikes that extend several inches above the surface of the water and are covered with bracts that resemble leaves. Submersed plants usually have poorly developed vascular systems and very limited structural tissue and depend on the water's buoyancy for support. Filamentous algae and macroalgae also could be considered submersed plants.</p>	<p>American elodea (<i>Elodea canadensis</i> and <i>E. nuttallii</i>) Bladderwort (<i>Utricularia</i> spp.) Brazilian elodea (<i>Egeria densa</i>) Brittle naiad (<i>Najas minor</i>) Coontail (<i>Ceratophyllum demersum</i>) Creeping rush (<i>Juncus repens</i>) Eurasian watermilfoil (<i>Myriophyllum spicatum</i>) Fanwort (<i>Cabomba caroliniana</i>) Hydrilla (<i>Hydrilla verticillata</i>) Parrotfeather (<i>Myriophyllum aquaticum</i>) Pondweeds (<i>Potamogeton</i> spp.) Proliferating spikerush (<i>Eleocharis baldwinii</i>) Southern naiad (<i>Najas guadalupensis</i>) Variable-leaf milfoil (<i>Myriophyllum heterophyllum</i>) Widgeongrass (<i>Ruppia maritima</i>) Wild celery (<i>Vallisneria americana</i>)</p>
<p>Free-floating plants — Plants in this group float on the surface of the water and may lie flat on the water or be raised well above the surface. These plants, with the exception of the duckweeds, watermeal, and mosquito ferns, have well-developed vascular systems and substantial supportive tissues. Most form true roots. Flowers extend above the surface of the water in the flowering plants.</p>	<p>Duckweeds (<i>Lemna</i> spp. and <i>Spirodela</i> spp.) Floating heart (<i>Nymphoides aquatica</i>) Frogbit (<i>Limnobium spongia</i>) Giant salvinia (<i>Salvinia molesta</i>) Mosquito fern (<i>Azolla caroliniana</i>) Waterhyacinth (<i>Eichhornia crassipes</i>) Waterlettuce (<i>Pistia stratiotes</i>) Watermeal (<i>Wolffia</i> spp.)</p>
<p>Floating leaf plants — These plants are rooted in the bottom and have their leaves attached to long, tough stems that extend to the surface from depths up to 6 ft or more. The leaves float directly on the surface of the water. Mature leaves of some species may push well above the surface into an emergent position. Most of these plants have extensive root and rhizome systems and well-developed vascular systems and supportive tissues. Flowers float just above the surface or are extended well above the surface on a tough stem. A few nonvascular representatives.</p>	<p>American lotus (<i>Nelumbo lutea</i>) Fragrant waterlily (<i>Nymphaea odorata</i>) Illinois pondweed (<i>Potamogeton illinoensis</i>) Spatterdock (<i>Nuphar luteum</i>) Water clover (<i>Marsilea quadrifolia</i>) Watershield (<i>Brasenia schreberi</i>)</p>
<p>Emergent plants — These plants grow rooted in the bottom with their leaves and green stems extending well above the surface of the water. A few species also may form floating mats. All have extensive root and rhizome systems and well-developed vascular systems and supportive tissues. Reproduction occurs vegetatively by rhizomes and stolons; floating mat-forming species also reproduce readily by stem fragmentation. Most flower prolifically and form many seeds.</p>	<p>Broadleaf Species Arrow arum (<i>Peltandra virginica</i>) Arrowhead (<i>Sagittaria</i> spp.) Asian spiderwort (<i>Murdannia keisak</i>) Frogbit (<i>Limnobium spongia</i>) Lizard's tail (<i>Saururus cernuus</i>) Pickerelweed (<i>Pontederia cordata</i>) Smartweeds (<i>Polygonum</i> spp.)</p> <p>Mat-forming Broadleaf Species Alligatorweed (<i>Alternanthera philoxeroides</i>) Creeping waterprimrose (<i>Ludwigia hexapetala</i>) Water pennywort (<i>Hydrocotyle</i> spp.) Water willow (<i>Justicia americana</i>)</p> <p>Sedges, Rushes, Spikerushes, and Grasses Bulrush (<i>Scirpus</i> spp.) Cattail (<i>Typha</i> spp.) Common reed (<i>Phragmites australis</i>) Flat sedge (<i>Carex</i> spp.) Foursquare (<i>Eleocharis quadrangulata</i>) Maidencane (<i>Panicum hemitomon</i>) Rushes (<i>Juncus</i> spp.) Sedge (<i>Cyperus</i> spp.) Soft rush (<i>Juncus effusus</i>) Softstem bulrush (<i>Scirpus validus</i>) Southern wildrice (<i>Zizaniopsis miliacea</i>) Spikerushes (<i>Eleocharis</i> spp.) Threesquare bulrush (<i>Scirpus americanus</i>) Torpedograss (<i>Panicum repens</i>) Water paspalum (<i>Paspalum repens</i>) Woolgrass (<i>Scirpus cyperinus</i>)</p> <p>Other Common Species Bur-reed (<i>Sparganium americanum</i>) Scouring rush (<i>Equisetum hymale</i>)</p>
<p>Woody plants — These are obligate, aquatic species of trees usually growing totally flooded or in saturated soils, but occasionally occur in upland areas (usually planted there). Some form systems of "knees" to provide aeration for the root systems. They are deciduous, dropping leaves in the autumn, and are rarely if ever vegetative during winter months.</p>	<p>Bald cypress (<i>Taxodium distichum</i>) Pond cypress (<i>Taxodium ascendens</i>) Tupelo (<i>Nyssa aquatica</i>)</p>

Biological Control of Aquatic Weeds with Triploid Grass Carp

While the triploid, sterile grass carp is a cost-effective control method, it is best suited for use in small ponds, where submersed aquatic plants are not required for fish and wildlife habitat. Grass carp are effective on most submersed weeds. They generally are less effective on algae and weeds in the floating and emergent groups. Refer to the chart below for information on the relative effectiveness of grass carp for different weeds.

Grass carp are normally stocked at 15 fish per acre in small ponds. In larger ponds, they are usually stocked at 15 to 20 fish per vegetated acre. Large fish (minimum of 8 to 10 inches long) should be stocked to prevent loss due to predation by large bass and wading birds. If the surface of the pond is completely covered with vegetation, some limited herbicide application or mechanical removal of weeds from a portion of the pond will be necessary before stocking to allow oxygen to reach the underlying water. Grass carp may be stocked at any time of the growing season, but best results are usually obtained by a late summer or fall stocking.

No permit is required to purchase up to 150 triploid grass carp for stocking a private pond. At a stocking rate of 15 fish per acre of water, 150 triploid grass carp are adequate to control vegetation in a 10-acre pond. A permit from the Wildlife Resources Commission is required for larger stockings. Grass carp may be purchased from a licensed distributor. For a list of North Carolina vendors, see <http://www.ncagr.com/aquacult/grasscarp.htm>. Permits, a list of certified distributors, and additional information on stocking of triploid grass carp may be obtained from the Wildlife Resources Commission, Chief of Inland Fisheries, 1721 Mail Service Center, Raleigh, NC 27699-1721, or call at (919) 707-0220.

Table 7-20. Biological Control of Aquatic Weeds with Triploid Grass Carp

Weed	Relative Effectiveness	Comments
Algae Filamentous (green and bluegreen) and planktonic	Poor	High stocking rates (60 to 75 or more fish per acre) with small fish (4 to 6 inches size) are required to achieve temporary control; control usually decreases as fish grow larger and are unable to feed on the algae.
Macroalgae Chara and Nitella	Good to Excellent	Chara usually is beneficial to fish and wildlife.
Floating and Floating-Leaved Weeds Duckweeds, watermeal	Poor	Small fish at very high stocking rates (see filamentous algae above) may give control; larger fish at normal stocking rates usually are not effective.
Water ferns (Azolla and Salvinia)	Fair to Poor	
Alligatorweed, water lilies, water primrose, lotus, watershield, spatterdock, waterhyacinth	Poor	Grass carp may feed lightly on weeds in this group, but control is usually unacceptable.
Emergent and Marginal Weeds Cattails, rushes, common reed, bulrushes, pickerelweed, pennywort, arrowhead	Poor	Grass carp may feed lightly on weeds in this group, but control is usually unacceptable.
Submersed Weeds	Good to Excellent	Most rooted and free-floating submersed weeds in ponds are readily controlled with triploid grass carp; control may be poorer on the watermilfoils, particularly Eurasian waterfoil.

Chemical Control of Aquatic Plants

Table 7-21. Chemical Control of Aquatic Plants

Herbicide, Formulation, and Mode of Action Code	Amount of Formulation	Active Ingredient Rate or Concentration	Precautions and Remarks ²
Algae, blue-green			
copper sulfate (various)	See label	0.5 to 1 ppm	Apply crystals or powder at early stage of growth by any method to give rapid and uniform dispersion. For best results, apply on a clear day. Do not apply to muddy water. Warning: Copper is toxic to fish. Formulated copper products have a greater margin of safety to fish.
sodium carbonate peroxyhydrate (various)	See label	0.3 to 1.7 ppm	Apply with 8 to 10 hours of daylight remaining. Do not reapply within 48 hours.
Algae, filamentous and planktonic			
copper complex (various)	0.6 gal/acre ft	0.2 ppm	Dilute with water in ratio of at least 9-to-1 and apply uniformly. For best results, apply on a clear day and break up floating mats of filamentous algae before treatment. Warning: Copper is toxic to fish.
copper sulfate (various)	See label	0.5 to 1 ppm	Same as under Algae, blue-green. For best results break up floating mats of filamentous algae before treatment. Warning: Copper is toxic to fish. Formulated copper products have a greater margin of safety to fish.
diquat (Reward) 2 lb/gal MOA 22	See label	0.18 to 0.37 ppm	For certain filamentous algae— <i>Pithophora</i> spp. and <i>Spirogyra</i> spp. Check label for application instructions. For best results, break up floating mats before treatment.
Algae, macro, chara, nitella			
copper complex (Cutrine-Plus Granular) 3.7 G (Cutrine-Plus) 0.9 lb/gal (K-Tea) 0.8 lb/gal	60 lb/surface acre 1.2 gal/acre ft 1.7 to 3.4 gal/acre ft	2.2 lb/acre 0.4 ppm 0.5 to 1.0 ppm	Distribute granular formulation evenly over infested area when plants are young. If chara is in water less than 3 ft deep or growth is near the surface, the liquid formulation may be used. Dilute with water in ratio of at least 9-to-1 and apply uniformly. Warning: Copper is toxic to fish.
Algae, Pithophora and cladophoraa			
flumioxazin (Clipper) 51% MOA 14	6 to 12 oz/A	3 to 6 ai/A or 100 to 400 ppb	Early morning applications may be more effective. If vegetation is dense, treat in sections to avoid reducing dissolved oxygen. Water pH greater than 7.5 will reduce effectiveness.

Table 7-21. Chemical Control of Aquatic Plants

Herbicide, Formulation, and Mode of Action Code	Amount of Formulation	Active Ingredient Rate or Concentration	Precautions and Remarks ²
Floating Weeds (except watermeal)			
2,4-D amine (various) MOA 4	See label	2 to 4 lb/acre	Thorough wetting of foliage is essential. Apply in 100 to 400 gallons of water per acre. Use low pressure, large nozzle, and spray thickener. For use on nonirrigation ditchbanks only. Do not apply to water.
bispyribac (Tradewind) 80% MOA 2	1 to 2 oz/A	0.8 to 1.6 oz ai/A	Controls duckweed, mosquito fern, salvinia, water hyacinth, water lettuce, and water pennywort. Apply with at least 30 gpa water volume. Include appropriate adjuvant.
carfentrazone (Stingray) 1.9 lb/gal, MOA 14	3.4 to 13.5 fl oz/acre	0.05 to 0.2 lb/acre	Controls water lettuce, waterhyacinth, salvia, duckweed, mosquito fern, and water spinach. Rates vary according to target species. Methylated seed oil or nonionic surfactant recommended.
diquat (Reward) 2 lb/gal MOA 22	0.5 to 0.75 gal/surface acre	1 to 1.5 lb/acre	Weeds controlled: pennywort, salvinia, waterhyacinth, waterlettuce. Apply in a spray volume of 150 to 200 gallons of water per acre plus 1 pint nonionic surfactant.
	1 gal/surface acre	2 lb/acre	For duckweed control, apply in a spray volume of 50 to 150 gallons of water per acre. Take care to cover all plants on water and damp marginal areas. Will require retreatment. A nonionic surfactant at 0.5% by volume will be needed.
glyphosate (various) MOA 9	See label	See label	For control of waterlilies, spatterdock, and lotus, apply as foliar spray on a calm day when there is little to no wave action. Vegetation must be on or above the surface for treatment to be effective. A nonionic surfactant (e.g. Cide-Kick or Induce) is required with Rodeo. If applying from a boat, take care not to create waves that may wash the herbicide off floating leaves. Will not control small floating plants, such as azolla, duckweed, or watermeal.
imazamox (Clearcast) 1 lb/gal, MOA 2	32 to 64 fl oz/acre	0.25 to 0.5 lb ai/acre 50 to 150 ppb	See label for specific weeds controlled. A nonionic surfactant or methylated seed oil is recommended for foliar applications. Spot treatments may be made with up to 5% solution by volume.
imazapyr (Habitat) MOA 2	1 to 4 pt/acre	0.25 to 1.5 lb/acre	Rates vary according to target species. Retreatment of some plants may be required. A nonionic surfactant is recommended. Will not control small floating plants, such as azolla, duckweed, or watermeal.
penoxsulam (Galleon) 2 lb/gal, MOA 2	2 to 5.6 fl oz/acre	0.03 to 0.09 lb/acre 5 to 150 ppb	A nonionic surfactant is recommended for foliar applications.
triclopyr (Renovate 3) MOA 4	0.5 to 2 gal/acre	1.5 to 6 lb/acre	Rates vary according to target species. Addition of approved nonionic surfactant is recommended.
topramezone (Oasis) 29.7%	up to 16 fl oz/acre	up to 0.35 lb/acre	Use of an aquatic safe surfactant is required for all foliar applications. Check label for specific irrigation restrictions.
Floating Weeds (watermeal and others)			
flumioxazin (Clipper) 51% MOA 14	6 to 12 oz/acre	3 to 6 ai/A or 100 to 400 ppb	Early morning applications may be more effective. If vegetation is dense, treat in sections to avoid reducing dissolved oxygen. Water pH greater than 7.5 will reduce effectiveness. A follow-up application may be needed for watermeal control.
fluridone (Sonar) 4 AS MOA 12	Ponds: 0.16 to 1.5 qt/acre	0.16 to 1 lb/acre 10 to 90 ppb	Use the maximum labelled rate for the average depth of your pond. Do not apply when there is substantial outflow from the pond. Do not apply as a spot treatment. See label for specific weeds controlled. For watermeal, use 45 to 90 ppb. Other floating species may be controlled with lower rates. Do not use treated water for irrigation for 7 to 30 days. See label for irrigation precautions. Warning: 30 days may be insufficient restriction if pond water will be used to irrigate very sensitive crops, such as tobacco, tomatoes, or peppers.
Emergent, Marginal, and Ditchbank Weeds			
2,4-D amine (various) MOA 4	See label	2 to 4 lb/acre	Thorough wetting of foliage is essential. Apply in 100 to 400 gallons of water per acre. Use low pressure, large nozzle and spray thickener. For use on nonirrigation ditchbanks only. Do not apply to water.
2,4-D granular (Navigate) 20 G (2,4-D Gran 20) 20 G MOA 4	150 to 200 lb/surface acre	30 to 40 lb/acre	Weeds controlled: arrowhead, bulrush, creeping waterprimrose, pickerelweed, smartweed, spatterdock, waterchestnut, waterlily, watershield. Rate depends upon species and depth of water. Check label. Apply early, when weeds are actively growing, with a rotary seeder. Spatterdock may require retreatment.
bispyribac (Tradewind) 80% MOA 2	1 to 2 oz/A	0.8 to 1.6 oz ai/A	Controls alligatorweed and parrotfeather. Apply with at least 30 gpa water volume. Include appropriate adjuvant.
carfentrazone (Stingray) 1.9 lb/gal, MOA 14	6.7 to 13.5 fl oz/acre	0.2 lb/acre	Suppresses alligatorweed and waterprimrose.
diquat (Reward) 2 lb/gal (Weedtrine) 0.4 lb/gal MOA 22	1 gal/surface acre	2 lb/acre	For control of cattails in ponds or lakes. For top kill, apply in 100 gal of water per acre with 0.25% to 0.5% nonionic surfactant. Apply before flowering for best results. Retreat as needed.
flumioxazin (Clipper) 51% MOA 14	6 to 12 oz/A	3 to 6 ai/A or 100 to 400 ppb	Early morning applications may be more effective. If vegetation is dense, treat in sections to avoid reducing dissolved oxygen. Ensure adequate coverage of dense vegetation or a follow-up application may be necessary.
glyphosate (various) MOA 9	See label	See label	Rates vary according to target species. Retreatment of alligatorweed is necessary. Aquatic-approved nonionic surfactant (e.g. Cide-Kick or Induce) required with Rodeo. Note: The use of very hard water or water containing high concentrations of iron to prepare spray solutions may result in reduced efficacy of glyphosate.
imazamox (Clearcast) 1 lb/gal MOA 2	32 to 64 fl oz/acre	0.25 to 0.5 lb ai/acre 50 to 500 ppb	See label for specific weeds controlled. A nonionic surfactant or methylated seed oil is recommended for foliar applications. Spot treatments may be made with up to 5% solution by volume. Rates vary according to target species. Retreatment of some plants may be required. A nonionic surfactant is recommended.
imazapyr (Habitat) MOA 2	1 to 6 pt/acre	0.25 to 1.5 lb/acre	Rates vary according to target species. Retreatment of some plants may be required. A nonionic surfactant is recommended.
penoxsulam (Galleon) 2 lb/gal, MOA 2	2 to 5.6 fl oz/acre	0.03 to 0.09 lb/acre 5 to 500 ppb	See label for specific weeds controlled and application details.
triclopyr (Renovate 3) MOA 4	0.5 to 2 gal/acre	1.5 to 6 lb/acre	Rates vary according to target species. Addition of an approved nonionic surfactant is recommended.
topramezone (Oasis) 29.7%	up to 16 fl oz/acre	up to 0.35 lb/acre	Use of an aquatic safe surfactant is required for all foliar applications. Check label for specific irrigation restrictions.

Table 7-21. Chemical Control of Aquatic Plants

Herbicide, Formulation, and Mode of Action Code	Amount of Formulation	Active Ingredient Rate or Concentration	Precautions and Remarks ²
Submersed Weeds³			
2,4-D granular (Navigate) 20 G, MOA 4	100 to 200 lb/ surface acre	20 to 40 lb/acre	Rate depends upon weed to be controlled and depth of water. Check labels for species and rates. Apply uniformly with a rotary seeder.
bispyribac (Tradewind) 80% MOA 2	See label	10 to 45 ppb	Controls hydrilla, sago pondweed, and Eurasian watermilfoil. Do not apply in areas of high water flow or water diffusion. Refer to label for specific details on application rate based on water volume.
carfentrazone (Stingray) 1.9 lb/gal MOA 4	0.286 to 5.75 gal/ acre	200 ppb	Controls Eurasian watermilfoil. Apply in spring or early summer as a subsurface application or with an appropriate adjuvant to ensure sinking and mixing of the spray mix.
diquat (Reward) 2 lb/gal MOA 22	1 to 2 gal/ surface acre	2 to 4 lb/acre	Weeds controlled: bladderwort, coontail, elodea, naiads, pond weeds. Apply early in season by pouring directly into water in strips 40 feet apart. Later in season, as weeds reach surface, pour in strips 20 feet apart or inject a dilute solution. Not effective in muddy water.
endothall (Aquathol K) 4.2 lb/gal (Aquathol Super K) 63 G	0.3 to 2.6 gal/acre ft 2.2 to 17.6 lb/acre ft	0.5 to 5 ppm	Weeds controlled: bass weed, bur reed, coontail, hydrilla (Aquathol K only), pondweeds, watermilfoil, water star grass. Rate depends upon weed species and type of treatment. Spot or marginal treatments require higher rates. Aquathol Granular is especially useful for spot or marginal treatments.
flumioxazin (Clipper) 51% MOA 14	See label	100 to 400 ppb	Early morning applications may be more effective. If vegetation is dense, treat in sections to avoid reducing dissolved oxygen. Water pH greater than 7.5 will reduce effectiveness.
fluridone (Sonar) AS MOA 12 (Sonar SRP) MOA 12	Ponds: 0.16 to 1 qt/acre Lakes: 0.2 to 4 qt/ acre Canals: 2 qt/acre Ponds: 3.2 to 30 lb/acre Lakes: 4 to 80 lb/ acre Canals: 40 lb/acre Rivers: 40 lb/acre	0.16 to 1 lb/acre 0.2 to 4 lb/acre 2 lb/acre 0.16 to 1.5 lb/acre 0.2 to 4 lb/acre 2 lb/acre 2 lb/acre	Do not use water for irrigation for 7 to 30 days. See label for specific irrigation precautions. Application to canals should be made only if water flow can be restricted. Warning: 30 days may be insufficient restriction if applied to small ponds and pond water will be used to irrigate very sensitive crops, such as tobacco, tomatoes, or peppers.
imazamox (Clearcast) 1 lb/gal, MOA 2	See label	50 to 500 ppb	Rates vary according to target species and depth to be treated. See label for specific weeds controlled and application details.
penoxsulam (Galleon) 2 lb/gal, MOA 2	See label	5 to 150 ppb	Rates vary according to target species and depth to be treated. See label for specific weeds controlled and application details.
triclopyr (Renovate 3 or OTF), MOA 4	See label	1.5 to 6 lb/acre 0.5 to 2.5 ppm	Rates vary according to target species and depth to be treated. See label for specific weeds controlled and application details.
topramezone (Oasis) 29.7%	up to 16 fl oz/acre	up to 0.35 lb/acre	Use of an aquatic safe surfactant is required for all foliar applications. Check label for specific irrigation restrictions.

¹ Mode of Action (MOA) code developed by the Weed Science Society of America. Cooper compounds, endothall, and sodium carbonate peroxyhydrate have not been assigned codes.

² Also see comments for specific herbicides under "Table 7-25. Labeled Sites and Restrictions."

³ Grass carp give cost-effective control on the majority of the weeds in this group and should be given consideration *before* using herbicides. See text at beginning of this section under *Biological Control of Aquatic Weeds with Triploid Grass Carp*. A permit is required to purchase more than 150 grass carp or for stocking in impoundments larger than 10 acres. Grass carp usually are **not effective** on filamentous algae, duckweed, watermeal, or any of the plants in the floating or emergent groups.

Table 7-22. Waiting Period (in Days) Before Using Water After Application of Herbicides for Aquatic Weed Control

Herbicide	Irrigation ¹	Fish Consumption	Watering Livestock	Swimming
2,4-D (various formulations and manufacturers)	Water use restrictions vary by formulation and manufacturer. In general, if water is used for irrigating sensitive crops, 2,4-D should not be used. Turfgrasses are generally tolerant to low concentrations of 2,4-D. Also, many 2,4-D formulations are NOT labelled for aquatic use. Read the label before purchasing and/or use.			
Bispyribac (Tradewind)	Do not irrigate until concentrations are < 1 ppb	No restrictions	Do not water livestock until concentrations are ≤ 1 ppb	No restrictions
carfentrazone (Stingray)	1 to 14 ²	No restrictions	0 to 1	No restrictions
copper (Copper sulfate pentahydrate, including Bluestone and EarthTec; and complexed copper formulations, including Algae-Pro, Captain, Clearigate, Cutrine-Plus, Cutrine-Plus Granular, K-Tea, Komeen, etc.)	No restrictions	No restrictions	No restrictions	No restrictions
diquat (Reward)	3 to 5 ³	No restrictions	1	No restrictions
endothal (Aquathol K) (Aquathol Super K) (Hydrothol 191) (Hydrothol 191 granular)	No restrictions for many situations. See label for specific restrictions	No restrictions	7 to 25	No restrictions
Flumioxazin (Clipper)	0 to 5 ³	No restrictions	No restrictions	No restrictions
fluridone (Sonar 4AS, Sonar SRP)	7 to 30 ³	No restrictions	No restrictions	No restrictions
Glyphosate (AquaMaster, Aqua Neat, Rodeo, Touchdown Pro)	No restrictions	No restrictions	No restrictions	No restrictions
imazamox (Clearcast)	0+ ³	No restrictions	No restrictions	No restrictions
Imazapyr (Habitat)	120	No restrictions	No restrictions	No restrictions
penoxsulam (Galleon)	Do not irrigate food crops until residues ≤ 1 ppb	No restrictions	No restrictions	No restrictions
sodium carbonate peroxyhydrate (GreenClean Pro, Pak 27)	No restrictions	No restrictions	No restrictions	No restrictions
topramezone (Oasis)	See label for specific irrigation restrictions	No restrictions	No restrictions	No restrictions
triclopyr (Renovate 3, Renovate OTF)	120 0 to established grass	No restrictions	Next growing season for lactating dairy animals	No restrictions

¹ Irrigation restrictions may be removed for specific products if a laboratory assay of treated water meets a standard as stated on the product label.

² Do not use treated water for irrigation in commercial nurseries or greenhouses.

³ Refer to product label for specific restrictions.

Table 7-23. Effectiveness of Herbicides and Triploid Grass Carp for Control of Weeds Commonly Found in N.C. Ponds

Weeds							endothall											
	2,4-D	bispyribac	carfentrazone	copper compounds	diquat	diquat +copper	Aquathol	Hydrothol	flumioxazin	fluridone	glyphosate	imazamox	imazapyr	peroxide compounds	penoxsulam	triclopyr	triploid grass carp	
Algae																		
Planktonic	NR	ID	NR	G	P	G	NR	P	ID	NR	NR	NR	NR	G	NR	NR	NR	
Filamentous	NR	ID	NR	G	E	E	NR	E	G	NR	NR	NR	NR	ID	NR	NR	P	
Chara / Nitella	NR	ID	ID	G	G	E	NR	G	P	NR	NR	NR	NR	ID	NR	NR	E	
Floating Plants																		
Azolla (mosquito fern)	NR	G	F	F	E	E	NR	NR	ID	E	NR	ID	NR	NR	G	NR	P	
Duckweed	P	G	G	P	G	G	NR	NR	E	E	NR	NR	NR	NR	G	P	P	
Frogbit	F	ID	ID	NR	E	E	NR	NR	G	NR	P	E	E	NR	ID	G	P	
Salvinia, common	NR	G	G	P	E	E	NR	NR	G	E	G	E	ID	NR	ID	NR	P	
Salvinia, giant	NR	G	G	P	E	E	F	NR	F	E	G	P	G	NR	E	NR	P	
Waterhyacinth	E	G	G	NR	G	G	NR	NR	P	F	G	E	G	NR	E	E	P	
Watermeal	NR	NR	NR	NR	P	P	NR	NR	G	G	NR	NR	NR	NR	P	NR	P	
Water lettuce	NR	G	G	NR	G	G	G	G	E	NR	E	G	E	NR	E	NR	P	
Emerged Plants																		
Alligatorweed	P	G	F	NR	NR	NR	NR	NR	F	F	G	G	G	NR	G	G	P	
American lotus	G	ID	NR	NR	NR	NR	NR	NR	ID	G	E	F	G	NR	ID	G	P	
Cattail	F	ID	NR	NR	F	F	NR	NR	P	G	E	G-E	E	NR	ID	F	P	
Creeping waterprimrose	E	ID	F	NR	NR	NR	NR	NR	ID	F	E	F	E	NR	G	E	P	
Floating hearts	P	ID	NR	NR	F	F	E	E	ID	F	G	G	G	NR	F	P	P	
Fragrant waterlily	G	ID	NR	NR	NR	NR	NR	NR	ID	G	E	G	E	NR	ID	G	P	
Grass species	NR	ID	NR	NR	F	F	NR	NR	NR	F	E	F	E	NR	ID	NR	P	
Parrotfeather	E	G	F	NR	NR	NR	NR	NR	F	NR	F	G	E	NR	G	E	NR	
Phragmites (Common reed)	NR	ID	NR	NR	NR	NR	NR	NR	P	NR	G	F-G	E	NR	NR	F	P	
Pickeralweed	G	ID	NR	NR	NR	NR	NR	NR	ID	NR	F	E	E	NR	ID	G	P	
Rush	NR	ID	NR	NR	NR	NR	NR	NR	ID	NR	G	ID	G	NR	ID	F	P	
Spatterdock	G	ID	NR	NR	NR	NR	NR	NR	ID	G	E	G	E	NR	ID	F	P	
Smartweeds	F	ID	NR	NR	F	F	NR	NR	ID	F	G	G	G	NR	F	G	P	
Waterpennywort	G	G	NR	NR	F	F	NR	NR	G	G	E	E	E	NR	F	G	P	
Watershield	E	ID	NR	NR	F	F	NR	NR	ID	F	E	G	G	NR	ID	E	P	
Submersed Plants																		
Bladderwort	P	ID	ID	NR	F	F	P	P	ID	E	NR	F-G	NR	NR	ID	P	E	
Cabomba	NR	ID	ID	NR	F	F	F	F	G	F	NR	F	NR	NR	ID	NR	F	
Coontail	G	ID	ID	NR	E	E	E	E	G	E	NR	NR	NR	NR	ID	G	E	
Egeria (Brazilian elodea)	NR	ID	ID	F	E	E	P	P	ID	E	NR	ID	NR	NR	G	NR	E	
Eurasian watermilfoil	E	G	G	NR	G	G	E	NR	G	E	NR	F	NR	NR	G	E	P	
Hydrilla, monoecious	NR	G	ID	F	G	E	E	E	G	E	NR	F	NR	NR	G	NR	E	
Naiad, brittle	NR	ID	ID	G	E	E	E	E	G	E	NR	ID	NR	NR	F	NR	E	
Naiad, Southern	NR	ID	ID	G	P	G	P	P	G	G	NR	ID	NR	NR	F	NR	E	
Parrotfeather	E	G	ID	NR	G	G	E	E	G	E	NR	F	NR	NR	G	E	F	
Pondweed species	NR	G	ID	NR	E	E	E	E	G	E	NR	G	NR	NR	G	NR	E	
Proliferating spikerush	NR	ID	ID	NR	NR	NR	NR	NR	P	F	NR	F	NR	NR	F	NR	E	
Variable leaf milfoil	E	ID	G	NR	E	E	E	E	E	G	NR	NR	NR	NR	NR	E	P	

Key: NR = Not Recommended; P = Poor; G=Good ; ID = Insufficient Data; F = Fair; E = Excellent

Pond Dyes

Pond dyes may be used to prevent the growth of filamentous algae and submersed macrophyte vegetation. Pond dyes are not herbicides and do not directly kill aquatic plants. They function by blocking light penetration to the bottom of the pond. As a result, these products are most effective when applied very early in the growing season.

The use of a pond dye in aquacultural ponds usually is not recommended, as they tend to inhibit phytoplankton productivity that is needed to produce oxygen and provide food for zooplankton, which are the major food of fry and the smaller juvenile fishes. Application rates usually are about one part per million or 1 gallon per acre for a pond averaging 4 feet deep (i.e., 1 gallon per 4 acre-feet of water) for algae and most submersed weeds. For hydrilla, the rate needs to be doubled, due to its ability to grow at very low light levels. Several of the available pond dyes are registered by the EPA for aquatic weed control. Pond dyes *should not be applied to drinking water supplies or to streams or any body of water where there is any substantial outflow.*

Table 7-24. Pond Dyes

Examples of Pond Dyes	EPA Registered
Admiral Liquid	Yes
Aquashade	Yes

Table 7-25. Labeled Sites and Restrictions

Herbicide and Formulation	Labeled Sites	Restrictions
2, 4-D amine (Weedar 64) 3.8 lb a.i./gal Other formulations	potable water reservoirs, farm and fish ponds, lakes, golf course water hazards, fish hatcheries	Delay the use of treated waters for irrigation and domestic purposes for 3 weeks after application unless an assay indicates that chemical water concentrates are below the minimum amount as specified on the product label. Do not treat irrigation ditches where water will be used for overhead irrigation of susceptible crops. Refer to specific product label for restrictions.
2,4-D granular (Navigate) 20 G	ponds and lakes	Do not apply to water used for irrigation, agricultural sprays, watering dairy animals, or domestic water supplies.
Bispyribac (Tradewind) 80%	Bayous, canals, fresh water ponds, lakes, marshes, and reservoirs	Do not irrigate until water concentrations are less than 1 ppb. Do not treat water used for crawfish production.
copper-complex (Cutrine-Plus) 0.9 lb/gal (Cutrine-Plus) 3.7 G (K-Tea) 0.8 lb/gal copper sulfate	potable water reservoirs, farm and fish ponds, lakes, golf course water hazards, fish hatcheries	No restrictions on use of treated water. Check tolerance of crop to copper applied in irrigation water. Trout are very susceptible to copper. Toxicity to other fish increases with decreasing hardness of water.
carfentrazone (Stingray) 1.9 lb/gal	ponds, lakes, reservoirs, marshes, wetlands, drainage ditches, canals, streams, rivers, etc.	Irrigation: Do not use treated water in commercial nurseries or greenhouses. Field crops may be irrigated after 1 day if less than 20% of surface area was treated, or after 14 days if treatment was 20% or more of surface area or until an assay indicates that chemical water concentrates are below a minimum amount as specified on the product label. Treated water may be used for turf irrigation with no restriction if less than 20% of the total water body was treated. A 14-day restriction applies for larger area treatments. Do not apply within 0.25 miles an active potable water intake (upstream only in flowing waters), or turn intake off for at least 24 hours as specified on product label. Do not drink or water livestock for 1 day if 20% or more of total surface area was treated. Applicators must be licensed or certified by the state.
diquat (Reward) 2 lb/gal	lakes, still ponds, ditches, laterals, waterways	Apply only to still water and/or public waters. Do not apply to turbid waters. Do not use treated water for irrigation of food crops, preparation of agricultural sprays, or for drinking for 5 days after application. Turf and nonfood crops may be irrigated 3 days after treatment. Do not use water for livestock for one day after treatment. Water use restrictions may be removed if an approved assay is conducted and water concentration is less than the maximum contaminant level as specified on product label.
dyes (Admiral Liquid) (Aquashade)	ponds and lakes with little to no outflow	No not apply to water bodies not under direct control of user. Do not apply to water that will be used for human consumption.
endothall (Aquathol K) 4.23 lb/gal (Aquathol Super K granular) 63% (Hydrothol 191) 2 lb a.i./gal (Hydrothol granular) 11.2%	drainage canals, lakes, ponds	Restrictions up to 25 days may apply to waters used for domestic uses, irrigation, or watering livestock. Setback distance of at least 600 feet from functioning potable water intakes may also apply. Refer to specific product label for current restrictions on domestic use, irrigation, livestock use, and setback distance. Hydrothol formulations may kill fish when rates exceed 0.3 ppm. Check label for drinking water restrictions. Fish may be killed by rates exceeding 0.3 ppm. Irrigation and animal consumption restrictions of 7 to 25 days, depending on rate.
Flumioxazin (Clipper) 51%	Bayous, canals, fresh water ponds, lakes, marshes, and reservoirs	Do not irrigate from treated water for at least 5 days. Do not treat water used for crawfish production.
fluridone (Sonar 4 AS or SRP)	lakes, ponds, canals	Treated ponds may not be used for irrigation for 7 to 30 days. See label for irrigation precautions. ¹
glyphosate (AquaMaster) 5.4 lb a.i./gal (AquaNeat) 5.4 lb a.i./gal (Rodeo) 5.4 lb a.i./gal (Touchdown Pro) 3 lb a.e./gal Other formulations	all bodies of fresh water and all types of aquatic sites	Do not apply within 0.5 mile of an active potable water intake (upstream only in flowing waters), or turn intake off for at least 48 hours as specified on product label. Refer to specific product label for restrictions.
imazamox (Clearcast)	in and around aquatic and noncropland sites	Irrigation: Do not apply to water to be used for irrigation of greenhouse or nursery plants. Do not irrigate from still or quiescent water bodies within 24 hours of application. Do not irrigate if concentrations exceed 50 ppb.
imazapyr (Habitat)	in and around standing and flowing waters, including estuarine and marine sites	Irrigation: Do not use treated water for 120 days following application or until an assay indicates that chemical water concentrations are below a minimum amount as specified on the product label. Do not apply within 0.5 mile of an active potable water intake (upstream only in flowing waters), or turn intake off for at least 48 hours as specified on product label. Do not apply to fast-moving waters. Do not apply to irrigation ditches or canals within 1 mile of an active irrigation water intake unless the irrigation restrictions can be observed. Applicators must be licensed or certified by the state.
penoxsulam (Galleon)	in and around quiescent water bodies and exposed sediments of de-watered areas	Do not apply to flowing water. Irrigation: Do not apply to water to be used for irrigation of greenhouse or nursery plants. Do not irrigate established food crops, other than rice, if concentrations exceed 1 ppb. Do not irrigate established rice if concentrations in treated water exceed 30 ppb. No restrictions on use of treated water for turf irrigation, if concentrations are less than 30 ppb. Consult SePRO for other situations/commodities.

Table 7-25. Labeled Sites and Restrictions

Herbicide and Formulation	Labeled Sites	Restrictions
sodium carbonate peroxyhydrate (GreenClean Pro) (PAK 27)	ponds, lakes, lagoons, canals, ditches, etc.	Do not apply to treated, finished drinking water reservoirs.
triclopyr (Renovate 3) 3 lb/gal (Renovate OTF) 10 G	quiescent and slow-moving waters; non-irrigation canals	Irrigation: Do not use treated water for 120 days following application or until treated water has a non-detectable triclopyr level by an assay as specified on the product label. No restriction on irrigation of established grass. Applications around potable water intakes must observe minimum setback distances and/or minimum water concentrations as specified on the product label. Do not apply directly to or allow to come in direct contact with grapes, tobacco, vegetable crops, flowers, and other desirable broadleaf plants. Do not apply to estuarine or marine sites; do not apply directly to un-impounded rivers or streams; and do not apply to irrigation ditches or canals. Do not allow lactating dairy animals to graze treated areas until the next growing season after application unless spot-treatment was applied to less than 10% of total grazable area. Animals for slaughter must be removed from the treated area for at least 3 days.

¹Water use restrictions for irrigation vary with formulation. See label for precautions. A 30-day restriction may be insufficient if applied to small ponds intended for irrigation of very sensitive crops, such as tobacco, tomatoes, or peppers.

Chemical Control of Specific Weeds

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Table 7-26. Chemical Control of Specific Weeds

Herbicide and Formulation	Amount of Formulation	Time of Application	Precautions and Remarks
Artichoke, Betony or Florida Betony			
dichlobenil (Casoron) 4 G (Gordon's Barrier) 4 G (Proteam Zapzit) 4 G	100 to 250 lb/acre	Any time. Fall or winter best.	<i>Do not use on cropland.</i> See Precautions and Remarks under Weed Control in Woody Ornamentals . In order to comply with state noxious weed regulations, contact your local plant protection specialist or NCDA&CS weed specialist at 919-707-3749.
mesotrione (Tenacity) 4 SC	4 to 8 fl oz/acre	Apply to young, actively growing weeds.	Use a nonionic surfactant at 0.25% v/v. Reapply in 3 weeks. Controls Florida betony.
Bamboo (Cane)			
glyphosate (Accord) 4 SL (Roundup PRO) 4 SL and various other trade names	2% solution sprayed to wet	Midsummer to early fall while actively growing.	For large canes; first cut canes and allow to regrow to 4 to 6 feet in height. Avoid drift to desirable vegetation. Use Accord for forestry and utility rights-of-way sites.
	1 part herbicide + 2 parts water, applied with sponge	Whenever new shoots are in the "husk" stage (before leaves open) and are 12 feet to 24 inches in height.	Wear rubber gloves. Wipe entire shoot with a sponge dampened with the herbicide. Sponge should not be dripping wet. Do not allow contact with desirable vegetation; avoid dripping onto grass.
Bermudagrass			
glyphosate + fluazifop (Roundup PRO) 4 SL + (Fusilade DX) 2 EC	2 to 0.75 qt/acre	See Precautions and Remarks	Apply when bermudagrass is actively growing. Repeat applications when bermudagrass regrows. Wait 30 days after last application to seed, sprig, or sod new bermudagrass.
Dazomet (Basamid)	218 to 525 lb/acre	See Precautions and Remarks	Restricted Use Pesticide. May be used to control many annual and perennial weed species including bermudagrass. Apply to properly prepared soil and incorporate physically or with water. Consult and follow label directions.
Berries (<i>Rubus</i> spp.)			
glyphosate (Accord) 4 SL (Roundup PRO) 4 SL and various other trade names	3 to 4 qt/acre as broadcast spray or 1% to 1.5% solution with handheld equipment	After bloom stage	Use higher rate for plants that have reached the woody stage of growth. Best results are obtained when sprayed in late summer after berries are formed. Use Accord for forestry and utility rights-of-way sites. Roundup PRO should be used for industrial and other noncropland areas. Use Roundup ULTRA on agricultural areas.
triclopyr amine (Garlon 3 A) 3 SL	1 gal/100 gal water	After leaves fully expand in spring and before leaf color change in fall	See comments under kudzu.
Florida Betony			
atrazine (AATrex 4L) 4L	1 to 2 qt/A	Fall and/or winter	May be used on centipedegrass, St. Augustinegrass and dormant bermudagrass. Do not apply after Dec. 31 on bermudagrass unless delay in greenup is acceptable.
triclopyr + clopyralid (Confront) 3 SL	1 to 2 pt/A	Fall and/or winter	Do not apply to home lawns. May be used on centipedegrass, bermudagrass, and zoysiagrass. Do not apply to bermudagrass during transition. Repeat applications may be required.
MCPA amine + triclopyr amine + dicamba (Horsepower) 4.56 L	2 to 3 pt/A	Fall and/or winter	May be applied to home lawns by a commercial applicator. Not for use on turf grown for resale or other commercial uses such as sod or seed production. May be used on bermudagrass, zoysiagrass and bahiagrass.
MCPA ester + triclopyr ester + dicamba (Coolpower) 3.6 L	2.5 to 3.5 pt/A	Fall and/or winter	May be applied to home lawns by a commercial applicator. Not for use on turf grown for resale or other commercial uses such as sod or seed production. May be used on bermudagrass, zoysiagrass and bahiagrass.