

SECTION L.

AQUATIC WEED CONTROL

Kim Patten, John Madsen and Vanessa Howard Morgan

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In many ways, aquatic weeds are similar to terrestrial or land weeds. There are annuals and perennials. Many flower and produce seed, others propagate only asexually. Some produce tubers or winter buds, some are more shade tolerant than others, and nearly all respond to fertilization. Therefore, the management and control of these pests is similar in many respects to that of land weeds.

Usually, aquatic weeds are separated into four broad categories: emergent, submersed, floating, and algae. Emergent plants (sometimes called bank or marginal plants) are those rooted or anchored in the substratum with most of the leafstem tissue above the water surface. They do not rise and fall with the water level. Examples are: cattail (*Typha* spp.), Bulrush (*Schoenoplectus* spp.), and horsetails (*Equisetum* spp.). Submersed plants are adapted to grow with all or most of their vegetative tissue below the water surface. Examples of submersed plants include pondweeds (*Potamogeton* spp.), coontail (*Ceratophyllum demersum*), and Brazilian elodea (*Egeria densa*). Floating plants are those that are either free-floating or anchored to the substratum. They produce most of their leafstem tissue, or thalli, at or above the water surface. Leaves or thalli of floating plants rise and fall with the water level. Examples of floating plants include the duckweeds (*Lemna* spp.), azolla (*Azolla* spp.), and fragrant waterlilies (*Nymphaea odorata*). Most algae are also submersed and free-floating. However, some may be anchored by holdfasts to the substratum, rocks, old stumps, and other objects. Algae do not have true roots, stems, or leaves and are frequently called “pond scums” or slime.

Control Options for Emergent and Aquatic Weeds

Wise water management is necessary if aquatic vegetation control is to be more than temporary. Management must begin by evaluating all uses of a given body of water. Chemical, biological, and physical factors should be well understood and manipulated if possible to get the maximum use of the water for the benefit of the greatest number of people. Before undertaking management of aquatic weeds, consider the following:

- Biological aspects
 - Identify the problem species
 - Identify other species present
 - Determine density, stand, or scope of problem and stage of weed growth
 - Determine fish species present
- Water-use aspects
 - Irrigation, potable, recreation, fish production, livestock, and wildlife
 - Length of time water can be quarantined from each use
 - Amount and destination of outflow. Can outflow be regulated? If so, for how long?
- Physical aspects:
 - Size of channel or pond to be treated
 - Water depth and movement or velocity
 - Water turbidity
 - Water temperature
 - Water quality

Our expanding population and water use have increased the need to prudently manage our limited water supply. Increased fertilization, for example, stimulates aquatic plant growth and may trigger harmful algae blooms (cyanobacteria). Prime sources of fertilization are: 1) discharging untreated or septic-tank-treated wastes from shoreline homes; 2) storm sewer drainage from fertilized lawns and gardens; 3) uncontrolled drainage from heavily fertilized farmland and livestock feeding lots; 4) discharging effluents from municipal sewage treatment plants; 5) drainage from garbage dumps near watercourses, and 6) discharging treated or untreated wastes from industrial plants. Eliminating faulty practices and using good land and water management practices are essential in controlling unwanted aquatic vegetation.

Other cultural practices may prevent weedy aquatic plants from establishing or may minimize their impact. Vegetative buffers, comprised of plants with substantial root systems, like many rushes or sedges, can minimize inflow of excess nutrients into ponds or other impoundments. At a minimum, avoid fertilization of turf grasses within 10 to 20 feet of open water. Constructing ponds, ditches and canals with steep banks will minimize the marginal areas available for emergent weeds to become established. Banks with a 1 to 1.5 percent slope that extends at least 3 feet below the designed water level are optimal. Remove fertile topsoil from the pond or reservoir basin. If a beach area for swimming and other recreational purposes is desired, remove the fertile topsoil and replace it with sand. If possible, prevent water heavily laden with silt and nutrients from entering an impoundment. For ditch banks, plant grasses and use a 2,4-D program to keep out most undesirable broadleaf plants. East of the Cascades, seed redtop or creeping red fescue at the waterline, and crested wheatgrass on the shoulders and top of the ditch bank. Provide roadways on both ditch banks for weed control and other operations. Provide means to control water levels and water flow.

Biological Control

A few approved biological control agents are available for treatment of aquatic weeds common in the Pacific Northwest. The efficacy of biocontrol measures is difficult to predict, and even successful biocontrol programs generally do not result in a weed being eradicated. While biocontrol may serve as a solitary control measure, it typically works better as a complement to other strategies. Many of our most common aquatic weeds do not have viable control options. This is a function of stringent rules established to protect natural resources, including agricultural crops and native plants. Despite these limitations, a few biocontrol options for aquatic plants are worth noting.

The milfoil weevil (*Eurychiopsis lecontei*) is a native weevil normally found on the native northern watermilfoil (*Myriophyllum sibiricum*). This native weevil prefers to lay eggs on the non-native Eurasian watermilfoil (*Myriophyllum spicatum*) but requirements for overwintering habitat and susceptibility to fish predation may reduce efficacy. No operational plan for the use of native insects has been published in a peer-reviewed journal.

Grass carp (*Ctenopharyngodon idella*) have been used in limited settings to control abundant populations of aquatic plants. Only

sterile, triploid grass carp are permitted as biological control agents. Grass carp are generalist herbivores with some feeding preferences. They do not typically feed on emergent plants or water lilies, and strongly prefer some submersed species to others. The criteria and permit requirements for stocking grass carp vary from state to state. In Washington, a private fish stocking permit and possibly a Hydraulic Project Approval application (where inlets/outlets require screening) are required from the Washington Department of Fish and Wildlife. In Oregon, permits are issued by the Oregon Department of Fish and Wildlife only if: a) the waterbody is on private land (or land owned by an irrigation district or otherwise limited access to the public); b) is less than 10 acres or is a ditch or canal; c) and is outside the 100 year flood plain and is screened with ODFW approved screens.

These and other requirements limit the number of scenarios where grass carp are a viable option for weed control. Stocking rates vary according to the permitting agency and site specific conditions.

A number of classical biocontrol agents have been highly successful at controlling purple loosestrife (*Lythrum salicaria*). Two leaf-feeding beetles (*Galerucella californiensis* and *G. pusilla*), one root-feeding weevil (*Hyllobius transversovittatus*) and one seed-head weevil (*Nanophyes marmoratus*) have significantly reduced plant density and the number of flowering stems (thus reducing seed production) of purple loosestrife when populations have become established.

Manual or Physical Control

A number of physical control measures are available for control of emergent and aquatic weeds. These are generally those methods that are non-chemical and non-motorized. They include hand pulling, rakes, cutters, benthic barriers, drawdown, aeration, shading and weed rollers.

Equipment costs for manual or physical control are typically very low, but such measures are labor intensive and are therefore better suited to small, less established weed populations. Hand pulling and raking may result in turbid or murky water and may create plant fragments that can subsequently spread to new sites.

Mechanical Control

Many mechanical control technologies are available and may prove a reasonable choice depending on site specifics.

On ditch banks, mowers, scythes or string trimmers will temporarily reduce stands of emergent plants; searing or burning of plants with a propane torch may further retard growth, but needs to be done repeatedly for plants with established root systems as well as new weed seedlings.

In open water, cutting or shredding boats can slice through swaths of thick emergent or floating weeds to allow navigation channels between open water and moorage sites or docks. Rotovators, essentially large-scale underwater rototillers, work by tilling up lake, pond or river sediments to chop and loosen plant roots, which may then be skimmed from the water surface. These work well in loose cobble sediments where shallow rooted plants are easily dislodged.

Growth of emergent plants like cattails can be reduced by dredging, where fertile sediments are removed and water depth is increased to 6 to 10 feet. However, dredging is costly and will not generally prevent the growth of submersed plants. Additionally, dredging may require a Section 404 permit from the US Army Corps of Engineers, and/or a removal-fill permit from Oregon Department of State Lands or a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife. Mechanical harvesting machines cut aquatic plants approximately 5 feet below

the water surface and then convey the material to an on-board storage bin which may then be off-loaded for disposal. Mechanical harvesters are maneuverable around fixed structures like docks, but indiscriminately harvest everything in their path, potentially resulting in undesirable by-catch of fish, other wildlife or desirable native plants.

Chemical Control

When used in, over or near surface waters, herbicides must be registered for aquatic use.¹ Considerations in choosing a herbicide should include safety, effectiveness and selectivity, residues, and cost. Use restrictions for fishing, swimming, domestic use, livestock watering or irrigation are explicitly stated on labels and serve to protect people, domestic animals and wildlife. Check with local state game department or other regulatory personnel before applying herbicides to lakes, ponds, irrigation canals and other impoundments or conveyances.

In response to Sixth Circuit court decision (National Cotton Council, et al. vs. EPA) that required the EPA to develop permits for certain pesticide applications in, over and near waters of the State, NPDES-authorized states including Oregon and Washington have developed permit programs regulating applications of aquatic herbicides. In Oregon, the Department of Environmental Quality (OR DEQ) NPDES Program has developed two permits: the Pesticide General Permit (2300A) and the Irrigation District General Permit (2000J). These were required as of October 31, 2011.

In Washington, the Washington Department of Ecology (WADOE) manages the Aquatic Noxious Weed Control NPDES General Permit, Aquatic Plant and Algae Management General Permit, and The Irrigation System Aquatic Weed Control General Permit. These permits regulate the use of pesticides applied to manage aquatic plants in the surface waters of the State of Washington. Refer to the WADOE website (<http://www.ecy.wa.gov/programs/wq/pesticides/index.html>) to obtain the latest permit updates and legal requirements for the use of aquatic herbicides in Washington. In addition, products applied to aquatic sites in Washington are regulated as state restricted-use pesticides; their purchase and application must be made by properly licensed applicators who have an aquatic endorsement.

¹ All herbicides discussed in this chapter were approved for use in aquatic habitats as of June 2017, according to the Pesticide Information Center Online (PICOL) Database.

Calculations for Treating Flowing Water

Irrigation canals, drainage ditches, etc.

Definitions

ppm = (1 milligram or milliliter/L)

ppb = parts per billion (1 microgram or micro liter/L)

cfs = flow in cubic ft/ second

ppm = (Number of gallons of solvent x 1,000,000) ÷
(Number of cfs x 450 x time in minutes)

Gallons of solvent per cfs =
(450 x time in minutes x ppm) ÷ 1,000,000

Total gallons of solvent =
450 x time in minutes x ppm x cfs ÷ 1,000,000

Calculations for Treating Ponds and Lakes

Concentration based on parts per million by volume (ppm)

$$Q = A \times D \times C \times 0.33$$

Q = Number of gallons of herbicide required

A = Area of water surface in acres

D = Average depth of the pond or lake in feet

C = Desired final concentration of herbicide in ppm

Concentration based on parts per million by weight (ppm)

$$P = A \times D \times C \times 2.72$$

P = Number of pounds (active ingredient) of herbicide required

A = Area of water surface in acres

D = Average depth of the pond or lake in feet

C = Desired final concentration of herbicide in ppm

Concentration based on parts per billion by weight (ppb)

$$P = A \times D \times C \times 0.0027$$

P = Number of pounds (active ingredient) of herbicide required

A = Area of water surface in acres

D = Average depth of the pond or lake in feet

C = Desired final concentration of herbicide in ppb

Caution!

The information provided in this handbook is not intended to be a complete guide to herbicide use. Before using any chemical, read the recommendations on the label. Before a chemical can be recommended for a specific use, it must be thoroughly tested. Recommendations on the manufacturer's label, when followed, can prevent many problems arising from the improper use of a chemical.

Algae in Lakes, Ponds, Reservoirs, and Irrigation Channels

copper sulfate pentahydrate²

Rate 0.25 to 2 ppm suspended in burlap bags, poured directly into water of irrigation channels, injected into the water column, or applied over water surface of impoundments.

Time Apply early in spring and at 2- to 3-week intervals thereafter.

Remarks Safe in potable and irrigation water. Do not wait until a severe algae problem develops before applying. Efficacy reduced with low water temperatures and hard water.

Caution May be toxic to fish and aquatic invertebrates (especially trout); treat 1/2 to 1/3 of the water at a time and wait a minimum of 10 to 14 days between treatments.

Site of action Plant cells

Chemical family Inorganic

² Copper compounds are not allowed for aquatic use in Washington, except under the NPDES general permit for Irrigation Districts.

dimethylamine salts of endothall (Hydrothol)

Rate 0.05 to 0.3 ppm (for general algal control); 0.3 to 1.5 ppm (for increased longevity or use on difficult to treat species of algae). Sprayed on the water, injected below surface or granular application.

Time Apply when algal growth appears.

Remarks Liquid and granular formulations. Apply if algae in the irrigation channel must be removed to allow water delivery. However, water-use restrictions apply. See Caution below.

Caution Toxic to fish and wildlife. Fish may be killed at dosages above 0.3 ppm. Not for use in brackish/salt water. Minimum 600 ft setback from functioning potable water intakes. Do not use treated water for irrigation or agricultural sprays on food crops, watering livestock, or domestic purposes within 7 to 25 days following treatment, depending on concentration applied. Do not treat more than 1/10 of lake or pond at one time with concentrations higher than 1.0 ppm. Marginal or sectional treatments rather than an overall treatment is recommended.

Site of action Not well understood

Chemical family None generally recognized

sodium percarbonate (GreenClean)

Rate 30 to 170 lb per acre foot (heavy algal growth); 3 to 17 lb per acre foot (low algal growth/maintenance) broadcast manually or by a mechanical spreader. Liquid solutions may also be applied via surface treatment.

Time Apply when algal growth appears; apply early in the day during calm, sunny weather.

Remarks Short residual time; no use restrictions for swimming, fishing, irrigation, stock watering, following treatment. Uniform applications required for optimal results as these products only control algae in direct contact with granules/liquid.

Caution NOT intended for use in drinking water. Toxic to birds. Do not bring in contact with other pesticides, cleaners or oxidative agents.

Site of action Oxidizing agent after dissociating in water into sodium carbonate and hydrogen peroxide (H₂O₂).

Chemical family None generally recognized

sodium carbonate peroxyhydrate (GreenCleanPRO)

Rate 20 to 90 lb per acre foot (heavy algal growth); 2 to 9 lb per acre foot (low algal growth/maintenance) broadcast granules or suspended in burlap bags. Liquid solution may also be applied via surface treatment or injection.

Time Apply when algal growth appears; apply early in the day during calm, sunny weather.

Remarks Short residual time; no use-restrictions for swimming, fishing, irrigation, stock watering, drinking or domestic use following treatment. Uniform applications required for optimal results as these products only control algae in direct contact with granules/liquid. Liquid applications may not penetrate surface mats or blooms; second application may be required to treat bottom-growing algae.

Caution Avoid drift to adjacent crops where IPM strategies are in use as this product is toxic to bees, other beneficial insects and birds. Avoid use in shallow waters during amphibian breeding season. Excessive amounts of decaying algae can deplete dissolved oxygen,

potentially leading to fish kills; consider treating 1/2 to 1/3 of area at a time.

Site of action Oxidizing agent after dissociating in water into sodium carbonate and hydrogen peroxide (H₂O₂)

Chemical family None generally recognized

hydrogen peroxide (GreenClean Liquid)

Rate 1 to 30 gallons per surface acre.

Time Apply when algal growth appears; apply early in the day during calm, sunny weather.

Remarks May not penetrate surface mats or blooms; second application may be required to treat bottom-growing algae. No use restrictions. OMRI listed.

Caution Excessive amounts of decaying algae can deplete dissolved oxygen, potentially leading to fish kills; consider treating 1/2 to 1/3 of area at a time.

Site of action Oxidizing agent

Chemical family None generally recognized

Submersed Weeds in Flowing Canals and Ditches³

acrolein (Magnacide H)

Rate up to 8 ppm.

Time Apply when weed growth is no more than 4 to 6 inches tall.

Remarks Repeat treatments every 3 to 4 weeks during the remainder of the season.

Caution A **restricted-use herbicide**, due to its acute toxicity to humans. For retail sale to, and use by, certified applicators and only for those uses covered by the certified applicator's certification. Do not let humans or animals drink treated water. Toxic to fish and many other aquatic organisms. Special application equipment required. Use only oxygen-free nitrogen for a pressurizing agent. Following application, do not release treated water into any fish-bearing water, or area that might drain into fish-bearing water, until after the minimum waiting period defined on the appropriate label.

Site of action General cell toxicant

Chemical family None generally recognized

dimethylamine salts of endothall (Hydrothol)

Rate 0.2 to 5 ppm in flowing water for 6 to 120 hours.

Time Apply when submersed weeds are actively growing and interfering with water delivery.

Remarks Apply where water is slightly turbulent to facilitate mixing. Do not use treated water for any purpose within 7 to 25 days following treatment, depending on concentration applied. Not to exceed 5 ppm per application; maximum 30 ppm per growing season.

Caution Toxic to fish and wildlife. Fish may be killed at dosages above 0.3 ppm. Not for use in brackish/salt water. Minimum 600 ft setback from functioning potable water intakes. Do not use treated water for irrigation or agricultural sprays on food crops, watering livestock, or domestic purposes within 7 to 25

days following treatment, depending on concentration applied. Do not treat more than 1/10 of lake or pond at one time with concentrations higher than 1.0 ppm. Marginal or sectional treatments rather than an overall treatment is recommended.

Site of action Not well understood

Chemical family None generally recognized

Submersed Weeds in Non-flowing Canals and Ditches

2,4-D (Hardball)

Rate 2.5 to 6.2 gal/A-ft as concentrate.

Time Apply when plants are actively growing.

Remarks For use in quiescent or slow moving waters; apply to moving bodies of water only while traveling upstream. No use restrictions for swimming, fishing, watering livestock or domestic purposes other than noted below.

Caution Limited to 2 applications per season; maximum of 10.8 lb ae/acre-foot per application; minimum 21 days between applications. Irrigation/spray use of water requires setback distance of 600 to 2,400 ft from functional water intakes, a waiting period of 21 days or approved assay of 2,4-D concentrations <100 ppb. Drinking water use requires setback distance from functioning water intakes of 600 to 2,400 ft, a waiting period of 21 days from application, or approved assay of 2,4-D concentrations < 70 ppb at water intake. See label for sampling requirements and posting requirements. To avoid oxygen depletion and potential fish kills, treat no more than half the waterbody at a time; for large infestations, leave buffer strips 100 ft wide and delay treatment of these for four to five weeks.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

carfentrazone (Stingray)

Rate 0.05 to 0.2 lb ai/A.

Time Apply in spring or early summer to actively growing weeds.

Remarks Inject into water with a boat-mounted injection system. Material may be applied as a surface spray only in combination with a suitable polymer or similar adjuvant that will ensure rapid sinking and mixing of the spray mix. Apply only to water with little or no outflow.

Caution Moderately toxic to fish. Do not exceed 200 ppb in treated water. Do not apply within 1/4 mile of functioning potable water intakes in flowing or standing water. To avoid oxygen depletion and potential fish kills, treat no more than half the waterbody at a time; wait a minimum of 14 days before treating the remaining area. Consult label for water use restrictions.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazinone

dipotassium salt of endothall (Cascade Aquatic Herbicide)

Rate 0.5 to 5 ppm for varying exposure times (see label for specifics by target weed).

Time Apply as early as possible after weeds appear and while actively growing.

³ In Washington, applicators using these herbicides in flowing canals or ditches water must ensure that their concentrations do not exceed those stated in the NPDES permit at the point of compliance.

Caution Toxic to fish and wildlife. Not for use in brackish/salt water. Minimum 600 ft setback from functioning potable water intakes. Do not use treated water for animal consumption or other domestic use within 7 to 25 days of treatment, depending on concentration applied. Not effective on elodea or *chara*. Treat areas with abundant growth of weeds in sections, and 5 to 7 days apart to avoid fish kill due to low oxygen level from decomposing weeds.

Site of action Not well understood

Chemical family None generally recognized

diquat (Diquat Herbicide or Reward)

Rate 1 to 4 lb ai/A (0.5 to 2.0 gallons per surface acre).

Time Apply when weeds are actively growing and water temperatures are above 50°F.

Remarks Apply only to ponds and lakes with little or no outflow. Use diquat in waters that are totally under your control. In public waters, only federal or state public agencies or contractors under their direct control may use this product. Treat submersed weeds using an invert emulsion applied by either subsurface or bottom applications (surface applications to treat dense submersed weeds or in depths over 2 feet is not recommended). Safe for fish at the rates given. This treatment is not effective on attached algae or *chara*. There are no swimming or fishing restrictions in treated water.

Caution A moderately toxic herbicide that requires protective gear for handling and application. Toxic to aquatic invertebrates. Do not use treated water for domestic purposes, animal consumption, spraying, or irrigating food crops for 1 to 5 days depending on water use and rate applied. Do not let spray contact skin, eyes, or clothing. Do not breathe spray mist. Do not use in turbid water. To avoid oxygen depletion and potential fish kills, treat no more than half the waterbody at a time; wait a minimum of 14 days before treating the remaining area.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyrilidium

fluridone (Sonar, Avast!)

Rate 30 to 150 ppb per treated surface acre; maximum application rate or sum of all application rates cannot exceed 150 ppb per annual growth cycle.

Time For best results, apply just before or just as weeds begin active growth.

Remarks Treat when water movement will be minimal. Results are best when fluridone contacts target plants for at least 45 days. Conduct an enzyme-linked immunosorbent assay test (ELISA) to determine the concentration of active ingredient in the water. Use an application pattern that gives uniform distribution; avoid concentrating the herbicide.

Caution Irrigating with treated water may injure crops. See label for irrigation times after application. Do not irrigate established tree crops for at least 7 days after application. Depending on formulation and application site, do not irrigate other crops for 7 to 30 days after application. May injure vegetation growing along shoreline. Do not apply at rates greater than 20 ppb within 0.25 miles of any functioning potable water intake.

Site of action Group 12: bleaching; inhibits carotenoid biosynthesis

Chemical family None generally recognized

imazamox (Clearcast)

Rate 50 to 500 ppb surface applied or injected.

Time Apply early in the growing season.

Remarks Surface apply or inject into water column. Injection more effective on some species. Consult label. Apply to water with little or no flow. Repeat applications may be made, but do not apply at rates resulting in water concentrations greater than 500 ppb. There are no restrictions on use of treated water for livestock, swimming, fishing, agricultural spray or domestic use, as long as the setback restriction is observed.

Caution Do not use treated water to irrigate greenhouses, nurseries, or hydroponics. Do not use treated water for other irrigation purposes less than 24 hours after application is completed, and only as long as concentrations in water are equal to or less than 50 ppb. When treating irrigation canals, the initial flush of recharge water after application must not be used for irrigation purposes. Note label restrictions on setback distances on applications to potable water intakes.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

penoxsulam (Galleon SC)

Rate 5 to 150 ppb (0.9 to 26.1 fl. oz/A-ft).

Time Apply only to actively growing weeds.

Remarks For postemergence foliar applications or treatments to exposed sediments, use with a surfactant approved for aquatic use (use with organosilicone surfactants not recommended). May be mixed with other herbicides or algacides according to label specifications. Single applications should target minimum effective concentration of 25 to 75 ppb; split or multiple applications should target an initial dose of 10 to 30 ppb and subsequent applications to maintain that concentration for a minimum of 60 days. Use ELISA (enzyme-linked immunosorbent assay test) or other analytical techniques to determine penoxsulam concentrations.

Caution Maximum target concentration in any treated area is 150 ppb ai per annual growth cycle. Do not apply Galleon SC through any type of irrigation system or use treated water for hydroponic farming, irrigating greenhouses or nursery plants; see label for other crop specific irrigation restrictions. Do not use in areas subject to rapid dilution.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Triazolopyrimidine

Submersed Weeds in Lakes and Ponds

2,4-D (Hardball)

Rate 2.5 to 6.2 gal/A-ft as concentrate.

Time Apply when plants are actively growing.

Remarks For use in quiescent or slow-moving waters; apply to moving bodies of water only while traveling upstream. No use restrictions for swimming, fishing, watering livestock or domestic purposes other than noted below.

Caution Limited to 2 applications per season; maximum of 10.8 lb ae/A-ft per application; minimum 21 days between applications. Irrigation/spray use of water requires setback distance of 600 to 2400 feet from functional water intakes, a waiting period of 21 days or approved assay of 2,4-D concentrations <100 ppb. Drinking water use requires setback distance from functioning

water intakes of 600 to 2400 feet, a waiting period of 21 days from application, or approved assay of 2,4-D concentrations < 70 ppb at water intake. See label for sampling requirements and posting requirements. To avoid oxygen depletion and potential fish kills, treat no more than half the waterbody at a time; for large infestations, leave buffer strips 100 feet wide and delay treating them for four to five weeks.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

2,4-D granules (Aqua-Kleen, Navigate)

Rate 100 to 200 lb product/A.

Time Apply in spring or early summer before plants reach the water surface.

Remarks Susceptible weeds include water milfoils (*Myriophyllum* spp.) and water stargrass (*Heteranthera dubia*); higher rates and/or repeat treatments may be required for other weeds. Apply granules uniformly over water surface, either by hand or with a rotary spreader.

Caution Do not apply to water used for watering animals, agricultural sprays, domestic use, or irrigation. If weeds are abundant, treat one-third of the pond or lake at a time to avoid fish kill (due to low oxygen from decomposing weeds). Safe for fish at rate given.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

2,4-D dimethylamine salt (DMA 4IVM, Base Camp and others)

Rate 5.4 to 10.8 lb ae/A-ft

Time Apply in spring or early summer when aquatic weeds appear.

Remarks Apply to obtain a concentration of 2 to 4 ppm. A second application may be needed when weeds show signs of recovery.

Caution Maximum of 10.8 lb ae/A-ft per application; limited to 2 applications per season. Toxic to fish and aquatic invertebrates. Do not treat areas free of weeds. If weeds are abundant, treat 1/3 of the pond or lake at a time to avoid fish kill (due to low oxygen from decomposing weeds). Do not use water for irrigation if approved assay indicates 2,4-D concentration is above 0.1 ppm (100 ppb). Do not use treated water for drinking if approved assay indicates 2,4-D concentration is above 0.07 ppm (70 ppb). See label for sampling requirements and posting requirements.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

bispyribac-sodium (Tradewind)

Rate 15 to 45 ppb

Time Apply in spring or early summer to actively growing weeds.

Remarks Apply as a subsurface application targeting submerged aquatic weeds in slow moving or quiescent bodies of water. Repeat application to maintain desired water column concentration for 60 to 90 days, or until target weed is controlled. The use of ELISA (enzyme-linked immunosorbent assay test) or other analytical methods is recommended to determine if and when it is necessary to make sequential applications. Do not reapply

within 14 days after initial application, and do not exceed four applications per year.

Caution Do not apply to flowing water, intertidal or estuarine areas. Do not use treated water to irrigate food or ornamental crops, or as a water source for livestock until the concentration is ≤ 1 ppb. To delay herbicide resistance, alternate non-group 2 herbicides when possible. Consult label for other water use restrictions.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Pyrimidinylthiobenzoate

carfentrazone (Stingray)

Rate 0.05 to 0.2 lb ai/A.

Time Apply in spring or early summer to actively growing weeds.

Remarks Inject into water with a boat-mounted injection system. Material may be applied as a surface spray only in combination with a suitable polymer or similar adjuvant that will ensure rapid sinking and mixing of the spray mix. Apply only to water with little or no outflow.

Caution Moderately toxic to fish. Do not exceed 200 ppb in treated water. Do not apply within 1/4 mile of functioning potable water intakes in flowing or standing water. To avoid oxygen depletion and potential fish kills, treat no more than half the waterbody at a time; wait a minimum of 14 days before treating the remaining area. Consult label for water use restrictions.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazinone

dipotassium salt of endothall (Cascade)

Rate 0.5 to 5 ppm spread or sprayed on the water or injected below the water surface

Time Apply as early as possible after weeds appear, while actively growing.

Caution Toxic to fish and wildlife. Minimum of 600 ft setback from functioning potable water intakes. Do not use treated water for animal consumption or other domestic use within 7 to 25 days of treatment, depending on concentration applied. This formulation, at given concentrations, is not effective on elodea or *chara*. Treat areas with abundant growth of weeds in sections, 5 to 7 days apart to avoid fish kill due to low oxygen level from decomposing weeds.

Site of action Not well understood

Chemical family None generally recognized

dimethylamine salts of endothall (Hydrothol)

Rate 0.5 to 3 ppm sprayed on the water or injected below the surface.

Time Apply in late spring or early summer, while actively growing.

Caution **Toxic to fish and wildlife.** Fish may be killed at dosages above 0.3 ppm. Not for use in brackish/salt water. Minimum of 600 ft setback from functioning potable water intakes. Do not use treated water for irrigation or agricultural sprays on food crops, watering livestock, or domestic purposes within 7 to 25 days following treatment, depending on concentration applied. Do not treat more than 1/10 of lake or pond at one time with concentrations higher than 1.0 ppm. Marginal or sectional treatments rather than an overall treatment is recommended.

Site of action Not well understood

Chemical family None generally recognized

diquat (Diquat Herbicide or Reward)

Rate 1 to 4 lb ai/A (0.5 to 2.0 gallons per surface acre).

Time Apply when weeds are actively growing and water temperatures are above 50°F.

Remarks Apply only to ponds and lakes with little or no out-flow. Use diquat in waters that are totally under your control. In public waters, only federal or state public agencies or contractors under their direct control may use this product. Treat submersed weeds using an invert emulsion applied by either subsurface or bottom applications (surface applications to treat dense submersed weeds or in depths over 2 feet is not recommended). Safe for fish at the rates given. This treatment is not effective on attached algae or *chara*. There are no swimming or fishing restrictions in treated water.

Caution A moderately toxic herbicide that requires protective gear for handling and application. Toxic to aquatic invertebrates. Do not use treated water for domestic purposes, animal consumption, spraying, or irrigating food crops for 1 to 5 days depending on water use and rate applied. Do not let spray contact skin, eyes, or clothing. Do not breathe spray mist. Do not use in turbid water. To avoid oxygen depletion and potential fish kills, treat no more than half the water body at a time; wait a minimum of 14 days before treating the remaining area.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyrindilium

flumioxazin (Clipper)

Rate 100 to 400 ppb ai

Time Apply in spring or early summer to actively growing plants with limited biomass, and when weeds are growing in lower pH (less than 8.5) waters with high light penetration into the water column.

Remarks Apply in a sufficient volume of water per acre to ensure adequate contact with target weeds. Use higher concentrations when weed biomass is heavy and/or weeds are more mature and topped out. Do not exceed 400 ppb of the active ingredient flumioxazin during any one application. When making applications to water bodies greater than 7 feet deep, do not exceed 14.8 pounds of product per surface acre. Buffer spray solution to pH less than 7.0. Due to photosynthetic processes of submersed plants and algae, water pH tends to be lower in early morning hours compared to afternoon hours. Therefore, in water bodies with a higher pH, apply as early in the morning as possible to maximize the length of time Clipper Herbicide will remain at efficacious concentrations in the water column. To ensure adequate coverage, apply Clipper Herbicide with weighted trailing hoses in order to place the herbicide under the surface and throughout the biomass of aquatic vegetation. Keep swath width to a minimum in order to maximize contact with submersed aquatic vegetation.

Caution Rapid decomposition of vegetation resulting from herbicide treatment can result in loss of oxygen in water. A sudden decrease in dissolved oxygen can result in fish suffocation. If aquatic vegetation is dense, treat floating surface weeds in sections to avoid a rapid decrease in dissolved oxygen. Treat up to half of the water body and wait 10 to 14 days before treating the remaining area. Do not apply to flowing water, intertidal or estuarine areas. Treated water may not be used for irrigation purposes until at least five days after application. Do not re-treat

the same section of water with flumioxazin more than 6 times per year. Consult label for water use restrictions.

Site of action Group 14: protoporphyrinogen oxidase (PPO) inhibitor

Chemical family N-phenylphthalimide

fluridone (Sonar or Avast!)

Rate Ponds 45 to 90 ppb; whole lakes 10 to 90 ppb. Sum of all applications must not exceed 90 ppb/year for ponds; 150 ppb for lakes and reservoirs.

Time For best results, apply just before or just as weeds begin active growth.

Remarks For fluridone, a pond is defined as body of water 10 acres or less. A lake or reservoir is defined as having a surface area greater than 10 acres. Treat when water movement will be minimal. Rate is determined by area and depth of water treated, and density of target vegetation. May be applied to a pond's entire surface area. In lakes and reservoirs, apply to areas greater than 5 acres. Results are best when fluridone is in contact with target plants for at least 45 days. Make an enzyme-linked immunosorbant assay test (ELISA) to determine the active ingredient's concentration in the water. See label for rates for split or multiple applications to whole lakes and reservoirs and for partial lake treatment rates.

Caution Irrigating with treated water may injure crops. See label for irrigation times after applying. Do not irrigate established tree crops for at least 7 days after application. Depending on formulation and application site, do not irrigate other crops for 7 to 30 days after application. May injure vegetation along shoreline. Do not apply within 0.25 miles of any functioning potable water intake at rates greater than 20 ppb.

Site of action Group 12: bleaching; inhibits carotenoid biosynthesis

Chemical family None generally recognized

imazamox (Clearcast)

Rate 50 to 500 ppb broadcast to water surface or injected.

Time Apply early in the growing season.

Remarks Surface apply or inject into water column. May be applied as undiluted product or diluted with water prior to application. When weeds are matted at the surface, imazamox should be injected below the water surface to achieve better distribution. Apply to water with little or no flow. Repeat applications may be made, but do not apply at rates resulting in water concentrations greater than 500 ppb.

Caution Do not use treated water to irrigate greenhouses, nurseries, or hydroponics. Do not use treated water for other irrigation purposes less than 24 hours after application is completed, and only as long as concentrations in water are equal to or less than 50 ppb. Note label restrictions on setback restrictions to potable water intakes.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

penoxsulam (Galleon SC)

Rate 5 to 150 ppb (0.9 to 26.1 fl. oz/A-ft)

Time Apply only to actively growing weeds.

Remarks For post emergent foliar applications or treatments to exposed sediments, use with a surfactant approved for aquatic use (use with organosilicone surfactants not recommended).

May be mixed with other herbicides or algacides according to label specifications. Single applications should target minimum effective concentration of 25 to 75 ppb; split or multiple applications should target an initial dose of 10 to 30 ppb and subsequent applications to maintain that concentration for a minimum of 60 days (use ELISA or other analytical techniques to determine penoxsulam concentrations).

Caution Maximum target concentration in any treated area is 150 ppb ai per annual growth cycle. Do not use treated water for hydroponic farming, irrigating greenhouses or nursery plants; see label for other crop specific irrigation restrictions. Do not use in areas subject to rapid dilution, such as spot treatments in lakes or other large water bodies.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Triazolopyrimidine

triclopyr (Renovate 3 or Renovate LZR)

Rate 0.75 to 2.5 ppm ae concentration in water; apply as surface or subsurface application.

Time Apply in spring or early summer to actively growing weeds.

Remarks Treat 1/3 to 1/2 of the water body at a time and wait 10 to 14 days between applications to prevent possible fish kills due to oxygen depletion. Rates higher in the range are recommended in areas of greater water exchange. Apply as a surface or subsurface application in water that has little or no continuous outflow. When using liquid triclopyr to treat plants 6 ft below the water surface, use trailing hoses along with an approved aquatic sinking agent. There are no restrictions on recreation, including swimming and fishing, in the treated area or on livestock consumption of water.

Caution Do not apply when conditions favor drift to sensitive areas. Observe minimum setback distances from functional potable water intakes for human consumption. Do not exceed 2.5 ppm per season. Do not apply this product through any type of irrigation system and do not use treated water for irrigation for 120 days.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

Emergent Weeds in Marshes

2,4-D (Hardball)

Rate 2.3 gal/A in minimum spray volume of 5 gal mix/A with surface applications; 2.3 gal/A through standard boom system with minimum of 5 gal/A of spray mix.

Time Apply in spring or early summer; if needed, a second treatment may be applied before September.

Remarks Applications should be made when leaves are fully developed, above the waterline, and actively growing. Do not apply when wind speeds are at or above 10 mph (ground/surface applications) or 5 mph (aerial applications). No use-restrictions for swimming, fishing, watering livestock or domestic purposes other than noted below. See label for instructions on use of drift control agents and equipment to prevent drift to sensitive crops.

Caution Limited to 2 applications per season; maximum of 2.3 gal/A (4 lb ae/A) per application; minimum 21 days between applications. Irrigation/spray use of water requires setback distance of \geq 600 ft from functional water intakes, waiting period of 7 days or approved assay of 2,4-D concentrations $<$ 100 ppb. Drinking water use requires setback distance from functioning water intakes \geq 600 ft or drinking

water notification prior to application. See label for sampling requirements and posting requirements.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

2,4-D dimethylamine salt (DMA 4 IVM, Base Camp and others)

Rate 2 to 4 pints/A.

Time Apply in spring or early summer when aquatic weeds appear.

Remarks Repeat as necessary to kill regrowth or missed plants; use 4 pints/A rate when plants are mature or dense.

Caution Maximum of 8 pints/A per application; limited to 2 applications per season. Toxic to fish and aquatic invertebrates. Do not treat areas free of weeds. If weeds are abundant, consider partial treatments to avoid fish kill (due to low oxygen from decomposing weeds). Do not use water for irrigation if approved assay indicates 2,4-D concentration is above 0.1 ppm (100 ppb). Do not use treated water for drinking if approved assay indicates 2,4-D concentration is above 0.07 ppm (70 ppb). See label for sampling requirements and posting requirements.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

glyphosate (Rodeo, AquaNeat, AquaPro, AquaMaster, Cinco, Accord Concentrate and others)

Rate 0.75 to 3.75 lb ae/A (1.5 to 7.5 quart/A) applied as a broadcast spray or 0.75 to 2.0% solution in water applied through hand-held or high-volume equipment.

Time Apply when weeds or brush are actively growing.

Remarks See product label for application rate and growth stage of weed and brush species. If water is in the area to be sprayed, add a surfactant labeled for use in water at the manufacturer's surfactant label recommendations. Surfactant must be at least 80% ai. If used following drawdown, allow seven days after treatment before reintroducing water; treat within one day after drawdown to ensure weeds are actively growing.

Caution Rain within 6 hours after application may reduce effectiveness. Do not apply within 0.5 miles upstream of potable water intakes. Apply to moving bodies of water only while traveling upstream. Do not exceed 3.75 lb ae/A in any single application being made over water. Take care to avoid drift to desirable plants. Do not spray where weeds do not exist.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

imazamox (Clearcast)

Rate 0.125 to 0.5 lb ai/A (16 to 64 fl oz/A)

Time Apply as a foliage spray to actively growing emergent and floating plants.

Remarks Rate depends on species to be controlled. Postemergence applications require adding a spray adjuvant approved for use in aquatic sites. There are no restrictions on livestock watering, swimming, fishing, or domestic use as long as the setback restriction is observed, or for agricultural sprays.

Caution Do not use treated water to irrigate greenhouses, nurseries, or hydroponics. Do not use treated water for other irrigation purposes unless concentrations in water are equal to or

less than 50 ppb. Note label restrictions on setback restrictions to potable water intakes.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

imazapyr, isopropylamine salt (Arsenal, Habitat, Polaris AQ)

Rate 0.5 to 1.5 lb ae/A (2 to 6 pints/A), applied with surface or helicopter equipment in minimum of 2 gal water/A. For low volume foliar applications, use 0.5 to 5% concentration (without applying more than 6 pints/A per year).

Time Apply to vigorously growing emergent and floating vegetation.

Remarks Controls several annual, biennial, and perennial grass and broadleaf species. Rate depends on weed species and growth stage at time of application. Postemergence applications require adding a spray adjuvant (such as a nonionic surfactant or methylated seed oil) approved for use in aquatic sites. Controls emerged and floating vegetation that has most of its foliage above the water surface. No restrictions on recreational or livestock use of treated water. Moistens, but do not drench target vegetation.

Caution Do not apply more than 1.5 lb ae/A (6 pints/A product) per year. Do not apply within 0.5 miles of a potable water intake in a standing body of water unless the intake can be turned off for at least 48 hours after treatment. Do not apply to irrigation water. Unless imazapyr residues in the water are below 1 ppb, as determined by laboratory analysis, wait at least 120 days after application before using water for irrigation. To avoid oxygen depletion, treat no more than half a waterbody at a time, waiting 10 to 14 days between treatments. Do not spray where weeds do not exist.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

triclopyr (Renovate 3)

Rate 0.75 to 6 lb ae/A

Time Apply to actively growing broadleaf weeds and woody plants.

Remarks Use a labeled nonionic surfactant. Use the higher rates if hard-to-control species are prevalent or applications are in late summer or weeds are mature. There are no restrictions on recreation, including swimming and fishing, in treatment area or on livestock consumption of water.

Caution Do not apply when conditions favor drift to sensitive areas. Observe minimum setback distances from functional potable water intakes for human consumption. Do not exceed 6 lb ae/A per annual growing season.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

penoxsulam (Galleon SC)

Rate 2 to 5.6 fl oz/A with at least 10 GPA for aerial foliar applications and up to 100 GPA for ground foliar applications; for pre- or postemergent applications to exposed sediments, use 5.6 to 11.2 fl oz/A in a total spray volume of 20 to 100 GPA.

Time Apply only to actively growing weeds.

Remarks For post emergent foliar applications or treatments to exposed sediments, use with a surfactant approved for aquatic use (use with organosilicone surfactants not recommended). May be mixed with other herbicides or algaecides according to label specifications. Single applications should target minimum

effective concentration of 25 to 75 ppb; split or multiple applications should target an initial dose of 10 to 30 ppb and subsequent applications to maintain that concentration for a minimum of 60 days (use ELISA or other analytical techniques to determine penoxsulam concentrations).

Caution Maximum target concentration in any treated area is 150 ppb ai per annual growth cycle. Do not use in areas subject to rapid dilution, such as spot treatments in lakes or other large water bodies.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Triazolopyrimidine

Emergent Weeds along Drainage Ditches

2,4-D (Hardball)

Rate 1.15 gal/A (2 lb ae/A) with 100 to 400 GPA spray mixture with power sprayers

Time Apply in spring or early summer; if needed, a second treatment may be applied before September.

Remarks Applications should be made when leaves are fully developed, above the waterline, and actively growing. Do not apply when wind speeds are at or above 10 mph (ground/surface applications) or 5 mph (aerial applications). See label for instructions on use of drift control agents and equipment to prevent drift to sensitive crops.

Caution Limited to 2 applications per season; maximum of 1.15 gal/A (2 lb ae/A) per application; maximum of 2.25 gal/A (4 lb ae/A) per season; minimum 30 days between applications. Do not use on small canals with flow rates < 10 cfs where water will be used for drinking water purposes. Do not overspray to opposite bank or allow boom spray to be directed onto water surface; allow no more than 2 foot overspray onto water with an average of less than one foot overspray.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

2,4-D dimethylamine salt (DMA 4 IVM, Base Camp and others)

Rate 2 to 4 pints/A

Time Apply in spring or early summer when aquatic weeds appear.

Remarks Repeat as necessary to kill regrowth or missed plants; use 4 pints/A rate when plants are mature or dense.

Caution Maximum of 8 pints/A per application; limited to 2 applications per season, a minimum of 21 days apart. Toxic to fish and aquatic invertebrates. Do not treat areas free of weeds. If weeds are abundant, consider partial treatments to avoid fish kill (due to low oxygen from decomposing weeds). Do not use water for irrigation if approved assay indicates 2,4-D concentration is above 0.1 ppm (100 ppb). Do not use treated water for drinking if approved assay indicates 2,4-D concentration is above 0.07 ppm (70 ppb). See label for sampling requirements and posting requirements. Do not use on small canals with flow rates < 10 cfs where water will be used for drinking water purposes. Do not overspray to opposite bank or allow boom spray to be directed onto water surface; allow no more than 2 foot overspray onto water with an average of less than one foot overspray.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

bispyribac-sodium (Tradewind)

Rate 0.05 to 0.1 lb ai/A (1 to 2 oz/A)

Time Apply in spring or early summer to the foliage of actively growing weeds.

Remarks When applying to dense foliage of actively growing weeds, a second application may be required to ensure adequate coverage. Use with an adjuvant approved for aquatic use. Allow 30 days between applications, apply no more than 8 oz of product per acre per year, and do not exceed 4 applications per year. Bispyribac may be mixed with other registered foliar-applied aquatic herbicides for enhanced control of floating and emergent weeds.

Caution With aerial applications do not spray within 200 feet of dwellings, adjacent sensitive crops or environmentally sensitive areas. Consult label for water use restrictions.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Pyrimidonylthiobenzoate

flumioxazin (Clipper)

Rate 6 to 12 oz/A

Time Apply in spring or early summer to the foliage of actively growing weeds.

Remarks It is most effective when applied to young, actively growing weeds in water with a pH less than 8.5. Clipper Herbicide breaks down rapidly and loses herbicidal effectiveness in high pH water (pH greater than 8.5). When applying to dense foliage of actively growing weeds, a second application may be required to ensure adequate coverage. Application of Clipper Herbicide during early morning hours may enhance weed control. Use with an adjuvant approved for aquatic use. Buffer spray solution to pH less than 7.0. Do not re-treat the same section of water within 28 days of application. Flumioxazin may be mixed with other registered foliar applied aquatic herbicides for enhanced control of floating and emergent weeds.

Caution Rapid decomposition of vegetation resulting from herbicide treatment can result in loss of oxygen in water. A sudden decrease in dissolved oxygen can result in fish suffocation. If aquatic vegetation is dense, treat floating surface weeds in sections to avoid a rapid decrease in dissolved oxygen. Treat up to half of the water body and wait 10 to 14 days before treating the remaining area. With aerial applications do not spray within 200 feet of dwellings, adjacent sensitive crops or environmentally sensitive areas. Consult label for water use restrictions.

Site of action Group 14: protoporphyrinogen oxidase (PPO) inhibitor

Chemical family N-phenylphthalimide

glyphosate (Rodeo, AquaNeat, AquaPro, AquaMaster, Cinco, or Accord Concentrate)

Rate 0.75 to 3.75 lb ae/A (1.5 to 7.5 quart/A) applied as a broadcast spray or 0.75 to 2.0% solution in water applied through hand-held or high-volume equipment

Time Apply when weeds and brush are actively growing.

Remarks See label for application rate and growth stage of weed and brush species. If water is in the area to be sprayed, add a surfactant labeled for use in water at the manufacturer's surfactant label recommendations. Surfactant must be at least 80% ai. In dry ditches or after drawdown, allow seven days after treatment before reintroducing water; treat within one day after drawdown

to ensure weeds are actively growing. Apply as a 33% solution through wiper-type applicators. May be applied through hand-held or high-volume equipment as a 0.75 to 1.5% solution.

Caution Rain within 6 hours after application may reduce effectiveness. Do not apply within 0.5 miles upstream of potable water intakes. Apply to moving bodies of water only while traveling upstream. Do not overlap bank side applications more than 1 foot into open water. Do not exceed 3.75 lb ae/A in a single application being made over water. Take care to avoid drift to desirable plants. With bankside applications, do not overlap more than one foot into open water. Do not spray where weeds do not exist.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

imazamox (Clearcast)

Rate 0.125 to 0.5 lb ai/A (16 to 64 oz product/A)

Time Apply as a foliage spray to actively growing emergent and floating plants.

Remarks Rate depends on species to be controlled. Postemergence applications require adding a spray adjuvant approved for use in aquatic sites. There are no restrictions on livestock watering, swimming, fishing, or domestic use as long as the setback restriction is observed, or for agricultural sprays.

Caution Do not use treated water to irrigate greenhouses, nurseries, or hydroponics. Do not use treated water for other irrigation purposes unless concentrations in water are equal to or less than 50 ppb. Note label restrictions on setback restrictions to potable water intakes.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

imazapyr, isopropylamine salt (Arsenal, Habitat, Polaris AQ)

Rate 0.5 to 1.5 lb ae/A (2 to 6 pints/A), applied with surface or helicopter equipment in minimum of 2 gal water/A. For low volume foliar applications, use 0.5 to 5% concentration (without applying more than 6 pints/A per year).

Time Apply to vigorously growing emergent and floating vegetation.

Remarks Controls several annual, biennial, and perennial grass and broadleaf species. Rate depends on weed species and growth stage at time of application. Postemergence applications require adding a spray adjuvant (such as a nonionic surfactant or methylated seed oil) approved for use in aquatic sites. Controls emerged and floating vegetation that has most of its foliage above the water surface. No restrictions on recreational or livestock use of treated water. Moisten, but do not drench, target vegetation.

Caution Do not apply more than 1.5 lb ae/A (6 pints/A product) per year. Do not apply to canals or ditches unless a 120 day restriction on irrigation water can be observed or residual levels of imazapyr are determined by laboratory analysis to be less than 1.0 ppb. Do not apply to dry irrigation canals or ditches. Do not apply within 0.5 miles downstream of an active irrigation water intake. Applications upstream of active irrigation water intakes must be turned off for a period of time sufficient to allow treated water to completely flow past the intake (determined by water velocity, distance and length of water treated). To avoid oxygen depletion, treat no more than half a waterbody at a time, waiting

10-14 days between treatments. Do not spray where weeds do not exist.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

penoxsulam (Galleon SC)

Rate 2 to 5.6 fl oz/A with at least 10 GPA for aerial foliar applications and up to 100 GPA for ground foliar applications. For pre- or post-emergence applications to exposed sediments, use 5.6 to 11.2 fl oz/A in a total spray volume of 20 to 100 GPA.

Time Apply only to actively growing weeds.

Remarks For post-emergent foliar applications or treatments to exposed sediments, use with a surfactant approved for aquatic use (use with organosilicone surfactants not recommended). May be mixed with other herbicides or algaecides according to label specifications. Single applications should target minimum effective concentration of 25 to 75 ppb; split or multiple applications should target an initial dose of 10 to 30 ppb and subsequent applications to maintain that concentration for a minimum of 60 days (use ELISA or other analytical techniques to determine penoxsulam concentrations).

Caution Maximum target concentration in any treated area is 150 ppb ai per annual growth cycle. Do not apply Galleon SC through any type of irrigation system or use treated water for hydroponic farming, irrigating greenhouses or nursery plants; see label for other crop specific irrigation restrictions. Do not use in areas subject to rapid dilution.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Triazolopyrimidine

Emergent Weeds along Irrigation Ditches

2,4-D dimethylamine salt (DMA 4IVM, Base Camp and others)

Rate 2 to 4 pints/A product in 20 to 100 gal water

Time Apply in spring or early summer when weeds appear, but prior to bud or bloom.

Remarks Repeat as necessary to kill regrowth or missed plants; use 4 pints/A rate when plants are mature or dense. Do not overspray to opposite bank or allow boom spray to be directed onto water surface; allow no more than 2 foot of overspray onto water, with an average of less than one foot.

Caution Maximum of 4 pints/A per application; limited to 2 applications per season, a minimum of 30 days apart. Toxic to fish and aquatic invertebrates. Do not treat areas free of weeds. If weeds are abundant, consider partial treatments to avoid fish kill (due to low oxygen from decomposing weeds). Do not use water for irrigation if approved assay indicates 2,4-D concentration is above 0.1 ppm (100 ppb). Do not use treated water for drinking if approved assay indicates 2,4-D concentration is above 0.07 ppm (70 ppb). See label for sampling requirements and posting requirements. Do not use on small canals with flow rates < 10 cfs where water will be used for drinking water purposes. Do not allow dairy animals to graze on treated areas for a minimum of seven days after application.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

glyphosate (Rodeo, AquaNeat, AquaPro, AquaMaster, Cinco, Accord Concentrate and others)

Rate 0.75 to 3.75 lb ae/A (1.5 to 7.5 quarts/A) applied as a broadcast spray or 0.75 to 2.0% solution in water applied through hand-held or high-volume equipment

Time Apply when weeds and brush are actively growing.

Remarks See label for application rate and growth stage of weed and brush species. If water is in the area to be sprayed, add a surfactant labeled for use in water at the manufacturers' surfactant label recommendations. Surfactant must be at least 80% ai. In dry ditches or after drawdown, allow seven days after treatment before reintroducing water; treat within one day after drawdown to ensure weeds are actively growing. Apply as a 33% solution through wiper-type applicators. May be applied through hand-held or high-volume equipment as a 0.75 to 1.5% solution.

Caution Rain within 6 hours after application may reduce effectiveness. Do not apply within 0.5 miles upstream of potable water intakes. Apply to moving bodies of water only while traveling upstream. Do not overlap bank side applications more than 1 foot into open water. Do not exceed 3.75 lb ae/A in a single application being made over water. Take care to avoid drift to desirable plants. With bankside applications, do not overlap more than one foot into open water. Do not spray where weeds do not exist.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

imazapyr, isopropylamine salt (Arsenal, Habitat, Polaris AQ)

Rate 0.5 to 1.5 lb ae/A (2 to 6 pints/A), applied with surface or helicopter equipment in minimum of 2 gal water/A. For low volume foliar applications, use 0.5 to 5% concentration (without applying more than 6 pints/A per year).

Time Apply to vigorously growing emergent and floating vegetation.

Remarks Controls several annual, biennial, and perennial grass and broadleaf species. Rate depends on weed species and growth stage at time of application. Postemergence applications require adding a spray adjuvant (such as a nonionic surfactant or methylated seed oil) approved for use in aquatic sites. Controls emerged and floating vegetation that has most of its foliage above the water surface. No restrictions on recreational or livestock use of treated water. Moistens, but do not drench target vegetation.

Caution Do not apply more than 1.5 lb ae/A (6 pints/A product) per year. Do not apply to canals or ditches unless a 120 day restriction on irrigation water can be observed or residual levels of imazapyr are determined by laboratory analysis to be less than 1.0 ppb. Do not apply to dry irrigation canals or ditches. Do not apply within 0.5 miles downstream of an active irrigation water intake. Applications upstream of active irrigation water intakes must be turned off for a period of time sufficient to allow treated water to completely flow past the intake (determined by water velocity, distance and length of water treated). To avoid oxygen depletion, treat no more than half a waterbody at a time, waiting 10 to 14 days between treatments. Do not spray where weeds do not exist.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

Broadleaf, Floating, Emergent, Marginal, and Bank Weeds of Ponds and Lakes

2,4-D dimethylamine salt (DMA 4 IVM, Base Camp and others)

Rate 2 to 4 pints/A product in 20 to 100 gal/A

Time Apply in spring or early summer when aquatic weeds appear, prior to bud or bloom.

Remarks Repeat as necessary to kill regrowth or missed plants; use 4 pints/A rate when plants are mature or dense.

Caution Maximum of 8 pints/A per application; limited to 2 applications per season, a minimum of 21 days apart. Toxic to fish and aquatic invertebrates. Do not treat areas free of weeds. If weeds are abundant, consider partial treatments to avoid fish kill (due to low oxygen from decomposing weeds). Do not use water for irrigation if approved assay indicates 2,4-D concentration is above 0.1 ppm (100 ppb). Do not use treated water for drinking if approved assay indicates 2,4-D concentration is above 0.07 ppm (70 ppb). See label for sampling requirements and posting requirements. Do not use on small canals with flow rates < 10 cfs where water will be used for drinking water purposes. Do not overspray to opposite bank or allow boom spray to be directed onto water surface; allow no more than 2-foot overspray onto water with an average of less than one foot of overspray.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

bispyribac-sodium (Tradewind)

Rate 0.05 to 0.1 lb ai/A (1 to 2 oz/A)

Time Apply in spring or early summer to the foliage of actively growing weeds.

Remarks When applying to dense foliage of actively growing weeds, a second application may be required to ensure adequate coverage. Use with an adjuvant approved for aquatic use. Allow 30 days between applications, apply no more than 8 oz of product per acre per year, and do not exceed 4 applications per year. Bispyribac may be mixed with other registered foliar applied aquatic herbicides for enhanced control of floating and emergent weeds.

Caution With aerial applications do not spray within 200 feet of dwellings, adjacent sensitive crops or environmentally sensitive areas. Consult label for water use restrictions.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Pyrimidonylthiobenzoate

carfentrazone (Stingray)

Rate 0.05 to 0.2 lb ai/A

Time Apply in spring or early summer to actively growing weeds.

Remarks Inject into water with a boat-mounted injection system. Material may be applied as a surface spray only in combination with a suitable polymer or similar adjuvant that will ensure rapid sinking and mixing of the spray mix. Apply only to water with little or no outflow.

Caution Moderately toxic to fish. Do not exceed 200 ppb in treated water. Do not apply within 1/4 mile of functioning potable water intakes in flowing or standing water. To avoid oxygen depletion and potential fish kills, treat no more than half

the waterbody at a time; wait a minimum of 14 days before treating the remaining area. Consult label for water use restrictions.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Triazinone

glyphosate (Rodeo, AquaNeat, AquaPro, AquaMaster, Cinco, Accord Concentrate and others)

Rate 0.75 to 3.75 lb ae/A (1.5 to 7.5 quarts/A) applied as a broadcast spray or 0.75 to 2.0% solution in water applied through hand-held or high-volume equipment

Time Apply when weeds and brush are actively growing.

Remarks See label for application rate and growth stage of weed and brush species. Floating mats of vegetation may require re-treatment. If emergent infestations require treating the total surface of impounded water, treating the area in strips may avoid oxygen depletion, due to decaying vegetation, and prevent subsequent fish kill. If water is in the area to be sprayed, add a surfactant labeled for use in water at the manufacturers' surfactant label recommendations. Surfactant must be at least 80% ai. In dry ditches or after drawdown, allow seven days after treatment before reintroducing water; treat within one day after drawdown to ensure weeds are actively growing. Apply as a 33% solution through wiper-type applicators. May be applied through hand-held or high-volume equipment as a 0.75 to 1.5% solution.

Caution Rain within 6 hours after application may reduce effectiveness. Do not apply within 0.5 miles upstream of potable water intakes. Apply to moving bodies of water only while traveling upstream. Do not overlap bank side applications more than 1 foot into open water. Do not exceed 3.75 lb ae/A in a single application being made over water. Take care to avoid drift to desirable plants. With bankside applications, do not overlap more than one foot into open water. Do not spray where weeds do not exist.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

imazamox (Clearcast)

Rate 0.125 to 0.5 lb ai/A (16 to 64 oz product/A)

Time Apply as a foliage spray to actively growing emergent and floating plants.

Remarks Rate depends on species to be controlled. Postemergence applications require adding a spray adjuvant approved for use in aquatic sites. There are no restrictions on livestock watering, swimming, fishing, or domestic use as long as the setback restriction is observed, or for agricultural sprays.

Caution Do not use treated water to irrigate greenhouses, nurseries, or hydroponics. Do not use treated water for other irrigation purposes unless concentrations in water are equal to or less than 50 ppb. Note label restrictions on setback restrictions to potable water intakes.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

imazapyr, isopropylamine salt (Arsenal, Habitat, Polaris AQ)

Rate 0.5 to 1.5 lb ae/A (2 to 6 pints/A), applied with surface or helicopter equipment in minimum of 2 gal water/A. For low volume foliar applications, use 0.5 to 5% concentration (without applying more than 6 pints/A per year).

Time Apply to vigorously growing emergent and floating vegetation.

Remarks Controls several annual, biennial, and perennial grass and broadleaf species. Rate depends on weed species and growth stage at time of application. Postemergence applications require adding a spray adjuvant (such as a nonionic surfactant or methylated seed oil) approved for use in aquatic sites. Controls emerged and floating vegetation that has most of its foliage above the water surface. No restrictions on recreational or livestock use of treated water. Moistens, but do not drench target vegetation.

Caution Do not apply more than 1.5 lb ae/A (6 pints/A product) per year. Do not apply within 1.0 mile of an active irrigation water intake during irrigation season; applications of < 1 mile may be made during off-season, provided irrigation will remain inactive for 120 days minimum following treatment or until laboratory analysis shows imazapyr levels < 1.0 ppb.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

triclopyr (Renovate 3)

Rate 0.75 to 6 lb ae/A; 0.75 to 2.5 ppm ae concentration in water

Time Apply to actively growing broadleaf weeds and woody plants.

Remarks Use a labeled nonionic surfactant. Use the higher rate when plants are mature or weed mass is dense or for difficult-to-control weeds. Repeat as necessary to control re-growth and plants missed in the previous application. There are no restrictions on recreation in the treated area, including swimming and fishing, or on livestock consumption of water.

Caution Do not apply when conditions favor drift to susceptible vegetation. Do not exceed 6 lb ae/A triclopyr (8 quarts/A of Renovate) per annual growing season. Consult label for setback distances from potable water intakes when applying to control floating and emerged weeds in lakes, reservoirs, or ponds.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

Floating Weeds in Lakes, Ponds, Irrigation Canals, and Drainage Ditches**diquat (Diquat Herbicide or Reward)**

Rate 1 to 4 lb ai/A (0.5 to 2.0 gal per surface acre)

Time Apply when weeds are actively growing and water temperatures are above 50°F.

Remarks Add a registered nonionic surfactant when spot spraying at <0.5 gal per acre. Apply only to ponds and lakes with little or no outflow. Use diquat in waters that are totally under your control. In public waters, only federal or state public agencies, or contractors under their direct control, may use this product. Treat floating weeds by spot or broadcast treatments. Safe for fish at the rates given. There are no swimming or fishing restrictions for treated water.

Caution A moderately toxic herbicide that requires protective gear for handling and application. Do not allow spray to drift or come in contact with adjacent crops. Do not use treated water for domestic purposes, animal consumption, spraying, or irrigation for 1 to 5 days depending on water use and rate applied. Safe for fish at rates given. Do not let spray come in contact with skin, eyes, or clothing. Do not breathe spray mist.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

glyphosate (Rodeo, AquaNeat, AquaPro, AquaMaster, Cinco, Accord Concentrate and others)

Rate 0.75 to 3.75 lb ae/A (1.5 to 7.5 quart/A) applied as a broadcast spray or 0.75 to 2.0% solution in water applied through hand-held or high-volume equipment

Time Apply when weeds and brush are actively growing and most foliage is above the water surface.

Remarks See label for application rate and growth stage of weed and brush species. Floating mats of vegetation may require re-treatment. Add a surfactant labeled for use in water at the manufacturer's surfactant label recommendations; surfactant must be at least 80% ai.

Caution Rain within 6 hours after application may reduce effectiveness. Do not apply within 0.5 miles upstream of potable water intakes. Apply to moving bodies of water only while traveling upstream. Do not overlap bank side applications more than 1 foot into open water. Do not exceed 3.75 lb ae/A in a single application being made over water. Take care to avoid drift to desirable plants. Do not spray where weeds do not exist.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

penoxsulam (Galleon SC)

Rate 2 to 5.6 fl oz/A with at least 10 GPA for aerial foliar applications and up to 100 GPA for ground foliar applications; for pre- or postemergent applications to exposed sediments, use 5.6 to 11.2 fl oz/A in a total spray volume of 20 to 100 GPA.

Time Apply only to actively growing weeds.

Remarks For postemergence foliar applications or treatments to exposed sediments, use with a surfactant approved for aquatic use (use with organosilicone surfactants not recommended). May be mixed with other herbicides or algacides according to label specifications. Single applications should target minimum effective concentration of 25 to 75 ppb; split or multiple applications should target an initial dose of 10 to 30 ppb and subsequent applications to maintain that concentration for a minimum of 60 days (use ELISA or other analytical techniques to determine penoxsulam concentrations).

Caution Not for use in irrigation canals. Maximum target concentration in any treated area is 150 ppb ai per annual growth cycle. Do not apply Galleon SC through any type of irrigation system or use treated water for hydroponic farming, irrigating greenhouses or nursery plants; see label for other crop specific irrigation restrictions. Do not use in areas subject to rapid dilution.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Triazolopyrimidine

Treated Water Use Restrictions (Numbers of Days)

Trade Name	Common Name	Human			Animal	Irrigation		
		Drinking	Swimming	Fish Consumption	Drinking	Turf	Forage	Food Crops
Aquathol K	Endothall ^a	7-25	1	0	7-25	0	7-25	7-25
Aquathol Super K	Endothall ^a	7	1	0	7	0	7	7
Various	Copper Complexes	0	0	0	0	0	0	0
	Copper Sulfate ^a	0	0	0	0	0	0	0
Aqua-Kleen, DMA 4 IVM, Navigate	2,4-D	21 ^b	--	--	0	21 ^c	21 ^c	21 ^{c,d}
Habitat	Imazapyra	2	0	0	0	120 ^d	120 ^d	120 ^d
Hydrothol 191, Teton	Endothall	7-25	1	0	7-25	7-25	7-25	7-25
Renovate 3	Triclopyr	^f	0	0	0 ^g	0 ^h	120 ^h	120 ^h
Reward, Weedtrine-D	Diquat	1-3	0	0	1	1-3	5	5
Rodeo, AquaPro	Glyphosate	0	0	0	0	0	0	0
Sonar (Sonar AS, Sonar ARP, Sonar PR, Sonar QR)	Fluridone ^a	0	0	0	0	30 ⁱ	30 ⁱ	30 ^h
Stingray	Carfentrazone ethyl	1 ^k	0	0	1 ^k	14 ^k	14 ^k	14 ^k
GreenClean	Sodium percarbonate	no	0	0	no	0	0	0
GreenCleanPro, PAK 27, Phycomycon SPC	Sodium percarbonate peroxyhydrate ^a	0	0	0	0	0	0	0
Magnacide H	Acrolein ^a	no	no	no	no	See label		
Clipper	Flumioxazin	0	0	no	0	0-3	0	5
petroleum distillate	Xylene ^a	no	no	no	no	See label		
Clearcast	Imazamox	0 ^l	0	0	0	See label		
Tradewind	Bispyribac-sodium	0	0	0	0 ^l	0	0	0 ^l
Galleon SC	penoxsulam	0	0	0	0	0 ^m	0 ^m	0 ^{m,j}

^a For Washington there are additional water use restrictions mandated within the Aquatic Plant and Algae Management General Permit and the Irrigation Canal General Permit.

^b See label for distance allowed from potable water intake.

^c Shorter interval may be used if approved assay indicates less than 0.1 ppm 2,4-D.

^d Do not use in ditches where water is used to irrigate highly susceptible crops, such as cotton, grapes, and tomatoes.

^e Less if Habitat herbicide residue levels are determined by laboratory analysis or other appropriate means of analysis to be below 1 ppb.

^f Drinking water can only be used when concentration of Renovate 3 is less than 0.4 ppm as determined by laboratory analysis.

^g See label for drinking water or grazing restrictions for lactating dairy animals.

^h If Renovate 3 residue levels are determined to be nondetectable by laboratory analysis, there is no restriction for use of irrigation water on established grasses.

ⁱ Restrictions suggested by manufacturer.

^j No restrictions if less than 20% of the water surface is treated.

^k When concentration is less than 50 ppb

^l When concentration is less than 1 ppb

^m When concentration is less than 30 ppb

Control of Some Common Aquatic Weeds with Herbicides

	Copper Complexes Copper Sulfate a	Hydrothol 191	Reward	2,4-D	Aquathol K or Super K	Glyphosate	Sonar	Habitat	Renovate 3	Stingerray b	Galleon SC	Tradewind	Clearcast	Clipper	GreenClean	GreenCleanPro, PAK 27
Algae																
cyanobacteria or potentially environmentally harmful algae (single cell)	x	x													x	x
filamentous and water net	x	x	x											x	x	x
Chara and Nitella	x	x														
Floating Weeds (not attached to bottom)																
Azolla			x			x				x	x	x	x			
duckweed			x				x			x	x	x		x		
watermeal			x				x	x		x	x			x		
Emerged Weeds (attached to bottom)																
watershield				x			x		x	x			x			
fragrant waterlily				x			x	x	x				x			
frogbit			x	x				x	x	x			x	x		
water pennywort			x					x			x	x	x	x		
flowering rush			x				x						x			
parrotfeather			x	x	x		x	x	x	x	x	x	x			
spikerush				x			x				x		x			
Submersed Weeds																
bladderwort			x		x		x						x			
coontail		x	x		x		x		x				x	x		
bushy pondweeds (Najas)		x	x		x		x						x	x		
Eurasian watermilfoil		x	x	x	x		x		x	x	x		x	x		
fanwort		x					x		x					x		
pondweeds (Potamogeton)			x		x		x				x	x	x	x		
egeria / elodea	x	x	x				x				x					
hydrilla		x					x					x	x	x		
Emerged / shoreline Weeds																
water primrose						x		x	x							
yellow flag iris						x		x								
purple loosestrife						x		x								
phragmites & reed canary grass						x		x								
smartweed				x		x	x	x	x		x		x			
arrowhead		x	x	x			x	x	x		x		x			
willows				x		x		x	x	x						
cattail			x			x		x					x			
bulrush						x		x			x					
burweed				x												

NOTE: X indicates suppression or control of the specified aquatic weed by a particular herbicide. It is not intended that any suggested usage in this table be in violation with existing regulations or manufacturer's label.

^aUse of products containing copper are restricted because its toxicity to fish and its effectiveness in controlling aquatic weeds is depend on total alkalinity of the water. Copper cannot be used anywhere in Washington, except irrigation canals. This requires a NPDES irrigation permit.

^bProduct is efficacious when used in combination with a herbicide with systemic activity.

Treatment of Aquatic Weeds

Aquatic weeds	Treatment	Rate	Comments
Floating			
algae	copper sulfate (pentahydrate)	1 to 2 ppmw	Toxicity to fish and algae increases with temperature but decreases with water alkalinity. For water with less than 50 ppm total alkalinity, do not use copper sulfate. For water above 50 ppm, determine the amount of copper to use by dividing total alkalinity (ppm) by 100. This equals the desired copper concentration in the water. Catfish are not very tolerant to copper. Always leave untreated aquatic areas for fish to move into.
	copper complex	0.67 to 0.75 gal/A foot water 1.25 to 1.5 gal/A foot water	Complexed forms of copper are more active in alkaline water than the sulfate. For water with less than 50 ppm alkalinity, catfish may be killed. Apply a surface spray. Apply when algae begin to grow and water temperature is above 60°F. Best results when applied on sunny days. Apply when total alkalinity is above 50 ppm
duckweed	diquat	1 gal/surface acre	Inject or spray in nonflowing water. Do not apply diquat to muddy water. Spraying along the margins reduces reinfestation. Retreat if necessary.
Submerged			
elodea	diquat	2 gal/A	Inject or apply on surface of nonflowing water. Do not apply diquat to muddy water.
Eurasian watermilfoil	2,4-D amine	10 to 40 lb/A	Do not treat more than one-half lake or pond at one time to avoid oxygen depletion and fish kill. In large lakes leave 100-foot buffer strip. Do not treat within ½ mile of potable water intakes. Treat in spring when milfoil starts to grow. Spray on or inject under water.
	diquat	1 to 2.0 gal per surface acre	Distribute evenly over infested area. Inject or apply on surface of slow-flowing water. Do not apply diquat to muddy water.
	Endothall (Aquathol K and Aquathol granular)	0.5 to 2.5 ppmw	Safer to fish than dimethylalkylamine salts. Spray or inject liquids under water. Apply granules evenly with cyclone seeder. Apply as soon as possible after weeds begin to grow and water temperature is above 65°F. When treating in sections, treat on 5- to 7-day interval. Use higher rates when spot treating.

Treatment of Aquatic Weeds

Aquatic weeds	Treatment	Rate	Comments
Submersed and Emersed			
Eurasian watermilfoil	2,4-D (20% granules)	100 lb/A	Best results when applied in spring to early summer during early growth stage. Apply uniformly using portable spreader (cyclonic seeder). Rate depends upon weed species, weed mass, water depth, and water pH. Repeat application if needed. Do not use water for agricultural purposes, watering dairy animals, or domestic purposes.
bladderwort waterlily watershield coontail	2,4-D (20% granules)	150-200 lb/A	Rates are based on type of water body treated and average water depth. See label for details. Do not use water for irrigation from ponds for 30 days or lakes for 7 days after treatment.
elodea hydrilla naiad	Sonar AS	0.5-4 qt/A	Fluridone requires a long contact time (>60 days) to be effective. A test available from the manufacturer may be advisable for some water bodies to ensure that adequate concentrations of herbicide remain in the waterbody for effective control.
pondweed	Sonar PR	10-80 lb/A	
coontail Eurasian watermilfoil, waterprimrose, waterpurslane	Sonar SRP		
Emersed (Shoreline)			
arrowhead	2,4-D	4 to 8 lb/A	Spray on foliage. Use only formulations labeled for aquatics.
cattail	Rodeo	3 to 5 qt/A	Spray on foliage. See Rodeo entry below.
cattail pondlily waterlily	Habitat 2 lb ae/gal	2-3 pt/A or 1% solution	Spray on foliage. Add 1 at aquatic approved nonionic surfactant per 100 gallons spray solution.
Actively growing (floating or emersed) grasses, broadleaves and brush	Rodeo (glyphosate)	1.5 to 7.5 pt/A or spot treatments use 0.75 to 1.5% solution	For application to floating or emersed vegetation, undesirable shoreline weeds and brush by air, booms, or handheld equipment using 3 to 20 gal spray per acre. Do not expect control of vegetation that has a majority of the leaf surface submerged. Add 1 to 2 qt nonionic surfactant to 100 gal spray but use only X-77 if applications are made to aquatic sites. For hand guns, use 3 to 6 qt Rodeo in 100 gal water depending upon weed species. Spray to wet. For broadcast application use 1.5 to 2.5 pt for small annuals and 3 to 1.5 pt for perennial weeds and brush.
Emerged broadleaves	2,4-D (amine), 2,4-D Amine, and 2,4-D Amine No. 4	1.2 to 2.1 lb ai/A	For control of aquatic weeds in lakes, ponds, drainage ditches, and marshes. Apply 2.5 to 4.5 pt/A of 3.8 lb/gal or 1.67 to 3.0 pt/A of 5.64 lb/gal formulation in 50 to 100 gal water. Spray to wet foliage thoroughly. Apply when leaves are fully developed, actively growing, and are above the water level. Restrict applications to one-third to one-half of lake or pond. Repeat treatment once if needed.