RESOLUTION NO. 20-1342

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF BLACK DIAMOND, KING COUNTY, WASHINGTON APPROVING THE 2015 LAKE SAWYER INTEGRATED AQUATIC VEGETATION MANAGEMENT PLAN.

WHEREAS, Lake Sawyer, the fourth largest natural lake in King County, is an environmental and recreational asset for the region; and

WHEREAS, maintaining water quality in the Lake is an ongoing effort between the City, King County and the Washington State Departments of Ecology and Fish and Wildlife through the implementation of various management plans and monitoring activities; and

WHEREAS, Lake Sawyer is home to five State listed noxious weeds, which if allowed to infest the lake, will impact water quality; and

WHEREAS, in 2012 the City and King County Department of Natural Resources and Parks coordinated to develop an Integrated Aquatic Vegetation Management Plan (IAVMP) for Lake Sawyer; and

WHEREAS, the IAVMP was completed and approved by King County and the State Department of Ecology in 2015; and

WHEREAS, Due to staff turnover, the City did not formally approve the IAVMP; and

WHEREAS, The IAVMP provides a long-term and holistic course of action to manage noxious weeds in Lake Sawyer which will benefit the local community and the region;

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF BLACK DIAMOND, WASHINGTON, DOES RESOLVE AS FOLLOWS:

Section 1. The City of Back Diamond hereby approves the Lake Sawyer Integrated Aquatic Vegetation Management Plan.

PASSED BY THE CITY COUNCIL OF THE CITY OF BLACK DIAMOND, WASHINGTON, AT A REGULAR MEETING THEREOF, THIS 20TH DAY OF FEBRUARY 2020.

CITY OF BLACK DIAMOND:

Carol Benson, Mayor

Attest:

Brenda L. Martinez, City Clerk

Lake Sawyer Integrated Aquatic Vegetation Management Plan

King County, Washington

February 2015

King County

Department of Natural Resources and Parks
Water and Land Resources Division
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Alternate Formats Available

Lake Sawyer Integrated Aquatic Vegetation Management Plan
King County, Washington

Prepared for:

The City of Black Diamond

Submitted by:

King County Water and Land Resources Division
Department of Natural Resources and Parks

Funded in part by:

The Washington State Department of Ecology

King County
Department of
Natural Resources and Parks
Water and Land Resources Division

Acknowledgements

The City of Black Diamond and King County Department of Natural Resources and Parks' Water and Land Resources Division would like to thank the members of the Steering Committee for their help in the development of the lake Sawyer Integrated Aquatic Vegetation Management Plan. Additionally we would like to thank Jennifer Parsons and Lizbeth Seebacher from the Washington State Department of Ecology for their review and expertise in aquatic noxious weeds.

Citation

King County. 2015 Lake Sawyer Integrated Aquatic Vegetation Management Plan. Prepared by King County Freshwater Assessment Unit, Water and Land Resources Division. Seattle, Washington.

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EXECUTIVE SUMMARY

In 2012 the City of Black Diamond, with assistance from King County Department of Natural Resources and Parks, applied for and received a Washington State Department of Ecology Aquatic Weed Management Fund Grant. This grant was awarded to fund the development of an Integrated Aquatic Vegetation Management Plan (IAVMP) for Lake Sawyer, with the City providing the grant match. The City of Black Diamond and King County entered into an interagency agreement for King County staff to develop the IAVMP for Lake Sawyer, contained in this document.

Lake Sawyer is located within the city of Black Diamond in South Central King County. The lake is home to five Washington State listed noxious weeds. Without proper management, these invasive plants have the ability to create large monoculture stands that reduce biodiversity, impact water quality, and reduce recreational uses on the lake. The IAVMP is intended to provide a holistic approach for managing or eliminating these five weeds from Lake Sawyer for long-term public benefit. Input to and review of the IAVMP was provided by a resident advisory steering committee and by the general public at multiple public meetings.

The five aquatic weeds in Lake Sawyer are Eurasian milfoil, yellow flag iris, fragrant water lily, Japanese knotweed, and narrow leaf cattail.

Eurasian milfoil has been in the lake since at least 1976. Several aquatic plant surveys identified Eurasian milfoil as the lake's most dominant aquatic plant species, covering much of the shallow regions of the lake, although more recent surveys from 2012 and 2013 documented Eurasian milfoil around the lake, but in moderate to low densities with a large diversity of other plants also found.

In 2013, King County staff and a Washington State Department of Ecology aquatic plant specialist found milfoil weevils present on the invasive milfoil plants. The weevils provide biocontrol for Eurasian milfoil and have the ability to limit populations of the plants, often keeping the density of the invasive plants below a nuisance level, and are the likely cause of the reduced amount of Eurasian milfoil. The other noxious weeds in Lake Sawyer are found around the lake in varying densities.

The IAVMP outlines a long-term and holistic course of action for controlling the five aquatic weeds in Lake Sawyer that addresses community interests and concerns. This outline consists of plant control options, cost estimates, and potential funding options to implement the plan.

The plan has been approved by the Steering Committee, the City of Black Diamond, and the Washington State Department of Ecology. Department of Ecology approval of the IAVMP allows the City of Black Diamond to apply for Aquatic Species Management grants to implement it. These grants require a funding match from the applicant and generally are

awarded for the entirety of the plan. The long term success of invasive aquatic plant management in Lake Sawyer is dependent on several conditions, including:
(1) involvement of the community, (2) the availability of funding to implement the plan, and (3) the ability to use adaptive management to address unforeseen or changing environmental conditions.

1.0 INTRODUCTION

Lake Sawyer is located in south central King County Washington, within the city of Black Diamond. The Lake lies within the Big Soos Creek Basin of the Green River Watershed (Figure 1). It is the fourth largest natural lake in King County with a surface area of approximately 286 acres and depths reaching up to 60 feet (Figure 2).

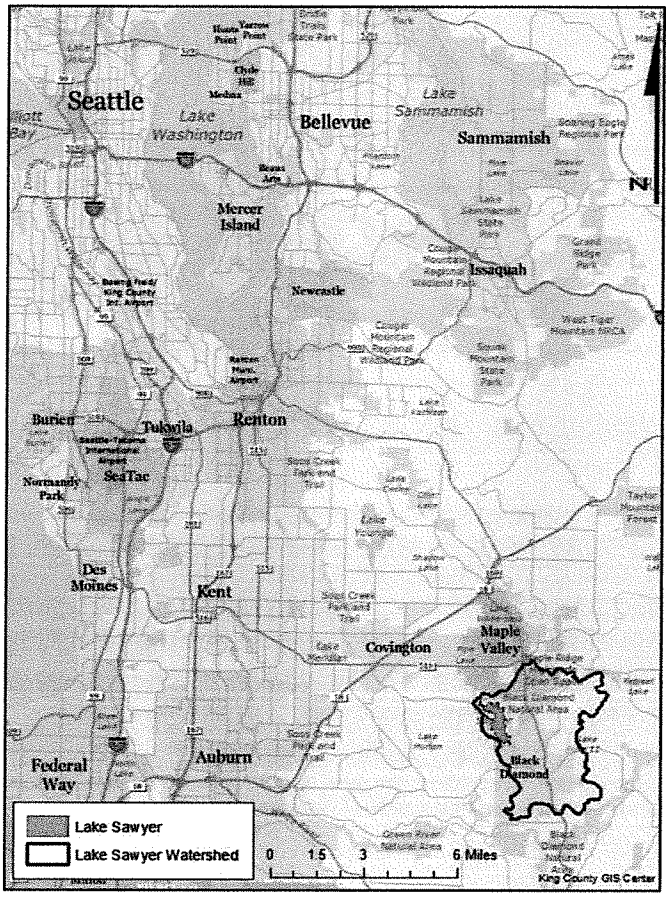


Figure 1. Map of Lake Sawyer watershed

The lake is used extensively for boating, water skiing, swimming, and fishing. Public access is provided at the Lake Sawyer Boat Launch and the Lake Sawyer Regional Park. The boat launch is located on the northwest side of the lake at the end of SE 296th Street. This park is approximately 1.8 acres in size and offers an updated launching ramp, picnicking opportunities, and beach access. The Lake Sawyer Regional Park (approximately 160 acres in size) is located on the south end of the lake and can be accessed from a newly constructed trailhead, just south of SE 312th Street along Lake Sawyer Road. The bulk-headed waterfront can be accessed via a trail that also ties into the larger Black Diamond Natural Area, which is owned by King County and is utilized for hiking, biking, and

sightseeing. This entire area offers some of the best natural, undisturbed scenery in the developed lowland area of the County, as well as excellent birding opportunities and numerous trails.

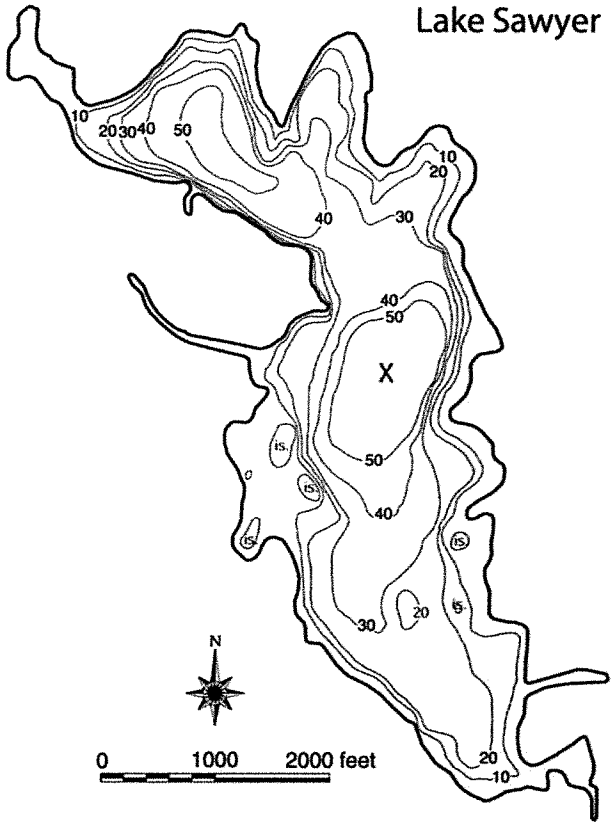


Figure 2. Lake Sawyer Bathymetric Map (X marks the maximum depth)

Lake Sawyer is home to five known invasive aquatic plants. These noxious weeds have the ability to hinder recreational activities as well as impact the ecology of the lake. Eurasian watermilfoil is known to grow to high densities that can create large monoculture stands, reduce water circulation, and limit swimming and boating activities. In addition to the Eurasian watermilfoil the lake also has populations of listed noxious weeds including: yellow flag iris, fragrant water lily, Japanese knotweed and narrowleaf cattail. The combination of these invasive pants can impact water quality, alter the shoreline of the lake by reducing species diversity, increasing plant density and restricting access.

The purpose of this Integrated Aquatic Vegetation Management Plan (IAVMP) is to provide the City of Black Diamond and its residents a series of steps to implement to effectively and

collectively control the invasive plants located in and around Lake Sawyer. The recommendations outlined in this document have been reviewed by the IAVMP Steering Committee, the City of Black Diamond, King County Department of Natural Resources and Parks (DNRP), and the Washington State Department of Ecology. The plan is not designed to be followed unwaveringly but to be used as a guide to manage the target species lake wide. The IAVMP is part of an integrated pest management plan and changes in species density or composition should result in an adaptive management response collectively agreed upon by the City of Black Diamond (or any associated/contracted entities) and a the implementation committee that may be formed to advise on the IAVMP's application.

The Washington State Department of Ecology awarded a grant and the City of Black provided a match to fund the development of this IAVMP. The grant does not provide funding to implement the plan of action developed in the IAVMP. After the acceptance of an Ecology approved IAVMP the City of Black Diamond will be eligible to apply for grants to implement the IAVMP.

This document presents information on the Lake Sawyer watershed, water quality in the lake, characterization of aquatic plants, preferred treatment options for the listed noxious weed in the lake, cost estimates for implementation of the plan, treatment timelines and funding options.

2.0 PROBLEM STATEMENT

Lake Sawyer and its natural areas are extensively used for various recreational activities including boating, skiing, swimming and fishing. These recreational activities can be negatively impacted by the introduction and proliferation of invasive noxious weeds. These plants can alter wildlife habitat, reduce recreational benefits, and affect aesthetic quality. Currently, if left untreated, the five listed noxious weeds found in Lake Sawyer can turn the shorelines and shallow waters of the lake into monospecific stands that reduce plant and animal diversity, and pose a potential threat to waters and riparian areas downstream of the lake outlet. The development and implementation of this IAVMP, along with the continued water quality monitoring at the lake, will help ensure that the beneficial and recreational uses of the lake continue into the future.

Lake Sawyer contains one Class B (Eurasian watermilfoil) and three Class C aquatic noxious weeds (fragrant water lily, narrow leaf cattail/hybrid and yellow flag iris), as well Class B species Japanese knotweed found in adjacent riparian areas. To date there has been no comprehensive lake-wide strategy to deal with these invasive plants (although a poorly documented herbicide treatment for milfoil was done sometime in 1972).

Currently Lake Sawyer is host to a moderate infestation of Eurasian watermilfoil, with the only dense stands located near the southern tip of the islands on the west side of the lake. There are also many small stands (2–3 plants) plants located throughout the lake. The native northern watermilfoil (*Myriophyllum sibericum*) is also present at low densities around the lake and might be mistaken for the noxious Eurasian species.

Aquatic plants surveys going back to the mid-1970s reported milfoil being the most abundant aquatic plant in the lake with coverage's of up to 80–90% of the shallow areas, (1976 survey), but while uncertain, it is possible that the northern milfoil plants may have been misidentified as Eurasian. Lake Meridian was the first lake in the area known to have Eurasian Milfoil, with plant samples collected as early as 1965.

A snorkel survey in 2013 by King County Lake Stewardship staff and Jennifer Parsons (aquatic plant specialist with WA Dept. of Ecology) documented a population of milfoil weevils living in every stand of Eurasian milfoil that was surveyed. The weevils were first identified in Lake Sawyer in 2000. It is important to note that if these milfoil weevils were not historically present in the lake (pre-2000's), their recent introduction might be responsible for the reduction in milfoil abundance to the levels seen today.

In addition to Eurasian watermilfoil, large patches of fragrant water lily are present around the lake. These patches are particularly dense in the northwestern "boot," the central-western shore, and the southeast portion of the lake. Summer aerial photos from 2011 show approximately 10 acres of fragrant water lily across the entire lake. Yellow flag iris is also present in patches along much of the shoreline in varying densities. The extent of the narrow leaf cattail (and hybrid) infestation is not currently known, due to the difficulty in

distinguishing that species from the native Typha species. Washington State Department of Ecology noted the species as present during the most recent survey conducted in 2008.

More about each invasive species is presented in section 6 (Noxious aquatic weeds in Lake Sawyer), but individually, or as a collective, these plants have the ability to:

- Pose a safety hazard to boaters by entanglement of boating equipment;
- Snag fishing lines and hooks;
- Crowd out native plants, creating monocultures lacking in biodiversity;
- Significantly degrade fish and wildlife habitat, which will potentially reduce fish and wildlife populations;
- Pose a safety hazard to swimmers due to entanglement;
- Increase potential breeding grounds for nuisance insects;
- Reduce wildlife viewing opportunities;
- Pose a threat to adjoining ecosystems; and
- Reduce property value.

While individual homeowners may make an effort to control these plants, carrying out a comprehensive lake wide management strategy will be much more likely to control these species and their impacts to the lake. If left unchecked, these plants have the ability to degrade the ecosystem and wildlife habitat, and to impair recreational activities.

3.0 MANAGEMENT GOALS

The Citizens of Black Diamond have determined that it is imperative to maintain the desirable environmental conditions and recreational benefits of Lake Sawyer. The lake is a heavily used recreational area and maintaining good water quality and controlling nuisance aquatic vegetation will help ensure that the lake is a resource used well into the future. Given the location of Lake Sawyer (Figure 3) and the expectation that development will continue in this region, the health of Lake Sawyer is on the forefront of concerns of users and residents of the lake. The approach used in addressing the noxious weeds in this document does not always consist of complete eradication of all the targeted species. Several species listed in this document may be to abundant to effectively eliminate without whole lake applications of herbicide and even then it may be difficult to fully eradicate the target species. Instead this document attempts to outline a strategy for effective *control* of the targeted species. This control may consist of the reduction of the targeted plants to a desired level (yellow flag iris, narrow leaf cattail), maintaining the species at a non-nuisance level (Eurasian milfoil) or eradication (fragrant water lily). The main strategies to ensure success in meeting this goal are:

1. Involve local community groups, nearby residents and adjacent landowners in each stage of the process;
2. Use the best available science to identify and understand likely effects of management actions on aquatic and adjoining terrestrial ecosystems prior to implementation;
3. Review the effectiveness of management actions through monitoring; and
4. Adjust the management strategy as necessary to achieve the overall goal.

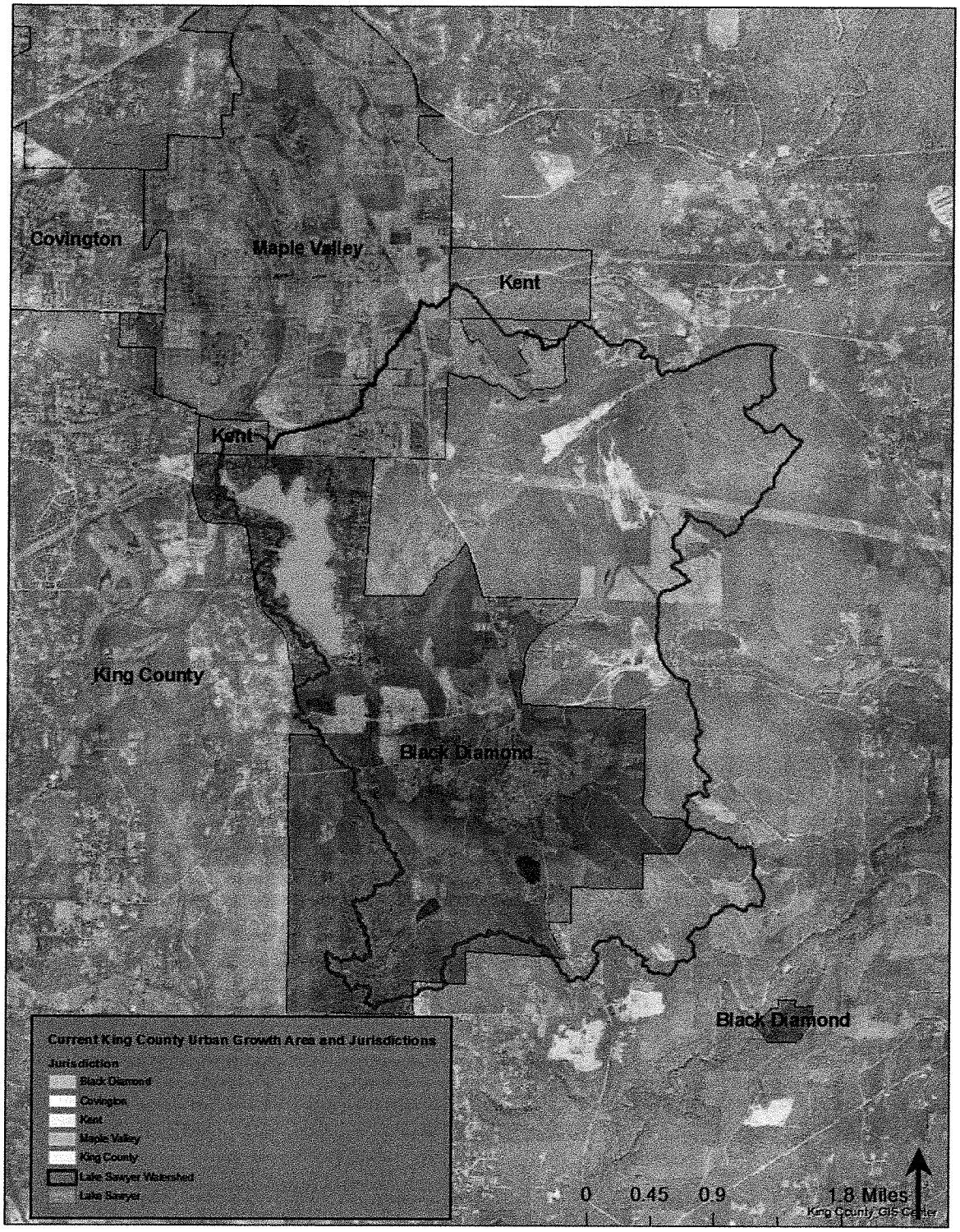


Figure 3. Lake Sawyer Watershed and Urban Growth Boundary

4.0 COMMUNITY INVOLVEMENT

In 2012 the City of Black Diamond contracted with King County DNRP for technical assistance and writing of the IAVMP. The King County Lakes and Streams Monitoring Group (KCLSMG) has experience in writing IAVMPs, in addition to managing weed control programs (often in conjunction with King County Noxious Weeds Group). This report was written with assistance from the noxious weeds staff, the City of Black Diamond staff and the Steering Committee.

4.1 Steering Committee, Outreach and Education

In February 2013 Lake Sawyer residents were invited to attend a Lake Sawyer Community Club meeting regarding the development of the IAVMP. At this meeting, information on the invasive weeds in the lake was presented to the group. Approximately 50 community members attended the meeting and after a presentation by King County staff, the City of Black Diamond made a request for volunteers to be on a Steering Committee. The Steering Committee was used to assist in the development of this IAVMP by acting as a community liaison and giving input as to the preferred methods of treatment for the targeted species.

Community members (Anthony Martinez, Bruce and Julie Earley, Angrid Henning, Glenn Ross, Mark Davidson and Bob Rothschilds), Aaron Nix (City of Black Diamond) and Chris Knutson (KCDNRP) also expressed interest in joining the steering committee. Throughout the development of this document draft versions were made available (by email) for the Committees review and input.

The Steering Committee met in person to hear a proposal of potential treatments in October of 2014. During this meeting the preferred alternatives were discussed and an approach to address the listed invasive weeds was decided upon. After the preferred alternatives were outlined and inserted into the draft IAVMP it was again made available for review by the Committee. The documented was then updated to address the concerns of the reviewers and the then finalized.

5.0 WATERSHED AND WATERBODY CHARACTERISTICS

5.1 Drainage Basin

About half of the Lake Sawyer watershed, including the lake itself, is within the city limits of Black Diamond. The majority of the remaining watershed is in unincorporated King County with a few small portions falling within the city limits of Kent and Maple Valley. The watershed constitutes 8310 acres of the Soos Creek Basin inside the Green River Watershed (King County 2000, King County 2010). This area is included in Water Inventory Resource Area 9, the Duwamish-Green combined watershed area. Three subbasins make up the Lake Sawyer watershed: The Lake Sawyer Subbasin (1324 acres), the Ravensdale Creek Subbasin (2532 acres), and the Rock Creek Subbasin (4454 acres) (King County, 2000). The city of Black Diamond is within the Rock Creek drainage, while a portion of the unincorporated community of Ravensdale lies within the Ravensdale Creek drainage (Figure 4).

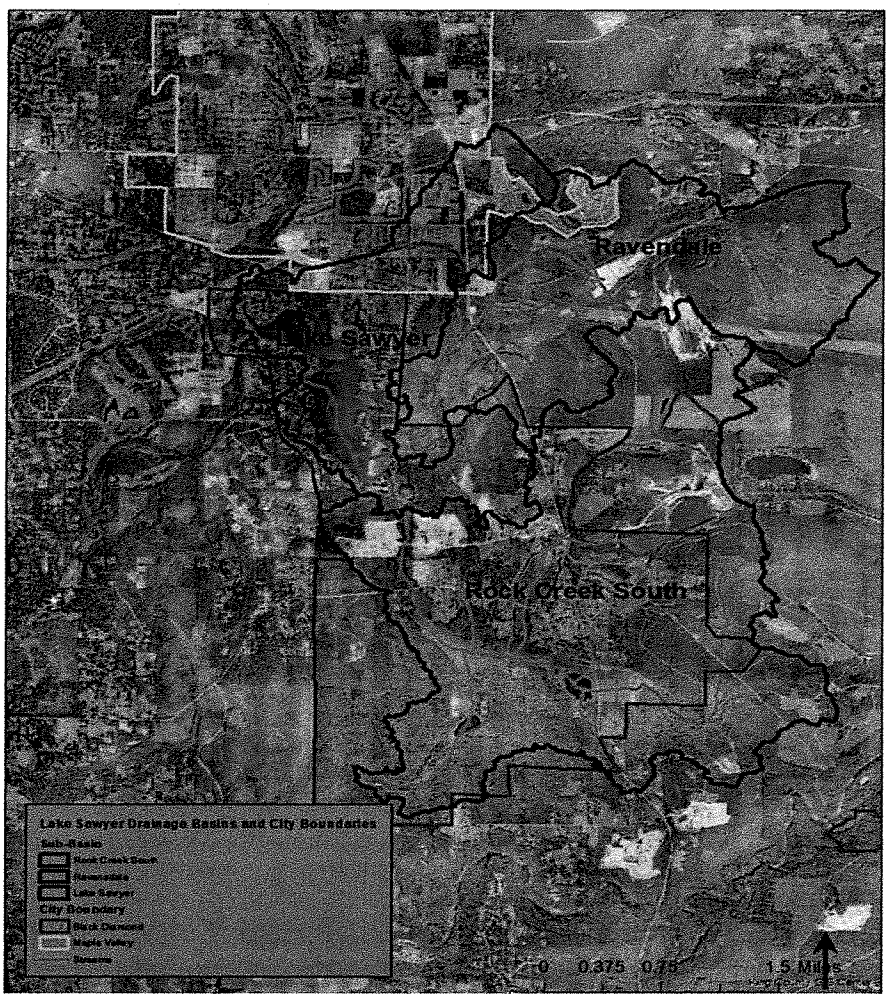


Figure 4. Lake Sawyer Drainage Basins and City Boundaries

5.2 Geology and Soils

There are over 15 major soil types in the Lake Sawyer watershed (Figure 5). The most common soil type is Everett gravelly sandy loam (EvC, EvD). This soil covers about 40 percent of the watershed and dominates the Lake Sawyer shoreline. Everett gravelly sandy loam is a deep soil consisting of glacial outwash (USDA, 2012). This soil is considered "excessively drained," which tends to decrease flooding potential, but may also increase the possibility for groundwater contamination. Alderwood gravelly sandy loam (AgC, AgD) is present in about 27 percent of the watershed. Alderwood soil types consist of moderately drained basal till covering a denser, more slowly drained material at a depth of 24 to 40 inches (USDA, 2012). Removal or compaction of Alderwood soils during urban development can potentially result in a higher water table (King County, 1993).

AgC	Alderwood gravelly sandy loam, 6–15% slopes	InC	Indianola loamy fine sand, 4–15% slopes
AgD	Alderwood gravelly sandy loam, 15–30 % slopes	Ma	Mixed alluvial land
AkF	Alderwood and Kitsap soils, very steep	No	Norma sandy loam
BeC	Beausite gravelly sandy loam, 6–15% slopes	Or	Orcas peat
BeD	Beausite gravelly sandy loam, 15–30% slopes	PITS	Pits
BeF	Beausite gravelly sandy loam, 40–75% slopes	RdC	Ragnar-Indianola association, sloping
Bh	Bellingham silt loam	Sk	Seattle muck
Bu	Buckley silt loam	Sm	Shalcar muck
EvB	Everett gravelly sandy loam, 0–5% slopes	Ur	Urban Land
EvC	Everett gravelly sandy loam, 5–15% slopes	W	Water
EvD	Everett gravelly sandy loam, 15–30% slopes		

Figure 5. Soils map of the Lake Sawyer Watershed. (from Hart Crowser 1990)

A hydrogeologic study of Lake Sawyer conducted by Hart Crowser (1990) indicates that there is a very complex stratigraphic and hydrogeologic system around Lake Sawyer and that the lake sits in a trough of low permeable till, between outcropping bedrock to the east and surficial till outcrops to the north and west. More highly permeable outwash deposits overlie the till to the east of the lake, but are largely absent to the west.

5.3 Streams, Wetlands, and Sensitive Areas

The Lake Sawyer watershed contains over 20 designated wetlands, and 7 named creeks are located within the City of Black Diamond Planning area (Figure 6). Ravensdale Creek and Rock Creek are the major inflows to Lake Sawyer and enter the lake on the southern shore. Covington Creek, the lake outlet, leaves the lake from its central western shoreline.

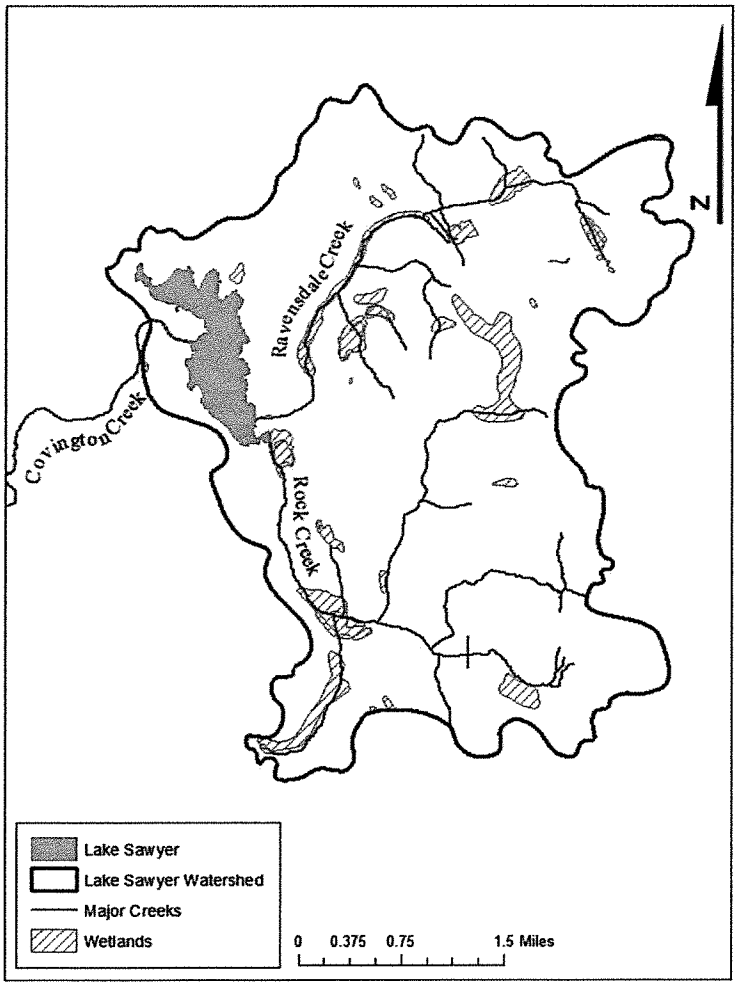


Figure 6. Lake Sawyer Wetlands and Creeks

According to the Lake Sawyer Management Plan (King County 2000), the aquatic habitat within the Lake Sawyer watershed is generally in excellent condition, with the exception of several stretches along Rock Creek. Lake Sawyer is a migration corridor for Coho salmon, and the upper reaches of Ravensdale Creek provide habitat for spawning and rearing, as well as habitat for other wildlife. A 1987 report on Covington Creek found the basin to have diverse and abundant habitat (King County, 1987). Rock Creek flows through the city of Black Diamond and has been impacted by residential development, coal mining, and forestry. Rock Creek contributes about twice the amount of phosphorus to the loading of Lake Sawyer than Ravensdale Creek (City of Black Diamond, 2009).

The wetlands in the Lake Sawyer watershed have been categorized according to Washington State Department of Ecology's wetland rating system. Five of the wetlands are designated as Class 1, representing the most valuable wetlands, which contain 40–60% open water, uncommon plant associations, and habitat suitable for Washington State endangered or threatened species (King County, 1993). One of these wetlands comprises a large area at the south end of Lake Sawyer including Frog Lake in Lake Sawyer Regional Park (Wetland 22, WRIA 9). Classifications of both wetlands and creeks may be found in Appendix A of the City of Black Diamond Comprehensive Plan (City of Black Diamond, 2009).

5.4 Water Quality and Existing Management

The general health of Lake Sawyer and its watershed has been a concern for several decades. Evidence of failing septic systems in the 1970s prompted the construction of a wastewater treatment plant in 1981 (Washington State Department of Ecology 2009). The plant operated from 1983–1992, and discharged to a natural wetland adjacent to Rock Creek – a major inflow to Lake Sawyer (King County 2000). The wetland was intended to work as a natural filtration system for the nutrients phosphorus and nitrogen, but the facility did not prove successful, and a study conducted by the Washington State Department of Ecology (Ecology) in 1989 determined that effluent from the plant was adversely affecting the lake (King County 2000). As a result, all wastewater was diverted to a King County sewer line in 1992 and conveyed to King County's South Treatment plant in Renton.

In order to address long-term water quality protection for the lake and watershed, a management plan was released by King County in July of 2000, partially funded by Ecology and the U.S. Environmental Protection Agency. The management strategy of the plan involved maintaining water quality in Lake Sawyer, especially in regards to nutrient loading, while accommodating growth in the area. The need to develop this plan was partially due to the phosphorus TMDL that was set for the lake in 1993. Management measures included stormwater control policies, watershed measures for new and existing development, regional stormwater and phosphorus control, aquatic plant management, in-lake contingency measures, and regular monitoring.

Lake Sawyer has been monitored by volunteers since the 1980s, participating in the King County Lake Stewardship Volunteer Monitoring Program since 1994 (King County, 2010). Twice a month from May through October, volunteers collect data and water samples which are sent to the King County Environmental Laboratory for analysis of total phosphorus, total nitrogen, and chlorophyll-*a*, with several other parameters measured twice during the period. Measurements of temperature, Secchi depth, lake level, and precipitation are collected on a daily or weekly basis year-long (Table 1). In addition, staff and volunteers from the City of Black Diamond have collected samples from Rock Creek and Ravensdale Creek – the two major lake inflows. These samples are collected monthly between November and May, as well as twice yearly during qualifying storm events (more than 1" of rain within 24 hours). The creek and stormwater samples are analyzed for total phosphorus, orthophosphate, alkalinity, conductivity, total suspended solids, and water stage for flow calculations. Storm flow samples are additionally analyzed for oil and grease.

Table 1. Average Summer (June–October) Trophic Parameters for Lake Sawyer. Chl-*a*=Chlorophyll-*a*, TP=Total Phosphorus, and TSI=Trophic State Index.

Year	No. of Samples	Secchi (meters)	Chl-*a* (µg/L)	TP (µg/L)	TSI Secchi	TSI Chl-*a*	TSI TP	TSI Average
1994	7	3.6	4.3	23.3	41.4	45.0	49.6	45.3
1995	9	4.4	4.5	15.7	38.6	45.3	43.9	42.6
1996	12	4.3	4.0	15.8	39.1	44.3	43.9	42.4
1997	12	4.8	3.7	21.6	37.5	43.3	48.5	43.1
1998	13	4.8	4.6	9.7	37.5	45.6	36.9	40.0
1999	13	4.5	5.0	9.1	38.4	46.3	36.1	40.2
2000	13	5.4	4.9	9.7	37.3	43.7	36.1	39.0
2001	13	3.5	5.0	14.2	42.1	44.6	40.4	42.4
2002	14	4.0	4.9	9.2	41.1	44.4	35.9	40.5
2003	14	5.50	4.2	10.3	41.7	42.4	36.3	40.1
2004	14	3.9	4.32	12.2	40.9	43.6	39.4	41.3
2005	-	-	-	-	-	-	-	-
2006	5	3.5	4.56	13.6	44.3	43.6	41.7	43.2
2007	6	3.5	4.36	12.8	44.1	43.5	38.8	42.1
2008	6	3.7	3.2	9.3	43.4	41.4	35.5	40.1
2009	5	4.0	2.6	8.6	42.5	37.9	34.9	38.4
2010	6	3.3	4.5	11.3	44.9	44.0	38.1	40.7
2011	6	3.5	3.82	12.0	44.0	41.6	38.9	41.5
2012	6	3.7	3.7	11.4	43.4	42.5	38.3	41.4
2013	7	3.7	3.34	9.6	43.3	40.1	36.6	40.0

Based on monitoring data, water quality in Lake Sawyer has appeared relatively stable over the last decade.

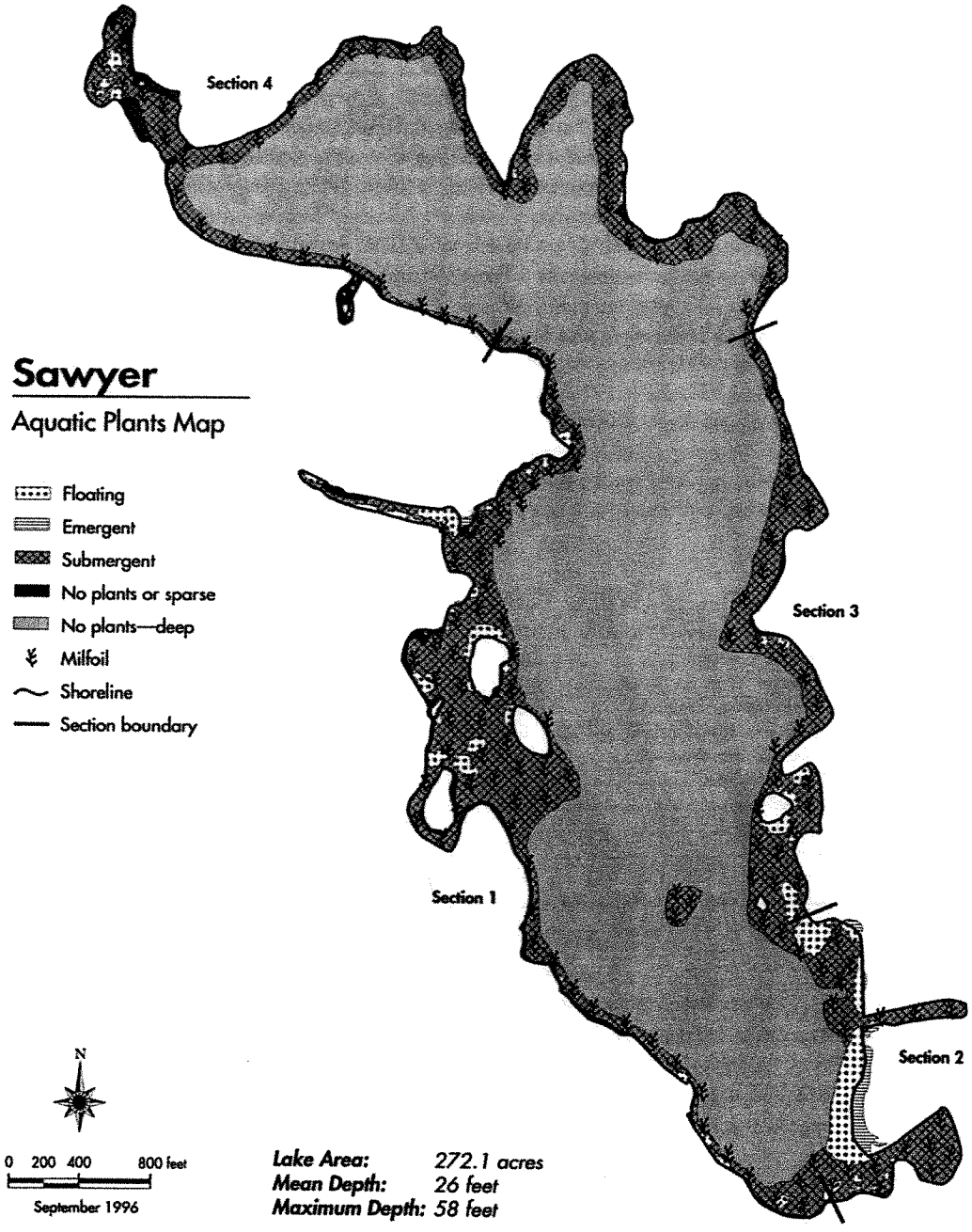
Additionally, the inlets (Ravensdale and Rock Creek) to Lake Sawyer have shown a decline in phosphorus concentrations since the 1990's. However, because significant land development in the watershed has occurred and is expected to continue, it is possible that phosphorus contributions could increase as a result. Therefore sustained monitoring is anticipated to document changes in water quality.

5.5 Characterization of Aquatic Plants

Aquatic plants, or macrophytes, serve a wide array of ecological functions, including providing habitat for fish and other animals, supporting the food chain, removing toxic compounds from runoff, providing erosion control and bank stabilization, and improving aesthetics. Aquatic plants are also an important component of nutrient cycling in lakes, acting by taking up nutrients from the sediments and releasing them into the water column when they die down in the fall.

Aquatic plants can be categorized into three main types:

1. Emergent: plants that are rooted in the sediment at or near the water's edge but have stems and leaves which grow above the water surface.
2. Floating: plants are rooted in the sediment and send stems upward so leaves are at the water's surface.
3. Submergent: plants are either freely floating or are rooted in the lake bottom but grow within the water and do not emerge above the water surface (Figure 7).



Aquatic Plant Mapping for Thirty-six King County Lakes Page 81

Figure 7. Lake Sawyer Aquatic Plant Community 1994

Over twenty native plant species have been identified in Lake Sawyer. The most comprehensive aquatic plant survey of Lake Sawyer occurred in August of 1994 (Table 2). Additionally, Eurasian milfoil surveys have been conducted at the lake as recently as 2012, during which other species of plants have been observed. Because a significant length of

time has passed since the last formal survey, the following table should not be considered comprehensive. According the 1994 survey, about 33 percent of the lake area supported plant growth. The submergent plant community comprised the largest portion of the aquatic plant population (25%), followed by emergent (5%), and floating (3%) (King County, 2000).

Table 2. Aquatic plants identified in Lake Sawyer, 1994-2012. Plant list based on an August 1994 survey, supplemented by later surveys conducted by King County staff.

Species Name	Common Name	Community Type	Status
Brasenia schreberi	Water Shield	Floating	Native
Ceratophyllum demersum	Coontail	Submergent	Native
Chara sp.	Muskgrass	Submergent	Native
Elodea canadensis	Water Weed	Submergent	Native
Juncus sp.	Rush	Emergent	Native
Myriophyllum sibiricum	Northern watermilfoil	Submergent	Native
Najas flexilis	Bushy Pondweed	Submergent	Native
Nitella sp.	Stonewart	Submergent	Native
Nuphar lutea	Yellow Pondlily	Floating	Native
Polygonum sp.	Smartweed	Emergent	Native
Potamogeton amplifolius	Large Leaf Pondweed	Submergent	Native
Potamogeton illinoensis	Illinois Pondweed	Submergent	Native
Potamogeton pectinatus	Sago Pondweed	Submergent	Native
Potamogeton praelongus	White Stemmed Pondweed	Submergent	Native
Potamogeton pusillus	Small Pondweed	Submergent	Native
Potamogeton robbinsii	Robbins Pondweed	Submergent	Native
Potamogeton zosteriformis	Flat Stemmed Pondweed	Submergent	Native
Scirpus sp.	Bulrush	Emergent	Native
Spiraea douglasii	Hardhack	Emergent	Native
Typha latifolia	Cattail	Emergent	Native
Utricularia sp.	Bladder Wort	Submergent	Native
Iris pseudacorus	Yellow Flag Iris	Emergent	Noxious/Invasive
Myriophyllum spicatum	Eurasian Watermilfoil	Submergent	Noxious/Invasive
Nymphaea odorata	Fragrant Waterlily	Floating	Noxious/Invasive
Polygonum cuspidatum	Japanese Knotweed	Emergent	Noxious/Invasive
Typha angustifolia	Narrow Leaf Cattail	Emergent	Noxious/Invasive

5.6 Fish

Laker Sawyer is home to a diverse mix of fish species. It is considered an important system for winter Coho that pass through the lake on their way to spawning grounds in Rock and Ravensdale Creeks. Several non-native warm water species are also known to be in the lake, including black crappie, brown bullhead, largemouth and smallmouth bass, pumpkin

seeds, sunfish, and yellow perch. Cold water native species such as rainbow trout, coastal cutthroat trout, and kokanee also live in Lake Sawyer (WDFW). The Washington Department of Fish and Game also has a stocking program that plants rainbow trout in the lake. In 2012 WDFW stocked the lake with 1,000 catchable rainbow trout (3 fish per pound or less), 700 triploids (1.5lbs or greater), 50,468 fry/fingerlings and 87,544 kokanee fry/fingerlings.

5.7 Beneficial and Recreational Uses

Lake Sawyer is heavily used for recreational purposes, primarily boating and fishing. The lake is stocked yearly by WDFW with rainbow trout (City of Black Diamond, 2009). Other recreational activities include sailing, canoeing, paddleboarding, kayaking, waterskiing, wakeboarding, swimming, picnicking, wildlife observation, and aesthetics.

Currently there is one boat launch located in the northwestern corner of the lake in Lake Sawyer Park. In October 1999, King County purchased 60 acres of open space along the southeastern shoreline from Palmer Coking Coal Company with the intention of providing a new County Park. An additional 105 acres were later purchased, including the wetland area surrounding Frog Lake and parts of Rock and Ravensdale Creeks. In 2005 ownership of most of the acreage was transferred to the City of Black Diamond as part of the "Black Diamond Area Open Space Protection Agreement." In 2008 the City released the Lake Sawyer Regional Park Development plan, which outlined improvements to be made to the park between 2008 and 2021. These improvements include adding restrooms, trails, parking lots, ball fields, and other facilities. In addition, half the site will be left in a "relatively natural or enhanced" natural state to preserve wildlife habitat and water quality, and allow for passive recreational use (City of Black Diamond, 2008).

6.0 NOXIOUS AQUATIC WEEDS IN LAKE SAWYER

The term "noxious weed" refers to those non-native plants that are legally defined by Washington State's Noxious Weed Control Law (RCW 17.10) as "highly destructive, competitive, or difficult to control once established." Noxious weeds usually are introduced either accidentally as contaminants or purposefully as ornamentals. Non-native plants often do not have natural predators (i.e. herbivores, pathogens) or strong competitors to control their numbers, as they may have had in their home range, which allows them to grow unchecked and may earn them the "noxious" designation. Five noxious weeds with aquatic associations have been identified in or around Lake Sawyer: Eurasian watermilfoil (*Myriophyllum spicatum*), yellow flag iris (*Iris psuedacorus*), fragrant water lily (*Nymphaea odorata*), Japanese knotweed (*Polygonum cuspidatum*) and narrow leaf cattail (*Typha angustifolia/ Typha x glauca*) and.

6.1 Eurasian Watermilfoil (*Myriophyllum spicatum*)

Eurasian watermilfoil (*M. spicatum*) is a submersed aquatic noxious weed that proliferates to form dense mats of vegetation in lakes. It is native to Europe, Asia, and North Africa and is also found in Greenland (Washington State Noxious Weed Control Board, 1995). A 1965 herbarium specimen from Lake Meridian in King County is the first known identification of Eurasian watermilfoil in Washington State. In 1974 it was identified in Lake Washington and from there spread to lakes along the Interstate 5 corridor. Eurasian milfoil was first noted in water quality studies conducted at Lake Sawyer in the 1970's, and in 1980 was identified as dominating the plant community (King County, 2000).

Eurasian watermilfoil is a submerged perennial with fine featherlike leaves that occur in whorls of 4 around the stem, with 12–16 leaflets per leaf. Eurasian milfoil looks very similar to native species of *Myriophyllum*, but often the number and shape of the leaflet pairs can be used as a distinguishing feature. Leaves are reddish-brown when close to the surface, and greener in deeper water. While there are no emergent leaves, pinkish emergent flower clusters may appear during the summer. In late summer and fall, *M. spicatum* undergoes autofragmentation, a process in which the plant breaks apart into smaller fragments, each developing roots and the potential to grow into a new plant. Fragmentation is also caused by wind, wave action, and activities such as boating and swimming. New infestations of Eurasian milfoil often develop when fragments are caught on boats and trailers, and then transported between water bodies. Eurasian watermilfoil spreads rapidly once established, and can degrade the ecological integrity of a water body in just a few growing seasons.

M. spicatum starts spring growth earlier than other native aquatic plants, and the dense canopies it forms often shade out native vegetation. Stagnant water created by dense mats creates breeding grounds for mosquitos. Eurasian watermilfoil can reduce dissolved oxygen – first by inhibiting water circulation, and directly as oxygen is consumed by

bacteria during the decomposition of dead plant material. Decomposition of *M. spicatum* also releases phosphorus and nitrogen into the water, which may increase algal growth. Dense mats of Eurasian milfoil can increase pH, increase water temperature by absorbing sunlight, and provide poor habitat for wildlife. Additionally, Eurasian watermilfoil negatively affects recreational activities such as swimming, fishing, and boating.

Eurasian Watermilfoil is present in several locations around the lake (Figure 8) and densities vary from single plants to dense stands of dozens of plants. A boat based milfoil survey was most recently conducted in the summer of 2012, and the most significant populations of the plants were found around the southern island in the west/central portion of the lake. Several other small stands were noted along the eastern shore and the "boot" area. It should be noted that this survey was done from a boat and it can be very difficult to distinguish between the native Northern Watermilfoil and the Eurasian Watermilfoil when they are in the lake and a sample is not available to inspect. It was thought during the survey that many of the milfoil plants noted along the northern shore may indeed be the native variety, but the plants were growing out of reach from staff on the boat and the identity could not be confirmed.

In 2013 King County staff, Lizbeth Seebacher (grant manager Ecology), and Jennifer Parsons (aquatic weed specialist Ecology) conducted a survey of the dense stands along the southern island to look for the presence of the milfoil weevil (*Euhrychiopsis lecontei*). During this survey, weevils were found living in the Eurasian milfoil stands. Population estimates were not conducted, but weevils were found living on nearly all the plants observed. Details about the effects that the weevils can have on the Eurasian milfoil populations are discussed in section 7.1.5.

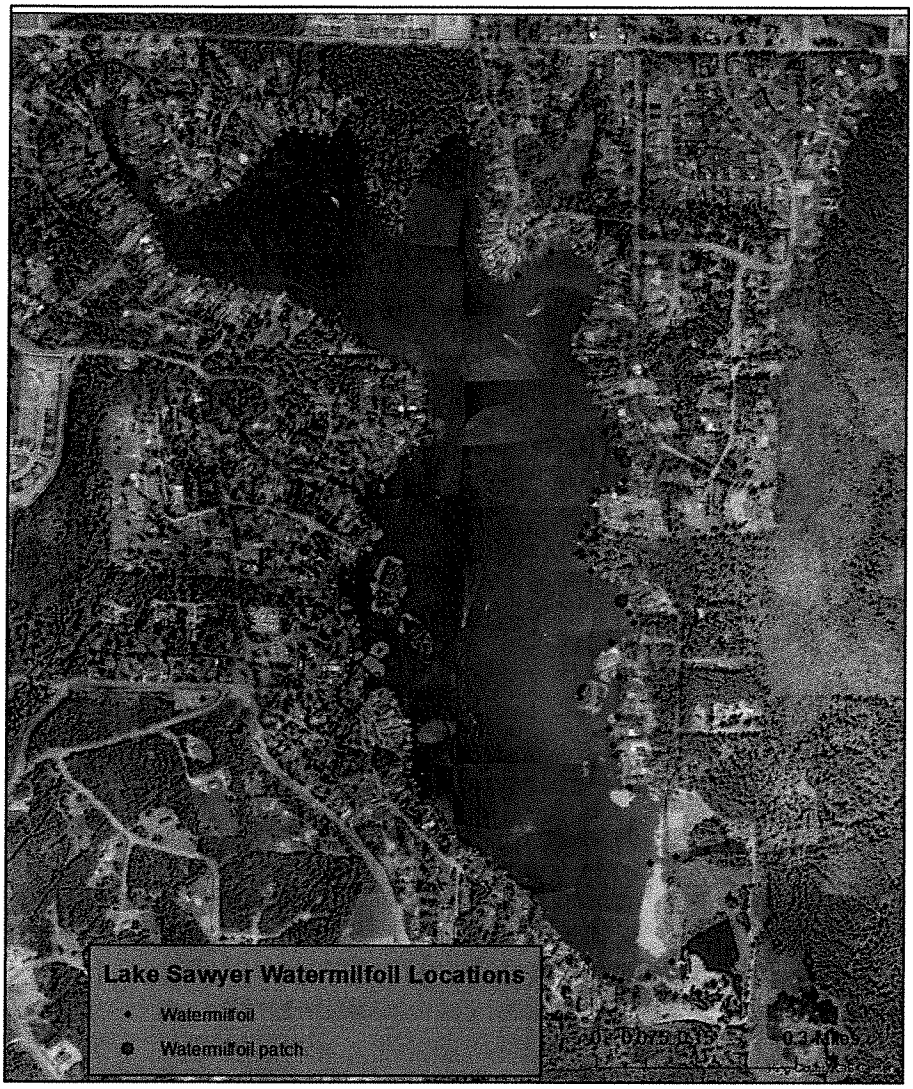


Figure 8. Lake Sawyer Eurasian Milfoil Locations (patch consists of 2 or more plants)

6.2 Yellow Flag Iris (*Iris pseudacorus*)

Yellow flag iris (*I. pseudacorus*) is native to Europe and the Mediterranean region (Washington State Noxious Weed Control Board 2001). It was introduced to North America as a garden ornamental and has been used for erosion control.

A distinguishing characteristic of the plant are its yellow flowers, but when not in bloom it may be confused with cattail (*Typha* sp.) or broad-fruited bur-reed (*Sparganium eurycarpum*). *I. pseudacorus* produces large fruit capsules with viable seeds late in the summer. The plant reproduces by both seeds and rhizomes. Rhizomes spread to form dense stands, which are capable of excluding even the toughest native plant species, such as *Typha latifolia* (cattail). Seeds are easily transported through water to invade other

areas. In addition to threatening plant diversity, *I. pseudacorus* can also alter hydrologic dynamics through sediment accretion between plants and stands along the shoreline.

6.3 Fragrant Water Lily (*Nymphaea odorata*)

Fragrant water lily (*N. odorata*) is a native plant of central and eastern North America. The plant has been introduced throughout most of the world, including Washington State, as an ornamental. The first record in Washington is from 1911 in Lake Washington (Washington State Noxious Weed Control Board, 2013).

Fragrant water lilies are floating perennial plants with showy flowers and horseshoe-shaped leaves (DiTomaso and Healy, 2003). Flowers are white or pink, and bloom from June through October. When not in flower, the leaves of *N.odorata* may be confused with *Nuphar polysepala* (yellow water lily), a native species, although *N. odorata* leaves are rounder and lay flat on the water, while the native lily's leaves are elephant-ear shaped and stand slightly above the surface.

When uncontrolled, this species tends to form dense monospecific stands that persist until senescence in the fall. Mats of floating leave inhibit wind mixing, and areas of extensive oxygen depletion can develop under lily stands in the summer. Lily mats may also increase water temperature, and the warm, stagnant water creates potential mosquito breeding areas. Fragrant water lilies can restrict lake access and hinder swimming, boating, and other recreational activity. *N. odorata* may limit the distribution of native water lilies (*Nuphar polysepala*), which occupy the same ecological niche and which provide food and habitat for local wildlife. 2011 summer aerial photos were digitized and approximately 10 acres of fragrant water lily was present at that time (Figure 9).

Figure 9. Lake Sawyer Fragrant Water Lily Locations 2010

6.4 Japanese Knotweed (*Polygonum cuspidatum*)

Japanese knotweed (*P. cuspidatum*) is native to Japan, but was introduced to the United States in the 1800's as an ornamental. Knotweed is found throughout North America and is increasingly common around stream corridors and lake shorelines.

P. cuspidatum is a perennial species that can quickly invade and take over riparian habitats. It is difficult to control due to vigorous rhizomes that form deep, dense underground mats. It is densely shrubby and can reach four to eight feet tall. Japanese knotweed can reproduce

by seed, rhizome, and most commonly by fragmentation. Fragments that fall into a water body are capable of colonizing elsewhere along the shoreline.

Thickets of *P. cuspidatum* can clog small waterways, reduce available habitat for fish and wildlife, and cause erosion problems when plants die back in the fall, leaving ground exposed to winter weather.

Lake Sawyer has sporadic Japanese knotweed clumps on adjacent parcels. The most notable presence of knotweed is in the park/natural area in the southeast corner of the lake.

6.5 Narrow Leaf Cattail (*Typha angustifolia)*

Narrow leaf cattail (*Typha angustifolia and Typha x glauca)* are perennial "cattails" that grow in fresh to slightly brackish waters up to approximately 3 meters in depth. They grow 1.5–3 meters tall, have dark green leaves and can be very difficult to distinguish from our native cattail (*Typha latifolia)*. It can also hybridize with the local species to create *Typha x glauca.* It is not widely distributed through the region but was identified in Lake Sawyer in 1997, which was the first time *Typha x glauca* was recorded in the state. It is not known whether *Typha angustifolia* is native to North America, but it has been present on the east coast since early European settlement.

Narrow leaf cattail blooms in June and July, and when in flower can be distinguished from our native species by the difference in the flowers. It spreads by both rhizomes and seeds and has the ability to out-compete native species and form monospecific stands. It can be a particularly aggressive invader in eutrophic, disturbed habitats, or aquatic areas with fluctuating water levels.

Due to the difficulty of distinguishing from the native species and that both nonnative species and native may be in mixed stands, the actual extent of narrow leaf cattail in Lake Sawyer is not currently known. It is recommended that future surveys attempt to distinguish both nonnative *Typha* species.

7.0 AQUATIC PLANT CONTROL ALTERNATIVES

This section outlines common methods used to control aquatic weeds. Much of the information in this section is quoted directly from the Washington State Department of Ecology's website:
http://www.ecy.wa.gov/programs/wq/plants/management/index.html

Additional information is derived from the field experience of the King County Noxious Weed Control Program and the King County Lake Stewardship Program. Recommendations found in the 2001 draft version of the "King County Regional Milfoil Plan" have also been taken into consideration.

Control/eradication methods discussed herein include Aquatic Herbicide, Manual Methods, Bottom Screens, Diver Dredging, Biological Control, Cutting, and Harvesting.

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Table 3. Summary of Management Alternatives

Broad control method category	Specific method	Use at Lake Sawyer	Effectiveness for yellow flag iris	Further consideration?	Effectiveness for Eurasian watermilfoil	Further consideration?	Effectiveness for knotweed	Further consideration?	Effectiveness for fragrant water lily	Further consideration?
Manual and Environmental Manipualtion Control Methods	Hand pulling	yes	not practical for a large area, can be useful for individuals as long as rhizome is removed	yes	must be sure entire plant and roots are removed	yes	not practical - cannot get all rhizomes	no*	not practical for a large area, can be useful for individuals to maintain open water in small areas	no*
	Diver hand pulling	Yes	not relevant	no	yes	Yes	not relevant	no	not practical for a large area, can be useful for individuals to maintain open water in small areas	no
	Raking	yes	not practical, will not remove rhizomes	no	not practical, causes fragmentation	no	not relevant	no	not relevant	no
	Bottom barriers/ weed mats	possible	effective for small patches but barrier may need to be in place for several years to effectively control	no*	not practical for a large area, can be useful for small areas of infestation	no	can suppress growth in some situations, but will not eradicate - good in combination with herbicide	YES*	not practical for a large area, can be useful for individuals	no*
	Willow stakes/ revegetation	not relevent	not relevent	no	not relevant	no	not relevant	no	not relevant	no
	Water level drawdown	not possible	not relevant	no	not relevant	no	not relevant	no	not relevant	no
Broad control method category	**Specific method**	**Compatible with Lake Sawyer water body characteristics**	**Effectiveness for yellow flag iris**	**Further consideration?**	**Effectiveness for Eurasian watermilfoil**	**Further consideration?**	**Effectiveness for knotweed**	**Further consideration?**	**Effectiveness for fragrant water lily**	**Further consideration?**
Mechanical Control Methods	Cutting	yes	cutting flowering plants will prevent seed dispersal, but will not kill plants, plants cut below the waterline may be controlled	no*	will not control, may spread infestation	no*	will not control, may spread infestation	no*	effective for short-term control of small areas, must be done frequently; will not eradicate	no*
	Harvesting	can't be done around docks, logs and other in-water obstructions	not relevent	no	effective for short term control of large infestations; will spread smaller infestations	no	not relevant	no	effective for short-term control of large infestations; expensive; must be done frequently	no
	Rotovation	difficult around docks, logs and other in-water obstructions	will cause extensive fragmentation and may spread	no	will cause extensive fragmentation and spread infestation	no	not relevant	no	no, will fragment rhizomes and may spread infestation	no
	Diver dredging	yes	not relevant	no	uses a suction dredge to remove plants from soil; expensive; can cause fragmentation and spread of infestation	yes	not relevant	no	not relevant	no
	Sediment dredge	difficult around in-water obstructions, causes water quality issues and fish habitat degredation	not relevent	no	will not control, may spread infestation	no	can be effective; causes severe short term water quality disturbance; requires extensive permits; very expensive	no	can be effective; causes severe short term water quality disturbance; requires extensive permits; very expensive	no
	Sediment agitation (weed rollers)	no	not relevent	no	useful around individual docks, but not applicable for larger infestation control, can casue fragmentation if area not cleared	no*	not relevant	no*	useful around individual docks, but not relevant for larger infestation control	no*

Table 3, continued

Broad control method category	Specific method	Compatible with Lake Sawyer water body characteristics	Effectiveness for yellow flag iris	Further consideration?	Effectiveness for Eurasian watermilfoil	Further consideration?	Effectiveness for knotweed	Further consideration?	Effectiveness for fragrant water lily	Further consideration?
Biological Control Methods	Grass carp	possible	not relevant	no	grass carp will eat Eurasian watermilfoil but only after they eat most of the other plants in the lake; an inefficient and environmentally costly method for control	no	not relevant	no	not relevant	no
	Galerucella beetles	no -infestation is too small	not relevant	no	not relevant	no	not relevant	no	not relevant	no
	seed feeding weevils and root feeding weevils	no -infestation is too small	not relevant	no	not relevant	no	not relevant	no	not relevant	no
	milfoil weevils	Yes, milfoil weevils present in lake	not relevant	no	may be effective if a reproducing population can be established, this requires proper shoreline habitat and a lack of predators	yes, population already present in the lake	not relevant	no	not relevant	no
Broad control method category	Specific method	Compatible with Lake Sawyer water body characteristics	Effectiveness for yellow flag iris	Further consideration?	Effectiveness for Eurasian watermilfoil	further consideration?	Effectiveness for knotweed	Further consideration?	Effectiveness for fragrant water lily	Further consideration?
Chemical Control	Diquat	not suitable because it does not kill plant roots	not relevant	no	will burn foliage, but roots remain intact, able to re-re sprout; does not eradicate the plant	no	not relevant	no	not relevant	no
	Endothall	not suitable because it does not kill plant roots	not relevant	no	will burn foliage, but roots remain intact, able to re-re sprout; does not eradicate the plant	no	not relevant	no	not relevant	no
	Fluridone	requires whole-late treatment	not relevant	no	will control milfoil through interference with photosynthesis; however it can be costly and is not appropriate for spot treatment	YES	not relevant	no	not relevant	no
	Glyphosate	Spot treat - kills whole plants	works well for yellow flag iris, especially when combined with imazapyr	YES	not relevant	no	works well for knotweed especially when combined with imazapyr	YES	aquatic formulations can be very effective when applied by a skilled contractor; can result in dead, floating root mats that may create other problems	YES
	Imazapyr	Usable at Lake Sawyer, but other herbicides are more cost effective and work just as well	works well for yellow flag iris, especially when combined with glyphosate	YES	not relevant	no	works well for knotweed especially when combined with glyphosate	YES	not relevant	no
	Triclopyr	Aquatic formulations can be used	not relevant	no	the Triclopyr TEA formulation can be very effective if propertly applied and concentrations are maintained for the required time period	YES	works but not effective for long term control	no	not relevant	no
	2,4-D	Aquatic formulations can be used	not relevant	no	very effective, if correct chemical is properly applied	YES	not relevant	no	very effective, if correct chemical is properly applied	no

7.1 Eurasian Watermilfoil (*Myriophyllum spicatum*)

7.1.1 Hand Pulling and Cutting

Hand pulling aquatic plants is similar to pulling weeds out of a garden. It involves removing entire plants (leaves, stems, and roots) from the area of concern and disposing of them in an area away from the shoreline. In water less than three feet deep no specialized equipment is required, although a spade, trowel, or long knife may be needed if the sediment is packed or heavy. Hand pulling can be used to temporarily control Eurasian watermilfoil in a small area if repeated on a regular basis. Hand pulling will likely not eradicate the plant from a water body and is impractical for large infestations. All pulled plant parts must be removed from the water, and a Hydraulic Project Approval (HPA) pamphlet permit is required. Several years of monitoring are needed for signs of plants growing from plant fragments. Milfoil can be composted on dry land or placed in yard waste bins.

Cutting differs from hand pulling in that plants are cut and the roots are not removed. Cutting is performed by standing on a dock or on shore and throwing a cutting tool out into the water. A non-mechanical aquatic weed cutter is commercially available. Two single-sided, razor sharp stainless steel blades forming a "V" shape are connected to a handle, which is tied to a long rope. The cutter can be thrown about 20–30 feet into the water. As the cutter is pulled through the water, it cuts a 48-inch-wide swath. Cut plants rise to the surface where they can be removed. Washington State requires that cut plants be removed from the water. The stainless steel blades that form the V are extremely sharp and great care must be taken with this implement. It should be stored in a secure area where children do not have access. Cutting of milfoil is generally not recommended as it will likely increase the infestation through fragmentation.

7.1.2 Diver Hand Pulling

Diver hand pulling involves the use of divers to carefully pull and bag entire milfoil plants. Divers are able to specifically target milfoil plants and carefully search the area for missed plants. Diver hand pulling is an expensive course of action with little likelihood of success. There may also be issues with hiring divers without specific commercial licenses, according to the Washington Department of Labor and Industries.

7.1.3 Bottom Barriers

An opaque bottom barrier can be used to suppress milfoil growth in small, discrete areas such as a boat launch or around a swimming area. Barriers need to be regularly cleaned because plants will root in the sediment that accumulates on top of them. They also may balloon up as gases can accumulate underneath from decomposition in the sediments. Fishing hooks also can snag bottom barriers and tear them making them ineffective and allowing milfoil to grow in the openings. Barriers are likely to be ineffective at Lake Sawyer

because the locations of the infestations are not easily accessed. These characteristics would make it hard to ensure proper installation and maintenance.

7.1.4 Chemical Control

The use of an aquatic formulation of 2,4-D DMA or triclopyr-TEA by licensed applicators can provide excellent initial control of the Eurasian watermilfoil (*see Appendix C for herbicide labels*) when the infestation is large and difficult to control with manual methods. These herbicides can be applied in the specific areas where the milfoil plants are growing, thus targeting only those plants, and leaving surrounding native submerged plants largely undisturbed. Whole lake treatment with fluridone for milfoil control is expensive and riskier (to non-target plants). The most current surveys in Lake Sawyer suggest that Eurasian milfoil is only found in several discrete locations that could be targeted without treating the entire lake.

There is some concern that the granular formulations of 2,4-D BEE pellet may settle by gravity into sediments, which could inhibit the release of the 2,4-D to the water column. If this is the case, the predicted level of control of Eurasian watermilfoil is not achieved because the concentrations released to the water column might not be high enough to kill the plants. Determination of which form of herbicide (liquid, pellet, or granular) will be most effective on Lake Sawyer milfoil can be made on the recommendation of experienced and licensed aquatic herbicide applicators.

Triclopyr-TEA is a fast acting systemic herbicide and is used for submerged plant control. In King County, the pellet formulation of triclopyr has been used in lakes and has been found to have a long resident time, despite the herbicide label stating it breaks down quickly. Careful monitoring of herbicide concentration levels over an extended time period should be done to make sure that the concentration is high enough to kill the targeted plants but not so high as to go above concentration levels recommended on the label. Two treatments may be required to keep the herbicide concentration at the appropriate level for the desired time period.

7.1.5 Milfoil Weevils

Following section borrowed from EPA website www.epa.water.gov.com

In 1989, biologists with the Vermont Department of Environmental Conservation (VTDEC) noticed a natural decline in the population of Eurasian watermilfoil in Brownington Pond in the northeastern region of the state. In 1990, VTDEC was awarded a $575,000 grant from the USEPA under section 314 of the Clean Water Act. The purpose of this grant was to examine the possibility of using aquatic herbivores found in Brownington Pond as a biological control for other EWM populations. This Clean Lakes Demonstration Program grant was awarded for the purpose of highlighting new and unique techniques for lake restoration.

Working under contract for VTDEC, researchers from Middlebury College mapped and studied the decreases and increases in EWM in Brownington Pond from 1990 through 1995. The study investigated a variety of factors (e.g., herbivores, water chemistry, and sediment chemistry) that could have influenced the fluctuations. The results of the plant and invertebrate sampling suggested that herbivorous insects played a primary role in the EWM declines observed in 1989 and 1992. The researchers were able to eliminate other factors as reasons for the declines, and the focus turned toward the herbivore populations in the pond.

The two main EWM herbivores present in Brownington Pond were an aquatic weevil native to North America, *Euhrychiopsis lecontei* (Figure 3, illustration courtesy of Susan Warren, VT DEC), and the caterpillar *Acentria ephemerella*. In examining the herbivores, the researchers noticed variations in the abundance of the aquatic weevil between 1990 and 1994 and compared the variations to those of the EWM. They noticed that the fluctuations in the weevil populations compared to the EWM populations were similar to those exhibited by predator-prey or host-parasitoid models (Creed and Sheldon, 1995). The evidence suggested that the naturally occurring weevil populations might have played a role in the decline of the Brownington Pond EWM population.

The Middlebury College researchers conducted laboratory and field experiments to further examine the relationship between EWM and the weevils, as well as their relationships to other herbivores and macrophytes. It was discovered that *Phytobius leucogaster*, another species of aquatic weevil, did feed on the EWM but had no significant negative effect on its growth (Sheldon, 1995). It was also discovered that the Acentria larvae reduced EWM growth in laboratory experiments (due to stem-cutting during feeding and retreat construction (Creed and Sheldon, 1994)). However, extensive caterpillar damage was not observed in Brownington Pond (Creed and Sheldon, 1994).

By researching the feeding behaviors of the weevil, the researchers were able to determine that all of its life stages can cause damage to the plant. The first instar larvae cause extensive destruction to the growing tip of the plant, thus preventing new stem growth. The late instar larvae hollow out the stem by feeding on its vascular tissue, thus reducing the plant's ability to transport the nutrients necessary for growth. The late instar larvae also destroy the lacunal system of the EWM, which serves as a gas reservoir for respired carbon dioxide (Nichols and Shaw, 1986, as cited in Creed and Sheldon, 1994) and also permits gas exchange between the plant roots and shoots (Grace and Wetzel, 1978, Nichols and Shaw, 1986, as cited in Creed and Sheldon, 1994). The adult weevils can damage the plant by feeding on its upper leaves, which can affect the plant's energy balance by transferring photosynthesis responsibilities to deeper leaves (Creed et al., 1992). The feeding may also make the plant more susceptible to infections by bacteria and fungi (Sheldon and Creed, 1995; Creed et al., 1992).

In addition to these direct effects, larval tunneling can also cause the plant to lose buoyancy and collapse into deeper waters, where it is subject to conditions different from those at the surface. This indirect effect of loss of buoyancy could in fact be more significant than the direct loss of leaf and stem tissue discussed above (Creed and Sheldon, 1995; Creed

et al., 1992). It can cause the plants to sink out of well-lit surface water, possibly to depths with insufficient light for photosynthesis (Creed et al., 1992). Plants that lose buoyancy due to weevil feeding could also entangle and sink other, undamaged plants.

The Middlebury College researchers conducted laboratory feeding trials to quantitatively assess the effects of the weevils on the EWM. The plants were collected and cleaned of all invertebrates, eggs, and other material. Data were collected concerning the plants' appearance, weight, and length. The plants were then placed in clear cylinders and zero, two, or four adult weevils were added to each cylinder. The results of the laboratory experiments showed that the wet weight of the EWM averaged 50 percent less in the two-weevil containers than in the no-weevil containers and 130 percent less in the four-weevil containers (Sheldon, 1995). In addition, the final plant shoot lengths were an average of 25 percent shorter in the two-weevil containers and 60 percent shorter in the four-weevil containers (Sheldon, 1995).

In field experiments, weevils were added to 30.5-centimeter-diameter, 2-meter-tall cylindrical enclosures in two lakes in which weevils were not present. Forty days after the addition of the weevils, the EWM plants in the three experimental weevil enclosures were compared to those in the three control enclosures. Plant weights were lower for the plants with weevils. In addition, the macrophyte formed canopies in the control enclosures and the surrounding areas, but in the weevil enclosures there were no plants at the water surface (Sheldon and Creed, 1995). The plants had collapsed, and most were at least 1 meter below the surface (Sheldon and Creed, 1995).

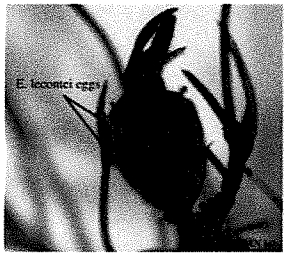
In addition to the effects on EWM, the Middlebury College researchers also investigated the effects of the weevils on other aquatic macrophytes, including several native milfoil species. They found that the weevils had no significant negative effects on the native, non-milfoil species, with no evidence of weevil feeding or egg-laying (Sheldon and Creed, 1995). Although the weevils did feed and lay eggs on portions of the native milfoil M. sibiricum, the resulting damage was not considered significant (Sheldon and Creed, 1995; Sheldon, 1995).

Based on the results from the Middlebury College laboratory and field experiments, the weevil was deemed acceptable by VTDEC as an experimental biological control because of the possibility that it might be able to control EWM and the low risk it posed to non-target native aquatic plants.

Life Cycle of the Milfoil Weevil

The complete life cycle of the milfoil weevil takes 21–30 days at 20–25 degrees C, with survival ranging from 20–70%; there is a linear relationship between development rate and temperature (Mazzei et al. 1999). Mazzei et al. (1999) provide a table with development times for each stage over a range of water temperatures.

Egg

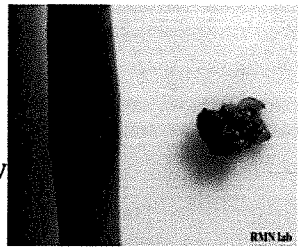


The milfoil weevil lays its eggs on milfoil plants, usually on apical meristems near the water surface (Sheldon and O'Bryan 1996a). Female weevils lay single eggs that they stick to the plant, and seem to prefer to lay eggs on meristems where no other eggs are present. However, up to 29 eggs have been laid on a single apical meristem when no other options were available (Sheldon and O'Bryan 1996a). Eggs are a yellow-cream color, elliptical, and approximately 0.5 mm long (Sheldon and O'Bryan 1996a). The egg stage lasts about 3–6 days at typical mid-summer temperatures of 20–25 degrees C. Hatching success has been reported to be between 65-100% (Sheldon and O'Bryan 1996a, Newman et al. 1997).

Larva

After hatching, first instar larvae feed on meristem tissues for 3 to 5 days, while older larvae spend the majority of their time inside the stem (Sheldon and O'Bryan 1996a) where they feed on cortical and vascular tissues. Larvae are generally found in the top 1 m of the plant (Sheldon and O'Bryan 1996a). Stems that have been hollowed-out by weevil larvae appear darkened, are less buoyant, and are weaker than undamaged stems (Creed et al. 1992). Occasionally, larvae will bore out of the stem, travel up or down the stem in a spiral path, and bore back into the stem. This behavior is most common when a larva reaches the end of an internode (Sheldon and O'Bryan 1996a). Late instar larvae reach a length of about 4.5 mm. Development time through the larval stage ranges from 8–15 days at 20–25 degrees C (Sheldon and O'Bryan 1996a, Newman et al. 1997). Survival through the larval stage has been recorded at 78–90% (Newman et al. 1997).

Pupa



The milfoil weevil pupates (metamorphoses) inside of milfoil stems in a pupal chamber. Generally, they are found further down the stem than larvae (> 0.5 m), possibly because a larger diameter stem is preferred for pupation (Sheldon and O'Bryan 1996a). However, successful pupal development has been recorded on stems as narrow as 1 mm (Newman et al. 1997). Typical development times through the pupal stage are 9–12 days at mid-summer water temperatures (20–25 degrees C) (Sheldon and O'Bryan 1996a, Newman et al. 1997). Survival through the pupal stage has been recorded at 69–80% (Newman et al. 1997).

Adult

Adult milfoil weevils are usually located on the upper 1 m of milfoil plants. They are weak swimmers, and will usually remain on a plant even after it has been disturbed. Adult weevils primarily eat milfoil leaves, but will also consume stem tissues (Sheldon and O'Bryan 1996a). This is the only stage of the weevil that can exit the water. However, it appears to only leave the water in fall when it migrates to shore and over winters terrestrially in organic matter near the

shoreline. They possess wings, but weevils are rarely observed in flight. It remains unclear if the weevil swims or flies on this short migration (Newman and Ragsdale 1995). Adult milfoil weevils are approximately 2–3 mm in length and have lived as long as 162 days in captivity (Sheldon and O'Bryan 1996a). Females lay an average of 1.9 eggs per day, and total egg production by captive females ranged up to 562 eggs (Sheldon and O'Bryan 1996a).

The complete life cycle takes from 17 to 30 days at 20–27 degrees C, with survival ranging from 20–70% (Newman et al. 1997, Mazzei et al., 1999). However, water temperature (Mazzei et al., 1999), host plant (Newman et al. 1997) and host plant quality (Sheldon 1997) have been shown to affect development time and success (see also Watson and Newman) This life cycle period allows for three or more generations per summer. In addition, Sheldon and O'Bryan (1996a) reported cyclical patterns in abundance of each life stage. They observed that a peak in egg abundance was followed by a peak in larvae abundance, followed by pupae abundance, and finally adult abundance. This pattern was repeated several times until fall when the adults stopped laying eggs (see also results from Minnesota). Shortly after all sub-adult life stages were no longer found, the adults disappeared, presumably to over winter on shore. Adults leave the shore in spring and return to the water after ice out, between mid-April and mid-May in Minnesota (Newman, Ragsdale and Biesboer 1997).

Host Plant Choice

The milfoil weevil is highly specific to milfoil plants (*Myriophyllum spp.*) (Sheldon and Creed 1995, Solarz and Newman 1996). Because the weevil is endemic to North America (Colonelli 1980, O'Brien and Wibmer 1982), and Eurasian milfoil probably was not established in North America until the 1940's (Smith and Barko 1990), it is evident that the original host was northern milfoil (Creed and Sheldon 1994a, Newman and Maher 1995). However, with the introduction and spread of Eurasian milfoil across much of North America, the milfoil weevil was exposed to a novel plant that is closely related to its natural host. Newman and Maher (1995) reported finding milfoil weevils on northern milfoil only in lakes where Eurasian milfoil was absent or, in one case, where Eurasian milfoil exhibited extensive weevil damage. This indicates that the milfoil weevil has undergone a host range expansion (Bernays and Chapman 1994) to include Eurasian milfoil.

Several laboratory experiments have demonstrated that adult milfoil weevils prefer Eurasian milfoil for feeding and oviposition. Sheldon and Creed (1995) showed that adults reared on Eurasian milfoil have high feeding preferences for milfoils, particularly Eurasian milfoil. Solarz (1995) showed that weevils are attracted to substances released by Eurasian milfoil into the water. Solarz and Newman (1996) demonstrated that weevils are specific to milfoils for oviposition. However, weevils reared on Eurasian milfoil highly prefer it over the native northern milfoil, whereas adult weevils reared on northern milfoil select northern and Eurasian milfoils equally (no preference). Furthermore, development times from egg to adult were 1–2 days longer and survival was lower on northern milfoil than on Eurasian milfoil for captive weevils (Newman et al. 1997). These results indicate that natural populations of the milfoil weevil will shift from the native northern milfoil to the

exotic milfoil when exposed to both. In addition, weevils may benefit from this shift through faster development and increased survival.

7.1.6 Recommended Treatments

Treatments of Eurasian milfoil at Lake Sawyer will likely include hand pulling and spot treatment with selective herbicides. Selective herbicides target dicots, which includes Eurasian milfoil. The native milfoil (Northern) is also a dicot, but is more resistant to herbicide, while the native pondweeds are monocots. As of 2013 there were small populations of Eurasian milfoil around the lake with the largest stand being located just south of the southern island on the west side of the lake. Northern milfoil plants (and the occasional Eurasian) are seen around the lake (usually as individual plants) and the density of invasive milfoil appears not to pose a threat to the biodiversity of this section of the lake at this time.

Given the presence of the milfoil weevils in the lake, an integrated pest management (IPM) approach is recommended. This approach would focus on conducting surveys of the lake on an annual (or every other year) basis. This survey would document the population of the milfoil and track any changes in coverage area (as well as track the population of the other vegetation addressed in the plan). Historic surveys of the lake (going back to 1976) indicate that Eurasian milfoil was the most common plant in the lake and that it formed a band around the lake of varying density. Subsequent surveys done between 1976 and 1996 indicate that Eurasian milfoil was still the most common plant in the lake and it covered a good portion of the littoral zone. Surveys done in 2012 and 2013 indicate a much less dense population of milfoil, and it is likely that the milfoil weevil is acting as a biological control to keep Eurasian milfoil in check.

Because of this biological control, the Steering Committee agreed upon recommending an approach of monitoring and hand pulling with the use of selective herbicides if the population of milfoil appears to be significantly increasing in coverage and density and becomes too large to hand pull effectively from a boat. The chemicals recommended for treatment are listed in Appendix C.

7.2 Yellow Flag Iris (*Iris pseudacorus*)

7.2.1 Hand Pulling or Cutting

Hand pulling of yellow flag iris is a feasible option for small infestations. In damp or wet soils seedlings can be easily removed while mature plants may require working with heavier tools such as pick axes, pulaskis, or saws. When removing plants, care must be taken to be sure to remove all rhizomes. Any rhizomes left will sprout new plants, so manually cleared areas must be monitored over time for new growth. When working with yellow flag iris, care should be taken to protect the skin from resins found in the leaves and rhizomes that can act as irritants. Emergent plants with continually inundated root systems can be cut below the waterline for effective control. It is recommended to cut them before

flowering. Rhizomes can continue to grow up to 3 months without water so disposal of plant material must be done in dry locations.

7.2.2 Bottom Barriers

Small patches of yellow flag iris can be controlled using a heavy tarp weighted at the edges. The tarp must extend beyond the edges of the infestation and needs to be checked periodically to insure plants aren't growing up around the tarp. Materials such as landscape fabric and heavy plastic may not be study enough to effectively control the plants. Coverings must be left in place for up to several years.

7.2.3 Chemical Control

Chemical control for yellow flag iris can be an effective alternative and may be the only option for moderate to large infestations. Yellow flag iris is a monocot and only non-selective herbicides are effective. These non-selective herbicides can injure or kill any plants they come in contact with, so special care must be used when applying these chemicals. Glyphosate is the most commonly used herbicide for yellow flag iris control. For effective control it should be applied in late spring through fall and needs to be applied directly to foliage or fresh cut leaves and stems. Yellow flag iris may require higher concentrations for effectiveness, so the label directions must be strictly followed. Imazapyr is also an effective treatment and may be applied in conjunction with glyphosate for good control. Imazapyr has been shown to have some residual soil activity, so care must be taken to not spray the root zones of desirable plants and avoid replanting for several months. All three herbicides are most effective in combination with a surfactant such as Competitor (selected surfactant must be approved for aquatic use). Multiple treatments may be required for dense infestations and retreatment is generally recommended. All aquatic herbicides must be applied by a licensed pesticide applicator and label directions must be adhered to.

7.2.4 Recommended Treatments

The abundance and distribution of yellow flag iris around Lake Sawyer may make eradication of the plant not feasible. Much of the shoreline around the lake has iris in varying densities. The preferred treatment option for the iris is to spray the near shore plants while treating the fragrant water lily, in combination with hand pulling by property owners around the lake. Care must be taken when treating the iris not to allow the chemical to drift onto desirable plants because non-selective herbicides will need to be used, putting other plants at risk if carelessly applied.

7.3 Fragrant Water Lily (*Nymphaea odorata*)

7.3.1 Hand Pulling and Cutting

Hand pulling and cutting can be used to temporarily control fragrant water lily in a small area such as around a dock, if repeated on a regular basis. Hand pulling will likely not eradicate the plant from a waterbody and is impractical for large infestations. While

cuttings won't increase the spread of fragrant water lily, all pulled or cut plants and plant parts must be removed from the water, and an HPA pamphlet permit is required. Several years of monitoring are needed for signs of plants growing from root fragments and from the seed bank. Fragrant water lily can be composted on dry land or placed in yard waste bins.

7.3.2 Bottom Barriers

An opaque bottom barrier can be used to suppress water lily growth in small areas such as a boat launch or under a swimming area. Barriers need to be regularly cleaned and maintained because plants will root in the sediment that accumulates on top of the barrier. Bottom barriers are not practical for large-scale infestations such as an entire lake bottom.

7.3.3 Sediment Agitation (Weed Rolling)

Weed rolling is a suitable way to temporarily control, but not eradicate, water lily in a small discrete area such as at the end of a dock. It is not suitable for any larger area. Weed rolling involves the use of a commercially available, low voltage power unit that drives an up-to-30-foot-long roller set on the lake bottom through an adjustable arc of up to 270 degrees. A reversing action built into the drive automatically brings the roller back to complete the cycle. Fins on the rollers detach some plants from the soil, while the rollers force other plants flat, gradually inhibiting growth. Detached plants should be removed from the water with a rake or gathered by hand. Once plants are cleared from the area, the device can be used as little as once per week or less to keep plants from recolonizing the area. Weed rolling is not applicable to lake-wide infestations.

7.3.4 Chemical Control

Chemical methods used to control fragrant water lily can be very effective and are appropriate for treatment of large areas that covered with water lilies. The most effective and environmentally low-toxic herbicide suitable is an aquatic version of glyphosate (*see Appendix C for herbicide label*). This aquatic herbicide must be used with a Washington State Department of Ecology-approved aquatic surfactant. Glyphosate is applied directly to the floating leaves through precise foliar spraying by an approved aquatic herbicide contractor. Foliar application of the herbicide reduces the chance that the herbicide will come in contact with and affect non-target plants. Glyphosate also has the advantage of working through translocation, whereby the chemical moves through the plant and kills the plant to the roots.

It is recommended that the spraying of the plants happens twice per growing season to ensure that none are missed. It is expected that herbicide treatment will occur over at least a two year period. The effectiveness of fragrant water lily control is easy to measure through visual surveys due to the floating leaves. The best control methods involve treating a limited area each year to reduce the chance of creating floating islands of decomposing rhizomes that can be persistent and very difficult to remove.

7.3.5 Recommended treatment

Fragrant water lily was the plant that was considered of high concern among lake residents. Over the last several years residents have noted that the water lily density seems to be increasing around the lake and has begun to restrict access to some shorelines and portions of the lake. There is some concern among residents that some people have been chemically treating the water lilies without having aquatic herbicide permits or using approved herbicides (and surfactants). Because of this, beginning an approved treatment plan for these plants is a primary concern for lake residents.

The preferred option for treatment of the water lilies is to hire a licensed aquatic herbicide applicator to spray the exposed foliage using an approved formulation of glyphosate. This is an inexpensive chemical that has been shown to be highly effective for treating fragrant water lily. Multiple applications will be required over a number of years to fully eradicate the lilies. It is recommended that treatments be done in June or July to allow time for follow up spot application(s) during the growing season.

A drawback of using herbicides to control the water lily is the potential for "uplifting" of mats of decomposing water lily roots that can form floating islands in the lake after the plants have died. Small patches of water lilies have a lower likelihood of forming these mats, but Lake Sawyer does have several large patches of lilies that may have the potential to create these floating mat islands. Note that the natural decay of fragrant water lily patches can also create these floating mats. Removal of the mats usually consists of towing the mats to a takeout point and cutting them up using hand tools or machinery. Disposal of the cut-up mats may be problematic. At a minimum, a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife (WDFW) will be required to remove the mats. Additional permits may be required depending on the specific circumstance.

7.4 Japanese Knotweed (*Polygonum cuspidatum*)

7.4.1 Hand Pulling and Cutting

Hand pulling or cutting is not suitable for large infestation areas of knotweed. The King County Noxious Weed Japanese knotweed control program recommends that manual control methods only be used when the stems of the plant number 50 or less.

Manual methods, consisting of digging up plant roots and cutting the canes to the ground several times a season, can be a larger part of an IPM control strategy. If manual methods are selected for knotweed control, it is important to be sure to plan on several years of implementation and activity for many days over the course of each season for proper control.

7.4.2 Soil Barriers

The use of geotextile barriers for knotweed is only suitable at the beginning of the growing season or after several cutting attempts have been made and slowed to slow down the

rapid growth of the plant. A barrier of geotextile fabric or black plastic can be placed on the area and extend 10 feet beyond the known infestation area. The barrier must remain for several growing seasons and be maintained to insure no holes in the barrier allow knotweed to grow through. Plants sprouting alongside the barrier need to be removed and if any plants are seen trying to push through, the barrier needs to be trampled. Only when no growth beneath the fabric is observed for a whole growing season can the barrier be removed.

Barriers for knotweed may work in areas where the infestation is very small and used in conjunction with other control methods.

7.4.3 Chemical Control

Chemical control used in conjunction with some manual method of control is the most effective way to deal with large infestations of Japanese knotweed.

Foliar applications

There are several types of chemicals that have been used on knotweed, but the most common and effective combination appears to be imazapyr and glyphosate (F. Lucero, pers. comm.). Glyphosate is non-selective and can cause damage to other area plants if the spray drifts. Repeat applications are likely necessary and work well in conjunction with imazapyr. Imazapyr is a slow-acting but highly effective herbicide. It is systemic and can stay in the soil for up to a year. Imazapyr is taken up by the roots and leaves of the plant and kills the knotweed slowly over time. Because this herbicide is not highly selective, this treatment limits the possibility of replanting any area where this chemical is used for at least one year.

Foliar applications are most effective when the knotweed is cut back in the spring and summer and herbicide is sprayed in fall, and this method will decrease the amount of herbicide necessary as well.

Injection method

Often knotweed is managed by injecting herbicide directly into the stem of the knotweed. The injection method is very selective, eliminates drift, and does not require any cutting prior to treatment. However, this method is very time intensive as each stem of knotweed needs to be injected with the herbicide. At this point only glyphosate can be used with the injection method. Herbicide guns can only be used on stems larger than ½ inch, so some small stems will go untreated. Proper maintenance of the injection gun is imperative to this method working.

Cut stem/pour applications

This method is similar to the injection gun method but 3mL of concentrated glyphosate is poured directly into the stem of each knotweed plant using a syringe-type piece of equipment. It is very labor intensive, like the injection method, and would work best on smaller infestations.

Wick-wipe method

This method uses a sponge at the end of an applicator, similar to those on a backpack sprayer, and the herbicide is directly "wiped" onto the leaves of the knotweed. Both imazapyr and glyphosate can be used for this method. While this method greatly reduces drift it is hard to insure the herbicide comes into enough contact with the knotweed to make the application worthwhile.

7.4.4 Recommended Treatment

Lake Sawyer riparian areas host a small number of Japanese Knotweed plants. The City of Black Diamond has already begun herbicide treatment on the plants. They are located in the natural area in the southeast portion of the lake. The preferred treatment of the knotweed is continued monitoring of the plants and spot treating them as necessary to eradicate the population.

7.5 Narrow Leaf Cattail (*Typha angustifolia* and *Typha x glauca*)

7.5.1 Hand Pulling and Cutting

Hand cutting or pulling can be an effective control for *Typha* species. Mowing or cutting has been shown to be effective when applied over the course of several years. Cutting the plants below the waterline is the key to effective control. Plants cut above the waterline will reduce biomass but the below water structures will remain healthy and the plants will regrow. Small amounts of living leaf material above the waterline may be enough to supply sufficient oxygen to the roots and may allow them to persist. Cutting the plants below the waterline later in the summer (August) seems to result in the best control.

7.5.2 Bottom Barriers/Shading

Shading with heavy black tarps has shown to be moderately effective at controlling *Typha* species when they are left in place for at least sixty days. Wherever the tarps are ripped or disturbed plants will survive. Applying this method to a large scale infestation would not be practical.

7.5.3 Chemical Control

Chemical control may be the most effective method for controlling large scale *Typha* infestations. The application of 2,4-D ester to plants before cattail heads appear in spring at a rate of 6lb acre per 100 gal of spray solution for spot treatments with the addition of a surfactant is effective for control. Multiple applications may be needed for complete control. Be sure to avoid drift from the desired application area. Glyphosate can also be applied to mature plants after head are formed. It should be applied at the rate of 3lb/acre. Glyphosate is a non-selective herbicide and will damage vegetation and grasses that are incidentally sprayed. Imazapyr can be applied after cattail heads have appeared and before

the first frost. It should be applied at 0.5 to 1 lb/acre. Caution should be taken to insure the chemical doesn't come in contact with the root zones of desirable trees. Water treated with imazapyr cannot be used for irrigation for 120 days.

7.5.4 Recommended Treatment

The population of narrow-leaf cattail around Lake Sawyer is not well documented. The first step toward controlling this invasive species is to determine the extent of the infestation. The recommendation is to conduct at least one survey of the lake during the growing season while the flowering heads are formed. After the plants are identified, the recommended treatment depends on the extent of the population. Small populations could be controlled by hand cutting the stems below the waterline during late summer. This seems to be the best method of control without using herbicides. If the infestation is determined to be too large to control by cutting, the recommended approach is to use a non-selective herbicide such as glyphosate (be sure to apply while the heads are formed). Care should be taken when doing this to avoid contacting desirable species with glyphosate because of the likelihood of damage to those plants.

8.0 RECOMMENDED TREATMENT PLAN

Lake Sawyer and its riparian areas are home to five listed noxious weed species whose presence can diminish the quality of Lake Sawyer as an ecological and human resource. Narrowleaf cattail densities are currently unknown yellow flag iris may be too abundant to eradicate. The small population of Japanese knotweed is currently being addressed by the City of Black Diamond and King County staff.

The goal of the treatment plan is to halt or even reverse the degradation of the lake resource caused by the offending species. The population of Eurasian milfoil appears to be held in check with the presence of the milfoil weevil observed on the densest plant populations. The fragrant water lily abundance appears to be steadily increasing and using an herbicide is recommended to eradicate this species of plant. The other three species (narrow leaf cattail, yellow flag iris and knotweed) addressed in this document will require a combination of monitoring and assessing any population changes with the appropriate follow up treatment. The following treatments recommended in this document comprise an Integrated Pest Management (IPM) strategy that balances target weed eradication or control, environmental protection, and feasibility.

8.1 Permits

Most aquatic weed control activities require permits from jurisdictions and agencies responsible for managing and protecting natural resources. Many manual and mechanical control methods are covered under the "Aquatic Plants and Fish" pamphlet, an HPA for small projects issued by the Washington Department of Fish and Wildlife that is free of charge and expedites the removal aquatic of noxious weeds. This HPA pamphlet permit applies only to use by individual land owners over small areas and only applies to aquatic noxious weeds, not "beneficial plants" or native plants that may be seen as nuisance weeds. A National Pollutant Discharge Elimination System (NPDES) permit must be obtained before aquatic herbicides can be applied to natural water bodies in Washington State. The Washington Department of Agriculture holds an NPDES permit for the management of emergent noxious weeds growing in wet areas such as lake shores, shallow freshwater wetlands, river banks, and estuaries. Licensed applicators can obtain coverage from the Washington Department of Agriculture under this permit free of charge. For herbicide treatment of in-lake plants (floating or submersed weeds) the project will need an Aquatic Plant and Algae Management NPDES permit from the Washington Department of Ecology. This permit must be held by the herbicide applicator or the legal entity hiring the applicator, it must be applied for at least sixty days before the herbicide application, and a permit fee applies. In 2014 the permit fee was $415 assessed per year through the life of the permit.

The treatment schedule laid out below is tentative and will be reassessed each year depending on the density and distribution of the plants found during surveys.

8.2 Eurasian Watermilfoil (Myriophyllum spicatum)

8.2.1 Initial Control (year 1)

It is recommended that a survey of Eurasian watermilfoil occur in early to mid-July. The proposed survey would be conducted from a small boat. Plant locations will be recorded using a combination of GPS and hand-marked detailed aerial photos incorporated in an electronic mapping file. If only a few plants are found or the density/distribution appears to be static, small scale hand pulling could be done by a snorkeler from the boat (where feasible), assuming the plants can be easily accessed. Herbicide treatments are only acceptable if the milfoil weevil population has significantly decreased or the plant abundance is noted to be significantly increasing. The most desirable option is for the biological control (milfoil weevil) to reduce the milfoil abundance and keep the species in check. This option requires the least amount of financial resources and has the potential to control the species long term. This preferred option may never result in the complete eradication of the Eurasian milfoil but it can be expect to keep the population of milfoil below nuisance levels.

If Eurasian milfoil is found to be greatly increasing in abundance, control will be accomplished using a selective aquatic herbicide formulation of 2,4-D DMA and/or triclopyr-TEA (see Appendix C for herbicide label). Suitable formulations include, but are not limited to: Renovate® OTF (granular triclopyr-TEA), Navigate® (granular 2,4-D) or Renovate® MAX G (granular triclopyr-TEA + 2,4-D). The herbicide will be applied by a licensed aquatic herbicide applicator at the label-recommended rate.

If herbicide treatment is warranted, it is recommended that initial treatment occur in mid to late July when milfoil plants have become visible in the water. Locations to be treated will be based on survey maps, GPS coordinates, and new visual observations of plants as the treatment occurs. A record of which areas were treated and amount of herbicide applied will be kept for 7 years, in addition to all other required herbicide application records. A record of herbicide application will also be entered into the Secure Access database through the State of Washington as part of the NPDES permit.

First year follow-up spot treatment (if warranted) could occur in mid to late August to control any plants that were missed during the July treatment. The second treatment is recommended to occur before milfoil plants are expected to fragment, usually early September.

If an herbicide treatment is done then a follow up survey in September is recommended to determine the effectiveness of the treatment. If contracted by the City of Black Diamond, the survey can be conducted by King County staff from a small boat, and any plants found will be mapped. If necessary, plants may be pulled.

8.2.2 Follow-up Control (years 2–5)

In years following an herbicide treatment (if undertaken), it is proposed that the lake be surveyed for milfoil in early July. If conditions warrant, one or two rounds of herbicide spot treatment could be scheduled for mid-July and mid- to late August. If the milfoil population is small and/or sparse enough, hand pulling will be done and all milfoil pieces will be bagged. A follow-up survey is recommended in September regardless of the control method(s) used. If the Eurasian milfoil densities don't warrant an herbicide treatment than it is recommend that only one annual survey be undertaken to assess the population.

8.2.3 Monitoring

If an aquatic herbicide treatment is applied than a NPDES permit will be required and that permit may stipulate (depending on herbicide used) monitoring of herbicide levels in the lake after treatment. General timelines consist of samples being collected at the time of the initial application and again five days post treatment. A baseline sample will also be taken before the application, since water quality experts at Ecology report heightened levels of herbicides in the lake surface water due to runoff after heavy storm events. One sample is taken from within the treatment area, and one from outside. These samples will be sent to an independent, Ecology-accredited laboratory for analysis. Sampling and analysis will continue until the herbicide levels drop below a predetermined threshold. This procedure will be required in each year in which an aquatic herbicide is applied.

Surveys after the initial application are essential to determining the success of the effort, and will be used to determine what measures need to be implemented to complete the milfoil control each year.

8.3 Yellow Flag Iris (*Iris pseudacorus*)

8.3.1 Year 1–5

Yellow flag iris is a very prevalent plant around Lake Sawyer. Because of this and the difficulty in effectively eradicating the species, it is not a primary target of this IAVMP. Instead of developing a plan to specifically target the yellow flag iris, treatment of shoreline plants (using glyphosate) that are adjacent to fragrant water lilies will be done during the water lily treatment. This can effectively reduce the plant population while not adding a large expense. In addition to the targeted spraying, it is recommended that homeowner education about invasive species become a priority for the community.

8.4 Fragrant Water Lily (*Nymphaea odorata*)

8.4.1 Initial Control (year 1)

Pretreatment survey of fragrant water lily is not necessary because the distribution of the plants has been consistent from year to year, and the expected distribution can be based on the past summer's air photos.

Initial control of fragrant water lily will be accomplished using a broad-spectrum aquatic herbicide formulation of glyphosate (*see Appendix C for herbicide label*). Suitable formulations include, but are not limited to: Rodeo®, AquaMaster®, and AquaPro®. The herbicide will be applied by a licensed aquatic herbicide contractor, on a calm, dry day to ensure good herbicide contact with the plants. Treatment of water lily will occur in June once the water lily plants have fully surfaced for the year.

As necessary, a second spot treatment of water lily will likely be scheduled for August. A final survey of remaining water lily plants is recommended to be conducted during the late summer survey and mapping.

8.4.2 Follow-up Control (years 2–5)

Year two and three water lily treatment will most likely consist of spot herbicide treatments in summer (August) if needed. A final survey of remaining water lily plants could be conducted during the late summer watermilfoil survey and mapping in early September. It is unlikely that annual herbicide treatment will be necessary after year three, but one more year of spot treatment may be necessary to complete eradication before the end of the project. As the populations of lily become smaller, cutting is a very viable option for the few stubborn patches that are bound to exist.

Floating mud mats

When water lilies die, often their root masses will swell with gas and rise to the surface, bringing up all the muck from the bottom of the lake around them. This is a natural process and will occur at the end of the life cycle of a water lily patch whether it died naturally or was controlled using herbicide. Occasionally these mats will sink again on their own, but just as often they will persist and become floating islands of vegetation. Many lake communities choose to leave them in place, but they can also be removed mechanically if desired. This plan does not provide funding for the removal of any mud mats that may form. If they do form as a result of the water lily control, the community can assess their effect on the lake and decide at that point whether to remove them or leave them in place. It is recommended that any floating mats observed be removed or landed in an area that will not hinder recreational activities on the lake.

Monitoring

The NPDES permit may require monitoring of herbicide levels in the lake after treatment (depending on the aquatic herbicide used). Water quality monitoring of herbicide levels is generally required of persistent herbicides that are applied in water. If glyphosate is chosen (a foliar spray) no herbicide level monitoring will be required. If other herbicides are chosen, independent samples may be required to collected at the time of the application and again five days post treatment.

A baseline sample will also be taken before the application (except with glyphosate treatment), since staff from the Washington State Department of Ecology has reported

heightened levels of herbicides in lake surface water due to runoff after heavy storm events. This is likely due to stormwater runoff being contaminated with herbicides. One sample should be taken from within the treatment area, and one from outside. All samples will be sent to an independent, Ecology-accredited laboratory for the analysis. Samples will continue to be collected and sent for laboratory analysis until the herbicide levels drop below a predetermined threshold. This procedure will be performed each year an application of herbicide for water lily control is conducted (with chemicals other than glyphosate). Surveys after the initial application are essential to determining the success of the effort, and will be used to determine what measures need to be implemented to complete the water lily control for Year 1 (and subsequent years).

8.5 Japanese Knotweed (*Polygonum cuspidatum)*

8.5.1 Year 1–5

Lake Sawyer has a small stand of Japanese knotweed located in the natural area on the southeast portion of the lake. The City of Black Diamond has already begun treating the plants with a systemic herbicide. With the help of King County Parks and the King County Noxious Weeds Program, the City will continue to monitor and treat the small population of plants.

8.6 Narrowleaf Cattail (*Typha angustifolia*)

8.6.1 Initial Control (year 1)

The abundance of narrowleaf cattail around Lake Sawyer is not well documented. The first step of the control strategy for this species is to conduct a survey (can be combined with Eurasian milfoil survey) and map the extent of the population around the lake.

After the survey is completed a strategy for control can be implemented. For minor infestations cutting below the waterline was selected as the preferred option. Larger infestations may require the use of a non-selective herbicide such as glyphosate. The herbicide must be applied after the heads are formed. If populations are sufficient to warrant chemical treatments it is possible to combine the herbicide treatment with the fragrant water lily treatment.

8.7 Follow up Control (years 2–5)

Follow up control of narrowleaf cattail is recommended to consist of continued monitoring and cutting with herbicide treatments being implemented when the cattail density is deemed too large to control with below waterline cutting.

9.0 PLAN ELEMENTS, COSTS AND FUNDING

Implementation of the Lake Sawyer IAVMP is schedules to span five years, at a total estimated cost of $58,462. Year one will begin after a funding source is identified and the project timeline established. The costs associated with the implementation of this IAVMP are based on 2014 dollars and are based on best professional judgment (table 4) and current infestation densities. Depending on Eurasian milfoil densities observed during the surveys, herbicide treatments may not be warranted and if not applied the total cost of the plan would likely be less. It should be noted that there is no funding in this plan for the removal of floating mats that may occur with the treatment of the fragrant water lilies. Any costs associated with the removal of the mats will need to be addressed by the City of Black Diamond and the local community.

Treatments and timelines may vary depending on changes noted in target species density and distribution observed during annual surveys. The City of Black Diamond has the authority to determine who will conduct the work associated with this project. Selected partners may consist of private contractors, King County DNRP, Washington State Department of Ecology and City of Black Diamond staff.

Table 4. Table 4. Estimated Cost of Lake Sawyer IAVMP implementation.

IAVMP Implementation Cost						
Task/Species	Year 1	Year 2	Year 3	Year 4	Year 5	5 Year Total
Eurasian Milfoil			$3,600	$1,500	$1,500	$6,600
Yellow Flag Iris	$500	$500	$500		$500	$2,000
Fragrant Water Lily	$6,000	$2,000	$2,000		$2,000	$12,000
Japanese Knotweed						0
Narrowleaf Cattail		$1,250		$1,250		$2,500
Weed Surveys/Monitoring	$2,100	$2,100	$2,100	$2,100	$2,100	$10,500
Community Outreach and Notification	$600	$600	$600	$600	$600	$3,000
Permitting	$415	$415	$415	$415	$415	$2,075
Printing	$400	$400	$400	$400	$400	$2,000
Project Administration and Reporting	$1,400	$1,400	$1,400	$1,400	$1,400	$7,000
Totals	$11,000	$8,250	$10,600	$7,750	$8,915	$47,675
					9% Tax	$4,291
					12.5% Contingency	$6,496
					Project Total	$58,462

9.1 Cost of the Plan

9.1.1 Planning Costs

Most of the planning has been completed through the creation of this IAVMP. Approximately 63% of the cost of researching, planning for and writing this management plan came in the form of a grant from the Washington State Department of Ecology's Aquatic Weeds Management Fund. The remaining costs came in the form of salary match from the City of Black Diamond. The total cost of the development of this IAVMP including lake surveys, outreach and writing of this document totaled approximately $39,000.

9.1.2 Capital Costs

There are no capital costs associated with this IAVMP. It is not anticipated that any equipment will need to be purchased, structures built, or property acquired.

9.1.3 Operational and Maintenance Costs

The majority of expenses associated with implementation of the Lake Sawyer IAVMP are operational and maintenance costs. These costs include mapping and surveying, treatment (herbicide or other), follow-up weed removal, community outreach, and project administration and management (table 4).

9.2 Sources of Funding

Funding for implementation of the Lake Sawyer IAVMP will come from a combination of sources that will change as the project progresses. A blend of grants, matching cash funds, and matching in-kind volunteer hours will most likely be used.

9.2.1 Grants

The Washington State Department of Ecology's Aquatic Weeds Management Fund (AWMF) in geared towards funding the sort of work that is proposed by the Lake Sawyer IAVMP. This IAVMP has been developed to be consistent with all AWMF guidelines and requirements. Given the lake-wide extent of the infestations, potential for infestation of neighboring habitat, and the support of the Lake Sawyer community, it is hoped that Ecology and other grant programs will offer funding. It was noted to the Steering Committee that the grants are given in a priority order and the emphasis on fragrant water lily could potentially reduce the likelihood of receiving this grant. The Steering Committee was also looking into the possibility of having the Lake Sawyer Community Club or lake side residents fund a portion of the work.

9.2.2 Matching Funds

Awarding of Ecology's AWMF grant requires matching funds. Requiring matching funds distributes the responsibility of funding between the state agency (Ecology) and the local stakeholders (Lake Sawyer residences and the City of Black Diamond). Both cash match and in-kind match are proposed to be used to fulfill this requirement. Cash matching funds are proposed to come from staff hours of King DNRP employees or Black Diamond staff. King County staff hours' value includes the total hourly cost of that employee's time. These total costs include: hourly rate, benefits, paid time off, and overhead. The weighted average cost of King County employee's staff time was calculated based on amount of time employees of particular pay levels were expected to work on the project. This weighted average cost came out to be $65/hour. In-kind matching funds are proposed to come from volunteer labor and supplies provided by Lake Sawyer residents. Volunteer hours are estimated at a rate of $15/hour.

9.2.3 Long-term Sustainability

The long-term sustainability of this project is dependent on the commitment of the Lake Sawyer community, the City of Black Diamond and it partners to communicate with each other the priorities of the community, weed treatment options, timelines, and grant availabilities. In the absence of an AWMF grant the steering committee will re-evaluate funding options. Through the participation in the development of this IAVMP the Steering Committee and the City of Black Diamond have demonstrated their desire to support this plan long term. Long term success of the project may require monitoring after the expiration of the plan. Additional funding for monitoring is not addresses in this plan and would be the responsibility of the City of Black Diamond to provide along with engaged community members or third parties hired by the City.

10.0 MONITORING, EVALUATION AND IMPLEMENTATION

10.1 Monitoring

Yearly surveying and monitoring of emergent, floating, and submerged aquatic noxious weeds are recommended to be conducted at Lake Sawyer. These surveys will help guide noxious weed control efforts and provide year to year baseline for progress towards weed control/eradication.

10.2 Evaluation of the Plan

The effectiveness of the plan on controlling targeted species will be evaluated yearly and adaptive changes will be made as needed. Year to year comparisons will be used to evaluate trends in specific target species abundance and distribution. The results of these comparisons will guide control efforts and may result in a change in future control strategies. This is especially relevant to Lake Sawyer given the unusual condition of having a Eurasian milfoil biological control in the lake (milfoil weevil). Success of the plan will be measured by the reduction in target weed species.

10.3 Implementation

The implementation of the plan will follow the process outlined below:

Convene a project Implementation Committee. This group will most likely consist of Black Diamond staff, interested community members and King County staff advisors. They will direct the implementation of the IAVMP.

Identify Funding Sources. The most likely source for funds to support the implementation of this plan is the Washington State Department of Ecology Aquatic Weed Management Fund Grant (AWMF). Other Local and regional grants may be pursued as well. The AWMF grant requires matching funds and time from the local agency and community and it could fund the entirety of the plan. This type of grant requires that the local community works in conjunction with a local government agency (Black Diamond).

Select an Herbicide Contractor. An approved herbicide contractor will be selected by the City of Black Diamond for treatment of the weeds outlined in this plan. Assuming the City of Black Diamond is awarded a grant for this work, the contractor will be hired according to the City of Black Diamonds procurement process. Contract proposals will include costs for the permit application and annual invoices, herbicide applications, and notification and postings required by the permits.

Application of Herbicide. Application of the herbicide will be completed as prescribed in this IAVMP unless consultation with the community, Ecology and/or the applicator leads to defensible changes in the plan and it is approved by the Implementation Committee and the Department of Ecology.

Public Education and Communication. The residents of Lake Sawyer will be notified about any upcoming herbicide applications as determined by the requirements in the NPDES permit, the results of yearly monitoring efforts, and any major changes made to the plan via the Implementation Committee. Much of this communication will be carried out by active members of the community who are involved in the Implementation Committee. The Committee will take into account public feedback when making decisions about the plan.

Long Term Monitoring and Maintenance. This will be done by the City of Black Diamond and the community after the completion of this plan. Funding and timing of continued monitoring and maintenance will be determined by the City of Black Diamond.

10.4 Implementation and Evaluation

- Convene a project Implementation Committee.
- Review proposed plan and develop timeline with specific tasks. The IAVMP will guide this process
- Implementation Committee internally assigns tasks.
- Issue a Request for Proposal for weed survey and control work.
- Secure necessary permit. Permit application will be coordinated with the contracted herbicide applicator.
- Implement public education and communication plan.
- Apply herbicide treatment. Application will be completed as prescribed in this IAVMP, unless consultation with Ecology and the applicator leads to defensible changes in the plan.
- Conduct follow up surveys. Professional contractors or city staff (or those contracted by them) may complete this work.
- Apply follow up treatment if necessary. Follow up surveys will dictate the extent of this work (if required).
- Conduct future surveys to track success and carry out additional actions, such as hand pulling, as necessary to meet the long term management objectives. Professional contractors and community members who have been adequately trained can complete this work, with community participation under supervision of city staff.

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Appendix A
Control Method options

This document outlines common methods used to control aquatic weeds. Much of the information in this section is quoted directly from the Washington State Department of Ecology's (Ecology) website:
http://www.ecy.wa.gov/programs/wq/plants/management/index.html

Additional information is derived from the field experience of the King County Noxious Weed Control Program, in particular from King County WLRD employees Katie Messick (Aquatic Noxious Weed Specialist) and Beth leDoux (Water Quality Planner), both WSDA licensed aquatic herbicide applicators. Recommendations found in the 2001 draft version of the "King County Regional Milfoil Plan" have also been taken into consideration.

Control/eradication methods discussed herein include Aquatic Herbicide, Manual Control Methods, Mechanical Control Methods, Environmental Manipulation, Biological Control, and the No Action Alternative.

Integrated Pest Management

- The preferred approach for weed control is Integrated Pest Management (IPM). IPM involves selecting from a range of possible control methods to match the management requirements of each specific site. The goal is to maximize effective control and to minimize negative environmental, economic and social impacts.
- Use a multifaceted and adaptive approach. Select control methods that reflect the available time, funding, and labor of the participants, the land use goals, and the values of the community and landowners. Management will require dedication over a number of years, and should allow for flexibility in method as appropriate.

Aquatic Herbicides

Description
The majority of the following text has been drawn from the Washington State Department of Ecology's website on chemical aquatic weed control:
http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html

Aquatic herbicides are chemicals specifically formulated for use in water to eradicate or control aquatic plants. Herbicides approved for aquatic use by the United States Environmental Protection Agency (EPA) have been reviewed and considered compatible with the aquatic environment when used according to label directions. However, individual states may also impose additional constraints on their use.

About Aquatic Herbicides

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants, or are applied to the water in either a liquid or pellet form.

- *Systemic* herbicides are capable of killing the entire plant by translocating from foliage or stems and killing the root.
- *Contact* herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and capable of re-growth.
- *Non-selective* herbicides will generally affect all plants that they come in contact with, both monocots and dicots.
- *Selective* herbicides will affect only some plants (usually dicots – broad leafed plants like Eurasian watermilfoil will be affected by selective herbicides whereas monocots like Brazilian elodea and our native pondweeds may not be affected). Most submersed aquatic plants are monocots

Because of environmental risks from improper application, aquatic herbicide use in Washington State waters is regulated and has certain restrictions. The Washington State Department of Agriculture must license aquatic applicators.

- Coverage under a discharge permit called a National Pollutant Discharge Elimination System (NPDES) permit must be obtained before aquatic herbicides can be applied to waters of the state. The Washington Department of Agriculture holds an NPDES permit for the management of noxious weeds growing in wet areas such as lake shores, freshwater wetlands, river banks, and estuaries. Licensed applicators can obtain coverage under this permit free of charge. Information about this permit is available here: http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html.
- For in-lake projects (floating or submersed weeds) applicators and/or the state or local government sponsoring the project must obtain coverage under Ecology's Aquatic Plant and Algae Management NPDES permit before applying herbicides. Information on this permit is available here: http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/aquaticplants/aquatic_plant_permit_index.html.

The Washington Department of Ecology requires notification and posting before treatment. There are additional mitigations to protect rare plants or threatened and endangered species.

Although there are a number of EPA registered aquatic herbicides, the Department of Ecology currently issues permits for seven aquatic herbicides (as of 2011 treatment season). Several other herbicides are undergoing review and it is likely that other chemicals may be approved for use in Washington in the future.

The chemicals that are currently permitted for use in 2014 under the Aquatic Plant and Algae Control Permit and the Noxious Weed Permit are (see Appendix C for examples of herbicide labels):

- Glyphosate – Trade names for aquatic products with glyphosate as the active ingredient include Rodeo®, AquaMaster®, and AquaNeat®. This systemic broad spectrum herbicide is used to control floating-leaved plants like water lilies and shoreline plants like purple loosestrife. It is generally applied as a liquid to the leaves. Glyphosate does not work on underwater plants such as Eurasian watermilfoil. Although glyphosate is a broad spectrum, non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Plants can take several weeks to die and a repeat application is often necessary to remove plants that were missed during the first application.
- Fluridone – Trade names for fluridone products include Sonar® and Whitecap®. Fluridone is a slow-acting systemic herbicide used to control Eurasian watermilfoil and other underwater plants. It may be applied as a pellet or as a liquid. Fluridone can show good control of submersed plants where there is little water movement and an extended time for the treatment. Its use is most applicable to whole-lake or isolated bay treatments where dilution can be minimized. It is not effective for spot treatments of areas less than five acres. It is slow-acting and may take six to twelve weeks before the dying plants fall to the sediment and decompose. When used to manage Eurasian watermilfoil in Washington, fluridone is applied several times during the spring/summer to maintain a low, but consistent concentration in the water. Granular formulations of fluridone are proving to be effective when treating areas of higher water exchange or when applicators need to maintain low levels over long time periods. Although fluridone is considered to be a broad spectrum herbicide, when used at very low concentrations, it can be used to selectively remove Eurasian watermilfoil. Some native aquatic plants, especially pondweeds, are minimally affected by low concentrations of fluridone.
- 2,4-D – There are two formulations of 2,4-D approved for aquatic use. The granular formulation contains the low-volatile butoxy-ethyl-ester formulation of 2,4-D (Trade names include AquaKleen® and Navigate®). The liquid formulation contains the dimethylamine salt of 2,4-D (Trade names include DMA*4IVM). 2,4-D is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species. Both the granular and liquid formulations can be effective for spot treatment of Eurasian watermilfoil. 2,4-D has been shown to be selective to Eurasian watermilfoil when used at the labeled rate, leaving native aquatic species relatively unaffected. By court-order the butoxy-ethyl-ester formulation of 2,4-D cannot be used in waters with threatened and endangered salmon-bearing waters in the Pacific Northwest.
- Diquat – A trade name for diquat is Reward®. Diquat is a fast-acting non-selective contact herbicide which destroys the vegetative part of the plant but does not kill

the roots. It is applied as a liquid. Typically diquat is used primarily for short term (one season) control of a variety of submersed aquatic plants. It is very fast-acting and is suitable for spot treatment. However, turbid water or dense algal blooms can interfere with its effectiveness

- Endothall – A trade name for the dipotassium salt of endothall is Aquathol®. Endothall is a fast-acting non-selective contact herbicide which destroys the vegetative part of the plant but generally does not kill the roots. Endothall may be applied in a granular or liquid form. Typically endothall compounds are used primarily for short term (one season) control of a variety of aquatic plants. However, there has been some recent research that indicates that when used in low concentrations, endothall can be used to selectively remove exotic weeds; leaving some native species unaffected. Because it is fast acting, endothall can be used to treat smaller areas effectively.
- Triclopyr-TEA – Trade names for triclopyr TEA include Garlon® 3A and Renovate 3®. There are two formulations of triclopyr. It is the TEA formation of triclopyr that is registered for use in aquatic or riparian environments. Triclopyr, applied as a liquid, is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species such as purple loosestrife. Triclopyr can be effective for spot treatment of Eurasian watermilfoil and is relatively selective to Eurasian watermilfoil when used at the labeled rate. Many native aquatic species are unaffected by triclopyr. Triclopyr is very useful for purple loosestrife control since native grasses and sedges are unaffected by this herbicide. When applied directly to water, Ecology has imposed a 12-hour swimming restriction to minimize eye irritation. Triclopyr received its aquatic registration from EPA in 2003 and was allowed for use in Washington in 2004.
- Imazapyr – Trade names for imazapyr include Habitat® and Polaris®. This systemic broad spectrum, slow-acting herbicide, applied as a liquid, is used to control emergent plants like spartina, reed canarygrass, and phragmites and floating-leaved plants like water lilies. Imazapyr does not work on underwater plants such as Eurasian watermilfoil. Although imazapyr is a broad spectrum, non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Imazapyr was allowed for use in Washington in 2004.
- *Adjuvants* – There are a number of adjuvants (surfactants, stickers, sinking agents) allowed for use under the NPDES permits. It is important that a surfactant be used as specified on the herbicide label to improve efficacy. In addition to careful selection of the aquatic herbicide used, selecting the appropriate adjuvant ensures the herbicide gets absorbed by the target plant. Approved aquatic surfactants ensure good plant contact while reducing/minimizing the detrimental effect of the substances to the greater ecosystem. Terrestrial herbicide surfactants can cause great harm to aquatic animals. Ecology supplies a list of adjuvants that are approved for use in aquatic situations. Often used non-ionic aquatic surfactants include Agri-Dex, Competitor, and LI-700. Ecology has approved a list of over 20 aquatic surfactants and it is largely up to the hired contractor as to which one they use.

Advantages (to the use of aquatic herbicides):

- Aquatic herbicide application can be less expensive than other aquatic plant control methods, especially when used in controlling widespread infestations of state-listed noxious aquatic weeds.
- Aquatic herbicides are easily applied around docks and underwater obstructions.
- Washington has had some success in eradicating Eurasian watermilfoil, a state listed noxious weed, from some smaller lakes (350 acres or less) using aquatic herbicides.

Disadvantages (to the use of aquatic herbicides):

- Some herbicides have swimming, drinking, fishing, irrigation, and water use restrictions (check the label and general permit).
- Non-targeted plants may be damaged or killed by some herbicides.
- Depending on the herbicide used, it may take several days to weeks or several treatments during a growing season before the herbicide controls or kills treated plants.
- Rapid-acting herbicides like endothall and diquat may cause low oxygen conditions to develop as plants decompose. Low oxygen can cause fish kills.
- To be most effective, generally herbicides must be applied to actively-growing plants, although sometimes fall applications of perennial plants can also be effective.
- Aquatic herbicides must be applied by licensed pesticide applicators. Application of herbicides to control submersed plants can be challenging and is best done by an experienced applicator. Many people have strong feelings against using chemicals in water. Community consensus is highly encouraged to ensure the success of lake weed control using herbicides.

Costs

Approximate costs for one-acre submerged or floating plant herbicide treatment:

- Glyphosate (not for submersed plant control): $300-$600
- Fluridone: $900 - $1,000
- 2,4-D: $700
- Endothall (not for floating plant control): $650
- Diquat (not for floating plant control): $300 - $400
- Triclopyr-TEA: $1,000
- Imazapyr (not for submersed plant control): $700-$800

Toxicology overview

EPA studies yield the parameters LD_{50} (acute lethal dose to 50% of a test population), NOEL (No Observable Effect Level, which is the highest test dosage causing no adverse responses), and RfD (EPA Reference Dose determined by applying at least a 100-fold uncertainty factor to the NOEL). The EPA defines the RfD as the level that a human could be exposed to daily with reasonable certainty of no adverse effect from any cause, in other words, a "safe" dose. Exposures to bystanders or consumers are deemed safe when the RfD is not exceeded (King County, 2003). Since all substances, natural or manmade, may prove toxic at a sufficiently high dose, one should remember the old adage "dose makes the poison." The LD_{50} value is useful for comparing one compound with another and for grouping compounds into general hazard classes. The higher the LD_{50} value the less toxic the substance is.

Any pesticide, such as 2,4-D, glyphosate or triclopyr TEA, that does not produce adverse effects on aquatic organisms until levels in water reach milligram per liter (i.e., mg/L, equivalent to a part per million (ppm)) would be considered of comparatively low hazard (King County, 2003). Substances that are biologically active in water at levels one-thousand-fold less, (i.e., µg/L, parts per billion, ppb), are considered highly hazardous to aquatic life. Most pesticides falling in the latter category are insecticides rather than herbicides.

Also, compounds that have half-lives less than 100 days are considered non-persistent compared to compounds having half-lives approaching one year or longer (for example, DDT). The half-life of 2,4-D is about 7 days in water, the half-life of triclopyr TEA is about 7 days in water, and the half-life of glyphosate is about 12 days in water. Since there are multiple factors that modulate the pesticides' hazard, just focusing on the half-life itself is a bit misleading for hazard assessment. It is now known that the longer a residue remains in soil/sediment, the less likely it will be taken up by plants, leach, or runoff (King County, 2003). This phenomenon is called residue aging and involves changes in the forces governing interactions of the chemical with the soil matrix over time.

2,4-D

As far as restrictions for aquatic 2,4-D applications, there is no fishing restriction, and three to five days after treatment the water is generally below the drinking water standard (70ppb (parts-per-billion), irrigation standard is 100ppb for broad-leafed plants). Although 2,4-D should not damage grass or other monocots, it is not recommended that one use treated water to water lawns during this first three to five days since over-spray will kill ornamentals or plants such as tomatoes and grapes that are very sensitive to 2,4-D. When used according to label directions, there are no swimming restriction for 2,4-D use. Ecology *advises* that swimmers wait for 24 hours after application before swimming in the treatment area, but that is an advisory only. The choice is up to the individual.

Human and general mammalian health- 2,4-D

The oral LD50 for 2,4-D (acid) is 764 mg/kg and the dermal LD50 is >2000 mg/kg. This chemical has a low acute toxicity (from an LD50 standpoint, is less toxic than caffeine and slightly more toxic than aspirin). The RfD for 2,4-D (acid) is 0.01 mg/kg/d. Recent, state-of-the-art EPA studies continue to find that it is not considered a carcinogen or mutagen, nor does it cause birth defects. It has a relatively short persistence in water, since it tends to bind to organic matter in the sediments. The herbicide 2,4-D generally does not bioaccumulate to a great extent, and the small amounts which do accumulate are rapidly eliminated once exposure ceases (Washington State Department of Ecology, 2001).

The risks to human health from exposure to aquatic 2,4-D applications were evaluated in terms of the most likely forms of contact between humans and the water to which the herbicide was applied. Ecology's Risk Assessment results indicate that 2,4-D should present little or no risk to the public from acute (one time) exposures via dermal contact with the sediment, dermal contact with water (swimming), or ingestion of fish (Washington State Department of Ecology, 2001). Based on the low dermal absorption of the chemical, the dose of 2,4-D received from skin contact with treated water is not considered significant. Dose levels used in studies are often far beyond what an animal or human would experience as a result of an aquatic application. Many experiments have examined the potential for contact by the herbicide applicator, although these concentrations have little relevance to environmental exposure by those not directly involved with the herbicide application. Once the herbicide has entered the water, its concentration will quickly decline because of turbulence associated mixing and dilution, volatilization, and degradation by sunlight and secondarily by microorganisms (King County, 2003).

Results of chronic exposure assessments indicate that human health should not be adversely impacted by chronic 2,4-D exposure via ingestion of fish, ingestion of surface water while swimming, incidental ingestion of sediments, dermal contact with sediments, or dermal contact with water (Washington State Department of Ecology, 2001). Pharmacokinetic investigations have demonstrated that 2,4-D is rapidly absorbed from the gastrointestinal tract and is quickly excreted. Animal toxicological investigations carried out at high doses showed a reduction in the ability of the kidneys to excrete the chemical, and resulted in some systemic toxicity. However, the high doses tested may not be relevant to the typical low dose human exposures resulting from labeled use. A review of the scientific and medical literature failed to provide any human case reports of systemic toxicity or poisoning following overexposure to these herbicide products when used according to label instructions (Washington State Department of Ecology, 2001). The risks to mammalian pets and wildlife should be closely related to these reported human risks, especially since many of the toxicity experiments are carried out on test animals by necessity.

> *Results indicate that 2,4-D should present little or no risk to the public from acute exposures via dermal contact with sediment, dermal contact with water, or ingestion of fish. Dermal contact with vegetation may present limited risk if it is contacted one hour after application. By 24 hours post-application non-carcinogenic risk is*

> *essentially nonexistent, as 2,4-D is unavailable for dermal uptake. Margins of safety for all acute exposure scenarios are greater than "100," implying that risk of systemic, teratogenic, or reproductive effects to humans is negligible.*
> (Washington State Department of Ecology, 2001)

The potential hazard to pregnant women and to the reproductive health of both men and women was evaluated. The results of the 2,4-D developmental or teratology (birth defects) and multigenerational reproduction studies indicate that the chemical is not considered to be a reproductive hazard or cause birth defects (teratogen) when administered below maternally toxic doses (Washington State Department of Ecology, 2001). A review of the histopathological sections of various 2,4-D subchronic and chronic studies provides further support that the chemical does not affect the reproductive organs, except in some higher dose groups beyond the potential level of incidental exposure after an aquatic weed application.

Aquatic animal health- 2,4-D

Based on laboratory data reported in the Department of Ecology's Risk Assessment of 2,4-D, 2,4-D DMA has a low acute toxicity to fish (LC50 ≥100 to 524 mg a.i./L for the rainbow trout and bluegill sunfish respectively). No Federally sensitive, threatened or endangered species were tested with 2,4-D DMA. However, it is likely that endangered salmonids would not exhibit higher toxic effects to 2,4-D DMA than those seen in rainbow trout. Since the maximum use rate of 2,4-D DMA would be no higher than the maximum labeled use rate (4.8 mg a.i./L) even the most sensitive fish species within the biota should not suffer adverse impacts from the effects of 2,4-D DMA. In conclusion, 2,4-D DMA will not affect fish or free-swimming invertebrate biota acutely or chronically when applied at typical use rates of 1.36 to 4.8 mg a.i./L (Washington State Dept. of Ecology, 2001). However, more sensitive species of benthic invertebrates like glass shrimp may be affected by 2,4-D DMA, but 80 and 90% of the benthic species should be safe when exposed to 2,4-D DMA acutely or chronically at rates recommended on the label. Field work indicates that 2,4-D has no significant adverse impacts on fish, free-swimming invertebrates and benthic invertebrates, but well-designed field studies are in short supply.

According to the Department of Ecology's Risk Assessment of 2,4-D, in the United States, 2,4-D BEE is the most common herbicide used to control aquatic weeds. 2,4-D BEE, has a high laboratory acute toxicity to fish (LC50 = 0.3 to 5.6 mg a.i./L for rainbow trout fry and fathead minnow fingerlings, respectively). Formal risk assessment indicates that short-term exposure to 2,4-D BEE should cause adverse impact to fish since the risk quotient is above the acute level of concern of 0.01 (RQ = 0.1 ppm/0.3 ppm = 0.33). However, the low solubility of 2,4-D BEE and its rapid hydrolysis to 2,4-D acid means fish are more likely to be exposed to the much less toxic 2,4-D acid. 2,4-D acid has a toxicity similar to 2,4-D DMA to fish (LC50 = 20 mg to 358 mg a.i./L for the common carp and rainbow trout, respectively). In contrast, formal risk assessment with 2,4-D acid indicates that short-term exposure to 2,4-D BEE should not cause adverse impact to fish since the risk quotient is below the federal level of concern of 0.01 (RQ = 0.1 ppm/20 ppm = 0.005). To conclude, 2,4-D BEE will have no significant impact on the animal biota acutely or chronically when

using applied rates recommended on the label (Washington State Dept. of Ecology, 2001). Although laboratory data indicates that 2,4-D BEE may be toxic to fish, free-swimming invertebrates and benthic invertebrates, data indicates that its toxic potential is not realized under typical concentrations and conditions found in the field. This lack of field toxicity is likely due to the low solubility of 2,4-D BEE and its rapid hydrolysis to the practically nontoxic 2,4-D acid within a few hours to a day following the application.

2,4-D is not considered hazardous to beneficial insects due to its low insecticidal activity and an adequate safety margin when products containing 2,4-D are used at recommended levels (National Pesticide Information Center, 2008).

Glyphosate

Glyphosate is a broad spectrum (non-selective) herbicide that is for use on non-submerged plants. The chemical works to inhibit an enzyme that is involved with the synthesis of amino acids, which are critical to plant growth (National Pesticide Information Center, 2010). Glyphosate is absorbed through foliage and translocated to the actively growing parts of the plant (National Pesticide Information Center, 2010). This slow acting herbicide may take up to 20 days to kill the plant. Several manufactures produce aquatic formulated versions of glyphosate.

In relation to shoreline applications, glyphosate is moderately persistent in soil, with an estimated average half-life of 47 days. It is strongly adsorbed to most soils, even those with lower organic and clay content. Thus, even though it is highly soluble in water, field and laboratory studies show it does not leach appreciably, and has low potential for runoff (except as adsorbed to colloidal matter). One estimate indicated that less than 2% of the applied chemical is lost to runoff (Malik et. al., 1989). Microbes are primarily responsible for the breakdown of the product, and volatilization or photodegradation losses will be negligible.

Human and general mammalian health

Examination of mammalian toxicity has shown that the acute oral and dermal toxicity of glyphosate would fall into EPA's toxicity category III. This category characterizes slightly to moderately toxic compounds. Glyphosate is practically nontoxic by ingestion, with a reported acute oral LD50 of 5600 mg/kg in tested rats. The risks of incidental contact from swimming in treated water have also been judged as low with a dermal LD50 of 7940 mg/kg, a very high threshold. The RfD for glyphosate is 0.1 mg/kg/d. To place the level of hazard to humans in perspective, the commonly consumed chemicals caffeine (present in coffee, tea, and certain soft drinks), aspirin (acetylsalicylic acid), and nicotine (the neuroactive ingredient in tobacco) have acute oral LD50's of 192, 1683, and 53 mg/kg, respectively. Thus, the herbicides for the most part are comparatively less toxic than chemicals to which consumers voluntarily expose themselves (King County, 2003).

Since the shikimic acid pathway does not exist in animals, the acute toxicity of glyphosate is very low. Animal studies, which the Environmental Protection Agency has evaluated in support of the registration of glyphosate, can be used to make inferences relative to human

health. The EPA has classified glyphosate as a compound with evidence of non-carcinogenicity for humans (National Pesticide Information Center, 2010). This conclusion is based on the lack of convincing carcinogenicity evidence in adequate studies in two animal species. Laboratory studies on glyphosate using pregnant rats (dose levels up to 3500 mg/kg per day) and rabbits (dose levels up to 350 mg/kg per day), indicated no evidence of teratology (birth defects). A three-generation reproduction study in rats did not show any adverse effects on fertility or reproduction at doses up to 30 mg/kg per day. Glyphosate was negative in all tests for mutagenicity (the ability to cause genetic damage).

Aquatic animal health

Technically, glyphosate acid is practically nontoxic to fish and may be slightly toxic to aquatic invertebrates (EXTOXNET, 1994). Some formulations may be more toxic to fish and aquatic species due to differences in toxicity between the salts and the parent acid, or to surfactants used in the formulation. There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms. In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms.

Tricloypyr-TEA

The following information and citations on triclopyr-TEA *are taken from the Washington State Department of Ecology's website on Aquatic Plant Management.* http://www.ecy.wa.gov/biblio/0410018.html (WA Dept. of Ecology EIS for triclopyr, 2004) http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/triclopyr_faq.pdf as well as the National Pesticide Information Center (2001).

Triclopyr, ((3,5,6-tricholoro-2-pyridinyl) oxyacetic acid) is an aquatic herbicide that utilizes a systemic mode of action used to control submerged, floating and emergent aquatic plants in both static and flowing water. It is also registered for a number of terrestrial uses including broadleaf weed control.

Triclopyr is a growth hormone of the *auxin* type. An auxin-type herbicide interferes with growth after the plant emerges. It contacts leaves, where sugar is produced, and moves to roots, tips, and parts of the plant that store energy, thereby interrupting growth. Since the movement of sugars from the leaves to other parts of the plant is essential for growth, this type of herbicide has the potential to kill simple perennial and creeping perennial weeds with only one or two foliar applications. Bending and twisting of leaves and stems is evident almost immediately after application. Delayed symptom development includes root formation on dicot stems: misshapen leaves, stems and flowers; and abnormal roots. Triclopyr has been claimed to be effective for a variety of fully or partially aquatic plants including Eurasian watermilfoil (*Myriophyllum spicatum*), fragrant water lily (*Nymphaea odorata*), and purple loosestrife (*Lythrum salicaria*). Triclopyr will not affect monocot plants such as pondweed species and coontail, rushes and cattails.

Triclopyr is formulated as a solution in water. Intentionally added inert or "other" ingredients in triclopyr formulations include water and triethanol amine (TEA). The water serves as the primary diluent/solvent in the liquid product while the triethanol amine is used to form the salt of the technical grade active ingredient.

DowElanco currently manufactures and distributes Garlon® 3A and SEPRO Corporation markets and distributes Renovate®3 under a separate label. The products are the same; DowElanco manufactures both products. The Renovate® label specifies selective control of nuisance and exotic plants such as Eurasian watermilfoil (*Myriophyllum spicatum*) and purple loosestrife (*Lythrum salicaria*).

Human and general mammalian health

The oral LD_{50} for Triclopyr-TEA is 1,847 mg/kg and the dermal LD_{50} is >5,000 mg/kg (SePRO, 2008). The Reference Dose (RfD) for Triclopyr TEA is 0.05 mg/kg/day and the NOEL (no observed effect level) is 5.0 mg/kg/day. Concentrated triclopyr products are corrosive and can cause skin irritation and irreversible eye damage if splashed in the eye. However, only dilute amounts of triclopyr are needed to kill Eurasian watermilfoil. These dilute concentrations have not been shown to cause skin irritation or other health effects. Triclopyr is not well absorbed through skin. If ingested, research has shown that low doses of triclopyr are rapidly excreted in humans and are unlikely to accumulate in human tissue or cause adverse effects.

In natural waters, the initial breakdown products of triclopyr are TCP and TMP. Tests in laboratory animals on both these metabolites have shown that their toxicity to mammals is less than or equal to triclopyr. These metabolites are relatively short lived in the environment. Complete breakdown of triclopyr results in carbon dioxide, oxamic acid, and other low molecular weight carboxylic acids. Triclopyr and its metabolites are excreted rapidly in humans and mammals. A study in human volunteers, given low doses showed that blood levels peaked two to three hours after ingestion and declined to undetectable levels within 48 hrs. A study in rodents showed that triclopyr and metabolites have a short residence time in other bodily tissues (12-15 hours).

Triclopyr is not considered to be a cause of cancer, birth defects, or genetic mutations. Nor is it considered likely to cause systemic, reproductive, or developmental effects in mammals at or near concentrations encountered during normal human use. However, Washington State Department of Health considers it prudent public health advice to minimize exposure to pesticides regardless of their known toxicity (Washington State Department of Ecology, 2004).

The only health concerns from triclopyr for swimming are minor eye irritation and exposure to children immediately after application. The risk of eye irritation and overexposure for children decreases rapidly because of dilution. A mandatory waiting time after application before swimming is allowed, mitigates the risk (Washington State Department of Ecology, 2004).

Exposure and risk calculations were determined for hypothetical situations involving ingestion and dermal contact with treated water while swimming and drinking potable water. Calculation of triclopyr exposures utilized the swimmer's weight, the skin surface area available for exposure, the amount of time spent in the treated water containing 2.5 and 0.5 ppm triclopyr, amount of water swallowed while swimming over specific time periods, and the estimated human skin permeability coefficient (Washington State Department of Ecology, 2004).

Risk analyses were completed for various populations. The most sensitive population was found to be children who swim for three hours and ingest water while swimming. However, a child would have to ingest 3.5 gallons of lake water where triclopyr had been recently applied to cause risk factors to be exceeded. Based on the label use directions and the results of the triclopyr toxicology studies, the aggregate or combined daily exposure to the chemical from aquatic herbicidal weed control does not pose an adverse health concern (Washington State Department of Ecology, 2004).

The Washington State Dept. of Health has *recommended* a 12-hour restriction for re-entry into triclopyr treated water to assure that the eye irritation potential and any other adverse effects will not occur. WDOH also recommends that those wanting to avoid even small exposures can wait one to two weeks following application when the triclopyr residues have dissipated from the water and sediments (Washington Department of Health, 1999).

Aquatic animal health

Triclopyr TEA and triclopyr acid are practically non-toxic to aquatic invertebrates and are not anticipated to be an acute or chronic risk due to their fairly short half-life (typically <5 days), low intrinsic toxicity to animals, and low tendency to accumulate in animal tissue. In the field where triclopyr TEA was used to control Eurasian watermilfoil, waterhyacinth, or purple loosestrife, no invertebrate mortality or changes in invertebrate population structure was seen that could be attributed to the use of triclopyr TEA (Washington State Department of Ecology, 2004).

Most species of fish are tolerant of triclopyr TEA. There have been no verified cases of toxicity to fish when triclopyr is used at the maximum use rate of 2.5 ppm. For aquatic organisms, the acute toxicity values for triclopyr varies by species (values for acute 96-hr LC_{50} ppm): rainbow trout (86-117), salmon species (82-182), and bluegill sunfish (148). The Environmental Protection agency Toxicity Rating system categorizes: "Slightly toxic (acute values 10-100 ppm) to Practically non-toxic (>100 ppm)."

All of these values are well above the maximum use rate of triclopyr TEA of 2.5 ppm. These species have LC_{50} values that are >10-fold greater than the expected environmental concentration (EEC) that occurs immediately after application therefore it is not likely that they would be adversely impacted by the effects of triclopyr TEA. In general, triclopyr TEA can be considered to have very low toxicity to environmentally relevant fish and aquatic invertebrates. Triclopyr TEA appears to be extremely safe for use in the presence of threatened and endangered salmonid game-fish.

Suitability for Lake Sawyer

Aquatic herbicides can provide an effective method for control and eventual eradication of noxious weeds at Lake Sawyer. Success in using aquatic herbicides to control aquatic noxious weeds is contingent upon many factors: correct formulation, timing, application method, adjuvants (surfactants) used, weather conditions when applied, etc. Also, the application of aquatic herbicide to all aquatic plants (emergent, floating, or submerged) is required to be done by Washington State Department of Agriculture Certified Aquatic Herbicide Applicator and requires the obtaining of an Aquatic Plant and Algae Management Permit from Washington State Department of Ecology.

Submerged and Floating Plant Control

Chemical control of the submerged aquatic weed, Eurasian watermilfoil, requires the use of specially formulated and applied herbicides.

The use of a formulation of 2,4-D DMA or triclopyr-TEA should provide excellent initial control of the Eurasian watermilfoil. Use of these herbicides, while applied to the water column, can be applied in the specific areas where the milfoil plants are growing, thus targeting only those plants and leaving the surrounding native submerged plants largely undisturbed. An expensive and riskier (to non-target plants) lake-wide treatment with fluridone for control of Eurasian watermilfoil is un-necessary because of the scattered nature of the infestation.

The loose sediments in Lake Sawyer are high in organic content and are flocculent around much of the lake's littoral zone. There is some concern that the granular formulations of 2,4-D may settle by gravity into these sediments, which could inhibit the release of the 2,4-D to the water column. If this was the case, the predicted level of control of Eurasian watermilfoil would not be achieved because the concentrations released to the water column may not be high enough to kill the plants. Determination of which form of the herbicides is used (liquid, pellet, or granular) will be most effective at Lake Sawyer can be made on the recommendation of experienced aquatic herbicide applicators.

Triclopyr-TEA use for submerged plant situations requires careful monitoring if herbicide concentration levels over an extended time period to make sure that the concentration is high enough to kill the targeted plants but not so high as to cause adverse side effects. Two treatments may be required to keep the herbicide concentration at the appropriate level for the desired time period.

One of the main reasons to eradicate milfoil is to maintain the health of the native aquatic plant community for all of the species that utilize them in their life cycles, as well as to maintain the viability of the lake for human recreational uses. The nature of the control methods to be implemented will minimize impacts to native aquatic vegetation. The control of the Eurasian watermilfoil will be conducted by methods designed to preserve (and eventually enhance or conserve) the native plant communities. Herbicide selective to

Eurasian watermilfoil will be used for its control (if necessary) and will not require a whole-lake treatment that would expose all the submersed plants to the herbicide.

Follow-up control methods (diver hand pulling and/or diver dredging) will focus specifically on Eurasian watermilfoil and should also leave beneficial plants intact. With these constraints in place, conservation areas should not need to be established to serve vital ecosystem functions until native plants re-establish.

Emergent Plant Control

The application of herbicide to the emergent species (yellow flag iris) is best conducted by manual spot applications. Control of yellow flag iris is most effectively achieved using a non-selective herbicide such an aquatic approved version of Glyphosate, in particular has been very effective in killing yellow flag iris plants.

An experienced herbicide applicator can selectively target individual emergent weed species and limit collateral damage to other species to a minimum. This is especially true when infestations are small so that large areas with a diverse plant distribution don't have to be treated. Since the emergent noxious weed infestations at Lake Sawyer are still confined largely to the shoreline, it should be relatively simple for the applicator to avoid significant collateral damage and preserve the native plant community.

Water Use Restrictions

Some residents of may have water right claims on Lake Sawyer and occasionally use lake water to irrigate their yards. Use of lake water that had recently been treated with herbicide to water landscape or vegetable gardens may cause damage to those plants. To ensure that all residents who might draw water from the lake are aware of water use restrictions, there will be announcements sent to all lakeside residents prior to each herbicide treatment. One announcement will be sent at the beginning of the summer with approximate dates of planned treatments, and subsequent announcements will be sent 7–10 days prior to each treatment, with exact dates of treatment and use restrictions.

Manual Control Methods

(hand pulling, diver hand pulling, raking, cutting using hand tools)

Hand pulling

Hand pulling of aquatic plants is similar to pulling weeds out of a garden. It involves removing entire plants (leaves, stems, and roots) from the area of concern and disposing of them in the trash or an area away from the shoreline, depending on the species. In water less than three feet deep no specialized equipment is required, although a spade, trowel, or long knife may be needed if the sediment is packed or heavy. In deeper water, hand pulling is best accomplished by divers with SCUBA equipment and mesh bags for the collection of plant fragments. Some sites may not be suitable for hand pulling such as areas where deep, loose flocculent sediments may cause a person hand pulling to sink deeply into the sediment. Other areas where hand pulling may be in effective are rocky areas (such as a

rip-rap wall), areas with large amounts of fallen wood, or areas with dense vegetation (such as reed canarygrass) where weed root removal is very difficult.

A sturdy rake makes a useful tool for removing aquatic plants. Attaching a rope to the rake allows removal of a greater area of weeds. Raking literally tears plants from the sediment, breaking some plants off and removing some roots as well. Specially designed aquatic plant rakes are available. Rakes can be equipped with floats to allow easier plant and fragment collection. The operator should pull towards the shore because a substantial amount of plant material can be collected in a short distance. Note that roots left in the soil will create new plants.

Cutting (using hand tools)

Cutting differs from hand pulling in that plants are cut and the roots are not removed. Cutting is performed by standing on a dock or on shore and throwing a cutting tool out into the water. A non-mechanical aquatic weed cutter is commercially available. Two single sided, razor sharp stainless steel blades forming a "V" shape are connected to a handle, which is tied to a long rope. The cutter can be thrown about 20 – 30 feet into the water. As the cutter is pulled through the water, it cuts a 48-inch wide swath. Washington State requires that cut plants be removed from the water. The stainless steel blades that form the V are extremely sharp and great care must be taken with this implement. It should be stored in a secure area where children do not have access.

All of the manual control methods create plant fragments. It's important to remove all fragments from the water to prevent them from re-rooting or drifting onshore. Plants and fragments can be composted or added directly to a garden.

Advantages

- Manual methods are easy to use around docks and swimming areas.
- The equipment is inexpensive.
- Hand-pulling allows the flexibility to remove undesirable aquatic plants while leaving desirable plants.
- These methods are environmentally safe if done carefully.
- Manual methods don't require expensive permits, and can be performed on aquatic noxious weeds with Hydraulic Project Approval obtained by reading and following the Pamphlet HPA *Aquatic Plants and Fish* (publication #APF-1-98) available free of charge from the Washington Department of Fish & Wildlife (1998).

Disadvantages

- Manual methods must include regular scheduled surveys to determine the extent of the remaining weeds and/or the appearance of new plants after eradication has been attained.

- As plants re-grow or fragments re-colonize the cleared area, the treatment may need to be repeated several times each summer.
- Because these methods are labor intensive, they may not be practical for large areas or for thick weed beds.
- Even with the best containment efforts, it is difficult to collect all plant fragments, leading to re-colonization or spread of the infestation.
- Some plants have massive rhizomes, are difficult to remove by hand pulling.
- Pulling weeds and raking stirs up the sediment and can make it difficult to see remaining plants. Sediment re-suspension can also increase nutrient levels in lake water.
- Hand pulling and raking impacts bottom-dwelling animals.
- The V-shaped cutting tool is extremely sharp and can be dangerous to use.

Permits

Permits are required for many types of manual projects in lakes and streams. The Washington State Department of Fish and Wildlife requires a *Hydraulic Project Approval* permit for all activities taking place in the water including hand pulling, raking, and cutting of aquatic plants. The Pamphlet HPA discussed above is free of charge. Large projects and some control methods may require individual HPAs, which do have a fee.

Costs

- Hand-pulling costs up to $130 for the average waterfront lot for a hired commercial puller.
- A commercial grade weed cutter costs about $130 with accessories. Weed rakes costs about $25to $125. Diver hand pulling about $5,000/day for a "long day" with two divers and a boat.

Suitability for Lake Sawyer

- Manual control of submersed weeds is an excellent treatment while the population remains small. It is also great follow up to any chemical control, since detailed and careful removal of remaining plants is easily done this way. At this point, the biological control (milfoil weevils) should be sufficient to control the remaining Eurasian watermilfoil plants.
- Manual methods may also be vital in combating new infestations of Eurasian watermilfoil in subsequent years.
- Manual methods have the potential for missing Eurasian watermilfoil plants, especially after stirring up sediments.
- Manual methods have the potential for fragmentation, exacerbating the existing Eurasian watermilfoil problem.

- Manual removal of loosestrife has been employed for several reasons with purple loosestrife; roots can be pulled out in loose, mucky soil or excavated in harder soil, killing the plants. In other situations this does not kill the mature perennial plants, but does halt seed production and can contain the infestation at current levels. If done repeatedly over several seasons it may starve the roots and kill the plants.

Mechanical Control Methods
(diver dredging, weed rolling, rotovation, harvesting, cutting)

Diver Dredging

Diver dredging (suction dredging) is a method whereby SCUBA divers use hoses attached to small dredges (often dredges used by miners for mining gold from streams) to suck plant material from the sediment. The purpose of diver dredging is to remove all parts of the plant including the roots. A good operator can accurately remove target plants, like Eurasian watermilfoil, while leaving native species untouched. The suction hose pumps the plant material and the sediments to the surface where they are deposited into a screened basket. The water and sediment are returned back to the water column (if the permit allows this), and the plant material is retained. The turbid water is generally discharged to an area curtained off from the rest of the lake by a silt curtain. The plants are disposed of on shore. Removal rates vary from approximately 0.25 acres per day to one acre per day depending on plant density, sediment type, size of team, and diver efficiency. Diver dredging is more effective in areas where softer sediment allows easy removal of the entire plants, although water turbidity is increased with softer sediments. Harder sediment may require the use of a knife or tool to help loosen sediment from around the roots. In very hard sediments, milfoil plants tend to break off leaving the roots behind and defeating the purpose of diver dredging.

Diver dredging has been used in British Columbia, Washington, and Idaho to remove early infestations of Eurasian watermilfoil (King County, 2003). In a large-scale operation in western Washington, two years of diver dredging reduced the population of milfoil by 80 percent (Silver Lake, Everett).

Advantages

- Diver dredging can be a very selective technique for removing pioneer colonies of Eurasian watermilfoil.
- Divers can remove plants around docks and in other difficult to reach areas.
- Diver dredging can be used in situations where herbicide use is not an option for aquatic plant management.
- Might be good spot control method in subsequent years (coordinated with diver survey)

Disadvantages

- Diver dredging is very expensive.
- Dredging stirs up large amounts of sediment. This may lead to the release of nutrients or long-buried toxic materials into the water column.
- Only the tops of plants growing in rocky or hard sediments may be removed, leaving a viable root crown behind to initiate growth.

Permits

Diver dredging requires Hydraulic Approval from the Department of Fish and Wildlife, and other permits may be required.

Costs

Depending on the density of the plants, specific equipment used, number of divers and disposal requirements, costs can run about $3,000 per day.

Suitability for Lake Sawyer

- Lake Sawyer is fairly dark and thus would make diver dredging very hard and not suitable as a control method.

Rotovation

Rotovators use underwater rototiller-like blades to uproot Eurasian watermilfoil plants. The rotating blades churn seven to nine inches deep into the lake or river bottom to dislodge plant root crowns that are generally buoyant. The plants and roots may then be removed from the water using a weed rake attachment to the rototiller head or by harvester or manual collection. Since rotovation causes severe short term turbidity and major fragmentation of both plants and roots, it is not recommended for any but small water bodies where all available area is already occupied by the weeds.

Harvesting

Mechanical harvesters are large machines which both cut and collect aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until disposal. Harvesting machines can cut plants from two to seven feet deep, but can be hindered by docks and submerged wood. A barge may be stationed near the harvesting site for temporary plant storage or the harvester carries the cut weeds to shore. The shore station equipment is usually a shore conveyor that mates to the harvester and lifts the cut plants into a dump truck. Harvested weeds are disposed of in landfills, used as compost, or in reclaiming spent gravel pits or similar sites. Harvesting of submerged weeds is usually done two or more times a growing season. Since harvesting causes major fragmentation of submersed weeds and cannot retrieve all fragments, harvesters often cause the infestation to spread. Therefore, harvesting is not recommended unless an entire water body is infested with the weed and the goal is maintenance of open water using a long term mowing schedule.

Cost

Harvesting costs range from $1,200 to $1,500 per acre per treatment.

Mechanical Cutting

Mechanical weed cutters cut aquatic plants several feet below the water's surface. Unlike harvesting, cut plants are not collected while the machinery operates and are left in the water column.

Suitability of Rotovation, Harvesting and Cutting for Lake Sawyer

None of these options are suitable for the level of infestation at Lake Sawyer. They are not eradication tools, but rather are used to manage and control heavy, widespread infestations of aquatic weeds. These processes create plant fragments, and therefore should not be used in systems where milfoil is not already widespread. In a light to moderate infestation of submerged aquatic weeds such as at Lake Sawyer, these methods would probably serve to spread and expand the infestation. According to Ecology, "There is little or no reduction in plant density with mechanical harvesting." Since the aim of this project is to eliminate milfoil from the system, these are not compatible control strategies. Harvesting and cutting do not remove root systems. Rotovation would cause damage to the lake sediments and associated animals in a system that does not already receive dredging for navigability.

Environmental Manipulation

(water level drawdown, bottom barriers/screens, nutrient reduction)

Water Level Drawdown

Lowering the water level of a lake or reservoir can have a dramatic impact on some aquatic weed problems. Water level drawdown can be used where there is a water control structure that allows the managers of lakes or reservoirs to drop the water level in the waterbody for extended periods of time. Water level drawdown often occurs regularly in reservoirs for power generation, flood control, or irrigation; a side benefit being the control of some aquatic plant species. However, regular drawdowns can also make it difficult to establish native aquatic plants for fish, wildlife, and waterfowl habitat in some reservoirs.

Suitability for Lake Sawyer

Drawdown is not a viable control strategy for Lake Sawyer. The outlet from Lake Sawyer is a natural stream that does not have a control structure installed. Not only would drawdown be difficult to achieve, it would also cause significant damage to the ecosystem. The amount of drawdown required to impact milfoil would dry out the littoral zone of the lake. This would damage native plants and animals in both the lake and the adjacent wetland and have many negative consequences for residents living around the lake.

Without a regular, strong surface inflow to the system (lake), returning the water level to a previous state would be both cost and time prohibitive.

Bottom Screens/Barrier

A bottom screen or benthic barrier covers the sediment like a blanket, compressing aquatic plants while reducing or blocking light. Materials such as burlap, plastics, perforated black Mylar, and woven synthetics can all be used as bottom screens. Some people report success using pond liner materials. There is also a commercial bottom screen fabric called Texel, a heavy, felt-like polyester material, which is specifically designed for aquatic plant control.

An ideal bottom screen should be durable, heavier than water, reduce or block light, prevent plants from growing into and under the fabric, be easy to install and maintain, and should readily allow gases produced by rotting weeds to escape without "ballooning" the fabric upwards.

Over time algae can accumulate on the bottom screen, resulting in the trapping of gas from below. Even the most porous materials, such as window screen, will billow due to gas buildup. Therefore, it is very important to anchor the bottom barrier securely to the bottom. Unsecured screens can create navigation hazards and are dangerous to swimmers. Anchors must be effective in keeping the material down and must be regularly checked. Natural materials such as rocks or sandbags are preferred as anchors.

The duration of weed control depends on the rate that weeds can grow through or on top of the bottom screen, the rate that new sediment is deposited on the barrier, and the durability and longevity of the material. For example, burlap may rot within two years, plants can grow through window screening material, and can grow on top of felt-like Texel fabric. Regular maintenance is essential and can extend the life of most bottom barriers.

Bottom screens will control most aquatic plants, however freely-floating species such as the bladderworts or coontail will not be controlled by bottom screens. Plants like Eurasian watermilfoil will send out lateral surface shoots and may canopy over the area that has been screened giving less than adequate control.

In addition to controlling nuisance weeds around docks and in swimming beaches, bottom screening has become an important tool to help eradicate and contain early infestations of noxious weeds such as Eurasian watermilfoil and Brazilian elodea. Pioneering colonies that are too extensive to be hand pulled can sometimes be covered with bottom screening material. For these projects, we suggest using burlap with rocks or burlap sandbags for anchors. By the time the material decomposes, the milfoil patches will be dead as long as all plants were completely covered. Snohomish County staff reported native aquatic plants colonizing burlap areas that covered pioneering patches of Eurasian watermilfoil. When using this technique for Eurasian watermilfoil eradication projects, divers should recheck the screen within a few weeks to make sure that all milfoil plants remain covered and that no new fragments have taken root nearby.

Bottom screens can be installed by the homeowner or by a commercial plant control specialist. Installation is easier in winter or early spring when plants have died back. In summer, cutting or hand pulling the plants first will facilitate bottom screen installation. Research has shown that much more gas is produced under bottom screens that are installed over the top of aquatic plants. The less plant material that is present before installing the screen, the more successful the screen will be in staying in place. Bottom screens may also be attached to frames rather than placed directly onto the sediment. The frames may then be moved for control of a larger area (see instructions for constructing and installing bottom screens).

Advantages

- Installation of a bottom screen creates an immediate open area of water.
- Bottom screens are easily installed around docks and in swimming areas.
- Properly installed bottom screens can control up to 100 percent of aquatic plants.
- Screen materials are readily available and can be installed by homeowners or by divers.

Disadvantages

- Because bottom screens reduce habitat by covering the sediment, they are suitable only for localized control.
- For safety and performance reasons, bottom screens must be regularly inspected and maintained.
- Harvesters, rotovators, fishing gear, propeller backwash, or boat anchors may damage or dislodge bottom screens.
- Improperly anchored bottom screens may create safety hazards for boaters and swimmers.
- Algae can accumulate on the screen, resulting in gas trapping, and ballooning of the screen.
- Swimmers may be injured by poorly maintained anchors used to pin bottom screens to the sediment.
- Some bottom screens are difficult to anchor on deep muck sediments.
- Bottom screens interfere with fish spawning and bottom-dwelling animals.
- Without regular maintenance aquatic plants may quickly colonize the bottom screen.

Permits

Bottom screening in Washington requires hydraulic approval, obtained free from the Department of Fish and Wildlife. Check with your local jurisdiction to determine whether a shoreline permit is required.

Costs

Barrier materials cost $0.22 to $1.25 per square foot. The cost of some commercial barriers includes an installation fee. Commercial installation costs vary depending on sediment characteristics and type of bottom screen selected. It costs up to about $750 to have 1,000 square feet of bottom screen installed. Maintenance costs for a waterfront lot are about $120 each year.

Suitability for Lake Sawyer

- Most of the lakeshore has only small infestations and the bottom barrier would just reduce habitat by covering the sediment.
- Infested areas are too scattered to use a bottom barrier without becoming cost prohibitive.

Biological Control

General Overview

The following information and citations on the watermilfoil weevil are taken from the Washington State Department of Ecology's website on Aquatic Plant Management. http://www.ecy.wa.gov/programs/wq/plants/management/biocontrol.html

Many problematic aquatic plants in the western United States are non-indigenous species. Plants like Eurasian watermilfoil, Brazilian elodea, and purple loosestrife have been introduced to North America from other continents. Here they grow extremely aggressively, forming monocultures that exclude native aquatic plants and degrade fish and wildlife habitat. Yet, often these same species are not aggressive or invasive in their native range. This may be in part because their populations are kept under control by insects, diseases, or other factors not found in areas new to them.

The biological control of aquatic plants focuses on the selection and introduction of other organisms that have an impact on the growth or reproduction of a target plant, usually from their native ranges. Theoretically, by stocking an infested waterbody or wetland with these organisms, the target plant can be controlled and native plants can recover.

Classic biological control uses control agents that are host specific. These organisms attack only the species targeted for control. Generally these biocontrol agents are found in the native range of the nuisance aquatic plants and, like the targeted plant, these biocontrol agents are also non-indigenous species. With classic biological control an exotic species is introduced to control another exotic species. However, extensive research must be conducted before release to ensure that biological control agents are host specific and will not harm the environment in other ways. The authors of *Biological Control of Weeds – A World Catalogue of Agents and Their Target Weeds* state that after 100 years of using

biocontrol agents, there are only eight examples, world-wide, of damage to non-target plants, "none of which has caused serious economic or environmental damage..." (Julien, 1982).

Search for a classical biological control agent typically starts in the region of the world that is home to the nuisance aquatic plant. Researchers collect and rear insects and/or pathogens that appear to have an impact on the growth or reproduction of the target species. Those insects/pathogens that appear to be generalists (feeding or impacting other aquatic plant species) are rejected as biological control agents. Insects that impact the target species (or very closely related species) exclusively are considered for release.

Once collected, these insects are reared and tested for host specificity and other parameters. Only extensively researched, host-specific organisms are cleared by the United States for release. It generally takes a number of years of study and specific testing before a biological control agent is approved.

Even with an approved host-specific bio-control agent, control can be difficult to achieve. Some biological control organisms are very successful in controlling exotic species and others are of little value. A number of factors come into play. It is sometimes difficult to establish reproducing populations of a bio-control agent. The ease of collection of the biocontrol and placement on the target species can also have a role in the effectiveness. Climate or other factors may prevent its establishment, with some species not proving capable of over-wintering in their new setting. Sometimes the bio-control insects become prey for native predator species, and sometimes the impact of the insect on the target plant just isn't enough to control the growth and reproduction of the species.

People who work in this field say that the more biological control species that you can put to work on a problem plant, the better success you will have in controlling the targeted species. There are some good examples where numerous biological control agents have had little effect on a targeted species, and other examples where one biocontrol agent was responsible for the complete control of a problem species.

However, even when biological control works, a classic biological control agent generally does not totally eliminate all target plants. A predator-prey cycle establishes where increasing predator populations will reduce the targeted species. In response to decreased food supply (the target plant is the sole food source for the predator), the predator species will decline. The target plant species rebounds due to the decline of the predator species. The cycle continues with the predator populations building in response to an increased food supply.

Although a successful biological control agent rarely eradicates a problem species, it can reduce populations substantially, allowing native species to return. Used in an integrated approach with other control techniques, biological agents can stress target plants making them more susceptible to other control methods.

A number of exotic aquatic species have approved classic biological control agents available for release in the US. These species include Hydrilla, water hyacinth, alligator weed, and purple loosestrife.

Another type of biological control uses general agents such as grass carp (see below) to manage problem plants. Unlike classical bio-control agents, these fish are not host specific and will not target specific species. Although grass carp do have food preferences, under some circumstances, they can eliminate all submersed vegetation in a waterbody. Like classic biological control agents, grass carp are exotic species and originate from Asia. In Washington, all grass carp must be certified sterile before they can be imported into the state. There are many waterbodies in Washington (mostly smaller sites) where grass carp are being used to control the growth of aquatic plants.

During the past decade a third type of control agent has emerged. In this case, a native insect that feeds and reproduces on northern milfoil (*Myriophyllum sibericum*) which is native to North America, was found to also utilize the non-native Eurasian watermilfoil (*Myriophyllum spicatum*). Vermont government scientists first noticed that Eurasian watermilfoil had declined in some lakes and brought this to the attention of researchers. It was discovered that a native watermilfoil weevil (*Euhrychiopsis lecontei)* feeding on Eurasian watermilfoil caused the stems to collapse. Because native milfoil has thicker stems than Eurasian watermilfoil, the mining activity of the larvae does not cause it the same kind of damage. A number of declines of Eurasian watermilfoil have been documented around the United States and researchers believe that weevils may be implicated in many of these declines.

Several researchers around the United States (Vermont, Minnesota, Wisconsin, Ohio, & Washington) have been working to determine the suitability of this insect as a bio-control agent. The University of Washington is conducting research into the suitability of the milfoil weevil for the biological control of milfoil in Washington lakes and rivers. Surveys have shown that in Washington the weevil is found more often in eastern Washington lakes and it seems to prefer more alkaline waters. However, it is also present in cooler, wetter western Washington. The most likely candidates for use as biological controls are discussed in the following section.

Grass Carp

The following information and citations on the watermilfoil weevil are taken from the Washington State Department of Ecology's website on Aquatic Plant Management.
http://www.ecy.wa.gov/programs/wq/plants/management/aqua024.html

The grass carp, also known as the white amur, is a vegetarian fish native to the Amur River in Asia. Because this fish feeds on aquatic plants, it can be used as a biological tool to control nuisance submergent aquatic plant growth.

Success with grass carp in Washington has been variable. Sometimes the same stocking rate results in no control, control, or even complete elimination of all underwater plants.

Only 18 percent of 98 Washington lakes stocked with grass carp at a median level of 24 fish per vegetated acre were found to have aquatic plants controlled to an intermediate level. In 39 percent of the lakes, all submersed plant species were eradicated. It has become the consensus among researchers and aquatic plant managers around the country that grass carp are an all or nothing control option. They should be stocked only in waterbodies where complete elimination of all submersed plant species can be tolerated.

Grass carp exhibit definite food preferences and some aquatic plant species will be consumed more readily than others. Eurasian watermilfoil is one of the less-preferable plants, and the fish will eat most other aquatic plants in the lake before eating it. Generally in Washington, grass carp do not consume emergent wetland vegetation or water lilies even when the waterbody is heavily stocked or over stocked.

Facts about grass carp:

- Are only distantly related to the undesirable European carp, and share few of its habits.
- Live for at least ten years and probably much longer in Washington waters.
- Will grow rapidly and reach at least ten pounds. They have been known to reach 40 pounds in the southern United States.
- Feed only on plants at the age they are stocked into Washington waters.
- Will not eat fish eggs, young fish or invertebrates, although baby grass carp are omnivorous.
- Feed from the top of the plant down so that mud is not stirred up. However, in ponds and lakes where grass carp have eliminated all submersed vegetation the water becomes turbid. Hungry fish will eat the organic material out of the sediments.
- Have definite taste preferences. Plants like Eurasian milfoil and coontail are not preferred. American waterweed and thin leaved pondweeds are preferred. Water lilies are rarely consumed in Washington waters.
- Are dormant during the winter. Intensive feeding starts when water temperatures reach 68° F.
- Are a river fish and have the desire to move from still waters into flowing waters.
- Are difficult to recapture if a waterbody has been overstocked.
- They may not feed in swimming areas, docks, boating areas, or other sites where there is heavy human activity.

Advantages

- Grass carp are inexpensive compared to some other control methods and offer long-term control, but fish need to be restocked at intervals.

- Grass carp offer a biological alternative to aquatic plant control.

Disadvantages

- Depending on plant densities and types, it may take several years to achieve plant control using grass carp and in many cases control may not occur or all submersed plants may be eliminated.
- The type of plants grass carp prefer may also be those most important for habitat and for waterfowl food.
- If the waterbody is overstocked, all submersed aquatic plants may be eliminated. Removing excess fish is difficult and expensive.
- If not enough fish are stocked, less-favored plants, such as Eurasian milfoil, may take over the lake.
- Stocking grass carp may lead to algae blooms.
- All inlets and outlets to the lake or pond must be screened to prevent grass carp from escaping into streams, rivers, or other lakes.

Permits

For Washington residents, a private fish stocking permit must be obtained from the Washington Department of Fish and Wildlife. Check with your Fish and Wildlife regional office to obtain a permit application. Also, if inlets or outlets need to be screened, an Hydraulic Project Approval application must be completed for the screening project. Grass carp may not be permitted to be stocked in some states.

Costs

In quantities of 10,000 or more, 8 to 12 inch sterile grass carp can be purchased for about $5.00 each for truck delivery. The cost of small air freighted orders will vary and is estimated at $10 to $20 per fish with shipping.

Other Considerations

- Would not achieve immediate results – takes time and is not guaranteed to work.
- Community may have concerns with introduced species
- Potential damage to the native plant community of the lake, which could result in the establishment of other aggressive plant species as pioneers
- Concerns from fishermen about grass carp
- Initial investment very expensive
- The introduction of grass carp has generally been discouraged by State agencies.

Suitability for Lake Sawyer

- Grass carp are not suitable for aquatic plant control in Lake Sawyer. The infestation of milfoil has not reached a level where a bio-control such as grass carp would be necessary.
- Their preferred food species include the dominant submersed aquatic species in Lake Sawyer, which might be grazed before the milfoil. They could remove all the beneficial plants that support a healthy fish population. Without cover and the invertebrates associated with beneficial native aquatic vegetation, the system would be degraded and some species (invertebrates, fish, etc.) may be extirpated.
- The lake also has an outlet stream that eventually flows into the Green River making it much more difficult to obtain the permits necessary to stock grass carp.

Watermilfoil Weevil

The following information and citations on the watermilfoil weevil are taken from the Washington State Department of Ecology's website on Aquatic Plant Management. http://www.ecy.wa.gov/programs/wq/plants/management/weevil.html

The milfoil weevil, *Euhrychiopsis lecontei*, has been associated with declines of Eurasian watermilfoil (*Myriophyllum spicatum)* in the United States (e.g. Illinois, Minnesota, Vermont, and Wisconsin). Researchers in Vermont found that the milfoil weevil can negatively impact Eurasian watermilfoil by suppressing the plants growth and reducing its buoyancy (Creed and Sheldon 1995). In 1989, state biologists reported that Eurasian watermilfoil in Brownington Pond, Vermont had declined from approximately 10 hectares (in 1986) to less than 0.5 hectares. Researchers from Middlebury College, Vermont hypothesized that the milfoil weevil, which was present in Brownington Pond, played a role in reducing Eurasian watermilfoil (Creed and Sheldon 1995). During 1990 through 1992, researchers monitored the populations of Eurasian watermilfoil and the milfoil weevil in Brownington Pond. They found that by 1991 Eurasian watermilfoil cover had increased to approximately 2.5 hectares (approximately 55-65 g/m2) and then decreased to about 1 hectare (<15 g/m2) in 1992. Weevil abundance began increasing in 1990 and peaked in June of 1992, where 3 - 4 weevils (adults and larvae) per stem were detected (Creed and Sheldon 1995). These results supported the hypothesis that the milfoil weevil played a role in reducing Eurasian watermilfoil in Brownington Pond.

Advantages

- Milfoil weevils offer a biological alternative to aquatic plant control.
- They may be cheaper than other control strategies.
- Biocontrols enable weed control in hard-to-access areas and can become self-supporting in some systems.
- If they are capable of reaching a critical mass, biocontrols can decimate a weed population.

Disadvantages

- There are many uncertainties as to the effectiveness of this biocontrol in western Washington waters.
- There have not been any documented declines of Eurasian watermilfoil in Washington State that can be attributed to the milfoil weevil.
- Many of our lakes, possibly including Bass Lake, have introduced sunfish populations that may predate on the milfoil weevils.
- Bio-controls often don't eradicate the target plant species, and there would be population fluctuations as the milfoil and weevil follow predator-prey cycles.

Permits

The milfoil weevil is native to Washington and is present in a number of lakes and rivers. It is found associated with both native northern milfoil and Eurasian watermilfoil. A company is selling milfoil weevils commercially. However, to import these out-of-state weevils into Washington requires a permit from the Washington Department of Agriculture. As of 2011 no permits have been issued for use of milfoil weevils to control aquatic weeds in Washington State.

Suitability for Lake Sawyer

Since the milfoil weevil is already present in Lake Sawyer it would be the preferred option for Eurasian watermilfoil control in the lake (it may already be the reason for the plants reduced abundance in the lake).

No Action Alternative

One option for managing aquatic weeds in Lake Sawyer is to let aquatic weeds continue to grow, and do nothing to control them. This "no action" alternative would acknowledge the presence of the aquatic weeds but would not outline any management plan or enact any planned control efforts. Effectively, a no action determination would preclude any integrated treatment and/or control effort, placing the choice and responsibility of aquatic weed control with lakefront property owners.

Suitability for Lake Sawyer

The milfoil infestation is currently low in density. It is possible that the population of milfoil weevils is operating as a biological control for Eurasian milfoil. There is the possibility that the population of noxious weeds could increase and as a result the section on herbicide treatment is included as an alternative control method. Based on results of informal surveys by residents and King County staff, the infestations of milfoil have fluctuated over the years. If there is no surveying or control efforts, it is possible that weed infestations will continue to grow, deteriorating the ecological and recreation benefits the lake provides.

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Appendix B
Noxious Weed Best Management Practices

King County

Eurasian Watermilfoil

Myriophyllum spicatum **Class B Non-Regulated Noxious Weed Control Recommended**

Variable-leaf Milfoil

Myriophyllum heterophyllum **Class A Noxious Weed Control Required**

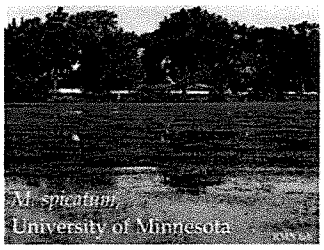
Haloragaceae

Legal Status in King County: Variable-leaf milfoil is a Class A Noxious Weed according to Washington State Noxious Weed Law, RCW 17.10 (non-native species that is harmful to environmental and economic resources and that landowners are required to eradicate). In accordance with state law, the King County Noxious Weed Control Board requires property owners to eradicate variable-leaf milfoil from private and public lands throughout the county (eradicate means to eliminate a noxious weed within an area of infestation). Eurasian watermilfoil is a Class B Non-Regulated Noxious Weed (non-native species that can be designated for control based on local priorities). The State Weed Board has not designated this species for control in King County. The King County Weed Control Board recommends control of Eurasian watermilfoil where feasible, but does not require it. State quarantine laws prohibit transporting, buying, selling, or distributing plants, plant parts or seeds of these milfoils.

BACKGROUND INFORMATION

Impacts and History

- Eurasian watermilfoil is native to Eurasia but is widespread in the United States, including Washington. In King County it is present in numerous lakes and slow moving streams and rivers.
- Variable-leaf milfoil is native to the eastern United States. It was introduced to southwestern British Columbia several decades ago and was confirmed in Thurston and Pierce Counties in 2007.
- Both of these plants are very aggressive and can outcompete native aquatic plants, forming dense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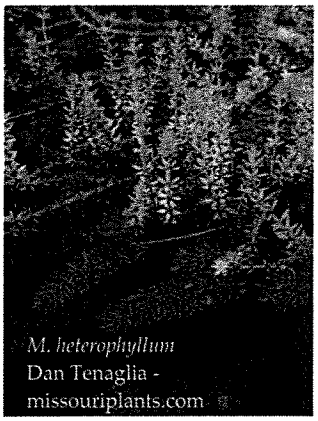
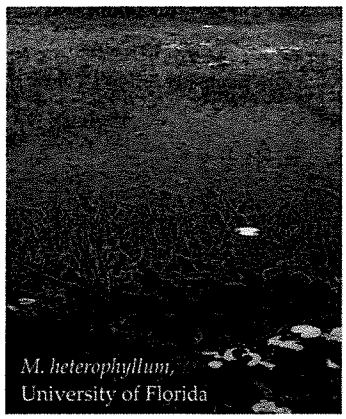
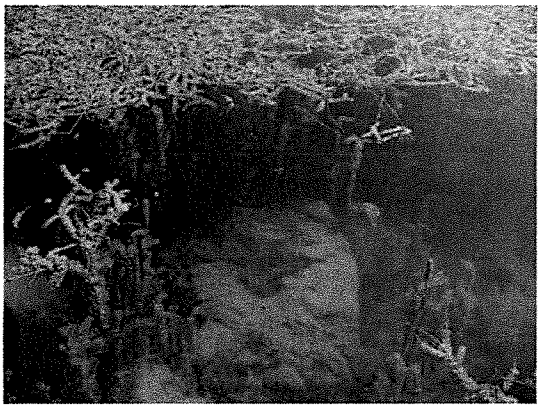
M. spicatum,
Andrzej Martyniak


M. heterophyllum
Dan Tenaglia -
missouriplants.com


M. heterophyllum,
University of Florida

monotypic stands. They can reduce biodiversity, change the predator/prey relationships in a lake and adversely impact the food web.

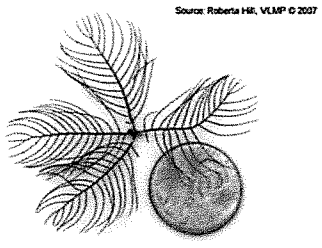
- These milfoil species impact recreation by eliminating swimming opportunities, fouling boat motors and snagging fishing lines.
- When allowed to grow in dense stands and "top out", the floating mats or emergent flower stems prevent wind mixing, and extensive areas of low oxygen can develop during the summer.
- Stagnant mats create mosquito breeding areas and increase the water temperature underneath by absorbing sunlight.
- These plants die back in the fall, and the resulting decay uses up dissolved oxygen and adds nutrients to the water, potentially increasing algae growth and related water quality problems.



Description, Reproduction and Spread

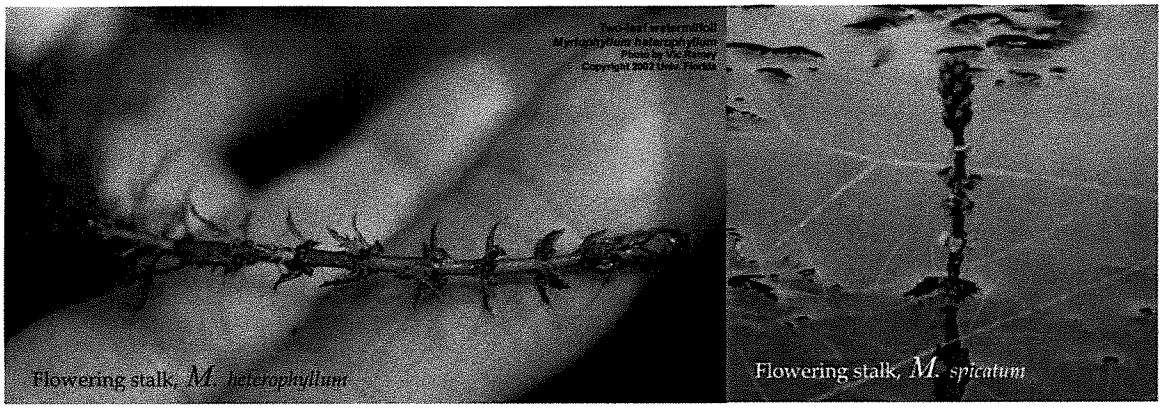
Milfoil species (*Myriophyllum* spp.) can be very difficult to tell apart, particularly when not in flower. Not only can the vegetative structures look very similar, but Eurasian watermilfoil (M. *spicatum*) is known to cross with the native northern milfoil (*M. sibiricum*), creating an invasive hybrid. Anyone who finds a new, aggressive population of milfoil should consult an expert to get a positive identification before taking action to control it.

Eurasian watermilfoil (*Myriophyllum spicatum*)



- Perennial, rhizomatous plant grows in water to 20 feet (possibly up to 30 feet) deep.
- Forms tangled underwater stands and dense floating mats.
- Leaves are in whorls of four, and are feathery, with generally more than 14 leaflet pairs per leaf. Leaves often appear squared-off at the tip. Leaves usually collapse against the stem when the plant is pulled from the water.
- Stems are long, branched near the surface, and usually reddish.
- Flowers are tiny and borne on reddish spikes above the water surface.
- Spread is generally by plant fragments or rhizomes.

- Can be confused with the native northern milfoil (*Myriophyllum sibiricum*), which generally has fewer than 14 leaflet pairs per leaf. The native milfoils also tend to retain their shape when pulled from the water rather than collapsing against the stem.



Variable-leaf milfoil (*Myriophyllum heterophyllum*)

- Perennial, rhizomatous plant grows in water to 15 feet deep.
- Forms tangled underwater stands and dense floating mats.
- Submersed leaves are in whorls of four to six, and are feathery, with six to 14 leaflet pairs per leaf.
- Flowering spikes emerge up to six inches above the water and have bright green, leaf-like bracts that are in whorls of 4 to 6 with toothed to entire margins.
- Flowers are tiny and borne in the axils of the leaf-like bracts.
- Submersed stems are stout (up to 8 mm in diameter), reddish, often with numerous branches. A cross-section of the stem will reveal "pie-shaped" air chambers.
- Spread is by plant fragments, rhizomes and seed.
- Has the ability to produce terrestrial plants with leaves resistant to drying. These apparently do not colonize new areas, but aid in the survival of the species in years when the water level is unusually low.
- Can be confused with the native western milfoil (*M. hippuroides*), which also has emergent flower stems with leaf-like bracts, and vegetative plants can be confused with the native northern milfoil (*Myriophyllum sibiricum*), which also has fewer than 14 leaflet pairs per leaf.

Habitat

- Milfoils grow in still and slow moving water, generally up to about 20 feet deep for Eurasian watermilfoil, and six to 15 for variable-leaf milfoil, depending on water clarity.
- They tend to cluster at downwind ends of smaller water bodies or in quiet coves where fragments can settle out of the water column and take root.
- Both tolerate a wide range of pH.
- Eurasian watermilfoil can tolerate brackish water.

Local Distribution

- Eurasian watermilfoil is widespread in western Washington and in King County, with established populations in the large lakes (Lakes Washington, Sammamish and Union), the Sammamish River, and a number of smaller lakes (notably Green Lake in Seattle).
- Variable-leaf milfoil was discovered in a lake in Thurston County in 2007, the first confirmed record in Washington State. It has since been found in another lake in Thurston County, as well as in two lakes in Pierce County (Blue and Clear Lakes), all four of which are privately owned. Since it is particularly difficult to distinguish from the native western milfoil (*M. hippuroides*), it may be established in other areas as well. The Washington State Department of Ecology is investigating other potential populations. At this writing, there are no confirmed populations of variable-leaf milfoil in King County.

CONTROL INFORMATION

Integrated Pest Management

- The preferred approach for weed control is Integrated Pest Management (IPM). IPM involves selecting from a range of possible control methods to match the management requirements of each specific site. The goal is to maximize effective control and to minimize negative environmental, economic and social impacts.
- Use a multifaceted and adaptive approach. Select control methods which reflect the available time, funding, and labor of the participants, the land use goals, and the values of the community and landowners. Management will require dedication over a number of years, and should allow for flexibility in method as appropriate.

Planning Considerations

- Survey area for weeds, set priorities and select best control method(s) for the site conditions and regulatory compliance issues (refer to the King County Noxious Weed Regulatory Guidelines).
- Small infestations may be effectively removed using manual methods or hand tools.
- Milfoil spreads by fragmentation, so care must be taken to contain and remove all plant fragments when using manual or mechanical control methods. Otherwise, the infestation will spread.
- Any control actions taken will necessarily affect all landowners adjacent to the water body and will require their approval and participation in order to succeed. In addition, many control options will be expensive and it will be more cost-effective to pool resources.
- Commit to monitoring. Once initial control has been achieved, be sure to conduct follow up monitoring and control in subsequent years in order to catch any overlooked patches or returning infestations before they can spread. Without this, control efforts can be wiped out within a few years. Monitor the site each year for at least three years after last observing any milfoil, and then again after three years.
- Any water body with a public boat launch should be monitored regularly since milfoils can be re-introduced easily from plant fragments on a boat or trailer.

Permitting and Regulatory Requirements

- Permits are required for all weed control work in natural water bodies.
- At minimum, the pamphlet **Aquatic Plants and Fish** is required. This pamphlet is published by the Washington State Department of Fish and Wildlife and acts as a Hydraulic Project Approval (HPA) permit. It is available free of charge online at http://wdfw.wa.gov/hab/aquaplnt/aquaplnt.htm or by calling (360) 902-2534. This "pamphlet HPA" is all you will need for most manual or light mechanical control methods.
- More extensive control, including some bottom barrier placement and all herbicide use, will require additional permits from Washington State. See the sections below for details.
- Permits and licenses are required for all herbicide use in aquatic systems. Minimum requirements include a pesticide applicator's license with an aquatic endorsement from the Washington Department of Agriculture and a permit from the Washington Department of Ecology.
- Some incorporated cities also regulate any work conducted in natural waterbodies. Contact your local jurisdiction for details.
- **Permit requirements can change from year to year. Contact the King County Noxious Weed Control Program for more information on current permitting requirements.**

Early Detection and Prevention

- Look for new plants. Get a positive plant identification from an authority such as King County Noxious Weed Control Program staff.
- Look for plants along lake shorelines and in stagnant or slow-moving water in wetlands and streams. Since these plants are often spread as fragments attached to boat motors and trailers, check especially around boat launches. Also check at the downwind end of the waterbody, and anywhere else where fragments could congregate or settle out of the water column.
- The best time to begin surveys is late spring when plants are visible, and surveys can continue into early fall when the plants senesce (die back).
- Clean all plant material off of boats, motors and trailers, and check bilgewater for plant fragments any time you have been in an infested water body (or a potentially infested water body).
- **Never dispose of unwanted aquarium or water garden plants or animals in a natural water body**. Variable-leaf milfoil in particular is still sold in some areas as an aquarium plant, and may have been introduced to Washington waters by careless dumping of aquariums.

Manual Control

- At minimum, an HPA pamphlet permit is required for all manual control activities in natural waterbodies. In incorporated areas, check with your local jurisdiction for other possible permit requirements.

- Hand pulling and the use of hand mechanical tools is allowable in all critical areas in unincorporated King County.
- Hand pulling can be successful for a very small area but is impractical for large infestations. Be sure to contain and remove all plants and plant fragments from the water.
- Weed rakes and weed cutters can assist in maintaining open water in a discrete area, such as around a dock, but will not eliminate the plants. Be sure to contain and remove all plants and plant fragments from the water.
- All manual control sites should be monitored for several years for signs of plants growing from roots or fragments.
- **DISPOSAL**: Milfoils can be composted on land away from water or placed in yard waste bins. Do not leave any plant parts or fragments in the water or near the water's edge. Variable-leaf milfoil can grow on exposed soil during periods of low water, so extra care should be taken to dispose of it away from the water.

Mechanical Control

- At minimum, an HPA pamphlet permit is required for all mechanical control activities in natural waterbodies. In incorporated areas, check with your local jurisdiction for other possible permit requirements.
- Cutting and harvesting using boat-mounted cutters or in-lake harvesting barges is effective at maintaining open water in water bodies with 100% of the available habitat infested. It must be done on a regular basis to maintain control. However, these methods will quickly spread these plants by creating numerous fragments, so cutting and harvesting are not recommended for small or partial infestations. Neither method will eradicate an infestation. In unincorporated King County, only an HPA pamphlet permit is required for cutting and harvesting noxious weeds.
- Diver dredging using boat or barge mounted suction dredges can be effective for small infestations or as a follow-up to herbicide treatment. Special care must be taken to remove all fragments. This method causes a temporary increase in turbidity and requires specific authorization from the Washington Department of Fish and Wildlife (WDFW).
- Rotovation (underwater rototilling) is not recommended since it causes severe fragmentation of the plants. Rotovation also results in significant short term turbidity and loss of water clarity and quality, as well as destruction of benthic habitat. Rotovation requires an individual HPA permit.

Cultural Methods

- An opaque bottom barrier can be used to suppress growth in small, discrete areas like at a boat launch or around a swimming area. Barriers need to be regularly cleaned because plants will root in the sediment that accumulates on top of them. This is not practical for large-scale infestations. Bottom barriers in Lake Washington and Lake Sammamish are not allowed without prior authorization by the Washington Department of Fish and Wildlife (WDFW) due to potential impact on sockeye salmon

spawning areas. A pamphlet HPA at minimum is required for bottom barrier installation. Other permits may also be required.

- Waterbodies with control structures can sometimes use water level drawdown to control submerged weeds. Generally the bottom must be exposed to heat or cold long enough to dry out completely, something that can be difficult to achieve in rainy western Washington. Occasionally drawdowns can backfire and increase subsequent germination of weed seeds, especially with variable-leaf milfoil. Drawdowns can have major impacts on native plants and other aquatic organisms. Carefully weigh the pros and cons before deciding on this option. A drawdown is not covered by the pamphlet HPA. Consult your local WDFW office for permit information.

Chemical Control

- Permits and licenses are required for all chemical control in water.
- Herbicides may be the most reasonable option for eradication of large submerged noxious weed infestations. Professional licensed contractors are available for hire to perform this task.
- Herbicides can only be applied to aquatic systems in Washington State by a licensed pesticide applicator. Aquatic formulations of herbicides are not available for sale over the counter to anyone without an aquatic pesticide license. **NEVER apply non-aquatic herbicide formulations to water since most of them include ingredients that are toxic to aquatic organisms.**
- Multiple years of treatment may be required to eradicate a milfoil infestation. For several years following treatment, monitor areas for new plants germinating from the seed bank. Remove any new growth using one of the manual control methods above.

Specific Herbicide Information

Milfoil species are dicots, and therefore selective herbicides can be used to control them with minimal collateral damage to the primarily monocot native plant communities. 2,4-D, a selective herbicide, and fluridone, a non-selective herbicide, have both been used to control Eurasian watermilfoil to good effect in western Washington lakes. However, 2,4-D cannot be used in waterbodies that support salmonids (salmon and trout species). Triclopyr, another selective herbicide, has been approved for control of submerged plants as of 2008 and shows promise as an alternative herbicide for milfoil control. Endothall and diquat, which are both contact herbicides, will control existing vegetation, but will not kill the roots, so the control is temporary.

The mention of a specific product brand name in this document is not, and should not be construed as an endorsement or as a recommendation for the use of that product. Chemical control options may differ for private, commercial and government agency users. **For questions about herbicide use, contact the King County Noxious Weed Control Program at 206-296-0290.**

Biological

- Triploid grass carp have been tried as a control for milfoil species, but milfoil is not palatable to them, and they will generally eat everything else in the waterbody first. Grass carp are not allowed in water bodies where the inlet and outlet cannot be screened to prevent fish from leaving the waterbody. Grass carp are not allowed anywhere in the Lake Washington and Lake Sammamish system. They are not recommended as a control for milfoil, although they can be used if these species predominate. Care should be taken to evaluate potential impacts on the native plant community before choosing grass carp as a control method.
- In some situations, the native milfoil weevil (*Euhrychiopsis lecontei*) seems to control Eurasian watermilfoil. The weevil appears to prefer Eurasian watermilfoil over its native host, northern watermilfoil (*Myriophyllum sibiricum*), and in lakes where the weevil occurs naturally, Eurasian milfoil has been shown to be less of a problem. Ongoing research is exploring lake conditions in which the weevil may thrive, including water pH and the abundance of insect-eating fish. Although no permits are needed to use native insects as biocontrol, currently the weevils are difficult to obtain in quantities high enough to have an effect on milfoil populations. Even when they have been specially reared and introduced, it can take several years for populations in a waterbody to reach sufficient levels to control milfoil populations. Biocontrols of any type will not eradicate milfoil, but if effective should reduce a milfoil population to below the threshold of significant impact.

SUMMARY OF BEST MANAGEMENT PRACTICES

- At all times at minimum a pamphlet HPA permit is required to do any activity that disturbs a lake bottom or wetland or streambed. For more extensive work, more specific permits will be required.
- Hand pulling or digging is recommended for small populations, with extreme care taken not to let fragments spread.
- Where a population has filled every possible inch of habitat in a waterbody and its connected waterways, cutting or harvesting when done consistently can maintain open water and diminish the adverse affects of these species.
- Bottom barriers can maintain small areas of open water around boat launches, swimming areas or docks, as long as care is taken to keep them free of debris and fragments.
- Diver dredging can be effective for small infestations or as a follow-up to herbicide treatment.
- To eradicate large areas of milfoil, herbicides are probably the best option.
- **Do not apply any herbicide to water without the proper licenses.** Hire a contractor to do the work.

Control in small isolated or man-made ponds

- Permits may be required (see "Permitting and Regulatory Requirements" section above).
- Drawdown can be very effective. Remove all plants and plant fragments. Let the bed dry out completely before refilling. Thoroughly clean pond liners. Examine or discard ornamental plants that may harbor plant fragments before re-introducing them to the pond.
- Manual control will work if the infestation is caught early and all fragments are removed.
- Bottom barriers may be effective over natural pond beds.
- Follow recommendations above for chemical control.

Control in small lakes

- Permits will be required for all control work (see "Permitting and Regulatory Requirements" section above).
- Community involvement will be essential for successful control efforts.
- For small pioneering infestations, manual control or bottom barriers may be effective. Monitor the lake for fragments and additional infestation sites. Maintain bottom barriers to prevent sediment buildup.
- For large or whole-lake infestations, chemical control will be the most effective (see above for chemical recommendations). Mechanical control may be used to manage infestations, but will not eradicate the weeds. Bottom barriers, if properly maintained, will create open water in small areas.

Control in flowing water (rivers, streams, ditches)

- Permits will be required for all control work (see "Permitting and Regulatory Requirements" section above).
- The most effective control will start with the furthest upstream infestation and move downward. If there are any weeds left upstream, any cleared site will likely be re-infested.
- If possible, contain the area being controlled with a boom to catch fragments before they float downstream.
- Manual control may be the most practical. Bottom barriers need to be securely anchored.
- Chemical control in flowing water is difficult. Consult an expert before considering this option.

Control along shores of Lakes Washington and Sammamish

- Permits will be required for all control work (see "Permitting and Regulatory Requirements" section above).
- Eradication of submerged aquatic weeds from these waterbodies is not practical.
- Bottom barriers, if properly maintained, can provide open water around docks, marinas, swimming beaches, and similar areas. Prior authorization by the Washington

Department of Fish and Wildlife (WDFW) is required due to potential impact on sockeye salmon spawning areas.

- Manual control of small patches may be sufficient.
- Mechanical control can be effective for lakeside communities or large marinas. Be sure to remove all fragments from the water.
- Spot control using chemicals can be effective in the right conditions. It is possible that more than one species of submerged noxious weeds may be present (particularly Brazilian elodea, which is increasing in these lakes). If this is the case, be sure to select an herbicide that will control all targeted weeds (consult BMPs for each weed or ask an expert for assistance in selecting herbicides). If there is any significant wave action or current, the chemicals will drift off target or quickly become diluted. Consult with a professional contractor before choosing this option. Neighboring property owners should be advised prior to spot chemical applications.
- Grass carp are not allowed in the Lake Washington and Lake Sammamish system.

Disposal Methods

- Eurasian watermilfoil can be left on land to dry out and/or decompose where it will not move into a waterway.
- Variable-leaf milfoil should not be left on the bank since it may root in damp soil.
- Both milfoils can be composted or placed in yard waste bins.

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King County
Department of
Natural Resources and Parks
Water and Land Resources Division
Noxious Weed Control Program

BEST MANAGEMENT PRACTICES

Yellow-flag iris
(*Iris pseudacorus*)
Iridaceae

Class C Noxious Weed; Not Designated for Control

Legal Status in King County: Class C Noxious Weed (non-native species that can be designated for control under State Law RCW 17.10 based on local priorities.) The King County Noxious Weed Control Board does not require property owners to control yellow-flag iris, but control is recommended.

BACKGROUND INFORMATION

Impacts and History

- Alternate common names include yellow flag, paleyellow iris and yellow iris.
- On state weed lists in Connecticut, Massachusetts, Montana and New Hampshire in addition to Washington. Also on the USDA Natural Resources Conservation Service invasive plants list and on the Exotic Plant Pest List of the California Exotic Pest Plant Council.
- Yellow-flag iris displaces native vegetation along streambanks, wetlands, ponds and shorelines and reduces habitat needed by waterfowl and fish, including several important salmon species.
- It clogs small streams and irrigation systems, and it dominates shallow wetlands, wet pastures and ditches. Its seeds clog up water control structures and pipes.
- Rhizome mats can prevent the germination and seedling growth of other plant species. These mats can also alter the habitat to favor yellow-flag iris by compacting the soil as well as increasing elevation by trapping sediments.
- Studies in Montana show that yellow-flag iris can reduce stream width by up to 10 inches per year by trapping sediment, creating a new bank and then dominating the new substrate with its seedlings, creating still more sediment retention (Tyron 2006).
- Even when dry, yellow-flag iris causes gastroenteritis in cattle (Sutherland 1990), although livestock tend to avoid it. All plant parts also cause gastric distress in humans when ingested, and the sap can cause skin irritation in susceptible individuals.
- Native to Europe and the Mediterranean region, including North Africa and Asia Minor. Found as far north as 68 degrees North in Scandinavia.

- The earliest North American record comes from Newfoundland in 1911, and it was established in British Columbia by 1931. By 1961 yellow-flag iris was reported to be naturalized in Canada (Cody 1961). It was established in California by 1957 and in Montana by 1958 (Tyron 2006). It is now naturalized in parts of most states and provinces throughout North America except in the Rocky Mountains. (NRCS Plants Database).

Description

- A perennial, emergent iris that creates dense stands along freshwater margins. It is the only naturalized, emergent yellow iris in King County.
- Grows to 5 feet (1.5 m) tall.
- Has numerous thick, fleshy rhizomes.
- Flowers are yellow, showy, and sometimes have brown to purple veins at the base of the petals. Several flowers can occur on each stem.
- Can bloom from April to August; in western Washington usually blooms May into July. It will remain green all winter in mild years.
- Broad, flat, pointed leaves are folded and overlap one another at the base. They are generally longer in the center of the plant and fan out in a single plane toward the edges of the plant. The leaves are dark green to blue-green.
- Fruits are large capsules to 3 inches (8 cm) long. They are 3-angled, glossy green and contain rows of many flattened brown seeds.
- Seeds are corky, large - about ¼ inch (7 mm) across, and float. Seed pods grow in clusters that resemble little bunches of bananas. Seeds spread by water and usually germinate after the water recedes along the edges of the shore. They do not usually germinate under water.
- When not in flower or seed, can be confused with cattails (*Typha sp.*), which are round at the base and taller than yellow-flag iris, while iris are flattened along one plane and shorter. Can also be mistaken for native bur-reeds (*Sparganium sp.*), which have thick, spongy leaves that are somewhat narrower than iris leaves.

Habitat

- Occurs in freshwater wetlands, fens, ponds, lake shores, river and stream banks, wet pastures and ditches.
- Grows in standing water or next to it on saturated soils. Prefers silty, sandy or rocky soil.
- Generally grows in shallow water, but can create extensive mats over deeper water.
- Sometimes cultivated as a garden ornamental or used for landscaping purposes.

Reproduction and Spread

- Spreads by seed and vegetatively (rhizomes).
- Produces extensive thick, fleshy rhizomes, forming dense mats that exclude native wetland species. Up to several hundred flowering plants may be connected rhizomatously. Rhizome fragments can form new plants if they break off and drift to suitable habitat. Rhizomes that dry out remain viable and will re-infest an area if they are re-moistened.

- Flat spongy seeds disperse through water and germinate after the water recedes along shorelines. Submersed seeds will generally not germinate.
- Plants take three years to mature before flowering (Tyron 2006).
- The flowers are pollinated by bumble-bees and long-tongued flies.

Local Distribution

- Widespread throughout King County.
- Present along most lake shores and many stream banks in the developed areas of the county.
- A few shallow wetlands significantly impacted.

CONTROL INFORMATION

Integrated Pest Management

- The preferred approach for weed control is Integrated Pest Management (IPM). IPM involves selecting from a range of possible control methods to match the management requirements of each specific site. The goal is to maximize effective control and to minimize negative environmental, economic and social impacts.
- Use a multifaceted and adaptive approach. Select control methods that reflect the available time, funding, and labor of the participants, the land use goals, and the values of the community and landowners. Management may require dedication over a number of years, and should allow for flexibility in method as appropriate.

Planning Considerations

- Survey area for weeds, set priorities and select best control method(s) for the site conditions and regulatory compliance issues **(refer to the King County Noxious Weed Regulatory Guidelines or local jurisdictions)**.
- Isolated plants can be effectively dug up. Take care to remove all of the rhizomes, in order to stop them from infesting a larger area.
- For larger infestations, the strategy will depend on the site. Generally work first in least infested areas, moving towards more heavily infested areas. On rivers and streams, begin at the infestation furthest upstream and work your way downstream.
- If conducting manual control, be sure to collect any rhizome fragments that may float free.
- Minimize disturbance to avoid creating more opportunities for seed germination.

Early Detection and Prevention

- Look for new plants. Get a positive plant identification by contacting your local noxious weed control program or extension service.
- Look for plants along river and lake shorelines, wetlands, ditches and wet pastures.
- The best time to survey is in April to June when the plants are in flower.
- Look for seedlings starting in late winter.
- Dig up small isolated patches, being sure to remove all the rhizome.
- Don't buy, move or plant yellow-flag iris.

- Clean any tools and machinery that were used in an infested area before moving to another site.

Manual

- Hand removal with the use of hand tools is allowable in all critical areas in unincorporated King County. Check with the local jurisdiction for regulations in other areas.
- When removing manually, care should be taken to protect the skin, as resins in the leaves and rhizomes can cause irritation.
- Manual control is feasible for individual plants or small stands. You can easily pull seedlings in damp or wet soil.
- Dig out mature plants, taking care to remove all the rhizome. The rhizome is tough and may require heavier tools, such as pickaxes, pulaskis or saws. If you do not get all the rhizome, more plants will be produced. Keep watching the location after you have removed the plants, and new leaves will show you where you missed any sections of rhizome. Continue to remove the rhizome, and in this way you can eradicate a small patch.
- Simon (2008) found that for plants emergent in standing water for the entire growing season, cutting all leaves and stems off below the waterline can result in good control. This method is most effective if the plants are cut before flowering.
- Be sure to dispose of any removed pieces of rhizome away from wet sites. Composting is not recommended for these plants in any home compost system, because rhizomes can continue growing even after three months without water (Sutherland 1990).

Mechanical

- Removal of yellow-flag iris with hand held mechanical tools is allowable in critical areas and their buffers in unincorporated King County. Check with the local jurisdiction for regulations in other areas.
- In unincorporated King County, riding mowers and light mechanical cultivating equipment may be used in critical areas if conducted in accordance with an approved forest management plan, farm management plan, or rural management plan, or if prescribed by the King County Noxious Weed Control Program.
- Repeated mowing or cutting may keep yellow-flag iris contained and can potentially kill it by depleting the energy in the rhizomes after several years of intensive mowing (Tu 2003).

Cultural

- Small patches can be covered with a heavy tarp weighted at the edges for several years (Simon 2008). Be sure to extend the tarp well beyond the edges of the infestation and check periodically to ensure that plants are not growing up around the tarp. Other materials (heavy plastic, landscape cloth) are not as effective.
- Burning is not recommended. Seeds germinate and grow well after late summer burning (Sutherland 1990), and plants have a strong tendency to resprout from rhizomes after burning (Clark et al. 1998).

Biological

- Although a number of insects and pathogens are known to attack yellow-flag iris (Tu 2003), no biological control agents are presently known, and no research is currently being conducted.

Chemical

- Herbicides should only be applied at the rates and for the site conditions and/or land usage specified on the label. **Follow all label directions.**
- Herbicides can only be purchased and applied to aquatic systems in Washington State by a licensed pesticide applicator (contact Washington State Department of Agriculture for more information on pesticide licenses).
- There are federal, state and local restrictions on herbicide use in critical areas and their buffers. Refer to the **King County Noxious Weed Regulatory Guidelines** for a summary of current restrictions and regulatory compliance issues.
- For control of large infestations, herbicide use may be necessary. Infested areas should not be mowed until after the herbicide has had a chance to work, which may take several weeks, depending on the herbicide used.
- Due to dense growth, re-application a few weeks after initial treatment will probably be needed to get complete coverage (Tyron 2006).
- For several years following treatment, monitor areas for new plants germinating from the seed bank or from rhizome fragments. In some cases several years of treatment may be necessary.

Specific Herbicide Information

Since yellow-flag iris is a monocot, only non-selective herbicides are effective. However, non-selective herbicides will injure or kill any plant they contact, so special care must be taken when using these chemicals. Both of the herbicides discussed below are non-selective.

Glyphosate (e.g. Rodeo™ or Aquamaster™). This is the most frequently used chemical for controlling yellow-flag iris. Apply to actively growing plants in late spring or early summer. Apply directly to foliage, or apply immediately to freshly cut leaf and stem surfaces. Avoid runoff. (Tu, 2003). Follow the label for recommended rates for yellow-flag iris since higher rates may provide better results. A study in Montana showed good results with 5% Rodeo plus Competitor (Tyron, 2006). Glyphosate at lower rates is not as effective as either imazapyr or imazapyr and glyphosate combined.

Imazapyr (e.g. Habitat®). Simon (2008) found that 1% imazapyr (with 1% non-ionic surfactant) sprayed in the fall resulted in good control. Imazapyr sprayed in the spring, or a combination of imazapyr (1%) and glyphosate (2.5%) sprayed in fall both result in good control, but slightly less effective than imazapyr alone. Note that imazapyr has been shown to have some residual soil activity, so care should be taken to avoid spraying in the root zone of desirable plants, and do not replant the treated area for several months after application.

The above listed herbicides require the addition of an approved surfactant. Follow label directions for selecting the correct type of surfactant. Be sure that the selected surfactant is approved for aquatic use.

The mention of a specific product brand name in this document is not, and should not be construed as an endorsement or as a recommendation for the use of that product.

Chemical control options may differ for private, commercial and government agency users. **For questions about herbicide use, contact the King County Noxious Weed Control Program at 206-296-0290.**

Experimental

Preliminary trials indicate that injecting herbicide into the cut flowering stems of yellow-flag iris may provide a successful alternative treatment method with little or no non-target damage. Check with your local weed control agency for progress.

SUMMARY OF BEST MANAGEMENT PRACTICES

Small Infestations in Native and/or Desirable Vegetation

- Hand digging is recommended for very young plants not yet established.
- Larger plants from isolated small populations can be dug out from moist upland areas. This is difficult but possible with persistence.
- Replace any divots created when removing the plants to lessen the amount of disturbed soil.
- Plants emergent in standing water can be cut below the waterline.
- If manual control is not possible due to site conditions or available labor, apply appropriate herbicide by spot spray, stem-injection or wick-wiper to minimize off target injury.

Large Infestations

- Persistent mowing or cutting over several years may be effective. Cutting flowering plants will stop seed dispersal.
- Herbicide use may be necessary.
- If the infestation is in a pasture, combine control methods with ongoing good pasture management. Encourage healthy grassy areas by seeding and fertilizing. Use a mix of grass and clover species to improve resistance to weeds. Fertilize according to the soil needs.

Control in Riparian Areas or Lake Shores

- Survey area and document extent of infestation. Start eradication efforts at the headwaters and progress downstream whenever possible.
- Focus on manual removal for small infestations if possible.

- When removing vegetation near streams and wetlands use barriers to prevent sediment and vegetative debris from entering the water system.
- For larger areas where herbicide use is warranted, use the method that will cause the least amount of damage to desirable vegetation, such as spot spraying or wick wiping.
- When large areas of weeds are removed, the cleared area needs to be replanted with native or non-invasive vegetation and stabilized against erosion.
- Control of larger areas will need to incorporate a management plan lasting for several years to remove plants germinating from the seed bank and rhizome fragments.

Control on Road Rights-of-Way

- Dig up small infestations if possible.
- Spot spray if digging is not practical due to soil, site conditions or size of infestation.
- If plants are in grassy areas, re-seed after control is completed.
- If plants are sprayed, wait until the herbicide has had a chance to work (up to several weeks) before mowing.

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Fragrant Water Lily

Nymphaea odorata
Nymphaeaceae

Class C Noxious Weed
Control Recommended

Legal Status in King County: Fragrant water lily is a Class C noxious weed (non-native species that can be designated for control based on local priorities) according to Washington State Noxious Weed Law, RCW 17.10. The State Weed Board has not designated this species for control in King County. The King County Weed Control Board recommends control of this species where feasible, but does not require it.

BACKGROUND INFORMATION

History and Impacts

- *Nymphaea odorata* is native to the eastern half of North America, including southern Canada. It has been introduced as an ornamental in many parts of the world and is now found throughout North America. Although found throughout Washington, fragrant water lily is especially prevalent in western Washington lakes where it has been intentionally planted by property owners who admired the showy flowers.
- It is believed that fragrant water lily was originally introduced into Washington during the Alaska Pacific Yukon Exposition held in Seattle in the late 1800s.
- Left unmanaged, water lilies can restrict lake-front access and hinder recreation.
- Drownings in King County have been attributed to swimmers getting tangled in dense water lily stems.
- Water lilies foul boat motors and restrict passage for non-motorized boats.
- When allowed to grow in dense stands, the floating leaves prevent wind mixing and extensive areas of low oxygen can develop under water lily beds during the summer.
- Aggressive water lily mats can outcompete native plants, reduce biodiversity, change the predator/prey relationships in the lake and adversely impact the food web.
- Stagnant mats create mosquito breeding areas and increase the water temperature underneath by absorbing sunlight.
- Water lilies die back in the fall, and the resulting decay uses up dissolved oxygen and adds nutrients to the water, potentially increasing algal growth and related water quality problems.

Description

- Perennial floating leaved rooted aquatic plant, growing in about three to six feet of water. Blooms June to October.
- **Round, green leathery leaves** up to 10 inches across have a basal slit. The flexible leaf stalk is attached at the base of the slit. The leaves float on the surface of the water, rarely sticking up above it as water level drops.
- **Many-petaled Flowers** are showy and range from white to pink (rarely yellow). They are borne on an individual stalk which curls like a corkscrew after the flower has been fertilized and pulls the flower under water. Seeds are leathery capsules with numerous small seeds.
- Both flower and leaf stalks arise from **thick fleshy rhizomes**.
- Adventitious roots attach the horizontal creeping and branching rhizomes.

Habitat

- Fragrant water lily occurs in shallow freshwater ponds and lake margins 3-6 feet deep.
- It will also grow in slow moving water.
- It can tolerate a wide range of pH, and it prefers substrates from mucky to silty.

Reproduction and Spread

- Spreads by floating seed and by rhizomes.
- Seeds disperse through the water by wind and wave action.
- Rhizome pieces can also break off and move through the water before establishing in a new location.
- A planted rhizome will spread to cover about a 15-foot diameter circle in five years.
- Primary source of distribution to new water bodies is deliberate planting. Many cultivars of *Nymphaea odorata* are available in the nursery trade. However, waterfowl can also spread the plant between water bodies.

Local Distribution

- While fragrant water lily is widely present in western Washington, it is less so in eastern Washington and uncommon to absent in western Oregon lakes.
- *Nymphaea odorata* was found in 27 of 36 surveyed lakes in the developed areas of King County in 1996. The number of ponds and smaller wetlands containing the plant is considerably larger.
- Requests for water lily control represent a high percentage of the herbicide permit requests received by the Washington State Department of Ecology.

CONTROL INFORMATION

Integrated Pest Management

- The preferred approach for weed control is Integrated Pest Management (IPM). IPM involves selecting from a range of possible control methods to match the management requirements of each specific site. The goal is to maximize effective control and to minimize negative environmental, economic and social impacts.
- Use a multifaceted and adaptive approach. Select control methods which reflect the available time, funding, and labor of the participants, the land use goals, and the values of the community and landowners. Management will require dedication over a number of years, and should allow for flexibility in method as appropriate.

Planning Considerations

- Survey area for weeds, set priorities and select best control method(s) for the site conditions and regulatory compliance issues **(refer to the King County Noxious Weed Regulatory Guidelines)**.
- Small infestations may be effectively removed using manual methods or hand tools.
- For many lake and wetland infestations, the whole community will need to be engaged. Any control actions taken will necessarily affect all landowners adjacent to the water body and will require their approval and participation in order to succeed. In addition, many control options will be expensive.
- Commit to monitoring. Once initial control has been achieved, be sure to conduct follow up monitoring in subsequent years in order to catch any overlooked patches or returning infestations before they can spread. Without this, your control efforts can be wiped out within a few years.

Early Detection and Prevention

- Look for new plants. Get a positive plant identification from an authority such as King County Noxious Weed Control Program staff.
- Look for plants along lake shorelines and in stagnant or slow-moving water in wetlands and streams.
- The best time to begin surveys is late spring when new leaves arise, and they can continue into early fall when the plants senesce.
- Dig up small isolated patches.
- Don't plant fragrant water lily in natural water bodies. It is legal to buy and plant water lilies, but their use as an ornamental should be restricted to small self-contained ponds and other man-made water features with no hydrologic connection to any natural body of water.

Manual

- Hand pulling or cutting can be successful for a small area if repeated on a regular basis. Impractical for large infestations. Must remove all pulled or cut plants and plant parts from the water. HPA pamphlet permit required.
- Carbohydrate depletion is a technique whereby during each growing season, all emerging leaves are consistently removed. Reports indicate that it takes about two to three seasons to kill the plants. This method is difficult to sustain and impractical for large infestations.
- To completely remove plants by hand you must dig up the entire rhizome. HPA pamphlet permit required.
- All manual control sites should be monitored for several years for signs of plants growing from root fragments and from the seed bank.
- Hand pulling and the use of hand mechanical tools is allowable in all critical areas.
- Fragrant water lily can be composted on land or placed in yard waste bins.

Mechanical

- Permits are required for all mechanical control methods.
- An opaque bottom barrier can be used to suppress growth in small, discrete areas like at a boat launch or around a swimming area. Barriers need to be regularly cleaned because plants will root in the sediment that accumulates on top of them. Not practical for large-scale infestations.
- Cutting and Harvesting using boat-mounted cutters or in-lake harvesting barges is a reasonable long-term control solution. These must be done on a regular basis to maintain control. Neither method will eradicate an infestation.
- Rotovation (underwater rototilling) dislodges the large, fleshy waterlily rhizomes which can then be removed from the water. This process results in the permanent removal of waterlily rhizomes. Rotovation results in significant short term turbidity and loss of water clarity and quality.
- Other mechanical solutions that have been tried include mounting a backhoe to a barge and digging the plants out.

Chemical

- Herbicides may be the most reasonable option for eradication of large fragrant water lily infestations. Professional licensed contractors are available for hire to perform this task.
- Herbicides can only be applied to aquatic systems in Washington State by a licensed pesticide applicator. Aquatic formulations of herbicides are not available for sale over the counter to anyone without an aquatic pesticide license. **NEVER apply non-aquatic herbicide formulations to water since most of them include ingredients that are toxic to aquatic organisms.**
- For several years following treatment, monitor areas for new plants germinating from the seed bank. Eradicate any new growth using one of the manual control methods above.

Specific Herbicide Information

Glyphosate (e.g. Rodeo™ or Aquamaster™) Apply to actively growing foliage. Avoid runoff. Caution: Glyphosate is non-selective: it will injure or kill other vegetation contacted by the spray. NEVER substitute Round-up™ or other landscape formulations of Glyphosate: these have additives that can devastate aquatic systems.

Imazapyr (Habitat®) Apply to actively growing foliage. Caution: Imazapyr is non-selective: it will injure or kill other vegetation contacted by the spray.

Triclopyr (Renovate†3). Apply to actively growing foliage. Triclopyr is selective: it will injure other broadleaved plants but not grasses or other monocots such as cattails, rushes, or most native aquatic plants.

All the above listed herbicides require the addition of an approved surfactant. Follow label directions for selecting the correct type of surfactant. Be sure that the selected surfactant is approved for aquatic use.

The mention of a specific product brand name in this document is not, and should not be construed as an endorsement or as a recommendation for the use of that product. Chemical control options may differ for private, commercial and government agency users. **For questions about herbicide use, contact the King County Noxious Weed Control Program at 206-296-0290.**

Biological

- There is currently no biological control approved for fragrant water lily.
- Although a number of organisms have been studied in the past, there is no current plan to pursue biological control for fragrant water lily due to the widespread use of the plant as an ornamental in private, isolated water features.

SUMMARY OF BEST MANAGEMENT PRACTICES

- At all times at minimum a pamphlet HPA permit is required to do any activity that disturbs a lake bottom or wetland or streambed. For more extensive work, more specific permits will be required.
- Hand pulling, cutting or digging is recommended for small populations.
- Where this is not practical, cutting or harvesting can keep a large population under control when done consistently.
- Bottom barriers can maintain small areas of open water around boat launches, swimming areas or docks.
- To remove large areas of water lilies, mechanical methods (such as rotovation) or herbicides can be used.
- **Do not apply any herbicide to water without the proper licenses.** Hire a contractor to complete the work.

Disposal Methods

- Fragrant water lily can be left on land to dry out and/or decompose in an area where it will not move into a waterway.
- Fragrant water lily can also be composted away from water or placed in yard waste bins.
- Never dispose of fragrant water lily into waterways, wetlands, or other wet sites where it might grow and spread.

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King County
Department of
Natural Resources and Parks
Water and Land Resources Division
Noxious Weed Control Program

BEST MANAGEMENT PRACTICES

Invasive Knotweeds
Bohemian Knotweed, Japanese Knotweed, Giant Knotweed, Himalayan Knotweed

Polygonum bohemicum, P. cuspidatum, P. sachalinense, P. polystachyum
Polygonaceae

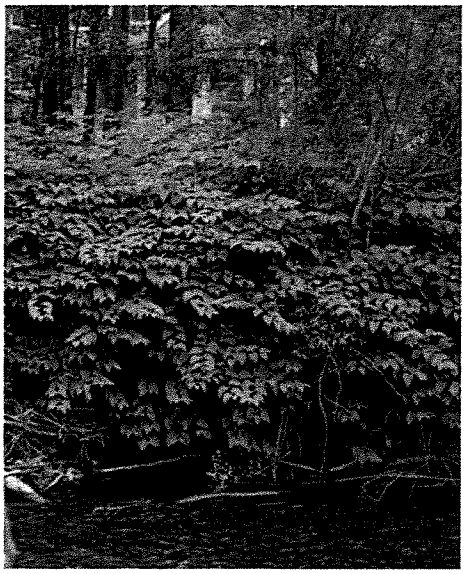
Class B Noxious Weed; Not Designated for Control

Legal Status in King County: Class B non-designated noxious weed (non-native species listed on the Washington State Weed List, but already widespread in this area). The King County Noxious Weed Control Board recommends, but does not require, property owners to control and prevent the spread of invasive knotweeds on public and private lands throughout the county. State quarantine laws prohibit transporting, buying, selling or offering invasive knotweed for sale or distributing plants, plant parts or seeds.

BACKGROUND INFORMATION

Impacts and History

- Displaces native vegetation due to its aggressive growth.
- Creates bank erosion problems and is considered a potential flood hazard. Despite knotweed's large rhizome mass, it provides poor erosion control.
- Lowers quality of riparian habitat for fish and wildlife.
- Thickets can completely clog small waterways.
- Forms dense stands that crowd out all other vegetation, degrading native plant and animal habitat.
- Difficult to control because of extremely vigorous rhizomes that form a deep, dense mat.
- Plants can resprout from stem or root fragments; plant parts that fall into the water can create new infestations downstream.
- Japanese and giant knotweeds are native to northeastern Asia. Giant and Japanese knotweeds hybridize to produce Bohemian knotweed. Himalayan knotweed is native to south and central Asia, including the Himalayas.
- Introduced in the U.S. in the late 1800s as ornamental plants and for erosion control.



Bohemian knotweed on the Cedar River

Description

- Large, clump-forming, herbaceous perennial with 4 to 12 feet tall, round canes with thin, papery sheaths and creeping roots. The hollow stems are jointed and swollen at the nodes, giving a bamboo-like appearance.
- Japanese, giant, Bohemian and Himalayan knotweed are members of the buckwheat family (Polygonaceae).
- Rhizomes can spread at least 23 feet (7 meters) from the parent plant and can penetrate more than 7 feet (2 meters) into the soil.
- Forms large, dense clones of either male or female plants.
- Stems are thick and hollow, resembling bamboo, green to reddish in color, often red-speckled. Young shoots look similar to red asparagus.
- Leaves are alternate, bright green with smooth edges. Leaf shape ranges from an elongate triangle (Himalayan knotweed), through rounded with a flat base (Japanese knotweed), somewhat heart-shaped (Bohemian knotweed) to huge, "elephant ear" type leaves (giant knotweed). Hybrids blur these distinctions. Leaf size may vary, however they are generally 4 to 6 inches long by 3 to 4 inches wide on Japanese knotweed and 7 to 9 inches long on hybrid Bohemian knotweed. Giant knotweed leaves often exceed 12 inches across, twice the size of Japanese knotweed leaves.
- Flowers are small, white/green on Japanese, Bohemian and giant knotweed and light pinkish-white on Himalayan knotweed and grow in showy plume-like branched clusters. Flowers form in July and August and grow in dense clusters from the leaf joints. Flowers are either all female (form seeds) or all male (don't form seeds) on each plant.
- Flowers in late July, typically start to form seeds by mid-August.

Habitat

- Can grow in partial shade or full sun.
- Knotweed thrives in any moist soil or river cobble, but can also grow in dry areas
- Most commonly found in the flood zone along rivers and creeks, it also grows in roadside ditches, railroad rights-of-way, unmanaged lands, wetlands, neglected gardens, and other moist areas.

Reproduction and Spread

- Knotweed typically starts growth in April, but can begin as late as June in higher elevations.
- Reproduces by seed and vegetatively from rhizomes and roots. Knotweed can spread rapidly due to its ability to reproduce vegetatively.
- Invasive knotweeds spread mainly by rhizomes. Rhizome and root fragments are dispersed by natural causes (flood, erosion) or man-made dispersal (roadside clearing, fill dirt).
- Root fragments, as small as ½ in (1 cm) can form new plant colonies and can also be spread in contaminated fill material.
- Cut or broken stems will sprout if left on moist soil or put directly into water, or if moved by beavers or earth-moving equipment. Each node on the plant stock is able to produce roots and new plants.

- Seeds can be viable for as long as 15 years. Seeds in the upper 1 inch (2 cm) of soil generally are viable for 4 to 5 years. Below 1 inch (2 cm), the seeds remain dormant longer. However, knotweed seedlings are not often found in the wild and most dispersal is by root and stem fragments.
- Knotweed canes die back with the first hard frost (Pridham and Bing 1975) and go dormant during the winter. The dead, brown stems may remain standing through the winter with new canes developing in the spring from the same rootstock.

Local Distribution

Found throughout King County. The heaviest concentrations of invasive knotweeds are found along riparian corridors and road rights-of-way. Infestations can also be found in residential gardens, wetlands, and upland areas.

CONTROL INFORMATION

Integrated Pest Management

- The preferred approach for weed control is Integrated Pest Management (IPM). IPM involves selecting from a range of possible control methods to match the management requirements of each specific site. The goal is to maximize effective control and to minimize negative environmental, economic and social impacts.
- Use a multifaceted and adaptive approach. Select control methods that reflect the available time, funding, and labor of the participants, the land use goals, and the values of the community and landowners. Management will require dedication over a number of years, and should allow for flexibility in method as appropriate.

Planning Considerations

- Survey area for weeds, set priorities and select best control method(s) for the site conditions and regulatory compliance issues **(refer to the King County Noxious Weed Regulatory Guidelines)**.
- Specific suggestions are given in the Best Management section.
- It is possible, but not easy, to control knotweed, especially on a landscape scale.
- Because of knotweed's incredibly extensive root system and sprouting ability, landscape level control requires long-term planning and follow-up.
- Because the plant spreads easily downstream by water, it is necessary to begin control from the furthest upstream infestation, including all tributaries and other upstream sources of possible re-infestation.
- Even on a patch-by-patch basis, successful eradication is likely to take several years and multiple treatments.
- Although there are potentially successful mechanical or manual control options for small patches, landscape level projects and large sites will likely require integrating herbicide into the control strategy.

- Outreach to all public and private landowners and the broader community, as well as volunteer recruitment and coordination, will improve the success of large landscape scale projects.
- Work with volunteers and other organizations in the community to expand the ability to physically get the work done.
- Landscape level projects may have a greater chance of success under a coordinated effort such as a Cooperative Weed Management Area (CWMA).
- Grants are available for invasive vegetation removal, such as knotweed, that benefits public resources, especially for work done through non-profit organizations or government agencies.

Early Detection and Prevention

- Monitor for new populations in May and June.
- Dig up isolated or small populations (50 stems or less). If there are more stems than you can remove manually, it may be necessary to treat the area with an appropriate herbicide in the late summer/early fall.
- Prevent plants from spreading away from existing populations by washing vehicles, machinery, and equipment that have been in infested areas.
- Prevent knotweed from entering waterways.
- Do not discard stems or root fragments in waterways or on moist soil.

Manual or Mechanical Control

- **When to use manual methods:** If there is easy access to the site and patches are reasonably small (50 stems or less), commit to following an intensive control regimen.
- **Variations:** Cutting, mowing, pulling, digging, covering.
- Cutting, mowing and pulling stimulates shoot growth and depletes the roots. The more shoots there are per linear foot of root, the more likely it will be to physically pull out the roots, exhaust them by depriving them of energy (i.e. by cutting the shoot off) or eradicating them with an herbicide treatment.
- When controlling knotweed manually, be sure to practice the four T's: timely, tenacious, tough and thorough (Soll 2004).
- Hand pulling and the use of hand mechanical tools to control noxious weeds are generally allowable in critical areas in unincorporated King County (refer to the **King County Noxious Weed Regulatory Guidelines** for details).
- Be aware that repeated cutting tends to produce numerous small stems that may make future treatment with stem injection more difficult.
- **CUT** stems close to the ground TWICE A MONTH OR MORE between April and August, and then once a month or more until the first frost, over 3 to 5 consecutive years (Soll 2004).
    - Try to keep plants from growing taller than 6 inches.
    - Using a machete, loppers or pruning shears, cut the stems to the ground surface. Using a mower/weed-eater, cut as low as possible and as often as possible. Be sure not to scatter stems or root fragments.
    - Rake and pile up the cut stems where they will dry out because stems or stem fragments can sprout, and the area (or adjacent areas) may become re-infested.

    - Goats are reported to eat knotweed and in some circumstances, controlled goat grazing may be an option similar to intensive mowing. Be aware that goats will eat desirable vegetation as well as knotweed.
    - Do not allow cut, mowed or pulled vegetation to enter waterways.
- **DIG** up as much root as possible in August over at least three consecutive years; reported to work for small, isolated patches.
    - Each time you see new sprouts (start looking a week after you pull), uproot them as well, trying to pull out as much of the root as you can each time.
    - Be sure to carefully dry or dispose of the roots. Do not put them in a compost pile.
    - Be sure to search at least 20 feet (7 meters) away from the original patch center.
- **COVER** with heavy duty geo-textile fabric or black plastic.
    - Works better with isolated and smaller patches on open terrain.
    - Plan to leave the covering material in place throughout three to five growing seasons.
    - First, cut stems down to ground surface. Next, cover the area with geo-textile fabric or heavy duty black plastic extending beyond the plant base and stems at least 7 feet beyond the outside stems. Leave covering material loose and clean of debris, weighted down with heavy rocks or cement blocks. Watch for holes in the fabric and at the perimeters for any new growth. Every two to four weeks during the growing season, stomp down re-growth under covering material and clean debris.
    - Try this method at the beginning of the year or after cutting the plant down several times during the growing season which will reduce some of the rapid plant growth.

Chemical

- Herbicides should only be applied at the rates and for the site conditions and/or land usage specified on the label. **Follow all label directions.**
- For your personal safety, at a minimum, wear gloves, long sleeves and pants, closed toe shoes, and appropriate eye protection. Follow label directions for any additional personal protection equipment needed.
- For herbicide use in critical areas and their buffers, certain restrictions apply depending on the site and jurisdiction. In unincorporated King County, refer to the **King County Noxious Weed Regulatory Guidelines** for a summary of current restrictions and regulatory compliance issues. Elsewhere, check with the local jurisdiction.
- **Variations:** foliar spray, wick wipe, cut and pour, or stem injection.
- Herbicides with the active ingredient glyphosate (Rodeo, Aquamaster, AquaNeat, among others), dicamba (Banvel, Clarity, among others), and imazapyr (Habitat, Arsenal) have shown to be variably effective in controlling knotweed either separately or in combination. Each offers benefits and potential risks.
- **Non-selective herbicide, injection method (glyphosate):** can effectively control knotweed. Currently only glyphosate products are labeled for the injection method. Aquamaster/Rodeo/AquaNeat, (aquatic formulations of glyphosate) can be used on or near aquatic sites while Roundup Pro, a non-aquatic formulation, can be used on terrestrial sites.
- **Non-selective herbicides, foliar applications (such as glyphosate, imazapyr)** are most effective when used in combination at a 2% - 1% ratio (2% glyphosate, 1% imazapyr). Glyphosate translocates to roots and rhizomes of perennial weeds and has no apparent soil

activity, while imazapyr is readily absorbed through foliage and roots and can be applied pre-emergent or post-emergent.

- **Selective Broadleaf Herbicides (such as dicamba)** may be more appropriate for knotweed patches adjacent to grass fields or in lawns. Dicamba is a growth regulating broadleaf herbicide, dicamba is readily absorbed and translocated from either roots or foliage. Do not apply to areas where roots of desirable species are growing.

Description of Chemical Control Methods

Foliar Application

- Backpack sprayer or large volume sprayer.
- Easiest and fastest method, risk of drift onto desirable vegetation and into water and soil.
- Use a systemic herbicide which translocates from leaves to the roots.
- Non-selective herbicides, such as glyphosate (Roundup) will harm all actively growing plants if leaves are sprayed. Selective broadleaf herbicides will not harm grasses.

Timing

The right time to apply herbicides is greatly affected by herbicide choice. According to Oregon Department of Agriculture literature, the ideal time to spray most deep-rooted perennials is when they are in bud to early flowering stage. However, because knotweed may be 15 feet tall when it begins to flower (July or August in the Pacific Northwest (PNW)), this is not always practical. Also, spraying taller plants means creating more risk of pesticide drift and older plants may not be as efficient in chemical translocation.

The best time, from a practical standpoint, is when the patches are 3 to 6 feet (1-2 m) tall. Although shorter plants may not have adequate leaf surface to absorb, and translocate, enough chemical to be effective, young, rapidly growing plants do have a more efficient biological process to translocate chemicals. A spring herbicide application or cutting will set back the plant so that it can be sprayed at an effective height and growth stage later in the year. Plants controlled later in the season can be cut to 5 ft in height immediately before spraying, although control effectiveness is somewhat reduced. TNC field data analysis suggest treatment done in April or May is not as effective as those done in June or July.

Regardless of herbicide choice, rate or spray timing, large, established patches (hundreds or thousands of stems) will almost certainly require foliar treatments over two or more years. Similar to treating patches mechanically, be sure to search for new shoots up to 20 feet or more away from the central patch after herbicide treatment begins (Soll 2004).

Specific Herbicide Information

Glyphosate: 2% to 5 % solution.

- Apply as coarse spray with complete, uniform coverage.
- Apply when knotweed is actively growing and most have reached the bud to early flowering stage until the first hard frost.
- Aquamaster/Rodeo plus surfactant (LI-700, Competitor, Agridex) are approved for aquatic sites.

- Roundup Pro (has surfactant mixed in) can be used on terrestrial sites.

Imazapyr : slow-acting and expensive but effective. Can be used alone or in combination with glyphosate.

- 1% solution with 0.25% surfactant or 0.5 to 1 lb per acre.
- Apply from midsummer after seed set until first killing frost.
- Habitat – approved for aquatic sites.
- Arsenal – approved for non-aquatic sites (see label for crop rotation and other restrictions).

Dicamba: 0.25 lb active ingredient with 1 gal water per 400 sq ft.

- Cut plants in June and then apply dicamba to regrowth in late August.
- Apply as basal spray to stems at ground level.
- For upland applications only.

Wick Wipe

- Use an applicator wand with a sponge on the end of a reservoir for the herbicide. Wipe the sponge soaked with herbicide on the leaves and stem of the plants.
- Use glyphosate at 33 to 75 % concentration.
- Greatly reduces drift.
- Hard to get chemical on leaf surface and seems to increase personal contact with herbicide.

Cut and Pour

- Good for small patches and greatly reduces drift.
- Cut stems between lowest 2 nodes.
- Put 3 ml undiluted (concentrated) glyphosate into stem cavity (can use a large needle with measured reservoir to be precise).
- Be very careful not to splash herbicide onto the ground.
- Follow label directions on amount applied per acre (i.e. for the 7.5 quart per acre label rate, can only treat 2375 stems per acre at 3 ml per stem).
- Timing best in late summer or early fall.
- Need to remove cut stems away from water where they can dry out and not spread off site.

Stem-Injection

- Use stem injection gun or similar tool.
- Follow directions carefully especially on calibrating and cleaning the equipment.
- Highly effective; 90% or more controlled in first year.
- Greatly reduces drift and is highly selective.
- No cut stems to deal with.
- Need to inject every cane in the stand; very time and labor intensive compared with foliar spraying.
- Can only inject stems over ½ inch in diameter so there will always be small stems that can't be injected in a population, especially in the second year of treatment.

- Inject 3 ml into each stem between first and second nodes from the ground, or between second and third node if cane is too woody lower down.
- Glyphosate is the only product labeled for injection method, and at 3 ml per cane, can only inject approximately 2375 canes per acre (label maximum is 7.5 quarts per acre).
- Timing best from early July to end of September.

Combination of Methods

- Using a combination of methods can increase efficacy.
- **Cut/Spray:** Cutting stems, followed by foliar spray 3 to 4 weeks later, instead of spraying twice, will reduce overall herbicide input into the watershed and is probably more labor efficient (can use volunteers or unlicensed crews to cut the infestation).
- **Bend/Spray:** This method is highly effective. Bend stems and then approximately 3 to 4 weeks later, spray site. Can use volunteers or unlicensed crews to bend the stems prior to foliar application.
- **Cut/Cover:** This method is moderately effective. Needs constant monitoring and controlling of plants around perimeter and scattered plants that grow through sheet mulch through holes/overlap areas. Every two to four weeks need to stomp down re-growth under covering material and clean off debris.
- **Spray/Spray:** Spring or summer spray followed by fall foliar spray; sets plants back so they can be sprayed at the appropriate growth stage and at the best (easiest) height. This method increases the amount of overall herbicide input into the watershed but takes the least time of all the methods other than spraying once.

The mention of a specific product brand name in this document is not, and should not be construed as an endorsement or as a recommendation for the use of that product. Chemical control options may differ for private, commercial and government agency users. **For questions about herbicide use, contact the King County Noxious Weed Control Program at 206-296-0290.**

Biological

- Biological control is the deliberate introduction of insects, mammals or other organisms which adversely affect the target weed species. Biological control is generally most effective when used in conjunction with other control techniques.
- Research is underway for possible biological control agents that have been identified in the knotweed's native range. However, there are currently no biological control agents available for managing invasive knotweed.

SUMMARY OF BEST MANAGEMENT PRACTICES

Small Infestations in Native and/or Desirable Vegetation

- Dig up plants by hand if soil is wet.
- Apply appropriate herbicide with wick wiper or by spot spray to minimize off target injury.
- Monitor site throughout growing season and remove any new plants. Remember to search at least 25 feet from the original infestation.

- If using an herbicide in a grassy area, use a selective herbicide to avoid injury to the grass or use a wick wiper or stem injector.

Large Infestations/Monocultures

- Mowing is not effective for controlling invasive knotweed infestations.
- Large infestations can be controlled with herbicides. (See the Chemical section of this BMP).
- Eradication of knotweed with a single herbicide application is difficult. Typically it takes several treatments, over 4 to 5 years to get an infestation under control.
- Be sure to monitor for invasive knotweeds on edges of sheet-mulched sites, at overlapped areas in the sheet-mulch, where sheet-mulch has been staked, and around edges of chemically treated areas.

Control in Riparian Areas

- Additional permits may be required for control of infestations in riparian areas. See Noxious Weed Regulatory Guidelines for more information (http://dnr.metrokc.gov/wlr/lands/weeds/pdf/Noxious_Weeds_Regulatory_Guidelines.pdf).
- When large areas of weeds are removed, the cleared area needs to be replanted with native or non-invasive vegetation and stabilized against erosion. Refer to the King County Surface Water Design Manual for further information about sediment and erosion control practices (call 206-296-6519 or go to http://dnr.metrokc.gov/wlr/Dss/Manual.htm for information).
- Survey area and document extent of infestation from the headwaters of waterways down.
- Focus on manual removal for small (less than 50 stems) infestations if possible.
- Target the knotweed, retain all native and beneficial plants.
- Inject plants directly adjacent to waterways with glyphosate.
- For larger areas where herbicide use is warranted, apply with a wick wiper or spot spray using low pressure and large droplet size.
- Use aquatic formulations if there is any risk of herbicide entering the water.
- Infested areas will need to incorporate a management plan lasting at least several years to control plants re-sprouting from the rhizome mass, skipped plants and any regrowth.
- Mowing will not control invasive knotweed species, but it can serve as the first step in a combination approach to control.

Control on Road Rights-of-Way

- Dig up small infestations if possible.
- Spot spray with appropriate herbicides.
- Mowing is not an effective means of control and can spread knotweed infestations along road rights-of-way, but it can serve as the first step in a combination approach to control.

Knotweed Disposal Methods

- Knotweed crowns and rhizomes should be collected and discarded with the trash or taken to a transfer station for disposal. Composting crowns and rhizomes is not recommended.
- Knotweed stems can be composted, but they will root on moist soil so they need to be completely dried out before composting.

- Stems can be left on site to dry out and decompose if they are in a dry area where they will not move into waterways or onto moist soil. The area should be monitored for re-growth and stems should not be moved to an un-infested area.
- Dried out stems may be broken up or chipped into pieces less than an inch long and then composted on site, disposed of in a city-provided yard waste container or in the green recycling at a transfer station.
- Stems of knotweed with seeds should be collected and put in the trash or taken to a transfer station. If removal is not feasible, these stems can be left on site. However, there is a risk of spread from the seeds, so the area should be monitored for several years for seedlings. Stems should be left well away from waterways, shorelines, roads and un-infested areas.
- Never dispose of knotweed plants or plant parts into waterways, wetlands, or other wet sites where they might take root.

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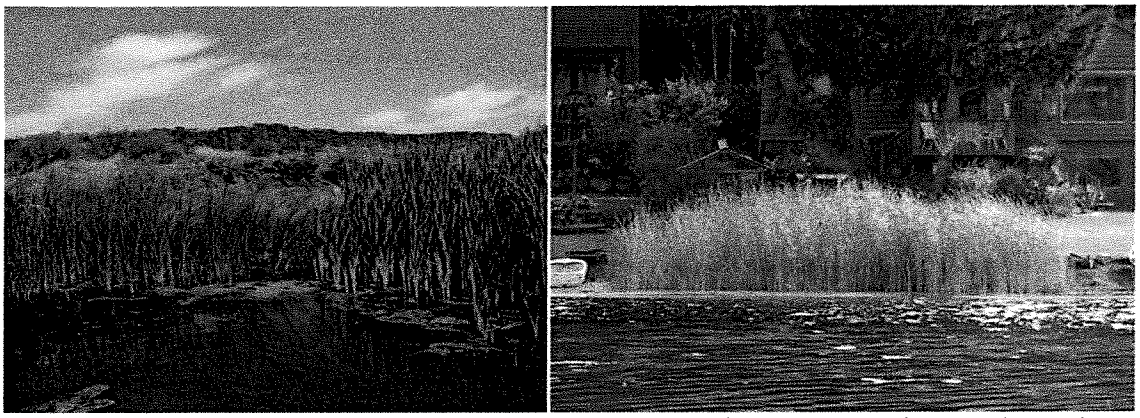
WRITTEN FINDINGS OF THE
WASHINGTON STATE NOXIOUS WEED CONTROL BOARD
DRAFT July, 2013

Scientific name:	All non-native *Typha* species and hybrids including: *Typha angustifolia* L., *Typha* × *glauca* Godr. pro sp. (*Typha angustifolia* x *T. latifolia*), *Typha domingensis* Pers. and related hybrids
Synonyms:	*Typha angustifolia*: *Typha angustifolia* L. var. *calumetensis* Peattie, *Typha angustifolia* L. var. *elongata* (Dudley) Wiegand
Common name:	cattail, cattail hybrids, narrow-leaf cattail, southern cattail, small reed mace, reed mace, flags, bulrushes, cat o'nine tails, Cossack asparagus, baco
Family:	Typhaceae
Legal Status:	Proposed Class B noxious weed (as a group); Noxious Weed Committee is considering a Class C listing instead.

Description and Variation:
Species-specific molecular markers have been developed to identify *Typha* species, their hybrids, or backcrossed progeny and are the best way to identify cattail species though tests may be cost prohibitive (Snow et al. 2010, Selboe and Snow 2004, Kuehn and White 1999). Measuring specific morphological traits may allow identification of *T. latifolia*, *T. angustifolia* and *T.* x *glauca* with approximately 90% accuracy. A discriminate analysis by Kuehn and White (1999) found measuring spike length, spike interval, leaf width, and stigma width at its widest point (measured with a compound microscope) provided this percentage of accurate identification (Kuehn and White 1999). Whereas Smith (2000) states that except for the presence of mucilage glands on the leaf blades, unique to *Typha domingensis* and its hybrids, the microscopic flower and bracteole structures are generally essential for accurate identification of *Typha* species and hybrids. This is partly due to changes in the inflorescences during development and partly because of phenotypic plasticity, especially of leaf blade widths. It is often necessary to use forceps to pull a few pistillate flowers out of the spike and observe them with a dissecting microscope at 20 power to 30 power.

Unless otherwise noted in the plant description, information is from Smith (2000) Flora of North America *Typha* treatment. Refer to Smith's key in the FNA treatment for identification and additional species and hybrid information.

Overall Habit:
Typha species and hybrids are perennials that grow in fresh to slightly brackish wetlands, often emergent in water up to 1.5 meters deep.



Images: Left image, *Typha domingensis* (left) and *Typha latifolia* (right) growing in Hutchinson Lake in Adams County WA, image by Jenifer Parsons DOE; Right image, *Typha angustifolia* growing in North Lake in King County WA, image by Jenifer Parsons DOE.

Roots:

Plants have unbranched rhizomes, growing up to 70 cm long by 5-40 mm wide. Rhizomes are starchy, firm and scaly. Roots from the rhizomes are fibrous and shallow (DiTomaso and Healy 2003).

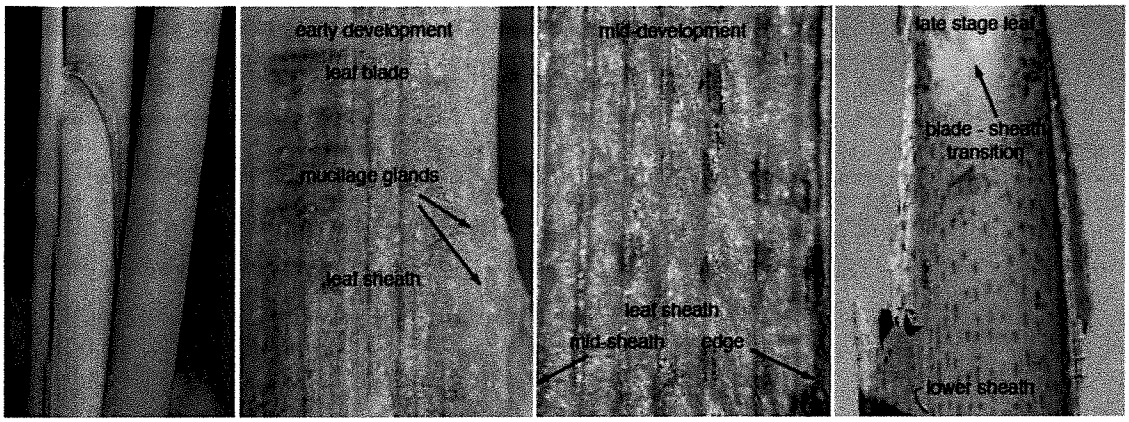
Stems and Leaves:

Typha stems are erect and pithy, growing from the rhizomes (Hitchcock et al. 1969). Stems are unbranched and either vegetative or flowering. Growing up to 4 meters tall, stems are elliptic in cross section. Leaves are alternately arranged, 2-ranked, sheathing, linear and rather spongy (Hitchcock et al. 1969). Leaf blades twist into a loose helix. Leaves have mucilage-secreting glands that are numerous in adaxial surface of leaf sheath and sometimes proximally (near the base) on the leaf blade. The glands are colorless to brown and roughly rectangular.

Typha angustifolia:

Stems of *Typha angustifolia* are 1.5-3 meters tall and not glaucous. Leaves are dark green, long, linear and strongly plano-convex, flat on one side and convex on the other (Grace and Harrison 1986) and up to 1 cm wide (DiTomaso and Healy 2003). Leaf sheath sides are membranous, margin broadly clear, and summit of sheath with membranous auricles (earlike lobes) which often disintegrate late in season. Leaves have mucilage glands that darken from clear to brown to black, as the plants ages (Lutz no date). The mucilage glands at sheath-blade transition are absent from the blade and usually from the center of the sheath near the summit. Leaves of *T. angustifolia* are longer than its inflorescences (Grace and Harrison 1986).

Image: *Typha angustifolia* with leaves longer than the inflorescences, image Jenifer Parsons, WA Dept. of Ecology.



Images: Left, *Typha angustifolia* top (summit) of leaf sheath, Image © 2005, Ben Legler; other three images show mucilage gland development of the adaxial surface (side toward the stem) of the leaf sheath on *T. angustifolia.* Glands occur on the leaf sheath but they are absent from the central part of the sheath and from the leaf blade. During mid to late development, they become visible to the unaided eye on the sides and lower central part of the sheath. Images Richard Lutz, http://iowaplants.com

Typha domingensis:
Stems of *Typha domingensis* grow 1.5-4 meters tall and are not glaucous. Like *T. angustifolia*, leaves of *T. domingensis* are long, linear and strongly plano-convex, flat on one side and convex on the other (DiTomaso and Healy 2003). Leaf sheaths have membranous sides, with broadly clear margins, and the summit is tapered to the leaf blade or has persistent, membranous auricles. Mucilage glands at sheath-blade transition are orange-brown and numerous on entire sheath and the lower 1-10 cm of the leaf blade. Widest leaf blades are 6-18 mm wide when fresh and the distal blade is about the same height as the inflorescence.

Typha x *glauca*:
Stems of *Typha x glauca* are 1-3 meters tall. The leaf sheaths are either auriculate at the base of the leaf blade or tapering. Its long, linear leaves are moderately plano-convex, 5-19 mm wide and can moderately overtop the inflorescence (Grace and Harrison 1986).

Flowers:
Typha inflorescences are cylindrical spikes of small monoecious flowers, with male (staminate) flowers occurring above the female (pistillate) flowers, all directly on the main axis and intermixed with slender hairs. Depending on the species or hybrid, the staminate flower spike may or may not be contiguous with the pistillate flower spike (Grace and Harrison 1986). Flowering time may shift depending on climate conditions and location. Male flower anthers are longer than the filaments (Hitchcock et al. 1969) and dehisce longitudinally. Female flowers' pistils have colorless, filiform hairs or apically enlarged and brown hairs that are exceeded by the stigmas. The carpodia are spongy and obovoid, bearing rudimentary styles. Male flowers are present early in the season and later absent, while female flowers may remain on the plant into the winter.

Images, Left image: example of three mature *Typha* pistillate spikes: left *T. latifolia* (broadleaf), center *T. angustifolia* (narrowleaf), right *T.* x *glauca* (hybrid), image MN Board of Water & Soil Resources;
Center image: *T. angustifolia* inflorescence showing a gap between the male and female flower spikes, image credit, Ben Legler, 2005; Right, *T.* x *glauca* inflorescences, image credit Robert W. Freckmann, University of Wisconsin-Stevens Point.

Typha angustifolia

Typha angustifolia typically blooms June through July (Hitchcock et al. 1969). The inflorescence consists of a narrow spike with an interval of naked axis 1-8 (-12) cm between the staminate and pistillate portions (Kuehn and White 1999). Staminate (male) flowers are 4-6 mm in size, anthers are 1.5-2 mm. Staminate flowers have brown, linear, almost bifid bracteoles and their pollen grains are in monads (Grace and Harrison 1986). The pistillate spike is 6-20 cm long and 5-6 mm across in flower expanding to 13 to 22 mm across in fruit. Pistillate flowers are on stalks +/- .05 mm long, are 2 mm in flower, and 5-7 mm when in fruit. Stigmas are linear and not fleshy (Grace and Harrison1986). Pistil hairs attach to the pistil base and their tips are medium brown and distinctly enlarged when viewed at 10-20 X magnification. Pistillate bracteole tips darker than (or as dark as) stigmas, very dark to medium brown, rounded (to acute), in mature spikes about equaling pistil hairs. Pistillate spikes are medium to dark brown.

Typha domingensis

Inflorescence blooms spring through summer. The staminate spike is separated from the pistillate spike by (0-)1-8 cm of naked axis. Pistillate spike is yellow to bright cinnamon-brown with whitish stigmas when flowering, maturing to orange to medium brown. Staminate flowers are 5 mm in size, with anthers 2-2.5 mm. Staminate scales are straw-colored to mostly bright orange-brown, variable in same spike, linear to cuneate, often laciniate distally and pollen in single grains (monads). Pistillate spike is 6-35 cm long by 5-6 mm wide in flower expanding to 15-25 mm wide in fruit. Pistillate flowers are on stalks 0.6 to 0.9 mm long, are 2 mm in flower and 8-9 mm in fruit. Pistil hair tips straw-colored to orange-brown in mass. Pistillate bracteole blades straw-colored to mostly bright orange-brown, much paler than to

nearly same color as linear stigmas, and acute (usually many acuminate) (DiTomaso and Healy 2003, Smith 2000).

Typha x *glauca*
Typha x *glauca* is typically intermediate between the characteristics of *T. latifolia* and *T. angustifolia* (Kuehn and White 1999). The gap between the pistillate spike and the staminate spike can range from 0-33 mm (Grace and Harrison 1986). Mature pistillate spikes are dark brown and the pistillate bracteoles pale and the stigmas are linear. The pollen is sometimes abortive with monads, diads, triads, and tetrads (Grace and Harrison 1986). *Typha* x *glauca* is highly sterile and produces very few or no seeds or viable pollen grains.

Fruits and Seeds:
Pistillate spikes usually persist into winter, when dry fruiting flowers often fall in masses. Fruits are small follicles, football-shaped, splitting longitudinally in water to release the seed. Seed counts per spike have been estimated ranging from 20,000 to 700,000 (Prunster 1941, Marsh 1962, Yeo 1964 in Grace and Harrison 1986). *Typha domingensis* is noted to not mature fruits on the cold coast of northern California. *Typha* x *glauca* may not produce any viable seeds.

Hybrid information
Hybrid descriptions included here are taken directly from Smith (2000) Flora of North America *Typha* treatment.

Typha x *glauca*: *T. latifolia* × *T. angustifolia* (=*T.* ×*glauca* Godr., pro sp.), Besides this parentage, Simon (2000) also notes that fertile or sterile intermediates between *T.* ×*glauca* and *T. angustifolia* occasionally occur, however. In spite of its sterility, *T.* ×*glauca* is remarkably successful ecologically. It often spreads by means of rhizomes to form often very large clones and out-competes the parental species, especially in eutrophic, disturbed habitats with unstable water levels (S. W. Harris and W. H. Marshall 1963; S. G. Smith 1987).

Typha domingensis × *T. latifolia* (= *T.* ×*provincialis* A. Camus, *T. bethulona* Costa) is known only from very few collections in Arkansas, California, Florida, Missouri, Nebraska, and North Carolina. All of these are highly sterile putative F_1s except for one putative F_2, in which the characteristics of the parental species are recombined, from southern California.

Typha angustifolia × *T. domingensis* is known from scattered specimens in Arkansas, California, Kansas, Kentucky, Missouri, and Nebraska. It is not known from the southeast coast, perhaps because of differences between the species in flowering dates. Most plants are highly fertile, and some may be F2 or later generation hybrids

Putative *T. angustifolia* × *T. domingensis* × *T. latifolia* trihybrids are locally common in California and rare in south-central United States. Introgression between the interfertile *T. angustifolia* and *T. domingensis* is presumably probably locally common in the south-central U.S. and north-central California, while introgression between *T. latifolia* and the other two species is probably very uncommon because of hybrid sterility. Published research presumably demonstrating introgression (e.g., N.C. Fassett and B. M. Calhoun 1952) is faulty (S. G. Smith 1967, 1987). The tetraploid *T. orientalis* of the Pacific Basin may be of hybrid origin (B. G. Briggs and L. A. S. Johnson 1968; S. G. Smith 1967, 1987).

Typha minima

Image, Typha minima, image by Andrea Moro, University of Trieste, Progetto Dryades, http://luirig.altervista.org

Typha minima Funck ex Hoppe, commonly called miniature cattail or dwarf cattail, is a non-native cattail species native to parts of Asia and Europe USDA ARS (2013). *Typha minima* looks like a miniature version of these other, larger, cattail species. It is described by Flora of China Editorial Committee (2010) as having: slender stems growing 16-65 cm tall; leaves usually basal and sheath-like and shorter than the scape; male part of flower spike 3-8 cm, with one deciduous bract at its base; female part of spike distinctly separate from the male, 1.6-4.5cm with bract at base. Its smaller size, narrow leaves and rounded female portion of the spike make this *Typha* species distinctly different from these other non-native *Typha* species. Currently there are not any herbarium records or known escaped populations of *T. minima* in the Pacific Northwest. *Typha minima* is sold as an ornamental pond plant and may also be used in floral arrangements. It is listed on New Hampshire's prohibited aquatic species list USDA ARS (2013).

Look-alikes:

Typha latifolia L., broad-leaved cattail or common cattail, Washington's only native *Typha* species, is distributed widely throughout Washington State and throughout North America and would not be included in this listing. *Typha latifolia* has erect stems growing 1.5-3 meters tall.

Leaves:

The erect shoots of *Typha latifolia* are more fanlike when young than in other North American species because the proximal leaves (dying by mid season) spread more widely. Leaves can appear glaucous when fresh. Leaf blades up to 120 cm long by 1-2.5 cm wide with the distal portion of the blade flat (DiTomaso and Healy 2003). Leaves are sheathing at the base, sheath sides are papery or membranous, margins narrowly clear and the summit tapered into blade to distinctly shouldered (truncate), or rarely with firm paper auricles. The mucilage glands at the sheath-blade transition are usually colorless and obscure. Mucilage glands are absent from the leaf blade and the center of the sheath. The widest leaf blades on shoot are 10-23 (-29) mm wide when fresh, distal blades about equaling inflorescence or occasionally slightly overtopping it (Smith 2000, Grace and Harrison 1986).

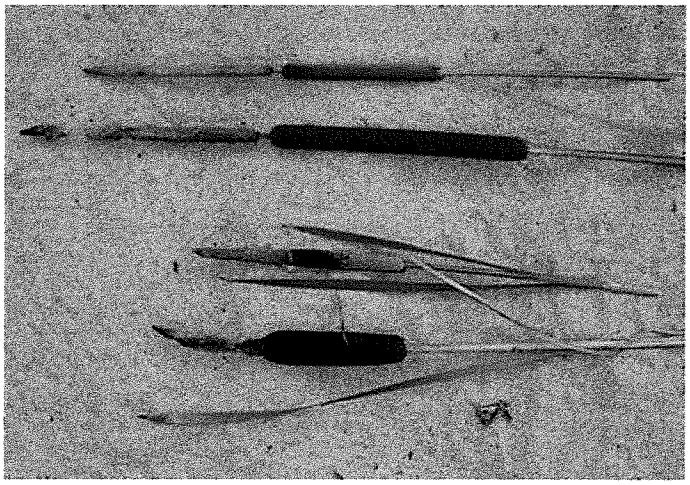


Image: *Typha domingensis* inflorescence above, *Typha latifolia* inflorescence below. Image credit: Tony Valois, Wildflowers of the Santa Monica Mountains National Recreation Area.

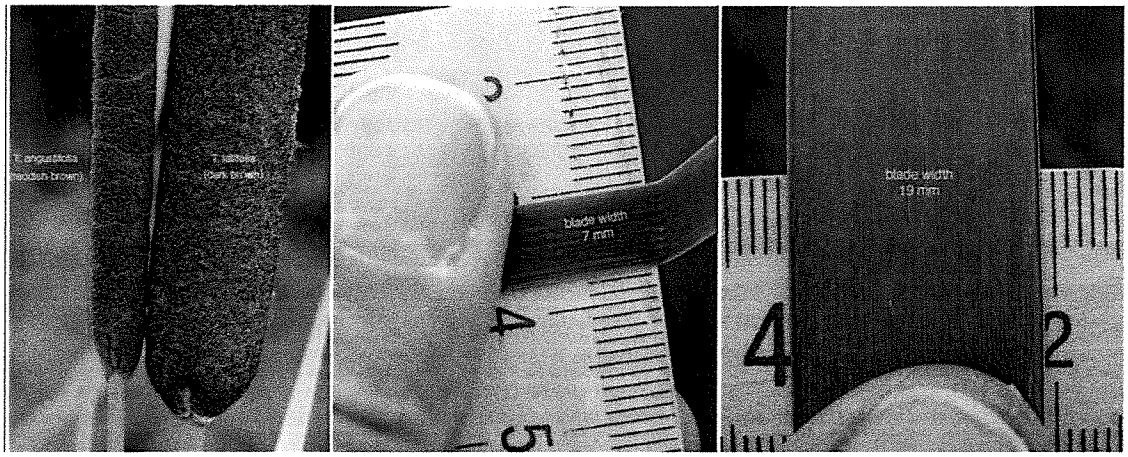
Inflorescence:

The staminate spike of *Typha latifolia* is continuous with the pistillate spike or rarely in some clones separated by a small gap up to 4 (-8) cm of naked axis. The staminate scales are colorless to straw-colored, filiform and simple. Staminate flowers are 5-12 mm and consist of 2-7 deciduous stamens and small, colorless hairlike bracts (bracteoles) (DiTomaso and Healy 2003). Anthers are 1-3 mm and shed

pollen in tetrads (clusters of 4 grains). Pollen grains of some *T. latifolia* plants separate slightly and may be shed partly as mixtures of triads, dyads, and monads, perhaps due to introgression (S. G. Smith unpublished in Smith 2000).

The pistillate spikes are pale green in flower and dry to a brownish, then later blackish brown or reddish brown color. Pistillate spike is 5-25 cm long by 5-8 mm wide in flower expanding to 24-36 mm across in fruit. Pistillate flowers are 2-3 mm in flower and 10-15 mm in fruit. Pistil hair tips are colorless and appear whitish in mass, not enlarged, with persistent stigmas forming a solid layer on the spike surface. Pistillate flowers are without bracteoles and the stigmas are flattened, lanceolate to ovate-lanceolate (Grace and Harrison 1986). Carpodia are exceeded by, and hidden among pistil hairs, straw-colored, with a rounded apex. *Typha latifolia* flowers late spring to summer in northern regions and spring to early summer in southern regions. In fruit, the pistillate spikes are often mottled with whitish patches of pistil-hair tips.

Grace and Harrison (1986) note the following characteristics as the best traits to distinguish *Typha latifolia* in the field: its broad, flat leaves that rarely overtop the inflorescence, the usually contiguous (or only slightly separated) staminate and pistillate spikes, and the robust dark brown pistillate spike at maturity. *Typha latifolia* hybridizes with the other North American cattail species, *T. angustifolia* and *T. domingensis* where their distributions overlap. Hybrid swarms of all 3 species have been identified in central California (Gucker 2008).



Images: Left, comparison image of *Typha angustifolia* (left) and *T. latifolia* (right) female spike color; center, width of a *T. angustifolia* leaf; right, T. *latifolia* leaf width. Images Richard Lutz, http://iowaplants.com

Habitat:

Typha species and hybrids grow in wet or saturated soils and aquatic sediments in marshes, wet meadows, lakeshores, pond margins, seacoast estuaries, ditches, bogs and fens (Grace and Harrison 1986). They can invade managed and recreation aquatic systems including canals, ditches, reservoirs, cultivated fields, farm ponds and swimming and boating areas (Grace and Harrison 1986, Smith 2000).

Geographic Distribution:

T. *domingensis*:

In Flora of North America, Smith (2000) notes it grows 0-2,000 meters elevation and occurs in the following places:

- United States (Alabama, Arizona, Arkansas, California, Colorado, Delaware, Florida, Georgia, Illinois, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Missouri, Nebraska, Nevada, New Mexico, North Carolina, Oklahoma, South Carolina, Texas, Utah, Virginia, Wyoming),
- Mexico
- West Indies
- Central America
- South America
- Eurasia
- Africa
- Pacific Islands (New Zealand)
- Australia

Smith (2000) additionally notes that *Typha domingensis* probably should be treated as a highly variable pantropic and warm temperate species, occurring to 40º E north and south latitude worldwide.

Typha angustifolia:
Because of many misidentified specimens, range expansion in recent years, and undercollecting, the distribution on the margins of the main range of *Typha angustifolia* is somewhat uncertain (Smith 2000). In recent decades it has expanded its range in many regions and become more abundant, especially in roadside ditches and other highly-disturbed habitats. USDA ARS (2013) lists the following localities as part of *T. angustifolia*'s native range:

- Northern Africa (Algeria, Morocco),
- Temperate parts of Asia (Afghanistan, Lebanon, Syria, Turkey, Armenia, Azerbaijan, Georgia, Russian Federation, Kazakhstan, Uzbekistan, Mongolia, China),
- Europe (Denmark, Finland, Ireland, Norway, Sweden, United Kingdom, Austria, Belgium, Czech Republic, Slovakia, Germany, Hungary, Netherlands, Poland, Switzerland, Belarus, Estonia Latvia, Lithuania, Moldova, Ukraine, Bulgaria, Former Yugoslavia, Romania, France, Portugal, and Spain),
- Canada (New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec, Manitoba, Saskatchewan),
- United States (Connecticut, Indiana, Maine Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, Wisconsin, Colorado, Wyoming, Delaware, Kentucky, Maryland North Carolina, South Carolina and Virginia).

Whether *Typha angustifolia* is native to eastern North America, or not to North America at all, is still unclear. Shih and Finkelstein (2008) studied herbarium records that suggest *T. angustifolia* may have been present in North America prior to European settlement, but it was not widespread. Recent research using microsatellite data and chloroplast DNA sequences do suggest though that *T. angustifolia* is an introduced species from Europe due to the high level of genetic similarity between North American and European populations that is indicative of relatively recent intercontinental dispersal (Ciotir et al. 2013).

Typha x *glauca* was described in Europe during the late 1800's but was not well recognized in North America until the 1950's (Kantrud 1992). The appearance of *T. x glauca* in the record soon after the arrival of *T. angustifolia* points to the fact that hybrids were not always widespread. Kantrud (1992) noted that *T. x glauca* went from being present in central North Dakota wetlands to becoming the most abundant hydrophyte in the state in the span of twenty years. Similarly, *T. domingensis* is a species

native to southern latitudes of North America, but has been spreading northward. *T. domingensis* can hybridize with *T. angustifolia* and *T. latifolia*. All of these *Typhas* have demonstrated invasive tendencies by their recent colonization of areas outside of their historic occurrences.

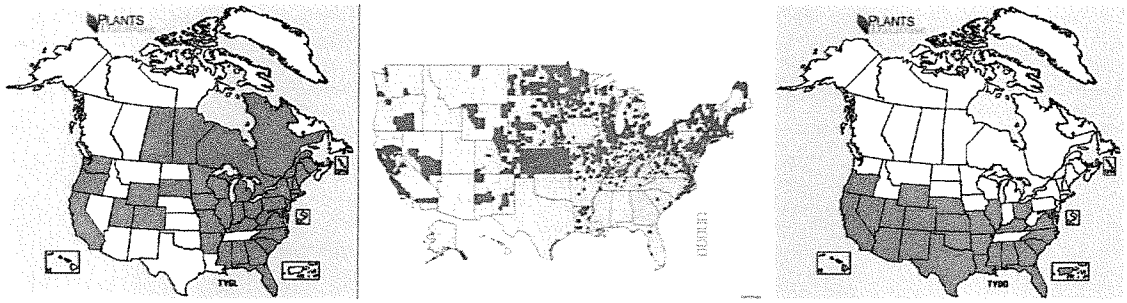


Image: Left, map of United States with documented Typha x glauca, image: USDA Plants 2013; Map of counties in the United States with the documented *T. angustifolia*, image EDDMaps 2013; Right, map of United States with documented *T. domingensis*, though not shown on this map, it has been documented in Washington State, image USDA Plants 2013.

Listings:
Typha x *glauca* is listed in Wisconsin as a restricted wetland species (under Chapter NR 40) and on Pennsylvania's Department of Conservation and Natural Resources Invasive Plant list of wetland plants. *Typha angustifolia* is listed on the Washington State Noxious Weed Control Board's monitor list, Wisconsin's restricted wetland species (under Chapter NR 40), and Pennsylvania's Department of Conservation and Natural Resources Invasive Plant list of wetland plants. Though not on an official state weed list, *T. angustifolia* and *T.* x *glauca* are listed as invasive plants to agricultural and ecological locations in North Dakota.

History and Distribution in Washington:
Typha domingensis and a hybrid *T. latifolia* x *T. domingensis* were first documented in Washington state in 2001 (Parsons and Smith 2004). These plants were found on the shores of lakes in the channeled scablands of central Washington where there is an abundance of *Typha* habitat that likely contain additional populations (Parsons and Smith 2004).

The earliest herbarium record of *Typha angustifolia* in Washington is from along Chinook River in Pacific County in 1957 (WTU 208019), with the next earliest collection from along the east margin of Grays Bay in Wahkiakum County in 1981 (WTU 284678) and the next from Benton County in 1984 (WS 290874). Herbarium records first document *T.* x *glauca* in Washington in 1997 in King County at Lake Sawyer (WTU 335393). The next earliest records of are of collections in Snohomish County at the Snohomish River Delta in 2002 (WTU 350444) and in Pierce County by the shore of Johnson Marsh in 2002 (WTU 355110). Known population locations compiled by David Heimer of the Washington State Department of Fish and Wildlife and Jenifer Parsons of the Washington State Department of Ecology are listed in Table 1.

Table 1. Non-native *Typha* species and hybrid population in Washington State (Heimer and Parsons 2013).

Species	County	Location
Typha angustifolia	Benton	Eastlake Pond
	Franklin	Mesa Lake
	Grant	Blythe Lake, Lower Crab Creek, Red Rock Lake
	Grays Harbor	Route 109 & Paulson Road, Hoquiam; Failor Lake
	King	Duwamish River, Lucerne Lake, North Lake, Otter

		(Spring) Lake, Pipe Lake, Lake Sammamish, Walsh Lake, Wilderness Lake
	Pacific	Chinook River
	Pierce	Bonney Lake, Clear Lake, Commencement Bay, Lake Kapowsin, Tanwax Lake
	Skagit	Sixteen Lake, South Skagit Bay
	Snohomish	Ebey's Slough, Quilceda Creek
	Spokane	Amber Lake, Badger Lake
	Thurston	Capitol Lake, Long Lake
	Wahkiakum	Grays Bay on Columbia River
	Whatcom	Stormwater ponds in North Bellingham
	Whitman	WSU Campus
Typha domingensis	Adams	Herman Lake, Hutchinson Lake
	Grant	Burke Lake
Typha x glauca	Grant	Unnamed pond (16N-23E-35)
	King	Sawyer Lake
	San Juan	Orcas Island private pond
	Skagit	Sixteen Lake
	Spokane	Liberty Lake
	Whatcom	Lake Terrell
T. latifolia x T. domingensis	Adams	Hutchinson Lake
	Grant	Burke Lake

Additional populations documented by herbarium records from the University of Washington Burke Herbarium that are not included in the table are as follows:

Typha angustifolia:

- SE of junction of Rainshadow Road and False Bay Drive, San Juan Island, San Juan County, WA (WTU 389137)
- Wawawai Road, Wawawai Canyon, Whitman County, WA (WTU 364530)
- Clear Lake, Pierce County, WA (WTU 370403) Jenifer Parsons s.n.

Typha x *glauca*:

- Duwamish River south of Seattle, King County, WA (WTU 368383)
- Grays Bay, near Pigeon, Wahkiakum County, WA (WTU 355110)
- Johnson Marsh, Fort Lewis, Pierce County, WA (WTU 379643)
- Snohomish River delta, Marysville, Snohomish County, WA (WTU 350444)

Biology:

Growth and Development:

Typha species tend to form extensive, almost pure stands in marshy areas (Hitchcock et al. 1969). *Typha angustifolia* and *T.* x *glauca* are noted to commonly form dense stands of live and dead biomass in coastal marshes of the Great Lakes (Vaccaro et al. 2009). Young plants produce multiple rhizomes and typically flower in their second year (Yeo, 1964 in Selboe and Snow 2004). In established stands, spring growth is high with deep water shoots tending to sprout before shoots in more shallow waters. *Typha* species generally produce leaves in the spring, flower in early to mid summer and have the greatest peak of rhizome growth in the fall that will constitute the first cohort of the follow spring (Grace and Harrison 1986). A study in Wisconsin found that total non-structural carbohydrates were at a maximum in old

rhizomes in early winter and that they gradually declined to a minimum in late June when flowering, which would be the time the plant is most susceptible to injury (Beule 1979).

Once *Typha* plants have senesced, they typically remain upright for 6-18 months before fragmenting, falling over and forming a litter layer (Davis and van der Valk 1978 in Vaccaro et al. 2009). Litter accumulation and biomass can vary depending on the setting (Vaccaro et al 2009).

Inflorescences are wind pollinated. All *Typha* and hybrids are protogynous, with the stigmas receptive several days prior to pollen release. Stigmas may still be receptive as pollen starts to release from its spike, so while outcrossing is favored, self-pollination may happen (Smith 1967 in Grace and Harrison 1986). Their small single-seeded fruits are dispersed and germinate on bare wet soils or under very shallow water (Smith 2000).

Non-native *Typha* species and hybrids may be found growing in the same habitats as native *Typha latifolia*. In stands where *Typha latifolia* and *T. angustifolia* grew mixed, *T. latifolia* density was reduced by 32 percent while *T. angustifolia* density was reduced by 59.4 percent compared to single species stands (Grace and Wetzel 1998). In a 32-year study, *Typha latifolia* actively restricted *T. angustifolia* from shallower locations (Grace and Wetzel 1998), while it has been shown that *T. domingensis* and *T. angustifolia* have a greater tolerance to deep water than *T. latifolia*, which died out from depths greater than 95 cm (Grace 1989). *Typha angustifolia* and *T. domingensis* can also tolerate a higher degree of salinity than *T. latifolia* (DiTomaso and Healy 2003).

Image: *Typha angustifolia* growing at 2.8 meters water depth in Clear Lake, Washington, image Jenifer Parsons, DOE.

Reproduction:

Typha species and hybrids can spread by rhizomatous growth and by seed (except for in most cases by *T.* x *glauca*). Plants are wind-pollinated (Grace and Harrison 1986 in Selboe and Snow 2004) and seeds are dispersed by wind, water, soil movement, human activities and by clinging with mud to the feet and fur of people and animals (DiTomaso and Healy 2003). Seeds primarily germinate in the spring on bare wet soils or under very shallow water. If conditions are favorable, seeds are capable of immediate germination, but if not, seeds may retain viability for long periods (Grace and Harrison 1986, van der Valk and Davis 1976 in Grace and Harrison 1986).

Establishment of new populations occurs often by seeds and then commonly spreads locally through vegetative growth of rhizomes (DiTomaso and Healy 2003). Plants can also spread by rhizome fragments that are moved to another location by tillage, water, and substrate movement and grow into new plants (DiTomaso and Healy 2003).

Hybrid seedlings are likely wherever two species form mixed stands and bare wet soil is available for seed germination and seedling establishment (Smith 2000). Hybrid populations are only found in regions where *T. latifolia* and *T. angustifolia* exist sympatrically (Shih and Finkelstein 2008). *Typha latifolia* and *T.*

angustifolia are now sympatric across a broad area in North America, and their hybrid, *T.* x *glauca* is commonly identified in areas where the parental species co-exist (reviewed in Galatowitsch et al. 1999; see also Kirk et al. 2011a; Travis et al. 2010 in Ciotir et al. 2013).

Control:

Typha species tend to invade and form monotypic stands in preferred habitats when hydrology, salinity or fertility change. Maintaining water flows into wetlands, lowering nutrient inputs and returning salinity to pre-disturbance levels will help maintain desirable plant communities (Stevens and Hoag 2006).

Mechanical Methods:

Mowing, burning, tilling and flooding have been used in combinations to control *Typha* species and hybrids.

Apfelbaum (1985) reviewed cattail control methods and found that control by all mechanical means was more a function of the relationship between water depth and height of the cut cattails than the methodology of cutting them. As long as flooding covered the entire cut cattail stem, reliable control of cattails could be achieved within several growing seasons (Apfelbaum 1985).

Mowing or clipping *Typha* species can be effective at controlling plants. In the Skagit Delta, Hood (2013) conducted an experiment on *T. angustifolia*, mowing it four times over the course of four years in a tidal marsh. The results were positive with native sedge (*Carex lyngyei*) and spikerush (*Elocharis palustris*) returning by year five. In trials by Sale and Wetzel (1983), they found that three below-water cutting during the growing season were enough to kill nearly all underwater structures. Similar cuts to plants above water reduced the total biomass, but much of the underwater structures remained healthy and able to regenerate. If a small amount of living or dead leaf material is left extending above the water, it is enough to supply adequate amounts of oxygen to the rhizomes and roots to prevent them from being killed.

If plants are cut above water, there will be considerable regrowth of plant material. In one experiment, stems were cut leaving 7 cm (3 inches) above the water surface, and no apparent kill resulted from the treatment (Nelson and Deitz 1966 in Beule 1979). Whereas in the same experiment, stems that were cut with at least 7 cm (3 inches) of water remaining over cut stems, more than 90% of the *Typha* reproduction was killed. The maintenance of water over the cut stubble is noted to be important in a number of studies if cutting is to be used as a control measure (Linde et al., 1976 in Sale and Wetzel 1983). Timing of the cutting treatment is also important. Cutting stems in May allowed for the best recovery of *Typha,* while cuttings that took place after May, resulted in better control with cutting in August (with cut plants being covered in water) resulted in 80% control in one experiment (Beule 1979).

Fire may be used as part of a *Typha* management plan. Fire will reduce aboveground plant debris, opening up stands for nesting waterfowl. *Typha* marshes are difficult to burn 2 years in a row though because accumulated plant debris is needed for fuel. The thick bases of *Typha* species are often the last part of the plant to dry out and are difficult to burn (Snyder 1993). Spring burning alone was not effective at controlling *Typha* in a Kansas wetland but did provide helpful site preparation before other management treatments were used (Kostecke et al. 2004). Ball (1990) compared mowing and burning treatments over ice in early spring, which were then flooded. Both treatments significantly reduced shoot density with mowing being significantly superior to burning at suppressing regrowth in shallow water, while in deeper water there was no significant difference between them. Kostecke et al. (2004) found discing or high-intensity grazing following prescribed burning effective in *Typha* control in a wetland

up to one year after treatment but also reduced non-*Typha* species diversity and shoot density. In this study, discing seemed to provide longer *Typha* suppression than the high intensity grazing, but ongoing management will still be needed. Also, if fire is prescribed during a drawdown followed by reflooding, it could eliminate standing cattail stems and reduce the need for cutting (Apfelbaum 1985).

Typha control by injuring developing rhizomes and shoots was investigated (Weller 1975). Crushing plants and reflooding showed that cattails injured after June had poor recoveries. Weller (1975) found that the success of crushing depended on the load used, number of times an area was crushed, and standing water depths after treatment. Spring and early summer treatments generally created favorable seedbeds for *Typha* that required a fall crushing to control seedlings. Crushing in this treatment involved pulling a 55-gallon water-filled drum behind a tractor. Deeper water areas showed highest control (up to 100 percent) while regrowth occurred in shallow areas.

Shading

Shading with black polyethylene tarps was experimented with to cover *Typha* species. Covering destroyed actively-growing plant tops wherever they were completely covered for a minimum of 60 days (Beule 1979). Wherever the tarps were ripped or disturbed, living stems were still present (Beule 1979). Using a sturdier tarp and being able to weight down tarps and keep them in place regardless of water depth, may work on small patches of *Typha*. Being able to apply this method on a large scale though would be limited.

Cultural Methods:

Manipulating water levels, if possible, is another technique that may be incorporated into a *Typha* management plan. Using water drawdowns to reduce *Typha* species and allow the establishment of annual species preferred by most waterfowl is a management option (Kadlec and Wentz 1974 in Grace and Harrison 1986). Increasing the water level may prevent *Typha* establishment. *Typha angustifolia* establishment was prevented when water levels were maintained at 1.2 m (47 in) or deeper (Steenis et al. 1958 in Apfelbaum 1985).

Biological Control:

During mechanical control trials in Wisconsin Buele (1979) noted deer eating the tops of succulent *Typha* seedlings less than 46 cm (18 inches) tall and the basal portions of resprouts less than 1 meter (3 feet) tall. Muskrats also continually fed on *Typha* during the trials and used plants for house building (Beule 1979).

Chemical methods:

The Pacific Northwest Weed Management Handbook provides the following recommendation for *Typha* species control using herbicide:

- Apply 2,4-D ester to plants before cattail heads appear in spring at a rate of 6 lb ae per 100 gal of spray solution for spot treatments with adding crop oil, diesel oil, or surfactant to increase wetting. Make sure to avoid drift to sensitive crops. Follow-up treatment will be needed.

- Apply glyphosate, a non-selective herbicide, to mature cattail plants after heads are formed and before frost at 3 lb ae/A. Glyphosate is a non-selective herbicide that will control grasses as well as other vegetation it comes in contact with.

- Apply imazapyr (Habitat) after cattail heads appear in the boot or after head emerges and before killing frost at 0.5 to 1 lb ae/A. Make sure not to apply in the root zone of desirable trees. Treated water cannot be used for irrigation for 120 days.

Select wick, broom or hand-spray applications in mid to late summer, followed by cutting and removing dead stems approximately a week later. Retreatment may be necessary due to *Typha* species' massive root system (Heimer and Parsons 2013).

Please refer to the PNW Weed Management Handbook, available online at http://weeds.ippc.orst.edu/pnw/weeds for further and specific herbicide instructions, as herbicide recommendations may have changed since the time of this writing.

Please note: Use of pesticides in water is regulated in Washington. All applicators must have an aquatic endorsement on their pesticide applicators' license, which is issued by the Washington State Department of Agriculture. In addition, coverage under a permit issued by the Department of Ecology is required. See http://www.ecy.wa.gov/programs/wq/pesticides/index.html for details.

Economic Importance:

Detrimental:
Invasive *Typha* species represent a threat to Washington through displacing native plants, through changing the genetic profile of native *Typha* stands, and through altering how organisms use marsh habitat. Non-native *Typha* species and hybrids can also be a serious problem in irrigated agricultural and managed aquatic systems.

Invasive *Typha* are capable of displacing native plants because of their tolerance to deeper water and to more saline conditions. Higher tolerance to depth and salinity means that the potential range that invasive *Typha* are capable occupying is much greater than the current distribution of *T. latifolia*. When competing with *T. angustifolia*, *T. latifolia* was restricted to shallower zones and could grow no deeper than about 37 cm (Grace and Wetzel 1998), while *T. angustifolia* could grow to depths greater than 100 cm (Grace and Wetzel 1982; Inoue and Tsuchiya 2009). Similarly, *T. domingensis* had a maximum depth of 150 cm (Grace 1987) and is invasive in brackish wetlands even in its native range (Smith 2000). The growth of invasive *Typha* into deeper habitats and their creation of very dense, monotypic stands can reduce, or eliminate emergent and submerged native plants through shading and resource competition. In a study by Selbo and Snow (2004), *T. angustifolia* was fifteen times more abundant that *T. latifolia*.

Allelopathy, through root exudates, may be a mechanism that confers a competitive advantage to *T. angustifolia* (Jarchow and Cook 2009). Roots exudates of *T. angustifolia* had an effect in greenhouse tests on river bulrush, *Bolboschoenus fluviatilis*, reducing longest leaf length, ramet number and biomass when activated carbon was not present (Jarchow and Cook 2009). Gallardo et al. (1998) found that aqueous extracts of *T. domingensis* were found to inhibit the growth of common water fern, *Salvinia minima*, with the root extracts being the most inhibitory.

In addition, in litter experiments *T. x glauca* was shown to outperform native plants in the uptake of nitrogen (Larkin et al. 2012). The net effect of this nutrient competiveness over multiple seasonal studies could be to move nitrogen away from native species into living and dead *T. x glauca* biomass (Larkin et al. 2012). Vaccaro et al. (2009) also found a reduction in non-*Typha* species density and seedling survival with an increase in *Typha* litter. While clonal species studied were not affected by the

Typha litter, annual or non-clonal herbaceous plants with less below ground storage did not survive in cattail litter additions and could be vulnerable to accumulation of litter, causing a reduction in plant diversity.

The potential hybridization by invasive *Typha* threatens the genetic integrity of native *T. latifolia* marshes. Both *T. angustifolia* and *T. domingensis* have the ability to hybridize with *T. latifolia*. Since 1888, *T. x glauca* has been recognized as an interspecific hybrid in Europe (Smith 1987 as cited in Galatowitsch et al. 1999). *Typha x glauca* is more competitive than either parent (McDonald 1955; Grace and Wetzel 1981, 1982 a & b; Smith 1987; Waters and Shay 1990, 1992 as cited in Galatowitsch et al. 1999) which can lead to a replacement of *T. latifolia*. Backcrosses by the F_1 generation (Snow et al. 2010) can further alter the genetic diversity of native *Typha latifolia* populations making identification and conservation of these populations difficult. A similar situation occurred when the invasive *Spartina alterniflora* hybridized with the native *Spartina foliosa* in San Francisco Bay (Daehler and Strong 1997) making identification and control difficult. *Typha domingensis* will hybridize with *T. latifolia* (sometimes called *T. x provincialis*), with progeny that are usually sterile, though F2 plants are known from California. *Typha angustifolia* and *T. domingensis* hybridize to form fertile offspring. Trihybrids of *T. latifolia* x *T. angustifolia* x *T. domingensis* are common in parts of California (Smith 2000). The hybrids *T.* x *glauca* and *T. latifolia* x *T. domingensis* are both present in Washington.

Once established, invasive *Typha* change higher trophic level dynamics in the marsh. For example, microalgal densities were found to be even lower on *T. angustifolia* than on *Phragmites* in a freshwater wetland, possibly due to allelopathic leachates (Kulesza et al. 2008). In a study on amphibians, Maerz et al. (2010) found that treatments containing plant detritus with high C:N (i.e. *Typha angustifolia*) resulted in poor metamorph production and performance. In addition, ducks tend to avoid wetlands with monotypic vegetation like hybrid cattail. This is likely due to reduced abundance of shallow aquatic plants and their associated invertebrates, which female ducks and their young feed on (Kantrud 1992). Similarly, Hood (2013) found that ducks utilized sites where *T. angustifolia* had been removed and replaced by *Carex lyngbyei*, but not the *T. angustifolia*-dominated control site.

Non-native *Typha* species and hybrids can present a serious problem in irrigated agricultural lands and managed aquatic systems (National Academy of Sciences-National Research Council 1976 in Grace and Harrison 1986). While being especially troublesome in rice fields (Muenscher 1955 in Grace and Harrison 1986), *Typha* species can invade irrigation canals, farm ponds, and drainage ditches, impeding water flow and increasing siltation (Grace and Harrison 1986). Also, *Typha* stands, primarily of *T.* x *glauca*, that were near sunflower fields in North Dakota provided roosting sites for birds that damaged crops before harvest (Ralston 2004). Swimming, boating, fishing and other recreational activities can also be impacted by the invasion of *Typha*. Reservoirs in Canada and the western United States have also been impacted by *Typha's* rapid invasion of sandbars and influence on siltation rates (Fletcher and Elmendork 1955 and Hallock 1973 in Grace and Harrison 1986).

While people use *Typha* species as a food source, intoxication of livestock has been suspected in a few cases with signs primarily related to digestive tract problems, but one case involved stiffness, tremors, and sweating in horses (Hansen 1930 in Burrows and Tyrl 2013). Cattle and sheep did not experimentally show any signs of intoxication to the leaves (Morton 1975 in Burrows and Tyrl 2013) and overall there is unlikely significant risk to livestock (Burrows and Tyrl 2013).

Typha species also have a high growth rate that allows it to establish and produce a high quantity of biomass in a short period of time. *Typha* productivity and growth rates have been quantified in Indiana

(Apfelbaum et al. 1983, Wilcox, Apfelbaum, and Heibert 1984). Apfelbaum (1985) reports that based on dry weight, cattails contributed 700 kilograms (1543 pounds) of biomass per hectare (approx. 600 lbs/acre) where it grew in monocultures. Estimates made from aerial photographs showed growth increased from 2 to 37.5 hectares (5-93acres) from 1938 to 1982. This study also confirmed declines in sedge-grass and prairie meadow vegetation as cattail increased (Apfelbaum 1985). At Horicon Marsh in Wisconsin, *Typha* monocultures increased from 30 to 80 percent cover from 1947 to 1971 and associated vegetation declined (Linde 1963, Bedford, Zimmerman, and Zimmerman 1974, Wisconsin DNR 1971 in Apfelbaum 1985).

Beneficial:

Native *Typha* species have many beneficial uses, and the most common *Typha* species in Washington is the native species *Typha latifolia*. Due to their limited distribution and seemingly recent introduction based on herbarium records, it is unknown if the non-native *Typha* species or hybrids have any beneficial uses here in Washington State.

There is extensive information on the use of *Typha* species as a food source and for its use in dwellings, mats, baskets and handicraft objects in different parts of the world (Smith 2000, Grace and Harrison 1986). Historically, *Typha* species were used by Native Americans for food products and medicines, though that is not as common now (Smith 1987 in Gallardo et al. 1999).

Typha species can also provide food and shelter for wildlife. Stands of *Typha* can be used for wildlife habitat and food sources (i.e. for muskrats) when it is interspersed with open water (Beule 1979) *Typha* species also stabilize shorelines, protecting them from erosion due to waves.

Gallardo et al. (1999) notes how *Typha* species are being studies for their ability to remove various kinds of pollutants from wastewater, including phosphorus (DeBusk et al. 1995), nitrogen (Zhu and Silora, 1995) and heavy metals (Karathanasis and Mithcell 1995; DeBusk et al. 1996).

Typha latifolia and *T. minima* inflorescences have been used in decorative arrangements and as pond ornamentals, but it is unknown if any non-native species or hybrids have been used in this manner.

Rationale for Listing:

Nonnative, invasive *Typha* species are capable of displacing native plants, changing the genetic profile of native *Typha* stands, altering marsh habitat, and invading managed aquatic systems. These *Typhas* have been documented for invasiveness in many parts of the country and currently have a limited distribution in Washington, although recorded occurrences are increasing. Control of known populations while they are still small and more manageable will help prevent these nonnative, invasive species from dominating valuable wetland habitat. A Class C listing will increase awareness of the invasiveness of these nonnative *Typha* species and their hybrids and will give county weed control boards the option of mandatory, local control.

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Appendix C
Herbicide Labels

ATTENTION:

This specimen label is provided for general information only.

- This pesticide product may not yet be available or approved for sale or use in your area.
- It is your responsibility to follow all Federal, state and local laws and regulations regarding the use of pesticides.
- Before using any pesticide, be sure the intended use is approved in your state or locality.
- Your state or locality may require additional precautions and instructions for use of this product that are not included here.
- Monsanto does not guarantee the completeness or accuracy of this specimen label. The information found in this label may differ from the information found on the product label. You must have the EPA approved labeling with you at the time of use and must read and follow all label directions.
- You should not base any use of a similar product on the precautions, instructions for use or other information you find here.
- Always follow the precautions and instructions for use on the label of the pesticide you are using.

21195I4-25

AQUAMASTER®

Herbicide by Monsanto

Complete Directions for Use in Aquatic and Other Non-crop Sites.

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

EPA Reg. No. 524-343 2009-2

GROUP	9	HERBICIDE

Read the entire label before using this product.

Use only according to label instructions.

Not all products listed on this label are registered for use in California. Check the registration status of each product in California before using.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION (OR REPACKAGING). SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

PRODUCT INFORMATION

1.0 INGREDIENTS

ACTIVE INGREDIENT:	
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt	53.8%
OTHER INGREDIENTS:	46.2%
	100.0%

*Contains 648 grams per liter or 5.4 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 480 grams per liter or 4.0 pounds per U.S. gallon of the acid, glyphosate.

No license granted under any non-U.S. patent(s).

2.0 IMPORTANT PHONE NUMBERS

FOR PRODUCT INFORMATION OR ASSISTANCE IN USING THIS PRODUCT, CALL TOLL-FREE, 1-800-332-3111.

IN CASE OF AN EMERGENCY INVOLVING THIS PRODUCT, OR FOR MEDICAL ASSISTANCE, CALL COLLECT, DAY OR NIGHT, (314) 694-4000.

3.0 PRECAUTIONARY STATEMENTS

3.1 Hazards to Humans and Domestic Animals

Keep out of reach of children.

CAUTION!

Remove contaminated clothing and wash clothing before reuse.
Wash thoroughly with soap and water after handling.

3.2 Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of: SPILL or LEAK, soak up and remove to a landfill.

3.3 Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling. This product can only be used in accordance with the Directions for Use on this label or in separately published Monsanto Supplemental Labeling. Supplemental labeling can be found on the www.cdms.net or www.greenbook.net websites or obtained by contacting your Authorized Monsanto Retailer or Monsanto Company representative. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulations.

4.0 STORAGE AND DISPOSAL

Proper pesticide storage and disposal are essential to protect against exposure to people and the environment due to leaks and spills, excess product or waste, and vandalism. Do not allow this product to contaminate water, foodstuffs, feed or seed by storage and disposal.

PESTICIDE STORAGE: STORE ABOVE 5°F (-15°C) TO KEEP PRODUCT FROM CRYSTALLIZING. Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using. Store pesticides away from food, pet food, feed, seed, fertilizers, and veterinary supplies. Keep container closed to prevent spills and contamination.

PESTICIDE DISPOSAL: To avoid wastes, use all material in this container, including rinsate, by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program. Such programs are often run by state or local governments or by industry. All disposal must be in accordance with applicable Federal, state and local regulations and procedures.

CONTAINER HANDLING AND DISPOSAL: See container label for container handling and disposal instructions and refilling limitations.

5.0 GENERAL INFORMATION (How This Product Works)

Product Description: This product is a postemergence, systemic herbicide with no residual soil activity. It gives broad-spectrum control of many annual weeds, perennial weeds, woody brush and trees. It is formulated as a water-soluble liquid and may be applied through standard equipment after dilution and mixing with water or other carriers according to label instructions.

Time to Symptoms: This product moves through the plant from the point of foliage contact to and into the root system. Visible effects are a gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts. Effects are visible on most annual weeds within 2 to 4 days, but on most perennial weeds may not occur for 7 days or more. Extremely cool or cloudy weather following treatment may slow activity of this product and delay development of visual symptoms.

Stage of Weeds: Annual weeds are easiest to control when they are small. Best control of most perennial weeds is obtained when treatment is made at late growth stages approaching maturity. Refer to the **"WEEDS CONTROLLED"** sections for specific weed instructions. Always use the higher product application rate in the labeled range

when weed growth is heavy or dense, or when weeds are growing in an undisturbed (non-cultivated) area. Reduced weed control may result from treating weeds with disease or insect damage, weeds heavily covered with dust, or weeds under poor growing conditions.

Cultural Considerations: Reduced control may result when applications are made to annual or perennial weeds that have been mowed, grazed or cut, and have not been allowed to regrow to the specified stage for treatment.

Rainfastness: Heavy rainfall soon after application may wash this product off of the foliage and a repeat application may be required for adequate control.

Mode of Action in Plants: The active ingredient in this product inhibits production of an enzyme in plants and microorganisms that is essential to formation of specific amino acids.

No Soil Activity: Weeds must be emerged at the time of application to be controlled by this product. Weeds germinating from seed after application will not be controlled. Unemerged plants arising from unattached underground rhizomes or rootstocks of perennials will not be affected by the herbicide and will continue to grow.

Maximum Application Rates: The maximum application or use rates stated throughout this label are given in units of volume (fluid ounces or quarts) of this product per acre. However, the maximum allowed application rates apply to this product combined with the use of any and all other herbicides containing the active ingredient glyphosate, whether applied separately or as tank mixtures, on a basis of total pounds of glyphosate (acid equivalents) per acre. If more than one glyphosate-containing product is applied to the same site within the same year, you must ensure that the total use of glyphosate (pounds acid equivalents) does not exceed the maximum allowed. The combined total of all treatments must not exceed 8 quarts of this product (8 pounds of glyphosate acid) per acre per year. See the "**INGREDIENTS**" section of this label for necessary product information.

ATTENTION

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of injury occurring from the use of this product increases when winds are gusty, as wind velocity increases, when wind direction is constantly changing or when there are other meteorological conditions that favor spray drift. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) that are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

NOTE: Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences.

5.1 Weed Resistance Management

GROUP	9	HERBICIDE

Glyphosate, the active ingredient in this product, is a Group 9 herbicide based on the mode of action classification system of the Weed Science Society of America. Any weed population may contain plants naturally resistant to Group 9 herbicides. Weed species resistant to Group 9 herbicides may be effectively managed utilizing another herbicide from a different Group or using other cultural or mechanical practices.

To minimize the occurrence of glyphosate-resistant biotypes observe the following general weed management recommendations:

- Scout your application site before and after herbicide applications.
- Control weeds early when they are relatively small.
- Incorporate other herbicides and cultural or mechanical practices as part of your weed control system where appropriate.
- Use the labeled rate for the most difficult weed in the site. Avoid tank mixtures with other herbicides that reduce this product's efficacy (through antagonism) or with tank mixtures that encourage rates of this product below those specified on this label.
- Control weed escapes and prevent weeds from setting seeds.
- Clean equipment before moving from site to site to minimize spread of weed seed.
- Use new commercial seed as free of weed seed as possible.
- Report any incidence of repeated non-performance of this product on a particular weed to your Monsanto representative, local retailer, or county extension agent.

5.2 Management Recommendations for Glyphosate-Resistant Weed Biotypes

NOTE: Appropriate testing is critical in order to confirm weed resistance to glyphosate. Contact your Monsanto representative to determine if resistance in any particular weed biotype in your area has been confirmed. Control recommendations for biotypes confirmed as resistant to glyphosate are made available on separately published supplemental labeling or Fact Sheets for this product and may be obtained from your local retailer or Monsanto representative.

Since the occurrence of new glyphosate-resistant weeds cannot be determined until after product use and scientific confirmation, Monsanto Company is not responsible for any losses that may result from the failure of this product to control glyphosate-resistant weed biotypes.

The following good weed management practices are recommended to reduce the spread of confirmed glyphosate-resistant biotypes:

- If a naturally occurring resistant biotype is present at your site, this product may be tank mixed or applied sequentially with an appropriately labeled herbicide with a different mode of action to achieve control.
- Cultural and mechanical control practices may also be used as appropriate.
- Scout treated sites after herbicide applications and control weed escapes of resistant biotypes before they set seed.
- Thoroughly clean equipment before leaving sites known to contain resistant biotypes.

6.0 MIXING

Clean sprayer parts immediately after using this product by thoroughly flushing with water.

NOTE: REDUCED RESULTS MAY OCCUR IF WATER CONTAINING SOIL IS USED, SUCH AS VISIBLY MUDDY WATER OR WATER FROM PONDS AND DITCHES THAT IS NOT CLEAR.

6.1 Mixing with Water

This product mixes readily with water. Mix spray solutions of this product as follows: Fill the mixing or spray tank with the required amount of water. Add the labeled amount of this product near the end of the filling process and mix well. Use caution to avoid siphoning back into the carrier source. Use approved anti-back-siphoning devices where required by state or local regulations. During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators, terminate by-pass and return lines at the bottom of the tank and, if needed, use an approved anti-foam or defoaming agent.

6.2 Tank Mixtures

When this product is tank mixed with other products, refer to the tank-mix product labels for approved non-crop sites and application rates. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture. Any labeled rate of this product may be used in a tank mix.

When this label lists a tank mixture with a generic active ingredient such as diuron, 2,4-D, or dicamba, the user is responsible for ensuring the mixture product label allows the specific application.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product with herbicides or other materials that are not expressly listed in this label. Mixing this product with herbicides or other materials not specified on this label may result in reduced performance.

6.3 Tank Mixing Procedure

When tank mixing, read and carefully observe label directions, cautionary statements and all information on the labels of all products used. Add the tank-mix product to the tank as directed by the label. Maintain agitation and add the labeled amount of this product.

Maintain good agitation at all times until the contents of the tank are sprayed. If the spray mixture is allowed to settle, thorough agitation is required to resuspend the mixture before spraying is resumed.

Keep by-pass line on or near the bottom of the tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50-mesh.

Always predetermine the compatibility of labeled tank mixtures of this product with water carrier by mixing small proportional quantities in advance. Ensure that the specific tank mixture product is registered for application at the desired site.

Refer to the "**Tank Mixtures**" section for additional precautions.

6.4 Mixing Percent Solutions

Prepare the desired volume of spray solution by mixing the amount of this product in water as shown in the following table:

Spray Solution

Desired Volume	Amount of AquaMaster herbicide					
	0.5%	0.75%	1%	1.5%	4%	8%
1 gal	2/3 oz	1 oz	1.3 oz	2 oz	5 oz	10 oz
25 gal	1 pt	1.5 pt	1 qt	1.5 qt	4 qt	2 gal
100 gal	2 qt	3 qt	1 gal	1.5 gal	4 gal	8 gal

2 tablespoons = 1 fluid ounce

For use in backpack, knapsack or pump-up sprayers, it is suggested that the amount of this product be mixed with water in a larger container. Fill sprayer with the mixed solution.

6.5 Surfactant

This product requires the use of a nonionic surfactant unless otherwise specified. When using this product, unless otherwise specified, mix 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. Increasing the rate of surfactant may enhance performance. Examples of when to use the higher surfactant rate include, but are not limited to: hard to control woody brush, trees and vines, high water volumes, adverse environmental conditions, tough to control weeds, weeds under stress, surfactants with less than 70 percent active ingredient, tank mixes, etc. These surfactants should not be used in excess of 1 quart per acre when making broadcast applications. Always read and follow the manufacturer's surfactant label for best results. Carefully observe all cautionary statements and other information appearing in the surfactant label.

6.6 Colorants or Dyes

Approved colorants or marking dyes may be added to this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilution. Use colorants or dyes according to the manufacturer's instructions.

6.7 Drift Reduction Additives

Drift reduction additives may be used with all equipment types, except wiper applicators, and sponge bars. When a drift reduction additive is used, read and carefully observe the precautionary statements and all other information appearing on the additive label. The use of drift reduction additives can affect spray coverage which may result in reduced performance.

7.0 APPLICATION EQUIPMENT AND TECHNIQUES

Do not apply this product through any type of irrigation system.

APPLY THESE SPRAY SOLUTIONS IN PROPERLY MAINTAINED AND CALIBRATED EQUIPMENT CAPABLE OF DELIVERING DESIRED VOLUMES.

SPRAY DRIFT MANAGEMENT

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment- and weather-related factors determines the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

7.1 Aerial Equipment

DO NOT APPLY THIS PRODUCT USING AERIAL SPRAY EQUIPMENT EXCEPT UNDER CONDITIONS AS SPECIFIED WITHIN THIS LABEL.

FOR AERIAL APPLICATION IN CALIFORNIA, REFER TO THE FEDERAL SUPPLEMENTAL LABELING FOR AERIAL APPLICATIONS IN THAT STATE OR COUNTY FOR SPECIFIC INSTRUCTIONS, RESTRICTIONS AND REQUIREMENTS.

This product, when tank mixed with dicamba, may not be applied by air in California. Only 2,4-D amine formulations may be applied by air in California.

TO PREVENT INJURY TO ADJACENT DESIRABLE VEGETATION, APPROPRIATE BUFFER ZONES MUST BE MAINTAINED.

Avoid direct application to any body of water.

Use the labeled rates of this herbicide in 3 to 25 gallons of water per acre.

Ensure uniform application. To avoid streaked, uneven or overlapped application, use appropriate marking devices.

AERIAL SPRAY DRIFT MANAGEMENT

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops. These requirements do not apply to public health uses.

1. The distance of the outermost nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

Importance of Droplet Size

The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see the **"Wind"**, **"Temperature and Humidity"**, and **"Temperature Inversions"** sections of this label).

Controlling Droplet Size

- **Volume:** Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with the higher rated flows produce larger droplets.
- **Pressure:** Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of nozzles:** Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle orientation:** Orienting nozzles so that the spray is released backwards, parallel to the air stream, will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.
- **Nozzle type:** Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.
- **Boom length:** For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.
- **Application height:** Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces the exposure of the droplets to evaporation and wind.

Swath Adjustment

When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller droplets, etc.).

Wind

Drift potential is lowest between wind speeds of 2 to 10 miles per hour. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 miles per hour due to variable wind direction and high inversion potential. **NOTE:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity

Set up equipment to produce larger droplets when making applications in low relative humidity to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions

Applications should not occur during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas

This product should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

Aircraft Maintenance

PROLONGED EXPOSURE OF THIS PRODUCT TO UNCOATED STEEL SURFACES MAY RESULT IN CORROSION AND POSSIBLE FAILURE OF THE PART. The maintenance of an organic coating (paint) which meets aerospace specification MIL-C-38413 may prevent corrosion. To prevent corrosion of exposed parts, thoroughly wash aircraft after each day of spraying to remove residues of this product accumulated during spraying or from spills. Landing gear is most susceptible.

7.2 Ground Broadcast Equipment

For broadcast ground applications, unless otherwise specified in this label or in separate supplemental labeling or Fact Sheets published by Monsanto, use this product at the rate of 1.5 to 3 pints per acre for annual weeds, 3 to 7.5 pints per acre for perennial weeds and 3 to 7.5 pints per acre for woody brush and trees. When used according to label directions this product will give control or partial control of herbaceous weeds, woody brush and trees listed in the **"WEEDS CONTROLLED"** section of this label.

Use the labeled rates of this product in 3 to 40 gallons of water per acre as a broadcast spray unless otherwise specified. As density of weeds increases, spray volume should be increased within the labeled range to ensure complete coverage. Carefully select proper nozzles to avoid spraying a fine mist. For best results with ground application equipment, use flat-fan nozzles. Check spray pattern for even distribution of spray droplets.

7.3 Hand-Held Equipment

Apply to foliage of vegetation to be controlled. For applications made on a spray-to-wet basis, spray coverage should be uniform and complete. Do not spray to the point of runoff. Use coarse sprays only.

For control of weeds listed in the "**Annual Weeds**" section of "**WEEDS CONTROLLED**", apply a 0.5-percent solution of this product to weeds less than 6 inches in height or runner length. For annual weeds over 6 inches tall, or unless otherwise specified, use a 1-percent solution. Apply prior to seedhead formation in grass or bud formation in broadleaf weeds.

For best results, use a 1.5-percent solution on harder-to-control perennials, woody vines, brush and trees. Make applications to perennials after seedhead emergence in grasses or bud formation in broadleaf weeds, woody brush and trees for best results.

For low-volume directed spray applications, use a 4- to 8-percent solution of this product for control or partial control of annual weeds, perennial weeds, or woody brush and trees. Spray coverage should be uniform with at least 50 to 75 percent of the foliage contacted. Coverage of the top one half of the plant is important for best results. If a straight stream nozzle is used, start the application at the top of the targeted vegetation and spray from top to bottom in a lateral zigzag motion. For flat-fan and cone nozzles and with hand-directed mist blowers, mist the application over the foliage of the targeted vegetation. To ensure adequate spray coverage, spray both sides of large or tall woody brush and trees, when foliage is thick and dense, or where there are multiple sprouts. For best results, apply to actively growing woody brush and trees after full leaf expansion and before fall color and leaf drop.

Unless otherwise specified, use the rates listed in the following "**Application Rates**" table for various methods of foliar application using high-volume, backpack, knapsack and similar types of hand-held equipment. When used according to label directions this product will give control or partial control of herbaceous weeds, woody brush and trees listed in the "**WEEDS CONTROLLED**" section of this label.

Application Rates

APPLICATION	AQUAMASTER HERBICIDE	SPRAY VOLUME GALLONS/ACRE
SPRAY-TO-WET		
Handgun or Backpack	0.5 to 1.5% by volume	spray-to-wet*
LOW-VOLUME DIRECTED SPRAY		
Backpack	4 to 8% by volume	15 to 25**
Modified High-Volume	1.5 to 3% by volume	40 to 60**

*For applications made on a spray-to-wet basis, spray coverage should be uniform and complete. Do not spray to the point of runoff.

**Low-volume directed applications with backpacks work best when treating weeds and brush less than 10 feet tall. For taller weeds and brush, high-volume handguns can be modified by reducing nozzle size and spray pressure to produce a low-volume directed spray.

7.4 Selective Equipment

This product may be applied through shielded applicators, hooded sprayers, wiper applicators or sponge bars, after dilution and thorough mixing with water, to listed weeds growing in any aquatic or non-crop site specified on this label.

AVOID CONTACT OF HERBICIDE WITH DESIRABLE VEGETATION, AS SERIOUS INJURY OR DEATH IS LIKELY TO OCCUR:

Applicators used above desired vegetation should be adjusted so that the lowest spray stream or wiper contact point is at least 2 inches above the desirable vegetation. Droplets, mist, foam or splatter of the herbicide solution settling on desirable vegetation is likely to result in discoloration, stunting or destruction.

Better results may be obtained when more of the weed is exposed to the herbicide solution. Weeds not contacted by the herbicide solution will not be affected. This may occur in dense clumps, severe infestations or when the height of the weeds varies so that not all weeds are contacted. In these instances, repeat treatment may be necessary.

Shielded and Hooded Applicators

A shielded or hooded applicator directs the herbicide solution onto weeds, while shielding desirable vegetation from the herbicide. Use nozzles that provide uniform coverage within the treated area. Keep shields on these sprayers adjusted to protect desirable vegetation. EXTREME CARE MUST BE EXERCISED TO AVOID CONTACT OF HERBICIDE WITH DESIRABLE VEGETATION.

Wiper Applicators and Sponge Bars

Wiper applicators are devices that physically wipe appropriate amounts of this product directly onto the weed.

Equipment must be designed, maintained and operated to prevent the herbicide solution from contacting desirable vegetation. Operate this equipment at ground speeds no greater than 5 miles per hour. Performance may be improved by reducing speed in areas of heavy weed infestations to ensure adequate wiper saturation. Better results may be obtained if 2 applications are made in opposite directions.

Avoid leakage or dripping onto desirable vegetation. Adjust height of applicator to ensure adequate contact with weeds. Keep wiping surfaces clean. Be aware that, on sloping ground, the herbicide solution may migrate, causing dripping on the lower end and drying of the wicks on the upper end of a wiper applicator.

Do not use wiper equipment when weeds are wet.

Mix only the amount of solution to be used during a 1-day period, as reduced activity may result from the use of leftover solutions. Clean wiper parts immediately after using this product by thoroughly flushing with water.

Nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended with all wiper applications.

For Rope or Sponge Wick Applicators—Solutions ranging from 33 to 75 percent of this product in water may be used.

For Panel Applicators—Solutions ranging from 33 to 100 percent of this product in water may be used in panel wiper applicators.

8.0 SITE AND USE INSTRUCTIONS

Unless otherwise specified, applications may be made to control any weeds listed in the "**Annual Weeds**", "**Perennial Weeds**" and "**Woody Brush and Trees**" rate tables. Refer also to the "**Selective Equipment**" section.

8.1 Aquatic Sites

This product may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, rice levees, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas.

This product may also be used to control the labeled weeds, woody brush and trees growing in other terrestrial non-crop sites listed on this label or in aquatic sites within these areas.

If aquatic sites are present in a non-crop area and are part of the intended treatment, read and observe the following directions:

This product does not control plants which are completely submerged or have a majority of their foliage under water.

There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.

Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.

NOTE: Do not apply this product **directly to water** within 0.5 mile upstream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 0.5 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 0.5 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 parts per million as determined by laboratory analysis. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications. This restriction does **NOT** apply to intermittent inadvertent overspray of water in terrestrial use sites.

For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.

Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not retreat within 24 hours following the initial treatment.

Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7.5 pints per acre must not be exceeded in any single broadcast application that is being made over water except as follows, where any labeled rate may be applied:

- Stream crossings in utility rights-of-way.
- Where applications will result in less than 20 percent of the total water area being treated.

When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

Tank Mixtures

Tank mixtures of this product plus 2,4-D amine may be used to increase the spectrum of vegetation controlled in aquatic sites. Use 1.5 to 2 pints of this product plus 1 to 2 quarts of 2,4-D amine (4 pounds active ingredient per gallon, labeled for aquatic sites) for control of annual weeds. Use 3 to 7.5 pints of this product plus 2 to 4 quarts of 2,4-D amine (4 pounds active ingredient per gallon, labeled for aquatic sites) for control or partial control of perennial weeds, woody brush and trees.

When tank mixing, read and carefully observe the label claims, cautionary statements and all information on the labels of all products used. Use according to the most restrictive precautionary statements for each product in the mixture. Mix in the following sequence: Fill sprayer tank one-half full with water, add AquaMaster herbicide, then 2,4-D amine and finally surfactant. Fill sprayer tank to final volume of water.

NOTE: DO NOT MIX AQUAMASTER HERBICIDE AND 2,4-D AMINE CONCENTRATES WITHOUT WATER CARRIER. DO NOT MIX AQUAMASTER HERBICIDE AND 2,4-D AMINE IN BYPASS INJECTOR-TYPE SPRAY EQUIPMENT.

For Control of Cordgrass (*Spartina spp.*)

The presence of debris and silt on the surface of cordgrass plants will reduce product performance. It may be necessary to wash targeted plants prior to application to improve herbicide uptake. Where cordgrass has been cut or mowed prior to application, allow significant regrowth before application to ensure adequate interception and uptake of the herbicide solution. Rainfall within 2 hours or immersion within 4 hours after application may reduce effectiveness.

Prior to application, survey the areas to be treated to determine if shellfish beds exist within the intended treatment area. Wait either until shellfish have been harvested before application is made or do not harvest shellfish for 14 days following treatment.

Add 1 to 2 quarts or more of nonionic surfactant or other adjuvant approved for use on aquatic sites and compatible with this product per 100 gallons of spray solution for broadcast applications (ground or air) and when using optical sensing application equipment.

Do not apply this product through any type of irrigation system.

APPLICATION: Under ideal application conditions, that is, where silt and debris are not present on plant surfaces, good spray coverage is achievable, target plants are actively growing and labeled rates and application volumes are used, allow at least 4 hours drying time before plants are covered by tidewater. Where one or more of these conditions are not met, schedule applications to allow at least 5 hours drying time before plants are covered by tidewater. Do not apply when wind speed at the application site exceed 10 miles per hour.

Broadcast Application (Ground): Apply 2 to 8 quarts of this herbicide in 5 to 100 gallons of spray solution per acre. For best results, complete coverage of cordgrass clumps is required.

Broadcast Application (Ground/Optical Sensing Application Equipment): Apply 2 to 8 quarts of this product in 5 to 100 gallons of spray solution per acre using equipment designed and calibrated to deliver spray solution only when cordgrass plants are present and detected by optical sensors. For best results, complete coverage of cordgrass clumps is required.

Hand-Held Backpack or High-Volume Equipment: Apply a 5 to 8 percent solution of this product. Ensure that complete coverage of cordgrass clumps is achieved. Do not spray to the point of runoff.

Broadcast Application (Air): Apply 2 to 8 quarts of this product in 5 to 10 gallons of spray solution per acre. Maintain at least a 50-foot buffer between commercial shellfish beds and treated areas. The potential for spray drift is dependent upon weather- and equipment-related factors. The applicator must be familiar with local wind patterns and monitor and record temperature and wind speed prior to and periodically during application. Schedule application in order to allow at least 5 hours before treated plants are covered by tidewater.

For Control of Giant Salvinia

For control of Giant Salvinia, this product may be applied as a 2.0% v/v spray-to-wet solution with 0.5 to 2.0% v/v of a nonionic surfactant containing at least 70 percent active ingredient. Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment.

For broadcast applications, apply 3 to 3.75 quarts of this product with an aquatic approved surfactant system containing 0.1% v/v nonionic organosilicone and 0.25% v/v nonionic spreader sticker surfactant in 3 to 40 gallons per acre as a broadcast treatment.

Allow at least 3 days after application before disturbing treated vegetation. This product does not control plants which are completely submerged or have a majority of their foliage under water.

8.2 Hollow Stem Injection

This product may be applied through hand-held injection devices that deliver labeled amounts of this product into targeted hollow stem plants growing in any aquatic or non-crop site specified on this label. For control of the following hollow stem plants, follow the use instructions below:

Castorbean *(Ricinus communis)*

Inject 4 mL/plant of this product into the lower portion of the main stem.

Hemlock, Poison *(Conium maculatum)*

Inject one leaf cane per plant 10 to 12 inches above root crown with 5 mL of a 5% v/v solution of this product.

Hogweed, Giant *(Heracleum mantegazzianum)*

Inject one leaf cane per plant 12 inches above root crown with 5 mL of a 5% v/v solution of this product.

Horsetail, Field *(Equisetum arvense)*

Inject one segment above the root crown with 0.5 mL/stem of this product. Use a small syringe that calibrates to this rate.

Iris, Yellow Flag *(Iris pseudocorus)*

Cut flower stems with clippers 8 to 9 inches above the root crown. Use a cavity needle that is pushed into the stem center and then slowly removed as 0.5 mL/stem of this product is injected into the stem.

Knotweed, Bohemian *(Polygonum bohemicum)*,

Knotweed, Giant *(Polygonum sachalinense)*, and

Knotweed, Japanese *(Polygonum cuspidatum)*

Inject 5 mL/stem of this product between second and third internode.

Reed, Giant *(Arundo donax)*

Inject 6 mL/stem of this product between second and third internode.

Thistle, Canada *(Cirsium arvense)*

Cut 8 to 9 of the tallest plants at bud stage in a clump with clippers. Use a cavity needle that is pushed into the stem center and then slowly removed as 0.5 mL/stem of this product is injected into the stem.

NOTE: Based on the maximum annual use rate of glyphosate for these non-crop sites, the combined total for all treatments must not exceed 8 quarts of this product per acre. At 5 mL per stem, 8 quarts should treat approximately 1500 stems.

8.3 Cut Stump

Cut stump treatments may be made on any site listed on this label. This product will control many types of woody brush and tree species. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut trees or resprouts close to the soil surface. Apply a 50- to 100-percent solution of this product to the freshly-cut surface **immediately after** cutting. Delays in application may result in reduced performance. For best results, applications should be made during periods of active growth and full leaf expansion.

For control of *Ailanthus altissima* (Tree-of-heaven) make a cut stump treatment according to the directions in this section using a spray mixture of 50 percent AquaMaster herbicide and 10 percent Arsenal.

DO NOT MAKE CUT STUMP APPLICATIONS WHEN THE ROOTS OF DESIRABLE WOODY BRUSH OR TREES MAY BE GRAFTED TO THE ROOTS OF THE CUT STUMP. Some sprouts, stems, or trees may share the same root system. Adjacent trees having a similar age, height and spacing may signal shared roots. Whether grafted or shared, injury is likely to occur to non-treated stems/trees when one or more trees sharing common roots are treated.

8.4 General Non-crop Areas and Industrial Sites

Use in areas such as airports, apartment complexes, commercial sites, ditch banks, driveways, dry ditches, dry canals, fencerows, forestry sites, golf courses, greenhouses, industrial sites, lumber yards, manufacturing sites, municipal sites, natural areas, office complexes, ornamentals, parks, parking areas, pastures, petroleum tank farms and pumping installations, railroads, rangeland, recreational areas, residential areas, rights-of-way, roadsides, schools, sod or turf seed farms, sports complexes, storage areas, substations, utility sites, warehouse areas, and wildlife management areas.

General Weed Control, Trim-and-Edge and Bare Ground

This product may be used in general non-crop areas. It may be applied with any application equipment described in this label. This product may be used to trim-and-edge around objects in non-crop sites, for spot treatment of unwanted vegetation and to eliminate unwanted weeds growing in established shrub beds or ornamental plantings. This product may be used prior to planting an area to ornamentals, flowers, turfgrass (sod or seed), or prior to laying asphalt or beginning construction projects.

Repeated applications of this product may be used, as weeds emerge, to maintain bare ground.

TANK MIXTURES: This product may be tank mixed with the following products. Refer to these product labels for approved non-crop sites and application rates. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture.

Arsenal	Outrider®
Barricade 65WG	Pendulum 3.3 EC
Certainty®	Pendulum WDG
diuron*	Plateau
Endurance	Princep DF
Escort XP	Princep Liquid
Garlon 3A	Ronstar 50 WP
Garlon 4	Sahara
Hyvar X	simazine*
Karmex	Surflan
Krovar I DF	Telar
Oust XP	2,4-D*

*User is responsible for ensuring that tank mixtures with products containing this generic active ingredient may be made provided the specific product is registered for this use.

This product plus dicamba tank mixtures may not be applied by air in California.

Brush Control Tank Mixtures

TANK MIXTURES: Tank mixtures of this product may be used to increase the spectrum of control for herbaceous weeds, woody brush and trees. When tank mixing, read and carefully observe the label claims, cautionary statements and all information on the labels of all products used. Use according to the most restrictive precautionary statements for each product in the mixture. Any labeled rate of this product may be used in a tank mix.

For control of herbaceous weeds, use the lower tank mixture rates. For control of dense stands or tough-to-control woody brush and trees, use the higher rates.

NOTE: For side trimming treatments, this product may be used alone or in tank mixture with Garlon 4.

PRODUCT
Arsenal
Escort XP
Garlon 3A*
Garlon 4

*Ensure that Garlon 3A is thoroughly mixed with water according to label directions before adding this product. Have spray mixture agitating at the time this product is added to avoid spray compatibility problems.

8.5 Habitat Management

Habitat Restoration and Management

This product may be used to control exotic and other undesirable vegetation in habitat management and natural areas, including riparian and estuarine areas, rangeland and wildlife refuges. Applications can be made to allow recovery of native plant species, prior to planting desirable native species, and for similar broad-spectrum vegetation control requirements. Spot treatments can be made to selectively remove unwanted plants for habitat management and enhancement.

Wildlife Food Plots

This product may be used as a site preparation treatment prior to planting wildlife food plots. Any wildlife food species may be planted after applying this product, or native species may be allowed to repopulate the area. If tillage is needed to prepare a seedbed, wait 7 days after application before tillage to allow translocation into underground plant parts.

8.6 Injection and Frill (Woody Brush and Trees)

This product may be used to control woody brush and trees by injection or frill applications. Apply this product using suitable equipment that must penetrate into the living tissue. Apply 1 mL of this product per each 2 to 3 inches of trunk diameter at breast height (DBH). This is best achieved by applying a 50- to 100-percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying diluted material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frilled or cut areas in species that exude sap freely. In species such as this, make the frill or cuts at an oblique angle to produce a cupping effect and use a 100-percent concentration of this product. For best results, application should be made during periods of active growth and after full leaf expansion.

8.7 Roadsides

All of the instructions in the **"General Non-Crop Areas and Industrial Sites"** section apply to roadsides.

Shoulder Treatments

This product may be used on road shoulders. It may be applied with boom sprayers, shielded boom sprayers, high-volume off-center nozzles, hand-held equipment, and similar equipment.

Guardrails and Other Obstacles to Mowing

This product may be used to control weeds growing under guardrails and around signposts and other objects along the roadside.

Spot Treatment

This product may be used as a spot treatment to control unwanted vegetation growing along roadsides.

TANK MIXTURES: This product may be tank mixed with the following products for shoulder, guardrail, spot and bare ground treatments, provided that the specific tank mixture product is registered for use on such sites. Refer to these product labels for approved non-crop sites and application rates. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture.

atrazine*	Landmark MP	Sahara DG
Crossbow L	Landmark XP	simazine*
dicamba*	Oust XP	Surflan AS
diuron*	Outrider	Surflan WDG
Endurance	pendimethalin*	Telar DF
Escort XP	Plateau	Velpar DF
Gallery 75 DF	Plateau DG	Velpar L
Krovar I DF	Poast	2,4-D*
Landmark II MP	Ronstar 50 WSP	

*User is responsible for ensuring that tank mixtures with products containing this generic active ingredient may be made provided the specific product is registered for this use.

See the **"MIXING"** section of this label for general instructions for tank mixing.

Release of Bermudagrass or Bahiagrass

Dormant Applications

This product may be used to control or partially control many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Treat only when turf is dormant and prior to spring greenup. This product may also be tank mixed with Outrider herbicide or Oust XP for residual control. Tank mixtures of this product with Oust XP may delay greenup.

For best results on winter annuals, treat when plants are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is at or beyond the 4- to 6-leaf stage.

Apply 6 to 48 ounces of this product in a tank mixture with 0.75 to 1.33 ounces Outrider herbicide per acre. Read and follow all label directions for Outrider herbicide.

TANK MIXTURES: Apply 6 to 48 fluid ounces of this product per acre alone or in a tank mixture with 0.25 to 1 ounce per acre of Oust XP. Apply the labeled rates in 10 to 40 gallons of water per acre. Use only in areas where bermudagrass or bahiagrass are desirable ground covers and where some temporary injury or discoloration can be tolerated. To avoid delays in greenup and minimize injury, add no more than 1 ounce of Oust XP per acre on bermudagrass and no more than 0.5 ounce of Oust XP per acre on bahiagrass and avoid treatments when these grasses are in a semi-dormant condition.

Actively Growing Bermudagrass

This product may be used to control or partially control many annual and perennial weeds for effective release of actively growing bermudagrass. Apply 12 to 36 fluid ounces of this product in 10 to 40 gallons of spray solution per acre. Use the lower rate when treating annual weeds below 6 inches in height (or runner length). Use the higher rate as weeds increase in size or as they approach flower or seedhead formation. These rates will also provide partial control of the following perennial species:

Bahiagrass	Johnsongrass
Bluestem, silver	Trumpetcreeper
Fescue, tall	Vaseygrass

This product may be tank mixed with Outrider herbicide for control or partial control of Johnsongrass and other weeds listed in the Outrider herbicide label. Use 6 to 24 ounces of this product with 0.75 to 1.33 ounces of Outrider herbicide. Use the higher rates of both products for control of perennial weeds or annual weeds greater than 6 inches in height.

TANK MIXTURES: This product may be tank mixed with Oust XP. If tank mixed, use no more than 12 to 24 fluid ounces of this product with 1 to 2 ounces of Oust XP per acre. Use the lower rates of each product to control annual weeds less than 6 inches in height (or runner length) that are listed in this label and the Oust XP label. Use the higher rates as annual weeds increase in size and approach the flower or seedhead stages. These rates will also provide partial control of the following perennial weeds:

Bahiagrass	Fescue, tall
Bluestem, silver	Johnsongrass
Broomsedge	Poorjoe
Dallisgrass	Trumpetcreeper
Dock, curly	Vaseygrass
Dogfennel	Vervain, blue

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment, but regrowth will occur under moist conditions. Repeat applications of the tank mix in the same season are not recommended, since severe injury may occur.

Actively Growing Bahiagrass

For suppression of vegetative growth and seedhead inhibition of bahiagrass for approximately 45 days, apply 4 fluid ounces of this product in 10 to 40 gallons of water per acre. Apply 1 to 2 weeks after full greenup or after mowing to a uniform height of 3 to 4 inches. This application must be made prior to seedhead emergence.

For suppression up to 120 days, apply 3 fluid ounces of this product per acre, followed by an application of 2 to 3 fluid ounces per acre about 45 days later. Make no more than 2 applications per year.

This product may be used for control or partial control of Johnsongrass and other weeds listed on the Outrider herbicide label in actively growing bahiagrass. Apply 1.5 to 3.5 fluid ounces of this product with 0.75 to 1.33 ounces of Outrider herbicide per acre. Use the higher rates for control of perennial weeds or annual weeds greater than 6 inches in height. Use only on well established bahiagrass.

TANK MIXTURES: A tank mixture of this product plus Oust XP may be used. Apply 4 fluid ounces of this product plus 0.25 ounce of Oust XP per acre 1 to 2 weeks following an initial spring mowing. Make only one application per year.

9.0 WEEDS CONTROLLED

Always use the higher rate of this product per acre within the labeled range when weed growth is heavy or dense or weeds are growing in an undisturbed (non-cultivated) area.

Reduced results may occur when treating weeds heavily covered with dust. For weeds that have been mowed, grazed or cut, allow regrowth to occur prior to treatment.

Refer to the following label sections for application rates for the control of annual and perennial weeds and woody brush and trees. For difficult to control perennial weeds and woody brush and trees, where plants are growing under stressed conditions, or where infestations are dense, this product may be used at 4.5 to 8 quarts per acre for enhanced results.

9.1 Annual Weeds

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See the **"GENERAL INFORMATION"** and **"MIXING"** and **"APPLICATION EQUIPMENT AND TECHNIQUES"** sections for labeled uses and specific application instructions.

Use 1.5 pints per acre if weeds are less than 6 inches in height or runner length and 1 to 4 quarts per acre if weeds are over 6 inches in height or runner length or when weeds are growing under stressed conditions.

For spray-to-wet applications, apply a 0.5-percent solution of this product to weeds less than 6 inches in height or runner length. Apply prior to seedhead formation in grass or bud formation in broadleaf weeds. For annual weeds over 6 inches tall, or for smaller weeds growing under stressed conditions, use a 0.75- to 1.5-percent solution. Use the higher rate for tough-to-control species or for weeds over 24 inches tall.

WEED SPECIES

Anoda, spurred	Lamb's-quarters*
Balsamapple**	Lettuce, prickly*
Barley*	Mannagrass, eastern*
Barley, little*	Mayweed
Barnyardgrass*	Medusahead*
Bassia, fivehook	Morningglory (*Ipomoea spp*)
Bittercress*	Mustard, blue*
Bluegrass, annual*	Mustard, tansy*
Bluegrass, bulbous*	Mustard, tumble*
Brome, downy*	Mustard, wild*
Brome, Japanese*	Nightshade, black*
Broomsedge	Oats
Buttercup*	Panicum, browntop*
Castorbean	Panicum, fall*
Cheatgrass*	Panicum, Texas*
Cheeseweed (*Malva parviflora*)	Pennycress, field*
	Pepperweed, Virginia*
Chervil*	Pigweed*
Chickweed*	Puncturevine
Cocklebur*	Purslane, common
Copperleaf, hophornbeam	Pusley, Florida
Copperleaf, Virginia	Ragweed, common*
Coreopsis, plains/tickseed*	Ragweed, giant
Corn*	Rice, red
Crabgrass*	Rocket, London*
Cupgrass, woolly*	Rocket, yellow
Dwarfdandelion*	Rye*
Eclipta*	Ryegrass*
Falsedandelion*	Sandbur, field*
Falseflax, smallseed*	Sesbania, hemp
Fiddleneck	Shattercane*
Filaree	Shepherd's-purse*
Fleabane, annual*	Sicklepod
Fleabane, hairy (*Conyza bonariensis*)*	Signalgrass, broadleaf*
	Smartweed, ladysthumb*
Fleabane, rough*	Smartweed, Pennsylvania*
Foxtail*	Sorghum, grain (milo)*
Foxtail, Carolina*	Sowthistle, annual
Geranium, Carolina	Spanishneedles***
Goatgrass, jointed*	Speedwell, corn*
Goosegrass	Speedwell, purslane*
Groundsel, common*	Sprangletop*
Henbit	Spurge, annual
Horseweed/Marestail (*Conyza canadensis*)	Spurge, prostrate*
	Spurge, spotted*
Itchgrass*	Spurry, umbrella*
Johnsongrass, seedling	Starthistle, yellow
Junglerice	Stinkgrass*
Knotweed	Sunflower*
Kochia	Teaweed/prickly sida
Thistle, Russian	Wild oats*
Velvetleaf	Witchgrass
Wheat*	

*When using field broadcast equipment (aerial applications or boom sprayers using flat-fan nozzles) these species will be controlled or partially controlled using 12 fluid ounces of this product per acre. Applications must be made using 3 to 10 gallons of carrier volume per acre. Use nozzles that ensure thorough coverage of foliage and treat when weeds are in an early growth stage.

**Apply with hand-held equipment only.

***Apply 3 pints of this product per acre.

9.2 Perennial Weeds

Best results are obtained when perennial weeds are treated after they reach the reproductive stage of growth (seedhead initiation in grasses and bud formation in broadleaves). For non-flowering plants, best results are obtained when the plants reach a mature stage of growth. In many situations, treatments are required prior to these growth stages. Under these conditions, use the higher application rate within the labeled range.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low-volume directed spot treatments, apply a 4- to 8-percent solution of this product.

Allow 7 or more days after application before tillage. If weeds have been mowed or tilled, do not treat until regrowth has reached the specified stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

WEED SPECIES	RATE (QT/A)	HAND-HELD % SOLUTION
Alfalfa*	0.7	1.5
Alligatorweed*	3.0	1.3
Anise (fennel)	1.5 – 3.0	1.0 – 1.5
Bahiagrass	2.3 – 3.75	1.5
Beachgrass, European (*Ammophila arenaria*)	–	3.5
Bentgrass*	1.0	1.5
Bermudagrass	4.0	1.5
Bermudagrass, water (knotgrass)	1.0	1.5
Bindweed, field	3.0 – 3.75	1.5
Bluegrass, Kentucky	1.5 – 2.3	0.75
Blueweed, Texas	3.0 – 3.75	1.5
Brackenfern	2.3 – 3.0	0.75 – 1.0
Bromegrass, smooth	1.5 – 2.3	0.75
Bursage, woolly-leaf	–	1.5
Canarygrass, reed	1.5 – 2.3	0.75
Cattail	2.3 – 3.75	0.75
Clover; red, white	2.3 – 3.75	1.5
Cogongrass	2.3 – 3.75	1.5
Cordgrass	2.3 – 3.75	1.0–2.0
Cutgrass, giant	3.0	1.0
Dallisgrass	2.3 – 3.75	1.5
Dandelion	2.3 – 3.75	1.5
Dock, curly	2.3 – 3.75	1.5
Dogbane, hemp	3.0	1.5
Fescue (except tall)	2.3 – 3.75	1.5
Fescue, tall	2.3	1.0
Guineagrass	2.3	0.75
Hemlock, poison	1.5 – 3.0	0.75 – 1.5
Horsenettle	2.3 – 3.75	1.5
Horseradish	3.0	1.5
Iceplant	1.5	1.5
Ivy; German, cape	1.5 – 3.0	0.75 – 1.5
Jerusalem artichoke	2.3 – 3.75	1.5
Johnsongrass	1.5 – 2.3	0.75
Kikuyugrass	1.5 – 2.3	0.75
Knapweed	3.0	1.5
Lantana	–	0.75 – 1.0
Lespedeza	2.3 – 3.75	1.5
Loosestrife, purple	2.0	1.0 – 1.5
Lotus, American	2.0	0.75
Maidencane	3.0	0.75
Milkweed, common	2.3	1.5
Muhly, wirestem	1.5 – 2.3	0.75
Mullein, common	2.3 – 3.75	1.5
Napiergrass	2.3 – 3.75	1.5
Nightshade, silverleaf	3.0 – 3.75	1.5
Nutsedge; purple, yellow	2.3	0.75
Orchardgrass	1.5 – 2.3	0.75
Pampasgrass	2.3 – 3.75	1.5

WEED SPECIES	RATE (QT/A)	HAND-HELD % SOLUTION
Paragrass	3.0	0.75
Pepperweed, perennial	3.0	1.5
Phragmites*	2.0 – 3.75	0.75 – 1.5
Quackgrass	1.5 – 2.3	0.75
Redvine*	1.5	1.5
Reed, giant (*Arundo donax*)	3.0 – 3.75	1.5
Ryegrass, perennial	1.5 – 2.3	0.75
Salvinia, giant	3.0 – 3.75	2.0
Smartweed, swamp	2.3 – 3.75	1.5
Spatterdock	3.0	0.75
Spurge, leafy*	–	1.5
Starthistle, yellow	–	1.5
Sweet potato, wild*	–	1.5
Thistle, artichoke	1.5 – 2.3	2.0
Thistle, Canada	1.5 – 2.3	1.5
Timothy	1.5 – 2.3	1.5
Torpedograss*	3.0 – 3.75	0.75 – 1.5
Trumpetcreeper*	1.5 – 2.3	1.5
Tules, common	–	1.5
Vaseygrass	2.3 – 3.75	1.5
Velvetgrass	2.3 – 3.75	1.5
Waterhyacinth	2.5 – 3.0	0.75 – 1.0
Waterlettuce	–	0.75 – 1.0
Waterprimrose	–	0.75
Wheatgrass, western	1.5 – 2.3	0.75

*Partial control

Alligatorweed—Apply 3 quarts of this product per acre as a broadcast spray or as a 1.3-percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.

Beachgrass, European—Apply an 8-percent solution of this products plus 0.5- to 1.5-percent nonionic surfactant on a low-volume spray-to-wet basis. Best results are obtained when applications are made when European beachgrass is actively growing through the boot to the full heading stages of growth. Make applications prior to the loss of more than 50 percent green leaf color in the fall. Do not treat when weeds are under drought stress. Repeat applications may be necessary.

Bermudagrass—Apply 4 quarts of this product per acre as a broadcast spray or as a 1.5-percent solution with hand-held equipment. Apply when target plants are actively growing and when seed heads appear.

Bindweed, field / Silverleaf Nightshade / Texas Blueweed—Apply 3 to 3.75 quarts of this product per acre as a broadcast spray west of the Mississippi River and 2.3 to 3 quarts of this product per acre east of the Mississippi River. With hand-held equipment, use a 1.5-percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade, best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.

Brackenfern—Apply 2.3 to 3 quarts of this product per acre as a broadcast spray or as a 0.75- to 1-percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.

Cattail—Apply 2.3 to 3 quarts of this product per acre as a broadcast spray or as a 0.75-percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early-to-full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.

Cogongrass—Apply 2.3 to 3.75 quarts of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.

Cordgrass—Apply 2.3 to 3.75 quarts of this product per acre as a broadcast spray or as a 1- to 2-percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.

Cutgrass, giant—Apply 3 quarts of this product per acre as a broadcast spray or as a 1-percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7- to 10-leaf stage prior to retreatment.

Dogbane, hemp / Knapweed / Horseradish—Apply 3 quarts of this product per acre as a broadcast spray or as a 1.5-percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth. For best results, apply in late summer or fall.

Fescue, tall—Apply 2.3 quarts of this product per acre as a broadcast spray or as a 1-percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.

Guineagrass—Apply 2.3 quarts of this product per acre as a broadcast spray or as a 0.75-percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.

Johnsongrass / Bluegrass, Kentucky / Bromegrass, smooth /Canarygrass, reed / Orchardgrass / Ryegrass, perennial / Timothy / Wheatgrass, western—Apply 1.5 to 2.3 quarts of this product per acre as a broadcast spray or as a 0.75-percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.

Lantana—Apply this product as a 0.75- to 1-percent solution with hand-held equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.

Loosestrife, purple—Apply 2 quarts of this product per acre as a broadcast spray or as a 1- to 1.5-percent solution using hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.

Lotus, American—Apply 2 quarts of this product per acre as a broadcast spray or as a 0.75-percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.

Maidencane / Paragrass—Apply 3 quarts of this product per acre as a broadcast spray or as a 0.75-percent solution with hand-held equipment. Repeat treatments will be required, especially to vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7- to 10-leaf stage prior to retreatment.

Milkweed, common—Apply 2.3 quarts of this product per acre as a broadcast spray or as a 1.5-percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.

Nutsedge: purple, yellow—Apply 2.3 quarts of this product per acre as a broadcast spray, or as a 0.75-percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at rhizome tips. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.

Pampasgrass—Apply a 1.5-percent solution of this product with hand-held equipment when plants are actively growing.

Phragmites—For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 3.75 quarts per acre as a broadcast spray or apply a 1.5-percent solution with hand-held equipment. In other areas of the U.S., apply 2 to 3 quarts per acre as a broadcast spray or apply a 0.75-percent solution with hand-held equipment for partial control. For best results, treat during late summer or fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.

Quackgrass / Kikuyugrass / Muhly, wirestem—Apply 1.5 to 2.3 quarts of this product per acre as a broadcast spray or as a 0.75-percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height (3- to 4-leaf stage of growth) and actively growing. Allow 3 or more days after application before tillage.

Reed, giant / Ice Plant—For control of giant reed and ice plant, apply a 1.5-percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.

Salvinia, giant—Apply as a 2.0% v/v spray-to-wet solution with 0.5 to 2.0% v/v of a nonionic surfactant containing at least 70% active ingredient. For broadcast applications, apply 3 to 3.75 quarts of this product with an aquatic approved surfactant system containing 0.1% v/v nonionic organosilicone and 0.25% v/v nonionic spreader sticker surfactant in 3 to 40 gallons per acre as a broadcast treatment.

Spatterdock—Apply 3 quarts of this product per acre as a broadcast spray or as a 0.75-percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.

Sweet potato, wild—Apply this product as a 1.5-percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the specified stage of growth before retreatment.

Thistle: Canada, artichoke—Apply 1.5 to 2.3 quarts of this product per acre as a broadcast spray or as a 1.5-percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2-percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.

Torpedograss—Apply 3 to 3.75 quarts of this product per acre as a broadcast spray or as a 0.75- to 1.5-percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.

Tules, common—Apply this product as a 1.5-percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth.

After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.

Waterhyacinth—Apply 2.5 to 3 quarts of this product per acre as a broadcast spray or apply a 0.75- to 1-percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.

Waterlettuce—For control, apply a 0.75- to 1-percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.

Waterprimrose—Apply this product as a 0.75-percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.

Other perennials listed on this label—Apply 2.3 to 3.75 quarts of this product per acre as a broadcast spray or as a 0.75- to 1.5-percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached early head or early bud stage of growth.

9.3 Woody Brush and Trees

Apply this product after full leaf expansion, unless otherwise directed. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when applications are made in the spring to early summer when brush species are at high moisture content and are flowering.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low-volume directed-spray spot treatments, apply a 4- to 8-percent solution of this product.

Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

WEED SPECIES	BROADCAST RATE (QT/A)	HAND-HELD SPRAY-TO-WET % SOLUTION
Alder	2.3 – 3.0	0.75 – 1.2
Ash*	1.5 – 3.75	0.75 – 1.5
Aspen, quaking	1.5 – 2.3	0.75 – 1.2
Bearclover (Bearmat)*	1.5 – 3.75	0.75 – 1.5
Beech*	1.5 – 3.75	0.75 – 1.5
Birch	1.5	0.75
Blackberry	2.3 – 3.0	0.75 – 1.2
Blackgum	1.5 – 3.75	0.75 – 1.5
Bracken	1.5 – 3.75	0.75 – 1.5
Broom; French, Scotch	1.5 – 3.75	1.2 – 1.5
Buckwheat, California*	1.5 – 3.0	0.75 – 1.5
Cascara*	1.5 – 3.75	0.75 – 1.5
Castorbean	–	1.5
Catsclaw*	–	1.2 – 1.5
Ceanothus*	1.5 – 3.75	0.75 – 1.5
Chamise*	1.5 – 3.75	0.75
Cherry; bitter, black, pin	1.5 – 3.75	1.0 – 1.5
Cottonwood, eastern	1.5 – 3.75	0.75 – 1.5
Coyote brush	2.3 – 3.0	1.2 – 1.5
Cypress; swamp, bald	1.5 – 3.75	0.75 – 1.5
Deerweed	1.5 – 3.75	0.75 – 1.5
Dewberry	2.3 – 3.0	0.75 – 1.2
Dogwood*	3.0 – 3.75	1.0 – 2.0
Elderberry	1.5	0.75
Elm*	1.5 – 3.75	0.75 – 1.5
Eucalyptus	–	1.5
Gallberry	1.5 – 3.75	0.75 – 1.5
Gorse*	1.5 – 3.75	0.75 – 1.5
Hackberry, western	1.5 – 3.75	0.75 – 1.5
Hasardia*	1.5 – 3.0	0.75 – 1.5
Hawthorn	1.5 – 2.3	0.75 – 1.2
Hazel	1.5	0.75
Hickory*	3.0 – 3.75	1.0 – 2.0
Honeysuckle	2.3 – 3.0	0.75 – 1.2
Hornbeam, American*	1.5 – 3.75	0.75 – 1.5
Huckleberry	1.5 – 3.75	0.75 – 1.5
Ivy, poison	3.0 – 3.75	1.5
Knotweed; Bohemian, Giant, Japanese**	–	–
Kudzu	3.0	1.5
Locust, black*	1.5 – 3.0	0.75 – 1.5
Madrone resprouts*	–	1.5
Magnolia, sweetbay	1.5 – 3.75	0.75 – 1.5
Manzanita*	1.5 – 3.75	0.75 – 1.5
Maple, red	1.0 – 3.75	0.75 – 1.2
Maple, sugar	–	0.75 – 1.2
Maple, vine*	1.5 – 3.75	0.75 – 1.5
Monkey flower*	1.5 – 3.0	0.75 – 1.5
Oak; black, white*	1.5 – 3.0	0.75 – 1.5
Oak; northern, pin	1.5 – 3.0	0.75 – 1.2
Oak, poison	3.0 – 3.75	1.5
Oak, post	2.3 – 3.0	0.75 – 1.2
Oak, red	–	0.75 – 1.2
Oak, scrub*	1.5 – 3.0	0.75 – 1.5
Oak, southern red	1.5 – 3.75	1.0 – 1.5
Orange, Osage	1.5 – 3.75	0.75 – 1.5
Peppertree, Brazilian (Florida holly)*	1.5 – 3.75	1.5
Persimmon*	1.5 – 3.75	0.75 – 1.5
Pine	1.5 – 3.75	0.75 – 1.5
Poplar, yellow*	1.5 – 3.75	0.75 – 1.5
Prunus	1.5 – 3.75	1.0 – 1.5
Raspberry	2.3 – 3.0	0.75 – 1.2
Redbud, eastern	1.5 – 3.75	0.75 – 1.5
Redcedar, eastern	1.5 – 3.75	0.75 – 1.5
Rose, multiflora	1.5	0.75
Russian olive*	1.5 – 3.75	0.75 – 1.5
Sage, black	1.5 – 3.0	0.75
Sage, white*	1.5 – 3.0	0.75 – 1.5
Sage brush, California	1.5 – 3.0	0.75
Salmonberry	1.5	0.75
Saltbush	–	1.0
Saltcedar**	1.5 – 3.75	0.75 – 1.5
Sassafras*	1.5 – 3.75	0.75 – 1.5
Sea Myrtle	–	1.0
Sourwood*	1.5 – 3.75	0.75 – 1.5
Sumac; laurel, poison, smooth, sugarbush, winged*	1.5 – 3.0	0.75 – 1.5
Sweetgum	1.5 – 2.3	0.75 – 1.5
Swordfern*	1.5 – 3.75	0.75 – 1.5
Tallowtree, Chinese	–	0.75
Tan oak resprouts*	–	1.5
Thimbleberry	1.5	0.75
Tobacco, tree*	1.5 – 3.0	0.75 – 1.5
Toyon*	–	1.5
Trumpetcreeper	1.5 – 2.3	0.75 – 1.2
Vine maple*	1.5 – 3.75	0.75 – 1.5
Virginia creeper	1.5 – 3.75	0.75 – 1.5
Waxmyrtle, southern*	1.5 – 3.75	1.5
Willow	2.3	0.75
Yerba Santa, California*	–	1.5

*Partial control

**Refer to specific instructions below

Alder / Blackberry / Dewberry / Honeysuckle / Oak, Post / Raspberry—For control, apply 2.3 to 3 quarts per acre as a broadcast spray or as a 0.75- to 1.2-percent solution with hand-held equipment.

Aspen, Quaking / Hawthorn / Trumpetcreeper—For control, apply 1.5 to 2.3 quarts of this product per acre as a broadcast spray or as a 0.75- to 1.2-percent solution with hand-held equipment.

Birch / Elderberry / Hazel / Salmonberry / Thimbleberry—For control, apply 1.5 quarts per acre of this product as a broadcast spray or as a 0.75-percent solution with hand-held equipment.

Broom: French, Scotch—For control, apply a 1.2- to 1.5-percent solution with hand-held equipment.

Buckwheat, California / Hasardia / Monkey Flower / Tobacco, Tree—For partial control of these species, apply a 0.75- to 1.5-percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Castorbean—For control, apply a 1.5-percent solution of this product with hand-held equipment.

Catsclaw—For partial control, apply a 1.2- to 1.5-percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Cherry: Bitter, Black, Pin / Oak, Southern Red / Sweet Gum / Prunus—For control, apply 1.5 to 3.75 quarts of this product per acre as a broadcast spray or as a 1- to 1.5-percent solution with hand-held equipment.

Coyote brush—For control, apply a 1.2- to 1.5-percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Dogwood / Hickory—For partial control, apply a 1- to 2-percent solution of this product with hand-held equipment or 3 to 3.75 quarts per acre as a broadcast spray.

Eucalyptus, Bluegum—For control of eucalyptus resprouts, apply a 1.5-percent solution of this product with hand-held equipment when resprouts are 6- to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to drought-stressed plants.

Knotweed: Bohemian, Giant, Japanese *(Polygonum bohemicum, P. sachalinense and P. cuspidatum)*

Stem Injection. See the **"Hollow Stem Injection"** section of this label.

Cut Stem. Cut stems cleanly just below the 2nd or 3rd node above the ground. Immediately apply 0.36 fluid ounce (10 mLs) of a 50-percent solution of this product into the 'well' or remaining internode. Ensure that removed upper plant material is carefully gathered and discarded so that it will not contact soil and regenerate plants from sprouting buds. Use of a bio-barrier such as cardboard, plywood or plastic sheeting is recommended.

The combined total for all treatments must not exceed 8 quarts per acre. At 10 mL of a 50-percent solution, approximately 1500 stems per acre may be treated.

Kudzu—For control, apply 3 quarts of this product per acre as a broadcast spray or as a 1.5-percent solution with hand-held equipment. Repeat applications will be required to maintain control.

Maple, Red—For control, apply as a 0.75- to 1.2-percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 1 to 3.75 quarts of this product per acre as a broadcast spray.

Maple, Sugar / Oak: Northern, Pin, Red—For control, apply as a 0.75- to 1.2-percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Peppertree, Brazilian (Holly, Florida) / Waxmyrtle, Southern—For partial control, apply this product as a 1.5-percent solution with hand-held equipment.

Poison Ivy / Poison Oak—For control, apply 3 to 3.75 quarts of this product per acre as a broadcast spray or as a 1.5-percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color.

Rose, Multiflora—For control, apply 1.5 quarts of this product per acre as a broadcast spray or as a 0.75-percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects.

Sage, Black / Sagebrush, California / Chamise / Tallowtree, Chinese—For control of these species, apply a 0.75-percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Saltbush, Sea myrtle—For control, apply this product as a 1-percent solution with hand-held equipment.

Saltcedar—For partial control, apply a 1- to 2-percent solution of this product with hand-held equipment or 3 to 3.75 quarts per acre as a broadcast spray. For control, apply a 1- to 2-percent solution of this product mixed with 0.25 percent Arsenal with hand-held equipment. For control using broadcast applications, apply 1.5 quarts of this product in a tank-mix with 1 pint of Arsenal to plants less than 6 feet tall. To control saltcedar greater than 6 feet tall using broadcast applications, apply 3 quarts of this product in a tank-mix with 2 pints of Arsenal.

Willow—For control, apply 2.3 quarts of this product per acre as a broadcast spray or as a 0.75-percent solution with hand-held equipment.

Other woody brush and trees listed in this label—For partial control, apply 1.5 to 3.75 quarts of this product per acre as a broadcast spray or as a 0.75- to 1.5-percent solution with hand-held equipment.

10.0 LIMIT OF WARRANTY AND LIABILITY

Monsanto Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

To the fullest extent permitted by law, buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil, crop or treated vegetation.

This Company does not warrant any product reformulated or repackaged from this product except in accordance with this Company's stewardship requirements and with express written permission from this Company.

THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. TO THE FULLEST EXTENT PERMITTED BY LAW, IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES.

Upon opening and using this product, buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement. If terms are not acceptable, return at once unopened.

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MONSANTO

Specimen Label

Dow AgroSciences

DMA® 4 IVM

Herbicide

For selective control of many broadleaf weeds in forests, ornamental turfgrass, non-cropland and aquatic areas. Also for control of trees by injection.

Active Ingredient:

2,4-Dichlorophenoxyacetic acid, dimethylamine salt	46.3%
Other Ingredients	53.7%
Total	100.0%

2,4-dichlorophenoxyacetic acid - 38.4% - 3.8 lb/gal

EPA Reg. No. 62719-3

Keep Out of Reach of Children

DANGER PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. Refer to the label booklet under "Agricultural Use Requirements" in the Directions for Use section for information about this standard.

Refer to inside of label booklet for Directions for Use.

Notice: Read the entire label. Use only according to label directions. **Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies at end of label booklet. If terms are unacceptable, return at once unopened.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Precautionary Statements

Hazards to Humans and Domestic Animals

DANGER

Corrosive • Causes Irreversible Eye Damage • Harmful If Swallowed, Inhaled Or Absorbed Through The Skin

Do not get in eyes, on skin, or on clothing. Avoid breathing vapor or spray mist. Wash thoroughly with soap and water after handling.

Personal Protective Equipment (PPE)

Some materials that are chemical-resistant to this product are made of any waterproof material. If you want more options, follow the instructions for category A on an EPA chemical resistance category selections chart.

All pilots must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks

All mixers, loaders, flaggers, other applicators and handlers must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks
- Chemical-resistant gloves
- Protective eyewear
- Chemical resistant apron when mixing or loading, cleaning up spills or equipment, or otherwise exposed to the concentrate

See engineering controls for additional requirements.

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Controls

When handlers use closed systems or enclosed cabs in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

Pilots must use an enclosed cockpit that meets the requirements listed in the Worker Protections Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d)(4-6)].

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

First Aid

If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

If on skin or clothing: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

If swallowed: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.

If inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment.

Note to Physician: Probable mucosal damage may contraindicate the use of gastric lavage.

Environmental Hazards

This product is toxic to fish and aquatic invertebrates. For terrestrial uses: Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Drift or runoff may adversely affect aquatic invertebrates and non-target plants. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas. Do not contaminate water when disposing of equipment washwaters or rinsate.

This chemical has properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination. Application around a cistern or well may result in contamination of drinking water or groundwater.

Aquatic Weed Control: Fish breathe dissolved oxygen in the water and decaying weeds also use oxygen. When treating continuous, dense weed masses, it may be appropriate to treat only part of the infestation at a time. For example, apply the product in lanes separated by untreated strips that can be treated after vegetation in treated lanes has disintegrated. During the growing season, weeds decompose in a 2 to 3 week period following treatment. Begin treatment along the shore and proceed outwards in bands to allow fish to move into untreated areas. Waters having limited and less dense weed infestations may not require partial treatments.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 48 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Chemical-resistant gloves made of any waterproof material
- Shoes plus socks
- Protective eyewear

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for Agricultural Pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Entry Restrictions for Non-WPS Uses: Do not enter or allow people (or pets) to enter the treated area until sprays have dried.

Storage and Disposal

Do not contaminate water, food, or feed by storage or disposal.
Pesticide Storage: Keep container tightly closed when not in use. If exposed to subfreezing temperatures, the product should be warmed to at least 40°F and mixed thoroughly before using.
Pesticide Disposal: Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law and may contaminate groundwater. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

Nonrefillable containers 5 gallons or less:
Container Handling: Nonrefillable container. Do not reuse or refill this container.
Triple rinse or pressure rinse container (or equivalent) promptly after emptying. **Triple rinse** as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. **Pressure rinse** as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip. Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Refillable containers larger than 5 gallons:
Container Handling: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or a mix tank. Fill the container about 10% full with water and, if possible, spray all sides while adding water. If practical, agitate vigorously or recirculate water with the pump for two minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times. Then offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Nonrefillable containers 5 gallons or larger:
Container Handling: Nonrefillable container. Do not reuse or refill this container.
Triple rinse or pressure rinse container (or equivalent) promptly after emptying. **Triple rinse** as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container 1/4 full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. **Pressure rinse** as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip. Then offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Product Information

DMA® 4 IVM herbicide is intended for selective control of many broadleaf weeds in forests, ornamental turfgrass, non-cropland and aquatic areas. Also for control of trees by injection.

Apply DMA 4 IVM as a water or oil-water spray during warm weather when target weeds or woody plants are actively growing. Application under drought conditions will often give poor results. Use low spray pressure to minimize drift. Generally, the lower dosages specified on this label will be satisfactory for young, succulent growth of susceptible weed species. For less susceptible species and under conditions where control is more difficult, use higher specified rates. Deep-rooted perennial weeds such as Canada thistle and field bindweed and many woody plants usually require repeated applications for satisfactory control. Consult your State Agricultural Experiment stations or Extension Service Weed Specialists for recommendations from this label that best fit local conditions.

Use Precautions and Restrictions

Be sure that use of DMA 4 IVM conforms to all application regulations.

Chemigation: Do not apply this product through any type of irrigation system.

Excessive amounts of 2,4-D in the soil may temporarily inhibit seed germination and plant growth.

Use of this product in certain portions of California, Oregon, and Washington is subject to the January 22, 2004 Order for injunctive relief in Washington Toxics Coalition et al. v. EPA, C01-0132C, (W.D. W.A.). For further information, please refer to EPA website: http://www.epa.gov/espp/litstatus/wtc/index.htm.

Spray Drift Management

A variety of factors including weather conditions (e.g., wind direction, wind speed, temperature, relative humidity) and method of application (e.g., ground, aerial, airblast) can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying this product.

Droplet Size
When applying sprays that contain 2,4-D as the sole active ingredient, or when applying sprays that contain 2,4-D mixed with active ingredients that require a coarse or coarser spray, apply only as a coarse or coarser spray (ASABE Standard 572) or a volume mean diameter of 385 microns or greater for spinning atomizer nozzles.

When applying sprays that contain 2,4-D mixed with other active ingredients that require a medium or more fine spray, apply only as a medium or coarser spray (ASABE Standard 572) or a volume mean diameter of 300 microns or greater for spinning atomizer nozzles.

Wind Speed
Do not apply at wind speeds greater than 15 mph. Only apply this product if the wind direction favors on-target deposition and there are not sensitive areas (including residential areas, bodies of water, known habitat for nontarget species, nontarget crops) within 250 feet downwind. If applying a medium spray, leave one swath unsprayed at the downwind edge of the treated field.

Temperature Inversions
If applying at wind speeds less than 3 mph, the applicator must determine if: a) conditions of temperature inversion exist, or b) stable atmospheric conditions exist at or below nozzle height. Do not make applications into areas of temperature inversions or stable atmospheric conditions.

Susceptible Plants
Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or crops thereof rendered unfit for sale, use or consumption. Susceptible crops include

cotton, okra, flowers, fruit trees, grapes (in growing stage), fruit trees (foliage), soybeans (vegetative stage), ornamentals, sunflowers, tomatoes, beans, and other vegetables, or tobacco. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Other State and Local Requirements
Applicators must follow all state and local pesticide drift requirements regarding application of 2,4-D herbicides. Where states have more stringent regulations, they must be observed.

Equipment
All aerial and ground application equipment must be properly maintained and calibrated using appropriate carriers or surrogates.

Aerial Application
The boom length must not exceed 75% of the wingspan or 90% of the rotor blade diameter.

Release spray at the lowest height consistent with efficacy and flight safety. Do not release spray at a height greater than 10 feet above the crop canopy unless a greater height is required for aircraft safety. This requirement does not apply to forestry or rights-of-way applications.

When applications are made with a crosswind, the swath will be displaced downwind. The applicator must compensate for this by adjusting the path of the aircraft upwind.

Groundboom Application
Do not apply with a nozzle height greater than 4 feet above the crop canopy.

Mixing

Mix DMA 4 IVM only with water unless otherwise directed on this label. Add about half of the water to the mixing tank, then add the DMA 4 IVM with agitation, and finally the rest of the water with continuing agitation.

Note: Adding oil, wetting agent, or other surfactant to the spray mixture may increase effectiveness on weeds, but also may reduce selectivity to crops resulting in crop damage.

Tank Mixing: When tank mixing, read and follow the label of each tank mix product used for precautionary statements, directions for use, weeds controlled, and geographic and other restrictions. Use in accordance with the most restrictive of label limitations and precautions. Do not exceed any active ingredient's maximum use rates when tank mixing. Do not tank mix this product with any product containing a label prohibition against tank mixing with 2,4-D.

Tank Mix Compatibility Testing: A jar test is recommended prior to tank mixing to ensure compatibility of this product and other pesticides. Use a clear glass quart jar with lid and mix the tank mix ingredients in their relative proportions. Invert the jar containing the mixture several times and observe the mixture for approximately 1/2 hour. If the mixture balls-up, forms flakes, sludges, jels, oily films or layers, or other precipitates, it is not compatible and the tank mix combination should not be used.

Mixing with Liquid Nitrogen Fertilizer
This product may be combined with liquid nitrogen fertilizer suitable for foliar application to accomplish broadleaf weed control and fertilization of corn, small grains or pastures in a single operation. Use DMA 4 IVM in accordance with directions for these crops provided in this label. Use liquid fertilizer at rates recommended by the supplier or Extension Service Specialist. Test for mixing compatibility as describe above before mixing in spray tank. A compatibility aid such as Unite or Compex may be needed in some situations. Compatibility is best with liquid fertilizer solutions containing only nitrogen. Mixing with N-P-K solutions may not be satisfactory, even with the addition of a compatibility aid. Pre-mixing 1 part DMA 4 IVM with up to 4 parts water may help in situations when mixing difficulty occurs.

Fill the tank about half full with the liquid fertilizer, then add the required amount of DMA 4 IVM with agitation.. Maintain agitation and complete filling the tank with liquid fertilizer. Apply immediately and continue agitation in spray tank during application. **Do not store the spray mixture.** Application during very cold weather (near freezing) is not advisable.

Sprayer Clean-Out
To avoid injury to desirable plants, equipment used to apply this product should be thoroughly cleaned before re-use or applying other chemicals.

1. Rinse and flush application equipment thoroughly after use at least three times with water. Dispose of all rinse water by application to treatment area or apply to non-cropland area away from water supplies.
2. During the second rinse, add 1 quart of household ammonia for every 25 gallons of water. Circulate the solution through the entire system so that all internal surfaces are contacted (15 to 20 min). Let the solution stand for several hours, preferably overnight.
3. Flush the solution out of the spray tank through the boom.
4. Rinse the system twice with clean water, recirculating and draining each time.
5. Remove nozzles and screens and clean separately.
6. If equipment is to be used to apply another pesticide or agricultural chemical to a 2,4-D susceptible crop, additional steps may be required to remove all traces of 2,4-D, including cleaning of disassembled parts and replacement of hoses or other fittings that may contain absorbed 2,4-D.

Application

Apply with calibrated air or ground equipment using sufficient spray volume to provide adequate coverage of target weeds or as otherwise directed in specific use directions. For broadcast application, use a spray volume of 3 gallons or more per acre by air and 10 gallons or more per acre for ground equipment. Where states have regulations which specify minimum spray volumes, they should be observed. In general, spray volume should be increased as crop canopy, height and weed density increase in order to obtain adequate spray coverage. **Do not apply less than 3 gallons total spray volume per acre.**

Rate Ranges and Application Timing
The lower dosages given will be satisfactory for young, succulent growth of sensitive weed species. For less sensitive species and under conditions where control is more difficult, the higher dosages will be needed. Apply DMA 4 IVM during warm weather when weeds are young and actively growing.

Spot Treatments
To prevent misapplication, spot treatments should be applied with a calibrated boom or with hand sprayers using a fixed spray volume per 1000 sq ft as indicated below.

Hand-Held Sprayers: Hand-held sprayers may be used for spot applications of DMA 4 IVM. Care should be taken to apply the spray uniformly and at a rate equivalent to a broadcast application. Application rates in the table are based upon the application rate for an area of 1000 sq ft. Mix the amount of DMA 4 IVM (fl oz or ml) corresponding to the desired broadcast rate in 1 to 3 gallons of spray. To calculate the amount of DMA 4 IVM required for larger areas, multiply the table value (fl oz or ml) by the thousands of sq ft to be treated. An area of 1000 sq ft is approximately 10.5 X 10.5 yards (strides) in size.

Rate Conversion Table for Spot Treatment:

Label Broadcast Rate (pint/acre)							
1/2	2/3	3/4	1	2	3	4	8
Equivalent Amount of DMA 4 IVM per 1000 sq ft							
1/5 fl oz[1] (5.5 ml)	1/4 fl oz (7.3 ml)	1/3 fl oz (8.3 ml)	3/8 fl oz (11 ml)	3/4 fl oz (22 ml)	1 fl oz (33 ml)	1 1/2 fl oz (44 ml)	3 fl oz (88 ml)

[1]Conversion factors: 1 fl oz = 29.6 (30) ml

Band Application: DMA 4 IVM may be applied as a band treatment. Use the formulas below to determine the appropriate rate and volume per treated acre.

$$\frac{\text{Band width in inches}}{\text{Row width in inches}} \times \text{Broadcast rate per acre} = \text{Band rate per treated acre}$$

$$\frac{\text{Band width in inches}}{\text{Row width in inches}} \times \text{Broadcast volume per acre} = \text{Band volume per treated acre}$$

Weeds Controlled

Annual or Biennial Weeds

beggarticks[1]
bittercress, smallflowered
bitterweed
broomweed, common[1]
burdock, common
buttercup, smallflowered[1]
carpetweed
cinquefoil, common
cinquefoil, rough
cocklebur, common
coffeeweed
copperleaf, Virginia
croton, Texas
croton, woolly
flixweed
galinsoga
geranium, Carolina
hemp, wild
horseweed (marestail)
jewelweed
jimsonweed
knotweed[1]
kochia
lambsquarters, common
lettuce, prickly[1]
lettuce, wild
lupines
mallow, little[1]
mallow, Venice[1]
marshelder
morningglory, annual
morningglory, ivy
morningglory, woolly
mousetail
mustards (except blue mustard)
parsnip, wild
pennycress, field
pepperweed[1]
pigweeds (*Amaranthus* spp.)[1]
poorjoe
primrose, common
purslane, common
pusley, Florida
radish, wild
ragweed, common
ragweed, giant
rape, wild
rocket, yellow
salsify, common[1]
salsify, western[1]
shepherdspurse
sicklepod
smartweed (annual species)[1]
sneezeweed, bitter
sowthistle, annual
sowthistle, spiny
spanishneedles
sunflower
sweetclover
tansymustard
thistle, bull
thistle, musk[1]
thistle, Russian (tumbleweed)[1]
velvetleaf
vetches

Perennial Weeds

alfalfa[1]
artichoke, Jerusalem[1]
aster, many-flower[1]
Austrian fieldcress[1]
bindweed (hedge, field and European)[1]
blue lettuce
blueweed, Texas
broomweed
bullnettle[1]
carrot, wild[1]
catnip
chicory
clover, red[1]
coffeeweed
cress, hoary[1]
dandelion[1]
docks[1]
dogbanes[1]
eveningprimrose, cutleaf
garlic, wild[1]
goldenrod
hawkweed, orange[1]
healal
ironweed, western
ivy, ground[1]
Jerusalem artichoke
loco, bigbend
nettles (including stinging)[1]
onion, wild[1]
pennywort
plantains
ragwort, tansy[1]
sowthistle, perennial
thistle, Canada[1]
vervains[1]
waterplantain
wormwood

[1]These weeds are only partially controlled and may required repeat applications and/or use of higher specified rates of this product even under ideal conditions of application.

Specific Use Directions

Forestry and Non-Cropland Areas

Agricultural Use Requirements for Forest Use (Except Tree Injection Use): For use in forests, follow PPE and re-entry instructions in the Agricultural Use Requirements section under the Directions for Use heading of this label.

Agricultural Use Requirements for Forest (Tree Injection Only) and Non-Cropland Areas: When this product is applied to non-cropland areas, and when applied by tree injection in forest sites, follow re-entry requirements given in the Non-Agricultural Use Requirements section under the Directions for Use heading of this label.

Forestry Uses
Forest site preparation, forest roadsides, brush control, established conifer release (including Christmas trees and reforestation areas)

Treatment Site/ Method of Application	DMA 4 IVM	Specific Use Directions
annual weeds biennial and perennial broadleaf weeds and susceptible woody plants	2 - 4 pt/acre 4 - 8 pt/acre	Apply when weeds are small and growing actively before the bud stage. Apply when biennial and perennial species are in the seedling to rosette stage and before flower stalks appear. For difficult to control perennial broadleaf weeds and woody species, use up to 1 gallon of DMA 4 IVM and 1 to 4 quarts of Garlon® 3A herbicide per acre. For conifer release, make application in early spring before budbreak of conifers when weeds are small and actively growing.
spot treatment to control broadleaf weeds	1.28 fl oz/gal of spray solution (see instructions for Spot Treatment)	**Note:** To control broadleaf weeds in small areas with a hand sprayer, use an application rate equivalent to the specified broadcast rate and spray to thoroughly wet all foliage. Mix 1.28 fl oz per gallon of spray solution and apply through pump up sprayer or backpack sprayer. Addition of a non ionic surfactant is recommended to improve coverage. See rate conversion table and instructions for Spot Treatment and use of hand-held sprayers under Application.
conifer release: species such as white pine, ponderosa pine, jack pine, red pine, black spruce, white spruce, red spruce, and balsam fir	1 1/2 - 3 qt/acre	To control competing hardwood species such as alder, aspen, birch, hazel, and willow, apply from mid to late summer when growth of conifer trees has hardened off and woody plants are still actively growing. Apply with ground or air equipment, using sufficient spray volume to ensure complete coverage. Because this treatment may cause occasional conifer injury, do not apply if such injury cannot be tolerated.
directed spray: Conifer plantations including pine	4 qt/100 gal	Apply when brush or weeds are actively growing by directing the spray so as to avoid contact with conifer foliage and injurious amounts of spray. Apply in oil, oil-water, or water carrier in a spray volume of 10 to 100 gallons per acre.
basal spray (may also be used in rangeland, pastures, and noncropland)	8 qt/100 gal or	Thoroughly wet the base and root collar of all stems until the spray begins to accumulate around the root collar at the ground line. Wetting stems with the mixture may also aid in control.
surface of cut stumps (may also be used in rangeland, pastures, and noncropland)	2.5 fl oz/gal of water	Apply as soon as possible after cutting trees. Thoroughly soak the entire stump with the 2,4-D mixture including cut surface, bark and exposed roots.
frill and girdle (may also be used in rangeland, pastures, and noncropland)		Cut frills (overlapping V-shaped notches cut downward through the bark in a continuous ring around the base of the tree) using an axe or other suitable tool. Treat freshly cut frills with as much of the 2,4-D mixture as they will hold.

Forestry Uses
Forest site preparation, forest roadsides, brush control, established conifer release (including Christmas trees and reforestation areas) (Cont.)

Treatment Site/ Method of Application	DMA 4 IVM	Specific Use Directions
tree injection application (may also be used in rangeland, pastures, and noncropland)	(1 - 2 ml per injection site)	To control unwanted hardwood trees such as elm, hickory, oak, and sweetgum in forests and other non-crop areas, apply by injecting at a rate of 1 ml of undiluted DMA 4 IVM per inch of trunk diameter at breast height (DBH) as measured approximately 4 1/2 ft above the ground. However, injection should occur as close to the root collar as possible and the injection bit must penetrate the inner bark. Applications may be made throughout the year, but for best results apply between May 15 and October 15. Maples should not be treated during the spring sap flow. For hard to control species such as ash, maple, and dogwood use 2 ml of undiluted DMA 4 IVM per injection site or double the number of 1 ml injections. **Note: No Worker Protection Standard worker entry restrictions or worker notification requirements apply when this product is directly injected into agricultural plants.**

Precautions and Restrictions:
- Do not allow sprays to contact conifer shoot growth (current year's new growth) or injury may occur.
- Do not apply to nursery seed beds.
- For conifer release, do not use on plantations where pine or larch are among the desired species.
- For broadcast applications, do not apply more than 8.42 pints of DMA 4 IVM (4 lb of acid equivalent) per acre per 12-month period.
- Limited to 1 broadcast application per year
- For basal spray, cut surface stumps, and frill applications, do not apply more than 16.84 pints of DMA 4 IVM (8 lb of acid equivalent) per 100 gallons of spray solution.

Non-Cropland Areas
Such as fencerows, hedgerows, roadsides, drainage ditches, rights-of way, utility power lines, railroads, airports, and other non-crop areas

Treatment Site/ Method of Application	DMA 4 IVM (pint/acre)	Specific Use Directions
annual broadleaf weeds biennial and perennial broadleaf weeds susceptible woody plants on rights-of-way	2 - 4 4 4 - 8	Apply when annual weeds are small and growing actively before the bud stage. Biennial and perennial weeds should be rosette to bud stage, but not flowering at the time of application. For difficult to control perennial broadleaf weeds and woody species, tank mix up to 1 gallon of DMA 4 IVM plus 1 to 4 quarts of Garlon 3A per acre. **For ground application:** (High volume) apply a total of 100 to 400 gallons per acre; (low volume) apply a total of 10 to 100 gallons per acre. **For helicopter:** Apply a total of 5 to 30 gallons per acre spray volume.
spot treatment to control broadleaf weeds	1.28 fl oz/gal of spray solution (see instructions for Spot Treatment)	**Note:** To control broadleaf weeds in small areas with a hand sprayer, use an application rate equivalent to the broadcast rate specified for this treatment site and spray to thoroughly wet all foliage. Mix 1.28 fl oz per gallon of spray solution and apply through pump up sprayer or backpack sprayer. Addition of a non ionic surfactant is recommended to improve coverage. See rate conversion table and instructions for Spot Treatment and use of hand-held sprayers under Application.
tree injection application		See instructions for tree injection application in Forestry Uses section.
southern wild rose broadcast application spot treatment	 up to 4 1.28 fl oz/gal of spray solution	Broadcast: Apply in a spray volume of 5 gallons or more per acre by aircraft or 10 gallons or more per acre by ground equipment. Apply when foliage is well developed. Thorough coverage is required. Mix 1.28 fl oz per gallon of spray solution and apply through pump up sprayer or backpack sprayer. Addition of a non ionic surfactant is recommended to improve coverage. Two or more treatments may be required.

Precautions and Restrictions:
- Do not apply to newly seeded areas until grass is well established.
- Bentgrass, St. Augustine, clover, legumes and dichondra may be severely injured or killed by this treatment.
- **Annual and perennial weeds:** Do not apply more than 4.21 pints of DMA 4 IVM (2 lb of acid equivalent) per acre per application. Do not make more than two applications per season. Do not reapply to a treated area within 30 days of a previous application.
- **Woody plants:** Do not apply more than 8.42 pints of DMA 4 IVM (4 lb of acid equivalent) per acre per use season. Do not make more than one application per season.
- Applications to non-cropland areas are not applicable to treatment of commercial timber or other plants being grown for sale or other commercial uses, or for commercial seed production, or for research purposes.

Turfgrass Uses

Ornamental Turfgrass (Excluding Grasses Grown for Seed or Sod Farms)
(Includes cemeteries and parks, airfields, roadsides, vacant lots, drainage ditch banks)

Use Requirements for Ornamental Turfgrass Areas: When this product is applied to ornamental turfgrass areas, follow PPE and reentry instructions in the Non-Agricultural Use Requirements section of this label.

Treatment Site/ Application Timing	DMA 4 IVM (pint/acre)	Specific Use Directions
ornamental turfgrass (postemergence) seedling grass (five-leaf stage or later) well-established grasses biennial and perennial broadleaf weeds	 3/4 - 1 2 - 3 3	Apply when weeds are small and actively growing. For best results, apply when soil moisture is adequate for active weed growth. Deep-rooted perennial weeds such as bindweed and Canada thistle may require repeat applications. Do not apply to newly seeded grasses until well established (five-leaf stage or later) and then use a maximum of 1 pint per acre. Cool season grasses are tolerant of higher rates.

Precautions and Restrictions:
- Do not use on creeping grasses such as bent except as a spot treatment.
- Do not use on injury-sensitive southern grasses such as St. Augustinegrass.
- Do not use on dichondra or other herbaceous ground covers. Legumes may be damaged or killed.
- Do not reapply within 21 days of a previous application.
- **Reseeding:** Delay reseeding at least 30 days following application. Preferably, with spring application, reseed in the fall and with fall application, reseed in the spring.
- Do not apply more than 2 broadcast applications per year per treatment site (does not include spot treatments).
- Do not apply more than 6.32 pints per acre of DMA 4 IVM (3 lb of acid equivalent) per year.

Aquatic Uses

Use Requirements for Aquatic Areas: When this product is applied to aquatic areas, follow PPE and re-entry instructions in the Non-Agricultural Use Requirements section of this label.

Control of Weeds and Brush on Banks of Irrigation Canals and Ditches

Target Plants	DMA 4 IVM (pint/acre)	Specific Use Directions
annual weeds biennial and perennial broadleaf weeds and susceptible wood plants	2 to 4 4	Apply using low pressure spray (10 to 40 psi) in a spray volume of 20 to 100 gallons per acre using power operated spray equipment. Apply when wind speed is low, 5 mph or less. Apply working upstream to avoid accidental concentration of spray into water. Cross-stream spraying to opposite banks is not permitted and avoid boom spraying over water surface. When spraying shoreline weeds, allow no more than a 2-foot overspray onto water surface with an average of less than 1 foot of overspray to prevent significant water contamination. Apply when weeds are small and growing actively before the bud stage. Apply when biennial and perennial species are in the seedling to rosette stage and before flower stalks appear. For hard to control weeds, a repeat application after 30 days at the same rate may be needed. For woody species and patches of perennial weeds, mix 1 gallon of DMA 4 IVM per 64 to 150 gallons of total spray. Wet foliage by applying about 3 to 4 gallons of spray per 1000 sq ft (10.5 X 10.5 steps).

Restrictions and Limitations:
- Do not apply more than 2 treatments per season or reapply within 30 days.
- Use 2 gallons or more of spray solution per acre.
- Do not apply more than 4.21 pints (2 lb of acid equivalent) per acre per application or more than 8.42 pints (4 lb of acid equivalent) per acre per use season.

Do not use on small canals with a flow rate less than 10 cubic feet per second (CFS) where water will be used for drinking purposes. CFS may be estimated by using the formula below. The aproximate velocity needed for the calculation can be detemrined by observing the length of time that it takes a floating object to travel a defined distance. Divide the distance (ft) by the time (sec) to estimate velocity (ft per sec). Repeat 3 times and use the average to calculate CFS.

Average Width (ft) x Average Depth (ft) x Average Velocity (ft per sec) = CFS

For ditchbank weeds: Do not spray cross-stream to opposite bank. Do not allow boom spray to be directed onto water.

For shoreline weeds: Boom spraying onto water surface must be held to a minimum and allow no more than a 2-foot overspray onto water with an average of less than 1 foot overspray to prevent introduction of greater than negligible amounts of chemical into the water.

Aquatic Weed Control in Ponds, Lakes, Reservoirs, Marshes, Bayous, Drainage Ditches, Canals, Rivers and Streams That are Quiescent or Slow Moving, Including Programs of the Tennessee Valley Authority

Notice to Applicators: Before application, coordination and approval of local and state authorities may be required, either by letter or agreement or issuance of special permits for aquatic applications.

Emergent and Floating Aquatic Weeds: Including Water hyacinth (*Eichornia crassipe*)
Application Rate: 2 to 4 quarts per acre.

Specific Use Directions
Application Timing: Spray weed mass only. Apply when water hyacinth plants are actively growing. Repeat application as necessary to kill regrowth and plants missed in previous operation. Use the 4 quart per acre rate when plants are mature or when weed mass is dense.

Surface Application: Use power operated sprayers with boom or spray gun mounted on boat, tractor or truck. Thorough wetting of foliage is essential for maximum control. Use 100 to 400 gallons of spray mixture per acre. Special precautions such as use of low pressure, large nozzles and spray thickening agents should be taken to avoid spray drift to susceptible crops. Follow label directions for use of any drift control agent.

Aerial Application: Use drift control spray equipment or thickening agent mixed in the spray mixture. Apply 1 gallon of DMA 4 IVM per acre using standard boom systems using a minimum spray volume of 5 gallons per acre. For Microfoil drift control spray systems, apply DMA 4 IVM in a total spray volume of 12 to 15 gallons per acre.

Restrictions and Limitations for Surface Applications to Emergent Aquatic Weeds
- Do not exceed 8.42 pints per acre (4 lb of acid equivalent) per surface acre per
- Spot treatments are permitted.
- Limited to two applications per season.
- Minimum of 21 days between applications.

Fish breathe dissolved oxygen in the water and decaying weeds also use oxygen. When treating continuous, dense weed masses, it may be appropriate to treat only part of the infestation at a time. For example, apply the product in lanes separated by untreated strips that can be treated after vegetation in treated lanes has disintegrated. During the growing season, weeds decompose in a 2 to 3 week period following

treatment. Waters having limited and less dense weed infestations may not require partial treatments. Other local factors such as water exchange and sediment load can also influence the dissolved oxygen level. Coordination and approval of local and state authorities may be required, either by letter of agreement or issuance of special permits for aquatic applications.

Water Use:

1. **Water for irrigation or sprays:**
   A. If treated water is intended to be used only for crops or non-crop areas that are labeled for direct treatment with 2,4-D such as pastures, turfgrass or cereal grains, the treated water may be used to irrigate and/or mix sprays for these sites at anytime after the 2,4-D aquatic application.
   B. Due to potential phytotoxicity considerations, the following restrictions are applicable: If treated water is intended to be used to irrigate or mix sprays for plants grown in commercial nurseries and greenhouses; and other plants or crops that are not labeled for direct treatment with 2,4-D, the water must not be used unless one of the following restrictions has been observed:
      i. A setback distance from functional water intake(s) of ≥600 ft. was used for the application, or,
      ii. A waiting period of 7 days from the time of application has elapsed, or,
      iii. An approved assay indicates that the 2,4-D concentration is 100 ppb (0.1 ppm) or less at the water intake. Wait at least 3 days after application before initial sampling at water intake.
2. **Drinking water (potable water):**
   A. Consult with appropriate state or local water authorities before applying this product to public waters. State or local agencies may require permits. The potable water use restrictions on this label are to ensure that consumption of water by the public is allowed only when the concentration of 2,4-D in the water is less than the MCL (Maximum Contaminant Level) of 70 ppb. Applicators should consider the unique characteristics of the treated waters to assure that 2,4-D concentrations in potable water do not exceed 70 ppb at the time of consumption.
   B. For floating and emergent weed applications, the drinking water setback distance from functioning potable water intakes is ≥600 ft.
   C. If no setback distance of ≥600 ft. is used for the application, applicators or the authorizing organization must provide a drinking water notification prior to a 2,4-D application to the party responsible for a public water supply or to individual private water users. Notification to the party responsible for a public water supply or to individual private water users must be done in a manner to assure that the party is aware of a water use restrictions when this product is applied to potable water.

The following is an example of an example of notification via posting, but other methods of notification which convey the above restrictions may be used and may be required in some cases under state or local law or as a condition of a permit.

Example:
Posting notification should be located every 250 feet including the shoreline of the treated area and up to 250 feet of shoreline past the application site to include immediate public access points. Posting must include the day and time of application. Posting may be removed if analysis of a sample collected at the intake 3 days or more following application shows that the concentration in the water is less than 70 ppb (100 ppb for irrigation or sprays), or after 7 days following application, whichever occurs first.

Text of notification: Wait 7 days before diverting functioning surface water intakes from the treated aquatic site to use as drinking water, irrigation, or sprays, unless water at functioning drinking water intakes is tested at least 3 days after application and is demonstrated by assay to contain not more than 70 ppb 2,4-D (100 ppb for irrigation or sprays).
Application Date: _____ Time: _____ .

   D. Following each application of this product, treated water must not be used for drinking water unless one of th following restrictions has been observed:
      i. A setback distance from functional water intake(s) of ≥600 ft. was used for the application, or,
      ii. A waiting period of at least 7 days from the time of application has elapsed, or,
      iii. An approved assay indicates that the 2,4-D concentration is 70 ppb (0.07 ppm) or less at the water intake. Sampling for drinking water analysis should occur no sooner than 3 days after 2,4-D application. Analysis of samples must be completed by a laboratory that is certified under the Safe Drinking Water Act to perform drinking water analysis using a currently approved version of analytical Method Number 515, 555, other methods for 2,4-D as may be listed in Title 40 CFR Part 141.24, or Method Number 4015 (immunoassay of 2,4-D) from U.S. EPA Test Methods for Evaluating Solid Waste SW-846.
   E. Note: Existing potable water intakes that are no longer in use, such as those replaced by a connection to a municipal water system or a potable water well, are not considered to be functioning potable water intakes.
   F. Drinking water setback distances do not apply to terrestrial applications of 2,4-D adjacent to water bodies with potable water intakes.

Submerged Aquatic Weeds: Including Eurasian Water Milfoil (*Myriophyllum spicatum*)

Treatment Site	Maximum Application Rate[1]	Specific Use Directions
aquatic weed control in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, rivers and streams that are quiescent or slow moving, including programs of the Tennessee Valley Authority	2.84 gallons (10.8 lb of acid equivalent) per acre foot	**Application Timing:** For best results, apply in spring or early summer when aquatic weeds appear. Check for weed growth in areas heavily infested the previous year. A second application may be needed when weeds show signs of recovery, but no later than mid-August in most areas. **Subsurface Application:** Apply DMA 4 IVM undiluted directly to the water through a boat mounted distribution system. Shoreline areas should be treated by subsurface injection application by boat to avoid aerial drift. **Surface Application:** Use power operated boat mounted boom sprayer. If rate is less than 5 gallons per acre, dilute to a minimum spray volume of 5 gallons per surface acre. **Aerial Application:** Use drift control spray equipment or thickening agents mixed with sprays to reduce drift. Apply through standard boom systems in a minimum spray volume of 5 gallons per surface acre. For Microfoil drift control spray systems, apply DMA 4 IVM in a total spray volume of 12 to 15 gallons per acre. Apply to attain a concentration of 2 to 4 ppm (see table below).

[1]DMA 4 IVM contains 3.8 lb of acid equivalent per gallon of product.

Table 1: Amount to Apply for a Target Subsurface Concentration

Surface Area	Average Depth (ft)	For typical conditions – 2 ppm (2,4-D a.e./ acre)	For typical conditions – 2 ppm (DMA 4 IVM gal/acre)	For difficult conditions – 4 ppm* (2,4-D a.e./acre)	For difficult conditions – 4 ppm* (DMA 4 IVM gal/ acre)
1 acre	1	5.4	1.42	10.8	2.84
	2	10.8	2.84	21.6	5.68
	3	16.2	4.26	32.4	8.53
	4	21.6	5.68	43.2	11.37
	5	27.0	7.10	54.0	14.21

*Examples include spot treatments of pioneer colonies of eurasian water milfoil and certain difficult to control aquatic species.

Restrictions and Limitations for Aquatic Sites With Submersed Weeds
Do not exceed 10.8 lb acid equivalent per acre foot.

Fish breathe oxygen in the water and a water-oxygen ratio must be maintained. Decaying weeds use up oxygen, but during the period when applications should be made, the weed mass is fairly sparse and the weed decomposition rate is slow enough that the water-oxygen ratio is not disturbed by treating the entire area at one time. If treatments must be applied later in the season when the weed mass is dense and repeat treatments are needed, apply product in lanes, leaving buffer strips which can then be treated when vegetation in treated lanes has disintegrated. During the growing season, weeds decompose in a 2- to 3-week period following treatment.

Do not apply within 21 days of previous application. Limited to 2 applications per season.

When treating moving bodies of water, applications must be made while traveling upstream to prevent concentration of 2,4-D downstream from the application.

Coordination and approval of local and state authorities may be required, either by letter of agreement or issuance of special permits for such use.

Water Use:

1. **Water for irrigation or sprays:**
   - A. If treated water is intended to be used only for crops or non-crop areas that are labeled for direct treatment with 2,4-D such as pastures, turfgrass or cereal grains, the treated water may be used to irrigate and/or mix sprays for these sites at anytime after the 2,4-D aquatic application.
   - B. Due to potential phytotoxicity and/or residue considerations, the following restrictions are applicable:

     If treated water is intended to be used to irrigate or mix sprays for unlabeled crops, non-crop areas or other plants not labeled for direct treatment with 2,4-D, the water must not be used unless one of the following restrictions has been observed:
     - i) A setback distance described in the Drinking Water Setback Table was used for the application, or,
     - ii) A waiting period of 21 days from the time of application has elapsed, or,
     - iii) An approved assay indicates that the 2,4-D concentration is 100 ppb (0.1 ppm) or less at the water intake. See Table 3 for the waiting period after application but before taking the initial sampling at water intake.

2. **Drinking water (potable water):**
   - A. Consult with appropriate state or local water authorities before applying this product to public waters. State or local agencies may require permits. The potable water use restrictions on this label are to ensure that consumption of water by the public is allowed only when the concentration of 2,4-D in the water is less than the MCL (Maximum Contaminant Level) of 70 ppb. Applicators should consider the unique characteristics of the treated waters to assure that 2,4-D concentrations in potable water do not exceed 70 ppb at the time of consumption.
   - B. For submersed weed applications, the drinking water setback distances from functioning potable water intakes are provided in Table 2 Drinking Water Setback Distance (below).
   - C. If no setback distance from the Drinking Water Setback Table (Table 2) is to be used for the application, applicators or the authorizing organization must provide a drinking water notification and an advisory to shut off all potable water intakes prior to a 2,4-D application. Notification to the party responsible for a public water supply or to individual private water users must be done in a manner to assure that the party is aware of the water use restrictions when this product is applied to potable water.

     The following is an example of an example of notification via posting, but other methods of notification which convey the above restrictions may be used and may be required in some cases under state or local law or as a condition of a permit.

     Example:
     Posting notification should be located every 250 feet including the shoreline of the treated area and up to 250 feet of shoreline past the application site to include immediate public access points. Posting should include the day and time of application. Posting may be removed if analysis of a sample collected at the intake no sooner than stated in Table 3 (below) shows that the concentration in the water is less than 70 ppb (100 ppb for irrigation or sprays), or after 21 days following application, whichever occurs first.

     Text of notification: Wait 21 days before diverting functioning surface water intakes from the treated aquatic site to use as drinking water, irrigation, or sprays, unless water at functioning drinking water intakes is tested no sooner than (insert days from Table 3) and is demonstrated by assay to contain not more than 70 ppb 2,4-D (100 ppb for irrigation or sprays).
     Application Date: _____ Time: _____ .
   - D. Following each application of this product, treated water must not be used for drinking water unless one of the following restrictions has been observed:
     - i) A setback distance described in the Drinking Water Setback Distance Table was used for the application, or,
     - ii) A waiting period of at least 21 days from the time of application has elapsed, or,
     - iii) An approved assay indicates that the 2,4-D concentration is 70 ppb (0.07 ppm) or less at the water intake. Sampling for drinking water analysis should occur no sooner than stated in Table 3. Analysis of samples must be completed by a laboratory that is certified under The Safe Drinking Water Act to perform drinking water analysis using a currently approved version of analytical Method Number 515, 555, other methods for 2,4-D as may be listed in Title 40 CFR, Part 141.24, or Method Number 4015 (immunoassay of 2,4-D) from U.S. EPA Test Methods for Evaluating Solid Waste SW-846.
   - E. Note: Existing potable water intakes that are no longer in use, such as those replaced by a connection to a municipal water system or a potable water well, are not considered to be functioning potable water intakes.
   - F. Drinking water setback distances do not apply to terrestrial applications of 2,4-D adjacent to water bodies with potable water intakes.

Table 2: Drinking Water Setback Distance for Submersed Weed Applications

Application Rate and Minimum Setback Distance (feet) From Functioning Potable Water Intake			
1 ppm*	2 ppm*	3 ppm*	4 ppm*
600	1200	1800	2400

*ppm acid equivalent target water concentration

Table 3: Sampling for Drinking Water Analysis After 2,4-D Application for Submersed Weed Applications

Minimum Days After Application Before Initial Water Sampling at the Functioning Potable Water Intake			
1 ppm*	2 ppm*	3 ppm*	4 ppm*
5	10	10	14

*ppm acid equivalent target water concentration

Terms and Conditions of Use

If terms of the following Warranty Disclaimer, Inherent Risks of Use and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. To the extent permitted by law, otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitation of Remedies.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. TO THE EXTENT PERMITTED BY LAW, Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Crop injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. To the extent permitted by law, all such risks shall be assumed by buyer.

Limitation of Remedies

To the extent permitted by law, the exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used.

To the extent permitted by law, Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. To the extent permitted by law, in no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer, Inherent Risks of Use and Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or Limitation of Remedies in any manner.

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Produced for
Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268

Label Code: D02-141-004
Replaces Label: D02-141-003
LOES Number: 010-00108

EPA accepted 06/14/10

Revisions:
1. Goggles or faceshield changed to protective eyewear.

Specimen Label

Dow AgroSciences™

Garlon® 3A

Specialty Herbicide

®Trademark of Dow AgroSciences LLC

For the control of woody plants, broadleaf weeds in forests and industrial non-crop areas, including manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, roadsides, railroads, fence rows, non-irrigation ditch banks, and around farm buildings; including application to grazed areas, and establishment and maintenance of wildlife openings on these sites, and in Christmas tree plantations. Use within production forests and industrial non-crop sites (including those listed above) may include applications to control target vegetation in and around standing water sites, such as marshes, wetlands, and the banks of ponds and lakes.

For use in New York State, comply with Section 24(c) Special Local Need labeling for Garlon 3A, SLN NY-060002.

Active Ingredient:	
triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt	44.4%
Other Ingredients	55.6%
Total	100.0%

Acid equivalent: triclopyr - 31.8% - 3 lb/gal

EPA Reg. No. 62719-37

Keep Out of Reach of Children

DANGER PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazard to Humans and Domestic Animals

Corrosive • Causes Irreversible Eye Damage • Harmful If Swallowed Or Absorbed Through Skin • Prolonged Or Frequently Repeated Skin Contact May Cause Allergic Reaction In Some Individuals

Do not get in eyes or on skin or clothing.

Personal Protective Equipment (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks
- Protective eyewear
- Chemical resistant gloves (≥14 mils) such as butyl rubber, natural rubber, neoprene rubber or nitrile rubber

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Controls

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS (40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

First Aid

If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

If on skin or clothing: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

If swallowed: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person. Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Note to Applicator: Allergic skin reaction is not expected from exposure to spray mixtures of Garlon 3A herbicide when used as directed.

Note to Physician: Probable mucosal damage may contraindicate the use of gastric lavage.

Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Under certain conditions, treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants, which may contribute to fish suffocation. This loss can cause fish suffocation. Therefore, to minimize this hazard, do not treat more than one-third to one-half of the water area in a single operation and wait at least 10 to 14 days between treatments. Begin treatment along the shore and proceed outwards in bands to allow fish to move into untreated areas. Consult with the State agency for fish and game before applying to public water to determine if a permit is needed.

This chemical has properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

Physical or Chemical Hazards

Combustible. Do not use or store the product near heat or open flame.

Notice: Read the entire label. Use only according to label directions. **Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies elsewhere on this label. If terms are unacceptable, return at once unopened.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 48 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Shoes plus socks
- Protective eyewear
- Chemical-resistant gloves (≥14 mils) such as butyl rubber, natural rubber, neoprene rubber or nitrile rubber

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for Agricultural Pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Entry Restrictions for Non-WPS Uses: For applications to non-cropland areas, do not allow entry into areas until sprays have dried, unless applicator and other handler PPE is worn.

Storage and Disposal

Do not contaminate water, food, or feed by storage and disposal.
Open dumping is prohibited.
Pesticide Storage: Store above 28°F or agitate before use.
Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Nonrefillable containers 5 gallons or less:
Container Reuse: Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available.
Triple rinse or pressure rinse container (or equivalent) promptly after emptying. **Triple rinse** as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. **Pressure rinse** as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

Refillable containers 5 gallons or larger:
Container Reuse: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or a mix tank. Fill the container about 10% full with water and, if possible, spray all sides while adding water. If practical, agitate vigorously or recirculate water with the pump for two minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times.

Nonrefillable containers 5 gallons or larger:
Container Reuse: Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available.
Triple rinse or pressure rinse container (or equivalent) promptly after emptying. **Triple rinse** as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container 1/4 full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. **Pressure rinse** as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

General Information for Production Forests and Industrial Non-Crop Areas

Use Garlon® 3A specialty herbicide for the control of woody plants and broadleaf weeds in forests and industrial non-crop areas including manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, roadsides, railroads, fence rows, non-irrigation ditch banks, and around farm buildings, including application to grazed areas, and establishment and maintenance of wildlife openings on these sites, and in Christmas tree plantations. Use within production forests and industrial non-crop sites (including those listed above) may include applications to control target vegetation in and around standing water sites, such as marshes, wetlands, and the banks of ponds and lakes.

Obtain Required Permits: Consult with appropriate state or local water authorities before applying this product to public waters. State or local public agencies may require permits.

General Use Precautions and Restrictions

For use in New York State, comply with Section 24(c) Special Local Need labeling for Garlon 3A, SLN NY-060002.

When applying this product in tank mix combination, follow all applicable use directions, precautions and limitations on each manufacturer's label.

Chemigation: Do not apply this product through any type of irrigation system.

Do not apply Garlon 3A directly to, or otherwise permit it to come into direct contact with, grapes, tobacco, vegetable crops, flowers, or other desirable broadleaf plants. Do not permit spray mists containing Garlon 3A to drift onto such plants.

It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands (such as flood plains, deltas, marshes, swamps, or bogs) and transitional areas between upland and lowland sites.

Water treated with Garlon 3A may not be used for irrigation purposes for 120 days after application or until residue levels of Garlon 3A are determined by laboratory analysis, or other appropriate means of analysis, to be 1 ppb or less.

Seasonal Irrigation Waters: Garlon 3A may be applied during the off-season to surface waters that are used for irrigation on a seasonable basis provided that there is a minimum of 120 days between applying Garlon 3A and the first use of treated water for irrigation purposes, or until residue levels of Garlon 3A are determined by laboratory analysis, or other appropriate means of analysis, to be 1 ppb or less.

Irrigation Canals/Ditches: Do not apply Garlon 3A to irrigation canals/ditches unless the 120-day restriction on irrigation water usage can be observed or residue levels of Garlon 3A are determined by laboratory analysis, or other appropriate means of analysis, to be 1 ppb or less.

- **Do not** apply to salt water bays or estuaries.
- **Do not** apply directly to un-impounded rivers or streams.
- **Do not** apply on ditches or canals currently being used to transport irrigation water or that will be used for irrigation within 4 months following treatment. It is permissible to treat irrigation and non-irrigation ditch banks.
- **Do not** apply where runoff water may flow onto agricultural land as injury to crops may result.
- When making applications to control unwanted plants on banks or shorelines of moving water sites, minimize overspray to open water.
- The use of a mistblower is not recommended.
- Apply no more than 2 lb ae of triclopyr (2/3 gallon of Garlon 3A) per acre per growing season on range and pasture sites, including rights-of-way, fence rows or any area where grazing or harvesting is allowed.
- On forestry sites, Garlon 3A may be used at rates up to 6 lb ae of triclopyr (2 gallons of Garlon 3A) per acre per year.
- For all terrestrial use sites other than range, pasture, forestry sites, and grazed areas, the maximum application rate is 9 lb ae of triclopyr (3 gallons of Garlon 3A) per acre per year.

Precautions for Potable Water Intakes for Emerged Aquatic Weed Control

See chart below for specific setback distances near functioning potable water intakes. **Note:** Existing potable water intakes which are no longer in use, such as those replaced by potable water wells or connections to a municipal water system, are not considered to be functioning potable water intakes. These setback restrictions do not apply to terrestrial applications made adjacent to potable water intakes.

	Garlon 3A Application Rate			
Area Treated	2 qt/acre	4 qt/acre	6 qt/acre	8 qt/acre
(acres)	Setback Distance (ft)			
4	0	200	400	500
>4 - 8	0	200	700	900
>8 - 16	0	200	700	1000
>16	0	200	900	1300

To apply Garlon 3A around and within the distances noted above from a functioning potable water intake, the intake must be turned off until the triclopyr level in the intake water is determined to be 0.4 parts per million (ppm) or less by laboratory analysis or immunoassay.

- **Recreational Use of Water in Treatment Area:** There are no restrictions on use of water in the treatment area for recreational purposes, including swimming and fishing.
- **Livestock Use of Water from Treatment Area:** There are no restrictions on livestock consumption of water from the treatment area.

Grazing and Haying Restrictions

Except for lactating dairy animals, there are no grazing restrictions following application of this product.

- **Grazing Lactating Dairy Animals:** Do not allow lactating dairy animals to graze treated areas until the next growing season following application of this product.
- Do not harvest hay for 14 days after application.
- Grazed areas of non-cropland and forestry sites may be spot treated if they comprise no more than 10% of the total grazable area.

Slaughter Restrictions: During the season of application, withdraw livestock from grazing treated grass at least 3 days before slaughter.

Avoiding Injurious Spray Drift

Make applications only when there is little or no hazard from spray drift. Small quantities of spray, which may not be visible, may seriously injure susceptible plants. Do not spray when wind is blowing toward susceptible crops or ornamental plants that are near enough to be injured. It is suggested that a continuous smoke column at or near the spray site or a smoke generator on the spray equipment be used to detect air movement, lapse conditions, or temperature inversions (stable air). If the smoke layers or indicates a potential of hazardous spray drift, do not spray.

Aerial Application: For aerial application on rights-of-way or other areas near susceptible crops, apply through a Microfoil† or Thru-Valve boom†, or use an agriculturally labeled drift control additive. Other drift reducing systems or thickened sprays prepared by using high viscosity inverting systems may be used if they are made as drift-free as mixtures containing agriculturally labeled thickening agents or applications made with the Microfoil or Thru-Valve boom. Keep spray pressures low enough to provide coarse spray droplets. Spray boom should be no longer than 3/4 of the rotor length. Do not use a thickening agent with the Microfoil or Thru-Valve booms, or other systems that cannot accommodate thick sprays. Spray only when the wind velocity is low (follow state regulations). Avoid application during air inversions. If a spray thickening agent is used, follow all use recommendations and precautions on the product label.

† Reference within this label to a particular piece of equipment produced by or available from other parties is provided without consideration for use by the reader at its discretion and subject to the reader's independent circumstances, evaluation, and expertise. Such reference by Dow AgroSciences is not intended as an endorsement of such equipment, shall not constitute a warranty (express or implied) of such equipment, and is not intended to imply that other equipment is not available and equally suitable. Any discussion of methods of use of such equipment does not imply that the reader should use the equipment other than is advised in directions available from the equipment's manufacturer. The reader is responsible for exercising its own judgment and expertise, or consulting with sources other than Dow AgroSciences, in selecting and determining how to use its equipment.

Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications:

1. The distance of the outer most operating nozzles on the boom must not exceed 3/4 the length of the rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees.

Where states have more stringent regulations, they should be observed.

The applicator should be familiar with and take into account the information covered in the following Aerial Drift Reduction Advisory. [This information is advisory in nature and does not supersede mandatory label requirements.]

Aerial Drift Reduction Advisory

Information on Droplet Size: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversions).

Controlling Droplet Size:

- **Volume** - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- **Pressure** - Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of Nozzles** - Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle Orientation** - Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is the recommended practice. Significant deflection from horizontal will reduce droplet size and increase drift potential.
- **Nozzle Type** - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.

Boom Length: For some use patterns, reducing the effective boom length to less than 3/4 of the rotor length may further reduce drift without reducing swath width.

Application Height: Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

Swath Adjustment: When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

Wind: Drift potential is lowest between wind speeds of 2 to 10 mph. However, many factors, including droplet size and equipment type, determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **Note:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

Ground Equipment: To aid in reducing spray drift, Garlon 3A should be used in thickened (high viscosity) spray mixtures using an agriculturally labeled drift control additive, high viscosity invert system, or equivalent as directed by the manufacturer. With ground equipment, spray drift can be reduced by keeping the spray boom as low as possible; by applying 20 gallons or more of spray per acre; by keeping the operating spray pressures at the lower end of the manufacturer's recommended pressures for the specific nozzle type used (low pressure nozzles are available from spray equipment manufacturers); and by spraying when wind velocity is low (follow state regulations). In hand-gun applications, select the minimum spray pressure that will provide adequate plant coverage (without forming a mist). Do not apply with nozzles that produce a fine-droplet spray.

High Volume Leaf-Stem Treatment: To minimize spray drift, do not use pressure exceeding 50 psi at the spray nozzle and keep sprays no higher than brush tops. An agriculturally labeled thickening agent may be used to reduce drift.

Plants Controlled

Woody Plant Species

alder
arrowwood
ash
aspen
Australian pine
bear clover (bearmat)
beech
birch
blackberry
blackgum
Brazilian pepper
cascara
ceanothus
cherry
chinquapin
choke cherry
cottonwood
crataegus (hawthorn)
Douglas fir
dogwood
elderberry
elm
gallberry
hazel
hornbean
kudzu[1]
locust
madrone
maples
mulberry
oaks
persimmon
pine
poison ivy
poison oak
poplar
salt-bush (*Baccharis* spp.)
salt cedar[2]
salmonberry
sassafras
scotch broom
sumac
sweetbay magnolia
sweetgum
sycamore
tanoak
thimbleberry
tulip poplar
waxmyrtle
western hemlock
wild rose
willow
winged elm

[1]For complete control, re-treatment may be necessary.
[2]Use cut surface treatments for best results.

Annual and Perennial Broadleaf Weeds

bindweed
burdock
Canada thistle
chicory
curly dock
dandelion
field bindweed
lambsquarter
Mexican petunia
plantain
purple loosestrife
ragweed
smartweed
Spanish needles/ common beggarthicks
tansy ragwort
tropical soda apple
vetch
wedelia
wild lettuce

Purple Loosestrife (*Lythrum salicaria*)

Purple loosestrife can be controlled with foliar applications of Garlon 3A. For broadcast applications, use a minimum of 4 1/2 to 6 lb ae of triclopyr (6 to 8 quarts of Garlon 3A) per acre. Apply Garlon 3A when purple loosestrife is at the bud to mid-flowering stage of growth. Follow-up applications for control of regrowth should be made the following year in order to achieve increased control of this weed species. For all applications, a non-ionic surfactant should be added to the spray mixture. Follow all directions and use precautions on the label of the surfactant. Thorough wetting of the foliage and stems is necessary to achieve satisfactory control. A minimum spray volume of 50 gallons per acre is recommended for ground broadcast applications.

If using a backpack sprayer, a spray mixture containing 1% to 1.5% Garlon 3A or 5 to 7.6 fl oz of Garlon 3A per 4 gallons of water should be used. All purple loosestrife plants should be thoroughly wetted.

Application Methods

Use Garlon 3A at rates of 3/4 to 9 lb ae of triclopyr (1/4 to 3 gallons of Garlon 3A) per acre to control broadleaf weeds and woody plants. In all cases, use the amount specified in enough water to give uniform and complete coverage of the plants to be controlled. Use only water suitable for spraying. Use an agriculturally labeled non-ionic surfactant for all foliar applications. When using surfactants, follow the use directions and precautions listed on the surfactant manufacturer's label. Use the higher concentrations of surfactant in the spray mixture when applying lower spray volumes per acre. The order of addition to the spray tank is water, spray thickening agent (if used), additional herbicide (if used), and Garlon 3A. Surfactant should be added to the spray tank last or as recommended on the product label. If combined with emulsifiable concentrate herbicides, moderate continuous adequate agitation is required.

Before using any recommended tank mixtures, read the directions and all use precautions on both labels.

For best results, apply when woody plants and weeds are actively growing. When hard to control species such as ash, blackgum, choke cherry, elm, maples, oaks, pines, or winged elm are prevalent and during applications made in late summer when the plants are mature and during drought conditions, use the higher rates of Garlon 3A alone or in combination with Tordon® 101 Mixture specialty herbicide. (Tordon 101 Mixture is a restricted use pesticide. See product label.) Tordon 101 Mixture is not registered for use in the states of California and Florida.

When using Garlon 3A in combination with 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile ester herbicides, generally the higher rates should be used for satisfactory brush control.

Use the higher dosage rates when brush approaches an average of 15 feet in height or when the brush covers more than 60% of the area to be treated. If lower rates are used on hard to control species, resprouting may occur the year following treatment.

On sites where easy to control brush species dominate, rates less than those listed may be effective. Consult State or Local Extension personnel for such information.

Foliage Treatment With Ground Equipment

High Volume Foliage Treatment
For control of woody plants, use Garlon 3A at the rate of 3 to 9 lb ae of triclopyr (1 to 3 gallons of Garlon 3A) per 100 gallons of spray solution, or Garlon 3A at 3/4 to 3 lb ae of triclopyr (1 to 4 quarts of Garlon 3A) may be tank mixed with 1/4 to 1/2 gallons of 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile ester or Tordon 101 Mixture and diluted to make 100 gallons of spray solution. Apply at a volume of 100 to 400 gallons of total spray per acre depending upon size and density of woody plants. Coverage should be thorough to wet all leaves, stems, and root collars. (See General Use Precautions and Restrictions.) Do not exceed maximum allowable use rates per acre (see table below). Tordon 101 Mixture is not registered for use in the states of California and Florida.

Maximum Labeled Rate versus Spray Volume per Acre

Total Spray Volume (gal/acre)	Maximum Rate of Garlon 3A		
	Rangeland and Pasture Sites[1] (gal/100 gal of spray)	Forestry Sites[2] (gal/100 gal of spray)	Other Non-Cropland Sites[3] (gal/100 gal of spray)
400	Do not use	0.5	0.75
300	Do not use	0.67	1
200	Do not use	1	1.5
100	0.67	2	3
50	1.33	4	6
40	1.67	5	7.5
30	2.33	6.65	10
20	3.33	10	15
10	6.67	20	30

[1] Do not exceed the maximum use rate of 2 lb ae of triclopyr (2/3 gal of Garlon 3A)/acre/year.
[2] Do not exceed the maximum use rate of 6 lb ae of triclopyr (2 gal of Garlon 3A)/acre/year.
[3] Do not exceed the maximum use rate of 9 lb ae of triclopyr (3 gal of Garlon 3A)/acre/year on non-cropland use sites other than rangeland, pasture, forestry, and grazed areas.

Low Volume Foliage Treatment
To control susceptible woody plants, apply up to 15 lb ae of triclopyr (5 gallons of Garlon 3A) in 10 to 100 gallons of finished spray. The spray concentration of Garlon 3A and total spray volume per acre should be adjusted according to the size and density of target woody plants and kind of spray equipment used. With low volume sprays, use sufficient spray volume to obtain uniform coverage of target plants including the surfaces of all foliage, stems, and root collars (see General Use Precautions and Restrictions). For best results, a surfactant should be added to all spray mixtures. Match equipment and delivery rate of spray nozzles to height and density of woody plants. When treating tall, dense brush, a truck mounted spray gun with spray tips that deliver up to 2 gallons per minute at 40 to 60 psi may be required. Backpack or other types of specialized spray equipment with spray tips that deliver less than 1 gallon of spray per minute may be appropriate for short, low to moderate density brush.

Tank Mixing: As a low volume foliar spray, up to 9 lb ae of triclopyr (3 gallons of Garlon 3A) may be applied in tank mix combination with 1/2 to 1 gallon of Tordon K or 1 to 2 gallons of Tordon 101 Mixture in 10 to 100 gallons of finished spray. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida.

Broadcast Applications With Ground Equipment

Apply using equipment that will assure uniform coverage of the spray volumes applied. To improve spray coverage, add an agriculturally labeled non-ionic surfactant as described later under Directions for Use. See Maximum Labeled Rate versus Spray Volume per Acre table above for relationship between mixing rate, spray volume and maximum application rate.

Woody Plant Control
Foliage Treatment: Use 6 to 9 lb ae of triclopyr (2 to 3 gallons of Garlon 3A) in enough water to make 20 to 100 gallons of total spray per acre or 1 1/2 to 3 lb ae of triclopyr (1/2 to 1 gallon of Garlon 3A) may be combined with 1 to 2 gallons of 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile esters or Tordon 101 Mixture in sufficient water to make 20 to 100 gallons of total spray per acre. Tordon 101 Mixture is not registered for use in the states of California and Florida.

Broadleaf Weed Control
Use Garlon 3A at rates of 1 to 4 1/2 lb ae of triclopyr (1/3 to 1 1/2 gallons of Garlon 3A) in a total volume of 20 to 100 gallons of water per acre. Apply any time during the growing season. Garlon 3A at 1 to 3 lb ae of triclopyr (1/3 to 1 gallon of Garlon 3A) may be tank mixed with 1/2 to 1 gallon of Tordon K, Tordon 101 Mixture or 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile herbicides to improve the spectrum of activity. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida.

Aerial Application (Helicopter Only)

Aerial sprays should be applied using suitable drift control. (See General Use Precautions and Restrictions.) Add an agriculturally labeled non-ionic surfactant as described under Directions for Use. See Maximum Labeled Rate versus Spray Volume per Acre table above for relationship between mixing rate, spray volume and maximum application rate.

Foliage Treatment (Non-Grazed Rights-of-Way)

Non-grazed areas: Use 6 to 9 lb ae of triclopyr (2 to 3 gallons of Garlon 3A) or 3 to 4 1/2 lb ae of triclopyr (1 to 1 1/2 gallons of Garlon 3A) in a tank mix combination with 1 to 2 gallons of 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile esters or Tordon 101 Mixture, and apply in a total spray volume of 10 to 30 gallons per acre. Use the higher rates and volumes when plants are dense or under drought conditions. Tordon 101 Mixture is not registered for use in the states of California and Florida.

Interspersed areas in non-grazed rights-of-ways that may be subject to grazing may be spot treated if the treated area comprises no more than 10% of the total grazable area.

Forest Management Applications

For best control from broadcast applications of Garlon 3A, use a spray volume which will provide thorough plant coverage. Recommended spray volumes are usually 10 to 25 gallons per acre by air or 10 to 100 gallons per acre by ground. To improve spray coverage of spray volumes less than 50 gallons per acre, add an agriculturally labeled non-ionic surfactant as described under Directions for Use. Application systems should be used to prevent hazardous drift to off-target sites. Nozzles or additives that produce larger droplets of spray may require higher spray volumes to maintain brush control.

Forest Site Preparation (Not for Conifer Release)
Use up to 6 lb ae of triclopyr (2 gallons of Garlon 3A) and apply in a total spray volume of 10 to 30 gallons per acre or Garlon 3A at 3 to 4 1/2 lb ae of triclopyr (1 to 1 1/2 gallons of Garlon 3A) may be used with 1 to 2 gallons of Tordon 101 Mixture or 2,4-D 3.8 lb low volatile ester in a tank mix combination in a total spray volume of 10 to 30 gallons per acre. Use a non-ionic agricultural surfactant for all foliar applications as described under Directions for Use. Tordon 101 Mixture is not registered for use in the states of California and Florida.

Note: Conifers planted sooner than one month after treatment with Garlon 3A at less than 4 lb ae of triclopyr (1 1/3 gallons of Garlon 3A) per acre or sooner than two months after treatment at 4 to 9 lb ae of triclopyr (1 1/3 to 3 gallons of Garlon 3A) per acre may be injured. When tank mixtures of herbicides are used for forest site preparation, labels for all products in the mixture should be consulted and the longest recommended waiting period before planting observed.

Directed Spray Applications for Conifer Release
To release conifers from competing hardwoods such as red maple, sugar maple, striped maple, sweetgum, red and white oaks, ash, hickory, alder, birch, aspen, and pin cherry, mix 3 to 6 lb ae of triclopyr (1 to 2 gallons of Garlon 3A) in enough water to make 100 gallons of spray mixture. To improve spray coverage, add an agriculturally labeled non-ionic surfactant as described under Directions for Use. The spray mixture should be directed onto foliage of competitive hardwoods using knapsack or backpack sprayers with flat fan nozzles or equivalent any time after hardwoods have reached full leaf size, but before autumn coloration. The majority of treated hardwoods should be less than 6 feet in height to ensure adequate spray coverage. Care should be taken to direct spray away from contact with conifer foliage, particularly foliage of desirable pines.

Note: Spray may cause temporary damage and growth suppression where contact with conifers occurs; however, injured conifers should recover and grow normally. Over-the-top spray applications can kill pines.

Broadcast Applications for Conifer Release in the Northeastern United States
To release spruce, fir, red pine and white pine from competing hardwoods, such as red maple, sugar maple, striped maple, alder, birch (white, yellow or gray), aspen, ash, pin cherry and *Rubus* spp. and perennial and annual broadleaf weeds, use Garlon 3A at rates of 1 1/2 to 3 lb ae of triclopyr (2 to 4 quarts of Garlon 3A) per acre alone or with 2,4-D amine, like DMA 4 IVM, or 2,4-D ester to provide no more than 4 lb ae per acre from both products. Apply in late summer or early fall after conifers have formed their over wintering buds and hardwoods are in full leaf and prior to autumn coloration.

Broadcast Applications for Douglas Fir Release in the Pacific Northwest and California
To release Douglas fir from susceptible competing vegetation such as broadleaf weeds, alder, blackberry or Scotch broom, apply Garlon 3A at 1 to 1 1/2 lb ae of triclopyr (1 1/3 to 2 quarts of Garlon 3A) per acre alone or in combination with 4 lb per acre of atrazine. Mix all sprays in a water carrier with a non-ionic surfactant. Apply in early spring after hardwoods begin growth and before Douglas fir bud break ("early foliar" hardwood stage) or after Douglas fir seasonal growth has "hardened off" (set winter buds) in late summer, but while hardwoods are still actively growing. When treating after Douglas fir bud set, apply prior to onset of autumn coloration in hardwood foliage. **Note:** Treatments applied during active Douglas fir shoot growth (after spring bud break and prior to bud set) may cause injury to Douglas fir trees.

Cut Surface Treatments

Individual plant treatments such as basal bark and cut surface applications may be used on any use site listed on this label at a maximum use rate of 2.67 gallons of Garlon 3A (8 lb ae of triclopyr) per acre. These types of applications are made directly to ungrazed parts of plants and, therefore, are not restricted by the grazing maximum rate of 2/3 of a gallon of Garlon 3A (2 lb ae of triclopyr) per acre.

To control unwanted trees of hardwood species such as elm, maple, oak and conifers in labeled sites, apply Garlon 3A, either undiluted or diluted in a 1 to 1 ratio with water, as directed below.

With Tree Injector Method
Apply by injecting 1/2 milliliter of undiluted Garlon 3A or 1 milliliter of the diluted solution through the bark at intervals of 3 to 4 inches between centers of the injector wound. The injections should completely surround the tree at any convenient height. **Note: No Worker Protection Standard worker entry restrictions or worker notification requirements apply when this product is injected directly into plants.**

With Hack and Squirt Method
Make cuts around the tree trunk at a convenient height with a hatchet or similar equipment so that the cuts overlap slightly and make a continuous circle around the trunk. Spray 1/2 milliliter of undiluted Garlon 3A or 1 milliliter of the diluted solution into the pocket created between the bark and the inner stem/trunk by each cut.

With Frill or Girdle Method
Make a single girdle through the bark completely around the tree at a convenient height. The frill should allow for the herbicide to remain next to the inner stem and absorb into the plant. Wet the cut surface with undiluted or diluted solution.

Both of the above methods may be used successfully at any season except during periods of heavy sap flow of certain species - for example, maples.

Stump Treatment
Spray or paint the cut surfaces of freshly cut stumps and stubs with undiluted Garlon 3A. The cambium area next to the bark is the most vital area to wet.

Christmas Tree Plantations

Use Garlon 3A for the control of woody plants and annual and perennial broadleaf weeds in established Christmas tree plantations. For best results, apply when woody plants and weeds are actively growing. Garlon 3A does not control weeds which have not emerged at the time of application. If lower rates are used on hard to control woody species, resprouting may occur the year following treatment. Brush over 8 feet tall is difficult to treat efficiently using hand equipment such as backpack or knapsack sprayers. When treating large brush or trees or hard to control species such as ash, blackgum, choke cherry, elm, hazel, madrone, maples, oaks or sweetgum, and for applications made during drought conditions or in late summer when the leaves are mature, use the higher rates of Garlon 3A or use cut surface application methods. For foliar applications, apply in enough water to give uniform and complete coverage of the plants to be controlled. Applications made under drought conditions may provide less than desirable results.

Use Precautions:

- Do not use on newly seeded grass until well established as indicated by vigorous growth and development of secondary root system and tillering
- Newly seeded turf (alleyways, etc.) should be mowed two or three times before any treatment with Garlon 3A.
- Do not reseed Christmas tree areas treated with Garlon 3A for a minimum of three weeks after application.
- Do not use Garlon 3A if legumes, such as clover, are present and injury cannot be tolerated.

Spray Preparation

The order of addition to the spray tank is water, drift control agent (if used), non-ionic agricultural surfactant and Garlon 3A. Continue moderate agitation while mixing and spraying. Use a non-ionic agricultural surfactant for all applications. When using surfactants, follow use directions and precautions listed on the manufacturer's label. Use the higher recommended concentrations of surfactant in the spray mixture when applying lower spray volumes per acre.

Application

Apply in late summer or early autumn after terminal growth of Christmas trees has hardened of, but before leaf drop of, target weeds. Apply at a rate of 3/4 to 1 3/4 lb ae of triclopyr (2 to 5 pints of Garlon 3A) per acre as a foliar spray directed toward the base of Christmas trees. Use sufficient spray volume to provide uniform coverage of target plants (20 to 100 gallons per acre). **Do not apply with 2,4-D.** Application rates of Garlon 3A recommended for Christmas trees will only suppress some well established woody plants that are greater than 2 to 3 years old (see table below). Broadcast sprays may also be applied in bands between the rows of planted trees. Use spray equipment that will assure uniform coverage of the desired spray volume.

Spray solution from Garlon 3A can cause needle and branch injury to Christmas trees. To minimize injury to Christmas trees, direct sprays so as to minimize contact with foliage. Blue spruce, white spruce, balsam fir and Frasier fir are less susceptible to injury than white pine and Douglas fir.

Restriction: Apply Garlon 3A only to established Christmas trees that were planted at least one full year prior to application.

Application Rates and Species Controlled:

Garlon 3A		
2 pints/acre (3/4 lb ae of triclopyr)	3 to 4 pints/acre (1 1/2 lb ae of triclopyr)	5 pints/acre (1 3/4 lb ae of triclopyr)
clover dandelion dock, curly lambsquarters lespedeza plantain, broadleaf plantain, buckhorn ragweed, common vetch	bindweed, field (TG) blackberry[1] chicory (S) fireweed ivy, ground lettuce, wild oxalis poison ivy smartweed (TG) thistle, Canada (TG) violet, wild Virginia creeper[†]	arrowwood (SDL) aspen beech (SDL) birch (SDL) chinquapin cottonwood (SDL) elderberry grape, wild mulberry (SDL) poplar (SDL) sassafras (SDL) sumac (SDL) sycamore (SDL)

(TG) Top growth control, retreatment may be necessary
(S) Suppression
(SDL) Seedlings less than 2 to 3 years old
[1]Use 4 pint per acre rate

Directed Applications

To control hardwoods such as red maple, sugar maple, striped maple, sweetgum, red and white oaks, ash, alder, birch, aspen, and pin cherry, mix 4 to 20 fl oz of Garlon 3A in enough water to make 3 gallons of spray mixture. For directed applications, do not exceed 6 lb ae of triclopyr (2 gallons of Garlon 3A) per acre per year. To improve coverage, add a non-ionic agricultural surfactant to the spray. This spray mixture should be directed onto foliage of competitive hardwoods using knapsack or backpack sprayers with flat fan nozzles or equivalent any time after hardwoods have reached full leaf size, but before autumn coloration (when plants are actively growing). The majority of treated hardwoods should be less than 8 feet in height to ensure adequate spray coverage. **Note:** To prevent Christmas tree injury, care should be taken to direct spray away from contact with Christmas tree foliage.

Cut Surface Treatments

When treating large brush or trees or hard to control species such as ash, blackgum, choke cherry, elm, hazel, madrone, maples, oaks, salt cedar or sweetgum, and for applications made during drought conditions or in late summer when the leaves are mature, use cut surface treatments. (See directions for Cut Surface Treatments in preceding section of this label.)

Wetland Sites in Production Forests and Industrial Non-Crop Areas

Garlon 3A may be used within production forests and industrial non-crop sites to control target vegetation in and around standing water sites, such as marshes, wetlands, and the banks of ponds and lakes and transition areas between upland and lowland sites.

For control of woody plants and broadleaf weeds in these sites, follow use directions and application methods on this label for forestry and non-cropland sites.

Use Precautions:

Minimize overspray to open water when treating target vegetation in and around non-flowing, quiescent or transient water. When making applications to control unwanted plants on banks or shorelines of flowing water, minimize overspray to open water. **Note:** Consult local public water control authorities before applying this product in and around public water. Permits may be required to treat such areas.

Terms and Conditions of Use

If terms of the following Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitations of Remedies.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperature, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used.

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer, Inherent Risks of Use, and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

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Produced for
Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268

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Replaces Label: D02-101-038
LOES Number: 010-00084

EPA accepted 01/03/06

NAVIGATE®

GRANULAR AQUATIC HERBICIDE FOR CONTROLLING CERTAIN UNWANTED AQUATIC PLANTS

ACTIVE INGREDIENTS:	
2,4-Dichlorophenoxyacetic acid, butoxyethyl ester.....	**27.6%**
INERT INGREDIENTS:	**72.4%**
TOTAL	**100.0%**

*Isomer specific by AOAC method No. 6.D01-5

*2,4-Dichlorophenoxyacetic acid equivalent 19% by weight

EPA Reg. No. 71368-4-8959 **EPA Est. No. 407-IA-2**

KEEP OUT OF REACH OF CHILDREN

CAUTION

For Chemical Emergency, Spill, Leak, Fire, Exposure or Accident
Call Chemtrec Day or Night 1-800-424-9300

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED: Call a physician or Poison Control Center. Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. If person is unconscious, do not give anything by mouth and do not induce vomiting.

IF ON SKIN: Wash with plenty of soap and water. Get medical attention.

IF INHALED: Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.

IF IN EYES: Flush eyes with plenty of water. Call a physician if irritation persists.

PRECAUTIONARY STATEMENTS

CAUTION

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

Harmful if swallowed, absorbed through skin, or inhaled. Causes eye irritation. Avoid contact with skin, eyes or clothing. Avoid breathing dust. When handling this product, wear chemical resistant gloves. Wash thoroughly with soap and water after handling.

When mixing, loading, or applying this product or repairing or cleaning equipment used with this product, wear eye protection (face shield or safety glasses), chemical resistant gloves, long-sleeved shirt, long pants, socks and shoes. It is recommended that safety glasses include front, brow and temple protection.

Wash hands, face and arms with soap and water as soon as possible after mixing, loading, or applying this product. Wash hands, face and hands with soap and water before eating, smoking or drinking. Wash hands and arms before using toilet. After work, remove all clothing and shower using soap and water. Do not reuse clothing worn during the previous day's mixing and loading or application of this product without cleaning first. Clothing must be kept and washed separately from other household laundry. Remove saturated clothing as soon as possible and shower.

ENVIRONMENTAL HAZARDS

This product is toxic to fish. Drift or runoff may adversely affect fish and non-target plants. Do not apply to water except as specified on this label. Do not contaminate water when disposing of equipment washwaters. Do not apply to waters used for irrigation, agricultural sprays, watering dairy animals or domestic water supplies.

Clean spreader equipment thoroughly before using it for any other purposes. Vapors from this product may injure susceptible plants in the immediate vicinity. Avoid drift of dust to susceptible plants.

MIXING OR LOADING: Most cases of ground water contamination involving phenoxy herbicides such as 2,4-D have been associated with mixing/loading and disposal sites. Caution should be exercised when handling 2,4-D pesticides at such sites to prevent contamination of ground water supplies. Use of closed systems for mixing or transferring this pesticide will reduce the probability of spills. Placement of the mixing/loading equipment on an impervious pad to contain spills will help prevent ground water contamination.

DIRECTIONS FOR USE

IT IS A VIOLATION OF FEDERAL LAW TO USE THIS PRODUCT IN A MANNER INCONSISTENT WITH ITS LABELING.
READ THIS ENTIRE LABEL BEFORE USING THIS PRODUCT

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

STORAGE

Store in original container in a dry secured storage area.

PESTICIDE DISPOSAL

Pesticide wastes are toxic. Improper disposal of excess pesticide is a violation of Federal law and may contaminate ground water. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL

Do not reuse empty bag. Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If bag is burned, stay out of smoke.

NAVIGATE is a trademark of Applied Biochemists

NET WT. 50 LBS. (22.68 KG) **13529**

GENERAL PRECAUTIONS AND RESTRICTIONS
Do not use in or near a greenhouse.

OXYGEN RATIO
Fish breathe oxygen in the water and a water-oxygen ratio must be maintained. Decaying weeds use up oxygen, but during the period when NAVIGATE® should be used, the weed mass is fairly sparse and the weed decomposition rate is slow enough so that the water-oxygen ratio is not disturbed by treating the entire area at one time.

If treatments must be applied later in the season when the weed mass is dense and repeat treatments are needed spread granules in lanes, leaving buffer strips which can then be treated when vegetation in treated lanes has disintegrated. During the growing season, weeds decompose in a 2 to 3 week period following treatment.
Buffer lanes should be 50 to 100 feet wide. Treated lanes should be as wide as the buffer strips.

WATER pH
Best results are generally obtained if the water to be treated has a pH less than 8. A pH of 8 or higher may reduce weed control. If regrowth occurs within a period of 6 to 8 weeks, a second application may be needed.

PERMIT TO USE CHEMICALS IN WATER
In many states, permits are required to control weeds by chemical means in public water. If permits are required, they may be obtained from the Chief, Fish Division, State Department of Conservation or the State Department of Public Health.

GENERAL INFORMATION
NAVIGATE® is formulated on special heat treated attaclay granules that resist rapid decomposition in water, sink quickly to lake or pond bottoms and release the weed killing chemical in the critical root zone area.

This product is designed to selectively control the weeds listed on the label. While certain other weeds may be suppressed, control may be incomplete. Reduced control may occur in lakes where water replacement comes from bottom springs.

WHEN TO APPLY
For best results, spread NAVIGATE® in the spring and early summer, during the time weeds start to grow. If desired, this timing can be checked by sampling the lake bottom in areas heavily infested with weeds the year before.

If treatments are delayed until weeds form a dense mat or reach the surface, two treatments may be necessary. Make the second treatment when weeds show signs of recovery.

Treatments made after September may be less effective depending upon water temperatures and weed growth.

Occasionally, a second application will be necessary if heavy regrowth occurs or weeds reinfest from untreated areas.

HOW TO APPLY

FOR LARGE AREAS: Use a fertilizer spreader or mechanical seeder such as the Gerber or Gandy or other equipment capable of uniformly applying this product. Before spreading any chemical, calibrate your method of application to be sure of spreading the proper amount. When using boats and power equipment, you must determine the proper combination of (1) boat speed (2) rate of delivery from the spreader, and (3) width of swath covered by the granules.

FOR SMALL AREAS: (Around Docks or Isolated Patches of Weeds): Use a portable spreader such as the Cyclone seeder or other equipment capable of uniformly applying this product. Estimate or measure out the area you want to treat. Weight out the amount of material needed and spread this uniformly over the area. More uniform coverage is obtained by dividing the required amount in two and covering the area twice, applying the second half at right angles to the first.

Use the following formula to calibrate your spreader's delivery in pounds of **NAVIGATE** PER MINUTE:

$$\frac{\text{Miles per hour X spreader width X pounds per acre}}{495} = \text{pounds per minute}$$

Example: To apply 100 pounds of **NAVIGATE** per acre using a spreader that covers a 20 foot swath from a boat traveling at 4 miles per hour, set the spreader to deliver 16 pounds of **NAVIGATE** granules per minute.

$$\frac{4 \text{ mph} \times 20 \text{ feet} \times 100 \text{ Lbs./A}}{495} = 16 \text{ Lbs/Min.}$$

AMOUNTS TO USE
Rates of application vary with resistance of weed species to the chemical, density of weed mass at time of treatment, stage of growth, water depth, and rate of water flow through the treated area. Use the higher rate for dense weeds, when water is more than 8 feet deep and where there is a large volume turnover.

	NAVIGATE POUNDS PER ACRE	NAVIGATE POUNDS PER 2000 SQ. FT.
SUSCEPTIBLE WEEDS		
Water Milfoil (Myriophyllum spp.) Water stargrass (Heteranthera dubia)	100 TO 200	5
SLIGHTLY TO MODERATELY RESISTANT WEEDS		
Bladderwort (Utricularia spp.) White water Lily (Nymphaea spp.) Yellow water lily (Nuphar spp.) Or spatterdock* Water shield (Brasenia spp.) Water chestnut (Trapa natans) Coontail* (Ceratophyllym Demersum)	150 to 200	7-1/2 to 10

- Repeat treatments may be needed

LIMITED WARRANTY AND DISCLAIMER
The manufacturer warrants (a) that this product conforms to the chemical description on the label; (b) that this product reasonably fit for the purposes set forth in the directions for use when it is used in accordance with such directions; and (c) that the directions, warning and other statements on the label are based upon responsible experts' evaluation of reasonable tests of effectiveness, of toxicity to laboratory animals and to plants, and of residues on food crops and upon reports of field experience. Tests have not been made on all varieties or in all states or under all conditions. THE MANUFACTURER NEITHER MAKES NOR INTENDS, NOR DOES IT AUTHORIZE ANY AGENT OR REPRESENTATIVE TO MAKE, ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, AND IT EXPRESSLY EXCLUDES AND DISCLAIMS ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

THIS WARRANTY DOES NOT EXTEND TO, AND THE BUYER SHALL BE SOLELY RESPONSIBLE FOR, ANY AND ALL LOSS OR DAMAGE WHICH RESULTS FROM USE OF THIS PRODUCT IN ANY MANNER WHICH IS INCONSISTENT WITH THE LABEL DIRECTIONS, WARNINGS OR CAUTIONS.

BUYER'S EXCLUSIVE REMEDY AND MANUFACTURER'S OR SELLER'S EXCLUSIVE LIABILITY FOR ANY AND ALL CLAIMS, LOSSES, DAMAGES, OR INJURIES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, WHETHER OR NOT BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY IN TORT OR OTHERWISE SHALL BE LIMITED. AT THE MANUFACTURER'S OPTION, TO REPLACEMENT OF, OR THE REPAYMENT OF THE PURCHASE PORICE FOR, THE QUANTITY OF PRODCUT WITH RESPECT TO WHICH DAMAGES ARE CLAIMED. IN NO EVENT SHALL MANUFACTURER OR SELLER BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT.

NOTICE TO BUYER
Purchase of this material does not confer any rights under patents governing this product or the use thereof in countries outside of the United States.

MANUFACTURED FOR:

applied biochemists
MILWAUKEE, WI 1-800-558-5106

Specimen Label

Renovate® OTF

Aquatic Herbicide

Aquatic Sites: For control of emersed, submersed and floating aquatic weeds in the following aquatic sites: ponds; lakes; reservoirs; marshes; wetlands; impounded rivers, streams and other bodies of water that are quiescent; non-irrigation canals, seasonal irrigation waters and ditches which have little or no continuous outflow.

For use in New York State, comply with Section 24(c) Special Local Need labeling for Renovate® OTF, SLN NY-070004

Active Ingredient:	
triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt	14.0%
Other Ingredients	86.0%
TOTAL	100.0%

Acid equivalent: triclopyr - 10.0%.

Keep Out of Reach of Children

CAUTION / PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals

Causes moderate eye irritation. Avoid contact with eyes or clothing.

USER SAFETY RECOMMENDATIONS
Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside, then wash thoroughly and put on clean clothing.

First Aid	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15 - 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15 - 20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. In case of emergency endangering health or the environment involving this product, call **INFOTRAC** at **1-800-535-5053.**

Notice: Read the entire label. Use only according to label directions. **Before using this product, read "Warranty Disclaimer", "Inherent Risks of Use", and "Limitation of Remedies" at end of label booklet. If terms are unacceptable, return at once unopened.**

If you wish to obtain additional product information, please visit our web site at **www.sepro.com.**

EPA Reg. No. 67690-42
FPL 011808

Renovate is a registered trademark of Dow AgroSciences LLC.
Manufactured by: **SePRO Corporation** 11550 North Meridian Street, Suite 600 Carmel, IN 46032 U.S.A.

ENVIRONMENTAL HAZARDS

Under certain conditions, treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants, which may cause fish suffocation. Therefore, to minimize this hazard **DO NOT** treat more than one-half (1/2) of the water area in a single operation *and* wait at least 10 days between treatments when susceptible plants are mature and have grown to the water's surface, or when the treatment would result in significant reductions in total plant biomass. Begin treatment along the shore and proceed outwards in bands to allow fish to move into untreated areas. Consult with the State agency for fish and game before applying to public water to determine if a permit is needed.

AGRICULTURAL CHEMICAL: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all *Directions for Use* carefully before applying.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

General Information

When applying this product follow all applicable use directions, precautions and limitations.

For Aquatic and Wetland Sites: Use Renovate OTF Granular herbicide for control of emersed, submersed and floating aquatic weeds in the following aquatic sites: ponds; lakes; reservoirs; marshes; wetlands; impounded rivers, streams and other bodies of water that are quiescent; non-irrigation canals, seasonal irrigation waters and ditches which have little or no continuous outflow.

Obtain Required Permits: Consult with appropriate state or local water authorities before applying this product in and around public waters. State or local public agencies may require permits.

Recreational Use of Water in Treatment Area: There are no restrictions on use of water in the treatment area for recreational purposes, including swimming and fishing.

Livestock Use of Water from Treatment Area: There are no restrictions on livestock consumption of water from the treatment area.

GENERAL USE PRECAUTIONS AND RESTRICTIONS

Chemigation: Do not apply this product through any type of irrigation system.

Irrigation: Water treated with Renovate OTF may not be used for irrigation purposes for 120 days after application or until triclopyr residue levels are determined by laboratory analysis, or other appropriate means of analysis, to be 1.0 ppb or less. This label describes both required and recommended uses of a chemical analysis for the active ingredient, triclopyr. SePRO Corporation recommends the use of an Enzyme-Linked Immunoassay (ELISA) test for the determination of the active ingredient concentration in water. Contact SePRO Corporation for the incorporation of this analysis in your treatment program. Other proven chemical analysis for the active ingredient may also be used. The ELISA analysis is referenced in this label as the preferred method for the rapid determination of the concentration of the active ingredient in the water.

– **Seasonal Irrigation Waters:** Renovate OTF may be applied during the off-season to surface waters that are used for irrigation on a seasonal basis, provided that there is a minimum of 120 days between Renovate OTF application and the first use of treated water for irrigation purposes or until triclopyr residue levels are determined by laboratory analysis, or other appropriate means of analysis, to be 1.0 ppb or less.

– **Irrigation Canals/Ditches: Do not** apply Renovate OTF to irrigation canals/ditches unless the 120 day restriction on irrigation water usage can be observed or triclopyr residue levels are determined by laboratory analysis, or other appropriate means of analysis, to be 1.0 ppb or less.

– **There is no restriction on use of treated water to irrigate established grasses.**

- **Do not** apply Renovate OTF directly to, or otherwise permit it to come into direct contact with grapes, tobacco, vegetable crops, flowers, or other desirable broadleaf plants, and do not permit dust to drift into these areas.
- **Do not** apply to salt water bays or estuaries.
- **Do not** apply directly to un-impounded rivers or streams.
- **Do not** apply on ditches or canals currently being used to transport irrigation water or that will be used for irrigation within 120 days following treatment or until triclopyr residue levels are determined to be 1.0 ppb or less.
- **Do not** apply where runoff water may flow onto agricultural land as injury to crops may result.

Grazing and Haying Restrictions:
Except for lactating dairy animals, there are no grazing restrictions following application of this product.

- **Grazing Lactating Dairy Animals: Do not** allow lactating dairy animals to graze treated areas until the next growing season following application of this product.
- **Do not** harvest hay for 14 days after application.
- Grazed areas of non-cropland and forestry sites may be spot treated if they comprise no more than 10% of the total grazable area.

Slaughter Restrictions: During the season of application, withdraw livestock from grazing treated grass at least 3 days before slaughter.

BEST MANAGEMENT PRACTICES FOR DRIFT MANAGEMENT

Equipment used in the application of Renovate OTF should be carefully calibrated to be sure it is working properly and delivering a uniform distribution pattern. Aerial application should be made only when the wind velocity is 2 to 10 mph.

Applications should be made only when there is little or no hazard for volatility or dust drift, and when application can maintain Renovate OTF placement in the intended area. Very small quantities of dust, which may not be visible, may seriously injure susceptible plants, and Renovate OTF may be blown outside of the intended treatment area under extreme conditions. **Do not** spread Renovate OTF when wind is blowing toward susceptible crops or ornamental plants that are near enough to be injured.

Avoiding drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for drift. The applicator is responsible for considering all these factors when making decisions.

Ground Application Equipment: To aid in reducing drift, Renovate OTF should be applied when wind velocity is low (follow state regulations; see *Sensitive Area* under *Aerial Drift Reduction Advisory* below) or using a slurry injection system.

AERIAL DRIFT REDUCTION ADVISORY

This section is advisory in nature and does not supersede the mandatory label requirements.

Application Height: Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces drift potential.

Swath Adjustment: When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by

adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (e.g. higher wind).

Wind: Drift potential is lowest between wind speeds of 2 - 10 mph (follow state regulations). However, many factors, including equipment type, determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **Note:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Sensitive Areas: Renovate OTF should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

AQUATIC WEEDS CONTROLLED BY RENOVATE OTF

alligatorweed
American lotus
bladderwort
Eurasian watermilfoil
milfoil species
parrotfeather††
pickerelweed
pennywort
smartweed
water chestnut†,††
yellow water lily (*Nuphar spp.*, spatterdock)
white water lily (*Nymphaea* spp.)
water primrose (*Ludwigia* spp.)
watershield (*Brasenia* spp.)

† Not for use in California.
††Retreatment may be needed to achieve desired level of control.

Application Methods

Surface Application
Use a mechanical spreader such as a fertilizer spreader or mechanical seeder, or similar equipment capable of uniformly applying Renovate OTF. Before spreading any product, carefully calibrate the application equipment. When using boats and power equipment, you must determine the proper combination of (1) boat speed, (2) rate of delivery from the spreader, and (3) width of swath covered by the granules.

Use the following formula to calibrate the spreader's delivery in pounds of Renovate OTF per minute:

$$\frac{\text{miles per hour x swath width (feet) x pounds per acre}}{495} = \text{pounds per minute}$$

Aerial Application (Helicopter Only)
Ensure uniform application. All equipment should be properly calibrated using blanks with similar physical characteristics to Renovate OTF. To avoid streaked, uneven or overlapped application, use an appropriate tracking device (e.g. GPS). Refer to the *Aerial Drift Reduction Advisory* section of this label for additional precautions and instructions for aerial application.

Floating and Emersed Weeds
For control of water lily's (*Nymphaea* spp. and *Nuphar* spp.), watershield (*Brasenia* spp.), and other susceptible emersed and floating herbaceous weeds, apply 1.0 to 2.5 ppm a.e. triclopyr per acre. Apply when plants are actively growing.

Use higher rates in the rate range when plants are mature, when the weed mass is dense, in areas of greater water exchange, or for difficult to control species. Repeat as necessary to control regrowth, but do not exceed a total of 2.5 ppm a.e. triclopyr for the treatment area per annual growing season.

Submersed Weeds
For control of Eurasian watermilfoil (*Myriophyllum spicatum*) and other susceptible submersed weeds in ponds, lakes, reservoirs, impounded rivers, streams, and other bodies of water that are quiescent; non-irrigation canals, and seasonal irrigation waters, or ditches that have little or no continuous outflow, apply Renovate OTF using mechanical or portable granule spreading equipment. Rates should be selected according to the rate chart below to provide a triclopyr concentration of 0.50 to 2.5 ppm a.e. in treated water. Use of higher rates in the rate range is recommended in areas of greater water exchange. These areas may require a repeat application. However, total application of Renovate OTF must not exceed an application rate of 2.5 ppm a.e. triclopyr for the treatment area per annual growing season.

For optimal control, apply when Eurasian watermilfoil or other submersed weeds are actively growing.

Concentration of Triclopyr Acid in Water (ppm a.e.)

Avg. Water Depth (ft)	Pounds Renovate OTF / acre					
	0.5 ppm	0.75 ppm	1.0 ppm	1.5 ppm	2.0 ppm	2.5 ppm
1	14	20	27	41	54	67
2	27	41	54	81	108	135
3	41	61	81	122	162	202
4	54	81	108	162	216	270

For applications greater in depth than 4 feet, when targeting difficult to control species and/or in sites with high dilution potential, the following formula should be used to calculate applications rates should greater than 270 pounds of Renovate OTF be needed to achieve desired weed control. **NOTE: Do not** exceed 2.5 ppm a.e. triclopyr for the treatment area per annual growing season.

average depth x target ppm x 27 = pounds of Renovate OTF per acre

Example Calculation:
6 foot average depth x 2.5 ppm x 27 = 405 pounds of Renovate OTF per acre

SMALL SITE (LESS THAN 1/2 ACRE) / SPOT TREATMENT APPLICATION

For small treatment sites of 1/2 acre or less use the rate chart below to determine the application rate depending on average water depth to achieve a concentration of 1.25 to 2.5 ppm a.e. **Do not** exceed 2.5 ppm a.e. triclopyr for the treatment area per annual growing season. Use higher rates in small treatment areas and in areas prone to higher dilution and for heavy weed infestation. Use the lower rates for spot treatment application of areas less prone to dilution and lighter weed infestations. For best results, split the total application rate into three equal applications 8 to 12 hours apart. Apply when water is calm.

Example: A 100 ft. by 40 ft. lakeshore swimming area with a 4 ft. average depth, heavily infested with Eurasian watermilfoil

Step 1: Determine the area to be treated in square feet (ft^2) by multiplying the length of the area by the width.
– 100 ft. x 40 ft. = 4,000 ft^2

Step 2: Determine the amount of Renovate OTF to be used by consulting the Renovate OTF Rate Chart for Areas Less than 1/2 Acre.
– Use 24.7 lbs. of Renovate OTF total based on 4 foot average depth in Rate Chart below.

Step 3: Apply Renovate OTF uniformly over weeds in treatment site in three equal applications of 8.2 lbs. each, 8 - 12 hours apart.

Renovate OTF Rate Chart for Areas Less than 1/2 Acre

Area (ft^2)	Pounds Renovate OTF			
	3 foot average depth		4 foot average depth	
	1.25 ppm a.e.	2.5 ppm a.e.	1.25 ppm a.e.	2.5 ppm a.e.
500	1.2	2.3	1.5	3.0
1,000	2.3	4.6	3.1	6.1
4,000	9.3	18.6	12.4	24.7
10,000	23.2	46.5	31.0	61.9
20,000	46.5	93.0	62.0	123.9

For applications with an area or depth not included in the above chart, the following formula should be used to calculate application rates.

area (ft^2)/43,560 x average depth x target ppm x 27 = pounds of Renovate OTF

Example Calculation:
8,250 ft²/43,560 x 4 foot average depth x 1.25 ppm x 27 = 25.6 pounds of Renovate OTF

Small treatment application of Renovate OTF is recommended with waterproof gloves or a hand spreader to uniformly distribute flakes on target weeds.

Precautions for Potable Water Intakes:
For applications of Renovate OTF to control floating, emersed, and submersed weeds in sites that contain a functioning potable water intake for human consumption, see the chart below to determine the minimum setback distances of the application from the functioning potable water intakes.

Concentration of Triclopyr Acid in Water (ppm a.e.)

Area Treated (acres)	Required Setback Distance (ft) from Potable Water Intake				
	0.75 ppm	1.0 ppm	1.5 ppm	2.0 ppm	2.5 ppm
<4	300	400	600	800	1000
>4 - 8	420	560	840	1120	1400
>8 - 16	600	800	1200	1600	2000
>16 - 32	780	1040	1560	2080	2600
>32 acres, calculate a setback using the formula for the appropriate rate	Setback (ft) = (800*ln (acres) – 160) /3.33	Setback (ft) = (800*ln (acres) – 160) /2.50	Setback (ft) = (800*ln (acres) – 160) /1.67	Setback (ft) = (800*ln (acres) – 160) /1.25	Setback (ft) = (800*ln (acres) – 160)

Note: ln = natural logarithm

Example Calculation 1:
to apply 2.5 ppm Renovate OTF to 50 acres:

Setback in feet = (800 x ln (50 acres) – 160
= (800 x 3.912) – 160
= 2970 feet

Example Calculation 2:
to apply 0.75 ppm Renovate OTF to 50 acres:

$$\text{Setback in feet} = \frac{(800 \times \ln(50 \text{ acres}) - 160}{3.33}$$
$$= \frac{(800 \times 3.912) - 160}{3.33}$$
= 892 feet

Note: Existing potable water intakes which are no longer in use, such as those replaced by potable water wells or connections to a municipal water system, are not considered to be functioning potable water intakes.

To apply Renovate OTF around and within the distances noted above from a functioning potable water intake, the intake must be turned off until the triclopyr level in the intake water is determined to be 0.4 parts per million (ppm) or less by laboratory analysis or immunoassay.

WETLAND SITES
Wetlands include flood plains, deltas, marshes, swamps, bogs, and transitional areas between upland and lowland sites. Wetlands may occur within forests, wildlife habitat restoration and management areas and similar sites as well as areas adjacent to or surrounding domestic water supply reservoirs, lakes and ponds.

For control of emersed, floating or submersed aquatic weeds in wetland sites, follow use directions and application methods associated with the *Floating and Emersed Weeds* or *Submersed Weeds* sections on this label.

Use Precautions
Minimize unintentional application to open water when treating target vegetation in wetland sites. **Note:** Consult local public water control authorities before applying this product in and around public water. Permits may be required to treat such areas.

IF ANY CONTENT ON THIS LABEL IS NOT UNDERSTOOD, OR YOU NEED FURTHER ASSISTANCE, CONTACT A SEPRO AQUATIC SPECIALIST WITH QUESTIONS SPECIFIC TO YOUR APPLICATION.

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Terms and Conditions of Use

If terms of the following *Warranty Disclaimer, Inherent Risks of Use,* and *Limitation of Remedies* are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under *Warranty Disclaimer, Inherent Risks of Use* and *Limitations of Remedies.*

Warranty Disclaimer

SePRO Corporation warrants that the product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. SEPRO CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of SePRO Corporation as the seller. To the extent permitted by applicable law all such risks shall be assumed by buyer.

Limitation of Remedies

To the fullest extent permitted by law, SePRO Corporation shall not be liable for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories) shall be limited to, at SePRO Corporation's election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used.

SePRO Corporation shall not be liable for losses or damages resulting from handling or use of this product unless SePRO Corporation is promptly notified of such losses or damages in writing. In no case shall SePRO Corporation be liable for consequential or incidental damages or losses.

The terms of the *Warranty Disclaimer* above and this *Limitation of Remedies* cannot be varied by any written or verbal statements or agreements. No employee or sales agent of SePRO Corporation or the seller is authorized to vary or exceed the terms of the *Warranty Disclaimer* or *Limitations of Remedies* in any manner.

Storage and Disposal

Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available. Do not contaminate water, food, or feed by storage and disposal. Open dumping is prohibited.

Pesticide Storage: Store in original container. Do not store near food or feed. In case of leak or spill, contain material and dispose as waste.

Pesticide Disposal: Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

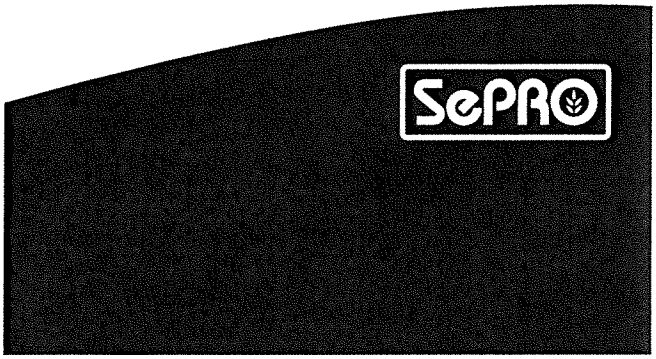
Container Disposal (Plastic Bags): Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

General: Consult federal, state, or local disposal authorities for approved alternative procedures.

Specimen Label

Renovate® MAX G

Aquatic Herbicide



FOR CONTROL OF AQUATIC WEEDS IN PONDS; LAKES; RESERVOIRS; MARSHES; BAYOUS; DRAINAGE DITCHES; NON-IRRIGATION CANALS; AND RIVERS AND STREAMS THAT ARE QUIESCENT OR SLOW-FLOWING.

Active Ingredient

triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt	4.0%
2,4-dichlorophenoxyacetic acid, dimethylamine salt	14.0%
Other Ingredients	82.0%
TOTAL	100.0%

Acid equivalence (a.e.): 14.4%

NOTICE: Read the entire label. Use only according to label directions. **Before using this product, read *Warranty Disclaimer, Inherent Risks of Use* and *Limitation of Remedies* at end of label booklet. If terms are unacceptable, return at once unopened.**

For additional information on our products, please visit **www.sepro.com.**

EPA Reg. No. 67690-50
FPL061209
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SePRO Corporation 11550 N. Meridian Street, Suite 600, Carmel, IN 46032 U.S.A.

Precautionary Statements

Hazards to Humans and Domestic Animals

Causes substantial, but temporary eye injury. Harmful if swallowed. Avoid contact with skin or clothing. Do not get in eyes or on clothing. Wear protective eyewear (goggles, face shield, or safety glasses). Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. Remove and wash contaminated clothing before reuse. Wear long-sleeved shirt and long pants, socks, and shoes.

Keep Out of Reach of Children

WARNING/AVISO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

FIRST AID	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15 - 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If swallowed	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15 - 20 minutes. • Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. In case of emergency endangering health or the environment involving this product, call **INFOTRAC** at **1-800-535-5053.**

Note to Physician: Probable mucosal damage may contraindicate the use of gastric lavage.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

All loaders, applicators, and other handlers must wear:

- Long-sleeve shirt and long pants;
- Shoes and socks; and
- Protective eyewear.

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. If pesticide gets on skin, wash immediately with soap and water.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENGINEERING CONTROLS

Pilots must use an enclosed cockpit that meets the requirements listed in the WPS for agricultural pesticides [40 CFR 170.240(d)(6].

ENVIRONMENTAL HAZARDS

Fish breathe dissolved oxygen in the water and decaying weeds also use oxygen. When treating continuous, dense weed masses, it may be appropriate to treat only part of the infestation at a time. For example, in quiescent waters, apply the product to areas separated by untreated sections that can be treated after vegetation in treated areas has disintegrated. During the growing season, weeds decompose in a 2 to 4 week period following treatment. Begin treatment along the shore and proceed outwards in bands to allow fish to move into untreated areas. Waters having limited and less dense weed infestations may not require partial treatments.

AGRICULTURAL CHEMICAL: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Read all Directions for Use carefully before applying.

GENERAL INFORMATION

Renovate MAX G herbicide may be applied directly to water for the control of aquatic weeds. Renovate MAX G enhances target weed control, and provides selective control of many broadleaf weeds in: ponds; lakes; reservoirs; marshes; bayous; drainage ditches; non-irrigation canals; and rivers and streams that are quiescent or slow-flowing.

Renovate MAX G is formulated on biodegradable granules that, when applied to water bodies, immediately delivers Renovate MAX G down to the critical area for controlling target weeds. Renovate MAX G is quickly absorbed from the water through plant stems and foliage and from the hydrosoil by roots. Herbicidal symptoms are initially expressed 2 to 14 days following application and usually involve bending and twisting of apical sections and shoots of susceptible plants. Initial symptoms are followed by necrosis of terminal buds and above ground tissue.

Generally, target plants are controlled within 2 to 4 weeks after treatment, but depending on conditions and plant species can take up to 8 weeks for complete control.

When applying Renovate MAX G follow all applicable use directions, precautions and limitations. All Renovate MAX G concentrations referred to in this label are based on acid equivalence (a.e.).

Obtain Required Permits: Consult with the State or local agency with primary responsibility for pesticide regulation before applying to public waters to determine if a permit or public notification is required.

Recreational Use of Water in Treatment Area: There are no restrictions on the use of treated water for recreational purposes, including swimming, fishing and domestic purposes.

Livestock Use of Water from Treatment Area: There are no restrictions on consumption of treated water for potable use by livestock, pets, or other animals.

GENERAL USE PRECAUTIONS AND RESTRICTIONS

- **Do not** apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.
- **Do not** enter or allow people (or pets) to enter the treated area until dusts have settled.
- For requirements specific to your State or Tribe, consult the State or Tribal agency responsible for pesticide regulation.
- **Chemigation: Do not** apply Renovate MAX G through any type of irrigation system.
- **Do not** apply to salt water bays or estuaries.
- Applications to target areas are limited to two (2) per season.
- Apply a maximum of 93.7 pounds of Renovate MAX G (13.5 lbs a.e.)/acre-foot per application. **Do not** exceed 5.0 ppm during any single application.
- **Do not** apply within 21 days of previous application except when conducting split treatments. Split treatments, over relatively short periods of time (e.g. 1 to 4 days), may be effective in some areas to maintain adequate exposure with target plants, such as small sites or sites with higher dilution potential.
- When treating moving bodies of water, applications must be made while traveling upstream to prevent concentration of herbicide downstream from the application.

APPLICATION TO WATERS USED FOR IRRIGATION

Irrigation Restrictions

- **Do not** use treated water for irrigating greenhouse or nursery plants unless triclopyr and 2,4-D residues are confirmed to be less than 1 ppb by laboratory analysis.

- **Do not** use water treated with Renovate MAX G for hydroponic farming.

- **Do not** apply Renovate MAX G directly to, or otherwise permit it to come into direct contact with grapes, tobacco, vegetable crops, flowers, or other desirable susceptible broadleaf plants, and do not permit dust to drift into these areas.

- This label describes both required and recommended uses of a chemical analyses for the active ingredients, triclopyr and 2,4-D. SePRO Corporation recommends the use of an Enzyme-Linked Immunoassay (ELISA) test for the determination of Renovate MAX G concentration in water. Contact SePRO Corporation for the incorporation of these analyses into your treatment program. Other proven chemical analysis for the active ingredients may also be used. The ELISA analysis is referenced in this label as the preferred method for the rapid determination of the concentration of the active ingredients in the water. Both triclopyr and 2,4-D can be analyzed from a single water sample.

- If Renovate MAX G treated water is intended to be used only for crops or non-crop areas that are labeled for direct treatment with triclopyr and 2,4-D such as pastures, turf, or established grasses, the treated water may be used to irrigate and/or mix sprays for these sites at any time during and after application.

- Due to potential phytotoxicity and/or residue considerations, the following restrictions are applicable to other uses of irrigation water:

  - If treated water is intended to be used to irrigate or mix sprays for crops not labeled for direct treatment with triclopyr and 2,4-D, the water must not be used unless ***one*** of the following restrictions has been observed:
    - A waiting period of 120 days from the time of application has elapsed; or
    - An approved assay indicates that the triclopyr concentration is 1.0 ppb or less and the 2,4-D concentration is 100 ppb or less at the water intake. See Table 2 (*SAMPLING FOR DRINKING WATER ANALYSES*) for the recommended waiting periods after application but before taking the initial water sample at water intake.

  - If treated water is intended to be used to irrigate non-crop areas not labeled for direct treatment with triclopyr and 2,4-D (e.g. landscape ornamentals) or for other irrigation uses not described, consult with SePRO Corporation prior to commencing irrigation if triclopyr concentrations exceed 1.0 ppb and 2,4-D concentrations are greater than 100 ppb.

APPLICATIONS TO POTABLE WATER SOURCES

Potable Water Restrictions

- The potable water use restrictions on this label are to ensure that consumption of water by the public is allowed only when the concentration of triclopyr in water is less than 400 ppb and the concentration of 2,4-D in water is less than the MCL (Maximum Contaminant Level) of 70 ppb. Applicators should consider the unique characteristics of the treated waters to assure that triclopyr and 2,4-D concentrations in potable water do not exceed 400 ppb and 70 ppb, respectively, at the time of consumption.

- The drinking water setback distances from functioning potable water intakes are provided in Table 1 (*DRINKING WATER SETBACK DISTANCES*).

Table 1: Drinking Water Setback Distances

Application concentration and minimum setback distance (ft) from functioning potable water intake			
≤1 ppm†	1.1 to 2.0 ppm†	2.1 to 3.0 ppm†	3.1 to 5 ppm†
600	1,200	1,800	2,400

† ppm acid equivalent target water concentration

- Following each application of Renovate MAX G, treated water must not be used for potable water unless ***one*** of the following restrictions has been observed:
  - A setback distance described in Table 1 was used for the application;
  - A waiting period of at least 21 days from the time of application has elapsed; or
  - An approved assay indicates that the triclopyr concentration is 400 ppb or less and the 2,4-D concentration is 70 ppb or less at the water intake. Sampling for drinking water analyses should occur no sooner than stated in Table 2. **NOTE:** Sampling for drinking water analysis should occur no sooner than 3 days after Renovate MAX G application. Analysis of 2,4-D in drinking water samples must be completed by a laboratory that is certified under the Safe Drinking Water Act to perform drinking water analysis using a currently approved version of analytical Method Number 515, 555, other methods for 2,4-D as may be listed in Title 40 CFR, Part 141.24, or Method Number 4015 (immunoassay of 2,4-D) from U.S. EPA Test Methods for Evaluating Solid Waste SW-846.

Table 2: Sampling for Drinking Water Analyses†

Minimum days after application before initial water sampling at the functioning potable water intake		
≤1 ppm††	1.1 to 3.0 ppm††	3.1 to 5.0 ppm††
5	10	14

† These are general guidelines; the amount of time required for residues to reach concentrations acceptable for drinking or irrigation will depend on the total acres treated relative to water body size, application rates, water exchange rates, weed density, and various other factors. Consult a SePRO Aquatic Specialist for site specific recommendations.

††ppm acid equivalent target water concentration

- **If no setback distance from Table 1 is to be used for the application, applicators or the authorizing organization must provide a drinking water notification and an advisory to shut off all potable water intakes inside the setback zone prior to Renovate MAX G application.** Notification to the party responsible for a public water supply or to individual private water users must be done in a manner to assure that the party is aware of the water use restrictions when this product is applied to potable water. The following is an example of a notification via posting, but other methods of notification which convey the above restrictions may be used and may be required in some cases under state or local law or as a condition of a permit.

  - **Example:**
  - Posting notification should be located every 250 feet including the shoreline of the treated area and up to 250 feet of shoreline past the application site to include immediate public access points. Posting should include the day and time of application. Posting may be removed if analyses of a sample collected at the intake, no sooner than stated in Table 2, shows that the triclopyr concentration in the water is 400 ppb or less and the 2,4-D concentration is 70 ppb or less, or after 21 days following application, whichever occurs first.
    - **Text of notification:** Wait 21 days before diverting functioning surface water intakes from the treated aquatic site to use as drinking water unless water at functioning drinking water intakes is tested no sooner than [insert days from Table 2] and is demonstrated by assay to contain no more than 400 ppb triclopyr and 70 ppb 2,4-D. Application Date: _____, Time: _____.

- **NOTE:** Existing potable water intakes that are no longer in use, such as those replaced by a connection to a municipal water system or a potable water well, are not considered to be functioning potable water intakes.

- Drinking water setback distances do not apply to terrestrial applications of triclopyr or 2,4-D adjacent to water bodies with potable water intakes.

GRAZING AND HAYING RESTRICTIONS

Except for lactating dairy animals, there are no grazing restrictions following application of this product.

- **Grazing Lactating Dairy Animals: Do not** allow lactating dairy animals to graze treated areas until the next growing season following application of this product.

- **Do not** harvest hay for 14 days after application.

- Grazed areas of sites may be spot treated if they comprise no more than 10% of the total grazable area.

SLAUGHTER RESTRICTIONS

During the season of application, withdraw livestock from grazing treated grass at least 3 days before slaughter.

DRIFT MANAGEMENT

A variety of factors including weather conditions (e.g., wind direction, wind speed, temperature, relative humidity) and method of application (e.g., ground, aerial, airblast) can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying this product. Applying Renovate MAX G through an enclosed eductor or slurry injection injection system via a continuous stream of water and/or injected under the water surface further minimizes drift potential.

Wind Speed

Do not apply at wind speeds greater than 15 mph. Only apply this product if the wind direction favors on-target deposition and there are not sensitive areas (including, but not limited to, residential areas, bodies of water, known habitat for non-target species, non-target crops) near enough to be injured.

Temperature Inversions

If applying at wind speeds less than 3 mph, the applicator must determine if: a) conditions of temperature inversion exist, or b) stable atmospheric conditions exist at or below application height. Do not make applications into areas of temperature inversions or stable atmospheric conditions.

Susceptible Plants: Do not apply under circumstances where drift may occur to food, forage, or other plantings that might be damaged or crops thereof rendered unfit for sale, use or consumption. Susceptible crops include, but are not limited to, cotton, okra, flowers, grapes (in growing stage), fruit trees (foliage), soybeans (vegetative stage), ornamentals, sunflowers, tomatoes, beans, and other vegetables, or tobacco. Small amounts of pesticide drift that might not be visible may injure susceptible broadleaf plants.

Other State and Local Requirements: Applicators must follow all state and local pesticide drift requirements regarding application of triclopyr or 2,4-D herbicides in aquatic sites. Where states have more stringent regulations, they must be observed.

Equipment

All aerial and ground application equipment must be properly maintained and calibrated using appropriate carriers or surrogates.

Aerial applications

- Apply Renovate MAX G at the lowest height consistent with efficacy and flight safety. Do not apply at a height greater than 10 feet above the water surface or plant canopy unless a greater height is required for aircraft safety.

- When applications are made with a crosswind, the swath will be displaced downwind. The applicator must compensate for this by adjusting the path of the aircraft upwind.

AQUATIC WEEDS CONTROLLED BY RENOVATE MAX G

Efficacy and selectivity of Renovate MAX G is dependent upon dose, time of year, stage of growth, method of application, and water movement. The following categories—highly susceptible, moderately susceptible, and less susceptible—are provided to define species that may be controlled using Renovate MAX G.

Efficacy and selectivity is dependent on many factors, and can be managed through selection of application rates, application techniques and timing, etc. Rate selection will be partially dependent on characteristics of the treatment area. Consult with SePRO Corporation to determine best treatment protocols to manage individual species and to meet specific aquatic plant management objectives. Plants listed as moderately susceptible and less susceptible can be controlled under most use conditions, but generally require higher application rates.

HIGHLY SUSCEPTIBLE VASCULAR AQUATIC PLANTS
Eurasian watermilfoil (*Myriophyllum spicatum*)
hybrid watermilfoil (*Myriophyllum spicatum x sibiricum*)

MODERATELY SUSCEPTIBLE VASCULAR AQUATIC PLANTS
northern watermilfoil (*Myriophllyum sibiricum*)
other milfoil species (*Myriophyllum* spp.)
bladderwort (*Utricularia* spp.)
white water lily (*Nymphaea* spp.)
watershield (*Brasenia* spp.)

LESS SUSCEPTIBLE VASCULAR AQUATIC PLANTS
variable-leaf milfoil (*Myriophyllum heterophyllum*)
water stargrass (*Heteranthera dubia*)
coontail (*Ceretophyllum demersum*)
parrotsfeather (*Myriophyllum aquaticum*) ††
yellow water lily or spatterdock (*Nuphar* spp.)
water chestnut (*Trapa natans*) †, ††

† Not for use in California
†† Retreatment may be needed to achieve desired level of control.

Application Methods

Surface Application
Use a mechanical spreader such as a fertilizer spreader, blower, mechanical seeder, an eductor system, or similar equipment capable of uniformly applying Renovate MAX G. Before spreading any product, carefully calibrate the application equipment. When using boats and power equipment, you must determine the proper combination of (1) boat speed, (2) rate of delivery from the spreader, and (3) width of swath covered by the granules.

Use the following formula to calibrate the spreader's delivery in pounds of Renovate MAX G per minute:

$$\textbf{Pounds per Minute} = \frac{\text{miles per hour} \times \text{swath width (feet)} \times \text{pounds per acre}}{495}$$

Aerial Application (Helicopter Only)
Ensure uniform application. All equipment should be properly calibrated using blanks with similar physical characteristics to Renovate MAX G. To avoid streaked, uneven or overlapped application, use an appropriate tracking device (e.g. GPS). Refer to the *DRIFT MANAGEMENT* section of this label for additional precautions and instructions for aerial application.

Floating-leaf and Emergent Weeds
For control of water lily's (*Nymphaea* spp. and *Nuphar* spp.), watershield (*Brasenia* spp.), and other susceptible emergent and floating-leaf herbaceous weeds, apply up to 1.0 to 5.0 ppm. Apply when plants are actively growing.

Submersed Weeds
For control of Eurasian watermilfoil (*Myriophyllum spicatum*) and other submersed weeds, apply Renovate MAX G at concentrations up to 0.25 to 5.0 ppm in treated water. Rates should be selected according to the Table 3 (*CONCENTRATION OF RENOVATE MAX G IN WATER*). For optimal control, apply when Eurasian watermilfoil or other submersed weeds are actively growing.

When controlling Eurasian watermilfoil in plant communities containing other desirable susceptible species, selectivity may be enhanced generally by using a rate lower in the range, treatment timing, application technique, etc.; consult a SePRO Aquatic Specialist for site specific recommendations.

Table 3: Concentration of Renovate MAX G in Water (ppm a.e.)†

Average Water Depth (ft)	Pounds Renovate MAX G / Acre					
	0.25 ppm	0.5 ppm	1.0 ppm	2.0 ppm	4.0 ppm	5.0 ppm
1	4.7	9.4	18.8	37.5	75.0	93.7
2	9.4	18.8	37.5	75.0	150.0	187.5
3	14.1	28.1	56.3	112.5	225.0	281.2
4	18.8	37.5	75.0	150.0	300.0	375.0
5	23.4	46.9	93.8	187.5	375.0	468.7

†Use of higher rates in the rate range is necessary to achieve desired control in areas of greater water exchange; when treating more mature plants; when targeting more difficult to control aquatic species; and when treating small areas in larger bodies of water (spot treatments). Lower concentrations are generally used when conducting early season large-scale treatments; and treating larger areas, more immature plants, and areas with less potential for rapid water exchange. Some areas may require a repeat application to control re-growth.

The following formula can be used to calculate applications rates based on depths exceeding 4 feet deep or when using a concentration not in the Table 3.

Pounds of Renovate MAX G per Acre = average depth x target ppm x 18.75

Example Calculation:
6 foot average depth x 1.25 ppm x 18.75 = 140.6 pounds of Renovate MAX G per acre

NOTE: apply a maximum of 93.7 pounds of Renovate MAX G (13.5 lbs a.e.)/acre-foot per application. Do not exceed 5.0 ppm during any single application.

COMBINATIONS WITH OTHER HERBICIDES

Renovate MAX G may be combined or applied simultaneously with other herbicides to increase the weed control spectrum or enhance efficacy. Follow all applicable use directions, precautions, and restrictions on all labels used in the combination.

IF ANY OF THE CONTENT OF THIS LABEL IS NOT UNDERSTOOD, OR YOU NEED FURTHER ASSISTANCE, CONTACT A SEPRO AQUATIC SPECIALIST WITH QUESTIONS SPECIFIC TO YOUR APPLICATION.

Storage and Disposal

Do not contaminate water, food or feed by storage or disposal.

Pesticide Storage: Store in original container only. Do not store near feed or foodstuffs. In case of spill, contain material and dispose as waste.

Pesticide Disposal: Wastes resulting from use of this product may be used according to label directions or disposed of at an approved waste disposal facility.

Nonrefillable Container Disposal (non-rigid, any size): Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Terms and Conditions of Use

If terms of the following *Warranty Disclaimer, Inherent Risks of Use,* and *Limitation of Remedies* are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under *Warranty Disclaimer, Inherent Risks of Use* and *Limitations of Remedies.*

Warranty Disclaimer

SePRO Corporation warrants that the product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. **TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, SEPRO CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.**

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Limitation of Remedies

To the extent consistent with applicable law, the exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories) shall be limited to, at SePRO Corporation's election, one of the following:

(1) Refund of purchase price paid by buyer or user for product bought, or

(2) Replacement of amount of product used.

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