LAKE WASHINGTON AND THE SAMMAMISH RIVER

WITHIN THE CITY OF KENMORE, WASHINGTON

INTEGRATED AQUATIC VEGETATION MANAGEMENT PLAN

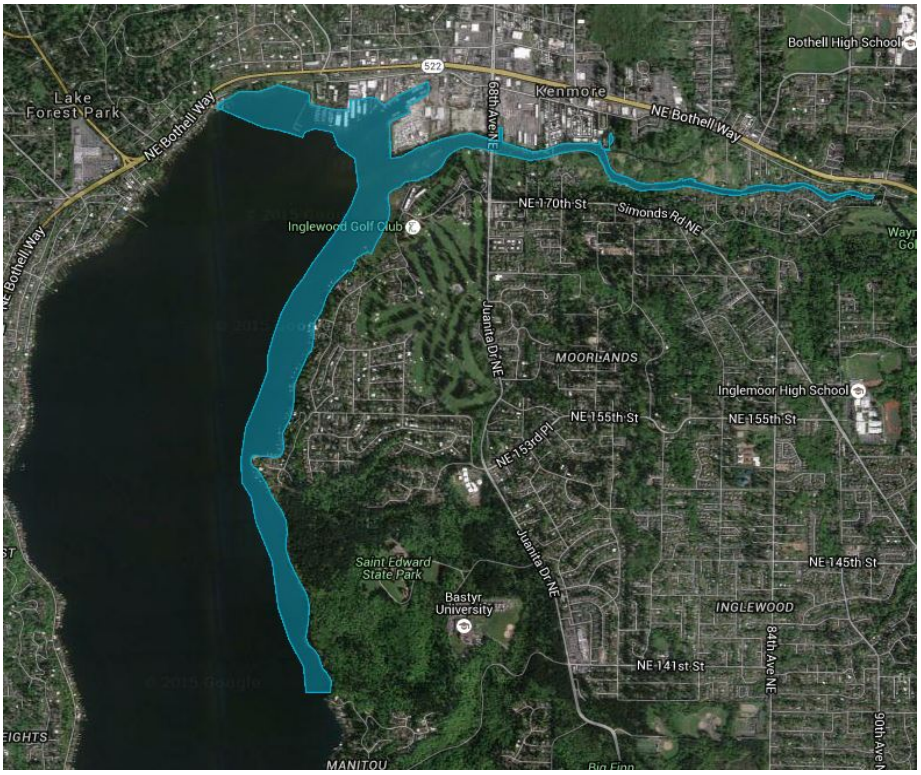


Image from Google Maps

Prepared by Herrera Environmental Consultants, Inc.

In Conjunction with the City of Kenmore

18120 – 68th Avenue Northeast, Kenmore, Washington 98028

With Grant Funding from the Washington State Department of Ecology

June 30, 2017

Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will copy correctly when duplexed.

CONTENTS

Acknowledgements v
Executive Summary vii
Introduction 1
Problem Statement 3
Public Involvement 7
Plant Management Goals 9
Waterbody Characteristics 11
Lake Washington 11
Watershed and Physical Characteristics 11
Water Quality 13
Sammamish River 18
Watershed 18
Fisheries 19
Water Quality 19
Beneficial Uses and Identified Problems 21
Aquatic Plant Community 27
2016 Plant Distribution and Density 27
Dominant Plant Distribution 29
Noxious Weed Species 30
Targeted Plant Descriptions 39
Past Management Efforts 43
Aquatic Plant Control Alternatives 45
Integrated Aquatic Plant Control Scenarios 49
Herbicide 53
Mechanical Harvesting 54
Manual Raking 55
Bottom Barriers 55
Plant Conservation 56
Future Considerations 56

Selected Action Strategy and Implementation 57
Action Strategy 57
Implementation 58
Monitoring and Evaluation Plan 61
Aquatic Plant Surveys 61
Evaluation 61
References 63

APPENDICES

Appendix A Kenmore Steering Committee and Public Meeting Presentations and Minutes
Appendix B Aquatic Plant Survey Maps
Appendix C Aquatic Plant Control Alternatives
Appendix D Target Species Best Management Practices

TABLES

Table 1. Physical Characteristics of Lake Washington. 11
Table 2. Aquatic Plant List for the Kenmore Survey on September 7 and 8, 2016. 29
Table 3. Summary of Permitted Aquatic Herbicide Use for Lake Washington. 43
Table 4. Aquatic Plant Control Options Considered for Kenmore. 47
Table 5. Maximum Plant Management Areas. 50
Table 6. Maximum Plant Control Cover and Control Cost. 50
Table 7. Herbicide Targets, Restrictions, and Cost. 53
Table 8. Required Permits. 58

FIGURES

Figure 1. Aquatic Vegetation Survey Area Within the City of Kenmore, Washington. 12
Figure 2. Temperature, Dissolved Oxygen, and pH at Station 0804 in Lake Washington. 14
Figure 3. Trophic State Index Values for Lake Washington. 15
Figure 4. Total Phosphorus and Chlorophyll-a at Station 0804 in Lake Washington. 17
Figure 5. Annual Water Quality Index Scores for the Sammamish River Station 450CC. 20
Figure 6. Beneficial Uses of Lake Washington and the Sammamish River, Kenmore, Washington. 23
Figure 7. Aquatic Vegetation Density Map, Kenmore, Washington. 31
Figure 8. Dominant Species Distribution and Aquatic Vegetation Sample Locations, Kenmore, Washington 33
Figure 9. Noxious Weed Distribution, Kenmore, Washington. 37
Figure 10. Maximum Aquatic Vegetation Control Areas, Kenmore, Washington. 51

ACKNOWLEDGEMENTS

The City of Kenmore is grateful to the Washington State Department of Ecology for providing funding, without which we might not have been able to create this Integrated Aquatic Vegetation Management Plan. In particular, the Department of Ecology's Lizbeth Seebacher has been instrumental in this process, providing guidance, answering questions, and serving on the steering committee for the project. We are also appreciative of Ben Peterson, King County Aquatic Noxious Weed Specialist, for being willing to provide information and insights as we worked through the process, and who also served on the steering committee. Casey Costello, Washington State Department of Fish and Wildlife, also lent his expertise to the committee, as did Douglas Poppe, Puget Sound Anglers Association, providing a fisherman's perspective. In addition, Kenmore business owner/agents Todd Banks, President of Kenmore Air; Jim Davidson, Owner of North Lake Marina; Greg Matz, Superintendent of Inglewood Golf Club; and Doug Ritchie, former Vice President of Kenmore Waterfront Activities Center, offered their perspectives as representatives of waterfront commercial enterprises. We would also like to thank Kenmore residents John Adamski and Matt Muller for providing both historical and current perspectives on the presence of aquatic weeds and water quality issues. Samantha Loyuk, City of Kenmore Associate Planner, provided input on City of Kenmore permit requirements. Rounding out the steering committee were Jennifer Gordon, City of Kenmore Public Works Operations Manager; and Quinn Proffitt, City of Kenmore Maintenance; both of whom offered input from the perspective of frequent observers of our parks and waters. Our thanks to Nancy Rapin and Karen Walter of the Muckleshoot Tribe for their review of the plan, as well as the many citizens who provided input during this project. Lastly, we would like to thank Herrera Environmental Consultants—in particular Rob Zisette and Julia Munger—for surveying and mapping and for providing scientific knowledge and expertise throughout the process.

EXECUTIVE SUMMARY

The City of Kenmore lies on the northern edge of Lake Washington, and also encompasses the mouth of the Sammamish River, giving the City 7.8 miles of shoreline. Among City of Kenmore goals is a commitment to advance the public's access and connection to the waterfront. In the fall of 2016, Kenmore residents approved the City's first bond measure, which will, in part, increase public access to and make improvements in three of Kenmore's waterfront parks: Log Boom Park on the northern shore of Lake Washington, and Rhododendron Park and Squire's Landing on the Sammamish River.

Dense growth of aquatic plants during the summer interferes with recreational and commercial use of the Sammamish River and Lake Washington in the City of Kenmore, creating obstructions for multiple users and inhibiting use for swimmers, kayakers, boaters and others. Negative impacts on riparian habitat are also of concern.

Residents and business owners within the City of Kenmore, as well as aquatic plant biologists and plant management experts, came together to develop goals and a proposal for the City's Integrated Aquatic Vegetation Management Plan (IAVMP), which is funded by a Washington Department of Ecology grant.

The management goals are to maintain recreational and commercial usability and habitat integrity of the lake and river by managing nuisance plants in identified beneficial use areas, and to keep swimming areas clear of weeds. Management activities will primarily target noxious weeds focusing on three aquatic noxious weeds (Eurasian watermilfoil, Brazilian egeria, and fragrant waterlily) that are abundant in the project area, and two emergent weed species (garden and purple loosestrife) that are not abundant but are required for control in this part of King County.

The aquatic plants will be controlled by a combination of hired contractors to do work in public areas, as well as manual removal and management by residents in private areas. Four state-approved aquatic herbicides were selected for use in this plan: glyphosate, triclopyr, imazapyr, and diquat. Non-chemical management methods may include inexpensive hand-held rakes for residents to use on their own waterfront properties, and the installation of bottom barriers around docks and swim areas. To preserve wildlife habitat, aquatic plants in conservation areas near the Inglewood wetlands will not be managed unless they further encroach upon the navigation channels.

Successful implementation of this plan revolves around a collective sharing of information. The City of Kenmore will work to solicit public input, and keep residents and businesses informed of current and future plant management strategies.

INTRODUCTION

In his Budget Cover Letter of October 24, 2016, Kenmore City Manager, Rob Karlinsey, said, "Cities like Kenmore can go beyond being just functional and providing basic public safety. Cities can play a key role in prosperity and human flourishing. In other words, it's not just about preventing suffering and undue hardship, which is important; our job is also about creating opportunities and clearing the path for our residents, businesses, and visitors to play, find fulfillment, and connect with each other as a community … Especially for Kenmore, the way to make progress on that upward trajectory [of becoming] is through continuous improvement or "relentless incrementalism." The overwhelming majority of our progress will be through the seemingly small, one-step-at-a-time improvements we make to our City. All of these incremental improvements add up over time to make a big difference." The creation and implementation of this Integrated Aquatic Vegetation Management Plan (IAVMP) is one of those incremental improvements that over time can make a big difference.

Rob Karlinsey continued, "As affirmed in Council Goal #2 [… advance the public's access and connection to the waterfront], a key component of a prosperous Kenmore is how we turn toward the lake and leverage this powerful asset. Our waterfront on beautiful Lake Washington is a precious resource that few cities have … We [have] heard clearly from the public that public access to the water is one of their highest priorities … Kenmore can bring the vision of its citizens to fruition and become a waterfront destination in its own right; not just a place to launch or store your boat—a place where boaters and visitors intentionally go to tour and have fun. In other words, Kenmore can become known for its beautiful waterfront and the public access it provides."

In the fall of 2016, Kenmore residents generously approved Kenmore's first bond measure, which will, in part, increase public access to and make improvements in three of Kenmore's waterfront parks: Log Boom Park on the northern shore of Lake Washington, and Rhododendron Park and Squire's Landing on the Sammamish River.

Aquatic noxious weeds are non-native plants that are particularly invasive in shoreline areas or open water. These plants negatively impact ecological processes, recreation, and business activities. With 7.8 miles of shoreline and multiple opportunities to enjoy the water, management of these weeds in the lake and river areas of Kenmore is critically important as more and more people gain access to the water. However, because Kenmore is on the receiving end of invasive weeds and other debris from the Sammamish River, this issue cannot be addressed in isolation from upstream communities. Therefore, we've also included the component of upstream outreach as a part of our plan.

The development of this IAVMP has been an interesting and valuable process that has given us the opportunity to focus our attention on the problem of aquatic noxious weeds and to gain citizen input on ways to address the problem. This document offers a menu of options available for the City and residents alike to utilize as we work to manage aquatic weeds.

PROBLEM STATEMENT

Dense growth of aquatic plants during the summer interferes with recreational and commercial use of the Sammamish River and Lake Washington in the city of Kenmore, creating obstructions for multiple users and inhibiting use for swimmers, kayakers, boaters and others. Negative impacts on riparian habitat are also of concern, as non-native invasive species crowd out native growth, alter water temperatures, and negatively impact the environment for fish and other aquatic animals.

Survey and mapping by Herrera Environmental Consultants, Inc. (Herrera) in early September 2016, which forms the basis for this IAVMP, was performed 6 to 10 weeks after herbicide treatments targeting Eurasian watermilfoil (milfoil) and Brazilian egeria (egeria) were conducted in five portions of the survey area. Pretreatment mapping in May and June 2016 showed a high density of Eurasian watermilfoil in portions of the following three treatment locations: deeper portions of Log Boom Park, small isolated portions from the mouth of the Sammamish River to just east of the 68th Avenue Northeast Bridge, and deeper portions of Lake Washington offshore of waterlilies adjacent to Inglewood Wetlands. Pretreatment mapping of plant density was not conducted at the remaining two treatment locations: Squire's Landing Park on the Sammamish River at the confluence with Swamp Creek and in Lake Washington at the Arrowhead Point neighborhood. It should be noted that the pretreatment surveys focused on high-use, public areas representing a small portion of the total project area. Therefore, plant location and density reported in the September survey do not represent typical conditions for the treated areas.

In addition to milfoil and egeria, the lowermost reach of the Sammamish River and most of Lake Washington north of Arrowhead Point was dominated by native plants of varied density. Another noxious weed, fragrant waterlily, covered the south shoreline of the lower 0.3 miles of the Sammamish River and extended 0.3 miles south along the eastern shore of Lake Washington. Green filamentous algae has formed in large floating mats along the Sammamish River banks and at the river mouth, and blue-green algae has periodically been found at toxic levels. These algae mats often wash up on public and private shorelines, creating problems ranging from a nuisance and malodorous deposit to high toxicity and unsafe water conditions. While not specifically addressed in this IAVMP, algae and aquatic vegetation ecosystems are interconnected.

Aquatic plants (macrophytes) may have an impact on the amount of floating and attached algae in a lake. They can provide a growing surface for an enormous amount of attached algae. These attached algae use up a portion of the nutrients dissolved in the water that might otherwise fertilize the floating algae and increase their growth. On the other hand, the macrophytes themselves, as they die back and decay, contribute nutrients to the water and thus can promote algal growth. So in many cases we cannot be sure (without very specific and detailed analyses) whether removing rooted plants would bring about more algae growth, or less, or no change. Source: Ecology 2017a.

Problems created by the presence of non-native, invasive plants fall into three categories—environmental, recreational, and economic—and there is significant overlap between categories.

Environmental problems created by dense aquatic weeds include:

- Negative impact on fish habitat
- Impact on native biodiversity by displacing native aquatic plants and reducing plant diversity
- Non-native aquatic weeds promote habitat for non-native fish species that prey on salmon and other indigenous species
- Increased levels of algae from nutrients released by plant decay
- Water quality concerns:
    - Low dissolved oxygen under plant canopies
    - High temperature from reduced water circulation

Recreational problems include:

- Dense weeds inhibit swimming and paddle sports and discourage water users
- Weeds get wound around boat motors and rudders
- Fishing lines get tangled with weeds
- Health risks of toxic blue-green algae scum that accumulates on dense and decaying plants
- Impacts on aesthetics:
    - Plant accumulation and decay
    - Foul aroma
    - Water clarity issues
- Reduced shoreline access

Economic impacts include:

- Reduction of navigable waterways by forcing lake traffic into narrower channels, which increases potential for conflict between boats and planes

- Decomposition of plants causes debris accumulation on the river and lake bottoms, which in turn results in reduction of water depth impacting navigable channels and access to moorage slips, especially for larger boats
- Costly repairs to damaged boat propellers and plane rudders
- Costly repairs to irrigation systems from clogged intake lines and damaged pumps
- Reduction of recreational uses and associated reduction in perceived quality of life
- Lower waterfront property values (Olden and Tamayo 2014)
- Cost of treatment to manage/control/eradicate

As the recipient of invasive aquatic weeds from upstream on the Sammamish River, the City of Kenmore has a challenging task in determining what will be possible to manage, control, and/or eradicate within its waters. A total of 10 of the observed species are on the Washington state noxious weed list, and garden and purple loosestrife are required to be controlled. In addition, control is recommended for Japanese knotweed, Eurasian watermilfoil, and fragrant waterlily. While control is not required by the King County Noxious Weed Control Board, management of Brazilian egeria is necessary for maintaining a healthy native plant population and addressing water body usability issues. Public education and engagement, management of all of these species, and early detection of any new or emerging invasive species will be the focus of this IAVMP.

PUBLIC INVOLVEMENT

Kenmore has a large waterfront community, both residential and commercial, and the City wanted to include representatives on the IAVMP steering committee with a broad spectrum of perspectives and geographic locations. The City reached out to community leaders from the residential community—residents who had been vocal in their desire to address the problem of aquatic weeds—and to all of the businesses with waterfront property locations.

As a result, the City was fortunate to gain the participation of Todd Banks, President of Kenmore Air, the largest seaplane operator in the United States; Jim Davidson, Owner of North Lake Marina, a family owned and operated marina on Kenmore's waterfront; Greg Matz, Superintendent of Inglewood Golf Club, located along both the Sammamish River and Lake Washington and irrigated by water from these sources; and Doug Ritchie, then Vice President of the Kenmore Waterfront Activities Center located adjacent to Squire's Landing Park along the Sammamish River.

John Adamski, waterfront homeowner in the Arrowhead Point community of Lake Washington for multiple decades and avid stand-up paddle boarder; and Matt Muller, waterfront property owner in the Inglewood residential area and frequent user of Lake Washington and the Sammamish River, both provided important perspective, including historical insights from John.

The City felt it would be valuable to have the perspective of a fisherman as well, so they posted notices at Log Boom Park and the public boat launch managed by the Department of Fish and Wildlife. When the notices didn't provide any additional steering committee members the City took a more active approach, went to the boat launch, and found Douglas Poppe, an officer in the Puget Sound Anglers Association.

With good community representation the City also reached out to agencies associated with the management of aquatic weeds, and was fortunate to gain the following additional members of the steering committee: Lizbeth Seebacher, Wetland and Aquatic Biologist for the Washington State Department of Ecology; Ben Peterson, Aquatic Noxious Weeds Specialist with King County; and Casey Costello, Habitat Biologist with the Washington State Department of Fish and Wildlife.

The steering committee was rounded out by two City staff members: Jennifer Gordon, Public Works Operations Manager; and Quinn Proffitt, Maintenance Worker and observer of City parks on a daily basis; and Janet Quinn, Project Coordinator for the City of Kenmore. Rob Zisette, Senior Aquatic Scientist and Project Manager with Herrera, was also included on the committee. Janet and Rob acted as co-facilitators for all meetings. Meeting presentations and minutes are presented in Appendix A.

In addition to the steering committee meetings, the City invited residential and commercial waterfront property owners and other residents to a community meeting held in January 2017 at Kenmore City Hall (see Appendix A). In response to extensive social media invitations to all Kenmore residents and written, mailed invitations to all waterfront property owners, 30 largely waterfront property owners met to hear about the development of the IAVMP, to learn about management options, and to express their thoughts on the work done to date. Participation was enthusiastic and there was clearly a desire to learn more and do more, both individually and collectively, to address aquatic weeds problems. As staffing and funding allows, the City of Kenmore plans to continue to reach out to the community to provide education and solicit input into chosen management strategies.

In addition, a meeting was held in May 2017 to respond to citizen questions and gauge interest in the formation by residents of a Plant Management Association that would allow them to work together to manage invasive plants. There was insufficient interest at the present time in forming an Association, but this remains a possibility as a future strategy.

Outreach to upstream jurisdictions has been an on-going process although no Coalition has been formed to date. Conversations with the cities of Bothell, Redmond, Woodinville and other upstream jurisdictions will continue as the City develops more specific ways of working together to address the Sammamish River system more holistically than could be achieved by one downstream City. Formation of a multi-jurisdictional coalition involving municipalities and non-profits and other interested organizations continues to be a City of Kenmore long-term vision.

The Muckleshoot Tribe provided comments on the draft IAVMP that are addressed in this final IAVMP.

In response to citizen requests, the City of Kenmore published a webpage that provides access to detailed information on permits and best management practices, as well as links to other aquatic weed-related topics. This page can be found at: <http://www.kenmorewa.gov/IAVMP>.

PLANT MANAGEMENT GOALS

The aquatic plant management goals are to maintain recreation and commercial usability and habitat integrity of the lake and river by managing nuisance plants in identified beneficial use areas, and to keep swimming areas clear of weeds for optimal usability.

Management priorities include:

- Control of regulated noxious weeds
- Control of dominant noxious weed species
- Early detection of emerging noxious weed species

Priority management areas include:

- Public parks, main channels, other high public use areas
- Private waterfront residences and businesses

Management goals include:

- Reduce impact on boating (hand-powered watercraft and motor boats):
    - Provide clear, clean water
    - Reduce weeds catching on paddles, rudders, propellers
- Provide clear, clean water for swimmers:
    - Reduce weeds near beach areas
    - Reduce noxious weeds or decomposed weeds on beaches
- Maintain healthy environment for fish:
    - Provide appropriate water temperatures
    - Provide appropriate dissolved oxygen levels

WATERBODY CHARACTERISTICS

LAKE WASHINGTON

Watershed and Physical Characteristics

The city of Kenmore lies along the northern end of Lake Washington near the outlet of the Sammamish River (Figure 1). Lake Washington is the largest lake in King County, and the second largest natural lake in the state of Washington. The lake's western shore is bounded by urban Seattle, and the eastern shore is bounded by the cities of Bellevue, Medina, Renton, and Kirkland. The lake is 22 miles long and has a surface area of 21,500 acres square miles and a mean depth of 108 feet (Table 1, King County 2017a). The basin area for the lake is 472 square miles, with the Cedar and Sammamish rivers as the largest freshwater inputs contributing an average of 57 percent and 27 percent of the total inflow volume, respectively.

Table 1. Physical Characteristics of Lake Washington.

Basin Area	300,000 acres (472 square miles)
Lake Area	21,500 acres
Lake Volume	2,350,000 acre-feet
Maximum Depth	214 feet
Average Depth	108 feet
Flushing Rate	0.43 per year
Length of Lake	22 miles
Main Inflows	Cedar River (57 percent) and Sammamish River (27 percent)
Main Outlet	Ship Canal to Puget Sound
Typical Period of Stratification	Late March to early November
Trophic State	Mesotrophic

Water is discharged from the lake via Union Bay and the Lake Washington Ship canal into Portage Bay in Lake Union, and ultimately to Puget Sound. The hydrology of Lake Washington has been significantly altered by human intervention. Construction of the Lake Washington Ship Canal in 1916 lowered the mean lake level by 9 feet and decreased the lake's surface area by 7 percent, eliminating the original shoreline and wetland habitats and transforming most shallow water habitat into upland areas. Deeper water areas were transformed to emergent and scrub-shrub wetlands. The US Army Corps of Engineers (USACE) maintains the level of Lake Washington between 20 and 22 feet as measured above the Puget Sound mean low tide through the operation of the Ballard Locks (King County 2010).

Legend

- Survey area
- City boundary
- Stream

Figure 1.
Aquatic Vegetation Survey Area Within the City of Kenmore, Washington.

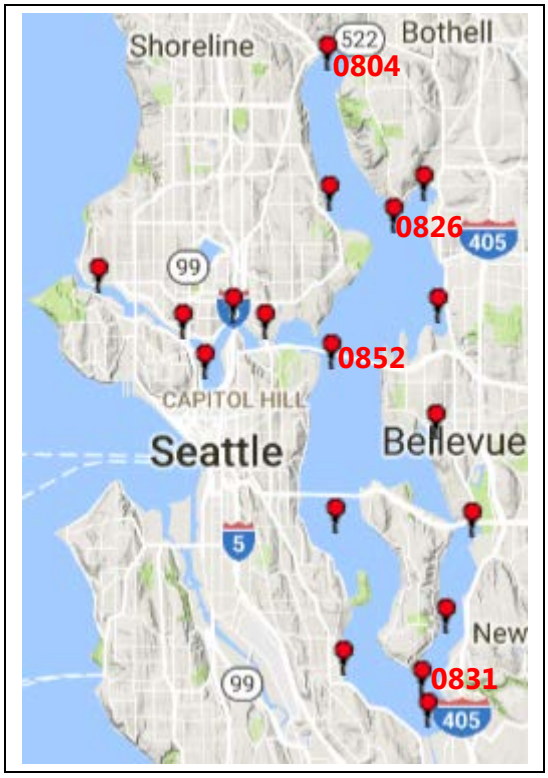
N

0 1,000 2,000 4,000 Feet

HERRERA

K:\Projects\Y2015\15-06194-000\Project\Report\vicinity_map.mxd (10/21/2016)

Water Quality

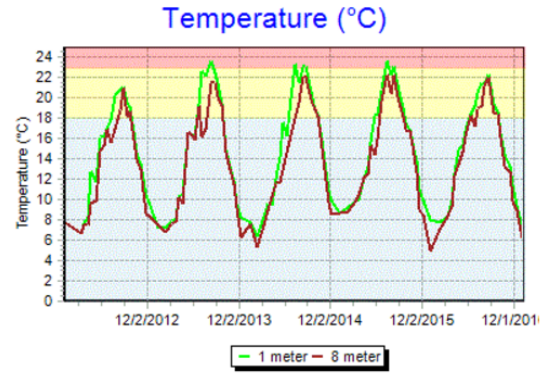


Lake Washington is the largest of the three major lakes in King County, and the second largest natural lake in the state of Washington. King County currently has four sampling stations located in Lake Washington: Station 0804 in the north near the mouth of the Sammamish River, Station 0826 near Juanita Bay, Station 0852 in the deep basin near I-520, and Station 0831 in the south end near the mouth of the Cedar River. Station 0852 is the legacy station that the University of Washington began monitoring in 1993. The other stations have been monitored since the early 1980s. In addition, sampling stations located around the shoreline of the lake, mostly near influent streams, were sampled from the mid-1980s until the program reduction in 2009.

Samples are collected twice monthly from March through November, and once monthly from December through February. There is also a monitoring buoy located in the central basin of the lake that collects continuous temperature, pH, oxygen, conductivity, chlorophyll-a, and turbidity readings throughout the water column, as well as weather information (King County 2017a).

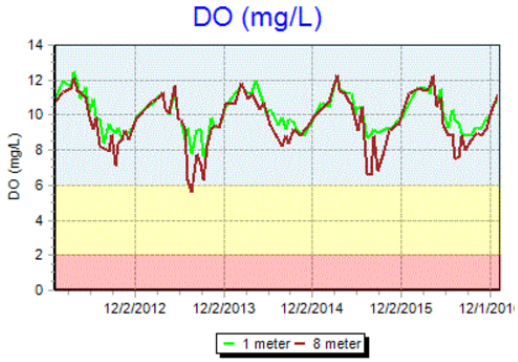
Temperature, Dissolved Oxygen, and pH

At Station 0804, temperatures in Lake Washington get down to between 5 and 7 degrees Celsius in the winter months, and can reach up to 24 degrees Celsius in the summer. Temperatures above 23 degrees Celsius can be fatal to salmonids (King County 2017a). Dissolved oxygen (DO) ranges from around 6 milligrams per liter (mg/L) in the winter to over 12 mg/L in the summer. The pH in Lake Washington typically reaches its highest in the middle of the summer, at around a pH of 8 or 9. The lake is more acidic in the winter, when the pH is typically around 7 to 7.5. Recent temperature, DO, and pH data for Station 0804 are presented in Figure 2.



= Temperatures > 23 °C are lethal to salmonids.

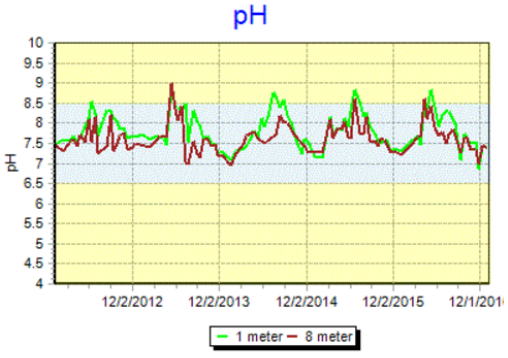
= Temperatures between 18 °C to 23 °C may be too warm for salmonid survival.



Note: Dissolved oxygen thresholds for salmonid survival are indicated by color changes.

= Concentrations < 2 mg/L are lethal to salmonids.

= Concentrations < 4.25 mg/L may threaten salmonid survival.



Note: State water quality standards for pH thresholds are indicated by color changes.

6.5 = the lower threshold, and 8.5 = the upper threshold of the Washington Aquatic Life Criteria.

Figure 2. Temperature, Dissolved Oxygen, and pH at Station 0804 in Lake Washington.

Trophic State

One way to characterize the health of lakes is by using total phosphorus, chlorophyll-a, and Secchi depth (water transparency) data to calculate the Trophic State Index (TSI, Carlson 1977). This index provides a way to rate and compare lakes according to their level of biological activity on a scale from 0 to 100. As the TSI values increase by 10 (10, 20, 30, etc.) they represent a doubling of algal biovolume that can be related to easily measured parameters through linear regression and re-scaling. The TSI scale provides thresholds for three ranges of lake primary productivity (oligotrophic, mesotrophic, and eutrophic representing low, moderate, and high amounts of algae growth). The indices are based on summer mean values (June through September) of three commonly measured lake parameters: water transparency measured by Secchi depth, and concentrations of total phosphorus (TP) and chlorophyll-a (Chla) in the epilimnion (upper 10-meter surface layer). TSI values for Lake Washington (Station 0852) are presented in Figure 3.

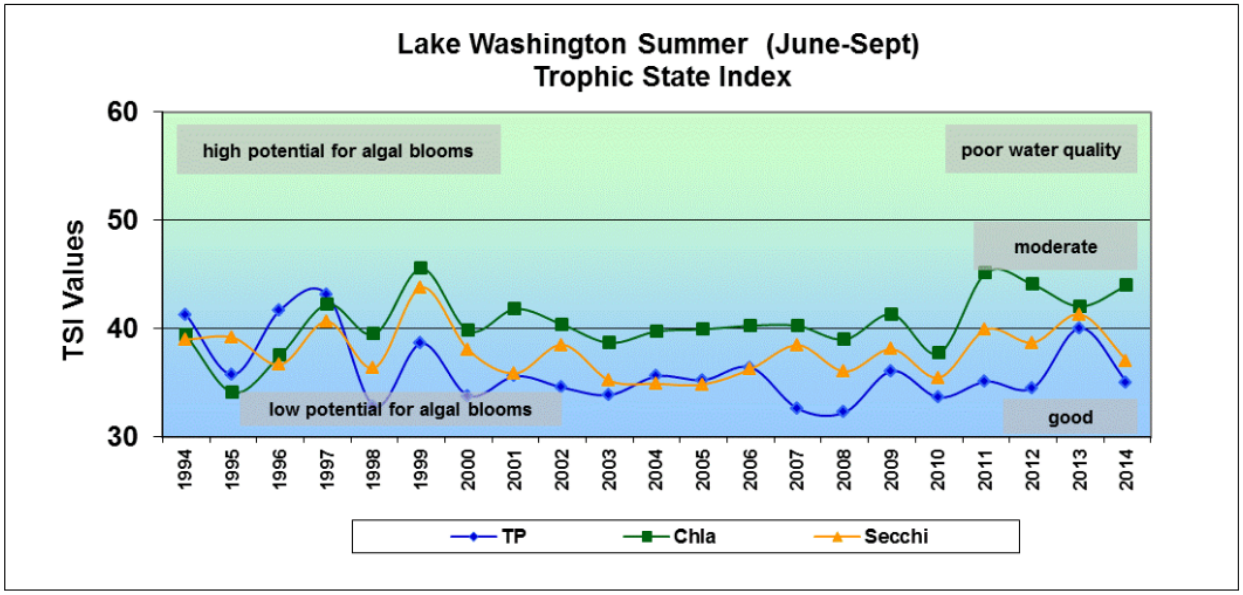


Figure 3. Trophic State Index Values for Lake Washington.

Secchi depth transparency is a measurement of water clarity produced by lowering a Secchi disk (an 8-inch disk with alternating black and white quadrants) into the water until the observer can no longer see it. This depth of disappearance, called the Secchi depth, is a relative measure of the water's transparency that can be used to look at events in a lake, trends over time, or make comparisons between lakes. Algae, soil particles, and other materials suspended in the water all affect transparency. The Secchi depth will decrease as these factors increase. In King County, clarity tends to be lower during periods of high algal growth (spring and summer) and during periods of high stormwater flows (winter).

Nutrients such as nitrogen, phosphorus, and silica are necessary for plant and animal growth. However, increasing nutrients availability can increase the growth of aquatic plants, which can cause nuisance blooms that subsequently decay. Decomposition can deplete oxygen to levels

incapable of sustaining many aquatic organisms, thus leading to more problems. In the temperate latitudes, **phosphorus** is most often the primary nutrient of concern in freshwater systems because it is usually the nutrient that is in shortest supply, thus limiting algae growth. If excess phosphorus gets into lake water, it can cause nuisance algal blooms or even algal blooms that produce toxins. Additional phosphorus from human activities enters water bodies via pathways such as discharge of detergents, runoff containing fertilizers, pet waste, car washing and seepage from failing septic systems. Sediment can also be a source of phosphorus, as phosphorus readily binds to soil particles and is washed into the lakes. Through chemical reactions, phosphorus may be later released into the water column from the lake sediments when DO concentrations fall below 0.2 mg/L.

In general the TSI-TP values for Lake Washington fluctuate below the low (good) to moderate threshold indicating fairly consistent low phosphorus with low potential for nuisance algal blooms (see Figure 3). Recent seasonal patterns in total phosphorus and chlorophyll near the water surface at the north station (Station 0804) are presented in Figure 4. Total phosphorus concentrations tend to peak in the spring and decline to minimum values in the late fall, but patterns are highly variable between years.

Chlorophyll is the green pigment in plants that allows them to create energy from light (photosynthesis). Measuring chlorophyll provides an indirect estimate of the amount of algae in the water column. Chlorophyll-a is a measure of the portion of the pigment that is still actively photosynthesizing at the time of sampling. There are several other forms of chlorophyll present in different groups of algae, as well as other assisting pigments and degradation byproducts that may be found in the water, but chlorophyll-a is the most common form present and is used as an indicator of the volume of algae present.

In general, the TSI chlorophyll-a values for Lake Washington are much higher than the TSI total phosphorus values (see Figure 3). TSI chlorophyll-a values have fluctuated at and above the low to moderate threshold, indicating low to moderate potential for nuisance algal blooms. Recent seasonal patterns in total phosphorus and chlorophyll near the water surface at Station 0804 are presented in Figure 4. Chlorophyll concentrations typically follow total phosphorus concentrations, but are less variable and show a more distinctive peak in the spring followed by decline to minimum values in winter.

The more phosphorus that can be prevented from entering lakes, the less chance that a potentially toxic cyanobacteria bloom will occur. The cyanobacteria generally responsible for making toxins are known to be poor competitors for phosphorus, so the available levels must be high before they will do well in a body of water. Phosphorus inputs can be minimized through well-designed storm water drainage systems, maintenance of sewer infrastructure, changing homeowner and business behaviors (such as using no phosphorus-rich fertilizers on lawns), education and incentives, and replacing watershed septic systems with sewers (King County 2017a).

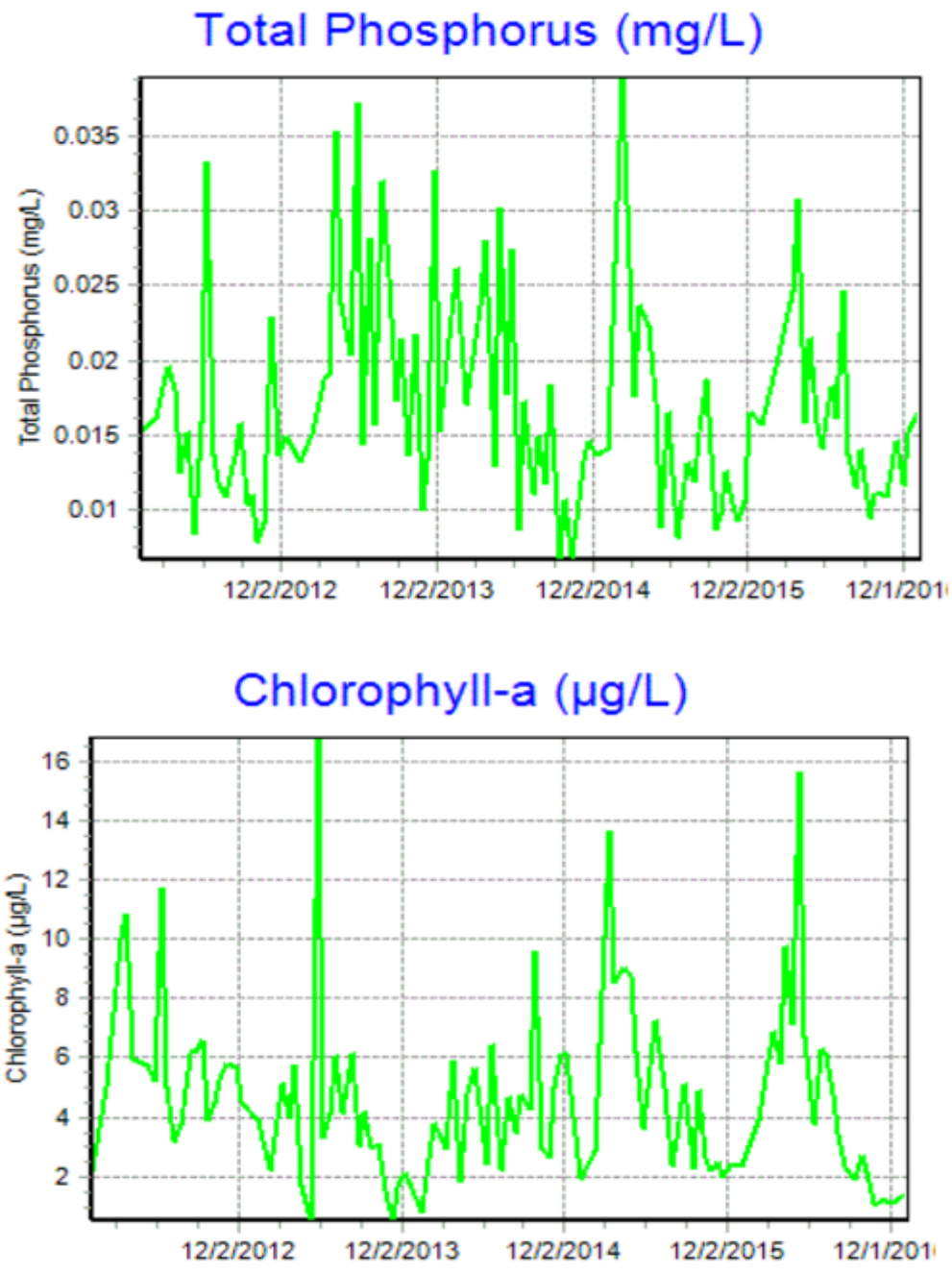


Figure 4. Total Phosphorus and Chlorophyll-a at Station 0804 in Lake Washington.

SAMMAMISH RIVER

Watershed

The Sammamish River basin drains a watershed composed of approximately 153,600 acres that includes 62,080 acres in the Lake Sammamish basin, 32,000 acres in the Bear Creek basin, and 42,880 acres that are the combined Little Bear, Swamp, and North Creek basins. The remaining 16,640 acres comprise the Sammamish River sub-basin (King County 2017b).

Historically, the Sammamish River was somewhat longer than it is today with abundant "swampy" areas that were filled with peat and diatomaceous earth. In 1891, the US Army Corps of Engineers reported that the river was 17 miles long. The river corridor was heavily logged from the 1870s through the early 20th century. Throughout the 20th century, the river went through dramatic changes that reduced the complexity of the floodplain including the lowering of the water level in Lake Washington, the channelization of the river, and the construction of drainage ditches in the river valley. The elevation of Lake Washington was lowered about 9 feet with the opening of the Chittenden Locks in 1916, and this elevation change drained much of the swampy Sammamish River corridor. Around the same time period, farmers in the Sammamish River Valley formed a drainage district that began to straighten the upper reach of the river dramatically. In 1962, The Corps of Engineers began to systematically dredge the river, primarily as a flood control project, thus deepening the river 5 feet throughout most its length, hardening the river's banks, and dramatically decreasing its remaining connection with the floodplain and cutting off most of the smaller tributaries to the river. The Corps' project also included the construction of a weir at the Lake Sammamish outlet. Overall, this project practically eliminated flooding in the Sammamish River valley and reduced the maximum flood elevations and seasonal water surface elevations in Lake Sammamish.

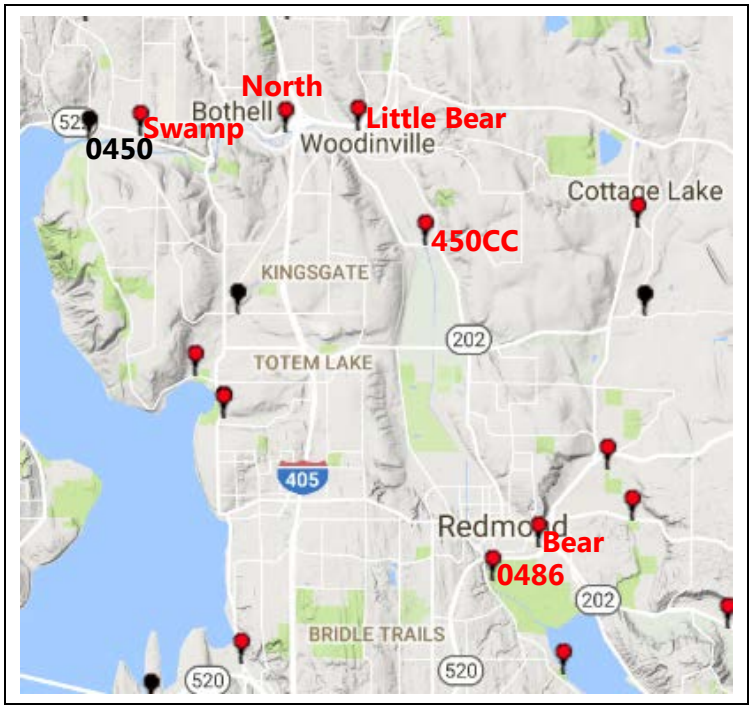
The Sammamish River is now about 13.5 miles long. The upper river corridor extends from the Lake Sammamish weir in Marymoor Park to the City of Woodinville through a floodplain valley that is more than a mile wide in places. Land use in this upper reach includes open space and recreational areas at Marymoor Park, urban commercial and residential development in the City of Redmond, the Willows Run Golf Course, the Sammamish Valley Agricultural Production District, and urban development again in the City of Woodinville. The lower reach extends from Woodinville to the mouth of the river at Lake Washington. This reach has a much narrower drainage area, which includes the downtown cores of Bothell and Kenmore but also some open space areas, including the Wayne and Inglemoor Country Club golf courses, Bothell parkland along the Sammamish River Trail, and Kenmore parks at the mouth of Swamp Creek and the mouth of the river. A major King County sewer line runs underneath the Sammamish River Trail, which is adjacent to most of the river.

Fisheries

Chinook, coho, sockeye, kokanee, steelhead, and coastal cutthroat are known salmonid species to currently inhabit the Sammamish River system (Kerwin 2001). The United States Fish and Wildlife Service has identified the river and its tributaries as potential foraging habitat for bull trout on the assumption that they are found in the watershed. Volunteers with the Salmon Watchers Program have been making observations at various locations within the Sammamish River basin since 1997.

Two salmon-bearing tributary systems are located in the upper reach: Bear Creek and Little Bear Creek. The lower reach includes two large salmon-bearing tributaries: Swamp Creek and North Creek (Kerwin 2001).

Water Quality



King County monitors the ecological health of the Sammamish River by collecting and analyzing surface water samples. Station 0486 is located at the Marymoor Park Bridge where Lake Sammamish drains into the Sammamish River. Sampling at this station began in 1971 and continues today. Station 0450 is located at the bridge on 68th Avenue Northeast in Kenmore where the river drains into Lake Washington. Sampling at this station began in 1971 but was discontinued in 2008 due to monitoring program budget cuts. Station 450CC, located where Northeast 145 crosses the Sammamish River, was added in 2009. The County also has stations at multiple locations along the major tributaries to the Sammamish River – Swamp Creek, North Creek, Bear Creek, and Little Bear Creek (King County 2017b).

Water quality samples are analyzed monthly for temperature, dissolved oxygen, pH, conductivity, turbidity, total suspended solids, orthophosphate, total phosphorus, ammonia, nitrate-nitrogen, total nitrogen, and fecal coliform bacteria. Results are compared to State water quality standards. Water quality standards are designed to protect public health and aquatic life. Comparing monitoring results to water quality standards allows an understanding of how safe the creek is for recreational contact as well as for aquatic life.

State water quality standards were revised in 2003. The Sammamish River is now categorized as "Core Summer Salmonid Habitat" for aquatic life use and "Extraordinary Primary Contact Recreation" for recreational use (swimming and water skiing). The river is on the 2012 Washington Department of Ecology's (Ecology) 303(d) list for violation of dissolved oxygen, fecal coliform, and water temperature standards (Category 5). Dissolved oxygen levels decrease when the temperatures increase. In addition, high nutrient (phosphorus and nitrogen) concentrations can exacerbate low oxygen conditions by increasing vegetative growth. Decaying algae and aquatic plants consume oxygen in the water. See Figure 5 for a summary of water quality index scores for Station 450CC in water year 2016 (King County 2017b).

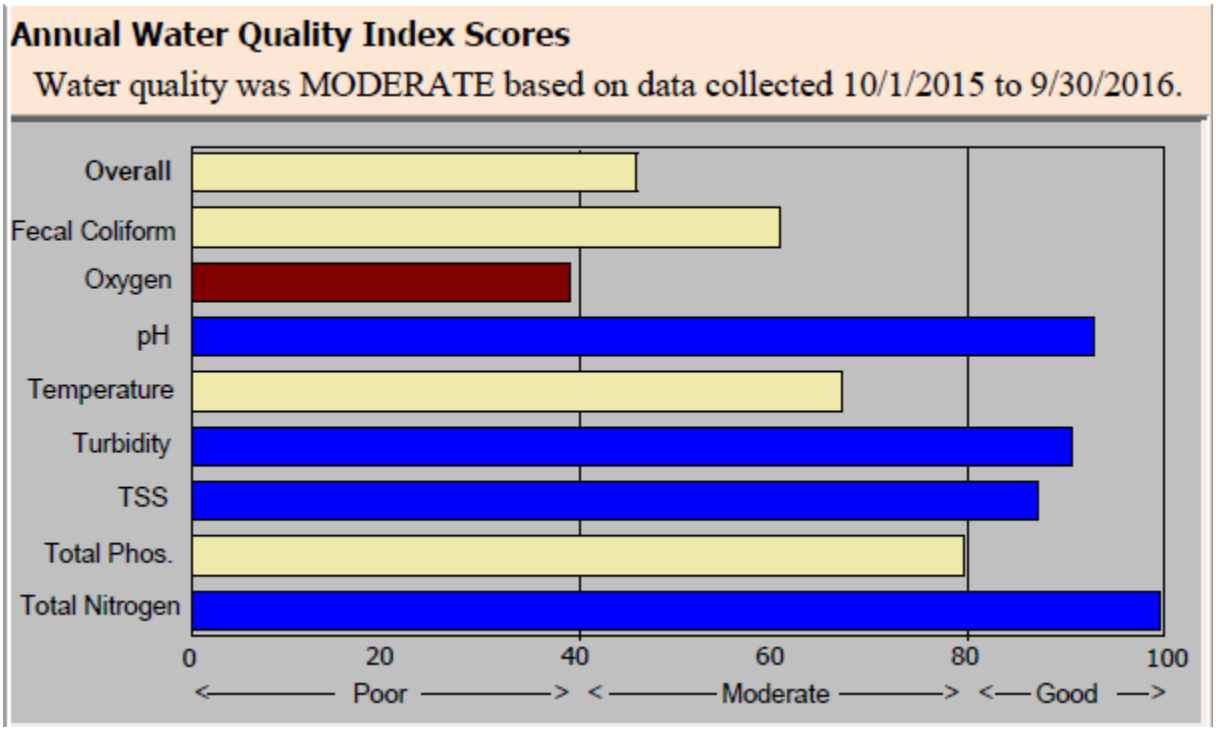


Figure 5. Annual Water Quality Index Scores for the Sammamish River Station 450CC.

Diazinon and other chemicals have been found in one irrigation and drainage ditch feeding the river at levels that are of concern. King County has done additional toxicity studies of the river (see King County 2017b).

A 28-year (1979–2007) trend analysis was conducted with water quality data from both Sammamish River stations. Results indicated that water quality might have declined over this 28-year period with significant increases in water temperatures and conductivity, and decreasing dissolved oxygen concentrations. High conductivity can suggest the presence of unidentified dissolved charged substances in the water. Water at the mouth of the river is becoming less acidic as indicated by the significant increase in pH. (The pH remains within acceptable range relative to the state standards.) Decreased total suspended solids (TSS), turbidity, nutrients (orthophosphate and total phosphorus, ammonia and total nitrogen), and bacteria levels indicate some improvements in water quality in the same 28-year period.

BENEFICIAL USES AND IDENTIFIED PROBLEMS

The project area provides numerous beneficial uses to humans and wildlife, including the following three types identified by the Steering Committee (Figure 6):

- Recreational Use: Boating, fishing, swimming, aesthetic and wildlife observation.
- Commercial Use: Marinas, Kenmore Air, water supply
- Wildlife Use: Waterfowl, aquatic mammals, fish, and other aquatic organisms.

Beneficial uses are impacted by excessive aquatic plant growth, including the following three types of problems identified by the Steering Committee:

- Environmental:
    - Negative impact of dense plants on fish habitat
    - Impact of invasive noxious weeds on native biodiversity
    - Excessive levels of algae from scum accumulation on dense plants and nutrient release by decaying plants that impair aquatic habitat
    - Water quality degradation (low dissolved oxygen and high temperature) in dense plant growth
- Recreational:
    - Inhibit swimming and paddle sports
    - Weeds wound around boat motors
    - Weeds tangled in fishing lines
    - Non-native weeds promote habitat for non-native fish species
    - Health risks of toxic blue-green algae and nuisance of excess filamentous green algae
    - Aesthetical impacts from plant accumulation and decay, foul aroma, and water clarity
    - Restricted shoreline access

- Economic:
    - Reduction of navigable waterways by forcing lake traffic into narrow lanes, and increased potential for conflict between boats and planes
    - Reduction of water depth that impacts access to moorage slips
    - Costly repairs to damaged boat propellers and plane rudders
    - Irrigation impacts from clogged intake lines and damaged pumps
    - Perceived quality of life
    - Lower waterfront property values (Olden and Tamayo 2014)
    - Cost to manage/control/eradicate

To protect beneficial uses and address the identified problems, the project area was segregated into the following three types of areas by the Steering Committee:

- Public Use Areas:
    - Saint Edward
    - Inglewood Wetlands
    - East Open Water
    - West Open Water
    - Log Boom Park
    - Lower Sammamish River
    - Rhododendron Park
    - Squire's Landing Park
- Commercial/Industrial Use Areas:
    - Kenmore Air
    - Marina
    - Warehouse/Industrial

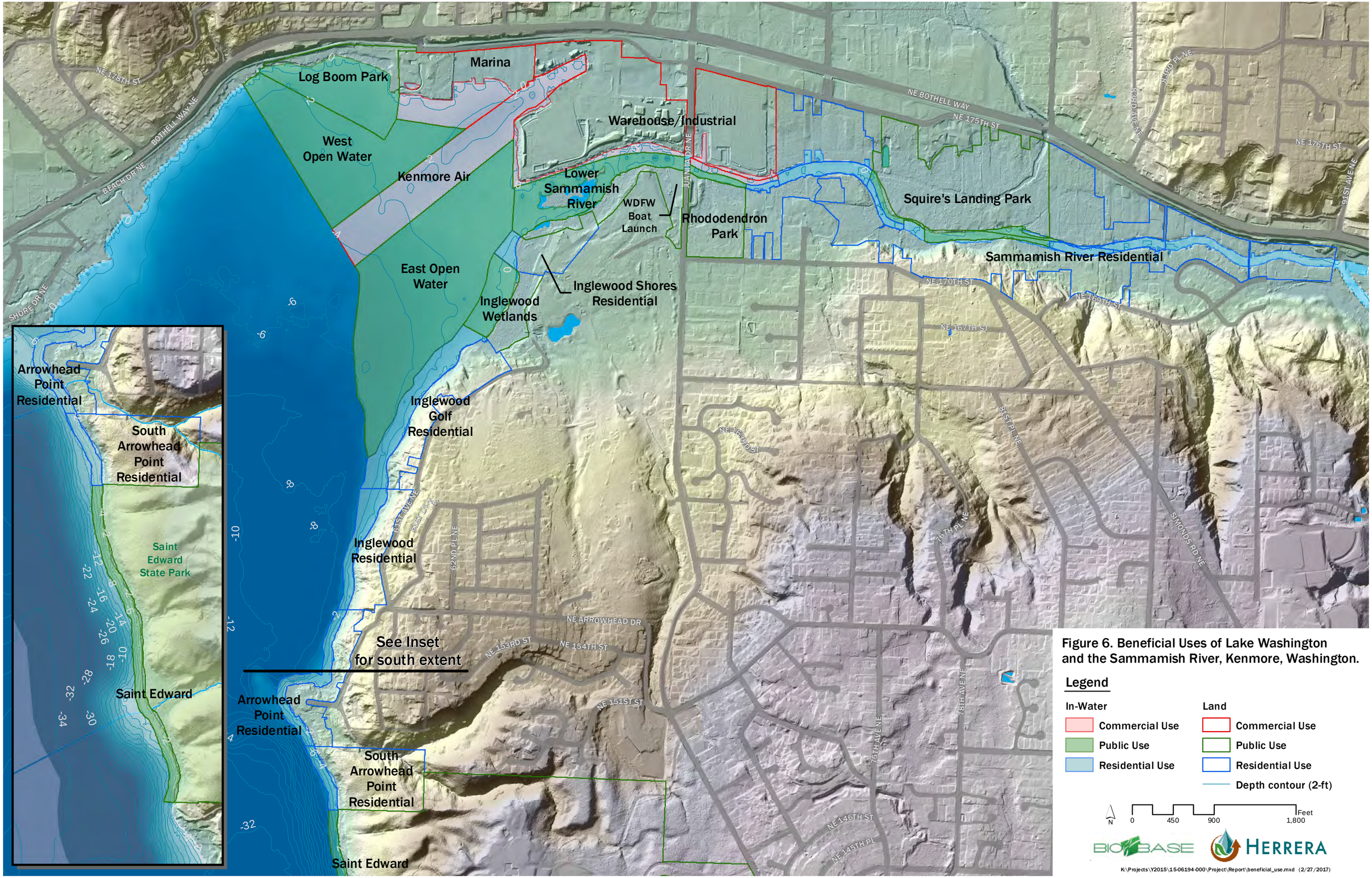


Figure 6. Beneficial Uses of Lake Washington and the Sammamish River, Kenmore, Washington.

Legend

In-Water	Land
Commercial Use	Commercial Use
Public Use	Public Use
Residential Use	Residential Use
	Depth contour (2-ft)

N 0 450 900 1,800 Feet

BIOBASE HERRERA

K:\Projects\Y2015\15-06194-000\Project\Report\beneficial_use.mxd (2/27/2017)

- Residential Use Areas:
  - South Arrowhead Point Residential
  - Arrowhead Point Residential
  - Inglewood Residential
  - Inglewood Golf Residential
  - Inglewood Shores Residential
  - Sammamish River Residential

AQUATIC PLANT COMMUNITY

The Washington State Department of Ecology (Ecology) has records of plant surveys on Lake Washington dating back to 1993 (Ecology 2015). Earlier aquatic plant surveys of Lake Washington were completed in 1979 and 1981 (Municipality of Metropolitan Seattle). A plant survey was conducted in October 2014 by the City of Kenmore and King County. Aquatic plant surveys of specific areas selected for herbicide treatment were performed in May and June 2016 by a contractor (Aquatechnex). Available historical survey maps are presented in Appendix B.

The most recent plant survey was conducted by Herrera on September 7 and 8, 2016, for this IAVMP. The plant distribution and density observed during this survey is described below, followed by a description of each target aquatic plant species.

2016 Plant Distribution and Density

Herrera conducted an aquatic vegetation survey of Lake Washington and the Sammamish River within the City of Kenmore on September 7 and 8, 2016 (Figure 1). The survey was conducted by two aquatic botanists (Rob Zisette and Julia Munger) using an inflatable boat and motor along transects spaced up to 120 feet apart. The river area was surveyed first, following one transect upriver along the south bank and then another transect downriver along the north bank, with occasional cross-river transects. The lake area south of the river was surveyed by following transects perpendicular to shore, and the remaining lake area was surveyed following parallel transects oriented in a northeast/southwest direction with additional transects located between docks.

Vegetation density and water depth data were collected along each transect using a Lowrance® HDS-7 underwater sonar and global positioning system (GPS), and data processing was provided by BioBase®. Vegetation density was calculated and interpolated between transects based on the relative proportion of plant biovolume in the water column. If there was little or no vegetation in a given location within the water column, the biovolume was recorded as a low density. If plants took up a large portion of the water column or came to the surface of the water, the biovolume was recorded as a high density.

An aquatic plant sampling rake was used to collect a total of 68 grab samples for identifying submersed plant species and estimating the percent abundance of each species in the samples. Dominant plant areas were delineated based on the sample results and visual observations where one or two species were present in higher densities than all other species, and thus determined to be dominant or co-dominant. In addition, the presence of emergent plant species was also noted with an emphasis on noxious weed species. Locations of plant species observations were recorded using separate GPS equipment.

Kenmore has a thriving community of native and non-native aquatic and shoreline plants. These plants can be divided into three general categories:

- Native – Beneficial
- Native – Nuisance
- Non-native – Noxious Weeds

The term "noxious weed" refers to those non-native plants that are legally defined by Washington's Noxious Weed Control Law (RCW 17.10) as highly destructive, competitive, or difficult to control once established. Noxious weeds have usually been introduced accidentally as a contaminant, or as ornamentals. Non-native plants often do not have natural controls (i.e., herbivores, pathogens) or strong competitors to control their numbers as they may have had in their home range. WAC 16.750 sets out three classes (A, B, and C) of noxious weeds based on their distribution in the state, each class having different control requirements. Class A weeds are required to be controlled. County Weed Boards are given some discretion as to setting control priorities for Class B and C weeds. The state also maintains a monitor list for certain plant species, which are weeds that are under consideration for noxious status.

The categorization of native plants is more subjective. Generally, native plants are considered beneficial because they often provide habitat and forage for animals, compete with non-native plants, and perform other ecological functions. Native plants become a nuisance when their growth is excessive and out of balance to the point of impacting the beneficial uses of the lake.

A total of 24 aquatic and emergent plant species were identified within the survey area (Table 2). Out of those species, 10 were classified as noxious weed species in Washington State. The remaining 14 plant species were common native species. No rare native species or non-native, non-invasive species were observed. The number and type of species observed represent a reasonably diverse aquatic plant community that is impacted by a relatively high number of invasive species.

Aquatic vegetation was the densest closest to the shoreline of the Sammamish River and Lake Washington (Figure 7). Vegetation density was low in the deep portions of the Sammamish River and eastern shoreline of the lake. There was also a large low density area near the center of the survey area, extending from the mouth of the Sammamish River toward the center of the lake. This low density area also extended to the northern-most tip of the lake, where Kenmore Air operates.

Table 2. Aquatic Plant List for the Kenmore Survey on September 7 and 8, 2016.

Plant Type	Common Name	Scientific Name	Status
Emergent Plants	Common cattail	*Typha latifolia*	Native
	Garden loosestrife	*Lysimachia vulgaris*	Noxious Weed – Class B
	Japanese knotweed	*Fallopia japonica*	Noxious Weed – Class B
	Narrow-leaf bur-reed	*Sparganium angustifolium*	Native
	Purple loosestrife	*Lythrum salicaria*	Noxious Weed – Class B
	Reed canarygrass	*Phalaris arundinacea*	Noxious Weed – Class C
	Spotted jewelweed	*Impatiens capensis*	Noxious Weed – Monitor List
	Yellow-flag iris	*Iris pseudacorus*	Noxious Weed – Class C
Floating Leaved Rooted Plants	Fragrant waterlily	*Nymphaea odorata*	Noxious Weed – Class C
	Grass-leaved pondweed	*Potamogeton gramineus*	Native
Free Floating Plants	Lesser duckweed	*Lemna minor*	Native
	Mexican water-fern	*Azolla mexicana*	Native
Submersed Plants	Brazilian egeria	*Egeria densa*	Noxious Weed – Class B
	Common waternymph	*Najas guadalupensis*	Native
	Common waterweed	*Elodea canadensis*	Native
	Coontail	*Ceratophyllum demersum*	Native
	Curly-leaf pondweed	*Potamogeton crispus*	Noxious Weed – Class C
	Eurasian watermilfoil	*Myriophyllum spicatum*	Noxious Weed – Class B
	Flat-stemmed pondweed	*Potamogeton zosteriformis*	Native
	Richardson's pondweed	*Potamogeton richardsonii*	Native
	Sago pondweed	*Potamogeton pectinatus*	Native
	Tapegrass	*Vallisneria americana*	Non-native
	White-stemmed pondweed	*Potamogeton praelongus*	Native
Plant-Like Algae	Nitella	*Nitella* sp.	Native

Dominant Plant Distribution

A total of 13 distinct dominant plant areas were mapped within the survey area, as shown in Figure 8. Dominant aquatic vegetation species include: Coontail (*Ceratophyllum demersum*), Eurasian watermilfoil (milfoil) (*Myriophyllum spicatum*), tapegrass (*Vallisneria americana*), white-stemmed pondweed (*Potamogeton praelongus*), Brazilian egeria (*Egeria densa*), flat-stemmed pondweed (*Potamogeton zosteriformis*), and common waterweed (*Elodea canadensis*).

Figure 8 also displays pie charts at the 68 sample locations exhibiting the relative percentages of three submersed vegetation categories: Eurasian watermilfoil, Brazilian egeria, and other species. Other submersed species include all native species and two non-native species, which includes tapegrass (*Vallisneria americana*) and one observation of curly-leaf pondweed (*Potamogeton crispus*). Because Eurasian watermilfoil, Brazilian egeria were found throughout the entire survey area, this figure conveys the areas in which these submersed noxious weeds are most prevalent.

The Sammamish River was dominated by the noxious weed Eurasian watermilfoil and the native plant coontail. Lake Washington was typically dominated by the non-native tapegrass in shallow areas and the native white-stemmed pondweed in deeper areas. Exceptions include co-dominance by Eurasian watermilfoil and tapegrass along the southernmost shoreline adjacent to Saint Edward State Park, co-dominance by Brazilian egeria and white-stemmed pondweed in the westernmost deep area of the lake, and co-dominance by flat-stemmed pondweed and common waterweed in the easternmost deep area of the lake.

Noxious Weed Species

A total of 10 of the observed species are on the Washington state noxious weed list (NWCB 2016) (see Table 2). In Washington State, weeds are designated as Class A, B, or C by the state's Noxious Weed Control Board (NWCB):

- Class A weeds are weeds that are not yet present in the state, or occur in only a few populations. These weeds usually occur in bordering states and present a risk for widespread infestation if they are not controlled. Class A weeds are required for control throughout the entire state.

- Class B weeds are widespread in some areas of the state but not others. The NWCB requires the control of Class B weeds in counties where a particular weed is not yet widespread.

- Class C weeds are widespread throughout the state. The NWCB does not require control for Class C weeds in any county.

Each county can choose to enforce the control of Class B or C weeds throughout the county or in particular locations if the NWCB has not already done so. In King County, Japanese knotweed and Brazilian egeria (both Class B) have been designated for required removal by the King County Noxious Weed Control Board in some areas of the county. However, these species are not required for control in Lake Washington or the Sammamish River. The state NWCB also has a state monitor list, which are not designated as Class A, B, or C. They are species that may be designated as A, B, or C weeds in the future.

There are no Class A noxious weeds on the site, but there are five Class B weeds, four Class C weeds, and one weed on the state monitor list. Two of the species, garden loosestrife (*Lysimachia vulgaris*) and purple loosestrife (*Lythrum salicaria*), are required for removal in King County (King County 2016).

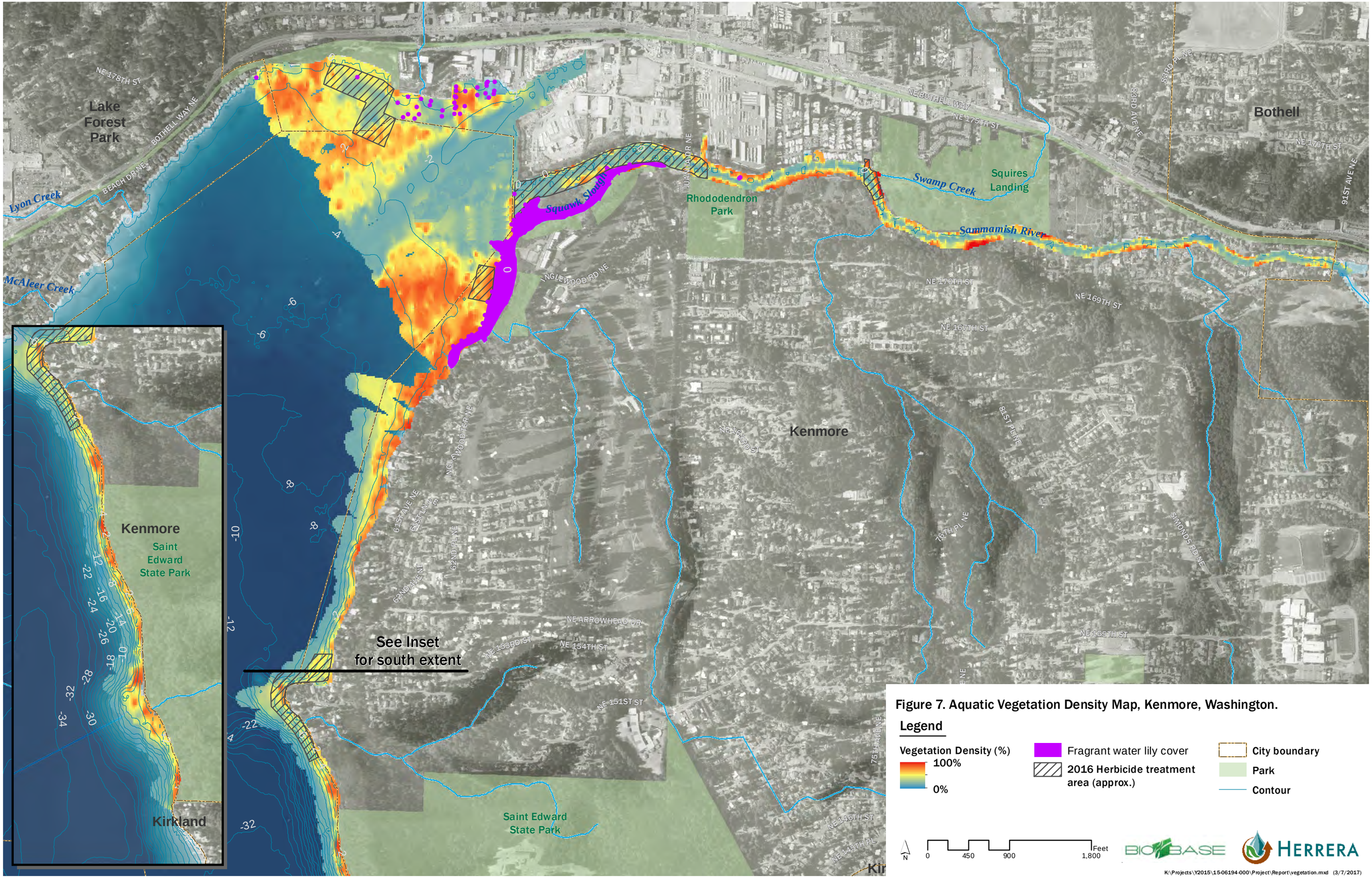


Figure 7. Aquatic Vegetation Density Map, Kenmore, Washington.

Legend

Vegetation Density (%)
100%
0%

Fragrant water lily cover

2016 Herbicide treatment area (approx.)

City boundary

Park

Contour

N

0 450 900 Feet 1,800

BIOBASE HERRERA

K:\Projects\Y2015\15-06194-000\Project\Report\vegetation.mxd (3/7/2017)

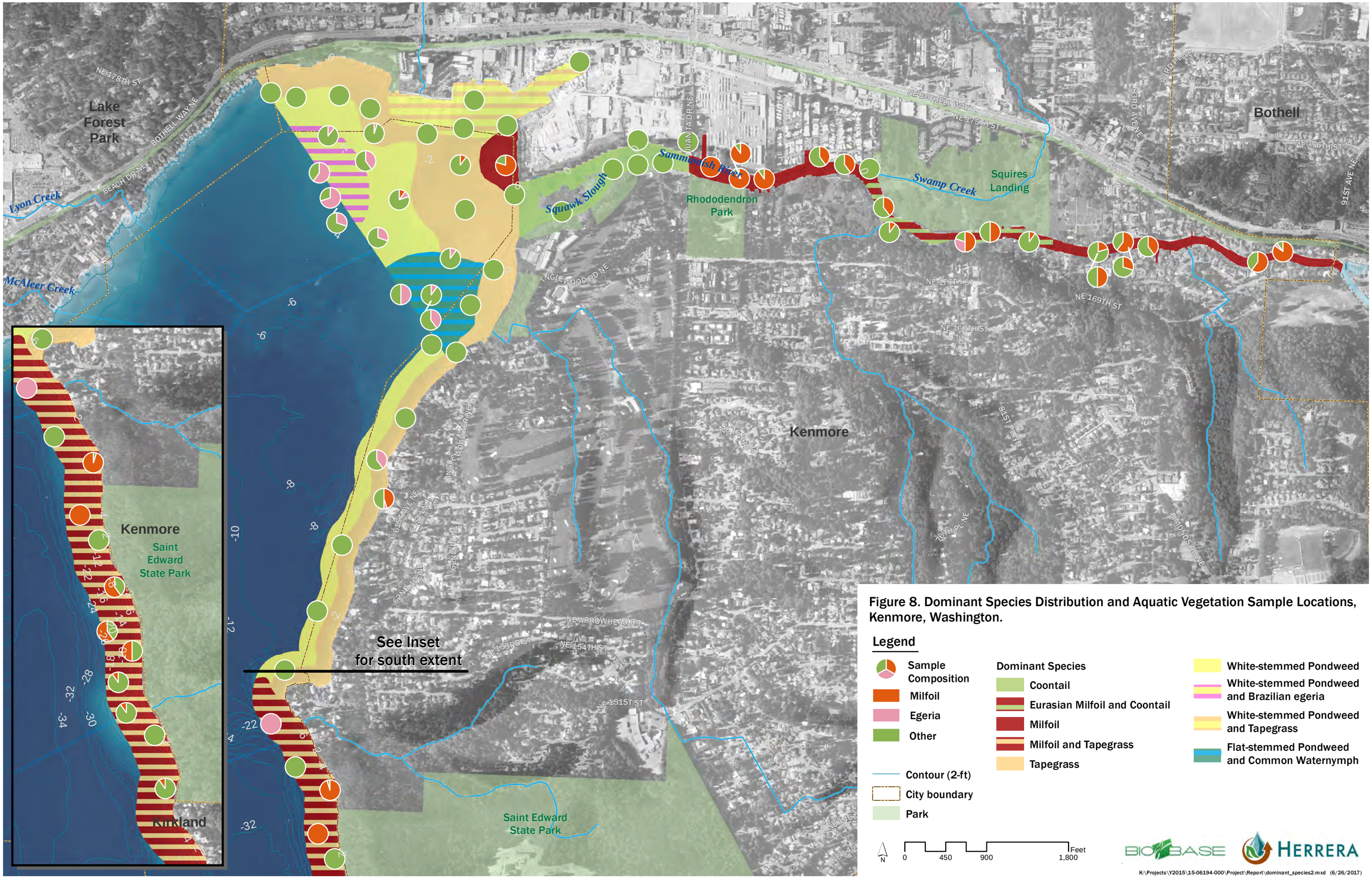


Figure 8. Dominant Species Distribution and Aquatic Vegetation Sample Locations, Kenmore, Washington.

Legend

- Sample Composition
  - Milfoil
  - Egeria
  - Other
- Contour (2-ft)
- City boundary
- Park

Dominant Species

- Coontail
- Eurasian Milfoil and Coontail
- Milfoil
- Milfoil and Tapegrass
- Tapegrass
- White-stemmed Pondweed
- White-stemmed Pondweed and Brazilian egeria
- White-stemmed Pondweed and Tapegrass
- Flat-stemmed Pondweed and Common Waternymph

N

0 450 900 1,800 Feet

BIOBASE HERRERA

K:\Projects\Y2015\15-06194-000\Project\Report\dominant_species2.mxd (6/26/2017)

Emergent Noxious Weeds

Six emergent noxious weed species were observed during the vegetation survey with locations shown in Figure 9. These species include garden loosestrife, purple loosestrife, Japanese knotweed (*Fallopia japonica*), yellow-flag iris (*Iris pseudacorus*), reed canarygrass (*Phalaris arundinacea*), and spotted jewelweed (*Impatiens capensis*). Only garden loosestrife and purple loosestrife are required for control in this part of King County. Although not mapped during the September 2016 survey, there exists a known infestation of the non-native genotype of common reed (*Phragmites australis)* along the south shore of the Sammamish River (B. Peterson, personal communication). This plant is a regulated (required for control) Class B noxious weed and is annually surveyed and controlled by the King County Noxious Weed Control Program.

Emergent noxious weed species were primarily found along the banks of the Sammamish River. The noxious weed cover was nearly 100 percent in undeveloped areas along the Sammamish River, especially upstream of the 68th Avenue Northeast Bridge. These noxious weeds occurred in front of developed properties as well, although with less abundance. Reed canarygrass was the dominant noxious weed species along the Sammamish River, although all of the species were observed in abundance.

All of the emergent noxious weed species (with the exception of Japanese knotweed) were also seen along the banks of Lake Washington, but with much less frequency. There was one observation each of yellow-flag iris and garden loosestrife, and two sightings of purple loosestrife. There were numerous small, infrequent patches of both spotted jewelweed and reed canarygrass on the lake shore.

Aquatic Noxious Weeds

Four aquatic noxious weeds were observed within the survey area: fragrant waterlily (*Nymphaea odorata*), which is a rooted floating-leaved plant; and Brazilian egeria (*Egeria densa*), curly-leaf pondweed (*Potamogeton crispus*), and Eurasian watermilfoil (*Myriophyllum spicatum*), all of which are submersed aquatic plants (see Figure 9). None of these species are required for control in this part of King County.

Eurasian watermilfoil was growing densely in the Sammamish River upstream of 68th Avenue Northeast. Eurasian water milfoil was the dominant or co-dominant species upstream of 68th Avenue Northeast, while Brazilian egeria was subdominant at one location upstream of Squire's Landing Park. There was no fragrant waterlily found upstream of the 68th Avenue Northeast Bridge, but it covered the entire shallow waters on the south bank of the river downstream of the 68th Avenue Northeast Bridge, completely overtaking a side channel at the outlet of the Sammamish River. No curly-leaf pondweed was found in the Sammamish River.

Within Lake Washington, most of the fragrant waterlily was confined to the northeastern shore, adjacent to the Sammamish River. There were other small patches throughout the lake, particularly near the marina docks at the north end of the lake. Curly-leaf pondweed was only found in one location near the northwestern portion of the lake survey area. Eurasian watermilfoil and Brazilian egeria were found throughout the lake survey area, although in varying densities. Eurasian watermilfoil was most dense in shallow areas and near the shore, while Brazilian egeria was most dense in deep areas and toward the middle of the survey area.

Between 6 and 10 weeks before the plant survey, aquatic noxious weeds were treated with herbicides at four locations within Lake Washington and the Sammamish River. Under contract with the City of Kenmore, a licensed aquatic herbicide applicator (Aquatechnex) surveyed the areas in May and early June 2016 to determine the appropriate treatment methods. The areas were treated with the systemic herbicide triclopyr on June 27, 2016, to control Eurasian watermilfoil, and then treated with the contact herbicide diquat on July 29, 2016, to control Brazilian egeria. Approximate locations of the treatment areas are shown in Figure 7. There was noticeably less Eurasian watermilfoil and Brazilian egeria in the two larger treatment areas located near Log Boom Park in Lake Washington and in the Sammamish River downstream of 68th Avenue. The two smaller treatment areas, located near Squire's Landing Park in the Sammamish River and the Inglewood Country Club in Lake Washington, did not appear to have less aquatic noxious weeds than adjacent areas. Pretreatment (May/June 2017) and post-treatment (September 2016) plant density maps are compared in Appendix B.

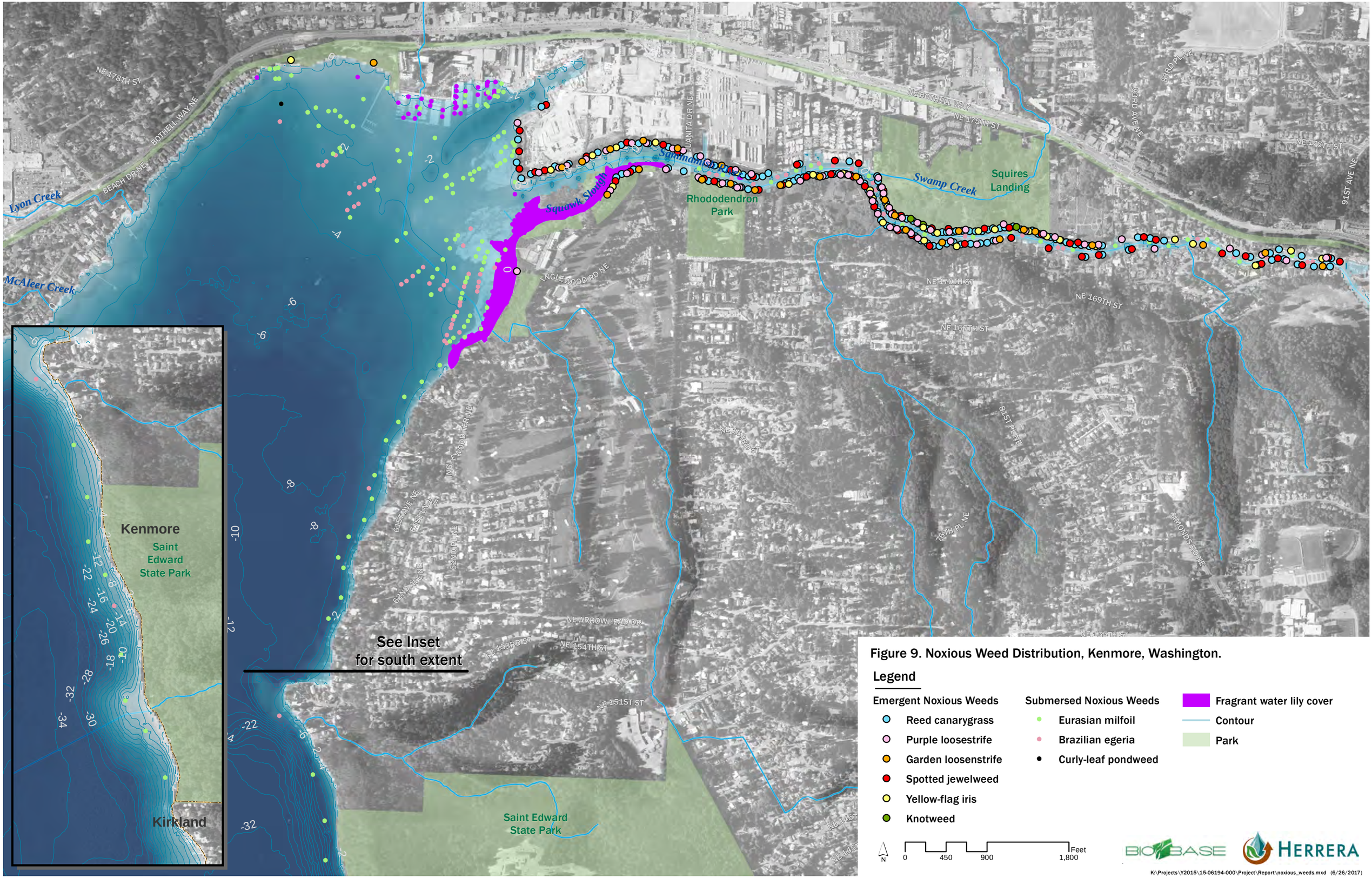


Figure 9. Noxious Weed Distribution, Kenmore, Washington.

Legend

Emergent Noxious Weeds
- Reed canarygrass
- Purple loosestrife
- Garden loosenstrife
- Spotted jewelweed
- Yellow-flag iris
- Knotweed

Submersed Noxious Weeds
- Eurasian milfoil
- Brazilian egeria
- Curly-leaf pondweed

- Fragrant water lily cover
- Contour
- Park

N

0 450 900 1,800 Feet

BIO BASE HERRERA

K:\Projects\Y2015\15-06194-000\Project\Report\noxious_weeds.mxd (6/26/2017)

TARGETED PLANT DESCRIPTIONS

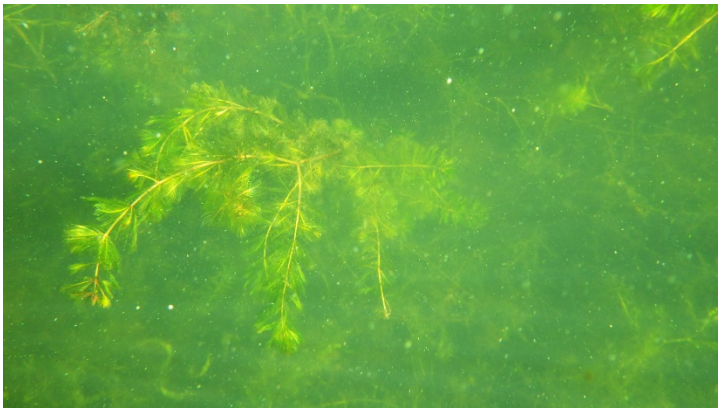
Several plants, including fragrant waterlily, Eurasian watermilfoil, Brazilian egeria, and purple and garden loosestrife, are targeted for control in the 2017 IAVMP. These plants are described below based on *An Aquatic Plant Identification Manual for Washington's Freshwater Plants* (Ecology 2001), where descriptions of other plants in Lake Washington and the Sammamish River may be found.

Fragrant waterlily is native to the eastern half of North America. It is a Class C noxious weed and it is not required for control in King County. It was most likely introduced into Washington during the Alaska Pacific Yukon Exposition in Seattle in the late 1800s. It has often been introduced to ponds and lakes because of its beautiful, large white or pink (occasionally light yellow), many-petaled flowers that float on the water's surface, surrounded by large, round green leaves. The leaves are attached to flexible underwater stalks rising from thick fleshy rhizomes. Adventitious roots attach the horizontal creeping and branching rhizomes.

Fragrant waterlily (*Nymphaea odorata*)

This aquatic perennial herb spreads aggressively, rooting in murky or silty sediments in water up to 10 feet deep. It prefers quiet waters such as ponds, lake margins and slow streams and will grow in a wide range of pH. Shallow lakes are particularly vulnerable to being totally covered by fragrant waterlilies. Fragrant waterlily spreads by seeds and by rhizome fragments. A planted rhizome will cover about a 15-foot-diameter circle in 5 years.

Eurasian watermilfoil is native to Eurasia and northern Africa, but it is a widespread invasive plant in North America. It is a Class B noxious weed, but it is not required for control in King County. This plant spreads rapidly and outcompetes many other native aquatic plant species. It can also be easily confused with native milfoils, and sometimes genetic testing is needed to identify milfoils to species. Eurasian watermilfoil is a submersed aquatic plant that spreads from plant fragments and rhizomes. The leaves are long and feather-like, and arranged in whorls of four around the stems, which are often reddish in



Eurasian watermilfoil (*Myriophyllum spicatum*)

color. Eurasian watermilfoil is found in rivers, lakes, and ponds, and tolerates a wide variety of water quality conditions.

Brazilian egeria (*Egeria densa*)

Brazilian egeria is a submersed aquatic plant. It is native to South America, but it is a widespread invasive plant in North America. It is a Class B noxious weed, but it is not required for control in Lake Washington or the Sammamish River in King County. It is commonly sold as an aquarium plant in other parts of the US, but it is illegal to sell in the state of Washington. This plant spreads rapidly and outcompetes many other native aquatic plant species. The leaves are clumped densely in whorls of four to six in the upper part of the plant, and more spread apart in whorls of three near the base of the plant. The plant primarily reproduces from stem fragments.

Purple loosestrife (*Lythrum salicaria L.*) is a Class B noxious weed that is on the quarantine list and is required to be controlled by Washington State.

Purple loosestrife (*Lythrum salicaria*)

Purple loosestrife is an emergent aquatic plant that usually grows on moist or saturated soils. A mature, well-established plant often grows up to 10 feet tall and 5 feet wide. Each plant can contain 30 to 50 herbaceous stems that rise from a common rootstock. The purple-magenta colored, five- to six-petaled flowers grow on long spikes. Purple loosestrife seed production depends on plant age, size, and vigor. A 4-to 5-year-old plant with 30 stems reportedly produces an estimated 2,700,000 seeds. Seed maintains viability of over 80 percent for at least 3 years.

Purple loosestrife is native to Eurasia and was first discovered in the Puget Sound region in 1929. Impacts on native vegetation have been dramatic. It is a vigorous competitor and can crowd other vegetation including native species. In a short period of time it will completely dominate a site. Impacts on wildlife have not been well studied; however, purple loosestrife appears to reduce waterfowl and aquatic mammal activity.

Garden loosestrife
(*Lysimachia vulgaris*)

Garden loosestrife is an emergent aquatic plant that usually grows on moist or saturated soils. It is classified as a Class B noxious weed, and it is required for control in King County. The plant may grow up to over 4 feet tall. The leaves are arranged irregularly, in whorls, alternately, or oppositely on the stem. The five-petaled flowers grow on long spikes, and are bright yellow with orange centers. The plant propagates with seeds as while as rhizomes.

Garden loosestrife is native to Eurasia, and has been introduced to North America. It is found in marshes, and along the shorelines of lakes, ponds, and occasionally streams.

PAST MANAGEMENT EFFORTS

Aquatic herbicide treatments in Lake Washington have been permitted through the Washington State Department of Ecology's permit program since 2008 (Ecology 2017b). Only five documented treatments of aquatic plants in the lake are listed (Table 3). Additional permitted treatments have been performed, including those in the project area in 2016.

Table 3. Summary of Permitted Aquatic Herbicide Use for Lake Washington.

Year	Target Plant	Chemical Used	Amount[a]	Permit Number
2008	Eurasian watermilfoil, Brazilian egeria	Diquat dibromide	20 gal.	WAG994118
2010	Eurasian watermilfoil, Brazilian egeria	Diquat dibromide	6 gal.	WAG994118
2011	Eurasian watermilfoil	Diquat dibromide	18.65 lbs.	WAG994118
2013	Fragrant waterlily	Glyphosate	1.35 lbs.	WAG994118
2013	Eurasian watermilfoil, pondweeds	Diquat dibromide	22.38 lbs.	WAG994118

[a] Application area is not recorded (Ecology 2015).

Between 6 and 10 weeks before the 2016 plant survey, aquatic noxious weeds were treated with herbicides at five locations within Lake Washington and the Sammamish River (see Section 7.1.2.2). Under contract with the City of Kenmore, a licensed aquatic herbicide applicator (Aquatechnex) surveyed four of the areas in May and June 2016 to determine the appropriate treatment methods. The areas were treated with the systemic herbicide triclopyr on June 27, 2016, to control Eurasian watermilfoil, and then treated with the contact herbicide diquat on July 29, 2016, to control Brazilian egeria. Approximate locations of the treatment areas are shown in Figure 9. There was noticeably less Eurasian watermilfoil and Brazilian egeria in the two larger treatment areas located near Log Boom Park in Lake Washington and in the Sammamish River downstream of 68th Avenue compared to surrounding areas. The two smaller treatment areas, located near Squire's Landing Park in the Sammamish River and the Inglewood Country Club in Lake Washington, did not appear to have less aquatic noxious weeds than adjacent areas. Pretreatment (May/June 2017) and post-treatment (September 2016) plant density maps are compared in Appendix B.

Under separate contract with lake residents, the licensed aquatic herbicide applicator (Aquatechnex) also treated a fifth area located offshore of Arrowhead Point (see Figure 9). Pretreatment survey data were not provided for comparison to post-treatment survey data.

AQUATIC PLANT CONTROL ALTERNATIVES

There are many methods used to control aquatic weeds. The methods chosen for aquatic plant control vary depending upon several factors, including: the species of aquatic plants targeted; whether the control goal is management or eradication; the cost of a method and availability of funds; the impacts to water quality and habitat; the safety and feasibility of a method; and support from lake residents. Control methods considered for Kenmore included:

- Chemical treatments
- Manual control methods
- Mechanical control methods
- Diver dredging
- Bottom screening
- No action

Table 4 provides a summary of each method considered, its advantages and disadvantages, and suitability for Kenmore. Full descriptions of each method, as well as advantages and disadvantages, permits, costs, and suitability for Kenmore, are summarized in Appendix C. Much of the information in Appendix C is taken directly from Ecology (1994), or from Ecology's Aquatic Plant Management website (Ecology 2016). Some of the information obtained from Ecology (1994, 2016) for Appendix C is outdated, and Ecology is in the process of updating website information. In addition, Appendix D provides information prepared by King County on best management practices for each target species.

It should also be noted that in the future there may be additional herbicides approved for use in Washington State, and other management strategies and tools may become available. The City of Kenmore intends to leave open the possibility of examining and utilizing these in the future.

Table 4. Aquatic Plant Control Options Considered for Kenmore.

Category	Method	Description	Advantages	Disadvantages	Target Plants
None	No Action	Nothing is done to control plant growth.	• No costs incurred	• No control achieved	
Chemical Methods	Aquatic herbicide	Chemicals are applied directly to plants or the lake to inhibit or restrict plant growth.	• Cost effective • High level of control	• Ecological impact concerns • Off target damage to native plants	• All plants
Manual Methods	Hand-pulling	Plants are removed by pulling out by hand.	• No equipment cost	• Small infestation eradications only	• Emergent
	Raking	Plants are raked from the shore or dock using a rake attached to a rope.	• Low equipment cost	• Small control areas only • High root regrowth	• Submersed
	Cutting	Plants are cut from the shore or dock using a specialized tool.	• Low equipment cost	• Small control areas only • Regrowth and drift • Safety issues	• All plants
Mechanical Methods	Mechanical harvesters	Plants are cut and collected using a large barge-mounted machine with conveyor.	• Collects fragments	• Fragment drift • Depth limitations • Dock obstructions	• Submersed, floating
	Mechanical weed cutters	Plants are cut several feet beneath the water surface using a hand-held machine or boat without collection conveyor.	• Low cost	• Plant collection/drift • Depth limitations • Dock obstructions	• submersed
	Rotovators	Plants are uprooted using a rototiller-like machine.	• Affects roots	• Plant collection/drift • Depth limitations • Dock obstructions • Water quality impacts	• All plants
Dredging Methods	Mechanical dredging	Sediment and plant material from the lake bottom is removed using barge-mounted suction equipment.	• Deepens lake • Removed nutrients and seeds	• Very high cost • Sediment disposal • Permitting	• All plants
	Diver dredging	SCUBA divers use a hose attached to a dredge to suck plants from the sediment underwater.	• Removes roots • Moderate infestation eradication	• High cost • Water quality impacts	• Submersed
Biological Methods	Milfoil weevil	Milfoil weevils are introduced to milfoil.	• Low cost	• Low control • Lack of availability in WA State • Milfoil only	• Milfoil
Other Methods	Bottom screening	A gas-permeable barrier is installed on the lake bottom that compresses existing aquatic plants while blocking light to prevent further plant growth.	• Effective for rooted plants in small areas around docks	• Moderate cost • Remove in 2 years unless 100 percent biodegradable, including weights to keep in place	• All plants

INTEGRATED AQUATIC PLANT CONTROL SCENARIOS

The aquatic plant management goal for our project area in Lake Washington and the Sammamish River is to use an integrated approach to control nuisance aquatic vegetation to a low enough level to not impact recreation or wildlife. While it is often the goal of IAVMPs to eradicate invasive species and cease herbicide treatments--allowing the native plant community to self-manage--that is not the intent of this plan. Widespread eradication of these plant species are especially difficult due to inputs from upstream, and eradication could detrimentally affect water quality, destabilize river banks, and create space for infiltration by more invasive species. Further, eradication of these species requires a high level of effort and expense to achieve and maintain because they are such widespread and prolific plants.

After consideration of many aquatic plant control methods, the City of Kenmore, with input from the steering committee, determined that a combination of herbicides, mechanical harvesting, and manual removal were best suited for the project area. A maximum control area for each beneficial use area was considered (Table 5; Figure 10). A high level of control would target nearly 100 percent of those areas using herbicides and mechanical methods.

To assess the potential costs of controlling all of these areas with herbicide and mechanical harvesters, the total area was multiplied by unit costs of the two different treatments (Table 6). This comparison shows that control of all areas would be expensive at approximately $150,000/year for herbicide treatment and $300,000/year for mechanical harvesting, and submersed plants would be the most expensive type of plant to control.

Table 5. Maximum Plant Management Areas.

Area	Total Area (acres)	Submersed Cover (acres)	Floating Cover (acres)	Emergent Cover (miles)
Public				
Saint Edward	6.6	8.8	0.0	0.0
Inglewood Wetlands	5.9	2.3	3.6	0.1
East Open Water	65.2	40.6	0.2	0.0
West Open Water	36.5	31.0	0.0	0.0
Log Boom Park	16.4	16.6	0.0	0.1
Lower Sammamish River	1.4	2.4	5.6	0.1
Rhododendron Park	1.0	0.7	0.0	0.1
Squire's Landing Park	4.6	3.0	0.0	0.5
Commercial				
Kenmore Air	28.3	2.0	0.0	0.0
Marina	9.8	6.4	0.3	0.0
Warehouse/Industrial	6.0	3.9	0.0	0.5
Residential				
South Arrowhead Point Residential	1.9	2.5	0.0	0.0
Arrowhead point Residential	5.4	7.0	0.0	0.0
Inglewood Residential	5.3	0.0	1.2	0.0
Inglewood Golf Residential	10.2	8.9	1.2	0.0
Inglewood Shores Residential	1.4	0.0	1.2	0.0
Sammamish River Residential	14.2	10.5	0.0	1.1

Table 6. Maximum Plant Control Cover and Control Cost.

	Submersed Plants	Floating-Leaved Plants	Emergent Plants
Public Area (acres/miles)	105.3	9.5	0.9
Commercial Area (acres/miles)	30.7	3.9	0.5
Residential Area (acres/miles)	28.9	3.6	1.1
Total Area (acres/miles)	164.9	17.0	2.4
Annual Herbicide Treatment Cost[a]	$148,397	$5,111	$730
Annual Mechanical Harvesting Cost[b]	$263,817	$27,258	$0

[a] Herbicide treatment cost based on $900/acre for one diquat and one triclopyr treatment of submersed plants, $300/acre for one glyphosate treatment of floating-leaved plants, and $300/mile for one glyphosate treatment of emergent plants.

[b] Mechanical harvesting costs are based on $1,600 for two harvests of submersed or floating leaved plants, and do not include disposal costs. Emergent plants would be removed by hand by volunteers at no cost.

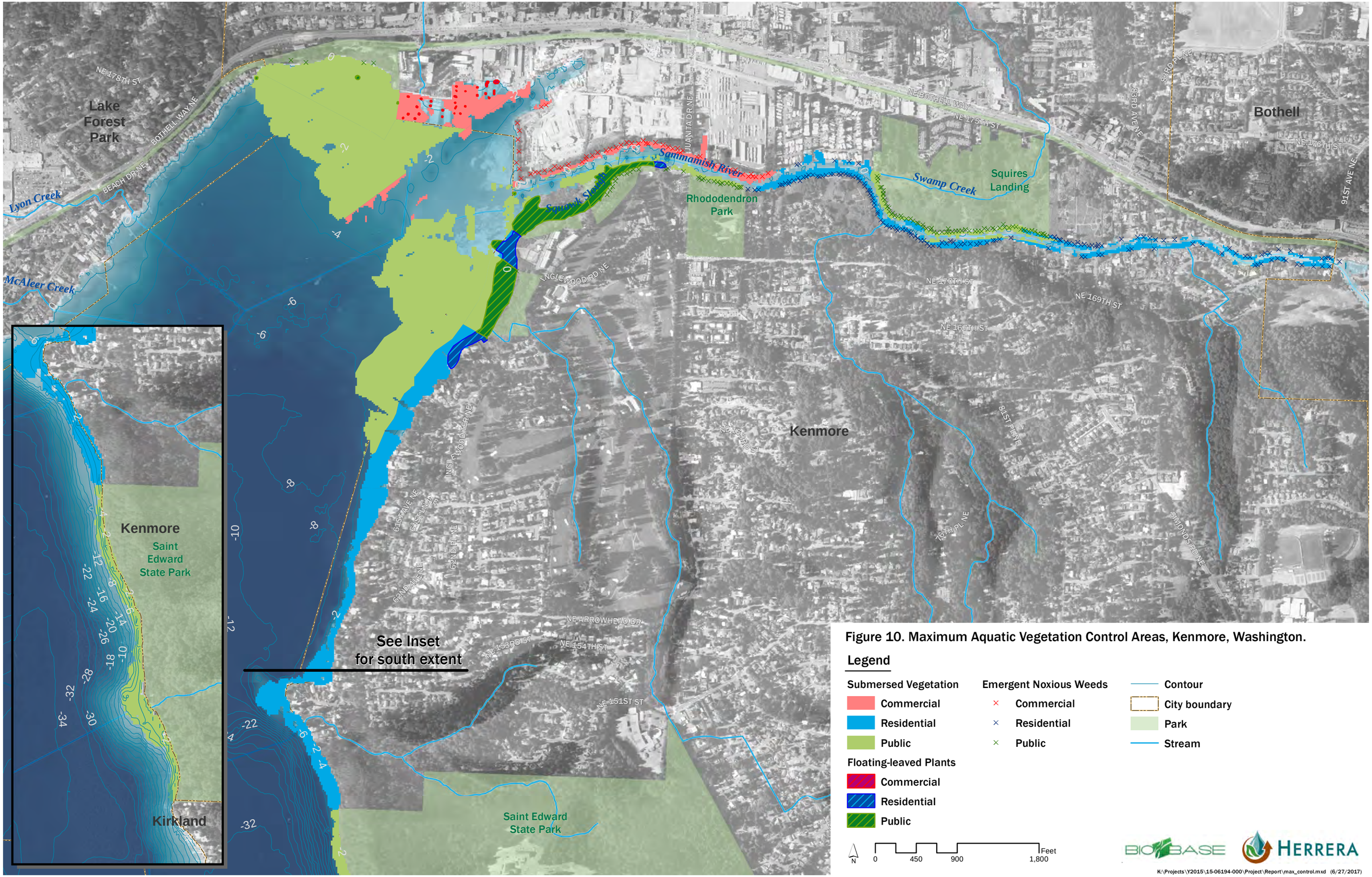


Figure 10. Maximum Aquatic Vegetation Control Areas, Kenmore, Washington.

Legend

Submersed Vegetation
- Commercial
- Residential
- Public

Floating-leaved Plants
- Commercial
- Residential
- Public

Emergent Noxious Weeds
- Commercial
- Residential
- Public

- Contour
- City boundary
- Park
- Stream

N

0 450 900 1,800 Feet

BIOBASE HERRERA

K:\Projects\Y2015\15-06194-000\Project\Report\max_control.mxd (6/27/2017)

HERBICIDE

Four primary herbicides were considered for use in this plan: glyphosate, triclopyr, imazapyr, and diquat (described below). Glyphosate can be used to treat fragrant waterlily, as well as emergent species, including purple and garden loosestrife (Table 7). Triclopyr can be used for submersed Eurasian watermilfoil and emergent species. King County has found that imazapyr works better than glyphosate or triclopyr for controlling garden loosestrife (B. Peterson, personal communication). Diquat will be used for control of submersed plants such as Brazilian egeria (recognizing that treatment of nuisance native plants is not eligible for funding under Ecology guidelines). Glyphosate was selected for control of fragrant waterlily because it has been effectively used in Lake Washington and many other lakes in the region. Triclopyr and diquat were selected because they can effectively control submersed aquatic plants. The dead plants are left to decay and are not removed for any type of treatment.

Table 7. Herbicide Targets, Restrictions, and Cost.

Herbicide	Target Plants	Use Restrictions	Approximate Cost/Acre
Glyphosate	Fragrant waterlily Emergent noxious weeds	None	$350
Triclopyr	Eurasian watermilfoil Emergent noxious weeds	12-hour swimming advisory (water application only)	$700
Imazapyr	Emergent noxious weeds	None	$700
Diquat	Brazilian egeria and most other submersed aquatic plants	24-hour swimming advisory	$500

All four herbicides are approved for aquatic use in Washington State based on environmental impact studies. As a result of these studies, there are many other herbicides allowed by the US Environmental Protection Agency (US EPA), but prohibited for use in Washington State. Full precautions will be taken during applications in Kenmore to ensure that herbicide levels do not exceed the amounts at which these hazards arise by not exceeding amounts specified by US EPA on the product label. Permit applicants should take care to observe all fish timing windows and permit conditions, including notifications and public notices.

Both glyphosate and diquat are relatively inexpensive with application costs around $350 and $500 per acre, respectively. (Terry McNabb, Aquatechnex, personal communication, October 2016). Triclopyr and imazapyr are slightly more expensive, at application around $700 per acre. These estimated per acre costs include two treatments performed a few weeks apart.

Glyphosate – (trade names for aquatic products with glyphosate as the active ingredient include Rodeo®, AquaMaster®, and AquaPro®). This systemic broad-spectrum herbicide is used to control floating-leaved plants like waterlilies and shoreline plants like purple loosestrife. It is generally applied as a liquid to the leaves. Glyphosate does not work on submersed plants. 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. The slow decay of waterlily roots (rhizomes) in large treated areas may result in floating root mats that impact recreation or require costly mechanical removal to prevent recreational impacts. Floating root mat control is not addressed in this IAVMP because large waterlily treatment areas are not anticipated for the project site.

Triclopyr – (trade name Renovate3®). There are two formulations of triclopyr. It is the triethylamine salt (TEA) formation of triclopyr that is registered for use in aquatic or riparian environments. Triclopyr, applied as a liquid or in granular form, is a relatively fast-acting, systemic, selective herbicide. In Washington, it is most commonly used for used for the control of Eurasian watermilfoil. 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 advisory to minimize eye irritation. Triclopyr received its aquatic registration from EPA in 2003 and was allowed for use in Washington in 2004.

Imazapyr – (Trade name Habitat®). 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.

Diquat – (trade names for aquatic products with diquat as the active ingredient include Reward®). Diquat is a fast-acting non-selective contact herbicide that destroys the vegetative part (e.g., leaves) 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. Ecology has imposed a 24 hour swimming advisory for the treated area.

MECHANICAL HARVESTING

Mechanical harvesting was identified as a suitable control method for Kenmore because it is relatively cost effective, chemical-free, and can treat large public areas while collecting plant fragments.

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. 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. Ecology does not recommend harvesting milfoil or egeria because it can create plant fragments

that help spread these invasive plants. However, fragment spread is less of a concern for this project area because these invasive plants are well established and widespread. Also, milfoil naturally produces large numbers of autofragments throughout the summer that have a higher carbohydrate content and are therefore much more viable than fragments cut by a harvester (Cooke et al 2005). Thus, milfoil fragments generated by harvesting may be less problematic than naturally produced autofragments and harvesting may reduce the parent stock producing autofragments.

Mechanical harvesting is ideally suited for large areas that are free from most obstacles such as docks. The harvesters are also difficult to maneuver in shallow water. The cost of using a mechanical harvester is about $1,600 per acre for two harvests/year (not including disposal).

Manual Raking

A third consideration for plant control in Kenmore is the use of publicly-available and inexpensive tools, such as hand-held rakes, for residents to use on their own waterfront properties. This is a preferred method for Kenmore. With this chemical-free method, small infestations of noxious weeds or nuisance native plants near docks can be controlled as needed.

Raking requires a sturdy rake 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. Ecology does not recommend manual raking of milfoil or Egeria because it can create plant fragments that help spread these invasive plants. As noted for mechanical harvesting, fragment spread is less of a concern for this project area because these invasive plants are well established and widespread, and raking of milfoil may reduce the parent stock producing autofragments.

Bottom Barriers

A final method of preferred plant control for Kenmore is the use of bottom barriers around docks and swim areas. 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. Bottom barriers are an excellent choice for small areas of control. The Washington Department of Fish and Wildlife requires barriers to be removed after a 2-year period unless the bottom barrier, including the weights to hold it in place, is made entirely of biodegradable material.

Plant Conservation

Kenmore desires to preserve some of the existing nuisance vegetation. This is in part to reduce costs, but more importantly to preserve fish habitat, protect water quality, prevent river bank erosion, and meet Ecology's permit standards. The steering committee identified conservation areas near the Inglewood wetlands where recreational activities are not impacted and no nuisance submersed or floating-leaved plants will be removed unless they further encroach upon the navigation channels. Emergent noxious weeds requiring control (garden and purple loosetrife) will continue to be controlled in conservation areas. Conservation areas are essential to the preservation of wildlife habitat, natural vegetation, and should be maintained as such to meet compliance with applicable federal, state, and local regulations.

Future Considerations

As noted in Aquatic Plant Control Alternatives, the City of Kenmore recognizes that best practices in the management of aquatic weeds are continually evolving. There may be additional herbicides approved for use in Washington State in the future, and other management strategies and tools may become available. The City of Kenmore intends to leave open the possibility of examining and utilizing any or all of these in the future.

SELECTED ACTION STRATEGY AND IMPLEMENTATION

ACTION STRATEGY

After assessing the control scenarios, the Steering Committee prioritized a maintenance level of control for the target plants that meets IAVMP goals using an integrated approach. To achieve these goals, the following priority areas were determined:

Lake Washington

- Log Boom Park Swimming and Boating
- Residential Area Swimming and Boating
- Marina Boating
- Kenmore Air Docking

Sammamish River

- Public and Residential Area Boating (including the WDFW boat launch and the river channel from the boat launch to the lake)
- Rhododendron Park
- Squire's Landing Park
- Class B Weed Control

The following plant management strategies were assessed to determine if they could meet the goals of the IAVMP:

- Herbicide treatment of invasive non-native submersed plants, nuisance native submersed plants, fragrant waterlily, and emergent loosestrife species in some or all areas.
- Harvesting submersed plants in some or all areas.
- Bottom barriers in dock and swim areas.
- Hand-pulling and raking by residents.
- No control of submersed plants or fragrant waterlily in Inglewood wetlands and other conservation areas unless there is further encroachment into navigation channels.

IMPLEMENTATION

The Development Services Department at the City of Kenmore is responsible for oversight of proposed development and permitting throughout the City of Kenmore. This includes regulating activities along the shoreline to ensure implementation of the Shoreline Management Act of 1971 (Washington State Legislature 2017), which recognizes that "the shorelines of the state are among the most valuable and fragile of its natural resources" and provides guidelines for permitted uses "designed and conducted in a manner to minimize, insofar as practical, any resultant damage to the ecology and environment of the shoreline area and any interference with the public's use of the water" (RCW 90.58.020). In addition, unless eligible for a Shoreline Substantial Development Permit (SSDP) exemption, permit requesters must complete a SEPA Environmental Checklist to determine whether the environmental impacts of any management efforts are significant. If a Shoreline Exemption is sought in lieu of a Shoreline Substantial Development Permit, applicants are responsible for demonstrating compliance with exemption criteria. Development Services will review all permits submitted to the City of Kenmore for compliance with the Shoreline Management Act of 1971 and the State Environmental Policy Act (SEPA). Fees for permits or exemptions issued by the City of Kenmore are based on the Fee Resolution in effect at the time of application. In general, work performed within the scope of this IAVMP will qualify for a Shoreline Exemption rather than a Shoreline Substantial Development Permit.

Because there are multiple jurisdictions and agencies concerned with Lake Washington and the Sammamish River, additional permits may be required by others. To determine what specific permits are required, anyone desiring to implement any of the strategies contained in this Plan should complete a Project Questionnaire at the Governor's Office for Regulatory Innovation and Assistance website (<www.oria.wa.gov>). The completed questionnaire generates a list of permits required for the project under consideration. Required permits are summarized in Table 8 for each plant management strategy. See Appendix C for additional permit information.

Table 8. Required Permits.

Method	Shoreline Permit Exemption from City of Kenmore	Aquatic Plant and Algae Management Permits from Ecology	Hydraulic Project Approval (HPA) Permit from WDFW
Herbicide	Exemption required	General permit required for all plants (Ecology 2017b), and noxious weed permit required for emergent noxious weeds (Ecology 2017c)	HPA not required
Mechanical Harvesting	Exemption required	Not required	HPA required for native plants, see pamphlet for noxious weeds (WDFW 2015)
Manual Raking/Pulling	Exemption required	Not required	See pamphlet for noxious weeds or native plants (WDFW 2015)
Bottom Barrier	Exemption required	Not required	See pamphlet for noxious weeds or native plants (WDFW 2015)

For projects implemented by the City of Kenmore, the City regularly will evaluate the management of aquatic weeds and the effectiveness of plant management strategies employed to date. The City will hire contractors to do work in public areas, such as large herbicide treatments and/or harvesting. The City will provide education and training to encourage residents to combine efforts in residential and commercial areas to manually remove aquatic plants or contract for herbicide treatment of noxious weeds.

The City also recommends that waterfront residents consider the formation of a Plant Management Association. This type of volunteer organization, formed by, run by, and for the benefit of, waterfront residents could provide an opportunity for residents to pool their resources and/or work in tandem with one another to employ approved management strategies such as jointly contracting with an herbicide application company or harvester, manual removal of plants, installation of bottom barriers, and other management strategies outlined in this plan.

Successful implementation of this plan revolves around a collective sharing of information. The City of Kenmore will work to solicit public input, and keep residents and businesses informed of current and future plant management strategies. As noted earlier, the City of Kenmore has published a webpage with useful links for permit and other information (<http://www.kenmorewa.gov/IAVMP>).

In addition, the City of Kenmore will continue to reach out to upstream jurisdictions to orchestrate joint plant management strategies. Conversations with upstream jurisdictions to date have garnered interest in continuing to stay in communication about the management of aquatic weeds in north Lake Washington and the Sammamish River as a whole.

MONITORING AND EVALUATION PLAN

Several different plant control-related monitoring and evaluation needs are identified for the City of Kenmore, including: aquatic plant surveys and evaluation of aquatic plant management activities. These evaluation activities are described below.

AQUATIC PLANT SURVEYS

Ongoing surveys and mapping will be necessary to evaluate the effectiveness of treatment strategies, to inform future treatments, and to detect new infestations of invasive plants. In response to the planned treatments, the aquatic plant community in the City of Kenmore may be in flux. It is critical that frequent and thorough surveys be conducted to document these changes and to detect new problems.

Subject to funding availability, a GPS/GIS survey and mapping effort may be performed by a contractor as a regular component of the long-term surveillance and management program. This survey effort will identify all plant species present in the lake and river and their relative abundance at each location. The survey map will include past management areas for comparison to plant densities observed in previous surveys and assessment of management effectiveness. These plant surveys will also help provide guidance for aquatic plant management in future years.

EVALUATION

Also subject to funding and staffing resources, a complete evaluation including a plant management report may be completed as needed. This report would describe which elements of the management plan have been implemented, relate the existing plant community to established goals, and make recommendations for the next year's activities.

This evaluation should begin with a description of which elements of the plan have been fully implemented, those that have not, and why. It should also include a summary of the plant survey results, both those obtained by volunteers and those by professionals. The evaluations should also provide a map of all management areas for each year. The survey results should be used to determine whether goals have been met. The community should also be asked for input on their satisfaction with aquatic plant and water body conditions. It is possible that the IAVMP goals will be met but that some people will remain dissatisfied.

Although it is unlikely that the needs of all stakeholders will be met (and it is possible that the IAVMP goals will be met but that some people will remain dissatisfied), an effort should be made to track concerns, especially if they are widespread. This information should be used to decide on the following:

- Has there been a quantifiable increase or decrease in the amount of nuisance plants in the lake?
- Have any other noxious aquatic plants been identified?
- Has there been a change in the occurrence and frequency of algae?
- What control methods work best and should other control methods (newly approved herbicides, for example) be considered?
- Is it necessary to revise the plan?
- Is funding adequate for the control measures in place?

Over the long term, adequate evaluations can make the difference between project success and failure, and the City of Kenmore will regularly monitor and evaluate the effectiveness of the various management strategies that have been employed. In addition, as noted earlier, potential new herbicides, management strategies, and tools will be considered as they become available.

REFERENCES

Carlson, R.E. 1977 A Trophic State Index for Lakes. Limnology and Oceanography, 3. 22, 361.

Cooke, G.D., E.B. Welch, S.A. Peterson, and S.A. Nichols. 2005. Restoration and Management of Lakes and Reservoirs. 3rd ed. Taylor and Francis Group, Boca Raton, Florida.

Ecology. 1994. A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans. First edition. Washington State Department of Ecology, Water Quality Financial Assistance Program, Olympia, Washington. January. <https://fortress.wa.gov/ecy/publications/publications/93093.pdf>.

Ecology. 2001. An Aquatic Plant Identification Manual for Washington's Freshwater Plants. Publication Number 01-10-032. Washington State Department of Ecology, Olympia, Washington. June.

Ecology. 2015. Washington State Lakes Environmental Data. Washington State Department of Ecology, Olympia, Washington. <https://fortress.wa.gov/ecy/coastalatlas/tools/LakeDetail.aspx>.

Ecology. 2016. Aquatic Plant Management. Washington State Department of Ecology, Olympia, Washington. <http://www.ecy.wa.gov/programs/wq/plants/management/index.html>

Ecology. 2017a. Native Freshwater Plants, Aquatic Plants and Lakes. Washington State Department of Ecology, Olympia, Washington. <http://www.ecy.wa.gov/programs/wq/plants/native/lakes.html>.

Ecology. 2017b. Aquatic Plant and Algae Management General Permit. Washington State Department of Ecology, Olympia, Washington. <http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/aquatic_plants/aquatic_plant_permit_index.html>.

Ecology. 2017c. Aquatic Noxious Weed Control NPDES General Permit. Washington State Department of Ecology, Olympia, Washington. <http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html>.

Goodpasture, et al. 1979. Municipality of Metropolitan Seattle – Water Quality Division. Aquatic Plants in Selected Waters of King County. Distribution and Community Composition of Macrophytes.

Kerwin, John. 2001. Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin. Washington Conservation Commission. September.

King County. 2010. Lake Washington History and Data. King County Lake Stewardship. <http://www.kingcounty.gov/environment/waterandland/lakes/lakes-of-king-county/lake-washington.aspx>.

King County. 2016. King County Noxious Weed List. Updated October 3. <http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/laws/list.aspx>.

King County. 2017a. Lake Washington Monitoring Overview. King County Water and Land Services. <http://green2.kingcounty.gov/lakes/LakeWashington.aspx>.

King County. 2017b. King County Water Quality Monitoring. <http://green2.kingcounty.gov/streamsdata/watershedinfo.aspx?Locator=0450>.

NWCB. 2016. 2016 Washington State Noxious Weed List. Washington State Noxious Weed Control Board. <http://www.nwcb.wa.gov/>.

Olden and Tomayo. 2014. Incentivizing the Public to Support Invasive Species Management: Eurasian Milfoil Reduces Lakefront Property Values. PLoS ONE 9(10): e110458. doi:10.1371/journal.pone.0110458. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0110458>.

Patmont, et al. 1981. Municipality of Metropolitan Seattle- Water Quality Division. Aquatic Plants in Selected Waters of King County. Distribution and Community Composition of Macrophytes.

Washington State Legislature. 2017. Chapter 90.58 RCW, Shoreline Management Act of 1971. Washington State Legislature, Olympia, Washington. <http://app.leg.wa.gov/RCW/default.aspx?cite=90.58>.

WDFW. 2015. Aquatic Plants and Fish, Rules for Aquatic Plant Removal and Control. Washington State Department of Fish and Wildlife, Olympia, Washington. Second Edition, July.

APPENDIX A

Kenmore Steering Committee and Public Meeting Presentations and Minutes

Kenmore IAVMP Steering Committee:

Jennifer Gordon, Public Works Operations Manager, City of Kenmore
Quinn Proffitt, Maintenance Work, City of Kenmore
Lizbeth Seebacher, Wetland and Aquatic Biologist, Washington State Dept. of Ecology
Ben Peterson, Noxious Weed Specialist II, King County
Casey Costello, Habitat Biologist, Dept. of Fish and Wildlife
Todd Banks, President, Kenmore Air
Jim Davidson, Owner, North Lake Marina in Kenmore
Doug Ritchie, Vice President, Kenmore Waterfront Activities Center
Douglas Poppe, Officer, Puget Sound Anglers Association
Greg Matz, Superintendent, Inglewood Golf Course and County Club
John Adamski, President, Arrowhead Point Community Waterfront Corporation
Matt Muller, Waterfront Property Owner

Facilitators:

Janet Quinn, Project Coordinator, City of Kenmore
Rob Zisette, Herrera Environmental Consultants

City of Kenmore

City of Kenmore Integrated Aquatic Vegetation Management Plan (IAVMP)

Steering Committee Meeting #1

Facilitated by:

Janet Quinn, Project Coordinator, City of Kenmore

Rob Zisette, Aquatic Scientist, Herrera Environmental Consultants, Inc.

October 28, 2016

HERRERA

City of Kenmore

Agenda

- Introductions (10 min.)
- IAVMP Document Overview (5 min.)
- Plant survey maps and interpretation (25 min.)
- Discuss plant problems (35 min.)
- Break (10 min.)
- Develop problem statement (15 min.)
- Identify interested groups and compile a list of contacts for the public meeting (10 min.)
- Project schedule and set dates for Public Meeting and 3rd Steering Committee Meeting (10 min.)
- Identify beneficial use areas (if time permits)
- Develop plant management goals (if time permits)

HERRERA

City of Kenmore

Steering Committee

- Jennifer Gordon, Public Works Operations Manager, City of Kenmore
- Quinn Proffitt, Maintenance Work, City of Kenmore
- Lizbeth Seebacher, Wetland and Aquatic Biologist, Washington State Dept. of Ecology
- Ben Peterson, Noxious Weed Specialist II, King County
- Casey Costello, Habitat Biologist, Dept. of Fish and Wildlife
- Todd Banks, President, Kenmore Air
- Jim Davidson, Owner, North Lake Marina in Kenmore
- Doug Ritchie, Vice President, Kenmore Waterfront Activities Center
- Douglas Poppe, Officer, Puget Sound Anglers Association
- Greg Matz, Superintendent, Inglewood Golf Course and County Club
- John Adamski, President, Arrowhead Point Community Waterfront Corporation
- Matt Muller, Waterfront Property Owner

HERRERA

City of Kenmore

IAVMP Citizen's Manual*

- Living Document: Be flexible and allow for changes in:
  - Aquatic plant problems
  - Water use priorities
  - Land uses
  - Plant control technologies
  - Government policies and regulations
- Long term venture
- There is no "magic bullet"
- Desired outcome/costs/environmental concerns

*From "A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans"

HERRERA

City of Kenmore

IAVMP Chapters*

- **Problem Statement**
- Past Management Efforts
- **Management Goals**
- Lake and Watershed Characteristics
- **Beneficial Use Areas**
- **Aquatic Plant Characteristics**
- Aquatic Plant Control Alternatives & Level of Intensity
- Integrated Aquatic Plant Control Scenarios
- Selected Action Strategy
- Public Involvement
- Monitoring and Evaluation Plan
- References

* Based on minimum standards specified in Aquatic Weeds Management Fund Guidelines

HERRERA

City of Kenmore

Historical Plant Surveys

King County - 1979 and 1981

City of Kenmore

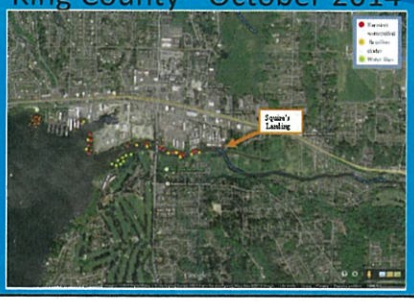
Historical Plant Surveys

BioSonics - 2001

City of Kenmore

Historical Plant Surveys

King County - October 2014



City of Kenmore

Historical Plant Surveys

AquaTechnex - May 2016

City of Kenmore

- IAVMP Survey September 7-8, 2016
- Sonar transects ≤ 120 ft spacing
- Species composition samples at 68 locations

City of Kenmore

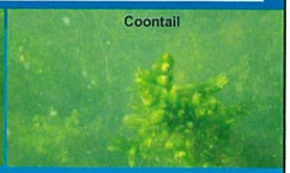
Plant List

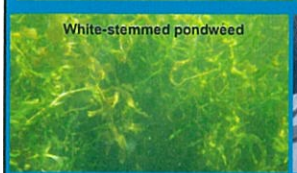
Table 1. Aquatic Plant List for the Kenmore Survey on September 7 and 8, 2016.

Plant Type	Common Name	Scientific Name	Status
Emergent Plants	Common cattail	Typha latifolia	Native
	Garden loosestrife	Lysimachia vulgaris	Noxious Weed- Class B
	Japanese knotweed	Fallopia japonica	Noxious Weed- Class B
	Narrow-leaf bur-reed	Sparganium angustifolium	Native
	Purple loosestrife	Lythrum salicaria	Noxious Weed- Class B
	Reed canarygrass	Phalaris arundinacea	Noxious Weed- Class C
	Spotted jewelweed	Impatiens capensis	Noxious Weed- Monitor List
	Yellow-flag iris	Iris pseudacorus	Noxious Weed- Class C
Floating Leaved Rooted Plants	Fragrant waterlily	Nymphaea odorata	Noxious Weed- Class C
	Grass-leaved pondweed	Potamogeton gramineus	Native
Free Floating Plants	Lesser duckweed	Lemna minor	Native
	Mexican water-fern	Azolla mexicana	Native
Submersed Plants	Brazilian elodea	Egeria densa	Noxious Weed- Class B
	Common waternymph	Najas guadalupensis	Native
	Common waterweed	Elodea canadensis	Native
	Coontail	Ceratophyllum demersum	Native
	Curly-leaf pondweed	Potamogeton crispus	Noxious Weed- Class C
	Eurasian watermilfoil	Myriophyllum spicatum	Noxious Weed- Class B
	Flat-stemmed pondweed	Potamogeton zosteriformis	Native
	Richardson's pondweed	Potamogeton richardsonii	Native
	Sago pondweed	Potamogeton pectinatus	Native
	Tapegrass	Vallisneria americana	Native
	White-stemmed pondweed	Potamogeton praelongus	Native
Plant-like algae	Nitella	Nitella sp.	Native

City of Kenmore

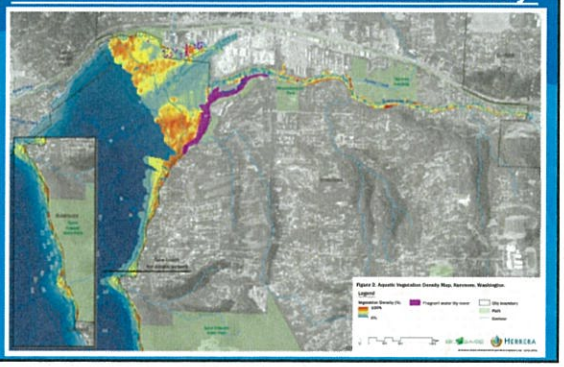
Example Plant Photographs





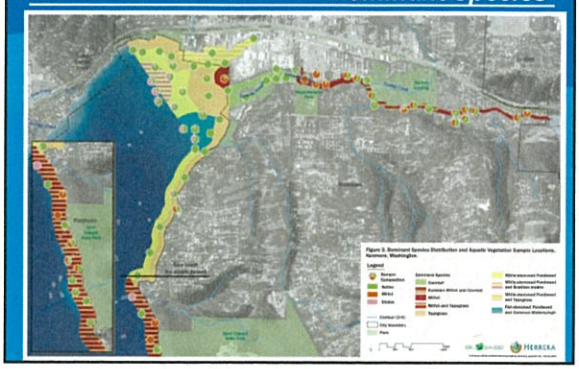
City of Kenmore

Plant Density



City of Kenmore

Dominant Species



City of Kenmore

Noxious Weeds

City of Kenmore

Defining the Problem(s)

Questions to consider:

- Who uses the water and how and where is it used?
- Who is missing from this discussion and how do they use the water?
- What important water body uses are being limited because of aquatic plants?
- Native vs. non-native species: Do differences matter?

Steps:

- List problems
- Group problems into categories
- Condense main categories into problem statement

HERRERA

City of Kenmore

Example Problem Statement

- Dense growth of aquatic plants interferes with recreational and business uses in some areas of the Sammamish River and Lake Washington in the City of Kenmore during the summer. Although some areas are impacted by native plants, recreational uses are primarily impacted by the invasive, non-native noxious weeds Eurasian watermilfoil and Brazilian elodea. Primary impacts of concern include ....

HERRERA

City of Kenmore

Public Meeting Contacts

- Federal agencies
- State agencies
- King County
- Cities of Bothell, Woodinville, Redmond, other
- Native American Tribes
- Environmental groups
- Fishing and special user groups
- Water-related businesses
- Landowner
- Other interested parties

HERRERA

City of Kenmore

Project Schedule

Activity	Date
Steering committee meeting #1 on plant survey, interpretive report and problem(s)	October 28, 2016
Steering committee meeting #2 on management goals, beneficial use areas, control methods, integrated control scenarios, and action strategy	December 16, 2016
Public meeting #1 all elements of draft IAVMP	**January 2017**
Draft IAVMP to Ecology	February 28, 2017
Steering committee meeting #3 on draft IAVMP comments	**April 2017**
Final IAVMP	June 30, 2017

HERRERA

City of Kenmore

Beneficial Use Areas

- Recreational Use
  - Boating
  - Fishing
  - Swimming
  - Aesthetic and wildlife observation
- Commercial Use
  - Marinas
  - Kenmore Air
  - Water supply
- Wildlife Use
  - Waterfowl
  - Aquatic mammals
  - Fish and other aquatic organisms

HERRERA

City of Kenmore

Plant Management Goals

- Control versus Eradication
  - Eurasian watermilfoil
  - Brazilian elodea
  - Fragrant waterlily
  - Other noxious weeds
  - Native plants
- Control areas
- Control period and frequency
- Conservation areas
- Use of chemicals
- Cost and funding

HERRERA

City of Kenmore

Aquatic Weeds Steering Committee Meeting

10-28-16

Attendees: Rob Zisette, Herrera Environmental Consultants; Doug Ritchie, Kenmore Waterfront Activities Center; Matt Muller, Waterfront Property Owner; Casey Costello, Dept. of Fish and Wildlife; Greg Matz, Inglewood Golf Club; Liz Seebacher, Dept. of Ecology; Jim Davidson, North Lake Marina; Quinn Proffitt, City of Kenmore; Todd Banks, Kenmore Air; Ben Peterson, King County; John Adamski, Waterfront Property Owner, Doug Poppe, Puget Sound Anglers Association; Rob Karlinsey, City of Kenmore; Janet Quinn, City of Kenmore. Unable to attend: Jennifer Gordon, City of Kenmore

Mission of the committee is to share observations/knowledge of aquatic weeds in the project area, develop the problem statement, and provide guiding input into the Integrated Aquatic Vegetation Management Plan.

Rob Zisette of Herrera presented survey results and maps of aquatic plants in the Sammamish River and Lake Washington within Kenmore city limits. Milfoil invaded the lake in the 1960's. John Adamski has seen an acceleration of milfoil over the past several decades and he observed that the survey of weeds prior to AquaTechnex's herbicide application in June and July 2016 showed a higher density of invasive plants. John recommended that the density and location of plants from this earlier survey should also be included as an addition to the Herrera report. The navigation channel is relatively free of noxious weeds, as are the areas that are in the path of barges. The U.S. Army Corps of Engineers last dredged the navigation channel in 1997. Plant growth has accelerated since then, from Todd's observations. Barges disturb the plants and create unsuitable habitat for them, although milfoil can endure more disturbance than other species because of its extensive root system and sturdy stems.

As of this date, elodea is completely gone where it was treated, and milfoil died back but is beginning to reappear. Curly-leaf pondweed was present in Arrowhead Cove before the 2016 treatment. Filamentous algae smells bad and is a significant problem. The abundance of filamentous algae and toxic blue-green algae has increased in recent years, and was worse in 2014 and 2015 than in 2016.

Rob Z. of Herrera has a lot of experience with aquatic weed management and IAVMPs, and he'll be assisting Kenmore with the development of our Plan. We'll want to reach out to Tribes to gain their perspective on a Management Plan as well.

Problems created by the presence of aquatic weeds and identified by the group:

- Inhibits swimming and other recreational use
- Inhibits commercial use by breaking cables on planes, making it difficult to steer
- Transference to other waters when plants adhere to planes or boats that then go to another water body
- Weed debris fouls beaches – negatively impacting property values
- Reduces navigable areas and condenses water traffic into smaller areas
- Native plants are choked out by noxious weeds
- Impacts aesthetics – turns water brown and murky
- Impacts fish habitat and fish physical and chemical environment – creates migration barrier, dissolved oxygen goes down, water temperature rises
- Weeds promote habitat for non-native fish species that prey on salmon and other natural species
- Toxic algae – be sure we don't create an environment for it through the treatment we choose
- Potential impact to public and private property through flooding and erosion

We grouped the problems into three categories: Environmental, Recreational, and Economic.

Environmental problems:

- Fish Habitat
- Algae
- Native Biodiversity
- Potential flooding/erosion
- Water Quality

Recreational problems:

- Inhibits swimming and watercraft
- Fishing
- Toxic Algae
- Aesthetics
    - Plant accumulation and decay
    - Aroma
    - Water clarity
- Shoreline access
- Irrigation considerations

Economic problems:

- Impact on planes, boats and other watercraft
- Property value impact
- Cost to control/remove
    - Define time frame of problem—when are aquatic weeds a problem (i.e., what seasons)
- Perceived quality of life
- Reduction of navigable waterways

Rob Z. and Janet will work together to write a problem statement to send out to the group for thoughts.

Send Janet contact info for people/groups you think should be invited to the public meeting. She will send out an electronic meeting request for the January public meeting – first choice Tuesday, second choice Wednesday (not great but workable), Thursday out for at least one party.

Next steering committee meeting is Friday, December 16th.

Thanks for participating!

10/28/16

City of Kenmore, Washington — Aquatic Weeds Steering

Kenmore City Hall

Friday, Octob 28th 2016
11:30 a.m. - 1:30p

	NAME	NAME OF BUSINESS OR COMPANY	ADDRESS
1	JOHN ADAMSKI	RETIRED	5906 NE ARROWHEAD DR KENMORE, WA
2.	Casey Costello	WDFW	1775 12th Ave Issaquah, WA
3.	Todd Banks	Kenmore Air	6321 NE 175th Kenmore, WA
4.	Greg Matz	Inglewood Golf Club	6505 Inglewood Rd NE Kenmore, WA 98028
5.	Ben Peterson	King County Noxious Weed Control Program	201 S. Jackson St. #60 Seattle, WA 98104
6.	Jim DAVIDSON	North Lake Marina	6201 NE 175th ST Kenmore 98028
7.	Doug Poppe	EASTSIDE PSA	13448 NE 83rd Redmond, WA
8.	DOUG RITCHIE	KENMORE CANOE & KAYAK TEAM	1037 NE 65th #352 SEATTLE WA 98115
9.	Quinn Proffitt	City of Kenmore	18120 68th Ave NE Kenmore WA 98028

10/28/16

City of Kenmore, Washington — Aquatic Weeds Steering

Kenmore City Hall — Friday, Octob
11:30 a.m. -

	NAME	NAME OF BUSINESS OR COMPANY	ADDRESS
10.	Rob Zisette	Herrera	rzisette@herrerainc.com
11.	Janet Quinn	City of Kenmore	
12.	MATT MULLER	REDBACK CONSULTING	
13.	Lizbeth Seebach	DOE	
14.	Ry Karlinsey	City of Kenmore	

City of Kenmore

City of Kenmore Integrated Aquatic Vegetation Management Plan (IAVMP)

Steering Committee Meeting #2

Facilitated by:

Janet Quinn, Project Coordinator, City of Kenmore

Rob Zisette, Aquatic Scientist, Herrera Environmental Consultants, Inc.

December 16, 2016

HERRERA

City of Kenmore

Agenda

- Review IAVMP Chapters (1 min.)
- Review Identified Problems (5 min.)
- Updates on park improvements (5 min.)
- Review plant maps (5 min.)
- Discuss plant management goals (15 min.)
  - City Manager identified priorities
- Overview of plant management methods (How) (20 min.)
- Identify beneficial use areas (Where) (20 min.)
- Discuss management strategies (Prioritize) (30 min.)
- Discuss level of intensity – balancing desired outcomes, costs, environmental concerns (15 min.)

HERRERA

City of Kenmore

IAVMP Chapters*

- Problem Statement
- Past Management Efforts
- **Management Goals**
- Lake and Watershed Characteristics
- **Beneficial Use Areas**
- Aquatic Plant Characteristics
- **Aquatic Plant Control Alternatives & Level of Intensity**
- Integrated Aquatic Plant Control Scenarios
- Selected Action Strategy
- Public Involvement
- Monitoring and Evaluation Plan
- References

* Based on minimum standards specified in Aquatic Weeds Management Fund Guidelines

HERRERA

City of Kenmore

Identified Problems

Environmental:
- Negative impact on fish habitat
- Impact on native biodiversity
- Increased levels of algae
- Water quality concerns
  - Low dissolved oxygen
  - High temperature

Recreational:
- Inhibit swimming & paddle sports
- Weeds wound around boat motors
- Weeds tangled in fishing lines
- Non-native weeds promote habitat for non-native fish species
- Health risks of toxic blue-green algae
- Aesthetical impact
  - Plant accumulation and decay
  - Foul aroma
  - Water clarity issues
- Shoreline access
- Irrigation challenges
  - Reduction of water circulation
  - Clogged intake lines
  - Damaged pumps
  - Contaminated water

Economic:
- Reduction of navigable waterways
  - Forces lake traffic into narrow lanes
  - Increases potential for conflict between boats and skiers
- Reduction of water depth
  - Impacts access to moorage slips
- Costly repairs to damaged boat propellers and plane rudders
- Perceived quality of life
- Lower waterfront property values*
- Cost to manage/control/eradicate

HERRERA

City of Kenmore

Log Boom Park Improvements

HERRERA

City of Kenmore

Rhododendron Park Improvements

HERRERA

City of Kenmore

Squire's Landing Improvements

HERRERA

City of Kenmore

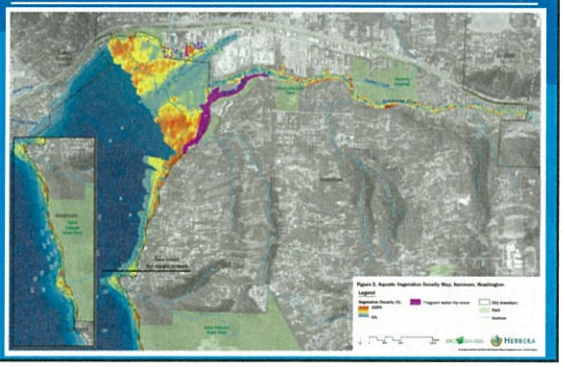
Plant List

Table 1. Aquatic Plant List for the Kenmore Survey on September 7 and 8, 2016.

Plant Type	Common Name	Scientific Name	Status
Emergent Plants	Common cattail	Typha latifolia	Native
	Garden loosestrife	Lysimachia vulgaris	Noxious Weed- Regulated Class B
	Japanese knotweed	Fallopia japonica	Noxious Weed- Nonregulated Class B
	Narrow-leaf bur-reed	Sparganium angustifolium	Native
	Purple loosestrife	Lythrum salicaria	Noxious Weed- Regulated Class B
	Reed canarygrass	Phalaris arundinacea	Noxious Weed- Nonregulated Class C
	Spotted jewelweed	Impatiens capensis	Noxious Weed- Monitor List
	Yellow-flag iris	Iris pseudacorus	Noxious Weed- Nonregulated Class C
Floating Leaved Rooted Plants	Fragrant waterlily	Nymphaea odorata	Noxious Weed- Nonregulated Class C
	Grass-leaved pondweed	Potamogeton graminaeus	Native
Free Floating Plants	Lesser duckweed	Lemna minor	Native
	Mexican water-fern	Azolla mexicana	Native
Submersed Plants	Brazilian elodea	Egeria densa	Noxious Weed- Nonregulated Class B
	Common waternymph	Najas guadalupensis	Native
	Common waterweed	Elodea canadensis	Native
	Coontail	Ceratophyllum demersum	Native
	Curly-leaf pondweed	Potamogeton crispus	Noxious Weed- Nonregulated Class C
	Eurasian watermilfoil	Myriophyllum spicatum	Noxious Weed- Nonregulated Class B
	Flat-stemmed pondweed	Potamogeton zosteriformis	Native
	Richardson's pondweed	Potamogeton richardsonii	Native
	Sago pondweed	Potamogeton pectinatus	Native
	Tapegrass	Vallisneria americana	Native
	White-stemmed pondweed	Potamogeton praelongus	Native
Plant-like algae	Nitella	Nitella sp.	Native

City of Kenmore

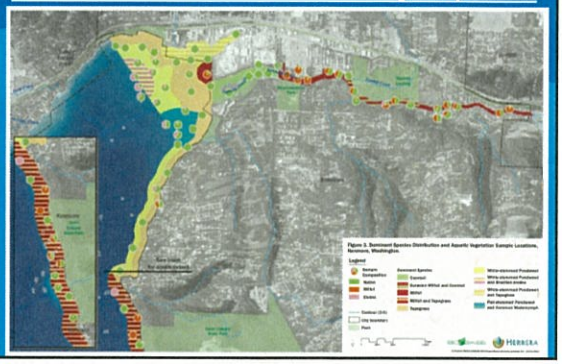
Aquatic Plant Density



HERRERA

City of Kenmore

Dominant Submerged Species



HERRERA

City of Kenmore

Noxious Weeds

HERRERA

City of Kenmore

Plant Management Goals

What do we want to achieve?

- Is it reasonable?
- Is it realistic?
- Will it be supported by the broader community?
- Is the cost reasonable relative to the benefit?

How will we prioritize?

Are incremental steps possible?

HERRERA

City of Kenmore

City Priorities

- Reduce impact on boating (hand-powered watercraft and motor boats)
  - Clear, clean water
  - No weeds catching on paddles, rudders, propellers
- Provide clear, clean water for swimmers
  - No weeds in beach areas
  - No decomposed weeds on beaches
- Maintain healthy environment for fish
  - Maintain appropriate water temperature

HERRERA

City of Kenmore

Plant Management Strategies - Parameters

- Species control or eradication
  - Eurasian watermilfoil
  - Brazilian elodea
  - Fragrant waterlily
  - Emergent noxious weeds
  - Native plants
- Control area priorities
  - Submersed/floating/emergent
  - Public/residential/commercial
- Control intensity
- Conservation areas
- Use of chemicals
- Cost and funding

HERRERA

City of Kenmore

Plant Management Methods

- Chemical herbicides
- Manual methods
- Mechanical methods
- Dredging methods
- Biological methods
- Other methods

HERRERA

City of Kenmore

Chemical Methods

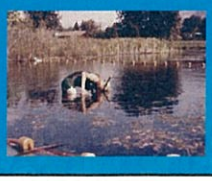
Method	Advantages	Disadvantages	Kenmore Potential
Aquatic Herbicides	• Cost effective • High level of control	• Ecological impact concerns	Yes-all plants

Method	Type (~Cost/Acre)	Target Plants	Kenmore Applicable
Fluridone	• Systemic, selective, liquid or granular ($1,000)	• Submerged (milfoil and elodea)	Yes-Milfoil and Elodea
2,4-D	• Systemic, selective, liquid only ($500)	• Submerged (milfoil)	No-Milfoil
Triclopyr-TEA	• Systemic, selective, liquid or granular ($700)	• Submerged (milfoil) • Emergent (loosestrife)	Yes-Milfoil Yes-Loosestrife
Diquat	• Contact, nonselective, liquid only ($350)	• Submerged (all plants)	Yes-Elodea and natives
Endothall	• Contact, nonselective, liquid only ($700)	• Submerged (all plants)	No-all plants
Imazapyr	• Systemic, nonselective, liquid only ($700)	• Floating-leaved (lily/others) • Emergent (loosestrife/others)	Possible Possible
Glyphosate	• Systemic, nonselective, liquid only ($350)	• Floating-leaved (lily) • Emergent (loosestrife/others)	Yes-Lily Yes-Loosestrife

City of Kenmore

Manual Methods

Method	Advantages	Disadvantages	Kenmore Potential
Hand-pulling	• Small infestation eradication	• Small control areas • Root removal difficult	Yes-emergent
Raking	• Low equipment cost • Easy of use	• Small control areas • High root regrowth	Yes-submersed
Cutting	• Low equipment cost	• Small control areas • Regrowth and drift • Safety issues	No



HERRERA

City of Kenmore

Mechanical Methods

Method	Advantages	Disadvantages	Kenmore Potential
Harvester	• Collects fragments	• Fragment drift • Depth limitations • Dock obstructions	Yes-submersed/floating
Weed Cutter	• Low cost	• Plant collection/drift • Depth limitations • Dock obstructions	No
Rotovator	• Effects roots	• Plant collection/drift • Depth limitations • Dock obstructions • Water quality impacts	No

HERRERA

City of Kenmore

Dredging Methods

Method	Advantages	Disadvantages	Kenmore Potential
Barge dredging	• Deepens lake • Removes nutrients and seeds	• Very high cost • Sediment disposal • Permitting	No
Diver dredging	• Removes roots • Moderate infestation eradication	• High cost • Water quality impacts	Yes-submersed

HERRERA

City of Kenmore

Biological Methods

Method	Advantages	Disadvantages	Kenmore Potential
Grass carp	• Low cost	• Unpredictable control • Outlet screen • Target native submersed plants	No
Insects	• Low cost	• Low control • Milfoil only	Yes-milfoil

HERRERA

City of Kenmore

Other Methods

Method	Advantages	Disadvantages	Kenmore Potential
Bottom screening	• Effective for rooted plants in small areas around docks	• Moderate cost • Remove in 2 years	Yes-all
Water level drawdown	• Low cost if existing inflow control	• Low control in PNW • Water quality/aesthetic impacts • Depth limitations • Permitting	No

HERRERA

City of Kenmore

Kenmore Potential Methods

Method	Advantages	Disadvantages	Kenmore Potential
Aquatic Herbicides: Triclopyr-Milfoil Diquat-Elodea Glyphosate-Lily/loosestrife	• Cost effective • High level of control	• Ecological impact concerns	Yes-all plants
Hand-pulling	• Small infestation eradication	• High cost	Yes-emergent
Raking	• Low equipment cost • Easy of use	• Small control areas • High root regrowth	Yes-submersed
Harvester	• Collects fragments	• Fragment drift • Depth limitations • Dock obstructions	Yes-submersed/ floating
Diver dredging	• Removes roots • Moderate infestation eradication	• High cost • Water quality impacts	Yes-submersed
Insects	• Low cost	• Low control • Milfoil only	Yes-milfoil
Bottom screening	• Effective for rooted plants in small areas around docks	• Moderate cost • Remove in 2 years	Yes-all plants

HERRERA

City of Kenmore

Beneficial Uses

- Recreational Use
  - Boating
  - Fishing
  - Swimming
  - Aesthetic and wildlife observation
- Commercial Use
  - Marinas
  - Kenmore Air
  - Water supply
- Wildlife Use
  - Waterfowl
  - Aquatic mammals
  - Fish and other aquatic organisms

HERRERA

City of Kenmore

Beneficial Use Areas

Public
- Log Boom Park
- West Open Water
- East Open Water
- Inglewood Wetlands
- North Arrowhead Point
- Rhododendron Park
- Saint Edward
- Squire's Landing Park
- WDFW Boat Launch

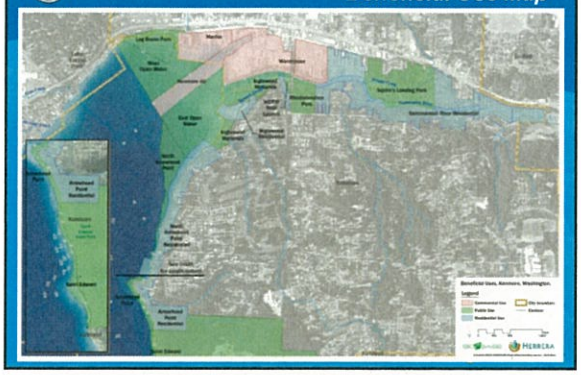
Commercial
- Kenmore Air
- Marina
- Warehouse

Residential
- Arrowhead Point Residential
- Saint Edward/South Arrowhead Point
- Inglewood Residential
- North Arrowhead Point Residential
- Sammamish River Residential

HERRERA

City of Kenmore

Beneficial Use Map



City of Kenmore

Plant Management Map

City of Kenmore

Maximum Plant Management Areas

Area	Total Area (Acres)	Submersed Cover (Acres)	Floating Cover (Acres)	Emergent Cover (Miles)
Public Total				
Saint Edward	8.1	8.8	0.0	0.0
Arrowhead Point	4.9	0.0	0.0	0.0
North Arrowhead Point	20.4	13.1	0.0	0.0
Inglewood Wetlands	13.7	3.4	5.6	0.1
East Open Water	52.4	30.7	3.7	0.0
West Open Water	38.5	32.9	0.0	0.0
Log Boom Park	14.4	14.6	0.0	0.1
Rhododendron Park	1.0	1.0	0.0	0.1
Squire's Landing Park	4.6	3.0	0.0	0.5
WDFW Boat Launch	0.3	0.0	0.0	0.0

HERRERA

City of Kenmore

Maximum Plant Management Areas

Area	Total Area (Acres)	Submersed Cover (Acres)	Floating Cover (Acres)	Emergent Cover (Miles)
Commercial				
Kenmore Air	28.3	2.0	0.0	0.0
Marina	9.8	6.4	0.3	0.0
Warehouse	6.0	3.9	0.0	0.5
Residential				
Arrowhead Point Residential	4.2	0.7	0.0	0.0
North Arrowhead Point Residential	12.0	11.1	2.6	0.0
Inglewood Residential	1.4	0.2	0.0	0.0
Sammamish River Residential	14.4	10.5	0.0	1.1

HERRERA

City of Kenmore

Maximum Plant Control Cost

	Submersed Plants	Floating-Leaved Plants	Emergent Plants
Public Area (acres/miles)	285.0	24.4	4.7
Commercial Area (acres/miles)	12.4	0.3	0.5
Residential Area (acres/miles)	142.5	12.2	2.3
Total Area (acres/miles)	142.5	12.2	2.3
Annual Herbicide Treatment Cost[a]	$128,253	$3,663	$700
Annual Harvesting Cost[b]	$228,005	$19,535	$0

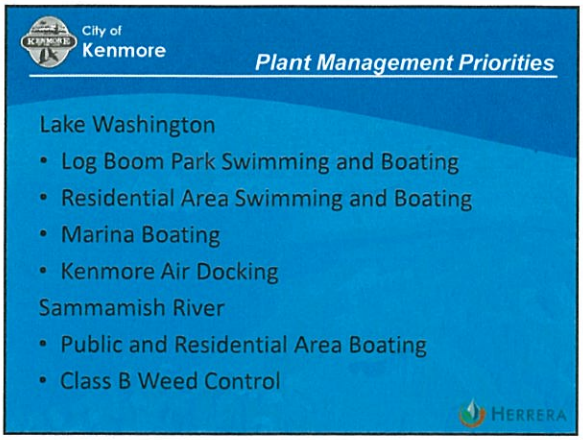
[a] Herbicide treatment cost based on $900/acre for one diquat and one triclopyr treatment of submersed plants, $300/acre for one glyphosate treatment of floating-leaved plants, and $300/mile for one glyphosate treatment of emergent plants.
[b] Harvesting costs based on $1,600 for two harvests of submersed or floating leaved plants. Emergent plants would be removed by hand by volunteers.

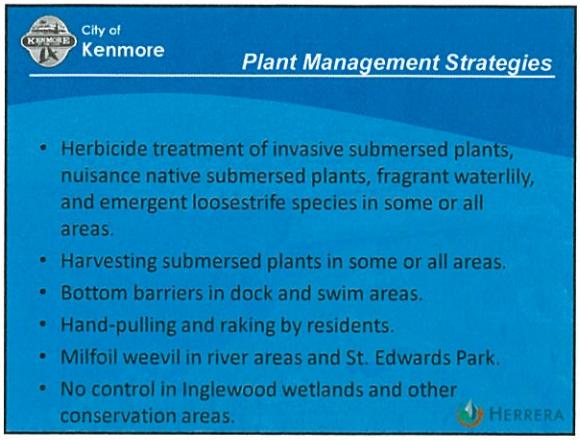
HERRERA

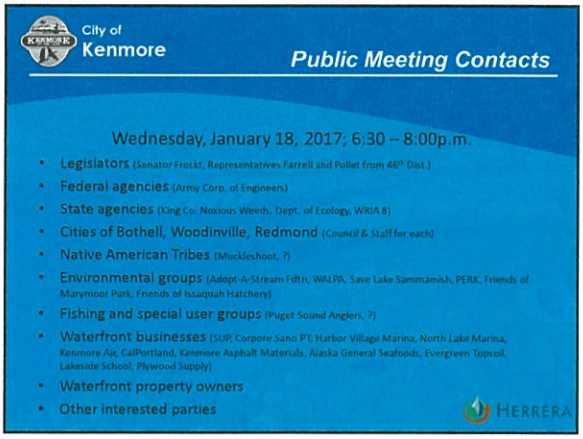
City of Kenmore

Beneficial Use Area Impacts

Area	Environmental			Recreational				Economic			Count
	Wildlife Habitat	Habitat Values	Lilly Pad Vegetation	Swimming	Boating /Fishing	Aesthetic Value	Access	Commercial Uses	Property Value	Irrigation Water	All
Public											
East Open Water					X	X					2
Inglewood Wetlands			X		X	X					3
Log Boom Park				X	X	X	X				4
North Arrowhead Point					X	X	X				3
Rhododendron Park	X				X	X					3
Arrowhead Point					X	X	X				3
Saint Edward	X				X	X					3
Squire's Landing Park	X		X		X	X	X				5
WDFW Boat Launch					X	X	X				3
West Open Water		X			X	X					3
Commercial											
Kenmore Air					X	X	X	X			4
Marina					X	X	X	X	X		5
Warehouse	X				X	X					3
Residential											
Arrowhead Point Residential	X			X	X	X	X		X	X	7
Inglewood Residential			X	X	X	X	X		X	X	7
North Arrowhead Point Residential			X	X	X	X	X		X	X	7
Sammamish River Residential	X		X	X	X	X	X		X	X	8


City of
Kenmore
Plant Management Priorities
Lake Washington
• Log Boom Park Swimming and Boating
• Residential Area Swimming and Boating
• Marina Boating
• Kenmore Air Docking
Sammamish River
• Public and Residential Area Boating
• Class B Weed Control
HERRERA


City of
Kenmore
Plant Management Strategies
• Herbicide treatment of invasive submersed plants, nuisance native submersed plants, fragrant waterlily, and emergent loosestrife species in some or all areas.
• Harvesting submersed plants in some or all areas.
• Bottom barriers in dock and swim areas.
• Hand-pulling and raking by residents.
• Milfoil weevil in river areas and St. Edwards Park.
• No control in Inglewood wetlands and other conservation areas.
HERRERA


City of
Kenmore
Public Meeting Contacts
Wednesday, January 18, 2017; 6:30 – 8:00p.m.
• Legislators (Senator Frockt, Representatives Farrell and Pollet from 46th Dist.)
• Federal agencies (Army Corp. of Engineers)
• State agencies (King Co. Noxious Weeds, Dept. of Ecology, WRIA 8)
• Cities of Bothell, Woodinville, Redmond (Council & Staff for each)
• Native American Tribes (Muckleshoot, ?)
• Environmental groups (Adopt-A-Stream Fdtn, WALPA, Save Lake Sammamish, PERK, Friends of Marymoor Park, Friends of Issaquah Hatchery)
• Fishing and special user groups (Puget Sound Anglers, ?)
• Waterfront businesses (SUP, Corpore Sano PT, Harbor Village Marina, North Lake Marina, Kenmore Air, CalPortland, Kenmore Asphalt Materials, Alaska General Seafoods, Evergreen Topsoil, Lakeside School, Plywood Supply)
• Waterfront property owners
• Other interested parties
HERRERA

Kenmore IAVMP Steering Committee Meeting

December 16, 2016, 11:30 – 1:40, Kenmore City Hall, 18120 68th Ave NE, Kenmore, WA 98028

Meeting Notes by Ben Peterson (King County Noxious Weeds, ben.peterson@kingcounty.gov)

In attendance: John Adamski (Arrowhead Community), Todd Banks (Kenmore Air), Casey Costello (WA Dept. of Fish and Wildlife), Jim Davidson (North Lake Marina), Leslie Harris (City of Kenmore), Greg Matz (Inglewood Golf Course), Matt Muller (Inglewood Waterfront), Ben Peterson(King County Noxious Weed Control Program), Quinn Proffitt (City of Kenmore), Janet Quinn (City of Kenmore), Doug Ritchie (Kenmore Waterfront Activities Center), Lizbeth Seebacher (WA Dept. of Ecology), Rob Zisette (Herrera)

Management Goals- Identifying what conditions we want to have.

Janet- read an example of "management goals" from the IAVMP Development Manual

Jim- Stressed Milfoil and other identified weeds, recreation and commercial uses

John- Recreation and commercial uses, swimming, boating, viewing water. He is very concerned about filamentous algae in addition to listed weeds. He listed many impacts of filamentous algae.

Janet- Said we could talk about filamentous algae more later when specific plants are discussed

Todd- Wondered how sedimentation plays into the issue (of problems with plants in the water)

Rob- Added "this is our Plan" and said if these issues of filamentous algae and sediment are important we can include them.

John- said it seems the plan should include things that are important and these issues should be listed in the Plan

Jim- wondered if deeper water would make it so fewer weeds would grow

Rob – says dredging would be cost prohibitive

Janet- says she checked with the Army Corps of Engineers and they said that they would have to put any dredged material in a landfill because the sediment is contaminated (with metals and PCBs – according to Rob).

Plant Management Strategies slide presentation and discussion - Rob

(Refer to presentation slides)

Slide 8 – Plant List

Rob- the main plants of concern are milfoil, elodea, water lily, and emergent weeds. There are native plants everywhere

Rob- The goal of eradicating any weeds is not realistic because of new weed reintroduction from upstream on the Sammamish River or elsewhere in Lake Washington. Control Area priorities are: Submersed, floating leaf, and emergent weeds

Slide 16 – Chemical Methods

Rob explained the difference between systemic and contact herbicides; explained the difference how fluridone works

Janet – said Aquatechnex applied triclopyr in 2016

Rob –Diquat has been used to limited effectiveness

Rob discussed imazapyr and glyphosate use on emergent weeds

John- mentioned that diquat can't be used until mid-July because of the Fish Window

Quinn- had a question about glyphosate affecting other (submersed) plants when use for treating fragrant water lily plants

Rob – said that herbicide used to spray on water lily plants would not affect any submerged aquatic plants but would affect native floating leaf plants if it was sprayed on them.

Slide 17 – Manual Methods

-Hand pulling and raking useful on a small scale (individual home owner basis)

-Cutting doesn't work well

Slide 18- Mechanical Methods

Harvester- cuts up to 8' deep, removes cut plant material

King County used a harvester in the 1980s, a harvester machine and operator can be hired for use

A harvester will remove weeds and algae (as opposed to aquatic herbicide applications use on submersed which may lead to an increase in algae when the plants die.

John- Filamentous algae appears in the spring along with the weeds

Rotovation- an underwater rototiller- sort of rips up the plants by the roots, results in sedimentation and plant fragments

Slide 19- Dredging Methods

Barge Dredging- Removing sediments and plants.

Usually nutrient-rich sediment remains (which will still promote the growth of aquatic plants).

Usually done to deepen a shipping lane/for boat navigation.

Barge dredging costs at least 10 times more than any other weed control method. (in the millions of dollars).

Todd- Says the channel is filling in with sediment. He wondered if there is any money available to pay for dredging

Janet- said the Army Corps of Engineers is not interested in this because of high cost of disposal due to contamination.

Rob – Says it is very unlikely that the Army Corps of Engineers could do it.

Diver Dredging- Diver with 4" diameter suction hose removes submersed plants.

Diver dredging removed submersed plants; can be very selective (i.e. the diver can just remove the weed plants and keep the native plants).

Diver dredging is akin to large-scale, precise hand pulling. It is expensive and there can be sedimentation issues.

Slide 20- Biological Methods

-no grass carp

-Milfoil weevils- not commonly used in Washington State. Rob suggested that it might be suitable to consider releasing milfoil weevils offshore of St. Edward Sate Park

Slide 21- Other Methods

Jim- wondered how well a harvester would work in the river channel due to the variable bottom depth.

Rob- a harvester operator could make it work in the Sammamish River channel

Casey- says bottom screens can be kept in place longer than two years if they are made from completely biodegradable component (or Sand/gravel)

Slide 25- Beneficial Use Map

There was a lot of discussion about dividing up the Inglewood and Arrowhead Pt residential use areas. There was also a discussion about how far out from the shore should be considered the "residential use" area as opposed to the "public use" area.

Slide 27- Maximum Plant Management Areas

Jim- St. Edward State Park row in the table- Total area (acres) is less than Submersed Cover area (acres).

Rob- said it is due to overlapping GIS layers, he will fix the table

Slide 28- Maximum Plant Management Areas

Rob- Kenmore Air "submersed cover (area)" is only a small area compared to the total area

Slide 29- Maximum Plant Control Costs

The table in the slide has some errors. Rob will update the table

Janet- for comparison, Aquatechnex herbicide application in 2016 cost $30,000.**

**correction from JQ – I misspoke: treatment for 2016 was closer to $38,000.00

Slide 30- Beneficial Use Area Impacts

Ben- add "swimming" to St. Edwards state park

Doug- asked Janet if the City bond money could pay for the weed control work

Janet- said the city bond money would not be available to pay for this work

Management Goals Discussion – Janet

A dry erase board was used by Janet to write out, and edit the groups "Management Goals" statement. The statement was changed several times through the meeting. The final form of the statement read as follows:

"The Management goals are to maintain recreational, commercial, and habitat use of the lake by managing nuisance plants in identified beneficial use areas and to keep swimming areas clear of weeds for safety reasons"

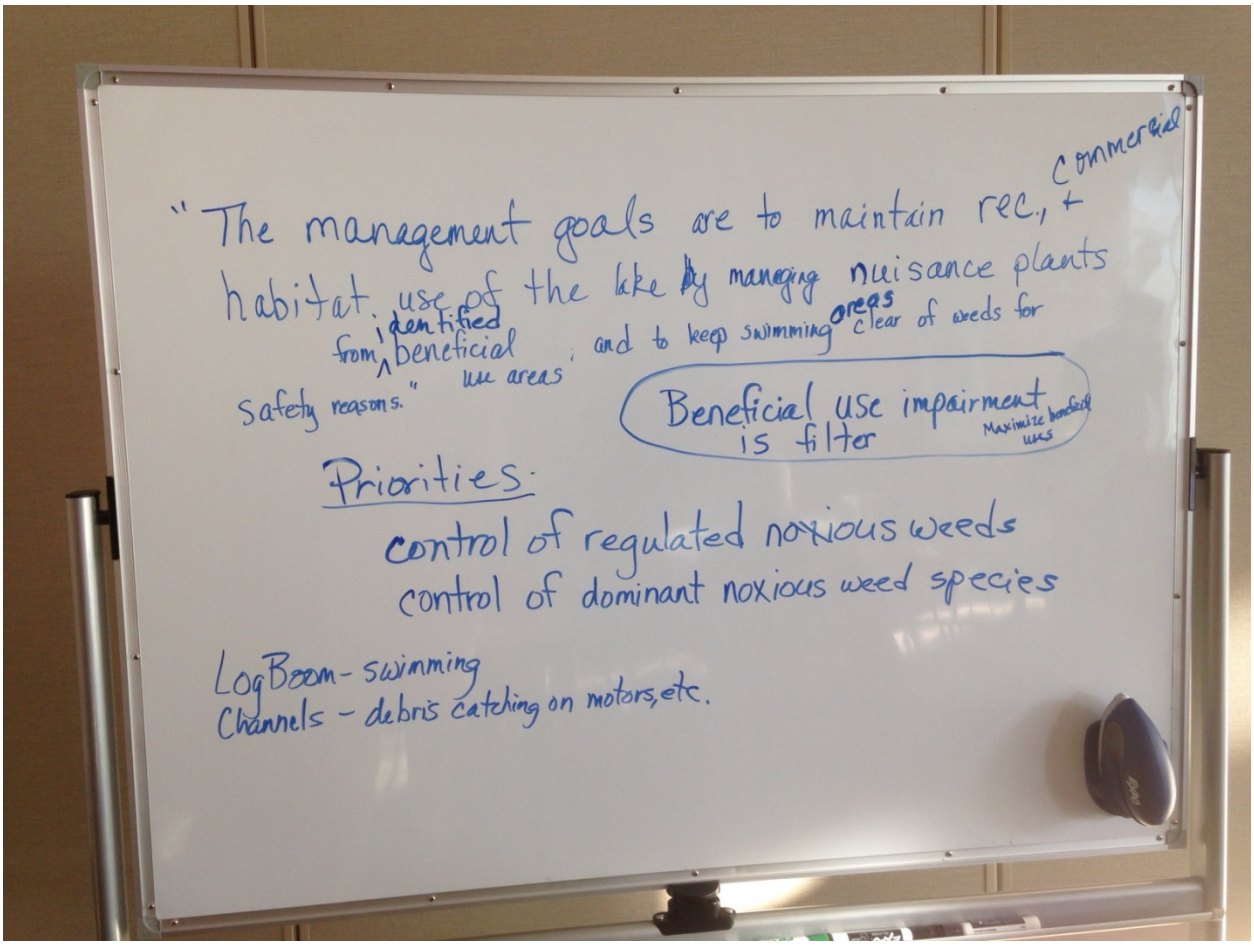
Beneficial use impairment is filter – maximize beneficial use

Priorities-

- *control of regulated noxious weeds*
- *control of dominant noxious weed species*

Log Boom Park – Swimming

Channels – debris catching on motors, etc.



John- asked Lizbeth if filamentous algae could be included in the Management Goals- he says algae should be recognized as part of the problem

Janet- Why are (filamentous) algae and weeds separate programs?

Lizbeth- The two are separated because they come from two separate Ecology funding sources. Those that are interested in the subject make a separate Algae Management plan. Says that filamentous algae can be mentioned in the Kenmore IAVMP. Suggested John work with Deb Bouchard at King County on the long-term algae management issue.

John- Are measurements and observations (presumably about parameters such as dissolve oxygen, temperature, nutrients in the water), pertinent to the IAVMP? He suggested these parameters are monitored as changes are made to the weeds. Does weed removal affect those parameters and algae?

Lizbeth- suggests working with the King County Lake program (Chris Knutson, Rachael Gravon)

Jim- Do we want to include the terminology “nuisance plants” rather than “noxious weeds”?

John- We ought to be able to relate the links of actions we recommend to the specific uses at different locations.

Rob- Beneficial use impairment becomes the priority. “Minimize impacts to beneficial uses.”

Slide 31 – Plant Management Priorities

Rob- tentative list of priorities for each waterbody. Rob says generally the Sammamish River channel is navigable as it is (without submersed weeds being controlled) because the weeds are generally only on the side of the channel and the main center part of the channel is relatively deep and mostly free of plants.

Slide 32- Plant Management Strategies – a list of suggested weed control strategies that vary by location

Meeting Sign-In Sheet
Aquatic Weeds Steering Committee Mtg. #2
December 16, 2016, 11:30am - 1:30pm
Kenmore City Hall
18120 68th Avenue NE, Kenmore WA 98028

	Name	Company Representing	Initials
1	John Adamski	Arrowhead Community	
2	Todd Banks	Kenmore Air	TB
3	Casey Costello	WA Dept. of Fish and Wildlife	
4	Jim Davidson	North Lake Marina	
5	Jennifer Gordon	City of Kenmore	
6	Greg Matz	Inglewood Golf Club	
7	Matt Muller	INGLEWOOD WATERFRONT	
8	Ben Peterson	King County	
9	Douglas Poppe	Puget Sound Anglers	
10	Quinn Proffitt	City of Kenmore	QRP
11	Janet Quinn	City of Kenmore	
12	Doug Ritchie	Kenmore Waterfront Activities Ctr.	D.R
13	Lizbeth Seebacher	WA Dept. of Ecology	
14	Rob Zisette	Herrera	
15	Leslie Harris	Kenmore	
16			
17			
18			
19			
20			

City of Kenmore

City of Kenmore Integrated Aquatic Vegetation Management Plan (IAVMP)

Public Meeting #1

Facilitated by:

Janet Quinn, Project Coordinator, City of Kenmore

Rob Zisette, Aquatic Scientist, Herrera Environmental Consultants, Inc.

January 18, 2017

HERRERA

City of Kenmore

Agenda

- Why we're engaged in this process
- What we hope to accomplish through an Integrated Aquatic Vegetation Management Plan (IAVMP)
- Why we invited you
- Work on an IAVMP that's been done so far
- Q & A
- What do you think? (Written input from you)

HERRERA

City of Kenmore

Why Are We Here?

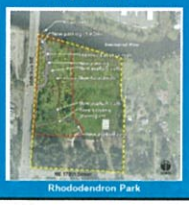
- Kenmore residents appreciate the water
- Components of Council's 20-Year Vision statement are 1) connection to waterfront; 2) protection of natural areas
- One of Kenmore City Council Goals is "to address watershed and water quality issues affecting the City"
- Noxious weeds have been observed in water and riparian areas
- City of Kenmore applied for and received Department of Ecology Grant to develop an Integrated Aquatic Vegetation Management Plan (IAVMP)
- Passage of Kenmore's Proposition 1 will allow the City to make improvements to water access and waterfront parks and increases the importance of managing aquatic weeds.

HERRERA

City of Kenmore

Park Improvements

Log Boom Park



Rhododendron Park

Squire's Landing

HERRERA

City of Kenmore

How An IAVMP Can Help Us

- Department of Ecology (DOE) and other Agency support as we work to address the presence of aquatic weeds*

  *Water Quality vs. Aquatic Weeds: Interconnected, but DOE separates Water Quality from Invasive Plants for funding purposes. Our IAVMP will acknowledge water quality concerns such as algae, but will not specifically focus on them. Primary focus will be on aquatic weeds.

- Coalesce our thoughts and strategize long term management of aquatic weeds.
- Form a Coalition with upstream jurisdictions to address aquatic weeds from the perspective of a water body system, rather than just Kenmore.

HERRERA

City of Kenmore

IAVMP Chapters*

* From DOE's Citizen's Manual for Developing Integrated Aquatic Vegetation Mgmt. Plans

- **Problem Statement**
- Past Management Efforts
- **Management Goals**
- Lake and Watershed Characteristics
- **Beneficial Use Areas**
- Aquatic Plant Characteristics
- **Aquatic Plant Control Alternatives & Level of Intensity**
- Integrated Aquatic Plant Control Scenarios
- Selected Action Strategy
- Public Involvement
- Monitoring and Evaluation Plan
- References

HERRERA

City of Kenmore

Why We Invited You

- We want to provide information on this project.
- We want to answer any questions you might have.
- We want your input:
  - What are you seeing on/in the water?
  - Are we on the right track in the work done so far?
  - Any considerations we missed?

HERRERA

City of Kenmore

Steering Committee Work

Steering Committee met twice to:

- Develop a Problem Statement for the IAVMP
- Identify Draft Management Goals
- Identify Beneficial Use Areas (i.e., target areas to focus City work on)
- Discuss and Identify Potential Management Strategies
- Discuss the level of Management Intensity

HERRERA

City of Kenmore

Steering Committee Members

- John Adamski, Kenmore Waterfront Resident
- Todd Banks, President, Kenmore Air
- Casey Costello, Habitat Biologist, WA State Dept. of Fish & Wildlife
- Jim Davidson, Owner, North Lake Marina
- Jennifer Gordon, Public Works Operations Manager, City of Kenmore
- Greg Matz, Superintendent, Inglewood Golf Club
- Matt Muller, Kenmore Waterfront Resident
- Ben Peterson, Noxious Weed Specialist, King County
- Douglas Poppe, Officer, Puget Sound Anglers Association
- Quinn Proffitt, Parks Maintenance, City of Kenmore
- Doug Ritchie, Executive Vice President, Kenmore Waterfront Activities Center
- Lizbeth Seebacher, Wetland and Aquatic Biologist, WA State Dept. of Ecology
- Rob Zisette, Aquatic Scientist, Herrera Environmental Consultants

HERRERA

City of Kenmore

Plant List

Table 1. Aquatic Plant List for the Kenmore Survey on September 7 and 8, 2016.

Plant Type	Common Name	Scientific Name	Status
Emergent Plants	Common cattail	Typha latifolia	Native
	Garden loosestrife	Lythrum salicaria	Noxious Weed- Regulated Class B
	Japanese knotweed	Fallopia japonica	Noxious Weed- Nonregulated Class B
	Narrow-leaf bur-reed	Sparganium angustifolium	Native
	Purple loosestrife	Lythrum salicaria	Noxious Weed- Regulated Class B
	Reed canarygrass	Phalaris arundinacea	Noxious Weed- Nonregulated Class C
	Spotted jewelweed	Impatiens capensis	Noxious Weed- Monitor List
	Yellow-flag iris	Iris pseudacorus	Noxious Weed- Nonregulated Class C
Floating Leaved Rooted Plants	Fragrant waterlily	Nymphaea odorata	Noxious Weed- Nonregulated Class C
	Grass-leaved pondweed	Potamogeton gramineus	Native
Free Floating Plants	Lesser duckweed	Lemna minor	Native
	Mexican water-fern	Azolla mexicana	Native
Submersed Plants	Brazilian elodea	Egeria densa	Noxious Weed- Nonregulated Class B
	Common waternymph	Najas guadalupensis	Native
	Common waterweed	Elodea canadensis	Native
	Coontail	Ceratophyllum demersum	Native
	Curly-leaf pondweed	Potamogeton crispus	Noxious Weed- Nonregulated Class C
	Eurasian watermilfoil	Myriophyllum spicatum	Noxious Weed- Nonregulated Class B
	Flat-stemmed pondweed	Potamogeton zosteriformis	Native
	Richardson's pondweed	Potamogeton richardsonii	Native
	Sago pondweed	Potamogeton pectinatus	Native
	Tapegrass	Vallisneria americana	Native
	White-stemmed pondweed	Potamogeton praelongus	Native
Plant like algae	Nitella	Nitella sp.	Native

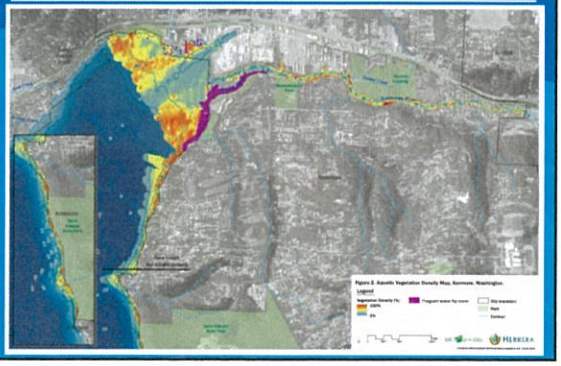
City of Kenmore

Noxious Aquatic Weeds in Kenmore

HERRERA

City of Kenmore

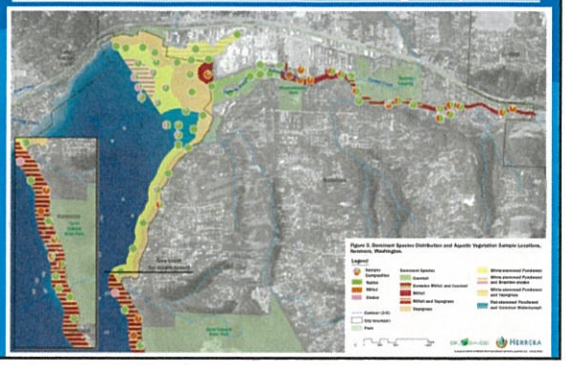
Aquatic Plant Density



HERRERA

City of Kenmore

Dominant Submerged Species



City of Kenmore

Noxious Weeds

City of Kenmore

Beneficial Uses

- Recreational Use
  - Boating
  - Fishing
  - Swimming
  - Aesthetic and wildlife observation
- Commercial
  - Marinas
  - Kenmore Air
  - Water supply
- Wildlife Use
  - Waterfowl
  - Aquatic mammals
  - Fish and other aquatic organisms

HERRERA

City of Kenmore

Identified Problems

Environmental:
- Negative impact on fish habitat
- Impact on native biodiversity
- Increased levels of algae
- Water quality concerns
  - Low dissolved oxygen
  - High temperature

Read the draft IAVMP problem statement at www.kenmorewa.gov/IAVMP

Recreational:
- Inhibit swimming & paddle sports
- Weeds wound around boat motors
- Weeds tangled in fishing lines
- Non-native weeds promote habitat for non-native fish species
- Health risks of toxic blue-green algae
- Aesthetical impact
  - Plant accumulation and decay
  - Foul aroma
  - Water clarity issues
- Shoreline access
- Irrigation challenges
  - Reduction of water elevation
  - Clogged intake lines
  - Damaged pumps
  - Contaminated water

Economic:
- Reduction of navigable waterways
  - Forces lake traffic into narrow lanes
  - Increases potential for conflict between boats and planes
- Reduction of water depth
  - Impacts access to moorage slips
- Costly repairs to damaged boat propellers and plane rudders
- Perceived quality of life
- Lower waterfront property values*
- Cost to manage/control/eradicate

HERRERA

City of Kenmore

Plant Management Goals Guiding Questions

Thought Filter:
- Minimize beneficial use impairment
- Maximize beneficial uses

What do we want to achieve?
- Is it reasonable?
- Is it realistic?
- Will it be supported by the broader community?
- Is the cost reasonable relative to the benefit?

HERRERA

City of Kenmore

Plant Management Goals

The Management Goals are to maintain recreational and commercial usability and habitat integrity of the lake and river by managing nuisance plants in identified beneficial use areas, and to keep swimming areas clear of weeds for safety reasons.

Priorities:

Control of regulated noxious weeds (loosestrife)

Control of dominant noxious weed species (milfoil, elodea, water lily)

Early detection of new noxious weed species

Priority Areas:

Public: Parks, main channels, public use areas

Private: Waterfront residences & businesses

HERRERA

City of Kenmore

City Priorities

- Reduce impact on boating (hand-powered watercraft and motor boats)
  - Clear, clean water
  - No weeds catching on paddles, rudders, propellers
- Provide clear, clean water for swimmers
  - No weeds in beach areas
  - No noxious weeds or decomposed weeds on beaches
- Maintain healthy environment for fish
  - Appropriate water temperature
  - Appropriate dissolved oxygen levels

HERRERA

City of Kenmore

Plant Management Strategies - Parameters

- Species control or eradication
  - Eurasian watermilfoil
  - Brazilian elodea
  - Fragrant waterlily
  - Emergent noxious weeds
  - Native plants
- Control priorities
  - Submersed/floating/emergent
  - Public/residential/commercial areas
- Control intensity
- Conservation areas
- Use of chemicals
- Cost and funding

HERRERA

City of Kenmore

Plant Management Methods

- Chemical Methods
- Non-chemical Methods
  - Manual
  - Mechanical
  - Dredging
  - Biological
  - Other

HERRERA

City of Kenmore

Applicable Methods

Type	Method	Advantages	Disadvantages	Target Plants
Chemical	Aquatic Herbicides	• Cost effective • High level of control	• Ecological impact concerns	All plants
Manual	Hand-pulling	• Small infestation eradication	• Small control areas • Root removal difficult	Emergent
Manual	Raking	• Low equipment cost • Easy of use	• Small control areas • High root regrowth	Submersed
Other	Bottom Screening	• Effective for rooted plants in small areas around docks	• Moderate cost • Remove in 2 years	All plants
Mechanical	Harvester	• Collects fragments	• Fragment drift • Depth limitations • Dock obstructions	Submersed, Floating
Dredging	Diver Dredging	• Removes roots • Moderate infestation eradication	• High cost • Water quality impacts	Submersed

HERRERA

City of Kenmore

Applicable Methods

City of Kenmore

Chemical Methods

Applicable Herbicide	Type (Cost/Acre)	Target Plants
Fluridone	Systemic, selective, liquid or granular ($1,000)	• Submersed (milfoil and elodea)
Triclopyr-TEA	Systemic, selective, liquid or granular ($700)	• Submersed (milfoil) • Emergent (loosestrife/others)
Diquat	Contact, nonselective, liquid only ($350)	• Submersed (elodea and natives)
Glyphosate	Systemic, nonselective, liquid only ($350)	• Floating-leaved (lily) • Emergent (loosestrife/others)
Imazapyr	Systemic, nonselective, liquid only ($700)	• Floating-leaved (lily/others) • Emergent (loosestrife/others)

Other Herbicide	Type (Cost/Acre)	Target Plants
2,4-D	Systemic, selective, liquid only ($500)	• Submersed (milfoil)
Endothall	Contact, nonselective, liquid only ($700)	• Submersed (all plants)

City of Kenmore

Other Non-chemical Methods

Type	Method	Advantages	Disadvantages	Target Plants
Manual	Cutting	• Low equipment cost	• Small control areas • Regrowth and drift • Safety issues	All plants
Manual	Weed Cutter	• Low cost	• Plant collection/drift • Depth limitations • Dock obstructions	Submersed
Mechanical	Rotovator	• Effects roots	• Plant collection/drift • Depth limitations • Dock obstructions • Water quality impacts	All plants
Dredging	Barge dredging	• Deepens lake • Removes nutrients and seeds	• Very high cost • Sediment disposal • Permitting	All plants
Biological	Grass carp	• Low cost	• Unpredictable control • Outlet screen • Target native plants	Submersed
Biological	Milfoils weevil	• Low cost	• Low control • Milfoil only	Milfoil
Other	Water level drawdown	• Low cost if existing inflow control	• Low control/high impacts • Permitting • Depth limitations	All plants

HERRERA

City of Kenmore

Beneficial Use Areas

Public
- Saint Edward
- Inglewood Wetlands
- East Open Water
- West Open Water
- Log Boom Park
- Lower Sammamish River
- Rhododendron Park
- Squire's Landing Park

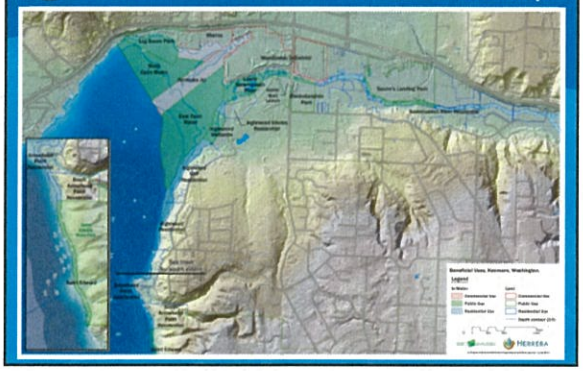
Commercial/Industrial
- Kenmore Air
- Marina
- Warehouse/Industrial

Residential
- South Arrowhead Point Residential
- Arrowhead Point Residential
- Inglewood Residential
- Inglewood Golf Residential
- Inglewood Shores Residential
- Sammamish River Residential

HERRERA

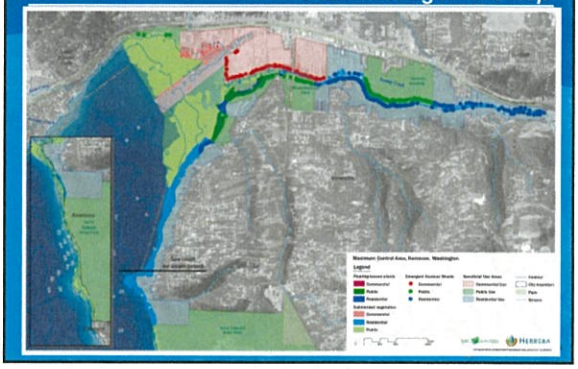
City of Kenmore

Beneficial Use Map



City of Kenmore

Plant Management Map



City of Kenmore

Maximum Plant Management Areas

Area	Total Area (Acres)	Submersed Cover (Acres)	Floating Cover (Acres)	Emergent Cover (Miles)
Public Total				
Saint Edward	6.6	8.8	0.0	0.0
Inglewood Wetlands	5.9	2.3	3.6	0.1
East Open Water	65.2	40.6	0.2	0.0
West Open Water	36.5	31.0	0.0	0.0
Log Boom Park	16.4	16.6	0.0	0.1
Lower Sammamish River	12.4	2.4	5.6	0.1
Rhododendron Park	1.0	0.7	0.0	0.1
Squire's Landing Park	4.6	3.0	0.0	0.5

HERRERA

City of Kenmore

Maximum Plant Management Areas

Area	Total Area (Acres)	Submersed Cover (Acres)	Floating Cover (Acres)	Emergent Cover (Miles)
Commercial				
Kenmore Air	28.3	2.0	0.0	0.0
Marina	9.8	6.4	0.3	0.0
Warehouse/Industrial	6.0	3.9	0.0	0.5
Residential				
South Arrowhead Point Residential	1.9	2.5	0.0	0.0
Arrowhead Point Residential	5.4	7.0	0.0	0.0
Inglewood Residential	5.3	0.0	1.2	0.0
Inglewood Golf Residential	10.2	8.9	1.2	0.0
Inglewood ShoreS Residential	1.4	0.0	1.2	0.0
Sammamish River Residential	14.2	10.5	0.0	1.1

City of Kenmore

Maximum Plant Control Cover/Cost

	Submersed Plants	Floating-Leaved Plants	Emergent Plants
Public Area (acres/miles)	105.3	9.5	0.9
Commercial Area (acres/miles)	30.7	3.9	0.5
Residential Area (acres/miles)	28.9	3.6	1.1
Total Area (acres/miles)	164.9	17.0	2.4
Annual Herbicide Treatment Cost[a]	$148,397	$5,111	$730
Annual Harvesting Cost[b]	$263,817	$27,258	$0

[a] Herbicide treatment cost based on $900/acre for one diquat and one triclopyr treatment of submersed plants, $300/acre for one glyphosate treatment of floating-leaved plants, and $300/mile for one glyphosate treatment of emergent plants.

[b] Harvesting costs based on $1,600 for two harvests of submersed or floating leaved plants. Emergent plants would be removed by hand by volunteers.

HERRERA

City of Kenmore

Beneficial Use Area Impacts

Area	Environmental			Recreational				Economic			Count
	Milfoil Dom.	Elodea Dom.	Lily/Tule expand.	Swimming	Boating /Fishing	Aesthet.	Access	Comm. Nav.	Property Value	Irrigation	All
Public											
Saint Edward	X			X	X	X					4
Inglewood Wetlands			X		X	X					3
East Open Water					X	X					2
West Open Water		X			X	X					3
Log Boom Park				X	X	X	X				4
Lower Sammamish River			X		X	X	X				4
Rhododendron Park	X				X	X					3
Squire's Landing Park	X		X		X	X	X				5
Commercial											
Kenmore Air					X	X	X	X			4
Marina					X	X	X	X	X		5
Warehouse/Industrial	X				X	X					3
Residential											
S. Arrowhead Point Residential	X			X	X	X			X		5
Arrowhead Point Residential	X			X	X	X	X		X	X	7
Inglewood Residential				X	X	X	X		X	X	6
Inglewood Golf Residential			X	X	X	X	X		X	X	7
Inglewood Shore Residential			X	X	X	X	X		X	X	7
Sammamish River Residential	X		X	X	X	X	X		X	X	8

City of Kenmore

Plant Management Priorities

Lake Washington

- Log Boom Park Swimming and Boating
- Residential Area Swimming and Boating
- Marina Boating
- Kenmore Air Docking

Sammamish River

- Public and Residential Area Boating
- Rhododendron Park
- Squire's Landing Park
- Class B Weed Control

HERRERA

City of Kenmore

Plant Management Strategies

- Herbicide treatment of invasive non-native submersed plants, nuisance native submersed plants, fragrant waterlily, and emergent loosestrife species in some or all areas.
- Harvesting submersed plants in some or all areas.
- Bottom barriers in dock and swim areas.
- Hand-pulling and raking by residents.
- No control in Inglewood wetlands and other conservation areas.

HERRERA

City of Kenmore

Q & A

Questions?

HERRERA

City of Kenmore

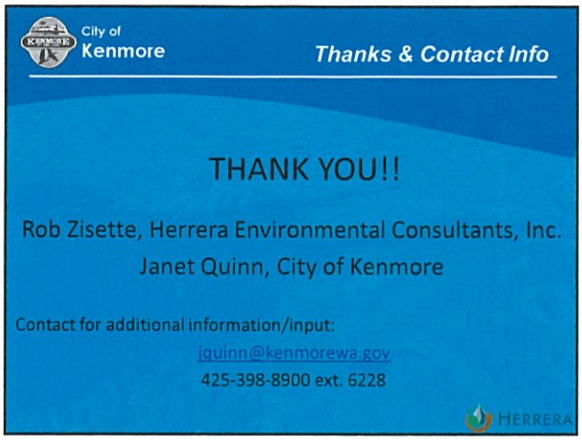
Written Input

Input on:

- Problem Statement
- Management Goals
- Beneficial Use Areas
- Management Strategies
- Suggestions/Ideas on any aspect of the IAVMP

Please write your information on a sticky note and attach it to any of the boards set up around the room, or you can write directly on the General Ideas/Suggestions board. Thanks!

HERRERA


City of
Kenmore
Thanks & Contact Info
THANK YOU!!
Rob Zisette, Herrera Environmental Consultants, Inc.
Janet Quinn, City of Kenmore
Contact for additional information/input:
jquinn@kenmorewa.gov
425-398-8900 ext. 6228
HERRERA

Public Meeting – Feedback/Suggestions

Management Goals/Strategies:

Let property owners know how to get rid of weeds—a phone number to call.

If you could send out community education on what each property owner could do to help, that would be great.

If the City has a contract with AquaTechnex, let homeowners know who to call and can homeowners get a contract rate.

General Comments (on information, process, project):

Need focus on prevention of water weeds—make sure homeowners, golf course and lawn maintenance companies control fertilizer runoff in rainwater. No phos. fertilizers.

Sedimentation in front of my home on S. Arrowhead Drive has decreased the depth off the bank by 2' to 3' and made a garden for purple loosestrife, reed canary grass and irises.

Please publicize info on AquaTechnex permit so we can contract for treatment this summer.

Please give property owners the chance to work with a weed control contractor this summer. Last year's treatment was very successful.

People for an Environmentally Responsible Kenmore (PERK) would like to offer their interactive map as a potential community education tool for the location of toxic algae (and other community education?).

Kenmore Government needs to inform us more fully of options to treat and/or the City's program to control weeds (e.g., 2016 herbicide treatment work by AquaTechnex).

From 30+ year waterfront resident: Thank you! 1. Noted increase of "froth" each summer (builds over summer). 2. Harvesting then thinking milfoil will float away? Does this just spread milfoil? Also floating "glumps" difficult for swimmers and property owners.

Safety data sheet warnings to public [when toxicity is high?]. Work with PERK to educate about possible O_2 increase possible due to herbicide.

Coordinate (City) efforts with private efforts to make a larger impact.

Try to limit spray/treatment (chemical) times to those of low human activity (spring/fall).

Residential Sammamish Slough includes children and dogs swimming—that should be added to info—near our house (close to eastern city limits)

Dioxins in Kenmore Navigation Channel – could we please get City to add some info to our grant-funded Interactive Map

Is scuba dredging done with underwater suction pump? [And if so] can you make one available to residents along the water?

And from Bothell Surface Water Manager:

It was difficult to understand what is ultimate goal? (Vision?) For ex.: open water and few to no aquatic plants? Suggestion was to be more specific, such as reduce [milfoil, elodea, etc.] abundance by 25% by _____.

Suggest that you use different treatments based on beneficial use, i.e., mechanical in swimming/primary contact areas and chemical in commercial zones.

Seemed hard to conceptualize that native plants are equally negative as non-native invasive ones. Preserve native vegetation.

Costs-out should span 10 or greater years due to the existing presence upstream of non-native species to re-seed the treated areas.

Please assess the loss of aquatic plants to shoreline erosion. A beneficial benefit of aquatic vegetation is reduced shoreline erosion; especially lake shore. (Beneficial use of lakeshore is to allow plants to grow.

Ask for the research papers on impact on phytoplankton.

Ask for the research papers on blue/green algae. Mere presence of blue/green algae doesn't mean toxins—some of it is not toxic. What triggers toxicity?

Suggest clarifying management options. (He left the meeting thinking that herbicide treatment was the only option being considered.)

Meeting Sign-In Sheet
Aquatic Weeds Public Meeting #1
January 18, 2017, 6:30pm - 8:00pm
Kenmore City Hall
18120 68th Avenue NE, Kenmore WA 98028

	Name	E-Mail Address	City
1	SCOTT PARROTT	SCOTTP@HEATHNorthwest.com	KENMORE
2	Charlie Garneski	charlieG5@Gmail.com	Kenmore
3	Jack Smith	rjcjsmith@aol.com	Kenmore
4	John Adamski	john_adamski2@yahoo	Kenmore
5	John Byrne	jahbyrne@msn.com	Kenmore
6	Lynda O'Brien	lyndaobrien@comcast.Net	Kenmore
7	(HARBOUR VILLAGE MARINA) ROLAND STROLIS	VIDOR@NWLINK.COM	KENMORE
8	Andy Loch	andy.loch@bellevuewa.gov	Bothell
9	Casey Costello	Casey.Costello@dfw.wa.gov	Issaquah
10	Gary Ullrich	pberglund@eltopia	Kenmore
11	Pat Park	patcpark@hotmail.com	KENMORE
12	Quincy Proffitt	QPROFFITT@KenmoreWA.gov	Kenmore
13	Jack Perry	playdough@msn.com	Kenmore
14	Nancy Bowen-Pogle	inglgdn99@hotmail.com	Kenmore

Meeting Sign-In Sheet
Aquatic Weeds Public Meeting #1
January 18, 2017, 6:30pm - 8:00pm
Kenmore City Hall
18120 68th Avenue NE, Kenmore WA 98028

	Name	E-Mail Address	City
1	Don Swanson	dons@plywoodsupply.com	Kenmore
2	Bob Spiger	rpiger@comcast.net	"
3	Theresa Marshall	theresa_marshall@hotmail.com	Kenmore
4	Ben Peterson	ben.peterson@kingcounty.gov	Seattle
5	CARL PEDERSEN	CCPEDERSEN@COMCAST.NET	KENMORE
6	Elizabeth Mooney	elizabeth.mooney@comcast.net	Kenmore
7	Jim MYERS	oda1959@comcast.net	Kenm
8	Jennifer Gordon	jgordon@kenmorewa.gov	
9	Heather Byrne	jahbyrne@msn.com	Kenmore
10	Michelle Gramm	michellegramm@metropolitanpark.info	Kenmore
11	Brent Cochran	brent_cochran@hotmail.com	Kenmore
12			
13			
14			

Meeting Sign-In Sheet
Aquatic Weeds Public Meeting #1
January 18, 2017, 6:30pm - 8:00pm
Kenmore City Hall
18120 68th Avenue NE, Kenmore WA 98028

	Name	E-Mail Address	City
1	Todd Banks	Todd b@Kenmorear.com	Kenmore
2	Steve + Eliza Capps	whidbeybeachgirl2@gmail.com	Kenmore
3	F. KLINE	fjksvd@comcast.net	KENMORE
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

Aquatic Weeds Steering Committee Meeting #3

May 5, 2017

Meeting Minutes

The Steering Committee held its final meeting to discuss the draft IAVMP. There was no PowerPoint presentation at this meeting; but the committee reviewed the draft, reviewed feedback from the Department of Ecology and input received from others, discussed revisions made to date, and possible new revisions.

The Steering Committee was supportive of the draft IAVMP and recommended putting a clause in the document that allows for consideration of future technologies and new herbicides approved at a future date.

Janet Quinn thanked Rob Zisette of Herrera Environmental Consultants, and members of the steering committee on behalf of the City of Kenmore and invited them to attend the meeting with waterfront property owners scheduled on May 11, 2017.

Meeting Sign-In Sheet
Aquatic Weeds Steering Committee Mtg. #3
May 5, 2017, 11:30am - 1:30pm
Kenmore City Hall
18120 68th Avenue NE, Kenmore WA 98028

	Name	Company Representing	Initials
1	John Adamski		
2	Todd Banks	Kenmore Air	
3	Casey Costello	WA Dept. of Fish and Wildlife	
4	Jim Davidson	North Lake Marina	
5	Jennifer Gordon	City of Kenmore	
6	Greg Matz	Inglewood Golf Club	
7	Matt Muller		
8	Ben Peterson	King County	
9	Douglas Poppe	Puget Sound Anglers	
10	Quinn Proffitt	City of Kenmore	
11	Janet Quinn	City of Kenmore	
12	Doug Ritchie	Kenmore Waterfront Activities Ctr.	
13	Lizbeth Seebacher	WA Dept. of Ecology	
14	Rob Zisette	Herrera	
15			
16			

City of Kenmore

Waterfront Property Owner Aquatic Weeds Meeting

May 11, 2017

Janet Quinn, City of Kenmore Project Coordinator
Tela Whiteman, City of Kenmore Permit Specialist
Rob Zisette, Herrera Environmental Consultants
Senior Aquatic Scientist

City of Kenmore

Agenda

- Status of Integrated Aquatic Vegetation Management Plan (IAVMP)
- What weed management is planned for public spaces?
- Permits: Why & How?
- Plant Management Association(s)?
  - Why & How?
- Discussion on Communication from/to City
- Q & A

City of Kenmore

IAVMP Status Update

- Draft submitted to Ecology in March 2017
  - Permit requirements for Kenmore were added (per Shoreline Management Act of 1971; RCW 90.58)
  - Small changes requested by Ecology, primarily to use a table for plant control alternatives rather than narrative
  - Trend in literature is to change Brazilian elodea to Brazilian egeria; corrected throughout document
  - Resident question on how to address dead plant removal; answer will be added in body of document

City of Kenmore

Aquatic Weed Management in Public Spaces

- City hired AquaTechnex to apply herbicide in public locations in 2016.
- IAVMP approval by Dept. of Ecology gives us potential grant funding opportunities.
- No plans to spray or treat this year (target as of now is every other year as funding allows).
- City focus is on public spaces: Log Boom Park, Rhododendron Park, Squire's Landing Park, mouth of Sammamish River to 68th Ave. bridge

City of Kenmore

Permit Requirements

- Shoreline Substantial Development Permit (SSDX)
  - What is an SSDX?
  - How do I apply?
  - What is the cost and expiration?
  - Q&A with Permit Specialist

Development Services Department

City of Kenmore

Plant Management Association

Lake/River Associations (Plant Mgmt. Assoc.?)

- Volunteer organizations
- Often non-profits (funded by membership dues if desired)
  - Advantages: Flexible and works well for carrying out low-cost activities; jointly contract with providers; monitor weeds/algae/water quality; work together on education and/or projects; apply for grant funding
  - Disadvantages: Dependent on dedicated volunteers
- Desire to proceed?
  - If yes, next steps (form steering committee?)
    - Secretary of State application for non-profit, then application to IRS for tax-exempt status if a 501(c)3

City of Kenmore

Communication from City

Kenmore's IAVMP found here:
http://www.kenmorewa.gov/IAVMP

- Short description of IAVMP
- Link to IAVMP
- Link to permit applications (samples?)
- PMA(s) contact information
- City plans for aquatic weed management
- Link to King County Best Management Practices for pertinent aquatic noxious weeds

City of Kenmore

Useful Websites

- Secretary of State: https://www.sos.wa.gov/corps/NonprofitCorporationsONLINEandpaperregistration.aspx
  - Resources, application, link to IRS, etc.
- Department of Ecology: http://www.ecy.wa.gov/
  - Search "Aquatic Weeds" for info on identification, management, permits, grant funding opportunities, etc.
- King County Noxious Weeds: http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds.aspx
  - Information on identification, Best Management Practices for individual weeds, brochures and other publications, etc.
- King County Lake Stewardship Program: http://www.kingcounty.gov/depts/dnrp/wlr/sections-programs/science-section/lake-stewardship-program.aspx
  - Reports, presentations and resources

City of Kenmore

Questions?

Q & A

City of Kenmore

Networking and Thanks

Thanks for attending!

Janet Quinn, City of Kenmore Project Coordinator, 425-984-6191
Tela Whiteman, City of Kenmore Permit Specialist, 425-984-6164
Rob Zisette, Sr. Aquatic Scientist, Herrera Environmental Consultants, 206-787-8262

APPENDIX B

Aquatic Plant Survey Maps

AQUATIC PLANTS IN SELECTED WATERS OF KING COUNTY

Distribution and Community Composition of Macrophytes

by

J. M. Goodpasture

J. I. Davis

R. I. Matsuda

Municipality of Metropolitan Seattle

Water Quality Division

1979

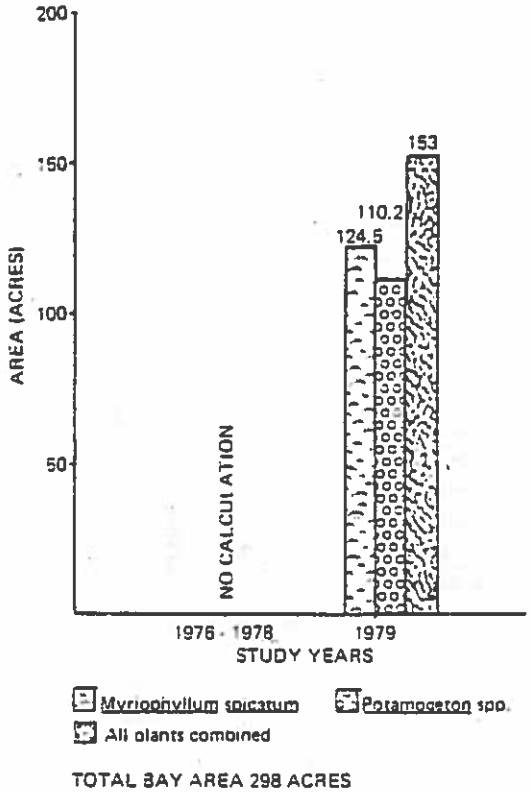
LAKE WASHINGTON - KENMORE AREA

Survey date:
August 30, 1979

SPECIES LIST

Ceratophyllum demersum
(coontail)
Elodea canadensis
(water weed)
Myriophyllum spicatum
(Eurasian water milfoil)
Nymphaea odorata
(fragrant white waterlily)
Potamogeton berchtoldii
(Berchtold's pondweed)
Potamogeton crispus
(curly-leaved pondweed)
Potamogeton richardsonii
(Richardson's pondweed)
Zannichellia palustris
(horned pondweed)

DENSITY: Light; some moderate to dense. Unchanged.



TOTAL BAY AREA 298 ACRES

MAXIMUM POTENTIAL MACROPHYTE COVERAGE 194 ACRES

Fig. 49. Histogram of areal coverages of macrophytes in Kenmore area, 1976-1979.

The overall density of plants in this part of Lake Washington is light. The dominant species are Potamogeton berchtoldii, Ceratophyllum demersum, and Myriophyllum spicatum. P. richardsonii, P. crispus, Zannichellia palustris, and Elodea canadensis are less abundant but still important. In the northern end of this region the plants form an interlocking network of plant beds, each bed being comprised of 2 to 4 species. The map depicts in general what actually appears as a mosaic pattern. The maximal extension of C. demersum toward the deep water shown on the map is approximate. Plant densities were light and distances to shore points great, making accurate determinations difficult.

No significant changes in plant distribution and density appeared to have occurred since 1978.

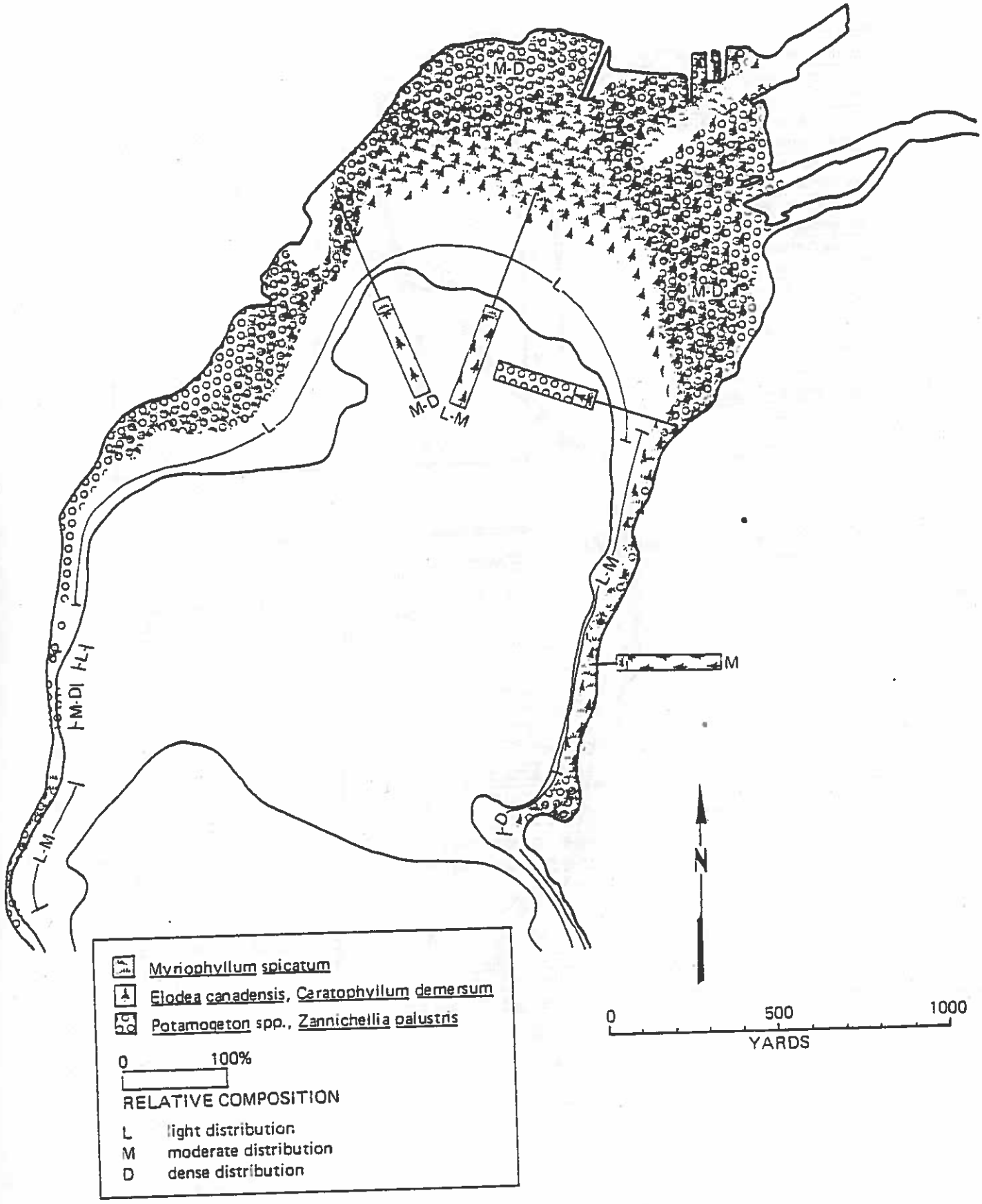


Fig. 50. Contour map showing areal distributions and densities of macrophytes as shown by 1979 survey.

AQUATIC PLANTS IN SELECTED WATERS OF KING COUNTY

Distribution and Community Composition of Macrophytes

by

Clayton R. Patmont, Harper-Owes

J. I. Davis

R. G. Swartz

Municipality of Metropolitan Seattle

Water Quality Division

1981

KENMORE AREA

Survey date:
August 3, 1981
August 4, 1981
August 5, 1981

SPECIES LIST
- Ceratophyllum demersum (coontail)
- Charales (macroalgae)
- Elodea canadensis (water weed)
- Juncus sp. (reed)
- Myriophyllum spicatum (Eurasian water milfoil)
- Najas flexilis (water nymph)
- Nuphar variegatum (yellow water lily)
- Potamogeton berchtoldii (Berchtold's pondweed)
- Potamogeton crispus (curly-leaved pondweed)
- Potamogeton natans (floating-leaf pondweed)
- Potamogeton pectinatus (thin-leaved pondweed)
- Potamogeton richardsonii (Richardson's pondweed)
- Vallisneria americana (tape grass)
- Zannichellia palustris (horned pondweed)

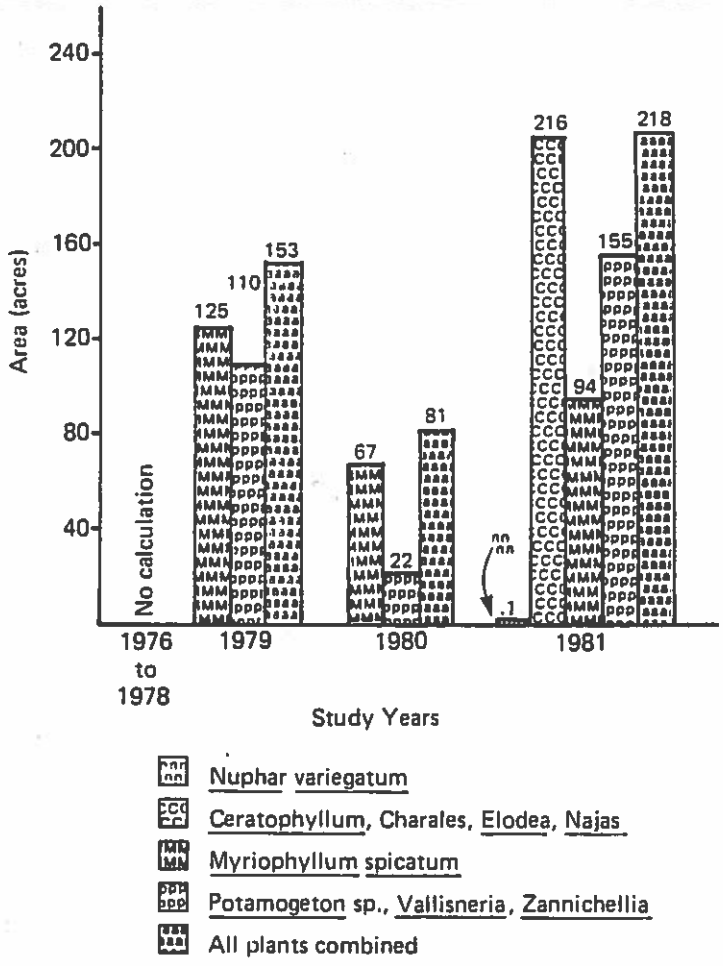


Fig.4-9 Histogram of areal coverages of macrophytes, 1976-1981.

Macrophyte areal coverage in the Kenmore area was substantially greater than in previous survey years, especially relative to 1980 levels. Much of this increase is attributable to extension of the Ceratophyllum population to an average depth of 5.5m. The plant community was dominated by Ceratophyllum; subdominants included Myriophyllum and Potamogeton berchtoldii. Myriophyllum areal coverage in 1981 was less than 1979, but more than 1980 levels. Potamogeton spp. areal coverage expanded well beyond 1979 levels. Plant densities were not markedly different between 1980 and 1981.

The increase in areal coverage above 1980 levels would probably have been more dramatic if the Kenmore navigational channel had not been dredged between the two study periods. The channel extends to a depth of approximately 8m and is devoid of plants.

KENMORE AREA

Just west of the navigation channel a new marina was constructed by soil excavation. No plants were observed in this 4m deep area. The 1981 survey was conducted before Metro's harvesting operations. The possible effect of previous harvests was not assessed.

A large area near the mouth of the Sammamish River was colonized by the benthic (attached to substrate) green alga Hydrodictyon. This alga typically coexisted with macrophytes in sparse and patchy plant communities. Following substantial wind events, large mats of the alga were observed suspended in the water column and often accumulated on leeward shores. Hydrodictyon beds were also reported in the 1980 survey.

KENMORE AREA

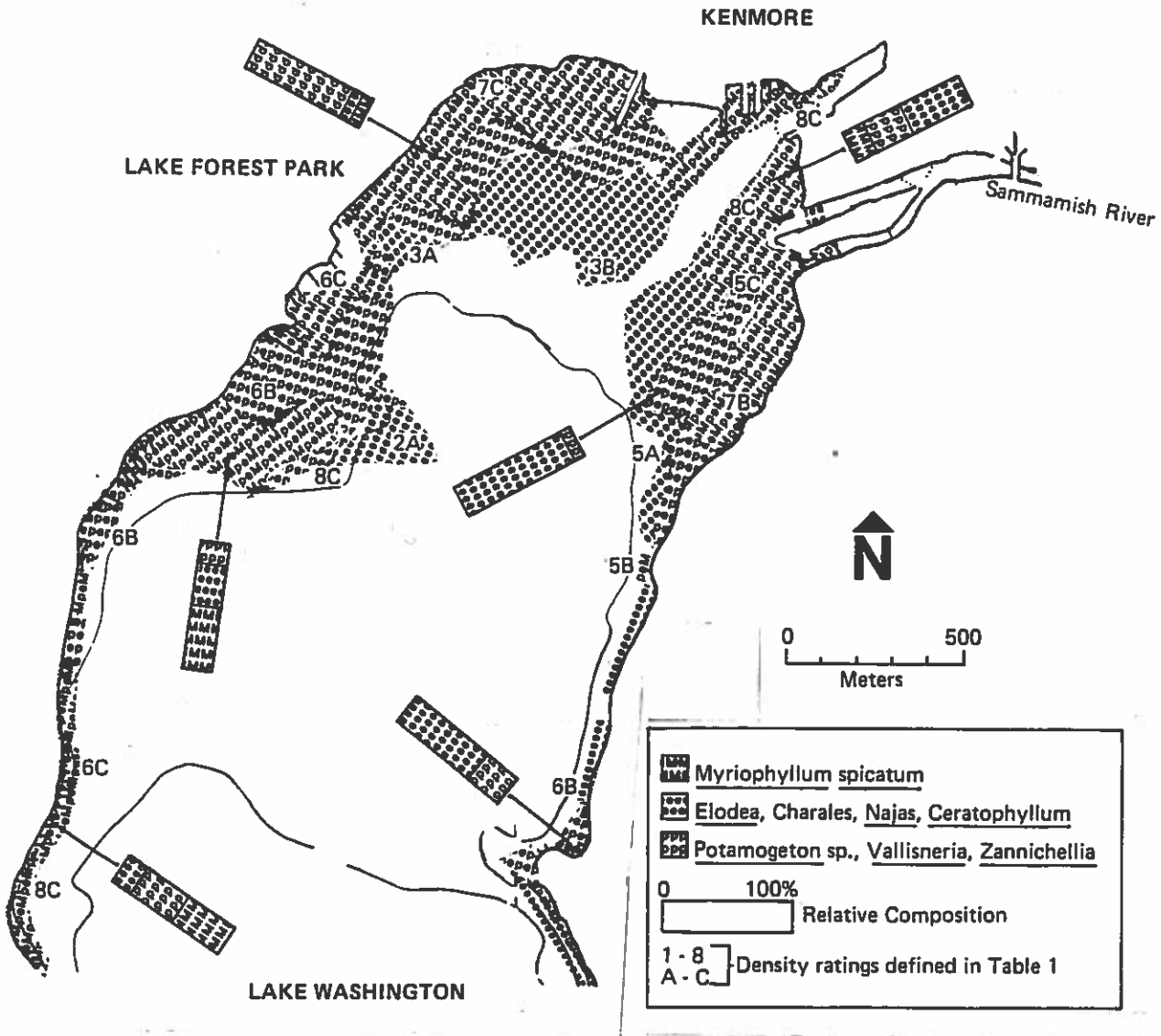
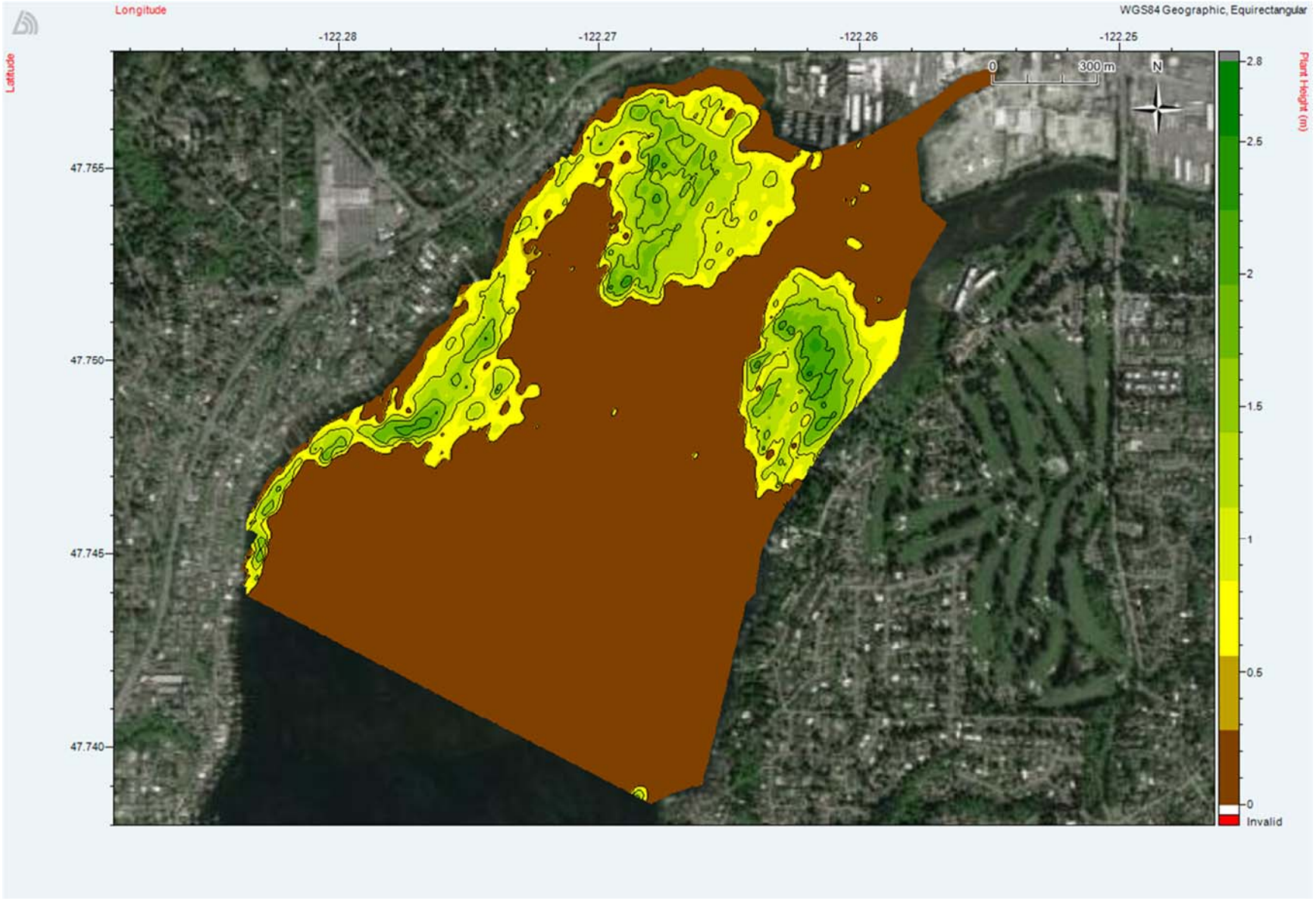
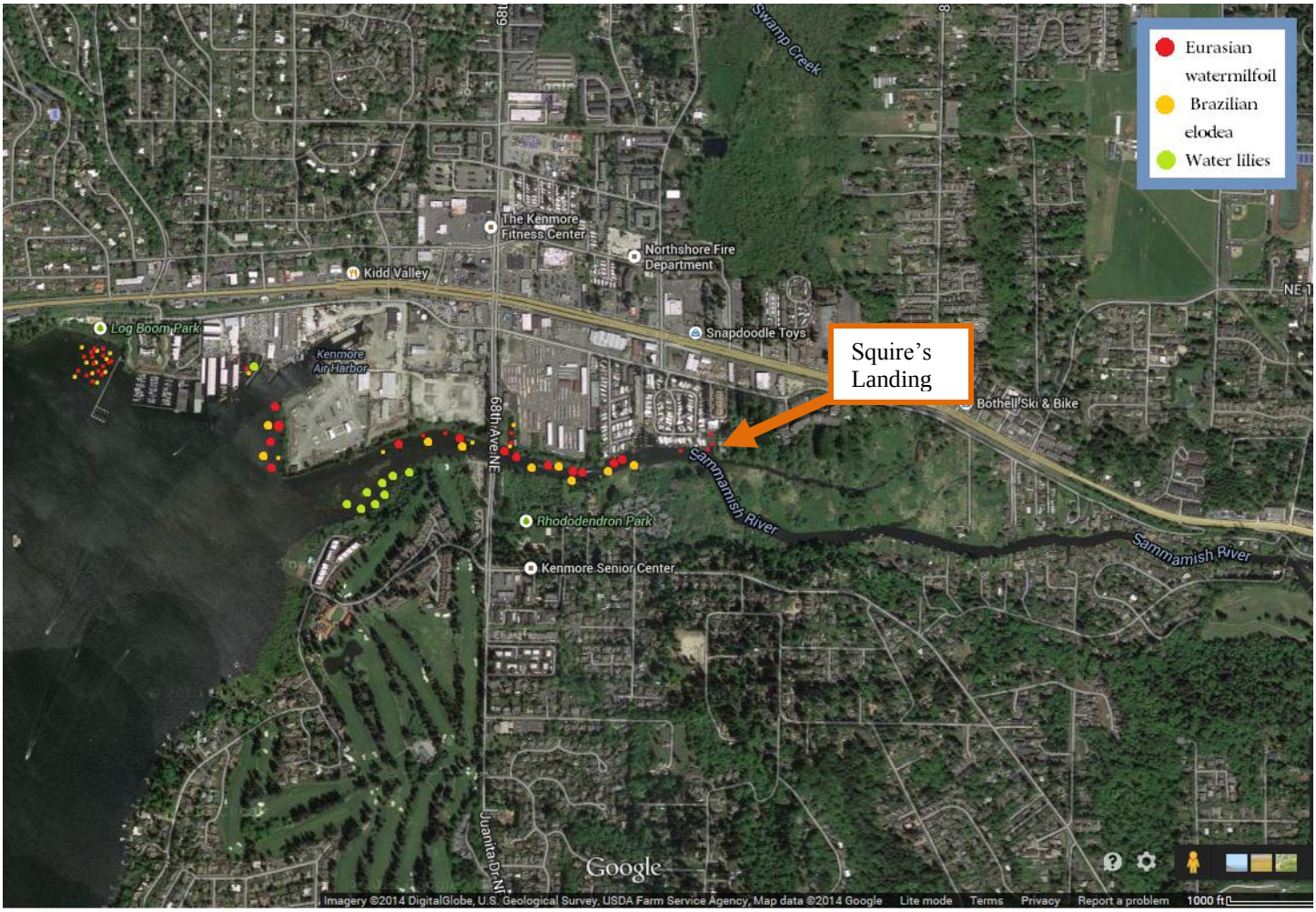


Fig. 4-10 Contour map showing areal distributions and densities of macrophytes as shown by 1981 survey.

North Lake Washington Aquatic Plant Cover on June 19, 2001 (BioSonics 2016).



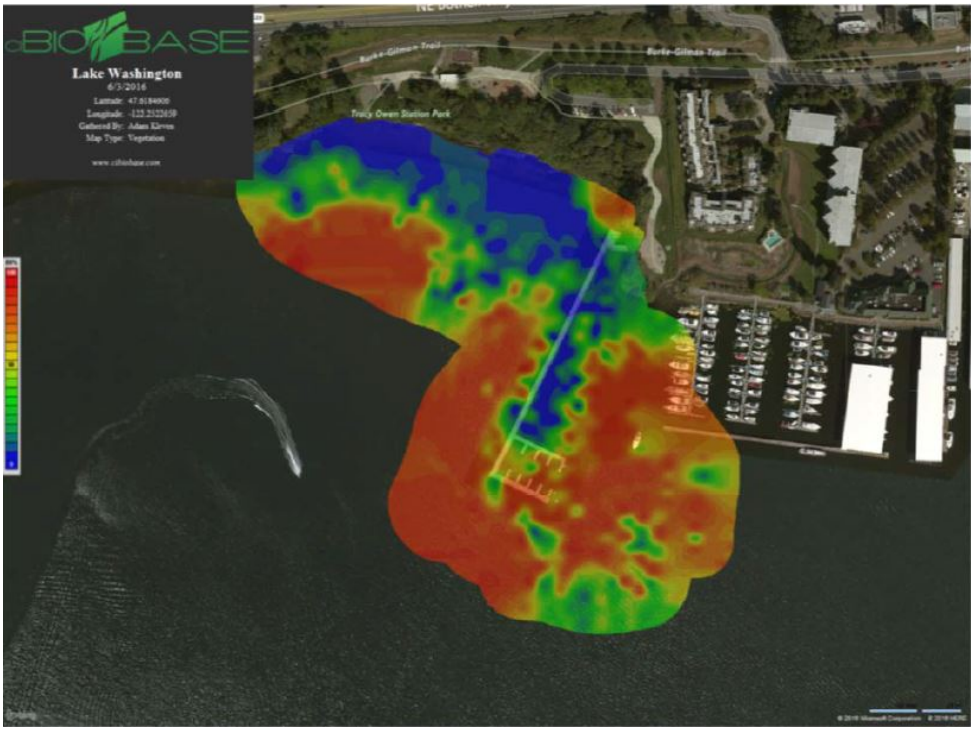
North Lake Washington Aquatic Plant Height on June 19, 2001 (BioSonics 2016).



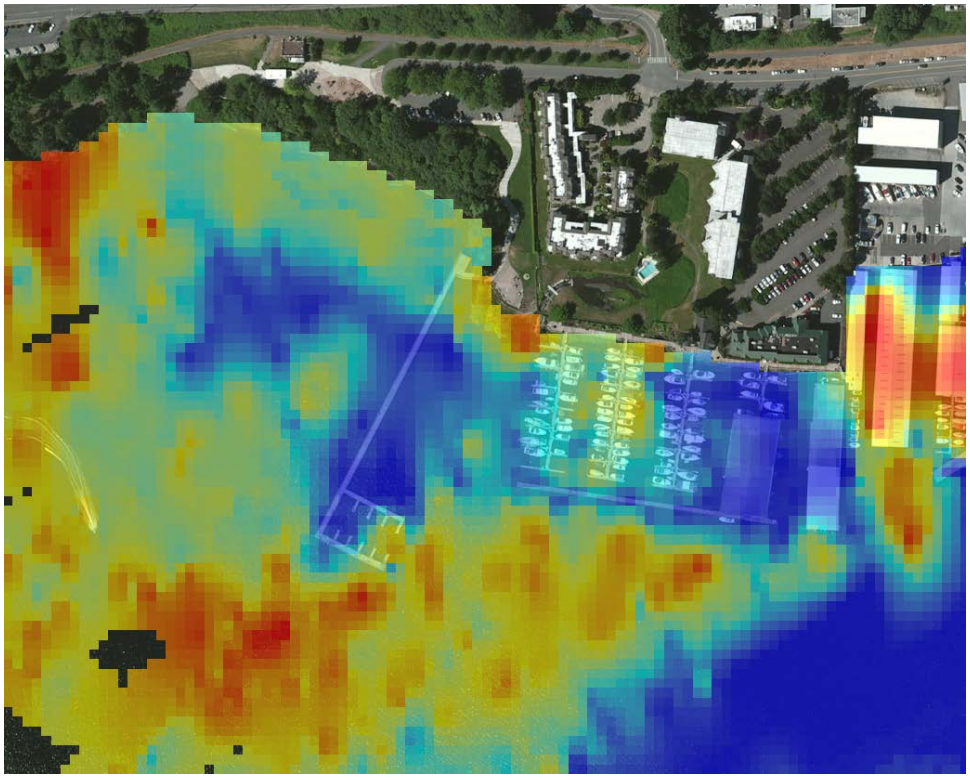
The image above shows the locations of three prominent invasive aquatic weed species, based upon an exploratory survey performed last year (October 2014) by City staff in conjunction with Ben Peterson, Noxious Weed Specialist from the King County Noxious Weed Control Program. We are seeking grant funding to do a more thorough survey, which will also look at weed infestation along Kenmore's portion of the eastern shore of Lake Washington.

Eurasian watermilfoil, Brazilian elodea, and water lilies appeared to be rooted in marked locations, while floating fragments were present almost the entire route between the mouth of the river and Squire's Landing. The total area these plants covered is around 30 acres, from Log Boom Park on the western side of Kenmore to Squire's Landing. This level of infestation would be classified as "Class 2 – Moderate" (locally abundant in patches along the shoreline, total acreage greater than 3 acres). **Note that this survey was done in October, when invasive plants are not as abundant.**

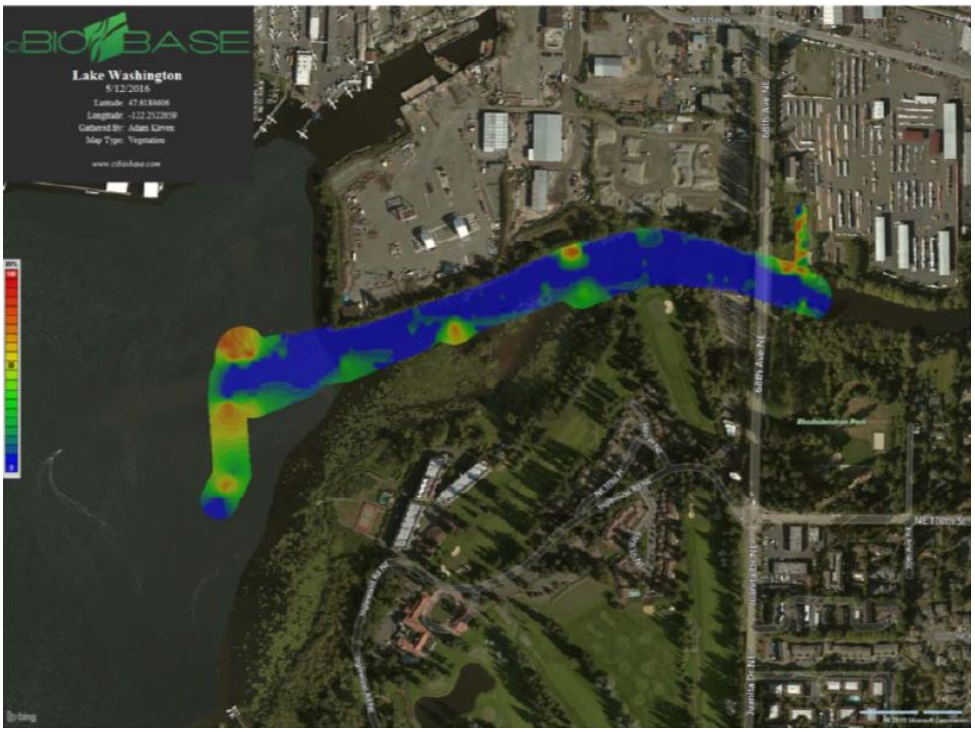
July 2016 Pretreatment Areas: Log Boom Park



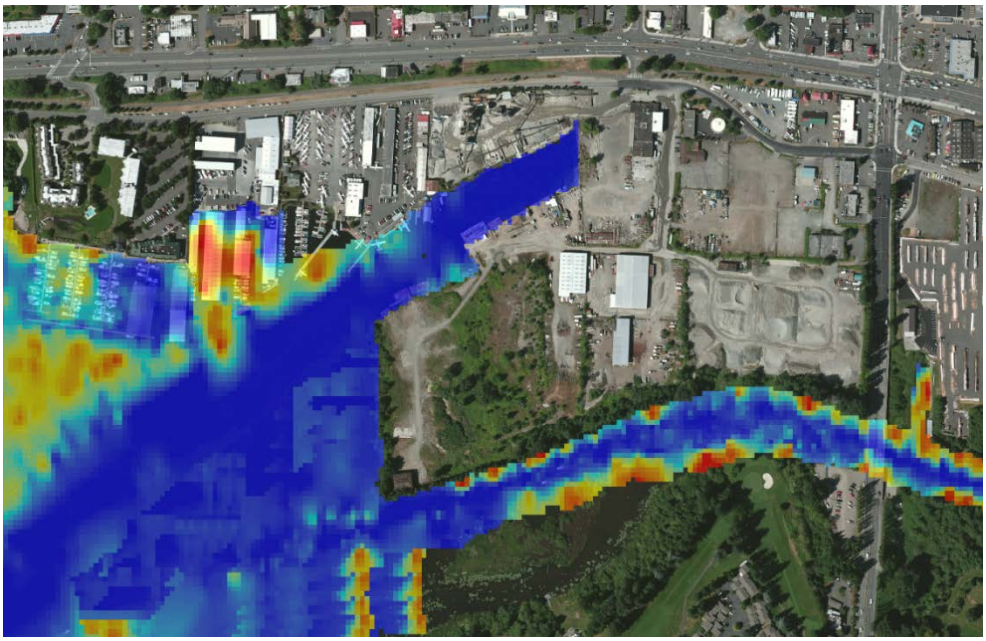
September 2016 Post-Treatment Areas: Log Boom Park



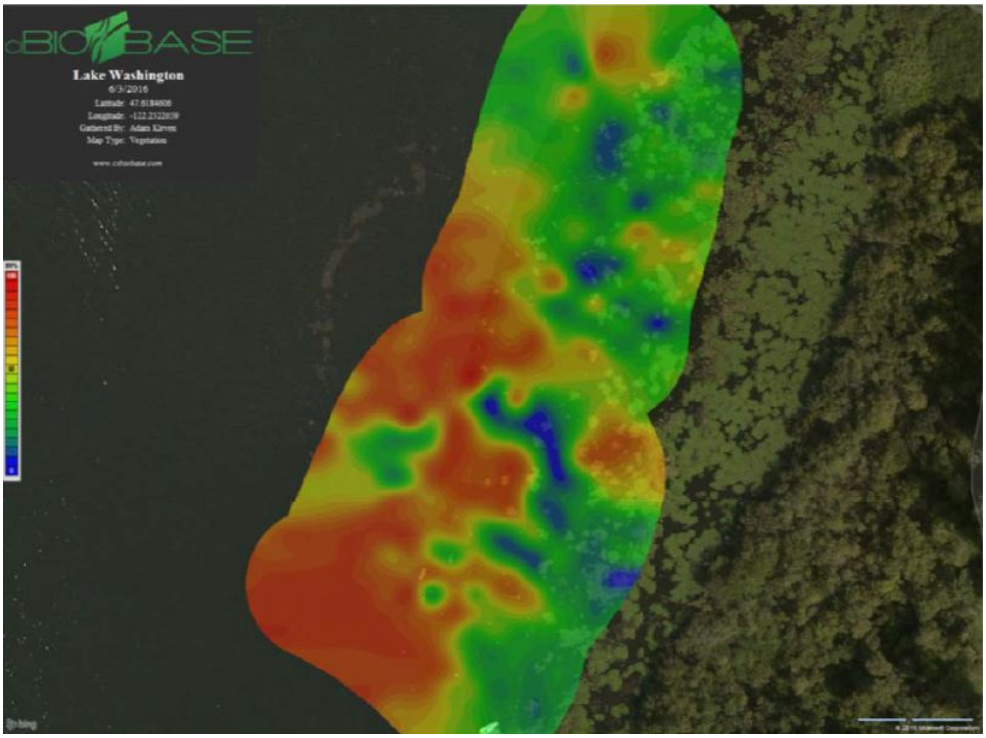
July 2016 Pretreatment Areas: Sammamish River Mouth



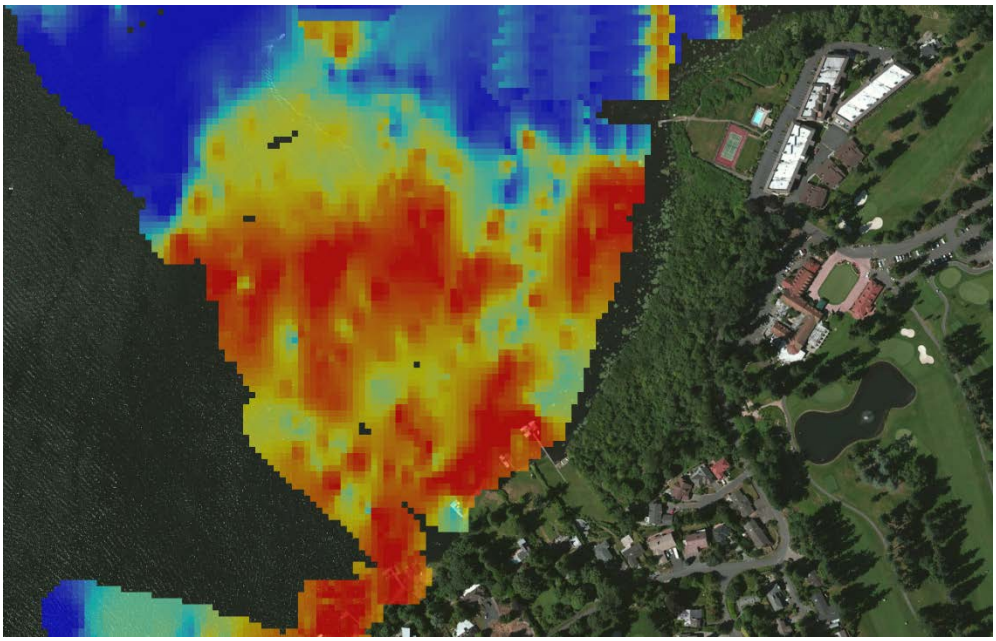
September 2016 Post-Treatment Areas: Sammamish River Mouth



July 2016 Pretreatment Areas: Inglewood Zone



September 2016 Post-Treatment Areas: Inglewood Zone



APPENDIX C

Aquatic Plant Control Alternatives

PLANT CONTROL ALTERNATIVES

CONTENTS

No Action 2
Chemical Herbicides 4
Manual Methods 8
Mechanical Methods 10
Diver Dredging 11
Mechanical Dredging 13
Biological Methods 15
Bottom Screening 17
Water Level Drawdown 19
Waterlily Root Mat Removal 20
References 22

This appendix presents information about common methods used to control aquatic weeds. Much of the information in this section was obtained from the Citizen's Manual for Developing IAVMPs (Ecology 1994) and Washington State Department of Ecology (Ecology) Aquatic Plant Management website (Ecology 2017). It is important to note that some of the information obtained from Ecology 2017 is out of date, and this website is being updated by Ecology.

Control and eradication methods discussed below include: chemical treatments; manual methods such as mechanical hand-pulling, raking, and cutting; mechanical methods such as mechanical harvester, mechanical weed cutters, and Rotovators; diver dredging and mechanical dredging; biological control methods such as the introduction of grass carp; and other methods including bottom screening, water level drawdown, Aquamog dredging, and DinoSix dredging. Table B-1 designates plant control activities that need an Aquatic Plant and Algae Management General Permit from Ecology or a Hydraulic Project Approval (HPA) permit/authorization from the Washington Department of Fish and Wildlife (WDFW).

Table B-1. Permit Requirements for Aquatic Noxious Weed and Beneficial Plant Control.

Control Method	Aquatic Noxious Weeds			Aquatic Beneficial Plants		
	Pamphlet HPA	Pamphlet HPA and WDFW Authorization	Individual HPA	Pamphlet HPA	Pamphlet HPA and WDFW Authorization	Individual HPA[a]
Chemical Herbicides	Requires Aquatic Plant and Algae Management General Permit from Ecology					
Hand Pulling or Other Hand Tools	X			X	X[b]	
Mechanical Cutting and Harvesters	X				X	
Rotovators			X			X
Diver Dredges	X	X[b]			X	
Mechanical Dredges			X			X
Grass Carp	Requires Grass Carp Stocking Permit and Individual HPA (for outlet structure) from WDFW					
Bottom Barriers	X	X[b]		X	X[b]	
Water Level Drawdown			X			X

[a] Applicants may apply for Individual HPAs for projects that exceed pamphlet limitations.

[b] Prior authorization is needed from WDFW for projects that exceed specified thresholds.

HPA =- Hydraulic Project Approval

WDFW = Washington State Department of Wildlife

Source: WDFW 2015.

No Action

The first alternative considered was the "No Action" alternative 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" alternative would preclude any integrated treatment and/or control effort, placing the choice and responsibility of aquatic weed control with lakefront property owners.

This management plan is primarily focused on the eradication of noxious weeds and the control of nonnative and native nuisance aquatic plants. Both noxious and nuisance plants have reduced the beneficial uses of the lake. Several different alternatives to control (or eradicate) these plants are presented in this plan. However, the "no action" alternative was examined as a reference for all other proposed control techniques.

It is very likely that all beneficial uses of the lake will continue to be further degraded if no aquatic plant control methods are implemented. Because the lake is eutrophic, a shallow lake with high nutrient conditions, the aquatic plants are able to absorb nutrients from sediments and the water column, making the likelihood of further plant growth certain. Therefore, the "no-action" alternative is not acceptable due to the further reduction of beneficial uses of the lake (boating, fishing, and swimming). Other negative environmental impacts include a definite degradation of the overall aesthetics. The fish communities may be impacted directly (e.g., lack of dissolved oxygen) or indirectly (i.e., changes in food web dynamics) with an overabundance of aquatic plants. Loss of open water may also restrict waterfowl use and habitat. Excessive aquatic plants also influence water quality by causing more pronounced temperature stratification and potentially a reduction in water circulation.

Chemical parameters such as pH, alkalinity, and dissolved oxygen may also be impacted through alteration of biological processes such as photosynthesis, respiration, and decomposition.

Advantages and Disadvantages

Advantages of the No Action alternative include:

- No treatment cost.
- No herbicide concerns.
- No need for permits.

Disadvantages of the No Action Alternative include:

- Quality of the lake will continue to decline.
- Recreational opportunities will decline.
- Fish and wildlife habitat will be reduced or impaired.
- Property values will decline.

Suitability for Kenmore

Unless control measures are enacted, the coverage of nuisance aquatic plants is likely to increase. This could degrade water quality and reducing the diversity of native aquatic plants. The "no action" alternative is not acceptable by members of the Kenmore steering committee.

CHEMICAL HERBICIDES

Aquatic herbicides are chemicals specifically formulated for use in water to eradicate or control aquatic plants. 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 can kill 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 regrowth (chemical mowing). Non-selective herbicides will generally affect all plants that they contact. Selective herbicides will affect only some plants.

To be approved for use in aquatic environments, an herbicide must pass stringent toxicity testing by the federal government. These tests are designed to assess impacts to the target population (plants) as well as non-target populations such as fish, aquatic insects, and other organisms. The tests also examine what happens to the chemical over the long term to ensure the chemical quickly breaks down into a nontoxic form or becomes unavailable for uptake by aquatic organisms. Washington State has set more stringent standards. Therefore, some of the aquatic herbicides approved for use in the United States are not approved for use in Washington.

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. In addition, an Aquatic Plant and Algae Management General Permit is required from Ecology for herbicide applications. This permit is a combined National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit. It covers the in-water and shoreline (including roadsides and ditch banks) treatment of native and noxious plants and algae. It also covers nutrient inactivation treatments. The permit allows the discharge of a specific list of aquatic labeled herbicides, algaecides, biological water clarifiers, adjuvants, marker dyes, and nutrient inactivation products into the freshwaters of Washington (Ecology 2016).

Although there are a number of herbicides registered for aquatic use by the US Environmental Protection Agency (US EPA), Ecology currently issues permits for 17 aquatic herbicides.

Only herbicides known to be effective on the target species and approved for use in Washington State were considered for this plan. A brief discussion of these herbicides from Ecology (follows below:

- **Glyphosate** – (trade names for aquatic products with glyphosate as the active ingredient include Rodeo®, AquaMaster®, and AquaPro®). This systemic broad-spectrum herbicide is used to control floating-leaved plants like waterlilies and shoreline plants like purple loosestrife. It is generally applied as a liquid to the leaves. Glyphosate does not work on underwater plants such floating bladderwort. 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.

- **Diquat** – (trade names for aquatic products with diquat as the active ingredient include Reward®). Diquat is a fast-acting non-selective contact herbicide which destroys the vegetative part (e.g., leaves) 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.

- **Triclopyr** – (trade name Renovate3®). There are two formulations of triclopyr. It is the triethylamine salt (TEA) formation of triclopyr that is registered for use in aquatic or riparian environments. Triclopyr, applied as a liquid or in granular form, is a relatively fast-acting, systemic, selective herbicide. In Washington, it is most commonly used for used for the control of Eurasian watermilfoil. 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 the US EPA in 2003 and was allowed for use in Washington in 2004.

- **Imazapyr** – (trade name Habitat®). 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.

Advantages and Disadvantages

Advantages of herbicides include:

- Aquatic herbicide application can be less expensive than other aquatic plant control methods.

- Aquatic herbicides generally provide a high level of control.

- Aquatic herbicides are easily applied around docks and underwater obstructions.
- Many herbicides are fast acting.

Disadvantages of herbicides include:

- Some herbicides have swimming, drinking, fishing, irrigation, and water use restrictions.
- Herbicide use may have unwanted impacts to people who use the water and to the environment.
- Non-targeted plants as well as nuisance plants may be controlled 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.
- To be most effective, generally herbicides must be applied to rapidly growing plants.
- Some expertise in using herbicides is necessary to be successful and to avoid unwanted impacts.
- Many people have strong feelings against using chemicals in water.
- Some cities or counties may have policies forbidding or discouraging the use of aquatic herbicides.

Permits and Costs

An Aquatic Plant and Algae Management General Permit is needed for any herbicide application. The City of Kenmore may be required to monitor herbicide levels in the lake as part of the permit process. The requirement of monitoring of herbicide levels started in 2003, whether the chemical has been applied directly to the water or along the shoreline where it may have gotten into the adjacent surface water. The applicator must apply to Ecology for coverage under their permit every 5 years. The permit is approximately $500 and will be billed once the permit is approved. Ecology requires that a Discharge Management Plan and State Environmental Protection Act checklist be submitted with the permit application. An IAVMP may be submitted in lieu of a Discharge Management Plan. There are no additional permit requirements from the City of Kenmore.

Approximate costs for 1 acre of herbicide treatment (costs will vary from site to site) are:

- Glyphosate: $350
- Diquat: $500

- Triclopyr: $700
- Imazapyr: $700

Other Considerations

The US EPA conducts very thorough risk assessments of all pesticides approved for use in the United States. These tests evaluate human exposure risks as well as risks posed to the environment resulting from persistence, accumulation, and mobility in the environment. Complete assessments are available from US EPA or the pesticide manufacturers. The state of Washington sets more stringent standards than the US EPA when considering which pesticides to allow.

Suitability for Kenmore

Aquatic herbicides can provide an effective method for control and eventual eradication of noxious weeds. Four primary herbicides were considered for use in this plan: glyphosate, triclopyr, imazapyr, and diquat (described below). Glyphosate can be used to treat fragrant waterlily, as well as emergent species, including purple and garden loosestrife. Triclopyr can be used for submersed Eurasian watermilfoil and emergent species. King County has found that imazapyr works better than glyphosate or triclopyr for controlling garden loosestrife (B. Peterson, personal communication). Diquat will be used for control of submersed plants including Brazilian elodea and nuisance native aquatic plants. Glyphosate was selected for control of fragrant waterlily because it has been effectively used in Lake Washington and many other lakes in the region. Triclopyr and diquat were selected because they can effectively control submersed aquatic plants.

All four herbicides are approved for aquatic use in Washington State based on environmental impact studies. As a result of these studies, there are many other herbicides allowed by the US Environmental Protection Agency (US EPA), but prohibited for use in Washington State. Full precautions will be taken during applications in Kenmore to ensure that herbicide levels do not exceed the amounts at which these hazards arise by not exceeding amounts specified by US EPA on the product label.

Follow-up control methods (hand pulling and/or cutting) will focus specifically on the target species and should also leave beneficial plants intact. An experienced herbicide applicator can selectively target individual 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.

Manual Methods

Manual methods include hand-pulling, raking, and cutting, described as follows.

- **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 3 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 flocculent sediments may cause a person hand pulling to sink deeply into the sediment.

- **Raking** requires a sturdy rake 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.

- **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 to 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.

Advantages and Disadvantages

Advantages of manual methods include:

- Small infestations can be eradicated.
- The equipment is inexpensive.
- Easy to use around docks and swimming areas.
- Many manual methods can be carried out by trained volunteers and shoreline residents.

- Hand-pulling allows the flexibility to remove undesirable aquatic plants while leaving desirable plants.
- These methods are environmentally safe.

Disadvantages of manual methods include:

- Hand-pulling is a high-cost method.
- Because these methods are labor intensive, they may not be practical for large areas or for thick weed beds.
- As plants regrow or fragments recolonize the cleared area, the treatment may need to be repeated several times each summer.
- Even with the best containment efforts, it is difficult to collect all plant fragments, leading to recolonization for some plants.
- Some plants, like waterlilies, which have massive rhizomes, are difficult to remove by hand pulling.
- Pulling weeds and raking stirs up the sediment making 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 and Costs

Manual removal of aquatic plants in Washington requires compliance with the Aquatic Plants and Fish pamphlet (WDFW 2015) for control of noxious weeds, or an individual HPA permit for control of native plants in a large area. Hand-pulling, raking, and mechanical cutting are two methods commonly used by residents that do not require an authorization or an individual HPA permit for control of aquatic noxious weeds.

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. A commercial rake costs about $95 to $125. A homemade weed rake costs about $85 (asphalt rake is about $75 and the rope costs 35 to 75 cents per foot).

Other Considerations

The community may need to invest money into buying the equipment and operation. 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. This is a large time investment by lakeside residents.

Suitability for Kenmore

Diver hand-pulling is not recommended for floating leaved plants due to difficulties with root (rhizome) removal, and is not cost-effective for control of large areas of nuisance submersed plants due to diver expense and fragment release.

Raking can be used to control nuisance submersed plants, especially in early summer when it begins to reach the water. Nuisance submersed plants are easily removed by rakes, but raking will generate fragments that may spread to other areas if they are not properly contained. However, most nuisance plants are already widespread throughout the lake, so fragmentation is not a huge issue. Prior authorization is needed from WDFW for projects that exceed specified thresholds, which is 50 percent of the littoral zone.

Mechanical Methods

Mechanical methods include mechanical harvesters, mechanical weed cutters, rotovators, and mechanical dredging.

- **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. 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.

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

- Rotovators use underwater rototiller-like blades to uproot fragrant waterlily plants. The rotating blades churn 7 to 9 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.

Advantages and Disadvantages

Advantages of mechanical methods include:

- Large areas can be treated.
- No chemical residue.
- Harvesters will collect plant fragments.
- Rotovators will negatively impact plant roots.
- Weed cutters have a low operation cost.

Disadvantages of mechanical methods include:

- Increased fragment drift and difficulty in plant collection, which can create new plant populations elsewhere in the lake.
- These machines are difficult to navigate around docks and other obstacles.
- Difficult to maneuver in shallow water.
- Rotovators can stir up sediments and negatively impact water quality.

Permits and Costs

Mechanical methods may require an individual HPA permit from WDFW.

Other Considerations

None.

Suitability for Kenmore

Mechanical harvesting was identified as a suitable control method for Kenmore because it is relatively cost effective, chemical-free, and can treat large public areas while collecting plant fragments.

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 fragrant waterlily, 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 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 acre to 1 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, some plants tend to break off leaving the roots behind and defeating the purpose of diver dredging.

Advantages and Disadvantages

Advantages of diver dredging include:

- Diver dredging can be a very selective technique for removing pioneer colonies of submersed noxious weeds.
- Divers can remove plants around docks and in other difficult to reach areas.
- Diver dredging can be used in situations where herbicide is not an option for aquatic plant management.

Disadvantages of diver dredging include:

- Diver dredging is very expensive.
- Dredging stirs up large amounts of sediment. This may lead to the release of nutrients and buried toxic materials into the water column.
- Only the tops of plants growing in rocks or hard sediments may be removed, leaving a viable root crown behind to initiate growth.
- In some states, acquisition of permits can take years.

Permits and Costs

Permits are required for many types of projects in lakes and streams. Diver dredging requires an HPA permit WDFW. Diver dredging may also require a Section 404 permit from the US Army Corps of Engineers. Depending on the density of the plants, specific equipment used, number of divers and disposal requirements, costs can range from a minimum of $1,500 to $2,000 per day.

Other Considerations

Diver dredging could be useful for spot control in subsequent years (coordinated with diver survey).

Suitability for Kenmore

Diver dredging removes the plant in its entirety. It removes the biomass above the sediment as well as roots and tubers in the sediment. This alternative is best used for a pioneering infestation of invasive submersed plants in soft sediments. Because diver dredging causes excessive stirring up of sediments, this method is not recommended.

Mechanical Dredging

Mechanical dredging uses large, barge-mounted excavation or suction equipment to remove sediment and associated plant material from the lake bottom. Mechanical dredging may be a suitable waterlily control strategy and a method for preventing problems with waterlily rhizome mats.

Advantages and Disadvantages

Advantages of mechanical dredging:

- Increases lake depth.
- No chemical residue.
- Large areas can be treated.
- Eliminates problems with floating rhizome mats.

Disadvantages of mechanical dredging:

- High cost: depending on the depth of material removed and area dredged, cost estimates range from about $30,000 to $200,000 per treatment.

- Material disposal: the material that is dredged needs to be disposed somewhere. Trucking and disposal at landfills or off-site facilities can potentially equal the cost of treatment as more heavy equipment is involved and time is consumed.
- Permits may be difficult to obtain.
- This method is slow (only about 100 cubic yards, or about 1/6 of an acre removing 1 foot of sediment, per day).
- Dredging can release nutrients from the sediment.

Permits and Costs

Mechanical dredging requires an individual HPA permit from WDFW. Dredging represents a significant disturbance to the lake substrate requiring a detailed environmental evaluation to obtain permits.

Other Considerations

Dredged material would need to be loaded onto trucks and taken off site for disposal. This would represent a significant cost. It also may be logistically difficult to maneuver heavy equipment to and from the lakeshore due to access restrictions. A rough cost estimate was obtained from Aquamog, a regional operator of sediment excavation equipment. While there are many cost considerations, removal of approximately 2 feet of sediment would cost about $45,000 per acre.

Aquamog Dredging

The Aquamog is owned and operated by Aquatic Environments, Inc. of California. The Aquamog has many configurations, but the one most suitable for removing sediment and rhizome mats is essentially a toothed clamshell bucket on a dredge-mounted excavator arm. Material removed by the Aquamog may be loaded onto a small barge or directly deposited on shore, and then offloaded into a truck where it would be hauled off site.

Dredging using the Aquamog machine is expensive. An estimate obtained for Aquamog indicated that dredging 2 feet of material from the lake bottom would cost approximately $45,000 per acre not including hauling and disposal cost, which often doubles the project cost, according to the Aquatic Environments representative. The amount of material removed from a depth of 2 feet in 1 acre is equivalent to 3,227 cubic yards. The Aquamog machine works at a rate of about 1 acre every 2 weeks. The cost of planning and obtaining permits needed to perform this type of work is estimated to be about $10,000. Thus, the total cost for dredging and disposal of 3,227 cubic yards from 1 acre is estimated to be approximately $100,000.

DinoSix Dredging

The DinoSix is a hydraulic dredge with a rotating cutterhead. The DinoSix pumps the dredged material directly into a 105-foot by 25-foot geotextile bag located on shore. The bag needs to be placed on a flat surface and would fill to a height of approximately 3 feet, containing approximately 3,000 cubic yards of material and representing approximately 2 feet of material from 1 acre. The bag needs to be drained for a period of 3 to 4 months before the dry material can be removed from the bags and hauled off site.

It was estimated by Sediment Removal Solutions that the geotextile bag would be filled in 5 days at a cost of approximately $30,000. Assuming an equivalent cost for disposal and $10,000 for planning and permitting, the total cost for dredging and disposal of approximately 3,000 cubic yards from 1 acre with the DinoSix is estimated to be approximately $70,000.

The DinoSix is recommended over the Aquamog for dredging due to the lower cost. In addition, the DinoSix is expected to have fewer water quality impacts during hydraulic dredging than mechanical removal by the Aquamog.

BIOLOGICAL METHODS

Milfoil weevils are a possible treatment option for Eurasian watermilfoil. 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 fewer 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 to 65 g/m^2) and then decreased to about 1 hectare (<15 g/m^2) in 1992. Weevil abundance began increasing in 1990 and peaked in June of 1992, where 3 to 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.

Another documented example where a crash of Eurasian watermilfoil has been attributed to the milfoil weevil is in Cenaiko Lake, Minnesota. Researchers from the University of Minnesota reported a decline in the density of Eurasian watermilfoil from 123 g/m^2 in July of 1996 to 14 g/m^2 in September of 1996. Eurasian watermilfoil remained below 5 g/m^2 in 1997, then increased to 44 g/m^2 in June and July of 1998 and declined again to 12 g/m^2 in September of 1998 (Newman and Biesboer 2000). In contrast, researchers found that weevil abundance in Cenaiko Lake was 1.6 weevils (adults and larvae) per stem in July of 1996. Weevil abundance,

however, decreased with declining densities of Eurasian watermilfoil in 1996 and by September 1997 weevils were undetectable. In September of 1998 weevil abundance had increased to >2 weevils per stem (Newman and Biesboer 2000).

Based on observations made by researchers in Vermont, Ohio and Wisconsin it seems that having 2 weevils (or more) per stem is adequate to control Eurasian watermilfoil. However, as indicated by the study conducted in Cenaiko Lake, Minnesota, an abundance of 1.5 weevils per stem may be sufficient in some cases (Newman and Biesboer 2000).

In Washington State, the milfoil weevil is present primarily in eastern Washington and occurs on both Eurasian and northern watermilfoil (*M. sibiricum*), the latter plant being native to the state (Tamayo et. al. 1999). During the summer of 1999, researchers from the University of Washington determined the abundance of the milfoil weevil in 11 lakes in Washington. They found that weevil abundance ranged from undetectable levels to 0.3 weevils (adults and larvae) per stem. Fan Lake, Pend Oreille County, had the greatest density per stem or 0.6 weevils (adults, larvae, and eggs per stem). The weevils were present on northern watermilfoil. These abundance results are well below the recommendations made by other researchers in Minnesota, Ohio, Vermont, and Wisconsin of having at least 1.5 to 2.0 weevils per stem in order to control Eurasian watermilfoil.

To date, there have not been any documented declines of Eurasian watermilfoil in Washington State that can be attributed to the milfoil weevil, although Creed speculated that declines of Eurasian watermilfoil in Lake Osoyoos and the Okanogan River may have been caused by the milfoil weevil. In Minnesota, Cenaiko Lake is the only lake in that state that has had a Eurasian watermilfoil crash due to the weevil; other weevil lakes are yet to show declines in Eurasian watermilfoil. Researchers in Minnesota have suggested that sunfish predation may be limiting weevil densities in some lakes (Sutter and Newman 1997). The latter may be true for Washington State as sunfish populations are present in many lakes in the state, including those with weevils. In addition, other environmental factors that may be keeping weevil populations in check in Washington, but have yet to be studied, include over-wintering survival and habitat quality and quantity (Jester et. al. 1997; Tamayo et. al., in press). Although the milfoil weevil shows potential as a biological control for Eurasian watermilfoil, more work is needed to determine which factors limit weevil densities and what lakes are suitable candidates for weevil treatments in order to implement a cost- and control-effective program.

Advantages and Disadvantages

Advantages of milfoil weevil include:

- Milfoil weevil introductions have correlated with decreases in milfoil abundance in some lakes that have been studied.
- Milfoil weevil offer a biological alternative to chemical plant control.

Disadvantages of milfoil include:

- Milfoil weevil also feed on native milfoil species.
- There is still more research needed to determine the level of effectiveness of milfoil weevils.

Permits and Costs

More research is needed to determine the costs of maintaining a milfoil weevil population.

Other Considerations

Other factors about milfoil weevil to consider include:

- Would not achieve immediate results—milfoil weevils take time to establish and the method is not guaranteed to work.
- Community may have concerns about introduced species.

Suitability for Kenmore

Milfoil weevils are not suitable for Kenmore, because more research is needed to determine if they would be an effective control method. Although the milfoil weevil shows potential as a biological control for Eurasian watermilfoil more work is needed to determine which factors limit weevil densities and what lakes are suitable candidates for weevil treatments in order to implement a cost- and control-effective program.

Bottom Screening

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, AquaScreen, and woven synthetics can all be used as bottom screens. 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.

Even the most porous materials, such as AquaScreen (plastic-coated glass fiber), 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 2 years, plants can grow on top of screen and fabric materials. Regular maintenance is essential and can extend the life of most bottom barriers. Bottom screens will control most aquatic plants; however, non-rooted species such as the bladderworts or coontail will not be controlled by bottom screens.

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.

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.

Advantages and Disadvantages

Advantages of bottom barriers include:

- 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 of bottom barriers include:

- Because bottom barrier 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 screen may create safety hazards for boaters and swimmers.

- 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 and Costs

Bottom screening in Washington requires an HPA in accordance with restrictions specified in the Aquatic Plants and Fish pamphlet (WDFW 2015) for control of noxious weeds, or an individual HPA permit for control of native plants in a large area. Local jurisdictions may require shoreline permits. 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.

Other Considerations

None.

Suitability for Kenmore

Bottom barriers have been used in other lakes to control aquatic plants. Without constant upkeep and maintenance, the long-term benefits of bottom barriers are minimal. Currently, infested areas are too spread out to use a bottom barrier without becoming cost prohibitive. Most of the lakeshore residences have only small infestations and the bottom barrier would just reduce habitat by covering the sediment.

Barriers could be effective in localized areas, such as in swimming areas and around docks, to prevent re-infestation after initial control. Installing a bottom barrier at a dock can provide these benefits.

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 water body for extended periods of time.

Water level drawdown often occurs regularly in reservoirs for power generation, flood control, or irrigation, with 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.

Drawdown is not a viable control strategy for Lake Washington. Water level drawdown would cause significant damage to the ecosystem, and effect areas far outside of Kenmore. The amount of drawdown required to impact nuisance aquatic plants would dry out the entire littoral zone of the lake. This would damage native plants and animals in the lake and have many negative consequences for residents and businesses around the lake.

Without a surface inflow to the system, returning the water level to a previous state would be both cost-and time-prohibitive.

WATERLILY ROOT MAT REMOVAL

Waterlily root mats often float to the surface in the years after waterlilies have been treated with herbicide. Waterlily root mats can impede water navigation and detract from the aesthetics of the lake. Waterlily root mat removal methods include moving them to a location where water navigation will not be impacted, and completely removing the root mats from the lake using heavy equipment.

- **Moving waterlily root mats** involves hauling the root mats into an area where water navigation will not be hindered, such as a conservation area. Boats or other vessels are used to haul the root mats into place. The root mats are then anchored to prevent them from floating into navigation areas.

- **Removal of waterlily root mats** requires heavy equipment. A boat or other vessel is used to haul the root mats to shore. Large root mats may need to be broken up using a high-pressured water jet for easier transport. Once the root mats are hauled to shore, an excavator is used to bring them to land and into a dump truck. The root mats are allowed to dewater in the dump truck before being taken to a landfill for disposal.

Advantages and Disadvantages

Advantages of waterlily root mat removal include:

- Improved navigation.

- Increased safety for boating and swimming.

- Improved aesthetics.

Disadvantages of waterlily root mat removal include:

- The methods for complete waterlily root mat removal are very expensive.
- Permits are required for complete waterlily root mat removal.

Permits and Costs

Moving Waterlily Root Mats

No permit is needed if root mats are not removed from the lake. Hauling and anchoring costs are estimated to be approximately $1,000 per day.

Complete Removal of Waterlily Root Mats

An HPA is needed from WDFW to remove root mats from a lake. It is estimated that each 1-acre waterlily root mat will be about 2 feet thick and have volume of 3,227 cubic yards. At a boat launch, the waterlily root mats would be brought on shore using an excavator and allowed to dewater to remove excess weight. The cost is estimated to be approximately $5,000 per day for boat and excavator equipment operators and machinery. It would require approximately 10 days to remove 1 acre of root mats. Disposal as yard waste at a landfill is estimated to cost $45 per ton disposal rate; 1 acre of root mats, at 0.4 ton per cubic yard, would cost approximately $60,000 for disposal. Initial planning and permitting is estimated to cost an additional $10,000.

Other Considerations

None.

Suitability for Kenmore

The cost of completely removing waterlily root mats from Kenmore may be prohibitively expensive.

REFERENCES

Bonar, S.A., B. Bolding, and M. Divens. 2002. Effects of Triploid Grass Carp on Aquatic Plants, Water Quality, and Public Satisfaction in Washington State. North American Journal of Fisheries Management 22:98–105.

Creed, R. P., and S. P. Sheldon. 1995. Weevils and watermilfoil: did a North American herbivore cause the decline of an exotic plant? Ecol. Applic. 5:1113–1121.

Ecology. 1994. A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans. First edition. Washington State Department of Ecology, Water Quality Financial Assistance Program, Olympia, Washington. January. <https://fortress.wa.gov/ecy/publications/publications/93093.pdf>.

Ecology. 2016. Aquatic Plant and Algae Management General Permit. National Pollutant Discharge and Elimination System and State Waste Discharge General Permit. Washington State Department of Ecology, Olympia, Washington. April.

Ecology. 2017. Aquatic Plant Management website. Washington State Department of Ecology, Olympia, Washington. <http://www.ecy.wa.gov/programs/wq/plants/management/index.html>

Jester, L. L., M. A. Bozek, S. P. Sheldon, and D. R. Helsel. 1997. New records for *Euhrychiopsis lecontei* (*Coleoptera*: *Curculionidae*) and their densities in Wisconsin lakes. Great Lakes Entomology. 30:169–176.

Newman, R. M., and D. D. Biesboer. 2000. A decline of Eurasian watermilfoil in Minnesota associated with the milfoil weevil, *Euhrychiopsis lecontei*. Journal. Aquatic Plant Management. 38 (2):105–111.

Sutter, T. J., and R. M. Newman. 1997. Is predation by sunfish (*Lepomis* spp.) an important source of mortality for the Eurasian watermilfoil biocontrol agent *Euhrychiopsis lecontei*? Journal Freshwater Ecology. 12:225–234.

Tamayo, M., C. W. O'Brien, R. P. Creed, C. E. Grue, and K. Hamel. 1999. Distribution and classification of aquatic weevils (Coleoptera: Curculionidae) in the genus *Euhrychiopsis* in Washington State. Entomology. News 110:103–112.

Tamayo, M., C. E. Grue, and K. Hamel. 2000. The relationship between water quality, watermilfoil frequency, and weevil distribution in the State of Washington. J. Aquatic Plant Management 38:112–116.

WDFW. 2015. Plants and Fish, Rules for Aquatic Plant Removal and Control. Washington Department of Fish and Wildlife, Olympia, Washington. Second Edition. July.

APPENDIX D

Target Species 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

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.

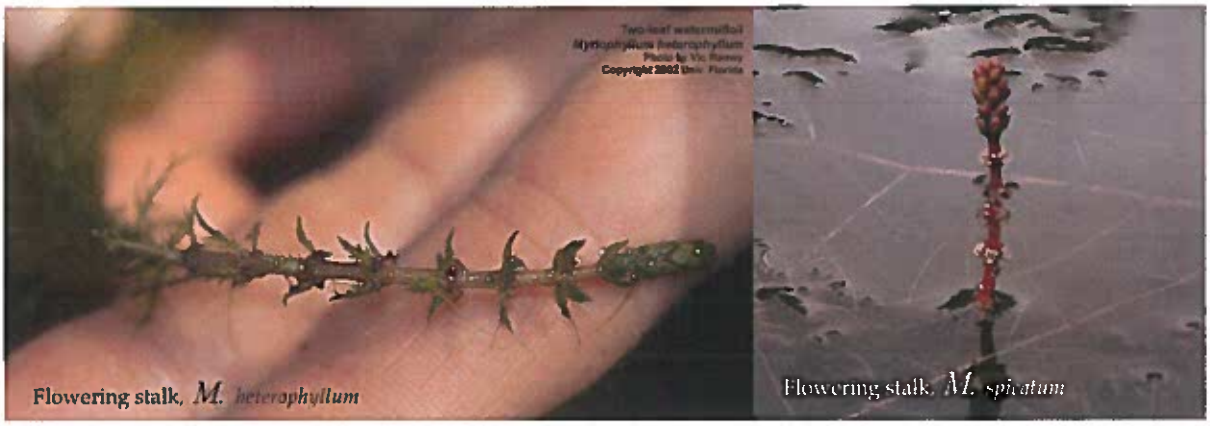
Description, Reproduction and Spread

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.

References

Aiken, S. G. 1981. A conspectus of *Myriophyllum* (Haloragaceae) in North America. Brittonia 33: 57-89.

Bates, L.A., E. R. Burns and D.H. Webb. Eurasian Watermilfoil (*Myriophyllum spicatum* L.) in the Tennessee-Valley: An update on the biology and control. Tennessee Valley Authority, Muscle Shoals, Alabama 35660. 104-115.

Crow, G. E. and C. B. Hellquist. 1983. Aquatic vascular plants of New England: Part 6. Trapaceae, Haloragaceae, Hippuridaceae. Station Bulletin 524. New Hampshire Agricultural Experiment Station, University of New Hampshire, Durham, New Hampshire.

Goldsby, T.L. and D.R. Sanders. 1977. Effects of consecutive water fluctuations on the submersed vegetation of Black Lake, Louisiana. Journal of Aquatic Plant Management. 15:23-8.

Hogan, W.D. and S.B. Hopkins. 1978. Improved efficacy in aquatic vegetation control. Proceedings of the Southern Weed Science Society 31: 237.

Hotchkiss, N. 1972. Common marsh, underwater and floating-leaved plants of the United States and Canada. Dover Publications, Inc., New York.

Madsen, J.D., J.W. Sutherland, J.A. Bloomfield, L.W. Eichler and C.W. Boylen. 1991. The decline of native vegetation under dense Eurasian watermilfoil canopies. J. Aquatic Plant Management 29: 94-99.

Manning, J.H. and D.R. Sanders. 1975. Effects of water fluctuation on vegetation in Black Lake, Louisiana. Hyacinth Control Journal 13: 17-24.

Netherland, M.D. and K.D. Getsinger. Efficacy of triclopyr on Eurasian watermilfoil: Concentration and exposure time effects. 1992. US Army Corps of Engineers Waterways Experiment Station. Miscellaneous Paper A-92-1.

New Hampshire Department of Environmental Services, 2008. Environmental Fact Sheet: Variable Milfoil. http://www.des.state.nh.us/factsheets/bb/bb-23.htm

Ohio Department of Natural Resources, Division of Natural Areas and Parks. 2008. www.dnr.state.oh.us/dnap.

Pieterse, A.H. and K.J. Murphy. eds. 1993. Aquatic Weeds The Ecology and Management of Nuisance Aquatic Vegetation. Oxford University Press.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Vascular Flora of the Carolinas. The University of North Carolina Press, Chapel Hill.

Tarver, D. P., J. A. Rogers, M. J. Mahler, and R. L. Lazor. 1986. Aquatic and wetland plants of Florida. Third Edition. Florida Department of Natural Resources, Tallahassee, Florida.

United States Army Corps of Engineers. Noxious and Nuisance Plant Management Information System. 2008. http://el.erdc.usace.army.mil/pmis.

University of Minnesota, 2006. Biological Control of Eurasian Watermilfoil webpage: http://fwcb.cfans.umn.edu/research/milfoil/milfoilbc.html

Washington Department of Ecology, 2003. Non-native freshwater plants, webpage: http://www.ecy.wa.gov/programs/wq/plants/weeds/

Westerdahl, H.E. and K.D. Getsinger, eds. 1988. Aquatic plant identification and herbicide use guide, volume II: Aquatic plants and susceptibility to herbicides. Technical report A-88-9. Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, MS.

Brazilian Elodea

Egeria densa **Class B Noxious Weed**
Hydrocharitaceae **Control Required except in Selected Areas**

Legal Status in King County: Brazilian elodea is a class B 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 may be required to control based on distribution in the county and local priorities). The King County Noxious Weed Control Board requires property owners to control Brazilian elodea on private and public lands in the county except in Lakes Washington, Sammamish, Union and Fenwick (control, as defined by state law, means to prevent all seed production and to prevent the dispersal of all propagative parts capable of forming new plants). State quarantine laws prohibit transporting, buying, selling, or distributing plants, plant parts or seeds of Brazilian elodea.

BACKGROUND INFORMATION

Impacts and History

- Native to South America and introduced to the United States through the aquarium trade, it is found scattered throughout western Washington. In King County it is established in Lakes Washington, Sammamish, Union, Fenwick and Dolloff. It is also prolific in the Sammamish River and around Fisherman's Terminal on the Lake Washington Ship Canal.
- Very aggressive and can outcompete native aquatic plants, forming dense monotypic stands. Can reduce biodiversity, change the predator/prey relationships in the lake and adversely impact the food web.
- Impacts 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 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 may 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

- Perennial, grows in up to 20 feet of water.
- Generally submergent but can form floating mats.
- Leaves are visibly smooth-edged (teeth are visible with magnification) and densely packed in whorls of four (or up to six).
- Relatively showy white flower has three petals and a yellow center. It is fragrant and floats on the water surface. Flowers are attached on slender stalks to the base of leaf whorls, and there are up to three flowers per whorl. Only male plants are known from the United States.
- Can thrive in relatively low light. High temperatures and high light conditions can cause senescence (die back).
- Often has two major growth periods, one in spring and one in fall. Some plants often persist through the winter.
- Is not known to seed in North America. Spreads by fragmentation.
- Can be confused with the native American waterweed (*Elodea canadensis*), which has a less robust appearance and smooth-edged leaves generally in whorls of three.
- In the nursery trade, also known as Brazilian waterweed, South American waterweed, Common waterweed, Egeria, and Anacharis.

Native *Elodea canadensis* (left) and *Brazilian elodea* (right)

Habitat

- Occurs in still and slow moving water up to about 20 feet deep, depending on water clarity.
- 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.
- Tolerates a wide range of pH.

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).
- Small infestations may be effectively removed using manual methods or hand tools.
- Brazilian elodea spreads by fragmentation, so extreme 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, your control efforts can be wiped out within a few years. Monitor the site each year for at least three years after last observing any Brazilian elodea, and then again after three years.

Permitting and Regulatory Requirements

- Permits are required for all weed control work in natural waterbodies.
- At minimum, the pamphlet Aquatic Plants and Fish is required. This pamphlet is published by the Washington State Department of Fish and Wildlife (available free of charge online at http://wdfw.wa.gov/licensing/aquatic_plant_removal or by calling (360) 902-2534) and acts as a Hydraulic Project Approval (HPA) permit. 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 fall when the plants begin to 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 waterbody (or a potentially infested waterbody).
- **Never dump unwanted aquarium or water garden plants or animals into a natural waterbody.** Brazilian elodea is still sold in some areas as an aquarium plant, and it was probably introduced to Washington waters by careless dumping of aquariums. It has several other common names, including Brazilian waterweed, South American waterweed, and Anacharis.

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**: Brazilian elodea 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.

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 waterbodies 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. Thurston County successfully controlled Brazilian elodea in the Chehalis River using this method. 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. 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, including Brazilian elodea fragments, 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. Consecutive drawdowns may be more effective than a single attempt. 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 Brazilian elodea infestation. For several years following treatment, monitor areas for new plants. Remove any new growth using one of the manual control methods above.

Specific Herbicide Information

The only herbicide allowed in Washington waters that has been shown to be successful against Brazilian elodea is fluridone (e.g., brand name Sonar®). Endothall and diquat have proven successful in combination with copper compounds, but the use of copper is illegal in most Washington State waters due to its demonstrated toxicity to juvenile salmonids.

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 206-477-9333.**

Biological

- Triploid grass carp can be an option for controlling Brazilian elodea. Tests have shown that the carp prefer Brazilian elodea to native species. However, in practice, grass carp may remove the entire plant community. Grass carp are not allowed in water bodies where the inlet and outlet cannot be screened. Care should be taken to evaluate potential impacts on the native plant community before choosing grass carp to control Brazilian elodea.
- Although research is being done on a variety of invertebrates and pathogens, there are currently no accepted biocontrol agents for Brazilian elodea other than grass carp.

SUMMARY OF BEST MANAGEMENT PRACTICES

- At all times a minimum of a pamphlet HPA permit is required to do any activity that disturbs a lake bottom, wetland or streambed. For more extensive work, more specific permits will be required.
- Hand-pulling is recommended for small populations, with extreme care taken to remove all plants and fragments from the water.
- Where the plant has filled every possible inch of habitat in a water body and its connected waterways, 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, as long as care is taken to keep them free of debris and fragments.
- Diver dredging has been effective in the Chehalis River and can be a good option in moving water.
- To eradicate large areas of Brazilian elodea, 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).
- Drawdowns 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.
- Triploid grass carp may be an option if eradication is not desired.

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, or grass carp where allowed and appropriate, 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 downstream. 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.
- Diver dredging has proven effective in flowing water.

- Manual control may be the most practical for small infestations. Bottom barriers need to be securely anchored.
- Chemical control in flowing water is difficult. Consult an expert before considering this option.
- Grass carp will not be allowed in flowing water.

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 water bodies 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 in these lakes 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 Eurasian watermilfoil, which is widespread 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

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

References

Goldsby, T.L. and D.R. Sanders. 1977. Effects of consecutive water fluctuations on the submersed vegetation of Black Lake, Louisiana. Journal of Aquatic Plant Management. 15:23-8.

Hogan, W.D. and S.B. Hopkins. 1978. Improved efficacy in aquatic vegetation control. Proceedings of the Southern Weed Science Society 31: 237.

Hotchkiss, N. 1972. Common marsh, underwater and floating-leaved plants of the United States and Canada. Dover Publications, Inc., New York.

Manning, J.H. and D.R. Sanders. 1975. Effects of water fluctuation on vegetation in Black Lake, Louisiana. Hyacinth Control Journal 13: 17-24.

Pieterse, A.H. and K.J. Murphy. eds. 1993. Aquatic Weeds The Ecology and Management of Nuisance Aquatic Vegetation. Oxford University Press.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Vascular Flora of the Carolinas. The University of North Carolina Press, Chapel Hill.

Thurston County Noxious Weed Control Agency, 2009. Brazilian Elodea *(Egeria densa)* removal on the Chehalis River, webpage: http://www.co.thurston.wa.us/tcweeds/special-projects.htm

Washington Department of Ecology, 2003. Non-native freshwater plants, webpage: http://www.ecy.wa.gov/programs/wq/plants/weeds/

Westerdahl, H.E. and K.D. Getsinger, eds. 1988. Aquatic plant identification and herbicide use guide, volume II: Aquatic plants and susceptibility to herbicides. Technical report A-88-9. Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, MS.

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.

References

Brayshaw, C.T. 1989. Buttercups, Waterlilies, and Their Relatives: (The Order Ranales) in British Columbia. Royal British Columbia Museum Memoir No.1. Royal British Columbia Museum

Hotchkiss, N. 1972. Common marsh, underwater and floating-leaved plants of the United States and Canada. Dover Publications, Inc., New York.

Washington Department of Ecology, 2003. Non-native freshwater plants, webpage: http://www.ecy.wa.gov/programs/wq/plants/weeds/

Westerdahl, H.E. and K.D. Getsinger, eds. 1988. Aquatic plant identification and herbicide use guide, volume II: Aquatic plants and susceptibility to herbicides. Technical report A-88-9. Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, MS.

Whitley, J.E., B. Basset, J.G. Dillard, and R.A. Haefner. 1990. Water Plants for Missouri Ponds. Missouri Department of Conservation, P.O. Box 180, Jefferson City, MO 65102.

Garden Loosestrife

Lysimachia vulgaris
Primulaceae

Class B Noxious Weed
Control Required

Legal Status in King County: Garden loosestrife is a Class B Noxious Weed (non-native species harmful to environmental and economic resources that landowners may be required to control based on distribution in the county and local priorities) according to Washington State Noxious Weed Law, RCW 17.10. In accordance with state law, the King County Noxious Weed Control Board requires property owners to control garden loosestrife on private and public lands throughout the county (control means to prevent all seed production and to prevent the dispersal of all propagative parts capable of forming new plants). In addition, state quarantine laws prohibit transporting, buying, selling, or distributing plants, plant parts or seeds of garden loosestrife.

BACKGROUND INFORMATION

Impacts and History

- Garden loosestrife displaces native vegetation along streambanks, wetlands and shorelines and reduces habitat needed by waterfowl and fish, including several important salmon species.
- Garden loosestrife can clog shallow waterways, increase sediment retention and interfere with water flow.
- Garden loosestrife is a native of Eurasia, where it occurs in fens, wet woods, lake shores, and river banks.
- In eastern North America, garden loosestrife is naturalized in parts of most states and provinces from Minnesota east to Newfoundland and Maryland and appears to be increasing in the Ohio River Valley (Cusick 1986). In the west, the species is present in Colorado, Montana, Oregon, Washington and British Columbia (NRCS Plants Database).
- Although the species is being monitored in most eastern states and provinces, it is currently considered a noxious weed only in Connecticut and Washington State. This may be due to colder winters providing a measure of control in some regions.
- First documented in Washington in 1978 in the NE corner of Lake Washington near Juanita Junction, garden loosestrife is probably an escaped garden plant.

- In Washington, infestations of garden loosestrife are currently known in King County, Whatcom County, Skagit County, Thurston County and Stevens County.

Description

- Perennial emergent plant that appears to remain in the vegetative stage for some time prior to blooming. The presence of a flowering specimen generally indicates it has been in an area for some years.
- Flowers are yellow, showy and primrose-like (5 petals), with the biggest cluster atop the stem and smaller clusters on stalks from the base of the upper leaves. Stamens are red-orange. Blooms from July to late August or September.
- Stems are round with soft hairs, occasionally broadly flattened.
- Leaves are 3-5 inches long, ovate, hairy beneath, and irregularly arranged (usually in whorls of 3-4, sometimes opposite) , with small orange or black glands on the underside visible with magnification.
- Seed pods are egg-shaped capsules with a few seeds each.
- Can be confused with the less aggressive *Lysimachia punctata* (spotted loosestrife, sometimes also called garden loosestrife), which bears single or small clusters of larger, more star-shaped flowers in leaf axils only, never in a terminal cluster like *Lysimachia vulgaris*.

Garden loosestrife (*Lysimachia vulgaris*) flowers are in clusters near the top of the stem; petals are somewhat rounded.

Spotted loosestrife (*Lysimachia punctata*) flowers are in leaf axils; petals are more pointed.

Habitat

- Occurs in freshwater wetlands, fens, wet woods, lakeshores, and river and stream banks.
- Grows on moist or saturated soils.
- Sometimes cultivated as a garden ornamental or used for landscaping purposes.

Reproduction and Spread

- Garden loosestrife spreads primarily vegetatively (by rhizomes) and also by seed.

- Produces extensive reddish-colored rhizomes that will reach out into the adjacent open water. Rhizomes have been recorded growing up to 15 feet long into the water.
- Seeds can disperse through water and are a secondary source of spread.

Local Distribution

- Found on lake shores and waterways in several areas of King County.
- Major infestations located on the shorelines of Lakes Washington and Sammamish, and along the Sammamish River.
- Smaller or pioneering infestations are present on Lake Burien, Rutherford Slough, the lower Snoqualmie River, the Raging River and a small number of other locations.

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 or local jurisdictions)**.
- Areas vulnerable to erosion (steep slopes or shorelines within the zone of influence of wave action) should not be dug up without erosion-prevention measures in place. Large cleared areas need to be replanted with native or non-invasive vegetation and stabilized against erosion. Infestations in these situations may require more concentrated efforts to control.
- Control practices in critical areas should be selected to minimize soil disturbance or efforts should be taken to mitigate or reduce impacts of disturbance. Any disturbed areas need to be stabilized to control erosion and sediment deposition. Refer to the King County Surface Design Manual for further information about sediment and erosion control practices (call 206-296-6519 or go to http://kingcounty.gov/wlr/Dss/Manual.htm for more information).
- Generally work first in least infested areas, moving towards more heavily infested areas.
- Properly dispose of all parts of the plant (see Disposal Methods section below).
- Small areas of seedlings may be effectively dug up. Isolated plants should be removed, taking 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 upriver and work your way downstream.
- 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 July and August when the plants are in flower, however seedlings may not flower in the first year.
- Look for seedlings starting in June.
- Dig up small isolated patches.
- Prevent plants spreading from existing infestations by cleaning off equipment, boots, clothing and animals that have been in infested areas.
- Don't buy or plant garden loosestrife. According to state quarantine laws it is illegal to buy, sell or offer garden loosestrife or any of its cultivars for sale.

Manual

- Hand pulling and the use of hand mechanical tools is allowable in unincorporated King County critical areas. Check with the local jurisdiction for regulations in other areas.
- Manual control is feasible for individual plants or small pioneering stands. Carefully dig out as much root and rhizome as possible; this plant doesn't pull well (breaks off from long rhizomes leaving root fragments behind).
- 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 may be impractical to impossible when trying to remove hardy, woody roots or extensive rhizome networks in compacted soils. Care should be taken to minimize erosion when digging in saturated soils on shorelines.
- If the plants are in seed, **cut off and bag all seed heads** before removing plants. Brush off boots, clothes and animals before leaving the infested area.
- All manual control sites should be monitored for several years for signs of plants growing from rhizomes and from the seed bank.
- **DISPOSAL:** Garden loosestrife seed heads, plant parts and roots must be bagged, removed from the site, and discarded in the trash or taken to a transfer station. **Do not compost or place in yard waste.**

Mechanical

- Removal of garden loosestrife with hand held mechanical tools is allowable in critical areas and their buffers within 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 may keep garden loosestrife contained and slow dispersal by seed, but won't kill the plants or prevent spread by rhizomes. Plant fragments will root if left behind, so if care is not taken to remove all plant fragments, mowing may also facilitate spread rather than control.
- Cutting alone is not a control option for garden loosestrife. New plants will grow from the rhizomes.
- Sheet mulching or covering using black plastic, landscape fabric, or cardboard and six inches of mulch is an interim option for dense seedling infestations. It does not kill the roots of mature plants, but it does slow down growth and seed dispersal. The covering must extend several feet beyond the edges of the infestation and be weighted so the plants cannot push it up. The edges of the covered area must be monitored for plants coming up from rhizomes extending beyond the sheet. Covering materials should also be monitored for damage or gaps and repaired or re-installed as needed.

Chemical

- **Precautions:**
  - Herbicides should only be applied at the rates and for the site conditions and/or land usage specified on the label of the product being used. **Follow all label directions.**
  - 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.
  - For your personal safety, at a minimum wear gloves, long sleeves, long pants, closed toe shoes, and appropriate eye protection. Follow label directions for any additional personal protection equipment needed.
  - 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 many include ingredients toxic to aquatic organisms.**
- 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.
- For several years following treatment, monitor areas for new plants germinating from the seed bank. In some cases several years of treatment may be necessary.
- When treating an area intermixed with native monocots (cattails, grasses, sedges, etc), we recommend using a selective herbicide. The monocots will not be harmed by the herbicide and will be able to help suppress new plants emerging from the seed bank.

Specific Herbicide Information

Glyphosate (e.g. Rodeo® or AquaMaster®): Apply to actively growing plants at full to late flowering stage. Application to pre-flowering plants or seedlings may also be effective, but unless the extent of the infestation is well known, plants can be difficult to locate when not

in flower. Apply to foliage but avoid runoff. Caution: Glyphosate is non-selective and it will injure or kill other vegetation contacted by the spray including grasses, cattails and other monocots.

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

Triclopyr (Garlon 3A® and Renovate 3®). Apply when plants are in the mid to full-bloom stage. Application to pre-flowering plants or seedlings may also be effective, but unless the extent of the infestation is well known, plants can be difficult to locate when not in flower. Triclopyr is a selective herbicide and will kill only dicots. It will not harm monocots such as grasses, sedges, cattails and many 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 in Washington State.
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

- No biological control agents are presently known. No research is currently being conducted.

SUMMARY OF BEST MANAGEMENT PRACTICES

Small Infestations in Native and/or Desirable Vegetation

- Hand digging is recommended for very young plants not yet established, when vegetative spread is less likely to occur.
- Larger plants from isolated small populations can be dug out from moist upland areas. This may be impractical to impossible when trying to remove hardy, woody roots in compacted soils. Care should be taken to minimize erosion when digging in saturated soils on shorelines.
- If the plants are in seed, **cut off and bag all seed heads.** It is very difficult to remove the plants without dispersing the seeds.
- Replace any divots created when removing the plants to lessen the amount of disturbed soil.
- If manual control is not possible due to site conditions or available labor, apply appropriate herbicide with wick wiper or spot spray to minimize off target injury.

- If using an herbicide in an area that has desirable monocots, use a selective herbicide to avoid injury to those plants.

Large Infestations in Areas with Monocots

- Cutting alone is not a control option for garden loosestrife. New plants will develop from rhizomes.
- Sheet mulching using black plastic, landscape fabric, or cardboard and six inches of mulch is an interim option for dense seedling infestations. It does not kill the roots of mature plants, but it does slow down growth and seed dispersal. This method is also non-selective.
- If an area has desirable monocots present, use a selective herbicide and encourage the growth of the monocots.

Control on Shorelines

- Additional permits may be required for control of infestations in riparian areas. See Noxious Weed Regulatory Guidelines for more information.
- 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 Design Manual for further information about sediment and erosion control practices (call 206-296-6519 or go to http://kingcounty.gov/wlr/Dss/Manual.htm for more information).
- Survey area and document extent of infestation.
- Focus on manual removal for small infestations if possible.
- When removing vegetation on shorelines (by lakes, streams and wetlands) use barriers to prevent sediment and vegetative debris from entering the water system.
- Cutting or mowing will not control garden loosestrife but it can serve in the interim until more effective control measures can be utilized.
- For larger areas where herbicide use is warranted, spray using low pressure and large droplet size to reduce drift. If herbicide could potentially drift into the water or a wetland area, use only approved aquatic herbicides and surfactants after obtaining the necessary permits.
- When large areas of weeds are removed, the cleared area needs to be replanted with native or non-invasive vegetation to prevent re-invasion by weeds and stabilized against erosion.
- Infested areas will need to be monitored for several years to control plants growing from root fragments and germinating from the extensive seed bank.

Control along Road Rights-of-Way

- Hand dig small infestations if possible.
- Spot spray larger infestations. Use a selective broadleaf herbicide in areas with desirable monocots such as grasses, sedges or cattails; if controlled with a non-selective herbicide, re-seed after control is completed.

- If plants are about to flower, they can be cut until a more effective control strategy can be used.
- If plants are sprayed, wait until the herbicide has had a chance to work before mowing.

Disposal Methods

- All garden loosestrife flowers, seed heads, plant parts, and roots must be bagged and discarded in the trash or taken to a transfer station.
- **Do not compost or place in yard waste. Never dump plant material as weeds may spread from yard waste piles.**

References

Cusick, A.W. 1986. Distributional and taxonomic notes on the vascular flora of West Virginia. Castanea. 51: 56-65.

Washington State Noxious Weed Control Board. 1997. Written Findings. http://www.nwcb.wa.gov/weed_info/Lysimachia_vulgaris.html (Accessed 1/10/2008).

USDA NRCS Plants Profile database: http://plants.usda.gov/java/profile?symbol=LYVU. (Accessed 1/10/2008).

Purple Loosestrife

Lythrum salicaria
Lythraceae

Class B Noxious Weed
Control Required

Legal Status in King County: Purple loosestrife is a Class B Noxious Weed (non-native species harmful to environmental and economic resources that landowners may be required to control based on distribution in the county and local priorities) according to Washington State Noxious Weed Law, RCW 17.10. In accordance with state law, the King County Noxious Weed Control Board requires property owners to control purple loosestrife on private and public lands throughout the county (control means to prevent all seed production and to prevent the dispersal of all propagative parts capable of forming new plants). In addition, state quarantine laws prohibit transporting, buying, selling, or distributing plants, plant parts or seeds of purple loosestrife.

BACKGROUND INFORMATION

Impacts and History

- Purple loosestrife is an invasive and competitive noxious weed that alters wetland ecosystems by replacing native and beneficial plants. Water-dependent mammals and waterfowl and other birds leave wetlands when their food source, nesting material and shelter are displaced by purple loosestrife.
- Dense infestations of purple loosestrife also alter the landscape by trapping sediments and thereby raising the water table.
- Although young shoots of purple loosestrife are palatable to cattle (and to white-tailed deer), larger plants are not, and so cattle graze preferentially on pasture grasses, giving purple loosestrife a distinct advantage in grazed areas. Over time, mature purple loosestrife plants will dominate, removing the use of the land as pasture. Similar processes can lead to destruction of hay meadows. Occasionally, deer browse the tops of mature plants in wetlands, but this doesn't appear to reduce the overall density of purple loosestrife.
- Purple loosestrife was introduced to the United States in the early 1800's at northeastern port cities, in ship ballast obtained from European tidal flats. Over the next 100 years it spread through canals and other waterways as far as the Midwest. It arrived in marine

estuaries in the Pacific Northwest in the early 1900s, suggesting that it was spread by maritime commerce.

- Purple loosestrife has also been commonly cultivated for the horticultural trade and became prized by bee-keepers in the mid 1900s. Deliberate planting and escapes from cultivation undoubtedly aided in the spread of infestations across the country.
- Purple loosestrife was first collected in Washington in 1929 from Lake Washington. The first eastern Washington collection was in the 1940s from the Spokane area, although there are reports that it escaped from a garden to the Spokane River ten years earlier.

Description

- Perennial emergent aquatic plant, reaching over 9 feet tall and 5 feet wide. As many as 30-50 herbaceous stems annually rise from a persistent perennial tap root and spreading rootstock.
- **Square stems** (usually 4-sided, sometimes 6-sided). Leaves are usually opposite. The leaves are linear in shape, 1.5 to 4 inches long, with smooth edges, and are sometimes covered with fine hairs.
- The showy **magenta or purple flowers appear from July to October** on flowering spikes. The flowers have 5 to 7 greenish sepals, 5 to 7 magenta petals and 12 stamens. Flowers will continue until frost.
- In winter months, dead, brown flower stalks remain with old seed capsules still visible.




Habitat

- Occurs in freshwater and brackish wetlands, lake and river shorelines, ponds, shallow streams and ditches, wet pastures and other wet places.
- Grows on moist or saturated soils or in shallow water. Can tolerate a range of soil pH and nutrients.
- Requires partial to full sunlight. Productivity is significantly reduced at 40% of full light.

Reproduction and Spread

- Spreads mainly by seed but also by stem and root fragmentation. A mature plant may have as many as thirty flowering stems capable of producing an estimated two to three million, pepper-sized seeds per year. Most seeds remain viable after two years in a natural water body, and stored in laboratory conditions they are viable for about three years.
- Dispersal is mainly by water, but seeds can also be transported on feathers and fur of waterfowl and other wetland animals as well as in mud on boots, tires, boats and pets. There is also some evidence of wind dispersal.
- Seedling densities sharply fall beyond 34 feet of the parent plant.
- Seed banks build for years, unnoticed until the right conditions of disturbance appear, resulting in a population explosion. Mature plants can live for 20 years.
- Vegetative spread is also possible. Buried stems harbor adventitious buds with the ability to produce shoots or roots. Breaking off stems or roots during incomplete plant removal initiates bud growth. Removed stems left on moist soil will also grow roots and sprout.

Local Distribution

- Found on lakes and waterways throughout King County, with 1,214 total sites reported in 2010.

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 or local jurisdictions)**.
- Control practices in critical areas should be selected to minimize soil disturbance, or efforts should be taken to mitigate or reduce impacts of disturbance. Any disturbed areas need to be stabilized to control erosion and sediment deposition. Refer to the King County Surface Design Manual for further information about sediment and erosion

control practices (call 206-296-6519 or go to http://kingcounty.gov/wlr/Dss/Manual.htm for more information).

- Small infestations can be effectively hand-pulled or dug up if conditions allow (see section on Manual Control for more information). Isolated plants should be carefully removed 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, begin at the infestation furthest upriver and work your way downstream.
- Minimize disturbance to avoid creating more opportunities for seed germination.
- Properly dispose of all parts of the plant (see Disposal Methods section below).

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, in ponds, wetlands, ditches and wet pastures.
- The best time to survey is in July and August when the plants are flowering; however, seedlings may not flower in the first year.
- Look for seedlings starting in June.
- Dig up or pull small isolated patches.
- Prevent plants spreading from existing infestations by cleaning off equipment, boots, clothing and animals that have been in infested areas.
- Don't buy or plant purple loosestrife. According to state quarantine laws it is illegal to buy, sell or offer purple loosestrife or any of its cultivars for sale.

Manual

- Hand pulling and the use of hand mechanical tools is allowable in unincorporated King County critical areas. Check with the local jurisdiction for regulations in other areas.
- If the plants are in flower or seed, **cut off and bag all flower stalks and seed heads.** It is very difficult to pull the plants without dispersing the small, lightweight seeds. Brush off boots, clothes and animals before leaving the infested area.
- Hand pulling is recommended when plants are rooted in mucky, sandy or other loose, wet soil. Grasp the base of the plant and pull slowly with steady pressure to release the roots from the soil. Pulling purple loosestrife by hand is easiest when plants are young. Older plants have larger roots that can be eased out with a garden fork. Remove as much of the root system as possible, because broken roots may sprout new plants.

- Cutting plants at the base when in flower may prevent seeding, but cut plants may continue to produce flowers. Sites should be consistently and regularly monitored until frost to cut and remove any subsequent flowers. Cutting will not kill the plants, and they will need to be controlled every year. Do not leave cut plant parts on site, because root and stem fragments can take root and form new plants.
- All manual control sites should be monitored for several years for plants growing from root fragments and from the seed bank.
- **DISPOSAL:** All purple loosestrife plant parts, including flowers, seed heads, stems, leaves and roots must be securely bagged, and discarded in the trash or taken to a transfer station. **Do not compost or place in yard waste. Plants may regenerate in compost. If you have the ability to burn plants, following all local regulations and restrictions, burning vegetative material is an acceptable disposal method. Do not burn flowering stems or seed heads.**
- **NOTE:** Under the Washington State Lythrum quarantine (WAC 16.752.400-415), it is illegal to transport, buy, sell, offer to sell, or to distribute plants, plant parts or seeds of purple loosestrife into or within the state of Washington. However, by following the recommendations in this Best Management Practices document you are covered under the King County Noxious Weed Control Program's permit to transport purple loosestrife for the purpose of taking it to a transfer station or landfill.

Mechanical

- Removal of purple loosestrife with hand held mechanical tools is allowable in critical areas and their buffers within unincorporated King County. Check with the local jurisdiction for regulations in other areas.
- Mowing is not recommended. Since plant fragments can produce new shoots, mowing may facilitate spread rather than control.
- Cutting alone is not a control option for purple loosestrife. New plants will grow from the roots. Cutting late in the season but before seed set reduces shoot production more than mid-summer cutting.
- Sheet mulching or covering using black plastic, landscape fabric, or cardboard and six inches of mulch is an interim option for dense seedling infestations. It does not kill the roots of mature plants, but it does slow down growth and seed dispersal. The covering must extend several feet beyond the edges of the infestation and be weighted so the plants cannot push it up. The edges of the covered area must be monitored for plants coming up from rhizomes extending beyond the sheet. Covering materials should also be monitored for damage or gaps and repaired or re-installed as needed.

Chemical

- **Precautions:**
  - Herbicides should only be applied at the rates and for the site conditions and/or land usage specified on the label of the product being used. **Follow all label directions.**
  - 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.
    - For your personal safety, at a minimum wear gloves, long sleeves, long pants, closed toe shoes, and appropriate eye protection. Follow label directions for any additional personal protection equipment needed.
    - A Washington State pesticide license with an aquatic endorsement is required for the purchase of aquatic herbicides. **NEVER apply non-aquatic herbicide formulations to water since many include ingredients toxic to aquatic organisms.**
- For large infestations of purple loosestrife, herbicide use may be necessary for effective control.
- Cutting after spraying is not necessary. If cutting is desired, infested areas should not be cut until after the herbicide has had a chance to work, which may take several weeks.
- In sensitive areas or areas prone to erosion, careful spot-spraying will create less disturbance than manual or mechanical control.
- For several years following treatment, monitor areas for new plants germinating from the seed bank. In some cases several years of treatment may be necessary.
- When treating an area intermixed with native monocots (cattails, grasses, sedges, etc), using a selective broadleaf herbicide is recommended. The monocots will not be harmed by the herbicide and will be able to help suppress new plants emerging from the seed bank.

Specific Herbicide Information

Glyphosate (e.g. Rodeo®, AquaMaster® or Aqua Neat®): Apply to actively growing plants at early flowering stage. Application to pre-flowering plants or seedlings may also be effective, but unless the extent of the infestation is well known, plants can be difficult to locate when not in flower. Glyphosate works slowly, so plants may not appear to be affected for a couple of weeks. A second application a few weeks after the first may be helpful to control plants not in flower or otherwise skipped during the first application. Apply to foliage but avoid runoff. Caution: Glyphosate is non-selective and it will injure or kill other vegetation contacted by the spray including grasses, cattails and other monocots.

Imazapyr (Habitat®, Polaris®): Apply to foliage any time the plant is actively growing. Caution: Imazapyr is non-selective and highly effective even at low doses: it will injure or kill other vegetation contacted by the spray including trees, desirable vegetation, and grasses, cattails and other monocots. Also, imazapyr is soil-active and can harm trees and other plants rooted in the spray area or sometimes immediately downhill from the area being sprayed.

Triclopyr (Garlon 3A® and Renovate 3®). Apply when plants are in the mid to full-bloom stage. Application to pre-flowering plants or seedlings may also be effective, but unless the extent of the infestation is well known, plants can be difficult to locate when not in flower. Triclopyr is a selective herbicide and will kill only dicots (broadleaf plants and trees). It will not harm monocots such as grasses, sedges, cattails and many 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 in Washington State.

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 can take up to six years to have a significant impact on the infestation. Purple loosestrife population density and the number of flowering plants can be reduced, but there will always be some plants remaining when using biological control agents. Releases should be made only at sites where loosestrife infestations are large and immediate eradication of the weed is not the primary objective.
- All biological control agents approved for use on purple loosestrife in Washington State will not feed on any plant species other than purple loosestrife in our area.
- Where feasible, biological control plans should incorporate another non-chemical control method to be able to prevent all seed production as required by state law. If the infestation is inaccessible, remove flowers at the edges of the infestation to the greatest extent possible. If *Galerucella* or *Hylobius* species are present, flower heads should be cut, bagged and properly disposed of by the time of flower drop in mid to late August. If *Nanophyes marmoratus* weevils are present, flower/seedheads should be cut very carefully in early September after emerging adult weevils have left the flowerheads for the season. If there is any chance of mature seeds being present in the seed heads, extreme care should be taken to avoid spread.
- Biological control is not recommended or prescribed for small infestations.
- Two species of *Galerucella* beetles were first released in Washington in 1992 and subsequently have been released in King County several times in many locations. These small golden-brown leaf-feeders defoliate plants and attack the terminal bud area, halting or drastically reducing seed production. The larvae feed constantly on the leaf underside. Loosestrife seedling mortality is high. These beetles are highly mobile and are often found in King County in locations far from release sites. *Galerucella* beetles do not do well near salt water.



Galerucella beetles feeding on purple loosestrife


Hylobius transversovittatus

- *Hylobius transversovittatus* is a root-mining weevil that also eats leaves. The adult beetle is reddish brown and ½ inch long. It eats from the leaf margins, working

inward. Eggs are laid in the lower 2-3 inches of the stem, or sometimes in the soil near the root. The larvae then work their way to the root, where they eat the carbohydrate reserves. Evidence of larvae in the root is a zig-zag pattern. *Hylobius* tolerates coastal areas and is a better choice for infestations near salt water.

- *Nanophyes marmoratus* is a tiny seed weevil. Larvae and adults impact purple loosestrife by feeding on unopened flower buds. Flower buds with larval feeding damage usually abort and fail to produce seeds. Adults also feed on developing leaves, further weakening plants. *Nanophyes* can also be successful when used in conjunction with *Hylobius*.

Nanophyes weevil on purple loosestrife

SUMMARY OF BEST MANAGEMENT PRACTICES

Small Infestations in Native and/or Desirable Vegetation

- Hand pulling is recommended for young plants or older plants in loose, wet soil.
- Larger plants from isolated small populations can be dug out from moist upland areas. This may be impractical to impossible when trying to remove hardy, woody roots in compacted soils. Care should be taken to minimize erosion when digging in saturated soils on shorelines.
- If the plants are in flower or in seed, **cut off and bag all flower heads.** Pulling plants in seed will disperse the small, lightweight seeds. Cut plants may continue to produce flowers, so these sites will have to be consistently and regularly monitored until frost to cut and remove any subsequent flowers.
- When digging or pulling on shorelines, take appropriate erosion control measures.
- If manual control is not possible due to site conditions or available labor, apply appropriate herbicide with wick wiper or spot spray to minimize off target injury.
- If using an herbicide in an area that has desirable grasses and other monocots, use a selective broadleaf herbicide to avoid injury to grasses and other monocots.

Large Infestations in Areas with Monocots

- Cutting alone is not a control option for purple loosestrife. Shoots and adventitious roots will develop. Cutting late in the season but before seed set reduces shoot production more than mid-summer cutting. Cut plants may continue to produce flowers, so these sites will have to be consistently and regularly monitored until frost to cut and remove any subsequent flowers.
- Sheet mulching using black plastic, landscape fabric, or cardboard and six inches of mulch is an interim option for dense seedling infestations. It does not kill the roots of mature plants, but it does slow down growth and seed dispersal. This method is also non-selective.
- If an area has desirable monocots present, use a selective herbicide and encourage the growth of the monocots.

- If the infestation is in a pasture, encourage healthy grassy areas by seeding and fertilizing. Use a mix of grass and clover species to improve resistance to purple loosestrife. Fertilize according to the soil needs.
- If using biological control, areas need to be monitored and any flowers removed and properly disposed of where feasible. If the infestation is inaccessible, remove flowers around the edges of the infestation to the greatest extent possible. If *Galerucella* or *Hylobius* insects are present, flower heads should be cut, bagged and properly disposed of by the time of flower drop in mid to late August. If *Nanophyes marmoratus* weevils are present, flower/seedheads should be cut very carefully in early September after emerging adult weevils have left the flowerheads for the season. If there is any chance of mature seeds being present in the seed heads, extreme care should be taken to avoid spread.

Control on Shorelines

- 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 Design Manual for further information about sediment and erosion control practices (call 206-296-6519 or go to http://kingcounty.gov/wlr/Dss/Manual.htm for more information).
- Survey area and document extent of infestation.
- Focus on manual removal for small infestations if possible.
- When removing vegetation on shorelines (by lakes, streams and wetlands) use barriers to prevent sediment and vegetative debris from entering the water system.
- Cutting will not control purple loosestrife but it can serve in the interim until more effective control measures can be accomplished.
- For larger areas where herbicide use is warranted, spray using low pressure and large droplet size to reduce drift. If herbicide could potentially drift into the water or a wetland area, use only approved aquatic herbicides and surfactants after obtaining the necessary permits.
- Infested areas will need to be monitored for several years to control plants growing from root fragments and germinating from the extensive seed bank.

Control along Road Rights-of-Way

- Pull small infestations if possible.
- Spot spray larger infestations. Use a selective broadleaf herbicide in areas with desirable monocots such as grasses, sedges or cattails; if controlled with a non-selective herbicide, re-seed after control is completed.
- If plants are about to flower, they can be cut until a more effective control strategy can be used. Be sure to dispose of cut plant parts properly.
- If plants are sprayed, wait until the herbicide has had a chance to work before conducting any regular right-of-way mowing.

Disposal Methods

- All purple loosestrife plant parts, including flowers, seed heads, stems, leaves and roots must be securely bagged, and discarded in the trash or taken to a transfer station. **Do not compost or place in yard waste. Plants may regenerate in compost. If you have the ability to burn plants, following all local regulations and restrictions, burning vegetative material is an acceptable disposal method. Do not burn flowering stems or seed heads.**
- **NOTE:** Under the Washington State Lythrum quarantine (WAC 16.752.400-415), it is illegal to transport, buy, sell, offer to sell, or to distribute plants, plant parts or seeds of purple loosestrife into or within the state of Washington. However, by following the recommendations in this Best Management Practices document you are covered under the King County Noxious Weed Control Program's permit to transport purple loosestrife for the purpose of taking it to a transfer station or landfill.

References

Bender, J; update by Rendall, J 1987. Element stewardship abstract for *Lythrum salicaria* Nature Conservancy, Arlington, VA. http://wiki.bugwood.org/Lythrum_salicaria

Benefield, C, California Invasive Plant Council. *Lythrum salicaria*. Retrieved March 4, 2005 from UC Davis web page: http://ucce.ucdavis.edu/datastore/detailreport.cfm?usernumber=61&surveynumber=182

William, R.D. and D. Ball, T. Miller, R. Parker, J. Yenish, T. Miller, D. Morishita and P. Hutchinson. 2002. Pacific Northwest Weed Management Book. Oregon State University, revised annually.

Written Findings. 1997. Washington State Noxious Weed Control Board.

Rawinski, Tom. 1982. The ecology and management of purple loosestrife (*Lythrum* salicaria *L.) in central New York. M. S. thesis, Cornell University.*

Thompson, Daniel Q., Ronald L. Stuckey, Edith B. Thompson. 1987. Spread, Impact, and Control of Purple Loosestrife (*Lythrum salicaria*) in North American Wetlands. U.S. Fish and Wildlife Service. 55 pages.

http://www.nps.gov/plants/alien/fact/lysa1.htm

King County Noxious Weed Control Program
BEST MANAGEMENT PRACTICES

King County

Invasive Knotweeds

Bohemian Knotweed
Polygonum x bohemicum (Fallopia x bohemica)
Japanese Knotweed
Polygonum cuspidatum (Fallopia japonica)
Giant Knotweed
Polygonum sachalinense (Fallopia sachalinense)
Himalayan Knotweed
Polygonum polystachyum (Persicaria wallichii)
Polygonaceae – Knotweed/Buckwheat Family

Class B Noxious Weeds
Control Recommended
(required in selected areas)

Legal Status in King County: The species of knotweed listed above are classified as Class B noxious weeds (non-native species that can be designated for control based on local priorities) according to Washington State Noxious Weed Law, RCW 17.10. The Washington State Noxious Weed Control Board has not designated these species for required control in King County. The King County Noxious Weed Control Board recommends control of these species wherever feasible, and requires control in selected areas (see current King County Noxious Weed List for details). State quarantine laws prohibit transporting, buying, selling or offering these species for sale or distributing plants, plant parts or seeds.

BACKGROUND INFORMATION

Impacts and History

- Displaces native vegetation due to its fast-growing, dense, 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. Changes nutrient cycling of rivers and lowers water quality.
- Thickets can completely clog small waterways.
- Forms dense stands that crowd out all other vegetation, degrading native plant and animal

habitat.

- Damages pavement, limits sight visibility along roads, and obscures guard rails and road signs.
- Roots interfere with drainage and septic systems.
- Invades turf and landscaped areas.
- Difficult to control because of extremely vigorous rhizomes and roots that form a deep, dense mat.
- Plants can re-sprout from very small root and rhizome fragments.
- Plant stems and rhizomes that fall into the water can create new infestations downstream.
- Japanese and giant knotweed are native to northeastern Asia. They hybridize to produce Bohemian knotweed. Himalayan knotweed is native to south and central Asia, including the Himalayas.

- All species were introduced into the U.S. and Canada starting in the late 1800s as ornamental plants and for erosion control and have since spreadwidely.

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 varies. : Himalayan knotweed leaves are like an elongated triangle, Japanese knotweed leaves are rounded with a flat base and short pointed tip Bohemian knotweed leaves vary from a heart-shaped base to a flat base and variable leaf tip shape, and giant knotweed leaves are huge, "elephant ear" type leaves with a distinctly heart-shaped base and elongated pointed tip. Leaf size also varies, however Japanese knotweed leaves are generally 4 to 6 inches long by 3 to 4 inches wide, hybrid Bohemian knotweed leaves are 7 to 9 inches long, and 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

The key to controlling knotweed is controlling the rhizomes. What you see on the surface is only a fraction of the problem. "Control measures that fail to address the regenerative capacity of the rhizomes will not control this plant." (Gover et al 2005). 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.

Begin by surveying area for knotweed, setting priorities and selecting the best control method(s) for the site conditions and regulatory compliance issues **(refer to the King County Noxious Weed Regulatory Guidelines)**.

It is possible but not easy to control knotweed, and it is especially difficult on a landscape scale, such as along a river, or when spread over many properties. Because of knotweed's incredibly extensive root system and sprouting ability, landscape level control requires long-term planning and follow-up. Even on a patch-by-patch basis, successful eradication is likely to take several years and multiple treatments.

On rivers and streams, knotweed spreads easily downstream by water, so it is necessary to begin control from the furthest upstream infestation, including all tributaries and other upstream sources of possible re-infestation.

For large, landscape scale projects, outreach to all public and private landowners and the broader community, as well as volunteer recruitment and coordination, will improve the success of the project. 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.

Below, each method is first described individually, and then Best Management Method recommendations are provided for different types of infestations.

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 at least April and August, and then once a month or more until the first frost, over 3 to 5 consecutive years (Soll 2004). This can vary depending on the growth of the plant. The important thing it to keep the plant from storing any new root energy.
    - Keep plants from growing taller than 6 inches.

- Using a machete, loppers or pruning shears, cut the stems to the ground surface. If using a mower/weed-eater is necessary, cut as low 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. Dried stems can be crushed and composted on site or discarded in yard waste.
- Stems or stem fragments left on moist soil or in water may sprout at the nodes, and the area (or adjacent areas) may become re-infested.
- Large piles of composting knotweed stems have been known to self-ignite, so take care not to create large piles and monitor regularly.
- Goats and chickens are reported to eat knotweed and in some circumstances, controlled grazing may be an option similar to intensive mowing. Be aware that goats will eat desirable vegetation as well as knotweed. Grazing should reduce the growth of knotweed, but is unlikely to completely kill the plants. For best results, maintain intense grazing pressure for at least 5 years over the entire knotweed patch or until plants stop growing back.
- Never allow cut, mowed or pulled knotweed 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.
  - Roots of established plants may extend down 7 to 10 feet deep, and rhizomes are often very large and woody and difficult to dig up.
  - Be sure to carefully dispose of the roots in garbage. Do not put them in a compost pile because they remain viable for a very long time. Roots and rhizomes dry out very slowly, so burning isn't usually a feasible disposal option for rhizomes.
  - 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 search at least 20 feet away from the original patch center for new sprouts.
- **COVER** with heavy duty geo-textile fabric or black plastic.
  - Works better with isolated and smaller patches on open, undisturbed terrain.
  - Plan to leave the covering material in place throughout at least five growing seasons, longer if the soil is wet or the population large and well-established.
  - 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.

- Install covering 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 Control

- Herbicides should only be applied at the rates and for the site conditions and/or land usage specified on the herbicide 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.
- Herbicides with the active ingredients glyphosate (e.g. Rodeo, Roundup, Aqua Neat among others), imazapyr (e.g. Habitat, Polaris, Arsenal), triclopyr (e.g. Garlon, Renovate, Element) and aminopyralid (e.g. Milestone) have shown to be variably effective in controlling or suppressing knotweed either separately or in combination. Results vary depending on the timing, rate and method of application. See below for detailed information.
- Aquatic herbicides are Restricted Use Pesticides in Washington and can only be purchased and used for aquatic applications by WSDA licensed pesticide applicators with an aquatic endorsement on their license. Also, state and sometimes local permits are generally required when applying pesticides in water or where herbicides are likely to drift into water.
- Aquatic herbicides that are also labeled for use in terrestrial areas, such as Roundup Custom, can be purchased and used by non-licensed individuals for treating knotweed, as long as the plants being treated are not growing in water and the herbicide is not likely to drift into water, such as with the stem injection method.

Types of Chemical Control Methods

Foliar Application

- Use a backpack sprayer or large volume sprayer.
- Easiest and fastest method, but potentially higher risk of drift onto desirable vegetation and into water and soil.
- Use a systemic herbicide that translocates from leaves to the roots.
- The most effective chemical on knotweed is imazapyr and the second most effective is glyphosate. These products can also be combined to produce

quicker visual signs of treatment, but does not increase the effectiveness of using imazapyr alone.

- The most effective time to spray knotweed with glyphosate or imazapyr is generally July to October, or between bud formation and when the plant dies back after the first frost, with later treatments in that time period generally being more effective than earlier. Early treatments may require a follow-up spray to control re-growth. This will vary with weather and water availability. Usually the most effective time for a single treatment is late August/early September.
- Non-selective herbicides such as glyphosate (e.g. Roundup) and imazapyr (e.g. Habitat, Polaris) kill both grass and broadleaf plants. Selective broadleaf herbicides will not harm most grasses if used according to label. However, there are currently no selective broadleaf herbicides that provide more than one season of knotweed control. Triclopyr and aminopyralid will provide short-term control of knotweed, but generally won't kill the plants. Metsulfuron and dicamba will also control top growth of knotweed although generally don't control the rhizomes. 2,4-D is not effective on knotweed.
- Where it is not possible to spray over the top of the plants due to height and access, spray the stems and the undersides of the leaves and get as much coverage of the plants as possible.
- Avoid spraying knotweed when bees and other pollinators are present on the flowers whenever feasible. When pollinators are present, consider spraying either before full-bloom or after petals begin to drop. You can also spray earlier or later in the day when bees are not as active. If necessary to spray when plants are in full flower, spray the stems and undersides of the leaves and avoid spraying the flowers as much as possible. You may also consider clipping and removing the flowers prior to foliar spray, or using a stem injection method. Alternately, beekeepers can be notified and asked to move bees away from areas being treated if there are concerns about exposure.
- If plants are cut back, allow them to re-grow for at least six weeks, or to about 3 to 6 feet tall, before spraying. If plants are bent over to make them shorter and easier to spray, allow them to recover for one to two weeks before spraying to make sure they are actively growing again. Typically, spraying re-growing or bent knotweed is not as effective as spraying full grown plants, but it is sometimes more efficient and necessary because of land use or visibility issues.
- If it is necessary to keep plants from growing tall for visibility or other reasons, 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.
- Experience in Pennsylvania suggests June 1 as a good cutting date if follow up spraying is planned. They found that regrowth when cut June 1 is

vigorous, but limited in height (6 to 10 ft tall knotweed cut in June resulted in 2 to 4 foot tall re-growth). Cutting too early in the season can result in regrowth that reaches full height and waiting too late in the season can result in almost no regrowth and will limit the ability to spray and control next season's growth (Gover et al 2005).

- Continue to monitor and treat annually in the late summer as long as there is re-growth. Re-growth the following years will be much shorter and sparser, and can be sprayed with considerably less herbicide, although it will take more time to locate all the plants. Re-growing plants can also be dug up once they are very small, although it is still difficult to remove all the roots.
- Regardless of herbicide choice, rate or spray timing, large, established patches (hundreds or thousands of stems) will almost certainly require foliar treatments over at least three years, possibly many more. 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.

Specific Herbicide Information

Glyphosate: 2% to 5% solution plus surfactant (as recommended on label).

- 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.
- Roundup Custom/AquaneatRodeo plus surfactant (e.g. Competitor, Agridex) are approved for aquatic sites.
- Roundup ProMax or other products containing glyphosate can be used on terrestrial sites. Add surfactant if advised on label. The concentration of active ingredients can vary by product so make sure to use the rate recommended on the label. The percent rate given here is based on a product such as Roundup ProMax that has 48% active ingredient.

Imazapyr : slow-acting and expensive but highly effective on knotweed.

- 1% solution with 0.25% to 1% surfactant or 0.5 to 1 lb per acre.
- Apply from midsummer after seed set until first killing frost.
- Habitat and Polaris are approved for aquatic sites.
- Arsenal and other imazapyr products are approved for various non-aquatic sites (see label for crop rotation and other restrictions).
- Imazapyr has some soil activity and may impact roots of other plants in the area being sprayed for several months after application. Follow label instructions before planting into treated area and use caution around tree roots and on permeable soils.

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 (or as directed on product label).
- Greatly reduces drift.
- Hard to get chemical on leaf surface and seems to increase personal contact with herbicide.
- May be appropriate for small re-growing plants growing near desirable vegetation.

Cut and Pour

- Not very effective and generally not recommended.
- Cut stems between lowest 2 nodes and 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.
- Timing best in late summer or early fall.
- 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).
- Need to remove cut stems away from water where they can dry out and not spread off site.

Hollow Stem-Injection

- Timing is best from late July to end of September (or whenever the stems dry out and start splitting when injected).
- Use a stem injection gun or similar tool that can be calibrated to the required amount.
- Follow directions carefully especially on calibrating and cleaning the equipment.
- Highly effective; usually 95% or more controlled in first year.
- Greatly reduces drift, is highly selective and there are 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.
- Glyphosate is the only product labeled for hollow stem injection. Aquatic formulations of glyphosate such as Roundup Custom (formerly sold as Aquamaster), Rodeo, or Aqua Neat can be used on or near aquatic sites while Roundup ProMax and other non-aquatic formulations, can be used on non-aquatic sites.

- Inject the concentrated herbicide product into each stem between first and second nodes from the ground, or between second and third node if cane is too woody lower down.
- Most labels recommend 5 ml per cane for knotweed, but our experience and WSU Extension trials have shown that 3ml is just as effective as 5 ml, so we recommend using 3 ml.
- Mark stems immediately after injecting with spray paint or a grease pen to avoid missing stems or doubling up (once stems are injected they won't hold another dose and herbicide will spill out of the stem).
- Make sure to stay within the per acre label rate for the glyphosate product you are using. For example, with a label maximum of 7.5 quarts per acre, at 3ml per cane, you can only inject approximately 2,375 canes per acre.
- For two to three years following stem injection, plan on either spot-spraying or digging up any re-growing plants. Plants will be smaller and sparser, but follow up is essential to long term control.

Combination of Methods

- Using a combination of methods may work better for some site conditions, labor availability or land use needs. However, none of these methods are as effective as spraying full grown knotweed in late summer or using hollow stem injection.
- **Cut/Spray:** Cutting stems, followed by foliar spray 6 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:** Bend stems and then approximately 2 to 4 weeks later, spray plants. Volunteers or unlicensed crews can be used 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 the combination methods.

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 or your local Weed Board or Extension Agent.**

Biological Control

- 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.
- There are currently no biological control agents approved for managing invasive knotweed in the United States, but it is likely that agents will be approved in the near future. In Washington, contact the WSU Integrated Weed Control Project at http://invasives.wsu.edu/aboutus.htm for current information.

SUMMARY OF BEST MANAGEMENT PRACTICES

Small Infestations in Native and/or Desirable Vegetation

- Dig up plants or apply appropriate herbicide with wick wiper or by spot spray to minimize off target injury (follow directions above for the method used).
- Monitor site throughout growing season and remove any new plants. Remember to search at least 20 feet from the original infestation.
- If using an herbicide in a grassy area, consider using a selective herbicide to avoid injury to the grass or a wick wiper or stem injector.
- Re-vegetate bare areas with appropriate vegetation or cover with mulch while desirable vegetation becomes established. Do not leave large areas of bare soil.

Large Infestations/Monocultures

- Mowing is not effective for controlling invasive knotweed infestations and can spread infestations further.
- Large infestations can be controlled with herbicides or a combination of methods (follow directions in the appropriate sections above).
- Eradication of knotweed with a single herbicide application is difficult. Typically it takes several treatments, over 4 to 6 years to get an infestation under control.
- If using the covering method, be sure to monitor for knotweed growth on the edges of sheet-mulched sites, at overlapped areas in the sheet-mulch, and where sheet-mulch has been staked. For sprayed sites, monitor annually around the edges of chemically treated areas.
- Use erosion control measures in areas subject to erosion, especially on steep slopes or riverbanks.
- Plan on re-vegetating with desirable vegetation after the initial 2-3 years of treatment, especially in areas likely to be re-infested with knotweed or other

invasive vegetation. Mulch bare areas until vegetation is re-established where feasible.
- Consider replanting with vegetation that is beneficial to bees and other pollinators when clearing large areas of knotweed. Use native or non-invasive plants only.

Control in Riparian Areas

- Additional permits may be required for control of infestations in riparian areas. See the **King County Noxious Weed Regulatory Guidelines** for more information or contact your local jurisdiction.
- Whenever large areas of vegetation 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 206-477-4800 or go to http://www.kingcounty.gov/environment/waterandland/stormwater/documents/surface-water-design-manual.aspx for information).
- Survey area and document extent of infestation from the headwaters of waterways down.
- Consider manual removal or stem-injection for small (less than 50 stems) infestations if feasible.
- Target the knotweed, retaining and protecting native and beneficial plants.
- Use aquatic formulations where there is any risk of herbicide entering the water.
- Infested areas should incorporate a management plan lasting at least several years to control plants re-sprouting from the rhizome mass, skipped plants and any regrowth.

Control on Road Rights-of-Way

- Mowing is not an effective means of control and can spread knotweed infestations along road rights-of-way.
- Small plants should be dug up or spot sprayed with an appropriate herbicide. Large patches can be sprayed in late summer/early fall or controlled with a combination of cutting and spraying (see instructions above).
- Where necessary for visibility or other issues, plants can be cut down or sprayed in May or June and then sprayed again in late summer or early fall.

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 and crushed 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.
- Large piles of composting knotweed stems have been known to self-ignite so monitor piles and avoid creating very large stacks. Knotweed stems burn when dry but the hollow compartments can burst and create small explosions when burned.
- 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 or infest areas downstream.

References

Child, L.E. and P.M. Wade. 2000. The Japanese Knotweed Manual: The Management and Control of an Invasive Alien Weed. Packard Publishing Limited, West Sussex, UK.

Gerber, E., Kerbs, C., Murrell, C. Moretti, M., Rocklin, R., Schaffner, U., 2008. Exotic Invasive Knotweed (*Fallopia* spp.) Negatively Affects Native Plant and Invertebrate Assemblages in European Riparian Habitats. Biological Conservation 141, 646-654.

Gover, Art, Jon Johnson, and Larry Kuhns. 2005. Managing Japanese Knotweed and Giant Knotweed on Roadsides. Penn State Roadside Research Project, Department of Horticulture, College of Agricultural Sciences, Fact Sheet 5. Online: http://plantscience.psu.edu/research/projects/vegetative-management/publications/roadside-vegetative-mangement-factsheets/5managing-knotweed-on-roadsides. Accessed July 8, 2015.

Hood, W.G., Naimann, R.J., 2000. Vulnerability of riparian zones to invasion by exotic vascular plants. Plant Ecology 148, 105-114.

Peachey, E., editor. 2015. Pacific Northwest Weed Management Handbook [online]. Corvallis, OR: Oregon State University. Online http://pnwhandbooks.org/weed. Accessed July 8, 2015.

Silver, J., Hutten, M., 2004. Knotweed Control on the Hoh River Summary Report – 2002 to 2004. 10,000 Years Institute. Port Townsend, WA.

Soll, Jonathan. 'Controlling Knotweed (*Polygonum cuspidatum, P. sachalinense, P. polystachyum* and hybrids) in the Pacific Northwest". 2004. The Nature Conservancy. Online: http://www.invasive.org/gist/moredocs/polspp01.pdf. Accessed July 14, 2015.

Urgenson, L., 2006. The Ecological Consequences of Knotweed Invasion into Riparian Forests. University of Washington, College of Forest Resources. Seattle, WA.

Urgenson, L., Reichard, S., Halpern, B., 2009. Community and Ecosystem Consequences of Giant Knotweed (*Polygonum sachalinense*) Invasion into Riparian Forests of Western Washington, USA. Biological Conservation 142, 1536-1541.

Washington State Department of Agriculture (WSDA), 2005. 2005 Washington State Integrated Knotweed Management Plan. http://agr.wa.gov/plantsinsects/weeds/knotweed/docs/KnotweedIPMPlan.pdf (accessed February 21, 2014).

Washington State Noxious Weed Control Board. Written Findings. http://www.nwcb.wa.gov/siteFiles/Polygonum_cuspidatum.pdf, http://www.nwcb.wa.gov/siteFiles/Polygonum_polystachyum.pdf, http://www.nwcb.wa.gov/siteFiles/Polygonum_x_bohemicum.pdf, http://www.nwcb.wa.gov/siteFiles/Polygonum_sachalinense.pdf. Accessed July 14, 2015.

Reed Canarygrass

Phalaris arundinacea **Class C Noxious Weed**
Poaceae **Control Recommended**

Legal Status in King County: Reed canarygrass (RCG) 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

- Native to Eurasia and possibly North America as well. No reliable way to tell the difference between native and introduced populations. Present on every continent except Antarctica.
- Widespread throughout most of North America including Washington State
- European cultivars widely introduced as hay and forage
- Agricultural use in the Pacific Northwest began at the turn of the 20th century as the first crop following logging for areas being converted to farming
- Used for soil stabilization, although waterways can undermine sod and increase erosion
- Can cause indigestion in livestock
- Forms monospecific stands over time and drastically reduces wetland species diversity
- Can form physical barriers to salmonid migration
- Flooded RCG fields have been known to confuse and strand migrating salmon
- Provides little food for native wildlife species
- Contributes to increased water temperatures
- Dense colonies decrease water flow, increase siltation, contribute to flooding
- Pollen and chaff can aggravate allergies in humans

Reed canarygrass leaf and ligule (*left*); reed canarygrass inflorescence w/seeds formed (*right*)

Description

- Cool-season sod-forming perennial grass 3-9 feet (1-3m) tall
- Rhizomes and dead stems can form sod over 1.5 feet (0.5m) thick that few other species can penetrate
- Stems hairless, hollow, to ½ inch (1.25 cm) in diameter, often reddish near top
- Leaves stick out at a 45 degree angle from the stem
- Leaf blades flat, hairless, ¼ to ¾ inch (0.6-1.9cm) wide, up to 1.5 feet (0.5m) long
- Ligule long and membranous
- Inflorescence is a compact panicle on tall stems high above leaves
- Flowers May to July
- Inflorescence turns from green to purplish in full bloom, then straw colored when seeds form
- Seeds are shiny brown
- Dead stems remain erect and persist throughout the winter, making identification in winter possible

Habitat

- Grows best in wet to damp soil
- Can tolerate prolonged drought in seasonally wet areas
- Can survive in deeper water if recently inundated
- Wet meadows, streambanks, lake margins, ditches, shallow wetlands
- Full sun, does not tolerate shade well

Reproduction and Spread

- Spreads by seed, rhizomes and vegetative fragments
- All plant parts float, facilitating spread in standing or moving water

- Rhizomes:
  - More common form of spread is by rhizomes
  - Rhizomes can extend over 10 feet per year and form a thick mat
- Seeding:
  - Each inflorescence can produce up to 600 seeds;
  - Seeds will not germinate in dense shade
  - Seed germination generally low, seeds viable for less than four years
  - Cold temperatures required for flowering and seed germination
  - Seeds spread on animals, humans (boots, clothing, tools) and cars/machinery
- Vegetative fragments:
  - Detached stems or rhizomes grow into new plants when in contact with bare soil
- Can become established in a disturbed wetland in less than 12 years

Reed canarygrass seeds on muddy boots

Local Distribution

Very widespread in King County in all available habitats

CONTROL INFORMATION

Many of the control techniques discussed below require permits to implement. Refer to the **King County Noxious Weed Control Regulatory Guidelines** for more information on permitting. This document outlines permits and regulations that pertain to physical, cultural, and chemical control methods. The document is available at: www.kingcounty.gov/weeds

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.
- In most cases, a successful reed canarygrass control project will involve at least two different control methods

Early Detection and Prevention

- Reed canarygrass is identifiable year round. Search for it in winter when other grasses are dormant and RCG's persistent, straw-colored stalks are easily seen.
- RCG can be slow to invade intact wetland systems with healthy native plant communities. Any RCG plants found in this situation should be pulled or otherwise carefully controlled as soon as possible.
- Prevent plants from spreading away from existing populations by washing vehicles, boots and animals that have been in infested areas.
- Invasion of any disturbed wetland, including wetland restoration sites, is common since RCG is so widespread. Take measures to prevent establishment such as heavily mulching around new plantings and following a regular maintenance regime to remove new introductions.

Manual Control: using hand tools

- Hand pulling and the use of hand tools are allowable in unincorporated King County critical areas. Check with the local jurisdiction for regulations in other locations.
- Pulling is usually not a viable option because rhizomes will remain in the soil and resprout. It is possible to pull seedlings in wet/mucky soil.
- Dig with hand tools only small clumps in soft soil where you have a reasonable chance of removing all roots and rhizomes.
- Cut small patches with hand clippers or machetes as close to the ground as possible to prevent seeding or as part of an integrated approach. Cutting alone will not kill the plants.
- Clean tools after use to minimize risk of spread.
- Always dispose of removed material properly (see below).

Mechanical Control: using mechanical tools

- Mow or cut using an appropriate tool for the infestation location and size (mowers, brush cutters, line trimmers, tractor-drawn mowers, etc). Follow recommendations below under "Large Infestations/Monocultures" for frequency and timing of mowing.
- Cultivate using discing or tilling machinery as part of an IPM program. Cultivating alone will increase RCG by cutting up and spreading rhizomes unless done frequently through several seasons.
- Burn using a hand-held weed torch. Several varieties are available online. Follow all instructions and safety considerations for the model you use. Do not use a torch in dry or windy conditions. For best results heat small or cut plants slowly to kill all growth.
- Prescribed burning can stimulate growth if done at the wrong time. In the Pacific Northwest that means that burning alone is impractical since fall burns are usually the only timing possible, and fall is the wrong time of year to burn RCG. However, burning can be used as a pre-treatment with other methods such as tilling, shade cloth installation or herbicide application, since it will remove above-ground dead litter.

Burning may require special permits. Check with your local jurisdiction prior to attempting a prescribed burn. For unincorporated King County check with the Department of Permitting and Environmental Review (http://www.kingcounty.gov/property/FireMarshal/BurnBanInfo.aspx)

- Excavating (as with a backhoe) is generally not advised. If a wetland restoration design calls for excavating in reed canarygrass-dominated areas, dispose of all removed plant material properly (see below) and/or bury sod and soil under at least two feet of uncontaminated soil.
- Clean tools and machinery after use to minimize risk of spread.
- Always dispose of removed material properly (see below).

Cultural Control

1) Covering

a) Cover with commercially available shade cloth and secure tightly with stakes, rebar, large garden staples or other appropriate devices. Overlap sections of cloth by at least one foot, and extend the coverage at least two feet beyond the edge of the infestation. Monitor edges and seams for shoots from lateral growth of rhizomes. Shade cloth should be left in place for at least two growing seasons. Shade cloth does not biodegrade and must be removed after use.

b) Sheet mulch using several layers of thick, clean cardboard (no tape or staples). Overlap pieces by at least one foot and extend coverage at least two feet beyond edge of infestation. Cover cardboard with at least four inches of wood mulch or hog fuel.

c) Sheet mulching as described above plus planting densely (2-3 ft. (0.6-0.9 m) apart) with live willow stakes has proven successful in the Puget Sound area, but will not work in areas that get flooded.

2) Flooding

a) If it is possible to manipulate water levels, flood to at least 18 inches (if combined with intensive cultivation) or at least 32 inches if flooding is the only control method.

3) Planting shade

a) Establish desirable trees and shrubs to form shade canopy. Where possible, plan to establish a multi-layered dense canopy, preferably with conifers in the overstory. Dense planting of alders or cottonwoods has also been shown to reduce RCG once a canopy is formed.

b) Install live willow stakes planted at a density of 2-3 ft. (0.6-0.9 m) apart.

c) Any planting effort must include monitoring and spot control of reinvasion for several seasons until trees and shrubs are large enough to compete with RCG. Heavy mulching when plants are small will help.

d) Incomplete shade will allow RCG to recover and/or re-invade.

Chemical Control

Precautions

1) Herbicides should only be applied at the rates and for the site conditions and/or land usage specified on the label of the product being used. **Follow all label directions**.
2) For your personal safety, at a minimum wear gloves, long sleeves, long pants, closed toe shoes, and appropriate eye protection. Follow label directions for any additional personal protection equipment needed.
3) Permits and licenses are required for all chemical control in water and where herbicide is likely to drift into water.
4) Herbicides can only be applied to aquatic systems in Washington State by a licensed pesticide applicator with an aquatic endorsement on their license.
5) A Washington State pesticide license with an aquatic endorsement is also required for the purchase of aquatic herbicides. **NEVER apply non-aquatic herbicide formulations to water since many include ingredients toxic to aquatic organisms**.

Application Methods

1) Small areas can be successfully treated with one application, but larger areas may require several years of treatment to exhaust the seed bank.
2) Spot spray small infestations taking care to avoid damaging surrounding vegetation.
3) Herbicide application prior to covering or sheet mulching can increase efficacy of those methods. Allow for enough time for the herbicide application to take effect so the read canarygrass is dead prior to mulching.
4) Small patches (less than 2 feet in diameter) can be tied in a bunch just before flowering, cut above the tie and then treated with a 33% glyphosate solution applied directly to the stems.
5) Wick-wipe using a wick-wipe tool or hand swiping.
6) Wick-wipers attached to a tractor can treat tall stands without affecting shorter vegetation underneath.

Specific Herbicide Information

1) **Glyphosate** (aquatic labeled trade names include Rodeo ®, AquaMaster ®, Aquaneat ®, Glypro ®). Effective when applied in a 1.5 to 5 percent solution with a nonionic, surfactant (only use surfactants approved for use in aquatic areas by Washington Department of Ecology).

2) **Imazapyr** (aquatic formulations include Habitat ® and Polaris®). Effective when applied at a 1.5 percent solution with a nonionic surfactant (only use Ecology-approved aquatic surfactants). Imazapyr remains active in soil for some time and may cause collateral damage to nearby vegetation, including trees. Recommended only when applied to a RCG monoculture where the site will not be replanted until the following growing season or later. Conducting a soil bioassay prior to planting is recommended to avoid any residual effects from the herbicide in the soil.

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. Additional information and recommendations can be found in the references listed at the end of this document. **For questions about herbicide use, contact the King County Noxious Weed Control Program, Washington State Department of Agriculture or Washington State Department of Ecology.**

Biological Control

- There is no known biocontrol at this time.

BEST MANAGEMENT PRACTICES

Reed canarygrass is widespread in King County, and eradication is unlikely in all but the most isolated locations. Reinfestation is likely unless control, monitoring and maintenance are carefully planned and implemented. Successful long term control will follow these steps:

1. **Prevention**: If you have a wetland dominated by native plants, monitor the edges and immediately remove any reed canarygrass you find. Avoid disturbing the wetland.
2. **Remove existing plants:** Follow the recommendations below that best suit your situation to remove or kill all existing reed canarygrass plants in the infestation. Generally work first in least infested areas, moving towards more heavily infested areas.
3. **Deplete seed bank:** In all but early pioneering infestations the seed bank should be depleted if at all possible before replanting the area (if necessary). Allow seeds to grow and then remove the plants several times over at least two seasons for best results. Seeds can remain viable for up to four years.
4. **Revegetate** with shade-producing or highly-competitive native or other desirable species. Choose plants that will thrive in your location. Best results are obtained with a planting plan that will ultimately establish a multi-layered shade canopy, preferably coniferous, but lighter shade or other plant communities can reduce the impact of reed canarygrass. Consult a restoration specialist for assistance with your area.
5. **Monitoring and maintenance** of any controlled site is imperative until desirable vegetation becomes well established. Any site left unmaintained will revert back to reed canarygrass within a few years.

Permits may be required for some control techniques and some situations. See Control Information section above for more information.

Small Infestations

- **Manual:** Not practical for any but the smallest patches. Hand dig when the ground is soft. Be sure to remove all roots and rhizomes. Any roots or rhizomes left in the soil will resprout. Monitor the site for regrowth. Properly dispose of all removed plant material.
- **Shade:** Cover with shade cloth or sheet mulch with several layers of cardboard and four to six inches of wood mulch. Leave in place for at least one growing season. Monitor the edges for shoots coming up from lateral growth of rhizomes. Efficacy can be increased by pre-treating with herbicide (allow enough time for the herbicide to kill the reed canarygrass before covering), flaming, or removing above ground plant material at or just after flowering, either with hand tools or a line trimmer. Properly dispose of all removed plant material.
- **Burn**: Flaming using hand-held weed torch (many varieties available online) may be possible in some situations. Remove dead stems and thatch as much as possible prior to flaming to reduce threat of smoke and fire. Flame emerging shoots frequently during at least one growing season to weaken and kill roots. Monitor site for regrowth.
- **Chemical:** Spot spray or wick wipe with approved aquatic herbicide just past flowering stage when maximum energy has been depleted from the root system.

Large Infestations / Monocultures

Multiple methods will be required in most situations for large infestations.

1. **Remove or kill established plants.** Depending on feasibility, site conditions and resources, use mowing, cultivation, flooding, burning or herbicide alone or in combination. Research has demonstrated that the following combinations work in many situations:
    - Mow at least 5 times per year for several years.
    - Mow in late spring and again in August, spray in October-November, repeat for at least three growing seasons.
    - Mow or burn in late spring, then cultivate repeatedly (every two weeks). Repeat at least two growing seasons.
    - Spray in late spring and late fall for at least two growing seasons.
    - Cultivate, then flood: Cultivate as soon as possible in spring; be sure to get entire sod layer. Allow sod to dry out, repeating cultivation throughout growing season to ensure thorough drying of the entire infestation. At the end of the growing season, flood to at least 18 inches through late spring the following year.
    - Where manipulation of water levels is possible, flood to at least 32 inches (0.85m) and maintain that depth for at least one growing season. Use other methods to control around the edges of the flooded zone. If using flooding only, additional seasons may be required, or other methods should be used to control regrowth after water levels drop.

- Note: mowing or burning alone fewer than 5 times per growing season has been shown to INCREASE reed canarygrass density.

2. **Eliminate seed bank.** This may not be necessary if long-term goal includes establishment of multi-layered canopy for shade, however it is critical if shade establishment is not planned. Seeds remain viable for up to four years. Allow seeds to germinate and then control the seedlings in one of the following ways:
    - Cultivate repeatedly over at least two growing seasons
    - Flame or apply herbicide to seedlings as they emerge
    - Flood the area where seedlings are present
3. **Establish desirable vegetation.** Shading is the best long-term control strategy. Where possible, establish a multi-layered dense canopy, preferably with conifers in the overstory.
4. **Live willow stakes** installed 2 to 3 feet (0.60-0.91 m) apart in areas of shallow inundation or high soil moisture content can diminish RCG within two growing seasons.
5. **Monitor for regrowth/reinvasion and maintain site.** Control regrowth and re-infestations using techniques for small patches.

Control in Irrigation Ditches

For control of reed canarygrass in the maintenance of agricultural ditches, follow the recommendations in the **Manual of Best Management Practices for Maintenance of Agricultural Waterways in King County**.
http://www.kingcounty.gov/environment/waterandland/stormwater/agricultural-drainage-assistance/waterway-maintenance-bmp-manual.aspx .

Control Along Road Rights-of-Way

- Follow appropriate recommendations as described above for small or large infestations.
- Spot spray infestations in mixed vegetation, taking care not to spray beneficial plants.
- Do NOT mow plants in seed.

Disposal Methods

- Above-ground vegetative plant parts can be composted in a professional composting facility.
- Many plant parts will form roots if left in contact with moist soil. If composting on site, dry thoroughly on a tarp or black plastic before composting.
- Plant parts can be burned where conditions allow. Follow local burn regulations
- Rhizomes, plants in seed, and sod should be disposed of in a landfill.
- All plants parts, including seed, roots and sod, can be buried a minimum of two feet deep in weed-free soil. Buried RCG must remain undisturbed for at least four years.

REFERENCES

Antieau, Clayton J. 1998. Biology and Management of Reed Canarygrass, and Implications for Ecological Restoration. Society for Ecological Restoration. http://www.ser.org/sernw/pdf/RCG_BIO_MGT.pdf.

Apfelbaum, Stephen I. and Charles E. Sams. 1987. Ecology and control of reed canarygrass. Natural Areas Journal 7: 69-74.

Dobrowolski, J.P.` and T.W. Miller. 2004. Reed canarygrass – a formidable foe for Washington's riparian areas. Sustaining the Pacific Northwest: Food, Farm, and Natural Resource Systems 2(3):11-13.

Foster, R.D. and P.R. Wetzel. 2005. Invading monotypic stands of *Phalaris arundinacea*: a test of fire, herbicide, and woody and herbaceous native plant groups. Restoration Ecology 13:318-324.

Hook, P.B. and J.K. Klausmann. 2008. *Streamside Revegetation and Reed Canarygrass Suppression at Silver Creek Preserve*, Project Completion Report Prepared for The Nature Conservancy, Idaho Field Office by Intermountain Aquatics, Inc., Driggs, ID

Hook, Paul B., K.M Salsbury and J. M. Klausmann. 2009. Revegetation of reed canarygrass infested riparian areas: performance of pre-vegetated coir after 3 to 6 years. National Meeting of the American Society of Mining and Reclamation, Billings, MT, *Revitalizing the Environment: Proven Solutions and Innovative Approaches.* R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502. http://asmr.us/Publications/Conference%20Proceedings/2009/0597-Hook-ID.pdf.

Invasive Plants Association of Wisconsin Reed Canary Grass web page http://www.ipaw.org/invaders/reed_canary_grass/index.aspx

Jenkins, Noah J., J Alan Yeakley, Elaine M. Stewart. 2008. First-Year Responses To Managed Flooding Of Lower Columbia River Bottomland Vegetation Dominated By *Phalaris arundinacea.*Wetlands 28(4):1018-1027.

Kercher, S. M. and J. B. Zedler. 2004. Multiple disturbances accelerate invasion of reed canary grass (*Phalaris arundinacea* L.) in a mesocosm study. Oecologia 138:455–464

Kilbride, K.M. and F.L. Paveglio. 1999. Integrated pest management to control reed canarygrass in seasonal wetlands of southwestern Washington. Wildlife Society Bulletin 27:292-297.

Kim, K.D., K. Ewing and D. E. Giblin. 2006. Controlling *Phalaris arundinacea* (reed canarygrass) with live willow stakes: a density-dependent response. Ecological Engineering 27:219-227

Moore, S., D. Ward, and B. Aldrich. 2000. Transplanting large trees for reed canarygrass control. Reed Canarygrass Working Group Conference, Washington State Department of Transportation, USDA Natural Resources Conservation Service, and Society for Ecological Restoration – Northwest Chapter, March 15, 2000, Olympia, Washington.

Pennsylvania Department of Conservation and Natural Resources Exotic Plant Tutorial for Natural Land Managers web page
http://www.dcnr.state.pa.us/forestry/invasivetutorial/reed_canary_grass_M_C.htm

Reinhardt, C. and S.M. Galatowitsch. 2004. *Best Management Practices for the Invasive* Phalaris arundinacea L. *(Reed Canary Grass) in Wetland Restorations*. University of Minnesota Report, published by Minnesota Department of Transportation, Research Services Section.

Reinhardt Adams, C. and S. M. Galatowitsch. 2006. Increasing the effectiveness of *Phalaris arundinacea* L. (reed canarygrass) control in wet meadow restorations. Restoration Ecology 14(3):440-450.

Seebacher, Lizbeth A. 2008. *Phalaris arundinacea* Control and Riparian Restoration within Agricultural Watercourses in King County, Washington. Dissertation, University of Washington.
http://depts.washington.edu/uwbg/research/theses/Dissertation_Lisbeth_Seebacher_2008.pdf

Stannard, Mark and Wayne Crowder. 2002. USDA, NRCS Plant Guide: REED CANARYGRASS *Phalaris arundinacea L*. USDA NRCS Pullman Plant Material Center, Pullman, Washington. http://plants.usda.gov/plantguide/pdf/pg_phar3.pdf (accessed 2/13/2015).

Tu, Mandy, 2004. Reed Canarygrass Control & Management in the Pacific Northwest. The Nature Conservancy's Wildlife Invasive Species Team.
http://www.invasive.org/gist/moredocs/phaaru01.pdf

Washington State Noxious Weed Control Board, 1995.Written findings.
http://www.nwcb.wa.gov/siteFiles/Phalaris_arundinacea.pdf.

Wisconsin Department of Natural Resources, 2009. Reed Canary Grass Fact Sheet.
http://dnr.wi.gov/invasives/fact/reed_canary.htm.

Wisconsin Reed Canary Grass Management Working Group. 2009. Reed Canary Grass (*Phalaris arundinaceae*) Management Guide: Recommendations for Landowners and Restoration Professionals. PUB-FR-428 2009.

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.

References

Center for Aquatic and Invasive Plants, University of Florida website: http://aquat1.ifas.ufl.edu/seagrant/iripse2.html

Clark, F.H, C. Mattrick and S. Shonbrun (eds.). 1998. **Rogues Gallery: New England's Notable Invasives.** New England Wild Flower. New England Wildflower Society. Vol. 2, No. 3. Pp. 19-26.

Cody WJ. 1961. ***Iris pseudacorus* L. escaped from cultivation in Canada**. Canadian Field Nat., 75: 139-142 Ecology 78: 833-848.

Exotic Plant Pest List (http://www.cal-ipc.org/1999_cal-ipc_list/, October 19, 1999). California Exotic Pest Plant Council. California.

Simon, Bridget. 2008. **Yellow-flag Iris Control and Education**. http://www.ecy.wa.gov/Programs/wq/plants/weeds/YFI%20Final%20Report%20to%20DOE%206-30-08.pdf

Sutherland WJ. 1990. **Biological flora of the British Isles. *Iris pseudacorus* L**. J. Ecology 78(3):833-848

Thomas, L.K., Jr. 1980. **The impact of three exotic plant species on a Potomac Island**. National Park Service Scientific Monograph Series, Number 13.

Tu, Mandy. 2003. **Element Stewardship Abstract for *Iris pseudacorus*.** The Nature Conservancy's Wildland Invasive Species Team. Website: http://www.invasive.org/gist/esadocs/documnts/irispse.pdf

Tyron, Paul. 2006. **Yellow Flag Iris Control, in the Mission Valley of Western Montana**. Presented at the 2006 Washington State Weed Conference, Yakima, WA. Lake County Weed Control, 36773 West Post Creek Road, St. Ignatius, MT 59865, 406-531-7426.