CITY OF TUMWATER'S
BARNES LAKE MANAGEMENT DISTRICT

INTEGRATED AQUATIC VEGETATION MANAGEMENT PLAN

~ 2007 ~

(Page intentionally left blank)

ACKNOWLEDGEMENTS

The City of Tumwater wishes to acknowledge the significant contribution provided by the members of the Barnes Lake Steering Committee toward the completion of the 2007 Barnes Lake Integrated Aquatic Vegetation Management Plan.

BARNES LAKE STEERING COMMITTEE

Kathy Peterson (Chair)

Ron Lumaguip (Vice Chair)

Bill Baxter

Bob Hayes

Judith Loft

Paul Strawn

John Swander

Rosemary Walsh

The Barnes Lake Steering Committee expressly thanks the Tumwater City Council for their support of the lake management district formation and management goals.

TUMWATER CITY COUNCIL

Ralph C. Osgood, Mayor

Judith Hoefling

Pete Kmet

Neil McClanahan

Jerry Murphy

Ed Stanley

Karen Valenzuela

Bruce Zeller

The support of various agency staff is also appreciated, including those individuals who attended meetings and provided both regulatory and technical guidance. We wish to acknowledge: Kathy Hamel, Kelly McLain and Jenifer Parsons (Washington Department of Ecology), and Jim Bachmeier (Thurston County Water and & Waste Management). Sue Davis, Thurston County Water & Waste Management provided a baseline water quality assessment for Barnes Lake.

Report prepared by: Dan Smith, Water Resources Program Manager
City of Tumwater

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Barnes Lake lies within the City of Tumwater in the Deschutes River watershed in Thurston County, Washington. The 27-acre lake is infested with the non-native fragrant waterlily. Members of the Barnes Lake community realized the seriousness of the aquatic weed problem and initiated a partnership with staff from the City of Tumwater to apply for an Aquatic Weeds Management Permit through the Washington Department of Ecology (Ecology). Since complete eradication is very difficult to achieve, and re-introduction is very likely, the community organized a lake management district (LMD) with the support of the City of Tumwater to provide the technical expertise and funding mechanisms necessary to implement ongoing monitoring, management and control.

Other non-native, noxious and native nuisance weed species with expanding infestations at Barnes Lake also threaten to degrade the ecological and recreational benefits of the system. Big Floating Bladderwort (Utricularia inflata), reed canary grass (Phalaris arundinacia), and the native yellow water lily (Nuphar polysepala) have expanded beyond a pioneering level of infestation and are well established around the shoreline and in the lake.

This Integrated Aquatic Vegetation Management Plan (IAVMP) is a planning document developed to ensure that the permit applicant (City of Tumwater) and the Barnes Lake LMD community have considered the best available information about the waterbody and the watershed prior to initiating control efforts. To tackle the difficult task of generating community awareness and action for an environmental issue, a core group of residents formed a steering committee, which includes one City of Tumwater staff member from the Water Resources Program. Members of the Barnes Lake LMD Steering Committee and City of Tumwater staff worked in partnership to develop this IAVMP for Barnes Lake.

Through their work, the Steering Committee has developed plans to educate the wider community about the problem, inspire them to contribute feedback about potential treatment options, and explore ongoing community-based funding mechanisms. The community ultimately agreed upon an integrated treatment strategy, which includes initial chemical treatments with a systemic aquatic herbicide, followed by a combination of manual, mechanical, and cultural control methods to maintain the outcome. This plan presents lake and watershed characteristics, details of the aquatic weed problems at Barnes Lake, the process for gaining community involvement, discussion of control alternatives, and recommendations for initial and ongoing control of noxious aquatic weeds threatening Barnes Lake.

THE PROBLEM DEFINED

Barnes Lake is a private 30-acre lake located within the City of Tumwater in Thurston County and lies within the Deschutes River watershed. The residents living along the shoreline have private access and many others have clear views to the lake. Many of the residents enjoy a long history of living on the lake and are dedicated to preserving the beauty of the lake, enhancing the ecosystem to support varied species of wildlife, and insuring the economic vitality of the residential and commercial properties.

Over the course of the past 30 years, Barnes Lake has gradually become over-run with native lilies (figure 1), identified as Spatterdock (*Nuphar polysepala),* and a non-native invasive plant (figure 2), identified as Fragrant Water Lily (*Nymphaea ordata*). Native aquatic plants provide beneficial uses such as fish and wildlife habitat, shoreline stabilization, and water filtration. However, an overabundance of these plants at Barnes Lake has reduced beneficial uses such as fishing, non-motorized boating, swimming, and aesthetics. The non-native plants that exist in the lake lack natural predators, out-compete native plants, can be difficult to control, and are destructive to the natural environment.

The infestation of these plants threatens to choke out the surface of the lake completely, and the annual dying off of the lily pads has resulted in the lake becoming increasingly shallow due to the deposition of organic materials. As a result of the sediment deposition and increased nutrient loads, cattails, willows and other shrubs and trees have become well established around the perimeter of the lake and continue to encroach deeper into the waterline as conditions become favorable for their growth. In addition to the excessive growth at the perimeter of the lake, decomposing organic materials deposited in low-water areas have created conditions conducive to forming islands in the center of the lake and other land masses around the lake. It is also likely that other invasive weeds may have become established under the canopy of the lily pads. Further research is needed to determine the extent of the aquatic vegetative growth.

Figure 1: Native Spatterdock (photo by K. Dressler)

Figure 2: Non-Native Fragrant Water Lily (photo by K. Dressler)

When the lilies cover the surface of the lake, it becomes unusable to the residents and the wildlife that inhabit Barnes Lake. In essence, the ecosystem is out of balance. The fish, ducks, geese, birds, eagles, and people all avoid the infested areas, which encompass a majority of the lakes surface area. Many of the wildlife species abandon the area completely at the height of the vegetative growing season. Lakeshore residents are prevented from pursuit of recreational activities such as swimming, fishing, and non-motorized boating. Residents not living on the Barnes Lake shoreline have been impacted by the excessive growth of emergent plants limiting sight lines and reduced the aesthetic value of living near the lake.

Lower water levels over the past 30 years due to natural drought cycles have increased the potential for excessive vegetative growth. While it is not uncommon for shallow water bodies with undefined inlets to undergo a natural process known as eutrophication, or the aging of a lake by the biological enrichment of its water, it may be possible to promote activities that would potentially increase the water level to a height beneficial to enhance wildlife and encourage recreational uses of the lake. Future studies may include a complete hydrological assessment, an examination of declining water levels, and a feasibility evaluation of management options such as diversion of stormwater and increasing the height of an earthen berm located near the recognized outlet of Barnes Lake.

Stormwater is known to contain pollutants of concern. There are numerous stormwater outfalls serving the immediate area and overland runoff from lakeshore properties that may contain nutrients and other pollutants contributing to the decline of water quality and encouraging vegetative growth within Barnes Lake. Additional studies will evaluate the impact of stormwater and other potential sources of contaminants on Barnes Lake and determine appropriate activities to reduce or eliminate the identified negative influences.

The health and appearance of this unique lake goes beyond being a steward of natural habitat for fish, birds, and small wildlife. It has an economic factor that affects the value and quality of life for the homeowners of Barnes Lake and the surrounding community. With the unavoidable advent of urban residential expansion, demand for homes with unique social settings will increase. If the lake is permitted to evolve into a diminishing pond or to be completely obscured with vegetation, this will decrease the value of properties on Barnes Lake and provide less taxable assets for city and school funding.

In 2002, a group of homeowners formed the Barnes Lake Conservancy (BLC), dedicated to preserving the lake through the formation of a lake management district. In 2005, residents living on and near the lake voted to establish the Barnes Lake Management District (LMD) and incur the costs of addressing the changing conditions. The Barnes LMD and City of Tumwater staff have taken the responsibility of coordinating all aquatic plant and other lake management activities for Barnes Lake. It is important to note that aquatic plant control and other management activities are entirely funded by the LMD and not by public agencies. Lake residents have continued to supply volunteer time and financial resources for the management of Barnes Lake.

LAKE MANAGEMENT DISTRICT GOALS

Because of the potentially serious impacts and the strong concern of the Barnes Lake Community, the LMD is acting to implement a control plan for the invasive noxious and native nuisance vegetation in Barnes Lake. The LMD Steering Committee's goal is to advise the Tumwater City Council on LMD activities to insure a high-level of lake health while balancing the recreational, wildlife, water quality, and aesthetic needs of Barnes Lake. To accomplish its goal, the LMD is planning activities as described below.

1. Remove every invasive noxious plant identified each year in an effort to ultimately eradicate this vegetation in Barnes Lake.
2. Control the native, nuisance vegetation in the existing infected areas, reducing the overall abundance of the plants.
3. Maintain or enhance recreational and residential uses of the lake while minimizing the impact of control efforts on these uses.
4. Protect water quality and fish and wildlife habitat using control methods that allow sustainable native plant and animal communities to thrive.
5. Manage sediment appropriately through the reduction of sediment accumulation and possible removal of existing sediments.
6. Monitor water levels and assess options for maintaining optimal water levels for recreational, environmental, and aesthetic values.
7. Conduct on-going studies to monitor the health of the lake.
    a. Limnological
    b. Hydrologic
    c. Bathymetric
    d. Annual water quality
    e. Annual vegetation
    f. Wildlife Survey updates
8. Encourage opportunities for lake resident education, including environmental best management practices and boat safety.
9. Utilize the most cost effective treatment measures and minimize impacts to the Barnes Lake homeowner and environment.

Because the studies and plans necessary to determine the condition of the lake and identify potential solutions for improving conditions are to be conducted as components of this plan, the above goals are broadly defined. Detailed work plans will be developed annually for implementation of specific activities and recommendations based on these studies.

PUBLIC INVOLVEMENT METHODS

Options for public involvement and comment for activities undertaken by the Barnes Lake Management District include steering committee meetings, City of Tumwater Council meetings and public hearings, and other outreach events conducted by the Barnes Lake Conservancy.

The Barnes Lake Management District was formed in 2005 through a petition to the City of Tumwater by residents and landowners surrounding Barnes Lake. The LMD membership is represented by a Steering Committee that typically meets each month. The Steering Committee activites to-date have consisted of the development of this plan, gathering baseline water quality and vegetation data, and pursuing the initial permit application to Ecology for the treatment of invasive and nuisance vegetation on Barnes Lake. The Steering Committee has reviewed past plant control efforts and management goals, organized public meetings, selected aquatic vegetation control measures, and reviewed available funding options during meetings held in 2005 and 2006. The feasibility of dredging was also considered and will be reviewed in more detail during future years after the vegetation control measures have been fully implemented and control has been maintained.

The following are current members of the Barnes Lake Steering Committee: Kathy Peterson, – Chair, Ron Lumaguip – Vice Chair, Bill Baxter, Bob Hayes, Judith Loft, John Swander, and Rosemary Walsh. Dan Smith, Water Resources Program Manager with the City of Tumwater is the staff representative to the Steering Committee.

Multiple public meetings were held in 2004 and 2005 as part of the formation process for the Barnes Lake Management District. These meetings were conducted by the Tumwater City Council and public notices were sent to all affected parties including residents, commercial interests, and local and state agencies, inviting participation and comment on the goals identified in the petition. Since the formation of the LMD and Steering Committee, all meetings have been open to the public.

The first joint public meeting between the LMD Steering Committee and the Barnes Lake Conservancy took place on February 28, 2006. The meeting was devoted to providing general information on the lake, existing control measures, reviewing the identified problems impacting the lake, and to agreeing on aquatic plant management goals and objectives. Additionally, the meeting provided an opportunity to review the problem statement, the anticipated budget, and solicit comments from the LMD membership and area residents.

The following outreach methods and stakeholders were identified to encourage public involvement and develop a list of potentially interested parties to receive notices of public meetings.

Outreach Methods

1. Barnes Lake Conservancy
    a. Primary method to distribute educational materials and updates
    b. Informational updates can be presented by the Steering Committee twice per year, or as needed to cover critical issue
    c. Barnes Lake Conservancy Website http://home.comcast.net/~barneslake/Main.htm
2. City of Tumwater Website: www.ci.tumwater.wa.us/BLMD.htm
3. Informational Brochures

4. Public Meetings
    a. Steering Committee
    b. Barnes Lake Management District
    c. Barnes Lake Conservancy
    d. Tumwater City Council and Public Works Committee
5. Direct notification to LMD Membership
6. Press Releases/Public Service Announcements
    a. Newspaper
    b. Radio

Recognized Stakeholders:

1. LMD Membership
    a. Homeowners
    b. Renters
    c. Landowners
    d. Mega Foods
    e. WA Department of Transportation
    f. Tumwater School District, including faculty and students of Michael T. Simmons
    g. Tumwater United Methodist Church
2. Non-LMD members, yet lake-area residents
3. City of Tumwater
4. State Agencies
    a. WA Department of Fish & Wildlife
    b. Ecology
5. Other Interested Parties, including but not limited to, Barnes Lake area renters, other Lake Management Districts, and area environmental organizations.

The Lake Management District Steering Committee outlined an approach for public outreach during the initial year of management activities. The schedule below was followed to encourage open discussion among LMD members and interested parties. LMD members were notified in advance by direct mailing of the date, time, and subject of the meetings.

February 2006 – The Annual Meeting of the Barnes Lake Conservancy was held to inform interested parties of the planning stages necessary to meet the goal of vegetation management. City of Tumwater staff attended the meeting to discuss budgetary, planning, and permitting activities necessary to move the LMD closer to the initial treatment of the lake to control vegetation.

June 2006 – After vegetation control methods were identified, the LMD Steering Committee held a public information meeting in conjunction with a Barnes Lake Conservancy gathering. The intent of this meeting was to solicit comments from the LMD membership as to the appropriate measure to implement effective vegetative controls.

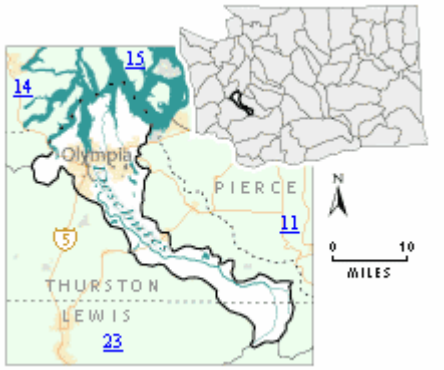
August 2006 – Based on comments gathered at the June meeting and information reviewed by the LMD Steering Committee, an appropriate method of vegetation control was to be selected at this meeting. A public meeting in conjunction with the regularly scheduled LMD Steering Committee meeting was held to present the control scenario prior to its implementation.

September 2006 – An initial lake treatment was planned for September; however, as permits were not received by the City of Tumwater, the LMD was unable to proceed with the first round of treatments. A letter was sent to all LMD members to apprise them of the situation.

October 2006 – A public meeting was planned in conjunction with the regularly scheduled LMD Steering Committee meeting to evaluate the success of the vegetative control measure. As no treatments were conducted, the public meeting was not held.

CHARACTERISTICS OF THE BARNES LAKE WATERSHED

Barnes Lake is a shallow 30-acre lake, including small islands, located within the City of Tumwater in Thurston County. Barnes Lake lies completely within the Deschutes River watershed. The contributing area to Barnes Lake encompasses approximately 113 acres, bounded by Tumwater Hill to the north and a wetland complex to the west. Barnes Lake discharges through the southeast corner to the Deschutes River; however, a constructed berm restricts flow during the summer months and meters the flow during wetter periods. There are no obvious tributaries to the lake other than overland stormwater flow. A future hydrologic analysis will help identify additional sources of influent, such as groundwater. Wetlands are found to the west of Barnes Lake, but it is unclear whether they are hydraulically connected.



Barnes Lake has a total surface area of 27.09 acres and estimated volume of 122 acre-feet. In a recent water quality survey completed by Thurston County for the Barnes LMD, the maximum depth was recorded between 2.0 and 3.0 meters (6.5–9.8 feet). The estimated volume was determined using an average depth of 4.5 feet. A future bathymetric study may be conducted to further define the physical characteristics of the lake identified in Table 1.

Table 1 – Physical Characteristics of Barnes Lake Watershed

Watershed Area*	113 Acres
Surface Area	27.09 Acres
Lake Volume*	122 Acre-feet
Maximum Depth*	9.8 Feet
Shoreline Lengt*h*	6,455 Feet

**estimated*

Barnes Lake is a private lake, with no public access. The primary land use surrounding Barnes Lake is residential, although some mixed commercial and institutional facilities exist on the southern and eastern shores of the lake. Despite their location, the commercial and institutional facilities do not permit access to the lake's shoreline and activities are limited to the confines of their structures.
Lake water quality data is being collected to assist in the identification sources of non-point pollution, although it is expected that constituents commonly associated with stormwater will be found. Such potential contaminants include fecal coliform from stormwater runoff, wildlife, and septic systems, and nitrate and phosphorus. Excessive use of fertilizers and other vegetation management materials can also contribute to the non-point pollution loading of the lake. Additionally, decomposing organic materials deposited in low-water areas has resulted in the formation of islands within the lake and land masses near the lake's shorelines.

The Barnes Lake Management District and the City of Tumwater have contracted with Thurston County's Environmental Health Department to collect monitoring data consistent with their lakes program. The data to be collected includes: temperature, dissolved oxygen, pH, conductance,

phosphorus, nitrogen, clarity, and the identification of chlorophyll and algae. Thurston County will maintain the data with their lakes program and submit a final report to the City at the end of each monitoring period.

At the time this report was prepared, inorganic water quality data, including phosphorus and nitrogen, and the identification of algae and chlorophyll a, was being processed. Field parameters are identified in Table 2, below. Dissolved oxygen (DO) for Barnes Lake is considered very low for the time of year sampled. Lakes in good health reach 100% saturation for oxygen around 9 mg/L at the surface. The low DO result could be indicative of the surface vegetation of water lilies, which could prevent proper mixing, and the abundance of organic material decomposing in the water body. DO will be an important parameter to monitor as the LMD conducts activities on the lake.

Table 2: Water Quality Monitoring – Baseline Sampling Event – May 22, 2006
Sampling conducted by: Thurston County Water & Waste Management

	Parameter					
Depth	**Temperature (˚C)**	**pH**	**Dissolved Oxygen (mg/L)**	**Specific Conductance (umhos/cm)**	**Phosphorus (mg/L)**	**Nitrogen (mg/L)**
Surface	17.45	6.7	4.36	23	na	na
1 m	17.2	6.5	3.30	23	na	na
2 m	14.77	6.3	0.37	28	na	na
3 m	12.03	6.3	0.37	46	na	na
Water Clarity	Visibility to 1.75 meters					
Notes:	Water appearance – orange, tannin color and clear.					

The City of Tumwater maintains a public stormwater system surrounding Barnes Lake, the northern-most part of the Littlerock/2nd Avenue sub-basin. While not all stormwater facilities are directly connected to Barnes Lake, there are 13 catch basins serving small tributary areas discharging directly to Barnes Lake through seven outfalls. All remaining catch basins discharge to the east in the Deschutes River. All privately-owned catch basins and other storm facilities will be inventoried in future years as part of the City's National Pollutant Discharge Elimination System (NPDES) Phase II program.

Figure 3: Stormwater Map of Barnes Lake

The City of Tumwater's Stream Team has developed a storm drain marking program to help educate homeowners and businesses. The kick-off event for the Barnes Lake area occurred on April 22nd, Earth Day 2006. This program brought local volunteers together to apply storm drain markers on all public and private catch basins and provide local residents and businesses educational information on the importance of keeping pollutants out of the storm systems and ways to reduce these pollutants around the home and business.

Over the course of the past 30 years, Barnes Lake has gradually become over-run with native and non-native lilies, as well as other vegetative growth. The non-native plants that exist in the lake lack natural predators, out-compete native plants, can be difficult to control, and are destructive to the natural environment.

The infestation of these plants threatens to choke out the surface of the lake completely, and the annual dying off of the lily pads has resulted in the lake becoming increasingly shallow due to the deposition of organic materials. In addition, lower water levels over the past 30 years due to natural drought cycles have increased the potential for excessive vegetative growth.

AQUATIC PLANT MAP & CHARACTERIZATIONS

The first and most comprehensive aquatic plant survey of Barnes Lake occurred on May 12, 2006 by Ecology's Environmental Assessment Program. The survey was conducted by boat using a two-person crew. Each type of vegetation was characterized by scientific name, common name, and distribution. Vegetation was further classified as native or non-native. The catalyst for the formation of the LMD and this survey was complaints from the Barnes Lake community that non-native waterlilies were increasing in density.

Figure 4: Waterlily Extents (2003 Aerial Photo)

The majority of the infestation of waterlilies covers the majority of the littoral zone and is spreading into the middle of the lake. The noxious waterlilies are interspersed with the native waterlilies, together forming a large mat and shading out other vegetation.

The Washington Natural Heritage Program (WNHP) performed a search of their Natural Heritage Information System database for rare plant species, select rare animal species, and high quality wetland and terrestrial ecosystems in the vicinity of Barnes Lake. This search did not find any endangered, threatened, or sensitive plant species recorded for Barnes Lake. (http://www.wa.gov/dnr/htdocs/fr/nhp/wanhp.html).

NOXIOUS AQUATIC WEEDS IN BARNES LAKE

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 predators (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, C) of noxious weeds based on their distribution in the state, each class having different control requirements. County Weed Boards are given some discretion as to setting control priorities for Class B and C weeds.

Table 3 details the seventeen species found on Barnes Lake during the initial 2006 plant survey conducted by Ecology. Two of the five non-native weed species have been listed as a noxious weed: Fragrant waterlily (Nymphaea odorata) and reed canary grass (Phalaris arundinacia). Big floating bladderwort (Utricularia inflate) is listed in the US Department of Agriculture's database as an aquatic noxious weed, currently requiring monitoring and quarantine, but is not required to be removed at this time.

Fragrant waterlily and reed canary grass are Class C Noxious Weeds; Class C weeds are generally not required by law to be controlled and contained, but counties may designate a Class C weed for control in their county or in certain areas of their county. Neither fragrant waterlily nor reed canary grass is required to be controlled in Thurston County.

Aerial photos and the vegetation survey have determined that the distribution of fragrant waterlily is wide-spread; its thick growth covers the substrate at the exclusion of other species. At this time, fragrant waterlily will be the primary focus of plant management efforts on Barnes Lake.

Table 3: Barnes Lake Aquatic Plant Survey – May 12, 2006				
Scientific Name	**Common Name**	**Distribution**	**Comments**	**Native/Non-Native**
Nymphaea odorata	fragrant waterlily	5	dense in water less than about 2.5 m.; Not flowering yet.	Non-Native; Class C Noxious Weed
Utricularia inflata	Swollen bladderwort	3	Flower float forming, some with flower buds	Non-Native; Quarantine
Phalaris arundinacia	Reed canary grass	2	Shore	Non-Native; Class C Noxious Weed
Callitriche sp.	Water-starwort	1	Found in area cleared of lilies, north arm of lake	Possibly non-native; determination of species required
Solanum sp.	Nightshade	1	Along shore	Possibly non-native; determination of species required
Nuphar polysepala	Spatter-dock, yellow waterlily	3	Blooming, leaves rising above surface	Native
Polygonum sp.	Smartweed	3	Shoreline, not blooming yet	Native
Salix sp.	Willow	3	On islands	Native
Brasenia schreberi	Watershield	2	Scattered among lilies	Native
Eleocharis sp.	Spike-rush	2	Emergent species	Native
Typha latifolia	Common cattail	2	On islands, along shore	Native
Ludwigia palustris	Water purslane	1	Shallow water, north end	Native
Menyanthes trifoliata	Buckbean	1	Along east shore, blooming	Native
Potamogeton sp.	Thin-leaved pondweed	1	No seeds to id species, looks like P. pusillus	Native
Ranunculus aquatilis	Water buttercup	1	Not flowering, in cleared area, north arm of lake	Native
Unknown	Unknown	2	Shallow water plant with rounded opposite leaves, not blooming	Unknown
Unknown #2	Unknown	2	Long opposite leaves, may be Lysimachia thyrsiflora? Not flowering	Unknown

Distribution Values:

0. The distribution was not recorded (plant may not be submersed)
1. Few plants in only 1 or a few locations
2. Few plants, but with a wide, patchy distribution
3. Plants growing in large patches, co-dominant with other plants
4. Plants in nearly monospecific patches, dominant
5. Thick growth covering the substrate at the exclusion of other species

FRAGRANT WATERLILY (*NYMPHAEA ODORATA*)

This species is native to the eastern half of North America. 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.

Figure 5: Fragrant Waterlily (Nymphaea ordata)

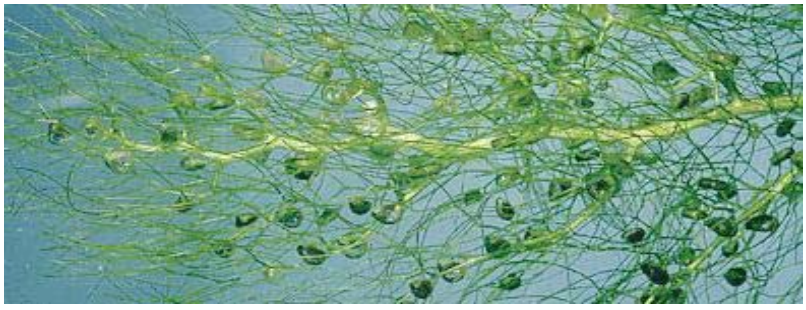
This aquatic perennial herb spreads aggressively, rooting in murky or silty sediments in water up to seven feet deep. It prefers quiet waters such as ponds, lake margins and slow streams and will grow in a wide range of pH. Shallow lakes are particularly vulnerable to being totally covered by fragrant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

The fragrant waterlily has firmly established itself on Barnes Lake. When uncontrolled, the lily community forms dense monospecific stands that can persist until senescence in the fall. Mats of these floating leaves prevent wind mixing and extensive areas of low oxygen can develop under the waterlily beds in the summer. Waterlilies can restrict lakefront access and hinder swimming and other recreational activities. They may also limit the native waterlily (Nuphar luteum) with which it overlaps in distribution. The fragrant waterlily is still expanding on Barnes Lake, and so its future impacts are not clear.

SWOLLEN BLADDERWORT *(UTRICULARIA INFLATA)*

Swollen bladderwort (Utricularia inflata) is a member of a group of free floating, rootless, carnivorous aquatic plants. It is native in the southeastern United States, but is increasingly being seen in some western Washington lakes where it is considered to be a nuisance. In 1998, it has been seen in many lakes in Mason, Kitsap, and Thurston Counties. Where present, it has been known to form dense beds of floating plants. Lake Limerick residents spend several thousand dollars harvesting this species each summer.

Figure 6: Swollen Baldderwort (Utricularia inflata)



In Washington, swollen bladderwort flowers from June to July forming a wheel-like floating platform that supports a yellow snapdragon-like flower. These flowers stick up about six inches above the water surface. Washington's native bladderworts do not have this "floating wheel" to support their flowers, but when not flowering our native bladderwort and swollen bladderwort are very similar in appearance.

Swollen bladderwort reproduces from small fragments and from seed. A Florida botanist reports that when plants become stranded on mud, they can produce long threadlike branches with each "thread" bearing a tiny tuber at its tip. When not in flower, swollen bladderwort floats below the water's surface.

Bladderwort obtains its nutrients from the water and from tiny creatures that it captures in its seed-like bladders. These bladders are actually traps that use a vacuum to capture small invertebrates that trigger a trap door. Once inside the bladder, enzymes are secreted to digest the prey, providing the plant with nutrients.

The swollen bladderwort infestation in Washington appears to be in a pioneering stage. It has not been determined how these plants were introduced, nor is there good distribution data. Because of the interesting "spoke-like" flower platform and the yellow flowers, bladderwort may have been introduced as a water garden plant or aquarium plant. It may also be popular with people who cultivate carnivorous plants.

Swollen bladderwort has been observed in isolated ponds where it is unlikely that boats visit. This plant might be spreading by waterfowl. A 1996 Sonar treatment in Lake Limerick, Mason County, appeared to control this species for about two years. Grass carp will consume swollen bladderwort, although it did not appear to be a preferred species in Silver Lake, Cowliz County, Washington. Another technique used by Lake Limerick residents is to hire school kids to rake or hand pull each plant from the lake. The bladderwort infestation in Barnes Lake is growing in large patches throughout the lake. Ecology recommends the LMD monitor its distribution and consider options for eradication in future years.

REED CANARY GRASS *(PHALARIS ARUNDINACIA)*

A highly variable species, reed canary grass (Phalaris arundinacea L.) is a rhizomatous perennial grass that can reach three to six feet in height. The sturdy, often hollow stems can be up to ½ inch in diameter, with some reddish coloration near the top. The leaf blades are flat and hairless, ¼ to ¾ of an inch wide. The flowers are borne in panicles on culms high above the leaves. The panicles are generally three to six inches in length. The species flowers in June and July (Weinmann et al. 1984; Hitchcock et al. 1969).

Figure 7: Reed canary grass (Phalaris arundinacia)

Reed canary grass forms dense, highly productive single species stands that pose a major threat to many wetland ecosystems. The species grows so vigorously that it is able to inhibit and eliminate competing species (Apfelbaum and Sams 1987). In addition, areas that have existed as reed canary grass monocultures for extended periods may have seed banks that are devoid of native species (Apfelbaum

and Sams 1987). Unlike native wetland vegetation, dense stands of reed canary grass have little value for wildlife. Few species eat the grass, and the stems grow too densely to provide adequate cover for small mammals and waterfowl (Maia 1994). The species is considered a serious weed along irrigation banks and ditches because infestations can increase siltation (Marten and Heath 1973). When in flower, the species produces abundant pollen and chaff, which aggravate hay fever and allergies (Weinmann et al. 1984).

Although reed canary grass is planted as a forage crop in some areas, the species poses a significant threat to the state's wetlands. Reed canary grass is extremely aggressive and often forms persistent, monocultures in wetlands and riparian areas. Infestations threaten the diversity of these areas, since the plant chokes out native plants and grows too densely to provide adequate cover for small mammals and waterfowl. The grass can also lead to increased siltation along drainage ditches and streams. Once established, reed canary grass is difficult to control because it spreads rapidly by rhizomes.

Frequently cultivated as a forage species, reed canary grass is an important component of lowland hay from Montana to Wisconsin (Hitchcock 1950). In some areas, the grass has been used for erosion control. The variegated-leaved variety picta L. is sometimes grown as an ornamental under the common name "ribbon grass" or "gardener's garters" (Hitchcock 1950; Hitchcock et al. 1969).

Reed canary grass is a circumboreal species (Larson 1993). While possibly native to North America, European cultivars have been widely introduced for use as hay and forage on the continent; there are no easy traits known for differentiating between the native plants and European cultivars (White et al. 1993). The species is rather common throughout most of southern Alaska and Canada, as well as all but the southeastern portion of the U.S. (Hitchcock et al. 1969).

A wetland plant, this species typically occurs in soils that are saturated or nearly saturated for most of the growing season, but where standing water does not persist for extended periods. However, established stands can tolerate extended periods of inundation. Ideal conditions typically occur in roadside ditches, rights-of-way, river dikes and levees, shallow marshes, and meadows (Weinmann et al. 1984).

Reed canary grass is a perennial species. It spreads by seeds or by creeping rhizomes. The species will also produce roots and shoots from the nodes of freshly cut, well-jointed culms (Marten and Heath 1973). It flowers from June through August in Washington.

Glyphosate, Amitrol, Dalapon, and Paraquat have all been tried with some success. Maximum control depends on the timing of application (Apfelbaum and Sams 1987). These herbicides provide control for up to two years at the most. After this period, reed canary grass recolonizes a treated area from adjacent stands or from seed bank recruitment (White et al. 1993). However, only glyphosate (Rodeo®) is licensed for use in aquatic systems in Washington. Rodeo® application, followed in two to three weeks by prescribed burning has also been effective. The use of fire helps to ensure mortality by killing resprouts and germinants (Apfelbaum 1993).

Studies in the Midwest indicate that prescribed burning is effective in areas with an existing component of native plants, either above ground or in the soil seed bank. To be effective, burns should be conducted in the late spring, early to mid-summer, or early to mid-fall. Early spring burning stimulates the production of shoots (Apfelbaum 1993).

Heavy equipment has been used unsuccessfully in reed canary grass removal. Rapid regrowth occurs from rhizomes and seeds that remain in the soil even after mechanical removal . Clipping back plants at ground level and covering them with opaque black plastic tarps can reduce but not eliminate populations (Apfelbaum and Sams 1987). However, this method is not always effective because reed canary grass shoots can grow up through most materials, and seasonal inundation may displace covering materials (Gillespie and Murn 1992). Mowing may be a valuable control method, since it removes seed heads before seed maturation and exposes the ground to light, which promotes the growth of native species. Studies in Wisconsin indicated that twice-yearly mowings (in early to mid-June and early October) led to increased numbers of native species in comparison to reed canarygrass-infested plots that were not mowed (Gillespie and Murn 1992).

NIGHTSHADE *(SOLANUM SP.)*

In Ecology's survey, the species of Nightshade found along the shores of Barnes Lake was not specifically identified due to similarity among the variants when they are not flowering and will need further identification during the flowering season. The Barnes LMD will refine the identification during the flowering season, monitor the extent of nightshade distribution, and determine if the species falls into the non-native, noxious weed catagory.

In Washington, Silverleaf nightshade is listed as a Class A Noxious Weed. The Silverleaf nightshade is a branched, deep-rooted, perennial herb, one to four feet tall. Slender, yellow spines occur on the stems or leaf ribs of the plant. The lance-shaped leaves are one to four inches long by 1 inch wide, with wavy margins; they are covered with short, silvery-white, star-shaped hairs that give the plant a dusky or silvery-gray color. The blue, violet or rarely white flowers have five fused petals, ¾ inch across, with bright yellow stamens. Flowers grow on stalks in clusters or singly at the end of stems or branches. The fruit is yellow to brownish, juicy berries, ½ inch in diameter. Seeds are flat, brown and 1/10 to 1/5 inch long.

YELLOW FLAG IRIS *(IRIS PSEUDACORUS)*

Figure 8: Yellow Flag Iris

This Class C noxious weed was identified by residents of Barnes Lake. Control is recommended but not required in Thurston County.

When flowering, yellow flag iris is unmistakable with its showy yellow flowers colorfully displayed along the edge of water and in wetlands. In Washington, the flowers occur in late spring or early summer.

Several flowers can occur on each stem, along with one or two leafy bracts. The leaves are mostly basal and are folded and clasp the stem at the base in a fan-like fashion. Yellow flag iris is perennial, and will remain green during winter where the weather is mild. It has stout rhizomes and long, spreading roots. The plants spread rhizomatously and grow tightly bunched together.

This is the only yellow iris found in Washington's wet areas, but when not flowering it may be confused with cattail (Typha latifolia) or broad-fruited bur-reed (Sparganium eurycarpum). Yellow flag is native to Europe, Great Britain, North Africa and the Mediterranean region. It has been introduced in temperate areas nearly world-wide and occurs throughout the United States.

Yellow flag iris will sicken livestock if ingested, and is generally avoided by herbivores (although muskrats will eat the rhizomes). Contact with the resins can cause skin irritation in humans.

WILDLIFE ON BARNES LAKE

Barnes Lake and its surrounding habitats support a variety of fish, birds, and animals by providing nesting, forage, and cover. The lake is not regularly stocked, although LMD members have stated that at various times in the past twenty years, the lake has been stocked with bass.

The mixed forest and wetland plant communities around the lake provide non-breeding habitat for a few Puget Sound lowland amphibian species, such as the Pacific chorus frog (Psudacris regilla). Mammals expected to make use of the lake and adjacent wooded areas include: opossum (didelphus marsupialis), bats such as the little brown bat (myotis lucifugus), Douglas squirrel (tamias doglasii), and raccoon (procyn lotor).

Kathy Peterson, Barnes LMD Steering Committee Chair, provided the survey list developed through neighborhood communications.

Table 4: Wildlife Survey
Conducted by the residents of Barnes Lake

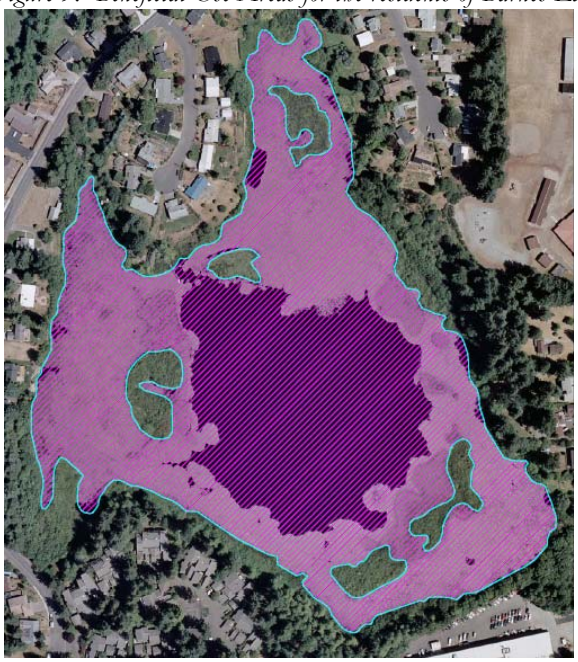
Avian							
Common Name	**Resident**	**Seasonal**	**Observed**	**Common Name**	**Resident**	**Seasonal**	**Observed**
Bufflehead Duck	☐	☒	☐	Greenwing Teal	☐	☒	☐
Canvasback Duck	☐	☒	☐	Gulls (various)	☒	☐	☐
Chickadee	☒	☐	☐	Great Blue Heron	☒	☐	☐
American Coot	☒	☐	☐	Green-backed Heron	☒	☐	☐
Cormorant	☒	☐	☐	Anna Hummingbird	☒	☐	☐
Cedar Waxwing	☐	☒	☐	Rufous Hummingbird	☐	☒	☐
American Crow	☒	☐	☐	Jack Snipe	☒	☐	☐
Diver Duck	☒	☐	☐	Stellar's Jay	☐	☒	☐
Bald Eagle	☐	☐	☒	Lesser Scaup	☐	☒	☐
House Finch	☐	☒	☐	Mallard	☒	☐	☐
Flicker	☒	☐	☐	Merganser	☐	☒	☐
Common Goldeneye	☐	☒	☐	Red-Winged Blackbird	☒	☐	☐
American Goldfinch	☐	☒	☐	American Robin	☐	☒	☐
Canada Goose	☒	☒	☐	Western Sandpiper	☒	☐	☐
Sparrow	☒	☐	☐	Rufous-sided Towhee	☐	☒	☐
Starling	☐	☒	☐	Widgeon	☐	☒	☐
Green Swallow	☐	☒	☐	Wood Duck	☐	☒	☐
Tree Swallow	☐	☒	☐	Pileated Woodpecker	☐	☒	☐
Mammalian				**Fish, Miscellaneous**			
Bats	☐	☒	☐	Bass	☒	☐	☐
Feral Cats	☒	☐	☐	Bluegill	☒	☐	☐
Mice	☒	☐	☐	Catfish	☒	☐	☐
Opossum	☒	☐	☐	Croppie	☒	☐	☐
Racoon	☒	☐	☐	Frogs	☒	☐	☐
Rat	☒	☐	☐	Salamander	☒	☐	☐
Squirrel	☒	☐	☐		☐	☐	☐

The Priority Habitats and Species Program of the WDFW was contacted to determine if any species or habitats of concern residing in Barnes Lake or in the immediate vicinity. According to staff at WDFW, no sensitive plant or animal communities are known to exist in the area, or are reliant upon Barnes Lake for protective habitat.

BENEFICIAL USES OF BARNES LAKE

Barnes Lake is a private lake located within the City of Tumwater in Thurston County. There are no public boating and boat access areas, and motorized boating and water skiing activities are not feasible due to shallow water and stumps in the lake. Over the past 30 years, Barnes Lake has gradually become over-run with vegetation, which has reduced beneficial uses such as fishing, non-motorized boating, swimming, and aesthetics.

Figure 9: Beneficial Use Areas for the residents of Barnes Lake



The residents living along the shoreline have private access and many others have clear views to the lake. Many of the residents enjoy a long history of living on the lake and are dedicated to preserving the beauty of the lake, enhancing the ecosystem to support varied species of wildlife, and insuring the economic vitality of the residential and commercial properties.

Conservation Areas are sites determined by the Steering Committee to be essential to the preservation of wildlife habitat, natural vegetation, and shall be maintained as such to meet compliance with applicable federal, state, and local regulations.

Ecology provided the Barnes LMD Steering Committee with guidance pertaining to the development of conservation areas. Non-native, noxious weeds are allowed 100% eradication and native species are allowed a 60% removal in beneficial use areas. Delineation of the conservancy areas presented a unique challenge due to the wide spread integration of native and invasive waterlilies. The total area designated for conservation was determined assuming both species cover the area equally, with 100% eradication (9.1 acres) of the non-native, fragrant waterlily, and 60% (5.5 acres) removal of the native spatterdock.

Table 5: Vegetation Coverage of Barnes Lake			
Total Surface Water Area	**27.09 Acres**		
Pre-Treatment			
Open Water	8.78 acres	Fragrant Waterlily	Spatterdock
Total Waterlily Infested Area	18.32 acres	9.15 acres	9.15 acres
Post-Treatment			
Open Water	23.43 acres		
Total Conservation Areas	4.20 acres	0 acres	3.66 acres

The following have been tentatively identified as Conservancy Areas: the shorelines of the WA State Department of Transportation, Tumwater United Methodist Church, and the Tumwater School District Administration building. These areas include habitats that are integral to the lake ecosystem, such as nesting sites, fish rearing or spawning areas. However, lilies covering the surface of the lake limit the beneficial uses for residents and wildlife inhabiting Barnes Lake. Wildlife and lake residents

avoid the infested areas, which encompass a majority of the lake's surface. Many of the wildlife species abandon the area completely at the height of the vegetative growing season. Conservation areas, approximately 4.2 acres of the lake surface, are highlighted in yellow in Figure 9.

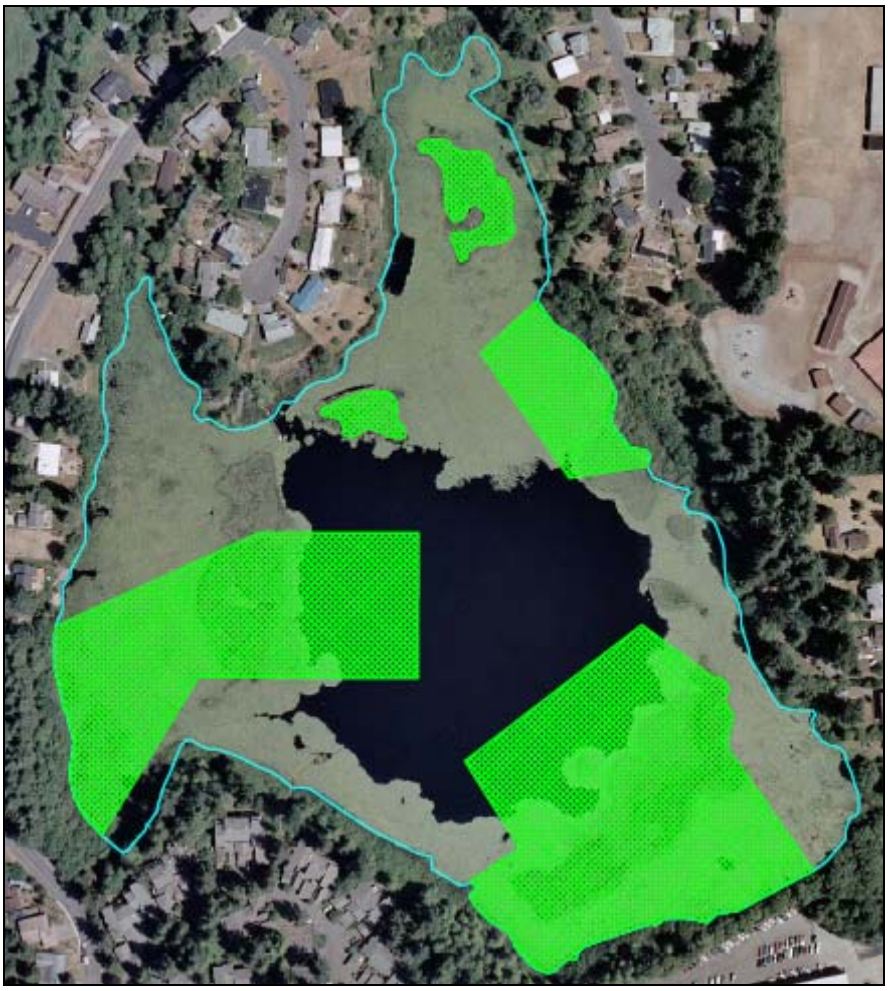


Figure 10: Conservation Areas for Native Spatterdock on Barnes Lake

Maintaining the health and appearance of Barnes Lake accomplishes more than simple stewardship of the natural habitat for fish, birds, and small wildlife. The lake also has an economic influence affecting property values and the quality of life for homeowners along the shores of Barnes Lake and the surrounding community. If the lake is permitted to manifest into a diminishing pond or to be completely obscured with vegetation, a downgraded economic factor will occur.

BARNES LAKE WATER RIGHTS

Some residences on Barnes Lake may have water rights. To ensure that all residents who might draw water from the lake are aware of any potential water use restrictions, there will be announcements sent to all lakeside residents prior to each herbicide treatment. One announcement will be sent at the beginning of the summer with approximate dates of planned treatments, and subsequent

announcements will be sent 7 – 10 days prior to each treatment, with exact dates of treatment and use restrictions. The announcement must let water right holders know who to contact should this interfere with their rights. The lake management group may have to provide alternate water sources to these people should they object to the treatment.

VEGETATION MANAGEMENT HISTORY

The residents of Barnes Lake have managed aquatic plants since the early 1980s with funds raised from neighbors and volunteer labor. The Barnes LMD was established in 2005 to ensure funds are available for long-term control of nuisance vegetation and eradication of invasive species and the lake continues to be actively managed with the support of all residents of Barnes Lake. A summary of previous aquatic plant management efforts is shown in Table 6.

Two primary plant control activities have taken place over time at Barnes Lake, although not on a regular basis; mechanical cutting and herbicide control for both species of water lily found in Barnes Lake. Mechanical harvesting took place in 1985 to control native submerged vegetation and noxious fragrant waterlilies. The aquatic herbicide, Rodeo® was used three times in the past 20 years. The first application occurred in the early 1980's and was successful in eradicating a number of the lilies, although subsequent treatments did not occur, allowing the vegetation to firmly re-establish. The second application occurred in 1993, again with no follow-up treatments. Residents recall a third application, although a specific date could not be determined.

Table 6. Summary of aquatic plant control methods by plant community*

Year	*Native & Submerged Plants(2)*	*Fragrant Waterlily(2)*
1983	Herbicide Application – Rodeo®	Herbicide Application – Rodeo®
1988	Mechanical Cutting	Mechanical Cutting
1993	Herbicide Application – Rodeo®	Herbicide Application – Rodeo®

* Does not include plant control (e.g. pulling, raking, bottom barriers, limited herbicide use) by lake residents or contractors hired by lake residents

The main areas of concern with the aquatic plant community in Barnes Lake are the overabundance of fragrant waterlilies and the native spatterdock lilies. The presence of swollen bladderwort is also a concern and will be addressed in future years. Other concerns include; the encroachment of emergent vegetation into open water areas, degradation of shoreline habitat by noxious emergent plants (e.g. reed canary grass, nightshade), preserving aquatic vegetation in conservancy areas, and informing individual homeowners on the proper methods for small-scale plant control efforts. The Barnes LMD Steering Committee will continue to monitor the different aquatic plant control methods used in the lake and work with City of Tumwater staff to keep lake residents notified of plant management activities.

As part of a comprehensive review of plant management techniques, all control alternatives described and approved by Ecology were initially considered for use in Barnes Lake. These included the use of various herbicides, harvesting, rotovation, sediment dredging, stocking grass carp, and other techniques. The process for selection of the preferred control option(s) began with a review of the entire range of control alternatives typically available to Washington State residents. The advantages and disadvantages of each were described as well as a discussion of their appropriateness for use in the lake. The most feasible control alternatives were selected and combined to form different strategies that met some or all aquatic plant management goals.

Two control methods for eradication of fragrant waterlily were considered. These control methods included:

- Annual applications of the systemic herbicide glyphosate (Rodeo®) until eradication is achieved.
- Continued small-scale harvesting. (Note: This technique was selected for further review even though lake residents understood that it did not meet the goal of fragrant waterlily eradication)

At this point, no other control options were selected for the control of other vegetation. The primary goal of the LMD is to address the lily infestation in Years 1 and 2 while developing a sound course of action for emergent vegetation and other known noxious and nuisance vegetation.

AQUATIC PLANT CONTROL OPTIONS

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

Control/eradication methods discussed below include physical control methods, chemical treatments, and mechanical control methods, including bottom screens, diver dredging, biological control, rotovation, cutting, harvesting, and drawdown.

"DO NOTHING" OPTION

The first option considered was the "Do Nothing" option to let aquatic weeds continue to grow and do nothing to control them. This "no action" alternative would acknowledge the presence of the aquatic weeds but would not outline any management plan or enact any planned control efforts. Effectively, a "no action" determination would preclude any integrated treatment and/or control effort, placing the choice and responsibility of aquatic weed control with lakefront property owners.

This management plan is primarily focused on the eradication of noxious weeds and the control of native submerged plants. Both noxious and nuisance plants have reduced the beneficial uses of the lake. Several different options to control (or eradicate) these plants are presented in this plan. However, the "no-action" alternative was examined in order to serve 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 directly from 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. 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 OF NO-ACTION ALTERNATIVE:

- no treatment cost

DISADVANTAGES OF NO-ACTION ALTERNATIVE:

- quality of the lakes will continue to decline,
- recreational opportunities will decline,
- fish and wildlife habitat will be reduced or impaired,
- property values will decline.

SUITABILITY FOR BARNES LAKE

The fragrant waterlily infestation is currently severe in density; covering approximately 18 acres, or more than 65% of the total surface area of the lake. Unless control measures are enacted, the density is likely to increase each future growing season until the entire littoral zone of the lake is dominated by fragrant waterlilies. Based on results of informal surveys of aerial photos by residents and City of Tumwater staff, the infestations of fragrant waterlily have increased annually. If there is no control effort, it is likely that weed infestations will continue to grow, causing Barnes Lake to continue to degrade in water quality and its diverse population of native aquatic plants. The "no action" alternative is not preferred by members of the Barnes Lake community.

CHEMICAL CONTROL METHODS

AQUATIC HERBICIDES

http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html

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

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants, or are applied to the water in either a liquid or pellet form. Systemic herbicides are capable of killing the entire plant by translocating from foliage or stems and killing the root. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and capable of re-growth (chemical mowing). Non-selective herbicides will generally affect all plants that they come in contact with, both monocots and dicots. Selective herbicides will affect only some plants (usually dicots – broad leafed plants like fragrant waterlily will be affected by selective herbicides whereas monocots like Brazilian elodea and native pondweeds may not be affected).

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, because of a March 2001 court decision (Ninth Circuit Court of Appeals), coverage under a discharge permit called a National Pollutant Discharge Elimination System (NPDES) permit must be obtained before aquatic herbicides can be applied to some waters of the U.S. This ruling, referred to as the Talent Irrigation District decision, has further defined Section 402 of the Clean Water Act. Ecology has developed a general NPDES permit which is available for coverage under the Washington Department of Agriculture for the management of noxious weeds growing in an aquatic situation and a separate general permit for nuisance aquatic weeds (native plants) and algae control. For nuisance weeds (native species also referred to as beneficial vegetation) and algae, applicators and the local sponsor of the project must obtain a NPDES permit from Ecology before applying herbicides to Washington water bodies.

Although there are a number of EPA registered aquatic herbicides, Ecology currently issues permits for seven aquatic herbicides. Several other herbicides are undergoing review and it is likely that other chemicals may be approved for use in Washington in the future. As an example, Renovate® (Triclopyr) has been approved by the U.S. EPA for aquatic use in November 2002, making it the

first aquatic herbicide to receive registration since 1988. Renovate® was designed to be effective on both emergent and submersed plants.

The chemicals that are currently permitted for use are:

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 as Eurasian watermilfoil or hydrilla. Although glyphosate is a broad spectrum, non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Plants can take several weeks to die and a repeat application is often necessary to remove plants that were missed during the first application.

Fluridone – (Trade names for fluridone products include: Sonar® and Avast!®). Fluridone is a slow-acting systemic herbicide used to control Eurasian watermilfoil, hydrilla and other underwater plants. It may be applied as a pellet or as a liquid. Fluridone can show good control of submersed plants where there is little water movement and an extended time for the treatment. Its use is most applicable to whole-lake or isolated bay treatments where dilution can be minimized. It is not considered effective for spot treatments of areas less than five acres. It is slow acting and may take six to twelve weeks before the dying plants fall to the sediment and decompose. When used to manage Eurasian watermilfoil in Washington, fluridone is applied several times during the spring/summer to maintain a low, but consistent concentration in the water. Although fluridone is considered to be a broad-spectrum herbicide, when used at very low concentrations, it can be used to selectively remove Eurasian watermilfoil. Some native aquatic plants, especially pondweeds, are minimally affected by low concentrations of fluridone.

2,4-D – There are two formulations of 2,4-D approved for aquatic use. The granular formulation contains the low-volatile butoxy-ethyl-ester (BEE) formulation of 2,4-D (Trade names include: AquaKleen® and Navigate®). The liquid formulation contains the dimethylamine salt (DMA) of 2,4-D (Trade name - DMA*4IVM). 2,4-D is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species.

Endothall - Dipotassium Salt – (Trade name Aquathol®) Endothall is a fast-acting nonselective contact herbicide which destroys the vegetative part of the plant but generally does not kill the roots. Endothall may be applied in a granular or liquid form. Typically endothall compounds are used primarily for short-term (one season) control of a variety of aquatic plants, including hydrilla. However, there has been some recent research that indicates that when used in low concentrations, endothall can be used to selectively remove exotic weeds; leaving some native species unaffected. Because it is fast acting, endothall can be used to treat smaller areas effectively.

Diquat – (Trade name Reward®). Diquat is a fast-acting non-selective contact herbicide that destroys the vegetative part of the plant but does not kill the roots. It is applied as a liquid. Typically diquat is used primarily for short-term (one season) control of a variety of submersed aquatic plants. It is very fast acting and is suitable for spot treatment. However, turbid water or dense algal blooms can interfere with its effectiveness. Diquat was allowed for use in Washington in 2003.

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, is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species such as purple loosestrife. Triclopyr can be effective for spot treatment of Eurasian watermilfoil and is relatively selective to Eurasian watermilfoil when used at the labeled rate. Many native aquatic species are unaffected by triclopyr. Triclopyr is very useful for purple loosestrife control since native grasses and sedges are unaffected by this herbicide. When applied directly to water, Ecology has imposed a 12-hour swimming restriction to minimize eye irritation. Triclopyr received its aquatic registration from EPA in 2003 and was allowed for use in Washington in 2004.

Imazapyr – (Trade name Habitat®). This systemic broad spectrum herbicide, applied as a liquid, is used to control emergent plants like spartina, reed canarygrass, and phragmites and floating leaved plants like waterlilies. 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

- Aquatic herbicide application can be less expensive than other aquatic plant control methods.
- Aquatic herbicides are easily applied around docks and underwater obstructions.
- 2,4-D DMA, 2,4-D BEE, and Triclopyr TEA have been shown to be effective in controlling smaller infestations (not lake-wide) of Eurasian watermilfoil in Washington, and could also be used on the purple loosestrife and yellow flag iris.
- Washington has had some success in eradicating Eurasian watermilfoil from some smaller lakes (320 acres or less) using Sonar®.
- Glyphosate is the recommended chemical for fragrant waterlily control.

Disadvantages

- 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.
- Rapid-acting herbicides like Aquathol® may cause low oxygen conditions to develop as plants decompose. Low oxygen can cause fish kills.
- To be most effective, generally herbicides must be applied to rapidly growing plants.
- Some expertise in using herbicides is necessary in order 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
A NPDES permit is needed. Although the noxious and nuisance NPDES permits do not currently require the development of Integrated Aquatic Vegetation Management Plans (IAVMP), the City of Tumwater has recommended the Barnes LMD develop a plan. The City of Tumwater and the Barnes LMD will 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. For noxious weed control, the applicator must apply to the Washington Department of Agriculture (Agriculture) for coverage under their NPDES permit every five years. There is no application fee to obtain NPDES coverage under Agriculture's permit for Noxious Weeds, although permit fees up to $500 will be billed once the permit is approved. Ecology requires that a State Environmental Protection Act checklist be submitted with the permit application. There are no additional permit requirements from the City of Tumwater.

Costs
Approximate costs for one-acre herbicide treatment (costs will vary from site to site):

- Glyphosate: $250
- Fluridone: $900 to $1,000
- Endothall: $650
- 2,4-D: $600
- Diquat: $300 to $400
- Triclopyr: $1,000

Other Considerations
The focus of the discussion below is the active ingredient Glyphosate since the Steering Committee has chosen this chemical as the best option for the start of the Integrated Treatment Strategy for Barnes Lake. Since glyphosate (Rodeo®) is the recommended treatment for fragrant waterlilies, and other chemicals would have required a whole lake treatment and can be very expensive per unit, they were not chosen as options and are not discussed in further detail.

EPA studies yield the parameters LD50 (acute lethal dose to 50% of a test population), NOEL (No Observable Effect Level, which is the highest test dosage causing no adverse responses), and RfD (EPA Reference Dose determined by applying at least a 100-fold uncertainty factor to the NOEL).

The EPA defines the RfD as the level that a human could be exposed to daily with reasonable certainty of no adverse effect from any cause, in other words, a "safe" dose. Exposures to bystanders or consumers are deemed safe when the RfD is not exceeded (Felsot, 1998). Since all substances, natural or manmade, may prove toxic at a sufficiently high dose, one should remember the old adage "dose makes the poison." The LD50 value is useful for comparing one compound with another and for grouping compounds into general hazard classes.

According to Felsot (1998), any pesticide, such as glyphosate, that does not produce adverse effects on aquatic organisms until levels in water reach milligram per liter (i.e., mg/L, equivalent to a part per million, ppm) would be considered of comparatively low hazard.

Substances that are biologically active in water at levels one-thousand-fold less (i.e., µg/L, parts per billion, ppb), are considered highly hazardous to aquatic life. Most pesticides falling in the latter category are insecticides rather than herbicides.

Also, compounds that have half-lives less than 100 days are considered non-persistent compared to compounds having half-lives approaching one year or longer (for example, DDT). The half-life of glyphosate is about 12 days in water. Since there are multiple factors that modulate the pesticides' hazard, just focusing on the half-life itself can be misleading for hazard assessment. It is now known that the longer a residue remains in soil/sediment, the less likely it will be taken up by plants, leach, or runoff (Felsot, 1998). This phenomenon is called residue aging and involves changes in the forces governing interactions of the chemical with the soil matrix over time.

Glyphosate

Examination of mammalian toxicity has shown that the acute oral and dermal toxicity of glyphosate would fall into EPA's Toxicity Category III. This category characterizes slightly to moderately toxic compounds. Glyphosate is practically nontoxic by ingestion, with a reported acute oral LD50 of 5600 mg/kg in tested rats. The risks of incidental contact from swimming in treated water have also been judged as low with a dermal LD50 of 7940 mg/kg, a very high threshold. The RfD for glyphosate is 0.1 mg/kg/d. To place the level of hazard to humans in perspective, the commonly consumed chemicals caffeine (present in coffee, tea, and certain soft drinks), aspirin (acetylsalicylic acid), and nicotine (the neuroactive ingredient in tobacco) have acute oral LD50's of 192, 1683, and 53 mg/kg, respectively. Thus, the herbicides for the most part are comparatively less toxic than chemicals to which consumers voluntarily expose themselves (Felsot, 1998).

Since the shikimic acid pathway does not exist in animals, the acute toxicity of glyphosate is very low. Animal studies, which the EPA has evaluated in support of the registration of glyphosate, can be used to make inferences relative to human health. The U.S. Forest Service's glyphosate fact sheet reports that the EPA has concluded that glyphosate should be classified as a compound with evidence of non-carcinogenicity for humans (Information Ventures, Inc.). This conclusion is based on the lack of convincing carcinogenicity evidence in adequate studies in two animal species. Laboratory studies on glyphosate using pregnant rats (dose levels up to 3500 mg/kg per day) and rabbits (dose levels up to 350 mg/kg per day), indicated no evidence of teratology (birth defects). A three-generation reproduction study in rats did not show any adverse effects on fertility or reproduction at doses up to 30 mg/kg per day.

Glyphosate was negative in all tests for mutagenicity (the ability to cause genetic damage). Technically, glyphosate acid is practically nontoxic to fish and may be slightly toxic to aquatic invertebrates (EXTOXNET, 1996). Some formulations may be more toxic to fish and aquatic species due to differences in toxicity between the salts and the parent acid, or to surfactants used in the formulation. There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms. In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms.

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

Microbes are primarily responsible for the breakdown of the product, and volatilization or photodegradation losses will be negligible. The manufacturer of Rodeo®, one of the aquatic

formulations of glyphosate, recommends use of a nonionic surfactant with all applications to improve efficacy. Of the approved surfactants for aquatic use in Washington, only LI-700 (Loveland Industries, Inc.) may be used for fragrant waterlily control and will therefore be applied directly to the water. Based on the results of searches of the published literature and the Toxic Substances Control Act Test Submission (TSCATS) database, little data is available regarding the toxicity of the surfactant formulations (Diamond & Durkin, 1997). The oral LD50 was >5000 and 5900 mg/kg in male and female rats, respectively, and the dermal LD50 for a 24-hour exposure was >5000 mg/kg in rabbits. These values are in the same range as glyphosate alone, EPA's toxicity category III, which puts LI-700 in a category of lower risk to mammals.

Suitability for Barnes Lake

Aquatic herbicides can provide an effective method for control and eventual eradication of noxious weeds. Glyphosate should be very effective on the target fragrant waterlily and spatterdock species. Westerdahl and Getsinger (1988) report excellent control of the fragrant waterlily with glyphosate. Generally glyphosate is the recommended herbicide for waterlily control because it can be applied directly to the floating leaves, unlike fluridone or endothall which must be applied to the water. The application of glyphosate allows specific plants or areas of plants to be targeted for removal. Generally two applications of glyphosate are needed. The second application later in the summer controls the plants that were missed during the first herbicide application. The control effectiveness of fragrant waterlily is easy to measure through visual surveys due to the floating leaves.

One of the main reasons to eradicate fragrant waterlily is to maintain the health of the native aquatic plant community for all of the species that utilize them in their life cycles, as well as to maintain the viability of the lake for human recreational uses. The nature of the control methods to be implemented will minimize impacts to native aquatic vegetation. The control of the fragrant waterlily will be conducted by methods designed to preserve (and eventually enhance or conserve) the native plant communities. The herbicide for the fragrant waterlily will be applied to the floating leaves, and therefore should be easily focused to kill only the target vegetation.

Follow-up control methods (hand pulling and/or cutting) will focus specifically on the two target species and should also leave beneficial plants intact. With these constraints in place, native plant communities will have an opportunity to re-establish in the delineated conservancy areas. 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.

We do not anticipate any need to revegetate after controlling the fragrant waterlily since the delineated conservancy areas are currently colonized with the native spatterdock.

A drawback of using herbicides is the "uplifting" of mats of decomposing waterlily roots that can form large floating islands in the waterbody after the herbicides have killed the plants. The waterlilies are in large monospecific stands around the lake. These areas could potentially generate floating sediment mats because of their size. Volunteers from the community will remove any sediment mats created in these areas, for which we will need to get Hydraulic Project Approval from WDFW. For smaller mats, we may tow them to shore and remove the sediment with hand tools. If larger mats occur, we will have to investigate machinery mounted on a barge to dig or dredge out the sediment mat.

Past community efforts at Barnes Lake have used aquatic herbicides, so we do not anticipate disagreement with this recommendation from the community. Based on the agreeable response from highly-attended public meetings, support for herbicide use from the Barnes Lake community has been demonstrated. Prior to any activities on the lake, outreach materials will be sent to all watershed residents informing them of the actions and appropriate contact information will be provided for any questions or comments. The watershed residents will be notified prior to any treatments with the anticipated treatment dates.

PHYSICAL CONTROL METHODS

MANUAL METHODS

Hand-Pulling

Hand-pulling aquatic plants is similar to pulling weeds out of a garden. It involves removing entire plants (leaves, stems, and roots) from the area of concern and disposing of them in an area away from the shoreline. In water less than three feet deep no specialized equipment is required, although a spade, trowel, or long knife may be needed if the sediment is packed or heavy. 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.

Cutting

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

Raking

A sturdy rake makes a useful tool for removing aquatic plants. Attaching a rope to the rake allows removal of a greater area of weeds. Raking literally tears plants from the sediment, breaking some plants off and removing some roots as well. Specially designed aquatic plant rakes are available.

Rakes can be equipped with floats to allow easier plant and fragment collection. The operator should pull towards the shore because a substantial amount of plant material can be collected in a short distance.

Cleanup

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

Advantages

- Manual methods are easy to use around docks and swimming areas.
- The equipment is inexpensive.

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

Disadvantages

- As plants re-grow or fragments re-colonize the cleared area, the treatment may need to be repeated several times each summer.
- Because these methods are labor intensive, they may not be practical for large areas or for thick weed beds.
- Even with the best containment efforts, it is difficult to collect all plant fragments, leading to recolonization.
- 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

Permits are required for many types of manual projects in lakes and streams. The Washington State Department of Fish and Wildlife requires a Hydraulic Project Approval permit for all activities taking place in the water including hand pulling, raking, and cutting of aquatic plants.

Costs

Hand-pulling costs up to $130 for the average waterfront lot for a hired commercial puller. A commercial grade weed cutter costs about $130 with accessories. A commercial rake costs about $95 to $125. A homemade weed rake costs about $85 (asphalt rake is about $75 and the rope costs 35-75 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 Barnes Lake

Manual methods will be important in assisting in the removal of floating mats, after the chemical control methods have been evaluated for their effectiveness. At this point, diver hand-pulling should be sufficient to remove the remaining waterlily plants outside of the conservancy areas. Cutting can also be used to control small areas of fragrant waterlily, especially those close to the shoreline. Using this method out in the open water would require a stable boat (not canoe) and great care not to injure oneself or another passenger. Since repeated cutting over several seasons may be required to starve the roots, this would fit best as a supplement to other control methods.

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 back to the water column (if the permit allows this), and the plant material is retained. The turbid water is generally discharged to an area curtained off from the rest of the lake by a silt curtain. The plants are disposed of on shore. Removal rates vary from approximately 0.25 acres per day to one acre per day depending on plant density, sediment type, size of team, and diver efficiency. Diver dredging is more effective in areas where softer sediment allows easy removal of the entire plants, although water turbidity is increased with softer sediments. Harder sediment may require the use of a knife or tool to help loosen sediment from around the roots. In very hard sediments, milfoil plants tend to break off leaving the roots behind and defeating the purpose of diver dredging.

Diver dredging has been used in British Columbia, Washington, and Idaho to remove early infestations of Eurasian watermilfoil. Diver dredging is less effective on plants where seeds, turions, or tubers remain in the sediments to sprout the next growing season. For that reason, Eurasian watermilfoil is generally the target plant for removal during diver dredging operations.

Advantages

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

Disadvantages

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

Permits

Permits are required for many types of projects in lakes and streams. Diver dredging requires Hydraulic Approval from the Department of Fish and Wildlife. Also diver dredging may require a Section 404 permit from the U.S. Army Corps of Engineers.

Costs

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 Barnes Lake

Diver dredging removes the plant in its entirety. It removes the biomass above the sediment as well as the tubers in the sediment. This option is best used for pioneering infestation and in soft sediments. Diver dredging could be used after the initial herbicide applications to remove plants that

were missed or unaffected by the herbicide. The soft organic sediments in Barnes Lake should make this method effective. However, permit costs may warrant having this work done as diver hand pulling since the roots should be largely removed from the loose sediments without the need for dredging. Diver dredging greatly disturbs sediments and can affect nutrient concentrations and algal production in the lake. Since other techniques for removal are more suitable, this should not be considered.

Bottom Screens

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

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

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

The duration of weed control depends on the rate that weeds can grow through or on top of the bottom screen, the rate that new sediment is deposited on the barrier, and the durability and longevity of the material. For example, burlap may rot within two years, plants can grow through window screening material, and can grow on top of felt-like Texel fabric. Regular maintenance is essential and can extend the life of most bottom barriers. Bottom screens will control most aquatic plants; however, freely-floating species such as the bladderworts or coontail will not be controlled by bottom screens. Plants like Eurasian watermilfoil will send out lateral surface shoots and may canopy over the area that has been screened giving less than adequate control.

In addition to controlling nuisance weeds around docks and in swimming beaches, bottom screening has become an important tool to help eradicate and contain early infestations of noxious weeds such as Eurasian watermilfoil and Brazilian elodea. Pioneering colonies that are too extensive to be hand pulled can sometimes be covered with bottom screening material.

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

- Installation of a bottom screen creates an immediate open area of water.

- Bottom screens are easily installed around docks and in swimming areas.
- Properly installed bottom screens can control up to 100 percent of aquatic plants.
- Screen materials are readily available and can be installed by homeowners or by divers.

Disadvantages

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

Permits

Bottom screening in Washington requires Hydraulic Project Approval. Local jurisdictions may require shoreline permits.

Costs

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

Other Considerations

None

Suitability for Barnes Lake

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 the Barnes Lake Condominium's dock, to prevent re-infestation after initial control. Installing a bottom barrier at a dock can provide these benefits. Since there is not a swimming beach at Barnes Lake, individual docks seem the only appropriate place to install a bottom barrier to enhance the recreational potential of the lake.

BIOLOGICAL CONTROL METHODS

GENERAL OVERVIEW

Many problematic aquatic plants in the western United States are non-indigenous species. Plants like Eurasian watermilfoil, Brazilian elodea, and purple loosestrife have been introduced to North

America from other continents. Here they grow extremely aggressively, forming monocultures that exclude native aquatic plants and degrade fish and wildlife habitat. Yet, often these same species are not aggressive or invasive in their native range. This may be in part because their populations are kept under control by insects, diseases, or other factors not found in areas new to them.
The biological control of aquatic plants focuses on the selection and introduction of other organisms that have an impact on the growth or reproduction of a target plant, usually from their native ranges. Theoretically, by stocking an infested waterbody or wetland with these organisms, the target plant can be controlled and native plants can recover.

Classic biological control uses control agents that are host specific. These organisms attack only the species targeted for control. Generally these biocontrol agents are found in the native range of the nuisance aquatic plants and, like the targeted plant, these biocontrol agents are also non-indigenous species. With classic biological control an exotic species is introduced to control another exotic species. However, extensive research must be conducted before release to ensure that biological control agents are host specific and will not harm the environment in other ways. The authors of *Biological Control of Weeds – A World Catalogue of Agents and Their Target Weeds* state that after 100 years of using biocontrol agents, there are only eight examples, world-wide, of damage to non-target plants, "none of which has caused serious economic or environmental damage…"

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

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

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

Sometimes the bio-control insects become prey for native predator species, and sometimes the impact of the insect on the target plant just isn't enough to control the growth and reproduction of the species. People who work in this field say that the more biological control species that you can put to work on a problem plant, the better success you will have in controlling the targeted species. There are some good examples where numerous biological control agents have had little effect on a targeted species, and other examples where one bio-control agent was responsible for the complete control of a problem species.

However, even when biological control works, a classic biological control agent generally does not totally eliminate all target plants. A predator-prey cycle establishes where increasing predator

populations will reduce the targeted species. In response to decreased food supply (the target plant is the sole food source for the predator), the predator species will decline. The target plant species rebounds due to the decline of the predator species. The cycle continues with the predator populations building in response to an increased food supply.

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

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

In 1992 three beetles were released in Washington for purple loosestrife control. Their damaging impact on purple loosestrife populations was evident in the Winchester Wasteway area of Grant County in 1996. In 1998, 1999, and 2000, the Washington State Noxious Weed Control Board organized insect collection for state, local, and federal staff. Thousands of insects were collected and distributed to purple loosestrife sites throughout the state and even the United States. The King County Noxious Weed Control Program has placed Galerucella sp. from the Winchester Wasteway on a number of purple loosestrife sites, including Barnes Lake. Barnes Lake was chosen because of a high density of the target plant and the fact that other control methods were impractical.

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

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

Several researchers around the United States (Vermont, Minnesota, Wisconsin, Ohio, & Washington) have been working to determine the suitability of this insect as a bio-control agent. The University of Washington conducted research into the suitability of the milfoil weevil for the biological control of milfoil in Washington lakes and rivers. Surveys have shown that in Washington the weevil is found more often in eastern Washington lakes and it seems to prefer more alkaline

waters. However, it is also present in cooler, wetter western Washington. The most likely candidates for use as biological controls are discussed in the following section.

Grass Carp
http://www.ecy.wa.gov/programs/wq/plants/management/aqua024.html

The grass carp (Cteno pharynogodon), also known as the white amur, is a vegetarian fish native to the Amur River in Asia. Because this fish feeds on aquatic plants, it can be used as a biological tool to control nuisance aquatic plant growth. In some situations, sterile (triploid) grass carp may be permitted for introduction into Washington waters.

Permits are most readily obtained if the lake or pond is privately owned, has no inlet or outlet, and is fairly small. The objective of using grass carp to control aquatic plant growth is to end up with a lake that has about 20 to 40 percent plant cover, not a lake devoid of plants. In practice, grass carp often fail to control the plants, or in cases of overstocking, all the submersed plants are eliminated from the waterbody.

The Washington Department of Fish and Wildlife determines the appropriate stocking rate for each waterbody when they issue the grass carp stocking permit. Stocking rates for Washington lakes generally range from nine to 25 eight- to eleven-inch fish per vegetated acre. This number will depend on the amount and type of plants in the lake as well as spring and summer water temperatures. To prevent stocked grass carp from migrating out of the lake and into streams and rivers, all inlets and outlets to the pond or lake must be screened. For this reason, residents on water bodies that support a salmon or steelhead run are rarely allowed to stock grass carp into these systems.

Once grass carp are stocked in a lake, it may take from two to five years for them to control nuisance plants. Survival rates of the fish will vary depending on factors like presence of otters, birds of prey, or fish disease. A lake will probably need restocking about every ten years.

Success with grass carp in Washington has been varied. Sometimes the same stocking rate results in no control, control, or even complete elimination of all underwater plants. Bonar et. al. found that only 18% of 98 Washington lakes stocked with grass carp at a median level of 24 fish per vegetated acre had aquatic plants controlled to an intermediate level. In 39% of the lakes, all submersed plant species were eradicated. It has become the consensus among researchers and aquatic plant managers around the country that grass carp are an all or nothing control option. They should be stocked only in water bodies where complete elimination of all submersed plant species can be tolerated.

Grass carp exhibit definite food preferences and some aquatic plant species will be consumed more readily than others. Pauley and Bonar performed experiments to evaluate the importance of 20 Pacific Northwest aquatic plant species as food items for grass carp. Grass carp did not remove plants in a preferred species-by-species sequence in multi-species plant communities. Instead they grazed simultaneously on palatable plants of similar preference before gradually switching to less preferred groups of plants. The relative preference of many plants was dependent upon what other plants were associated with them. The relative preference rank for the 20 aquatic plants tested was as follows:

Potamogeton crispus (curly leaf pondweed) = P. pectinatus (sago pondweed) > P. zosteriformes (flatstemmed pondweed) > Chara sp.(muskgrasses) = Elodea canadensis (American waterweed) =

thinleaved pondweeds Potamogeton spp. > Egeria densa (Brazilian elodea) (large fish only) > P. praelongus (white-stemmed pondweed) = Vallisneria americana (water celery) > Myriophyllum spicatum (Eurasian watermilfoil) > Ceratophyllum demersum (coontail) >Utricularia vulgaris (bladderwort) > Polygonum amphibium (water smartweed) > P. natans (floating leaved pondweed) >P. amplifolius (big leaf pondweed) > Brasenia schreberi (watershield) = Juncus sp.(rush) > Egeria densa (Brazilian elodea) (fingerling fish only) > Nymphaea sp. (fragrant waterlily) > Typha sp. (cattail) > Nuphar sp. (spatterdock).

Generally in Washington, grass carp do not consume emergent wetland vegetation or waterlilies even when the waterbody is heavily stocked or over stocked. A heavy stocking rate of triploid grass carp in Chambers Lake, Thurston County resulted in the loss of most submersed species, whereas the fragrant waterlilies, bog bean, and spatterdock remained at pre-stocking levels. A stocking of 83,000 triploid grass carp into Silver Lake, Washington resulted in the total eradication of all submersed species, including Eurasian watermilfoil, Brazilian elodea, and swollen bladderwort. However, the extensive wetlands surrounding Silver Lake have generally remained intact. In southern states, grass carp have been shown to consume some emergent vegetation (Washington State Department of Ecology, 2002).

Grass carp stocked into Washington lakes must be certified disease free and sterile. Sterile fish, called triploids because they have an extra chromosome, are created when the fish eggs are subjected to a temperature or pressure shock. Fish are verified sterile by collecting and testing a blood sample.

Triploid fish have slightly larger blood cells and can be differentiated from diploid (fertile) fish by this characteristic. Grass carp imported into Washington must be tested to ensure that they are sterile. Because Washington does not allow fertile fish within the state, all grass carp are imported into Washington from out-of-state locations. Most grass carp farms are located in the southern United States where warmer weather allows for fast fish growth rates. Large shipments are transported in special trucks and small shipments arrive via air.

Here are some facts about grass carp:

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

Advantages

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

Disadvantages

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

Permits

Stocking grass carp requires a fish-stocking permit from the Washington Department of Fish and Wildlife. Also, if inlets or outlets need to be screened, an Hydraulic Project Approval application must be completed for the screening project.

Costs

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

Other Considerations

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

Suitability for Barnes Lake

Grass carp are not suitable for aquatic plant control in Barnes Lake. Grass carp do not generally find the major invasive aquatic plant, fragrant waterlily, palatable and will tend to ingest all other submersed species of aquatic plants. Additionally, the carp could remove all the beneficial plants that support a healthy fish population. Without cover and the invertebrates associated with beneficial native aquatic vegetation, the system would be degraded and some species (invertebrates, fish, etc.) may be extirpated.

ROTOVATION, HARVESTING, AND CUTTING

ROTOVATION

Rotovators use underwater rototiller-like blades to uproot fragrant waterlily plants. The rotating blades churn seven to nine inches deep into the lake or river bottom to dislodge plant root crowns that are generally buoyant. The plants and roots may then be removed from the water using a weed rake attachment to the rototiller head or by harvester or manual collection.

HARVESTING

Mechanical harvesters are large machines, which both cut and collect aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until disposal. 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.

CUTTING

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

Suitability for Barnes Lake

None of these options are suitable for the level of infestation at Barnes Lake. They are not eradication tools, but rather are used to manage and control heavy, widespread infestations of aquatic weeds.

These processes create plant fragments. According to Ecology, "There is little or no reduction in plant density with mechanical harvesting". Since the aim of this project is to eliminate fragrant waterlily from the system, these are not compatible control strategies. Harvesting and cutting do not remove root systems. Rotovation would cause damage to the lake sediments and associated animals in a system that does not already receive dredging for navigability.

Drawdown

Lowering the water level of a lake or reservoir can have a dramatic impact on some aquatic weed problems. Water level drawdown can be used where there is a water control structure that allows the managers of lakes or reservoirs to drop the water level in the waterbody for extended periods of time.

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

Suitability for Barnes Lake

Drawdown is not a viable control strategy for Barnes Lake. The outlet from Barnes Lake has a permanent weir with limited drawdown capacities. Not only would drawdown be difficult to achieve, it would also cause significant damage to the ecosystem. The amount of drawdown required to impact fragrant waterlily 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 living 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.

NUTRIENT REDUCTION

NUTRIENT REDUCTION ALTERNATIVE

At lakes in watersheds with identifiable sources of excess nutrients, a program to reduce nutrients entering the lake could possibly be an effective method of controlling aquatic vegetation. Sources of excessive nutrients might include failing septic tanks, other accidental or planned wastewater effluent, or runoff from agricultural lands. If nutrient reduction were enacted as the primary method of weed control, extensive research would be necessary to determine the current nutrient budget for the lake and surrounding watershed, whether nutrient reduction would result in milfoil reduction, and to identify and mitigate the natural and human-mediated nutrient sources.

SUITABILITY FOR BARNES LAKE

Nutrient reduction is not an appropriate control measure for the following reasons:

- It is not an eradication method.
- There is no evidence that there is significant point-source nutrient loading at Barnes Lake.
- There is no evidence that reducing nutrient loads to the water column would impact fragrant waterlily growth.
- However, all lake residents should strive to reduce nutrient loading to their lake by practicing and implementing Best Management Practices.

SELECTED TREATMENT OPTION

Initially there was some concern expressed about the use of chemicals in an aquatic environment. Discussions of the toxicity of the selected herbicides and the herbicide approval process helped to alleviate some of these concerns. The following summary of the herbicide approval process is provided for clarification.

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 insure the chemical quickly breaks down into a non-toxic form or becomes unavailable for uptake by aquatic organisms. Washington State has in turn set more stringent standards. Therefore, some of the aquatic herbicides approved for use in the United States are not approved for use in Washington. The relatively low toxicity of the herbicides (Rodeo®, Reward® and Aquathol®) considered for use in this plan warranted their acceptance as three of the handful of aquatic herbicides allowed for use in Washington State.

The City of Tumwater strongly recommends that any pesticides being used in an aquatic environment meet the review criteria and be approved for use by Thurston County or as specifically allowed by the Thurston County Board of Health. Thurston County has developed an extensive pesticide review program to determine which chemicals can be applied in the environment with the least impacts. Glyphosate (Rodeo®) is an herbicide that is currently approved for use by Thurston County. The herbicide Reward® considered in this plan contains the active ingredient diquat dibromide. Diquat dibromide failed a pesticide review in 1991 (Thurston County 2004b). Some of Thurston County's concerns associated with diquat dibromide included:

- Yellow perch suffer significant respiratory stress when herbicide concentration in water is similar to what is normally present during aquatic vegetation control.
- Diquat also contains ethylene dibromide as an inert ingredient, which is considered to be an animal positive carcinogen.
- Persists in the soil for years with little degradation even though not biologically or chemically active.
- EPA requested additional testing for possible adverse effects in gene mutation and DNA damage.
- There were some effects to male reproductive capacity in mice.
- Cows were especially sensitive to treated waters.
- Respiratory equipment was recommended for applicators.

Aquathol® (active ingredient endothall) also failed a pesticide review conducted in 2000 (Thurston County 2004b). Some of the County's concerns associated with Aquathol® included:

- Salmonid smoltification and gill injury are significant.
- Potential dermal and eye irritation, and 24-hour swimming restrictions after treatment.
- High mobility, and may persist in low oxygen environments.

INTEGRATED TREATMENT PLAN

Barnes Lake and its associated shoreline contain three listed noxious weed species that should have control measures implemented to halt the spread of their invasions and reverse the degradation currently occurring. The three target species are the fragrant waterlily (*Nymphaea odorata*), big floating bladderwort (*Utricularia inflata*), and reed canary grass (*Phalaris arundinacia*). Although all three species at Barnes Lake are highly aggressive and are difficult to control/eradicate, we believe that the goal of eradication is reasonable for all of them, and we can be successful within the time frame of the project. Additionally, yellow flag iris *(Iris pseudacorus)* has been identified by residents of Barnes Lake. A survey for yellow flag iris will be conducted by the consultant selected to implement treatments on the lake and a management plan for eradication of this Class C noxious plant will be developed.

PRIMARY TARGET: FRAGRANT WATERLILY (NYMPHAEA ODORATA)

Fragrant waterlily is a floating-leaved noxious aquatic plant that has been found at the lake since at least the early 1980's. Barnes Lake currently has approximately 18 acres of floating-leaved plants, the majority of which are fragrant waterlilies. These plants grow in nearshore areas (<10 feet deep) and favor areas with deep mucky sediment.

The management objective for fragrant waterlilies is eradication. While fragrant waterlilies are the dominant floating-leaved plant in the lake, they co-exist with others such as yellow waterlilies and watershield. It is desirable to retain these other plants because of their habitat and recreational value. To meet these needs, targeted applications of an herbicide with the active ingredient glyphosate (e.g. Rodeo®) is recommended.

Glyphosate was selected for the herbicide treatment because of effectiveness, duration, low cost, and negligible environmental impact. Glyphosate is a systemic herbicide that is absorbed by foliage and passed throughout the plant. Since it kills the rhizomes, it results in long-term control of the plant community. This herbicide has low toxicity to bottom-dwelling organisms, fish, birds, and other mammals and dissipates quickly; therefore it is considered to have a low environmental impact. Unlike mechanical harvesting, glyphosate can also be used to control fragrant waterlilies inside of lake residents' docks, providing more relief from these noxious weeds. Although LMD-sponsored applications of this herbicide have occurred previously at Barnes Lake, treatments have not been continuously applied and therefore the efficacy of the treatments was limited. Herbicide treatments have been highly effective in controlling fragrant waterlilies at Lake Lawrence, Thurston County since 1996. Fragrant waterlilies were reduced from approximately 80 acres to less than one acre at Lake Lawrence using a fragrant waterlily Integrated Plant Management (IPM) prescription adopted by the Lake Lawrence LMD.

Prior to treatment, a detailed aquatic plant survey and GPS mapping effort would be conducted to identify all the fragrant waterlilies (individual plants and patches of plants) in the lake. Glyphosate would then be applied to these patches and single plants where they occur. The first treatment should take place late enough in the season to ensure that all fragrant waterlilies have reached the surface of the lake. It is relatively common for some plants to survive the initial treatment as they are either not identified by the applicator or herbicide is washed off by waves. Thus a second treatment conducted a few weeks later would result in improved control. Care should be taken by the

applicators to avoid collateral damage to the native floating-leaved plants such as yellow waterlilies and watershield. The herbicide would be re-applied annually until fragrant waterlilies are eradicated.

Smaller patches of plants and single plants will be completely treated the first year this plan is implemented. However, due to the size of the larger patches of plants, those areas will be gradually eliminated over three to four years by spraying the outer edges of the patch. The amount of fragrant waterlilies will steadily decrease through continued annual treatments until eradication is achieved. This program of gradual elimination should help to alleviate the potential for decomposing waterlily material to float to the surface and become a nuisance for lake users. It is estimated that fragrant waterlilies will be eradicated or at undetectable levels after five consecutive years of treatment.

Native submerged aquatic plants might become established in areas of the lake where fragrant waterlilies are eradicated. These plants may need to be controlled if they colonize this shallow water habitat and impede beneficial uses.

The cost of using glyphosate typically ranges from $250 - $350 per acre treated if at least 10 acres are treated. For smaller treatment areas this unit cost does not apply since most applicators charge a minimum fee to cover costs such as public notification and plant surveys. For example, at Lake Lawrence in Thurston County, approximately two acres of fragrant waterlilies were treated in 2003. The treatments took place on two separate occasions, included public notification and a survey, and cost approximately $5,000.

It is estimated that approximately 18 acres of fragrant waterlilies would be treated the first year at a cost of $8,500. Additional treatment costs will vary dependent upon the efficacy of previous treatments, but are estimated to cover one to three acres during each of the next few years at a cost ranging from $6,325 to $2,500 annually. Although annual costs may change as the plants near eradication, over the 5-year period of this plan, glyphosate treatment has been estimated to cost $24,375 (Table 7).

By implementing this eradication strategy, it is possible that eventually only a few (single plants) fragrant waterlilies will be found during the annual plant survey. It may not be cost-effective to hire an applicator to spray only a few plants. Although difficult, alternative methods such as hand-pulling or diver hand-removal could be used to control low numbers of these plants. It should also be emphasized that lakeside residents are allowed to locally remove fragrant waterlilies by hand pulling, installing bottom barriers, or other physical methods. Although this requires time and energy on the part of the residents, it compliments the lake-wide eradication effort.

Removal of the dead vegetative material will be also be considered as part of the regular vegetation management program where herbicides are being used to control lily growth. According to treatment experts, Barnes Lake is susceptible to floating "mats" – dead organic material that floats to the surface after treatment due to the natural decay process, sediment type, and general shallow nature of the lake. Initial cost estimates range from $1,500 - $4,000 per day and can be completed employing different methods and materials.

YEAR ONE

Control efforts on the fragrant waterlily will begin in the summer of 2007 with Glyphosate. All vegetated areas of the lake will be treated, approximately 18 acres. The intensity of control will be equal across the entire lake, with eradication of fragrant water lily as the end goal.

In addition to posting requirements, the permit issued by Ecology requires monitoring of the glyphosate levels in the lake after treatment. Independent samples will be collected about one hour after the application and again 24 hours post treatment. One sample is taken from within the treatment area, and one from outside. These four samples (per application) will be sent to an independent, Ecology-accredited laboratory for the analysis. A follow up treatment may be done later in the summer of 2007 to insure control over the fragrant waterlily population. It is not likely that the lilies will be eradicated by Year One. A contractor will be hired in Year One for a two-year treatment cycle.

The native waterlily (*Nuphar polysepala*) is well represented in the lake where much of the fragrant waterlily is currently found and is likely to expand its distribution. The selective nature of spot applications of Glyphosate should minimize impacts to non-target vegetation, and may allow the native waterlily to rebound or expand. Native water lily outside of identified conservancy areas will also be eradicated during herbicide applications under the current permitting period.

YEAR TWO

Year Two will include another glyphosate application. A glyphosate application will be performed when floating leaves have formed on the waterlily (approximately the same time as Year One). Two glyphosate applications are planned in Year Two, the initial application and a follow-up spot treatment for any missed plants. Lake residents will monitor vegetative growth and coordinate volunteer events for cutting and removing any plants not killed by the herbicide. This manual control will be performed by the end of the summer before the plants set seed.

YEAR THREE - FIVE

In future years, we may need to eliminate returning plants or new infestations. The LMD Steering Committee has planned for a "final" herbicide application in Year Three in terms of fragrant waterlily control, but also believes that continued application of herbicides is necessary to achieve total eradication of all noxious plant species. These future applications will be addressed in updates to this plan.

Cutting by volunteers will be used to control small areas of waterlily. If the level of waterlily infestation again gets to the point where manual control is no longer feasible, the LMD will plan for an herbicide application the following summer.

After the initial eradication of the fragrant waterlily, the LMD Steering Committee will review the necessity of emergent plant removal. Control of emergent plants is reviewed below.

EMERGENT PLANT CONTROL

There are two problem categories associated with emergent aquatic plants at Barnes Lake: the noxious weeds' big floating bladderwort, reed canary grass, and yellow flag iris; and native yellow water lilies that are potentially impacting beneficial uses of the lake.

NOXIOUS EMERGENT PLANTS

Big floating bladderwort (*Utricularia inflata*) is a noxious aquatic plant that is targeted for eradication from the lake. Swollen bladderwort (*Utricularia inflata)* is a member of a group of freely-floating, rootless, carnivorous aquatic plants. It is native in the southeastern United States, but is increasingly

being seen in some western Washington lakes where it is considered to be a nuisance, including Barnes Lake.

Reed canary grass (*Phalaris arundinacia*) is another noxious weed that exists in multiple locations along the shoreline of Barnes Lake. A highly variable species, reed canary grass (*Phalaris arundinacea* L.) is a rhizomatous perennial grass that can reach three to six feet in height.

Yellow flag iris (*Iris pseudacorus)* may be pretty, but it is invasive and fast spreading. If left unchecked, it can take over a shoreline or a wetland in a matter of a few years. These dense growing emergent aquatic weeds can choke off access to Barnes Lake and reduce viable habitat for native wildlife.

Barnes Lake's aquatic vegetation management program will target yellow flag iris for treatment with a glyphosate based herbicide, however cooperation of all lake residents is necessary to make this treatment effective.

To adequately treat these plants, the contractor will need access to all lake front properties to conduct a survey and provide treatments, as necessary. The LMD Steering Committee will contact LMD members requesting permission for the contractor to enter the individual lake front properties. Yellow flag iris has a tremendous propagation potential. As a result, any single plant left untreated has the potential to generate literally millions of additional plants, so it is important that all property owners participate in the treatment.

While hand removal of these weeds can slow the spread of these plants, if it is not done correctly, it can actually increase the spread of these invasive plants. Current information indicates that the most effective way to remove these plants is with a glyphosate-based herbicide. However, this plant is so resilient, it may take two or three seasons of repetitive treatment to completely eradicate yellow flag iris and its dense root structures.

Lake residents will be advised to not cut yellow flag iris before treatment. The more surface area on the plant, the greater the absorption of the herbicide and the more effective the treatment. The potential impacts from yellow flag iris to both aquatic and nearshore habitat is a significant concern. Herbicide treatment will be applied by a license applicator under the strict requirements of the state permit.

As with fragrant waterlilies, all invasive bladderwort, reed canary grass and yellow flag iris shall be identified and mapped during the plant surveys. Although the overall abundance of these plants is still moderate, several large patches exist at the lake. Glyphosate will be used to treat them at the same time that fragrant waterlilies are sprayed. Eradicating these species before they become even more abundant is a priority. The annual cost to treat invasive bladderwort, reed canary grass, and yellow flag iris may be highly variable but is not estimated to incur additional costs above that designed for the fragrant waterlily treatments.

Native Emergent Plants

Native emergent plants such as yellow waterlily, smartweed, willow, and cattails are currently reducing beneficial uses in the lake in a few locations.

Cattails are found on each of the established islands as well as along the shorelines. Herbaceous plants found along the shorelines, such as willow and alder, also contribute to the reduction in beneficial uses for the lake residents. These plants have begun to encroach into the lake's littoral zone and are starting to impede resident access. The cattails, willow, and alder are also accelerating filling of the littoral zone. This is occurring due to two mechanisms: through trapping sediment in the water column and their annual contribution of material to the lake bottom through plant decay.

The selected strategy to control native emergent plants is to use glyphosate to control them in areas where lake access, beneficial uses, and aesthetic values are being impaired while leaving a buffer zone of emergent plants to support fish and wildlife habitat. Prior to treatment, a detailed aquatic plant survey and GPS mapping effort would be conducted to identify the overall abundance and density of the emergent species in the lake and areas where their presence is impairing beneficial use of the lake.

Glyphosate would be applied only to sections of the lake where the native vegetation is impeding access, with the exception of the conservancy areas. Those treatable areas will be determined by the City of Tumwater, the LMD steering committee, and regulatory agencies by comparing a current plant survey with prior qualitative survey results. Where native emergents are restricting access to the lake in front of residents' homes, glyphosate can be used to maintain access for views, non-motorized boating and swimming. This control will not occur unless specific permission is obtained from the property owners. More extensive control of native emergents in front of lake residents' homes will have to be negotiated among the property owners, City of Tumwater staff, and Ecology.

Controlling the native emergents should take place at the same time the fragrant waterlilies are treated, followed by further control a few weeks later. Areas where glyphosate will be used should be flagged prior to treatment. Care should be taken by the applicators to avoid collateral damage to non-targeted native vegetation. The applicator should cover desirable plants adjacent to treatment areas to minimize damage to non-target vegetation. Areas with State-listed sensitive plants should be identified and placed off limits prior to control of emergent vegetation. Spot control of targeted native emergents using glyphosate is likely to last up to three years before they grow back and re-treatment is necessary. It is estimated that up to one acre of native emergents will be sprayed in a treatment season at an approximate cost of up to $3,500 and will take place annually, as needed, during the permitted period. The total cost over the 5-year period of this plan is estimated to be $10,000 (Table 7).

PUBLIC OUTREACH

The public education program for Barnes Lake consists of three parts; the exotic plant prevention plan (under development), lakeside stewardship education, and watershed protection/pollution prevention for protecting the lakes' water quality.

EXOTIC PLANT PREVENTION

All watershed residents should be sent copies of an exotic plant prevention brochure. A group of lake homeowners should be trained to identify invasive plants and perform periodic volunteer surveys of the lakeshore.

There are a number of other non-native plants that are more destructive and difficult to control than the fragrant waterlily currently in Barnes Lake. Other non-native, highly invasive plants of concern that are already present in Washington State include; Parrotfeather (*Myriophyllum aquaticum*), Brazilian Elodea (*Egeria densa*), Hydrilla (*Hydrilla verticillata*), Fanwort (*Cabomba caroliniana*), and Water Hyacinth (*Eichhorinia crassipes*). These plants grow in the littoral zones of lakes, ponds, or rivers. A pro-active program to prevent their introduction or detect them before they become widespread is critical.

Shoreline (emergent) noxious plants are also destructive and difficult to control. Examples of these plants include Yellow Flag Iris *(Iris pseudacorus),* Purple loosestrife (*Lythrum salicaria*) and Garden loosestrife (*Lysimachia vulgaris*).

To be effective this program should include both a source control component (prevention) and a detection program. The objective of source control is to prevent non-native aquatic plants from entering the lake. The objective of the detection program is to be able to quickly identify noxious plants in the lake before they become widespread and more costly to control.

Lake residents should also receive informative brochures or newsletter articles on an annual basis reminding them of plant invasion problems and the importance of keeping their own properties free of such plants. It is also recommended that the lake community develop a public information campaign. Simply having volunteers hand out exotic plant identification cards for a few hours will emphasize the importance of the effort.

Early detection is the next step to protect against new infestations. While an infestation is still small, there are options for control that are much less expensive than the whole-lake treatment methods. Early detection, if done properly, requires both a trained group of lake volunteers and periodic surveys to assess the plant community. The main purpose of these surveys is to search for non-native aquatic plants.

However, it will also provide a means for monitoring the native plant communities and determining where future control efforts should be focused. Volunteers would be trained each year in plant identification and survey techniques and each would be given the responsibility for surveying a certain section of shoreline once a month during the growing season. Their purpose would be to note any substantial changes in the plant community and to look for new invasions of nuisance species.

The primary advantage of controlling small infestations is that it reduces the chance that a large area would need to be controlled by a more intensive and expensive technique. Drawbacks of controlling small infestations are the high costs associated with hand pulling. Costs for hand pulling by contract divers range from $500 to $2,500 per day depending upon plant type, acreage, and density. Although the volunteer survey program should have no long term cost, a training workshop would be necessary the first year. A volunteer training workshop cost of $2,000 has been included in plan implementation cost estimates (Table 7) during Year 4.

The exotic plant control plan complements the plan for the eradication of fragrant waterlily. The surveys would be relied upon to detect new infestations of existing noxious weeds and allow immediate removal of the plants. If another exotic plant is found, immediate action should be taken and a survey should be planned for later in the same year to insure there were no surviving colonies. If the area infested is too large to control by hand pulling, or if after two follow-up surveys the exotic plant is still found, bottom barriers would be placed in all areas where the plant was detected.

Treatment with herbicide is recommended as a final resort if these efforts do not result in eradication of the exotic plant. These additional surveys, bottom barrier installation, and herbicide treatments are contingency elements to the overall aquatic plant control plan for the lake.

LAKESIDE STEWARDSHIP EDUCATION

Each lakeside resident should be provided with educational material about how to reduce the amount of pollutants entering the lake from their property, as well as about things they should do to help retain a complex, diverse, and therefore healthier lake environment.

Lakeside property owners should be provided with information about problems associated with typical urban type landscapes around lake shorelines. This should include information on the drawbacks of using ornamental turf (lawns), and the benefits of adding shoreline plants and diversified lawn plantings which create habitat structure for birds and wildlife.

Some important considerations for proper stewardship of lakeside property are described here. Informative brochures or newsletter articles should be used to educate lakeside property owners about best management practices (BMPs). Some examples of stewardship ideas include:

- Encourage native plants and grasses for landscaped areas in nearshore zones to decrease the amount of fertilizers, pesticides, and other pollutants entering the waterbody.
- Establish a "pollutant free zone" within 50 feet of the shoreline. Try to keep all pollutants; private herbicide applications, painting projects, landscape fertilizers, and etc. away from this zone.
- Plant a shoreline buffer of shrubs and tall grasses, preferably native species. This one small activity will cause multiple environmental benefits. If properly designed, it will keep geese and other waterfowl from moving onto lawn areas. The vegetation will help filter out pollutants from landscaped areas before they reach the lake. It will provide protection from shoreline erosion, and it will provide habitat for the many wildlife species that utilize nearshore areas.
- Preserve natural "structure" that exists along the shoreline and in the shallow nearshore area, or if necessary, clean up only a narrow strip alongside the dock area. If a tree along the shoreline finally falls in, leave it. Add structure in the form of tree tops, twig bundles, and rocks to diversify and naturalize the nearshore area and attract more fish and wildlife.

- Allow emergent vegetation and other plants to colonize some portion of waterfront area.

Public education and involvement should also center around the annual plant surveys. In the spring of each year the Steering Committee should plan a short workshop to describe plant survey results from the past year and the plant control strategy for that year (e.g. when, where, and what control measures will be used). During the workshop, a schedule should be agreed upon for volunteer surveys. At this time everyone should be trained or re-trained on plant identification and survey techniques.

Since much lake related public education information is already contained in available brochures, there is little cost associated with developing the information. A $500 per year cost has been included for development and reproduction of brochures, with an additional $250 for mailing and postage. It is assumed that the first plant workshop would be done by a professional who can develop a training and survey program during Year 4. After that the workshops would be put on by lake resident volunteers. The cost for the initial workshop was estimated at $1,500 (Table 7).

WATERSHED PROTECTION/POLLUTION PREVENTION

Over the long term, the quality of Barnes Lake may be most impacted by development activity in the watershed. Recommendation of watershed protection measures is beyond the scope of this plan; however lake residents should be aware of the potential impacts and take a pro-active role to insure protection of their lake. Lake residents need to monitor watershed related activities to insure that appropriate BMPs are being carried out in nearby commercial and residential developments. This should include; tracking where activities are occurring, reviewing permit applications to insure proper BMPs have been included, reporting violations to permit conditions or water quality standards, and generally keeping informed about the watershed problems.

PLAN ELEMENTS, COSTS, AND FUNDING

Table 7 outlines the tasks and estimated costs of implementation on an annual basis. Implementation of the Barnes Lake IAVMP will span the permitting period of five years, at a total estimated cost of $98,128. As additions are made to the management program, this plan will be updated to reflect the new information and budget forecast. The majority of the costs accrue in the first several years, which is the period of most aggressive treatment. Beyond that, costs are directed at detecting and controlling re-introduction of noxious aquatic plant species.

Table 7: Budget with use of Glyphosate

Task	2007	2008	2009	2010	2011	Total
Lily Treatment	$8,500	$6,325	$4,550	$2,500	$2,500	**$24,375**
Vegetation Survey	$2,000	$2,000	$ --	$2,000	$ --	**$6,000**
Emergent Weed Treatment	$740	$750	$1,500	$3,500	$3,500	**$10,000**
Vegetation Removal	$8,500	$4,000	$2,500	$2,500	$2,500	**$20,000**
Water Quality Monitoring	$ 4,000	$ --	$4,500	$ --	$4,500	**$14,000**
Education and Outreach	$500	$550	$550	$2,600	$600	**$4,800**
Printing Costs	$240	$250	$250	$750	$250	**$1,750**
Administration & Misc.	$1,800	$1,857	$1,882	$1,882	$1,882	**$9,312**
Totals	**$26,280**	**$15,732**	**$15,732**	**$15,732**	**$15,732**	**$89,208**
Contingency (10%)	$2,628	$1,573	$1,573	$1,573	$1,573	$8,920
Grand Total	**$28,908**	**$17,305**	**$17,305**	**$17,305**	**$17,305**	**$98,128**

SOURCE OF FUNDING

Beginning in 2006, the Barnes Lake Management District began to collect assessments for project implementation. These assessments are the primary source of funding available for lake management activities. While the bulk of the funding will come from this source, the City of Tumwater provides management oversight and other mechanisms to ensure funding for treatments are available to the LMD. Additionally, grant funding may become available for activities relating to education, outreach, and clean-up activities. Volunteer labor from LMD residents may also be utilized to help control costs of vegetation management.

The following sections discuss sources of funding for aquatic plant control related activities. It is important to understand that the Barnes Lake LMD is the only group that funds large-scale annual plant control and water quality monitoring. Public agencies are not currently funding these annual activities and the LMD has been collecting assessments for this work since 2006.

BARNES LAKE MANAGEMENT DISTRICT ASSESSMENTS

Barnes Lake LMD members are assessed an annual fee which is used to fund lake management activities. Public hearings were conducted during the formation of the management district to determine member support for the formation and assessment fees. The LMD has been in existence

since 2005 and is authorized to exist for 30 years, expiring in December 2035. Under Resolution R2005-013, approved by the Tumwater City Council on April 19, 2005, the roll of rates and charges was authorized, assessing each property in the management district a fee based on the property's classification.

Table 8: Assessments Schedule

Property Class	Rate	# of Properties	Total $ Per Class
Residential w/Frontage	$240	26	$6,240
Undeveloped Residential w/Frontage	$120	3	$360
Public/Commercial	$480	3	$1,440
Condo w/View	$192	21	$4,032
Condo w/o View	$96	50	$4,800
Residential w/View	$77	5	$385
Undeveloped Residential w/View	$48	1	$48
	Totals	***109***	***$17,305***

Some areas of the lake (e.g. lands covered by water or parcels used exclusively for private roads or utilities) are exempt from LMD fees.

The LMD currently collects approximately $17,305 in assessments to fund lake management activities. Almost all of these funds are budgeted for annual lake management activities such as aquatic vegetation surveys, noxious plant eradication, water quality and plant control monitoring, and administrative costs. Any funds not used in a given year are rolled over to the following year and are held as a contingency fund for unanticipated lake management efforts.

The Tumwater City Council approved an ordinance that sets rates and charges for the Barnes Lake LMD. The current annual assessments collected by the LMD will fund most of the yearly plant control related activities proposed in this plan. If more funds are needed, the LMD Steering Committee has the authority to recommend raising assessment rates as needed, for the duration of the LMD.

Barnes Lake is a private lake used only by lake residents and LMD members. Some members may be experienced in the organization of fund-raising activities such as raffles and benefits, which could become annual events in the area. This represents an additional potential source of funding for lake management activities.

GRANTS

As Barnes Lake is a private lake, there are currently no state grant options for funding management activities. In the event members opt to open the lake to public use, public grants would be available through the State's Aquatic Weed Management Fund (AWMF). There is a competitive process for awarding these grant funds that begins with a written application. The annual application period begins October 1st and closes on or about November 1st of each year. Workshops are held before or during the application period to explain the application process and general program requirements. Application guidelines, criteria, and other information about this program are detailed on Ecology's Aquatic Plants and Lakes website, under Aquatic Weed Grants.

Limits have been set on the size of grants that are available.

- The maximum grant amount for general aquatic weed management is $75,000. With the local match requirement of 25 percent, this equates to a project cost of $100,000.
- Planning grants are limited to $30,000. With the local match requirement, this equates to a project cost of $40,000.
- The maximum grant amount for early infestation grants is $50,000.

Limits have also been set on the amount of funds available to each public body during each funding cycle. The ceiling amount per public body is $75,000 for general aquatic weed management projects and $75,000 for early infestation projects. Funding for implementation of an IAVMP is expected to be used over a five to 10-year period and does not occur annually.

MATCHING FUNDS

The City of Tumwater does not provide matching funds to the private Lake Management District, but does provide project administration and staff support. Currently, there is no charge for services provided by City staff for their extensive support and technical expertise.

EVALUATION AND IMPLEMENTATION

Several different plant control-related monitoring and evaluation needs are identified for Barnes Lake. These include:

- Plant surveys,
- Herbicide residue monitoring, and
- An annual evaluation of lake management activities.

Water quality monitoring should also be a regular part of lake management activities. The following sections describe specific activities as they relate to aquatic plant management at the lake.

AQUATIC PLANT SURVEYS

Ongoing surveys are critical to preventing the rapid expansion of existing fragrant waterlily or new infestations of other noxious and native, nuisance weeds.

This is especially true for Barnes Lake due to its high aesthetic value to neighboring properties. When infestations are relatively small there are options for control that are much less expensive than, for instance, treating the whole lake with herbicide. Aquatic plant surveys performed in 2006 by Ecology staff included search efforts for fragrant waterlily and the identification of other plant species and their relative locations and densities. Surveys to be conducted by a contractor include the use of GPS equipment to help document the relative densities and locations of different plant species along transect lines.

It is recommended that a GPS/GIS survey and mapping effort be performed annually as a regular component of the long-term surveillance program.

Aquatic plant maps and an explanatory report should be prepared and provided to the residents of Barnes Lake as part of an education and awareness program. It is recommended that a survey of all the plant communities be incorporated into the noxious/nuisance and emergent vegetation survey efforts.

Additional surveys could also be used to assess the effectiveness of the treatment efforts. Surveys just before and after herbicide applications will be used to determine the immediate effectiveness of the treatments. Surveys a few weeks after treatments could also be used to assess plant recovery.

HERBICIDE MONITORING

Monitoring for herbicide residues is a required component of the NPDES Nuisance Weed permit. Because public sources of funding for the treatment of nuisance weeds are currently not available, all costs including monitoring are derived from lake management district funds.

Herbicide sampling should be accomplished by experienced water quality professionals. Ecology recommends that this may include, but is not limited to, the herbicide applicator (note: ideally the person sampling should not be the applicator or use applicator's boat or equipment because of the possibility of sample contamination. Ecology strongly discourages the applicator from sampling

because of potential for conflict of interest), a County or State water quality professional, or a private firm with monitoring expertise.

Ecology also allows trained volunteers (lake residents) to collect samples. In general, monitoring for herbicide residues involves sampling water within and outside of the treatment area; immediately before and after treatment, 24 hours after treatment, and potentially at some later time interval. Exact locations, time to sample, and number of samples vary depending on the herbicide(s) applied and target species.

Samples are then sent to an accredited laboratory for analysis. The results of herbicide monitoring are submitted to Ecology in the same year that treatment occurs.

A post-application assessment of the areas treated with herbicide should at a minimum include: an estimate of the effectiveness of application (quantitative or qualitative), any dead or dying organisms, algae conditions, and may include other available data (dissolved oxygen, pH, Secchi disk, turbidity, etc.).

It is estimated that herbicide monitoring would cost approximately $5,000 in the years in which herbicide is used at the lake (Table 7). This estimate includes time, labor, travel, and analytical costs. In instances where the manufacturers of the herbicides perform the sample analysis for free, the overall cost of herbicide monitoring may be less.

ANNUAL EVALUATION

A complete annual evaluation should be completed that describes which elements of the management plan have been implemented, relates the existing plant community to established goals, and makes 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. These results should be used to determine whether goals have been met. The community should also be asked for input on their satisfaction with plant and lake conditions. For example, it is possible that the goals will be met, but that some people will remain dissatisfied.

Although it is unlikely that the needs of all stakeholders will be met, 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 dramatic increase or decrease in the amount of nuisance plants in the lake? Have any other noxious aquatic plants been identified? Should other control tools (bottom barriers, for example) be considered? Is it necessary to implement a back-up plan? Is funding adequate for the control measures in place? Over the long-term, adequate annual evaluations can make the difference between project success or failure. It is estimated that writing an evaluation would cost approximately $2,500 per year with a summary of the report published in a newsletter (Table 7).

IMPLEMENTATION PLAN

YEAR 1

The first and most important steps for implementing the IAVMP have already been taken by the Barnes Lake residents. These include, securing a long term funding source (i.e., the LMD) and establishing a committee to oversee plan implementation. Therefore activities in the first year of this plan can focus directly on aquatic plant control. As soon as this IAVMP is approved by the State, planners should move forward in obtaining bids for management activities outlined in this plan.

City of Tumwater staff should work with the LMD steering committee to obtain bids from contractors for management activities. After a contractor is selected, the areas to be targeted for harvesting should be reviewed with the contractor by the LMD Steering Committee.

The herbicide treatment for fragrant waterlilies needs to be scheduled. The treatment of these noxious weeds should be preceded by a detailed survey, and in the case of yellow flag iris (and potentially Japanese knotweed) permission should be obtained from residents prior to treatment. It is recommended that the first treatment of native nuisance plants be postponed until year 2, after a more thorough examination of the areas where these plants are growing is conducted. An annual evaluation that details all lake management activities should be prepared at the end of the year.

Removal of the dead vegetative material will be considered as part of the regular vegetation management program where herbicides are being used to control lily growth. According to treatment experts, Barnes Lake is susceptible to floating "mats" – dead organic material that floats to the surface after treatment due to the natural decay process, sediment type, and general shallow nature of the lake. Initial cost estimates range from $1,500 - $4,000 per day and can be completed employing different methods and materials.

YEAR 2

The activities of year 1 would continue to the second year, and include spot control of invasive emergent vegetation where they are impeding lake access along the high use shorelines. A detailed survey of the extent of emergent growth in year 1 will reveal exactly where the vegetation should be controlled. The survey will provide baseline information useful in determining how effective the treatment is, as well as an understanding of how long the spot treatment lasts before becoming necessary again.

This second year would also be a good time to include the use of trained lake volunteers to assist in the detection of new invasive species. The efforts of these volunteers would complement the contractor surveys and allow lake residents to actively participate in lake management activities.

ONGOING

Each year the LMD steering committee will need to evaluate the past year's progress. At the very least they will need to determine what management activities should be continued and/or whether herbicide treatments are necessary. The steering committee should also review annual evaluations from past years to determine if long-term aquatic plant management goals are being met.

Other items to be considered on an annual basis include lakeside resident education and volunteer programs.

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

1. **Review proposed plan and develop an annual work plan with specific tasks.** The IAVMP will guide this process.
2. **Assign tasks to Steering Committee members.**
3. **Issue a Request for Proposals for weed survey and control work, as necessary.** After the first round of lake treatments (2 years), contracts for services should be reviewed annually.
4. **Secure necessary permits.** Permit application will be coordinated with the contracted applicator.
5. **Develop and implement a community education plan.**
6. **Apply herbicide treatment.** Application will be completed as prescribed in IAVMP, unless consultation with Ecology and the applicator leads to defensible changes in the plan.
7. **Conduct follow-up surveys**. Professional contractors and community members who have received adequate training can complete this work, with community participation under supervision of City of Tumwater staff.
8. **Apply follow-up herbicide treatment if necessary.** Follow-up surveys will determine the extent to which this work is necessary.
9. **Conduct diver surveys and hand-pulling as necessary.** Professional contractors and community members who have received adequate training can complete this work, with community participation under supervision of City of Tumwater staff.

SUMMARY AND CONCLUSIONS

The Barnes Lake LMD has been active in working to control aquatic plants since its inception in 2005. This Integrated Aquatic Vegetation Management Plan for Barnes Lake serves as an aquatic plant management guide for lake residents and City of Tumwater for the currently authorized permitting period.

This plan was developed through a public involvement process following guidelines set by Ecology. During the plan development process lake residents reviewed plant management goals and objectives, control methods, and selected a preferred aquatic plant control strategy. This strategy was designed to address both native nuisance plants and noxious plants at the lake.

The native submerged plants at Barnes Lake impede beneficial uses such as swimming, non-motorized boating, and fishing. Native emergent plants such as cattails are also impeding shoreline views and lake access for some lake residents. The noxious aquatic weeds fragrant waterlily, and yellow flag iris also threaten beneficial uses and fish and wildlife habitat, and their abundance and distribution need to be continuously monitored and eradicated as feasible. Without some sort of action plan, the aerial coverage of these aquatic plants is likely to increase and further impede beneficial uses of the lake. This report details a plan for:

- Eradicating fragrant waterlily and other non-native plants with the use of a glyphosate-based herbicide (Rodeo®),
- Control of native submerged plants with a recommended, State-approved herbicide that is approved for use by the City of Tumwater and is effective for controlling plants in Barnes Lake,
- Control of native emergents (i.e. cattails) and other native, nuisance vegetation where it is impeding access to the lake.

Implementation of this plan is estimated to cost approximately $99,261 for a five-year program.

Re-invasion by fragrant waterlily, bladderwort, reed canary grass, yellow flag iris, and other non-native plants will be closely monitored through annual surveys. Public education and awareness programs will be focused on exotic plant prevention, and providing general pollution prevention and best management practices information to lake residents.

The Steering Committee and interested lake residents will be involved in development of the yearly plant control strategy and will be responsible for soliciting volunteers for surveys and plant control activities. This will insure long-term involvement of lake residents in lake management decisions and activities.

REFERENCES

Aiken, S. G., P.R. Newroth, and I. Wile. 1979. The Biology of Canadian Weeds. 34. Myriophyllum spicatum L. Canadian Journal of Plant Science. 59:201-215. Cited in Sheldon and Creed, 1995.

Blatz, Gretchen, January 2007. Personal Communication. Wildlife Data Management Biologist, Washington State Department of Fish & Wildlife.

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.

City of Federal Way, 2006. *Steel Lake Integrated Vegetation Management Plan.* Department of Public Works, Surface Water Management Division.

City of Federal Way, 2006. *North Lake Integrated Aquatic Vegetation Management Plan. D*epartment of Public Works, Surface Water Management Division.

Diamond, Gary L. and Patrick R. Durkin. 1997. *Effects of Surfactants on the Toxicity of Glyphosate, with Specific Reference to RODEO.* Animal and Plant Health Inspection Service (APHIS), SERA TR 97-206-1b.

Extension Toxicology Network (EXTOXNET). 1996. *Pesticide Information Profiles: Glyphosate*. Oregon State University. Retrieved August 14, 2002. Available online at: http://ace.orst.edu/cgibin/mfs/01/pips/glyphosa.htm

Felsot, Allan S. 1998. *Hazard Assessment of Herbicides Recommended for Use by the King County Noxious Weed Control Program*. Prepared for the Utilities and Natural Resources Committee of the Metropolitan King County Council. Available online at: http://dnr.metrokc.gov/wlr/lands/weeds/herbicid.htm

Hamel, Kathy. September 2004 - December 2006. Personal communication. Aquatic Plant Specialist, Washington State Department of Ecology. Olympia, WA.

Information Ventures, Inc. 1995. *Pesticide Fact Sheet: Glyphosate.* Prepared for U.S. Department of Agriculture, Forest Service. Available online at: http://infoventures.com/e-hlth/pestcide/glyphos.html

Malik, J., G. Barry, and G. Kishore. 1989. *Mini-review: The herbicide glyphosate*. BioFactors. 2(1):17 25, 1989.10-100

McLain, Kelly. January 2006 – September 2006. Personal communication. Permit Coordinator, Washington State Department of Ecology.

Moody, Sandra. June 2006. Personal communication. Environmental Review & Grants Coordinator, Washington State Department of Natural Resources, Olympia, WA.

Reed, P. 1988. *National List of Plant Species that Occur in Wetlands: Northwest Region 9.* U.S. Fish and Wildlife Service, Biological Report 88 (26.9).

Richter, K.O. and A.L. Azous, 2001a. *Amphibian Distribution, Abundance, and Habitat Use* in: *Wetlands and Urbanization: Implication for the Future.* Azous, A.L. and R.R. Horner (eds), Lewis Publishers, Boca Raton. 338 pp.

Tetra Tech, Inc. 2003. Lake Lawrence Integrated Aquatic Vegetation Management Plan – Alum and Sediment Dredging Feasibility Assessment. *Prepared for* EnviroVision Corporation. Seattle, WA.

Thurston County. 1995. *Lake Lawrence Management Plan.* Thurston County Department of Water and Waste Management and Lake Lawrence Improvement Club. Olympia, WA.

Thurston County, 2004. *Long Lake Integrated Aquatic Vegetation Management Plan.* Thurston County Department of Water and Waste Management. Olympia, WA

Thurston County. 2002. Thurston County Water Resources Monitoring Report, 1999 – 2001 Water Year. Thurston County Department of Environmental Health and Storm and Surface Water Program. Olympia, WA. May 2002.

United States Department of Agriculture, Soil Conservation Service. 1973. *Soil Survey King County Area Washington.* U.S. Government Printing Office, Washington D. C.

Washington State Department of Ecology, 2001a. *An Aquatic Plant Identification Manual for Washington's Freshwater Plants.* 195pp.

Washington State Department of Ecology, 2006. *Non-native Freshwater Plants: Swollen Bladderwort.* Available online at: http://www.ecy.wa.gov/programs/wq/plants/weeds/bladder.html

Washington State Department of Ecology, 2001b. *Herbicide Risk Assessment for the Aquatic Plant Management Final Supplemental Environmental Impact Statement (Appendix C - Volume 3: 2,4-D).* Available online at: http://www.ecy.wa.gov/pubs/0010043.pdf

Washington State Department of Ecology, 2002. *Aquatic Plant Management website.* Available online at: http://www.ecy.wa.gov/programs/wq/plants/management/index.html

Washington State Department of Ecology, 2004. Environmental Impact Statement for Permitted use of Triclopyr. 115pp. Available online at: http://www.ecy.wa.gov/biblio/0410018.html

Washington State Department of Ecology. 1994. A citizen's manual for developing integrated aquatic vegetation management plans, first edition. Washington Department of Ecology, Water Quality Financial Assistance Program, Olympia, WA.

Washington State Department of Ecology. 2006. Water Rights Accounting and Tracking System.

Washington State Department of Ecology. 2006. Washington State's Water Quality Assessment 303(d). WDOE Water Quality Program, Olympia, WA.

Washington State Noxious Weed Control Board. 1995. *Eurasian watermilfoil.* In: Written Findings. Available online at: http://www.nwcb.wa.gov/weed_info/milfoil.html

Washington State Noxious Weed Control Board. 2001. *Iris pseudacorus.* In: Written Findings.

Washington State Noxious Weed Control Board. 1997. *Lythrum salicaria.* In: Written Findings. Available online at: http://www.nwcb.wa.gov/weed_info/ploosestrife.html

Washington State Noxious Weed Control Board. 2001b. *Nymphaea odorata.* In: Written Findings.

Westerdahl, H.E. and K.D. Getsinger (eds), 1988. *Aquatic Plant Identification and Herbicide Use Guide; Volume I: Aquatic Herbicides and Application Equipment.* Technical Report A-88-9, US Army Engineer Waterways Experiment Station, Vicksburg, TAS.