Introduction

Spanaway Lake is located just east of Joint Base Lewis-McChord in Pierce County, Washington. The lake provides a unique recreational opportunity to both the citizens of the region and those serving, or having served, our state or country while stationed at or visiting one of these military installations. There is a robust fishery in the lake, anglers come from all over to go after stocked trout, largemouth and small mouth bass, perch and the lake has some of the best fishing for Rock Bass in the region. There is a well-used Pierce County Park on the lake with two swimming beaches, a boat ramp, and a fishing dock. There is also a well-established lakefront community where residents have lived for generations enjoying the opportunity the lake provides to swim, boat, and fish.

In recent years however, residents and interested agencies have noted an expanding population of submerged aquatic weed growth that is impinging on recreational use of the lake. There have also been episodes of Harmful Algae Blooms and local health departments have posted the lake for potential toxic events recently.

The Washington Department of Ecology (DOE) recognized that aquatic weed species pose to our water resources. In the 1990's the Legislature through the work of a Joint Select Committee of the House, Senate and interested parties developed a program to help communities develop management strategies and implement them.

This program is funded by collecting a tax on the registration of boat trailers as they are the primary vector for spread. These funds are used by DOE to administer this program and to provide grant funding for management planning and control activities. The first step in this process for an infested water body is to build a stakeholder group and assist them in planning to target and control the invasive aquatic weed. This is done through the development of an Integrated Aquatic Vegetation Management Plan or IAVMP for short. Once this planning process is completed, the action plan that is developed can be implemented. The stakeholders can apply for DOE grant funds to help implement the plan.

In the case of Spanaway Lake, concerned citizens approached Pierce County to sponsor a grant to create an IAVMP. The DOE grant program requires involvement of a public entity that can contract with the agency. The County decided that it has a role in the protection of the lake and submitted the necessary application to Ecology to be considered for a planning grant. In the fall of 2016 this application was accepted by DOE and in the spring of 2017 that agency determined that the Spanaway application ranked high enough to receive funding support. The group "Friends of Spanaway Lake" is the lead on this work.

This plan follows the guidelines established by the DOE. The plan will be reviewed by the various stakeholders and edited as necessary to meet the needs of the community and to solve the invasive aquatic weed problem in Spanaway Lake.

Problem Statement and Management Goals

The first step was to try and identify key stakeholders that should be part of the planning process. In many cases one jurisdiction or lake homeowner's association includes the primary stakeholder group. In this case there are both local residential lakeside property owners and one large County Park.

The group was able to identify and obtain participation in this process from the following groups:

- Friends of Spanaway Lake
- Spanaway Lake Shoreline Residential Property Owners
- Pierce County Parks
- American Power Boat Association (holds event on the lake)

As a first key step in the planning process, this group of stakeholders discussed and developed the following Problem Statement and Management Goals to help focus the direction of the planning effort.

<u>Problem Statement:</u>

Excessive aquatic weed growth and Harmful Algae Blooms have become a problem in Spanaway Lake the past few years. Curly Leaf Pondweed, which is a state-listed noxious weed, is starting to appear in Spanaway Lake. Numerous species of native aquatic plants have expanded to the point of interfering with beneficial uses. The lake is currently under a Toxic Algae Advisory from Pierce County Health Department. Swimming, boating, fishing, and other recreational uses have been greatly impacted by these conditions. Swimmer safety along the shorelines is a serious concern and should be given priority. Transfer of Curly Leaf Pondweed to other lakes from boats or other watercraft using Spanaway Lake is also a major concern. A growing monoculture of Curly Leaf Pondweed could adversely impact the diversity of the native plant communities and impacting native fish and wildlife populations if not dealt with early.

Management Goals:

- Maintain recreational and habitat uses of the lake by removing aquatic weeds on the state noxious weed list, Curly Leaf Pondweed and White-Water Lily are the primary species to focus on. ****** yellow iris?
- Keep swimming areas clear of excessive aquatic weed growth for safety reasons.
- Keep boating areas clear of nuisance aquatic weed growth to minimize boat damage and transfer potential.
- Educate property owners and lake users about the negative impacts of invasive aquatic weeds such as Curly Leaf Pondweed.
- Choose appropriate control methods that are both effective and environmentally sensitive.
- Establish an agreement or memorandum of understanding among all lake front property owners and other interested parties to:
    - Determine equitable financing options for all lake front property owners to address ongoing control or eradication of Curly Leaf Pondweed and White-Water Lily, manage nuisance aquatic weed growth and mitigate Harmful Algae Blooms (it should be noted that a separate Phosphorus Management Plan is in development for HAB management and this document does not consider that issue).
    - Determine maintenance responsibilities.
- Reduce overall costs by using volunteer labor when possible.

With this Problem Statement and these Management Goals providing direction, the balance of this document will go through DOE's IAVMP planning process to develop an action plan for the community.

Waterbody and Watershed Features

Spanaway Lake is one of the larger lakes within Pierce County, Washington. The surface area of the lake is 272 surface acres with an average depth of 16 feet and a maximum depth of 28 feet. The lake was formed by glacial activity and is connected with a shallow ground water system that generally flows from the southeast to the northwest. The lake is in a sub basin of the Clover Creek Watershed. The sub-basin around Spanaway Lake is approximately 17 square miles.

Water flow into the lake is predominantly from groundwater. Studies have indicated that the shallow aquifer contribution is relatively high. Other surface water moves into the lake from a large wetland system that forms Coffee Creek on the southwest side of the lake. Outflow is to the north though Spanaway Creek which eventually flows into Clover Creek.

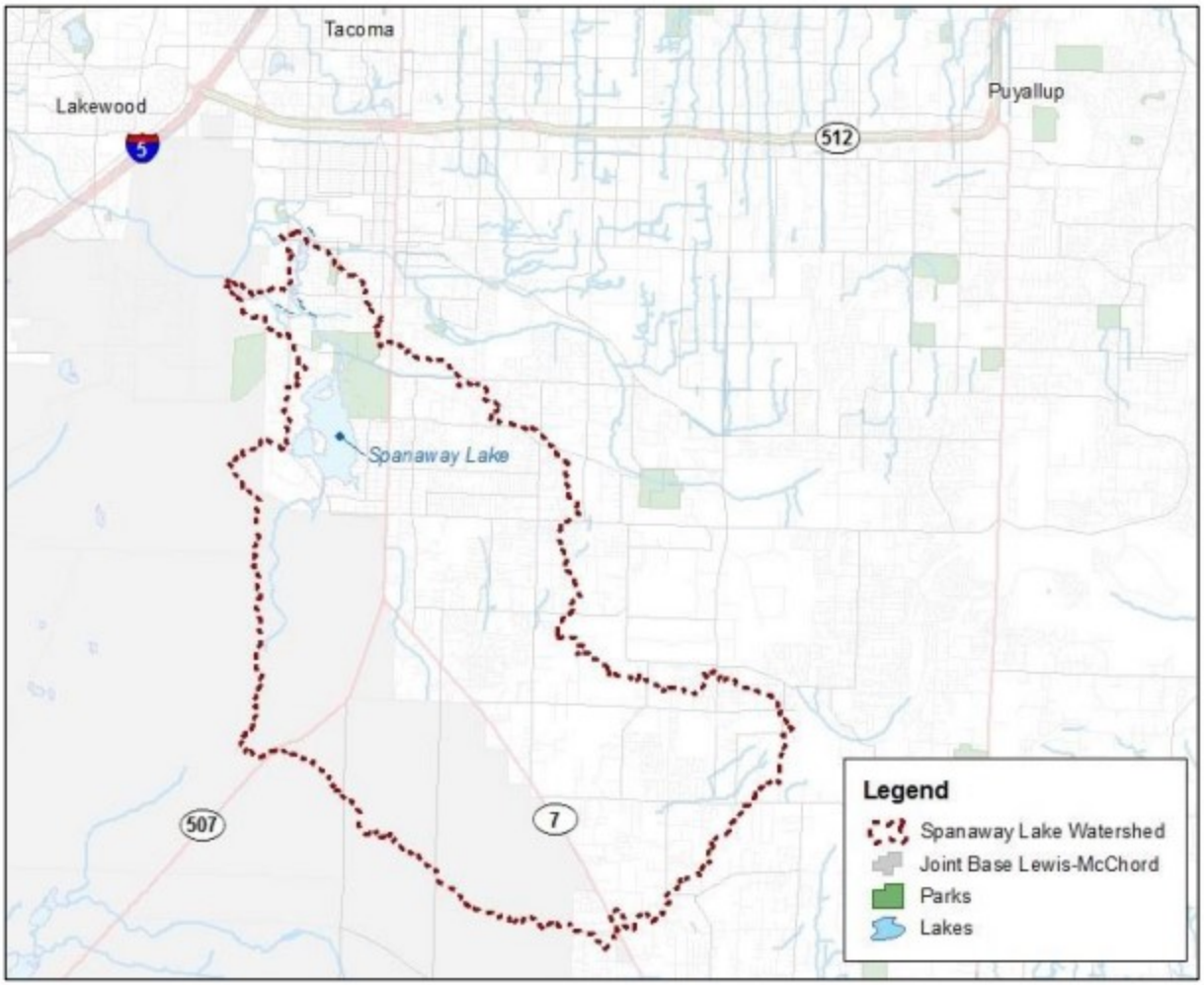
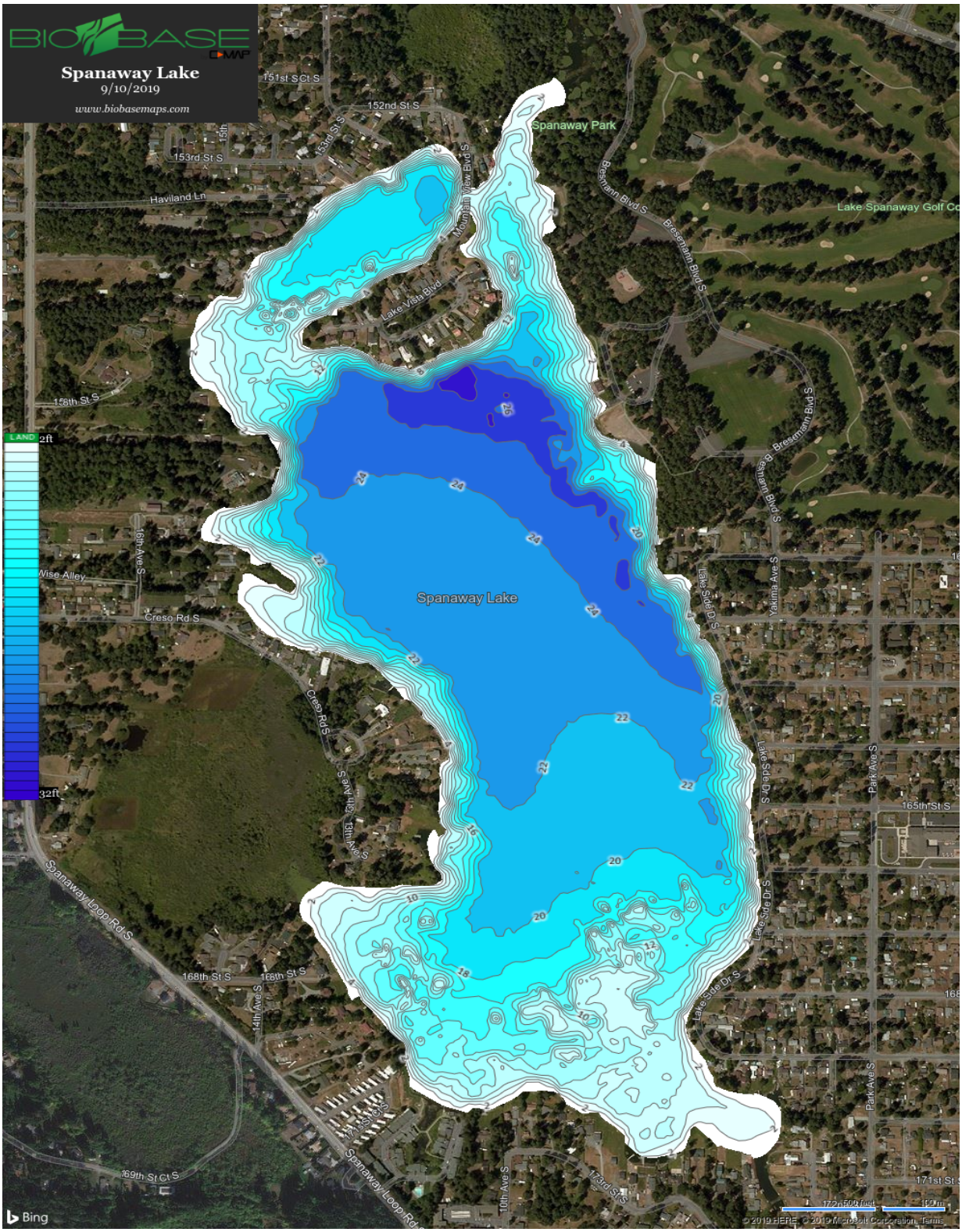


Figure 1. Spanaway Lake

Land use around the lake and throughout the watershed is urban. These land uses influence lake water quality. Ground water studies indicate that there are excessive nutrients present in the groundwater adjacent to the lake. Phosphorus and nitrates are present. And the Friends of Spanaway Lake have been attempting to locate upwelling sites with some success, flow from these "springs" is relatively high and constant.

Spanaway Lake receives an extremely high level of recreational use because of its location near Tacoma and JBLM. Pierce County maintains a large park on the lake and continually active public boat ramps. There are two public swimming beaches within the park and numerous other areas where lake residents access the lake for swimming. Boating and fishing are extremely popular both by park users and the members of the lakeside community. Traditionally there is also an annual powerboat race that is scheduled although COVID has impacted that in the short term.



Spanaway Lake Contour Map, collected using hydro-acoustic data September 2019

The lake is considered Eutrophic and can develop harmful algae blooms periodically. In recent years, this condition has occurred annually. A separate phosphorus mitigation plan is being developed. This plan will focus primarily on problem vascular aquatic plant growth.

Microcystis Bloom on Spanaway Lake September 2019. Algae cells accumulating in White Water Lily beds on the lake.

A separate phosphorus management plan is being developed for the lake.

Additional information can be found in the Spanaway Lake Management Plan developed by Pierce County Public Works at this link: https://www.co.pierce.wa.us/DocumentCenter/View/78545/Spanaway-Lake-Management-Plan

Identify Beneficial Use Areas

The stakeholders discussed this at length and came up with the following beneficial use zones. These can be divided into shoreline and open water uses.

Spanaway Lake has two primary types of ownership of the shoreline. There are approximately 4.39 mile of shoreline on the lake. Of that 0.6 miles of shoreline are County Park; 0.36 miles are undeveloped and the remainder is developed as residential lakeshore properties. These are predominantly single-family dwellings although there are small trailer park and cabin/ apartments on the south end of the lake.

Most of the residential homes have docks, a swimming area and mooring for boats or watercraft. The identified beneficial uses in these areas are primarily for the use of the individual property owners and they include swimming off their property, fishing from their shoreline or dock, mooring watercraft, and other shoreline recreational opportunities. Significant portions of the areas within this category is heavily impacted by submerged aquatic weed growth interfering with all these beneficial uses.

There are two public beach facilities associated with the Pierce County Park on the lake. Dense aquatic plant beds are a threat to swimmers. They have been attributed with causing drowning deaths in Washington State most summers in recent history. They also pose a problem for lifeguards and/or first responders where swimmers are in trouble. If swimmers go down in the dense vegetation they often are not as visible as they would be in open water and the time it takes to locate them often ensures a negative outcome.

Spanaway Lake Park is heavily used by the community in the summer months. The beach is at capacity most days during the warmer summer months. Depending on County input these beaches should be managed to mitigate this impact in swimming areas. The public boat access should also be managed to remove problem vegetation. State law requires that boat trailers not transport aquatic vegetation because most boaters do not know how to identify invasive aquatic species. Currently Spanaway Lake has some Curly Leaf Pondweed present. This plant if transported to other regional water bodies by boats leaving the lake could post a threat to those waterbodies and as such weed growth should be removed from the access sites to limit potential movement.

Most of the surface acreage in Spanaway Lake is over deep water and these acres are not capable of supporting noxious aquatic weed growth for these reasons. Boating and waterskiing take place in this zone and on hot summer days this can be quite crowded. The deeper areas of the lake are heavily used by fishermen. While none of these beneficial uses are directly impacted by submerged aquatic weed growth because of water depths, the majority of the

people accessing this area have to contend with dense weed beds as they transition from the shoreline littoral areas to these deeper water portions of the lake.

Map Aquatic Plants

During the fall of 2019, Aquatechnex biologists conducted a mapping project on Spanaway Lake to support the development of the IAVMP.

Two technologies were used to perform this mapping effort.

The first step was to review bathymetry maps of the lake and determined where the team should focus mapping efforts.

Aquatic plants are limited by light and pressure with respect to the areas within a lake they can inhabit. Light is generally the limiting factor in most lake systems.

Aquatic plants, like their terrestrial relatives, need sunlight for photosynthesis, the processes all plants use to sustain themselves. With increasing depth, light can become extinct in water rapidly. With suspended material like algae or other turbidity, light penetration into the lake can be further degraded. As water clarity is generally uniform throughout an individual lake, the depth to which aquatic plants can grow is also generally uniform throughout the lake. In cases where water clarity is particularly good, aquatic plants then generally become limited by water pressure. Aquatic plants generally do not occur much below 28 feet because of water pressure and the impact on vascular processes within the plant. Some macroalgae can survive at deeper depths.

This area that can support aquatic plant growth is called the littoral zone of the lake. This is the area that would be the focus of the survey. A significant area in Spanaway Lake is too deep to support aquatic plant growth. With the identification of a potential littoral area using the 20-foot contour we identified areas of the lake that could be considered within the littoral area. That map was used to define survey areas for the mapping team.

The first mapping effort utilized a hydro-acoustic mapping technology to build shapes and boundary map for aquatic vegetation. This system uses a hydro-acoustic depth sounding system linked to Digital GPS (DGPS) equipment. The mapping vessel travels transects over the littoral areas of the lake and collects water depth, height of aquatic plants present and bottom composition data every second. This data file is then processed to build maps for these parameters. We use CiBioBase, a subscription-based Cloud computing technology for aquatic environments. This technology uses algorithms developed for analysis of hydro-acoustic data for these parameters.

The aquatic vegetation map generated by this system provides a measure of aquatic plant bio volume. Bio volume is the percent of the water column under the mapping vessel that is filled with aquatic vegetation. This map does not show plants by species. The maps generated show with a color HEAT map the location, shape, and density of aquatic plant growth in the lake. This information is used to further focus investigative efforts of the mapping team.

Armed with the aquatic plant coverage maps generated by CiBioBase, we deployed mapping vessels equipped with sampling rakes and Trimble submeter GPS data loggers and aquatic biologists to classify the species present in the lake. The team spent a few days investigating all areas where aquatic plant growth was present. They identified aquatic plants present and used the Trimble systems to further define the location and shape of aquatic weed beds present in the lake.

This data was processed and exported to ArcGIS mapping programs and final maps were created to support the IAVMP process. These maps consisted of a aquatic plant biovolume map and a coverage map showing the extent and shape of aquatic plant beds with species present information.

The team also noted the presence of any other native aquatic plant species in the lake.

Characterize Aquatic Plants

The first step in the mapping process was to obtain hydro-acoustic aquatic plant biovolume data for the littoral areas of the lake. This survey covered 254.4 acres of the lake or 97% of the water surface as recognized by this software. This was broken down into a few files or areas. In each area, several measurements are produced. The key measurements of interest to this project were:

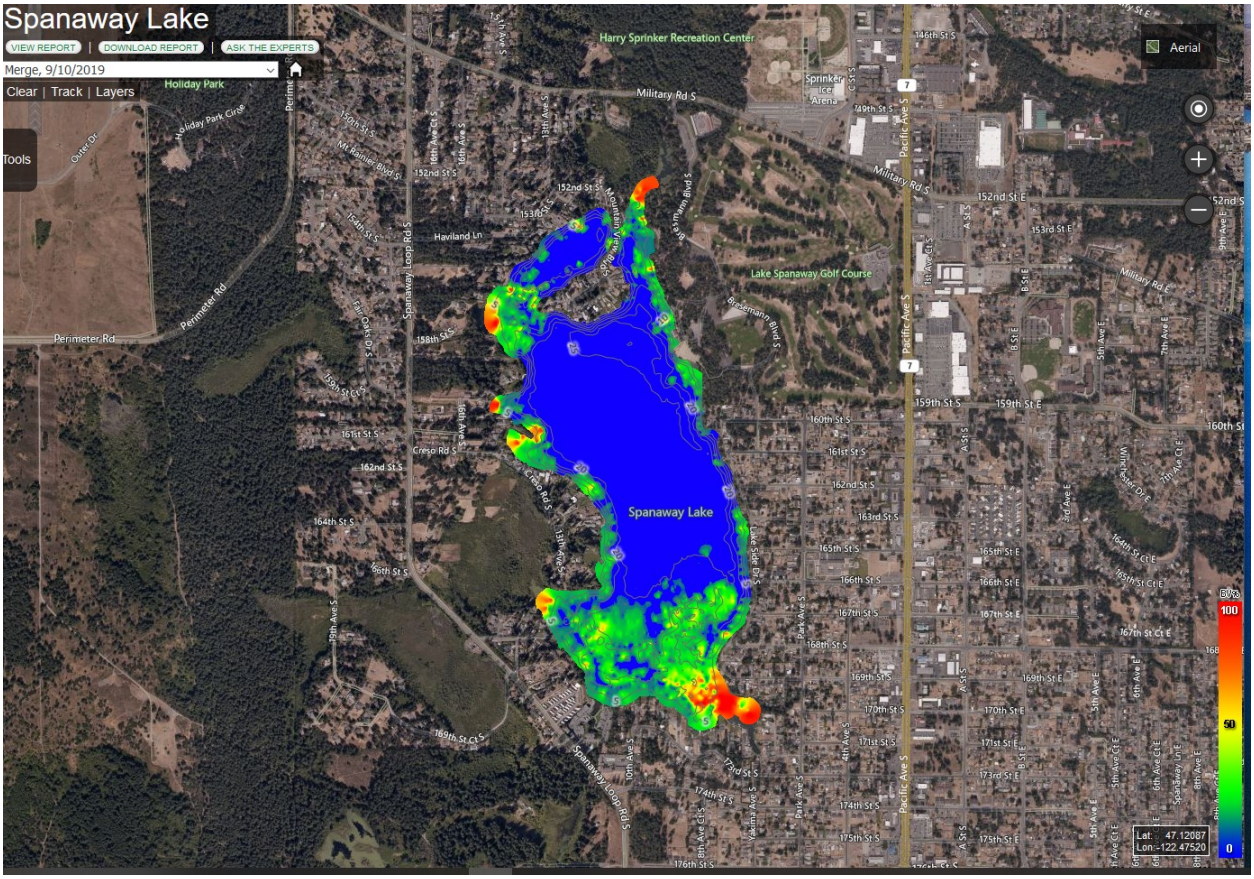
- Area surveyed in hectares and acres
- Percent of the water body
- Percent Area Covered (PAC) refers to the overall area within this survey grid with submersed vegetation present and growing
- BVp refers to the percent of the water column taken up by vegetation where vegetation exists. Areas with no vegetation present are not taken into consideration for this calculation
- BVw refers to the average percent of the water column taken up by vegetation regardless of whether vegetation exists. In areas with no vegetation, a zero value is

entered in to the calculation thus reducing the overall biovolume of the entire area covered by the survey

One of the few areas where native aquatic plant growth is dense and potentially impacting beneficial uses. Najas sp. is the dominant species present.

The following aquatic plant biovolume map shows the shape of aquatic plant beds in the lake and the percent of the water column occupied by this growth. The color ramp on the right bottom corner of the map shows biovolume. Blue areas at the bottom of the color ramp are areas where no aquatic vegetation is detected in the water column. The color ramp gradually moves to red with the corresponding percent of the water column filled with aquatic plant growth. Red indicates 100 percent of the water column is filled with plant growth, and the colors in between range from 0 to 100 percent. The map gives a good overall picture of location and density of aquatic plant growth.

Aquatic Plant biovolume survey



Area surveyed	253.34 acres
Percent of Water body	97.24% of waterbody (as calculated by BioBase)
PAC	30.8%
BVp	35.1%
BVw	10.8%

Once the hydro acoustic mapping work defined the aquatic plant bio volume in the lake by location and density, the team took those maps back to the field to identify species present in those communities. Several methods were used to examine these zones.

A survey boat was equipped with the CiBioBase GIS files and these were used to navigate to all locations where aquatic plant biovolume had been detected. The boat was also equipped with a Trimble JUNO DGPS receiver and data logger to help the survey biologists map species presence. The Trimble unit has a data dictionary set up for the team to use in mapping the species present. Trimble Terrasync Professional software allows the team to view the location of the mapping vessel, the location of the GIS files for aquatic plant biovolume and the data dictionary allows the team to add the location and species/density attributes to the map. On

return from the field, the Trimble Terrasync files are processed via differential correction to obtain submeter accuracy and exported as ESRI Shapefiles to be used in the analysis and creation of the final report.

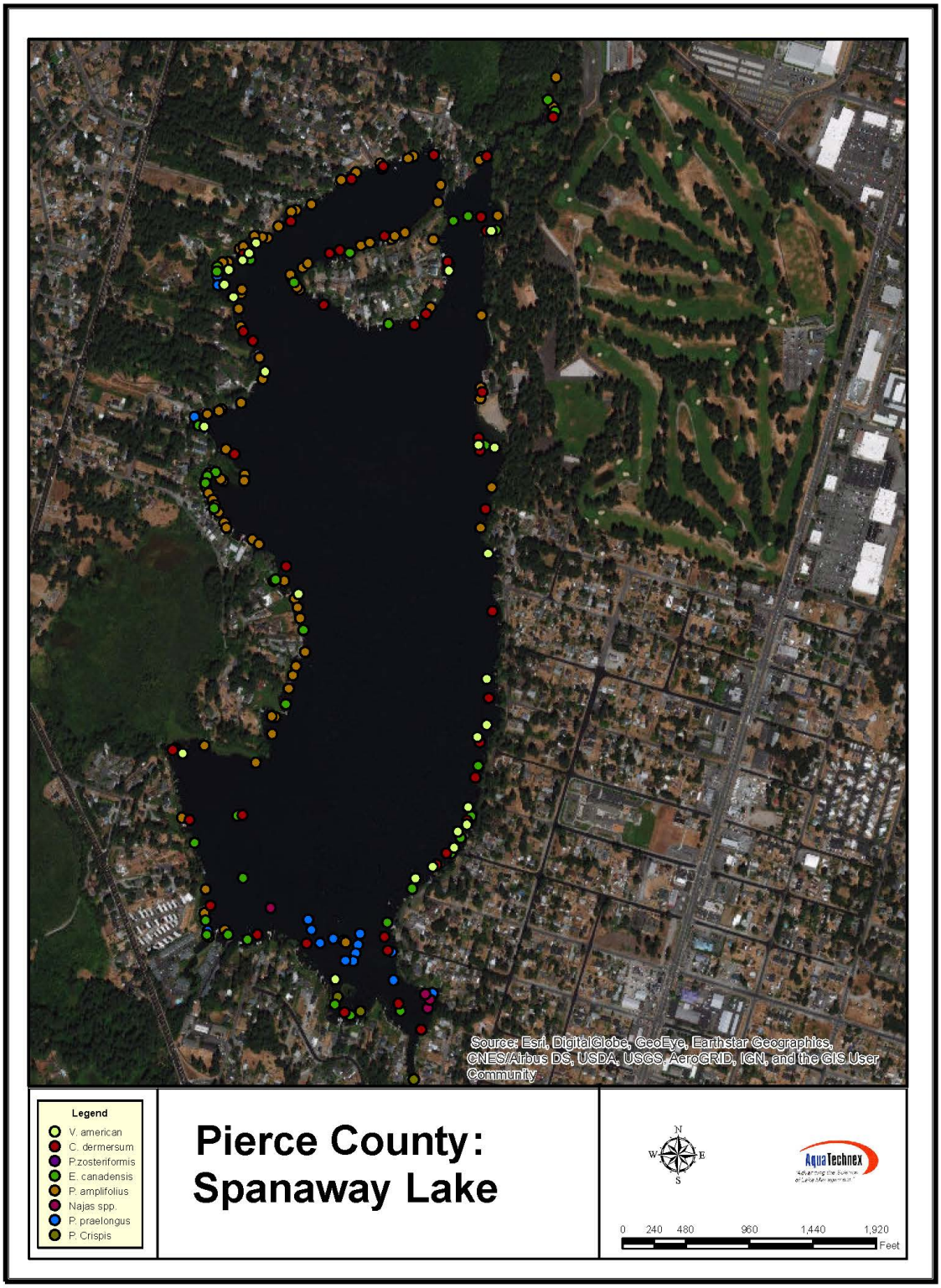
The survey team traveled and reviewed all locations in the lake where aquatic plant biovolume had been detected. In cases where monocultures of plants were found, an attribute was assigned via a line feature along the outside edge of the aquatic plant bed. In cases where aquatic plant biovolume had been mapped at depth but not visible from the survey boat, a sampling rake was deployed and retrieved, and plants collected were noted. The Trimble unit was used to map the location and the species attributes for conversion to Shapefiles.

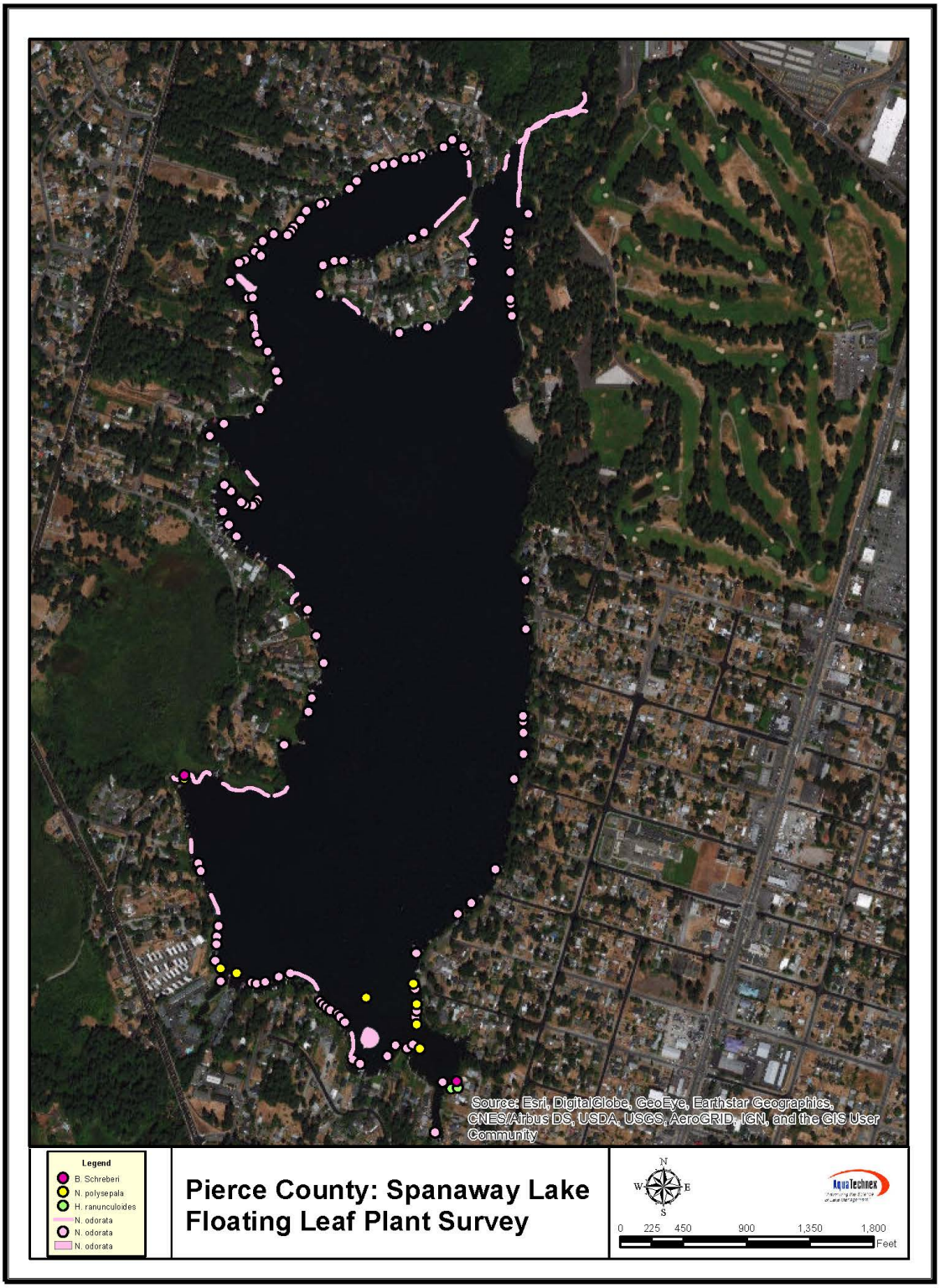
Most of the areas where submerged aquatic plants were present contained mixed native aquatic plant species.

The team observed the following submerged, floating leaf and emergent species present and adjacent to in Spanaway Lake:

Scientific Name	Common Name	Classification	Habitat
Vallisneria sp	Water Celery	Native species	Submerged
Ceratophyllum demersum	Coontail	Native species	Submerged
Potamogeton zosteriformis	Flat Stemmed Pondweed	Native species	Submerged
Elodea canadensis	American waterweed	Native species	Submerged
Potamogeton amplifolious	Largeleaf Pondweed	Native species	Submerged
Najas sp.	Naiad	Native species	Submerged
Potamogeton praelongus		Native species	Submerged
Potamogeton crispus	Curly Leaf Pondweed	Class C Noxious Weed	Submerged
Nymphaea odorata	White Water Lily	Class C Noxious Weed	Floating leaf
Brasenia schreberi	Water shield	Native species	Floating leaf
Nuphar polysepala	Spatterdock	Native species	Floating leaf
Hydrocotyle ranunculoides	Pennywort	Native species	Floating leaf/ emergent

Maps of the locations of these plants are presented here.




Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Legend
B. Schreberi
N. polysepala
H. ranunculoides
N. odorata
N. odorata
N. odorata
Pierce County: Spanaway Lake
Floating Leaf Plant Survey
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W
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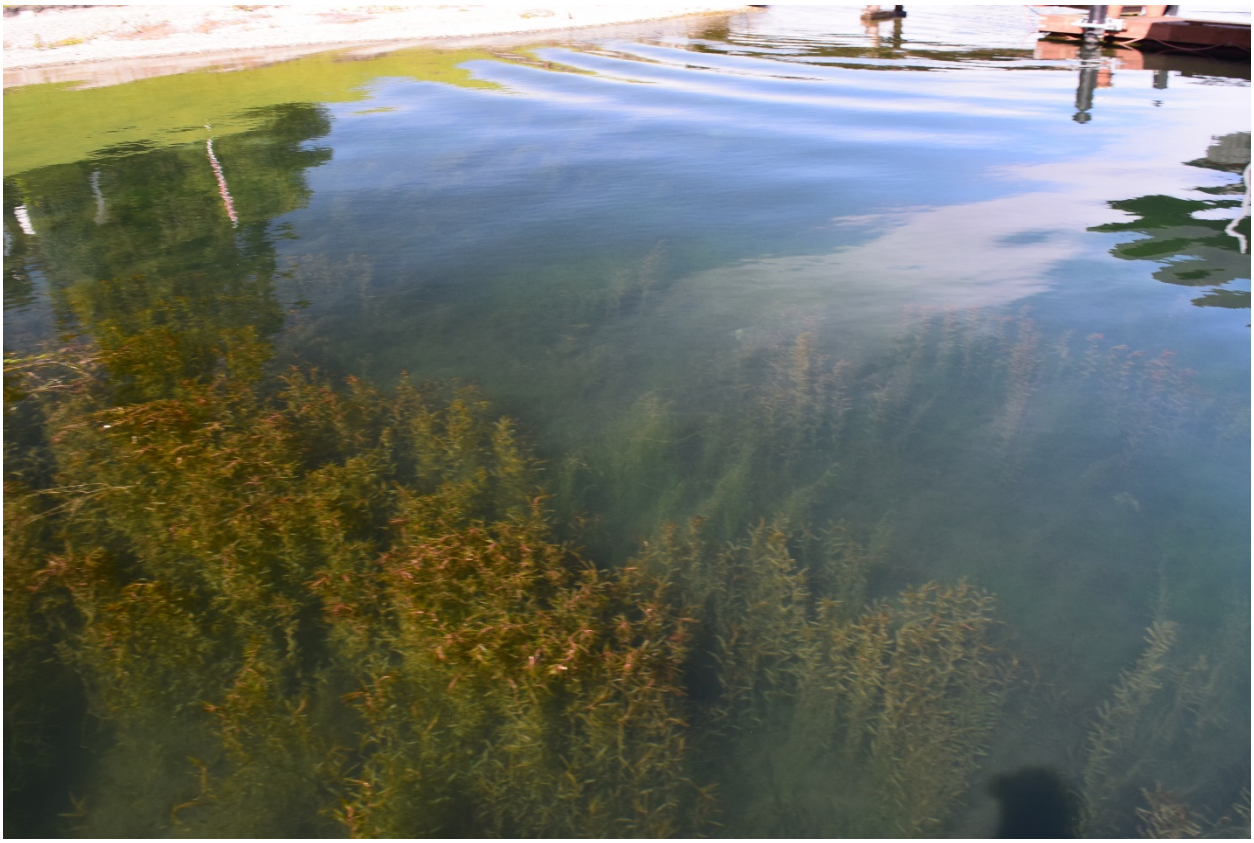
AquaTechnex
0 225 450 900 1,350 1,800
Feet

The most dominant noxious aquatic weed present at the time of this survey is *Nymphaea odorata* or White-Water Lily. As the map shows this plant is well distributed around the margins of the lake. Lily species can typically grow out to the 5-6 foot contour in a lake so they are present at the margins of the water body. They can however present a problem for lake users. They can form dense mats that restrict boat access and pose a threat to swimmers. Three persons drown in Bitter Lake, Seattle about a decade ago tangled in White Water Lily beds adjacent to a city park.

Typical White-Water Lily bed in Spanaway Lake.

The second primary noxious weed of concern is *Potamogeton Crispus* or Curly Leaf Pondweed. While Curly Leaf Pondweed is not yet widely distributed in Spanaway Lake, colonies are scattered throughout the littoral zone. This plant can be extremely aggressive. It was placed on the State Noxious Weed List as a Class C species about 1.5 decades ago. Since then it has become a more serious problem in many lakes and river systems in the state.



Curly Leaf Pondweed can form dense monocultures degrading habitat and posing significant weed problems when allowed to expand

Curly Leaf pondweed has a unique growth habit. The plants grow rapidly in the spring and through the summer months form turions (reproductive structures) at the upper leaf nodes. In last summer the plant normally starts to decline depositing these turion on the lake sediments. These turions can sprout in the fall and grow 6-12 inches and over winter in that state. This even occurs under ice in the midwestern states. When light days get longer in the spring, Curly Leaf is already emerged from the lake sediments and grows rapidly to the lake surface. As the beds get more dense, this shades out native species. The cycle then repeats with an increasing turion bank in the lake sediments and more significant growth the following year.

A close up picture of a Curly Leaf Pondweed tip in mid summer, note the dark formation of a turion at the tip. A number of these turions can form on each plant. As plant densities increase annually, turion production jumps geometrically and accelerates the expansion of the problem.

Native submerged aquatic species are also present at levels that are impacting beneficial uses for some lake residents.

Investigate Control Alternatives

Integrated aquatic plant management involves an understanding of the tools available to apply to a given situation and selecting the correct mix of technologies to deal with the problem as presented. It is also critical to understand that over time the correct mix of control strategies may change. Normally at the start of a major invasive species treatment program the problem is large in terms of acres covered or the percent of the littoral zone infested. The correct procedure is to implement the selected treatment strategy, evaluate the results of those treatments, review post treatment maps and again consider tools available and select the correct mix of technologies. These programs are generally ongoing in nature, it is rare that eradication occurs after the first applications. In many cases eradication never occurs but the target invasive weed populations can be reduced to the point of not interfering with beneficial

uses. The IAVMP process should be ongoing with a regular evaluation and reexamination of the tools available.

The toolbox for aquatic plant control includes physical, mechanical, biological and chemical control technologies.

An examination of each is presented here.

No Action Alternative

The No Action alternative is available to lake managers. This alternative leaves in place all the negative impacts caused by this noxious aquatic weed infestation. While there are no direct costs for management, costs to the community can include depressed property values, reduced tax collections, threats to the potable water supply, degradation of water quality and potential loss of life.

At this point Curly Leaf Pondweed is not well established in the lake. Failing to act against it now could lead to expanding populations and the cost of targeting it later may well exceed smaller focused treatments at this point.

Prevention

Prevention is an effective measure of aquatic plant management when certain invasive species that are found locally have **not yet** invaded the lake. *Myriophyllum spicatum* or Eurasian Watermilfoil is an extremely aggressive aquatic weed that is found in many of the lakes within a short driving distance of Spanaway Lake.

Eurasian Watermilfoil is primarily spread from lake to lake via boat trailer. Fragments of the weed can be trapped on boat trailers as they exit an infested lake and transported to another lake in this manner. Often fisherpersons that are experiencing a lack of action in one waterbody may chose to move to another. Fragments can also stay viable on trailers for some period, so a fishing trip to an infested lake and a second trip to an un-infested lake a few days later can also be problematic.

A prevention program would potentially halt the introduction of other noxious aquatic weeds from nearby lakes. In addition, there are threats from Zebra and Quagga Mussels on the horizon as they continue to move west. At this point these mussels have not been detected west of the Rocky Mountains, but the probability is that they will.

It is recommended that consideration be given to developing a prevention program for Spanaway Lake that involves public education. As Eurasian Watermilfoil and other invasive aquatic species such as mussels and other threats move closer to Western Washington the need for controlling access for boats and inspecting them prior to launch may need to be implemented.

Hand Pulling Alternative

Hand removal of submerged vegetation by digging or pulling is labor-intensive. Hand pulling is useful as a maintenance tool when the infestation is minimal and/or when small scale management is an option. The entire plant must be removed, collected in a storage bag, and transported to shore for proper disposal. Water depth greater than three feet typically requires the use of SCUBA divers. The cost and management effectiveness of plant removal depends on water clarity, sediment type, plant species, spread of plant fragments and density of vegetation being removed. This can also be useful in an integrated approach. When herbicide treatments are applied to eliminate the bulk of an invasive weed, divers can do periodic inspections to determine effectiveness of the treatment and at the same time carefully hand pull any remaining plants to protect the investment in the treatment.

Advantages

- Species specific
- Site specific
- Minimum impact on native plants
- Useful near underwater obstructions
- Immediate improvement as plants don't need to wait to die
- No cost if performed by trained volunteers

Disadvantages

- Water visibility may restrict effectiveness
- Can be costly
- Slow, labor intensive
- Fragments may be generated
- Short-term increase in turbidity
- $800-$1,600 per day for two divers with a support boat and operator, typical coverage ranges from 400 to 2,000 square feet per day
-

Appropriateness for Spanaway Lake

Professional diver hand pulling to remove the bulk of weed problem in Spanaway Lake would be cost prohibitive and labor intensive given the current amount of infestation. Hand pulling is not an effective control method when noxious weeds are widespread in the lake but may be useful once

the weed mass is reduced. Divers employed to survey the lake for effectiveness of weed control can also use the opportunity to hand pull in some areas and is therefore included in the plan.

These services can however be useful for individual shoreline land owners that want relief from problem growth.

This technique is probably not useful for targeting Curly Leaf Pondweed in the lake because of water clarity. This is generally impacted by an algae bloom that develops on the lake during the summer months.

Diver Assisted Suction Harvesting Alternative (DASH)

Diver Assisted Suction Harvesting is a method whereby SCUBA divers use hoses attached to small boats with small pumps aboard to hand harvest and suck plant material to the surface. The purpose of this method is to remove all parts of the plant including the roots. A good operator can accurately remove target plants while leaving native species untouched.

The suction hose pumps the plant material and some sediments to the surface where they are deposited into a porous bag (onion bag). The water and sediment are returned to the water column (if the permit allows this) and the plant material is retained. Turbid water is generally reduced by trained divers, as the divers hand pull plants from the sediment and direct the plant into the suction intake. Turbid water can be discharged to an area curtained off from the rest of the lake by a silt curtain, however, placement of sediment curtains is time consuming and costly and are usually unnecessary. 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, and diver efficiency.

DASH system harvesting aquatic weed growth. Divers use a suction system to remove target plants and send to collection basket or system on the surface.

DASH is more effective where softer sediment allows easy removal of the entire plant, 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 extremely hard sediments, Curly Leaf Pondweed that is well established will have a turion bank in the lake sediments that may be hard to locate and remove in this fashion, as compared to Eurasian Watermilfoil where removing the plant and roots can eliminate that plant when harvested.

Advantages

- DASH provides site-specific and species selective control
- Divers can remove plants around docks and in other difficult to reach areas
- DASH can be used in situations where herbicide use is not an option for aquatic plant management
- Use of suction results in reduced release of plant fragments
- Effective in large areas with light plant growth
- Low possibility for fish to be affected or harmed as they usually vacate the area while it is being harvested

Disadvantages

- Labor intensive and costly
- Suction harvesting stirs up deep sediments if the suction head contacts the lakebed. This may lead to the release of nutrients or long-buried toxic materials into the water column. However, a good operator can nearly eliminate this problem in low sediment laden lakes such as Spanaway Lake.

- The tops of plants growing in rocky or hard sediments may be removed, leaving a viable root crown behind to initiate growth
- Not appropriate for large, densely infested areas
- Entire plant removal difficult in rocky/gravel areas
- Potential short-term increased turbidity
- Invertebrates attached to the plants can be sucked up with plants and be destroyed

Costs of Diver Assisted Suction Harvesting:
$375.00 per hour of operation is a current market price for this work. Production depends on visibility and several other conditions as noted above.

Appropriateness for Spanaway Lake:

DASH is probably not appropriate as a primary method for controlling noxious and nuisance aquatic weeds in Spanaway Lake. Visibility is a primary factor during algae bloom conditions. The dominant noxious weeds present are White Water Lily and Curly Leaf Pondweed and both of these are not effectively targeted with DASH technology.

DASH technology would potentially be appropriate for use by individual property owners interested in localized control around their docks and beach areas.

Bottom Screens or Benthic Barriers Alternative

A bottom screen or benthic barrier covers the sediment like a blanket, compressing aquatic plants while reducing or blocking light. 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 best to remove as much plant material as possible (such as via suction harvesting) to reduce the gassing of the decomposing plants. Materials such as burlap, plastics and woven synthetics can all be used for bottom screens. It is important to anchor the bottom barrier securely to the bottom to keep wave action or ballooning from dislodging the barriers. Unsecured screens can create navigation hazards and are dangerous to swimmers. Anchors must be effective at 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 left in place may rot and tear within two years; in one season plants can grow through window screening material, or on top of felt-like fabric. Regular

maintenance is essential to extend the life of most bottom barriers. Barriers should be removed annually at the end of the growing season, so they do not become new rooting habitat for unwanted plants.

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 or small infestations of noxious weeds. Divers should recheck screens every few weeks to make sure that all targeted plants remain covered and that no new fragments have taken root nearby.

Advantages

- Not toxic
- Installation of a bottom screen creates an immediate open area of water
- Bottom screens are easily installed around docks and in swimming areas
- Professionally installed bottom screens can control up to 100 percent of aquatic plants
- Screen materials are readily available and can be installed by divers
- Barriers can be moved, removed, cleaned, and used in other water bodies or used repeatedly in one location for many years.

Disadvantages

- Because bottom screens reduce habitat by covering the sediment, they are suitable only for very localized control. According to the DOE, only 50% of the length of a shoreline area may be covered by bottom barriers at any one time.
- For safety and performance reasons, bottom screens must be regularly inspected and maintained, adding to initial cost.
- Boat anchors, fishing gear, or paddles may damage or dislodge bottom screens.
- Improperly anchored bottom screens may create safety hazards for boaters and swimmers.
- Some bottom screens are difficult to anchor on deep muck sediments.
- Bottom screens can interfere with fish spawning and bottom-dwelling animals.
- Without regular maintenance, aquatic plants may quickly colonize bottom screens.

Costs of Bottom Barriers:

- $0.35 to $0.85 per square foot for geotextile or burlap material
- $0.35 to $0.60 per square foot for labor to install barriers
- $0.30 to $0.50 per square foot for removal costs

Appropriateness for Spanaway Lake:

It is appropriate to install bottom screens under existing docks and in areas that may be difficult to reach with herbicide treatments and/or mechanical means. Bottom screens could be used on a limited and "as needed" basis as identified during diver surveys of the lake after herbicide, suction, or hand harvesting treatments. Areas possibly requiring bottom barriers are swimming areas at Spanaway Lake Park. Bottom barriers should be checked on a regular basis during diver hand-pulling to assure they are properly anchored and plants have not colonized on top of the screen. Screens will be removed at the end of each growing season.

Mechanical Control

There are two primary methods of mechanical control of submersed aquatic weed growth.

Aquatic Plant Harvesting

The primary methodology is aquatic plant harvesting. These machines have a cutter head that cuts and captures most of the aquatic plant growth during a pass and convey the plant mass onto the deck of the harvester. When the harvester storage area is filled, the machine travels to a shore unloading site and offloads the aquatic plant biomass. The shore team then disposes of the aquatic plant growth, generally at a land fill or composting facility.

The key to an effective aquatic plant harvesting operation is having the right mix of equipment and minimizing transport distances to shoreline unloading sites. All aquatic plant harvesting programs have two components; the harvester(s) work on the water to cut and collect target vegetation, and a shoreline site needs to receive the harvesters, unload the cut weed growth and transport it to a disposal site. Developed lakes often have extremely limited shoreline access for this type of activity forcing the harvesters to travel some distances. While they are moving back and forth to unload, no harvesting occurs. Generally, one mid-sized aquatic plant harvesting system can clear from 0.25 to 0.50 acres per day in open water when working within a quarter mile of the shore unloading site.

Aquatic plant harvesting operations targeting White-Water Lilies. The cutter head collects plants, they are stored on conveyor on harvester and transferred to shore conveyor system to dispose of plants

In addition, while aquatic plant harvesting is generally thought to be compatible with the environment, studies have documented severe negative impacts on fisheries and invertebrate communities from aquatic weed harvesting operations.

Sandy Engel with the Wisconsin DNR studied harvesting operations on lakes with invasive aquatic species present. He concluded that:

"Harvesting both removed and dislodged plant dwelling macroinvertebrates. Patches of displaced snails, caddisfly larva and chironomids drifted about the lake and onto shorelines after harvesting. Each harvest in 1980 removed about 3 million macroinvertebrates amounting in 22% in June and 11% in July of all plant dwelling macroinvertebrates in the lake. Insects alone accounted for one half of all macroinvertebrates harvested"

Further:
"Harvesting removed about 21,000 fish in 1980 and 31,000 in 1981. This constituted about one fourth of all fry in the lake based on electrofishing data. Over 90 percent were young of the year."

If harvesting were to be selected, there are two ways to proceed. An entity can purchase and operate this equipment, or a contractor can be hired.

Equipment purchase for a mid-sized aquatic plant harvester; a trailer and shore conveyor are currently in the $175,000.00-200,000.00 price range. One such system has the capacity to harvest between 0.25 and 0.5 acres per day. The capital cost of the system would have to be considered and factored into a cost per acre assumption. In addition, a large truck is required to support the transport of cut vegetation on the shore side of the operation. Other costs associated with operation are daily labor costs for at least three persons: a shore side driver to transport vegetation for disposal, an assistance to support docking and transfer of cut vegetation, and the harvester operator. This can involve prevailing wage rates if the operations are for a municipality, however the Washington Department of Labor and Industries in recent years had determined that managing and controlling aquatic weeds is not considered a "public work" and as such is not subject to these costs. Storage of the equipment on the water (marina dock space), fuel, plant disposal fees and other associated costs also must be considered.

The second option is contract harvesting. There are four or five companies that do this work in the western United States. They generally bill on a daily rate model with $1,625.00 per day being a recent average cost for the harvester and operator, the disposal work with a trailer conveyor generally costs an additional $250.00 per day but this can vary depending on how far disposal sites are for the cut vegetation. . This cost can go higher depending on the size of equipment and the cost of disposal of cut vegetation. The production limitations of shore access affect them as well and production costs would probably be in the same range as quoted above.

Lastly, harvesting operations do not kill the plant, they mow the top 5 feet off. As the harvester moves on to the next area, the milfoil will start to grow again. Areas harvested can be "topped out" again in 5- to 6 weeks.

Rotovation

The second mechanical option for aquatic plant control is rotovation. Rotovation tills the lake bottom disrupting aquatic plant biomass and root crowns thereby providing relief. Rotovation has not been widely used in Washington State because of the excessive turbidity it causes and the fact that it dislodges plants and root crowns from the lake substrate, where they then drift around the lake to recolonize.

Rotovation is not applicable to most submerged aquatic weed species that have reproductive structures other than root crowns. It is primarily used against Eurasian Watermilfoil and is not applicable to the problem species present in Spanaway Lake.

Biological Control

There is only one biological control method that is considered operational for the management of submerged aquatic weed growth.

Triploid Grass Carp

Triploid grass carp have been used in this role for years throughout the United States. This fish is native to northern Asia and consumes freshwater aquatic plant growth. Grass carp in general have not been allowed for stocking prior to the development of the triploid strain. State and Federal regulators have not wanted to have a reproducing population of these fish introduced to US waters because if left unchecked they could consume all the vegetation in a water body and dramatically alter the habitat within the system. In the 1990's fisheries biologists developed technologies to insure a sterile triploid fish. These fish can be used for aquatic plant management operations under permit in many states.

Grass carp are a poor choice for aquatic plant management where some noxious species are the primary target. These fish have feeding preferences and for example Eurasian Watermilfoil is

among the lowest option they will select if given choices. Grass carp when introduced initially consume the remaining native aquatic plants further impacting those populations.

In Washington State, triploid grass carp use is regulated by the Washington Department of Fish and Wildlife. Their permit program generally does not allow stocking of a public lake like Spanaway Lake and as such this approach would not be viable.

Chemical Control

Aquatic herbicides are an effective method of aquatic plant control. These products are reviewed by the US Environmental Protection Agency (EPA) and if they meet the Agency's requirement for efficacy and protection of the environment, they are approved for use nationally. Each state can then address any additional concerns they may have about products.

In Washington State the Department of Agriculture (WSDA) has regulatory authority to register aquatic herbicides for use and license applicators. This program ensures that those utilizing these products have the training necessary to make applications and protect the environment. The WSDA can classify products as general use and restricted use. Restricted use herbicides can only be sold to applicators licensed by the department in the category that the applicator is licensed in. WSDA has classified all aquatic herbicides as restricted use in Washington State.

Permit Requirements for Aquatic Herbicides

The other regulatory oversight for use of these products comes from the Washington DOE. This agency regulates treatment to specific waterbodies through a general National Pollution Discharge Elimination System (NPDES) Permit to make applications to "waters of the State". The DOE program is supported by a few Risk Assessments they have performed or commissioned on each product that is available under their permit program.

The herbicides that are available and effective on the noxious and nuisance weeds found in the lake are:

- Diquat is a broad-spectrum contact herbicide. It controls most submerged aquatic plant species including Curly Leaf Pondweed. Contact herbicides generally do not translocate within the plant, they kill the portions of the plant they meet. Diquat is a fast-acting product and comes as a liquid formulation. It is used in control projects when rapid removal of vegetation in the water column is necessary. It can also be used later in the

summer to clear vegetation that might otherwise auto-fragment and lead to further dispersal in the lake.

- Endothall is a broad-spectrum contact herbicide. It is also highly effective on Potamogeton species including Curly Leaf Pondweed and would be used much in the same way as diquat would be. Endothall is a bit more restrictive in terms of use of treated water than diquat.
- Fluridone is a very effective broad-spectrum systemic herbicide for submerged aquatic weeds. Plants like Curly Leaf Pondweed are very susceptible to this treatment. Fluridone has an exceedingly long contact exposure time requirement however and can not be used to spot treat plant beds effectively. It would be useful if a problem species like Curly Leaf Pondweed has expanded to the point of dominating the littoral areas of the lake
- Triclopyr is another systemic herbicide that has activity on plants in the broadleaf family. It can be used to selectively target waterlily growth and performs a bit better than 2,4-D in this role.
- Glyphosate herbicide is probably the most effective control measure for water lily growth in a lake. This systemic herbicide should be applied with an approved aquatic surfactant later in the growing season when the plants are actively producing sugars to store and overwinter in the root systems. It can provide long term control. Care should be taken if lily growth is present in lake sediments that have accumulations of peat. Treating large patches of lilies can result in the creation of mud islands some time after the treatments effectively control the lilies. If these soil types are present it is better to use a multiyear approach with smaller areas treated each year to mitigate this problem.

The costs associated with treatment activities in Washington State projected for 2019-2020 would be as follows.

The Washington Department of Ecology Permit application is the first step needed to move this forward.

A Notice of Intent to obtain coverage under the Statewide General NPDES permit for aquatic herbicides is the first step in this process. This filing can be done online by an applicator or other registered user of the site like the City. An applicator and a sponsor need to be identified (the applicator can be named later if there is a purchasing process that needs to occur and has not as of the time of filing). There is also a requirement to publish two legal notices in a local paper and deliver notification to shoreline property owners. And when the permit is issued there is an annual fee. The cost of filing the NOI is generally about $300-500.00 for the time involved. The cost of the two legal notices depends on the paper used, which in this case would most likely be The News Tribune. The mailing to shoreline residents is dependent on number of homes and includes development, printing, and postage. The last fee is the annual ecology

permit fee, this year it is $647.00, and it has been going up about $20-30.00 annually. So, the permitting process can cost between $1,000-2,000.00 depending on legal notice and mailing costs.

There are also some public notice requirements just prior to treatment. All lakeshore properties must receive notification 10 days prior to any treatment work performed. This notice gives the schedule, the products to be used and any water use restrictions that might be in place based on the application. On the day of treatment, there is also a posting requirement where shoreline properties receive signage so that people know the work is going to occur that day. These two steps cost approximately $2.000.00 for a lake treatment of this size.

The last cost is the application. The various products and costs per acre are estimated as follows (these are considered for budgetary purposes, costs may be lower and they should not be higher).

- Diquat, $350.00 per treated acre
- Endothall, $700.00 per treated acre
- Fluridone treatments are based on lake water volume. There is a requirement to make three to four applications at two week intervals to target submerged aquatic weed growth. This program is generally used when a laka is dominated by Eurasian Watermilfoil or Curly Leaf Pondweed. That is not the case here. Costs have to be developed based on conditions just prior to treatment and whole lake treatments are generally necessary so this would be cost prohibitive at this point.
- Glyphosate treatments for lilies $295.00 per acre.

When individual property owners which to contract with an applicator the costs are generally assessed by front foot of the property. For example, if a resident has 100 feet of frontage on the lake and the weed grow to approximately 100 feet off shore, a general cost for this marketplace would be $3.50 per front foot.

Specify control intensity

The control intensity should be driven by the Problem Statement and management goals. They are:

Problem Statement:

Excessive aquatic weed growth and Harmful Algae Blooms have become a problem in Spanaway Lake the past few years. Curly Leaf Pondweed, which is a state-listed noxious weed, is starting to appear in Spanaway Lake. Numerous species of native aquatic plants have expanded to the

point of interfering with beneficial uses. The lake is currently under a Toxic Algae Advisory from Pierce County Health Department. Swimming, boating, fishing, and other recreational uses have been greatly impacted by these conditions. Swimmer safety along the shorelines is a serious concern and should be given priority. Transfer of Curly Leaf Pondweed to other lakes from boats or other watercraft using Spanaway Lake is also a major concern. A growing monoculture of Curly Leaf Pondweed could adversely impact the diversity of the native plant communities and impacting native fish and wildlife populations.

<u>Management Goals:</u>

- *Maintain recreational and habitat uses of the lake by removing aquatic weeds on the state noxious weed list, Curly Leaf Pondweed and White-Water Lily are the primary species to focus on.*
- *Keep swimming areas clear of excessive aquatic weed growth for safety reasons.*
- *Keep boating areas clear of nuisance aquatic weed growth to minimize boat damage and transfer potential.*
- *Educate property owners and lake users about the negative impacts of invasive aquatic weeds such as Curly Leaf Pondweed.*
- *Choose appropriate control methods that are both effective and environmentally sensitive.*
- *Establish an agreement or memorandum of understanding among all lake front property owners and other interested parties to:*
    - *Determine equitable financing options for all lake front property owners to address ongoing control or eradication of Curly Leaf Pondweed, manage nuisance aquatic weed growth and mitigate Harmful Algae Blooms (it should be noted that a separate Phosphorus Management Plan is in development for HAB management) .*
    - *Determine maintenance responsibilities.*
- *Reduce overall costs by using volunteer labor when possible.*

Based on the stated management goals, the objective of this project initially should be to target the two primary noxious aquatic weed species in Spanaway Lake as economics allow.

The secondary objective should be to assist lake property owners manage their shoreline areas where nuisance aquatic weed growth is present.

Choose Integrated Treatment Scenario

At this point lake wide control efforts are limited by the availability of a funding mechanism to address lake wide issues. This severely limits the ability to choose integrated treatment

scenarios. One of the primary objectives of this program should be to start targeting White Water Lily and Curly Leaf Pondweed growth as these are the two primary invasive noxious weeds in the lake.

Herbicide treatments should be the primary initial method used for these targets.

An NPDES should be procured for the lake and sponsored by the Friends of Spanaway Lake. This past spring there was some confusion during the attempt to transfer an existing permit from one applicator to another. A third applicator submitted an NPDES application with the FOSL as sponsor. This permit can be used for work from the point where it is issues. It can also be transferred to other applicators, as necessary.

White Water Lily growth could be targeted either by a lake wide program managed by FOSL or by individual property owners until a lake wide funding program is available. Glyphosate herbicide with an aquatic surfactant is an extremely effective systemic treatment for this species. This approach would not impact water uses. Plant beds should be mapped, areas selected for treatment over a 2-3 year period to mitigate floating island development. A budget of $10,000.00 over three years would easily manage the growth present in the lake at this point.

Curly Leaf Pondweed should also be a focus of this program. This work should involve an annual mapping and treatment program. The lake should be surveyed by a team with accurate GPS technologies to locate and map all Curly Leaf Pondweed beds. These locations should then be treated prior to the plants forming turions in mid-summer or in the fall when turions have sprouted and are present on the lake bottom. This can be complicated when there is a fish timing window for the herbicides that might be considered for use. Endothall (Aquathol K and Aquathol Super K Granular) should be the primary tool and application should take place as soon as possible after fish timing windows expire.

A budget of $45,000.00 over three year should be sufficient to support this effort. If Curly Leaf control early in the program is successful, the entire budget might not be necessary.

Managing native aquatic plants opens the toolbox quite a bit.
Aquatic plant harvesting can be an effective means of maintaining beneficial uses and this can be used lake wide or locally by individual residents via contract harvesting

Aquatic herbicides can be used under the NPDES permit by an applicator to assist individual property owners deal with issues.

Diver removal and bottom barrier can be a very effective tool for individual property owners and the community beach areas.

As FOSL does not at this point have a funding source for lake wide management a list of potential contractors should be developed and made available to the community.

Develop Action Plan

The first step identified by the stakeholders is develop a funding mechanism to focus on noxious aquatic weed problems in the lake. This looks to be about $55,000.00 for a three year program that maps and targets White Water Lily growth and Curly Leaf Pondweed.

There are several potential funding sources for all or portions of this process. Some of them for consideration are:

- Stakeholder contributions; funding from lake shore residents.
- Washington Department of Ecology IAVMP implementation grant, up to $75,000.00 can be requested. While the two primary noxious aquatic weed problems are White Water Lily and Curly Leaf Pondweed are class C plants, this lake based on Geographic location and use may score high. In addition, there are early action funds available from Ecology to target new or limited infestations. The Curly Leaf Pondweed population in the lake poses a threat and is withing the parameters of that grant program at this point. A government entity must submit applications and administer the treatment program if this route is selected.
- Lake Management District (LMD) or Special Purpose District (SPD) set up for the entire lake, or private property owners on the lake. There are approximately 23,750 shoreline front feet around the entire lake. LMD's or SPD are generally set up based on front feet. An $55,000.00 budget divided by the entire shoreline front footage would be $2.31 per front foot. Individual private properties on the lake average 50 feet so individuals yearly cost under this scenario would be about $115.50.00. The larger landowners would pay more if they were included in the LMD or SPD. There would also be some administrative costs for the entity that managed the LMD that would need to be added to this figure. Both of these mechanisms allow a group like FOSL to petition for an election so lake residents can vote to establish this funding source. The primary difference between an LMD and a SPD is management. An LMD is set up by a government entity such as a City of County. They have to accept that role, and they manage decisions. A steering committee from a group like FOSL can make recommendations, but the government entity has final say so a good relationship with that entity is essential. A SPD allows a group like FOSL to vote on and approve their own board of directors from people that are members of the district so control is more localized. Any attempt to use this process should also factor in the potential need for phosphorus mitigation to mitigate toxic algae

blooms. Both approaches will need funding, with the phosphorus management work costing more than the suggested aquatic plant management approaches here.

- Organize private funding of control for affected properties. Applicators could contract with individual property owners to perform control work and operate under the permit secured for this lake either before large scale funding is secured or if an LMD or similar funding set up is not realized.

Before any work can be performed, the process of identifying funding sources, collecting funds, and working out any interagency agreements would be necessary.

Step One, Obtain Permits for use in 2020 and the future

Apply for the Washington Department of Ecology Aquatic Pesticide Permit for the lake. This involves filing a notice of intent (NOI) with Ecology to obtain coverage under their general NPDES permit. When the notice is filed, generally by the applicator, a mailing to all shoreline property owners is required as well as the publication of a public legal notice in the local paper. There is also a DOE annual permit fee. The permit fee is prorated during the year issued, for example if issued in May, prorated until end of fiscal year. After that, the permittee is billed each year for coverage from July 1 through the following June 30th. This permit should be maintained annually so that treatments can occur after Phase One work is completed if necessary.

Step Two, Obtain current conditions in the lake for 2020

A survey should be accomplished during the summer of 2020 to update maps of the two primary noxious aquatic weeds in the lake. White Water Lily and Curly Leaf Pondweed are the two primary threats to the long-term health of the lake. An accurate assessment of the locations of these along with current acreage would help fine tune funding requests.

Step Three, Insure application for Washington DOE Aquatic Plant Management Funding if the community wants to go that route

The window for applying to Washington Department of Ecology under their Freshwater Aquatic Weed Program is in November. The early action funding is more generally available. FOSL should also ensure that there is a government entity partner that is willing to and can submit these applications.

FOSL should communicate with Ecology program staff to confirm target dates for submittal. The application procedures should be studied, and a team assigned to develop a winning submission. The Freshwater Aquatic Weed Grants are received by Ecology, reviewed, and

ranked based on criteria like geography, lake use, the threat to other lakes from that infestation and cost. These are scored by the ranking team and funded until that year's money is exhausted.

The Early Action Grants have other criteria and are generally more available.

Step Four, Contracting

FOSL should work with the funding agencies to go through what ever purchasing requirements both the grant and the agency must award control work (if a grant is applied for and received). If there is an internal fund-raising program operated by FOSL independent of a grant, a Request for Proposal Process and Contract is still a good idea. The community will want experts in survey and control to be targeting noxious aquatic weed growth in the lake

Step Five, developed resources for the community to deal with native aquatic weed issues.

FOSL at this point has not decided to take on managing native aquatic plants impacting individual property owners. There is a current program that lake residents can use to treat their properties with aquatic herbicides. FOSL should also provide information on contractors that can provide aquatic weed harvesting, bottom barrier and diver removal technology so that residents can have a choice of how they want to manage their water fronts.

A web site with this information could be central to this mission.

Step Six, develop public education and outreach program

FOSL should strive to keep the public around the lake informed of efforts to protect the water resource. A web site and social media should be effectively used to communicate with stakeholders on a regular basis. Some of this media currently exists. A plan to add content should be developed and implemented.

Perform Post Treatment Evaluation of Control

It is critical in these programs to have a post treatment evaluation. Aquatic plant management in this case is targeting two aggressive invasive plants. While the survey and treatment of noxious weed work progresses, conditions can change.

Most effective programs have a debrief event near the end of the year or after a post treatment evaluation is performed. This allows stakeholders to discuss what worked well, what maybe did

not work well, lessons learned that would lead to future improvements to the program and development of action steps for the coming growing season.

The stakeholder's group should then develop Phase Two or ongoing work efforts to protect the investment by finding and targeting new growth in the lake before it reaches problematic levels.