Heart Lake

Integrated Aquatic Vegetation Management Plan / June 2012

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Heart Lake / Anacortes, Washington

Executive Summary

Heart Lake is located in the City of Anacortes in the Community Forest Lands. It is fed by seasonal streams and wetlands and itself is the headwaters of the Ace of Hearts Creek which ultimately flows into Fidalgo Bay. A hybrid milfoil that is a cross between the non-native Eurasian milfoil and the native northern milfoil was recently identified at the lake. The presence of Eurasian milfoil has been acknowledged for years by state researchers, Forest Lands staff and volunteers studying the lake. The hybrid milfoil was confirmed in a study of Heart Lake by Hererra Environmental Consultants in September 2010. (Appendix 1)

The milfoil in Heart Lake shares the characteristics of both the non-native invasive Eurasian milfoil (Myriophyllum spicatum) and the native northern milfoil (Myriophyllum sibiricum).

Heart Lake is the only known lake in Western Washington to host this hybrid milfoil exclusively, as of September 2010. Like Eurasian milfoil, the hybrid forms dense mats of vegetation near the shore line or in shallow areas of the lake. At Heart Lake the milfoil was found to be growing in an area from the shore to a depth of 6 feet. Since milfoil is spread by fragmentation and rhizomes it can infest a lake when transported via boat propeller or trailer. Once established, it can begin to disrupt the existing aquatic plant community within a few years by changing oxygen levels by its growth and subsequent decomposition in the fall. This can lead to additional nutrients in the lake, increased algae growth and warmer water temperatures.

The plant diversity that once existed at Heart Lake is out of balance according to the Herrera study. In addition to the spread of the hybrid milfoil, the native plant Hornwart (Ceratophyllum demersum) and filamentous green algae are crowding out other species. This has disrupted recreational activities and could negatively affect native flora and fauna dependent on the lake.

To begin to address these problems the City of Anacortes secured a grant from the Washington State Department of Ecology to create an Integrated Aquatic Vegetation Management Plan (IAVMP). It is a comprehensive approach that attempts to gather the best information available about the lake and with community involvement develop an effective aquatic plant management strategy. An Integrated Aquatic Vegetation Management Plan to control the hybrid milfoil is eligible for funding through the Department of Ecology's Aquatic Weed Management Fund. The plan, like others involving the Community Forest Lands, will seek to balance both conservation and recreational needs and activities when considering solutions to the milfoil problem.

To help create the plan, Anacortes Parks and Recreation staff organized a committee of community members to help provide feedback and direction. Three public meetings were held over the fall and winter of 2010 and 2011. The first was to review the findings of the plant survey at the lake, the second invited representatives from other lake districts in the area to discuss what they learned from previous milfoil eradication efforts, and the third was to allow for community

discussion prior to drafting a plan. A partial survey of wildlife at Heart Lake was completed by Aqua-Terr Systems, Inc. in the summer of 2011 (Appendix 2), to compliment a fish survey previously done by Western Washington University. (Appendix 3)

The committee gave careful consideration to the many options available for managing and eradicating milfoil that are discussed in this plan. It examined the methods listed by the Washington State Department of Ecology for milfoil removal and some of its own. The goal was to find the most effective approach for treating the hybrid milfoil that would do the least harm to the lake and its ecosystem.

Problem Statement

The recreation, conservation and wildlife benefits provided by Heart Lake are jeopardized by the presence of a hybrid milfoil. The milfoil has characteristics of both the non-native invasive Eurasian milfoil (Myriophyllum spicatum) and the native northern milfoil (Myriophyllum sibiricum). First identified in 1998 by a Washington State Department of Ecology survey, Eurasian Milfoil (Myriophyllum spicatum) is believed to have created a hybrid milfoil with the native northern milfoil (Myriophyllum sibiricum). The existence of a hybrid species was confirmed through genetic testing as part of the Herrera plant survey.

The lake itself appears to be out of balance as the past few years have seen not only the spread of milfoil but the overgrowth of filamentous green algae and Hornwart (Ceratophyllum demersum). As noted in the Herrera aquatic plant survey, native plants that were present in the year 2000 were not observed in 2010. These included Slender water-nymph (Najas flexilis), Stonewort (Nitella spp.), Leafy pondweed (Potamogeton foliosus), Bladderwort (Utricularia sp.), Fragrant water lily (Nymphea odorata) and Sago Pondweed (Stuckenia pectinata). Lake ecosystems are complicated and the exact cause of this decrease in plant diversity is unclear. The localized monoculture of milfoil and disturbance to the balance of aquatic plant life are likely culprits.

Use of the lake by recreational boaters and anglers while it is infested has the potential to spread the milfoil to lakes on the island that are currently free of milfoil or other lakes that are currently trying to rid themselves of the noxious weed. Milfoil can hitchhike on the boat, propeller and trailer of recreational users and is then unintentionally released in another body of water.

Shore fishing at Heart Lake has been made more difficult by the presence of the hybrid milfoil as anglers snare the weed with their gear. The extensive aquatic plant growth impedes recreational boating opportunities as well. Boaters complain of the milfoil entangling their propellers and those looking to troll are limited

by the spread of the milfoil and the problems associated with it. Paddlers have a difficult time enjoying the lake when it becomes clogged at the surface with thick aquatic plant growth. Finally, the popularity of Heart Lake as a local swimming spot has declined as the milfoil problem has grown the past few years.

To summarize, problems related to milfoil at Heart Lake include:

- Crowding out a diverse native plant stock in the lake.
- Posing a threat of spreading to adjacent lakes and wetlands in and around the Anacortes Community Forest Lands.

- Diminishing recreational opportunities such as fishing and boating.
- Increasing swimming hazards due to possible entanglement.

Management Goals

As part of the Anacortes Community Forest Lands, Heart Lake is surrounded by publicly owned land. Local residents therefore have been solicited to participate in the decision making process that led to the final draft of this plan.

A public meeting was held on December 7, 2010 as a follow up to the plant survey of the lake done in September of that year. Joy Michaud of Herrera Environmental Consultants was on hand to explain the plant survey and answer questions from the Committee set up to review this issue by the Parks and Recreation Department.

A second public meeting was held on January 20, 2011 featuring water quality specialists and planners who had experience managing lakes containing milfoil and other noxious weeds. On hand were Beth Ledoux, King County Water Quality Planner, Tracy Alker, Skagit County Water Resources Technician, and Dale Ramerman, a resident at Lake Erie.

A third meeting was held on March 24, 2011 to answer questions from the public prior to the creation of the first draft of this plan.

The ultimate goals at Heart Lake are:

- Eradicate the hybrid milfoil to prevent its spread to other lakes and wetlands in the Anacortes Community Forest Lands.
- Regain the native plant diversity to benefit wildlife habitat.
- Improve the recreational opportunities as outlined in the Anacortes Community Forest Lands Plan and Heart Lake Master Plan.
- Restore the aesthetic beauty of this lake nestled in the heart of the forest at the base of Mt. Erie.
- Avoid re-infestation of milfoil in Heart Lake.
- Do the least amount of harm possible to the lake and surrounding ecosystems in achieving the goals above.

Water body and Watershed Characteristics

Heart Lake is located near the center of Fidalgo Island within the City of Anacortes. It is surrounded by the Anacortes Community Forest Lands with Heart Lake Road running along its eastern shore. The lake is approximately 66 acres in size with a mean depth of 9 feet and a maximum depth close to 20 feet. It has 1.5 miles of shoreline with a seasonal creek called Ace of Hearts Creek that flows out of the lake to the north and eventually goes into a culvert which terminates in Fidalgo Bay.

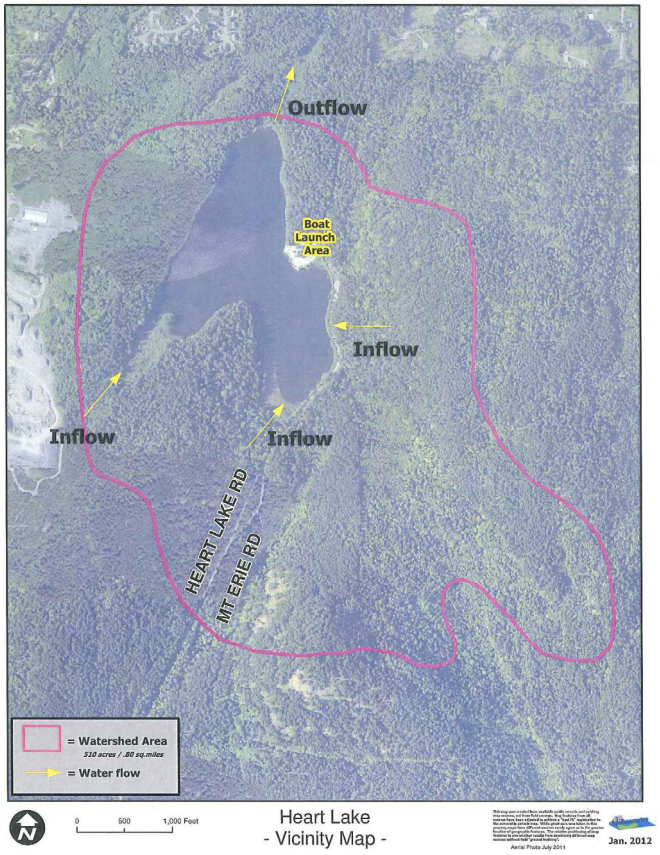
The water quality at the lake has been studied on a number of occasions, most recently in 2004 by stu-

Table 1. Water Quality measurements taken at Heart Lake on April 14, 2004. Measurements were obtained at mid-day using a YSI meter at the lake's deepest point.

Depth (m)	Temperature (C)	% Saturation	Dissolved Oxygen (mg/l)	Conductivity (uS)	Salinity (ppt)	Specific Conductivity (uS)
1	14.6	89.2	9.44	181.6	0.1	226.8
2	14.5	92.5	9.41	181.3	0.1	226.9
3	14.4	92.1	9.38	180.9	0.1	226.7
4	13.5	83.2	8.77	176.5	0.1	227
5	12	54.5	5.14	172.6	0.1	232.9

dents from Western Washington University. For comparison the lake was also studied in 1973 by Washington State Department of Ecology. (Appendix 4) In the reading from August of that year at the depth of 3 feet, the dissolved oxygen level was 9.2 and the temperature was 13.0 C. Comments from that report noted: "Emersed plants covered nearly the entire shoreline. An algae bloom was observed. Littoral bottom is mostly muck."

The land around the lack with the exception of Heart Lake road to the east and the gravel parking lot at the north end of the lake is native forest. The southern shore hosts a significant stand of old growth forest. There are no residences on or near the shore. The surrounding forests contain recreational trails and small beaches carved out by anglers. The lake is fed by three seasonal inflows and ditches. In 2002, 436 acres around the lake were transferred from Washington State Parks and Recreation to the City of Anacortes to be managed for recreation and conservation as per the ACFL Comprehensive Plan.



Beneficial and Recreational Uses

Heart Lake and the surrounding uplands are a very popular recreation destination. Because of its central location on Fidalgo Island its trail heads to all points in the Community Forest Lands are well used by hikers, cyclists, and equestrians. Its large parking area can accommodate large numbers of trailers and vehicles. The lake is stocked twice annually by the Washington Department of Fish and Wildlife with Rainbow Trout. Recreational boaters, kayaking classes, and local birders all make seasonal use of the lake.

The spread of the hybrid milfoil corresponding with the loss of native aquatic plant diversity have had a negative effect on recreation use of the lake's surface. Anglers fishing from shore as well as those trolling on the water have reported problems with the weeds fouling their gear and getting caught in their props.

Survey of Aquatic Plants

In September 2010 the City of Anacortes contracted with Herrera Environmental Consultants to survey aquatic vegetation at Heart Lake. Two milfoil species were previously found at Heart Lake by Washington Department of Ecology surveys. Native Northern watermilfoil (Myriophyllum sibiricum) was discovered in 1994 and Eurasian watermilfoil (Myriophyllum spicatum) was documented in 1998. According to the data collected by Herrera the milfoil identified in 2010 was solely a hybrid milfoil exhibiting characteristics of both species.

At the time of the Herrera survey, Hornwart (Ceratophyllum demersum) was found to be the dominant plant in the lake. The hybrid milfoil was growing in moderate to high density along most of the shoreline of the lake and in a band on the eastern side. Its cover-

age was estimated at over one third of the lake's 66 acres.

Other aquatic plants observed at Heart Lake included Yellow water-lily (Nuphar polysepala), Common elodea (Elodea Canadensis), Floating leaf pondweed (Potamogeton natans) and Star duckweed (Lemna trisula).

Fish and Wildlife Surveys

The City has commissioned two recent surveys of the fish and wildlife at the lake. The first was completed in 2004 by Western Washington University (WWU). The follow up was a partial survey of wildlife completed in 2011 by Aqua-Terre Services, Inc (ATSI).

The ATSI report found that Heart Lake was home to a variety of native amphibians and insects as expected for a lake of its size. No endangered or threatened species were observed. The WWU also found native amphibians as well as Rainbow Trout, Yellow Perch, Large Mouth Bass and Pumpkinseed (see appendices 2 and 3).

Aquatic Plant Management Alternatives

This section provides information on methods available for controlling aquatic weeds. Much of this information was quoted directly from Washington Department of Ecology sources located at their website.

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

Hand Pulling and Bottom Barrier Installation

During hand pulling, operators manually remove milfoil plants from the lake bottom, with care taken to remove the entire root crown and not to create fragments. It generally takes divers to reach and remove plants in deep water. Bottom barriers are semi-permanent materials laid over the top of milfoil beds and are analogous to using landscape fabric to suppress the growth of weeds in yards.

Due to expense and the time intensive nature of manual methods, sites suitable for hand pulling and bottom screening are limited to lakes or ponds only lightly infested with Eurasian water milfoil. This method is suitable for very early infestations of milfoil and for follow-up removal after herbicide treatments (whole lake or spot treatments) or diver dredging. To be cost-effective, generally the total amount of milfoil in the waterbody should be three acres or less in area, if all the milfoil plants were grouped together in one location. If the infestation has advanced beyond this point, it is more effective to consider other eradication techniques such as aquatic herbicides. This method may also be applicable in water bodies where residents can tolerate no herbicide use such as in a lake used as a municipal drinking water supply.

Applicability for Heart Lake

Hand pulling can be used for eliminating very small infestations. The spread of milfoil at Heart Lake appears to be beyond what can be eradicated by hand pulling. The infestation at Heart Lake is too widespread for effective management with bottom screens or barriers. Small areas near the shore could be treated with sea-

sonal barriers that are installed in June and removed in approximately September. If left in longer the barriers tend to collect silt and deteriorate becoming problematic.

Treatment with Selective Herbicides

Applicators need coverage under a permit called a National Pollutant Discharge Elimination System Permit (NPDES) permit to treat water bodies with aquatic herbicides in Washington. It is a law that only state-licensed applicators may apply aquatic herbicides in Washington under an NPDES permit.

2,4-D and triclopyr-TEA are relatively fast-acting selective herbicides that kill the entire plant (systemic herbicide). They have similar modes of action, primarily as a stimulant of plant stem elongation. Scientists consider these herbicides "selective" for milfoil because they generally target the broad-leaved plants (dicots) like milfoil. Most other aquatic plants are monocots (grass-like) and are unaffected by 2,4-D and triclopyr. Using a selective herbicide can selectively remove Eurasian watermilfoil while allowing native plants to flourish. Navigate® and Aqua-Kleen® are granular 2,4-D products (ester formulations) registered for aquatic use and DMA*4IVM® is a liquid formulation (amine formulation). Renovate® is a liquid formulation of triclopyr. There may also be generic products on the market for both herbicides.

Sites suitable for treatment include lakes or ponds partially or completely infested with Eurasian water milfoil. These herbicides are particularly suitable for spot treatments because they are fast-acting herbicides that only need a 48-hour contact time with the plant for effective treatment.

Granular formulations of 2,4-D appear slightly less effective in killing all milfoil plants than the liquid formulation - 85-95 percent efficacy for the granular formulations versus up to 100 percent efficacy with the liquid formulation. Because some plants remain alive and scattered throughout the littoral zone after 2,4-D treatment with the granular product, hand pulling extensive areas after treatment may not be effective in heavily infested lakes. Lake residents must be willing to fund the follow-up activities necessary to ensure continued milfoil eradication (or maintenance at extremely low amounts).

Applicators must identify water users needs prior to herbicide application due to drinking water and irrigation concerns. For 2,4-D, water within the treatment areas cannot be used for drinking until 2,4-D concentrations have declined to 70 ppb and water used for irrigation cannot be used until 2,4-D concentrations are 100 ppb or less. If water users do not have other water sources, the project proponents must arrange for alternative water supply during the time that 2,4-D is in the water.

In Washington, testing has shown that water both inside and outside of the area treated with granular formulations is generally below the drinking water standard one to three days after treatment. Granular 2,4-D products are good to use in water bodies where drinking or irrigation water supply is of concern. While more effective in removing Eurasian water milfoil, the liquid formulation of 2,4-D is much more persistent in the water. Water concentrations have been measured still above the drinking water standard

for more than 30 days after treatment in a small lake.

The granular formulation of 2,4-D is typically applied using a bow-mounted centrifugal or blower-type spreader and the pellets are uniformly spread over the water above the milfoil beds and slightly beyond. The clay particles sink to the bottom or are caught in the plants. The herbicide slowly releases from the clay and the plants take up the herbicide. Applicators generally recommend granular formulations for spot treatment since liquid applications may have more tendency to move away from the application site. When the liquid formulation is used, it is extremely important for applicators to apply it using subsurface injection methods. If Ecology funds the project through an Ecology grant or if there are irrigation or drinking water concerns, monitoring will be required. A 2,4-D analysis test kit may be available soon or environmental laboratories can also perform 2,4-D analysis. Rapid turn around of results costs more.

General impacts of 2,4-D treatment

2,4-D is a selective herbicide and Eurasian milfoil is particularly susceptible at a labeled rate of about 100 pounds per acre (granular product). If using the liquid formulation, an effective rate is 2 ppm (maximum label rate is 4 ppm). At these rates, impacts to most other aquatic plant species are minimal. Even if applied at higher rates there are only a few other aquatic plant species that are affected by 2,4-D. A study conducted in Loon Lake Washington showed that Eurasian milfoil was the only aquatic plant whose growth was statistically reduced by the 2,4-D application (Parsons, et. al, 2001). In the Loon Lake study up to 98 percent of the Eurasian milfoil biomass in the treatment plots was removed after a July treatment.

A few days after the 2,4-D treatment, observers will see the growing tips of milfoil plants twist and look abnormal. These plants will sink to the sediments usually within one to two weeks of treatment. Unless treatment takes place in dense beds of milfoil, it is unlikely for low oxygen conditions to develop. Results of spot treatment may be variable depending on water movement, size of treatment plot, size of the water body, density of milfoil, weather conditions, underwater springs, etc.

Applicability for Heart Lake

In discussion with other agencies regarding the use of selective herbicides, 2, 4-D can be very effective on Eurasian milfoil. Other agencies have found triclopyr effective for eliminating milfoil. Because both herbicides target broadleaf plants, aquatic grasses are generally unaffected. Heart Lake has a hybrid milfoil. It may be treated more successfully with either triclopyr or 2, 4-D depending on the dominant trait of the plant. With that in mind, testing both products in small and isolated samples may be the best approach to understand effectiveness and any problems that may arise.

Given the experiences of lakes in Western Washington the treatment may have to be repeated in successive summers in order to eliminate the hybrid milfoil.

Care would be taken so that herbicides did not reach the Ace of Hearts Creek outflow.

Water bodies suitable for whole-lake fluridone treatment

Fluridone is a systemic herbicide that kills the entire plant and is generally non-selective since most submersed plants will be killed or affected by a whole lake treatment. Fluridone inhibits the formation of carotene (pigment) in growing plants. In the absence of carotene, chlorophyll is degraded by sunlight. Because this is a slow process and the plants can "grow out" of this if fluridone is removed, the contact time between the plant and chemical needs to be maintained for many weeks. Sonar® and Avast!® are the trade names for aquatic herbicides that contain fluridone as the active ingredient. The liquid formulation of fluridone has been used for whole-lake milfoil eradication projects. New slow release granular formulations are also available and are now being used for whole lake treatments.

The premise for using fluridone as an eradication tool is that milfoil rarely produces viable seeds, so killing the vegetative growth will prevent spreading through fragmentation. Milfoil is particularly susceptible to fluridone and it is theoretically possible to achieve 100 percent kill. If all the milfoil plants are killed by fluridone treatment the only way that milfoil can reinfest the lake is to be reintroduced or germinate from seeds. Germination by seeds is considered rare.

Lakes and ponds suitable for whole-lake fluridone treatment are heavily infested with Eurasian milfoil throughout the littoral zone. Fluridone is not suitable for spot treatments (sites less than five-acres within a larger waterbody) since it is difficult to maintain enough contact time between the plant and the herbicide to kill the plant. However, the newer granular formulations are slow-release and are beginning to be proved effective for treating smaller areas. If milfoil is limited to patches within the littoral zone, selective herbicides such as 2,4-D or triclopyr may be a more effective treatment method (see the 2,4-D milfoil eradication strategy). Due to the high treatment costs, fluridone treatments have been limited to smaller sites in Washington. The largest lake in Washington where this method has been used for milfoil eradication has been Long Lake (about 330 acres). In larger lakes, treatment of selected coves or embayments is possible, although milfoil will eventually reinvade from untreated areas.

Special considerations

While there are no swimming, fishing, or drinking water restrictions when fluridone is in the water, the label warns against using the water for irrigation for seven to thirty days after treatment. Even at the low fluridone concentrations used to treat milfoil, some terrestrial plants may be sensitive to fluridone if they are watered with treated lake water.

Washington has had excellent success using this fluridone for milfoil eradication/control, but there is no guarantee that every lake group who tries this method will achieve the same results. Each site is different and many environmental factors may affect the treatment. Developing a site-specific plan for each lake is crucial to identifying environmental factors or concerns that may impact the treatment outcome. Fluridone needs to be applied correctly and with an

expert applicator to achieve the desired result. Because it is crucial to maintain a long contact time between fluridone and the targeted plants, designing a treatment plan and monitoring concentrations over time is an important part of each project.

Treatments can start as soon as milfoil begins rapidly growing. This can be as early as April or May and as late as early July and is site-specific. A critical factor particularly in western Washington is water flow. A heavy rainfall may wash the herbicide out of the system. For deeper lakes, treatment should be delayed until the thermocline develops and stabilizes in summer. For these reasons, fluridone treatments in Washington typically start in June or July rather than earlier.

Fluridone is applied in a liquid formulation by subsurface injection from trailing hoses by a state-licensed applicator. About a day or two after treatment, water samples should be collected to determine fluridone concentrations. The number of samples required depends upon the size and shape of the lake. In a long

narrow lake, three samples may be enough to determine lake concentration. In a small round lake, one sample taken in the middle may be sufficient. In a lake with many coves or channels, a number of samples may be needed to determine a whole lake concentration. Testing the water ensures that the target concentration of fluridone has been met. The SePRO Company has fluridone analysis test kits. Test results can be available within 48 hours and each sample costs about $100. Other laboratories can also perform fluridone analysis, but turn around times for results may be longer.

Fluridone concentrations are maintained in the lake over time by the application of additional herbicide at about bi-weekly intervals or as needed. To determine how much herbicide to add, water samples are collected about 10 to 14 days after the initial treatment and analyzed for fluridone. Generally during this two-week period, fluridone concentrations decrease by about half, due to plant uptake and exposure to sunlight. Fluridone is also more persistent in cooler waters. After fluridone concentrations are determined, the applicator applies enough herbicide to the lake to bring the whole lake concentration back up to the 8-10 ppb range. This scenario continues until fluridone concentrations have been held at 8-10 ppb in the lake for ten weeks. This fluridone concentration and exposure time should be sufficient to kill milfoil plants. During a typical treatment, the applicator may apply fluridone to the lake four times.

The SePRO Company has also developed a new patented test called effecTEST™ that their preferred applicators may use. Treated plants are collected at about five to six weeks after the initial treatment and effecTEST™ determines whether these plants have received enough herbicide to kill them or if a higher (or lower) concentration is needed.

Granular formulations have begun to change the way that some whole-lake treatments are being conducted in Washington. These formulations are being applied using a blower-type apparatus that evenly applies the pellets to the area. The pellets release slowly over the course of days or even weeks, depending on the formulation selected. This lessens the need for repeated visits to the water body by an applicator to maintain lake concentrations of fluridone, and may potentially lower treatment costs.

General impacts of fluridone treatment

There can be significant impacts to the water body during and following treatment. Fluridone is a generally non-selective herbicide, which means most submersed plants and some floating leaved plants will be killed by fluridone during the treatment. Emergent species like cattails will be impacted but will recover. A week to three weeks after the initial treatment, observers will see the growing tips of aquatic plants bleach pink to white. Water lilies will appear bleached and cattails and other emergent species may look variegated. Since this is a slow process, low oxygen conditions do not develop. The plants eventually drop out of the water column by about six weeks post-treatment.

While there is no direct toxicity of fluridone to animals, the loss of habitat does cause indirect impacts. The smaller fish lose their hiding places and because the larger fish can find them easily, they have greater chances of being eaten. Waterfowl that eat vegetation tend to move onto other vegetated waterbodies while waterfowl that eat fish enjoy better fishing opportunities on the treated lake. Sometimes increased algal blooms are observed in the year of treatment and for a year following treatment. However, eventually the lake reaches a new equilibrium and native aquatic plants recover. Naturally occurring plants have viable seeds, tubers, and overwintering buds that allow them to revegetate the lake the year following treatment, while milfoil does not. In Washington the colonization of the lake bottom by plant-like algae called brittlewort (Nitella spp.) and stonewort (Chara spp.) is often observed following a fluridone treatment. This is because algal species are resistant to fluridone and removing milfoil opens up space for them to colonize.

Up to 100 percent of the Eurasian watermilfoil in the lake should be killed. However in inlets or areas where the herbicide may be diluted by flowing water (including in-lake springs), milfoil may be under-treated and must be physically removed if eradication is to be successful. These areas should have been identified during plan development and alternative methods planned for milfoil removal. Under-treatment or no treatment of milfoil in inlet areas may result in the lake being reinfested unless immediate management methods are undertaken.

Applicability for Heart Lake

For complete eradication of milfoil a fluridone treatment has had some success in other area lakes. It can be expensive because it needs to be reapplied to maintain the necessary level to affect plant life. Because it is used on the entire lake in order to be effective, it can eliminate non-targeted plants. This may have a negative effect on wildlife habitat within the lake.

Concentrations of fluridone must be kept at the previously determined level for up to 10 weeks. Other lakes in our area have used a Floridone treatment followed up by spot treatments using other chemical applications such as 2,4-D and triclopyr.

Biological Control: Milfoil Weevil

The milfoil weevil, Euhrychiopsis lecontei, has been associated with the decline of Eurasian milfoil in limited parts of the United States. Washington State, through the Department of Ecology, has been studying the viability of this method of milfoil control. A study at Mattoon Lake in Central Washington released in the spring on 2012 showed a diminishment in the growth of Eurasian milfoil that the study attributed to an insect that was not the weevil. This area of research merits further investigation and applicability towards Heart Lake.

Triploid Grass Carp

Triploid grass carp are plant-eating fish from the Amur River Basin and lowland rivers in China and Rus-

sia. They are used as biological control for overabundant aquatic plants in some Washington waterbodies. Only sterile fish (triploids) are allowed to be stocked into Washington waters.

Waterbodies suitable for grass carp stocking

Grass carp are generally not recommended for milfoil control because milfoil is not a highly preferred food. Some research has indicated that grass carp have food preferences and will consume more palatable plant species, such as pondweeds and waterweed, before they will eat milfoil. As a result, the concern is that they can enhance milfoil growth by removing competition from native plants and opening up more area for milfoil to colonize. In Washington State, grass carp can be used for milfoil eradiation/control only in waterbodies where the eradication of ALL submersed aquatic plants can be tolerated. Sites where grass carp may be suitable for milfoil control are rare in Washington. They include very urban lakes like Green Lake in Seattle, privately-owned artificial lakes, or small lakes with a virtual monoculture of milfoil.

Special considerations

The Washington Department of Fish and Wildlife (WDFW) requires that all inlets and outlets to the lake be screened to keep grass carp from leaving the system. Therefore, grass carp are generally not allowed in waterbodies with salmon or steelhead since these fish need to pass freely between the lake and salt water. WDFW requires a lake-wide plan before allowing grass carp to be stocked into public lakes and they must issue a grass carp stocking permit before fish are allowed to be stocked.

General impacts of grass carp stocking

There can be significant impacts to the waterbody following grass carp stocking. Since native plants provide habitat, sediment stabilization, and many other important functions, removal of all submersed plants can have a severe impact on the waterbody. Most of the impacts due to grass carp stocking are attributed to the removal of the plants rather than direct impacts of the fish.

WDFW investigated the effects of grass carp on the water quality of 98 Washington lakes and ponds (Bonar, et. al, 1996). The average turbidity of sites where all submersed aquatic plants were eradicated was higher (11 nephelometric turbidity units [NTU's]) than sites where aquatic plants were controlled to intermediate levels (4 NTU's) or at sites where the vegetation was not affected by grass carp grazing (5 NTU's. In Silver Lake, NTU's of 50 were observed after all submersed plants were removed (Gibbons, 1997). Although there have been some reports that grass carp stocking can increase algal blooms, this does not appear to be the case in Washington. The increase in turbidity was all abiotic (probably suspended sediments). In other words, once the submersed species are removed or partially removed the lake becomes more turbid or muddy. Never the less, the satisfaction rate of the pond owners or lake residents with the results from stocking grass carp was high.

Frodge et. al (1995) observed positive water quality changes in Bull Lake, Washington and Keevies Lake, Washington after they were stocked with grass carp . Grass carp stocking and the resultant plant removal reduced some of the deleterious problems caused by excessive plant growth, such as low dissolved oxygen and high pH. The lake bottom in Silver Lake went from being anoxic and devoid of bottom dwelling invertebrates to oxidized and supportive of benthic organisms after grass carp had removed all submersed vegetation (Gibbons, 1997).

Pauley et. al (1995) studied fish communities for a six year period in three lakes before and after grass carp stocking. They concluded that while changes in fish

populations did occur in the lakes, no consistent trend occurred after the introduction of grass carp. It should be noted that in two of the lakes, aquatic plants were not totally eliminated.

Waterfowl that feed on submersed plants are affected when these plants disappear. A report from Silver Lake (Gibbons, 1997) showed that although there were no clear indications that the number of waterfowl in the lake had declined after grass carp introduction in May 1992, there was a sharp decrease in American coots in 1994, 1995, and 1996. These data suggest that the loss of submersed plants from the lake resulted in fewer birds that depended on these plants for food from Silver Lake.

Lake groups are strongly advised to monitor plant species and area of coverage, before and for several years after stocking grass carp. If the plants have not reduced in area or biomass after three years, more grass carp should be added. Since Fish and Wildlife issues the permit for extra fish, having monitoring data will provide them with the information to evaluate the request for extra fish.

Applicability for Heart Lake

Triploid grass carp have been used effectively for removal of vegetation at both Lake Erie and Lake Campbell on Fidalgo Island. The difficulty with carp is that they often prefer native species over milfoil and can consume a good deal of the native vegetation in a lake. This can dramatically alter the lake ecosystem and remove plants that are important to native wildlife. Other jurisdictions have reported difficulty removing the carp once they are stocked which in turn leads to "overgrazing."

Diver Dredging

Diver dredging (suction dredging) is a method whereby SCUBA divers use hoses attached to small dredges (often dredges used by miners for mining gold from streams) to suck plant material from the sediment. The purpose of diver dredging is to remove all parts of the plant including the roots. A good operator can accurately remove target plants, like Eurasian watermilfoil, while leaving native species untouched. The suction hose pumps the plant material and 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, and diver efficiency. Diver dredging is more effective 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.

Sites suitable for diver dredging include lakes or ponds lightly to moderately infested with milfoil. Because diver dredging can be very expensive, this method is often suitable for moderate to early infestations of milfoil or for follow-up milfoil removal after an herbicide treatment. Diver hand pulling can be

effective in lightly scattered patches of milfoil, whereas diver dredging may be more appropriate in denser milfoil beds. Diver dredging may also be applicable in waterbodies where no herbicide use can be tolerated. Theoretically diver dredging could be used in any waterbody to eradicate milfoil; however the costs for large scale projects would become high. Depending on the density of the plants, specific equipment used, and disposal requirements, costs can range from a minimum of $1,500 to $2,000 per day.

Development of an integrated vegetation management plan is advised prior to beginning a diver dredging project. Diver dredging projects may require a federal permit from the US Army Corps of Engineers. The necessity for the Corps of Engineers permit is site dependent. State permits for diver dredging for noxious weed removal is covered by the Hydraulic Approval pamphlet Aquatic Plants and Fish.

Applicability for Heart Lake

In conversations with the Department of Ecology and others experienced with diver dredging, it is estimated that divers could work up to a ¼ acre per day, perhaps less. The lake bed is very silty at Heart Lake so turbidity may limit vision underwater for divers and potentially make the work very slow. Like other applications, diver dredging would need to be repeated during consecutive growing seasons for control of the hybrid milfoil.

Mechanical Harvesting

Harvesting is a way to mechanically remove milfoil in order to provide open areas of water for recreational activities and navigation. Harvesting immediately removes surfacing milfoil mats, but since the cut plants grow back (sometimes within weeks), the same area may need to be harvested twice or more per growing season. Harvesting machines (harvesters) are specialized underwater mowing machines specifically designed to cut and collect aquatic plants. Cut plants are immediately removed from the water via a conveyer belt. The cut plants are stored on the machine until they can be off-loaded and disposed of properly. Several manufacturers sell various sizes and models of machine, and there are firms that contract for harvesting operations.

Waterbodies suitable for harvesting programs include larger lakes (about 100 acres or more), and rivers with widespread, well-established milfoil populations, where milfoil eradication is not an option. Since on-going harvesting operations are expensive, having a large lake association, residential community, or a motivated local government to share the harvesting costs is crucial.

Harvesting is not recommended in waterbodies with early infestations of milfoil since the resulting fragments are never completely contained and harvesting may increase the spread of milfoil throughout the waterbody. Because harvesting is a whole-lake activity it should be conducted under the direction of an integrated aquatic vegetation management lake plan. Factors to consider when designing a harvesting program include:

- Lake surface area, width, and depth.
- Vegetated acres.
- Bottom contours and bottom obstructions such as stumps, rocks, other debris.
- Traffic patterns.
- Prevailing winds.
- Harvester launching and off-loading sites.
- Shoreline development.
- Sensitive areas (critical habitat).

A reliable funding source, such as a Lake Management District or a committed local government, is necessary to provide funding either to purchase and operate a harvester or to contract for harvesting on an annual basis. In at least one jurisdiction (Skagit County, Washington), the County trained volunteers to operate the County-owned harvester to remove milfoil on

local lakes. However, liability may become an issue with volunteers using harvesters since harvesting machines have been known to capsize when improperly filled or overloaded.

Prior to harvesting, machinery launch sites (a paved ramp with deep water is best), and plant disposal off-loading sites need to be identified. A summer harvesting schedule must be developed. If harvesting services are contracted, bid documents and a contract need to be prepared. Hydraulic Project Approval must be obtained from Washington Fish and Wildlife.

General impacts of harvesting

While some people view harvesting as an excellent non-chemical control method for milfoil, others scoff at the waste of money to "merely mow the weeds." Harvesting plants has the added benefit of removing nutrients from the waterbody that are tied up in the plant biomass. Because only the top part of the plant is removed, the rest of the plants remain for habitat and sediment stabilization.

Harvesters are large machines and occasionally hydraulic fluid or fuel are leaked or spilled. The operator should have a spill plan and containment equipment available at all times. When working in shallow water, the propulsion system or the cutter head can sometimes churn up the sediment creating turbid water. Significant numbers of fish can be removed from a waterbody during harvesting activities as fish become collected along with the cut plants (Mikol, 1985). These are often juvenile fish, because larger fish can more easily avoid the harvester. Long term milfoil harvesting programs in Washington state include; the Columbia River, Lake Washington, and Green Lake. There is also a program aimed at native plant control on Long Lake (Thurston County).

Applicability for Heart Lake

This method is not in line with goal of eradication. Mowing can also spread plants to new areas of the lake as plant fragments take root in uninfested areas.

Water Level Drawdown

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

Lowering the water level in the winter exposes the sediment to both freezing and loss of water. Freezing can have a dramatic impact on aquatic plants (such as Eurasian watermilfoil or Brazilian elodea) that have no overwintering structures such as viable seeds, turions, tubers, or winter buds. Prolonged exposure to freezing temperatures is often fatal. Freezing of the sediments can also impact species like frogs, turtles, and inverte-

brates that may over winter in the drawn down area. Drawdowns may impact aquatic mammals such as beavers and muskrats. Winter weather may influence the success in killing the target species. Snow before a hard freeze may insulate the sediment and prevent freezing to a depth that will kill the roots; milder climates may not experience the freezing or dewatering conditions needed to kill the exposed plant roots and rhizomes.

Applicability for Heart Lake

Timing is an important factor when using water level drawdown to try and eradicate milfoil. The sediment in the lake bottom itself needs to freeze, a layer of ice or snow can insulate the roots limiting success. Getting the water out of the lake in a timely fashion in winter would be a complicated at Heart Lake because the Ace of Hearts Creek is the only outflow and not designed to handle the flow necessary to drain the lake. It is also quite likely that native plants and wildlife would be damaged by this process.

Lake Bottom Dredging

The Committee discussed the idea of dredging the lake bottom to increase the depth to the point where milfoil would not grow. It is estimated that milfoil can grow at a point of 20 feet to possibly 30 feet deep. According to research by the Washington State Department of Ecology the maximum depth at Heart Lake is 19 feet and the mean depth is 9 feet. To undertake this type of endeavor the substrate of the lake would need to be surveyed to understand what lay underneath the bottom; i.e., silt, sand, gravel or rock. The City would need to file a Joint Aquatic Resources Permit Application (JARPA) to see what would be required to remove the material. Cost for removal would be a significant factor.

Do Nothing

The Committee also discussed and took public comment on simply letting the hybrid milfoil continue to grow without treatment. This approach ran counter to the management plan for the lake. Leaving the milfoil to grow could eventually make boating, fishing and swimming very difficult as the plant expanded to even more areas. A growing monoculture of milfoil is also likely to harm the lake's ecosystem. The possibility that milfoil could spread to other lakes on Fidalgo Island is another reason to actively manage it at Heart Lake.

Treatment Strategy

For removing the hybrid milfoil at Heart Lake the main management method will be diver hand pulling. The goal will be to have divers pull out the milfoil by hand and carefully remove the fragments from the lake to prevent establishment of new plants. This process could take several seasons to complete depending how fast divers are able to work. This method is preferable as an initial approach to avoid a whole lake chemical treatment. If this initial strategy is not successful, the City will investigate other ways to prevent the spread of the hybrid milfoil including the use of herbicides.

A plant survey would need to be conducted by a qualified contractor before and after the hand pulling. This will help the City understand how much can be done on a daily or weekly basis and what areas will need to be rechecked in subsequent years.

There will be a limited test using herbicides at Heart Lake to determine their effectiveness on the hybrid milfoil. Because a hybrid milfoil may share characteristics of both the non-native invasive Eurasian milfoil (Myriophyllum spicatum) and the native northern milfoil (Myriophyllum sibiricum), it is unclear which herbicide would be more effective.

The City will proceed by setting up two test sites on the lake where each herbicide could be applied and

studied to measure effectiveness on the hybrid milfoil. Undesired results on surrounding flora or fauna could also be studied in these smaller sample areas before treating a larger area should the diver hand pulling become too expensive or fail to achieve the desired outcomes. Information will be passed on to Washington State Department of Ecology and other interested jurisdictions that are dealing with a hybrid milfoil.

The two test sites would each be approximately 10 feet by 10 feet in size. The first would use Triclopyr (TEA) a liquid solution, the second would use 2, 4-D liquid, which contains dimethylamine salt. In conversations with the Department of Ecology, there may be better results if the two test plots are enclosed to help better control the sample and monitor herbicide levels. The enclosure could be made of reinforced plastic sheeting or other material; appropriate methods will be investigated. This would have to be done with care and adequate signing to help the public understand the purpose of the enclosures. The herbicide application is done during the growing season when the weather has warmed sufficiently. Typically that would be late June or early July at Heart Lake. The public could expect test applications to be in the water 4 to 8 weeks depending on the conditions.

As with the diver removal by hand, a pre-application and post application plant survey are required. The pre-application would be done in the spring/early summer of the year the herbicide was applied and the follow up survey shortly after the treatment. As part of the program the City could also track levels the chemicals in the lake post application to measure concentration levels. Signs would be posted at Heart Lake to let the public know of the use of herbicides providing necessary information and contact numbers for follow up questions.

State law already prohibits the transportation of aquatic plants (RCW 77.15.290), but to help prevent reintroduction of either Eurasian milfoil or the hybrid milfoil education is also essential. A temporary boat wash station is one strategy that could be used during the height of fishing season with volunteers to check on boats during opening day weekend. This would hopefully help reduce the reintroduction of milfoil into Heart Lake and allow for boaters to learn how they can do their part to stop the spread of milfoil.

Signage around the lake with warnings about milfoil would also help to educate boaters who launched when volunteer "weed checkers" were not present. This public education program would also need to use local media outlets and public websites to help community members understand the goals and steps in the process to eradicate the Eurasian and hybrid milfoil at Heart Lake and prevent reintroduction.

Permits & Cost

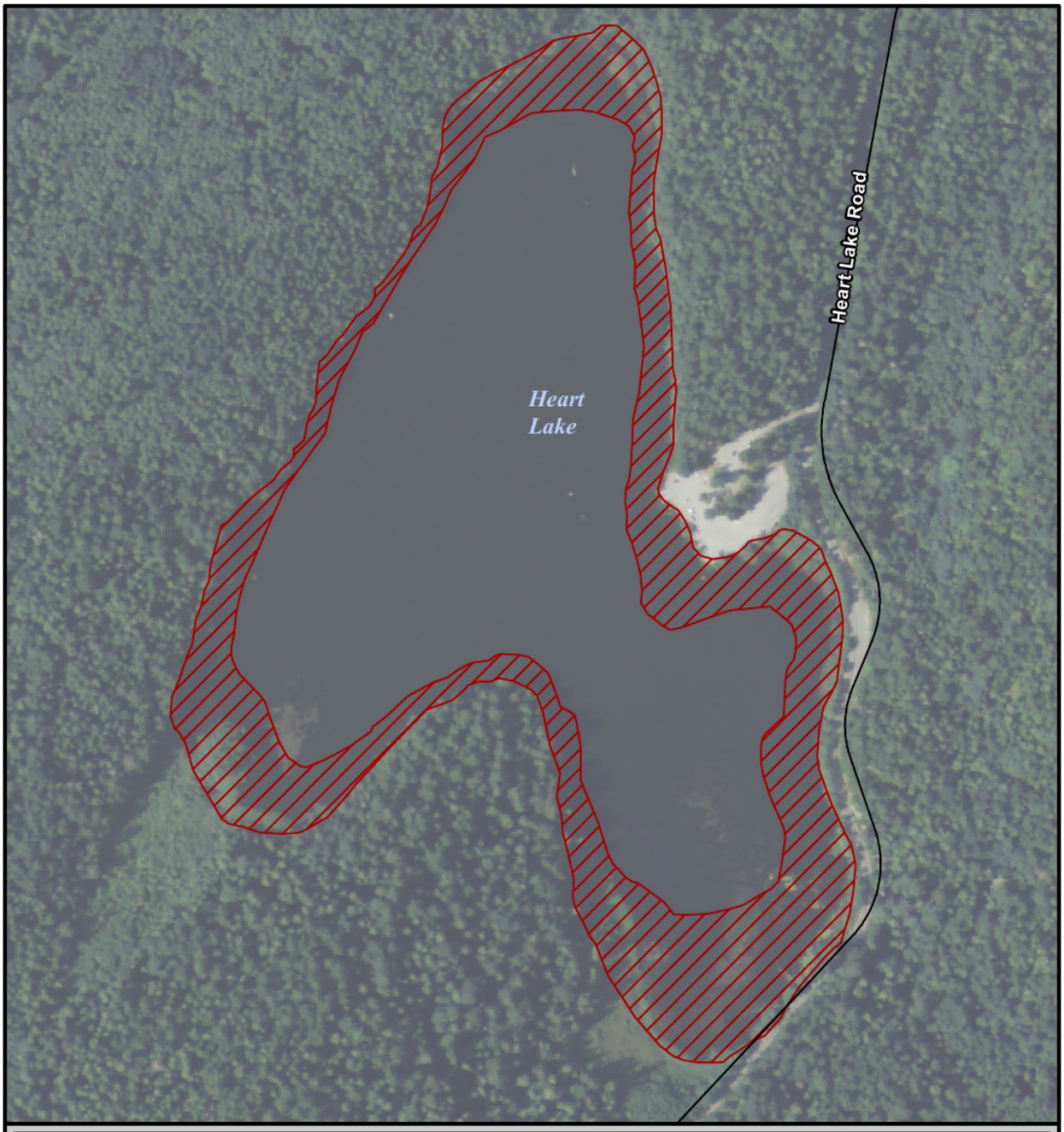
Permits for hand removal by divers must be obtained from the Washington Department of Fish and Wildlife (WDFW). Hand removal requires lake owners to use the guidelines in the Aquatic Plants and Fish brochure put out by WDFW. Additional permissions may

be necessary if the work is more than 10 feet from the shoreline. A National Pollutant Discharge Elimination System (NPDES) permit is necessary prior to application of herbicides at Heart Lake. The City could look into licensing its own staff to apply aquatic herbicides and purchasing the necessary equipment, depending on the method used.

Costs for diver removal by hand may be $6,000 to $8,000 an acre the first time through. The Herrera plant survey estimates 24.5 acres of milfoil present in the lake; removal of all currently identified milfoil by divers could cost $147,000 to $196,000. Any follow up subsequent work would have additional costs. The City would not attempt to do the whole lake at one time but would look at a limited area to test the effectiveness of this treatment.

The latest cost estimates from the Washington State Department of Ecology on the use of 2, 4-D are $300 -$600 per acre. Triclopyr is estimated to cost closer to $1,000 per acre. Suitable sites would need to be selected at Heart Lake where applicators could be certain the herbicides did not cross-contaminate one another. The enclosure option mentioned above may reduce the possibility of cross-contamination.

The City will request funds for both the diver removal by hand and the herbicide test plots from the Washington State Department of Ecology following the approval of the Integrated Aquatic Vegetation Management Plan. Based on the results of our first year of work additional funding may be sought from Ecology.



Legend

Milfoil presence

Figure 3. Observed milfoil.

N

0 200 400 800 Feet

HERRERA ENVIRONMENTAL CONSULTANTS

Aerial: USDA (2009)

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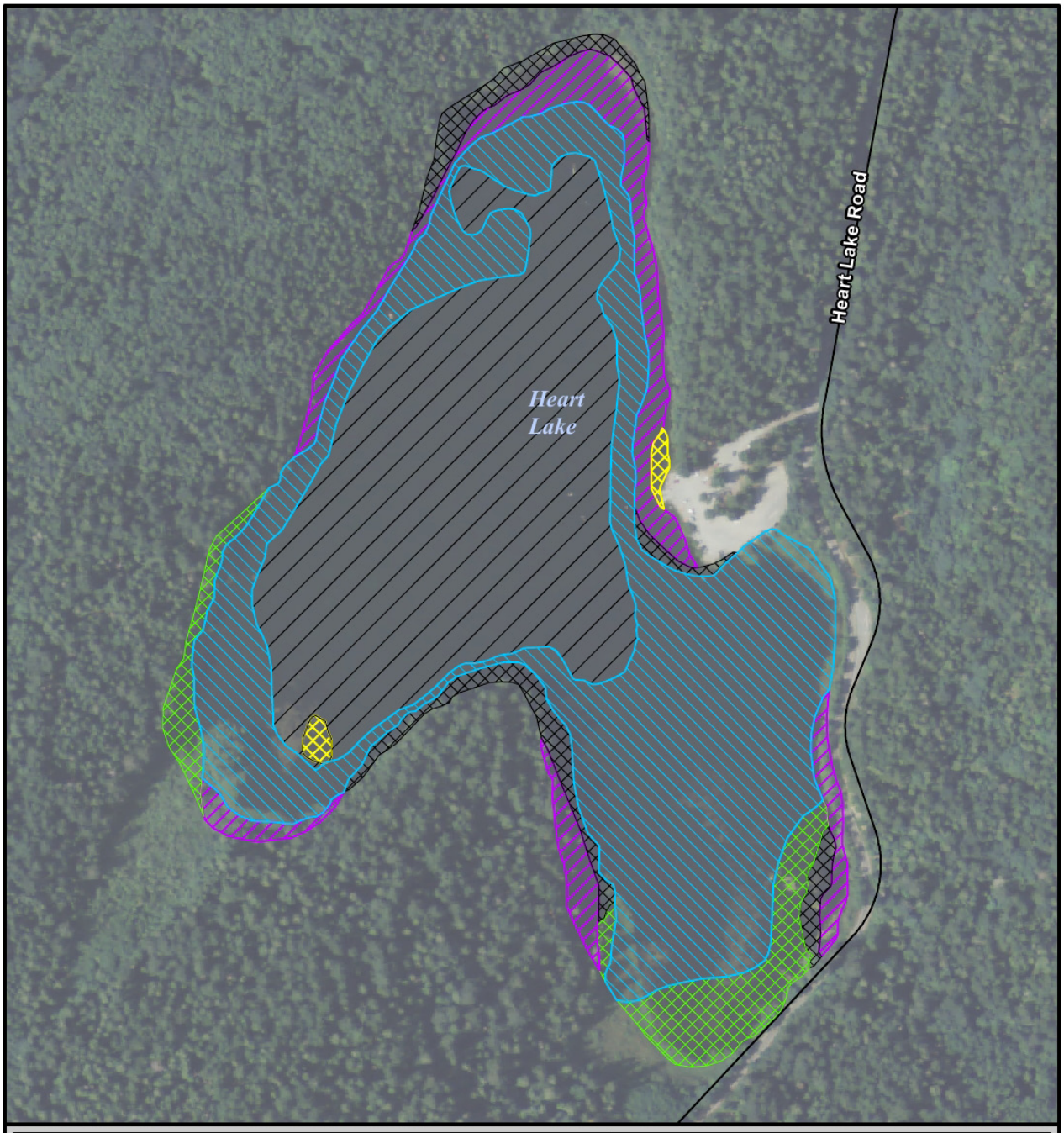

Legend

- Hornwort Dominant
- Hornwort and Milfoil Dominant
- Milfoil Dominant
- Milfoil and Yellow Water-lily Codominant
- Common Elodea Dominant
- No Plants

Figure 5. Plant community map.

N

0 200 400 800 Feet

HERRERA ENVIRONMENTAL CONSULTANTS

Aerial: USDA (2009)

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0 1 2 Miles

Heart Lake - Fidalgo Island
- Vicinity Map -

This map was created from available public records and existing map sources, not from field surveys. Map features from all sources have been adjusted to achieve a "best fit" registration to the ownership parcels map. While great care was taken in this process, maps from different sources rarely agree as to the precise location of geographic features. The relative positioning of map features to one another results from combining different map sources without field "ground truthing".

Aerial Photo July 2011

August 2012