INTEGRATED AQUATIC VEGETATION MANAGEMENT PLAN FOR OHOP LAKE

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PROJECT OVERVIEW

Ohop Lake is located in Pierce County, Washington near the town of Eatonville in the Nisqually watershed. It is a shallow lake (mean depth 14 feet), consequently a large portion of this 205 acre lake is littoral zone and represents potential aquatic plant habitat.

Brazilian elodea (*Egeria densa),* a State listed noxious weed, was apparently present in Ohop Lake in the early 1980s along the eastern shoreline and near the inlet (Hamel, K. Pers. Comm.). Herbicide treatments done during that time likely kept the population in check. It was first officially reported in Ohop Lake in an aquatic plant survey done in 1996. At that time it was estimated to cover 0.008 acres (376 square feet) (Whiley and Walter, 1997). In 2001, rooted colonies of Brazilian elodea were observed at three locations in the lake while floating fragments were observed in the extreme northern end of the lake (Northwest Aquatic Eco-systems 2002). By October 2002, the plants were scattered throughout the lake and in the case of the north end of the western shoreline, they were at high densities. The first herbicide treatment of the Brazilian elodea using Reward (with active ingredient diquat) occurred in summer of 2003. Another treatment occurred in 2004. Although these treatments were successful in suppressing the plant, the treatments were discontinued due to new State regulations that required development of an Integrated Aquatic Vegetation Management Plan (IAVMP) before allowing continued treatment with herbicides. This planning requirement for permit coverage was recently eliminated by Ecology.

The Ohop Lake Improvement Club in conjunction with the Pierce Conservation District applied for a planning grant from the State Department of Ecology (Ecology) to develop an IAVMP to address this and other aquatic plant problems. The planning process included a series of public and steering committee meetings ending with final agreement on the recommended plan.

This report provides a description of the aquatic plant control plan developed for Ohop Lake. The basic recommendations selected for aquatic plant control in this lake are:

- Annual treatments of remaining patches of Brazilian elodea with Reward® (active ingredient diquat) with improved reporting of the quantity and concentration of herbicides used.
- Annual diver surveys of the littoral zone and improved quantitative reporting of acres and locations of identified invasive plants.
- Continued use of Rodeo® (active ingredient glyphosate) to eradicate white waterlily from the lake and its outflow.
- Identification and eradication of other emergent invasive plants such as purple loosestrife, yellow flag iris and Japanese knotweed with Rodeo.
- Allowance for property owners to control nuisance native plants in the area near their property.
- Establishment of an Aquatic Plant Advisory Committee for the lake whose function is to make decisions annually about controls needed and review aquatic plant management goals.

Finally, if it is determined at a future time that the diquat is no longer being effective at suppressing the Brazilian elodea, eradication with Sonar® (active ingredient fluridone) was selected as the preferred approach.

PUBLIC INVOLVEMENT

Public Involvement has included steering committee meetings and public meetings. Announcements for public meetings included notices in the local paper and direct communication with members of the Ohop Lake Improvement Club, WDOE, WDFW, and Nisqually Tribe officials. Each element is described below. All meeting planning, organization and documentation (Appendix A) was provided by the Ohop Lake Improvement Club.

The first public meeting for development of the Ohop Lake Integrated Aquatic Plant Plan was held in conjunction with the annual meeting for the Lake Improvement Club held on June 25, 2005. At that meeting an overview of aquatic plant management issues was presented and the planning process for development of this IAVMP was described. The group completed the problem statement, identified and developed management goals and mapped beneficial uses. The meeting ended with a Questions and Answers session on general lake problems and control techniques.

A steering committee meeting was then held on September 8, 2005. This meeting began with an overview of available aquatic plant control strategies. However, the meeting's primary focus was discussing the options most applicable to Ohop Lake. Two potential strategies were presented in detail; one involved using fluridone to attempt to eradicate the Brazilian elodea the other involved using diquat to continue to suppress the growth. After thoughtful discussion of the differences in cost and weighing the reliability of the different strategies as well as potential for long-term satisfaction, the second option (continued use of diquat) was selected as the preferred strategy for at least the next few years. This was based on its current effectiveness and low cost. However, it was also agreed that more thorough annual plant surveys should be performed to allow better quantitative assessment of the effectiveness of this treatment. If this data indicates that the strategy is losing its effectiveness, eradication with fluridone will become the preferred strategy.

The second public meeting was held on October 1, 2005. At that meeting the overview of available aquatic plant control strategies was provided again to insure people understood how the final control scenarios were initially selected. However the majority of the meeting was spent discussing the advantages and disadvantages of the recommended control strategy and funding considerations. There was unanimous agreement to move forward with the strategy recommended by the steering committee.

LAKE AND WATERSHED CHARACTERISTICS

PHYSICAL CHARACTERISTICS

Ohop Lake is part of the Nisqually watershed and is located near the town of Eatonville. The lake is 2.5 miles long, has a surface area of 205 acres (0.32 square miles) and a mean depth of 14.1 feet (Table 1). The current drainage area for the lake is 18.2 square miles, which is half its historical size. In 1889, upper Ohop Creek was diverted to resolve the flooding problems in the lower valley. The diverted water was directed to Lake Kapowsin and the Puyallup watershed and thus reduced the overall drainage area for Ohop (Engel, 1954 as cited in Whiley and Walters 1997).

Groundwater is the dominant water source contributing via springs along the lake's western and eastern bluffs. The principal surface water source is Twenty-five Mile Creek, though drainage from the upper valley via Ohop Creek contributes a minor amount as well. Elevations in the drainage range from 525 feet at the lake to 2,402 feet in the uppermost reach of Twenty-five Mile Creek (Whiley and Walter, 1997).

Table 1. Physical Characteristics of Ohop Lake and its Watershed.

Characteristic	English Units	Metric Units
Watershed area	18.2 square miles	47.1 square kilometers
Surface area	205 acres	83 hectares
Ratio of Watershed : Lake Area	57	57
Lake volume	2,897 acre-ft	3,573,234 cubic meters
Maximum depth	19.7 feet	6 meters
Mean depth	14.1 feet	4.3 meters
Shoreline development	4.5 miles	7.3 kilometers
Water Residence Time (Summer)	174 days	

The lake flows into Ohop Creek and Lynch Creek which are tributaries to the Nisqually River. The lower six miles of Ohop Creek provide important spawning and rearing habitat for coho salmon (*Oncorhynchus kisutch*) (Whiley and Walter, 1997).

Geology

Glacial activity that occurred twelve thousand years ago greatly influenced the development of Ohop Valley and the lake. Large volumes of sand and gravel were moved through the area in glacial meltwater streams prior to each ice advance. As the glaciers advanced into the area, they caused compaction of the sand and gravel, transforming it into glacial till. The valley and lake were formed as the glaciers retreated.

In addition to the glacial till found throughout the valley, glacial outwash deposits are located above the eastern bluff of Ohop Lake. Bedrock (andesite) is also exposed east of the lake above the valley and is overlain with an unconsolidated deposit called the Mashel formation (Zulauf, 1979).

The Mashel formation and the overlying glacial till have low permeability, while the glacial outwash deposits are well drained soils. Due to the high permeability of the glacial outwash, rainwater is able to infiltrate the lake's eastern side and discharge as springs. However, the combination of permeable upland soils overlying poorly drained glacial tills has led to an ongoing problem with mass failures (i.e., landslides or sloughs) adjacent to Ohop Lake (Whiley and Walter, 1997). Although sediment physical characteristics were not described in the Phase I study, a sedimentation rate was calculated and estimated at between 0.55 to 0.68 cm/yr. This relatively high rate is probably indicative of the high winter season inflow rates in combination with the soil problems described above.

Wetlands

A map depicting associated wetlands is included as Appendix B. Wetlands are located at the inlet and outlet of the lake as well as a small section of the northwestern shoreline. The outlet wetlands are classified as freshwater emergent wetlands with a small area of forester/shrub wetland (USFWS, 2005). The wetland complex at the north end of the lake (at the inlet) is over 80 acres and contains three classes: emergent, forested, and open water (Sargent, 1996). This wetland is diverse allowing for the support of a wide variety of birds, waterfowl, and amphibians. In addition, osprey and bald eagle nests have been documented in the wetland area (Whiley, 1997).

The State Natural Heritage Information System was queried to obtain information on rare plants, high quality native wetland ecosystems and high quality terrestrial ecosystems within a 2 mile radius of the lake. Two state sensitive plant species are located in the area. They are the bristly sedge (*Carex comosa*) and the California sword-fern (*Polystichum californicum*) (WDNR, 2005).

Land Use

Forestry accounts for the majority (>90%) of land use in the lake drainage. Most of the forest lands are located upstream of the lake in the Twenty-five Mile Creek drainage. Agriculture accounts for 5% of the land use and is located above the lake and in the lower drainage of Twenty-file Mile Creek. Residential development is principally located adjacent to Ohop Lake and Clear Lake. About 200 homes surround Ohop Lake.

WATER QUALITY

Summer period algae blooms have occurred in Ohop Lake for several decades. These have been attributed to excessive phosphorus concentrations (Whiley and Walter 1997). The poor water quality has diminished recreation opportunities and concerns have been raised regarding human and animal health. In addition, these conditions have the potential to harm downstream salmon habitat (Whiley and Walter 1997).

Ohop Creek and Ohop Lake are both included on Washington State's 2004 303(d) list of impaired water. They are listed due to high concentrations of fecal coliform bacteria (Ohop Creek) and total phosphorus (Ohop Lake).

Information on water quality at the lake has been collected by State and Federal government agencies as well as the Nisqually Indian Tribe. Summer average phosphorus concentrations have ranged form 30 to 60 ug/L, and chlorophyll from 12 to17 ug/L. These parameters were selected for summary because of their direct and indirect relationships to algae concentrations. Phosphorus is an essential nutrient for plant and algae growth, while chlorophyll is a measure of the abundance of algae in the lake.

These water quality parameters can be used to determine the lakes trophic state. Trophic state is a common lake evaluation tool used because a lake is defined in relation to the degree of biological productivity that it supports. Lakes with low nutrients (i.e. low phosphorus), low algae levels and clear water are classified as nutrient poor or "oligotrophic." Lakes with high nutrients, high algae levels, and low water clarity are classified as nutrient rich or "eutrophic." "Mesotrophic" lakes have characteristics of both classifications. Classifying lakes in this manner is a useful way to describe changes in a lakes' water quality over time.

Total phosphorus, chlorophyll and transparency are the three water quality parameters most often used to rate the overall trophic condition of a lake. Based upon available data, Ohop Lake is classified as a eutrophic lake because its phosphorus values are greater than the threshold value of 20 ug/L and its chlorophyll values are greater than the threshold value of 10 ug/L. In addition, Secchi disk depth measurements of transparency were 1.9 m which is also below the threshold value of 2 m for eutrophic lakes. All three parameters indicate a eutrophic lake (Whiley and Walter, 1997). According to the 1997 study, the primary source of elevated phosphorus is the lake sediments. However, onsite wastewater treatment systems (i.e., septic systems) are also suspected of contributing to water quality problems by adding to the total phosphorus load (Whiley and Walter 1997). Most of the homes around the lake are on septic systems placed in glacial till soils. These soils are known to be fine, less well-drained and are rated as severe (poor) in their capacity to effectively treat wastewater (Zulauf, 1979). Additional sources could include lawn fertilizers or waste from domestic animals. Recommendations for control of these phosphorus sources (Whiley and Walter, 1997) included; reduction of erosion from the watershed, functional analysis of existing septic systems, promoting lakeside stewardship BMPs, managing aquatic plant growth, and an alum treatment to control internally generated phosphorus sources.

WATER RIGHTS

Ecology was contacted to provide information regarding the water rights for diversions out of Ohop Lake. According to the Water Rights Tracking System database (for T16N, R4E, S2,3,20 and 11 and T17N, R4E, S34 and 35),there are six water use records for this area; four of which are still active. The primary purpose stated for active records is "domestic single", meaning the water may be used for one dwelling with lawn and garden up to one-half acre. One of the active permits is for "domestic general," which is defined as "the use of water for all domestic uses not

specifically defined in the water right record or not defined by the other specific domestic use categories and including sewage treatment, farm supply, and laboratory use." These certificates for water diversions from the lake represent a combined total 1.59 acre feet per year (Carroll, 2005).

FISH AND WILDLIFE COMMUNITY

Warm water fish species dominate the fish population in Ohop Lake. Warm water resident fish include: catfish, black crappie, yellow perch, largemouth bass, brown bullhead, and pumpkin seed sunfish. The lake is popular for anglers with the season running from the last Saturday in April to October 31 of each year (WDFW, 2005).

The cold water fish species include rainbow trout (*Salmo gairdneri*) and several salmon species. The Washington State Department of Fish and Wildlife (WDFW) maintains a fish stocking program for Ohop Lake. In March and April of 2005, the department stocked 22,500 rainbow trout (8-12 inches long). In addition, for the first time, 617 triploid rainbow trout were stocked in April (WDFW, 2005). It is estimated that recreational anglers catch approximately 60% of the stocked trout each year. Those not caught, most likely do not survive the summer months when the water temperature is too warm (Whiley and Walter 1997).

The lake and creek provide habitat and migratory corridors for a number of protected salmon species. This includes; chinook, coho, pink, and sockeye salmon as well as winter and summer steelhead (Anderson, 2005.). Table 2 summarizes the fish distribution and stock status for these species.

Table 2. Fish Distribution and Stock Status in Ohop Lake and Creek.

Species	Fish Distribution	Stock Status
Fall Chinook	Spawning – lower reaches	depressed
Coho Salmon	Spawning – lower and upper reaches Presence – in lake	healthy
Winter Chum	Spawning – lower reaches Presence – lower wetland	healthy
Pink Salmon	Spawning – lower reaches Presence – lower wetland	unknown
Sockeye Salmon	Spawning – lower reaches Presence – in lake and upper reaches	unknown
Summer Steelhead	Spawning – lower reaches	unknown
Winter Steelhead	Rearing – lower reaches Spawning – lower reaches Presence – in lake and above	unknown

Source: Washington Department of Fish and Wildlife. Salmonscape Mapping.

The lower reach of Twenty-five Mile Creek is considered to provide the best coho habitat in the entire Nisqually basin. This has been attributed to the low stream gradient, well-established riparian vegetative cover, the presence of large woody debris and good spawning gravel. Even though the spawning area is limited to 1 kilometer of stream (due to impassable falls), the area receives more coho spawners than any other Nisqually River tributary (Whiley and Walter 1997).

According to the States' Natural Heritage Information System database for select rare animal species in this area, both osprey and mountain quail have been documented within a one mile radius of the lake. At the north end of Ohop Lake, two bald eagle nests have been documented. Bald eagles are state and federally threatened species. Riffle sculpin, another State monitored species, have also been collected north of the lake. Common loon, a state sensitive species are also present.

BENEFICIAL USE

Ohop Lake is located in a beautiful and still rural valley in the lower end of the Nisqually river watershed. Although much of the shoreline is occupied by homes and vacation residences, the shoreline has yet to be modified and hardened by bulkheads and residential lawns. There are still standing trees along most of the shore and downed trees that provide habitat at the shoreline. The inflow (Ohop Creek) enters at the northernmost end of the lake via a large wetland complex; the shoreline is largely undeveloped for approximately 2,000 feet along either side of the inflow. There is also a large section (approximately 1500 feet) of undeveloped shoreline on the south end of the lake adjacent to the WDFW boat ramp and outflow; this too is adjacent to wetland.

Figure 1 displays the beneficial use map for the lake. The public boat launch at the southern end of the lake is used by the public as a swimming access point. Swimming also occurs at individual docks throughout the lake. It is also a popular lake for water skiing; which occurs in all but the northernmost end of the lake where there are deadheads in the water that present a hazard to boating. Ohop Lake is an important fishing lake and it provides habitat and migratory pathways for a number of protected salmon species, including; chinook, coho, pink, and sockeye salmon and winter and summer steelhead (Anderson, S. Pers. Comm.). The public often accesses the lake for fishing from undeveloped sites on the west side. The lake and large wetlands that comprise the inlet and outlet areas are also utilized by migratory waterfowl as well as other birds and other wildlife species.

AQUATIC PLANT COMMUNITY

The earliest survey of aquatic plants was done by the USGS in 1971. At that time it was estimated that 26-50% of the shoreline of Ohop Lake was covered with emerged plants. At that time, 1-10% of the lake surface was covered with emerged plants (USGS, 1976). Dominant aquatic plant species included (USGS, 1973):

- Watershield (*Brasenia* spp.)
- Waterlily (*Nuphar variegatum* and *Nymphaea odorata*)
- Milfoil (*Myriophyllum* spp.)
- Pondweed (*Potamogeton* spp.)
- Waterweed (*Elodea* spp.)
- Cattail (*Typha* spp.)
- Sedge (*Cyperus* spp.)

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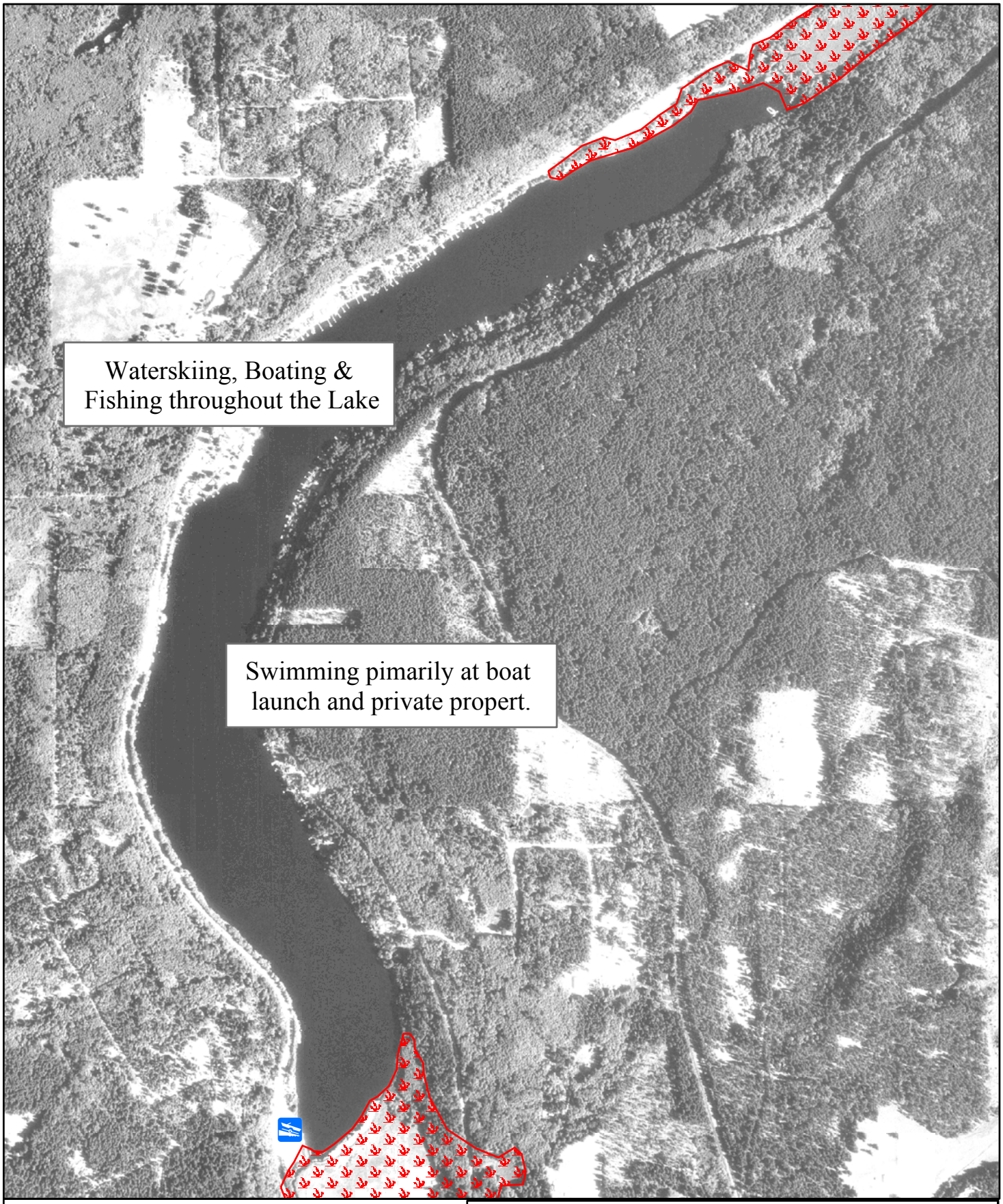

Legend

Boat Launch & Public Swimming

Wetlands

Figure 1. Beneficial Use Map for Ohop Lake.

0 125 250 500 750 1,000 Meters

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By the late 1990s, the lake was dominated by common waterweed (*Elodea canadensis)* and floating leafed plants, predominantly white waterlily (*Nymphaea odorata)* (Whiley and Walter, 1997). The waterlilies were mostly found in the shallow waters along the undeveloped portions of the shoreline. Some native lilies (*Nuphar polysepala* (previously *variagatum*) were found in patches, in the very near shore area. Along the eastern and western shorelines, common elodea tended to be dominant, with the highest densities of all plants (especially common elodea) present in the southern end of the lake. This is most likely due to the shallow depths and sediments that contain more organics. It has also been suggested that common waterweed may have been favored by the extensive use of endothall since common waterweed is resistant to this herbicide (Hamel, K. Written. Comm.). Similarly Ecology noted that the macro algae nitella and chara have become dense in this lake and that these species too tend to grow more densely in lakes that rely on chemical treatment to control vegetation (Hamel, K. Written Comm.).

Brazilian elodea (*Egeria densa),* a State listed noxious weed, covered an estimated 0.008 acres (376 square feet) of the lake during the 1997 study (Whiley and Walter, 1997). Other plants listed from that study included;

- Pondweed (*Potamogeton* spp.*)*
- Water-nymph *(Najas* spp.*)*
- Coontail *(Ceratophyllum demersum)*
- Common elodea *(Elodea canadensis)*

Tables 3 and 4 below were inserted directly from Ecology's aquatic plant website. It is a summary of survey data from Piece County, the Pierce County Noxious Weed Control Board, and the Department of Ecology surveys of Ohop Lake in 1996, 1997, and 2001. These data show a lake with a diverse native plant community as well as a community that has been invaded by exotic species such as yellow flag iris, reed canarygrass, fragrant water lily, and Brazilian elodea.

In 2001, rooted colonies of Brazilian elodea were observed at three locations in the lake while floating fragments were observed in the extreme northern end of the lake (Northwest Aquatic Ecosystems 2002). By October 2002, the plants were found in many more areas in the lake and in the case of the north end of the western shoreline, they were at high densities.

Table 3. Plant Species List for Ohop Lake.

Scientific Name	***Common Name***	***Scientific Name***	***Common Name***
Callitriche sp.	water-starwort	*Nuphar polysepala*	spatter-dock, yellow water-lily
Callitriche stagnalis	pond water-starwort	*Nuphar sp.*	yellow water-lily
Ceratophyllum demersum	Coontail; hornwort	*Nymphaea odorata*	fragrant waterlily
Ceratophyllum sp.	coontail	*Phalaris arundinacia*	reed canarygrass
Chara sp.	muskwort	*Polygonum hydropiperoides*	common smartweed
Egeria densa	Brazilian elodea	*Potamogeton amplifolius*	large-leaf pondweed
Eleocharis sp.	spike-rush	*Potamogeton crispus*	curly leaf pondweed
Elodea canadensis	common elodea	*Potamogeton epihydrus*	ribbonleaf pondweed
Fontinalis antipyretica	water moss	*Potamogeton praelongus*	whitestem pondweed
Iris pseudacorus	yellow flag	*Potamogeton sp (thin leaved)*	thin leaved pondweed
Iris sp.	Iris	*Potentilla palustris*	purple (marsh) cinquefoil
Lysimachia nummularia	creeping loosestrife	*Scirpus sp.*	bulrush
Myosotis laxa	small flowered forget-me-not	*Spiraea sp.*	spirea
Myosotis scorpioides	common forget-me-not	*Typha latifolia*	common cat-tail
Nitella sp.	stonewort	*Typha sp.*	cat-tail

Table 4. Ohop Lake Aquatic Plant Distribution and Density from 1996, 1997, and 2001 Surveys.

species	date	DV[1]	source[2]	comment
Callitriche sp.	7/25/1996	1	Ecology	near north end, no seeds for ID to species
"	9/25/1997	2	Ecology, Pierce Co NWCB	
Callitriche stagnalis	9/19/2001	1	Ecology	
Ceratophyllum demersum	7/25/1996	2	"	in deeper water
"	9/25/1997	2	Ecology, Pierce Co NWCB	
"	9/19/2001	3	Ecology	
Ceratophyllum sp.	7/25/1996	1	"	C. echinatum? No flower
Chara sp.	7/25/1996	3	"	
Egeria densa	7/25/1996	1	"	one patch found
"	9/25/1997	2	Ecology, Pierce Co NWCB	
"	9/19/2001	2	Ecology	
Eleocharis sp.	9/19/2001	2	"	
Elodea canadensis	7/25/1996	3	"	some dense patches, blooming
"	9/25/1997	2	Ecology, Pierce Co NWCB	
"	9/19/2001	4	Ecology	
Fontinalis antipyretica	7/25/1996	1	"	on log
Iris pseudacorus	7/25/1996	2	"	patches around the lake
"	9/25/1997	2	Ecology, Pierce Co NWCB	
Iris sp.	9/19/2001	3	Ecology	
Lysimachia nummularia	9/19/2001	1	"	
Myosotis laxa	9/19/2001	1	"	
Myosotis scorpioides	9/19/2001	1	"	
Nitella sp.	9/19/2001	4	"	
Nuphar polysepala	7/25/1996	2	"	few patches, closer to shore
Nuphar sp.	9/19/2001	3	"	
Nymphaea odorata	7/25/1996	4	"	rings most of the lake
"	9/25/1997	3	Ecology, Pierce Co NWCB	
"	9/19/2001	4	Ecology	
Phalaris arundinacia	7/25/1996	2	"	mostly at less developed south and north ends
"	9/25/1997	2	Ecology, Pierce Co NWCB	
"	9/19/2001	3	Ecology	
Polygonum hydropiperoides	9/19/2001	1	"	
Potamogeton amplifolius	7/25/1996	1	"	few scattered plants
"	9/25/1997	1	Ecology, Pierce Co NWCB	
"	9/19/2001	1	Ecology	
Potamogeton crispus	7/25/1996	1	"	few in south end
"	9/25/1997	1	Ecology, Pierce Co NWCB	
"	9/19/2001	1	Ecology	
Potamogeton epihydrus	7/25/1996		"	
"	9/25/1997	2	Ecology, Pierce Co NWCB	
"	9/19/2001	3	Ecology	
Potamogeton praelongus	9/25/1997	1	Ecology, Pierce Co NWCB	
"	9/19/2001	2	Ecology	
Potamogeton sp (thin leaved)	7/25/1996	2	"	no achenes
"	9/25/1997	1	Ecology, Pierce Co NWCB	
"	9/19/2001		Ecology	
Potentilla palustris	9/19/2001	1	"	
Scirpus sp.	7/25/1996	2	"	at north and south ends
"	9/19/2001	2	"	
Spiraea sp.	9/19/2001	3	"	
Typha latifolia	9/19/2001	3	"	
Typha sp.	7/25/1996	2	"	at north and south ends
"	9/25/1997	2	Ecology, Pierce Co NWCB	

1. "DV" (distribution value) is an estimate of density: 1 - few plants in only 1 or a few locations; 2 - few plants, but with a wide patchy distribution; 3 - plants growing in large patches, codominant with other plants; 4 - plants in nearly monospecific patches, dominant; and 5 - thick growth covering the substrate at the exclusion of other species.
2. "Source" is the organization that provided the data. "Ecology" refers to the Washington State Department of Ecology.

The first herbicide treatment of the Brazilian elodea using Reward (with active ingredient diquat) occurred in summer of 2003. Twenty acres were treated at a rate of two gallons per acre (Ecology herbicide database). According to the summary report provided by the herbicide applicator, the application went "very well" and there were few areas of re-growth seen during the September follow-up survey (AquaTechnex, 2003). The September 2003 survey results for Brazilian elodea and fragrant water lily are included as Figure 2. Another treatment using Reward was done in late July of 2004 and two acres of Brazilian elodea was treated with diquat at a rate of two gallons per acre (Ecology herbicide database). According to the September 2004 survey report (Aquatechnex, 2004), no Brazilian elodea plants were found in the area treated in July, and the large patch near the boat launch, that was treated the previous year, was still free of the plant. However, a new patch was observed in the northeast end of the lake. The September 2004 survey results for Brazilian elodea and fragrant water lily are included as Figure 3.

The most recent aquatic plant survey of Ohop Lake (Figure 4) was completed by Ecology in August 2005, approximately 15 months after the last herbicide application. Ecology took special note of the locations of Brazilian elodea during this survey. There were 7 patches of rooted plants observed; most were located near the northern end of the lake. However, floating fragments were found in 10 different places and were spaced along the entire eastern shore extending to the south end of the lake. These floating fragments represent potential new infestation areas.

Diquat is not normally expected to result in more than seasonal control of Brazilian elodea. This is because the herbicide does not kill the plant roots; it just removes all of the vegetation that is above the sediment. However, in Ohop Lake and also as documented by Ecology in Battle Ground Lake (Hamel, K. Written Comm.), diquat appeared to be effective in controlling Brazilian elodea for multiple seasons. For example, in Ohop Lake the large patch observed and treated in the southern end of the lake in 2003 was still free of Brazilian elodea in August of 2005.

It is less clear when white waterlily was first observed in the lake and the speed with which it colonized the nearshore zone. However, it was present in Ohop Lake at the time of the USGS survey in 1971 so was introduced before this date. It was reported as a dominant plant in the 1996 survey.

An early summer survey of these plants in 2003 indicated they were dispersed throughout the shoreline but were especially prevalent along the lower western shoreline and around the southern end of the lake as well as around the northern end of the lake. Ten acres of water lilies were treated with glyphosate during July and retreated in August of 2003. The September survey map for 2003 indicates that the populations were greatly reduced but not eliminated. No acreage amounts were provided. Less than two acres of white water lilies were treated twice again in 2004. By September of 2004, it was reported that a small percentage of white waterlily remained scattered at sparse densities around the lake. It was estimated that the remaining patches represented about 5 acres (Langen, K. pers. Comm.) Appendix E contains summary information on the characteristics and habitats of these plants.

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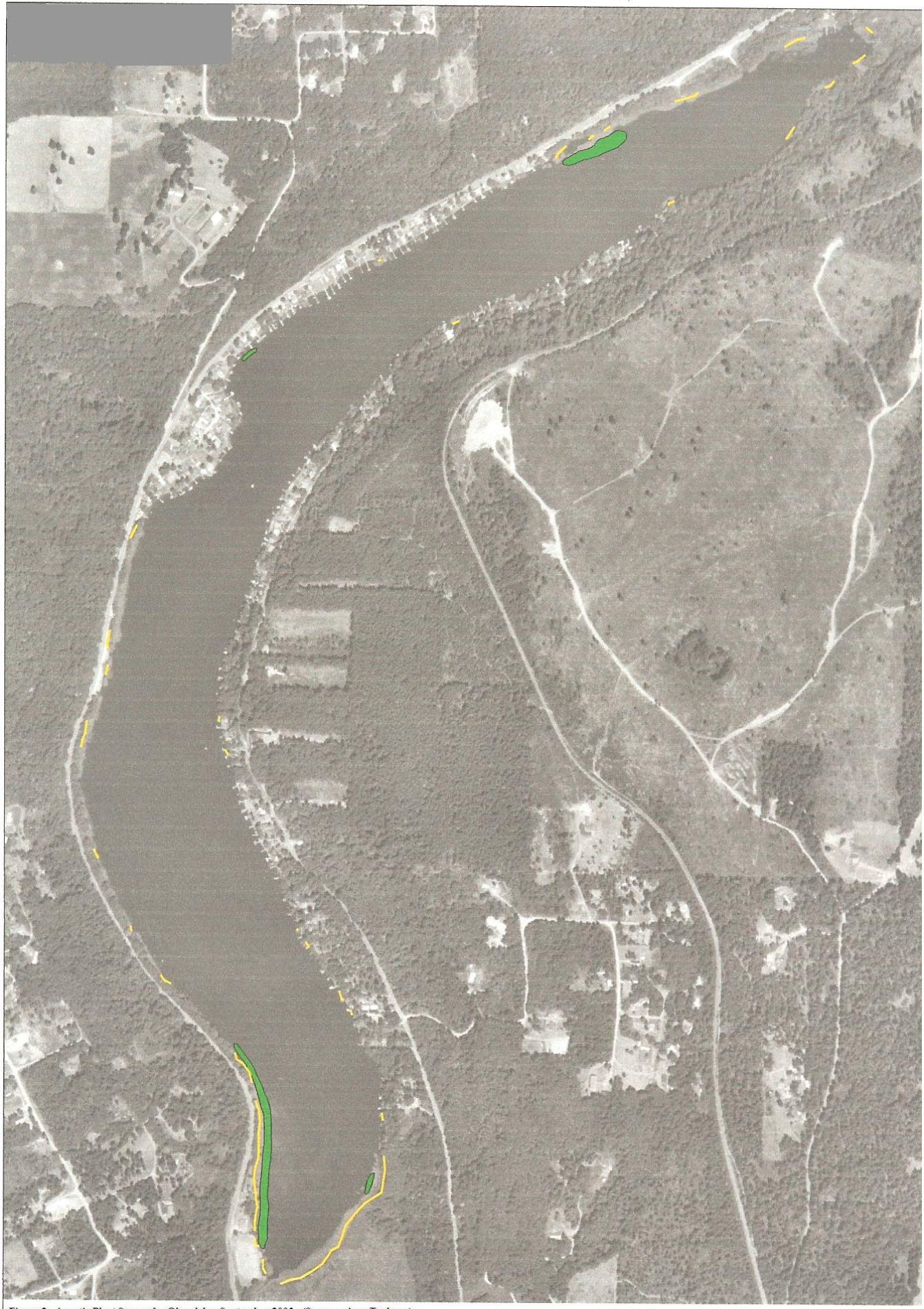

Figure 2. Aquatic Plant Survey for Ohop lake, September 2003. (Source: AquaTechnex)

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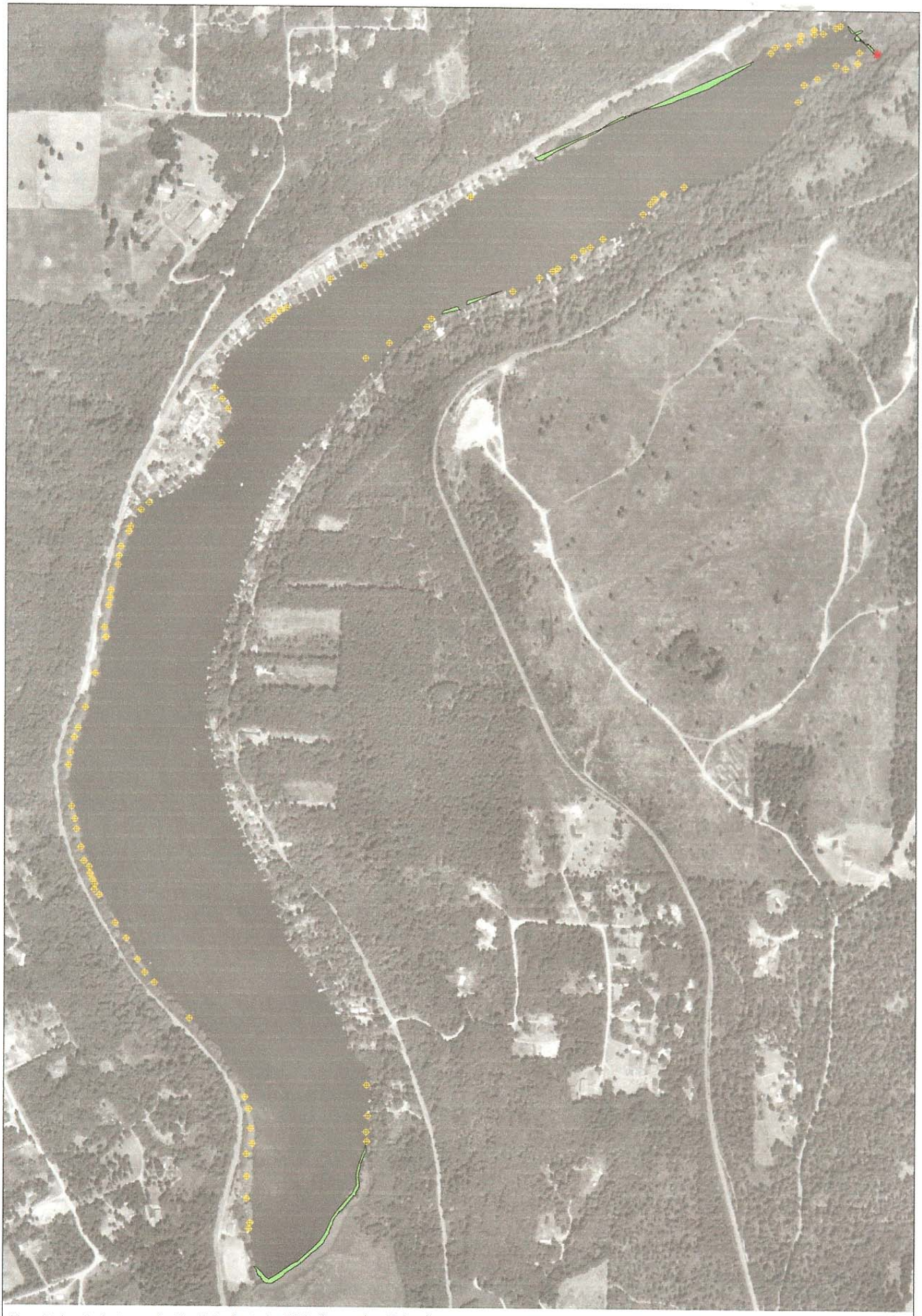

Figure 3. Aquatic plant survey for Ohop Lake, September 2004. (Source: AquaTechnex)

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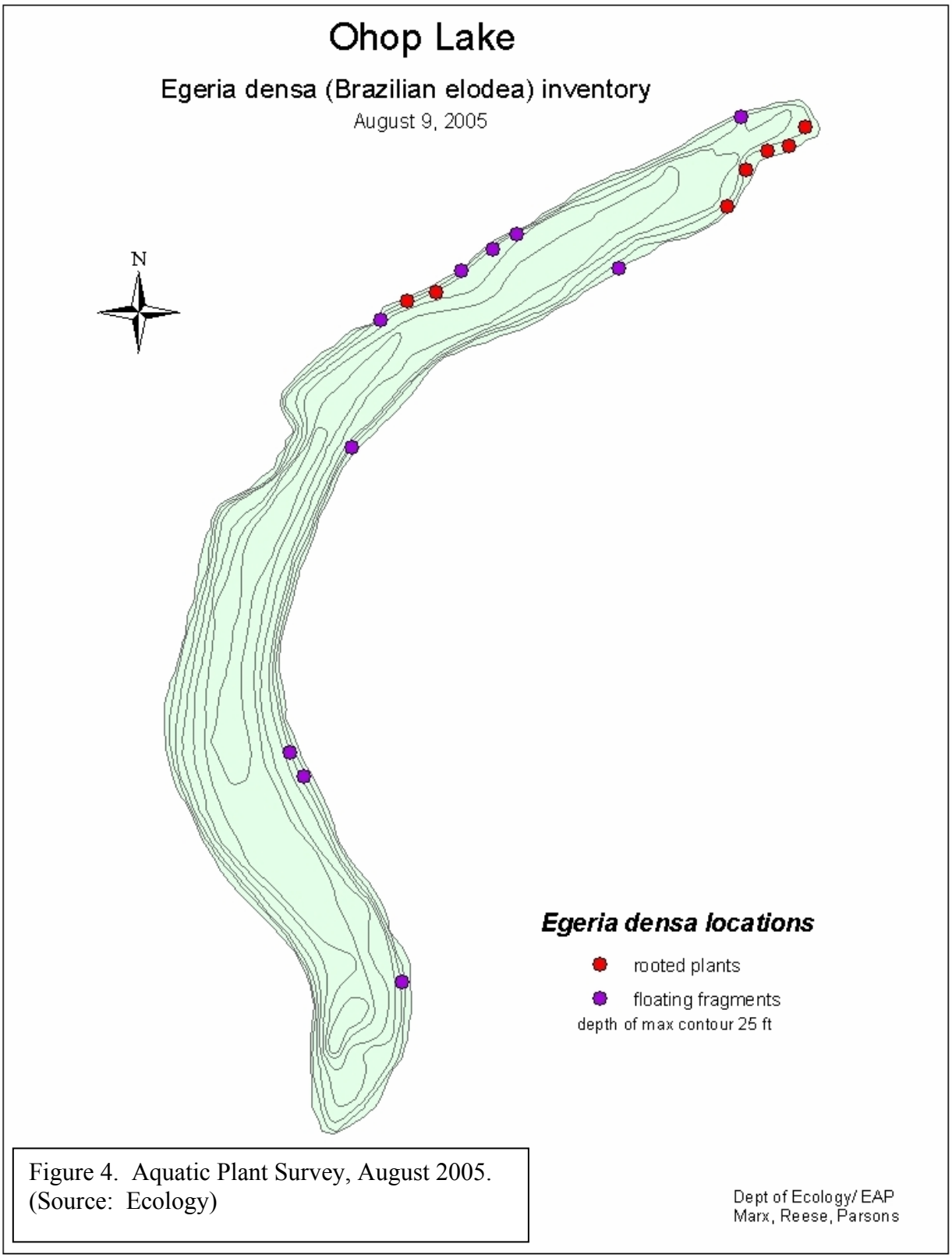

Figure 4. Aquatic Plant Survey, August 2005. (Source: Ecology)

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PROBLEM STATEMENT FOR OHOP LAKE

The following list of problems was developed at a June 2005 public meeting of the Ohop Lake Improvement Club.

- Brazilian elodea (*Egeria densa*) an invasive non-native plant has occurred throughout much of the lakes nearshore zone and has the capacity to colonize the majority of the open water area on Ohop Lake. (Roughly 50 to 75% of the surface area could be colonized.)
- Periodic herbicide treatments have been effective at controlling the Brazilian elodea infestation but eradication of Brazilian edodea will require continued attention.
- It is believed that the rapid growth of this plant is contributing to accelerated filling of the lake and if left unchecked will create more water quality problems through poor water movement and increased nutrient cycling.
- White waterlily (*Nymphaea odorata*) another invasive plant also exists around much of the lakes perimeter and in the lake outlet channel. If left uncontrolled, this plant could colonize the entire lake shoreline from the shoreline edge to a depth of at least 5 feet. The dense growth in the outlet channel is believed to be contributing to reduced lake flushing and may also provide salmon passage problems.

Other problems identified that are not necessarily related to aquatic plant management but may need to be considered when identifying control strategies were also listed.

- Operation of the lake outlet may be an issue. Currently the lake level increases rapidly in response to even moderate rainfall amounts.
- Algae populations are frequently high, resulting in poor water clarity. Any plant control activities need to take into account possible impacts to algae.
- Shoreline residences are served by onsite septic systems. It is likely that these are contributing nutrients to the lake and therefore enhancing algae growth.

The list of problems was used to create a problem statement for Ohop Lake. The purpose of the problem statement is to describe as clearly as possible how the lake and its inhabitants are being negatively impacted by aquatic plants.

> *Ohop Lake has been invaded by two non-native, noxious, aquatic plants; Brazilian elodea and white waterlily. These plants have the ability to colonize the entire littoral zone of the lake. These plants, if left unchecked, will limit human recreational use; especially boating, fishing, and swimming. They can also be expected to impact fish habitat through water quality impacts (reduced oxygen supplies) and limit use by other wildlife. Their existence also represents a threat to nearby lakes due to the increased potential for additional infestations. (There are at least 22 lakes within a 15 mile radius of Ohop; none of which currently are known to have Brazilian elodea and only 6 which have white waterlily.) The residents of Ohop Lake have been successfully limiting the growth of these plants through use of herbicides for the past two or three years. It is imperative that these plants continue to be controlled on an annual basis or eliminated. If no action is taken for even a few years, the plants can be expected to rapidly regain territory*

resulting in further beneficial use limitations and eventually in the use of greater quantities of herbicide to treat the expanding invasive plant beds.

Other noxious plants (yellow flag iris, curly leaf pondweed, reed canary grass, and Japanese Knotweed) also exist in and near the lake shore. Although these are not currently a high priority for the community, ultimately they may also required control.

AQUATIC PLANT MANAGEMENT GOALS

The final step before beginning development of a plant control plan was to define project goals. This is a critical step because the goals are used to determine what control strategies will work and will ultimately be used to evaluate whether the program has been a success. The following list of goals was developed during the June 2005 meeting of the Ohop Lake Improvement Club.

- Eradicate Brazilian elodea and White waterlily from Ohop Lake.
- Prevent invasions by new noxious plants
- Preserve beneficial uses of the lake for the long term; this includes maintaining recreational use and fish productivity.
- Maintain diverse fish and wildlife habitat.
- Improve water quality over the long term.

AQUATIC PLANT MANAGEMENT OPTIONS

There are two primary needs associated with the aquatic plant community in Ohop Lake; eradication of Brazilian elodea and the white waterlily. Over the long-term it is possible that native plants will reach nuisance levels, therefore a long-term plan that allows some control of native plants near residences and the boat launch needs to be considered. All eradication/control alternatives described and approved by Ecology were considered for use in Ohop Lake. These included the use of various herbicides, mechanical removal or harvesting, sediment dredging, stocking Grass Carp, and other techniques. Appendix C provides summary information on these control methods, a summary of their advantages and disadvantages as well as appropriateness for use in this lake.

The process of selection began with presenting the entire range of control alternatives typically available to Washington State residents and describing the advantages and disadvantages of each and how each might best be utilized on the lake. Most typical physical mechanisms would result in plant fragmenting and then increased occurrence and spread of the plant unless trained personnel were used to hand removal the Brazilian elodea plants. Installation of bottom barrier was considered as cost prohibitive at a large scale but appropriate for follow up treatments.

Grass carp are not likely to be permitted by WDFW due to salmon passage and use concerns. Chemical options for Brazilian elodea are also limited because the plant does not respond as well as, for example, milfoil to some of the herbicides. This information was first presented at a

steering committee meeting on September 8, 2005. At that meeting two different options for treating the Brazilian elodea were discussed.

- Use liquid fluridone (Sonar®) to eradicate the two large Brazilian elodea areas; using fabric curtains to isolate the area. (The use of curtains was recommended a way to improve treatment efficiency and reduce costs when compared to doing a whole lake treatment). Use handpulling, and bottom barrier techniques to eradicate plants in smaller areas.
- Continue to use diquat (Reward®) on a yearly basis to control plant growth.
- A third option not fully presented at the meeting but suggested by Ecology is to use granular Sonar to treat 5 acre patches around each infestation. (This has worked well in one lake tested by Ecology. However this product has also been shown to be ineffective in lakes with deep organic sediments. It should be considered for testing on Ohop if the diquat becomes ineffective.

After thoughtful discussion of the differences in cost and weighing the reliability of the different strategies as well as potential for long-term satisfaction, continued use of diquat for at least the next few years was selected as the preferred strategy. This was based on its current apparent effectiveness and low cost. However, if this strategy begins to lose its effectiveness, eradication with fluridone will become the preferred strategy.

The available options and recommended strategy were presented at a final public meeting and the group unanimously voted in support of this approach. The strategy is described in detail in the following section.

RECOMMENDED AQUATIC PLANT CONTROL PLAN

SUBMERGED PLANT CONTROL

The primary goal of the Submerged Plant Control plan is the eradication of the Brazilian elodea population, although it is acknowledged that eradication is a difficult goal to achieve with this species. In the event that eradication is not feasible, successful suppression in this case would mean that the total acreage of Brazilian elodea plants or number of locations where it is present decreases over time. In general, this means that although new locations may be identified, they would be balanced by removal of previously identified patches.

Implementation of this plan will require an annual diver survey followed by a diquat treatment of problem areas at a rate of two gallons per acre. Each year a diver survey should be scheduled for early summer (preferably June due to poor visibility later in the year) to identify the locations of existing Brazilian elodea plants and create a map with associated gps points or polygons. The basic survey information (gps data) should be provided to the herbicide applicator within two weeks to allow its immediate use to pinpoint the treatment areas. The diquat application should be scheduled to occur within 2 to 4 weeks of the survey, but no earlier than July 15 to comply with the WDFW salmon timing work windows for diquat. If possible, the treatment should be delayed if a large algae bloom is present, since this can affect the effectiveness of the treatment.

Since diquat is a fast-acting herbicide, the plants will immediately be removed which can impact results in low oxygen conditions and/or a release of nutrients and subsequent algae blooms. However, the small amount of acreage involved in the treatment and its dispersal around the lake will reduce or mitigate these potential impacts.

Although diquat is the herbicide selected for use due to its proven effectiveness in this lake, it is the intent of this plan to allow some flexibility in the herbicide used. If another herbicide becomes registered for use in Washington State that meets the goals of: effective suppression/eradiation of Brazilian elodea, low toxicity, and is appropriate for use in waters with salmon, it too should be considered for use.

Cost for the diquat treatment will depend upon the number of acres treated each year. Assuming there are a maximum of 5 to 7 acres for treatment (a slight expansion from 2004 survey) the estimated cost would be $3,000 for the first year and $2,000 each succeeding year for the application (Table 5) A contingency fund of $2,000 to $5,000 per year should be set aside to cover possible handpulling or bottom barrier installation where patches are too small for treatment. The largest expense is likely to be the diver surveys and reports. These would cost $2,500 to $6,500 each year depending upon conditions and survey objectives. Although expensive, these surveys are critical both for the detection of Brazilian elodea and the early detection of other non-native plants that could easily invade the lake. Over the long term (5 to 10 years), if the Brazilian elodea is eradicated, these surveys could be reduced to bi-annual efforts or reduced to a 1-day effort focused on problem areas.

If after two or three years this treatment strategy is not meeting the eradication goal and especially if there is an increase in size of patches or new patches are forming at a greater pace than old patches are being eradicated, then the treatment strategy will evolve to eradication with fluridone. Specifics of implementation of this strategy may need to change to reflect conditions in the lake at the time. However, a whole-lake treatment with fluridone would be prohibitively expensive and likely have limited success due to dilution by the inflow stream and loss through the outflow. Given the limited extent of the Brazilian elodea infestation in 2005, the intent would be to isolate larger patches of infested areas with a water impermeable geotextile curtain and treat with fluridone inside the curtain. The fluridone treatment would require three to four applications of the herbicide over a six week period to maintain the herbicide concentration at the appropriate level of 12 to 15 ppb. The curtains could then be moved to a new area and another patch treated during the same growing season. Because fluridone is not subject to fish timing windows, treatment could begin early in the spring. It is possible that as many as three different patches could be isolated and treated over one growing season using the same curtain. Areas that are too small to justify isolation behind curtains would either be eradicated through hand removal (appropriate where there are few plants or very small patches) or covered with bottom barrier.

For planning purposes it was assumed that the patch size and distribution would be similar to what was observed during the 2004 survey (Figure 4). Assuming purchase and installation of about 2,700 lineal feet of curtain and treatment of 14 acres of water this has been estimated at approximately $85,000, with follow-up treatment costs of $5,000 per year for the next two years. (It is possible that this cost can be reduced if a used curtain can be purchased or rented.) A

$5,000 per year contingency fund should also be included for hand removal and bottom barrier installation. And, as described above, diver surveys would also need to be more rigorous until the Brazilian elodea was eradicated. A 5 year planning level estimate of these costs is $145,000. These costs have not been included in Table 5 since this is the back up strategy.

Last, it is also a goal to maintain beneficial uses of the lake including, swimming, boating, and fish and wildlife habitat. The inflow and outflow wetlands, relatively large expanses of undeveloped shoreline, and healthy submerged and shoreline plant populations that exist throughout the lake, will continue to support the diverse habitats necessary for fish and wildlife. However, over the long term it is possible that native aquatic plants will reach an extent or densities that limit swimming or boating use. The long-term plant control needs for the lake include allowing for some control of native plants in the area near people's residences. This would include allowing property owners to maintain an access area or control zone in front of their property. The intention of creating this control zone is to allow space for a dock, boat access along one side of the dock, and swimming access along the other. This would impact only a small portion of the plant community that exists lake-wide. This approach would also effectively increase the amount of plant edge along the shoreline. Edge habitat is often more productive in terms of diversity and abundance of species. The amount of area that can be controlled will be driven by what is allowed by permit. These permit conditions are currently being revised and should be reviewed before implementing this activity.

It is assumed that most of the removal would be accomplished with the use of physical methods; raking, handpulling, bottom barrier, etc. However, the periodic use (maximum of once every two years) of diquat to control submerged plants or glyphosate to control floating-leaved or emergent plants should also be allowed. All residents wishing to control native plants along their shoreline should be presented with a copy of the Lake Stewardship section of this plan and asked to consider replacing habitat through either shoreline plantings, or placement of in-lake natural structures such as trees or large limbs.

This cost for native plant control in the residential areas would vary depending upon method used and be covered by participating homeowners. It is recommended that those interested in this control strategy join forces to hire an applicator to treat the entire area at one time. This will result in a more effective and less expensive treatment.

Implementation of the Submerged Plant Control strategy requires diver surveys. The primary goal of the surveys will be to search for Brazilian elodea or other invasive plants; a secondary goal will be characterizing the native plant community and how it changes over time. The extent to which this secondary goal will be met will be dependent upon dive conditions and how much Brazilian elodea is found. Given the lake conditions, a two-day effort is a reasonable expectation to achieve adequate coverage of the lake bottom. Not only is the lake perimeter fairly large, the presence of other plants at high densities and turbid water make for poor visibility and will increase diver time.

These diver survey efforts may need to become more intensive if it is found that new colonies are forming or existing plants are being missed. Diver surveys may then be warranted twice a year and should be as rigorous as necessary to thoroughly survey the entire littoral zone. (Note:

According to lake residents, water clarity decreases rapidly in this lake with the onset of summer. This is due to increased algae but also due to the fact that the lake water is highly colored and that this too increases during the season. Unfortunately, selection of a survey time is confounded by the fact that Brazilian elodea can be slow to grow in the spring and that treatment with diquat can not be scheduled until after July 15 to meet WDFW fish windows for salmon. Therefore, the survey should be scheduled for late June initially, to be close to the herbicide application date. However, if this is too late in the season and visibility is greatly impaired, an earlier survey date (late May) may be more appropriate. If in future years the strategy changes to fluridone treatments, there will be no restriction on the herbicide application date; however the limitations on visibility and the late growth of Brazilian elodea will still be primary considerations for scheduling the survey.

One of the goals of the implementation plan is to improve reliability of diver surveys and reporting, to allow better quantification of progress. The plant survey data will also be used to estimate the total acreage of Brazilian elodea plants remaining and to produce a report that describes whether or how the Brazilian elodea community is changing. This report should quantify: whether the acreage impacted is continuing to decrease; whether existing larger patches are changing in size, and whether new points of invasion are being found. This information will be critical to track over the long term to determine whether to continue with the diquat treatments or move to an eradication strategy. The survey and reporting costs shown in Table 5 are based on an assumption of two days of diving for the first 5 years and a more quantitative approach to evaluating the annual survey work.

FLOATING-LEAVED PLANT CONTROL

The only floating-leaved plant type that is a problem at the current time is white waterlily. As described previously, glyphosate (Rodeo) has been used to greatly reduce this plant community. This effort should continue until the plants are entirely eradicated from the lake. The treatment area must include the outflow channel, or it will serve as a long term source for re-generation of the plant. Also, there are concerns that the dense lily population in the outflow channel may be affecting lake flushing and impeding salmon passage. There are no timing restrictions for the use of glyphosate in salmon-bearing lakes so treatment can occur when floating leaves occur on the water's surface. Typically water lily beds are treated twice during each season. The second treatment is to treat "skips" where the applicator missed plants, to treat plants that grew out of the first treatment, or to treat plants that were not yet at the water surface during the first treatment.

Treatment costs for floating-leaved plant control are estimated at $2,000 per year for 3 years ($6,000 total) based on treatment of approximately 5 to 7 acres. This cost may decrease slightly each year as the number of acres impacted decreases. It is expected that eradication can be achieved within 3 years.

EMERGENT PLANT CONTROL

The non-native emergent plants (purple loosestrife, yellow flag iris) and Japanese knotweed (which has been identified near the lake outlet) should be located and targeted for treatment with glyphosate. The goal is eradication of these plants. However, to achieve this goal may require education of affected property owners to obtain their approval for the treatment. Survey information on the emergent plant community has not been completed. There is a plant survey scheduled for spring of 2006, problem emergent plants that are visible from the water will be noted during this survey. However, a more comprehensive survey may be required especially at the inlet and outlet locations in the vicinity of existing invasive plants that are planned for removal, due to the potential for bristly sedge (*Carex comosa*) or california swordfern (*Polystichum californicum*), two State sensitive plant species, existing in the area.

Treatment costs for emergent plant control are dependent upon acreage treated. These treatments should occur simultaneous to the treatment of the white waterlily. An annual contingency of $1,000 has been included in the plan costs. (This is not necessarily based on the number of acres that may be treated but on the overall costs for spot treatment of many small areas.)

OTHER ISSUES

As previously stated, algae populations are also a concern on Ohop Lake. Dense blooms occur throughout most of the summer. According to a recent study (Whiley and Walter 1997) the nutrients continually generated from the lake sediments are the primary cause of the elevated algae concentrations. However, the use of onsite (septic) wastewater systems on lakeshore property is also a likely nutrient source. Although algae control can not be directly addressed through development of this Integrated Aquatic Vegetation Management Plan, lake residents have expressed an interest in addressing this problem. Over the long term another alum treatment may be necessary to control the primary nutrient source. Although treatment with diquat can result in a temporary increase in algae due to input of nutrients from the dying plants, the few acres scheduled for treatment are not expected to notably impact algal levels, especially when compared to existing conditions.

DIQUAT AND GLYPHOSATE USE CONSIDERATIONS

The following provides summary information on the two herbicides selected for use in Ohop Lake. Additional information on both of these herbicides as well as fluridone (Sonar) (an herbicide that may potentially be used in Ohop Lake) is provided in Appendix D.
Diquat is a fast-acting non-selective contact herbicide which destroys the vegetative part of the plant but does not kill the roots. It is applied as a liquid. Typically diquat is used for short term (one season) control of a variety of submersed aquatic plants. It is very fast-acting; plants are killed within a few days and fall out of the water column in a week or two. It is suitable for spot treatment. However, turbid water or dense algal blooms can interfere with its effectiveness. It has very low toxicity. There are no swimming or fish consumption restrictions; there are drinking water and irrigation water restrictions of 1 to 5 days.

Glyphosate is applied as a liquid spray to the surface of the plants. It permanently kills the plants, but is not selective, that is, it will kill all emergent and floating-leaved plants it comes in contact with. While the herbicide is fast-acting, requiring only about two hours of contact time, its efficiency can easily be affected by waves caused by wind or boat activity that effectively wash off the herbicide before it takes affect. There are generally no water use restrictions associated with this herbicide, it breaks down rapidly and is non-detectable within 24 hours. Glyphosate should not be used within a quarter mile of a functioning potable water intake. If any residents are drinking the lake water (legally or otherwise), they should arrange for alternative water supply for a day or two after treatment. Plants die within a few weeks.
All aquatic herbicide applications in Washington State must be made by a state-licensed applicator. A new permit called a State Waste Discharge permit is needed to treat plants growing in waterbodies with aquatic herbicides. Coverage can be obtained for this permit through the Washington Department of Ecology. The permit should be available for use in March, 2006 and the permit fee is expected to be about $350 per year. Typically, the applicator obtains this coverage and carries out necessary posting of notices.

SENSITIVE SPECIES ASSESSMENT

There are two potential areas of concern associated with State or Federally identified species of concern: impacts to salmon from the in water application of diquat and impacts to bristly sedge (*Carex comosa*) and California sword fern (*Polystichum californicum*) from the shoreline treatments of glyphosate.

As previously described, a number of salmon species that are on the federal Threatened and Endangered Species list, pass through the lake. However, these fish primarily pass through the lake during the winter months; outside the period of herbicide application. Because Ecology's risk assessment for diquat indicated the diquat might have sub-lethal impacts to juvenile salmon (interference with smoltification), Ecology only allows diquat to be used within fish timing treatment windows set by the Washington Department of Fish and Wildlife. The timing window for diquat use in Ohop Lake opens up after July 15. Should additional data about diquat and juvenile salmon become available in the scientific literature, Ecology will re-evaluate this risk assessment for diquat. Last, only a few acres of the lake would be affected by the application. Over the long term, limiting the spread of Brazilian elodea will be beneficial for all fish habitat and for salmon passage.

The glyphosate that is recommended for use on invasive shoreline plants (yellow iris, purple loosestrife and Japanese knotweed) will also kill any sensitive species it comes in contact with. Both the bristly sedge and California swordfern are listed as State sensitive species and could occur in the wet nearshore areas where these invasive plants occur. (Information on these plants is provided in Appendix E.) A thorough search of the zones by a professional botanist in the immediate vicinity of any areas identified for treatment should be made to check for these plants. If any are found, an effort should be made to protect them from the herbicide through mitigation measures. WDNR's Natural Heritage Program should be contacted to determine how best to protect the plants. However, it is understood that one of the most significant threats to native and certainly sensitive species is the invasion of their habitat by noxious weeds such as those identified for removal in this plan. For example, the most critical threat to bristly sedge is

invasion by reed canary grass (WDNR 2000). Therefore, over the long term it is likely beneficial to these species to implement this plan.

According to the States' Natural Heritage Information System database for select rare animal species in this area, both osprey and mountain quail have been documented within a one mile radius of the lake. At the north end of Ohop Lake, two bald eagle nests have been documented. Bald eagles are state and federally threatened species. Riffle sculpin, another State monitored species, have also been collected north of the lake. Common loon, a state sensitive species are also present. None of these species are expected to be impacted by the proposed treatments. For osprey, loon, and eagles the concern would be whether their food supply (i.e., fish) would be directly affected or indirectly affected through accumulation of the chemical in their organs or tissues. The risk assessment for these chemicals indicates that is not a concern. The sculpin is a river dweller and mountain quail habitat or prey would not be affected.

Potential impact to wetlands is another area of concern. The emergent plants slated for treatment would occur in the wetlands. Although the equipment used for this type of treatment is fairly accurate, it is still reasonable to expect that non-targeted plants will be affected within the treatment areas. As described previously, one of the most significant threats to sensitive habitats such as wetlands is the invasion of noxious weeds. Therefore, over the long term it is likely beneficial to these species to implement this plan.

PLANT CONTROL ADVISORY COMMITTEE

On an annual basis decisions will need to be made about aquatic plant control activities that will require the time and attention of lake residents. Therefore, it is recommended that an aquatic plant control advisory committee be formed. This committee would have the following responsibilities:

- Review annual plant survey information and track potential problem areas. Make decisions on next steps. Next steps might include; contacting an herbicide applicator requesting additional diver time for handpulling, or ordering and installing bottom barrier, etc.
- Put together requests for bids from herbicide applicators or plant surveyors and select and hire contractors when necessary for completing these tasks.
- Insure herbicide application permit requirements are met and the application is carried out properly. In some lakes, residents take an active role during the application. On the day of the application, they meet the applicator at the site to review the application map and quantify herbicide use; some even follow the applicators to insure proper areas are being treated. These steps are taken to circumvent future questions from lakeside residents about the accuracy of the treatment.
- Insure herbicide application report includes documentation (herbicide used, concentration applied, number of gallons used and acres treated) necessary for annual report. Insure the aquatic plant survey report includes necessary quantification information.
- Document plant control activities. Documentation should include information on what activities were implemented each year; how many acres of what kind of plants were controlled; what was used to control them (e.g. what chemical at what concentration, how

was it applied and the rate of application) and the costs of the different programs (e.g. surveys and applications).

- Provide information to lake residents and act as spokespeople for answering questions on plant control problems and supporting long-term implementation of this plan.
- Provide general lake stewardship information to lake residents. This might include providing education on proper lakeside property management as well as information on avoiding introduction of invasive plants. For example, lake residents should be encouraged to never purchase and plant water lilies (such as those available through many nurseries) or any other nonnative species in Ohop Lake. That is how water lilies were originally introduced to this and many other lakes in Washington. Water lilies are only appropriate for ornamental ponds with no connection to natural waters.
- It is also helpful if one or two members of the committee are trained to identify the key invasive aquatic plants of concern in this State, so that lake residents have a resource to take plants to for I.D.
- It may also be beneficial for the committee to monitor boat use during glyphosate applications and ask people to reduce wave development during the 2 to 3 hours immediately following the treatment. This will help improve the effectiveness of the application.

PUBLIC EDUCATION PROGRAM

The public education program for Ohop Lake consists of three parts; an invasive plant prevention and detection program, volunteer patrols, and lakeside stewardship education.

INVASIVE PLANT PREVENTION AND DETECTION PROGRAM

There will always be a potential for re-infestation by Brazilian elodea and white waterlily as well as the potential for introduction of other invasive plants. Other non-native, highly invasive plants of concern include: Parrotfeather (*Myriophyllum aquaticum*), Eurasian watermilfoil (*Myriophyllum spicatum*) Hydrilla (*Hydrilla verticillata*), Fanwort (*Cabomba caroliniana*), and Water Hyacinth (*Eichhorinia crassipes*). The focus of control efforts for non-native plants is a prevention and detection program. A contingency plan is also presented in case control of a large area is required.

To be effective this program should include both a source control component and a detection program. The objective of source control is to prevent non-native submerged plants from entering the lake. The public and private boat launches represent areas where there is a high potential for introduction or re-introduction of invasive plants. It is recommended that the lake community institute some public information campaign for opening day of the fishing season and a few other key weekends. Simply having volunteers hand out exotic plant identification cards for a few hours and help with boat and trailer checks, will emphasize the importance of the effort and remind boaters of their responsibility to check equipment.

Early detection is the next step to protect against new infestations. While an infestation is still relatively small the options for control are much less expensive. Early detection requires annual surveys to assess the plant community. The main purpose of these surveys is to search for Brazilian elodea and any other exotic plants. However, it will also provide a means for monitoring the native submerged plant community.

All diver surveys should be done in such a manner as to thoroughly cover the lake bottom from the shoreline to depths of 20 feet. The survey report should describe the survey method in detail and must include production of a GIS based map that shows the locations of all invasive plants or patches of plants and a calculation of the acreage under each plant type. Actual gps coordinates for all invasive plants identified for control should also be provided.

The primary advantage of controlling small infestations is that it reduces the chance that a large area would need to be controlled by a more intensive and expensive technique. A drawback of controlling small infestations is the high costs associated with diver surveys and hand pulling. However, in the case of Ohop Lake annual surveys will be required to meet the primary goal of Brazilian elodea suppression. Therefore there are no additional costs associated with this plan element unless another invasive plant is detected. If another invasive plant is found, immediate action should be taken and a second dive should be planned for later in the same year to insure there were no surviving colonies.

These additional diver surveys and possible need for hand removal, bottom barrier installation, or herbicide treatments are contingency elements to the overall aquatic plant control plan for the lake. A contingency fund has been included as one of the plan cost elements, to help insure protection of the lake.

VOLUNTEER PATROLS

Lake residents should learn to identify Brazilian elodea so they can help with detection and removal. Whenever a lake resident finds Brazilian elodea they should collect a sample of the plant and mark the spot, if possible. If the plants are floating they should be immediately removed from the lake. This is done by carefully placing the plants, and any nearby plant fragments, in a bucket or bag and disposing of them in a place that is at least 200 feet from the lake or any stream or drainage.

It is recommended that one or more lake residents learn to identify the handful of invasive submerged plants that are problems in this State. These people can then be a resource to other lake residents who may not be sure of plant identification. All information on where plants are found or suspected should be conveyed to one person who can track this information and relay it to dive teams and applicators.

It is also recommended that volunteers periodically patrol the areas near previously identified patches of the Brazilian elodea and again, remove any floating fragments found and identify locations of remaining rooted plants.

Lake residents should also learn to identify the important shoreline plants that can become problems. This primarily includes Japanese knotweed, yellow flag iris, purple loosestrife and white waterlily. These plants are considered attractive to people who don't understand their invasive nature, so education can be very important. One approach to providing this education is to bring cuttings from these plants to the Club's annual meeting as well as to provide pictures of nearby colonies of these plants with directions, so people can go see the plant in "the wild".

LAKESIDE STEWARDSHIP EDUCATION

Each lakeside resident should be educated about how to reduce the amount of pollutants entering the lake from their property, as well as about things they can do to help retain a complex, diverse, and therefore healthier lake environment. The properties located directly adjacent to the lake have the greatest potential for adversely impacting the lake since pollutants generated on these properties can more easily reach the water.

Lakeside property owners should be provided with information about problems associated with typical urban type landscapes around lake shorelines. This should include information on the drawbacks of bulkheads and using ornamental turf (lawns), and the benefits of adding shoreline plants and diversified lawn plantings, which create habitat structure for birds and wildlife. Although the shoreline of this lake is still in good condition, conversion to a more urban shoreline can happen relatively quickly.

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

- Limit turf and landscaped areas to no closer than 25 feet from the shoreline. Native plants and grasses should be considered for landscaped areas to decrease the amount of fertilizers, pesticides, and other pollutants used.
- Establish a "pollutant free zone" within 50 feet of the shoreline. Try to keep all pollutants; gas for boats, painting projects, landscape fertilizers and poisons, and etc. away from this zone.
- Plant a shoreline buffer of shrubs and tall grasses, preferably native species. This one small activity will cause multiple environmental benefits. If properly designed it will keep geese and other waterfowl from moving onto lawn areas. The vegetation will help filter out pollutants such as fertilizers from landscaped areas before they reach the lake. It will provide protection from shoreline erosion, and it will provide habitat for the many wildlife species that utilize nearshore areas.
- Preserve natural "structure" such as fallen trees and boulders that exists along the shoreline and in the shallow nearshore area. If a tree along the shoreline finally falls in, leave it. Add structure in the form of treetops, twig bundles, and rocks to diversify and naturalize the nearshore area and attract more fish and wildlife.
- Avoid the use of bank armor such as bulkheads and riprap.
- Allow emergent vegetation, and other plants to colonize some portion of waterfront area.

PLAN ELEMENTS, COSTS, AND FUNDING

Table 5 provides a summary of each element identified in this plan and the associated costs. Total cost for the plan for the first ten-year period is estimated at $108,000. No costs have been included for the Plant Control Advisory Committee work or public education efforts since these are handled on a voluntary basis by lake association members. Although the Table shows projections over a 10-year period, it is understood that suppression of Brazilian elodea will likely be a permanent need and require long term funding.

GRANTS

Implementation funding for the continued suppression of Brazilian elodea and eradication of white waterlily and noxious emergent plants could be obtained from Ecology's Aquatic Weed Management Fund (AWMF) grant program. The AWMF grant program funds a variety of aquatic plant management projects statewide. Grants are awarded annually on a competitive basis. Local jurisdictions are eligible to compete for these grants, however, no one jurisdiction can be awarded more than $75,000 annually. The grants require a 25% match; thus to get the entire $75,000 would require $25,000 in matching funds for a total of $100,000. It is the intention of the Ohop Lake Improvement Club to apply for an implementation grant to cover some of the costs for implementing this plan. Plant Control Advisory Committee work and public education activities would be eligible for part of the in-kind match requirements for this grant program.

LONG TERM FUNDING

Over the long term a funding source outside of the AWMF grant program will be required to carry out the annual survey and aquatic plant control needs. These annual costs can be expected to range from $5,000 to $10,000. For this IAVMP, these long term costs would be handled through an existing tax assessment process. In 1960s, the property owners voted and approved a process for collecting an additional tax to cover expenses of lake improvement and maintenance including aquatic weed control. This tax is assessed based on shoreline frontage and collected by Pierce County via the property tax system. The amount collected annually is based on the steering committee's assessment of needs and estimated costs.

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Table 5. Estimated cost for implementation of the Ohop Lake IAVMP.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Submerged Plants											
Braz. Elodea Suppression	3000	2000	2000	2000	2000	2000	2000	2000	2000	2000	$21,000
Survey and Reporting	6500	6500	5000	5000	5000	2500	2500	2500	2500	2500	$40,500
Annual Contingency	5000	5000	5000	5000	5000	2000	2000	2000	2000	2000	$35,000
Nuisance Plant Control	**Covered by Individual Property Owners**										$0
Floating-Leaved Plants											
Waterlily Eradication	2000	2000	2000								$6,000
Emergent Plants											
Invasive Plant Eradication	1500	1000	1000	1000	1000	0		0		0	$5,500
Total Cost	**$18,000**	**$16,500**	**$15,000**	**$13,000**	**$13,000**	**$6,500**	**$6,500**	**$6,500**	**$6,500**	**$6,500**	**$108,000**

Braz. elodea suppression and Waterlily eradication costs are based on a maximum of 7 acres treated at $300 per acre for both diquat and glyphosate
This cost estimate does not include implementation of the eradication plan for Brazilian elodea; the contingency strategy if suppression does not work.

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IMPLEMENTATION AND EVALUATION

The following details a step-by-step approach to implementation of this plan:

Step 1) Set up a Plan Implementation Committee

The first step to implementing the plan is to set up an organization or committee that will take responsibility for it. The lake community will control how and whether the plan is implemented. Many of the tasks this committee will need to carry out are described in the plan under the "plant control advisory committee" section.

Step 2) Apply for a Plan Implementation Grant

Grants for up to $75,000 are available through the WDOE Aquatic Weeds Program for implementation of approved Aquatic Plant Management Plans. Lake residents should continue to work through the Pierce Conservation District to apply for these grant funds. Applications are due to Ecology by the end of October.

Step 3) Spring 2006 Diver Survey

The Spring 2006 survey cost is already covered through the existing Planning Grant. This survey should be scheduled for completion in May and the results provided to the selected herbicide applicator within two weeks of the application. The survey should also include to the extent possible gps locations for invasive shoreline plants.

Step 4) Select herbicide applicator

A bid should be prepared and an applicator selected for both the diquat and glyphosate applications. The bid should be prepared for release by February or March of 2006, allowing two weeks for bidders to respond, and time for processing of the permit, which is expected to take longer under the new permit. The bid should include preparation of permit applications and application costs, as well as all notification and posting requirements associated with the applications. Herbicide application for glyphosate can occur whenever water lilies are actively growing. Diquat application cannot take place until after July 15.

Step 5) Conduct Annual Evaluation

Complete a written annual evaluation for the lake records that describe what elements of the plan have been implemented, relates the existing plant community to established goals, and makes recommendations for the next year's activities.
It is important that there is some mechanism in place for periodic evaluation of this plan and determination of whether it is meeting stated goals or whether the goals have changed. This evaluation should be done on a yearly basis. It should begin with a description of which elements of the plan have been fully implemented, which have not, and why. It should also include a summary of the plant monitoring results, both those obtained by volunteers and those by professionals. These results should be used to aid in the determination of whether goals have been met. The community should also be asked for input on their satisfaction with plant conditions. For example, it is possible that the goals will be met, but that some people will

remain dissatisfied. Although it is unlikely that everyone's needs will be met, an effort should be made to track concerns, especially if they are widespread. This information should be used to decide on the following years activities; does an herbicide treatment need to be scheduled? Have any other invasive plants been identified? Do handtools need to be purchased? Is it necessary to implement the back-up or contingency plan? Over the long-term, adequate annual evaluations can make the difference between project success and failure.

Step 6) Institute Long-Term Program

Steps 3 through 5 will essentially need to be carried out over the long term. Eventually it may be beneficial to develop multiple year contracts with surveyors and applicators. This could be more cost effective and also help insure some consistency in methodology.

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APPENDIX A

RECORD OF PUBLIC MEETINGS

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IAVMP

25 JUNE 05

NAME

Felix M. Robinson
Vivian L. Robinson
Jack & Delores Chappell
~~Bob & [illegible]~~ Lenna Bergeron
[illegible]
Ken & Mavis Stanaway
[illegible]
Gretchen B Glenn
Michael & Diane Knowles
Edwin Stone
John Fuselman
Jim Carr
LaDonna Carr
Donnie & Craig Reeder
Doris Payne
Larry R Payne
Michelle Cornwell
[illegible]
MARK PAYNE
[illegible]
Katherine Glenn
Raymond E. Glenn III
[illegible]
[illegible]
Ron Ericson
John KAREN EADS
MARK SWEETLAND
LILEN TOMPKINSON

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Ohop Lake Improvement Club

Integrated Aquatic Vegetation Management Plan (IAVMP) Development Process

Attendance - Public Meeting – 8 September 2005

Bob Kimball residence, 40108 Ski Park Road, Eatonville, WA

Name	Signature	Address
Robert Kimball	Robert E. Kimball	Po Box 9, Sumner 98390
Dox Cook	D Cook	PO Box 1332 Eatonville 98328
Dennis Lowers	Dennis Lowers	PO Box 1332 Eatonville 98328
Dave Earles	Dave Earles	39002 Ski Park Rd
Allen Templeman	Allen Templeman	2127 7th Ave S.W. Puyallup 98371
Isabel Eagland	Isabel Eagland	Pierce Conservation District 1011 E Main Suite 106 Puyallup WA 98372
Doug Clough	Doug P Clough	28112 144th Ave E, Graham 98338
Jinnie Jones	Jinnie Jones	38813 Orville Rd. E. Eatonville 98328
Mark Payne	Mark Payne	3502 42nd Ave NE Tacoma WA 98422
Doris Payne	Doris Payne	~~3502 42nd Ave~~ 38705 Orville Rd. E. Eatonville 98328
Kelly Woyak	Kelly Woyak	38709 Orville Rd E
Denny Woyak	Denny Woyak	"
Jay P Richard	Jay P Richard	1220 4th Ave, Olympia 98506

Sheet 1 of 1

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Ohop Lake Improvement Club

Integrated Aquatic Vegetation Management Plan (IAVMP) Development Process

Attendance - Public Meeting - 1 October 2005

Eatonville Community Center, 305 Center Street West

Name	Signature	Address
Doug Clough	Doug P Clough	28112 - 144th Ave E, Graham 98338
WDFW Hal Michael	Hal Michael	600 Capitol Way N Olympia 98501-1091
Mark Payne	Mark Payne	38705 Orville Rd Eatonville WA 98328
Doris Payne.	Doris Payne.	3502 42nd Ave NE Tacoma WA 98422.
Ed Schroeder	Ed Schroeder	4011 Crystal Ln LP SE Puyallup, WA 98372
Isabel Rayland	Isabel Rayland	104 E Main, Suite 106 Puyallup WA 98372
Marty Reynolds	Marty R	38610 Ski Park Eatonville WA
Betty Templeman	Betty Templeman	2127 7th ave sw Puyallup
Allen Templeman	Allen Templeman	2127 7TH Ave S.W Puyallup 98371
Bill + Deb; Pitzl	Bill Pitzl	13901 Twin Lakes Dr E Graham, WA. 98338
Steve Wade	Steve Wade	13709 Twin Lk Dr S. Graham, WA 98338
Florian Leischner	F. Leischner	Nisqually Indian Tribe 12501 Yelm Hwy SE, Oly WA 98513
Marianna Bissonette		PO Box 1906 Eatonville, WA 98328
Jinnie Jones		PO Box 286 Eatonville, Wa 98328
Delores Chappell	Delores Chappell	POB 465 Eatonville
Ron Emerson	Ron Emerson	P.O. BOX 1394 Puyallup WA 98371
Renee Emerson	Renee Emerson	P.O. BOX 1394 Puyallup WA 98371
Nicole. Elliott		38826 Ski Park Rd E 98328
Marc Elliott		38826 Ski Park Rd E 98328
JACK CHAPPELL	John H Chappell	P.O. Box 465 Eatonville, Wa. 98328
DELORES CHAPPELL		

Sheet 1 of 1

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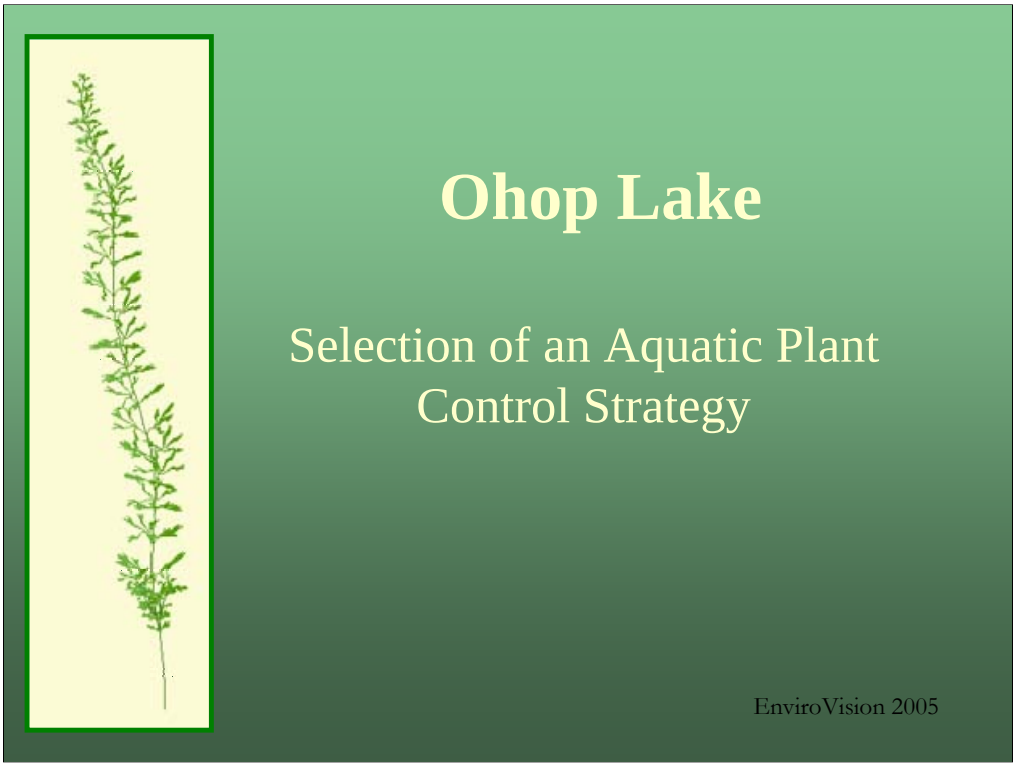
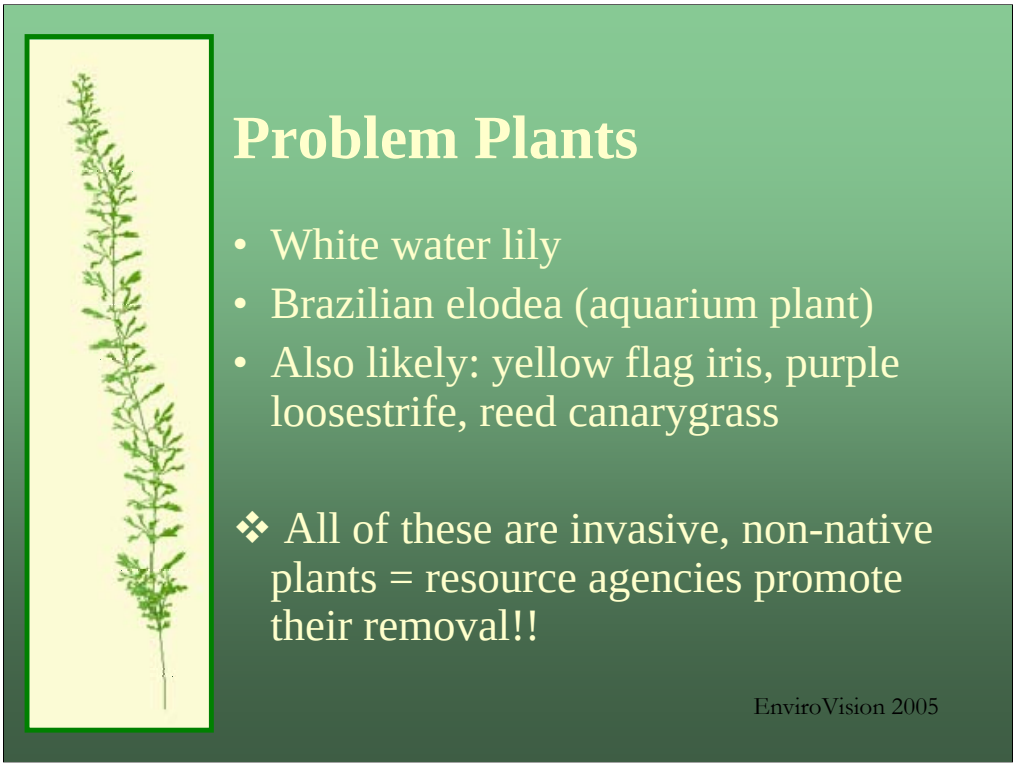


Ohop Lake IAVMP Development Process

Public Meeting, 1 Oct 2005, Eatonville Community Center

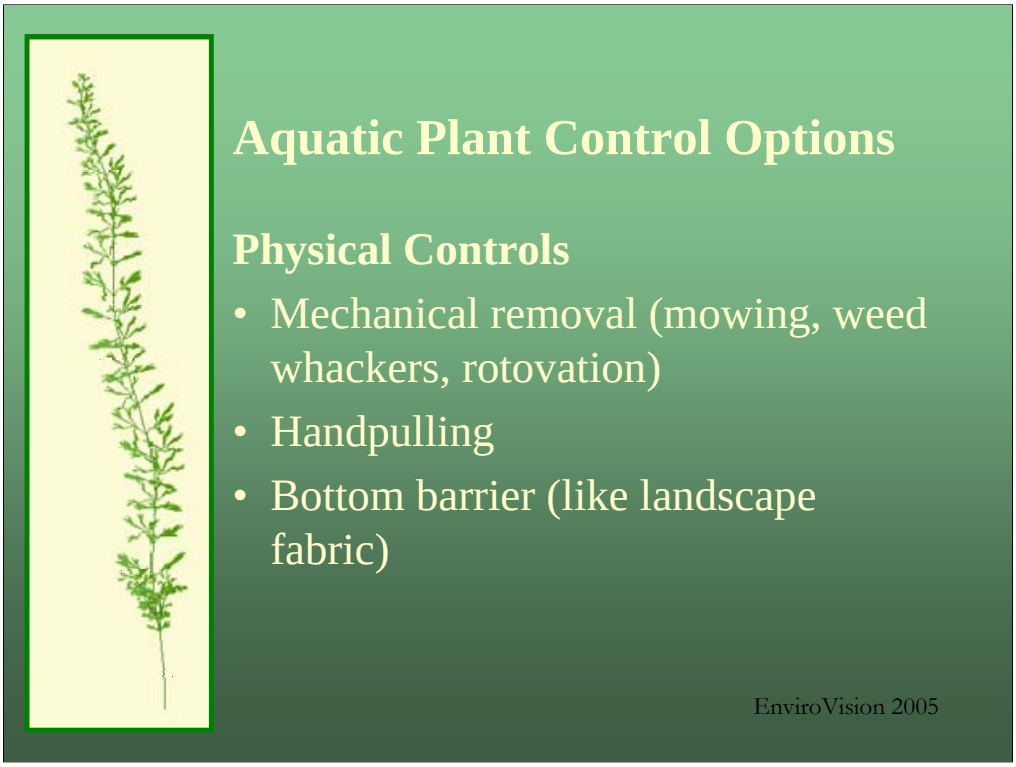
Minutes

The meeting began at 10:05am, with circulation of a signup sheet and introduction of Joy Michaud to the audience. Twenty-two (22) people were in attendance: Doug Clough, Hal Michael (WDFW), Mark Payne, Doris Payne, Ed Schroeder, Isabel Ragland (Pierce Conservation District), Marty Reynolds, Betty Templeman, Allen Templeman, Bill & Debi Pitzl, Steve Wade, Florian Leischner (Nisqually Indian Tribe), Marianna Bissennette, Jinnie Jones, Delores Chappell, Ron Ericson, Renee Ericson, Nicole Elliott, Marc Elliot, Jack Chappell, Bob Kimball.



Joy gave an overview of the "problem plants" we need to deal with. Note that "fragrant water lily" is synonymous with "white water lily" – the two terms were used interchangeably throughout the presentation.

Florian Leischner remarked that he'd seen "Japanese knotweed" beside Orville Road, at the north end of the lake. He stated that this could become a worse problem than the plants listed on the slide.



While giving an overview of Physical Control methods, Joy emphasized that "mechanical removal" should not be undertaken by property owners, as this can release plant fragments and accelerate the spread of problem plants throughout the lake.

Joy explained that Grass Carp would not be permitted for use in Ohop Lake, due to the conflicting requirements of (a) screening the lake outflow to prevent Grass Carp from leaving the lake and (b) the over-riding requirement of leaving the lake and streams open for salmon migration.

In response to Jinnie Jones and others in the audience who were intrigued with the idea of using Grass Carp to control the growth of troublesome vegetation, Joy reviewed experimental findings and practical experience with Grass Carp at other lakes. She cited several problems:

•No way to predict how many fish would be required

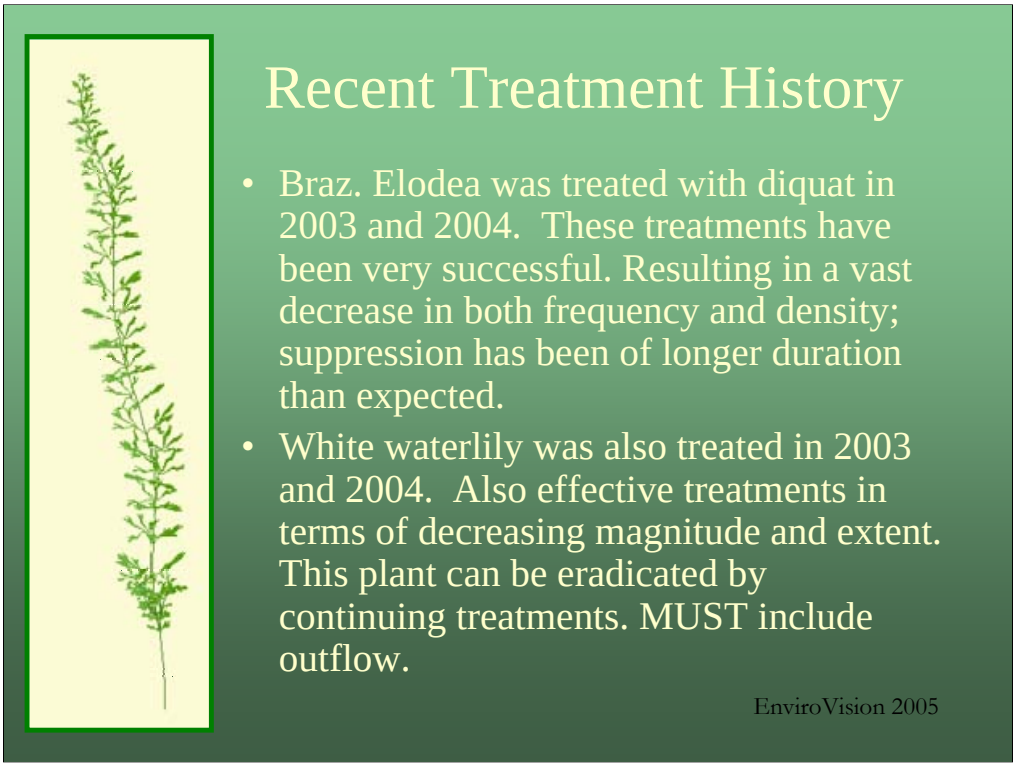
•It takes time for the fish to mature and begin consuming significant quantities of vegetation; meanwhile, lake residents become impatient and want to add more fish

•Excessive numbers of carp can have a negative impact on habitat, eating too much vegetation and stirring up sediment as they go after plant roots

•Carp don't like to be around people or human activity; they can't be counted on to eat vegetation in specific "problem" locations.

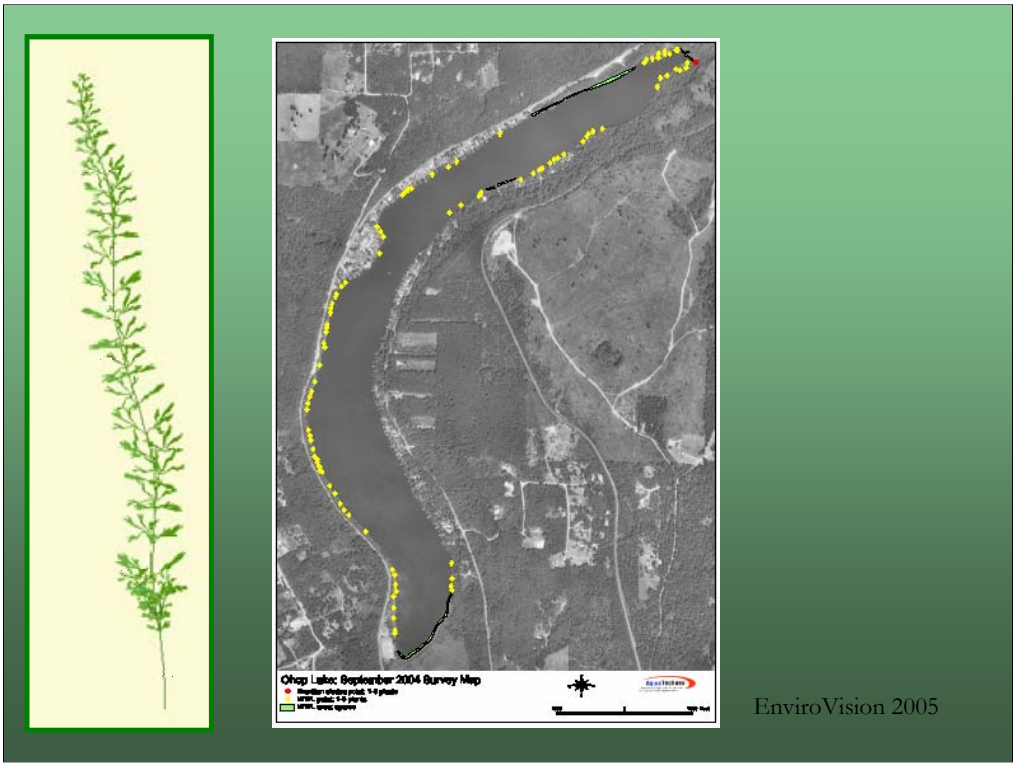
In conclusion she reiterated that we'd never get a permit for Grass Carp, anyway, due to the conflict with salmon migration.

In addition to making the points stated on the slide, Joy added that Glyphosate is the chemical we've been using to treat water lily.

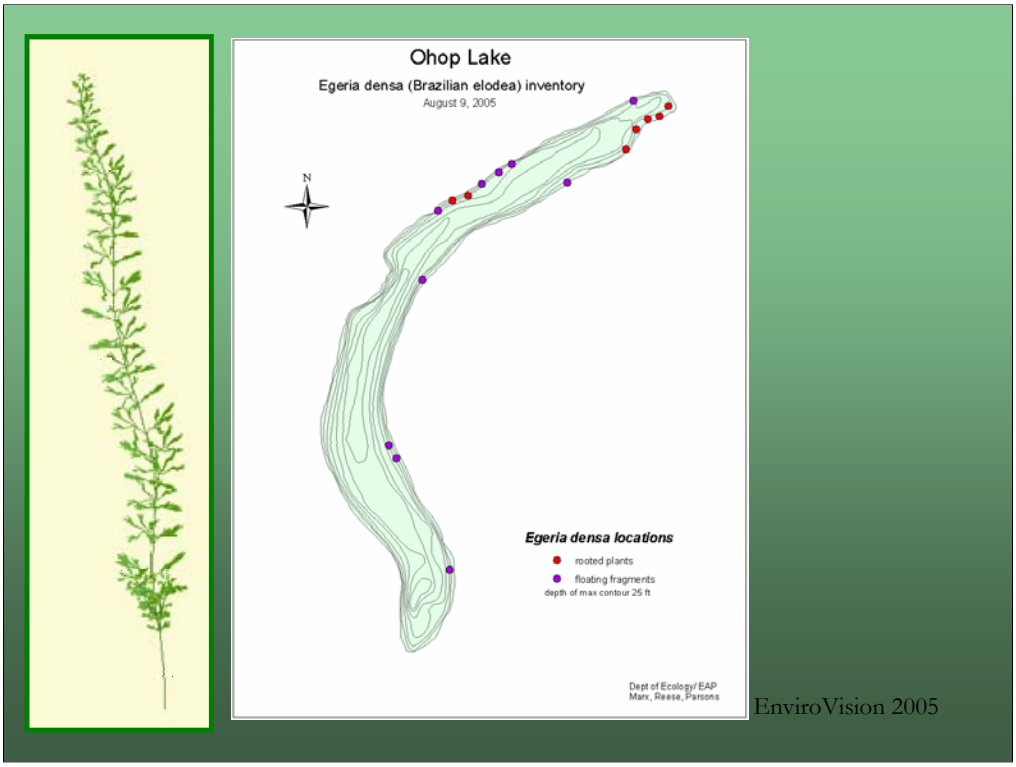


Joy repeated that diquat is not expected to kill the treated plants; still it has been very effective in Ohop Lake.

She mentioned again that glyphosate is the chemical we've been using to treat white water lily.



Joy discussed results of the September 2004 post-treatment survey, overlain on the satellite photo above. She explained that Brazilian elodea was found only near the north end of the lake (red dot at upper right), while quantities of white water lily (yellow dots) have been greatly reduced around the entire shoreline.



Results of the September 2004 survey – with respect to Brazilian elodea (BE) – were corroborated by an independent survey conducted by the Washington State Department of Ecology, in August 2005: Rooted Brazilian elodea plants reported at the south end of the lake when the present treatment effort began in 2002 are no longer in evidence. Floating plant fragments and isolated colonies of rooted plants were reported at several locations along the east shoreline, at the north end of the lake, and along the west shoreline toward the north end of the lake.

Key to the chart:

Purple dots represent floating BE fragments

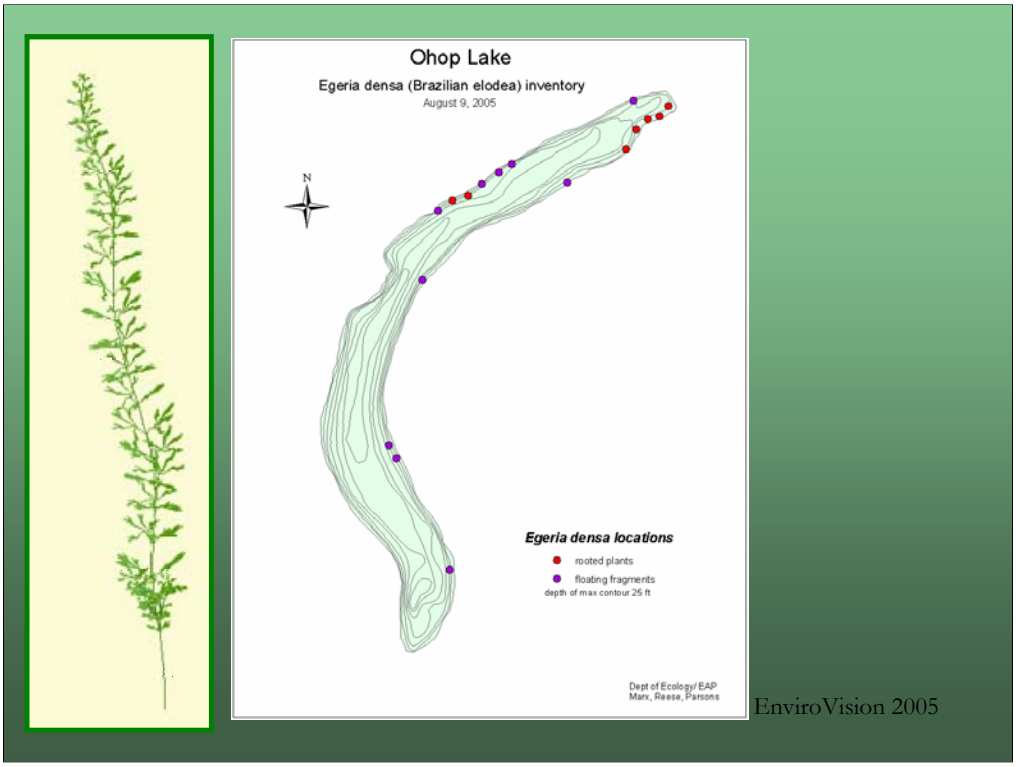
Red dots represent rooted BE plants

NOTE: “fragrant water lily” is the same as “white water lily”

Joy stated that the “Estimated Cost” is a “worst-case estimate”.

She pointed out that our annual treatment costs have been declining, as the area of Brazilian elodea infestation decreases: Cost in 2003 was about $8000, in 2004 about $4000. She would expect yearly costs to level off somewhere around $2000 – i.e. the minimum cost of personnel and equipment.

Use of “curtains” around treatment areas reduces amount of chemical needed to maintain required concentration in the water.



Joy pointed to areas along the north-west shoreline and at the north end of the lake where “curtains” might be installed.

Although the curtains are costly, they’re re-usable.

Joy pointed out that “eradication” is not a realistic goal, due to possibility that Brazilian elodea – or other problem plants – could be re-introduced via the public boat launch or by people dumping home aquariums into the lake.

In contrast the “suppression” strategy has proven to be effective in Ohop Lake. Our results are of interest throughout the state.

Joy remarked that there's still a concern – on the part of the OLIC Board – that chemical treatments in the past few years may not have been as effective as reported in recent lake surveys. This is the point of the third "bullet" in the slide: The strategy must include surveys by outside / independent parties, and must be quantitative: How many gallons of chemical were used? How many acres of BE or white water lily were treated?

Joy handed out copies of “Lake Stewardship” (1 page) and an overview of the aquatic herbicides Fluridone, Glyphosate, and Diquat (2 pages).

She described the role of “Aquatic Plant Czar” – Two or three people around the lake must be trained to reliably identify “problem” aquatic plants.

Bob Kimball pointed out that the OLIC Board has filled the role of “Aquatic Plant Control Advisory Committee” and would continue to do so once the IAVMP has been approved.

After fielding a number of questions / requests for clarification of points previously made, Joy asked for a show of hands by those who do not support the Recommended Strategy (on the preceding slide): No one raised a hand.

The meeting concluded at 11:05am

Respectfully submitted,

Doug Clough
Secretary, Ohop Lake Improvement Club

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APPENDIX B

USFWS MAPPED WETLANDS

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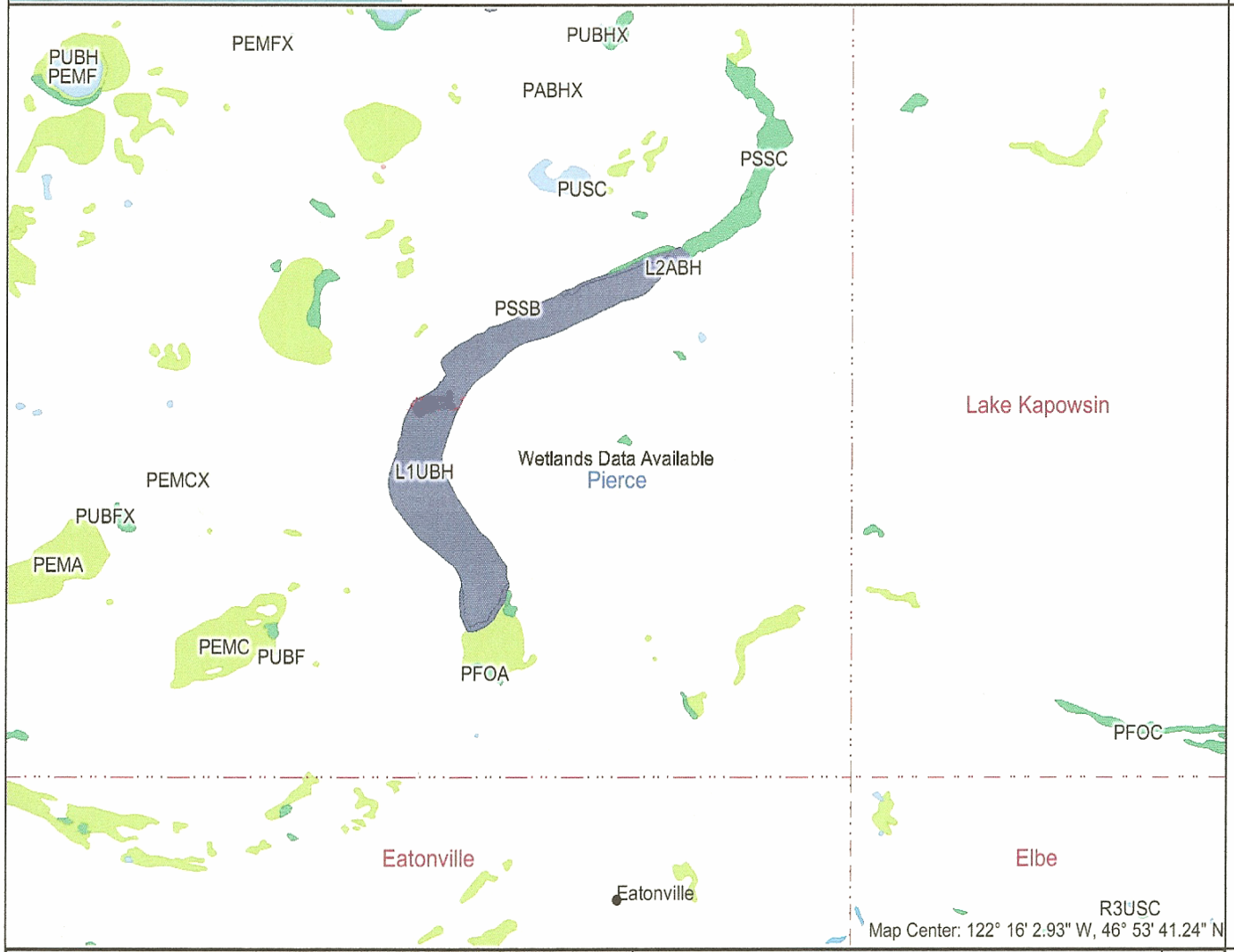
U.S. Fish & Wildlife Service
Wetlands Online Mapper

Ohop Lake - Pierce County



CONUS Cities
CONUS USGS Quad Index 24K
CONUS States 100K
CONUS Counties 100K
Lower 48 Wetland Polygons
Estuarine and Marine Deepwater
Estuarine and Marine Wetland
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Other
Riverine
Lower 48 Available Wetland Data
No Wetlands Data Available
Wetlands Data Available

N

Map Scale
Unavailable (unprojected data)

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APPENDIX C

AQUATIC PLANT CONTROL METHODS
&
SUMMARY OF APPLICABILITY

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INTRODUCTION

The IAVMP developed for Ohop Lake is primarily focused on the suppression of Brazilian elodea, eradication of white waterlily and possible long-term control of nuisance plants. The information in this Appendix was developed to provide a summary of aquatic plant control methods considered in development of plans for achieving these goals and a statement of their applicability to Ohop Lake management issues. Much of the information in this appendix is excerpted from A Citizen's Manual for Developing Integrated Aquatic Plant Management Plans (WDOE 1994), the Supplemental Environmental Impact Statement for the Department of Ecology's Aquatic Plant Management Program (WDOE 2001), and the Department of Ecology's Aquatic Plants and Lakes website: www.ecy.wa.gov/programs/wq/plants/management/index.html.

PLANT CONTROL TECHNIQUES

No-Action Alternative

The IAVMP planning process is based on the premise that some action should be taken to meet the goals set by the lake users. However, it is possible to take "No Action" and the impacts of this alternative should be examined to further define the long-term consequences of not implementing an aquatic plant management plan while also serving as a reference against which other control techniques can be compared.

If no action is taken to eradicate or greatly control the Brazilian elodea it can be expected to colonize the entire littoral zone of the lake; often resulting in an extension of the submerged plant zone to an even greater depth of 20 feet. The State and Nation-wide case histories of this plants growth habitat leave little doubt as to this eventuality. The result is a monotypic stand of very dense aquatic plants that grow and mat even the lake surface. Any type of boating in this area, whether for fishing, skiing, canoeing etc. becomes difficult and access to the open water where these activities might still occur is also difficult. Swimming (an activity that occurs almost always in the littoral zone) is greatly inhibited and may even be considered hazardous. Excessive aquatic plants also influence water quality by causing more pronounced temperature stratification and potentially a reduction in water circulation. Chemical parameters such as pH, alkalinity, and dissolved oxygen may also be impacted through alteration of biological processes such as photosynthesis, respiration, and decomposition.

Dense stands of aquatic plants have been shown to result in low oxygen levels that are detrimental to fish and likely other aquatic organisms. Aquatic edge habitat is reduced and there is less complexity and diversity of plant habitat. These impacts would result in degradation of the lake fishery. Overall the result is a loss of beneficial use by most organisms that have typically used Ohop Lake, and a critical loss in aesthetic enjoyment. Although supporting literature is not readily available to assess impacts of these changes to wildlife, it is likely that the change in habitat structure would affect use of the lake by such things as diving ducks and turtles.

Although the above description has focused on impacts from continued invasion by Brazilian elodea, the colonization of the nearshore area by fragrant waterlily would result in similar habitat changes and more limitation of beneficial use.

Advantages of No-Action alternative:
- no treatment cost,
- easiest to implement,
- potential long term consequences, although negative, imply no personal or agency risk.

Disadvantages of No-Action alternative:
- quality of the lake will continue to decline,
- recreational opportunities will decline,
- fish and wildlife habitat will be reduced or impaired,
- property values may decline,
- probable acceleration of lake filling process.

Preventive Tools

Controlling the input of nutrients such as nitrogen and phosphorus into the lakes may aid in limiting the growth potential of aquatic plants (including algae). Certain preventative measures to control the input of these nutrients into the lake should be considered. Most of these preventative measures are described as Best Management Practices (see Lake Stewardship section presented earlier).

Watershed and Shoreline Controls: The most recent study of Ohop Lake done by the Nisqually Tribe indicated that by far the largest source of phosphorus to the lake water is the lake sediments. However there is a large surface water inflow and therefore upstream watershed sources can be an important influence. Therefore standard watershed management practices should be followed to reduce the input of sediment and nutrients, and to insure adequate flushing of the lake.

Potential development of the lake shoreline is another watershed concern. The current, relatively low level of development along the shore means that the potential for impact over the long term is high. Lake stewardship practices that are described in this IAVMP should be considered for long-term protection of the lake.

Advantages of Watershed and Shoreline Controls:
- lessen the amount of nutrients entering the lake,
- lowers the potential for excessive sedimentation and erosion,
- provides more diverse, complex shoreline habitat,
- may provide ecological benefits to areas beyond the lake.

Disadvantages of Watershed and Shoreline Controls:
- can not be regulated effectively,
- not understood or valued by property owners.

Costs of Watershed and Shoreline Controls:

- none associated with this landowner education approach

Application for Ohop Lake Aquatic Plant Management:
Although there is value to these programs for long-term management in all lakes, these controls would not in any way decrease, control or affect the existence or continued colonization of Brazilian elodea or white waterlily.

In-Lake Nutrient Controls: The reduction in the availability of nutrients already present in the lake as a means of limiting algae and aquatic plant growth is a legitimate approach. However, only approaches that limited nutrients available through the sediments (dredging) would be useful for controlling aquatic plants. Sediment dredging is far too expensive to be considered as a common lake protection or restoration technique.

Public Awareness and Involvement Program: Lakeside and watershed residents should be informed of all aspects of aquatic plant, algae, and nutrient management. Their understanding of these management issues is critical to the long-term success of this plan. It is strongly recommended that a public education and awareness program be a major component of any management plan. This program would serve to keep residents informed of past, current, and future lake management activities and aid in promoting lake stewardship. The residents should also be made aware of changes in the plan should they be necessary, as well as assessing the effectiveness of current management activities. For this very small lake community, discussions of proper stewardship and results from lake management activities should be discussed at annual lake management meetings.

Lake and watershed residents should be supplied with information such as; tips on how to identify common aquatic plants, control of nutrients before they enter the lake (e.g. curbing fertilizer use on water-front property), simple aquatic plant control measures that can be employed by individual homeowners, and regulations governing such activities.

In general, lake and watershed residents gain satisfaction and a sense of ownership when they are directly involved in lake management activities. Therefore, public participation should be a key component of any lake management plan. Direct participation may take place through volunteer surveys and data collection, organization of meetings, and dissemination of materials related to lake management.

Advantages of a Public Awareness and Involvement Program:

- allows for more informed lake management decisions by stakeholders,
- potentially builds public support for proposed activities,
- involves lake and watershed residents in the decision-making process.

Disadvantages of a Public Awareness and Involvement Program:

- public must be committed to implementing plan and maintaining long-term continuity.

Costs of a Public Education and Awareness Program:
- variable depending upon approach.

Application for Ohop Lake Aquatic Plant Management:
Although public education programs are useful tools to improve long-term management of the lake, they can not affect the existence or continued invasion of Brazilian elodea or white waterlily. Public education is an important component of the Prevention and Detection program described in the IAVMP.

Physical Controls
Physical control techniques encompass most manual or mechanical efforts that remove, cover, shade or desiccate all or some portion of the targeted aquatic plants.

Hand Removal: This control technique is generally accomplished by digging or pulling aquatic plants and is similar to weeding your garden. In shallow waters, residents remove the plants by hand and/or by using hand-held gardening tools. In deeper waters ($\geq$ 3 feet) SCUBA divers can be used to hand remove plants. All plant materials are collected and placed in a bag for proper disposal on shore.

The effectiveness of this plant control technique is mainly a function of sediment type, visibility (water clarity), plant type, and the thoroughness in which the plants are removed. The duration of plant control mainly depends on the variables above and may last from weeks up to multiple years.

Advantages of Hand Removal:
- immediate clearing of the water column,
- can selectively remove targeted plant species,
- is an effective control option around docks, rafts, and boats,
- Equipment is inexpensive.

Disadvantages of Hand Removal:
- technique is time consuming and labor intensive,
- may have delay in removing plants due to disturbed sediments and low visibility,
- use of SCUBA divers in deeper waters more costly,
- it is not be feasible in areas of dense plant growth,
- some plant species difficult to remove,
- fragmentation of Brazilian elodea during hand removal may result in colonization of new places.

Costs of Hand Removal:
- no cost if performed by volunteers,
- $1,500-$2,500 per day for two divers and a support boat & operator,

Application for Ohop Lake Aquatic Plant Management:
The size of the Brazilian elodea patches precludes the use of hand removal as the primary tool. This method is appropriate as a supplemental control mechanism after treatment has been done

to minimize the areal extent and number of plants. There is some suggestion that water lilies can be killed by frequent (every few days) removal of the leaves; however this requires persistent effort and there is no conclusive evidence that it works to eradicate these plants.

Bottom Barrier Installation: Bottom barriers are essentially "underwater blankets" that cover the bottom sediments and the plants growing there. These barriers are made of many different materials such as burlap, sand-gravel, plastics, perforated black Mylar, and a material called Texel, which is specifically manufactured for aquatic plant control. These bottom barriers cover the bottom sediments and 1) kill the plants growing there, and 2) prevent new plants from becoming established. Although bottom barriers are mainly a small-scale control technique, they can be highly effective and provide long-term control.

Given enough time, almost all of these materials will trap pockets of gasses due to decomposition of organic material under them. When this occurs, many bottom barriers "balloon" upward, and become less effective and potentially hazardous to lake users. Therefore, it is important to properly anchor bottom barriers to the bottom, preferably using native materials such as rocks or sandbags. Bottom barriers should also be inspected periodically for sediment buildup and/or gas buildup. Periodic inspections also indicate if the materials being used need to be replaced, especially those that decompose (e.g. burlap).

Bottom barriers will control most aquatic plants but will not provide relief from freely floating plants such as coontail (Ceratophyllum demersum). Other plants such as Brazilian elodea may be able to form a canopy over the bottom barrier by putting out lateral shoots around the edges of the material, eventually growing up and over the barrier. Moreover, obstructions such as logs, rocks, and steep topography may inhibit the use of bottom barriers in some areas.

Bottom barriers can be installed by homeowners or by SCUBA divers depending on local conditions. The optimal time to install bottom barriers is in late winter or early spring before plants are growing rapidly. This minimizes the amount of gas that could potentially build up under the barrier due to decomposition of organic matter. If bottom barriers are to be used in areas of dense plant growth, it is advisable to cut and remove as much vegetation as possible prior to installation.

Advantages of Bottom Barriers:

- immediately creates an area of open water,
- relatively simple to install in swim beaches and around docks,
- controls 100% of plants where they are used,
- effective in targeting patches of plants too large to cost-effectively remove by hand.

Disadvantages of Bottom Barriers:

- high cost makes them cost effective only on a small scale,
- require periodic inspection, maintenance, and replacement,
- may be a safety hazard to lake users if not maintained properly,
- will kill all plants in areas where used,
- may negatively impact many bottom-dwelling organisms and eliminates fish spawning in immediate area,

Costs of Bottom Barriers:

- $0.35 to $1.25 per square foot for materials
- approximately $0.75 per square foot for installation
- $100 - $200 for annual maintenance

Application for Ohop Lake Aquatic Plant Management:
The size of the Brazilian elodea and water lily patches preclude the use of bottom barrier as the primary tool. This method is appropriate as a control mechanism after initial treatment has been done to minimize the areal extent and number of plants. Bottom barrier may be used to control small areas of plants or new infestations.

Water Column Dyes: To use this aquatic plant and algae control method; water-soluble colored dyes are added to the water column to suppress plant and algae growth. The dyes reduce the amount of sunlight available to plants and algae, and therefore inhibit photosynthesis. The dyes are formulated to absorb segments of the electromagnetic spectrum (light) that are optimal for photosynthesis. The use of water column dyes is limited to lakes or ponds with higher retention times (low flushing) and relatively clear water.

Advantages of Water Column Dyes:

- cost is low and no special equipment required,
- not toxic to humans, other wildlife using the water,
- may control both aquatic plants and algae.

Disadvantages of Water Column Dyes:

- may suppress both aquatic plants and algae,
- suppression may not be adequate to achieve goals,
- does not eradicate noxious plants,
- is less efficient when plants/algae at water surface,
- low water retention time may reduce effectiveness,
- may need to consider outflows and water rights of residents.

Costs for Water Column Dyes:

- $12.00 to $15.00 per acre foot.

Application for Ohop Lake Aquatic Plant Management:
This control method is not appropriate due to its lack of specificity to Brazilian elodea and low expected efficacy on aquatic plants. This treatment option would also be ineffective to the water lilies since their leaves float above the effective dyed area.

Sediment Removal: Removal of lake sediments controls aquatic plants primarily by reducing the available habitat where plants can growth by deepening the water body. This is most relevant for bottom-rooted aquatic plants. Sediment removal may also indirectly limit aquatic plant growth through removal of nutrients in the sediment, which are available to bottom-rooted plants. Sediments accumulate in a waterbody from many sources, including: stormwater drainage, surface water runoff, stream inflows, and erosion. Shallow lakes and ponds often have

abundant communities of aquatic plants. These plants accelerate the accumulation of sediment by trapping particles and through their annual senescence and decomposition.

Several different types of mechanical equipment are used to remove sediments from lakes. Some of these include: backhoes, drag lines, suction vacuums with pumps, and many other pieces of auxiliary support equipment used to de-water and transport materials. Settling ponds are often constructed to de-water sediments as transport of water-laden materials is very expensive. Extensive studies and testing are required prior to initiation of this control method. Several permits are also required, including one from the US Army Corps of Engineers.

Advantages of Sediment Removal:
- can be a long-term solution to suppress both aquatic plant and algae,
- decreases available plant habitat and potentially reduces amount of in-lake nutrients.

Disadvantages of Sediment Removal:
- extremely costly,
- may require several years to acquire permits,
- shoreline access for equipment and noise often a problem,
- may take multiple years to complete the operations,
- disturbance of benthic organisms and fish spawning habitat.

Costs for Sediment Removal:
- $400,000 to $600,000 for design, inspection, environmental monitoring,
- overall project cost typically in the millions of dollars.

Application for Ohop Lake Aquatic Plant Management:
This control method if aimed at the littoral zone of the lake can be considered appropriate for control of all aquatic plant habitat. However, it is cost prohibitive.

Water Level Drawdown: Water level drawdown is most commonly used in reservoirs for power generation, flood control, or irrigation. During drawdown, water is either pumped or drained out of a system. The low water levels often expose aquatic plants that are then subjected to desiccation and/or freezing. Plants that do not have over-wintering structures such as turions or tubers often are more severely impacted. In some instances, plants that are not completely killed exhibit stunted growth after the water level is restored. The level of plant control is mainly a function of how low the water is drawn down to, the length of time water is at a low level, and the average temperatures to which they are exposed during drawdown.

Advantages of Drawdown:
- may already be a scheduled activity to accomplish other objectives (e.g. power generation),
- often little or no cost,
- no chemical/herbicide concerns.

Disadvantages of Drawdown:
- short-term loss of beneficial uses (e.g. boating),
- impacts bottom-dwelling organisms and spawning habitat,
- lake morphology and climate may reduce effectiveness,
- not all problem plants are affected,
- is not effective at eradication of a noxious plant.

Costs of Drawdown:
- variable.

Application for Ohop Lake Aquatic Plant Management:
This method might curtail plant growth in the nearshore area but ultimately would not affect the long-term existence or increased colonization by Brazilian elodea.

Mechanical Controls

Hand Cutting: Hand cutting aquatic plants is accomplished by using a "cutting rake" to cut the plants below the surface. Most often the above-sediment portion of the plants are cut while leaving the roots behind. Some of the different "cutting-rakes" used are; scythes v-shaped rakes with a cutting edge, or thin cables. Often these tools have handles with a rope attached. The cutter is thrown out into to the water and retrieved to the shore, dock, or raft.

Advantages of Hand Cutting:
- equipment costs are minimal,
- requires no special training,
- provides immediate control,
- can be used around docks, boats, or rafts.

Disadvantages of Hand Cutting:
- not appropriate for milfoil control in partially infested lakes because it enhances milfoil spread,
- time consuming, labor intensive,
- often required several times throughout the growing season,
- should collect all plant fragments and dispose of on shore.

Costs of Hand Cutting:
- equipment costs typically $50 to $1000
- no labor cost unless contractor hired

Application for Ohop Lake Aquatic Plant Management:
Due to the increase in plant fragments from cutting, this is not an appropriate tool for use in lakes where Brazilian elodea has not already colonized the entire littoral zone. There is some suggestion that water lilies can be killed by frequent (every few days) removal of the leaves; however this requires persistent effort and there is no conclusive evidence that it works to eradicate these plants. This could be effective maintenance control for swimming and boating areas for some of the plants that are not listed as noxious plants.

Mechanical Harvesting: Mechanical harvesting is a control technique that is essentially mowing plants and collecting them to be disposed at an offshore location. Harvesters have blades that cut plants from 3-8 feet below the water and then move them up onto a conveyor belt and onto the machine. To offload the cut material, the harvester reverses the direction of the conveyer belt and transports the material to a truck on the shore. The truck then disposes of the material at a pre-determined location. A typical mechanical harvester may cut up to 2 acres per day. The amount of material that these machines can harvest is mainly limited by the time it takes to travel to the truck on the shore and offload the material.

Although mechanical harvesters can remove most of the aquatic vegetation in the areas in which they are working, they inevitably allow some of the cut material to escape. Also, simply cutting the upper portions of the plants does not inhibit their continued growth. Most harvesters only control plants for a few weeks up to a few months. Mechanical harvesting is not species-specific unless the harvester is used in an area that is basically a monoculture of a particular plant species. Due to the potential to produce many plant fragments, mechanical harvesting is not recommended for waterbodies with early or low-density infestations of Brazilian elodea. Mechanical harvesting also contributes to a significant mortality of small fish and invertebrates.

Advantages of Mechanical Harvesting:
- immediate removal of plants,
- no water use restrictions during operation,
- plant material may be used as a soil amendment.

Disadvantages of Mechanical Harvesting:
- not appropriate for milfoil control in partially infested lakes because plant fragmentation may actually enhance growth time consuming, limited by availability of sites to offload vegetation,
- equipment intensive, maintenance may slow operation,
- usually must be repeated several times throughout the growing season,
- plant fragmentation may actually enhance growth,
- not species-specific,
- negative impacts to invertebrates and small fish,
- may actually release more nutrients through agitation of sediment and plant leaching than through removal of biomass,
- high capital costs for machine purchase or use by management consultant.

Costs of Mechanical Harvesting:
- $750 to $1500 per acre for contract commercial aquatic plant harvesters,
- $100,000 to $180,000 for harvester/off-loader purchase,
- cost of disposal is highly variable.

Application for Ohop Lake Aquatic Plant Management:
Due to the increase in plant fragments from cutting, this is not an appropriate tool for use in lakes where Brazilian elodea has not already colonized the entire littoral zone. It is not an appropriate

tool for eradication of the waterlily. The machines would also have a difficult time accessing the lilies hidden under and around docks and other obstacles.

Rotovation: This plant control technique involves the use of a large underwater rototiller. Unlike mechanical harvesters, Rotovators dig down into the sediment seven to nine inches and grind up the lake bottom. This dislodges plants, roots and crowns. These plants then typically float to the surface. Mechanical harvesters may then be used to collect the plant material and transport it to shore for disposal. Rotovation provides for longer term control (1-3 years) than mechanical harvesters (weeks to months). Rotovation is not an effective option in areas with pioneering infestations of noxious plants that spread primarily by fragmentation. Also, rotovation is only effective on rooted aquatic plants and would not work well on freely floating plants.

Advantages of Rotovation:
- provides longer control than mechanical harvesting,
- may stimulate growth of desirable native plants,
- removes entire plant including roots,
- in some instances can be used year-round.

Disadvantages of Rotovation:
- expensive with high maintenance costs,
- destroys habitat for bottom-dwelling organisms and fish,
- temporarily reduces water clarity, releases nutrients from sediment,
- need to check for underwater utilities.

Costs of Rotovation:
- $1,500 to $2,000 per acre.

Application for Ohop Lake Aquatic Plant Management:
Due to the increase in plant fragments from cutting, this is not an appropriate tool for use in lakes where Brazilian elodea has not already colonized the entire littoral zone. Rotovation can be used to remove tubors and rhizomes (i.e., waterlilies) but at a minimum would require repeated application and would be cost prohibitive. Due to this techniques expense and general ineffectiveness, there are no known rotovators in Washington State.

Diver Dredging: Diver dredging is a plant control method where divers use suction hoses to vacuum plants up from the lake bottom. The vacuum suction is caused by the operation of small pumps on a surface boat. The SCUBA divers dig up or pull the plants from the lake and feed them into the suction hose. On the barge, plant material is trapped by a screen and water is returned to the lake.

This plant removal technique is more effective when removing plants in areas of loose sediment. This allows for easier removal of the plants, whereas plants rooted in hard sediment are more difficult to dislodge. However, in areas of loose sediment, visibility can be reduced by disturbing the lake bottom. This technique is best applied in areas with low levels of the plant(s)

species to be removed. Although a screen collects the plant material, fragmentation of plants is also an issue.

It is inevitable that the discharge water from the surface boat will be cloudy from sucking up sediment. This temporarily reduces water clarity and may fuel plant and algae growth through nutrient release. Sediment curtains are sometimes used to mitigate the drift of disturbed sediments, but there is no practical means to minimize nutrient release.

Advantages of Diver Suction Removal:
- useful in selectively removing target species,
- may be used in and around docks, boats, and other nearshore areas,
- feasible in areas where herbicides not an option.

Disadvantages of Diver Suction Removal:
- expensive, labor intensive, and relatively slow,
- not appropriate for brazilian elodea control in partially infested lakes because plant fragmentation may actually enhance growth time consuming, limited by availability of sites to offload vegetation,
- disturbs the bottom, releases nutrients,
- large rocks, logs, etc. may further reduce cost-effectiveness.

Costs of Diver Dredging:
- $1,500 to $2,500 a day (includes divers and support personnel).

Application for Ohop Lake Aquatic Plant Management:
Due to the high cost, this is not appropriate for use at this scale.

Biological Controls
The biological control of an aquatic plant problem focuses on the selection of organisms that have an impact on the growth of a target plant. By stocking a lake with these organisms or "agents", the population of the target plant can be reduced and native plants can recover. Although there have been some successes with using biological control agents to control pests, not all have been effective. In some instances biological control has been detrimental to non-target organisms. Biological control is an area of active research yet many of the tools and techniques in this field are still in the experimental stages and have not been approved for use.

Biological control agents are classified as "Classic" or "General". Classic biological control agents are those which are host-specific and attack only those species targeted for control. These biological control agents typically do not completely eradicate their host. Instead, they eventually develop a typical "predator-prey" relationship where both populations fluctuate around a given mean population density. Therefore, classic control agents do not eliminate their target species but, if successful, maintain the target species at a lower population density. General biological control agents are not host-specific and will target many other organisms. These are of limited use when attempting to control specific species.

A third type of biological control agent are those that have not evolved with the target species but will degrade the target species if it is present. These control agents are less common but show some promise in controlling introduced species.

Grass Carp: Grass carp (or White Amur) are plant-consuming fish native to China and Siberia. They can be used as a (general) biological control agent to control aquatic plants. Although it is proposed that they have feeding preferences for certain plant species, if stocked at a high rate will feed on all plant species. The rate at which they are stocked depends primarily on the number of vegetated acres and secondarily on the desired level of control, climate, water temperature, and other site-specific conditions. The recommended maximum stocking rate in Washington is 25 fish per acre (Bonar et al. 2002). A study of grass carp usage in Washington has indicated that in most cases grass carp either eat all the vegetation in the lake or have a negligible impact on plant levels. Paradoxically, even in those lakes where they have had negligible impact on aquatic plants, surveys of lake residents indicate an overall high level of satisfaction with using the grass carp as a plant control method.

Only sterile (triploid) grass carp may be stocked in waters in the state of Washington. Imported from out-of-state, these fish must be certified as sterile and disease-free. In order to prevent escape, waters with inlets and outlets must be screened prior to stocking grass carp. Due to predation and natural mortality, grass carp must be restocked on a periodic basis.

Water quality may improve after stocking grass carp as dense areas of vegetation are reduced (WDFW 1990). However, if the majority of aquatic plants are removed, it is likely that algae may become very abundant due to the increased availability of light and nutrients. Moderate control of aquatic plants using grass carp is difficult to achieve, and they should be stocked only in waters were removal of all aquatic plants is and acceptable condition.

Advantages of Grass Carp:
- are a biological control option for plant control,
- are inexpensive and may provide long-term plant control.

Disadvantages of Grass Carp:
- may take several years to achieve tangible and measurable decrease in plant biomass
- may alter composition of plant community without decreasing overall biomass,
- screening may be necessary to prevent escape and allow for salmonid migration,
- may result in increased turbidity
- no good predictions of the amount of control that will be achieved

Costs of Grass Carp:
- $10.00 to $15.00 per fish (plus delivery),
- typically $50 to $200 per acre,
- screening costs (if necessary) are site-specific.

Application for Ohop Lake Aquatic Plant Management:
Grass carp would not be an appropriate control tool for this lake due to conflicts with salmon usage issues.

***Developing Technique/Milfoil Weevils*:** The milfoil weevil, *Euhrychiopsis lecontei*, has been associated with declines of Eurasian watermilfoil in the United States (e.g. Illinois, Minnesota, Vermont, and Wisconsin). Within the state of Washington, milfoil weevils are more abundant in eastern side of the Cascade Mountains, and feeds on both Eurasian and Northern watermilfoil (*M. sibiricum*). This milfoil control technique has shown some promise, although it is not currently employed. Researches have a firm understanding at how these weevils influence plant growth at the individual plant level, but are still investigating weevil-milfoil dynamics on a larger scale (Creed 2000). More work is needed to determine which factors limit weevil densities and what lakes are suitable candidates for weevil usage in order to implement a cost effective control program.

Advantages of Milfoil Weevils:
- are a biological control option for milfoil control,
- likely to be relatively inexpensive and may provide long-term milfoil control,
- little to no disruption of native plant and animal communities.

Disadvantages of Milfoil Weevils:
- may not control milfoil to acceptable levels,
- may take several years to achieve tangible and measurable decrease in milfoil biomass,
- are susceptible to predation by small fishes,
- current success rate highly variable.

Costs of Milfoil Weevils:
- unknown at this time.

Application for Ohop Lake Aquatic Plant Management:
Not applicable for Brazilian elodea or waterlily.

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

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants or are applied to the water in either a liquid or pellet form. Systemic herbicides are capable of killing the entire plant. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and able to regrow. Non-selective, broad spectrum herbicides will generally affect all plants that they come in contact with. Selective herbicides will affect only some plants.

Because of environmental risks from improper application, aquatic herbicide application in Washington state waters is regulated and has the following restrictions:

- Applicators must be licensed by the Washington State Department of Agriculture.
- A discharge permit called a National Pollutant Elimination System Discharge (NPDES) permit must be obtained before aquatic herbicides can be applied to the waters of the state.
- Notification and posting are required and there may be additional mitigations proposed to protect rare plants or threatened and endangered species.

Ecology has developed a general NPDES permit for the management of noxious weeds growing in aquatic environments and a separate general permit for nuisance aquatic weeds (native plants) and algae control. For nuisance weeds (native species) and algae, applicators and the local sponsor of the project must obtain a NPDES permit from Ecology before applying herbicides to Washington waterbodies. For noxious weed control, applicators and their sponsors can obtain coverage under the Washington Department of Agriculture NPDES permit for noxious weed control.

Ecology currently issues permits for six aquatic herbicides and one algaecide for aquatic weed treatment for lakes, rivers, and streams. Weed control in irrigation canals is covered under another permit. Other herbicides are undergoing review and it is likely that other chemicals may be approved for aquatic use in Washington in the future.

The two contact herbicides registered and approved for use in Washington State are Endothall and Diquat. The five systemic herbicides registered and approved for use in Washington are Fluridone, trichlopyr, 2,4-D, imazapyr and Glyphosate.

Fluridone: Fluridone is a slow-acting systemic herbicide used to control Eurasian watermilfoil and other underwater plants. It may be applied as a pellet or as a liquid. Fluridone can show good control of submersed plants where there is little water movement and an extended time for the treatment. Its use is most applicable to whole-lake or isolated bay treatments where dilution can be minimized. It is not effective for spot treatments of areas less than five acres. It is slow-acting and may take six to twelve weeks before the dying plants fall to the sediment and decompose. When used to manage Eurasian watermilfoil in Washington, fluridone is applied several times during the spring/summer to maintain a low, but consistent concentration in the water. Although fluridone is considered to be a broad spectrum herbicide, when used at very low concentrations, it can be used to selectively remove Eurasian watermilfoil. Some native aquatic plants, especially pondweeds, are minimally affected by low concentrations of fluridone. Use of fluridone does not pose a threat to human health or to fish and wildlife when used according to the label (SePRO 2002). While there is a 14-day precaution when using treated waters for irrigation (potentially longer with multiple treatments), there are no other water use restrictions when using the liquid formulation of fluridone.

Advantages of Fluridone:

- systemic herbicide, will kill entire target plants,
- variety of plants are susceptible depending on treatment rates and timing,
- can be used to target specific species with correct application rates,
- no known toxicity to humans, fish, and wildlife,
- no water use restrictions for fishing, swimming.

Disadvantages of Fluridone:

- plants need exposure to herbicide for lengthy period of time,
- usually requires multiple treatments in a growing season,
- costly,
- high potential for herbicide drift, which dilutes chemical and may affect non-target plants.

Costs of Fluridone:

- $900 to $1,100 per acre

Application for Ohop Lake Aquatic Plant Management:
This control method is appropriate for Ohop Lake and is included as a possible option in the Recommended Aquatic Plant Control Plan for Brazilian elodea.

2,4-D: There are two formulations of 2,4-D approved for aquatic use. The granular formulation contains the low-volatile butoxy-ethyl-ester formulation of 2,4-D (Trade names include: AquaKleen® and Navigate®). The liquid formulation contains the dimethylamine salt of 2,4-D (Trade name - DMA*4IVM). 2,4-D is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species. Both the granular and liquid formulations can be effective for spot treatment of Eurasian watermilfoil. 2,4-D has been shown to be selective to Eurasian watermilfoil when used at the labeled rate, leaving native aquatic species relatively unaffected.

The mode of action of this chemical is primarily as a stimulant of plant elongation and cell division (WDOE 2001). This post-emergent herbicide is primarily used to control watermilfoil and water stargrass. This herbicide targets dicots (e.g. milfoils) and leaves monocots unharmed. Because most aquatic plants are monocots, 2,4-D can often be used for selective plant control.

As with most herbicides, effectiveness of the treatment is dependent upon the timing of the application and density of the target plant community. Repeat applications may be required in areas of dense plant growth. Susceptible plants will begin to show signs of herbicide damage in one to two weeks after treatment, followed by plant mortality and decomposition.

There are no fishing or swimming restriction associated with the use of 2,4-D although Ecology recommends "that due to risk of dermal contact, a swimming advisory shall be posted advising swimmers to wait 24 hours before reentering directly treated areas to allow time for granules to disperse" (WDOE 2001). This herbicide cannot be used in waters used for irrigation, agricultural sprays, watering dairy animals or domestic water supplies (Applied Biochemists

2002) for three to five days after treatment. The recent risk assessment prepared for Ecology as part of the 2001 Final Supplemental Environmental Impact Statement for the aquatic plant management program (WDOE 2001) indicated that "no significant adverse impacts on fish, free swimming invertebrates or benthic invertebrates" should be expected from 2,4-D (either formulation) applications at appropriate label rates.

Advantages of 2,4-D:
- fast-acting systemic herbicide which is effective in removing selected plants,
- unlikely to damage non-target plants when applied at labeled rates,
- can be used on small to large scale sites,
- limited water use restrictions,
- inexpensive when compared to other systemic herbicides.

Disadvantages of 2,4-D:
- application must be conducted 0.5 miles or greater from active drinking/domestic water withdrawals (unless approved by Ecology),
- 24 hour swimming advisory imposed by Ecology,
- treatment windows apply to areas where Endangered Species Act (ESA) listed salmonids and certain gamefish are present (according to WDFW specifications).

Costs of 2.4-D:
- $300 - $600 per acre.

Application for Ohop Lake Aquatic Plant Management:
This control method is not currently appropriate for Ohop Lake as it is primarily used for Eurasian watermilfoil and other broad-leaved aquatic plant control.

Triclopyr: This is a systemic herbicide with a water soluble triethylamine salt formulation containing three pounds of triclopyr acid equivalent per gallon. Triclopyr is effective on broad-leafed (dicots) plants such as Eurasian watermilfoil and does not harm monocots. Therefore, it is used for the selective removal of many noxious aquatic weeds including Eurasian watermilfoil and purple loosestrife. Triclopyr is a liquid product with a contact time requirement of 24 to 48 hours and can be used to treat specific areas. Susceptible plants exhibit epinasty (bending and twisting of plant tissue) within one day after treatment and die shortly thereafter.

Triclopyr does not accumulate in lake sediments or bottom-feeding fish, and has a low toxicity potential (SePRO 2003b). The primary means be which triclopyr breaks down is through photodegradation, with a typical half-life of 0.5 to 3 days.

Advantages of Triclopyr:
- selective for dicots such as milfoil,
- short contact time needed,
- kills entire target plant,
- potential for long-term control.

Disadvantages of Triclopyr:
- 12 hour swimming restriction,
- new product so there is little application history,
- high cost.

Costs of Triclopyr:
- $1,700 per acre (assumes maximum label rate applied).

Application for Ohop Lake Aquatic Plant Management:
This control method is not appropriate for Ohop Lake as the noxious weeds that currently reside in the lake are not affected by this herbicide.

Imazapyr: This systemic broad spectrum, slow-acting herbicide (Trade name Habitat®), applied as a liquid, is used to control emergent plants like spartina, reed canarygrass, and phragmites and floating-leaved plants like water lilies. Imazapyr does not work on underwater plants such as Brazilian Elodea. Although imazapyr is a broad spectrum, non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Imazapyr was allowed for use in Washington in 2004.

Imazapyr need to be applied by a knowledgable, state-licensed applicator, and obtaining a NPDES Noxious Weed Permit would also be necessary.

Advantages of Imazapyr:
- Does not kill submersed plants,
- A good applicator can spot treat certain plants for seemingly selective control,
- Washington Department of Ecology states effectiveness for water lily control,
- Safe for fish.

Disadvantages of Imazapyr:
- The EPA has stated that "jeopardy" will occur to terrestrial and aquatic plant species from the use of arsenal,
- Breaks down quickly in water, or on surfaces with a water sheen, necessitating extreme delicacy during the application,
- Water cupping on water lilies can void the effect of imazapyr,
- Does not distinguish between target species and non target species, so it will kill most emergent vegetation that it comes in contact with.

Costs of Imazapyr:
_- $210 per acre.

Application for Ohop Lake Aquatic Plant Management:
Not recommended. Imazapyr is not recommended for use on water lilies, and would have no effect on Brazilian Elodea since it breaks down so quickly in water. It could be used for control of reed canarygrass and in future years might be considered for control if other invasive plants have already been removed.

Glyphosate: This systemic broad spectrum herbicide (trade names include Rodeo®, Aquamaster®, or AquaPro®) is used to control floating-leaved plants like waterlilies and shoreline plants like purple loosestrife. It is generally applied as a liquid to the leaves. Glyphosate does not work on underwater plants such as Brazilian elodea. Although glyphosate is a broad spectrum, non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Plants can take several weeks to die and a repeat application is often necessary to remove plants that were missed during the first application.

Glyphosate should be applied by experienced and state-licensed (and insured) personnel. A NPDES Noxious Weed permit is required to apply glyphosate. There are no water-use restrictions associated with spraying glyphosate. However, the applicator is responsible for applying the herbicide in compliance with the product label and the NPDES Noxious Weed permit.

Advantages of Glyphosate:
- fast acting injury to plant tissue,
- low toxicity,
- not persistent in environment,
- spot treatments possible,
- low cost.

Disadvantages of Glyphosate:
- repeat application often necessary,
- non-target plant impacts sometimes difficult to mitigate as this is a fairly broad-spectrum.

Costs of Glyphosate:
- $250.00 - 350.00 per treated acre
- per acre costs higher when treated area < 5 acres

Application for Ohop Lake Aquatic Plant Management:
This control method is appropriate for use on the white water lilies and other noxious emergent and floating-leaved plants in this lake. This chemical would not be effective in treatment of Brazilian Elodea

Endothall: Endothall is a fast-acting non-selective contact herbicide, which destroys the vegetative part of the plant but generally does not kill the roots. Endothall may be applied in a granular or liquid form. Typically endothall compounds are used primarily for short-term (one season) control of a variety of aquatic plants. However, there has been some recent research that indicates that when used in low concentrations, endothall can be used to selectively remove exotic weeds; leaving some native species unaffected. Because it is fast acting, endothall can be used to treat smaller areas effectively. Endothall is not effective in controlling Canadian waterweed (*Elodea canadensis*) or Brazilian elodea.

There are several water-use restrictions associated with the use of Endothall. At application rates needed to control Eurasian watermilfoil (2.0 to 4.0 ppm) the water-use restrictions are: do not consume fish taken from treated areas for three days and do not use water from treated areas for watering livestock, preparing agricultural sprays for food crops, for irrigation or for domestic purposes for 14 days after application. There is no swimming restriction for Endothall products. However, Ecology recommends waiting 24 hours after the herbicide treatment before swimming, although there is no official label restriction for swimming. Fish toxicity is not a factor, according to the product labels, at doses below 100 ppm (Cerexagri 2003).

Advantages of Endothall:

- fast acting injury to plant tissue,
- little or no off-target drift impacts,
- spot treatments possible.

Disadvantages of Endothall:

- only provides temporary reductions in plant biomass (does not kill plant roots),
- non-target plant impacts are difficult to mitigate as this is a fairly broad-spectrum ,
- higher water-use restrictions relative to other herbicides,

Costs of Endothall:

- $650.00 per treated acre

Application for Ohop Lake Aquatic Plant Management:
This control method is not appropriate for Ohop Lake as it is not as effective and more costly than another contact herbicide (diquat) when used to control Brazilian elodea.

Diquat: Diquat is applied as a liquid and is a fast-acting non-selective contact herbicide which destroys the vegetative part of the plant but does not kill the roots. Diquat is effective on a variety of submersed plants, including Eurasian watermilfoil, and also some types of filamentous algae. Diquat kills plants rapidly, potentially causing a depletion of oxygen and release of nutrients from plant decay into the water column. Typically diquat is used primarily for short term (one season) control of a variety of submersed aquatic plants. Herbicide drift is usually minimal and it can be used to treat specific areas of the water. However, diquat may be less effective if applied to murky or turbid waters or areas with dense algal blooms. Also, repeat applications may be necessary for season-long plant control.

Diquat has slight toxicity to most animals and freshwater fish. It is slightly to highly toxic to aquatic invertebrates. However, Ecology approved Diquat for use in nuisance and noxious weed control (WDOE 2003) based on the completion of a Final Risk Assessment and the Final Supplemental Environmental Impact Statement for Diquat Bromide (WDOE 2002a and b).

Water use restrictions for the use of Diquat applications at a rate of two gallons Reward per surface acre (appropriate rate for Eurasian watermilfoil control) are three days for drinking water, one day for livestock drinking, three days for irrigation to turf and ornamental and five days for irrigation to food crops. There is no restriction for fishing or swimming in treated waters (Zeneca 1997).

Advantages of Diquat:

- rapid acting and effective against most plant species,
- does not bioaccumulate in aquatic organisms,
- no fishing or swimming restriction.

Disadvantages of Diquat:

- persistent, especially in sediments (although chemically inactive),
- some water-use restrictions in place,
- potentially toxic to aquatic organisms,
- repeat applications may be needed,
- rapid action may cause oxygen depletion and rapid release of nutrients into water
- only provides temporary (one to two season) control.

Costs of Diquat:

- $300 - $400 per acre for Reward®

Application for Ohop Lake Aquatic Plant Management:
This control method is appropriate for Ohop Lake and was identified as the primary technique to be used to control Brazilian elodea in the Integrated Aquatic Vegetation Management Plan. This method would not effectively control water lilies.

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APPENDIX D

HERBICIDE USE & OTHER PERMITTING

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PERMITTING AND HERBICIDE INFORMATION

The purpose of this appendix is to provide general information on permitting requirements and associated with implementation of the Ohop Lake IAVMP and also to provide fact sheets on the herbicides recommended for use; diquat, glyphosate, and fluridone.

PERMIT REQUIREMENTS

Most aquatic plant management tools can have an adverse impact on the environment if applied incorrectly or if too much vegetation is removed from a lake or river system. Because of this, there are a number of permits required to perform control work.

Project specific permitting for in-lake treatment of noxious weeds and all nuisance aquatic plant control activities is regulated through an Ecology State Waste General Permit. The permit and its provisions is currently being revised and scheduled for issuance in March of 2006. The general permit primarily applies to discharges to lakes and rivers. The applicator hired by an individual or lake group wishing to apply an aquatic herbicide must submit an application for coverage under this permit. Ecology will be developing application instructions, permit information, and an online application by March 2006.

An Hydraulic Permit Approval (HPA) permit is also required from Washington Department of Fish and Wildlife (WDFW) for any in water or shoreline work. However, WDFW has developed an informational pamphlet that serves as the permit. Citizens, units of government, or private weed control firms can obtain this pamphlet from WDFW. The pamphlet serves as the permit provided the conditions are read and followed. There is generally no need to submit any further paperwork. There are a number of general provisions that must be followed for all of the techniques described in this report. Not all of these provisions are required for each control method. The following common technical provisions are applicable to numerous control techniques and are listed here to avoid repetition.

Common Provisions from the HPA Pamphlet

- Removal of detached plants and plant fragments from the watercourse shall be as complete as possible. This is especially important when removing or controlling aquatic noxious weeds.
- Detached plants and plant fragments shall be disposed of at an upland site so as not to re-enter state waters.
- Work shall be conducted to minimize the release of sediment and sediment-laden water from the project site.
- Extreme care shall be taken to ensure that no petroleum products, hydraulic fluid or other deleterious material from equipment used are allowed to enter or leach into the watercourse.
- If at any time as a result of project activities or water quality problems, fish life are observed in distress or a fish kill occurs, operations shall cease and both the Department of Fish and Wildlife and the Department of Ecology shall be notified of the problem immediately. The project shall not resume until further approval is given by the Department. Additional measures to mitigate impacts may be required.

- Every effort shall be made to avoid the spread of plant fragments through equipment contamination. Persons or firms using any equipment to remove or control aquatic plants shall thoroughly remove and properly dispose of all viable residual plants and viable plant parts from the equipment prior to the equipment's use in a body of water.
- Existing fish habitat components such as logs, stumps, and large boulders may be relocated within the watercourse if necessary to properly install the bottom barrier, screen, weed roller or to operate the equipment. These habitat components shall not be removed from the watercourse.
- Alteration or disturbance of the bank and bank vegetation shall be limited to that necessary to conduct the project. All disturbed areas shall be protected from erosion, within seven calendar days of completion of the project, using vegetation or other means. The banks shall be revegetated within one year with native or other approved woody species. Vegetative cuttings shall be planted at a maximum interval of three feet (on center), and maintained as necessary for three years to ensure 80% survival. Where proposed, planting densities and maintenance requirements for rooted stock will be determined on a site-specific basis. After prior authorization by the Department, the requirement to plant woody vegetation may be waived for areas where the potential for natural revegetation is adequate, or where other engineering or safety factors preclude them.
- Due to potential impacts to sockeye spawning areas, prior authorization by the Department shall be required for activities in Baker Lake and Lakes Osoyoos, Ozette, Pleasant, Quinault, Sammamish, Washington, and Wenatchee. Authorization may or may not be given for the activity, and if given, may require mitigation through a written agreement between the applicant and the Department for impacts by the activity to the spawning area.

HERBICIDE FACT SHEETS

One-page fact sheets for each of the two herbicides recommended for immediate use (diquat and glyphosate) as well as the one herbicide identified at this time for possible follow-up control (fluridone) are provided on the following pages. More detailed information on health and toxicity testing associated with these herbicides is available at:
http://www.doh.wa.gov/ehp/ts/fs.htm.

DIQUAT

- Tradename Reward
- An herbicide used to control submerged (e.g. pondweeds) plants.
- Shown to be effective control for of Brazilian Elodea
- It does not permanently kill plants but provides seasonal control for one or more years.
- It is not selective for one or a few plants; that is, it affects most submerged vegetation.
- Applied as a liquid by direct injection into the water
- Water use restrictions include:
    1. fish consumption and swimming – no restriction (24-hour swimming advisory)
    2. livestock consumption – 1 day
    3. drinking water – 3 days
    4. irrigation for turf and ornamentals – 3 days
    5. irrigation for food crops – 5 days
- The maximum application rate allowable is 0.37 ppm
- Acute toxicity for some aquatic organisms include:
    1. Bluegill – 13.9 ppm
    2. Trout – 14.8 ppm
    3. Water fleas – 0.77 – 1.19 ppm
- Only slightly toxic to mammals in large amounts
- Rapidly binds to organic particles and sediment
- Plants are killed within a few days and fall out of the water column within a week or two
- Control lasts all season or longer.
- For further information see:
    1. http://www.syngentaprofessionalproducts.com/labels/Index.asp?nav=PrdLst&F=PrdDsp
    2. http://www.ecy.wa.gov/biblio/0210052.html
    3. http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html

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GLYPHOSATE

- Tradenames include Rodeo®, AquaMaster®, and AquaPro®. An herbicide used to control emergent (e.g. cattail) and floating-leaved (e.g. white water lily) plants.
- When applied at the right time of year and under the right conditions, it has potential to act as a permanent contact herbicide
- It is not selective for one or a few plants; that is, it affects most emergent vegetation.
- Applied as a liquid by spraying onto plants along with a surfactant and a dye
- There is a drinking water use restriction for this herbicide
- This herbicide typically applied at a rate of about 0.2 mg glyphosate per liter of water (0.2 mg/L)
- Acute toxicity for some aquatic organisms include:
    1. Bluegill - >1000 mg/L
    2. Rainbow trout - >1000 mg/L
    3. Water fleas – 930 mg/L
- Practically non-toxic to mammals
- Nicotine, aspirin, and caffeine are more lethal than glyphosate when ingested in large quantities
- Breaks down rapidly, non-detectable within 24 hours
- Plants die within a few weeks
- A repeat application is sometimes necessary
- For further information see:
    1. http://www.cygnetwest.com/rodeomsds.pdf
    2. http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html
    3. http://www.ecy.wa.gov/pubs/0010040.pdf

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FLURIDONE

- Tradenames include Sonar® and Avast!®. (Manufacturers labels and MSDS for Sonar have been included in this appendix. This does not imply preference to this brand.)
- An herbicide used to control submerged vegetation (e.g. milfoil).
- It permanently kills the plants and roots.
- It is not selective for one or a few plants; that is, it affects most submerged vegetation.
- Applied in pellet or liquid form.
- There are no water restrictions with this herbicide. However, the use of treated water within 7 to 30 days for irrigation could result in harm to crops.
- Acute toxicity for some aquatic organisms include:
    1. Bluegill - 12 mg/L
    2. Rainbow trout – 11.7 mg/L
    3. Water fleas – 6.3 mg/L
- Not as effective on patches smaller than five acres since it is difficult to maintain enough contact time between the plant and the herbicide to kill the plant.
- Whole lake fluridone concentration of 12-15 ppb (parts per billion or µg/liter) should be maintained in the lake for approximately ten weeks during the spring and/or summer to achieve eradication. The sum of all applications should not exceed 150 ppb per annual growth cycle.
- Bleaching of plants observed within three weeks with plants, dying by six weeks.
- For further information:
    1. http://www.doh.wa.gov/ehp/ts/Fluridone.doc
    2. http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html
    3. http://www.epa.gov/iris/subst/0054.htm
    4. http://www.ecy.wa.gov/programs/wq/plants/management/fluridone_strategies.html

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APPENDIX E

CHARACTERISTICS AND HABITAT OF KEY PLANTS IN OHOP LAKE

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CHARACTERISTICS AND HABITAT OF KEY PLANTS

The following information is intended to provide a general description of the plants at Ohop Lake that are of primary interest in the 2006 IAVMP. These include five problem invasive plants and two State listed sensitive species.

Problem Invasives

Fragrant Water Lilly (Nymphaea odorata)
Reed Canarygrass (Phalaris arundinacea L.)
Brazilian elodea (Egeria densa)
Yellow Flag (Iris pseudacorus*is)*
Japanese Knotweed (Polygonum cuspidatum)

State Sensitive Species

Bristly Sedge (Carex Comosa)
California Swordfern (Polystichum californicum)

The information on Fragrant Water Lilly, Reed Canarygrass, Brazilian Elodea, and Japanese Knotweed was obtained from Washington State Department of Ecology's website, http://www.ecy.wa.gov/programs/wq/plants/weeds/index.html.

The sources of information on Yellow Flag Iris, Bristly sedge, and California Swordfern are listed below the descriptions of each plant.

FRAGRANT WATER LILIES (NYMPHAEA ODORATA)

These plants are exceptionally beautiful water plants with floating leaves and large many-petaled fragrant blossoms. They are wonderful additions to backyard ponds and even "tub gardens." The nursery industry has hybridized them and produced many color variations. They sell tropical water lilies and hardy water lilies. It is the hardy white and (sometimes) pink lilies that have become naturalized in Washington lakes and rivers. These plants are native to the eastern United States and it is believed that the water lily was introduced to Washington during the Alaska Pacific Yukon Exposition held in Seattle in the late 1800s. Because of their great beauty, water lilies have been intentionally planted in many Washington lakes, especially those lakes in western Washington. However, lake residents are strongly discouraged from planting fragrant waterlilies in lakes or natural waterbodies. Not only are water lilies aggressive plants, but sometimes "hitchhiker" plants such as hydrilla can also be introduced to our lakes when water lilies are planted.

Growth Habit

Water lilies grow in dense patches, excluding native species and even creating stagnant areas with low oxygen levels underneath the floating mats. These mats make it difficult to fish, water ski, swim, or even paddle a canoe through. Although relatively slow-spreading, water lilies will

eventually colonize shallow water depths to six feet deep and can dominate the shorelines of shallow lakes. For this reason, planting water lilies in lakes is not recommended.

Water lilies reproduce by seed and also by new plants sprouting from the large spreading roots (underground stems called rhizomes). A planted rhizome will cover about a 15-foot diameter in about five years. Fragrant water lily has an interesting pollination strategy. Each white or pink flower has many petals surrounding both male and female reproductive parts, and is only open during the daytime for three days. On the first morning, the flowers produce a fluid in the cup-like center and are receptive to pollen from other flowers. However, they are not yet releasing pollen themselves. Pollen-covered insects are attracted by the sweet smell, but the flower is designed so that when they enter the flower, they fall into the fluid. This washes the pollen off their bodies and onto the female flower parts (stigmas) causing fertilization. Usually the insects manage to crawl out of the fluid and live to visit other flowers, but occasionally the unfortunate creature will remain trapped and die when the flower closes during the afternoon. On the second and the third days, the flowers are no longer receptive to pollen, and no fluid is produced. Instead, pollen is released from the stamens (the flexible yellow match-shaped structures in the flower center). Visiting insects pick up the pollen and transport it to flowers in the first day of the flowering cycle. After the three days the flowers are brought under water by coiling their stalks. The seeds mature under water and after several weeks are released into the water. Water currents or ducks, which eat the seeds, distribute them to other areas. This flowering regimen is followed nearly throughout the summer, producing many eye-pleasing blooms and a large supply of seeds.

In addition to reproducing by seeds, water lilies spread by rhizomes. Anyone who has tried to curtail this plant's growth in front of their dock knows how tenacious these root systems are. Also, if pieces of the rhizome are broken off during control efforts, they will drift to other locations and establish a new patch of lilies.

Native American Use

The fragrant water lily was utilized in many ways by Native Americans in the eastern United States. Roots of this and other water lilies were used medicinally as a poultice for sores and tumors, internally for many aliments including digestive problems, and rinse made for sores in the mouth. The leaves and flowers were also used as cooling compresses. In addition, the rhizomes were occasionally used as food and the young leaves and lower buds were eaten as a vegetable. Even the seeds were fried and eaten or ground into flour. Wildlife, including beaver, muskrat, ducks, porcupine, and deer also will eat the leaves, roots, or seeds. In moderate quantities the fragrant water lily can also benefit the lake by providing shelter and habitat for fish and invertebrates and shade to cool the water. However, our native water lilies, like spatterdock (***Nuphar polysepalum***) and watershield (***Brasenia schreberi***), will also provide the same benefits as the fragrant water lily and are not invasive.

Identification

Because of their large, showy flowers, water lilies are easy to identify when flowering. They have white or pink showy flowers. When not in flower look for:

- Nearly-circular floating leaves, up-to-11 inches in diameter.
- The underside of the leaf is often red or purple with numerous veins.
- The stem is attached to the center of the leaf.
- The leaves each have a deep cleft to the stem.

REED CANARYGRASS (PHALARIS ARUNDINACEA L.)

This is highly variable species and is a rhizomatous perennial grass that can reach three to six feet in height. The sturdy, often hollow stems can be up to 1/2 inch in diameter, with some reddish coloration near the top. The leaf blades are flat and hairless, 1/4 to 3/4 of an inch wide. The flowers are borne in panicles on culms high above the leaves. The panicles are generally three to six inches in length. The species flowers in June and July (Weinmann et al. 1984; Hitchcock et al. 1969).

Economic Importance

Detrimental - Reed canarygrass forms dense, highly productive single species stands that pose a major threat to many wetland ecosystems. The species grows so vigorously that it is able to inhibit and eliminate competing species (Apfelbaum and Sams 1987). In addition, areas that have existed as reed canarygrass monocultures for extended periods may have seed banks that are devoid of native species (Apfelbaum and Sams 1987). Unlike native wetland vegetation, dense stands of reed canarygrass have little value for wildlife. Few species eat the grass, and the stems grow too densely to provide adequate cover for small mammals and waterfowl (Maia 1994). The species is considered a serious weed along irrigation banks and ditches because infestations can increase siltation (Marten and Heath 1973). When in flower, the species produces abundant pollen and chaff, which aggravate hay fever and allergies (Weinmann et al. 1984).
Although reed canarygrass is planted as a forage crop in some areas, the species poses a significant threat to the state's wetlands. Reed canarygrass is extremely aggressive and often forms persistent, monocultures in wetlands and riparian areas. Infestations threaten the diversity of these areas, since the plant chokes out native plants and grows too densely to provide adequate cover for small mammals and waterfowl. The grass can also lead to increased siltation along drainage ditches and streams. Once established, reed canarygrass is difficult to control because it spreads rapidly by rhizomes.

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

Geographic Distribution

Reed canarygrass is a circumboreal species (Larson 1993). While possibly native to North America, European cultivars have been widely introduced for use as hay and forage on the

continent; there are no easy traits known for differentiating between the native plants and European cultivars (White et al. 1993). The species is rather common throughout most of southern Alaska and Canada, as well as all but the southeastern portion of the U.S. (Hitchcock et al. 1969).

Habitat

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

Growth, Development, and Reproduction

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

BRAZILIAN ELODEA (EGERIA DENSA)

This is an attractive, robust plant well-suited to aquarium life. Up until 1996 it was commonly sold in Washington pet stores under the name "anacharis." It was also sold in plant nurseries as an "oxygen" plant. Because of its invasive properties that allow it take over in waterbodies where it is introduced, it is no longer being sold in Washington.

Growth Habit

Unfortunately Brazilian elodea grows very well in Washington lakes when thoughtless people dispose of aquarium contents in our lakes or when boaters carry it from an infested lake into an uninfested waterbody. Because Brazilian elodea is from South America and was originally imported disease and insect free for the aquarium trade, it has few natural predators to keep its growth in check. When introduced to a lake, it soon forms dense mats that choke out our native aquatic plants. These mats are unsightly, interfere with swimming, boating, fishing, and water skiing and provide poor habitat for fish. Brazilian elodea has been introduced into many lakes in western Washington (follow this link to see which lakes it is found in). Because the lakes are not close together, we believe that most infestations are the result of people dumping aquariums into the lake.

Once introduced, Brazilian elodea reproduces by the spread of plant fragments. Because all the Brazilian elodea plants in the United States are male, no seeds are produced. Branches sprout from "double nodes" located at about eight inch intervals along the stems. If a Brazilian elodea fragment does not have a "double node", it can not grow into a new plant.

Identification

Brazilian elodea and its relatives hydrilla and American waterweed look very similar. Here are some ways to tell these three plants apart:

- Brazilian elodea is a very bushy plant with dense whorls of bright green leaves (except when growing with insufficient light, in which case the leaves are widely spaced). Brazilian elodea usually has four leaves per whorl (arranged around the stem) and each leaf is at least 2 cm long.
- American waterweed is smaller than Brazilian elodea and generally has three leaves per whorl. Each leaf is usually less than 1 cm long.
- Hydrilla, probably the most dreaded aquatic invader of the United States, has five leaves per whorl and tiny spines along the leaf margins. The midrib of each leaf is often reddish. Hydrilla produces tubers (small potato-like structures). Neither Brazilian elodea or American waterweed has tubers.

YELLOW FLAG (IRIS PSEUDACORUS*IS)*

This is a wetland plant that is especially showy during its short blooming period. This good-looking plant has been transplanted into well-watered gardens all over the world and has widely escaped; it is also used in sewage treatment, and is known to be able to remove metals from wastewaters. Like cat-tails, yellow iris colonizes into large numbers, forming very dense monotypic stands, out competing other plants.

Habitat

Yellow Flag Iris is an herbaceous perennial that grows in thickets. It grows in thickets, with a clumped distribution in grasslands, and more linear growth in woodlands. Although its leaves sometimes die back over winter, but can still spread via underground rhizomes and seeds if winter are mild. The plant is drought tolerant, and seeds tend to germinate and grow well after being burnt in late summer. Flowering varies from early spring in the southern U.S. to summer, in areas as far north as Canada.

Yellow Flag Iris grows in water to 25cm in depth, or very near water, like lakeside mud. This plant can tolerate high soil acidity, from pH 3.6 to pH 7.7 and can withstand high periods of anoxia (low soil oxygen).

Source: Non-Native Invasive Aquatic Plant in the United States. Center for Aquatic and Invasive Plants, University of Florida and Sea Grant.
http://aquat1.ifas.ufl.edu/seagrant/iripse.2.html

JAPANESE KNOTWEED (POLYGONUM CUSPIDATUM)

Description and Variation

Japanese knotweed (*Polygonum cuspidatum*) is a perennial species with spreading rhizomes and numerous reddish-brown, freely branched stems. The plant can reach four to eight feet in height and is often shrubby. The petioled leaves are four to six inches long and generally ovate with an abrupt point. The whitish flowers are borne in open, drooping panicles. The plant is dioecious, so male and female versions of the inconspicuous flowers are produced on separate plants. The

approximately 1/8 inch long fruits are brown, shiny, triangular achenes, (Hitchcock and Cronquist 1964; Hickman 1993).

Economic Importance

Detrimental - Japanese knotweed is a very aggressive species (Hitchcock and Cronquist 1964) that is capable of crowding out all other vegetation (Ahrens 1975); Hickman (1993) lists the species as a noxious weed. In addition, the plant can create a fire hazard in the dormant season (Ahrens 1975). Japanese knotweed is an escaped ornamental that is becoming increasingly common along stream corridors and rights-of-way in Washington. The species forms dense stands that crowd out all other vegetation, degrading native plant and animal habitat. This perennial plant is difficult to control because it has extremely vigorous rhizomes that form a deep, dense mat. In addition, the plant can resprout from fragments; along streams, plant parts may fall into the water to create new infestations downstream.

Beneficial - The plant is sometimes grown as an ornamental.

Geographic Distribution

As its name indicates, Japanese knotweed is a native of Japan (Hickman 1993). However, it has become naturalized in North America, where it is found from Newfoundland and many parts of the northeastern U.S. (Muenscher 1955), west to California (Hickman 1993) and the Pacific Northwest (Hitchcock and Cronquist 1964)

Habitat

An escaped ornamental, Japanese knotweed is often found in waste places, neglected gardens, roadsides, and along streambanks (Muenscher 1955; Figueroa 1989). Because Japanese knotweed often grows along riparian corridors, we are considering it to be an invasive freshwater weed.

History

A native of Asia, this species was introduced to England in 1825 for use as an ornamental (Patterson 1976). Japanese knotweed was subsequently introduced to the U.S. for use in ornamental hedges and for erosion control (Pridham and Bing 1975).

Growth, Development, and Reproduction

Japanese knotweed is a perennial plant. This species spreads by seed and by long, stout rhizomes (Muenscher 1955). However, colonies rarely establish from seed. Primary spread of the species is reported to be through mechanical movement of plant parts (Figueroa 1989).

BRISTLY SEDGE (CAREX COMOSA)

In general, sedges are grass-like, fibrous rooted plants often found growing in marshy areas. A common phrase, "sedges have edges," helps identify these plants, and refers to the fact that most of the members of this genus have three sided stems that are triangular in cross section. More than 130 sedge species occur in Washington. Most inhabit wet areas, although some species are

found on dry sites. At the tips of their stems, sedges typically have erect or drooping brown or green flower spikes.

Bristly Sedge is a grass-like perennial with clustered stems, 50-100 cm tall and arising from a short rhizome. The long, glabrous leaves are flat and 4-11 mm wide. Flowers are clustered in cylindrical spikes, 2-7 cm long. The lowest bract is much longer than the inflorescence. Male flowers are borne in a narrow spike at the top; 3-5 nodding female spikes, 15 mm thick, occur below. The glabrous, spreading, pale green, lance-shaped perigynia are 5-8 mm long, and have a long beak ending in two long, slender, divergent lobes. The papery scales subtending the perigynia are 1-2 mm long with a pointed tip that is up to 6 mm long. Each perigynium has 3 stigmas and a 3-sided achene. Fruit matures in July. Other closely related coarse sedges with nodding spikes are *Carex Hystricina* and C. Utriculata, but neither of these species have perigynia with sharp-pointed, spreading lobes. A hand lens is needed for positive identification.

Sources: *http://nhp.nris.state.mt.us/plants/illust/sid834i.pdf*. An Aquatic Plant Identification Manual for Washington's Freshwater Plants. June 2001, Publication 01-10-032. Washington State Department of Ecology

CALIFORNIA SWORDFERN (POLYSTICHUM CALIFORNICUM)

General Description

An evergreen fern approximately 5 to 26 in. (12 to 26 cm) tall. There are approximately 20 to 45 leaflets on each side of the rachis, or main stem, of the leaf, or frond. The leaflets are 1½ to 4 in. (4 to 10 cm) long and ½ to 1¼ in. (1 to 3 cm) wide. The leaves, or fronds, appear to be made up of opposite leaflets, divided to the middle of the each leaflet. Each leaflet becomes spiny and toothed toward the base of each leaflet and becomes less toothed as you approach the tip of the leaflet. Its leaflets are somewhat stiff and opposite or slightly offset.

Habitat

This fern has been found on slopes, dry rocky terrain, by stream banks, vertical cliffs, rock crevices, and in partial shade or open areas. It is a versatile species, making use of almost any habitat. Washington populations occur at elevations ranging from 244 to 305 ft (800 to 1000 m).

Identification Tips

Polystichum californicum is very similar to *P. munitum*, *P. scopulinum*, and *P. andersonii*. A technical key is recommended in order to tell the four species, as well as their hybrids, apart. *P. californicum* differs from *P. munitum* by having finely toothed leaflets rather than having prominently saw-toothed leaflets, or having sword-like leaflets. A distinguishing character between *P. scopulinum* and *P. californicum* is the teeth on each leaflet: *P. scopulinum* has long, coarse hairs on its teeth, whereas *P. californicum* has short, abruptly ending points on its teeth. *P. andersonii* grows a chaffy bud, or fiddlehead, for new growth, and has a conspicuously chaffy stalk, or rachis; whereas *P. californicum* lacks any such chaffy bud and has a rachis which is not as chaffy.

Source: http://www.dnr.wa.gov/nhp/refdesk/fguide/pdf/polcal.pdf