LAKE LELAND

INTEGRATED AQUATIC PLANT MANAGEMENT PLAN

December 1998

Prepared by
Susan Taylor and Glenn Gately
Resource Technicians

Jefferson County Conservation District
205 West Patison St.
Port Hadlock, WA 98339

for
Lake Leland Steering Committee

This project was funded by Washington State Department of Ecology
and
Jefferson County Parks and Recreation

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ACKNOWLEDGMENTS

Whenever a project of this scope takes place, there are numerous people to thank. The Leland Aquatic Plant Management Plan is the result of many, many hours of work contributed by a dedicated group. We offer our thanks to each and everyone of you: to county, state, and federal staff; to the Leland and local communities; and to those business consultants who gladly provided information. We apologize if we have inadvertently missed anyone in the following list:

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EXECUTIVE SUMMARY

Lake Leland is located in the foothills of the Olympic Mountains in eastern Jefferson County five miles north of Quilcene, Washington. It is a small (100 acre) shallow lowland lake that was created by a glacial process and has a mean depth of 13 feet and a maximum depth of about 20 feet. Nearly 60 percent of the 2.8 miles of shoreline is developed with residences, weekend camp lots, and the Jefferson County Park.

Lake Leland offers varied recreational activities for residents and visitors alike. Easy access from state Highway 101 brings many people to the Leland County Park for camping and picnicking. The park includes 22 campsites, a boat ramp, swimming area, and fishing dock. Private docks also provide boaters and swimmers access to the water. The lake supports an excellent warmwater fishery, including largemouth bass, bluegill, black crappie and yellow perch. Rainbow trout are stocked annually. Camping, swimming, fishing, boating, bird watching, and relaxing in a peaceful rural environment are some of the enjoyable amenities that make Lake Leland one of the most popular lakes in the county. Due to its rural location and diversity of native vegetation, the lake supports a wide variety of wildlife. Both eagles and osprey are known to nest in the area and great blue herons and pileated woodpeckers are frequently sighted. In winter the migratory trumpeter swan is present along with Canada geese and an assortment of other waterfowl. Additionally, the lake provides several residents with domestic water.

In 1994, a Department of Ecology (Ecology) aquatic survey of the lake revealed the presence of Brazilian elodea (*Egeria densa*), a non-native invasive waterweed. This popular aquarium plant, now illegal to sell in Washington State, is listed as a noxious weed by the Washington State Noxious Weed Control Board. The plant has been steadily spreading since its introduction in the south end of the lake and can now be found in patches along most of the shoreline. The south end of the lake is becoming impassable to motor boats, which become entangled in the dense aquatic weed. The invasive plant has also impacted fishing and swimming around numerous private docks and other shoreline areas. Brazilian elodea occurs near the county park swimming area and boat ramp and may become a safety issue. Visual aesthetics are being affected, and an altered ecological balance may affect fish and wildlife. An important concern is the possibility of this weed spreading to other non-infected lakes. Brazilian elodea spreads by fragmentation and can easily be transported to new locations on boat motors, trailers, and fishing gear.

Another non-native invasive weed, reed canary grass (*Phalaris arundinacea*), is a problem aquatic weed in Leland Creek, which drains Lake Leland. This water tolerant grass, introduced into the area to provide forage for livestock in wet areas, is notorious for growing in stream channels and causing drainage problems. Canary grass grows densely in the 2000 feet of Leland Creek immediately downstream of Lake Leland and is a major factor in the flooding problem and high water level in Lake Leland. Historically, there has been a problem with high waters in the area, much of which can be attributed to canary grass and beaver dams in Leland Creek. The higher water table has contributed to flooded roads and has caused some problems with septic systems.

Impaired septic systems could result in an excess of nutrients and fecal coliform bacteria in the lake. To date, two homes have been flooded and others are at risk. Several properties are in jeopardy and useable farm lands have decreased. Dead trees resulting from high waters can be noted around the lake shoreline.

These problems have been of great concern to the community. Several years ago interested residents approached county and state officials to seek solutions to improve the situation. In June of 1997, the Jefferson County Conservation District was awarded a grant by Ecology to develop an Integrated Aquatic Plant Management Plan for Lake Leland. The report that follows is the result of over a year spent searching for a feasible solution to the aquatic weed problems at the lake. As part of the plan process, a steering committee was formed with interested representation from the community, county agencies, Ecology and Washington Department of Fish and Wildlife (WDFW). The committee formed a set of goals and evaluated all currently available aquatic plant control options. Goals dictated that the chosen control option be cost effective, environmentally friendly, and meet the needs of the community. After several meetings in which the different types of control methods were considered, it became apparent that there is no ideal management tool that is 100 percent effective and meets all the above criteria. After much deliberation and evaluation of the pros and cons of each control option, the steering committee reached a consensus of opinion. The following are the committee's recommendations.

The first and most important recommendation is that the Leland Neighborhood Improvement Club take on a permanent role to address lake water quality issues. This will assure coordination and continuity over the long term.

For the long-term, large-scale reduction of Brazilian elodea, the steering committee favors the use of a biological control agent, triploid grass carp. However, there are several factors to consider when choosing to use grass carp; the most important of which is the possibility of total eradication of aquatic plants in the lake. This would be detrimental to fish and wildlife and possibly to water quality (increased turbidity). Because of the unpredictability of grass carp as a control method, the committee recommends that grass carp not be introduced into the lake at this time. Water quality and plant biomass studies, which are required prior to stocking grass carp, have been completed, and grass carp are certainly an option for the future. The committee, including Ecology and WDFW, will periodically reassess lake conditions, especially the distribution and density of Brazilian elodea and the health of the fishery. Based on these conditions, the committee will reevaluate the use of grass carp as a control.

For localized reductions around docks and short stretches of shoreline, the steering committee recommends hand pulling or cutting the weed and the placement of bottom barriers. These methods can improve swimming safety and fishing conditions in limited areas.

To address the reed canary grass problem in Leland Creek, the steering committee feels that the use of the herbicide RODEO (glyphosate) would be appropriate. It is the least damaging and most cost effective method of control. This herbicide is applied directly to the emergent plant and is inert in water. Also, there are no known domestic

water intakes on Leland Creek. A spring and fall follow-up application by hand spraying should clear the channel of canary grass. Maintenance spraying will probably be needed in future years to keep the canary grass under control. If feasible, tree planting along the treeless stretch of the creek bank would help eliminate the grass.

The steering committee recognizes that the effective management of both Brazilian elodea and reed canary grass will be an on-going concern and will require a long-term commitment. Monitoring of the plant community and beneficial uses such as fishing, boating, and swimming needs to be continued. This aquatic plant management plan is not static and is expected to change as conditions change.

Public education is an important element in the control of aquatic nuisance plants. Signs have been developed by Ecology to bring attention to the Brazilian elodea infestation in Lake Leland and to show fishermen and other lake users how to avoid transporting aquatic plants from one lake to another. These signs are being installed at Lake Leland and other eastern Jefferson County lakes. Educational flyers have been distributed to visitors and residents alike and it is recommended to continue this practice. Yearly mailings to inform residents of Best Management Practices that reduce nutrient and sediment inputs to the lake are also recommended.

This plant management plan is a result of the work of a dedicated group of people. Many thanks to all of you who have contributed your volunteer time for all aspects of the process. This includes hours on, in, and around the lake surveying aquatic plants, reading staff gages, monitoring water quality, demonstrating weed control methods—and attending meetings, meetings, meetings. We could not have accomplished this without all of you.

PROBLEM STATEMENT

In January of 1998 at the second meeting of the Lake Leland steering committee, members established a list of problems related to invasive aquatic vegetation. Many of these problems had been previously identified at meetings of the Leland Neighborhood Improvement Club and at a public meeting in August 1997, which specifically addressed invasive vegetation in Lake Leland. The identified problems are related to three invasive weeds: Brazilian elodea *(Egeria densa)*, reed canary grass (*Phalaris arundinacea*), and yellow flag iris (*Iris pseudacorus*). The problems associated with each species are discussed below.

BRAZILIAN ELODEA

In the summer of 1994 during a routine Department of Ecology aquatic plant survey of Lake Leland, the presence of Brazilian elodea was first officially noted. This noxious, non-native, invasive species has been spreading at a steady rate and is rapidly filling in the shoreline up to a depth of about ten or eleven feet. In the last four years, Brazilian elodea has become well established in the south end of the lake, and plants are now found scattered along the perimeter of the rest of the lake (Figure 1). Fishing, boating, and swimming have been affected due to the density of the plant. Many private docks have become totally surrounded with this noxious weed, which hampers safe swimming.

Jefferson County Parks and Recreation provides a campground and maintains a swimming area and boat ramp at the lake. Brazilian elodea has now been found along the shoreline of the park which could eventually hinder safe swimming in that area. The rapidly spreading weed could result in less use of the county campground, which is a source of revenue to Jefferson County Parks and Recreation.

The community feels that their property values could be lowered by the steady encroachment of the weed. Another concern is that Brazilian elodea could alter the ecological balance of the lake, affecting fish and wildlife habitat and the excellent warm water fishery that presently exists at the lake.

A very important concern of the committee is the potential for the spread of Brazilian elodea to other lakes in the surrounding area. This noxious weed is easily transported to other locations on boat motors, trailers, and fishing gear and is known to establish new infestations from plant fragments. There are several lakes in the area that currently are not infested with Brazilian elodea, one of which is Crocker Lake, located just three miles north of Lake Leland. Fishermen are known to utilize both lakes in the same day.

A final concern is that the methods chosen to control invasive plants in the lake do not jeopardize the water quality of the lake. Lake Leland is a source of domestic water for some residents, and the community is particularly concerned about using broad spread chemical treatments which might compromise human safety.

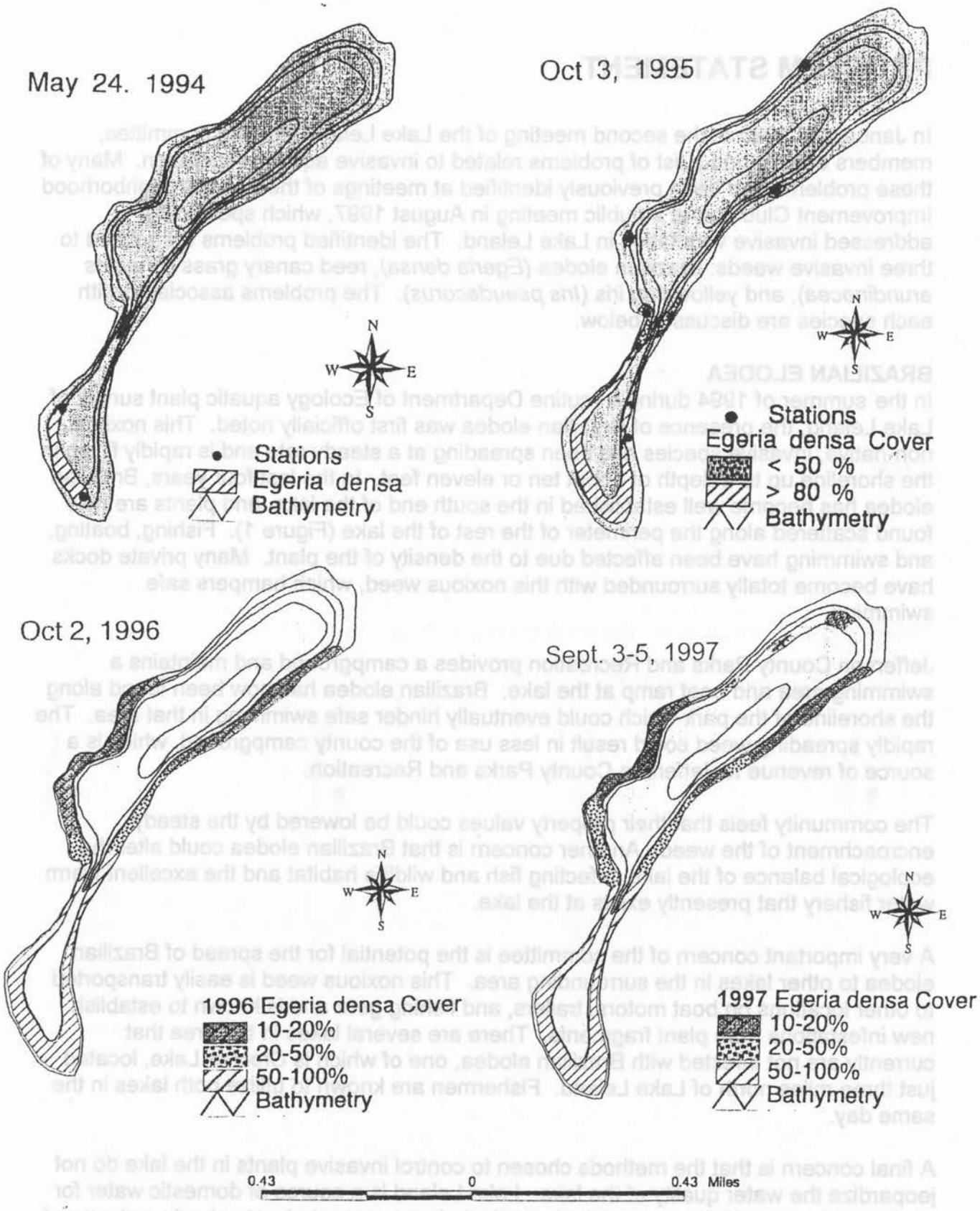

FIGURE 1 Maps showing the spread of Brazilian elodea in Lake Leland from 1994 to 1997 (1994-1996 maps are from Parsons 1997).

REED CANARY GRASS

Reed canary grass, another exotic species listed by the state as a noxious weed, is also a problem at Lake Leland. This water tolerant grass, introduced into the area to provide forage for livestock in wet areas, is notorious for growing in stream channels and causing drainage problems. Canary grass grows densely in the upper 2000 feet of Leland Creek and is a major factor in causing the flooding problem and high water level in Lake Leland. Beaver dams on Leland Creek also contribute to the problem.

The steering committee has thoroughly discussed the history of the flooding problem, which has occurred for a long time. During the late 1940's the Soil Conservation Service (SCS) assisted local farmers in dredging out the inflow and outflow channels to the lake. According to long time resident Hector Munn (Munn 1986), the lake level dropped dramatically for several seasons, enough so that docks had to be extended to reach the water level. One could walk through the culvert under Leland Valley Road West. The road is now flooded most of the winter and spring, and the culvert is full all summer long. However, the dredging was only a temporary fix. In April of 1988, the SCS again addressed the drainage problem and provided an analysis (Appendix A). The SCS had no solutions to recommend due to environmental factors, permit systems, and federal and state regulations regarding wetlands. Recurrent flooding over Highway 101 north of the lake prompted the Department of Transportation to look for a solution to the rising water table in late 1990. The Jefferson County Conservation District served as lead agency and identified removal of canary grass, a beaver dam, and natural obstructions as a first step in the solution. In the fall of 1991, a Leland Creek channel restoration project utilizing an excavator and a "Cookie Cutter" (a flat bottomed boat used to cut vegetation in lakes) cleared canary grass from the 2000 foot section of Leland Creek below Lake Leland and, as a result, the lake flowed steadily through the outlet (Appendix A). The lake water level dropped dramatically for a few years but has since returned to previous levels (see Figure 12 in Watershed Characteristics). Flooding was only temporarily reduced, because problems of funding, responsibility, and permitting plagued the project and prevented continued maintenance to ensure that the outlet remained open.

Seven years later the issue has not resolved itself. The outlet channel is again virtually clogged with canary grass and the flooding problem has been increasing. Over the past three years the lake level has continued to rise. The higher water table has contributed to flooded roads (county and state) and septic drainfields. The latter could result in the release of nutrients and fecal coliform bacteria to the lake. To date, two homes have been flooded and others are at risk. Several properties are in jeopardy and useable farm lands have decreased. Dead trees resulting from a high water table can be seen around the shoreline. Since it has been demonstrated that improved drainage reduces the lake water level, neighbors regularly patrol Leland Creek for obstructing beaver dams. And they continue to look for feasible solutions to control the canary grass.

It should be noted that the Washington Natural Heritage Information System database lists the presence of bristly sedge (*Carex comosa*), a state sensitive plant species, in the wetland at the south end of the lake and along Leland Creek. Although the Natural Heritage Program has no regulatory authority, the Leland community wishes to respect

the uniqueness of the Leland ecosystem and will plan any canary grass controls with respect to this information.

YELLOW FLAG IRIS

Yellow flag iris, a non-native invasive species not listed on the state noxious weed list, has been spreading in some areas of the lake shoreline. The density of the iris along the shore crowds out native vegetation and can impede human or wildlife passage.

AQUATIC PLANT MANAGEMENT GOALS

At its first meeting in November of 1997 (Appendix B), the Leland steering committee developed a set of goals for the Lake Leland Integrated Aquatic Plant Management Plan (IAPMP). These goals were formulated after discussion which took into account the lake and its characteristics, the Leland community, and all associated costs. The goals are outlined as follows:

- Reduce and then maintain Brazilian elodea at as low a density as is environmentally and economically feasible.
- Reduce reed canary grass in Leland Creek.
- Reduce yellow flag iris along the lake shoreline.
- Seek a balanced approach for treatments. Take into consideration all beneficial uses including the domestic water source, recreational use, the fishery, and wildlife habitat.
- Develop and begin implementation of an educational plan that will reduce the chances of Brazilian elodea spreading to other lakes.
- Develop and begin implementation of an aquatic survey of all lake vegetation.
- Continue lake water quality monitoring and data collection for baseline information.
- Seek funding mechanisms in order to continue long term control of invasive aquatic plants.

WATERSHED and LAKE CHARACTERISTICS

WATERSHED CHARACTERISTICS

Lake Leland (T28N R2W S26) is located in the foothills of the Olympic Mountains in eastern Jefferson County approximately five miles north of Quilcene, WA. It lies within the Hood Canal watershed and more specifically the Little Quilcene subwatershed. The Lake Leland watershed itself contains approximately 3500 acres (Figure 2). Land uses are divided among forestry, agriculture, recreation, and rural residences. The primary land use is forestry, including both public and private timber harvest. Approximately 74 percent of the watershed is in second growth lowland forest. Roughly one percent of the land is used for agriculture and the remaining 25 percent in rural residential areas. The lake shoreline is about 60 percent developed with residences, weekend camp lots, and the Jefferson County Park. This park provides 22 campsites, a boat ramp, swimming area, and fishing dock.

Native vegetation typical of the Pacific northwest is present around the lake. This primarily consists of Douglas fir, western redcedar, western hemlock, red alder, big leaf maple, vine maple, rhododendron, salmonberry, red elderberry, evergreen and red huckleberry, Oregon grape, salal, and swordfern. According to the Natural Heritage Information System, a state sensitive plant species, bristly sedge (*Carex comosa*), occurs in a wetland at the south end of the lake and along Leland Creek. A rare forested wetland type (western redcedar/western hemlock/skunkcabbage) has also been identified in the northwest quarter of section 23 and is designated Priority 1 for protection by the Natural Heritage Program (Appendix C).

Many unnamed streams and ditches flow into the lake including a major inlet at the north end of the lake. This inlet flows through a wetland before it passes under Highway 101 approximately 300 feet east of the lake. At the west side of the highway, the stream is joined by a drainage ditch which flows from the south and is fed by hillside springs and pasture runoff. This combined flow then proceeds through residential property to the lake. The riparian zone in this area includes willow, maple, spiraea, and various reeds and grasses. The main inlet and several other streams flow throughout the year. There are many subsurface inflows, as any swimmer in the lake can testify. The only surface outflow is Leland Creek located at the south end of the lake. Leland Creek flows into the Little Quilcene River, which flows into the Hood Canal. From the lake, Leland Creek passes through a wetland, past a non-functioning fish weir, and then under Leland Valley Road West. During the winter and into spring, the creek flows over the road at this point. Wetlands surround the north and south ends of the lake and extend along the west side of the lake. There are several isolated wetlands located throughout the watershed (Figure 3), and a snag rich habitat has been identified at the wetland north of the lake (WDFWa 1998).

The topography of the Leland watershed is nearly flat or gently sloping around the immediate lake shore. The topography then steepens to 15-30 percent around most of the lake except in the southwest area where it is 30-50 percent. The highest elevation

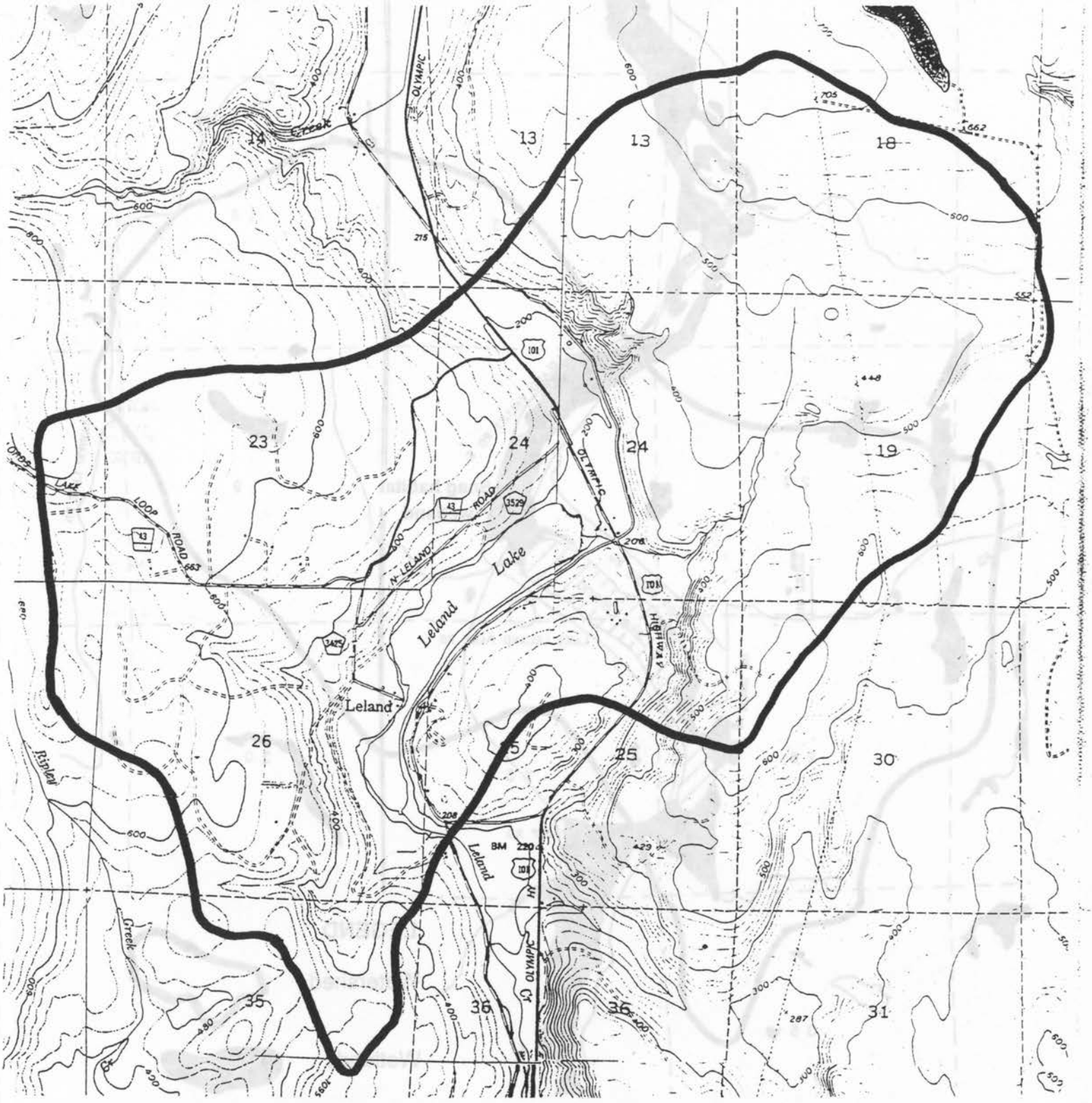

FIGURE 2 Topographic map showing boundary of Lake Leland watershed (from USGS 7.5 minute series quadrangle maps-Uncas, Center, Quilcene, and Mt. Walker).

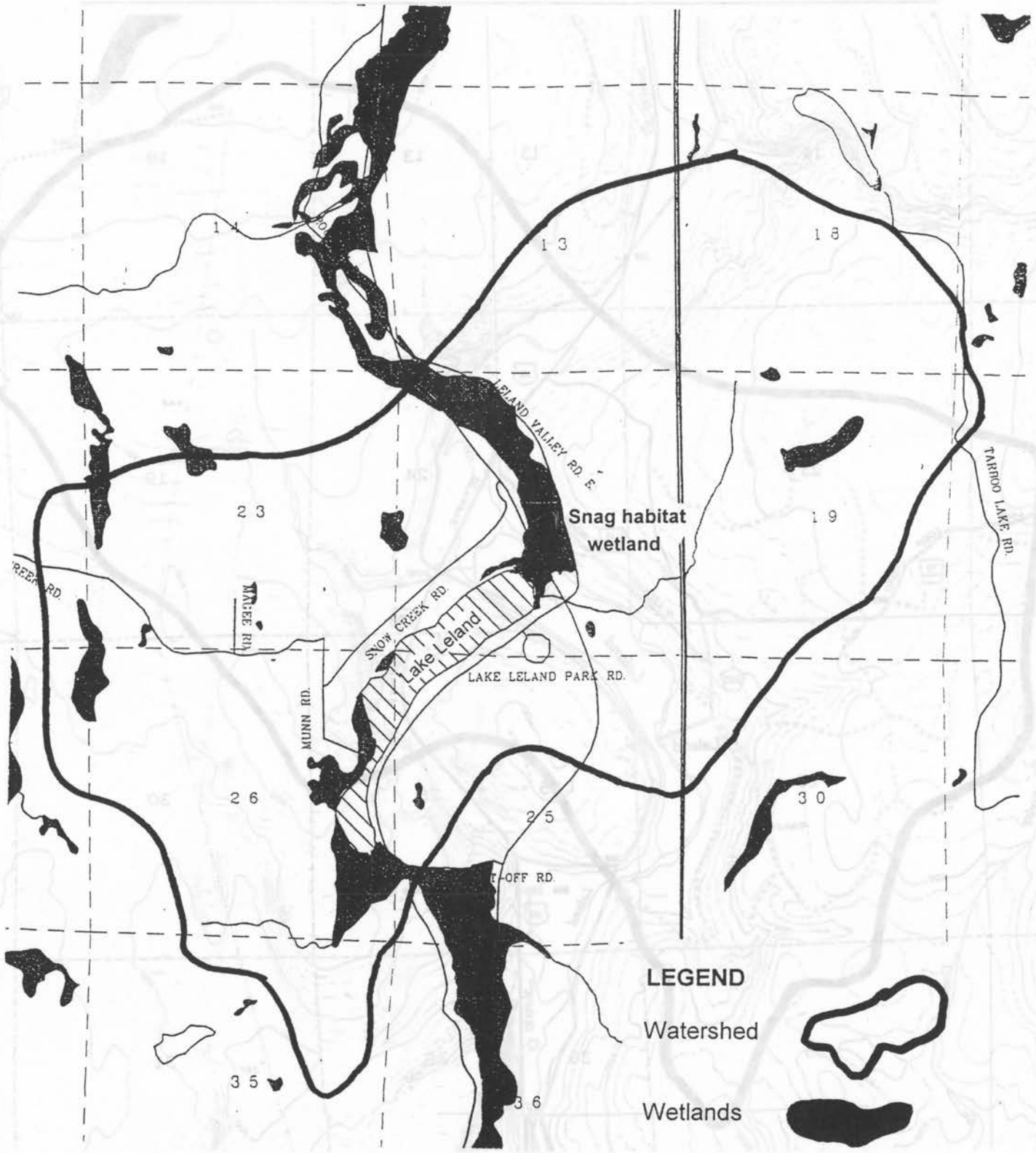

FIGURE 3 Map showing wetlands in Lake Leland watershed (from Jefferson County's Critical Areas-Wetland Map, July 8, 1994).

in the watershed is approximately 880 feet and the lake itself is just under 200 feet in elevation.

The soils in the Leland watershed belong to two different associations: Alderwood-Sinclair and Quilcene-Alderwood-Cathcart . The Alderwood-Sinclair association, the primary soil type, was formed in glacial till under a forest of mixed conifers and broadleaf vegetation. The soils are gravelly throughout and are moderately well drained with moderately rapid permeability. But, a very slowly permeable cemented layer exists at a depth of 20 to 40 inches. During the winter, the perched water table lies above this cemented layer.

On nearly level to rolling slopes, runoff is slow to medium with a slight to moderate chance for water erosion. On the steeper slopes (15-30%), where ravines and steep drainages are found, runoff is medium to rapid, and the danger of water erosion increases from moderate to severe.

The Quilcene-Alderwood-Cathcart association soils formed in shale, sandstone, and glacial till. These soils are located between 200 and 500 feet in elevation on nearly level to very steep slopes. Quilcene soils consist of a surface layer of silt loam and a subsoil of silty clay loam and gravelly clay which is underlain by weathered shale at a 20 to 40 inch depth. The Alderwood soils are a gravelly sandy loam that is underlain by the cemented layer. Cathcart soils have a surface layer of gravelly silt loam and a gravelly loam subsoil that is underlain by sandstone bedrock at 24 to 40 inches depth. This association is moderately well to well drained.

Both of the associations are used for forestry, wildlife habitat, and recreation. A limited amount of clearing has taken place for pasture crops and home gardens. Suitability for septic tanks and drainfields is classified as having severe limitations due to the seasonally perched water tables and slow permeability (USDA 1975).

Land uses in the watershed including forestry, agriculture, and residential development are potential sources of non-point pollution to Lake Leland. Runoff on frozen or saturated soils could result in nutrients and fecal coliform bacteria entering the lake. Logging could increase the sediment load entering the lake. And, because phosphates adhere to soil particles, an increase in sediment load could be accompanied by an increase in phosphorus loading. Logging can also result in higher peak flows and thereby contribute to the flooding problem. Residences and camp trailers along the shoreline and the tributaries of the lake are also potential sources of pollution. Failing septic drainfields could allow both nutrients and bacteria to enter the lake. Lawn and garden fertilizers are another potential nutrient source.

LAKE CHARACTERISTICS

Lake Leland is a shallow lowland lake created by a glacial process. It is about 100 acres in size and has a mean depth of 13 feet and a maximum depth of about 20 feet (Figure 4). The lake, somewhat boot shaped, lies on a north-south axis with three quarters of the lake in a main body and the remaining quarter south of a narrow neck. The lake is about one mile long and has a maximum width of more than 300 feet and a drainage basin of approximately 6 square miles. The 2.8 miles of shoreline gently slope to the lake.

Water Quality

Water quality data for Lake Leland extends back to 1974, although most of the data has been collected since 1993. Water quality monitoring was conducted on the south end of the lake and on the lake's tributaries for the first time in 1998. Monitoring was intensified during 1998 to obtain the baseline data that is required prior to stocking grass carp, should they be chosen to control Brazilian elodea. Some of the most relevant monitoring data collected by the U.S. Geological Survey, Washington Department of Ecology, and Jefferson County Conservation District are included in this report. A complete, more detailed report will be prepared separately by the Jefferson County Conservation District.

The single most important parameter relevant to Brazilian elodea and other plants is phosphorus. Of the nutrients required, phosphorus is almost always the limiting one in fresh water. Total phosphorus, which includes both available and unavailable forms, appears to have declined in the epilimnion (upper part of the water column) of Lake Leland since 1974, and this decline appears to have continued in recent years (Figures 5 and 6). Chlorophyll *a*, indicative of phytoplankton abundance, also appears to have declined (Figure 7). This apparent decrease in phytoplankton abundance may explain the slight apparent increase in Secchi disk readings, which indicate an increase in water clarity (Figure 8). Total phosphorus levels were higher in the south end of the lake than in the main lake on each of the four dates sampled (Figure 6).

The apparent decreasing phosphorus and chlorophyll levels and increasing Secchi disk readings could indicate a shift in the plant community from phytoplankton to macrophytes. Certainly, Brazilian elodea is known to have increased in abundance since 1994.

Whether phosphorus is used by phytoplankton or macrophytes, care should be taken to minimize its input into the lake and tributaries. Potential sources of phosphorus are decaying vegetation, animal wastes, fertilizers, detergents, and failing septic drainfields. Minimizing the input of phosphorus from these sources will help minimize the spread of Brazilian elodea. It will also help slow eutrophication, the natural aging process of a lake.

In January 1998, the District monitored 22 of Lake Leland's tributaries (Figure 9). Many of these were small drains which flowed only during the wet season. We selected the 10 largest tributaries and continued monitoring these through September. Of the 22 tributaries monitored in January, the selected ten accounted for 92% of the phosphorus

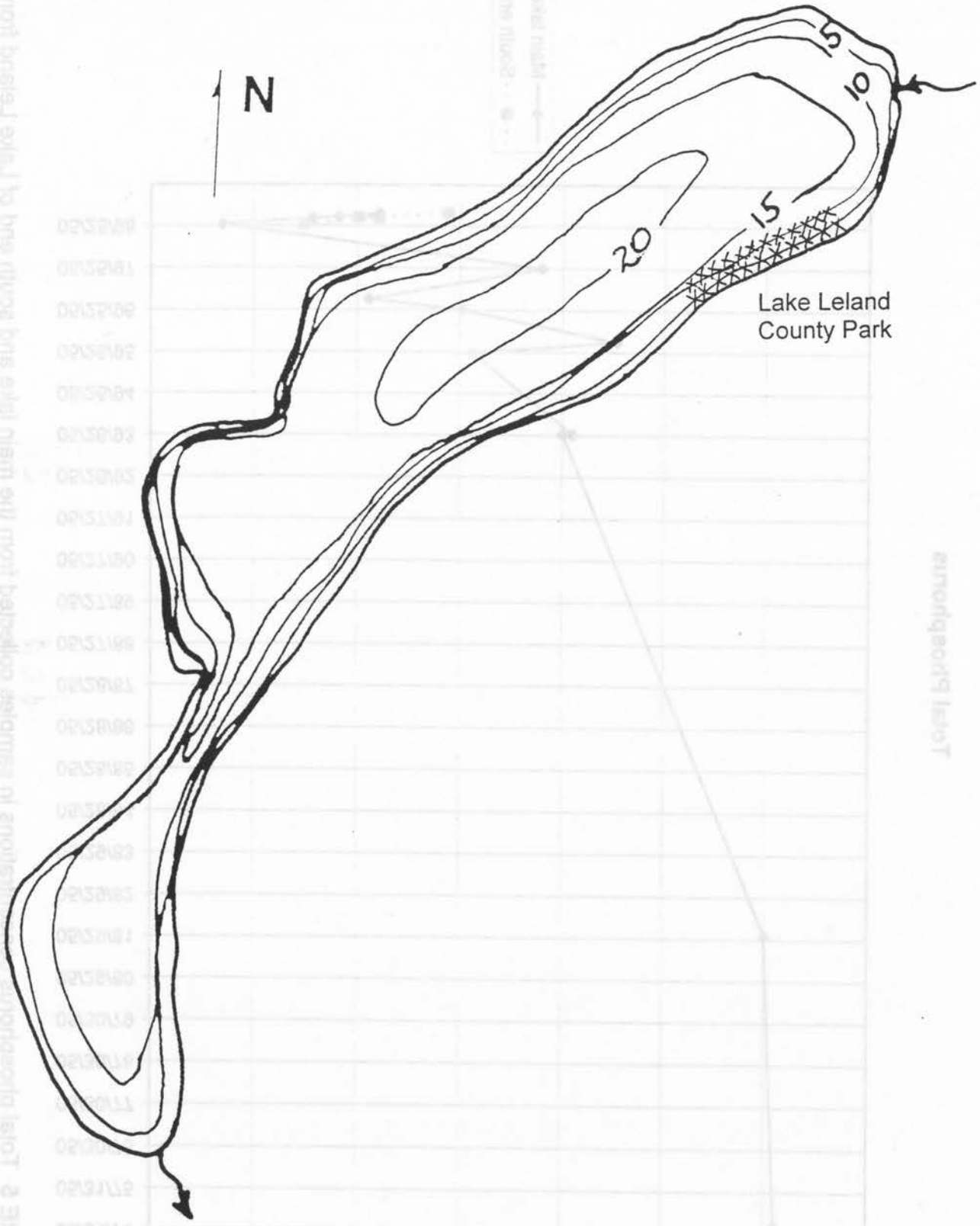

FIGURE 4 Bathymetric map of Lake Leland showing County Park facilities including fishing dock, boat launch, and swimming area (crosshatched).

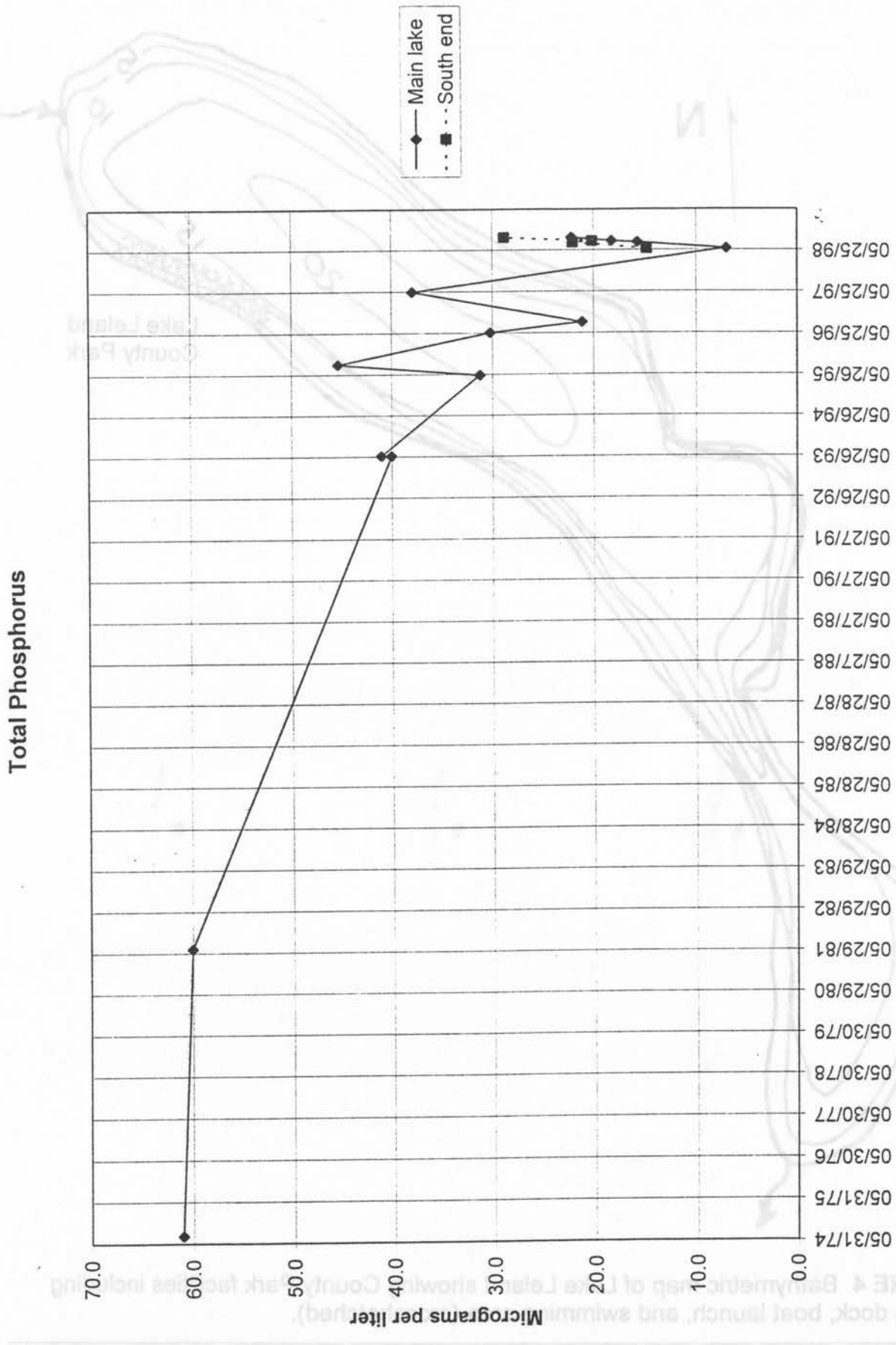

FIGURE 5 Total phosphorus concentrations in samples collected from the main lake and south end of Lake Leland from 1974 to 1998 (data courtesy of Washington Department of Ecology).

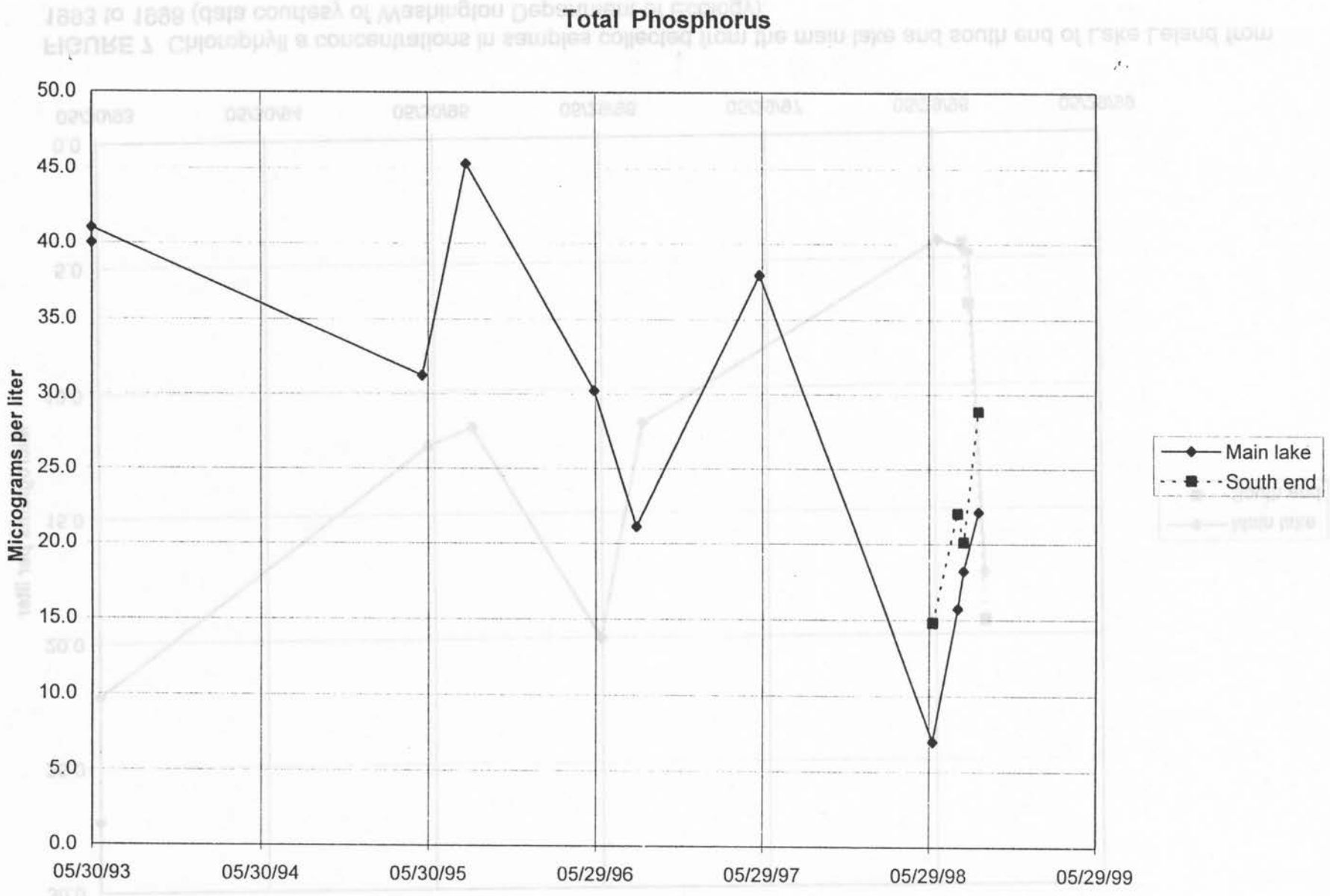

FIGURE 6 Total phosphorus concentrations in samples collected from the main lake and south end of Lake Leland from 1993 to 1998. Data is the same as in Figure 5, but the shorter time frame allows better discernment between main lake and south end concentrations (data courtesy of Washington Department of Ecology).

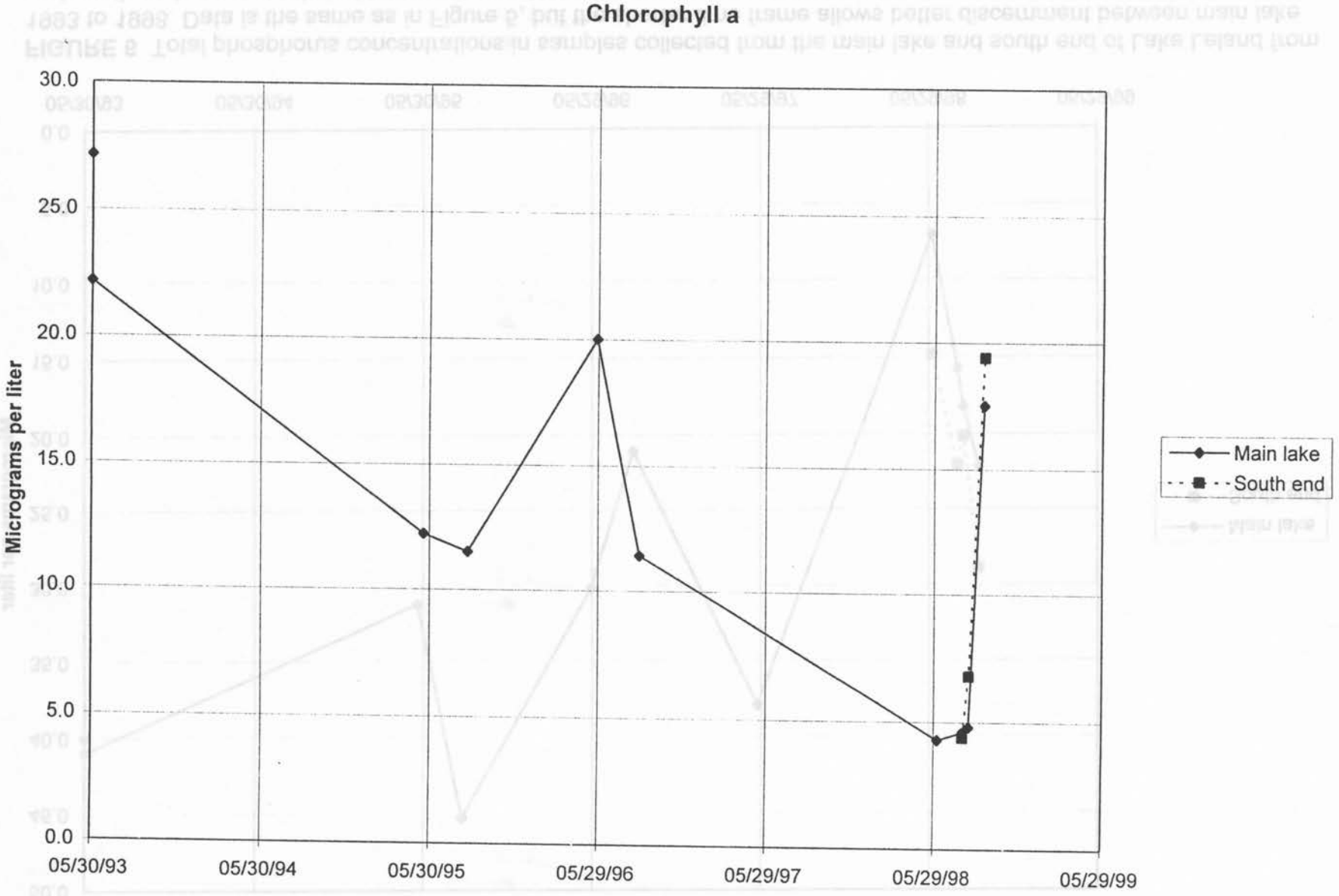

FIGURE 7 Chlorophyll *a* concentrations in samples collected from the main lake and south end of Lake Leland from 1993 to 1998 (data courtesy of Washington Department of Ecology).

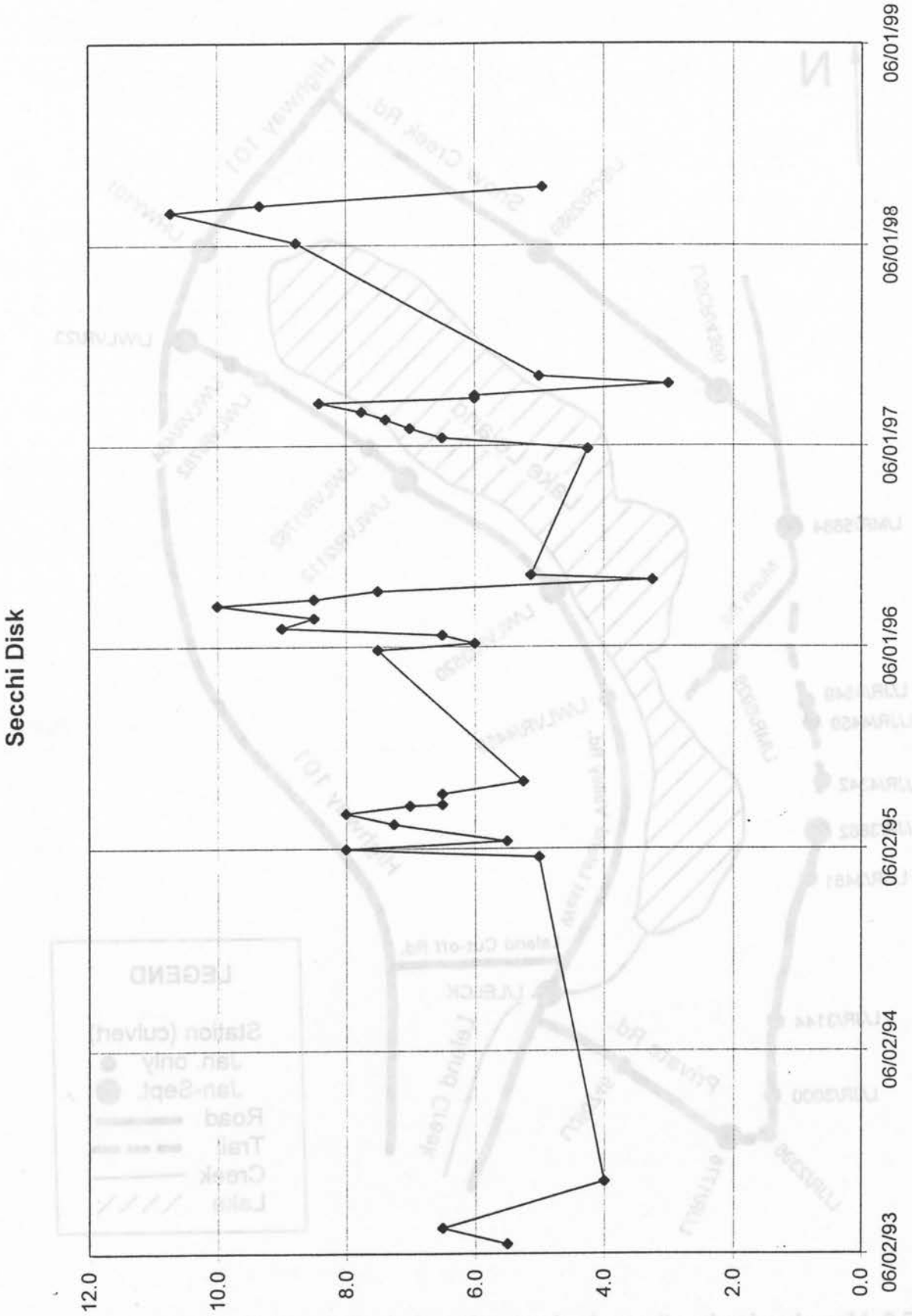

FIGURE 8 Secchi disk readings taken in Lake Leland (main lake) from 1993 to 1998 (data courtesy of Washington Department of Ecology).

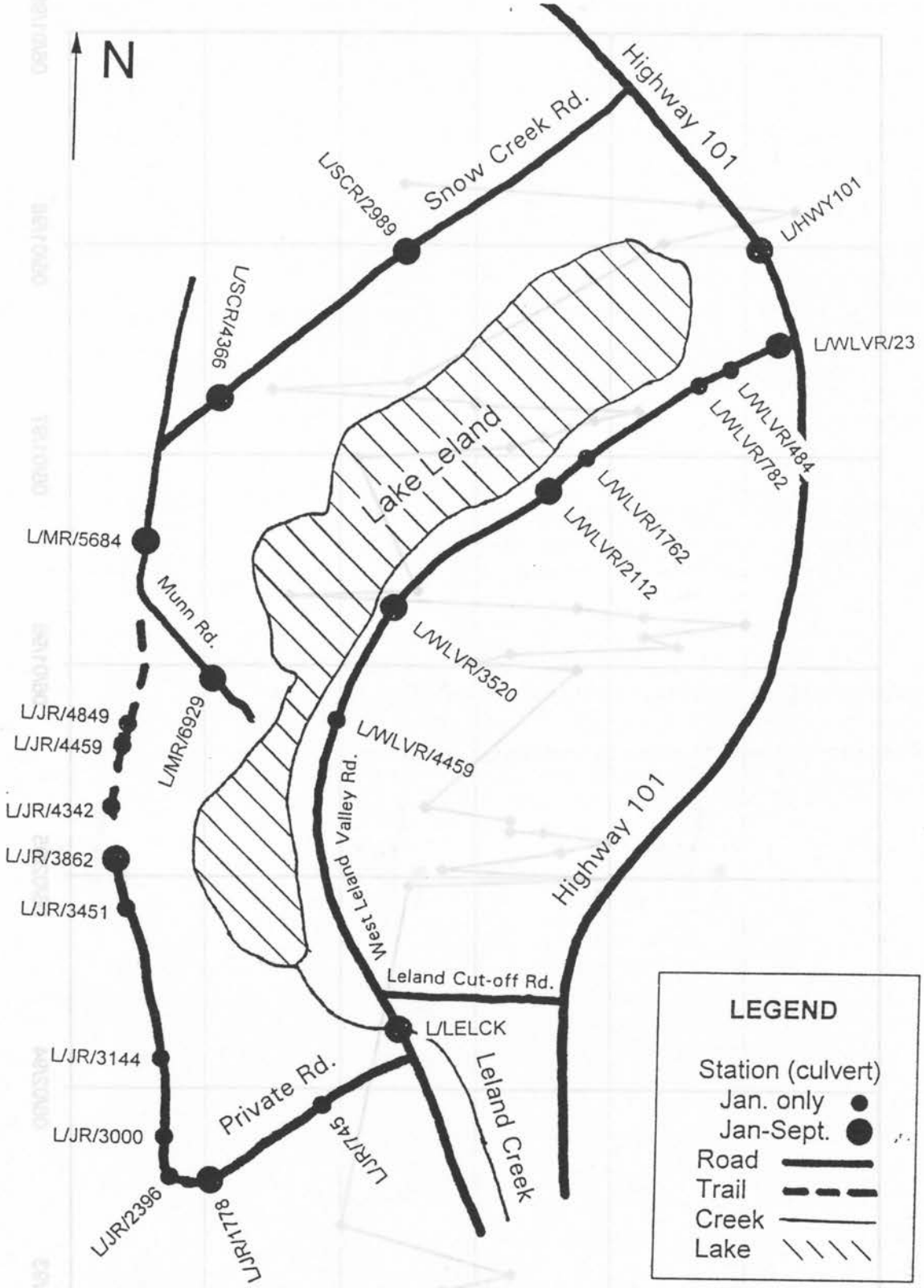

FIGURE 9 Map showing locations of culverts where Lake Leland tributaries and Leland Creek were sampled monthly from January to September 1998.

loading. The highest average phosphorus loadings came from three sources: L/HWY101 and L/WLVR/23 at the north end of the lake, and L/JR/1778 at the south end, where Brazilian elodea is densest.

Of the 22 tributaries monitored in January, the 10 selected tributaries accounted for 97% of the total flow. However, the combined flows from these ten accounted for a much smaller percentage of the lake's outflow measured in January, February, April, and June (Figure 10). Ground water and surface runoff probably accounted for much of the observed differences during these months and undoubtedly also contributed to the phosphorus loading of the lake. It should be recognized that most of a lake's annual phosphorus loading can occur during a few major rain events, and our data may not reflect such inputs.

Another important limiting factor which affects the distribution of plants is light. In Lake Leland, plants do not appear to grow at depths much greater than 10 feet. It is noteworthy, however, that Brazilian elodea occurred at the 10 foot (3 meter) depth along 30% of the transects (see Figure 19 in Aquatic Plant Characterization). This is in contrast to fern leaf pondweed (*Potamogeton robbinsii*), whitestem pondweed (*Potamogeton praelongus*), and common elodea (*Elodea canadensis*), which occurred in less than 10% of the transects. Possibly, Brazilian elodea may be more adapted to deep water than native plants. However, to speak of Brazilian elodea as "taking over the lake" is an exaggeration. Planimeter measurements on Figure 4 indicate that only about 30% of the lake is 10 feet deep or less. Thus, under worst case conditions, approximately 70% of the lake would remain free from Brazilian elodea.

Dissolved oxygen is another parameter of interest relative to Brazilian elodea. During the day plants give off oxygen, but at night, when photosynthesis ceases, they actually consume oxygen. In addition, in late summer and fall when plants die back, their decomposition by bacteria and other decomposers also results in oxygen consumption. To better understand how dense stands of Brazilian elodea would affect dissolved oxygen levels, monitoring was conducted in the south end of the lake over a 24-hour period on September 3 and 4. Oxygen was measured every 4 hours at 0.5 meter depth intervals in three habitat types: dense Brazilian elodea, moderately dense Brazilian elodea/whitestem pondweed, and open water with no apparent plants (Figure 11).

Oxygen levels were generally high (8-10 mg/L) in the upper 1-2 meters in all three habitat types; below 1-2 meters, oxygen levels decreased as depth increased. Differences in oxygen levels occurred among the three habitat types, and these differences were generally greatest at the lower depths. However, regardless of depth, the pattern was invariably the same: open water had the highest oxygen levels, the moderately dense stand of Brazilian elodea/whitestem pondweed was next highest, and the dense stand of Brazilian elodea had the lowest levels.

Oxygen levels in lakes normally decrease from surface to bottom and oxygen can be very low near the bottom. Although oxygen levels at these lower depths could not sustain fish for extended periods of time, fish are known to forage in these areas for short durations.

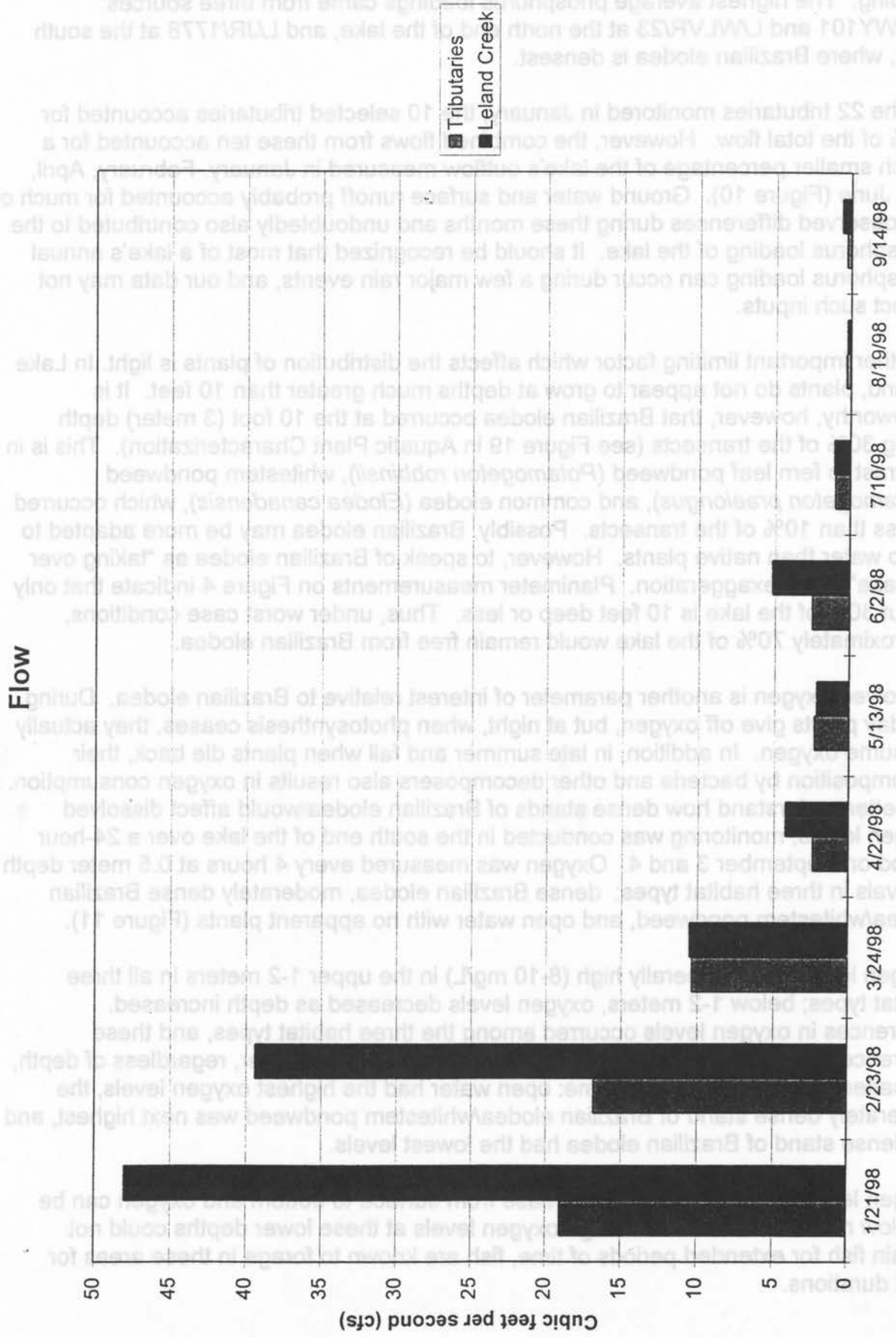

FIGURE 10 Comparison of combined flows from 10 Lake Leland tributaries to the outflow from Leland Creek by month.
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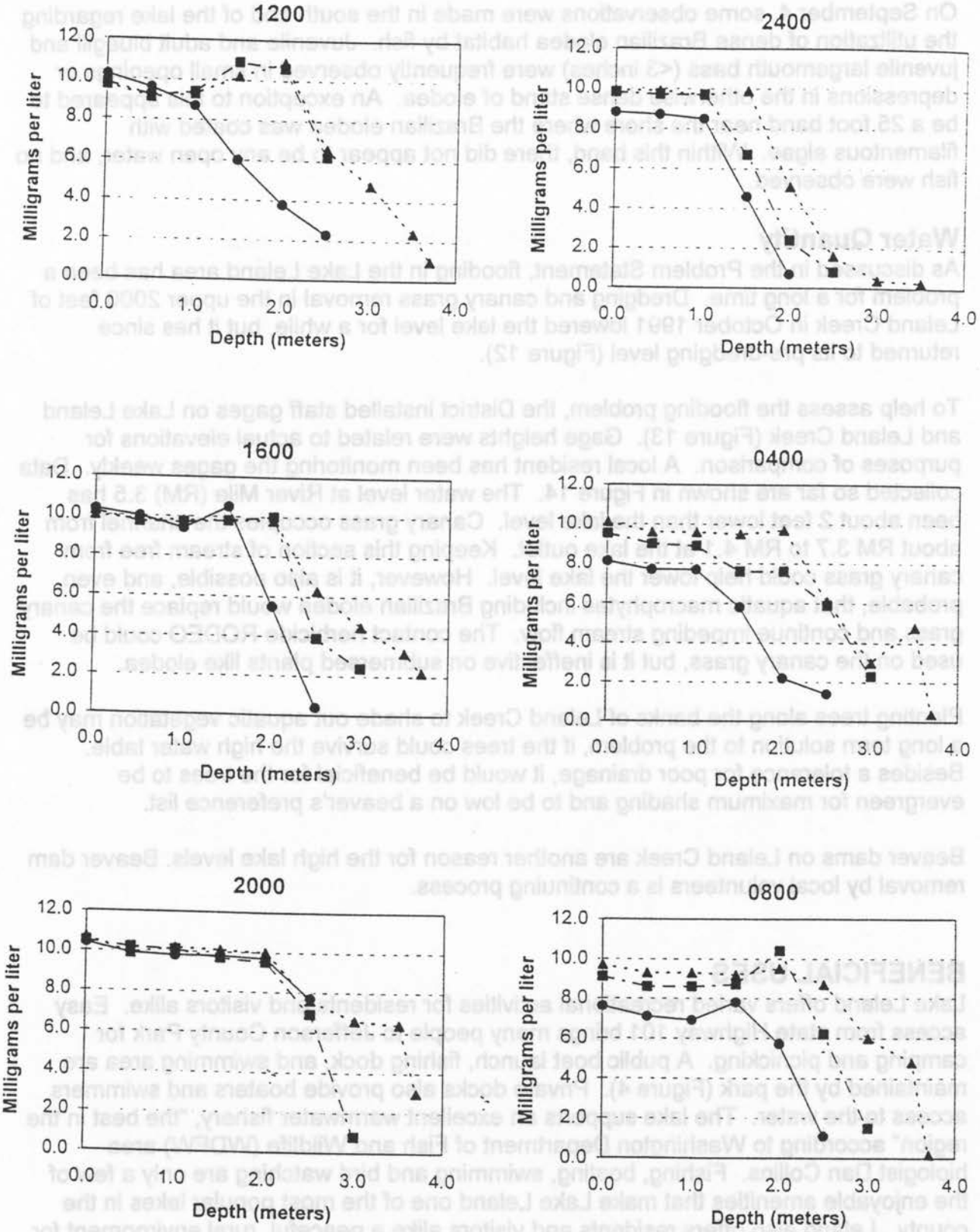

FIGURE 11 Dissolved oxygen levels measured on September 3-4, 1998 every 4 hours at 0.5 meter depth intervals in three habitat types (see legend) in the south end of Lake Leland.

On September 4, some observations were made in the south end of the lake regarding the utilization of dense Brazilian elodea habitat by fish. Juvenile and adult bluegill and juvenile largemouth bass (<3 inches) were frequently observed in small openings or depressions in the otherwise dense stand of elodea. An exception to this appeared to be a 25 foot band near the shore where the Brazilian elodea was coated with filamentous algae. Within this band, there did not appear to be any open water, and no fish were observed.

Water Quantity

As discussed in the Problem Statement, flooding in the Lake Leland area has been a problem for a long time. Dredging and canary grass removal in the upper 2000 feet of Leland Creek in October 1991 lowered the lake level for a while, but it has since returned to its pre-dredging level (Figure 12).

To help assess the flooding problem, the District installed staff gages on Lake Leland and Leland Creek (Figure 13). Gage heights were related to actual elevations for purposes of comparison. A local resident has been monitoring the gages weekly. Data collected so far are shown in Figure 14. The water level at River Mile (RM) 3.5 has been about 2 feet lower than the lake level. Canary grass occupies the channel from about RM 3.7 to RM 4.1 at the lake outlet. Keeping this section of stream free from canary grass could help lower the lake level. However, it is also possible, and even probable, that aquatic macrophytes including Brazilian elodea would replace the canary grass and continue impeding stream flow. The contact herbicide RODEO could be used on the canary grass, but it is ineffective on submersed plants like elodea.

Planting trees along the banks of Leland Creek to shade out aquatic vegetation may be a long term solution to the problem, if the trees could survive the high water table. Besides a tolerance for poor drainage, it would be beneficial for the trees to be evergreen for maximum shading and to be low on a beaver's preference list.

Beaver dams on Leland Creek are another reason for the high lake levels. Beaver dam removal by local volunteers is a continuing process.

BENEFICIAL USES

Lake Leland offers varied recreational activities for residents and visitors alike. Easy access from state Highway 101 brings many people to Jefferson County Park for camping and picnicking. A public boat launch, fishing dock, and swimming area are maintained by the park (Figure 4). Private docks also provide boaters and swimmers access to the water. The lake supports an excellent warmwater fishery, "the best in the region" according to Washington Department of Fish and Wildlife (WDFW) area biologist Dan Collins. Fishing, boating, swimming and bird watching are only a few of the enjoyable amenities that make Lake Leland one of the most popular lakes in the county. Leland also offers residents and visitors alike a peaceful, rural environment for those who want to relax and just enjoy nature.

The diversity of native vegetation throughout the Leland watershed and the lake supports a wide variety of wildlife. Both eagles and osprey are known to nest in the

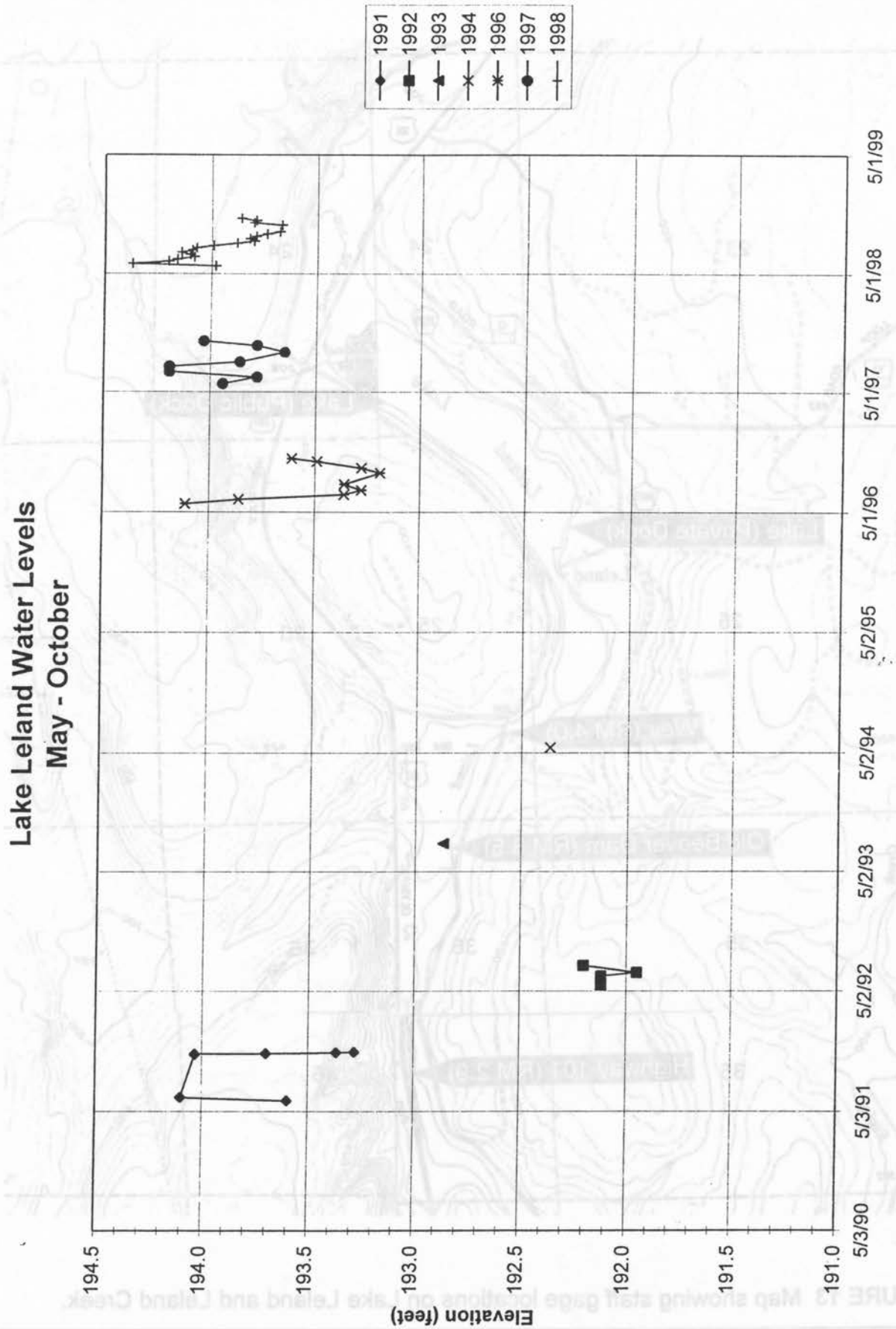

FIGURE 12 Lake Leland May to October water levels from 1991 to 1998.

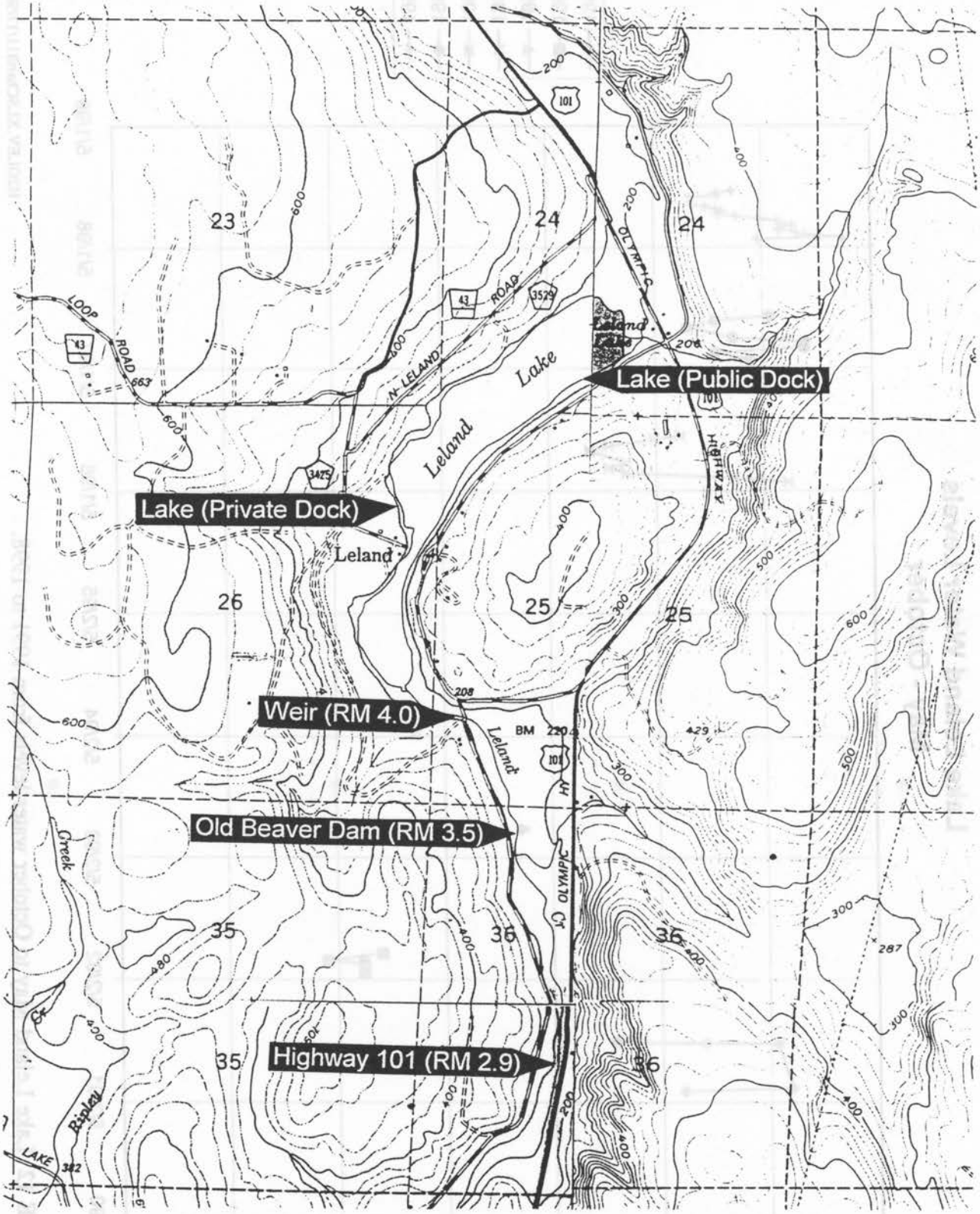

FIGURE 13 Map showing staff gage locations on Lake Leland and Leland Creek.

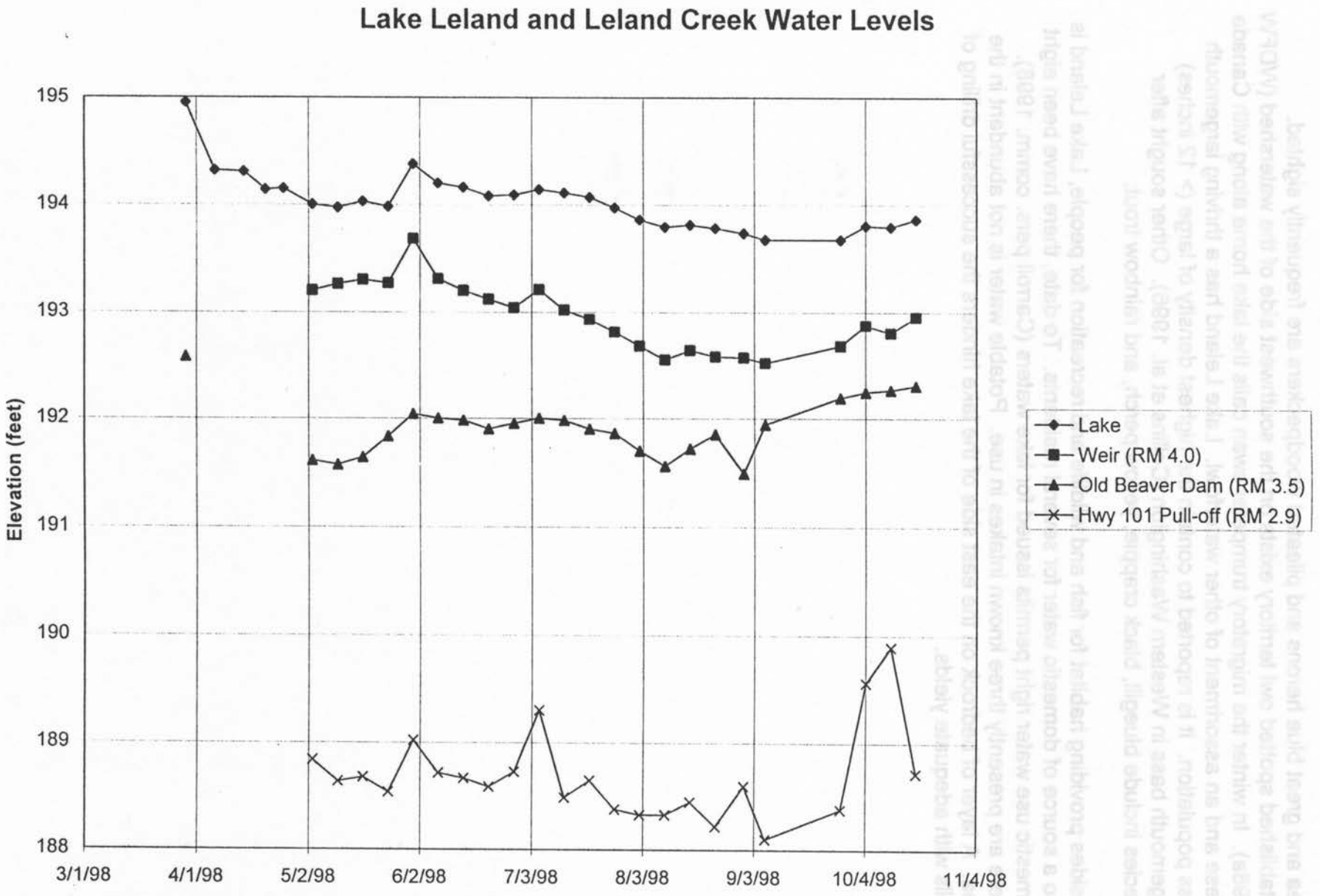

FIGURE 14 Relationship of Lake Leland water level to levels at three locations on Leland Creek from March to October 1998.

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area and great blue herons and pileated woodpeckers are frequently sighted. Established spotted owl territory exists on the southwest side of the watershed (WDFW 1998a). In winter the migratory trumpeter swan calls the lake home along with Canada geese and an assortment of other waterfowl. Lake Leland has a thriving largemouth bass population. It is reported to contain the highest density of large (> 12 inches) largemouth bass in Western Washington (Collins et al. 1996). Other sought after species include bluegill, black crappie, yellow perch, and rainbow trout.

Besides providing habitat for fish and wildlife and recreation for people, Lake Leland is also a source of domestic water for several residents. To date, there have been eight domestic use water right permits issued for lake waters (Carroll pers. comm. 1998). There are presently three known intakes in use. Potable water is not abundant in the area. A layer of bedrock on the east side of the lake hinders the successful drilling of wells with adequate yields.

AQUATIC PLANT CHARACTERIZATION

During August and September of 1997, Jefferson County Conservation District personnel characterized the aquatic plants of Lake Leland by conducting distribution and abundance surveys. The purpose of these surveys was to characterize and quantify the aquatic plant community in sufficient detail so as to be able to distinguish temporal changes in the distribution and abundance of Brazilian elodea and other aquatic plants. The surveys provide baseline data which can be used to evaluate control treatments (or no treatments).

METHODS

Distribution Monitoring

Initially, 27 transect sites, 150 meters apart, were flagged around the 4050 meters of shoreline (Figure 15). Plants were later sampled at 0.5, 1, 2, and 3 meter depths along the transects, perpendicular to the shoreline. Plant samples were collected from a boat by throwing out a "plant sampler" perpendicular to the transect (parallel to the shoreline) and retrieving it. The "plant sampler" consisted of two iron bow rakes (each with fourteen 2.25 inch tines spaced 1.0 inch apart) attached to each other back to back; one handle was completely removed and the other was shortened to 8 inches. A rope was attached to a screw-eye in the end of the shortened handle. Plants were identified and assigned an index of abundance (1=sparse, 2=moderate, 3=dense). Photos were taken to document examples of the abundance indices (Figure 16). In addition to using the "plant sampler," surveyors used visual estimates in assigning abundance indices where plants could be readily observed and identified.

Abundance Monitoring

Plant biomass was monitored at five sites (Figure 15). At each site, three transects were established parallel to the shore; one at 1 meter depth, one at 2 meters, and one at 3 meters. Transects were marked by a 25-meter floating line with an anchor and float at each end. Three samples were taken along each transect at places determined by a random number generator. Weighted lines were suspended from the marked places to pinpoint the sample location on the lake bottom. A SCUBA diver positioned a 0.5 m x 0.5 m quadrat sampler on the bottom with the weighted line in the center. The quadrat sampler, constructed of PVC pipe, actually had three sides for ease of positioning the sampler around the line. Using scissors, the SCUBA diver cut the plants within the quadrat just above the roots and placed them in a "goody" bag. At the surface the contents of the "goody" bag were transferred to a labeled plastic bag. The plastic bags were taken to a processing station on shore where the plants were sorted and identified and then placed in tarred, labeled paper bags.

Laboratory work was conducted at the US Geological Survey's Marrowstone Field Station in Nordland, Washington. Here the bags were placed in a drying oven at 105° C for 24 to 72 hours. After reaching constant weight (checked by periodic weighings), the bags were weighed to the nearest hundredth of a gram, tare weights subtracted, and the "dry plant weights" recorded.

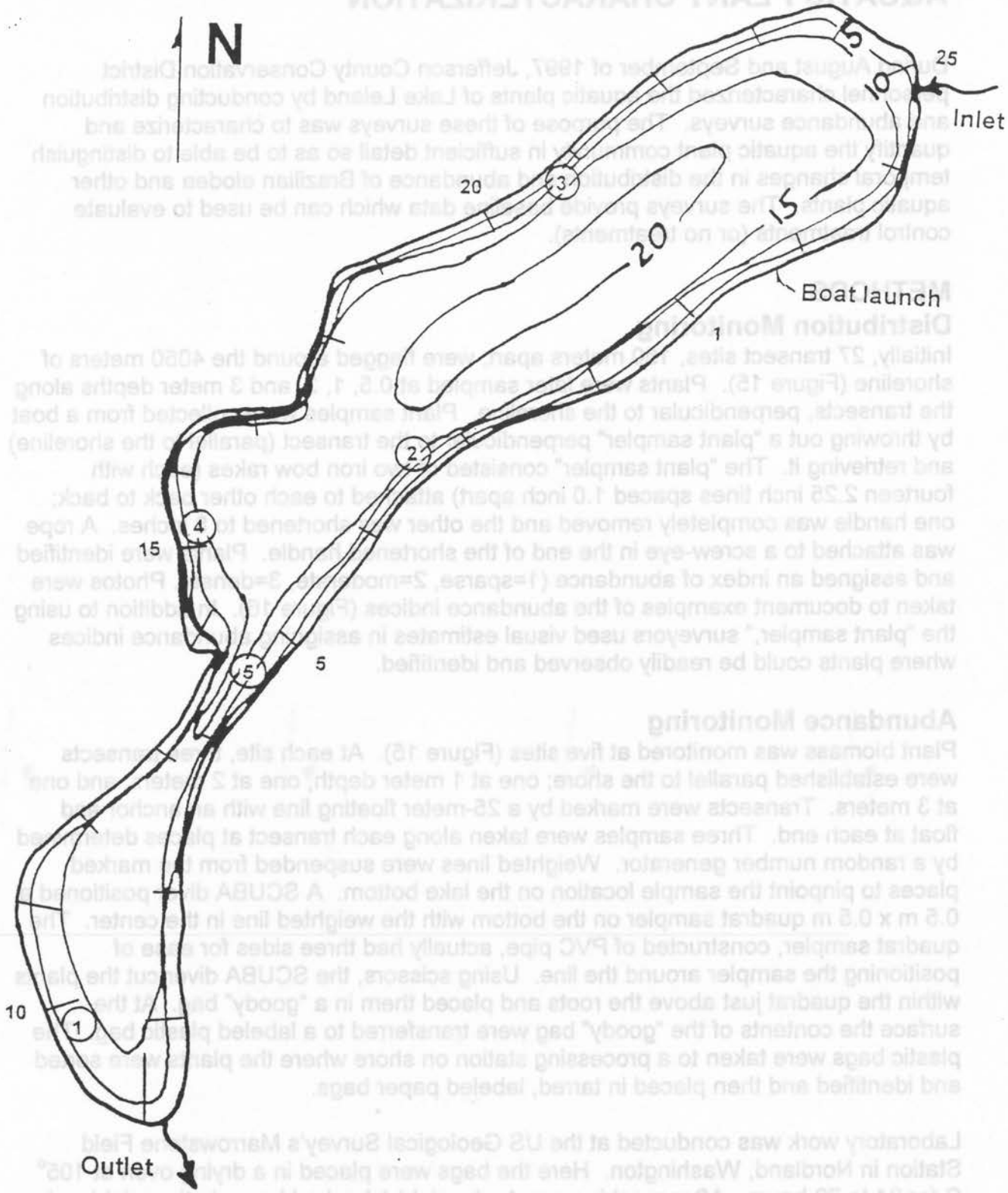

FIGURE 15 Lake Leland monitoring sites for plant distribution (lines) and plant abundance (circles). Depth contours are shown in feet.

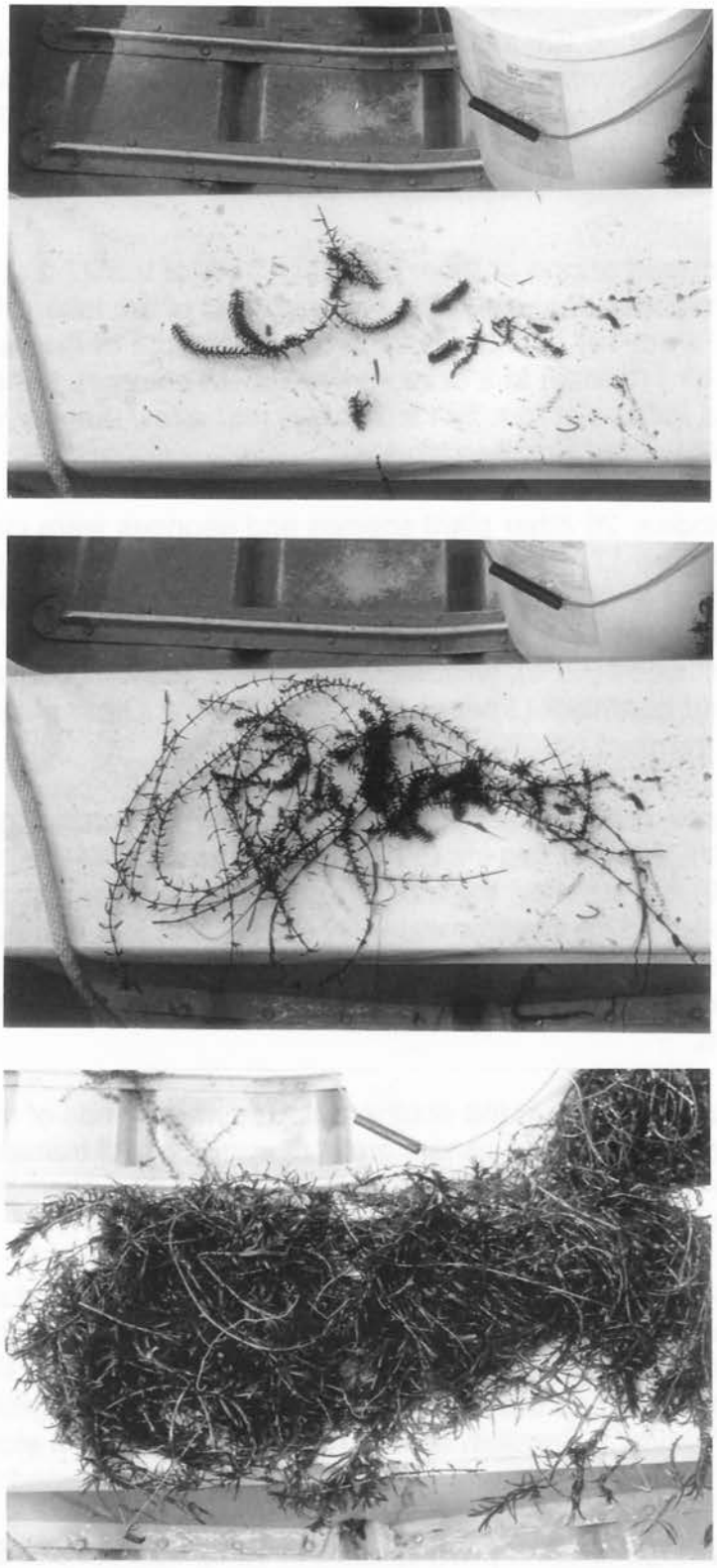

FIGURE 16 Examples of varying plant quantities representing three indices assigned to samples collected along distribution transects: 1=sparse (top), 2=moderate (middle), and 3=dense (bottom).

In the distribution monitoring, District personnel were unsure in differentiating between coontail (*Ceratophyllium demersum*) and stonewort (*Nitella spp*). All were identified as coontail in the distribution monitoring. Both plants were identified by Ecology personnel in the abundance monitoring.

RESULTS

Brazilian elodea occurred at one or more depths in 85% of the 27 distribution transects (Figure 17). The plant was densest in the southern end of the lake, where it was first observed in 1994 (Figure 18). All transects in the area south of the neck had abundance indices of 3 (dense) at 2 or more depths. In contrast, transects in the main body of the lake had indices of mostly 1's (sparse) and a few number of 2's (moderate), and 4 transects were void of Brazilian elodea.

Besides Brazilian elodea, 26 other plant species and sponges were identified in transect samples (Figure 17, Table 1). When all depths were combined, Brazilian elodea had the highest frequency of occurrence (85%), followed by common elodea (78%), yellow water-lily (*Nuphar lutea*) (70%), reed canary grass (67%), yellow flag iris (63%), fern leaf pondweed (59%), whitestem pondweed (48%), coontail and/or stonewort (33%), and hardhack (*Spiraea douglasii*) (30%). Other plant species and sponges were less frequent (<30%).

At the 0.5 meter depth, predominant plants consisted of reed canary grass (67%), Brazilian elodea (59%), yellow flag iris (59%), common elodea (44%), and yellow water-lily (33%) (Figure 19). At 1 meter, the most common plants were Brazilian elodea (59%), common elodea (52%), yellow water-lily (48%), fern leaf pondweed (37%), and yellow flag iris (30%). At 2 meters, Brazilian elodea (41%), common elodea (41%), and whitestem pondweed predominated. And at 3 meters, only Brazilian elodea (30%) was appreciably frequent.

Yellow flag iris occurred mainly in the southern and northern ends of the lake at 0.5 and 1 meter depths (Figure 20). Reed canary grass occurred on all transects in the southern end of the lake and intermittently along the main lake shoreline at 0.5 and 1 meter depths (Figure 21).

Of the five biomass sample sites, the highest dry weights occurred at site 1 in the southern end of the lake (Figure 22, Table 2). At this site, Brazilian elodea predominated at 3 meters (43 gm/m^2) and at 2 meters (223 gm/m^2). Whereas at 1 meter, fern leaf pondweed had the highest average dry weight (88 gm/m^2), followed by yellow water-lily (37 gm/m^2), Brazilian elodea (33 gm/m^2), common elodea (13 gm/m^2), coontail (8 gm/m^2), stonewort (1.1 gm/m^2), and thin leaved pondweed (0.2 gm/m^2).

Brazilian elodea outweighed other plant species in samples from site 5 on the eastern side of the neck (Figure 22, Table 2). Plant abundance at this site was greatest at the 1 meter depth where Brazilian elodea averaged 14 gm/m^2 and common elodea averaged 9 gm/m^2. At site 3, yellow water-lily (42 gm/m^2) predominated the 1 meter depth and whitestem pondweed (9 gm/m^2) predominated at the 2 meter depth. No appreciable plant biomass occurred in samples from sites 2 and 4. Brazilian elodea was found in trace amounts at these sites.

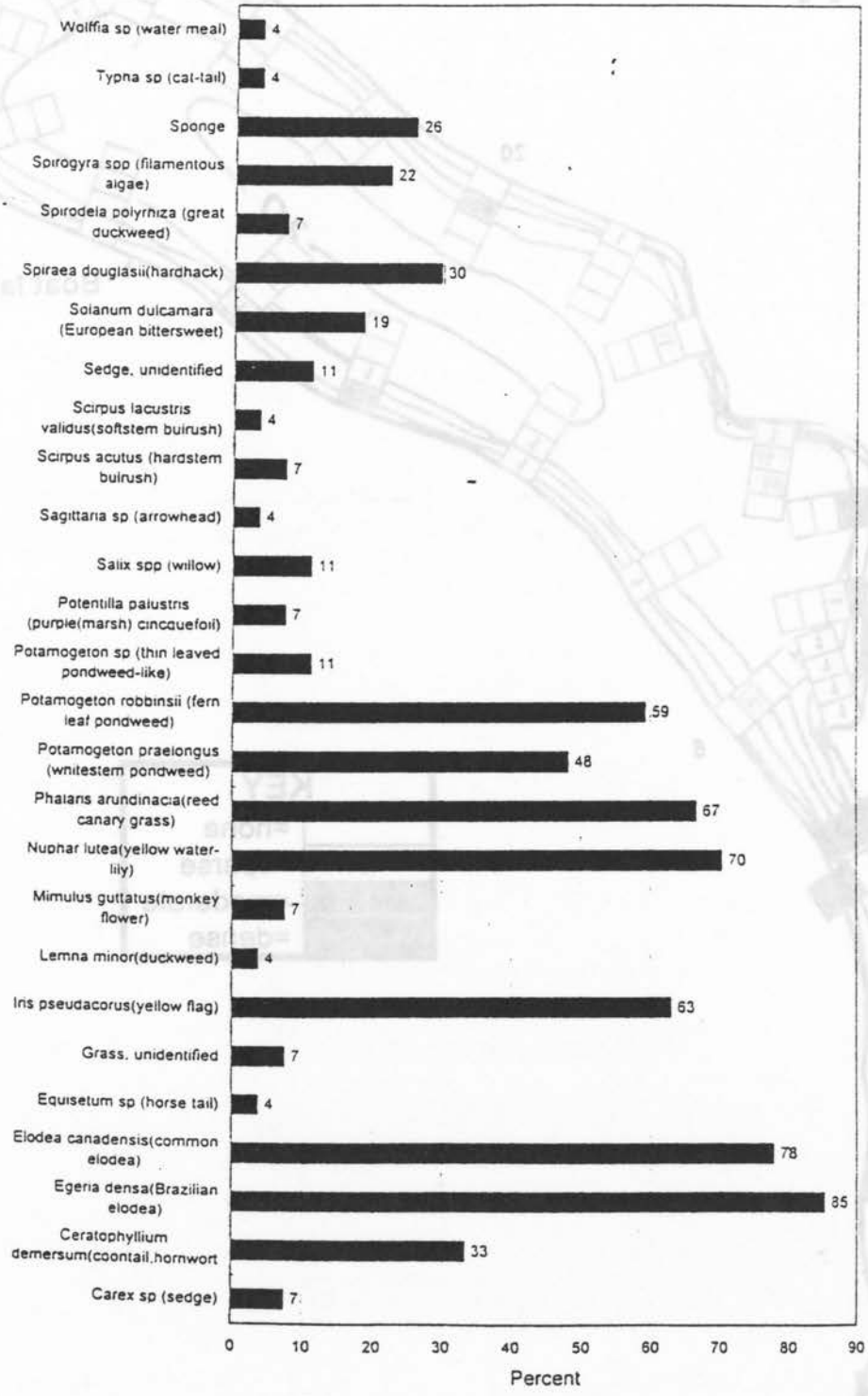

FIGURE 17 Frequency of plants occurring in 27 transects (all depths combined) sampled at 150 meter intervals around the shoreline of Lake Leland on September 3-5, 1997.

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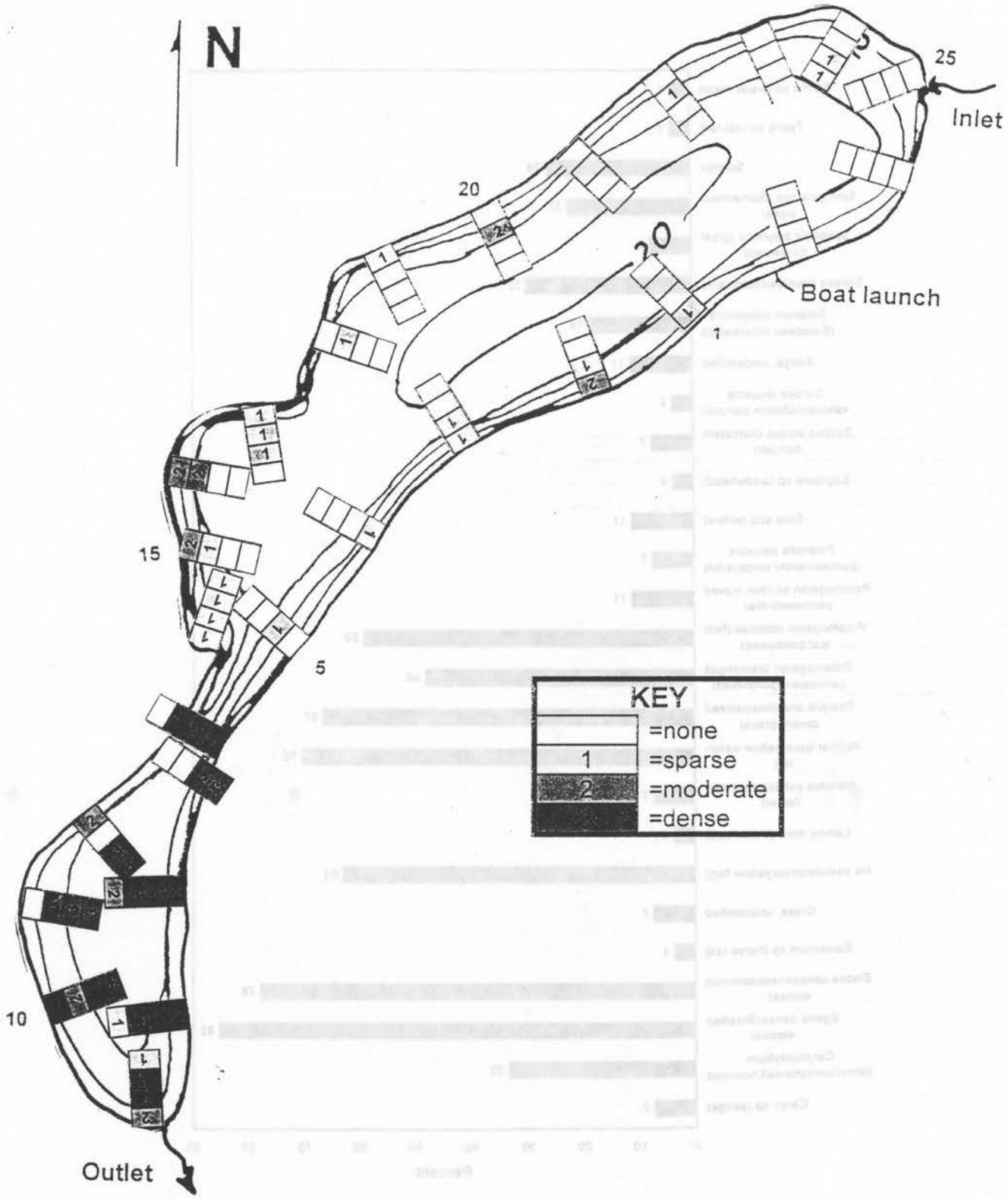

FIGURE 18 Distribution of Brazilian elodea in Lake Leland surveyed on September 3-5, 1997. Abundance indices (see key) show the relative abundance of the plant along transects at 0.5 (closest to shore), 1, 2, and 3 meter depths.

TABLE 1 Relative abundance of plants sampled at four different depths on 27 transects at 150 meter intervals around the shoreline of Lake Leland on September 3-5, 1997: 1=sparse, 2=moderate, and 3=dense. DEPALL2.XLSSheet111/2/98

Transect no.	Depth (meters)	Aquatic bryophyte(moss,liverwort)	Carex sp (sedge)	Ceratophyllium demersum(coontail,hornwort)	Egeria densa(Brazilian elodea)	Eleocharis sp (spike-rush)	Elodea canadensis(common elodea)	Equisetum sp (horse tail)	Grass, unidentified	Iris pseudacorus(yellow flag)	Lemna minor(duckweed)	Lysimachianummularia (creeping loosestrife)	Mimulus guttatus(monkey flower)	Nitella sp (stonewort)	Nuphar lutea(yellow water-lily)	Nymphaea odorata(fragrant water lily)	Phalaris arundinacia(reed canary grass)	Polamogeton amplifolius (large-leaf pondweed)	Polamogeton ephydrus(ribbonleaf pondweed)	Polamogeton praelongus (whitestem pondweed)	Potamogeton robbinsii (fern leaf pondweed)	Potamogeton sp (thin leaved pondweed-like)	Potentilla palustris (purple(marsh) cinquefoil)	Salix spp (willow)	Sagittaria sp (arrowhead)	Scirpus acutus (hardstem bulrush)	Scirpus lacustris validus(softstem bulrush)	Sedge, unidentified	Solanum dulcamara (European bittersweet)	Sparganium angustifolium (narrowleaf bur-reed)	Spiraea douglasii(hardhack)	Spirodela polyrhiza (great duckweed)	Spirogyra spp (filamentous algae)	Sponge	Typha sp (cat-tail)	Wolffia sp (water meal)
1	0.5				1		1														1														
1	1																																		
1	2																																2		
1	3																																1		
2	0.5				2		1								1		2			1														
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3	0.5				1										2		2																		
3	1				1										2																				
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3	3																																		
4	0.5				1		2			2					2		2																		
4	1			1			2								2					2														
4	2						1													1															
4	3																																1		
5	0.5									3																							2		
5	1				1		1								2						3														
5	2						1								1					2	2														
5	3																			1															
6	0.5				3		1		1	2			1				2																		
6	1				3		1						1		1																		1		
6	2			1	3		1														1														
6	3																																2		
7	0.5				3		2			2							2																		
7	1				3		2														1														
7	2				3		2													2															
7	3				2																														
8	0.5				3		1			1					2		2																		
8	1				3		1																												
8	2				3																														
8	3				1																														
9	0.5		2		2					3			2		3		3				1									1		2	3			
9	1				3					3			2				2			1	3									1			1			
9	2				3					2			2				1				3		1								1		2			
9	3				1																														
10	0.5			3	3		2			1					2		3				1									1		2				
10	1			3	2		1								2						2	1													

TABLE 1 Cont'd Relative abundance of plants sampled at four different depths on 27 transects at 150 meter intervals around the shoreline of Lake Leland on September 3-5, 1997: 1=sparse, 2=moderate, and 3=dense.

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Transect no	Depth (meters)	Aquatic bryophyte(moss,liverwort)	Carex sp (sedge)	Ceratophyllium demersum(coontail,hornwort)	Egeria densa(Brazilian elodea)	Eleocharis sp (spike-rush)	Elodea canadensis(common elodea)	Equisetum sp (horse tail)	Grass, unidentified	Iris pseudacorus(yellow flag)	Lemna minor(duckweed)	Lysimachianummularia (creeping loosestrife)	Mimulus guttatus(monkey flower)	Nitella sp (stonewort)	Nuphar lutea(yellow water-lily)	Nymphaea odorata(fragrant water lily)	Phalaris arundinacia(reed canary grass)	Potamogeton amplifolius (large-leaf pondweed)	Potamogeton epihydrus(ribbonleaf pondweed)	Potamogeton praelongus (whitestem pondweed)	Potamogeton robbinsii (fern leaf pondweed)	Potamogeton sp (thin leaved pondweed-like)	Potentilla palustris (purple(marsh) cinquefoil)	Salix spp (willow)	Sagittaria sp (arrowhead)	Scirpus acutus (hardstem bulrush)	Scirpus lacustris validus(softstem bulrush)	Sedge, unidentified	Solanum dulcamara (European bittersweet)	Sparganium angustifolium (narrowleaf bur-reed)	Spiraea douglasii(hardhack)	Spirodela polyrhiza (great duckweed)	Spirogyra spp (filamentous algae)	Sponge	Typha sp (cat-tail)	Wolffia sp (water meal)
10	2			1	3		1																												
10	3			1	3		2																												
11	0.5									3							1												2		2				
11	1			2	3		2								1						3											2			
11	2				3		1																									1			
11	3				3																														
12	0.5		1		2		1			1	1				2		2				3					1					1	2			3
12	1			1						1	1				1						3											3			3
12	2				3					1																						1			
12	3				3																												1		
13	0.5									3							1													1					
13	1									3							1													1					
13	2			2	3		2																												
13	3				3																														
14	0.5				1																														
14	1				1																														
14	2				1		1																											2	
14	3				1																														
15	0.5				2		2															1					2		1						
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15	3						1																												
16	0.5				2		1										2				1					2									
16	1				2		2		1												1														
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16	3																																		
17	0.5				1																														
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19	3																																		

TABLE 1 Cont'd Relative abundance of plants sampled at four different depths on 27 transects at 150 meter intervals around the shoreline of Lake Leland on September 3-5, 997: 1=sparse, 2=moderate, and 3=dense.

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Transect no.	Depth (meters)	Aquatic bryophyte(moss,liverwort)	Carex sp (sedge)	Ceratophyllium demersum(coontail,hornwort)	Egeria densa(Brazilian elodea)	Eleocharis sp (spike-rush)	Elodea canadensis(common elodea)	Equisetum sp (horse tail)	Grass, unidentified	Iris pseudacorus(yellow flag)	Lemna minor(duckweed)	Lysimachianummularia (creeping loosestrife)	Mimulus guttatus(monkey flower)	Nitella sp (stonewort)	Nuphar lutea(yellow water-lily)	Nymphaea odorata(fragrant water lily)	Phalaris arundinacia(reed canary grass)	Potamogeton amplifolius (large-leaf pondweed)	Potamogeton epihydrus(ribbonleaf pondweed)	Potamogeton praelongus (whitestem pondweed)	Potamogeton robbinsii (fern leaf pondweed)	Potamogeton sp (thin leaved pondweed-like)	Potentilla palustris (purple(marsh) cinquefoil)	Salix spp (willow)	Sagittaria sp (arrowhead)	Scirpus acutus (hardstem bulrush)	Scirpus lacustris validus(softstem bulrush)	Sedge, unidentified	Solantm dulcamara (European bittersweet)	Sparganium angustifolium (narrowleaf bur-reed)	Spirgea douglasii(hardhack)	Spirodela polyrhiza (great duckweed)	Spirogyra spp (filamentous algae)	Sponge	Typha sp (cat-tail)	Wolffia sp (water meal)
20	0.5									3					1														1						
20	1				2					3					1					2										1					
20	2																			2	1														
20	3																																		
21	0.5									3							1							1						1					
21	1						1			3					2					1							1					1			
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21	3																				1												1		
22	0.5				1					1							1			1															
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23	0.5									3							2													1					
23	1						1			3					2					2			2							1					
23	2		1				1								1					3	2														
23	3																																		
24	0.5									3							2							1					1		1				1	
24	1				1					3							2					1							1		1				
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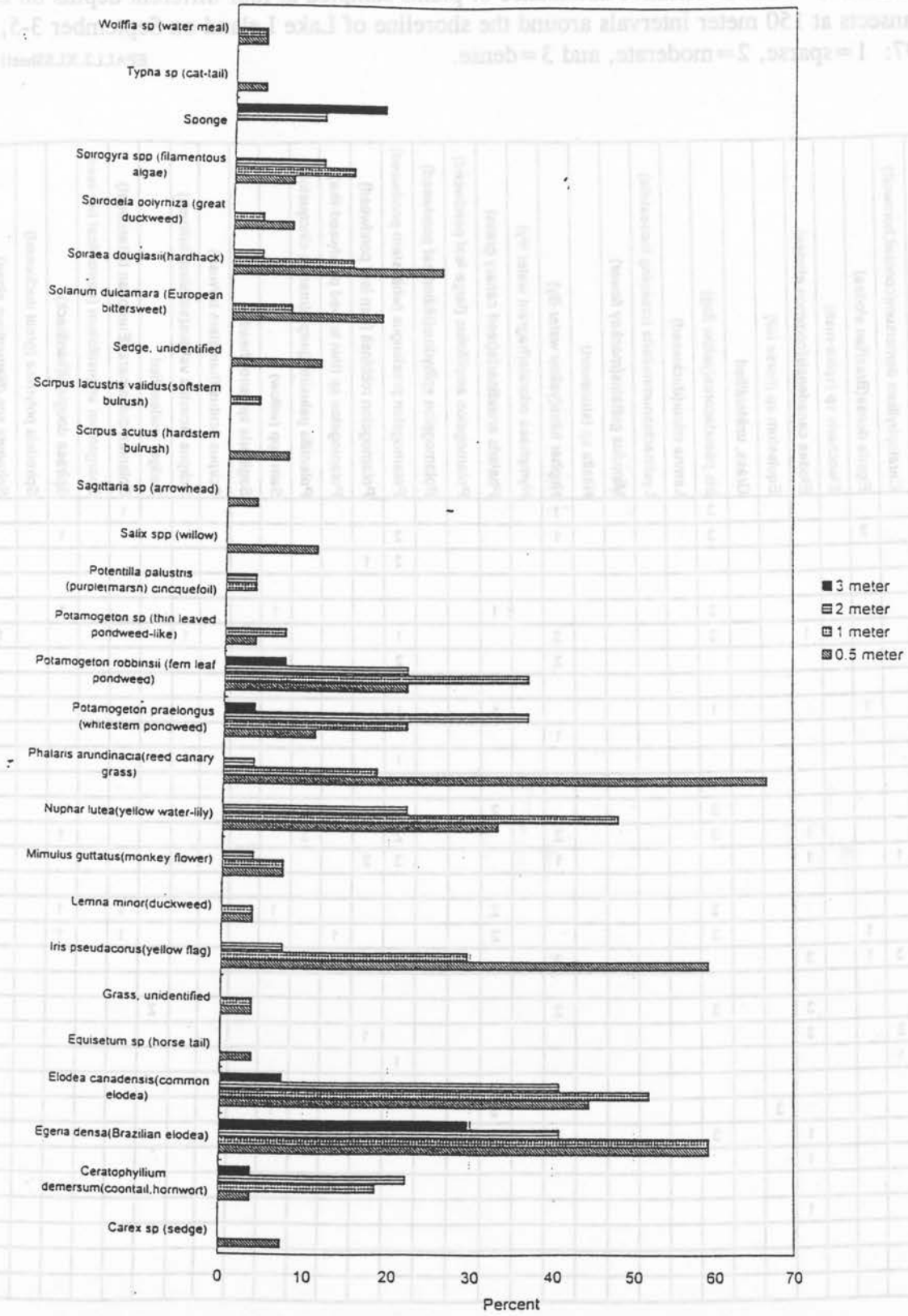

FIGURE 19 Frequency of plants occurring in 27 transects at four different depths sampled at 150 meter intervals around the shoreline of Lake Leland on September 3-5, 1997.

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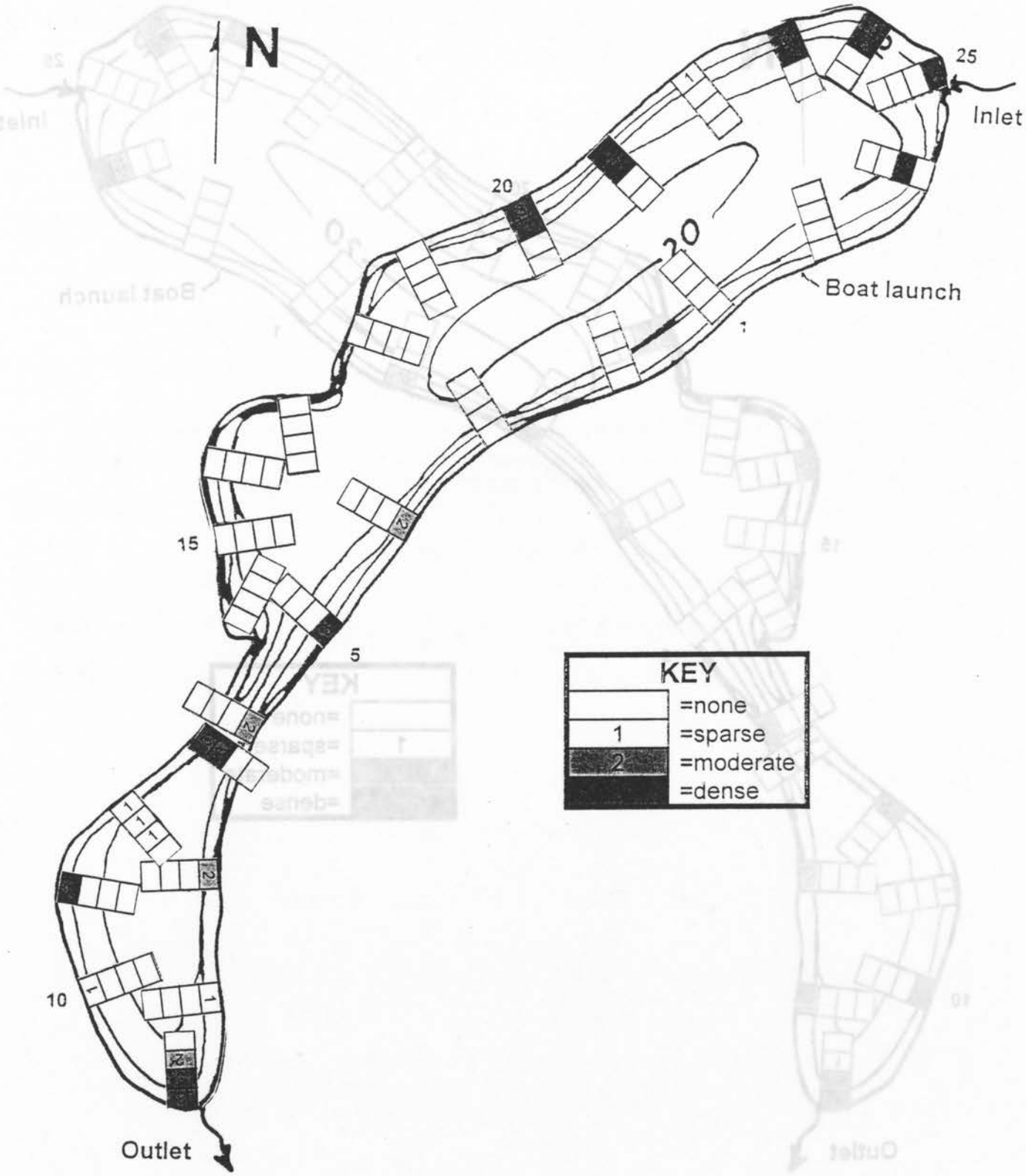

FIGURE 20 Distribution of yellow flag iris in Lake Leland surveyed on September 3-5, 1997. Abundance indices (see key) show the relative abundance of the plant along transects at 0.5 (closest to shore), 1, 2, and 3 meter depths.

FIGURE 21 Distribution of reed canary grass in Lake Leland surveyed on September 3-5, 1997. Abundance indices (see key) show the relative abundance of the plant along transects at 0.5 (closest to shore), 1, 2, and 3 meter depths.

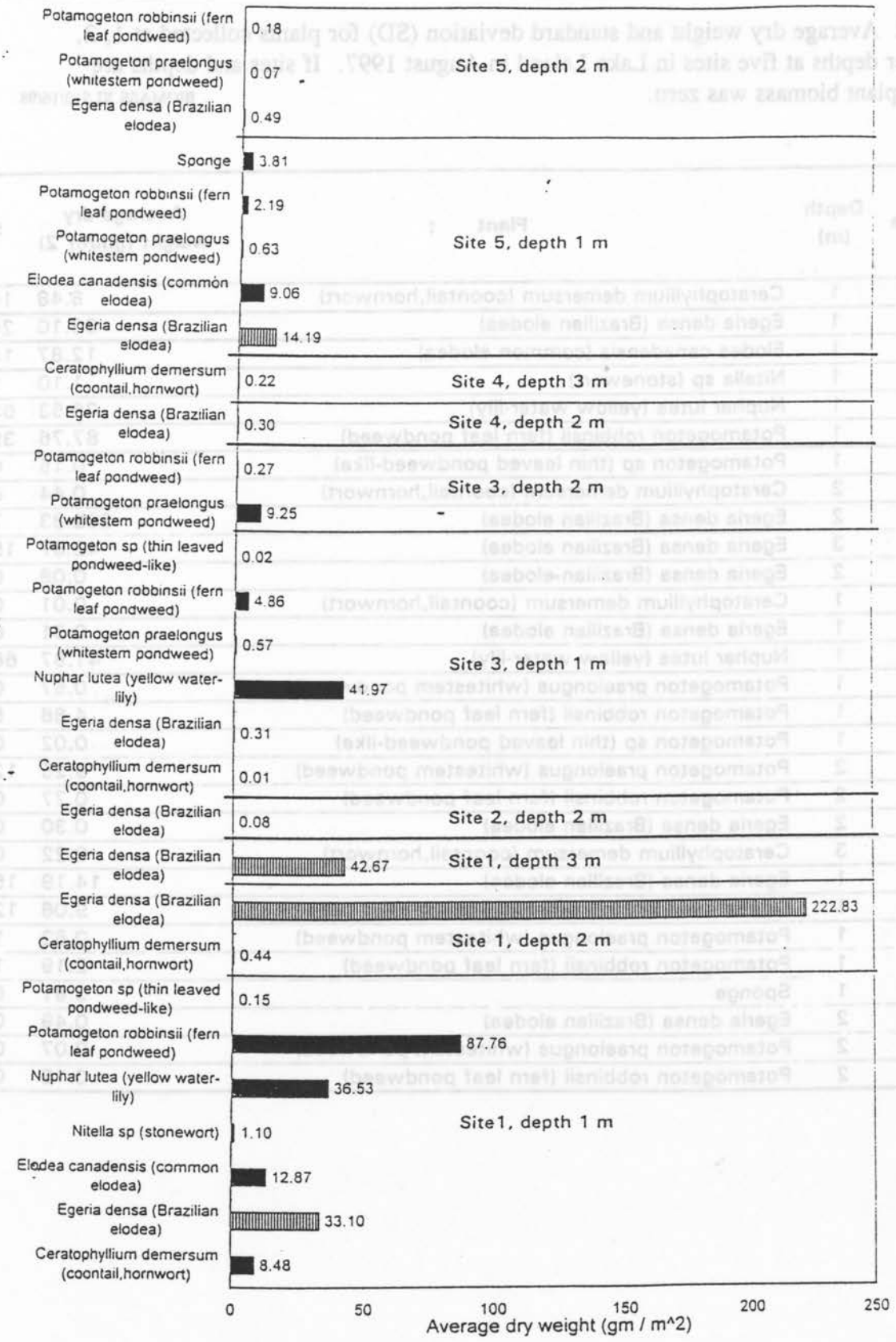

FIGURE 22 Biomass by site and depth of plants sampled in Lake Leland in August 1997. For sites and depths not listed, biomass was zero. BIOMASS.XLS10/18/98

TABLE 2 Average dry weight and standard deviation (SD) for plants collected at 1, 2, and 3 meter depths at five sites in Lake Leland in August 1997. If sites and depths are not listed, plant biomass was zero.

BIOMASS.XLS10/16/98

Date	Site	Depth (m)	Plant	Average dry weight (gm/m^2)	SD
8/27/97	1	1	Ceratophyllium demersum (coontail,hornwort)	8.48	10.32
8/27/97	1	1	Egeria densa (Brazilian elodea)	33.10	26.82
8/27/97	1	1	Elodea canadensis (common elodea)	12.87	18.74
8/27/97	1	1	Nitella sp (stonewort)	1.10	1.85
8/27/97	1	1	Nuphar lutea (yellow water-lily)	36.53	63.27
8/27/97	1	1	Potamogeton robbinsii (fern leaf pondweed)	87.76	39.97
8/27/97	1	1	Potamogeton sp (thin leaved pondweed-like)	0.15	0.25
8/27/97	1	2	Ceratophyllium demersum (coontail,hornwort)	0.44	0.76
8/27/97	1	2	Egeria densa (Brazilian elodea)	222.83	7.96
8/27/97	1	3	Egeria densa (Brazilian elodea)	42.67	15.43
8/27/97	2	2	Egeria densa (Brazilian elodea)	0.08	0.14
8/27/97	3	1	Ceratophyllium demersum (coontail,hornwort)	0.01	0.02
8/27/97	3	1	Egeria densa (Brazilian elodea)	0.31	0.34
8/27/97	3	1	Nuphar lutea (yellow water-lily)	41.97	66.12
8/27/97	3	1	Potamogeton praelongus (whitestem pondweed)	0.57	0.99
8/27/97	3	1	Potamogeton robbinsii (fern leaf pondweed)	4.86	5.32
8/27/97	3	1	Potamogeton sp (thin leaved pondweed-like)	0.02	0.03
8/27/97	3	2	Potamogeton praelongus (whitestem pondweed)	9.25	12.60
8/27/97	3	2	Potamogeton robbinsii (fern leaf pondweed)	0.27	0.47
8/27/97	4	2	Egeria densa (Brazilian elodea)	0.30	0.52
8/27/97	4	3	Ceratophyllium demersum (coontail,hornwort)	0.22	0.38
8/11/97	5	1	Egeria densa (Brazilian elodea)	14.19	15.53
8/11/97	5	1	Elodea canadensis (common elodea)	9.06	12.96
8/11/97	5	1	Potamogeton praelongus (whitestem pondweed)	0.63	1.10
8/11/97	5	1	Potamogeton robbinsii (fern leaf pondweed)	2.19	1.92
8/11/97	5	1	Sponge	3.81	6.60
8/11/97	5	2	Egeria densa (Brazilian elodea)	0.49	0.84
8/11/97	5	2	Potamogeton praelongus (whitestem pondweed)	0.07	0.13
8/11/97	5	2	Potamogeton robbinsii (fern leaf pondweed)	0.18	0.31

DISCUSSION

Based on these results, Brazilian elodea appears to rank highest both in terms of distribution and abundance. And this has occurred in only four years from the time it was first noticed. Brazilian elodea is unquestionably a very competitive plant, probably the most competitive submersed plant in Lake Leland. It grows well at all depths within the littoral zone (about 0-10 feet deep). At the present rate of increase, it probably will eventually occupy a large part of Lake Leland's littoral zone.

PUBLIC INVOLVEMENT

The Leland Community has a long standing history of public involvement with the formation of the Leland Neighborhood Improvement Club in 1907. The purpose, as noted at the time "...shall be social, civic, and more particularly, the improvement of the Leland Community." In recent years "improvement" has grown to encompass the protection and the enhancement of the quality of life in the Leland area. Concern for water quality has been a discussion point at meetings. The spread of "the weed" (unknown by name at the time) in the south end of the lake was of great interest. After identification of Brazilian elodea in 1994 by Department of Ecology, Kathy Hamel and Jenifer Parsons, representing Ecology, were invited to a Leland meeting to discuss the presence of Brazilian elodea in the lake. Club President Chris Hertel proceeded to approach Jefferson County Commissioners and Jefferson County Parks and Recreation for help in the matter. Eventually, with the assistance of the Jefferson County Conservation District, grant funding was awarded for a Lake Leland Brazilian elodea study through the Department of Ecology's Aquatic Weeds Management Fund. The dedication of several community members brought this about. There has never been a question of community involvement as the community has had an active interest in the quality of life at Leland for decades.

In July of 1997, a community outreach was initiated to include all Leland area property owners, both residents and non-residents, in the IAPMP planning process. A letter was sent to these individuals with information regarding the presence of Brazilian elodea in the lake and explaining the aquatic plant management plan process. The community was asked for their input and support and was informed of a public meeting regarding the issue (Appendix D). Nearly 100 letters were sent out and an article was published in the local newspaper. Several property owners were unable to attend but did request to be kept informed on the matter. The meeting was attended by eleven community members.

From this point a steering committee, comprised of representation from the local community and concerned county and state agencies, was formed. Tribal interests (Peter Bahls, Port Gamble S'Klallam Tribe) were asked for input and kept informed of the process and decisions made. The Jefferson County Conservation District took a lead role in the proceedings. The Lake Leland IAPMP steering committee consists of the following members:

- Doug Barley (Leland property owner)
- George Bauer (Leland resident and property owner)
- Linda Bauer (Leland resident and property owner)
- Don Case (Leland resident and property owner)
- Lowell Davis (Leland resident and property owner)
- Bruce Munn (Leland resident and property owner)
- Jim Munn (Leland resident and property owner)
- Hector Munn (Leland property owner)
- Joanne Peterson (Leland resident and property owner)

- David Christensen (Jefferson County Environmental Health)
- Glenn Gately (Jefferson County Conservation District)
- Al Latham (Jefferson County Conservation District)
- Lauren Mark (Jefferson County Development Review Division)
- Warren Steurer (Jefferson County Parks and Recreation)
- Susan Taylor (Leland resident, property owner, and Jefferson Conservation District)
- Dan Collins (Washington Department of Fish and Wildlife)
- Kathy Hamel (Washington Department of Ecology)

Community members were encouraged to participate, and meetings were open to all interested parties. The community at large was kept informed by committee members, newsletters, and local newspaper articles (Appendix D). During the planning process, the committee met formally five times. Meetings were held on November 14, 1997, January 9, February 6, March 20, and November 18, 1998 (Appendix B).

Two public workshops were held: the first in August of 1997 and the second in late September of 1998. At the first workshop, interested residents were trained in aquatic plant identification and familiarized with plant monitoring methods. The planning process was discussed, and community volunteers came forward to form the beginning of the steering committee. Following this workshop, photographs of the training were displayed at the Jefferson County Conservation District's booth at the Quilcene Fair. At the booth, information on the Leland Project and on the prevention of the spread of noxious aquatic weeds was made available to the public. The second workshop was held to demonstrate the use of some of the hand control methods that had been discussed in meetings. This event took place at a private dock in the south end of the lake where the Brazilian elodea is most prevalent (Appendix D). Both workshops were well attended. The dedication and commitment of Leland community members who value the quality of their surroundings was very evident.

AQUATIC PLANT CONTROL ALTERNATIVES

Treatment methods for the control of noxious aquatic plants are various (physical, mechanical, biological, chemical) and may be initiated for the short term or long term. What works in one situation may not work in another. Or perhaps a combination of treatments might be best. The steering committee examined each available option in terms of suitability for Lake Leland. Environmental effects, costs, user friendliness, effectiveness, and permitting were points for evaluation. Management of Lake Leland as a whole with its variety of uses (wildlife habitat, excellent fishery, domestic water source, recreation) was taken into account. Both the advantages and disadvantages of each control method were considered.

The following descriptions were excerpted from A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans (Gibbons et al. 1994) and Aquatic Plants and Fish (WDFW 1998b). Additional information was gathered from presentations by Kathy Hamel (Ecology), Scott Bonar (WDFW), and Dan Collins (WDFW).

The following is a list of control alternatives as presented to the steering committee by Kathy Hamel. Those controls most pertinent to Lake Leland or Leland Creek are in **bold**.

Physical Controls
- **Hand-pulling / cutting**
- **Bottom barrier**
- Water level drawdown

Mechanical Controls
- Harvesting and cutting
- Rotovation
- Diver-operated dredging

Biological Controls
- **Triploid grass carp**

Chemical Controls
- Fluridone
- **Glyphosate**
- Endothall

No Action Alternative

PHYSICAL CONTROLS

HAND-PULLING

Description Hand-digging and removal of rooted, submerged plants is a labor intensive control method. This method involves digging out the entire plant with roots. Plants are then deposited in a dry disposal area away from the shoreline. No specialized gear is required in waters less than three feet. In deeper waters, hand pulling is most efficient with divers using snorkeling equipment or SCUBA gear. Divers carry mesh bags for collection of plants. Plants then need to be disposed of on shore.

Effectiveness and Duration Sediment type, visibility, and thoroughness in removal of the entire plant, particularly the roots, all affect the speed at which plants are removed. A high degree of control, lasting more than one season, is possible when complete removal has been achieved.

Advantages This method results in immediate clearing of the water column of nuisance plants. The technique is very selective in that individual plants are removed. It is most useful in sensitive areas where disruption must be kept to a minimum and also works well in hard to get places. It is a highly labor intensive control and, therefore, most appropriate in small or low density areas. Environmental impacts, including turbidity increases and bottom disruption, are short-term.

Disadvantages This method is time-consuming and can be very costly if contract divers are employed. Diver visibility may become obscured by the digging process, making it difficult to see and remove roots. Hand-pulling is not practical for large areas.

Costs Costs will vary depending on whether contract divers and laborers or volunteers are used. According to the 1994 IAVMP Manual, expenses can run between $500 to $2400 per day.

Permits Hydrologic Project Approval (HPA) is required from Washington Department of Fish and Wildlife at no charge. The process includes requesting and reading a pamphlet titled Aquatic Plants and Fish (WDFW 1998b). The booklet itself serves as the HPA and is available from WDFW area habitat biologist Chris Byrnes, Port Orchard, WA, 360-895-6123.

Appropriateness for Lake Leland This method would be useful for small-area, short-term control of Brazilian elodea around private docks and along short shoreline segments. Some type of boom or boat could be used to help collect fragments. Hand-pulling or digging is also suggested as a control method for the removal of yellow flag iris, although residents who have tried this report that it is very labor intensive.

HAND-CUTTING

Description This is also a manual method but does not involve hand-pulling the roots. The plants are cut or torn using tools that can be pulled through the weed beds by boat or manually. This work can be done using hand held cutting tools, some of which may

be powered. Items such as rakes, chains, logs, railroad ties, or even old bedsprings may be dragged across the bottom to collect plants. Collected plants should be disposed of at a dry land location. Because roots are not removed, this is a less intensive removal technique. Mechanized weed cutters are also available that can be operated from the surface for small-scale control (similar to an underwater lawnmower). And mechanized weed rollers, which flatten and wear down weeds by frequent agitation, are useful around docks. Weed rollers can be shared by neighbors but are cumbersome to install.

Effectiveness and Duration With hand-cutting, root systems and lower stems are left intact. As a result, effectiveness is usually short-term as rapid regrowth is possible from the remaining root masses. Duration of control is limited to the time it takes the plant to grow to the surface (probably less than one season). With a weed roller, control is achieved on a continuos basis.

Advantages Hand-cutting and mechanized weed cutters or rollers result in immediate removal of the nuisance plant and quickly create open water for swimming or fishing. Hand-cutting is similar to hand-pulling but costs can be minimal. Hand-cutting is site specific and can be species specific, if care is used, which minimizes environmental disruption. Mechanized rollers and cutters are site specific and offer low-cost operation after the initial purchase.

Disadvantages The hand-cutting method is time-consuming and labor intensive. Visibility may become obscured by turbidity generated during cutting activities. This technique does not result in long-term reductions in growth because roots are left intact. Duration of control of Brazilian elodea would be minimal, probably less than one season. Cut plants must be removed from the water. Fragments are numerous, making clean up messy and laborious. This method is not practical for large areas. Mechanized weed rollers and cutters are expensive to purchase and require maintenance and are not species specific. Weed rollers are not permitted for removal of early infestations of noxious aquatic weeds because they create fragments and might help spread the plant to new locations.

Costs Assuming volunteers are used, costs are limited to the purchase of cutting implements. This can vary from under $100 for the Aqua Weed Cutter (Sunrise Corp.) to approximately $1500 for the mechanized underwater lawnmower Swordfish (Redwing Products). A Water Weed Cutter (Aquacide Company) was purchased for $135 and found to be a very effective tool.

Permits The permitting process is the same as for hand-pulling.

Appropriateness for Lake Leland Hand cutting of Brazilian elodea would be most applicable for short-term and small-scale control around private docks and in light areas of infestation along the shoreline. A hand-cutting tool called the Water Weed Cutter was demonstrated during the tool effectiveness workshop. It was used to clear a heavily infested area around a dock and was found quite easy to use. The actual weed cutting with the tool went rather quickly. The time consuming element was the collection of the weed fragments. One should note that though the tool is easy to use it

is quite sharp and could be dangerous if safety is not kept in mind. In order to keep a dock weed-free with this cutter, one would probably need to use it several times a season. The mechanized weed roller may be used around private docks, but the area needs to be free of obstructions.

BOTTOM BARRIER

Description Barrier material is applied over the lake bottom to prevent plants from growing. Bottom covering materials such as sand-gravel, polyethylene, polypropylene, synthetic rubber, burlap, fiberglass screens, woven polyester, and nylon film have all been used with varying degrees of success. Typically, synthetic (geo-textile) fabrics or burlap are used. Bottom barriers can be used at any depth, with divers often utilized for deeper water treatments. Usually, bottom conditions (presence of rocks or debris) do not impede barrier applications, although pre-treatment clearing of the site is often useful.

Effectiveness and Duration Bottom barriers create an immediate open water area. Duration of control is dependent on a variety of factors, including type of material used, application techniques, and sediment composition. Synthetic materials like Aquascreen and Texel have eliminated nuisance plant conditions for at least the season of application. If short-term control is desired for the least expense, burlap is a good choice of materials. It has been known to provide up to two to three years of relief from problematic growth before eventually decomposing (Truelson 1989). The intensity of control is high. In some situations, after satisfactory control has been achieved (usually several months), bottom barriers may be relocated to other areas to increase benefits.

Advantages Bottom barriers can usually be easily applied to small, confined areas such as around docks, boat launches, or swimming beaches. They can be installed by homeowners. Bottom barriers are hidden from view and do not interfere with shoreline use. They are site specific and can be installed around obstructions. Bottom barriers do not result in significant production of plant fragments (advantageous for Brazilian elodea treatment). Barriers are most appropriately used for localized, small-scale control where exclusion of all plants is desirable.

Disadvantages Depending on the material, major drawbacks to the application of bottom barriers include some or all of the following: control not species specific, high material cost if used on a large scale, labor-intensive installation, limited material durability, possible suspension due to water movement or gas accumulation beneath material, eventual regrowth of plants from above material, requires area free of large obstructions. Periodic maintenance (yearly) of bottom barrier materials is beneficial to remove accumulations of silt and any rooting fragments. In some situations, removal and relocation of barriers may not be possible (natural fiber burlap decomposes over time). If used over a large area, sediment covers can produce environmental impacts such as a decrease in the populations of bottom-dwelling organisms like aquatic insects.

Costs Bottom barrier material costs vary depending on the type of material used. Rolls of synthetic material for aquatic barrier use can be purchased in 300 foot lengths and either 12 or 15 foot widths for $300 to $350. Rolled burlap material (available in

fabric stores or outlets) averages from $0.15 to $0.25 / sq. ft. Costs for professional installation are an additional $0.25-$0.50 / sq. ft. A Leland community member has installed a bottom barrier using a 20 X 20 ft plastic tarp. These are relatively inexpensive to purchase at a local hardware store. Current costs are about $8.50 for an 8 x 10 ft tarp and $25 for a 16 x 20 ft tarp.

Permits The permit process is the same as for hand-pulling but prior authorization from WDFW is required for projects that exceed specified thresholds. See Aquatic Plants and Fish (WDFW 1998b) for specific information.

Appropriateness for Lake Leland Bottom barriers would be appropriate around docks at Lake Leland where there are no large obstructions and also along short stretches of shoreline. Cost and maintenance of bottom barriers confine them to very small-scale use. One barrier is currently being tested in front of a dock in the heavily infested south end of the lake. This barrier was cheaply constructed with a 20 X 20 ft plastic tarp which was tied to a frame of plastic pipe. Rebar was inserted in the pipe to weight it down. Sandbags or other weights could also be used. Ecology Publications offers a fact sheet on building bottom barriers (Appendix E). This and other publications may be obtained at no cost by calling Jean Witt, Ecology Publications at 306-407-7472.

WATER LEVEL DRAWDOWN

Description Drawdown involves exposing plants and root systems to prolonged freezing and loss of water. It is generally performed in winter months. The use of drawdown as an aquatic plant management tool is more common for use in reservoirs and ponds than in natural lakes. A water control structure for drainage or high capacity pumps are needed to draw the water down.

Effectiveness and Duration Although freezing can have a dramatic impact on some plants, Brazilian elodea is known to have over-winter buds. Also, temperatures in the Leland area rarely reach the sub-zero temperatures that would be necessary for a large scale kill.

Appropriateness for Lake Leland Drawdown is not feasible at Lake Leland. Because of this, advantages, disadvantages, costs, and permits relating to drawdown were not addressed.

MECHANICAL CONTROLS

HARVESTING / CUTTING

Description Mechanical harvesters are large floating machines that cut plants below the water surface. Harvesting is considered a short-term technique that temporarily removes nuisance plants. To achieve maximum removal of plant material, harvesting is usually performed during summer when submersed and floating-leafed plants have grown to the water's surface. Conventional single-staged harvesters combine cutting, collecting, storing, and transporting vegetation into one piece of machinery. Cutting machines are also available which perform only the cutting function. Maximum cutting

depths for harvesters and cutting machines range from 5 to 8 feet with a swath width of 6.5 to 12 feet.

Effectiveness and Duration The immediate effectiveness of harvesting is creating open water. The duration of control is variable. Factors such as frequency and timing of harvest, water depth, and depth of cut may influence the duration of control. Harvesting has not proven to be an effective means of sustaining long-term reductions in the growth of milfoil. Regrowth of milfoil to pre-harvest levels typically occurs within 30-60 days (Perkins and Sytsma 1987) depending on water depth and the depth of cut. Aquatic plant researchers note that any effects on the control of Brazilian elodea would also be short term.

Advantages Harvesting is most suitable for large lakes and open areas with few surface obstructions. A specific location can be targeted leaving an area open for fish and wildlife. There is usually little interference with recreational use of the water body during harvesting operations. By cutting only the top 5 ft of the plant, some habitat remains. Harvesting has the added benefit that removal of in-lake plant biomass also eliminates a source of nutrients, often released during fall die back and decay. This is of important consequence in those water bodies with extensive plant beds and low nutrient inputs from outside sources. Furthermore, harvesting can reduce sediment accumulation by removing organic matter that normally decays and adds to the bottom sediments. Depending on species content, harvested vegetation can be easily composted and used as a soil enhancement.

Disadvantages Cut plant material requires collection and removal from the water with off-loading sites needed for plant disposal. Collecting machines fill up very quickly which makes the process quite lengthy. Harvesting creates numerous plant fragments which would contribute to the spread of Brazilian elodea. It is not species specific and can be detrimental to juvenile fish which are removed indiscriminately by the process. Harvesting can enhance the growth of opportunistic plant species that invade treated areas. Capital costs for the machine purchase are high ($35,000-$150,000) and equipment requires considerable maintenance. Harvesters are not very efficient and repeated treatments are necessary--rather like mowing a lawn.

Costs Harvesting costs depend on a variety of factors such as program scale, composition and density of vegetation, equipment used, skill of personnel, and site-specific constraints. Detailed costs are not uniformly reported, so comparing project costs of one program to another can be difficult. Currently, contract aquatic plant harvesting operations cost about $750.00 per acre on non-prevailing wage rate projects and $1000.00 per hour if prevailing wage is required (McNabb pers. comm. 1998). Using a recent estimate of control at one acre per day, contracting would be very costly. The current purchase price for a new harvesting system is approximately $110,000 plus an ongoing operations and maintenance expense each year.

Permits The permit process is the same as for hand-pulling.

Appropriateness for Lake Leland Mechanical harvesting is more appropriate for larger lakes. The cost of the equipment would be prohibitive, particularly in the light of

the short-term control offered by harvesting. Harvesting results in the production of numerous plant fragments which would contribute to a larger scale infestation of Brazilian elodea in the main lake.

ROTOVATION

Description Rotovation is basically underwater cultivation or rototilling using a barge-mounted rototiller or amphibious tractor towing a cultivator. Plants and root crowns are uprooted as bottom sediments are tilled to a depth of up to 12 inches. Bottom tillage is usually performed in the cold months of winter and spring to reduce plant regrowth potential. This technique is generally used for milfoil control and is most suitable for use in larger lakes due to the size of the equipment and the high cost.

Effectiveness and Duration Depending on plant density, control offered by rotovation may last up to two or three years.

Advantages A high percentage of entire plants, including the roots, can be removed during tillage. Plant density is generally reduced. By removing the canopy, tilling stimulates the growth of native plants which is of potential benefit to fish.

Disadvantages Bottom obstructions limit the use of rotovation. Tillage should not occur where water intakes are located. Short term turbidity increases in the area of operation, and short-term impacts on water quality and the benthic invertebrate community can occur (Gibbons et al. 1987). Rotovation is not advised where bottom sediments have excessive nutrients and/or metals because of their potential release into the water column. Rotovation is not species selective. Plant fragments are produced and the machine does not collect plants. The process is very labor intensive and expensive.

Costs Bottom tillage costs vary according to treatment scale, density of plants, machinery used and other site constraints. Contract costs for rotovation in Washington range from $1200-$1700 / acre depending on treatment size.

Permits An individual HPA is required from WDFW for all rotovation projects. Also, the use of bottom tillage requires a temporary modification of water quality standards from Ecology. A shoreline permit may also be required, so contact must be made with the Jefferson County Planning Department. It may also be necessary to obtain a letter of approval from Washington Department of Natural Resources.

Appropriateness for Lake Leland Rotovation is generally used for milfoil control and, like harvesting, is more suitable in a larger lake. This procedure is cost prohibitive and also would contribute to the spread of Brazilian elodea.

DIVER-OPERATED SUCTION DREDGING

Description With this technique, divers operate portable dredges with suction heads that remove plants and roots from the sediment--essentially vacuuming the bottom of the lake. The suction hoses draw the plant/sediment slurry up to a small barge or boat carrying the dredge. On the barge, plant parts are separated from the sediment slurry

and retained for later off-site disposal. The sediment slurry can be returned to the water column.

Effectiveness and Duration Diver dredging can be highly effective under appropriate conditions. Removal efficiency depends on sediment condition, density of aquatic plants, and underwater visibility (Cooke et al. 1993). This technique works well to control early low-level infestations of milfoil or Brazilian elodea. It can also be used as a maintenance tool following herbicide treatments.

Advantages This method of control is site and species specific. Disruption of sediments are minimized. Plant parts are collected for later disposal, and the spread of fragments is minimized which is important in the control of Brazilian elodea or milfoil. Diver dredging can cover a much larger area than is practical for hand pulling and it can be effective in soft sediments. Also, it can be easily operated around obstacles and in tight places.

Disadvantages Diver dredging is labor intensive and very costly. Two divers and a tender are needed. Turbidity, and release of nutrients and other contaminants from disturbed sediments are some environmental concerns. The turbidity caused by the machine creates poor visibility which slows the process. Some sediment and non-target vegetation may inadvertently be removed during the process. Some fragment loss may be expected if dredged slurry is directly returned to the lake. It would be even more costly if slurry were disposed of upland.

Costs The costs can vary depending on density of plants, type of equipment used, and disposal requirements. State regulations on contract divers for dredging work are stringent and prevailing wage rates are high. Two divers and a tender are needed. Costs can range from a minimum of $1100 / day to upwards of $2000 / day with actual removal rates varying from approximately ¼ to one acre per day.

Permits Four different permits are needed, one of which takes up to two years. WDFW requires a Hydraulic Permit and the Corps of Engineers may also require a permit. A shoreline management permit is required from the Jefferson County Planning Department, and it may be necessary to obtain a letter of approval from DNR. A temporary modification of water quality standards due to increased turbidity is required from Ecology.

Appropriateness for Lake Leland This method is very costly, very labor intensive and slow going, so it isn't very practical for widespread infestations such as in Lake Leland. It may work well at Lake Leland (with soft sediments) if volunteer equipment and labor were used, but, as mentioned above, the permitting process is long and can take up to two years. Some community members have discussed the possibility of building the equipment on a very low budget. If so, diver dredging could come up at a later date as a control of interest in selected areas.

BIOLOGICAL CONTROLS

The desire to find a more "natural" means for long term control, to reduce use of expensive equipment, and to eliminate the use of chemicals has created an interest in biological control agents to reduce the quantity of non-native aquatic weeds. The only biological method of control for Brazilian elodea at this time is the use of triploid grass carp. Grass carp were brought into the United States from Malaysia in the 1960's and have been used to control aquatic weeds extensively in the South. Triploid carp, which are sterile, were legalized for use (by permit) in lakes and ponds in Washington State in 1990.

TRIPLOID GRASS CARP

Description Grass carp or white amur (*Ctenopharyngodon idella*) are plant consuming fish native to the large rivers of China and Siberia. They have definite feeding preferences, though there is a wide range of plants that they will eat. Under the right circumstances, these fish are known to control certain submersed nuisance aquatic plants. They are most suitable for use as a lake-wide, low intensity control over the long term.

Calculating the optimum stocking rate to achieve the desired control of the target plant is not easily achieved. Variable factors such as the amount of plant material available (both target species and other plants), water temperature, climate, and predators, along with past experiences from other lakes, are considered in determining the stocking rate. In order to introduce the carp, a permit is required from Washington Department of Fish and Wildlife (WDFW 1998b) and specific state regulations must be adhered to. Only sterile fish can be planted. Inlets and outlets must be screened to keep the carp out of other water bodies. These regulations are in place to prevent problems that have occurred in other lakes where grass carp were introduced.

In a study of 98 lakes in Washington State, Bonar et al. (1996) reported that grass carp achieved successful vegetative control in only 20 percent of the lakes. In 40 percent of the lakes, the grass carp denuded all the vegetation and in the remaining 40 percent no difference was noticed. Despite this low success rate, 83 percent of the landowners interviewed were satisfied with the results. It should be noted that in this study only lakes achieving over 50 percent of vegetative control were counted as successful. Also, most of the lakes were less than ten acres in size.

Control Effectiveness and Duration Effectiveness of grass carp in controlling aquatic weeds is dependent on several factors: feeding preferences, metabolism, temperature, and stocking rate (Ecology 1992). Grass carp eat in a hierarchy with distinct preferences. For example, newly introduced carp in Devil's Lake, Oregon initially preferred thinleaf pondweeds (*Potamogeton* spp.). However, as the fish grew larger (12-14 inches), Brazilian elodea became the favored food. This change in food preference took approximately one year. According to WDFW biologist Scott Bonar (pers. comm. 1998), it generally takes about two to three years to see noticeable results from stocking when the density of carp is adequate. Restocking may be necessary in five to ten years.

Advantages Depending on the problem plant species and other site constraints, proper use of grass carp can achieve long-term reductions in nuisance growth of vegetation without much management. In some cases, introduction of grass carp may result in improved water quality conditions, where water quality deterioration is equated with dense aquatic plant growth (Thomas et al. 1990). Compared to other plant control techniques, costs for grass carp are relatively low though screens on inlets and outlets can add considerably to costs. Long term operation and maintenance costs are relatively inexpensive.

Disadvantages The target plant may not be high on the grass carp's preference list. The fish may avoid areas of the water body experiencing heavy recreational use, resulting in less plant removal in these locations. Plant reductions may not become evident for several years. Full ecological impacts of grass carp introductions in Northwest waters are still being determined, and there may be a problem which is presently unrecognized.

Overstocking of grass carp could result in eradication of beneficial plants and have serious impacts on the overall ecology of the water body. Overstocked carp are very difficult to remove, and these fish can live 14 years or more in Washington waters. Also, costs for screening inlets and outlets can be substantial. Because of the unpredictability of grass carp control, the WDFW recommends that they not be introduced where total plant eradication and increased turbidity cannot be tolerated. Total eradication has caused turbidity problems in other lakes where all submersed plants were eaten and carp began rooting on the bottom. Other consequences of total submersed plant eradication include: loss of habitat which provides protection for young fish and other aquatic organisms, loss of a waterfowl food source, and the possible establishment of another invasive species in the newly created niche. With the removal of a large biomass of aquatic macrophytes, there is a potential for increased algae production.

Costs The costs for grass carp control include those for the fish and any needed screens for inlets and outlets. Rotating drum screens require electricity to run them. At a stocking rate of 10 to 25 fish per vegetated acre at an average cost of $10 per fish and an estimated 5 to 10 acres of Brazilian elodea, the fish cost would range from $500 to $2500. WDFW estimated a cost of $39,300 to install a drum screen at the existing fish weir on Leland Creek. This cost may be reduced with the use of volunteer labor. An additional screen on the major inlet may also be required.

Permits WDFW requires a game fish planting permit prior to grass carp introduction to a water body. In addition, if outlet screening is necessary, hydraulic approval is required from the WDFW. A shoreline exemption permit is required from Jefferson County Permit Center for "installation of a permanent or temporary structure within or near the lake" (Mark pers. comm. 1998). Department of Natural Resources Natural Heritage Program must be contacted for assessment of threatened or endangered plant species.

Appropriateness for Lake Leland Since Brazilian elodea appears to be a preferred food for grass carp, their use as a large-scale control in Lake Leland does have some

merit. There has been quite a bit of discussion in the community about the use of carp, as it is a more preferred option than the use of herbicides. However, questions have been raised over the suitability of introducing one exotic species to control another exotic species.

Because Lake Leland has an excellent fishery and supports a great deal of waterfowl and wildlife, the possibility of total vegetative eradication is a big concern. The habitat provides protection for young fish and other aquatic organisms and food for waterfowl. Wintering trumpeter swans feed on the Brazilian elodea but they have been seen on the lake long before the presence of the Brazilian elodea. Last year the swans spent a lot of time around the Leland Creek wetlands rather than on the lake.

To lessen the chance of total eradication, a conservatively low stocking rate could be used. A low stocking rate would also lessen the chance for increasing nuisance algae production. Even if the reduction of Brazilian elodea was less than 50 percent (the criteria used to determine success by Bonar et al. 1996), Leland residents would consider it successful. Besides stocking fewer carp, it could be advantageous to stock larger carp. Larger fish are less susceptible to predation and have a higher preference for Brazilian elodea than smaller fish.

At the present time, the steering committee does not endorse the use of grass carp but does not rule them out as a future option. The committee will periodically reassess conditions in the lake and reevaluate grass carp as a possible control. The committee will keep informed of the results of using grass carp in other lakes, especially Duck Lake (located on the Washington coast) where grass carp were stocked at a low density to control Brazilian elodea.

CHEMICAL CONTROLS

The use of aquatic herbicides has historically been a common method of controlling invasive aquatic weeds. In recent years, there has been a shift away from broad use of herbicides. Environmental, economic, political, and social implications are considered as well as results from thorough reviews of target effectiveness.

Currently, there are four aquatic herbicides allowed in the State of Washington for control of aquatic weeds. Two are the systemic herbicides *fluridone* and *glyphosate*. These herbicides are absorbed by the plant and can kill the entire plant roots and shoots. The third herbicide is *endothall*, a contact herbicide. This type of herbicide kills only the plant part that it comes in contact with leaving roots alive and capable of regrowth. A fourth herbicide is copper sulfate and chelated coppers. Copper compounds are generally only permitted for algae control at this time. Because copper accumulates in the sediment and never breaks down and can be toxic to fish, the state strongly discourages its use—even for algae management. Therefore, only *fluridone*, *glyphosate*, and *endothall* will be examined here.

FLURIDONE

Description More commonly known as SONAR, this herbicide is a very slow acting

systemic type of herbicide that has to remain in contact with the plant for up to eight to ten weeks. It is commonly used in the management of aquatic plants in freshwater ponds, lakes, reservoirs, or irrigation canals. It is formulated as a liquid (SONAR 4AS) sprayed above or below the surface, and in controlled release pellets(SONAR SRP) which are spread on the surface of the water. Fluridone is effectively absorbed and translocated by both plant roots and shoots (Westerdahl and Getsinger 1988).

Effectiveness and Duration This chemical is most effective where there is little water movement and provides good control of both submersed and emergent aquatic plants in this situation. Its use is most applicable for whole lake or isolated bay treatments to control a variety of exotic and native species. Fluridone is reportedly successful in control of Eurasian milfoil and Brazilian elodea. Characteristics typical of fluridone use are whitened leaves, retarded growth, and plant mortality. Effects of fluridone treatment are noticeable 7-10 days after application with control of target plants often taking 60-90 days to become evident (Westerdahl and Getsinger 1988). Because of the delayed nature of toxicity, the herbicide is best applied during the early growth phase of the target plant, usually spring or early summer.

Advantages Because of its ability to kill roots and shoots, fluridone has a long lasting effect. A variety or emergent and submersed aquatic plants are susceptible to fluridone treatment. Extensive human health risk studies report that when used according to label instructions, fluridone does not affect human health. The chemical also has low toxicity to zooplankton, benthic invertebrates, fish, and wildlife.

Disadvantages Because of its slow acting capabilities, the effects of fluridone may take up to several months. It is not effective in flowing water situations because of the long uptake time needed for absorption and herbicidal activity. Fluridone is not suitable for treating a defined area within a large lake because of the potential for drift. Also the potential exists for release of nutrients to the water column and consumption of dissolved oxygen from the decaying plants. Non-target plants will be affected, because, as mentioned above, a variety of plants show degrees of susceptibility to fluridone treatment. Mitigation of lost vegetation may be necessary. There are label recommendations for delay in the use of treated waters for irrigation purposes. To protect drinking water sources, it is recommended that no applications be made within a quarter mile of a domestic water intake—although whole lake applications at 20 ppb or less target concentration can be made within a quarter mile of drinking water intakes (Hamel pers. comm. 1998).

Costs Sonar is an expensive herbicide. Treatment costs by private contractors vary depending on lake characteristics but start around $1000 per acre. A recent price quote recommended a budget of $116,000 for Sonar treatment of Lake Leland (McNabb pers. comm. 1998). This would include five Sonar treatments and five samplings, permitting, public notification, bathymetric mapping, and volume calculations. This price could be reduced, depending on how well the lake retains Sonar.

Permits The use of aquatic herbicides is regulated primarily by Ecology and Washington Department of Agriculture. Each agency should be contacted for recent

information. A short-term modification to state water quality standards is required from Ecology prior to treatment. Jefferson County regulations require a shoreline exemption permit (Mark pers. comm. 1998).

Appropriateness for Lake Leland After discussions of the pros and cons of broad chemical use in the lake, the Leland community has chosen to look for alternative control options. This conclusion is based on environmental and human health concerns. The long term health effects for humans and wildlife are questioned. Untargeted native vegetation is killed. And, as mentioned earlier, there are lake residents who are dependent on the lake as a source of domestic water. Sonar label restrictions specifically refer to potable water intakes and irrigation use. It is felt that whole lake chemical treatments are not practical. The high cost is another barrier to use at Leland. Although fluridone is reportedly successful in the treatment of Brazilian elodea, large scale applications of SONAR (four treatments over a ten week period) made a few years ago in Lake Limerick in Mason County indicate otherwise. According to Limerick community member Dan Robinson (pers. comm. 1998), the Brazilian elodea infestation was initially knocked back 99.5 percent—success. But, by the end of the next season, Brazilian elodea had come back with a wide spread light growth throughout the lake. It now appears that Brazilian elodea has buds in the soil that survive broad scale chemical applications. Based on his experience with Lake Limerick, Robinson felt that, for long-term control, applications of the herbicide at higher than 20 ppb chemical concentration would need to be made.

GLYPHOSATE

Description The commercial brand of glyphosate known as RODEO is approved in Washington for aquatic use. This herbicide is a non-selective and broad spectrum chemical used primarily for control of emergent or floating leafed plants such as water lilies. Glyphosate is a systemic herbicide that is applied to the emergent vegetation of actively growing plants. It is rapidly absorbed and translocated throughout plant tissues, affecting the entire plant, including the roots.

Effectiveness and Duration Glyphosate is effective against many emergent and floating leafed plants but, according to the manufacturer, will not control plants that are completely submerged or those that have a majority of their foliage below the water. The herbicide binds tightly to soil particles on contact and thus is unavailable for root uptake by plants. Because of this strong adherence to soil particles, glyphosate is practically non-mobile and unlikely to migrate to groundwater. Initial evidence of herbicide effects includes the wilting and yellowing of plants, but this may not be apparent for seven days or more. These effects are followed by browning and death.

Advantages As a systemic herbicide, glyphosate is capable of killing the entire plant, producing long term control benefits. Glyphosate carries no swimming, fishing or irrigation label restrictions. It dissipates quickly from natural waters, with an average half-life of two weeks in an aquatic system. This herbicide has a low toxicity to benthic invertebrates, fish, birds, and mammals.

Disadvantages Glyphosate is a non-selective herbicide and therefore can affect susceptible non-target plant species. There is a possibility of drift during aerial

application but it is expected to be minimal if label and permit instructions are followed. Though there are no irrigation label restrictions, there are potable water restrictions within one half mile of intakes in standing or flowing water. To make applications within the half mile limit, potable water intakes must be turned off for a minimum of 48 hours after the application or until a laboratory measured level of glyphosate in the water is below 0.7 ppm.

Costs Treatment costs by a private contractor average approximately $300 per acre, depending on the scale of treatment. Current bids for one application of RODEO to control reed canary grass in the upper 2000 feet of Leland Creek range from approximately $800 to $3800. At least two applications in a year would probably be necessary.

Permits The permit process is the same as for fluridone.

Appropriateness for Lake Leland Since RODEO is inactive for submersed plants, it would not control Brazilian elodea and would not be suitable for whole lake treatment.

Appropriateness for Leland Creek As previously mentioned, chemicals are not a control of choice for the community, but RODEO is seriously being considered to control reed canary grass in Leland Creek. This particular herbicide is inert in water, and though there are half-mile domestic water intake restrictions, there are no known potable intakes within that distance. Research with Ecology's Water Resources section indicates that two surface water right certificates were issued, one in 1967 and the other in 1968 (Carroll pers. comm. 1998). These permits were issued for use two to three miles below the project area and it is not known if they are still in existence. RODEO can produce long term control and, if applied carefully perhaps with a backpack pump, can target specific plants. As mentioned earlier, a sensitive plant species, bristly sedge, has been detected along Leland Creek. Applications of RODEO would need to be selective if bristly sedge occurs in the spray area. Clallam County has used RODEO to control canary grass in the past year and should be consulted for their results before it is used at Leland. Also, it should be noted that there is a possibility of Brazilian elodea or another aquatic weed replacing the canary grass. It is believed, though, that these macrophytes would not impede water flow as much as the canary grass.

ENDOTHALL

Description Although Endothall is a contact-type herbicide, it is not readily translocated in plant tissues. Endothall formulations (active ingredient endothall acid, 7-oxabicyclo(2,2,1)heptane-2,3-dicarboxylic acid) are currently registered for aquatic use in Washington in either inorganic or amine salts. Aqueous or granular forms of the dipotassium salt of endothall, AQUATHOL (Elf Atochem), is permitted in State waters with stringent use restrictions on water contact, irrigation, and domestic purposes over and above label restrictions.

Effectiveness and Duration Being a contact herbicide, endothal kills only the plant parts that it contacts which is usually the upper stem portions. The entire plant is not killed so this herbicide is generally used for short term control of nuisance aquatic plants. Contact efficiency and regrowth from the unaffected root masses determine

duration of control. Effective reductions in plant biomass can range from a few weeks to several months. In some circumstances, season-long control can be achieved but carryover control into the next season is not typical.

Advantages This type of treatment generally acts faster than translocating herbicides such as fluridone; evidence of tissue death is often apparent in one to two weeks. Cost wise this type of treatment is several hundred dollars per acre cheaper than fluridone over the same area. There is little or no drift impact using proper application techniques.

Disadvantages Endothall is a contact herbicide, so control is temporary. Non-target plants can be affected. Oxygen levels can become low. There are swimming use restrictions in Washington State of seven to eight days and also water use restrictions.

Costs Average costs run about $700 per acre.

Permits The permit process is the same as for fluridone.

Appropriateness for Lake Leland As previously mentioned, the use of whole lake chemical treatment is not a preferred option for the Leland community. Non-target plants could be affected. This particular herbicide requires swimming, fish consumption, irrigation, and domestic use restrictions. There is concern for the safety of this product in light of all the restrictions. Because only the upper part of the plant is killed, this product is not a good choice.

THE NO-ACTION ALTERNATIVE

Along with control alternatives to be investigated, the **"no action"** alternative should also be considered. There are several situations in which taking no action is appropriate. Consensus on control strategy may be unattainable or simply taking no action may be more favorable than using control options. No action might be the choice while waiting for new, more effective or environmentally friendly strategies to be developed.

If taking no action is considered, it is important to think about the eventual consequences to the target water body and perhaps surrounding water bodies, particularly in the case of a non-native invasive weed such as Brazilian elodea. The effects of dense weeds on water quality, fish and wildlife habitat, aquatic organisms, and recreation and tourism are all concerns to be addressed when considering the no action alternative. In order to maintain a perspective, the consequences of taking no action should be weighed against the costs and benefits of various plant control options.

As pointed out by David Christensen of Jefferson County Environmental Health (pers. comm. 1998), the no action alternative, though allowing for more infestation of Brazilian elodea, may cause an eventual decline. Research on Eurasian watermilfoil (*Myriophyllum spicatum*) has shown that control methods can lengthen the time for this

plant to be dominant, and if left alone, it will become subdominant after a couple of decades. This may also be true for Brazilian elodea. In fact, Long Lake in Kitsap County has had a Brazilian elodea infestation for about 20 to 30 years and has been extensively studied by the University of Washington. In that lake, there has been a gradual decline in the biomass over time, but recently the biomass has resurged (Parsons and Hamel pers. comm. 1998). The residents of Long Lake are very unhappy about the plant and its impacts to recreation in the lake, and, currently, they are looking for an effective control.

Considering the fact that there are no large-scale control options without associated risks, the no-action alternative has appeal. Though the negative impacts of Brazilian elodea encroachment throughout the littoral zone of Lake Leland are substantial, some of these impacts, such as swimming safety, can be addressed using small-scale controls (hand-pulling and bottom barriers). At the present time, it is felt that no action on a large-scale, along with low risk control on a small-scale is a suitable combination.

Because of the complexities involving the flooding problem and reed canary grass in Leland Creek, taking no-action on the canary grass is not felt to be appropriate.

PREVENTATIVE TECHNIQUES

A prevention program that educates the public about noxious aquatic weeds is a valuable and important part of aquatic management planning. Weed control is not weed prevention. Education is a great prevention tool. This can be accomplished in the form of continued newsletters, flyers, and newspaper articles. More neighborhood workshops for training in the recognition of troublesome aquatic plants can help citizens with the early detection of different noxious weeds. Monitoring the areas that have used specific control methods such as hand-pulling and bottom barriers will add knowledge for future planning.

Public awareness of the problem can make a difference in the spread of exotic plants. Signs are being posted at the boat ramp and nearby lakes describing the invasive plant problem and the need to keep boats, trailers, and fishing gear free of plant fragments. Occasional weekend volunteers checking boat motors and trailers for noxious weeds at the boat ramp would reinforce this message. Boat washing stations have been used successfully at some lakes. Presently, there is no running water at the Leland boat launch, but this is a good preventative tool that may be able to be utilized in the future.

INTEGRATED TREATMENT ACTION PLAN

AQUATIC PLANT CONTROL INTENSITY ZONES

In any water body, control of nuisance aquatic plants can be achieved at different scales: high intensity control, low intensity control, or no control. For example, high intensity control may be needed around docks and in swimming areas, whereas, low intensity control or no control would be suitable in most other areas.

At the present time, the steering committee feels that high intensity control of Brazilian elodea is appropriate around private docks, the boat launch, and swimming areas, and no control is appropriate for the rest of the lake (Figure 23). If in the future the spread of Brazilian elodea degrades the fishery, a low control (conservatively low stocking of grass carp) is deemed appropriate.

For the reed canary grass in the upper 2000 feet of Leland Creek, the committee feels a high intensity control is appropriate because of the flooding problem and its impact on on county and state roads, septic drainfields, and encroachment of the lake on adjacent lands.

At the present time, the yellow flag iris is not considered a serious problem and low intensity control would be appropriate.

RECOMMENDED CONTROL STRATEGY

Brazilian elodea

After spending several steering committee meetings looking at the available options for controlling Brazilian elodea, there is a consensus of opinion on one fact–at this point in time, there is no 100 percent method of control that is environmentally friendly, cost effective, and meets the needs of the community. The process of evaluation has come down to one of weighing the pros and cons for each scenario. The steering committee recognizes that the effective management of Brazilian elodea will be an on-going concern and will take a long term commitment. The management strategy is not static and may need to change over time as conditions change.

For the present, the steering committee recommends the following strategies to address the presence of Brazilian elodea in Lake Leland:

- Encourage a permanent role within the Leland Neighborhood Improvement Club (LNIC) to address lake water quality issues.
- Encourage a continued volunteer commitment from LNIC and other interested community members.
- Continue to monitor the lake for water quality and fish and wildlife habitat conditions (Ecology, WDFW).
- Continue mapping the spread of Brazilian elodea (Ecology, LNIC).

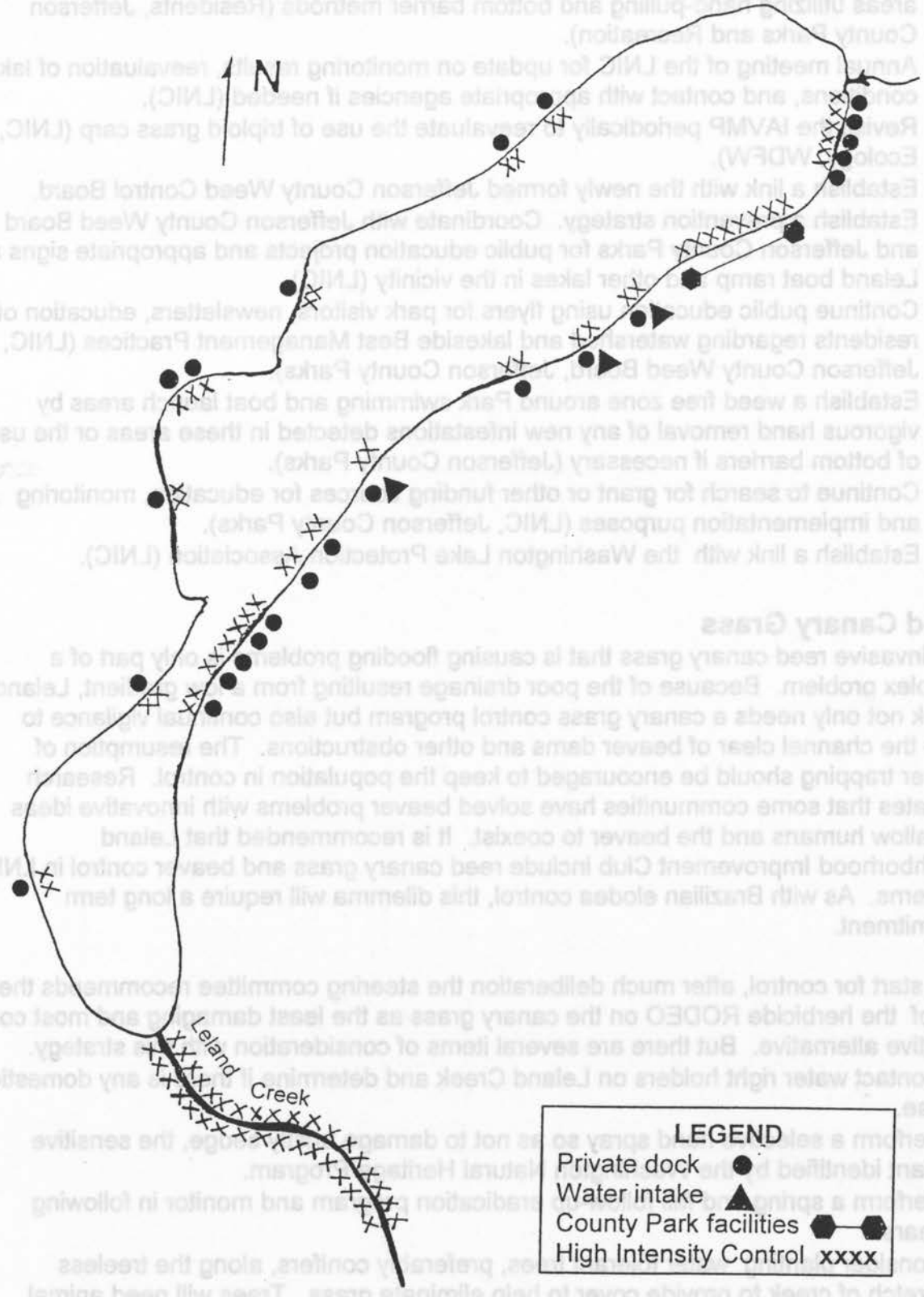

FIGURE 23 Map of Lake Leland and Leland Creek showing high intensity control zones.

- Encourage small scale weed control around private docks and low bank swimming areas utilizing hand-pulling and bottom barrier methods (Residents, Jefferson County Parks and Recreation).
- Annual meeting of the LNIC for update on monitoring results, reevaluation of lake conditions, and contact with appropriate agencies if needed (LNIC).
- Revisit the IAVMP periodically to reevaluate the use of triploid grass carp (LNIC, Ecology, WDFW).
- Establish a link with the newly formed Jefferson County Weed Control Board.
- Establish a prevention strategy. Coordinate with Jefferson County Weed Board and Jefferson County Parks for public education projects and appropriate signs at Leland boat ramp and other lakes in the vicinity (LNIC).
- Continue public education using flyers for park visitors, newsletters, education of residents regarding watershed and lakeside Best Management Practices (LNIC, Jefferson County Weed Board, Jefferson County Parks).
- Establish a weed free zone around Park swimming and boat launch areas by vigorous hand removal of any new infestations detected in these areas or the use of bottom barriers if necessary (Jefferson County Parks).
- Continue to search for grant or other funding sources for education, monitoring and implementation purposes (LNIC, Jefferson County Parks).
- Establish a link with the Washington Lake Protection Association (LNIC).

Reed Canary Grass

The invasive reed canary grass that is causing flooding problems is only part of a complex problem. Because of the poor drainage resulting from a low gradient, Leland Creek not only needs a canary grass control program but also continual vigilance to keep the channel clear of beaver dams and other obstructions. The resumption of beaver trapping should be encouraged to keep the population in control. Research indicates that some communities have solved beaver problems with innovative ideas that allow humans and the beaver to coexist. It is recommended that Leland Neighborhood Improvement Club include reed canary grass and beaver control in LNIC concerns. As with Brazilian elodea control, this dilemma will require a long term commitment.

As a start for control, after much deliberation the steering committee recommends the use of the herbicide RODEO on the canary grass as the least damaging and most cost effective alternative. But there are several items of consideration with this strategy.

- Contact water right holders on Leland Creek and determine if there is any domestic use.
- Perform a selective hand spray so as not to damage bristly sedge, the sensitive plant identified by the Washington Natural Heritage Program.
- Perform a spring and fall follow-up eradication program and monitor in following years.
- Consider planting water tolerant trees, preferably conifers, along the treeless stretch of creek to provide cover to help eliminate grass. Trees will need animal damage controls.
- Be diligent and consistent.

- Link with Jefferson County Public Works as a possible funding source for canary grass control to eliminate road flooding.
- Consult with Clallam County Weed Board for results on their recent use of RODEO to control reed canary grass.

Yellow Flag Iris

Yellow flag iris, which has increasingly been spreading along the shore of the lake, can best be controlled by hand digging. Those residents who would like to see less of the plant along their shoreline are encouraged to selectively remove the plant.

PRIMARY ACTIONS, TIMELINE, and COST

• September, every year	Meeting held to review conditions in Lake Leland and Leland Creek and to decide what action, if any, to take.
• October 1999	Apply for a three year implementation grant to control canary grass in Leland Creek, conduct plant monitoring in Leland Creek and Lake Leland, and provide public education on noxious plant control and Best Management Practices. Estimated cost, $30,000.

PUBLIC EDUCATION PROGRAM

Throughout the IAPMP process, public outreach has been regularly occurring to keep the larger community informed on the status of the proceedings. Meetings, workshops, newsletters, and newspaper articles have been utilized in the past. These methods of education are expected to continue with the help of volunteers from the Leland Neighborhood Improvement Club. Information has also been disseminated through the Jefferson County Conservation District in the form of public displays. This form of awareness will be encouraged to continue.

Signs that bring attention to the Brazilian elodea problem in Lake Leland and show how to avoid the spread of noxious aquatic plants have been developed by Ecology. These are being installed at the Leland boat ramp and other nearby lakes. Similar notices are being placed on the campground bulletin board, and educational flyers are scheduled to be handed out to visitors and residents alike. Since noxious aquatic weeds are spread by transport on boat motors, trailers, and fishing gear, continued public outreach to boaters utilizing the public launch is highly recommended. Residents trained in the identification of noxious aquatic weeds should continue annual monitoring of lake vegetation for early detection of any new noxious infestations.

In addition to noxious aquatic weed information, the importance of Best Management Practices (BMP's) should also be stressed to the community. These watershed stewardship activities should help reduce nutrient, contaminant, and sediment inputs into the lake. Ecology has a publication entitled Blueprint for a Lake-friendly Landscape

(Appendix F) that addresses BMP's for shoreline properties. It would be beneficial to distribute a copy to all lakeside residents on a yearly basis.

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APPENDIX A

LELAND CREEK DRAINAGE PROBLEM

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LELAND CREEK DRAINAGE PROBLEM

Leland Creek Drainage Problem
A history and an analysis
Hector J. Munn, 1314 E. North St., Newberg, OR 97132
December1986

The following is presented as a record to document what is perceived as an economic problem to land owners of Leland valley. It is certainly a growing nuisance. Potential damage to homes and property is predictable. We hope this document will assist planners and budget makers.

Part I: Geophysical.

Leland Lake and Crocker Lake are the remnants of glacially dug lakes in a valley that extends from Discovery Bay to the north to Quilcene Bay to the south in Jefferson County, Washington. A slight rise separates two drainages. The north drainage carries Andrews Creek into Crocker Lake and on to Snow Creek and Discovery Bay, a distance of about 7 miles. The south drainage goes through Leland Lake and by way of Leland Creek to Little Quilcene River, about 4 miles south, and then to Quilcene Bay.

Leland Lake, Lake Hooker on older maps, is about one mile long and shaped like a shoe with a North-South axis tilted to the East. (SEE MAP.) It receives water from two major year around streams at the north end, "Boulton Creek" and "Kawamoto Creek," and one year around stream at the south end, "Munn Creek". There are several intermittent creeks, or "winter only" streams, on the west side: "Ralls' Creek", "Stuttler Creek", "The Point Creek". (These are all my names.) There are also numerous springs on the west side and smaller drainages off "Strawberry Hill", which rises from the east shore of the Lake. The Lake is drained by one stream, which is officially called Leland Creek.

Leland Creek leaves the southeast corner of the Lake and starts to the east but turns southward in the first 1/4 mile. In about 1 mile, it is joined by a year around creek from the east, "Hooker Creek". In about 3 miles Leland Creek is carried under U.S. 101, following that highway on the east until it joins Little Quilcene River about 4 miles south of the Lake.

The key concern of this report is the portion of Leland Creek from the Lake to the underpass of U.S. 101. The Lake elevation is about 195 feet and the underpass, 3 miles later is about 190 feet. That is a 5 foot drop in about 15,000 feet. This is the basic problem. In order to be an effective drainage route, the creek must be clear all the way.

Much of the valley floor and land around the Lake is peat or peat covered by thin layers of stream sediments. The valley was much larger when the glacier first melted away. At least one mud flow pushed down into the valley, the tongue of land on which Jan Jensen house sits. Plant growth produced the peat and periodic floods from the major streams covered the peat with gravel, shale, and mud.

"Strawberry Hill", which forms the East side of the Lake, was overcut by the glacier and is composed of pre-glacial shale strata. Thus the east shore of the Lake is solid, and free of marsh land. The west shore has two stream built deltas with a low bank shore. The south and north shores are marsh land without a significant bank even though each has a year around stream entering with low deltas.

Part 2: Early History

The lowland between Discovery Bay and Quilcene Bay was undoubtedly a route used by northwest Indians. The Clallam Indian tribes lived along the Straits of Jaun de Fuca and had settlements at the mouth of streams entering Discovery Bay. Twanoh (Twana) Indians lived along Hood Canal and had a settlement or two at the head of Quilcene Bay.

There is evidence that a temporary encampment was used on Lake Leland where Ralls' Creek enters the Lake. This encampment is near the narrows in the lake at which location there was evidence of a tree on each side being felled by fire cutting to form a log crossing. This would have been a part of the trail system that the first settlers found. The tribes would come into the area for hunting purposes and would cross through the valley for trading purposes.

The Native Americans had footpaths that followed the solid edges of the swamps. These paths were used by the settlers and gradually widened for carts and wagons. With some modification and swamp crossing, this same network became the Leland Valley Road as it is today.

When white settlers arrived, the valley floor was wooded with spruce and red cedar with willow and alder interspersed. Higher land with better drainage was covered with Douglas fir, white fir,and grand fir, as well as western red cedar, hemlock and spruce. The broad leaf maple, vine maple, cascara, wild cherry, hawthorn, crab apple and other smaller deciduous species common to the northwest were found just as today.

Some smaller home sites were opened beginning with the homestead period in the 1860's. But most of the valley floor was cleared following the coming of the Port Townsend Southern Railroad in 1889. The railroad brought construction workers, sawmills, a school, a store and eventually a resort. Almost everyone had a barn for a few family milk cows, a team of horses or mules, pigs and hay. A few acres was cleared for garden, pasture and hay land. Cream was collected and sent to Port Townsend as the only cash product other than meat, lumber, and railroad ties.

The grade for the railroad was placed along the east bank of the Lake. It crossed Leland Creek at the south end of the Lake (Bridge 15) and parallelled Leland Creek. The creek bed was rerouted in some places and bridged six times (Bridges 16-21). Except for the rerouting, the stream bed was unchanged. It may have been deepened and channelled near the bridges. Near Bridges 17-19, there are cuts through sandstone and the stream bed near them is sandstone. The railroad was shortlived. It was abandoned in the early 1920's and the right-of-way sold in 1938-39.

Leland Creek was lined with trees, so it was shaded and flowed well. I recall the remains of at least two log bridges that crossed near the county road culvert. One carried an old county road and another carried a skidroad off to the west side of the Lake. The bridge decks of these crossings were lower than the summer water level is today, indicating better drainage before farms were cleared. There was a very large cedar log found in this same area and it is suspected that it was a tree felled by the Indians as a crossing.

My great grand parents moved to Leland, April 26, 1891. George Washington Edwards was 56 at the time. A son-in-law, Thad Smith, had come two years earlier. Both had homesites in the valley east of Strawberry Hill . My grandfather, James H. Munn took up a homestead one mile west of the lake in April of 1893. After he married my grandmother, Ana M. Edwards, they purchased land on the west shore of the Lake from Mr. Nichols, who had homesteaded the land. My father, second of 6 children, was born in 1895 in the log house that set near Ralls' Creek at the Lake edge and close to where Ralls' house is today.

Land was cleared from the lake shore up. A sawmill, a house and creamery were built near the Lake. A fruit cannery, which later became the dairy and hay barn, was built back from the Lake. My first memory, about 1934, was that there was a back yard between grandma Munn's house and the Lake. I would estimate that the Lake surface in the summer was about 3 -4 feet below the current summer level. In the winter, water would come up to the back steps, a rise of 4-5 feet. How rapidly it would drain, I'm not sure. Winter flooding has always been an issue.

Mr. Nichols reached his homestead by trail on the west side of the Lake. He could cross the narrows just as the Indians did. However, he had a raft a boat for crossing as well and would ferry early settlers across.

The first county bridge was put in in the late 1880's. Jim Munn was able to use it to get to his homestead to the west. The bridge was low, about three feet above the summer water level. In the winter the water would cover the bridge and the planking would lift off or the pilings would lift out of the bottom, so that it became like a rollercoaster. A new bridge was built on fir piling in 1903. Its cedar deck was about 8 feet above summer level so that boats could go under with a man standing up. It was also well above winter water level. It didn't last long as the fir piling rotted quickly. It was replaced in 1915 with cedar piling. The caps, stringers, braces decking and railings were all cut in the Munn sawmill. The piling for that bridge stood until it was removed in 1972. It was redecked at least 2 times. The deck was about 10 feet above summer water level.

Part 3: Recent History

As mentioned, the county road was built on high ground quite close to the Indian trails. Today it is Boulton Road, East Leland Valley Road and West Leland Valley Road. It parallels the railroad grade. South of the Lake the road parallels Leland Creek. A small bridge carried the county road over Leland Creek to the south. The bridge was replaced with a culvert and a fill in the 50's.

In the 1928-29, Olympic Highway, U.S. Highway 101, was built through this valley. Its grade was placed to the east of the county road except for a portion north of the Lake. South of the Lake, US 101 was placed through the swamp and actually right in Leland Creek. Leland Creek was moved to the ditch on the west side of the highway for about a half mile. To do this, the ditch was cut into a sandstone bank. It is possible that this cut has never been deep enough and forms a slight barrier to water flow. It is a location of slumping fo the banks as well. The State Highway Department should keep a constant vigil to keep the ditch clear.

The bed of the highway sunk down and in 1938 it was rebuilt through the peat by blasting out the peat and back filling with shale and gravel. Even today, these portions, one at the north end of the Lake and one south of Faith Farm, tend to sink.

In the summer of 1937 my father purchased an 18 acre portion of the Matson farm just at the south end of the Lake. This is currently owned by Jan and Donna Jensen. Dad then began to clear the adjacent land to the west on a "40" belonging to his mother, my grandmother. The east 20 acres of that "40" is now mine. Munn Creek flows along the west side of the 20 acre plot into the Lake. Its channel is a dug channel. Early maps do not show it entering the Lake, but flowing into Leland Creek at the railroad Bridge 15.

My first memory of Munn Creek at the south end of the Lake was that it was cut deeper than today. About 1940-45 steelhead and salmon would come into it in the fall. When Ralls' Creek had water in it in the fall, there would be salmon in it as well. This is evidence that the Lake was lower and that Leland Creek was open for upward migration of fish. George Munn, my father's brother, recalls that as a child in the 1900's he would carry the salmon and stealhead fry from the pools of Ralls' Creek to the Lake as the stream dried up in early summer.

In about '49 or '50 (I was away at school), the farmers got together and with Soil Conservation Service assistance dredged the system from Boulton Farms through to the underpass at US 101. Lateral ditches were also dug on our farm and what is now the Faith Farm as well as on farms at the north end of the Lake. The water drained will in the summer and for the next few summers! The summer lake level was at least 6 feet lower than today. There was a beach almost all around the lake. At Leland Resort, the cabins had been built out over the water so boats could be pulled up along side. Following the ditching, the cabins became high and dry. All docks had to be relocated out farther. The culvert under West Leland Valley Road near Jan Jensen's could be walked through! Today it is full to capacity all summer with slack water.

Farmers opened up a lot of land that had been marshy or brushy. The fields would carry a plough and mowing machine right to the creek bank. During this time there were several active dairy farms in the valley.

State fishery decided that fish stocked into Lake Leland would escape down Leland Creek. They put in a fish wheel into Leland Creek. The wheel has a concrete floor, which some claimed that it dammed the stream. It is easy to see, however, that if water were down to the bottom of the fish weir, there would be no problem with winter flooding.

Part IV: The Beavers

Some say they came by natural migration from Penny Creek 4 miles to the southwest. Others say that someone who was unhappy with the drainage project imported the animals. From whatever source, the beavers disrupted the drainage picture from about 1956 on. The first dam was down Leland Creek about 1000 feet from the Lake (or about 500 feet up stream from the county road). The dam was effective in raising the Lake about 4 feet in the summer. Today it is the primary factor for about 6 feet from that low water mark. Not only does it raise the Lake, but it keeps a full basin prior to the heavy rain periods and retards the release of the high water into the fall when heavy rains begin. Even a moderate rain storm will bring the water level over U.S. 101 and all lower shore areas.

There have been as many as six beaver dams on Leland Creek. Different people worked to remove the dams stick by stick or with dynamite. I have tried and been successful in a few cases. At this time there are at least three beaver dams between the Lake and the ditch next to US 101, 1.5 mile south. If any one of these dams is breached, the others tend to limit the drainage "loss" to the beaver until the breach is repaired. The beaver have been shot, trapped and harassed, to little avail.

Beavers aren't the entire problem, however. The open marsh land became a perfect environment for bull rushes. Cows do not eat bull rush, so it soon over takes a pasture. The farmers discovered that canary grass will grow above and shade out the bull rush and canary grass does very well on the wet land. However, cows will eat canary grass only when it is young and tender. Older grass blades are sharp. The mature grass falls into the stream and builds up a mat. It eventually becomes hydroponic and fully covers the stream and retards flow.

Whenever peat land is cleared and plowed, the dry, unprotected peat will rot away. So even though the peat soil seems high and dry to start, after a generation of cultivation it becomes lower and wetter. This phenomenon can be seen at the Faith Farm where a pond was dredged a few years back. The dredged soil has pretty well rotted away leaving a permanent pond.

The stream bank is a good environment for willow, hardhack, alder and brush. When these die they fall into the stream and fill it up. There has been little or no clearing of the stream bed since it was dredged in 1950.

Part V: Summary of the problem

So today, the summer level of the Lake is the highest in recent history. This can be clearly demonstrated by the water kill of willow, alder, spruce and maple around the Lake, especially notable at the north end to the east of U.S.101, but equally noted all along the south end. All the inflowing streams are filling in and overflowing adjacent fields because they no longer have as much gradient as they approach the lake.

The beaver dams are large and effective. The sluggish stream is full of canary grass roots and stalks. Where the stream is tree-lined there is much debris filling the stream.

Winter flood level rises well into the yards of homes built in the 20's to 50's. It even invades basements and porches. High water flooding roads is so common that the State Highway has permanent warning signs on U.S. 101 to caution the unwary driver.

Winter access into pasture areas by farmers is greatly restricted by soggy land and by water often deep enough to float a boat.

Approximately 40-50 acres of farm land at the south end of the Lake and 30-40 acres at the north end have become lost to the high water table maintained by the beaver dams.

Part VI: Are there solutions?

Several responses and strategies come to mind.

1) **No action.** To do nothing can have some justification. It has no direct cost in expenditure for equipment or labor. There is an argument for letting nature take its course. The wet land harbors special wild life, not just beaver, but blue heron, fish hawks, young fish, etc. The effort of obtaining permits and convincement of detractors would be unnecessary.

There are real costs, however. It is predictable that there will be increasing loss to homes and diminishment of farm land. The flooding of US 101 will not cease. The inconvenience of water over the county road will increase as run-off is retarded.

It is uncertain to me whether inaction will change the pollution of Quilcene Bay from the Leland Creek source. As farm land is lost, there will be fewer cattle to cause the pollution and fewer homes to contribute to the pollution.

2) **Redredging.** Various plans could be suggested for opening up the channel. Perhaps a minimum effort with heavy equipment would be to dredge 1.5 to 2 miles of the channel from the Lake to where it meets the highway. Perhaps the lower part would also need clearing, another 2 miles. This is the portion with sandstone stream bed. With the economic return on this land now, it is unlikely that the investment could be recovered.

3) **Hand clearing.** This is the "labor intensive" solution. A lot of improvement of the stream flow could be provided if the channel were cleared of debris and if the beaver dams were removed. A constant vigil would need to be followed to keep the stream clear. The portion of the stream that could be cleared is that which runs through the trees from about a mile south of the Lake to Highway 101. The main beaver dam above the fish wheel would have to be breached.

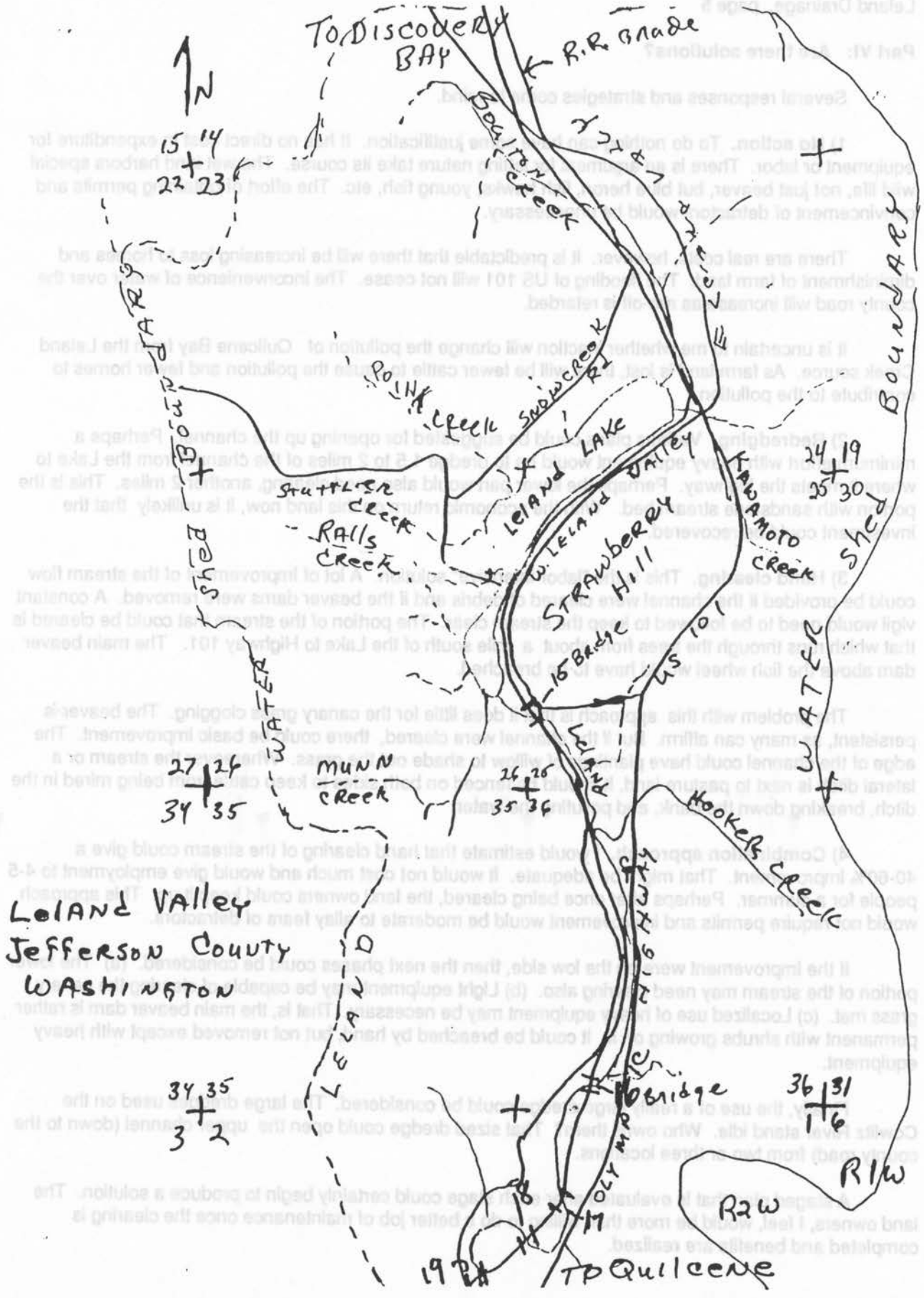
The problem with this approach is that it does little for the canary grass clogging. The beaver is persistent, as many can affirm. But if the channel were cleared, there could be basic improvement. The edge of the channel could have plantings of willow to shade out the grass. Whereever the stream or a lateral ditch is next to pasture land, it should be fenced on both sides to keep cattle from being mired in the ditch, breaking down the bank, and polluting the water.

4) **Combination approach.** I would estimate that hand clearing of the stream could give a 40-60% improvement. That might be adequate. It would not cost much and would give employment to 4-5 people for a summer. Perhaps after once being cleared, the land owners could keep it up. This approach would not require permits and improvement would be moderate to allay fears of detractors.

If the improvement were on the low side, then the next phases could be considered. (a) The lower portion of the stream may need clearing also. (b) Light equipment may be capable of clearing the canary grass mat. (c) Localized use of heavy equipment may be necessary. That is, the main beaver dam is rather permanent with shrubs growing on it. It could be breached by hand, but not removed except with heavy equipment.

Finally, the use of a really large dredge could be considered. The large dredges used on the Cowlitz River stand idle. Who owns them? That sized dredge could open the upper channel (down to the county road) from two or three locations.

A staged plan that is evaluated after each stage could certainly begin to produce a solution. The land owners, I feel, would be more than willing to do a better job of maintenance once the clearing is completed and benefits are realized.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To Discovery Bay
R.R. Grade
Boulton Creek
Snow Creek Rd
Snow Creek
Leland Lake
Leland Valley
Kamamoto Creek
Strawberry Hill
W. Leland
Stuttler Creek
Rails Creek
Rapp Rd
Beaver Shed
Water Boundary
Shed
US 101
16 Bridge
Larson Rd
Munn Creek
Hooker Creek
Olympic Hwy
Bridge
Leland Valley
Jefferson County
Washington
To Quilcene
R1W
R2W
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LELAND LAKE/LELAND CREEK DRAINAGE ANALYSIS

SOIL CONSERVATION SERVICE

APRIL 7, 1988

Introduction

In March 1988, a group of landowners residing in the Leland Lake and Leland Creek area met with representatives of the Jefferson Conservation District, Soil Conservation Service, State Department of Transportation, State Department of Fisheries, and the State Department of Wildlife concerning perceived drainage problems along the upper reaches of Leland Creek and high water levels in Leland Lake. The Soil Conservation Service was requested to inventory the problem and, if possible, to suggest low-cost alternatives for reducing any identified hinderances to drainage. A basic inventory of the affected area was completed on April 6, 1988 by Kerry Perkins, Paul Ludwig, and Greg Fisher of the Soil Conservation Service.

Problem

Winter flooding and a high water table occurs adjacent to Leland Creek from the Lake outlet downstream to approximately the center of Section 1, T28N, R2WWM, and from the Lake inlet upstream to approximately the northern section line of Section 24, T28N, R2WWM.

The water level of Leland Lake has risen a number of feet in recent years due to impeeded downstream flow of Leland Creek. The higher Lake water level has caused flooding of basements in homes immediately adjacent to the Lake and problems with septic systems according to the residents.

During high winter flows, Leland Creek causes flooding over State Highway 101 in Section 24, upstream of Leland Lake. High water levels in Leland Creek also results in year-round saturation of the Highway road balast.

History

An evaluation of flooding problems along Leland Creek was completed by the Soil Conservation Service in 1948. Subsequently, a drainage project was proposed for Leland Creek covering an area for approximately 12,840 feet below the Lake outlet and about 4,500 feet upstream of the Lake. The project plan called for clearing a right-of-way, excavation of the the channel bottoms and bank slopes, and

the installation of a road culvert just below the Lake outlet to control the Lake water level. The project was initiated but, since no "as-built" records exist, the extent of work accomplished is unknown (a construction progress report was apparently completed on January 10, 1949).

A second SCS evaluation of flooding problems was completed in June 1956. Apparently, no maintenance was completed following the 1948 project, and the Creek reverted to pre-1948 conditions. The second project plan called for the excavation of Leland Creek for about 10,000 feet downstream and 1,500 feet upstream of Leland Lake and the construction of a weir at the outlet of the Lake to control the Lake level. As far as is known, this second project was never initiated.

THE LELAND CREEK WATERSHED

From its mouth at the Little Quilcene River, the total Leland Creek watershed is about 5,120 acres.

The vast majority of the watershed is forestland. It appears to have been heavily logged about 40 years ago and was allowed to regenerate naturally to a mixture of hardwood and coniferous trees. Approximately 700 acres (about 7% of the watershed) has been clearcut in the past 8-10 years - most of the harvested area occurs on gently sloping foothills in the northwestern portion of the watershed. Since the remaining portion of the watershed has a low percentage of high value coniferous trees, it is unlikely that large-scale harvesting operations will be conducted in the near future. Recent sediment inputs into Leland Creek from logging operations appear to be minimal.

Currently, there are a maximum of 50-70 acres of pastureland being impacted by the flooding of Leland Creek. There are a few additional pasture/hayland fields in the watershed that are not affected by flooding.

PRESENT CONDITION OF LELAND CREEK

A fish screen/weir and associated concrete structure was installed in Leland Creek some years ago just upstream of the Leland Loop Road culvert, about 650 feet downstream of the Lake outlet. The weirs' purpose was to prevent the escapement of fish from Leland Lake. Any secondary function of the weir is unknown. The screen portion of the structure has been removed.

From Leland Lake Downstream about 10,750 Feet

From the outlet of Leland Lake to the Leland Loop Road culvert (about 650 feet), Leland Creek's channel is almost totally obscurred by a dense stand of Reeds canarygrass. A beaver lodge and the clipping of adjacent riparian vegetation was observed in this stretch, but no beaver dam was encountered. Water flow was very slow in this section and the road culvert was completely full. According to USFWS Circular 39, "Wetlands of the U.S., the Creek channel in this stretch would probably be a Type 3 wetland and the adjacent riparian zone a Type 2 wetland.

The plugging of the channel by canarygrass persists for an additional 1,700 feet downstream of the road culvert until the channel enters a 600 foot stretch with sufficient woody riparian vegetation to eliminate the grass. The water flow was again very slow in the canarygrass section but appeared to accelerate considerably in the stretch covered with adjacent woody vegetation. The wetlands in the canarygrass section would be a Type 2 and in the woody section a Type 6.

The Creek then divides into two separate branches. The western branch occupies the old borrow-ditch adjacent to the railroad grade and contains dense woody riparian vegetation. Water flow appeared to be good in this branch. The eastern branch meanders out through a dense shrub swamp, preventing close examination of the channel. Beaver activity was apparent in this area and may be slowing flows. The majority of the water volume appeared to flow down this eastern channel. These two branches are about 1,600 feet in length. After the branches rejoin, the next 1,000 feet of channel is very near to Highway 101, is fairly heavily wooded, and appeared to have good flow. The wetlands in these two stretches would be a combination of Type 6 and 7.

The next stretch covering about 3,700 feet flows through an area with dense Reeds canarygrass. Even though the water was flowing quite well, there is no doubt that the canarygrass in the channel is significantly retarding flow capacities. At the beginning of this stretch, an old fence line runs across the channel and hangs up a considerable amount of vegetation. At the very downstream end of this grassy area, minor flow impediments are caused by a log and a partial sediment dam. The wetlands in these areas are probably Type 2.

The Creek then enters a more woody section for the final 1,500 which we inventoried. No apparent restrictions were noted.

From Leland Lake Upstream about 4,000 Feet

No restrictions were observed from the inlet of Lake Leland through the Highway 101 road culvert (about 300 feet). Wetlands in this area would primarily be Type 3 or 6.

The next upstream stretch of about 2,000 feet is a dense shrub swamp. A beaver dam and lodge exists about 200 feet upstream of the Highway 101 road culvert. This beaver dam is restricting flow. The creek meanders out through the shrub thickets, which prevented close examination of the channel. This shrub swamp formerly contained various tree species which have died out due to the deterioration of the drainage. A peat soil occupies this area. The wetlands would be primarily Type 7.

In the final upstream stretch of about 2,000 feet, the creek flows through more peat soil which is farmed. A water table at or near the soil surface occurs on the entire peat area during the winter months. Primarily Type 2 wetlands.

At this point, Leland Creek passes underneath Highway 101. This is the main location in which the Creek floods the Highway during winter storm events.

SUMMARY

In the past, some drainage projects were initiated in the upper reaches of Leland Creek. Over the years, little maintenance has been performed and areas adjacent to the Creek have reverted to various types of wetland. The Creek channel itself, both above and below Leland Lake, has various water flow impediments. These include live vegetation (primarily canarygrass), beaver activity, and organic debris such as tree trunks. The Creek does not appear to have a high mineral sediment input nor accelerated streambank erosion at this time. The water flow impediments in the Creek below the Lake are at least partially responsible for the higher water level in the Lake and the flooding adjacent to the Creek. The elevated Lake water level, beaver activity, and the deteriorated drainage system have at least partially contributed to the flooding of fields and Highway 101 above the Lake.

Historically, it was demonstrated that the improvement of drainage outlets can reduce the Lake water level and the flooding of areas adjacent to the Creek. The costs of completing drainage improvements must be carefully weighed against the potential gains in income resulting from increased agricultural production and less frequent flooding of Highway 101. In addition to economic considerations, various environmental factors and permit systems will have to be addressed before the alterations to wetlands and Lake levels can be initiated.

Due to existing federal regulations governing the alteration of many of the wetland types found in this inventory, the Soil Conservation Service can not provide any additional technical or financial assistance beyond this point that would involve the draining of wetlands.

Paul Ludwig
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Olympia, Wa.

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cc: Kerry Perkins, D.C., Port Angeles
Frank Easter, A.C., Olympia
Dean Renner, A.E., Olympia

LELAND CREEK WATERSHED DATA

Lake Leland	103 acres
Roads and Highways	115+ acres
Power Line Right of Way	18 acres
Agricultural Land	201 acres
Agricultural Land Affected by Flooding	60-90 acres
Homesites	100 acres
Woodland	4583 acres
Total Acres	5120

MAJOR PROBLEMS

Flooding of Agricultural Land

Flooding of Residential Land

Flooding of State and County Roads

Potential loss of Fish Habitat

Proposed Project Description

Reconstruction of the Lake's inlet and outlet channels, for a distance of approximately 2 miles downstream of Lake Leland and .85 miles upstream of the lake, removal of rank brush, beaver dams and other vegetative growth in the existing channel and side slopes. Installation of a water control structure at the lower end of Lake Leland to mitigate the potential loss of wetlands.

Existing Problems with Channel

Changes made in alignment and channel bottom; and filling in the channel with silt, logs and detritus has changed the hydraulic qualities of the drainage channel to such an extent that it no longer is adequate to carry off the normal winter run-off from Lake Leland and its watershed

Jefferson County Conservation District

Creating WIN-WIN solutions that put CONSERVATION ON THE GROUND!

NEWSLETTER

Volume 4, No. 4 Fall 1990

Conservation District Takes Lead Agency Status On Lake Leland Flooding

The Jefferson County Conservation District has been asked by the Department of Transportation to take lead agency status to correct the flooding conditions of Highway 101 in the Lake Leland area of Quilcene.

In an effort to get started on the process a meeting was held at the Quilcene Community Center on November 16th. Invited to attend were representatives from: the State of Washington Departments of Ecology, Fisheries, Transportation and Wildlife along with legislator, van Jones; federal agents of the Soil Conservation Service and the US Army Corps of Engineers; Jefferson County agents of Health, Planning and Public Works; along with local residents and a Timber, Fish and Wildlife representative. All five supervisors and the office manager of the conservation district attended with the meeting led by a professional facilitator from Port Townsend, Jim Rough.

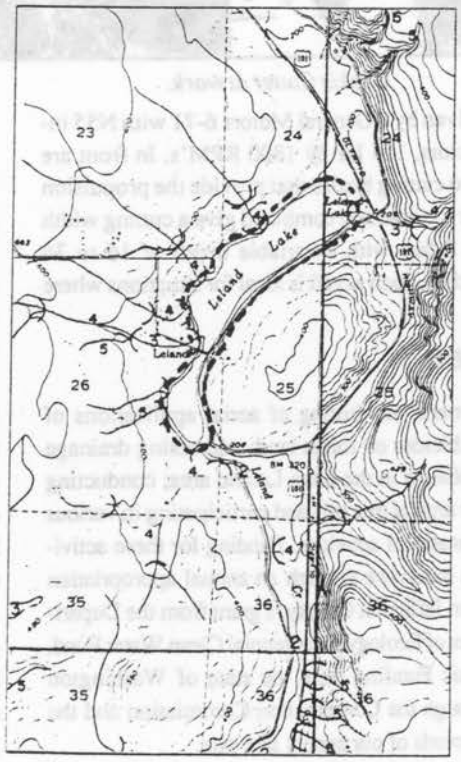
Long time resident Hector Munn came up from Portland, Oregon where he teaches. Mr. Munn had written a five page history of the area several years back in an attempt to bring clarity to the situation. (Copies of this report are available from the district office in Port Townsend.)

Where Washington State Highway 101 skirts Lake Leland, there is a natural wetland with a peat bog over 40 feet deep on which the road sits. In 1948 the outflow of the lake was channeled and cleaned out which lowered the lake between three and five feet from its present level. The lower lake provided a reservoir for runoff during the rainy season. The outflow of the lake is once again clogged which some believe is the cause of the level of the lake to rise. Flooding conditions now exist that threaten septic systems and basements, reduce pasture land and create severe road conditions.

Three main problems were identified as a result of the meeting: 1) How to keep Highway 101 safe? 2) How to keep Highway 101 safe and minimize the impact to wetlands? 3) How to address the encroachment of wetlands? The conservation district has proposed a three step solution whose first step is to remove reed canarygrass, a beaver dam and natural obstructions below the county road. The Department of Transportation will review this first step in view of all the issues raised. The work, if approved, could not begin before July 1 since the coho salmon have returned to the stream and are spawning below the lake.

The problem of a rising water table has not gone away for the past 10 to 15 years. In fact, it has become progressively worse. It is hoped that this meeting gave greater understanding of the perplexity of the problem and that everyone will work together to see that the road conditions on Highway 101 improve.

OFFICIAL WATER TYPE REFERENCE MAP
County: JEFFERSON • T.28N., R. 2 W.
Scale = 1:24,000



LEGEND

- 1+ — Shoreline of statewide significance (200' SMZ)
- 1,2,3,4,5 — Stream classification
- Shoreline of state. Type 1
- Termination of shoreline
- 3 — Stream Indication
- Termination of stream classification
- Special protection area
- Diversion for public water supply classifications 1, 2 or 3
- SMZ — Streamline Management Zone

The stream classifications on this map have been agreed upon by the Washington State Departments of Game, Ecology, Fisheries, and Natural Resources. Date Revised: 11/1989

A-13

Jefferson County Conservation District

Creating WIN-WIN solutions that put CONSERVATION ON THE GROUND!

NEWSLETTER

Volume 5, No. 4 Fall 1991

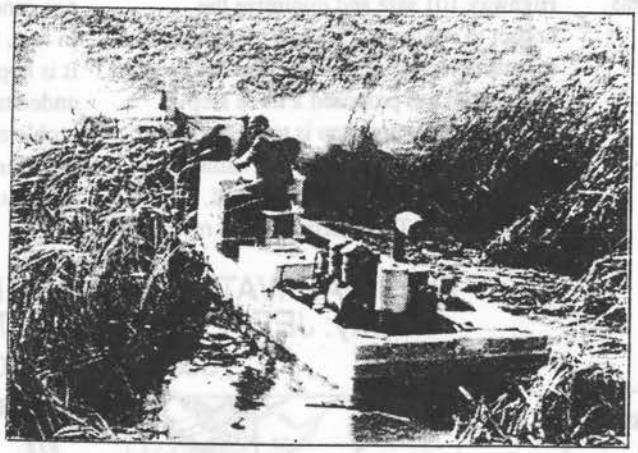
LAKE FLOWS AGAIN!

After years of inattention, Leland Lake has water flowing steadily out the outlet. The project took the efforts of many individuals and enterprises.

Once a Hydraulics Permit Application (HPA) was approved by Randy Johnson of the Washington Department of Fisheries to permit vegetation removal in Leland Creek, Leavitt Trucking Company was hired and moved in on mats with their backhoe. The weather was cooperative and the work was completed up to the fish weir in only two days! The flow above the weir was still impeded, but the work below the unty road near Jan and Donna Jensen's property dropped the water level 23 inches. Now the problem was how to get equipment into the very matted, wet and deep area above the weir.

The conservation district had learned from the Department of Ecology's Bill Leonard of the Cookie Cutter, a machine used by the Washington Department of Wildlife to remove vegetation in wetlands. As good luck would have it, this machine, owned and operated by World Environmental Services out of the state of Florida, was doing work for the US Navy on Indian Island. Cindi Kunz, the field biologist for Indian Island, obtained permission for the district supervisors and staff to come onto the base and see the Cookie Cutter work on cattails.

The Cookie Cutter is a 33 foot long, 6 foot beam, aluminum flat-bottomed boat power



Cookie Cutter at work.

driven by a General Motors 6-71 with N55 injectors, 174 HP @ 1800 RPM's. In front are two cutting blades that provide the propulsion for the boat and combined give a cutting width of 8 feet with a variable depth of 16 to 36 inches. Such a craft is ideal for situations where conventional equipment has difficult access because of fencing or trees along the banks or wet conditions.

Mike Abbruzze of World Environmental Services was hired and with a total of 6 hours working in the outlet, the Cookie Cutter cut through the blockages so one could see a channel again. Dams were orchestrated by district technician Al Latham with the help of supervisors, Roger Short and Glen Huntingford and staff, Bruce Marston.

It is anticipated that by allowing the outflow free passage, the lake can again function as a reservoir for the heavy winter rains with the dam holding the lake steady during the dry summer times. The initial reaction is one of joy and anticipation of runs of silver salmon reentering the lake.

Over the coming year, the district will work on phase two of the project to further address the flooding problems on highway 101 and adjacent agricultural land by establishing an unobstructed flow of water from the point of flooding to Lake Leland and lowering the Lake approximately 1 foot. Flooding of 101 and the adjacent landowner's properties and most especially their septic systems could be either eliminated or at least greatly reduced.

Additionally, the adjacent landowner, Faith Farm, is looking to fence the stream and plant trees to create a riparian zone to improve bank stabilization, reduce canary grass competition and establish new habitat for wildlife and fish. "New" habitat will include the construction of 20 - 2' x 6' wooden rafts to act as cover for fish from predators like the great blue heron. The total number of trees anticipated to be planted is 2,000. It is hoped that the DNR's WCC crew will be available to participate in all of these projects and that ASCS Cost -Sharing will be available for funding of the fencing.

1991 District Activities Reviewed

As 1991 rolls to a close, this would be a good time to review the district's activities and accomplishments. The work load has kept the district's five supervisors: Roger Short, John Boulton, Al Jakeway, Glen Huntingford and Phil Andrus and two staff: Bruce Marston and Al Latham hopping " year. We would like to share what we have .en up to with our readers.

Projects undertaken in 1991 have included: implementation of Best Management Practices (BMP's) to address agricultural nonpoint pollution; providing technical assistance to landowners; monitoring of aerial applications of herbicides on forest land; addressing drainage problems in the Lake Leland area; conducting our annual tree sale and participating in various educational activities. Funding for these activities has come through an annual appropriation from Jefferson County, a grant from the Department of Ecology's Centennial Clean Water Fund, Basic Funding from the state of Washington through the Conservation Commission and the proceeds of our annual tree sale.

continued page 4

APPENDIX B

STEERING COMMITTEE MEETINGS

Diver dredging - diver operates gold dredge-sucks plants out

Advantages

- Good for early infestation
- Can be effective in soft sediments
- Site specific

Disadvantages

- Machine creates poor visibility and turbidity so slow going
- Labor intensive
- Expensive-need 2 divers and a tender
- Fragmentation
- Roots remain in hard sediments
- 4 different permits needed (one takes 2 yrs.)
- Not practical for widespread infestation such as we have

Dredging - removes sediment from lake bottom

Advantages

- A good way to restore lake back to pre housing conditions
- Turns the clock back on nutrients
- Removal of excessive nutrients will stop algae blooms

Disadvantages

- Extremely expensive $$$$$$
- Disposal of material also adds to costs
- Cost probably makes it not an option for Lake Leland
- Environmental impacts
- Several years of permits

Water level draw down - not feasible for Lake Leland

Aquatic Herbicides - permitted in WA

Copper compounds - Komeen product name

- Mostly used as an algaecide
- Does not degrade and can build toxic level in sediments
- Short term effect

Endothall - Aquathol product name

- Burns plant back to roots - a "contact" herbicide which is temporary, plant will grow back
- Can cause oxygen levels to become low
- Swimming restrictions 7-8 days
- Water use restrictions

Glyphosate - Rodeo, Round up product names

- Systemic herbicide - absorbed by plant
- Can produce long term control
- Non-toxic
- No restrictions on swimming and domestic water use
- Can target specific plant
- Good for use with reed canary grass or yellow flag iris for control
- **Inactive in water so does not work for Brazilian elodea**

Fluridone - Sonar

A better tool for Milfoil than Brazilian elodea which has buds that survive
Somewhat successful for Brazilian elodea in Lake Limerick (99.5% initial reduction)
Removed bio-mass but B elodea **does** come back (Limerick treated in 1996, now reappearing as a widespread light growth)
Need to retreat every few years
Slow acting - 8 to10 week treatment period
Water use restrictions for irrigation and domestic use
Pellet release cannot be used within ¼ mile of water intake
Need to use correctly or can have environmental or human health concerns
Kills untargeted plants

Prevention

Need good education program

Scott Bonar then took over to talk about the biological control using triploid grass carp. Highlights from his talk and his report follow:

- Brought in from Malaysia in 60's and used extensively in the South
- Triploid carp which are sterile introduced (eggs treated in a press-not with chemical)
- Legalized in 1990 in WA for use in lakes and ponds
- Research done across state on use from 1990-1995 –looked at 99 lakes
- Monitored amount and type of plants remaining--also did water quality surveys
- Separated lakes into different areas of control: eradication, no control site (greater than 50% vegetation remaining and carp in more than 2 years), control site (intermediate amount of vegetation remaining w/carp in 2-5 years) *This is goal for most stockings in WA—you want to leave some plants in lake.*
- F & W standpoint: plants effect feeding efficiency of fish--too many plants fish can't feed effectively and grow slowly (stunted)—intermediate level of plants the feeding relationship works very well, get good production of fish—wipe out all plants (forage base) not good for fish. Plants important to waterfowl for food.

Results of study: 184 sites approved to stock with grass carp—most very small ponds and lakes less than 10 acres. Grass carp eat in hierarchy--initially Brazilian elodea not preferred until fish grows a bit (8-12" when stocked, 12-14" to eat elodea, took approximately one year in Devil's Lake—ate thinleaf pondweed first, then elodea). Generally takes about two years for effect from stocking. Wide range of stocking rates used (5-174 fish per vegetated acre). After 2 year period most lakes were either eradicated or no major effects noticed. Seems to be all or nothing control—only 18% of waters reached goal of intermediate control. Median stocking rate for all lakes combined which resulted in control was 24 fish/vegetated acre. Stocking rates which resulted in eradication were as low as 8 fish/vegetated acre and no control rates as high as 109 fish/veg acre. Lake sizes were not included in this information. After excluding lakes less than 1 acre (which is about half of lakes) only one eradication stocking rate was lower than the median control rate of 24 fish/veg acre. But stocking rates that resulted in no control (remember no control is greater than 50% vegetation remaining) varied from 7-74 fish/veg acre. Why the variability? One cause may be that grass carp are susceptible to mortality in shipping or predation by eagles, osprey, otters. Fish are hard to remove so overstocking not a good idea. Can live to age of 14 in WA.

Stocking rate recommendations: Insufficient information to recommend different stocking rates. Lot of variability in results. Science not there yet.
Public satisfaction: Popular method of control. Property owners satisfied with results in 83% of 49 lakes stocked. All landowners achieving control or eradication were highly or moderately satisfied. Aesthetics increased, swimming and boating improved. Not much change noted in angling quality. In 13 lakes where grass carp had little or no effect, landowners were highly or moderately satisfied with 54% of introductions. Perhaps growth rate was slowed in these instances or the fact that they felt they were doing something contributed to satisfaction.
Water quality impacts: Turbidity (cloudiness of water) significantly higher in lakes with total eradication. No difference in turbidity between control and no control sites. Turbidity sediment related because did not notice difference in algae.
Recommendations for policy: Recommend stocking only lakes that can tolerate total eradication, because it is a possibility. Need to have good barriers on outlet that will work during flooding.

The presentations were followed with a period for questions, answers, and discussion. Many thoughtful questions were asked mainly relating to the use of aquatic herbicides or carp. Since the herbicides are not totally effective with B elodea, the question was asked if there was anything that **is** effective. Kathy answered grass carp. She talked about the eventual possibility of a bio control that is B elodea specific. Don asked if a permit was needed for hand pulling around his dock and Kathy answered that yes, the rules have recently changed. Dan Collins suggested that I contact Tim Rymer in Port Angeles for more information on this process.

Joanne wondered if there was any way to determine the amount of predators in an area and use that information to help predict success or failure of using carp. Scott answered that it would be very difficult to really predict how many otters or cormorants might be eating how many carp but agreed that information would make stocking easier. Paul wondered if there were any negative effects on the predators or their offspring because of the injection used to make carp sterile. Scott answered that the only effect was that the predator was better fed. He explained that the injection is a natural part of the carp, the pituitary not a chemical. Eggs are then pressed which restricts cell division and makes a triple chromosome resulting in sterilization. Al asked what total eradication meant. Scott responded that submersed vegetation is taken out but that emergents will be left or perhaps nibbled on a bit such as water lilies. Glenn asked if there might be a different rate of eradication based on the size of a lake. He felt that a small pond with concentrated fish might be more apt to be totally eradicated than a larger lake with a small proportion of vegetation. Scott replied that they did not look at lake size, only at the amount of fish per vegetated acre. I have wondered about this myself and it seems to be a good point.

Due to the length of the meeting, we were not able to talk much about our preferred options but the few mentioned are as follows: grass carp, no action, hand pulling, bottom barriers, Roger Short's weed cutter, and the possibility of moveable carp pens. Lauren Mark also requested that we go through the process of elimination of options by being clear as to why a particular option is not chosen. She will need this information in certain circumstances where a county permit is required. This is also the process recommended by DOE and is how I planned on writing up the draft report. It was decided to meet again on Feb. 6th at 10:00am at the ARC.

FORM F: RECORD OF MEETING ATTENDANCE

Agreement No: _____ Recipient: _____ Payment Request _____ Page ____ of ____

Purpose of Meeting: 2nd Steering Committee Meeting Lake Leland Date of Meeting: 1/9/98

Name (please print)	Representing	No. of Hours at Meeting	Signature (required)
GEORGE BAUER	PROPERTY OWNER		George Bauer
LINDA BAUER	" " "		Linda L. Bauer
Doug Barley	" " "		Doug Barley
DON CASE	" "		Donald Case
Joanne Peterson	" "		Joanne Peterson
Warren Steurer	Jefferson County		W Steurer
Roger Short	Citizen JCCD		Roger Short
DAN Collins	WDF & W		Dan C. Collins
PAUL Wilcox	CONCERNED Fisherman		Paul J. Wilcox
Hector Munn	Property owner		Hector J Munn
JIM Munn	"		Jim Munn

ELEMENT NUMBER _____ TOTAL VOLUNTEER HOURS: _____ x $12.50 = $ _____

Enter the value computed in the lower right hand box on Form C1 for the appropriate element.

Jefferson County Conservation District
205 W. Patison St., Port Hadlock, WA 98339 - Phone (360) 385-4105

LAKE LELAND
Integrated Aquatic Vegetation Management Plan

THIRD STEERING COMMITTEE MEETING

2/6/98
10:00am to noon (or thereabouts)
Edwina Winters Family Retreat
285 Munn Road—Lake Leland
Quilcene, WA

AGENDA

INTRODUCTIONS

PROGRESS REPORT

PRIORITIZE AREAS OF CONCERN & CONTROL METHODS

- Brazilian elodea
- Reed canary grass and flooding
- Yellow flag iris

NEXT STEP

SCHEDULE NEXT MEETING

CLOSING

B-16

Meeting notes—Steering Committee Meeting (#3) held February 6, 1998

Those in attendance at meeting number three were Al Latham (JCCD), Glenn Gately (JCCD), Dan Collins (WDFW), Warren Steurer (JC Parks), Don Case, Joanne Peterson, Doug Barley, George and Linda Bauer, and myself. Kathy Hamel (DOE), Lauren Mark (JC Planning), and Dave Christianson (JC Environmental Health) were unable to attend this meeting as well as Lowell Davis, Paul Wilcox, and Bruce or Jim Munn representing community interest.

For the record, we prioritized the problem vegetation with the non native Brazilian elodea as top concern followed by reed canary grass and lastly the yellow flag iris. The areas on the lake for aquatic control are the shoreline out to approximately ten feet (particularly in front of residences and the park swimming area), private docks, and the south end of the lake. There the Brazilian elodea is most concentrated and completely covers the shoreline extending about one third of the way across the lake from each side. This leaves a small spot in the center of this area weed free for fishing and boat traffic.

Also for the record, we ran through the complete list of options eliminating the majority for one reason or another. It was agreed that none of the options are that great.

Physical Control Techniques

Hand-pulling: We were very much in agreement that hand pulling will be a part of our recommendations for the vegetation management plan. This method will work well along the shoreline in the larger portion of the lake where the weed is less abundant. We propose to use this method around private docks also. This will be accomplished with the use of volunteer labor for the most part. There was much discussion on the use of different interest groups such as bass fishing clubs, students, diving clubs, scouts, and local environmental groups. Warren suggested Americorp which is partially grant funded. The county has used this program before in conjunction with the Forest Service. I will follow up with Dave Johnson USFS to see if the program still exists in this area. Dan Collins also recommended the Belfair camp kids who are used on forest fires. They may be available to help early in the fire season. Dan is looking into this. Glenn suggested we have a yearly elodea festival which may be a good idea to get volunteer folks together. Don mentioned the fact that we are seeking a very environmental solution, and we may be able to find a lot of help from the environmentally conscious community members. We have a pretty good resource of volunteers in the area, so labor may not be much of a problem. It will take quite a bit of organization and coordination though, but it can be done.

Bottom Barriers: There are some problems associated with bottom barrier use in Lake Leland but they may be appropriate in a few areas around private docks. The bottom of the lake is pretty soft with a silt layer and anchoring the barriers securely may be a problem. Also, there are big logs in the way near many of the docks. Apparently the Jensen's (south end of lake) laid down barrier around their dock and the weed grew through it. This is just hearsay, and I will follow up on the procedure and product they used. Bottom barrier materials can be costly.

Weed Rolling: This is the somewhat portable (?) roller that pivots from the corner of a dock. The logs on the bottom may make this impossible at some docks. We have questions about the effectiveness of this machine and its durability. Dan is looking into this. They may be a good idea in some areas, but we need to know more.

Water level draw down: We would not be able to draw down enough to make an impact on the Brazilian elodea. As it is, the lake is increasingly higher each year.

Mechanical

Harvesting and Rotovation: These methods are large scale and much more suitable for larger lakes. They are very expensive methods, and the disadvantages of both methods out weigh the advantages for use in our particular situation.

Diver Dredging: This method is also very costly. It may work well here if we could find some volunteer equipment. But it does take a long permitting process (up to 2 years) and is very labor intensive and slow going.

Biological

Grass Carp: We still have many questions and concerns regarding the use of grass carp. We all agree that the potential prospect of total aquatic vegetation eradication is something to be very concerned about. The lake supports a very good warm water fishery that could be effected by total eradication. We also have quite a bit of wildlife in the area that are supported by the lake; bald eagles, osprey, trumpeter swans, and otters, to name a few. Those of us who live here enjoy the wildlife, and we do not want to create changes that would reduce this wildlife population.

Joanne suggested using moveable pens which would confine the fish and would eliminate the predation problem. The pens could be moved about letting the carp graze in certain areas. In theory this sounds like an excellent idea. At this point, we don't know if it is feasible—there are lots of unanswered questions like how would we assure that the grass gets inside while not letting the fish escape. Glenn feels that if we use carp at all we should just put them in the whole lake. If we were to get permission from WDFW to use the carp, Dan said they would recommend a small stocking (such as in Duck Lake). He then showed us some pictures of a small pond near Chimacum that had been stocked (illegally) with carp using less than the "model" number of fish. In three to four years time the fish grew a lot, but the stocking resulted in no weed control. The pond was still loaded with weeds when the fish were removed. It is not known why a small stocking seems to result in very little, if any, control. Dan had some other examples as well, but they, too, were all small ponds. Studies on Duck Lake have not been completed, but I am going to talk to someone there familiar with the project and see if they have any comments, pro or con, at this point.

Concerns were voiced about the study method for the lakes presently stocked with carp. In reporting success or non success, over 50% of vegetation remaining is counted as a non success. In our situation, even a 25% reduction would be viewed as successful. It would be interesting to look at the raw data and see exactly what the specific reductions are for a particular lake or pond size compared to stocking rates. I intend to follow up on this with Scott Bonar. I would like to narrow the data down and see if there is information available on the amount of control that actually took place while being listed as no control.

Al and Dan both suggested that Peter Bahls be contacted again to see how the Tribe would feel about the use of carp in Leland. If they are negative we need go no farther with the carp idea. I will call him again and set up a personal appointment to talk with him about the subject.

The idea of using carp is not dead yet though another idea has been presented by Paul Wilcox and Lowell Davis who could not attend today. Paul's uncle lived on a lake that had some type of weed overabundance. He used to clear a path around his dock and out into the lake by dragging a railroad tie along the bottom. Paul says it worked well and suggests that we look into "borrowing" the barge with pulley from Coast Oyster and dragging the south end of the lake. We brainstormed a bit and decided that this idea was worth pursuing. This all tied in with the festival (volunteer) idea for hand pulling in the other needed parts of the lake. Don Case and I are looking into the feasibility of Coast or some other type of boat. I think we could get good support as mentioned earlier, because of our choice of environment first.

Chemicals

The Leland community has been adverse to the use of chemicals and first became interested in the aquatic weed project in order to find a solution other than chemical. After looking at the material presented at the last meeting, the use of chemical is still the last choice. Of the four chemicals allowed by the state, only Fluridone (Sonar) is effective against Brazilian elodea and to be effective needs repeated applications. Label warnings restrict use within ¼ mile of water intakes. Those residents who use the lake as a source for domestic water are particularly opposed, as are other residents who question the long term health effects for humans and wildlife. Sonar kills untargeted plants. We are not sure that permission would be granted by WDFW to use chemicals due to our excellent warm water fishery. Dan Collins said it was granted at Limerick as a lessor of evils. After talking with Dan Robinson of Lake Limerick where Fluridone has been used, I question the effectiveness of the chemical. The lake was treated in 1996 four times over a ten week period. The Brazilian elodea was initially knocked back (99.5%) but is now reappearing with a wide spread light growth. He says they will need to treat again in a few years and will use a higher chemical concentration. There are no domestic water intakes at Lake Limerick. Another negative is the cost of chemicals.

After review of the options, general consensus was to follow a plan of monitoring with no action for now other than recommending hand-pulling strategic areas (shoreline and docks) and look for an environmentally sensitive method for pulling weed on a larger scale in the south end (barge or boat with pulley). If it appears that we are losing the fishery because of the vegetation or other serious problems arise, we could reevaluate the use of carp. This is an ongoing process and our selection of options for control may change as situations dictate. We have good data available as to weed bio-mass and distribution, and Dan said that the WDFW has good bass population estimates for Leland. With continued fish monitoring, we may find that we can live with the weed although a good education program will be needed to increase awareness and help prevent the spread of non native aquatics.

Next we talked about the reed canarygrass problem and Leland Creek. Al Latham brought some interesting paperwork showing lake levels and he presented information on the work that JCCD has done in the past to combat the grass and deal with high water levels. In the fall of 1991, the creek channel was cleaned out downstream of the fish weir (below culvert) for approximately 1300' with an excavator. Between the weir and the lake outlet, a "cookie cutter" was used to remove the vegetation. Within three days a drop in lake level was noticed. At that time boards were placed in the weir to create a dam effect. The canarygrass was treated in October of 1991. A storm in February of the following year took the boards out. Since 1992, the canarygrass and beaver dams have been coming back which causes a worst case scenario for water level. In June of 1991, the lake water level from the fishing dock to the old beaver dam just past the Jensen's (approximately ¼ mile into the trees) was pretty level (a distance of about 2000'). The next 2000' down Leland Creek drops about 3'. Al feels we would have some fall in there except for the beaver dams. Basically, if the channel (which is still there) is kept clear from the lake to the woods, the lake level would rise and fall with seasons. He talked about the use of shade to control reed canarygrass but noted that dense total shade works best. The canarygrass tends to grow with just planting willows. Some conifers are needed too. Willow trees were planted along with the dredging but they did not grow well in the thick grass and the ones that did survive were eaten by beaver. Al noted that Roger Short has been maintaining control of reed canarygrass on Chimicum Creek through his property with an initial dredging and the occasional use of *Rodeo*. He has also used landscaping to smother out the grass.

Al mentioned that Jerry Gorsline, a Washington Environmental Council representative to the TFW (timber, fish and wildlife) process sees *Rodeo* as a tool to use with reed canarygrass. We could spray the channel every two-three years for a maintenance program to keep it clear. BUT, opening the creek to the sun will create a niche for other aquatic weeds. For example, Brazilian elodea. This was discussed a bit, and Al said that the B elodea would slow the flow a bit, but it may not be as bad as the canarygrass, particularly since the elodea dies back in the winter when the flooding is the worst. Costs may not be all that expensive to spray the channel, maybe $1000-$2000. It would be best to spray in early September when the plant is putting its energy into the roots and nutrients have died down. There is a better kill with less chemical at this time. An aquatic applicator license is needed. Al spoke with John Haas of Resource Renewal who has an herbicide license and would be willing to apply for the aquatic license when needed. It may be possible to use implementation grant funds for this cost or some sort of fund with land owners.

Don asked about the safety of *Rodeo* downstream. Al replied that it is inert when it hits the water and also the grassy wetlands would filter any out. Permitting may be easy as we would be maintaining a channel that is already present. Fisheries would most likely want to see trees growing along the banks. Willow is probably all that will grow there, and there is a time lag before the trees grow up. Willow can also create problems with woody debris in the creek which would cut the water flow down. We need a clear channel for lake level which is not a natural situation. It is possible that with a lower water level the area may be dryer allowing the planting of some conifers.

An interesting side note: George mentioned that a survey done for the state highway in 1926 shows a high level water mark similar to that of today. Apparently this is not a new problem.

Glenn mentioned that the county transportation department had talked about building the road between the weir and the culvert (the old Leland Valley Rd) up and placing culverts on the existing road so people can drive their cars through during high water. We talked about tying this into the management plan in some way. We also discussed the beaver dam problem and tying it into the plan with the reasoning that a lower lake reduces impacts on septic systems which reduces the nutrients feeding the B elodea. Glenn has talked with a woman in eastern WA where they have successfully used pipe placed through beaver dams for control—rather than eradication of the beavers of their dams. Joanne has read about this method also and agreed that it might successfully work for us. This would need maintenance but probably not more than is being done right now destroying the dams. And It would give us a chance to coexist with the beaver.

Next meeting was set for Friday, March 20th at 10am at the ARC. We will review drafts of the plan and look at the options again.

FORM F: RECORD OF MEETING ATTENDANCE

Agreement No: G9700233 Recipient: Jefferson Co Conservation District Payment Request ____ Page ____ of ____

Purpose of Meeting: Steering Committee Meeting #3 Date of Meeting: 2/6/98

Name (please print)	Representing	No. of Hours at Meeting	Signature (required)
Al Latham	JCCD	3	
Glenn Gately	JCCD		
Dan Collins	WDFW		
Warren Steurer	JC PARKS		
Don Case	Leland Community		
Joanne Peterson	"		
Doug Barley	"		
George Bauer	"		
Linda Bauer	"		
Susan Taylor	"	✓	

ELEMENT NUMBER _____ TOTAL VOLUNTEER HOURS: _____ x $12.50 = $ _____

Enter the value computed in the lower right hand box on Form C1 for the appropriate element.

ECY 060-13 (6/95)

Ecology is an Equal Opportunity and Affirmative Action Employer.

F-17 B-21

* please note: I forgot to hand out attendance sheet. I have filled in the names of those present. See SCM #3 Meeting Notes for confirmation (attached)

Susan Taylor

Meeting notes—Steering Committee Meeting (#4) held March 20, 1998

This meeting was attended by Kathy Hamel (DOE), Glenn Gately (JCCD), Don Case and Hector Munn representing the community, and myself. Several people who were unable to attend called or wrote with their ideas which I presented. I have tried to capture the highlights. Please review and let me know if you have any additions or deletions.

The first item on the agenda was the reed canary grass in Leland Creek just beyond the lake outlet. We talked about the chemical Rodeo and its use in WA state for control of noxious emergent plants. Kathy Hamel told us that the state is rather conservative on its choice for herbicides that can be used and that Rodeo is a good choice as far as chemicals go. Glyphosate is the active ingredient in both Rodeo and Roundup. The difference between the two is the added surfactant (a surfactant is a detergent type material that helps the herbicide penetrate the plant-it helps hold it to the plant). The surfactant used in Roundup is very toxic to fish but not the surfactant in Rodeo. Rodeo is inactive in water though the chemical compounds are still in the water. Toxicity data is available in the Noxious Emergent Species EIS which can be ordered through the library. I will look into this. Kathy pointed out that Rodeo is not a selective herbicide, but it can selectively target a particular species with a good applicator who takes care to target only the canary grass-perhaps with a backpack spray. There are drinking water intake restrictions, and we talked about the need to notify or survey creek side residents to determine if anyone is taking creek waters for domestic purpose. I mentioned a report I had received from Ecology on water rights that lists nothing in current use. Hector said that at one time "squatters" were using the creek for water, but that was quite some time ago. Don and I agreed to door knock to make personal contact with each home owner. Kathy stated that Rodeo is one of the most innocuous herbicides for use in the state and that there would be "a lot less impact than a lake-wide application."

We talked a bit about the "empty niche" and the possibility of Brazilian elodea filling in behind the canary grass. Glenn pointed out that it may fill in but probably won't be as detrimental as the grass. The elodea dies back in the winter when the flooding is most prevalent. At our last meeting, Al Latham also expressed opinions on this that concur with Glenn.

Hector mentioned that there used to be trees (willow and some spruce) along the stretch of creek between the lake and the weir but high water killed all of them. When the creek channel was dug out in 1990, trees were planted at that time, but they were eaten by deer and beaver. Any newly planted trees will need animal control.

David Christensen, who could not be present, sent a letter (attached) with his comments and reminded us that removal of the reed canary grass may only partially impact lake levels. There are other issues along with the canary grass (beaver dams, woody debris blockages, not much drop in elevation between lake and creek). I passed a copy of Dave's letter out to everyone for their information and comments.

Don asked Kathy for Ecology's opinion on "no action". He wondered if we would be missing the boat by not taking whole lake action now as the elodea is going to get worse every year. Kathy feels that "the boat" has already been missed. The time to take immediate action was in 1994 when the plant was first discovered by Jenifer Parsons during an Ecology survey. Ecology tends to do what lake residents want to do. She stated that we don't have a whole lot of good control options. The herbicide Sonar was used in Lake Limerick, which controlled for the short term, but the weed is growing back. Herbicide treatments will have to be repeated, but residents there are happy to live with herbicides (the lake is not a domestic water source). Harvesting tried at Limerick and Duck Lakes was not liked. The machine fills up rapidly because there is so much biomass with Brazilian elodea and much of the time is spent going to shore to dispose of the weed. Dave's letter also mentioned harvesting at Long Lake, Kitsap County as generally not successful.

On the ride home a steering meeting, Kathy and Dan Collins discussed the use of carp. The WDFW point of view is that Leland is their best warm water fishery in the region. Carp are unpredictable. If carp were improperly stocked, it will affect the bass fishery. If the bass fishery begins to decline from the presence of the elodea then WDFW is more likely to try carp. Kathy feels it would be appropriate for us to take no whole lake action at this time; to keep in the study mode with Ecology and WDFW and reevaluate with updated sets of data. In the meantime, we can take some action by educating residents on local controls that they can use on an individual basis around their docks and shorelines. Bruce Munn called me with his input and is leaning away from the carp idea at this time. He does favor getting together for some type of hand pull parties. Dave's comments question the naturalness of introducing one exotic species to control another exotic species. It may be the least damaging, most cost effective, and overall most effective solution in the short term, but the variable experiences in other lakes may have potential for long term damage. We are all well aware of the potential for complete plant eradication and, therefore, are reluctant to endorse carp at this time.

We then talked about planning a demonstration day where we can actually use some of the tools available and be able to recommend from personal experience. We will purchase a cutting tool (V-shaped with razor sharp edges that is thrown out and dragged back cutting weeds in its path) and use a weed rake that Glenn had constructed for our sampling. We could possibly rent a winch and try dragging a rail tie to shore to create a pathway. We can also borrow Roger Short's cutter boat (both of these ideas were talked about at the last meeting). We would like to do some type of bottom barrier demonstration also. We want to wait for warm waters to do the project so will plan on doing it in late summer. Kathy would like to be included in this workshop so she can get some "hands on" experience. I will check with Tim Rymer on availability of the new pamphlet that serves as the HPA. Kathy says that it has been completed. Harvested plants will be dumped on shore-they can be added to compost for good fertilizer. Glenn asked if we would need some type of boom to control segments. Kathy replied, not necessarily because the weed is already wide spread through the lake but she did suggest floating a child's plastic swimming pool to help collect some plant fragments. Using a rake was also suggested.

Kathy talked about the use of mechanical weed rollers and said that they really work. King County was granted a pilot project and used a couple of loaners from the company. They did work, took about 3 hours to set up, it mounts to the dock, and uses a step down voltage system (12 volt). They were found to be not as portable as first thought and are very expensive (a couple thousand $). There was not enough money to do a long enough study to determine conclusively bottom disturbance. The tool did definitely disturb bottom dwelling creatures. They are trick to use in soft sediments. If a resident has the money, they are virtually care free once installed and are just turned on as needed. For some reason, weed rollers are not all that popular in WA state but are successfully widely used in the Midwest.

Glenn passed out copies of an article on a study where cleared rows perpendicular to shoreline were shown to create good fishery while managing macrophytes (*Managing Macrophytes to Improve Fish Growth: A Multi-lake Experiment.* Olson, M. et al 1998. Fisheries Management Vol. 23 No. 2.). Glenn sent Dan a copy.

Kathy mentioned that she has been putting together a non-indigenous species plan for the state and has put in a research request for funding someone to study in South America and look for biological control organisms for Brazilian elodea, milfoil, and parrotfeather.

We discussed the format for the final report. Glenn asked Kathy if we could split the creek and the lake problems and deal with problems and controls of each separately even though the grant is specifically to deal with Brazilian elodea in Lake Leland. Kathy agreed that would be the best way to approach it. Reed canary grass is a noxious species and would be included in the grant as a problem for the lake even though the problem exists in Leland Creek. We all agreed that separation of the two is the best approach.

Kathy reminded Glenn that she would like 24 hour oxygen samples done in August. She explained that some testing has been done under mats of milfoil and that milfoil is devoid of oxygen even during the day. A lot of photosynthesis occurs on top of the mats, but the wind can't penetrate the mats to mix the oxygen. In testing fish were not able to survive under milfoil. There has been no sampling done for Brazilian elodea. It is a different type of plant and may have oxygen because the leaves go all the way up the plant (not like milfoil). The leaves are photosynthetic and produce oxygen that may mix enough to support fish. Kathy stated that plants affect water quality by changes in oxygen and/or pH. Temperature effects can also occur. The lake is fed by bottom springs in some areas. Kathy suggested doing temperature profiles to avoid spring areas where there would be better mixing.

I asked about the inclusion of the watershed approach in planning efforts. Kathy stated that watershed is more of a background tool and not a control. We should be aware of what is going on in our watershed. It is a way to identify potential problems.

We then talked about yellow flag iris. Kathy says that it is an invasive species and education on that point will let property owners know that it is okay to pull it. You can dig it, but it is not easy to pull. It is a pretty plant, but it does need managing. One can cut seed heads and dig around the plants to keep them from spreading. The surface of the plant can be treated with Rodeo in a spray bottle.
Some residents may not mind that their shoreline is becoming impassable.

We are not going to schedule another meeting until after the demonstration day. I will contact everyone once we get a date and time set up. I will let Kathy know well in advance so she can take part.

LAKE LELAND
Integrated Aquatic Vegetation Management Plan

FOURTH STEERING COMMITTEE MEETING

3/20/98
10:00am to noon
Edwina Winters Family Retreat
285 Munn Road—Lake Leland
Quilcene, WA

AGENDA

INTRODUCTIONS

DISCUSSION

- Reed Canary Grass Control Options
- Brazilian Elodea Control Options

REVIEW OF DRAFT PORTIONS

SCHEDULE NEXT MEETING

CLOSING

B-25a

FORM F: RECORD OF MEETING ATTENDANCE

Agreement No: G9700233 Recipient: Jefferson Co. Conservation District Payment Request ____ Page ____ of ____

Purpose of Meeting: STEERING COMMITTEE MEETING #4 Date of Meeting: 3/20/98

Name (please print)	Representing	No. of Hours at Meeting	Signature (required)
Kathy Hamel	Ecology	2 1/2	KSHamel (can't be counted as in-kind)
HECTOR MUNN	LAND OWNER	2 1/2	Hector J Munn
DON CASE	" "	2 1/2	Don Case
Glenn Gately	Jef. Co. Cons. Dist.	2 1/2	Glenn Gately
Susan Taylor		2 1/2	Susan Taylor

ELEMENT NUMBER _____ TOTAL VOLUNTEER HOURS: _____ x $12.50 = $ _____

Enter the value computed in the lower right hand box on Form C1 for the appropriate element.

ECY 060-13 (6/95)

Ecology is an Equal Opportunity and Affirmative Action Employer.

F-17
B-26

Jefferson County Health & Human Services

CASTLE HILL CENTER • 615 SHERIDAN • PORT TOWNSEND, WA • 98368

March 17, 1998

Susan Taylor
Jefferson County Conservation District
205 W. Patison St.
Port Hadlock, WA 98339

Dear Ms. Taylor:

I would like to offer comments on the Draft documents and decisions that the steering committee has come to at this point. I apologize that I will be in Olympia on March 20, in negotiations regarding Washington State drilling regulations, and will be unable to attend the steering committee.

I believe that I can provide written comments that may be useful in the discussions. I am pleased with the progress that has been made, and that all of the options are being discussed in both short-term and long-term costs and benefits.

In the Draft Document listing control alternatives, I think the discussion should be put in the context of the ecosystem, and thus the issues of aquatic vegetation management is but a part of the overall management of the lake as a fishery, drinking water supply, and habitat for wildlife. Other comments:

1) You should change "doing nothing" to taking no action. It sounds like more of a conscious, thought-out strategy. The no action alternative may cause more immediate Brazilian elodea encroachment, but may then allow a quicker decline. Research on other species has shown that control methods only lengthen the time for dominance, and that if left alone, some invasive species (milfoil and maybe others) will become subdominant after a couple of decades.

2) Lakes naturally undergo succession. The succession is one where they fill in with sediment over a period of time, allowing colonization of aquatic vegetation over a larger proportion of the lake's surface. All the methods proposed to reduce the Brazilian elodea in Lake Leland do not address the fact that the depth of the lake is the determining factor on how much of the lake will become covered with the Brazilian elodea. None of the strategies is a permanent fix, except for maybe the grass carp option. One long term fix that has not been discussed is one that is rather distasteful to most -- dredging to make the lake deeper and reduce the amount of area that Brazilian elodea can occupy. I know of many lakes where that after many other attempts at control strategies, the final recommendation was that the only long-term fix was to reverse the succession process by deepening the lake.

3) It sounds as though the different targeted species will have different control strategies. I am concerned that the control strategies document only discusses the costs and benefits as they relate to Brazilian elodea. Many of the concerns raised by lakeshore residents are with the high lake water level, and the target species to solve that problem is reed canary grass. The cost/benefit analysis may be completely different.

4) The costs of bottom barriers should be summed up so that a better comparison can be made. I do not have a good idea of how many square feet of coverage would be necessary.

5) For effects of harvesting on Brazilian elodea, look to Long Lake, Kitsap County. There will be several UW theses on the harvesting impacts, but it is similar to milfoil- short term, and generally not successful.

6) I do not think it is accurate to say that introduction of one exotic species to control another exotic species is more "natural for long term control." Some of the greatest environmental disasters have been because of the impacts of an exotic species (planned or unplanned). In the short term, it may be least damaging, most cost-effective, and overall most effective. However, there have been variable experiences in other lakes that have used grass carp. I think that the potential long-term damage of the introduction of an exotic species into an ecosystem would have to be mentioned along with the benefits that are listed.

Comments on meeting notes:

Residents are concerned about the "long term health effects for humans and wildlife" within Lake Leland and are concerned about the use of a herbicide that "kills untargeted plants." Both of the same issues should be raised for the use of Rodeo for control of reed canary grass. One difference is the drinking water supply issue, and that could be mentioned as a key difference. But the wildlife issue and non-specificity of the herbicide should be discussed.

Will grass carp affect the reed canary grass at all? I don't think so, but it should be stated somewhere in the control options when the in-lake measures will or will not impact the reed canary grass. It may indicate that certain measures may take care of both problem weeds.

I am concerned that there are several factors that are contributing to the high water levels and that focusing on the aquatic vegetation may only partially impact lake levels and thus cause a lot of disappointment among the residents. The lake level issue should be address as a separate concurrent process, which needs vegetation control among other things.

I am unsure what is meant by the statement, "We need a clear channel for lake level which is not a natural situation." Is the lake level not natural, the clear channel not natural, or is the woody debris not natural? My guess is that woody debris should improve the stream, so long is there is not complete blockage, and as long as the stream channel is allowed to meander to reduce the energy from floods.

It is inaccurate to think that reducing nutrients to the lake will reduce the Brazilian elodea, as is stated in the minutes from the last meeting. B. elodea obtains nutrients from the sediment, and in fact an opposite relationship is often seen between aquatic plants and in-lake nutrients. Higher nutrients lead to more algae which shade out the aquatic vegetation.

These are my thoughts so far. Again, I apologize for the inability to attend the meeting again. My Ecology meeting came up at the last minute and is almost an "emergency" to clarify some language in proposed well drilling rules that are about to be codified this month. If the language is not clarified, it could cause the whole rule adoption process to be reset and cause one more year of public meetings before adoption.

Good luck with the meeting. Hope this helps. Please keep me informed on the progress.

Sincerely,

Dave Christensen
Water Resource Specialist

B-28

JEFFERSON COUNTY PERMIT CENTER

621 Sheridan Street, Port Townsend, WA 98368

February 4, 1998

Susan Taylor
351 Leland Valley Road West
Quilcene, WA 98376

Dear Ms. Taylor:

Due to other commitments, I will be unable to attend the Lake Leland steering committee meeting this month. I would like to congratulate your group for the excellent job you have done, so far, in conducting a study and searching for solutions to combat the Brazilian elodea invasion at Lake Leland.

Should the steering committee decide to only stock grass carp in the Lake, no shoreline permit would be required from Jefferson County. However, use of chemicals and/or installation of a permanent or temporary structure within or near the Lake would require a shoreline exemption permit. I can assist you in the permitting process once you decide which method(s) to utilize. When you apply for an Hydraulic Project Approval (HPA), please include Jefferson County Permit Center on the SEPA checklist mailing list. There are comments we would like to be considered, for example, based on information contained in the report by Bonar et el ("*Management of Aquatic Plants in Washington State Using Grass Carp: Effects on Aquatic Plants, Water Quality and Public Satisfaction 1990-1995*") these concerns have been raised:

(1) Predation of fish is likely with both an active bald eagle and osprey breeding territory in the vicinity of the lake. How is this going to be addressed?

(2) Turbidity levels may increase in the lake, how will this effect the quality of the water withdrawn for residential uses?

Discussion of these and other issues should be included in the SEPA analysis. If you have any questions or need further information you can reach me at (360) 379-4464.

Sincerely,

W. Lauren Mark

W. Lauren Mark
Associate Planner

cc: Al Scalf, Director of Communtiy Development
Dave Christensen, Environmental Health Department
Warren Steurer, Parks & Recreation Manager
Shelly Ament, Eagle Habitat Biologist, WA Dept. of Fish & Wildlife
Jeffree Stewart, WA Dept. of Ecology, Shorelands

B-28a

FORM F: RECORD OF MEETING ATTENDANCE

Agreement No: _____ Recipient: _____ Payment Request _____ Page ____ of ____

Purpose of Meeting: FIFTH STEERING COMMITTEE MTG Date of Meeting: 11/18/98

Name (please print)	Representing	No. of Hours at Meeting	Signature (required)
Jennifer Parsons	Ecology	3	
DAN Collins	WDF & W	3	
Glenn Gately	Conservation District	3	Glenn Gately
Russ Taylor	JCCD / resident	3	
neglected to pass around for signatures - also in attendance			
George / Linda Bauer	Leland	3	
Don Case	Leland	3	
Hector Munn	Leland	3	
Al Latham	JCCD	3	

ELEMENT NUMBER _____ TOTAL VOLUNTEER HOURS: _____ x $12.50 = $ _____

Enter the value computed in the lower right hand box on Form C1 for the appropriate element.

ECY 060-13 (6/95)

F-17

B-29

Jefferson County Conservation District
205 W. Patison St., Port Hadlock, WA 98339 - Phone (360) 385-4105

November 3, 1998

Dear Steering Committee Members,

After a long busy summer with the Forest Service, I have spent the last several weeks working on completion of a draft IAVMP. I would appreciate it if each of you would take the time to read through what I have finished to date. You are my editors. I need feedback, particularly if I have misinterpreted the intentions of the group. You each have your area of expertise and hopefully will review for accurate information. After writing over such a long period of time, I find it hard to read through looking for continuity and things like repetitiveness. There are a few written areas where I still want to add a bit more information and will keep working on those sections. I will indicate these so you will know that what you are reading is not complete. I am not including all of the maps, figures, or appendixes at this time. I also need to go back and insert citations.

I know that everyone is very busy, but I am hoping that we can get together for a meeting around the 18th or 19th of November to finalize the report. Feel free to contact me with your editing advice before that time. I realize that this is a short turn around but am thinking that it will be easier on us all if we get through this before the holidays. Thank you in advance for all of your help.

Sincerely,

Susan Taylor

B-30

APPENDIX C

NATURAL HERITAGE PROGRAM

APPENDIX C

NATURAL HERITAGE PROGRAM

September 23, 1998

WASHINGTON STATE DEPARTMENT OF
Natural Resources

JENNIFER M. BELCHER
Commissioner of Public Lands
KALEEN COTTINGHAM
Supervisor

Susan Taylor
Jefferson County Conservation District
205 W Patison St
Port Hadlock WA 98339

SUBJECT: Lake Leland Aquatic Vegetation Management Plan (T28N R02W S13,23-26; T28N R01W S18,19)

We've searched the Natural Heritage Information System for information on rare plants, high quality wetland ecosystems and high quality terrestrial ecosystems in the vicinity of your study area. A summary of this information, and corresponding materials, are enclosed. These data are being provided to you for informational and planning purposes only - the Natural Heritage Program has no regulatory authority.

The occurrence of *Carex comosa* (bristly sedge), a state sensitive plant species, noted on the enclosed summary was found in a wetland located at the south end of Lake Leland and along Leland Creek. The report of the occurrence in 1994 noted reed canarygrass as present and dominate in some areas, and that recent dredging of the creek had taken place. Both the presence of reed canarygrass and the methods to control it (such as dredging or other activities affecting hydrology) could adversely affect bristly sedge.

The rare forested wetland type identified in Section 23 is one of only 6 high-quality examples of the western redcedar - western hemlock / skunkcabbage wetland in Puget Trough. This forested wetland type has been designated Priority 1 for protection in the Natural Heritage Plan.

We have begun to add information to our database on selected groups of animals of conservation concern, such as freshwater mussels, butterflies, salamanders, and bats. However, the authority for protection of animal species in Washington rests with the Department of Fish and Wildlife. To ensure that you receive information on all animal species of concern, please contact Priority Habitats and Species, Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA 98501-1091, or by phone (360) 902-2543.

If you have any questions, you can reach me at (360) 902-1667. Please feel free to contact us for additional review as specific management plans are developed.

Sincerely,

Sandy Swope Moody

Sandy Swope Moody, Environmental Coordinator
Washington Natural Heritage Program

Enclosures

FOREST RESOURCES DIVISION
PO BOX 47016 ▪ OLYMPIA WA 98504-7016
PHONE 360-902-1340 FAX 360-902-1783

C-1

WASHINGTON NATURAL HERITAGE INFORMATION SYSTEM
ENDANGERED, THREATENED AND SENSITIVE PLANTS
HIGH QUALITY WETLAND ECOSYSTEMS AND HIGH QUALITY TERRESTRIAL ECOSYSTEMS
IN THE VICINITY OF LAKE LELAND WATERSHED
REQUESTED BY JEFFERSON COUNTY CONSERVATION DISTRICT

Data Current as of September 1998

TOWNSHIP, RANGE AND SECTION	ELEMENT NAME	STATE STATUS	FEDERAL STATUS
T28N R02W S25 SWOFSW	*Carex comosa* (bristly sedge)	S	
T28N R02W S23 E2OFNW	Thuja plicata - Tsuga heterophylla / Lysichiton americanus forest (Western redcedar - western hemlock / skunk-cabbage forest)		

State Status definitions:

E = Endangered: Any vascular plant taxon in danger of becoming extinct or extirpated from Washington within the foreseeable future if factors contributing to its decline continue. Populations of these taxa are at critically low levels or their habitats have been degraded or depleted to a significant degree.

T = Threatened: Any vascular plant taxon likely to become Endangered in Washington within the foreseeable future if factors contributing to its population decline or habitat degradation or loss continue.

S = Sensitive: Any vascular plant taxon that is vulnerable or declining and could become Endangered or Threatened in the state without active management or removal of threats.

X = Possibly Extinct or Extirpated from Washington: Based on recent field searches a number of plant taxa are considered to be possibly extinct or extirpated from Washington. Taxa in this group are all high priorities for field investigations. If found, they will be assigned one of the above status categories.

R = Review: Taxa of potential concern, but for which no status has yet been assigned.
Group 1 = Taxa in need of additional field work before a status can be assigned.
Group 2 = Taxa with unresolved taxonomic questions.

W = Watch: Taxa more abundant and/or less threatened in Washington than previously assumed.

APPENDIX D

PUBLIC INVOLVEMENT

APPENDIX D

PUBLIC INVOLVEMENT

JEFFERSON COUNTY CONSERVATION DISTRICT
205 W. Patison St., Port Hadlock, WA 98339 - Phone (360) 385-4105

July 21, 1997

Voter Registration
Jefferson County Courthouse

I would like to request a copy of the list of registered voters for the Leland precinct. This list will be used by the Conservation District in conjunction with a current project at Lake Leland. A grant from the Washington State Department of Ecology has been secured to implement a Lake Leland Brazilian Elodea Study. This non-native invasive aquatic weed has been found growing in Lake Leland and presents many problems. The study will help determine an invasive plant management plan for the lake. Input from the local community is highly desirable to this planning process, and the Leland voter registration list will be used to make initial contact with the Leland community regarding this matter.

Sincerely,

Susan Taylor

Susan Taylor
Resource Technician
Lake Leland Brazilian Elodea Study

D-1

Jefferson County Conservation District
205 W. Patison St., Port Hadlock, WA 98339 - Phone (360) 385-4105

July 23, 1997

Dear Leland Property Owner,

For several years the Washington State Department of Ecology and the Leland Neighborhood Improvement Club have been monitoring the spread of a non-native invasive aquatic weed growing in Lake Leland. The weed, Brazilian elodea (*Egeria densa*) was first detected in 1994 during an aquatic plant survey performed by the Department of Ecology. This weed has been spreading in the lake at a steady rate. First noticed in the southern end of the lake, it can now be found in patches along much of the shoreline. Brazilian elodea is a popular aquarium plant, commonly called Anacharis, that was sold in most pet stores. The sale of this plant in Washington is now illegal, but many western Washington lakes are already infested. This noxious weed is hard to control and spreads rapidly through fragmentation. Fragments can develop into new plants and can also be spread to other lakes on boat motors, trailers, or fishing gear. Water quality, fishing, swimming, and visual aesthetics are being affected.

Recently, the Department of Ecology awarded funding to the Jefferson County Conservation District to develop an aquatic plant management plan that will reduce and then manage Brazilian elodea in Lake Leland. There are several possible options available, and the Conservation District, along with the Leland Neighborhood Improvement Club, will be looking into this matter and seeking the best solution for our particular situation at Lake Leland. We would like input and support from lake property owners and the local community. We are holding a public meeting on August 14th, Thursday, at 7:30 p.m. at the Quilcene Community Center. If you are interested and would like to know more or would like to help out with aquatic surveys or serve on a steering committee, please attend. We would like to see you there.

If you are unable to attend but would like to receive occasional updated information, please print your name and mailing address below, refold this sheet with our address facing front, stamp, and return or call 360-385-4105.

Sincerely,

Susan Taylor
Resource Technician
Leland Aquatic Weed Project

D-2

Jefferson County Conservation District
205 W. Patison St., Port Hadlock, WA 98339 - Phone (360) 385-4105

August 5, 1997

Dear Leland Community Member,

Those of you who live on or near the lake may notice unusual activities on the lake in the coming weeks. An aquatic plant monitoring study for Lake Leland is about to begin. This project entails a training in aquatic plant identification and familiarization with the monitoring process which takes place on Monday August 11th at 1:00 PM. The official sampling will begin on Thursday August 27th at 8:00 AM. Plant samples will be collected by two different methods. Scuba divers will be used to actually hand pull plants in one type of survey. In the other, a weighted, double sided rake will be thrown from a boat to snag the vegetation at certain sites on the lake. The purpose of this aquatic monitoring is to determine the amounts, types, and distribution of aquatic vegetation present in the lake at this time. Baseline data, which can be used to evaluate treatments utilized to control the Brazilian elodea, will be established. If you would like more information or are interested in participating, please give me a call at 765-3108. I will be glad to answer your questions.

Sincerely,

Susan Taylor

Susan Taylor
Resource Technician
Leland Aquatic Weed Project

D-3

Money given for Lake Leland weed study

By Viviann Kuehl
Leader Contributing Writer

Lake Leland residents are trying to curb the spread of Brazilian elodea, an invasive non-native aquatic weed with the potential to literally fill the lake.

Leland resident Susan Taylor has written a $35,000 grant with help from Glenn Gately of the Jefferson County Conservation District. The grant seeks state Department of Ecology (DOE) money for a study of the options to control or eradicate Brazilian elodea in Lake Leland and to provide education and information to the public.

"We want to make as many people aware of the problem as possible," said Taylor.

On behalf of the Leland Neighborhood Improvement Club, the conservation district requested and received a promise of county matching funds for the potential grant from DOE's Aquatic Weed Management Fund. Up to half of the county's 25 percent share can be furnished with county wages and in-kind contributions, making the cash contribution from the county around $5,000. The grant funding decision by DOE will not be made until February 1997.

The Jefferson County commissioners were unanimous in their decision to find a funding source to provide the required cash match for the planning grant to study the best way to handle this problem.

Options for aquatic weed control include cutting, dredging, chemical controls, biological controls, bottom barriers and environmental barriers, but not all of them are appropriate to Brazilian elodea or Lake Leland.

Since the elodea spreads by segmentation, cutting is not a good solution. Because some residents have domestic water rights from the lake, herbicides are a cause of concern. Handpulling with divers is very expensive, and may be feasible only in areas less than three acres. Use of triploid carp as a biological control requires some fairly extensive studies for the state Department of Fish and Wildlife, said Taylor, to determine the impact on the lake and on trumpeter swans who eat it, too.

Apparently Lake Leland is the only lake in Jefferson County infested by Brazilian elodea. It has spread over the lake's southern section and has advanced into spots in the northern portion. No signs of the weed have been found in Crocker, Tarboo and Anderson lakes, although it can spread from pieces caught on boat motors. The closest known infested lake is Long Lake in Kitsap County.

"It has definitely spread," said Taylor, who has been monitoring it over the summer. "We will be looking for solutions to the problem whether or not we get the grant."

D-4

Lake Leland weeds capture $35,000 study

By Viviann Kuehl
Leader Contributing Writer

The Lake Leland Neighborhood Improvement Club welcomes some unusual activity on the lake this month as an aquatic plant monitoring study begins.

The study is the first step in developing an integrated aquatic vegetation management plan for control or eradication of the Brazilian elodea infesting Lake Leland, a concern of club members and area residents for several years. The study provides baseline data to determine the effectiveness of treatments used to control the invasive non-native aquatic weed.

The $35,000 study, funded by the state Department of Ecology (DOE), written and administered by the Jefferson County Conservation District and encouraged by the club, consists of plant sampling by two different methods to determine the location and extent of Brazilian elodea in the lake, and development of a plan to address the problem.

Training for the study took place Monday, Aug. 11. Official sampling begins Thursday, Aug. 27 at 8 a.m. during the plant's peak growing season.

Brazilian or giant elodea (*Egeria densa*), also called anacharis, grows from branching stems on the bottom, rising to the surface where it forms a dense mat that chokes out other plants, restricts water movement, traps sediments, and causes fluctuations in water quality. Dense beds interfere with navigation, fishing, swimming and waterskiing, and it can completely fill a lake.

"It can have a pretty big impact," said Jenifer Parsons, weed control specialist for the Washington State Department of Ecology (DOE) and monitor of lakes in Western Washington. "It makes boating and swimming and things like that very unpleasant."

Parsons confirmed the presence of Brazilian elodea in Lake Leland in 1994, and estimated it to have doubled from 1994 to 1996. Patches found on the southern end of the lake grew to a solid mass completely filling in that portion of the lake in the spring of 1996, said Parsons, when it also spread to the northern portion of the lake. It is now found in patches along most of the shoreline.

A native smaller elodea, *Elodea canadensis* or waterweed, is also present, but does not grow with the vigor and freedom from disease and predators of its Brazilian cousin.

Brazilian elodea was sold as an attractive, robust aquarium plant until it appeared as a vigorous weed in Washington lakes, outcompeting even milfoil where it has become established. It is thought to have been introduced by aquarium dumping, but it can also travel on boats as milfoil does. Sales of Brazilian elodea are now illegal in Washington.

Broken sections of the plant can root to form new plants. When growth slows in the fall, Brazilian elodea also becomes very brittle, with new potential plant sections breaking easily off the parent plant.

The study will measure both the density and distribution of plant life in the lake, in two surveys.

In the density survey, divers will be bagging samples of entire plants cut from the lake bottom at three or four specific locations in the lake to measure plant abundance. They will take a minimum of three samples at each location along 25-meter lines parallel to the shore. The plants gathered will be sorted, identified, dried, weighed and their biomass calculated by both site and depth.

Distribution monitoring determines the location of plant life around the lake. Samples will be taken at four different depths along each of approximately 30 lines perpendicular to the shore, evenly spaced about 150 meters apart along the 4500 meters of shoreline. Using double-sided rakes cast from a boat for sampling, the plants thus obtained will be identified and rated for density. Data will be reported in tables and the distribution of each species will be mapped.

The information gained in the study provides a yardstick for measuring future control attempts. Options for aquatic weed control include cutting, dredging, chemical controls, biological controls, bottom barriers and environmental barriers, but not all of them are appropriate to Brazilian elodea or Lake Leland.

A special community meeting to discuss Lake Leland's aquatic health and to develop a management plan is planned Thursday, Aug. 14 at 7:30 p.m. in the Quilcene Community Center. Susan Taylor of the Jefferson County Conservation District's Leland Aquatic Weed Project, also a member of the Leland Neighborhood Improvement Club, will present options to address the spread of Brazilian elodea in Lake Leland, and recruit volunteers to help with the study or serve on a steering committee.

"We want to make as many people aware of the problem as possible," said Taylor. "We would like input and support from lake property owners and the local community in developing a management plan."

Wednesday, October 1, 1997
The Port Townsend Jefferson County LEADER

Lake Leland management plan targets choking weeds

By Viviann Kuehl
Leader Contributing Writer

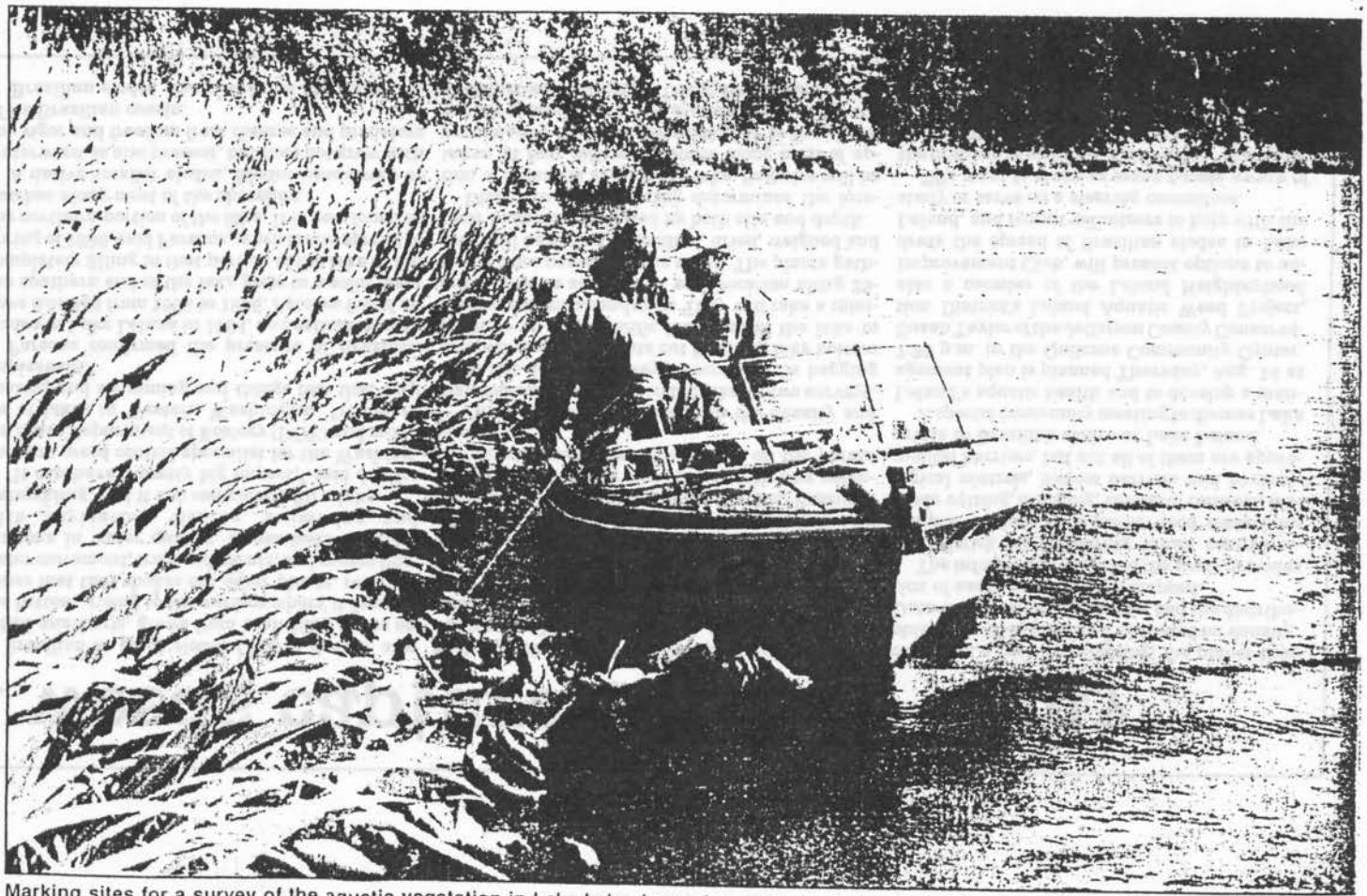
The first phase of developing an integrated management plan for Lake Leland has been accomplished with a detailed survey of Lake Leland's aquatic vegetation.

The plan's development, underwritten by a $35,000 grant from the Department of Ecology (DOE), has widespread support from residents and members of the Lake Leland Community Improvement Club who see it as crucial to maintaining Lake Leland as a lake.

The plan aims to control noxious weeds in the lake, particularly Brazilian elodea and Reed's canary grass. Both plant species were introduced into the lake and are now threatening to take over the shoreline out to its maximum growing depth of about 10 feet.

Elodea is an escaped aquarium plant no longer sold in Washington, but now thriving in Lake Leland and other scattered lakes in Western Washington. It grows from branching stems on the bottom, rising to the surface where it forms a dense mat that chokes out other plants, restricts water movement and traps sediments. It can grow new plants from broken pieces and is particularly brittle in the fall.

The elodea problem is compounded by the presence of canary grass. Reed's canary grass.



Marking sites for a survey of the aquatic vegetation in Lake Leland was done with the help of volunteers. The detailed survey is the basis for evaluating solutions to protect the lake from an onslaught of invasive plants.
—Submitted photos

now listed as a noxious weed, was introduced by farmers as a feed grass in the 1940s. Unfortunately, cattle will only eat it when young and tender in the spring,. The rest of the year it grows, filling in wet areas. Thick canary grass at the lake's south drainage contributes to the slow-moving water elodea prefers.

"Between the elodea and the canary grass there isn't a whole lot of movement," said Susan Taylor, project coordinator working through the Jefferson County Conservation District and a Leland resident.

Another element that may complicate the picture is beaver dams. Although beavers were removed from the area in the past, they are reportedly back in the area building dams.

The management planning started with a detailed survey of the lake to find out exactly how much and where the lake's aquatic vegetation is, to use as a baseline in judging results of various treatments to control the invasive plants. The survey was accomplished with the help of 17 volunteers, including those contributing boats and lending facilities, and staff from the Department of Ecology.

"You have to do this as scientifically as possible. Where it was really thick it was hard to do," said Taylor.

Two types of monitoring — one to check the distribution of plant life near the shore and another to check plant abundance in the lake — were done at the height of the Brazilian elodea growing season in late August and early September.

In late August five different sites for abundance monitoring were selected in the lake. Each site consists of three lines 25

Volunteer divers Kevin Wright, a Leland resident, and Rex Long dove down to the bottom to collect vegetation at three points along each line, using a half-meter square quadrant sampler made from white PVC pipe. They cut all plants inside the square just above the roots and collected them in a bag.

The collected plants were sorted, identified, labeled by site and point and taken to the USGS Marrowstone Island field station drying oven to obtain a dry weight. Mean dry weights with standard deviation will be reported for each site by individual depth and by all depths combined.

In a processing station set up in a gazebo, volunteers Bruce Munn, Sammie Kay, Doug Barley, Lowell Davis, Jerry Welch, Ted Hunter, Don Case, Joanne Peterson and Candy Garrison sorted out the species with help from Jennifer Parsons and Kathy Hamil of the DOE Aquatic Weeds Management Program.

In early September the distribution monitoring was done. At 27 sites around the shore of the entire lake, samples of aquatic plants in the lake were taken at 1/2-, 1-, 2- and 3-meter depths along lines perpendicular to the shore. The lines were evenly spaced approximately 150 meters apart around the lake.

In the first day's work the site points were measured and marked by volunteers Chris Novello, Linda Gately and Bruce Marston using two boats.

Later, Taylor and Glen Gately of the Conservation District went to each marked site, carrying in their boat a pole with depth marks and a double-sided rake made by welding two 14-tine rake heads together. They measured depths along each line to find the proper survey spots, then threw out the rake and drew it back in to collect plant samples. All species gathered were sorted and recorded with a density rating for that point.

Elodea was found at 23 of the 27 sites.

"I was surprised at how quickly it's moving and rooting," said Taylor, "because I was out last October by the highway and didn't see any. This year there are scattered plants there. The south end is incredibly thick. It looks like you could walk on water. You can hardly get a boat down there. I guess the surprise for me is just how rapidly it's spreading. It's showing up even down in the swimming and docking area."

Taylor cautions boat owners to check boats, motors and fishing gear to make sure elodea is not inadvertently transported to any other lake in the area. So far, elodea has not been spotted in other Jefferson County lakes.

"This has been a real interesting project for me," said Taylor. "We're looking at it as a whole watershed, rather than trying to concentrate on one little particular piece. It's looking at the watershed as a whole to solve problems."

Now it's time to explore the solutions and measure their impacts, and Taylor already has some ideas to try.

"The places around the lake

Lowell Davis holds aloft a mass of elodea taken from Lake Leland during a recent survey of aquatic plants.

where it's just beginning, that could be handled with a bottom barrier and pulling," she speculated. "Around some people's docks it's getting pretty thick, but at the south end there's just too much of it."

The plan will involve a look at the nutrients in the lake. Nutrients, such as fertilizers and compostable organic material like grass clippings and leaves, can help speed up plant growth.

"As population density around a body of water, like a lake, increases, the lake just naturally gets more nutrients in it, so that's how you get the speeding up of eutrophication," said Gately.

It's also important to keep septic systems working properly, said Gately. As the water level is raised by vigorous plant growth blocking the drainage, septic fields can be affected.

D-7

Plants are gathered from Lake Leland with the help of local volunteers interested in controlling the invasive plants that threaten to fill the lake.

WALKER MTN. NEWS

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Vol. 1 No. 3 August 1997

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Elodea Spreading

For several years the Washington State Department of Ecology and the Leland Neighborhood Improvement Club have been monitoring the spread of a non-native invasive aquatic weed growing in Lake Leland. The weed, Brazilian elodea was first detected in 1994 during an aquatic plant survey performed by the Dept. of Ecology. This weed has been spreading in the lake at a steady rate. First noticed in the southern end of the lake, it can now be found in patches along much of the shoreline. Brazilian elodea is a popular aquarium plant, commonly called Anacharis, that was sold in most pet stores. The sale of this plant in Washington is now illegal, but many western Washington lakes are already infested. This noxious weed is hard to control and spreads rapidly through fragmentation. Fragments can develop into new plants and can also be spread to other lakes on boat motors, trailers, or fishing gear.

Water quality, fishing, swimming, and visual aesthetics are being affected.

Recently, the Dept. of Ecology awarded funding to the Jefferson County Conservation District to develop an aquatic plant management plan that will reduce and manage Brazilian elodea in Lake Leland. There are several possible options available, and the Conservation District, along with the Leland Neighborhood Improvement Club, will be looking into this matter and seeking the best solution for our particular situation at Lake Leland.

We would like input and support from lake property owners and the local community. We are holding a public meeting on Thursday, Aug 14th at 7:30pm at the Quilcene Community Center. If you are interested and would like to know more or would like to help out with aquatic surveys or serve on a steering committee, please attend. We would like to see you there.

If you are unable to attend, but would like to receive occasional updated information, please call 385-4105 or write to Jefferson County Conservation District 205 W Patison St., Port Hadlock, Wa. 98339

Susan Taylor---------
Resource Technician
Leland Aquatic Weed Project

Elodea Discussed

The Lake Leland Community Association met in August at the Community Center in Quilcene to discuss what, if anything could be done about the problem of Brazilian Elodea in the lake. A study headed by Susan Taylor is currently being done to determine the degree of infestation and provide information as to the different means of controlling this weed, which is not a native plant but is very prolific where ever it has been introduced. Both Long Lake, in Kitsap County and Lake Limerick, in Mason county, have significant infestation, along with many other lakes in Western Washington. Oregon also has a major problem with Brazilian Elodea.

So far Lake Leland is the only lake in the county where it has started, but that may not last. People who use the lake, especially boaters should take special care to avoid spreading it. Make sure that when you leave the lake to check your boat and trailer for any water plants that may be caught there and remove them, even small pieces. The reason for this is that the plant spreads by fragmentation and even small pieces can grow into new plants.

There were various methods of control discussed at the meeting, including the use of herbicides which was basically dismissed as many people in the area have permits to draw water from the lake for personal use. The other options were the introduction of grass carp to the lake, which eat elodea as food of choice, or harvesting by hand, either with divers or from boats. Any method of control has to have community approval before it can be implemented. One thing that has been found to be true about Brazilian elodea is that it is persistent and that controlling it is expensive and time consuming.

Leland neighbors fight lake weed

Long-term solution is elusive

By Viviann Kuehl
Leader Contributing Writer

Lake Leland neighbors gathered recently to get some hands-on experience in the fight to control a rapidly growing aquatic weed taking over the lake.

Designated an aquatic noxious weed by the state, Brazilian elodea (*egeria densa*) reproduces like an underwater morning glory. Broken pieces of the plants can start new plants and growth is rapid.

Leland residents have been researching non-herbicide methods to control the weed without affecting drinking water taken from the lake. A plan to introduce sterile carp into the lake to eat the elodea is on hold. Meanwhile, the elodea is growing.

Glenn Gately of the Jefferson County Conservation District recently organized a workshop for local residents to demonstrate what people could do, on a small scale, around docks.

"It's a good idea," Department of Ecology's Kathy Hamel said of the workshop. "This is to get an idea of how well it's going to work, how difficult it's going to be, and how much it's going to cost."

In addition to Gately and Hamel, on hand for the session were over a dozen residents and a tool called an aqua cutter, a Hockney weed cutter mounted on Roger Short's boat, and a bottom barrier built by residents.

The approximately 25-square foot bottom barrier was constructed in about three hours by Jan and Donna Jensen. It consists of a framework of PVC pipe, welded together with rebar inside the pipes, attached to a tarp. The barrier was put in place underwater by the group.

Lake Leland residents positioned a bottom barrier in an attempt to check the growth of Brazilian elodea in Lake Leland.—*Photo by Viviann Kuehl*

"I look at it as a better way," said Hamel. "The idea is you just block the sunlight, and the plants don't grow. It can be used pretty effectively around docks, and can last for years, depending on sediment buildup rates."

Sediment that settles on the tarp can create new soil for new plants, so some cleaning maintenance is required. As the covered plants decompose, gasses produced by the decomposition will probably lift the tarp, which can be resettled into position. Similar barriers have been used successfully in Long Lake near Silverdale, by parks departments in Seattle and other places, said Hamel.

A bottom barrier is especially useful in early infestation of elodea and milfoil, but it is necessary to be persistent in making sure no plants escape notice, grow and take over the area, said Hamel.

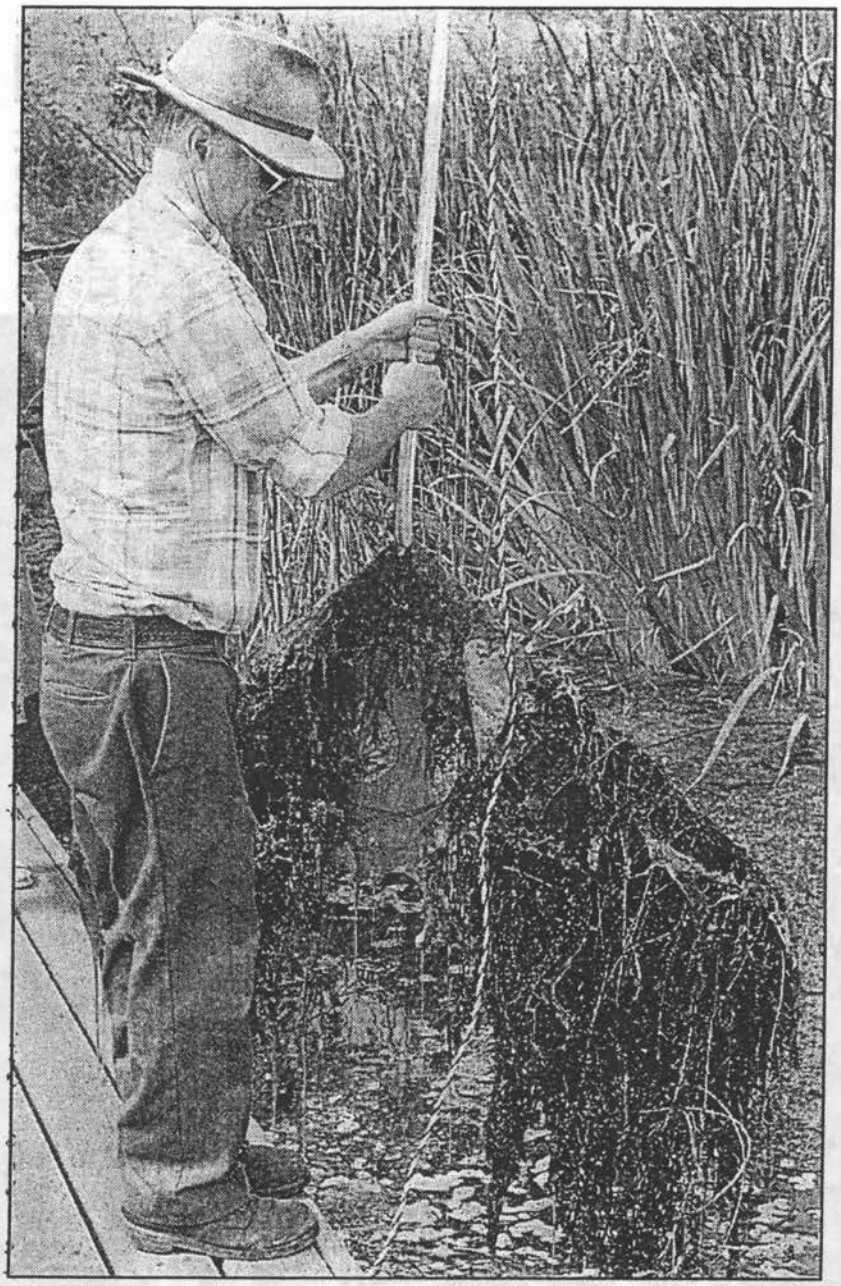
Property owner Donna Jensen reported being unable to swim in their dock area for three years because of the growth of aquatic weeds. The dock area was elodea-free when the dock was replaced in 1993, but is now clogged.

"I think it's going to work great for fishing and swimming," said Donna, "and that's what it's meant to do."

Cutting methods also demonstrated were use of the aqua cutter hand tool and the mechanical

See WEED, Page B 3

The LEADER
Section B
Wednesday, Sept. 30, 199



Glenn Gately uses a tool to remove Brazilian elodea growing in Lake Leland. *—Photo by Viviann Kuehl*

Weed: Attack now

—Continued from Page B 1

Hockney cutter mounted on the boat. The problem with cutting is retrieval of the cut pieces. If left in the water, they can proliferate the problem rather than reduce it.

The aqua cutter is a two pronged rake with two-foot long razors mounted on the prongs. The cutter is thrown into the water and pulled through the weeds with a rope to cut plants.

The Hockney cutter consists of a three-sided, toothed cutter frame which can be raised and lowered on the front of a boat. The boat is driven with paddles because weeds clog a regular outboard.

Detailed information is available to the public through a 58-page pamphlet titled *Aquatic Plants and Fish* from the Washington Department of Fish and Wildlife, (360) 249-6523, or call Hamel at the DOE, (360) 407-6562, for other printed information and Internet information site addresses.

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Jefferson County Conservation District Newsletter

Volume 11 Issue 3 SUMMER 1997

District Awarded Aquatic Weed Management Planning Grant

Recently, Jefferson County Conservation District was awarded a grant from the Washington State Department of Ecology (DOE), to work with the Lake Leland community to develop an aquatic plant management plan to control the growth and spread of Brazilian elodea (*Egeria densa*) in Lake Leland, one of our county's most popular lakes.

For the past several years DOE, along with the Leland Neighborhood Improvement Club, has been monitoring the status of the invasive, non-native elodea. It was discovered in Lake Leland in 1994 and has been spreading ever since. Brazilian elodea is a popular aquarium plant, now illegal to sell, that has found a niche in many Western Washington lakes. It is difficult to control and spreads rapidly from just fragments of the plant. It is spread to other lakes by boat motors, trailers or fishing gear.

The District has hired a part time technician, Susan Taylor, to work exclusively on the development of a management plan for Lake Leland. Susan's duties will include coordinating public involvement meetings with the local citizens that live or own land around the lake and government agencies, assisting with lake weed monitoring, and developing the aquatic plant management plan. Another district technician, Glenn Gately, will also be involved in developing the plan. Glenn's emphasis will be on developing and conducting water quality and aquatic vegetation monitoring, and then assisting in the development of the plan.

Based on the lake monitoring data, Susan and Glenn will assess the information and assist the Lake Leland community to determine the best control options.

The entire project will receive assistance and support from DOE. The process in which to complete the monitoring and then develop the plan to control Brazilian elodea may take up to 18 months.

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Brazilian elodea
(*Egeria densa*)

Jefferson County Conservation District Newsletter

Volume 11 Issue 4 FALL 1997

WHAT IS A CONSERVATION DISTRICT?

Sure, you've seen us at fairs, you receive our newsletters, and you probably know that we assist landowners in enhancing the natural resources of Jefferson County on a non-regulatory basis. You may also know that we are our own entity, and *not* part of county government, or state government (we are actually a legal sub-division of state government), etc. etc.

But, how much do you really *know* about conservation districts? Here's a few questions to test your knowledge! Think hard, as you may be surprised by the answers!

1. Who 'runs' the conservation district? (Caution, this could be a trick question!)
2. Where did conservation districts come from?
3. Where does the conservation district get funding to operate?
4. How many conservation districts are there in Washington State? In the United States?
5. What does the term "putting conservation on the ground" mean?
6. What other government agency works closely with conservation districts to provide technical expertise?

If you know the answers to all of these questions, congratulations! You know a great deal about who we are and how conservation districts work!

If you don't know the answers to these questions, then maybe it's time you stopped by or called our office to find out more about what conservation districts can do for you!

(Answers are provided on page 3)

UPDATE ON LAKE LELAND AQUATIC WEED STUDY

by Susan Taylor, District Technician

This past summer the Leland Aquatic Weed Project was presented to the local community at a public meeting where information was distributed and input was requested. Volunteers were also solicited to work on an aquatic plant monitoring study that began in August. The purpose of the monitoring is to determine the amounts, type, and distribution of aquatic vegetation present in the lake at this time. The surveying took several days to complete with the help of 17 volunteers who contributed their valuable time and also equipment such as boats, diving gear, and facilities.

Conservation District employees and staff from the Washington State Dept. of Ecology also assisted. Baseline data will be established from this survey and used in the future to evaluate treatments utilized to control the Brazilian elodea that is invading Lake Leland. Reed canary grass, which is also contributing to problems with the lake will also be included in the control solutions. Preliminary distribution monitoring results showed Brazilian elodea present on 23 of the 27 sites (85%) around the shore of the entire lake. This is a definite increase from observations made approximately a year ago.

The Leland community has responded with great support of this project. Local interest and participation is a very necessary component of the planning process. A core group has been formed from interested Leland property owners. This group, referred to as the Steering Committee, will also include representation from the appropriate county and state agencies which have an interest in the project. The first Steering Committee meeting will take place this November, and the aquatic plant management planning process will be formalized with development of a problem statement and identification of goals that are to be met. This committee will represent the local community at large and will be responsible for completing the steps involved in the Department of Ecology's *Manual for Developing Integrated Aquatic Vegetation Management Plans*. The Steering Committee will also be responsible to share information and allow for participation of all interested community members in the planning process. To facilitate this process, a public meeting will be scheduled following the first Steering Committee meeting.

Lake Leland Update continued from page 1...

The Conservation District would like to extend a big **Thank You** to all those volunteers who are contributing to the success of the Lake Leland Project.

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D-14

THANK YOU VOLUNTEERS

Jefferson County Conservation District Newsletter
Volume 12 Issue 1
WINTER 1998

The District staff (Al, Rosie, Susan, and Glenn) would like to acknowledge the many volunteers who have helped make this past year a successful one.

For the part several years, Brazilian elodea has been increasing its distribution in Lake Leland. This year the District began providing technical assistance and administering a grant (funded by Washington Dept. of Ecology and Jefferson County Parks and Recreation) to determine the best method(s) of combating this invasive aquatic plant. So far several planning meetings have been held and an intensive plant survey conducted.

Volunteer Lowell Davis pulls in the anchor, camoflaged under a load of Brazilian elodea.

Volunteers were integral to both the planning process and plant monitoring. Using their own boats and SCUBA gear, two volunteers did the diving; some provided and operated motor boats; others assisted in the sorting and identifying of the plants. So far, volunteers have reduced the County's cost by over $3000. We thank the following volunteers for this significant contribution: **David and Carolyn Wixson, Don Case, Joanne Peterson, Candy Garrison, Bruce Munn, Sammie Kay, Doug Barley, Lowell Davis, Jerry Welch, Kevin Wright, Rex Long, Ted Hunter, Roy Ridderbusch, George and Linda Bauer, Elmer Hughes, Norm Willis, Linda Gately, Bruce Marston, Chris Novello, Paul Wilcox,** with special thanks to **Bob Bergeron** of the ARC (Advocates for the Rights of Citizens with Developmental Disabilities and their Families), for providing a meeting place and refreshments to the steering committee.

Last March over 10,000 tr
were distributed to Jefferson Co
residents. Many of them were r
along salmon streams and will
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**Tom Ammeter, J
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r (valued at over $1,000), which
Port Townsend business
anufactures, but also many hours of his time in the installation process.

Our "thank you" would not be complete without thanking the numerous landowners that have implemented BMPs on their land and graciously allowed the District and their volunteers to conduct the monitoring. **Thank you landowners.**

Another year is now beginning. If any of you would like to help out as a volunteer, give us a call.

Susan Taylor, Lowell Davis, and Jerry Welch helping with the plant sampling on Lake Leland.

D-15

Lakeshore Conservation District Newsletter
Winter 1995

Thank You Volunteers

Volunteer Darrell Davis pauses in the morning's sampling under a haul of Brazilian elodea

APPENDIX E

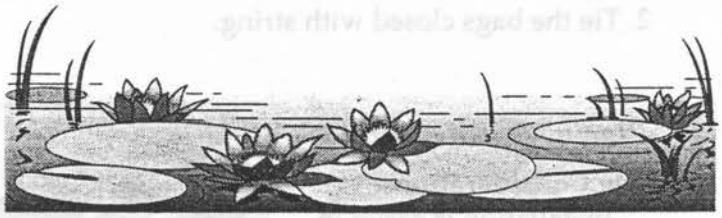
INSTRUCTIONS FOR BUILDING
AND
INSTALLING BOTTOM SCREENS

APPENDIX E

INSTRUCTIONS FOR BUILDING AND INSTALLING BOTTOM SCREENS

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Instructions for Building and Installing Bottom Screens



Many lake-front residents have problems with aquatic plants growing in swimming areas or alongside docks. Bottom screening provides an inexpensive and effective means of controlling these plants. This document provides instructions for building and installing bottom screens.

A bottom screen is a cloth-like material that covers the lake bottom like a blanket. Bottom screens block light, preventing the growth of aquatic plants. Bottom screening (bottom barriers) can be an excellent method of controlling aquatic plants at swimming beaches and in boat mooring areas.

Most aquatic plants can be controlled with bottom screens. Waterlilies are controlled well, although installation and maintenance difficulties can be created by their large roots and the mucky sediments in which they sometimes grow. Plants such as coontail and bladderwort that do not root in the sediment, can not be controlled by bottom screening.

Bottom screens can be installed by the home owner. The material may be placed directly on the lake bottom or attached to frames to facilitate handling under water. The use of bottom screens is usually confined to shallow water, unless diving gear is available.

Materials Required for Three 12' X 12' Bottom Screen Frames

- Fifteen 2" X 2"s, each twelve feet long.

  Note: Fir and cedar 2" X 2"s are suitable and may be more readily available, in twelve foot lengths, than pine.

- Nails (#6 Spiral) or screws, 2" long.
- Marine plywood, ¼" for making gussets. Forty-eight gussets are required for bracing, top and bottom of each of the three 12' X 12' frames *(see sketch below)*. Approximately twelve square feet of plywood is required.
- Lath (if nails instead of staples are used for securing material to the frames). About 165 lineal feet required.
- Screening material, allowing for some selvage, about 440 square feet required.
- Twelve polypropelene bags 2' X 2' for use as sandbags.
- Clean sand or gravel to fill twelve bags approximately ¾ full, about 1 cubic yard.

Tools Required

- Hammer
- Saw
- Utility knife or heavy scissors for cutting material.
- Staple gun (if staples are used instead of lath for securing material to the frames).

Building Instructions

A. *Screening Materials*

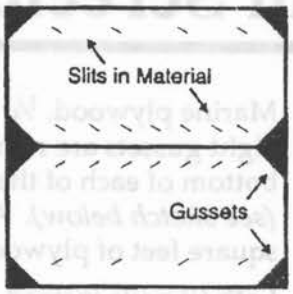
Screening materials should be opaque and of a sturdy material that doesn't tear easily. Ideally these materials should be heavier than water and permeable to the gases that will be generated by rotting vegetation.

Materials suitable for screening include burlap, woven synthetics, perforated black mylar, landscaping fabric (sold in hardware stores and at plant nurseries), and geotextiles used in road construction. Keep in mind that some fabrics, such as burlap, will deteriorate more rapidly than others.

E-1

B. *Screen Construction*

1. Lay out the 2 X 2's for one frame - four sides, plus middle brace.
2. Measure and cut gussets from the ¼" marine plywood. These will be triangular pieces with each side 5" long. Sixteen gussets are required for each frame.



3. Nail or use screws to secure gussets at each corner of the frame and at both ends of the center brace on the "up" or visible side of the frame.
4. Carefully turn the frame over and lay the screening material on top.

   Note: Screening material can be used in six foot widths if it is more conveniently available.
5. Nail gussets or use screws to secure them to one end of the frame with the screening material underneath.
6. From the opposite end of the frame, pull the material tight and nail or screw down gussets.
7. Staple the screening material to each of the 2 X 2's so that it is secured along the entire length (or nail down, using the lath).
8. Trim excess material even with the outside of the frame.

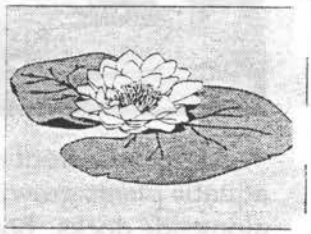
9. Repeat for other frames.

C. *Sand Bags*

Sand bags are used to anchor the bottom screens to the sediment. Even the most porous materials will billow due to gas buildup, sometimes causing the frame to "lift off" the bottom. Therefore, it is very important to anchor the bottom screen securely. Unsecured screens can create navigation hazards and are dangerous to swimmers. Anchors must be effective in keeping the material down and must be regularly checked.

1. Fill each bag about ⅔ full with <u>clean</u> sand or gravel (fill material containing dirt will cloud the water as the bags are put into place). If the screen site has a soft or muck bottom try filling the bags only ½ full. The bags may cause the screens to sink if the sediment is very soft.
2. Tie the bags closed with string.

D. *Placing Bottom Screens*



Site Considerations:

Installation is easier in the winter or early spring when plants have died back. In summer, it's desirable to cut or hand-pull the plants first.

Be aware that boat propellers may dislodge bottom screens in shallow areas. Also fish hooks can get caught in the material. If the screened area is to be used for boat mooring, swimming, fishing, or wading, it may be prudent to post a sign telling users that the bottom screen is in place.

1. Remove any sticks and stones from the area to be screened, especially where the edges of the frame will lie.
2. Slide the frame into the water. This can be more easily done with two people.
3. While the screens are floating on the surface, cut slits about one inch long in the material, in a pattern similar to that shown in the sketch shown above. This will allow the air trapped under the screen to escape, making it easier to lower the screen to the bottom. The slits will also allow gases generated by rotting vegetation to escape.
4. If you are installing the screen near a dock, line up the frame with the dock. Lower the frame into place by placing a sandbag on each corner and allowing the frame to slowly sink. Once it is on the bottom and in the position you want, add a sandbag to each end of the center brace.
5. Install the second and third frames adjacent to each other. If two people are working together, one can push while the other squeezes the frames together. Make sure there are no gaps between each frame and that the cross pieces are parallel with the other frames.

E-2

6. Place the remaining sand bags, concentrating the weight where the frames meet. Overlap the bags so that they rest partly on each frame. This will help to keep the frames in place.
7. Pull the aquatic weeds along the edge of the frames to keep them from growing over the screened area. Milfoil tends to "canopy" over adjacent areas.
8. If any mechanical harvesting is taking place on the lake, notify the equipment operator about the bottom screen and ask him/her not to harvest in this area.

D. Relocating Screens

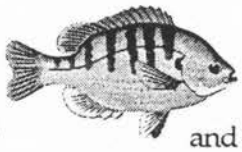
Bottom screens installed during the growing season will suppress the plants within about four weeks. The bottom screens can then be moved to a new location or be removed for storage. If bottom screens have been in place during the growing season, plant suppression will usually be effective for the remainder of the summer.

Screens are easily moved underwater by two people. They can be moved around the same dock or to an adjacent dock.

E. Maintenance

The duration of weed control depends on the rate that weeds can grow through or on top of the bottom screen, the rate that new sediment is deposited on the screen, and the durability and longevity of the material. Regular maintenance can extend the life of most bottom screens.

1. Frequently check the bottom screen for gas bubbles. If gas bubbles are forming under the material, cut one or two additional slits on top of the bubble to release the gas.
2. If the screens are not removed from the water at the end of the season, they should be checked at the beginning of the new growing season for any accumulation of sediment. This can be removed by sweeping or up-ending the screens. Check with the Department of Fish and Wildlife to determine if you need a permit to clean the bottom screens.



F. Fish Spawning Areas

Screens covering spawning beds should be moved in the early spring and not replaced until the spawning activity is over, usually sometime during the early summer.

Permits

Bottom screening requires a type of permit called a hydraulic approval, obtained free from the Washington State Department of Fish and Wildlife. In some counties, a shoreline permit may also be required. Check with your local jurisdiction to determine if a shoreline permit is required.

Contacts

Contacts are provided for your convenience. It is not our intention to endorse or promote specific vendors or products and this list may not be comprehensive.

The following companies install bottom screens and may sell bottom screening kits to home owners.

AquaZone
82 Foreman Rd.
McCleary, Washington 98557
(206) 495-3920

Resource Management, Inc.
2900B 29th Ave. SW
Tumwater, Washington 98512
(206) 754-3460

Allied Aquatics
4426 Bush Mountain Dr. SW
Olympia, Washington 98502
(206) 357-3285

Global Diving
2763 13th Ave. SW
Seattle, Washington 98134
(206) 623-0621

If you have special accommodation needs, please contact Kathy Hamel at (206) 407-6562 or (206) 407-7155, Telecommunications Device for the Deaf (TDD).

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Acknowledgement: Tom Clingman of Thurston County Lakes Program for his help in preparing this Fact Sheet.

6. Place the remaining sand bags, concentrating the weight where the frames meet. Overlap the bags so that they rest partly on each frame. This will help to keep the frames in place.

7. Pull the aquatic weeds along the edge of the frames to keep them from growing over the screened area. Milfoil tends to "canopy" over adjacent areas.

8. If any mechanical harvesting is taking place on the lake, notify the equipment operator about the bottom screen and ask him/her not to harvest in this area.

D. *Relocating Screens*

Bottom screens installed during the growing season will suppress the plants within about four weeks. The bottom screens can then be moved to a new location or be removed for storage. If bottom screens have been in place during the growing season, plant suppression will usually be effective for the remainder of the summer.

Screens are easily moved underwater by two people. They can be moved around the same dock or to an adjacent dock.

E. *Maintenance*

The duration of weed control depends on the rate that weeds can grow through or on top of the bottom screen, the rate that new sediment is deposited on the screen, and the durability and longevity of the material. Regular maintenance can extend the life of most bottom screens.

1. Frequently check the bottom screen for gas bubbles. If gas bubbles are forming under the material, cut one or two additional slits on top of the bubble to release the gas.

2. If the screens are not removed from the water at the end of the season, they should be checked at the beginning of the new growing season for any accumulation of sediment. This can be removed by sweeping or up-ending the screens. Check with the Department of Fish and Wildlife to determine if you need a permit to clean the bottom screens.

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APPENDIX F

BLUEPRINT for a LAKE-FRIENDLY LANDSCAPE

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BLUEPRINT for a LAKE-FRIENDLY LANDSCAPE

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Focus

Blueprint for a Lake-friendly Landscape

Shoreline landscaping can have a major impact on swimming, boating and fishing in your lake. Why? Because toxins from stormwater run-off, pesticides and fertilizers can lower water quality, trigger algal blooms, kill fish and cause excess weed growth. "Lake friendly" landscaping reduces the need for pesticides and fertilizers, helps filter harmful contaminants out of run-off before they pollute your lake, and helps control erosion.

Problems with Shoreline Landscapes

The most common shoreline landscape is a wide lawn with exotic ornamental plants leading to a bulkhead. Here are some problems with this type of landscape:

Problem: Excess Nutrients. Wide use of lawn and garden fertilizers on shoreline property can cause nutrients to build up in the water. Rain and watering can wash fertilizers out of your yard and garden and into the lake. Fertilizer buildup in the water results in rapid aquatic plant growth and algal blooms, which hamper swimming and boating activities and kill fish. Careless discarding of lawn clippings and yard debris near the lake will also cause excess nutrients to pollute the lake.

Solution: Leave some native vegetation along your shoreline. If native vegetation is gone, reduce the size of your lawn by replanting native species of trees, shrubs and ground cover. Native plants require fewer pesticides and fertilizers, and once established, need less water than exotic ornamental varieties. Create buffer areas with native plants to act as a natural filter system, trapping nutrients from stormwater run-off before they enter the lake. Dispose of lawn clippings and yard debris or start compost piles well away from the lake or nearby streams and wetlands.

Problem: Excess Toxins. Pesticides commonly used around homes and gardens (such as diazinon, dursban and orthene) and herbicides (such as Weed and Feed and Round-Up) can cause serious damage to fish, wildlife and people when they get in the lake water. They may be blown directly into the lake when applied on a windy day or washed off plants and soil by rain or watering. Improper storage and disposal of these chemicals also can pollute the lake.

Solution: Always read labels carefully and avoid using pesticides and herbicides whenever possible, especially on windy days. Use pesticides only when you actually see a pest.

Dispose of unused pesticides and containers at the local hazardous waste disposal site.

Helpful hints for landscaping near lakes

Problem: Bulkheads. A bulkhead is not the best or only way to prevent erosion. Bulkheads create unnatural drop-offs that can be dangerous, especially to children and the elderly. They also interrupt natural shoreline vegetation.

Solution: Planting and maintaining natural vegetation instead of constructing a bulkhead will control soil erosion and run-off, provide a more gradual transition from yard to lake, help beautify your lake and enhance wildlife habitat.

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Problem: Canada Geese. Lake-side lawns encourage nuisance populations of Canada geese, who like to feed in short grassy areas. Bird feces on docks and lawns can contribute harmful nutrients to the lake water, in addition to being unsightly, unsanitary and unsafe.

Solution: Replace lawn next to the lake with a six- to eight-foot-wide buffer zone of low-growing plants. Consider placing a path through the buffer zone for lake access to a dock or gravel beach. Many plants are suitable for this area of wet soil, including salal, ajuga reptans, vaccinium vitis-idaea, cotoneaster dammeri and rubus tricolor. For the gardening enthusiast, the buffer zone is an ideal area for a perennial flower or herb garden or a bed of wildflowers.

Lake-Friendly Landscape Plan. Shown here is a sample landscape plan that protects water quality and encourages native plants, fish and wildlife close to shore. Remember that encouraging shoreline habitat doesn't mean building a barrier of native vegetation between your home and the lake. A balanced approach to waterfront landscaping retains natural habitat and reduces pollution and erosion, while also meeting your aesthetic and access needs.

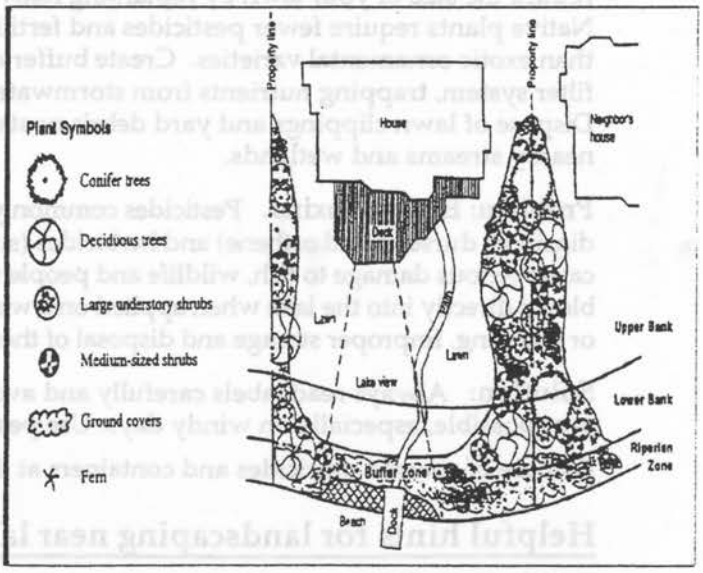
In the example below, two neighbors have worked together to create native plant zones. The following are descriptions and recommended plants for each zone.

Riparian Zone - This zone extends about two feet up the bank from the edge of the lake. Fluctuating water levels and the wave action from boats and wind impact this zone. Plants here must tolerate wet soils for long periods and have deep root systems to minimize erosion. Low-growing plants are best, so the view from your home or deck is unobstructed. Examples of plant varieties suitable for this zone are: lady fern, sedges (many species) and blue flag iris.

Lower Bank - This two- to 10-foot zone is adjacent to the riparian zone. The soil here tends to be moist but not wet. Your plan for this zone should include at least three shrubs (such as red osier dogwood, red elderberry and evergreen huckleberry) and two ground cover varieties (such as lady fern, bunchberry and sword fern).

Upper Bank - This zone extends from the end of the lower bank zone toward your home. The landscape here should include at least three shrubs (such as serviceberry, mock orange and red flowering currant) and two ground cover plants (such as salal, sword fern and pig-a-back).

Mixed throughout the upper and lower bank zones should be at least two varieties of shade trees and two types of shade and cover plants to create a multi-layered canopy. Some good choices for shade trees are: chokecherry, Oregon ash and western hemlock. For shade and cover: vine maple, western crabapple and hazelnut.



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For more information

For more information, please contact Terra Hegy at (206) 407-6530/SCAN 407-6530. If you have special accommodation needs, please contact Kathy Hamel at (206) 407-6562 (voice) or (206) 407-7155 (TDD, Telecommunications Device for the Deaf).

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