WASHINGTON STATE DEPARTMENT OF ECOLOGY

Aquatic Plants Technical Assistance Program

1999 Activity Report

May 2000

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WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Aquatic Plants Technical Assistance Program

1999 Activity Report

by
Jenifer Parsons

Environmental Assessment Program
Olympia, Washington 98504-7710

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Abstract

The objectives of the Aquatic Plant Technical Assistance Program are to:

- ◊ provide advice on aquatic plant identification, biology, and management to government agencies and the public;
- ◊ document aquatic plant distribution and habitat through site visits; and
- ◊ assist with evaluating projects supported by Freshwater Aquatic Weed Program grant money.

During the 1999 field season, aquatic plant data were gathered at 86 different waterbodies located throughout the state. Several previously unknown populations of non-native invasive aquatic plants were recorded. *Myriophyllum spicatum* (Eurasian watermilfoil) was found in Palmer Lake, Okanogan County, Black Lake, Pacific County, Marshall Lake, Pend Oreille County and Drano Lake, Skamania County. *Egeria densa* (Brazilian elodea) was found for the first time in Loomis Lake, Pacific County. A population of *Myriophyllum aquaticum* (parrotfeather) was found in Brooks Slough, Wahkiakum County. The emergent species *Lysimachia vulgaris* (garden loosestrife) was found in the wetlands around Fish Lake, Chelan County and Lake Alice, King County. *Lythrum salicaria* (purple loosestrife) was previously unknown from Riley Lake in Snohomish County, as was *Epilobium hirsutum* (hairy willow-herb) at Spearfish Lake, Klickitat County. Also *Typha angustifolia* (lesser cat-tail) was first noted in Tanwax Lake, Pierce County and Sixteen Lake, Skagit County this year.

In addition to routine aquatic plant monitoring, we completed the data collection and analysis for the 2,4-D demonstration project that was started in 1998 in Loon Lake, Stevens County. We also collected biomass data from Long Lake, Kitsap County as part of a study looking at long-term trends in the *Egeria densa* population. Additional plants for the herbarium collection were gathered, and we provided educational and technical outreach and assisted with projects funded by Freshwater Aquatic Weed Program grant money.

Introduction

Legislative action in 1991 (RCW 43-21A.660) established the Freshwater Aquatic Weed Account to provide expertise on aquatic plant issues and a source of grant money for local aquatic plant management projects. The need for this program was recognized when the spread of aquatic plant problems in the state's public waters outgrew the ability of agencies to adequately address them. To provide technical expertise for aquatic plants, one full-time position was created within the Environmental Assessment Program of the Department of Ecology. The objectives for this position are to:

- ◊ provide technical assistance on aquatic plant identification and management to government agencies and the public;
- ◊ conduct site visits to identify aquatic plants, evaluate plant community structure and identify the existence or potential for problems, particularly as they relate to invasive non-native aquatic plants; and
- ◊ assist with rating grant applications to the Freshwater Aquatic Weed Account.

The purpose of this report is to document the progress of the Aquatic Plant Technical Assistance Program with respect to these objectives during 1999, concentrating on site visit results. Reports on the program's results from 1994, 1995, 1996, 1997, and 1998 are also available (Parsons, 1995a; Parsons, 1996; Parsons, 1997; Parsons, 1998; Parsons, 1999).

To reduce confusion, all plants are referred to by their scientific names. Table 1 lists the common names for the plants most frequently mentioned in the text.

Table 1. Scientific and common plant names

Scientific Name	Common Names
Cabomba caroliniana	fanwort
Egeria densa	Brazilian elodea
Hydrilla verticillata	hydrilla
Ludwigia hexapetala	water primrose
Lysimachia vulgaris	garden or yellow loosestrife
Lythrum salicaria	purple loosestrife
Myriophyllum aquaticum	parrotfeather
Myriophyllum spicatum	Eurasian watermilfoil
Nymphaea odorata	fragrant waterlily
Polygonum hydropiper	marshpepper
Utricularia inflata	big floating bladderwort

Technical Assistance

After the Freshwater Aquatic Weed Account was established, an external advisory committee identified technical assistance for aquatic plant taxonomy, ecology, and management as a high priority for the new Freshwater Aquatic Weed Management Program. Technical assistance was later defined as "Provid(ing) technical expertise within Ecology and to other agencies, local governments, lakes groups, and the general public regarding aquatic plant ecology and taxonomy, aquatic plant management, development of integrated aquatic plant management plans, and other aquatic plant management issues. Assistance will be provided through on-site visits, development of technical reports, participation in public workshops, and presentations to private and public groups and societies."

Providing technical assistance involves working with public and private sectors to develop a broad understanding of the roles aquatic plants play in the ecosystem and how human behavior influences aquatic plant communities. Toward this aim, I participated in several workshops, meetings, and conferences and wrote articles for various publications between January 1 and December 31, 1999 (Table 2). Kathy Hamel of Ecology's Water Quality Program also provides technical assistance that is not listed in this table. I also assisted the public and local governments on an informal basis through phone conversations, identification of mailed plant specimens, and informal meetings that are not listed. Much of this information, as well as other publications the Department of Ecology has produced on aquatic plants in Washington, are available on Ecology's web pages (http://www.wa.gov/ecology).

Table 2. Aquatic plant technical outreach activities - 1999.

Function	Date	Location	Role
Western Aquatic Plant Management Society newsletter	1/99		Edited and published the Winter edition
Western Aquatic Plant Management Society Annual Conference	3/24-3/25/99	Reno, NV	Presented paper titled ‘The effect of 2,4-D on an early infestation of Eurasian milfoil’, attended sessions and board meeting
Washington Lakes Protection Association conference	4/8-4/10/99	Spokane, WA	Presented paper on 'Why aquatic weeds take over a lake', attended sessions
Western Aquatic Plant Mgmt Society newsletter	5/99		Wrote articles, edited and produced newsletter
Editor	5/5/99		Edited a paper submitted to the Journal of Aquatic Plant Management
Met with lake resident, Wild Duck Lake	7/12/99	Easton, WA	Discussed aquatic plant management techniques, conducted survey
Wrote article for 'Waterline' newsletter	8/99		Topic was biology and ecology of *Brasenia* (watershield)
Presented aquatic plant workshop at Diamond Lake	8/23/99	Pend Oreille Co, WA	Discussed aquatic plant ID, ecology and control of noxious weeds
Technical Assistance to Alaska	9/9-9/10/99	Juneau, AK	Assisted with aquatic plant ID and discussed management methods
Western Aquatic Plant Management Society newsletter	9/99		Edited and produced newsletter
Workshop on Aquatic Weed Identification and Control	10/6/99	Kelso, WA	Conducted field trip and part of workshop for 60 people concerned with noxious aquatic weeds
Met with Thurston County Noxious Weed Board personnel	10/20/99	Black River, Thurston Co.	Mapped *Polygonum hydropiper* population
Western Aquatic Plant Management Society newsletter	12/99		Wrote an article, edited and produced newsletter
Environmental Assessment Program Seminar	12/2/99	Olympia, WA	Presented an overview of noxious aquatic weeds in Washington
Aquatic Weed Taskforce Meeting	12/14/99	Olympia, WA	Presented overview of Aquatic Plant Monitoring in Washington

Site Visits

Introduction

This section documents aquatic plant surveys conducted during the 1999 field season with the assistance of a student intern, Sarah O'Neal. The general purpose of site visits was to identify aquatic plants, targeting exotic invasive species. We also evaluated plant community structures, estimated the extent of, or potential for, aquatic plant problems, and suggested possible management options. Another important aspect of the site visits was to expand the aquatic plant database and herbarium collection. Two special projects were also conducted this year. We continued an intensive plant monitoring project on Loon Lake, Stevens County as part of an herbicide efficacy study. We also collected biomass data from Long Lake in Kitsap County to look for long term trends in the *Egeria densa* population.

Site Visit Objectives

The specific 1999 site visit objectives were:

◊ to revisit selected lakes with exotic invasive plants in order to assess plant population changes since earlier surveys;
◊ to revisit other selected lakes considered to be at high risk for a non-native plant invasion;
◊ to conduct field surveys in selected lakes that had not been surveyed by this program during previous field seasons;
◊ to continue plant community monitoring projects on selected lakes; and
◊ to collect detailed plant biomass and distribution data in Loon Lake, Stevens County and in Long Lake, Kitsap County.

During site visits, meetings with concerned citizens or local government representatives were arranged if appropriate. If new populations of exotic species were found, the local weed board representative or county extension agent was contacted.

Field Methods

For a detailed discussion of field methods and data quality control, refer to the Aquatic Plant Technical Assistance Final Quality Assurance Project Plan in Parsons (1995b). The main goal of field site visits is to create the most comprehensive species list possible for each waterbody. This facilitates the discovery of potentially problematic aquatic plants and provides baseline aquatic plant distribution information.

For most lakes the method used is to circumnavigate the littoral zone in a small boat. When a different plant or type of habitat is observed, samples are collected for identification using a weighted rake, by hand-pulling or by visual observation. In addition, notes on species distribution, abundance, and maximum depth of growth are made. This method was recommended by other aquatic plant researchers (Sytsma, 1994; Warrington, 1994) and was used successfully during the previous five years. However, it should be noted that because the surveys are conducted from the surface, small populations of any plant species may be overlooked.

Secchi depth and alkalinity data were also collected on selected lakes. This was ancillary to the plant data, so time and logistical constraints limited the frequency of sample collection. These parameters were chosen because they have been shown to influence plant community type (Srivastava *et al.*, 1995; Smart, 1990; Kadono, 1982; Hellquist, 1980) and because they are relatively easy to obtain. The alkalinity samples were collected in open water to minimize the diel influence of macrophytes. Alkalinity was measured using a Hach® field test kit model AL-DT with a digital titrator to determine phenolphthalein and total alkalinity as $CaCO_3$. Secchi depth was also measured in deep, open water.

We also conducted habitat surveys on twenty lakes as part of the Lake Water Quality Assessment program at Ecology. The lakes were chosen by the project lead for that program. At each lake we evaluated the shoreline at 10 pre-selected locations using a method developed by the USEPA. See O'Neal et al. (2000) for the results of this project.

All field visits occurred between late spring and early fall to correspond with the time of maximal plant growth and flowering. Sampling locations were recorded with a written description, visual placement on a map, and with a Global Positioning System (GPS) unit. We collected any unusual plant species and known or suspected exotic species. These were pressed, mounted, and retained in the herbarium collection (see Herbarium section in this report). All data were recorded on field forms and entered into a relational database (see Parsons 1995a for a database design description).

Aquatic Plant Survey Results

During the 1999 field season 88 site visits were made to 86 different waterbodies. Highlights of results from these surveys are provided in the following section. In addition, several special projects will be discussed in subsequent sections. These include:

◊ an update on the *Hydrilla verticillata* eradication project in Pipe and Lucerne Lakes;
◊ monitoring of *Polygonum hydropiper* in the Black River;
◊ monitoring of *Egeria densa* in Lake Leland;
◊ rare plants found;
◊ a section on the Loon Lake demonstration project; and
◊ results from the Long Lake biomass monitoring project.

General Results

Appendix A lists the lakes where aquatic plant data were gathered during the 1999 field season, the extent of the survey, and any aquatic plants listed with the Washington State Noxious Weed Control Board that were found (Chapter 16-750 WAC). A similar table with data summarizing all six years of this program is contained in Appendix B. The author will provide additional information on any of the listed waterbodies upon request.

The results of these surveys include the discovery of previously unknown populations of several listed noxious weeds. *Myriophyllum spicatum* was found in Palmer Lake, Okanogan County, Black Lake, Pacific County, Marshall Lake, Pend Oreille County and Drano Lake, Skamania County. *Egeria densa* was found for the first time in Loomis Lake, Pacific County. A population of *Myriophyllum aquaticum* was found in Brooks Slough, Wahkiakum County. The emergent species *Lysimachia vulgaris* was found in the wetlands around Fish Lake, Chelan County and Lake Alice, King County. *Lythrum salicaria* was previously unknown from Riley Lake in Snohomish County, as was the *Epilobium hirsutum* (hairy willow-herb) at Spearfish Lake, Klickitat County. Also, the *Typha angustifolia* (lesser cat-tail) from Tanwax Lake, Pierce County and Sixteen Lake, Skagit County were first discovered this year. This cattail species is currently on the noxious weed monitor list. In addition, local noxious weed personnel discovered *M. spicatum* in Long Lake, near Spokane and in a private pond near the Teanaway River in Kittitas County. Island County weed board personnel also reported the *E. hirsutum* from Crockett Lake, and *E. densa* from a private pond on Whidbey Island. Past years of training County Noxious Weed Board personnel, State Fish and Wildlife Biologists, and volunteers with the Lake Water Quality Assessment Program in aquatic weed identification have greatly increased the number of aquatic non-indigenous species reports we receive from outside the agency.

Appendix C and Figures 1 and 2 contain maps illustrating where known populations of the noxious invasive aquatic plants *Myriophyllum spicatum*, *Egeria densa,* and *Myriophyllum aquaticum* occur in Washington. We have also become concerned about the apparent spread of *Utricularia inflata* in recent years, so we have begun to track populations of this plant as well (Figure 3). The maps include sites that have been visited by Aquatic Plant Management Program personnel and those reported by reliable sources. Also included are waterbodies where weed eradication efforts have been undertaken within the last five years. If no recurrence of the targeted weed occurs in five years, then the lake or pond will be removed from this list. Goss Lake in Island County was removed from the *M. spicatum* distribution map this year for this reason.

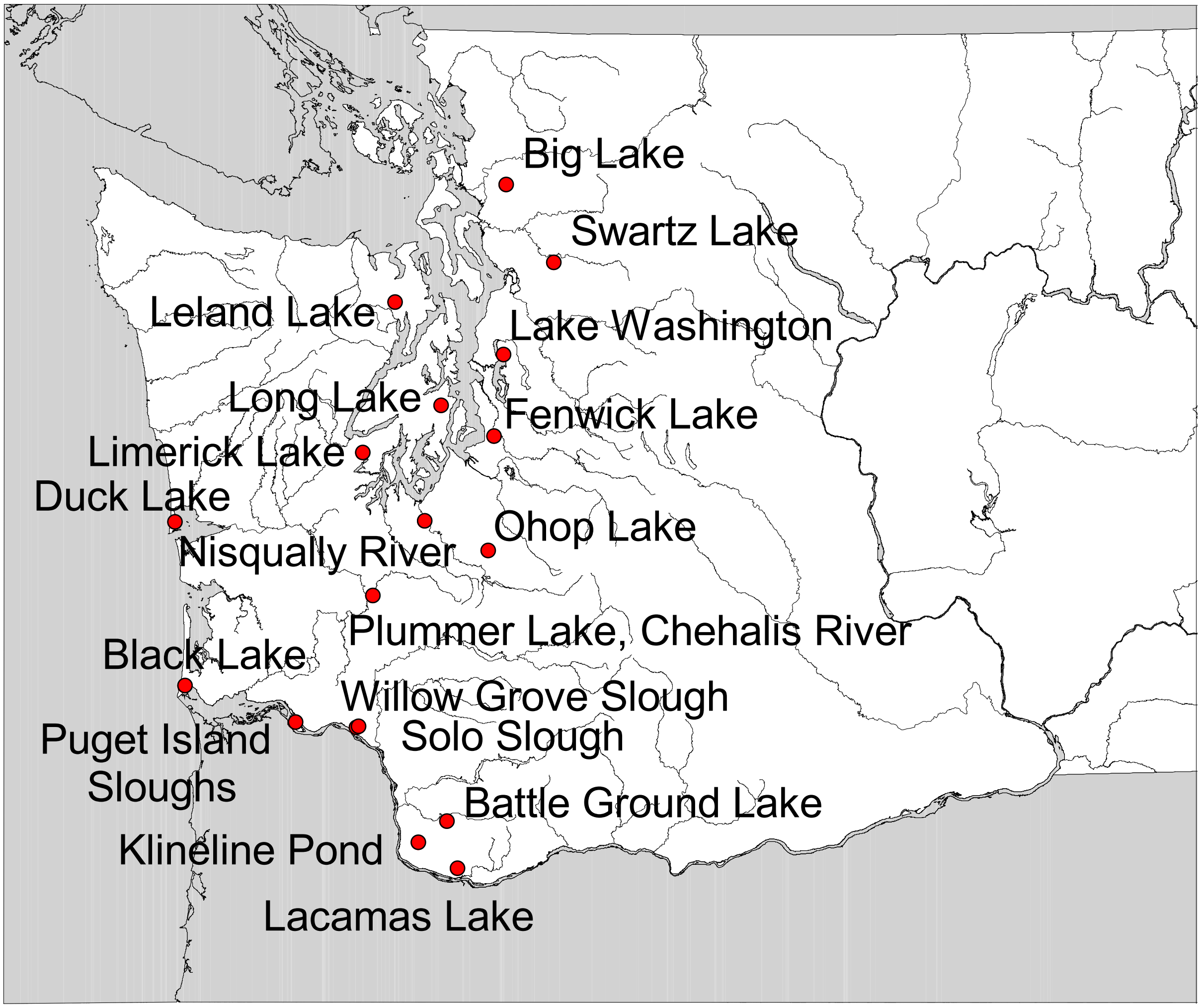


Figure 1. Known locations of *Egeria densa* in Washington, 1999.

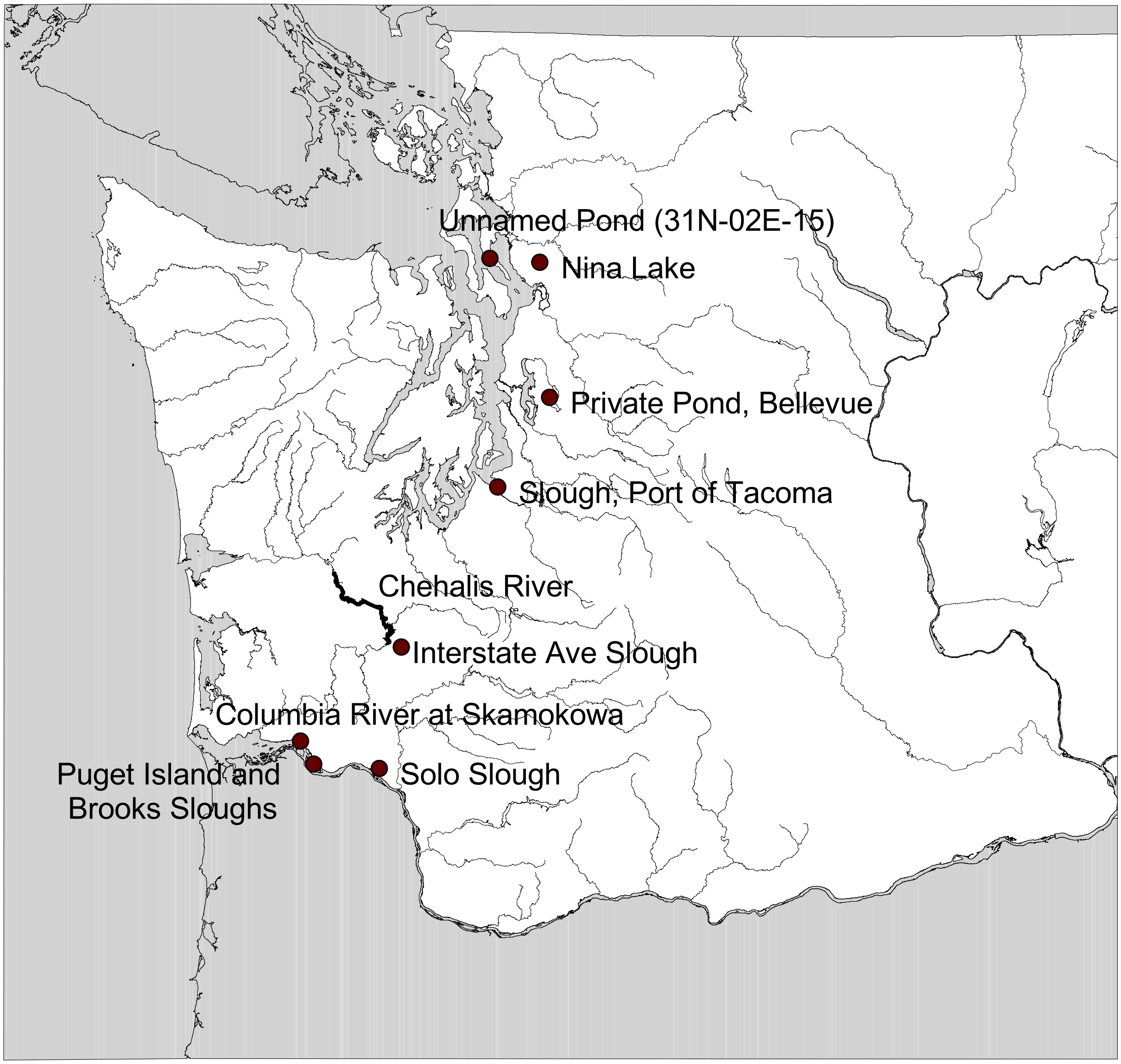


Figure 2. Known locations of *Myriophyllum aquaticum* in Washington, 1999.

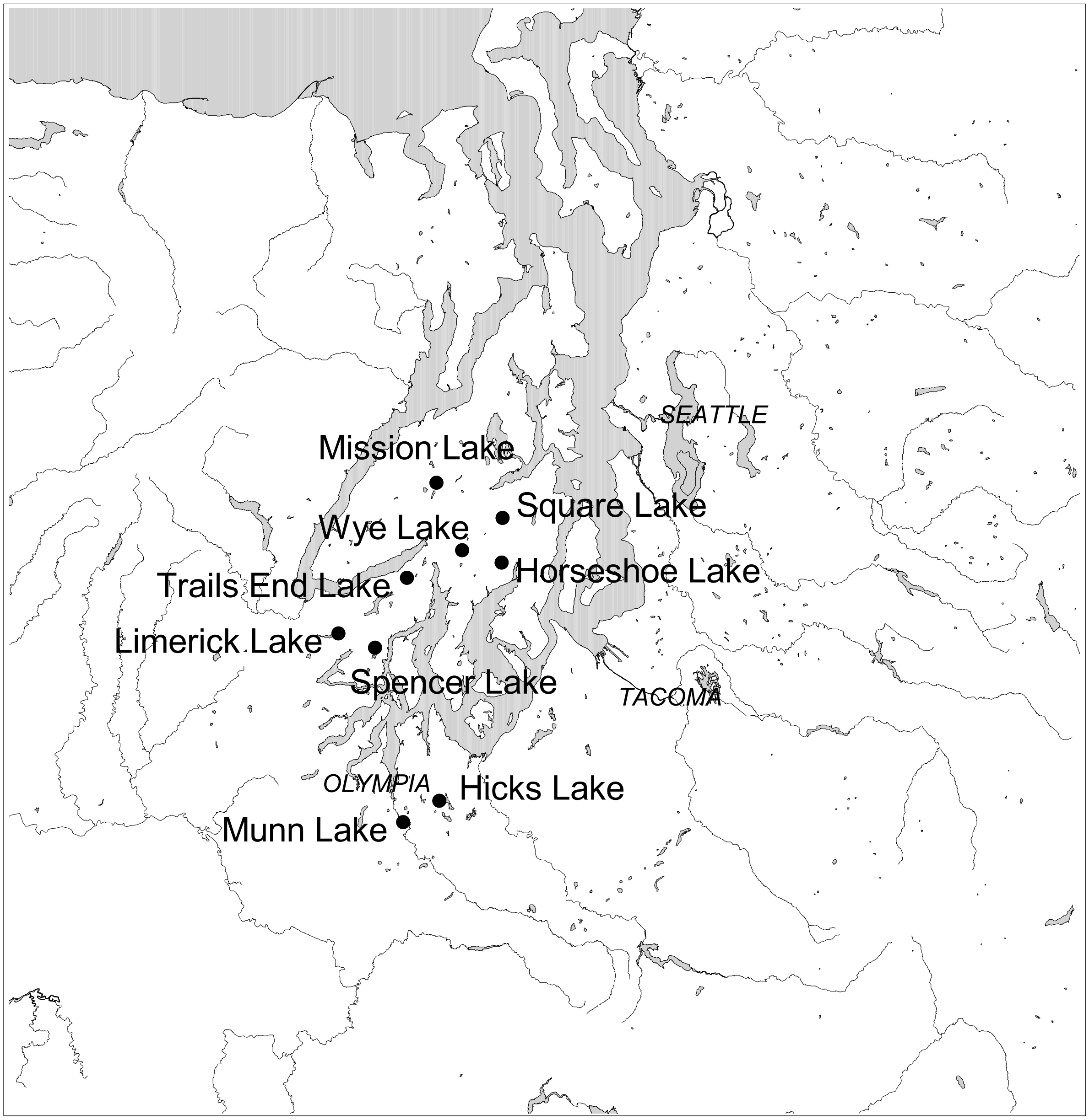


Figure 3. Known locations of *Utricularia inflata* in Washington, 1999.

Hydrilla Verticillata - An Update

The presence of *Hydrilla verticillata* was confirmed in Pipe and Lucerne Lakes (King County) on June 1, 1995. *Hydrilla* is an aggressive, non-native aquatic plant which will out-compete native vegetation if given the opportunity. Where it has become established (in the southern United States as far north as Connecticut and west to California), its rapid growth has radically changed aquatic environments. It is particularly difficult to control due to its many propagation strategies which include tubers, turions, plant fragments, and seeds. Federal and State agencies spend millions of dollars each year attempting to control its growth (Langeland, 1990; Anderson, 1987).

Because this was the first known population of *Hydrilla* in the northwest, aggressive action was taken to attempt its eradication. During the summers of 1995 through 1997, the 73 acre Pipe/Lucerne Lake system was treated with the systemic aquatic herbicide fluridone (brand name Sonar®) each year. A complete discussion of the events leading to these treatments during the first two years is provided in Parsons (1997). In the summers of 1998 and 1999 the population had been reduced enough to switch to a pellet form of the herbicide which was applied to selected areas still supporting *Hydrilla*. Each year has seen a reduction in *Hydrilla* tuber germination, with the 1999 population consisting of a very patchy distribution of up to 10 plants/m^2 (Lamb, 1999).

The treatment results from the summer of 1999 will not be known until spring 2000, when new plant growth can be assessed. King County again plans to contract for diver surveys in June, 2000 to assess the level of new *Hydrilla* germination. This information will be used to help determine if additional herbicide applications will be recommended, or if other methods such as diver hand-pulling can be depended upon (Walton, 2000).

Black River *Polygonum hydropiper*

Midway through the 1998 field season we were alerted to citizen concern regarding an emergent aquatic plant in the lower reaches of the Black River in Thurston County. By September the plant had reached maturity and it was determined to be marshpepper, or *Polygonum hydropiper* (Old, 1998). This is a non-native plant that normally does not aggressively outcompete native species. However, at this time it was forming an impressive growth from the shoreline into water three feet deep in the Black River.

At the end of September 1998 we surveyed the river with personnel from the Thurston County Noxious Weed Board to begin monitoring the extent of the *P. hydropiper* population (Figure 4). It is not known if the plant was growing so vigorously due to an inherent ability to dominate the shallow water habitat, or if it could be simply responding favorably to some quality of the environment. This river segment had been the subject of a water quality study prompted by a fish kill in the late 1980's. The results identified high nutrient levels flowing into this part of the river, mostly from agricultural runoff (Pickett, 1994).

In October 1999 we again monitored the river downstream from the School Land Road boat launch. The *P. hydropiper* population was considerably less at this time than the previous year (Figure 4), and had not spread downstream. The difference could be due to weather conditions during the two years. The summer of 1998 was warm and sunny, with high levels of plant growth observed in many aquatic situations. In 1999 the summer was cool and wet, with high water levels and cold water repressing plant growth in many systems. This stretch of river will continue to be monitored periodically to track the *P. hydropiper* population.

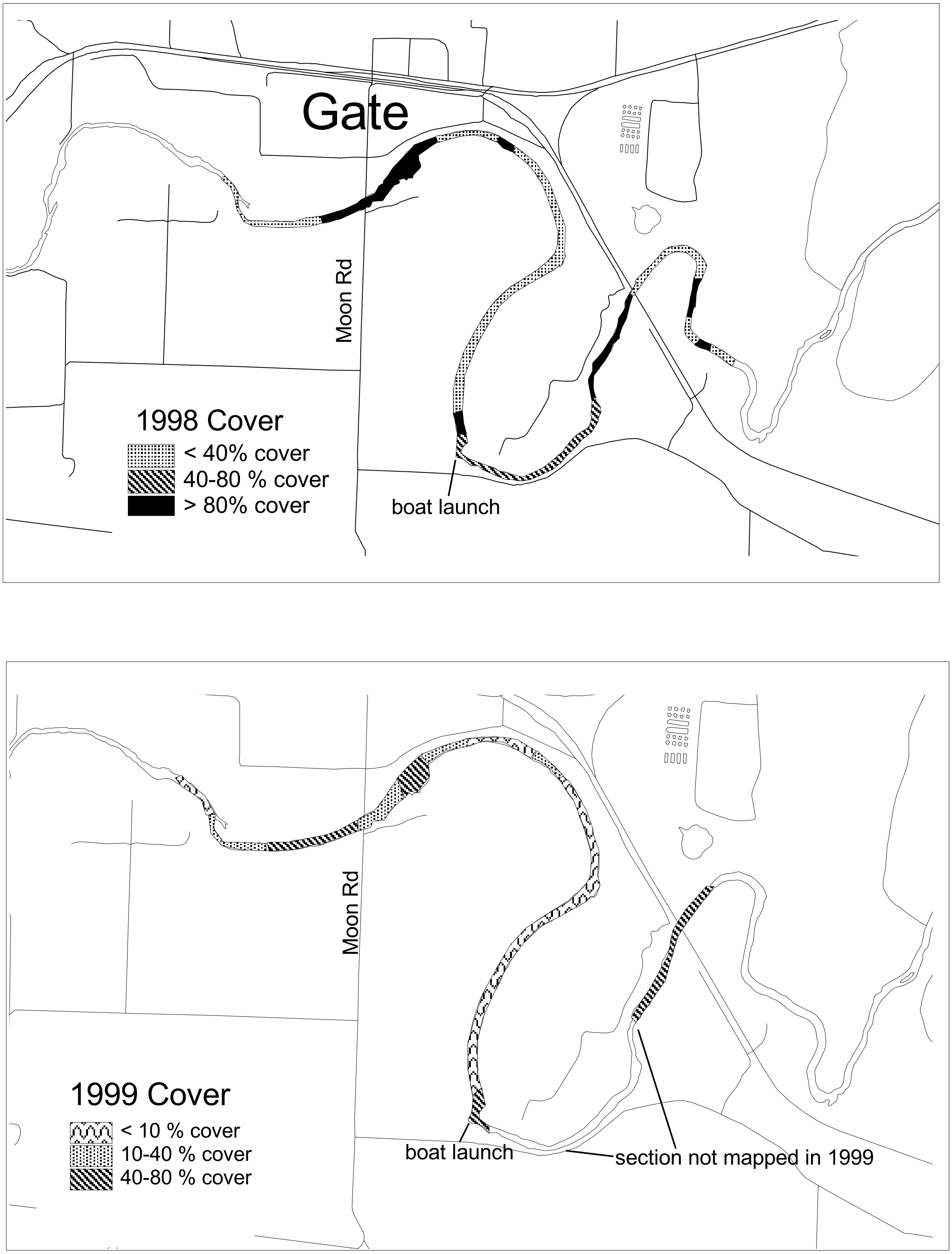


Figure 4. Black River *Polygonum hydropiper* density in 1998 and 1999.

Lake Leland *Egeria densa* Spread

Lake Leland is a 110 acre shallow lake in rural Jefferson County on the east side of the Olympic Peninsula. Historically it has supported a diverse community of native vegetation that provided important wildlife habitat for many species including amphibians and wintering trumpeter swans. It is also well known as a popular warm water fishery (Collins, 1995).

In late May 1994 an isolated though well developed population of *Egeria densa* was discovered in the western end of the lake. Additional site visits were made in 1995 and 1996 to monitor the *Egeria* spread. In 1997 the Jefferson County Conservation District along with several local community members completed a detailed aquatic plant and water quality study, supported by grant money from the Aquatic Weed Management Fund. They found that *Egeria* was present along 85% of the 27 transects inventoried for aquatic plants. The results of this study were included in an Integrated Aquatic Plant Management Plan (Taylor and Gately, 1998). In 1999 we again monitored the lake to further document the *Egeria* population.

Figures 5 and 6 present maps of the *Egeria* coverage in 1994, 1995, 1996, and 1999. They illustrate the rapid spread of this plant throughout most of the littoral zone. In 1994 the *Egeria* appeared restricted to the southern end of the lake. By 1996 it had spread into a significant portion of the main lake body. In 1999 it was found nearly throughout the littoral zone, and the cover of *Egeria* in relation to the native macrophyte species had increased substantially.

The Lake Leland Integrated Aquatic Plant Management Plan calls for localized *Egeria* control in the swimming area near the boat launch and around private docks. More aggressive measures were not called for at this time due to financial restraints, and concern about the environmental impacts of the control methods (Taylor and Gately, 1998).

Rare Plants

In addition to the weedy species, populations of plants listed as rare by the Washington Natural Heritage Program (WNHP) (Washington Natural Heritage Program, 1997) were observed during the field surveys. Two previously unknown populations of *Heteranthera dubia* (water star-grass) were found in Stevens and Okanogan Counties. Also, previously observed populations of *Limosella acaulis* (mudwort) in Grant County, *Lobelia dortmanna* (water lobelia) in Mason County, and *Hydrocotyle ranunculoides* (water penny-wort) were visited. All sightings were reported to the WNHP database manager.

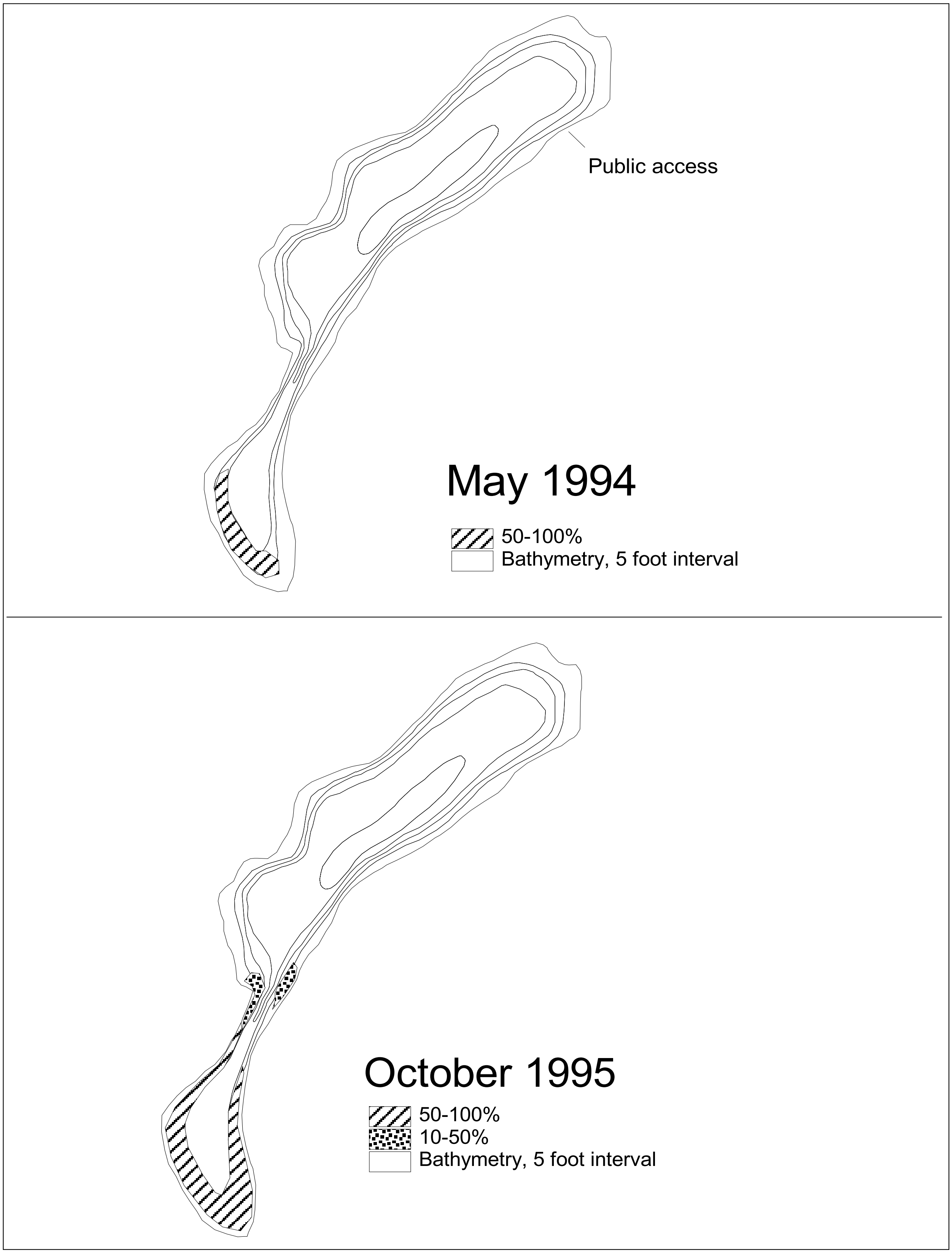


Figure 5. Lake Leland *Egeria densa* cover, 1994 and 1995.

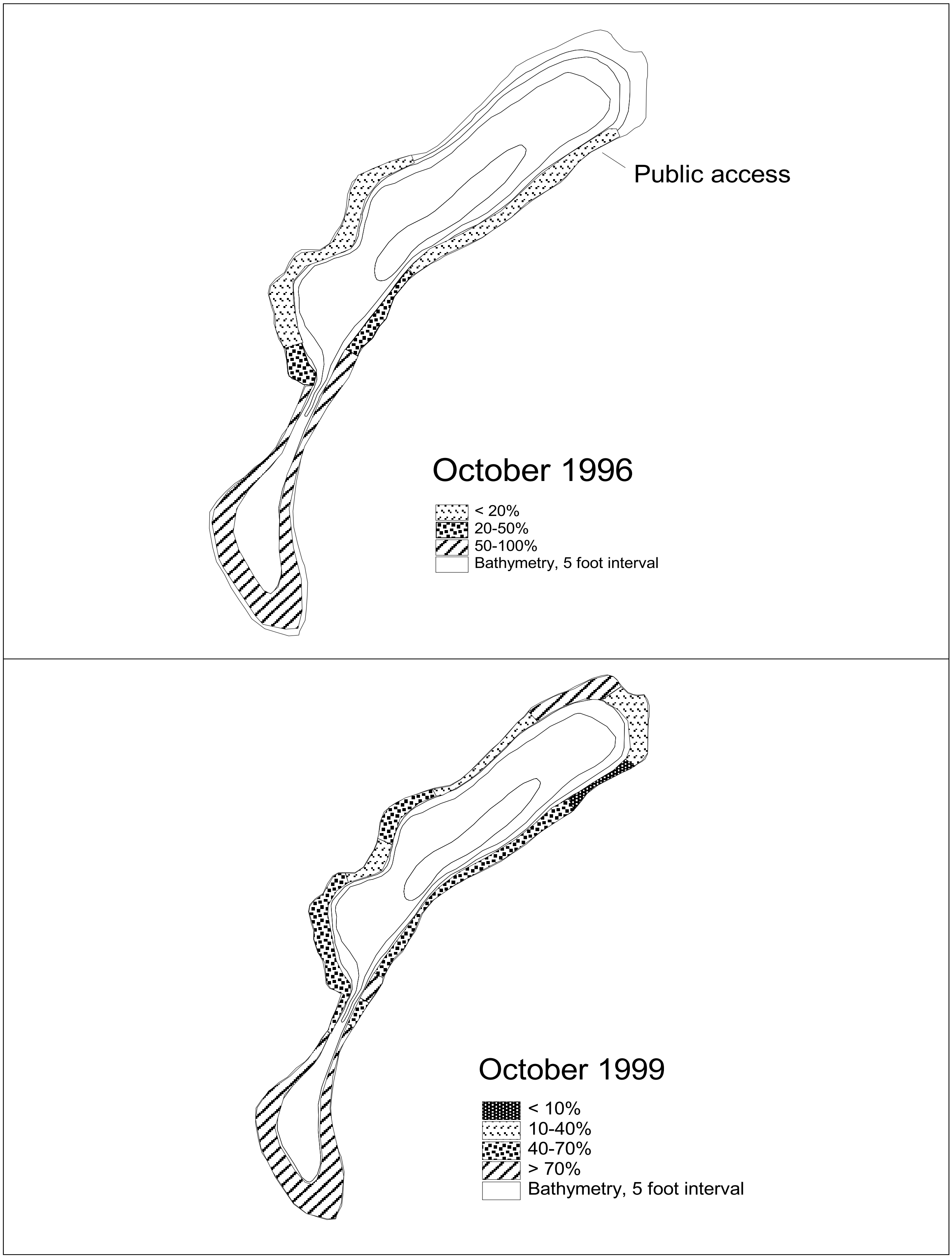


Figure 6: *Egeria densa* cover in Lake Leland, 1996 and 1999.

Loon Lake Study

The demonstration project examining the effects of the herbicide 2,4-D on native plants and the invasive *Myriophyllum spicatum* in Loon Lake, Stevens County was completed in 1999. The project results were written up for publication in the peer reviewed 'Journal of Aquatic Plant Management'. The following is the abstract from this paper. The full manuscript is included in Appendix D.

Abstract

A patchy distribution of Eurasian milfoil (*Myriophyllum spicatum* L.) in Loon Lake was treated with the herbicide 2,4-D during July 1998. Aquatic plant biomass and frequency data were collected before treatment, and six weeks and one year after treatment. Aqueous concentrations of 2,4-D increased to 1 to 2 mg/l within three days of treatment and were below detection limits by one week after treatment. Macrophyte data were analyzed to assess the herbicide's impacts on Eurasian milfoil as well as the rest of the aquatic plant community. Results showed a significant decrease in Eurasian milfoil biomass and frequency in treated areas 6 weeks after treatment, which continued through the one year post-treatment samples. No other plant species were significantly affected by the herbicide application.

Long Lake Project

Introduction

Long Lake in Kitsap County has had a long history of aquatic plant monitoring and management. Most of this work was done by Dr. Welch and his students at the University of Washington although early projects were funded by the Federal Clean Lakes Program (Entranco, 1980). One of the reasons this lake received so much attention was the presence of the invasive non-native plant *Egeria densa*. Because Long Lake is shallow (maximum depth 12 ft, mean depth 6 ft) much of the lake area has been filled with this aquatic plant. Several treatments of the lake have taken place between 1976 and the present in an effort to curtail the plant’s growth and improve water quality. Wertz (1996) summarized the effects of these treatments on the plant community between 1976 and 1994. In the course of this analysis a long term decline in the *Egeria* biomass was noted. Although in 1996 data were collected from the water surface using a rake to aid in creating an aquatic plant management plan (Gibbons, 1997), no biomass data had been collected since 1994 using methods comparable to the earlier study period. We collected biomass data in 1999 following methods similar to those used by Welch and his students to see if the biomass decline was still in evidence.

Study Site

Long Lake is located south of Bremerton on the Kitsap Peninsula. The surface area is 340 acres, with a maximum depth of 12 feet and mean depth of 6 feet (Bortleson et al., 1976). Aquatic plants grow to about 10 feet deep. The lake is considered naturally eutrophic, and experiences turbid water conditions due to planktonic algae during some years. The shoreline is mostly developed with single family homes, although there is an extensive wetland at the south end where the lake receives water from a tributary. The outflow is from the lake's north end. Long Lake is a popular recreational area with a water ski course at the south end and a productive fishery.

Methods

Previous sampling efforts had divided the lake into four sections for data collection and analysis (Figure 7). These sections were developed to better characterize the different habitats found in the four regions of the lake. The northern section generally has the steepest bathymetry, with areas of rocky substrate and represents 14% of the lake area. The middle section is the largest (51% of lake area) and deepest portion, with open water in the middle. The bathymetry of the middle section is gentle with fine sediment. The south section is shallow throughout, has fine sediment, and represents 17% of the lake area. The lilies section, at 18% of lake area, is the shallowest, and historically has contained the greatest aquatic plant biomass, even when the extensive water lily beds are excluded from the analysis (Wertz, 1996).

Welch and his students collected previous biomass data using SCUBA divers and a steel circle with a net attached. The area sampled was 0.255 m^2 (Wertz, 1996). In our study we also used SCUBA divers, but the sampling area was a 0.1 m^2 PVC pipe sampling frame. We collected samples on August 17, 1999 to correspond to the time other biomass studies had been conducted. All plant material was collected from inside the frame and placed into a mesh bag. Each sample was transferred to labeled plastic bags on the support boat. The depth of each sample was also noted. We collected samples from 20 sites located in a stratified random manner in the four different lake sections (Figure 7). At each site two samples were collected from randomly located points within the sample area, for a total of 40 biomass samples.

The samples were processed in the lab following collection. All samples were separated by species and placed into preweighed, dried, and numbered paper bags. The samples were dried at 60° C until a constant weight was reached (usually 24 hours). The bags were then reweighed and a dry weight for each species in each sample was calculated. Mean biomass was then calculated using SYSTAT® for each lake section. A weighted mean was used for the whole lake biomass values based on the percent area represented by each lake section. Our results were then compared to results from previous years.

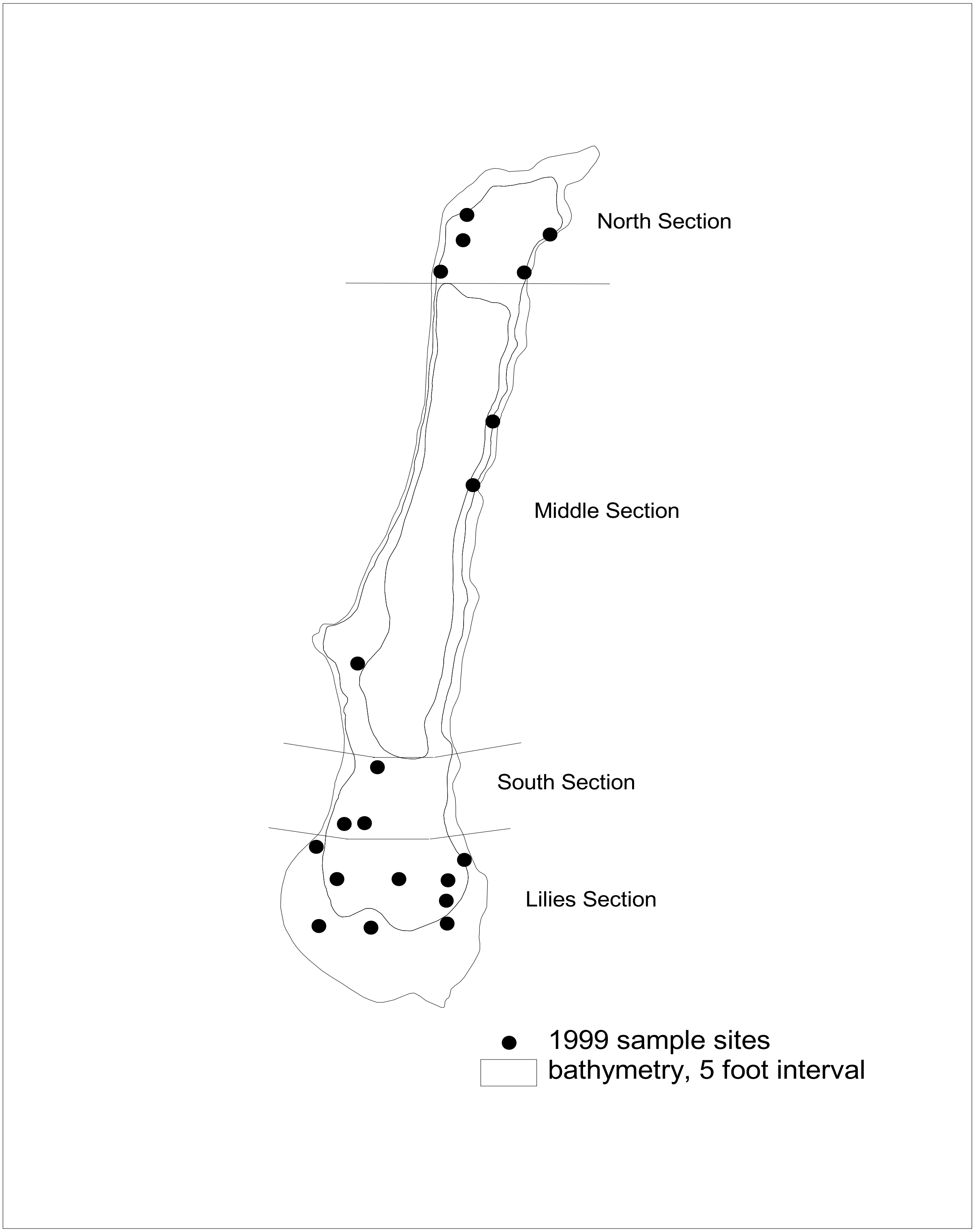


Figure 7. Sampling sections and sample sites on Long Lake, Kitsap County.

Results and Discussion

Mean biomass for the different species are presented in Table 3 for the whole lake and for each of the 4 lake sections. The species with by far the greatest total biomass was *Egeria densa.* The north and south sections supported the greatest total biomass, largely driven by the high biomass of *Egeria densa* in those areas. The lilies section had the greatest number of species represented in the samples (10), and the least proportion of *Egeria*.

Table 3. Mean biomass for individual species by lake area and the area-weighted mean whole lake biomass. August 1999.

Species	common name	Mean Biomass (g/m2)				
		Whole Lake	North N=10	Middle N=6	South N=6	Lilies N=18
Ceratophyllum demersum	coontail	8.35	10.18	5.37	3.65	19.81
Egeria densa	Brazilian elodea	113.89	153.33	93.35	176.23	82.54
Elodea canadensis	American waterweed	0.86	0.16	0.53	0.12	3.06
Fontinalis antipyretica	water moss	0.00	0.01	0	0	0
Najas flexilis	common naiad	0.05	0	0	0	0.27
Nitella sp.	stonewort	1.63	2.95	0.22	0.07	6.09
Potamogeton crispus	curly leaf pondweed	0.16	0	0	0	0.88
Potamogeton pusillus	slender pondweed	2.99	3.05	0.10	0.02	13.96
Potamogeton zosteriformis	eel-grass pondweed	1.55	5.46	0.78	1.85	0.39
Utricularia vulgaris	common bladderwort	2.75	0	0	0	15.27
Zannichellia palustris	horned pondweed	0.03	0	0	0	0.16
Total of all species		132.26	175.14	100.35	181.93	142.41

Using data from Jacoby et al. (1982), Kvam (1992), and Wertz (1996) Figure 8 was created to compare the mean whole lake biomass of total species over the years of data collection, including the 1999 data. Mean summer secchi depth is also included to compare water clarity with plant biomass. During all years sampled except 1986 *Egeria* has been the dominant plant. The whole lake *Egeria* biomass was reported to average 129 g/m2 between 1976 and 1984, with a high of more than 200 g/m2 in 1976. In 1985 and 1986 it crashed to a low of less than 20 g/m2. From 1987 to 1992 it recovered to an average of 70 g/m2. In 1993 and 1994 it was again down to 54 g/m2 and 29 g/m2 respectively (Wertz 1996). In 1999 the *Egeria* biomass was 113.9 g/m2, again at levels seen during the 1980's.

Several lake management strategies have been used on Long Lake since 1979 and studied by Welch and several graduate students (Hufschmidt, 1978; Jacoby et al., 1982; DeGasperi, 1988; Kvam, 1992; Jaiswal, 1993; Welch, 1996; Wertz, 1996). In 1979 a lake level drawdown was undertaken in hopes that this would control the aquatic plant population through desiccation and sediment compaction. In 1980 the lake was treated with alum to reduce water column phosphorus levels. In 1988 through 1990 macrophyte harvesting was tried as a method of reducing nutrient levels in the water, as well as to reduce the macrophyte biomass. In 1991 the lake was again treated with alum. Through analyzing the years of data Wertz (1996) determined that the alum treatments led to increases in the macrophyte biomass, likely due to increased water clarity usually brought on by decreased water column nutrients. The years of harvesting did not decrease the macrophyte biomass because the *Egeria* could grow more quickly than the harvester could cut it (Kvam, 1992).

By 1994 however, there seemed to be a trend toward reduced levels of macrophytes in the lake and increased turbidity in the water (Jacoby et al., 2000). But in 1999 the aquatic plant levels again were up to levels seen in the 1980's. Unfortunately we do not have nutrient data, or water clarity data for 1999. But if the trends reported in Long Lake are continuing, then one would expect higher water clarity in the lake with the increased plant biomass (Jacoby et al., 2000). Data collected in 1998 from the Lake Water Quality Assessment Program showed a mean summer secchi depth of 1.9 m and a mean summer total phosphorus of 29.3 ug/l (O'Neal et al., 2000). These values are similar to what was reported during years of high macrophyte biomass (Jacoby et al., 2000). During 1998 plant growth was not quantified by biomass, but was noted as being dense in the 10 sites sampled. Thus, it appears that over the last few years the lake has again shifted toward a macrophyte dominated system, with increased water clarity and decreased water column nutrients.

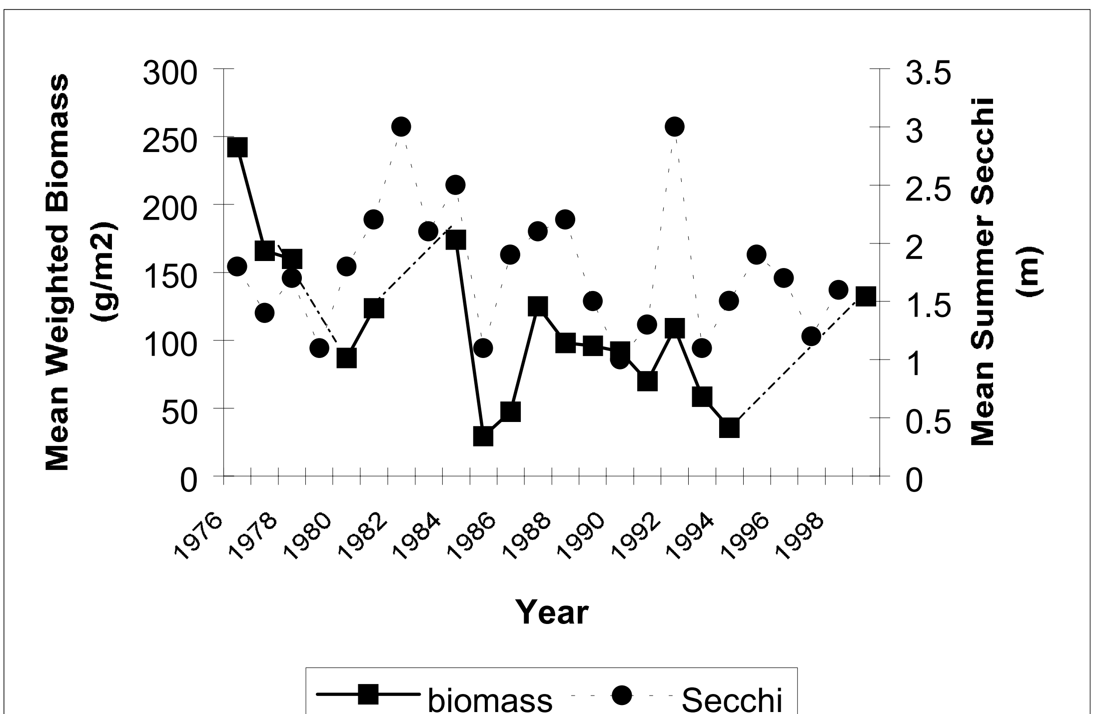


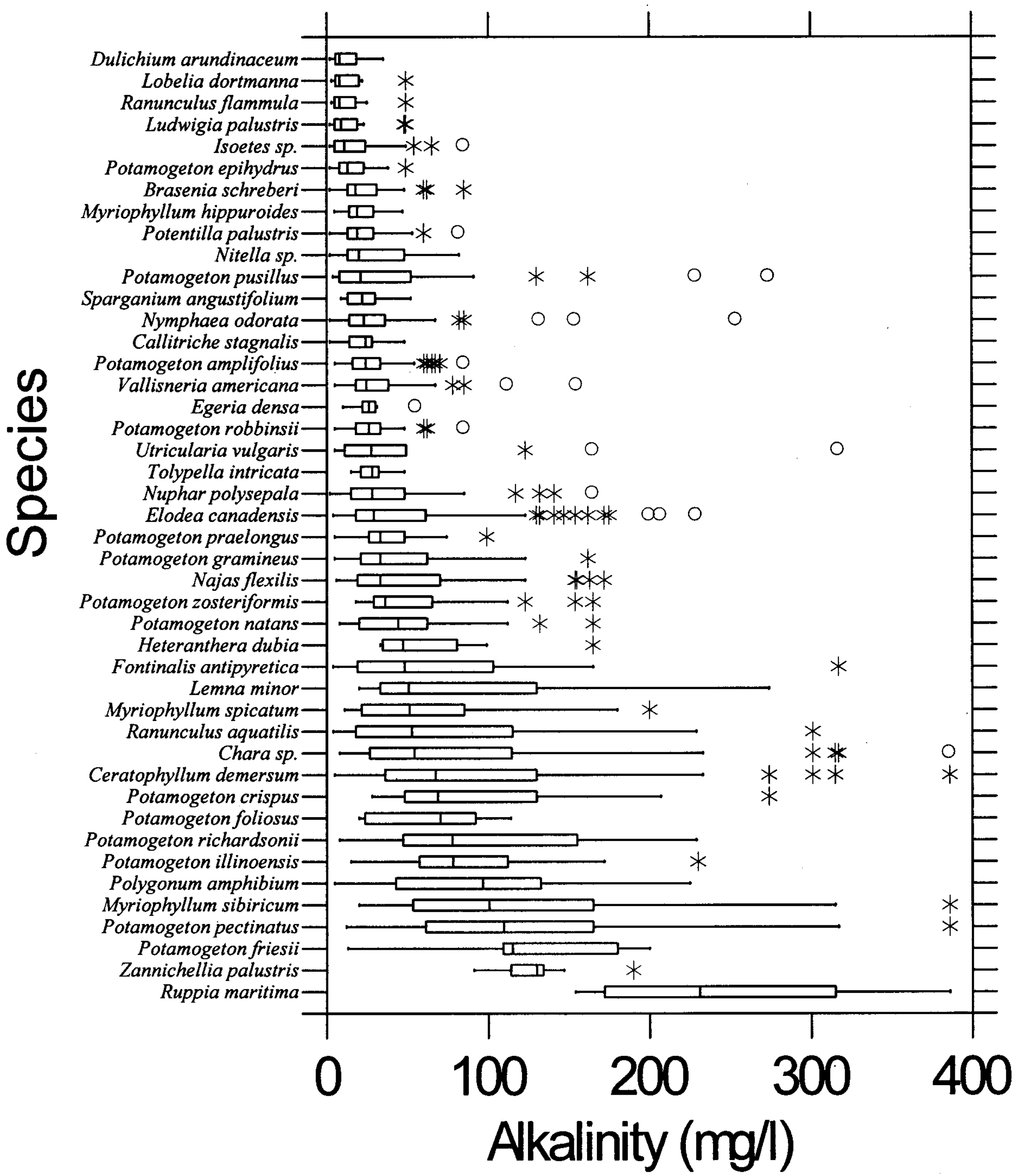
Figure 8. Long Lake whole lake mean biomass from selected years.

Alkalinity Results

There is a wide range of alkalinity values reported for Washington lakes, from a low of 2 mg/l to a high of greater than 1,000 mg/l $CaCO_3$. The general trend is of lower values in the Western and Northeast portions of the state, and higher values in the Columbia Basin. Appendix E lists the alkalinity results for 1995 through 1999. Samples were analyzed using a Hach® field test kit; confidence in these values should be limited to ±10 mg/l (Hach® Company, 1994). About 170 different lakes have been tested for alkalinity, with a median value of 33 mg/l $CaCO_3$ and a mean of 68 mg/l $CaCO_3$.

Figure 9 presents the alkalinity ranges for lakes where various submersed and floating leaved plant species were observed. To be included in the figure, a species must have been observed in at least seven different lakes. Also, the plot only includes alkalinity levels of less than 400 mg/l; this omitted eight occurrences from lakes with higher alkalinity. The majority of species are found in lakes with low to moderate alkalinity. A few species such as *Dulichium arundinaceum, Lobelia dortmanna, Ranunculus flammula, Ludwigia palustris,* and *Potamogeton epihydrus* appear to prefer lakes with quite low alkalinity. Several others have a broad range of tolerance such as *Ranunculus aquatilis, Ceratophyllum demersum, Myriophyllum sibiricum*, and *Potamogeton pectinatus*. On the other end of the scale *Zannichellia palustris* and *Ruppia maritima* were found in lakes with high levels of alkalinity.

The Washington data were compared to results from similar studies in Japan, New England, and Florida in the 1998 Annual Report (Parsons, 1999). These data will also be analyzed more rigorously in the future for a paper on this topic alone. Therefore, additional analysis and discussion will not occur in this report.



Legend:

bar within the box - median
hinges (box edges) - within which 25% to 75% of the values lie
whiskers - include values within 1.5 Hspreads of the hinges (Hspread is the absolute value of the difference between the values of the two hinges).
asterisk - values within 3 Hspreads of the hinges
open circle - values outside 3 Hspreads of the hinges

Figure 9. Box plot of alkalinity ranges for selected macrophytes.

Herbarium

Methods Used in Aquatic Plant Identification

All plants were identified to the lowest taxonomic group possible, usually to species unless critical features of the plant were missing (such as flowers or fruits). To assure proper identification, a number of books and other sources have been consulted as cross references (Appendix F). In addition, several people from within and outside the agency are consulted in cases where identification is difficult. If this is not conclusive, the plant is sent to national taxonomic experts for an opinion. Kartesz (1994), The Jepson Manual (Hickman, 1993), and personal consultation with authors of the Flora of North America (Flora of North America Editorial Committee, 1993) are used to ensure the nomenclature is current. In the case of questionable *Myriophyllum* species, samples were sent to Oluna Ceska or the USDA Aquatic Weed Lab in Davis, California for identification by analysis of the plant's flavonoid chemistry (Ceska, 1977).

Methods Used in Collection and Preservation

The methods used to preserve collected aquatic plants were those of Haynes (1984). First, all available plant parts (roots, stem, and flowering parts) were collected and sealed in a wet plastic bag. Within three days, but usually sooner, the plants were washed, identified, and arranged on a sheet of 100% rag herbarium paper. If the plant was too limp to maintain its shape in air, it was arranged on the paper in a tray of water. The herbarium sheets with plants and a written site description were then sandwiched between newspaper, blotter paper and cardboard in a plant press. When the specimen dried, it was fixed to the paper with herbarium glue or binding tape (if it was not already sufficiently adhered from the wet pressing process). A label with identification and collection information was attached. These finished reference specimens are stored in a sealed herbarium cabinet located in the Ecology headquarters building benthic laboratory.

Currently, the herbarium collection contains 117 unique taxa from 40 families (Appendix G). There are a total of 356 specimens, and in most cases each species is represented by more than one specimen. Each time a noxious weed is found, a collection is made to be kept as a record. Additional taxa will be added to the herbarium as they are collected in future years. Also, specimens from aquatic plant mapping projects funded under the Aquatic Weed Management grant program are housed in this herbarium. The collection is available to both Ecology staff and the public as a reference and permanent record.

Aquatic Weed Management Fund Related Activities

Money was available from the Aquatic Weed Management Fund (AWMF) to fund a grant cycle in autumn 1999. This was after a two year hiatus due to insufficient funds. This year we had approximately $300,000 to fund projects qualifying for assistance. Table 4 lists all the projects that applied for funding. Since the amount of funding available was not sufficient to cover all projects applying for money, the projects were ranked in order of priority by a team of Ecology employees familiar with lake issues. The highest ranking eight projects were either fully or partly funded.

In addition to the regular funding cycle, two applications for early infestation funds were received and funded in 1999. Each was a mapping and control project to combat early infestations of *Myriophyllum spicatum* in Black Lake, Stevens County and Mason Lake, Mason County. For additional information on this grant program and the use of the monies contact Kathy Hamel, the AWMF administrator at the Department of Ecology, Water Quality Program.

Table 4. List of applicants for AWMF grant funds in 1999 and the amount awarded.

Applicant Name	**Project Title**	**Requested Amount**	**Amount Funded**
Snohomish County	Seven Lakes Milfoil Eradication/Implementation	$ 70,875	$70,875
City of Kent	Lake Fenwick Weed Control Plan	$ 12,000	$12,000
City of Kent	Lake Meridian Weed Control Plan	$ 15,000	$15,000
Skagit County	Lake McMurray Exotic Weed Eradication	$ 75,000	$75,000
Stevens Conservation District	Managing Milfoil on Long Lake	$ 30,000	$30,000
Clear Lake Water District	Clear Lake Milfoil Management (Pierce County)	$ 33,750	$33,750
University of Washington	Weevil Nutrition	$ 75,000	$35,000
King County	Milfoil Eradication Pilot Project	$ 75,000	$35,000
Skagit County	Erie-Campbell Plant Management Plan	$ 30,000	$0
King County Weed Board	King County Purple Loosestrife	$ 75,000	$0
Pacific Conservation District	Loomis Lake Milfoil Control	$ 63,900	$0
Thurston County	Aquatic Weed Survey, Response and Mapping	$ 26,709	$0
Benton Weed Board	Tri-County Purple Loosestrife Survey/Control	$ 14,000	$0
Yakima Weed Board	Yakima River Purple Loosestrife Taskforce	$ 48,750	$0
		$644,984	**$306,625**

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Appendix A

Site Visit Table 1999

County	Waterbody Name	WRIA*	Date	Survey Extent	Plants of Concern
Adams	Sprague Lake	34	9/1/1999	selected areas	none
Chelan	Fish Lake	45	8/12/1999	west end	*Lysimachia vulgaris*
	Wapato Lake	47	8/10/1999	whole lake	*Myriophyllum spicatum*
	Wenatchee Lake	45	8/9/1999	east and west ends	none
Clark	Battleground Lake	28	6/17/1999	whole lake	*Egeria densa*
	Lacamas Lake	28	6/17/1999	whole lake	*Egeria densa*
Cowlitz	Kress Lake	27	9/30/1999	whole shore	*Myriophyllum spicatum*
	Merrill Lake	27	6/23/1999	several sites	none
	Sacajawea Lake	25	6/23/1999	whole lake	none
	Silver Lake	26	9/30/1999	launch area	none
Ferry	Curlew Lake	60	7/28/1999	10 sites, launches	none
Grant	Burke Lake	41	9/29/1999	whole lake	*Lythrum salicaria*
					Myriophyllum spicatum
	Evergreen Lake	41	9/28/1999	whole lake	*Lythrum salicaria*
					Myriophyllum spicatum
	Quincy Lake	41	9/29/1999	whole lake	*Lythrum salicaria*
Grays Harbor	Duck Lake	22	9/21/1999	10 sites	*Egeria densa*
					Myriophyllum spicatum
Island	Goss Lake	6	8/4/1999	whole lake	none
Jefferson	Leland Lake	17	10/7/1999	whole lake	*Egeria densa*
King	Alice Lake	7	8/12/1999	whole lake	*Lysimachia vulgaris*
					Lythrum salicaria
	Desire Lake	8	9/7/1999	whole lake	*Lythrum salicaria*
			7/8/1999	whole lake	*Myriophyllum spicatum*
	Otter (Spring) Lake	8	7/8/1999	whole lake	*Myriophyllum spicatum*
					Typha angustifolia
	Pipe Lake	9	6/10/1999	selected areas	*Hydrilla verticillata*
	Sawyer Lake	9	7/21/1999	whole lake	*Myriophyllum spicatum*
					Typha angustifolia
	Shady Lake	9	7/8/1999	whole lake	*Myriophyllum spicatum*
Kitsap	Long Lake	15	8/17/1999	selected areas	*Egeria densa*
					Lythrum salicaria
					Myriophyllum spicatum
	Square Lake	15	6/2/1999	1 site, shore	*Utricularia inflata*
Kitsap/Mason	Tiger Lake	15	6/14/1999	whole lake	none
Kittitas	Wild Duck Lake	39	7/12/1999	whole lake	none
Klickitat	Horsethief Lake	30	6/17/1999	1 site, shore	*Amorpha fruticosa*
					Myriophyllum spicatum
	Spearfish Lake	30	6/17/1999	whole shore	*Epilobium hirsutum*
Mason	Mason Lake	14	9/22/1999	whole shore	*Myriophyllum spicatum*
	Phillips Lake	14	6/8/1999	whole lake	none
	Spencer Lake	14	6/15/1999	whole lake	*Utricularia inflata*
	Wooten Lake	15	7/22/1999	whole lake	none

County	Waterbody Name	WRIA*	Date	Survey Extent	Plants of Concern
Okanogan	Ell Lake	52	7/15/1999	whole lake	none
	Aeneas Lake	49	7/12/1999	south end	none
	Blue Lake (37N-25E-22)	49	7/14/1999	whole lake	none
	Chopaka Lake	49	7/13/1999	selected areas	none
	Davis Lake	48	8/10/1999	1 site, shore	none
	Fish Lake	49	7/14/1999	whole lake	none
	Long Lake	52	7/15/1999	whole lake	none
	Palmer Lake	49	7/13/1999	whole lake	*Myriophyllum spicatum*
	Patterson Lake	48	8/10/1999	whole lake	none
	Pearrygin Lake	48	8/11/1999	whole lake	*Lythrum salicaria*
	Round Lake	52	7/15/1999	whole lake	none
	Spectacle Lake	49	7/14/1999	selected areas	none
	Big Twin Lake	48	8/11/1999	whole lake	none
	Little Twin Lake	48	8/11/1999	whole lake	none
	Whitestone Lake	49	7/13/1999	1 site, shore	*Myriophyllum spicatum*
Pacific	Black Lake	24	6/22/1999	1 site, shore	*Egeria densa*
					Myriophyllum spicatum
	Loomis Lake	24	6/22/1999	whole lake	*Egeria densa*
					Myriophyllum spicatum
Pend Oreille	Browns Lake	62	8/25/1999	whole lake	none
	Kent Meadows Lake	62	8/25/1999	2 sites, shore	none
	Leo Lake	59	7/28/1999	whole lake	none
	Marshall Lake	62	8/24/1999	whole lake	*Myriophyllum spicatum*
	Parker Lake	62	8/24/1999	1 site, shore	none
	Skookum Lake, North	62	8/24/1999	whole lake	none
	Trask Pond	57	8/25/1999	shore	none
Pierce	Clear Lake	11	7/6/1999	whole lake	*Myriophyllum spicatum*
					Typha angustifolia
	Harts Lake	11	6/24/1999	whole lake	*Myriophyllum spicatum*
	Rapjohn Lake	11	8/2/1999	whole lake	none
	Tanwax Lake	11	7/6/1999	whole lake	*Typha angustifolia*
	Whitman Lake	11	8/5/1999	whole lake	none
Skagit	Beaver Lake	3	9/15/1999	whole lake	*Myriophyllum spicatum*
	Big Lake	3	9/15/1999	whole lake	*Egeria densa*
	Campbell Lake	3	8/4/1999	whole lake	*Myriophyllum spicatum*
	Clear Lake (34N-05E-07)	3	9/15/1999	whole lake	*Myriophyllum spicatum*
	Erie Lake	3	9/16/1999	whole lake	none
	McMurray Lake	3	8/3/1999	whole lake	*Myriophyllum spicatum*
	Sixteen Lake	3	8/3/1999	whole lake	*Myriophyllum spicatum*
					Typha angustifolia
Skamania	Drano Lake	29	6/17/1999	1 site, shore	*Myriophyllum spicatum*
Snohomish	Howard Lake	5	7/20/1999	whole lake	none
	Ki Lake	5	7/19/1999	whole lake	none

County	Waterbody Name	WRIA*	Date	Survey Extent	Plants of Concern
Snohomish con't	Martha Lk. (31N-04E-18)	5	7/20/1999	whole lake	none
	Riley Lake	5	7/19/1999	whole lake	*Lythrum salicaria*
Spokane	Long Lake (Reservoir)	54	8/31/1999	selected areas	*Lythrum salicaria*
					Myriophyllum spicatum
	Newman Lake	57	8/31/1999	south end	none
Stevens	Deer Lake	59	7/27/1999	whole lake	none
	Gillette Lake	59	7/27/1999	whole lake	none
	Loon Lake	59	6/28/1999	whole lake	*Myriophyllum spicatum*
	Starvation Lake	59	7/26/1999	whole lake	none
Thurston	Black River near Gate	23	10/20/1999	5 mile reach	*Polygonum hydropiper*
	Munn Lake	13	5/25/1999	1 site, shore	*Utricularia inflata*
			6/21/1999	whole lake	*Utricularia inflata*
Wahkiakum	Brooks Slough	25	6/22/1999	1 site, shore	*Myriophyllum aquaticum*
Whatcom	Cain Lake	3	9/13/1999	whole lake	none
	Samish Lake (East Arm)	3	9/14/1999	whole lake	none
	Terrell Lake	1	9/14/1999	whole lake	*Lythrum salicaria*

* WRIA – Water Resource Inventory Area number

Appendix B

Site Visit Summary Table 1994-1999

County	Waterbody Name	WRIA	Date	Survey Extent	Noxious Aquatic Weeds
Adams	Herman Lake	41	7/28/1998	whole lake	*Lythrum salicaria*
	Sprague Lake	34	9/16/1997	south half	none
			9/1/1999	selected areas	none
Asotin	Snake River at Chief Timothy S.P.	35	8/4/1997	3 sites	none
Chelan	Antilon Lake	47	8/31/1994	shore, N and S ends	none
	Chelan Lake	47	8/31/1994	from City Park shore	*Myriophyllum spicatum*
	Dry Lake	47	8/31/1994	from shore, east end	none
	Fish Lake	45	6/16/1997	west shore	none
			8/12/1999	west end	*Lysimachia vulgaris*
	Roses Lake	47	8/31/1994	south shore	none
			6/17/1997	whole littoral	none
	Wapato Lake	47	8/31/1994	entire shoreline	*Myriophyllum spicatum*
			6/27/1995	whole littoral	
			8/8/1995	whole littoral	
			9/11/1995	whole littoral	
			6/24/1996	whole littoral	
			7/15/1996	milfoil sites	
			9/16/1996	milfoil sites	
			7/16/1997	whole littoral	
			8/10/1999	whole lake	
	Wenatchee Lake	45	9/1/1994	west end, east launch	none
			8/9/1999	east and west ends	none
Clallam	Beaver Lake	20	7/9/1996	whole littoral	none
	Crescent Lake	19	7/10/1996	4 sites	none
	Ozette Lake	20	7/9/1996	3 sites	none
	Pleasant Lake	20	7/11/1996	whole littoral	none
	Sutherland Lake	18	7/11/1996	whole littoral	none
	Unnamed (30N-04W-17)	18	7/13/1995	ID from plant sample	*Myriophyllum spicatum*
Clark	Battleground Lake	28	4/13/1994	from dock only	*Egeria densa*
			6/17/1999	whole lake	*Egeria densa*
	Caterpillar Slough	28	8/15/1995	spot check from boat	*Myriophyllum spicatum*
	Columbia R. at Ridgefield	28	8/15/1995	spot check from boat	*Myriophyllum spicatum* *Lythrum salicaria*
	Lacamas Lake	28	9/3/1997	whole littoral	*Egeria densa*
			6/17/1999	whole lake	*Egeria densa*
	Vancouver Lake	28	8/15/1995	spot check from shore	none
Columbia	Snake River at Little Goose Dam	35	8/5/1997	spot check, boat	*Myriophyllum spicatum*
	Snake River near Lyons Ferry	35	8/5/1997	spot check, boat	*Myriophyllum spicatum*
Cowlitz	Kress Lake	27	9/30/1999	whole shore	*Myriophyllum spicatum*
	Merrill Lake	27	6/23/1999	several sites	none
	Sacajawea Lake	25	8/4/1998	3 sites, shore	none
			6/23/1999	whole lake	none

County	Waterbody Name	WRIA	Date	Survey Extent	Noxious Aquatic Weeds
Cowlitz con't	Silver Lake	26	9/7/1994	several locations thu' lake	*Myriophyllum spicatum*
			9/19/1995	several sites, from boat	none
			8/4/1998	south half	none
			9/30/1999	launch area	none
	Solo Slough	25	4/13/1994	spot check from shore	*Myriophyllum aquaticum*
			7/14/1994	spot check from shore	*Cabomba caroliniana*
			8/16/1995	from shore	*Egeria densa*
			8/8/1996	from shore	*Ludwigia hexapetala*
			5/28/1997	spot check from shore	*Myriophyllum spicatum*
			8/4/1998	1 site, shore	
	Willow Grove Slough	25	4/13/1994	spot check from shore	*Cabomba caroliniana*
			7/14/1994	spot check from shore	*Myriophyllum spicatum*
			8/16/1995	several sites, from boat	*Egeria densa*
			8/4/1998	1 site, shore	*Lythrum salicaria* *Myriophyllum spicatum*
Douglas	Jameson Lake	44	6/26/1996	1 site from shore	none
Ferry	Curlew Lake	60	8/22/1995	5 sites, whole littoral	none
			8/2/1996	4 sites (luanches)	none
			8/13/1997	5 sites (launches)	none
			5/19/1998	2 sites, boat	none
			7/28/1999	10 sites, launches	none
	Ellen Lake	58	8/23/1995	whole littoral	none
	Ferry Lake	52	8/13/1997	whole littoral	none
	Swan Lake	52	8/13/1997	whole littoral	none
	Trout Lake	58	8/22/1995	whole littoral	none
	Twin Lakes	58	8/23/1995	4 sites, both lakes	none
			8/14/1997	3 sites, both lakes	none
Franklin	Scooteney Reservoir	36	7/26/1995	spot check from shore	*Myriophyllum spicatum*
	Snake River - Lower Monumental Dam	33	8/20/1996	spot check, boat	*Myriophyllum spicatum*
	Snake R, Ice Harbor Dam	33	8/19/1996	spot check, boat	*Myriophyllum spicatum*
	Snake River at Levey Park	33	8/19/1996	spot check, boat	none
	Snake R at Windust Park	33	8/20/1996	spot check, boat	none
	Snake R at Lyons Ferry	34	8/5/1997	spot check, boat	*Myriophyllum spicatum*
Garfield	Snake River at Lower Granite Dam	35	8/4/1997	spot check, boat	none
Grant	Alkali Lake	42	7/16/1996	whole littoral	none
	Babcock Ridge Lake	41	7/24/1995	2 sites, whole littoral	*Myriophyllum spicatum* *Lythrum salicaria*
	Banks Lake	42	6/25/1996	spot check, shore	none
	Billy Clapp Lake	42	8/30/1995	4 sites, whole littoral	*Myriophyllum spicatum*
	Blue Lake	42	7/16/1996	whole littoral	none
	Burke Lake	41	6/28/1994	entire shoreline	*Lythrum salicaria*

County	Waterbody Name	WRIA	Date	Survey Extent	Noxious Aquatic Weeds
Grant con't			9/19/1996	whole littoral	*Myriophyllum spicatum*
			9/24/1997	whole littoral	
			9/9/1998	whole lake	
	Burke Lake con't		9/29/1999	whole lake	
	Canal Lake	41	8/30/1995	4 sites, whole littoral	*Lythrum salicaria*
	Corral Lake	41	7/25/1995	whole littoral	*Lythrum salicaria*
	Crater Lake	41	7/24/1995	spot check from shore	none
	Deep Lake	42	6/25/1996	whole littoral	none
	Dry Falls Lake	42	6/25/1996	spot check, shore	none
	Evergreen Lake	41	6/27/1994	entire shoreline	*Lythrum salicaria*
			9/12/1995	8 transects, whole littoral	*Myriophyllum spicatum*
			9/18/1996	whole lake	
			9/23/1997	whole lake	
			9/9/1998	whole lake	
			9/28/1999	whole lake	
	Frenchman Hills	41	7/29/1998	1 site, shore	*Lythrum salicaria*
	Lenore Lake	42	7/17/1996	whole littoral	none
	Long Lake (17N-29E-32)	41	8/31/1995	2 sites, whole littoral	none
	Moses Lake	41	7/15/1998	10 sites, boat	*Lythrum salicaria*
	Park Lake	42	6/26/1996	whole littoral	none
			9/10/1998	whole lake	none
	Potholes Reservoir	41	8/7/1994	6 sites on N & W side	*Myriophyllum spicatum*
			7/16/1998	10 sites, boat	none
	Quincy Lake	41	6/28/1994	entire shoreline	*Lythrum salicaria*
			9/13/1995	3 transects, whole littoral	
			9/17/1996	3 transects, whole littoral	
			9/22/1997	whole littoral	
			9/8/1998	whole lake	
			9/29/1999	whole lake	
	Rocky Ford Cr	41	7/28/1997	spot check, shore	*Lythrum salicaria*
	Soda Lake	41	7/25/1995	whole littoral	none
	Stan Coffin Lake	41	6/29/1994	entire shoreline	*Myriophyllum spicatum*
					Lythrum salicaria
	Warden Lake	41	7/25/1995	2 sites, whole littoral	*Lythrum salicaria*
			7/28/1998	whole lake	
	Winchester Wasteway	41	7/26/1995	spot check from shore	*Lythrum salicaria*
			7/28/1998	1 site, shore	
	Windmill Lake	41	8/30/1995	south end	none
Grays Harbor	Aberdeen Lake	22	7/22/1996	whole littoral	none
	Duck Lake	22	9/9/1995	2 sites, from shore	*Egeria densa*
			8/18/1998	main lake	*Lythrum salicaria*
			9/21/1999	10 sites	*Myriophyllum spicatum*
	Failor Lake	22	6/25/1997	whole littoral	none
	Quinault Lake	21	10/7/1996	75% of littoral	none
	Sylvia Lake	22	7/22/1996	whole littoral	none

County	Waterbody Name	WRIA	Date	Survey Extent	Noxious Aquatic Weeds
Island	Cranberry Lake	6	8/24/1994	4 sites around lake	none
			9/5/1996	spot check, shore	none
	Crockett Lake	6	9/4/1996	spot check, shore	none
	Deer Lake	6	9/4/1996	whole littoral	none
	Goss Lake	6	9/5/1996	whole littoral	none
			8/4/1999	whole lake	none
	Lone Lake	6	9/4/1996	whole littoral	*Lythrum salicaria*
Jefferson	Anderson Lake	17	7/8/1996	whole littoral	none
	Crocker Lake	17	5/24/1994	northwest half - littoral	none
			6/14/1995	whole littoral	
			6/11/1996	whole littoral	
			8/27/1997	whole littoral	
			9/3/1998	whole lake	
	Leland Lake	17	5/24/1994	entire shoreline	*Egeria densa*
			6/14/1995	whole littoral	
			10/3/1995	whole littoral	
			11/8/1995	Egeria site	
			6/11/1996	whole littoral	
			7/2/1996	whole littoral	
			10/2/1996	whole littoral	
			8/27/1997	spot check	
			9/3/1998	whole lake	
			10/7/1999	whole lake	
	Tarboo Lake	17	7/2/1996	whole littoral	none
King	Alice Lake	7	8/12/1999	whole lake	*Lysimachia vulgaris*
					Lythrum salicaria
	Desire Lake	8	9/7/1999	whole lake	*Lythrum salicaria*
			7/8/1999	whole lake	*Myriophyllum spicatum*
	Lucerne Lake	9	6/9/1995	outlet	*Hydrilla verticillata*
			7/15/1995	spot check	*Myriophyllum spicatum*
	Meridian Lake	9	7/10/1997	whole littoral	*Lythrum salicaria* *Myriophyllum spicatum*
	Morton Lake	9	8/19/1997	whole littoral	none
	Otter (Spring) Lake	8	7/8/1999	whole lake	*Myriophyllum spicatum*
					Typha angustifolia
	Pipe Lake	9	6/1/1995	several sites, divers	*Hydrilla verticillata*
			6/9/1995	near boatlaunch, outlet	*Myriophyllum spicatum*
			7/12/1995	from shore	
			7/15/1995	6 sites, biomass samples	
			8/1/1995	6 sites, biomass samples	
			6/18/1996	spot check, boat	
			7/21/1997	3 sites	
			6/9/1998	whole lake	
		8	11/17/199	3 sites, boat	

County	Waterbody Name	WRIA	Date	Survey Extent	Noxious Aquatic Weeds
King con't			6/10/1999	selected areas	
	Sawyer Lake	9	8/7/1997	whole littoral	*Myriophyllum spicatum*
			7/21/1999	whole lake	*Typha angustifolia*
	Steel Lake	9	5/11/1994	entire shoreline	*Myriophyllum spicatum*
	Shady Lake	9	7/8/1999	whole lake	*Myriophyllum spicatum*
	Washington Lake	8	8/24/1998	Juanita Bay	*Egeria densa* *Myriophyllum spicatum*
	Wilderness Lake	9	8/19/1997	whole littoral	*Lythrum salicaria* *Myriophyllum spicatum*
Kitsap	Buck Lake	15	7/22/1998	whole lake	*Lythrum salicaria*
	Horseshoe Lake	15	8/22/1996	whole littoral	none
	Island Lake	15	7/22/1998	whole lake	none
	Kitsap Lake	15	8/3/1995	2 sites, whole littoral	none
			8/28/1997	4 sites	none
			7/1/1998	south end	none
	Long Lake	15	9/12/1994	several locations	*Egeria densa*
			3/17/1995	6 transects, whole lake	*Myriophyllum spicatum*
			7/22/1997	2 sites	*Lythrum salicaria*
			8/28/1997	3 sites	
			8/17/1999	selected areas	
	Mission Lake	15	9/9/1996	whole littoral	none
			6/18/1998	whole lake	*Utricularia inflata*
	Panther Lake	15	8/2/1995	whole littoral	none
	Square Lake	15	7/22/1997	spot check, shore	none
			6/2/1999	1 site, shore	*Utricularia inflata*
	Wildcat Lake	15	10/4/1995	4 sites, whole littoral	none
			8/20/1998	whole lake	none
	William Symington Lake	15	9/16/1998	whole lake	none
	Wye Lake	15	7/1/1998	1 site, shore	*Utricularia inflata*
Kitsap/ Mason	Tiger Lake	15	9/9/1996	whole littoral	none
			6/14/1999	whole lake	none
Kittitas	Cle Elum Reservoir	39	7/29/1998	1 site, shore	none
	Easton Lake	39	8/30/1994	spot check from shore	none
			6/18/1997	spot check, shore	none
	Kiwanis Pond	39	8/30/1994	spot check from shore	none
	Lavender Lake	39	6/18/1997	whole littoral	*Myriophyllum spicatum*
			7/27/1998	whole lake	
	unnamed fishing pond	39	8/30/1994	most of shoreline	none
	Unnamed Ponds nr Easton	39	6/18/1997	spot check, shore	none
	unnamed ponds	39	8/30/1994	spot checks	*Lythrum salicaria* at one
	Wild Duck Lake	39	7/27/1998	2 sites, shore	none
			7/12/1999	whole lake	none
Klickitat	Columbia River at Bingen	29	8/14/1995	spot check from shore	*Myriophyllum spicatum*
	Columbia River at Maryhill	30	8/14/1995	spot check from boat	*Myriophyllum spicatum*

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Klickitat con't	Horsethief Lake	30	8/14/1995	spot check from shore	*Myriophyllum spicatum*
			6/17/1999	1 site, shore	*Amorpha fruticosa*
	Spearfish Lake	30	6/17/1999	whole shore	*Epilobium hirsutum*
Lewis	Carlisle Lake	23	8/20/1997	whole littoral	none
	Chehalis River	23	7/27/1995	shoreline, from boat	*Myriophyllum aquaticum*
			9/10/1996	1 site from shore	
	Chehalis River con't		7/23/1997	spot check, shore	*Egeria densa*
			8/20/1997	1 mile of river	
	Interstate Ave Slough	23	8/20/1997	spot check, shore	*Myriophyllum aquaticum*
	Mayfield Reservoir	26	10/5/1998	south half	*Myriophyllum spicatum*
	Plummer Lake	23	8/20/1997	whole littoral	*Egeria densa*
	Swofford Pond	26	9/15/1998	east end	*Myriophyllum spicatum*
Lincoln	Sprague Lake	34	8/6/1994	cove at NE end of lake	none
Mason	Benson Lake	14	7/23/1996	whole littoral	none
	Devereaux Lake	15	8/16/1994	spot check from shore	none
	Haven Lake	15	8/16/1994	entire shoreline	none
			6/8/1998	whole lake	none
	Isabella Lake	14	7/19/1994	entire shoreline	none
			8/2/1995	checked for rare plant	none
			8/18/1997	whole littoral	*Lythrum salicaria*
	Island Lake	14	7/23/1996	whole littoral	*Myriophyllum spicatum*
			6/24/1997	whole littoral	
			7/9/1998	whole littoral	
	Limerick Lake	14	8/15/1994	entire shoreline	*Egeria densa*
			7/13/1995	spot check, boat	*Utricularia inflata*
			7/22/1997	2 sites	
			7/8/1998	whole lake	
	Lost Lake	14	8/11/1994	entire shoreline	none
			6/10/1997	whole littoral	none
	Lystair (Star) Lake	22	6/12/1998	whole lake	none
	Maggie Lake	15	8/19/1998	whole lake	none
	Mason Lake	14	8/7/1996	whole littoral	none
			9/14/1998	whole lake	*Myriophyllum spicatum*
			9/22/1999	whole shore	
	Nahwatzel Lake	22	6/26/1997	whole littoral	none
	Phillips Lake	14	7/20/1998	whole lake	none
			6/8/1999	whole lake	none
	Spencer Lake	14	8/15/1994	most of shoreline	*Lythrum salicaria*
			7/13/1995	spot check, boat	*Lythrum salicaria*
			8/22/1996	south end, boat	none
			7/22/1997	2 sites	none
			6/15/1999	whole lake	*Utricularia inflata*
	Tee Lake	15	8/19/1998	whole lake	none
	Trails End (Prickett)	15	6/16/1998	whole lake	*Lythrum salicaria*
					Utricularia inflata

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Mason con't	Wooten Lake	15	8/16/1994	most of shoreline	none
			6/16/1998	whole lake	none
			7/22/1999	whole lake	none
Okanogan	Aeneas Lake	49	7/25/1994	entire shoreline	none
			7/12/1999	south end	none
	Alta Lake	48	6/29/1995	whole littoral	none
	Big Twin Lake	48	8/9/1995	most of littoral	none
	Big Twin Lake con't		8/11/1999	whole lake	none
	Blue Lake (37N-25E-22)	49	7/14/1999	whole lake	none
	Bonaparte Lake	49	8/27/1996	whole littoral	none
	Buffalo Lake	53	8/21/1995	3 sites, boat	none
	Chopaka Lake	49	7/13/1999	selected areas	none
	Conconully Lake	49	7/26/1994	7 sites thru' shoreline	*Myriophyllum spicatum*
	Conconully Reservoir	49	7/26/1994	north end	none
			9/18/1997	whole littoral	*Myriophyllum spicatum*
	Crawfish Lake	52	8/28/1996	whole littoral	none
	Davis Lake	48	8/9/1995	whole littoral	none
			8/10/1999	1 site, shore	none
	Duck (Bide-a-Wee) Lake	49	8/28/1996	spot check, shore	none
			9/18/1997	spot check	none
	Ell Lake	52	7/15/1999	whole lake	none
	Fish Lake	49	7/26/1994	entire shoreline	none
			7/14/1999	whole lake	none
	Green Lake	49	6/29/1995	2 sites, whole littoral	none
	Leader Lake	49	8/29/1996	whole littoral	none
	Little Twin Lake	48	8/9/1995	whole littoral	none
			8/11/1999	whole lake	none
	Long Lake	52	7/15/1999	whole lake	none
	Omak Lake	49	8/28/1996	north end, boat	none
	Palmer Lake	49	7/27/1994	aunches, from shore	none
			6/28/1995	whole littoral	none
			7/13/1999	whole lake	*Myriophyllum spicatum*
	Patterson Lake	48	8/10/1995	2 sites, whole littoral	none
			8/10/1999	whole lake	none
	Pearrygin Lake	48	8/10/1995	3 sites, whole littoral	*Lythrum salicaria*
			8/11/1999	whole lake	
	Round Lake	52	7/15/1999	whole lake	none
	Sidley Lake	49	8/27/1996	spot check, shore	none
	Spectacle Lake	49	7/27/1994	5 sites, various locations	none
			8/27/1996	whole littoral	none
			9/17/1997	3 sites	none
			7/14/1999	selected areas	none
	Wannacut Lake	49	7/28/1994	3 sites	none
	Whitestone Lake	49	7/27/1994	5 sites, other locations	*Myriophyllum spicatum*
			6/28/1995	6 sites, whole littoral	*Lythrum salicaria*

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Okanogan con't			8/26/1996	whole littoral	
			9/17/1997	whole littoral	
			7/13/1999	1 site, shore	*Myriophyllum spicatum*
Pacific	Black Lake	24	7/12/1994	spot check, shore	*Egeria densa*
			8/8/1996	most of shoreline	
			8/26/1997	whole littoral	
			6/22/1999	1 site, shore	*Myriophyllum spicatum*
	Island Lake	24	7/14/1994	entire shoreline	none
			8/26/1997	whole littoral	none
	Loomis Lake	24	7/13/1994	most of shoreline	none
			8/25/1997	whole littoral	*Myriophyllum spicatum*
			6/22/1999	whole lake	*Egeria densa*
	O'Neil Lake	24	7/12/1994	entire littoral	none
			8/25/1997	spot check, shore	none
	Surfside Lake	24	7/13/1994	5 sites from bridges	none
			8/25/1997	spot check, shore	none
Pend Oreille	Bead Lake	62	8/12/1997	coves, 5 sites	none
	Browns Lake	62	7/31/1996	spot check, shore	none
			8/25/1999	whole lake	none
	Davis Lake	62	8/2/1994	most of littoral	none
			7/30/1996	north end, boat launch	*Myriophyllum spicatum*
			8/12/1997	whole littoral	
	Diamond Lake	55	8/2/1994	boatlaunch, from shore	none
			7/31/1996	east end, boat launch	none
			8/11/1997	west half	none
	Fan Lake	55	8/3/1994	entire shoreline	*Lythrum salicaria*
			8/12/1997	whole littoral	
	Frater Lake	59	8/1/1996	spot check, shore	none
	Half Moon Lake	62	7/31/1996	north end	none
	Horseshoe Lake	55	7/13/1998	west half	none
	Kent Meadows Lake	62	8/25/1999	2 sites, shore	none
	Leo Lake	59	7/28/1999	whole lake	none
	Little Spokane River	55	8/2/1994	at Fertile Valley Rd crossing	*Myriophyllum spicatum*
			8/2/1994	at Haworth Rd crossing	none
	Marshall Lake	62	8/1/1994	3 sites, mostly at inlets	none
			8/24/1999	whole lake	*Myriophyllum spicatum*
	Mill Lake	62	8/1/1996	2 sites, shore	none
	Nile Lake	62	8/1/1996	spot check, shore	*Myriophyllum spicatum*
	Parker Lake	62	8/24/1999	1 site, shore	none
	Pend Oreille River	62	8/1/1996	spot check, shore	*Myriophyllum spicatum*
	Sacheen Lake	55	8/2/1994	3 sites, entire shore	*Myriophyllum spicatum*
					Lythrum salicaria

County	Waterbody Name	WRIA	Date	Survey Extent	Noxious Aquatic Weeds
Pend Oreille con't	Skookum Lake, North	62	7/31/1996	spot check, shore	none
			8/24/1999	whole lake	none
	Skookum Lake, South	62	7/31/1996	whole littoral	none
	Sullivan Lake	62	8/1/1996	north and south, boat	none
	Trask Pond	57	8/25/1999	shore	none
	Unnamed Wetland nr Usk	62	8/1/1996	shore	none
Pierce	American Lake	12	10/4/1994	4 sites	none
			10/6/1998	whole lake	none
	Bay Lake	15	9/28/1995	whole littoral	*Lythrum salicaria*
	Carney Lake	15	7/1/1998	1 site, shore	none
	Clear Lake	11	7/21/1994	entire shoreline	*Myriophyllum spicatum*
			6/12/1996	whole littoral	
			6/23/1997	whole littoral	*Typha angustifolia*
			7/6/1999	whole lake	
	Harts Lake	11	6/17/1996	spot check, shore	*Myriophyllum spicatum*
			7/3/1996	whole littoral	
			6/24/1999	whole lake	
	Ohop Lake	11	7/25/1996	whole littoral	*Egeria densa*
			9/25/1997	whole littoral	
	Rapjohn Lake	11	7/25/1996	whole littoral	none
			8/2/1999	whole lake	none
	Silver Lake	11	6/17/1996	spot check, shore	none
	Spanaway Lake	12	9/11/1996	whole littoral	*Lythrum salicaria*
	Steilacoom Lake	12	6/19/1996	spot check, boat	none
			8/26/1998	whole lake	none
			10/21/1998	1 site, boat	none
	Tanwax Lake	11	7/21/1994	entire shoreline	none
			9/12/1996	whole littoral	none
			7/6/1999	whole lake	*Typha angustifolia*
	Whitman Lake	11	8/5/1999	whole lake	none
San Juan	Cascade Lake	2	9/9/1997	whole littoral	none
	Hummel Lake	2	9/8/1997	whole littoral	none
	Mountain Lake	2	9/9/1997	whole littoral	none
	Sportsman Lake	2	9/10/1997	whole littoral	none
Skagit	Beaver Lake	3	8/25/1994	entire shoreline	none
			9/15/1999	whole lake	*Myriophyllum spicatum*
	Big Lake	3	8/23/1994	3 sites, extreme ends	*Egeria densa*
			8/23/1994	& launch	*Myriophyllum spicatum*
			9/15/1999	whole lake	
	Campbell Lake	3	6/7/1994	entire shoreline	none
			8/13/1996	whole littoral	*Myriophyllum spicatum*
			7/2/1997	whole littoral	
			8/4/1999	whole lake	
	Cavanaugh Lake	5	8/24/1998	whole lake	none

County	Waterbody Name	WRIA	Date	Survey Extent	Noxious Aquatic Weeds
Skagit con't	Clear Lake (34N-05E-07)	3	8/25/1994	boatramp only	*Myriophyllum spicatum*
			9/15/1999	whole lake	
	Cranberry Lake	3	8/25/1998	2 sites, shore	none
	Erie Lake	3	8/24/1994	Entire shoreline	none
			8/13/1996	spot check, shore	none
			7/2/1997	whole littoral	none
			9/16/1999	whole lake	none
	Everett Lake	4	8/15/1996	spot check, shore	none
	Heart Lake (35N-01E-36)	3	8/13/1996	whole littoral	none
			8/25/1998	whole lake	*Myriophyllum spicatum*
	Heart Lake con't	3	8/24/1994	most of shoreline	none
	McMurray Lake	3	6/6/1994	entire shoreline	*Myriophyllum spicatum*
			8/23/1994	entire shoreline	
			8/3/1999	whole lake	
	Pass Lake	3	7/2/1997	spot check, shore	none
	Sixteen Lake	3	6/6/1994	entire shoreline	*Myriophyllum spicatum*
			8/3/1999	whole lake	
Skamania	Coldwater Lake	26	8/27/1998	80% of shore	*Myriophyllum spicatum*
	Drano Lake	29	6/17/1999	1 site, shore	*Myriophyllum spicatum*
Snohomish	Blackmans Lake	7	8/5/1998	whole lake	*Lythrum salicaria*
	Goodwin Lake	7	6/20/1995	3 sites, littoral survey	*Myriophyllum spicatum*
	Howard Lake	5	7/20/1999	whole lake	none
	Ki Lake	5	7/19/1999	whole lake	none
	Martha Lake (31N-04E-18)	5	7/20/1999	whole lake	none
	Martha Lake (27N-04E-01)	8	8/5/1998	whole lake	none
	Nina Lake	7	6/20/1995	2 sites, from shore	*Myriophyllum aquaticum*
	Riley Lake	5	7/19/1999	whole lake	*Lythrum salicaria*
	Roesiger (north arm) Lake	7	8/6/1998	whole lake	*Myriophyllum spicatum* *Lythrum salicaria*
	Roesiger (south arm) Lake	7	8/25/1994	east side, littoral	none
			6/21/1995	spot check, boat	none
			8/29/1995	most of shoreline	none
			8/6/1998	whole lake	*Myriophyllum spicatum*
	Shoecraft Lake	7	8/15/1996	whole littoral	*Myriophyllum spicatum*
	Stevens Lake	7	9/10/1997	4 sites	none
Spokane	Amber Lake	34	8/5/1994	at boatramp, from shore	none
	Badger Lake	34	8/5/1994	2 sites at extreme ends	none
	Chapman Lake	34	8/24/1995	3 sites	none
	Clear Lake	43	8/4/1994	4 sites, most of shoreline	none
	Downs Lake	34	8/3/1994	from shore - one location	none
	Eloika Lake	55	8/3/1994	3 sites, missed some places	*Myriophyllum spicatum*
	Fishtrap Lake	43	8/4/1994	3 sites	none

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Spokane con’t	Liberty Lake	57	7/13/1998	whole lake	*Myriophyllum spicatum*
	Long Lake (reservoir)	54	8/6/1994	2 sites nr boatlaunch	*Lythrum salicaria*
			8/25/1995	1 site	*Nymphoides peltata*
			8/31/1999	selected areas	*Myriophyllum spicatum*
	Medical Lake	43	7/14/1998	whole lake	none
	Medical, West Lake	43	7/14/1998	whole lake	none
	Newman Lake	57	8/31/1999	south end	none
	Silver Lake	34	8/4/1994	only at boatramp	none
			8/24/1995	2 sites	none
	Williams Lake	34	8/5/1994	boatlaunch, south end	none
			9/16/1997	whole littoral	none
Stevens	Deep Lake	61	7/30/1997	whole littoral	none
	Deer Lake	59	7/29/1997	whole littoral	none
Stevens	Deer Lake con't	59	7/27/1999	whole lake	none
	Gillette Lake	59	7/27/1999	whole lake	none
	Jumpoff Joe Lake	59	7/29/1997	whole littoral	none
	Loon Lake	59	9/25/1996	whole littoral	*Myriophyllum spicatum*
			7/31/1997	1 site	*Lysimachia vulgaris*
			6/24/1998	whole lake	*Lythrum salicaria*
			8/11/1998	whole lake	
			6/28/1999	whole lake	
	Starvation Lake	59	7/26/1999	whole lake	none
	Waitts Lake	59	7/30/1997	whole littoral	*Lythrum salicaria*
Thurston	Black Lake	23	7/8/1994	north end	none
			4/18/1995	1 site to test methods	none
	Black River near Gate	23	8/18/1998	1 site, shore	*Polygonum hydropiper*
			9/15/1998	1 site, shore	
			9/30/1998	5 mile reach	
			10/20/1999	5 mile reach	
	Clear Lake	11	8/7/1995	1 site	none
	Hicks Lake	13	5/24/1995	3 sites, shoreline	*Utricularia inflata*
	Lawrence Lake	13	11/7/1995	spot check from shore	none
	Long Lake	14	6/6/1995	spot check	*Myriophyllum spicatum*
			9/20/1995	milfoil site	
			10/18/1995	spot check	
			11/2/1995	milfoil site	
	Munn Lake	13	6/3/1998	1 site, shore	*Utricularia inflata*
			10/14/1998	1 site, shore	
			5/25/1999	1 site, shore	
			6/21/1999	whole lake	
	Offutt Lake	13	7/7/1998	whole lake	none
	Summit Lake	14	7/23/1997	west end	none
	Ward Lake	13	7/6/1998	whole lake	none

County	Waterbody Name	WRIA	Date	Survey Extent	Noxious Aquatic Weeds
Wah-kiakum	Brooks Slough	25	6/22/1999	1 site, shore	*Myriophyllum aquaticum*
	Columbia River, Cathlamet	25	8/16/1995	spot check, boat	*Lythrum salicaria* *Myriophyllum spicatum*
	Columbia River at Skamokawa	25	8/8/1996	spot check, boat	*Lythrum salicaria*
	Puget Island Sloughs	25	5/16/1995	2 sloughs, from shore	*Egeria densa* *Myriophyllum aquaticum*
Walla Walla	Snake River - Lower Monumental Dam	33	8/20/1996	spot check, boat	*Lythrum salicaria* *Myriophyllum spicatum*
	Snake River at Charbonneau Park	33	8/19/1996	spot check, boat	none
	Snake River at Fishhook Park	33	8/19/1996	spot check, boat	none
	Snake R, Ice Harbor Dam	33	8/19/1996	spot check, boat	*Myriophyllum spicatum*
Whatcom	Cain Lake	3	8/14/1996	whole littoral	none
			9/13/1999	whole lake	none
	Samish Lake (East Arm)	3	6/30/1997	whole littoral	none
			9/14/1999	whole lake	none
	Samish Lake (West Arm)	3	6/30/1997	whole littoral	none
			9/14/1999	whole lake	none
	Silver Lake	1	7/1/1997	whole littoral	none
	Terrell Lake	1	8/14/1996	whole littoral	*Lythrum salicaria*
			9/14/1999	whole lake	
	Toad (Emerald) Lake	1	7/3/1997	whole littoral	none
	Whatcom Lake	1	6/21/1995	3 sites, littoral, west basin	*Myriophyllum spicatum*
	Wiser Lake	1	8/14/1996	spot check, shore	none
			7/1/1997	whole littoral	none
Whitman	Rock Lake	34	8/5/1994	south boatramp, from shore	none
			9/15/1997	spot check, shore	none
	Snake R at Central Ferry	35	8/5/1997	spot check, shore	*Myriophyllum spicatum*
	Snake R at Little Goose Dam	35	8/5/1997	spot check, boat	*Myriophyllum spicatum*
	Snake River at Lower Granite Dam	35	8/4/1997	spot check, boat	*Myriophyllum spicatum*
Yakima	Dog Lake	38	7/30/1998	whole lake	none
	Giffin Lake	37	7/19/1995	from shore	none
	Leech Lake	39	7/30/1998	whole lake	none
	Morgan Lake	37	7/19/1995	spot check, from shore	none
	pond nr hwy 12	37	8/8/1994	one spot, from shore	none
	Unnamed pond (14N-19E-31)	39	7/18/1995	spot check, from shore	none
			7/29/1998	1 site, shore	none
	Unnamed Ponds	37	7/18/1995	spot check, from shore	*Myriophyllum spicatum*

County	Waterbody Name	WRIA	Date	Survey Extent	Noxious Aquatic Weeds
Yakima con't	(12N-19E-20)		7/29/1998	4 sites, shore	*Lythrum salicaria*
	Wenas Lake	39	7/29/1998	whole lake	none
	Yakima River	37	8/8/1994	from Selah to Arboretum	*Lythrum salicaria*
			9/27/1994	Arboretum to Union Gap	*Lythrum salicaria*
			7/19/1995	Mabton Bridge	none

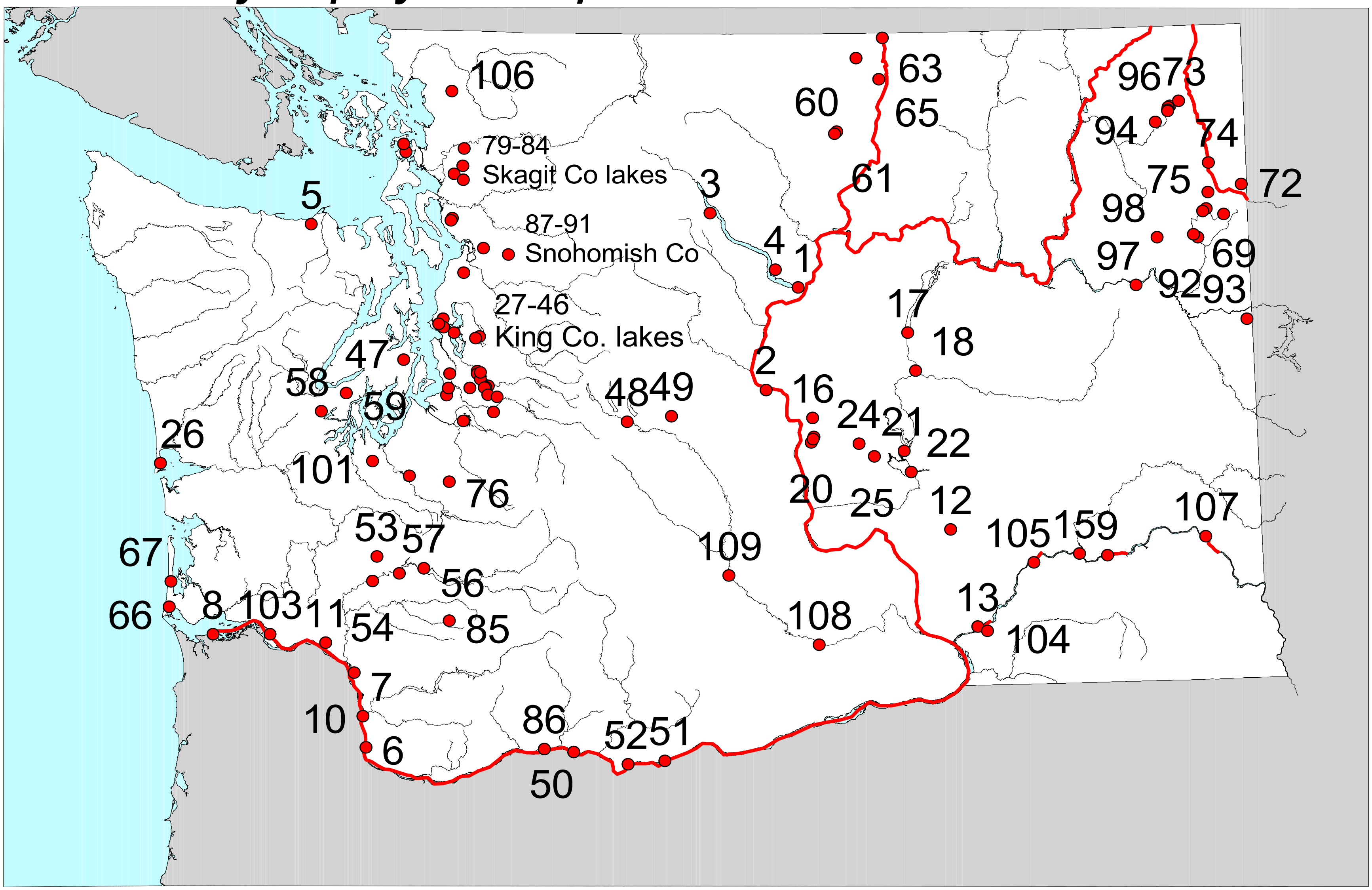
Appendix C

Myriophyllum spicatum Distribution Map

Lakes Known to Contain Eurasian milfoil (*Myriophyllum spicatum*), 1999

County	No.	Waterbody Name	County	No.	Waterbody Name
Chelan	1	Chelan Lake	Lewis, con't	56	Riffe Lake
	2	Cortez (Three) Lake		57	Swofford Pond
	3	Domke Lake	Mason	58	Island Lake
	4	Wapato Lake		59	Mason Lake
Clallam	5	unnamed pond	Okanogan	60	Conconully (Salmon) Lake
Clark	6	Caterpillar Slough		61	Conconully Reservoir
	7	Columbia River at Ridgefield		62	Okanogan River
Clatsop, OR	8	Columbia River at Astoria		63	Osoyoos Lake
Columbia	9	Snake River, Little Goose Dam		64	Palmer Lake
Cowlitz	10	Kress Lake		65	Whitestone Lake
	11	Willow Grove Slough	Pacific	66	Black Lake
Franklin	12	Scooteney Reservoir		67	Loomis Lake
	13	Snake River, Ice Harbor Dam	Pend Oreille	68	Davis Lake
	14	Snake River, Lower Mon. Dam		69	Diamond Lake
	15	Snake River at Lyons Ferry		70	Fan Lake
Grant	16	Babcock Ridge Lake		71	Little Spokane River
	17	Banks Lake		72	Marshall Lake
	18	Billy Clapp Lake		73	Nile Lake
	19	Burke Lake		74	Pend Oreille River
	20	Evergreen Lake		75	Sacheen Lake
	21	Moses Lake	Pierce	76	Clear Lake
	22	Potholes Reservoir		77	Harts Lake
	23	Stan Coffin Lake		78	Hidden Lake
	24	Winchester Wasteway	Skagit	79	Big Lake
	25	Winchester Wasteway Ext.		80	Campbell Lake
Grays Harbor	26	Duck Lake		81	Clear Lake (34N-05E-07)
King	27	Angle Lake		82	Heart Lake
	28	Bass Lake		83	McMurray Lake
	29	Desire Lake		84	Sixteen Lake
	30	Green Lake	Skamania	85	Coldwater Lake
	31	Lucerne Lake		86	Drano Lake
	32	Meridian Lake	Snohomish	87	Goodwin Lake
	33	Number Twelve Lake		88	Roesiger Lake
	34	Otter (Spring) Lake		89	Shoecraft Lake
	35	Phantom Lake		90	Silver Lake (28N-05E-30)
	36	Pipe Lake		91	Stevens Lake
	37	Sammamish Lake	Spokane	92	Eloika Lake
	38	Sawyer Lake		93	Liberty Lake
	39	Shadow Lake	Stevens	94	Black Lake
	40	Shady Lake		95	Gillette Lake
	41	Ship Canal		96	Heritage Lake
	42	Star Lake		97	Long Lake (Reservoir)
	43	Steel Lake		98	Loon Lake
	44	Union Lake		99	Sherry Lake
	45	Washington Lake		100	Thomas Lake
	46	Wilderness Lake	Thurston	101	Long Lake
Kitsap	47	Long Lake		102	Scott Lake
Kittitas	48	Lavender Lake	Wahkiakum	103	Columbia River, Cathlamet
	49	Private Pond	Walla Walla	104	Snake River, Ice Harbor Dam
Klickitat	50	Columbia River, Bingen		105	Snake River, Lower Mon. Dam
	51	Columbia River, Maryhill	Whatcom	106	Whatcom Lake
	52	Horsethief Lake	Whitman	107	Snake River, Low. Granite Dam
Lewis	53	Carlisle Lake	Yakima	108	Byron Lake
	54	Cowlitz River		109	Unnamed Ponds nr. Parker
	55	Mayfield Reservoir			

Myriophyllum spicatum Locations 1999



Appendix D

Loon Lake Demonstration Project

Manuscript of paper submitted to the Journal of Aquatic Plant Management

The Use of 2,4-D to Selectively Control an Early Infestation of Eurasian Watermilfoil in Loon Lake, Washington.

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ABSTRACT

A patchy distribution of Eurasian watermilfoil (*Myriophyllum spicatum* L.) in Loon Lake was treated with the herbicide 2,4-D during July 1998. Aquatic plant biomass and frequency data were collected before treatment, and six weeks and one year after treatment. Aqueous concentrations of 2,4-D increased to 1 to 2 mg/l within three days of treatment, and were below detection limits by one week after treatment. Macrophyte data were analyzed to assess the herbicide's impacts on Eurasian watermilfoil as well as the rest of the aquatic plant community. Results showed a significant decrease in Eurasian watermilfoil biomass and frequency in treated areas 6 weeks after treatment, which continued through the one year post-treatment samples. No other plant species were significantly affected by the herbicide application.

Key words: aquatic plants, herbicides, biomass, frequency, *Myriophyllum spicatum* L.

INTRODUCTION

Eurasian watermilfoil is not native to North America, and is considered to be highly invasive in temperate climates. It will tolerate a wide range of environmental conditions, and tends to quickly grow to the surface in the spring where it branches extensively and forms a dense mat (Nichols and Shaw 1986, Smith and Barko 1990, Madsen 1998). Dominance of a waterbody by Eurasian watermilfoil causes both environmental and economic impacts. Environmental impacts include a reduction in the biodiversity and frequency of native aquatic plant species, and impacts to the water quality such as lowered dissolved oxygen and changes to the nutrient cycling in the littoral zone (Aiken et al. 1979, Nichols and Shaw 1986, Frodge et al. 1991, Madsen et al. 1991). These impacts can lead to a reduction of the habitat value for invertebrates, fish and waterfowl (Newroth 1985, Dibble and Harrel 1997, Dibble et al. 1997). The dense vegetation at the surface also creates a nuisance for recreational boaters, and a swimming hazard (Newroth 1985). Eurasian watermilfoil is the most widespread invasive aquatic weed in Washington, and has been documented in more than 100 lakes and rivers

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throughout the state (Parsons 1998). Hundreds of thousands of dollars are spent annually by governments and local citizens to control its growth.

It is extremely difficult to control Eurasian watermilfoil after it has been introduced to a waterbody due to its effective means of spreading through fragmentation and stolons (Aiken et al. 1979, Smith and Barko 1990, Madsen and Smith 1997). Once the population has grown beyond just a few plants, we have found that Eurasian watermilfoil is nearly impossible to eradicate using physical methods such as hand pulling or placement of bottom barriers. In small lakes (less than 150 ha), herbicides have been used on a whole lake basis to eradicate the plant or at least provide control for several years (Parsons 1998). However, until recently, no tool was available in Washington to effectively manage intermediate levels of this plant in larger lakes where treating the whole littoral zone is not feasible.

In 1998 the State Legislature directed the Department of Ecology to conduct a demonstration project to study the effects of the herbicide 2,4-D (2,4-dichlorophenoxy acetic acid) on a pioneering population of Eurasian watermilfoil in Loon Lake, located in northeast Washington (Figure 1). This herbicide was chosen because it can effectively and selectively treat small Eurasian watermilfoil patches. It is registered by USEPA for aquatic use, and, although at the time of the study it was not allowed in Washington waters, it is widely used by other states for Eurasian watermilfoil control (approximately 10,000 acres per year are treated with 2,4-D for Eurasian watermilfoil control in the United States (Lembi 1996)).

Broad-leaf dicotyledonous species are more susceptible to 2,4-D than narrow leaf monocots (Lembi 1996). Several studies have demonstrated the effectiveness and selectivity of 2,4-D against the dicot Eurasian watermilfoil at low doses and short exposure times (Killgore 1984, Miller and Trout 1985, Carpentier et al. 1988, Green and Westerdahl 1988, Bird 1993). The herbicide works by mimicking the plant hormone auxin. This affects the plant's respiration and food reserves, and causes excessive growth, cell division, and death (Christopher and Bird 1992, Sprecher and Netherland 1995). Once applied in the environment, 2,4-D tends to rapidly dissipate depending on the degree of water movement, temperature, pH, and the substrate present (Joyce and Ramey 1986). Microorganisms present in water and sediments will convert the herbicide to carbon dioxide, water, and chlorine, as will exposure to UV light (Aly and Faust 1964, Hemmett and Faust 1969, Joyce and Ramey 1986).

METHODS AND MATERIALS

Site Description

Loon Lake is located in the mountainous northeast corner of Washington State about 100 km (60 miles) north of Spokane. It is 445 hectares (1,100 acres) with 12.7 km (7.9 miles) of shoreline at an elevation of 726 meters (2,381 feet). The maximum depth is 30.5 m (100 feet), mean depth 14 m (46 feet) (Dion et al. 1976). It is an oligo-mesotrophic lake with moderate levels of nutrients and generally good water clarity (Smith et al. 2000). Loon Lake hosts a diverse plant and animal community, with at least 28 species of aquatic macrophytes growing to 6.7 m (22 feet) deep (Table 1). According to regional fisheries biologists, species present include rainbow trout, planted eastern brook trout and brown trout, lake trout (Mackinaw), kokanee salmon and warm water species such as largemouth bass, pumpkinseed sunfish, and yellow perch (C. Vail, Regional Fish Biologist, personal communication). The shoreline is about 85% developed with seasonal and year-round residences. The remaining 15% is mostly wetlands.

Eurasian watermilfoil was first found in Loon Lake in September 1996 at which time its distribution was limited to the northwest corner and a few other scattered patches around the lake. In the summer of 1997 diver hand-pulling and bottom barriers were used in an attempt to reduce the population. However, by the end of the summer it was evident that the Eurasian watermilfoil was continuing to spread beyond a level that divers could contain. At the time of this study the Eurasian watermilfoil was spreading, but still limited to small patches within about 24 ha, mainly in the northern half of the lake and in water less than three meters deep.

Herbicide Application

The herbicide used was the granular 2,4-D formulation Aqua-Kleen® (2,4-D BEE (butoxy ethanol ester), 19% acid equivalent). Treatment occurred on July 8, 1998 and consisted of 2,722 kg applied over approximately 24 ha containing Eurasian watermilfoil (112 kg/ha of product, 21 kg/ha acid equivalent). This application rate was calculated to attain the 1 to 2 mg/l target concentration for 24 to 48 hours recommended for severe injury or complete control of Eurasian watermilfoil (Green and Westerdahl 1988). Treatment took place in early July to coincide with the window during which Eurasian watermilfoil is most susceptible to control efforts (May to July in northern latitudes) (Madsen 1997).

Water samples were collected before treatment, and three hours, one day, three days, one week, two weeks and three weeks after treatment to determine the 2,4-D concentrations. Four areas treated with 2,4-D were chosen for sample collection. At each site, duplicate samples were taken from the upper and lower one third of the water column at the treatment area center, and at 50 meters and 100 meters from the lakeward edge of the treatment area. All collection site locations were recorded with positions from a Global Positioning System (GPS) Unit. The samples were frozen and shipped to the analytical chemistry laboratory at the US Army Engineers Lewisville Aquatic Ecosystem Research Facility in Lewisville TX. Residue analyses were conducted using approved procedures (APHA, 1976) with a detection limit of 0.005 mg/l.

Aquatic Plant Community

The aquatic plant community was assessed before treatment and at six weeks and one year after treatment using the following three methods: 1) biomass sampling in six study plots; 2) line intercept frequency sampling for six study plots; and 3) point intercept frequency sampling for the whole lake.

The six study plots set up for the biomass and line intercept frequency sampling were established based on knowledge of the Eurasian watermilfoil distribution from a spring 1998 survey. Four plots to be treated with herbicide were located in areas with the densest known growths of Eurasian watermilfoil, and two plots were located in areas thought to be free of Eurasian watermilfoil for the no-treatment control (Figure 1). Although for scientific purposes it would have been preferable to establish control plots in areas with Eurasian watermilfoil, this was not done to accommodate the project's goal of treating all Eurasian watermilfoil within the lake. One transect from the untreated plot 4 ended up too close to a treatment area to be considered untreated. Therefore, plot 4 was split during statistical analyses and the treated transect was added to the treatment group.

Within each plot two 100 meter transects marked at 1 meter intervals were established within the area of plant growth (less than 6.7 meters deep). The transect lines sometimes curved in order to avoid deeper water. Careful notes and GPS points were used to ensure that the transects were in the same locations during all three data collection efforts.

Biomass. During all three sampling periods ten biomass samples were collected in each plot; five along each transect line. The sample points were located at stratified-random distances along and away from the transect lines; each sample was located randomly at 20 meter intervals and between 1 to 5 meters away from the line.

Sample collection and processing followed methods described by Madsen (1993). The samples were collected by a diver using SCUBA gear and a 0.1 square meter frame made of PVC pipe. The diver placed the frame on the sediment at the predetermined sample site and collected all shoot biomass within the frame. Plants were placed in a mesh bag, carried to a nearby boat, and transferred to a labeled plastic bag. On shore the samples were rinsed, trimmed to remove any remaining roots, sorted by species, and placed into preweighed and numbered paper bags. Samples were allowed to air dry until the end of each four-day sample period when the paper bags were returned to the lab and dried in a forced air oven at 60 C to a constant weight. They were then reweighed to 0.01 gram accuracy. The resulting data were entered into a relational database and analyzed with the statistical package SYSTAT® (SPSS Inc., Chicago, IL) using summary statistics and Analysis of Variance (ANOVA) after performing a $\log_{10}+1$ transformation to approximate a normal distribution.

Line Intercept Plant Frequency. This method utilized the same transect lines used for biomass sampling (see previous section), and the data were gathered simultaneously. All species observed crossing the vertical plane made between the transect line and the lake bottom were recorded by a snorkeler at one meter intervals (Madsen 1999). Data were gathered the length of the transect where the plants could be seen from the surface or with a quick dive.

The data were entered into a relational database and the statistical package SYSTAT® was used to perform Chi-square two-by-two analyses on species present in at least 5% of the sample intervals. Comparisons of the presence – absence data were made separately for the treated and untreated plots. Three combinations of the sample dates were analyzed: before treatment (June 1998) with 6 weeks after treatment (August 1998), before treatment with one year after treatment (June 1999), and 6 weeks after treatment with one year after treatment. The probability was adjusted using a Bonferroni correction to account for multiple comparisons.

Point Intercept Plant Frequency. Plant samples were gathered at points on a 50 by 50 meter grid developed for the littoral zone using a Geographical Information System (GIS) (Madsen 1999). A GPS was used to find these points as Universal Transverse Mercator (UTM) coordinates in the field. At each point two samples were gathered from the starboard side of the boat. If the sample site was in shallow water, the plant species were recorded from an area of approximately 3 by 3 meters using visual observation. In deeper water a plant sampling device was thrown twice, and all recovered species were recorded. The sampling device consisted of two metal leaf rakes bolted together with the handles removed and replaced with a 30 meter marked rope. The depth of the sample site was also recorded.

Data were entered into a relational database and the statistical package SYSTAT® was used to perform Chi-square two-by-two analyses on species observed in at least 15 samples. Comparisons were made on the presence - absence data between all combinations of sampling times. The probability was adjusted using a Bonferroni correction to account for multiple comparisons.

RESULTS AND DISCUSSION

Herbicide Application

No herbicide residue was detected in the water samples collected before treatment. Results from the 2,4-D residue analysis from samples collected up to one week after treatment are provided in Table 2. The herbicide concentrations increased to the targeted level of between 1 to 2 mg/l in treated areas within one day of treatment, then generally diminished by 3 days after treatment and were not detectable by 1 week after treatment or thereafter. Plot 5 had the lowest concentrations, probably due to springs located in the area that enhanced herbicide dissipation. There was little herbicide detected off site in samples collected 100 meters from the treatment areas. This pattern of rapid dissipation is typical for aquatic 2,4-D applications (Lim 1976, Killgore 1984, Carpentier et al. 1988). However, the Eurasian milfoil in all areas where 2,4-D residue levels were measured were exposed to a concentration and exposure time sufficient to cause severe injury or complete control (Green and Westerdahl 1988).

Aquatic Plant Community

Biomass. A total of 24 species were found in the biomass samples. Whitestem pondweed and Richardson's pondweed were combined due to difficulty in distinguishing the two species; several of these plants were observed with intermediate characteristics which led us to suspect hybridization. Plant distribution was very patchy, with several samples containing no measurable plant matter, and other samples with as many as seven different species. Total biomass ranged from 0.1 to 1,396.4 g/m^2 dry weight, with an average of 37 g/m^2 dry weight. The most commonly collected plant was Robbins' pondweed, found in 48% of total samples. This plant also had the greatest total biomass. Tables 3 and 4 list the mean biomass for the most common species collected, divided into pretreatment, six weeks post-treatment, one year post-treatment and treated versus untreated plots.

Eurasian watermilfoil demonstrated the only significant decrease in plant biomass by six weeks after treatment, with a 98% reduction during this time interval. One year after treatment the biomass in treated plots was still reduced by 87% compared to pretreatment levels. Killgore (1984) had similar results on Lake Osoyoos in north-central Washington, where there was a 91% reduction in Eurasian watermilfoil biomass 28 days after treatment, and an 86% decrease by 84 days after treatment using a similar application rate of the same 2,4-D formulation. Getsinger and Westerdahl (1984) got 60 to 70% Eurasian watermilfoil control by 28 days after treatment, and a 50 to 60 % reduction in the original biomass by day 56 when using a similar application rate (22 kg acid equivalent/ha) of a different 2,4-D formulation (14-ACE-B) in Lake Seminole, Florida. The rebound in Eurasian watermilfoil biomass experienced in these other studies, and evident in this study by one year after treatment, indicate that additional measures will need to be taken to maintain reduced Eurasian watermilfoil biomass in Loon Lake. Gibbons and Gibbons (1985) reached a similar conclusion in a study using a different formulation of 2,4-D in the Pend Oreille River in northeast Washington. They found that two applications of the herbicide over the growing season produced better Eurasian watermilfoil control than a single application at both low and high herbicide concentration levels.

Among the other dicotyledonous species, water marigold was the only one to show a significant change in any of the three comparisons for the treated and untreated plots. It decreased significantly in the treated plots between August 98 and June 99. This is probably a seasonal effect, since most aquatic plants in Washington attain peak biomass toward the end of summer.

None of the monocot species' biomass was affected by the herbicide. Water celery was the only one to change significantly, with an increase in August relative to the two June samples. This pattern was also demonstrated by the majority of other species, and is most likely due to seasonal growth patterns. Exceptions to this pattern were common elodea, Robbins' pondweed, and flat-stem pondweed. These species showed a decrease in August (possibly due to early growth and senescence compared to the species that peaked in August), or an increase in biomass over time. In a study where Eurasian watermilfoil was the dominant species before treatment, Miller and Trout (1985) observed that native species, especially the algae muskwort and the monocot common naiad, increased after treatment when compared to control areas. Similarly, Sprecher et al. (1998) observed no significant reduction in the monocot sago pondweed when exposed to up to 2 mg/l 2,4-D for 24 hours.

An additional ANOVA was conducted on all the biomass data grouped as either monocots or dicots (except the muskwort sp., which was kept separate because it is a macroalgae, not a flowering plant). Table 5 shows the mean biomass on the different sampling dates for treated and untreated plots. When tested statistically, no group showed a significant difference between the dates ($p > .05$). The herbicide's selectivity for dicots would lead one to expect this group to decrease in treated plots. The peak dicot biomass in August increased less in the treated plots than in the untreated plots, but this was partially due to the significant decrease in Eurasian watermilfoil over this time period.

Line Intercept Plant Frequency. Species were recorded and analyzed at a total of 2,475 transect intervals for all observation periods (before and after treatment, treated and untreated plots). A total of 24 different species were identified on the transect surveys. Large-leaf pondweed was the most frequently observed plant, and several, such as water smartweed and Richardson's pondweed were uncommon on the transect lines. Two species, northern watermilfoil and water marigold, were combined due to the difficulty experienced in differentiating them under water. Along many of the transects the species assemblage was diverse, with many one meter intervals containing up to 7 different species. Twelve percent of intervals contained no plants. These were mostly located in areas where the transects crossed bottom barriers placed the previous year for Eurasian watermilfoil control, or in areas of sandy substrate.

Results from the Chi-square analysis in percent present for the three sample dates and P-values for the three comparisons are given for the most common species in Table 6 and Table 7. Eurasian watermilfoil showed a significant decrease in frequency in the treated plots between the pretreatment sample collection and both the six week post-treatment, and one year post-treatment sample collection. This is the only species that showed a significant decrease throughout both post-treatment collection periods. By one year after treatment there was a low frequency of Eurasian watermilfoil in the untreated plots, indicating that this species was continuing to spread. These data corroborate results from the biomass data.

The other common dicots along the transects were northern watermilfoil, water marigold and bladderwort. The combination of northern watermilfoil and water marigold showed a significant decrease in the one year post-treatment data. It is not known why this decrease occurred, but the fact that it was evident in both the treated and untreated plots would indicate that it was not a result of the herbicide, but probably due to different growing conditions between the years. The bladderwort showed just the opposite effect, with a significant increase one year post-treatment in the treated plots. These results are similar to what was found with the biomass data.

Of the monocots, eel-grass pondweed showed a significant decrease in frequency by 6 weeks after treatment in the untreated plots. This could be due to an early senescence of this species, since it usually grows and blooms early in the season (Borman et al. 1997). It was present again at a high frequency by June 1999. A similar pattern of higher biomass in the June samples is also present in the eel-grass pondweed data from the treated plots. Three species, common naiad, Robbins' pondweed and water celery were present at a significantly higher frequency during the August sampling than either of the June samplings in the treated plots, probably due to a seasonal growth pattern. Other species (sago pondweed in treated plots and large leaf pondweed in untreated plots) showed a significantly higher frequency one year post-treatment. Again, this is likely due to factors other than the herbicide treatment, such as variability in growing conditions from year to year.

Point Intercept Plant Frequency. We sampled a total of 602 points and observed 28 different species during the point intercept frequency survey. As with the biomass data, whitestem pondweed and Richardson's pondweed were combined due to suspected hybridization. Results from the Chi- square analysis are given in Table 8. The collection frequency of Eurasian watermilfoil was not significantly different using this lake-wide sampling method between any of the sampling dates, in contrast to what was found with the line-intercept survey method and the biomass data. This is probably due to the different scopes of these sampling methods. The treatment plots for the line intercept and biomass methods were located in areas known to contain the highest concentrations of Eurasian watermilfoil, and also were areas where the herbicide was applied. In contrast, the point intercept method sampled the entire littoral zone, and included areas where the Eurasian watermilfoil was sparsely distributed, and left untreated.

The fact that Eurasian watermilfoil was only present in three to six percent of the samples from the whole littoral zone is evidence of its early stage of invasion.

The significant differences seen in the common naiad and water celery were probably due to seasonal increases in seed or rhizome sprouting, since the highest frequency for both was seen in the August samples. The increase of large-leaf pondweed in June 1999 could have been due to an annual fluctuation. A similar increase of this species was seen from the line intercept data in the untreated plots.

In conclusion, the 2,4-D herbicide application in Loon Lake significantly reduced both the biomass and frequency of Eurasian watermilfoil in the treatment plots during the year of treatment. One year after treatment Eurasian watermilfoil frequency in treated plots remained significantly lower than pre-treatment levels. The other plant species growing in the lake did not show any significant reductions in biomass or frequency as a result of the herbicide treatment. Thus, the application rate and formulation of 2,4-D used in this study selectively controlled Eurasian watermilfoil in Loon Lake without significantly impacting the native aquatic plant species. However, one year after treatment the Eurasian watermilfoil was increasing again slightly, so continued management activities will be required to keep its growth in Loon Lake under control.

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Table 1: Aquatic plant species in Loon Lake, WA. Growth forms are indicated by e, emergent; f, floating-leaved; and s, submersed. Type is defined as m, monocot; and d, dicot.

Scientific name	Common name	Growth form	Type
Brasenia schreberi Gmel.	watershield	f	d
Ceratophyllum demersum L.	coontail	s	d
Chara sp.	muskwort	s	macroalgae
Eleocharis sp.	spikerush	s	m
Eleocharis palustris (L.) R. & S.	common spikerush	e	m
Elodea canadensis Rich.	common elodea	s	m
Fontinalaceae	aquatic moss	s	moss
Heteranthera dubia (Jacq) MacM.	water star-grass	s	m
Megalodonta beckii Greene	water marigold	s	d
Myriophyllum sibiricum Kom.	northern watermilfoil	s	d
Myriophyllum spicatum L.	Eurasian watermilfoil	s	d
Najas flexilis (Willd.) R. and S.	common naiad	s	m
Nitella sp.	stonewort	s	macroalgae
Nuphar polysepala Engelm.	spatterdock, yellow waterlily	f	d
Nymphaea odorata Ait.	fragrant waterlily	f	d
Polygonum amphibium L.	water smartweed	f	d
Potamogeton amplifolius Tucker.	large-leaf pondweed	s	m
Potamogeton gramineus L.	grass-leaved pondweed	s	m
Potamogeton illinoensis Morong.	Illinois pondweed	s	m
Potamogeton natans L.	floating leaf pondweed	s	m
Potamogeton pectinatus L.	sago pondweed	s	m
Potamogeton praelongus Wulf.	whitestem pondweed	s	m

Potamogeton richardsonii (Ben.) R.	Richardson's pondweed	s	m
Potamogeton robbinsii Oakes	Robbins' pondweed	s	m
Potamogeton sp.	thin leaved pondweed	s	m
Potamogeton zosteriformis Fern.	Flat-stem pondweed	s	m
Ranunculus aquatilis L.	water buttercup	s	d
Scirpus sp.	bulrush	e	m
Utricularia vulgaris L.	bladderwort	s	d
Vallisneria americana Michx.	water celery	s	m

Table 2. Aqueous 2,4-D residue levels (mg/l) in Loon Lake, WA, 1998. All values are averages of two analyses per sample, and the average of duplicate samples at each collection site. Time intervals are after treatment. Sample ID designation: U - from the upper 1/3, L - from the lower 1/3 of the water column. N.D. is not detectable.

Sample area	Sample location	Sample ID	3 hours	1 day	3 days	1 week
Plot 2	treatment area	U3	0.676	1.377	0.613	N.D.
		L3	0.931	1.577	1.236	N.D.
	50 m outside	U3	0.039	0.052	0.100	N.D.
		L3	N.D.	0.074	0.300	N.D.
	100 m outside	U3	N.D.	0.162	N.D.	N.D.
		L3	N.D.	N.D.	0.157	N.D.
Plot 5	treatment area	U3	0.282	N.D.	N.D.	N.D.
		L3	1.262	N.D.	N.D.	N.D.
	50 m outside	U3	N.D.	N.D.	N.D.	N.D.
		L3	N.D.	N.D.	N.D.	N.D.
	100 m outside	U3	N.D.	N.D.	N.D.	N.D.
		L3	N.D.	N.D.	N.D.	N.D.
Plot 6	treatment area	U3	0.235	0.628	N.D.	N.D.
		L3	0.130	1.421	N.D.	N.D.
	50 m outside	U3	0.218	0.259	0.739	N.D.
		L3	N.D.	0.735	0.743	N.D.
	100 m outside	U3	N.D.	0.110	0.522	N.D.
		L3	N.D.	N.D.	N.D.	N.D.
Granite Point	treatment area	U3	1.817	0.374	N.D.	N.D.
not located with		L3	1.427	0.181	N.D.	N.D.
in a sample plot	50 m outside	U3	N.D.	N.D.	N.D.	N.D.
		L3	N.D.	N.D.	N.D.	N.D.
	100 m outside	U3	N.D.	N.D.	N.D.	N.D.
		L3	N.D.	N.D.	N.D.	N.D.

Table 3. Mean biomass and ANOVA results from selected species in 2,4-D treated plots in Loon Lake, WA 1998-1999. Significantly different comparisons are indicated by letters and underscores.

Species	biomass (g/m2)			
	June 98 n=45	Aug 98 n=45	June 99 n=45	P-value
Chara	1.33	14.46	2.37	0.084
Elodea canadensis	5.42	8.04	17.46	0.684
Heteranthera dubia	0.18	1.04	0.06	0.068
Megalodonta beckii	1.38ab	<u>8.37a</u>	<u>0.48b</u>	**0.013**
Myriophyllum sibiricum	2.55	1.20	0.21	0.161
Myriophyllum spicatum	<u>6.58a</u>	<u>0.16b</u>	0.83ab	**0.009**
Najas flexilis	0.03	0.54	0.22	0.112
Potamogeton amplifolius	7.44	20.20	10.91	0.367
Potamogeton gramineus	0.46	2.06	0.16	0.092
Potamogeton praelongus + *Potamogeton richardsonii*	3.36	4.35	3.24	0.819
Potamogeton robbinsii	86.57	59.84	43.98	0.857
Potamogeton zosteriformis	0.27	0.13	0.60	0.514
Utricularia vulgaris	0.51	1.75	7.60	0.410
Vallisneria americana	<u>0.31a</u>	<u>4.75b</u>	<u>0.15a</u>	**0.007**

n= number of samples

Table 4. Mean biomass and ANOVA results from selected species in untreated plots, Loon Lake, WA 1998-1999. Significantly different comparisons are indicated by letters and underscores.

Species	June 98	Aug 98	June 99	P-value
	biomass (g/m^2)			
	n=15	n=15	n=15	
Chara	10.39	17.60	7.22	0.631
Elodea canadensis	29.63	19.49	23.47	0.650
Heteranthera dubia	0.30	0.57	0.37	0.798
Megalodonta beckii	5.08	20.81	0.79	0.294
Myriophyllum sibiricum	7.16	4.87	0.00	0.114
Myriophyllum spicatum	0.00	0.01	2.01	0.134
Najas flexilis	0.00	1.20	0.01	0.180
Potamogeton amplifolius	12.03	35.73	11.39	0.574
Potamogeton gramineus	0.00	0.00	0.00	-
Potamogeton praelongus +				
Potamogeton richardsonii	4.05	31.14	1.49	0.097
Potamogeton robbinsii	21.20	16.34	29.62	0.864
Potamogeton zosteriformis	2.25	0.01	0.98	0.394
Utricularia vulgaris	0.00	0.00	0.00	-
Vallisneria americana	0.41ab	<u>3.92a</u>	<u>0.10b</u>	**0.031**

n= number of samples

Table 5. Mean biomass (g/m^2) of monocots and dicots and ANOVA results, Loon Lake, WA 1998-1999.

Treated Plots	June 98	Aug 98	June 99	P-value
Monocots	104.98	102.48	77.38	.735
Dicots	11.77	13.40	12.31	.453
Untreated Plots				
Monocots	69.97	108.40	67.43	.874
Dicots	12.33	25.69	2.80	.284

Table 6. Macrophyte frequency and results from Chi-square analysis of line-intercept data, 2,4-D treated plots in Loon Lake, WA, 1998-1999.

Species	% present			P-value		
	June 98	Aug 98	June 99	June 98 with Aug 98	June 98 with June 99	Aug 98 with June 99
No plants	13	13	12	0.931	0.358	0.401
Chara	21	20	20	0.601	0.549	0.937
Elodea canadensis	5	6	7	0.248	0.175	0.833
Megalodonta beckii + *Myriophyllum sibiricum*	19	20	12	0.599	**0.001***	**0.000***
Myriophyllum spicatum	17	5	4	**0.000***	**0.000***	0.429
Najas flexilis	3	11	4	**0.000***	0.310	**0.000***
Potamogeton amplifolius	27	31	27	0.147	0.977	0.137
Potamogeton gramineus	10	12	12	0.359	0.344	0.957
Potamogeton pectinatus	8	7	14	0.487	**0.000***	**0.000***
Potamogeton robbinsii	17	30	20	**0.000***	0.171	**0.000***
Potamogeton zosteriformis	3	2	7	0.357	0.006	**0.000***
Utricularia vulgaris	5	8	14	0.020	**0.000***	**0.000***
Vallisneria americana	3	17	5	**0.000***	0.082	**0.000***

* significant at $P \leq 0.004$

Table 7. Macrophyte frequency and results from Chi-square analysis of line-intercept data, untreated plots, Loon Lake, WA, 1998-1999.

Species	% present			P-value		
	June 98	Aug 98	June 99	June 98 with Aug 98	June 98 with June 99	Aug 98 with June 99
No plants	12	13	5	0.732	0.036	0.013
Chara	45	46	44	0.876	0.892	0.762
Elodea canadensis	10	18	15	0.053	0.217	0.450
Megalodonta beckii + *Myriophyllum sibiricum*	30	35	17	0.358	0.008	**0.000***
Myriophyllum spicatum	0	0	1	-	0.189	0.164
Najas flexilis	1	6	1	0.010	0.654	0.015
Potamogeton amplifolius	35	32	52	0.561	**0.004***	**0.000***
Potamogeton gramineus	1	5	1	0.080	0.474	0.015
Potamogeton pectinatus	0	0	2	-	0.107	0.088
Potamogeton robbinsii	5	15	17	**0.004***	**0.001***	0.647
Potamogeton zosteriformis	27	6	28	**0.000***	0.932	**0.000***
Utricularia vulgaris	1	0	0	0.289	0.280	0.737
Vallisneria americana	2	6	3	0.076	0.618	0.162

* significant at $P \leq 0.004$

Table 8. Macrophyte frequency and results of Chi-square analysis on the point intercept frequency data, Loon Lake, WA, 1998-1999.

Species	% present			P-value		
	June 98 n=195	Aug 98 n=198	June 99 n=209	June 98 with Aug 98	June 98 with June 99	Aug 98 with June 99
No plants	12	13	11	0.688	0.803	0.510
Brasenia schreberi	11	11	15	0.958	0.177	0.159
Ceratophyllum demersum	2	3	7	0.753	0.024	0.046
Chara	41	32	32	0.073	0.077	0.959
Elodea canadensis	19	27	29	0.068	0.031	0.747
Heteranthera dubia	5	10	6	0.063	0.636	0.152
Megalodonta beckii	14	17	13	0.528	0.673	0.286
Myriophyllum sibiricum	24	24	22	0.974	0.701	0.676
Myriophyllum spicatum	6	5	3	0.621	0.265	0.535
Najas flexilis	4	15	9	**0.000***	0.065	0.041
Potamogeton amplifolius	16	23	33	0.115	**0.000***	0.021
Potamogeton gramineus	5	7	4	0.300	0.694	0.148
Potamogeton natans	7	6	4	0.510	0.138	0.409
Potamogeton pectinatus	2	4	4	0.372	0.293	0.876
Potamogeton praelongus + *Potamogeton richardsonii*	15	20	13	0.206	0.670	0.087
Potamogeton robbinsii	28	34	33	0.154	0.245	0.777
Potamogeton zosteriformis	5	4	8	0.438	0.227	0.049
Vallisneria americana	6	14	5	0.009	0.699	**0.002***

* significant at $P \leq 0.003$

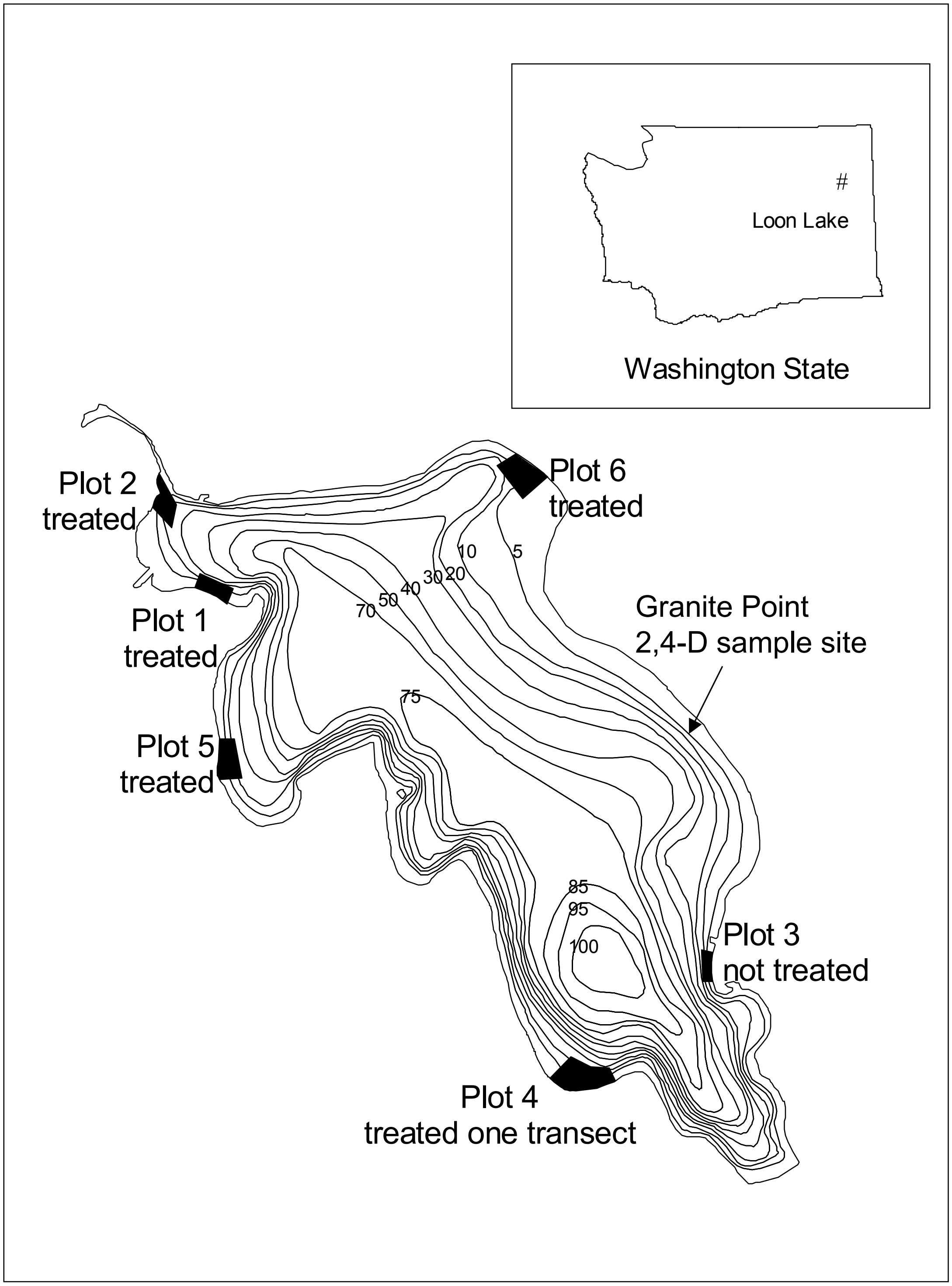

Figure 1: Loon Lake, Washington. Location of 6
study plots. Depth contour intervals marked in feet.

Appendix E

Alkalinity Results, 1995-1999

Note: In 1996, 1998, and 1999 a known standard addition was used to test the accuracy of the field test kit. An average correction value was calculated from the results and applied to the values from these years as recommended by the manufacturer (Hach, 1994). In 1997 a different procedure was used, and the results were highly variable. Therefore no correction value was calculated for that year. However, because the uncorrected values from 1997 were similar to values from other years in duplicated lakes, I felt the uncorrected values could be reported. Additional confidence in the 1997 data was gained when results nearly exactly matched the results from independent laboratory analyses (Parsons, 1997a).

County	Waterbody Name	Date	Alkalinity (mg/l $CaCO_3$)
Adams	Herman Lake	7/28/98	159
	Sprague Lake	9/1/99	141
Chelan	Roses (Alkali) Lake	6/17/97	254
	Wapato Lake	6/27/95	180
		8/8/95	172
		6/24/96	200
		6/17/97	175
		8/10/99	133
	Wenatchee Lake	8/9/99	5
Clallam	Beaver Lake	7/9/96	30
	Crescent Lake	7/10/96	49
	Ozette Lake	7/9/96	8
	Pleasant Lake	7/11/96	14
	Sutherland Lake	7/11/96	65
Clark	Lacamas Lake	6/17/99	24
Columbia	Snake River at Little Goose Dam	8/5/97	43
Cowlitz	Sacajawea Lake	6/23/99	54
Ferry	Curlew Lake	8/22/95	99
	Ellen Lake	8/23/95	70
	Swan	8/13/97	60
	Trout Lake	8/22/95	82
	Twin Lakes	8/23/95	33
Grant	Alkali Lake	7/16/96	229
	Babcock Ridge Lake	7/24/95	130
	Billy Clapp Lake	8/30/95	51
	Blue Lake	7/16/96	207
	Burke Lake	9/19/96	172
		9/24/97	134
	Canal Lake	8/30/95	154
	Corral Lake	7/25/95	230
	Deep Lake	6/25/96	147
	Evergreen Lake	9/12/95	57
		9/18/96	70
		9/23/97	63
		9/9/98	51
	Lenore Lake	7/17/96	931
	Long Lake (17N-29E-32)	8/31/95	118
	Moses Lake	7/15/98	119
	Park Lake	6/26/96	190
		9/10/98	149
	Potholes Reservoir	7/16/98	125
	Quincy Lake	9/13/95	233

County	Waterbody Name	Date	Alkalinity ($mg/l CaCO_3$)
		9/17/96	386
		9/22/97	301
Grant con't	Quincy Lake con't	9/8/98	303
	Soda Lake	7/25/95	97
	Warden Lake	7/28/98	165
Grays Harbor	Aberdeen Lake	7/22/96	28
	Failor Lake	6/25/97	11
	Quinault Lake	10/7/96	24
	Sylvia Lake	7/22/96	16
Island	Deer Lake	9/4/96	20
	Goss Lake	9/5/96	26
	Lone Lake	9/4/96	74
Jefferson	Anderson Lake	7/8/96	58
	Crocker Lake	8/27/97	20
	Leland Lake	6/14/95	22
		10/3/95	30
		6/11/96	26
	Tarboo Lake	7/2/96	9
King	Alice Lake	8/12/99	2
	Desire Lake	7/8/99	14
	Meridian Lake	7/10/97	28
	Otter (Spring) Lake	7/8/99	13
	Pipe Lake	6/18/96	31
	Sawyer Lake	8/7/97	48
	Shady Lake	7/8/99	19
Kitsap	Buck Lake	7/22/98	15
	Horseshoe Lake	8/22/96	5
	Island Lake	7/22/98	13
	Kitsap Lake	8/3/95	36
		7/1/98	35
	Mission Lake	9/9/96	35
		6/18/98	19
	Panther Lake	8/2/95	6
	Wildcat Lake	10/4/95	18
	William Symington Lake	9/16/98	28
Kitsap/Mason	Tiger Lake	9/9/96	5
Kittitas	Lavender Lake	6/18/97	24
		7/27/98	24
Mason	Benson Lake	7/23/96	6
	Haven Lake	6/8/98	13
	Isabella Lake	8/18/97	32
	Island Lake	6/24/97	16
		7/9/98	13
	Limerick	7/8/98	18
	Lystair (Star) Lake	6/12/98	8
	Maggie Lake	8/19/98	3
	Mason Lake	9/14/98	17
	Nahwatzel Lake	6/26/97	5
	Phillips Lake	7/20/98	6
	Tee Lake	8/19/98	8
	Trails End (Prickett) Lake	6/16/98	3

County	Waterbody Name	Date	Alkalinity ($mg/l\ CaCO_3$)
	Wooten Lake	6/16/98	9
Okanogan	Aeneas Lake	7/12/99	143
	Alta Lake	6/29/95	91
	Big Twin Lake	8/11/99	78
Okanogan con't	Blue Lake (37N 4E 22)	7/14/99	71
	Chopaka Lake	7/13/99	317
	Conconully Reservoir	9/18/97	56
	Crawfish Lake	8/28/96	21
	Davis Lake	8/9/95	162
	Fish Lake	7/14/99	103
	Green Lake	6/29/95	225
	Leader Lake	8/29/96	102
	Little Twin Lake	8/9/95	163
		8/11/99	123
	Omak Lake	8/28/96	2986
	Palmer Lake	7/13/99	47
	Patterson Lake	8/10/95	79
		8/10/99	82
	Pearrygin Lake	8/10/95	114
	Round Lake	7/15/99	115
	Spectacle Lake	8/27/96	77
		9/17/97	70
	Whitestone Lake	6/28/95	110
		9/17/97	114
Pacific	Black Lake	8/26/97	10
	Loomis Lake	8/25/97	23
Pend Oreille	Browns Lake	8/25/99	5
	Davis Lake	7/30/96	46
	Diamond Lake	7/31/96	35
	Horseshoe Lake	7/13/98	20
	Leo Lake	7/28/99	13
	Marshall Lake	8/24/99	11
	Skookum Lake, North	8/24/99	4
	Skookum Lake, South	7/31/96	9
	Sullivan Lake	8/1/96	52
Pierce	American Lake	10/6/98	32
	Clear Lake	6/12/96	20
		6/23/97	18
	Harts Lake	7/3/96	67
	Ohop Lake	7/25/96	28
	Rapjohn Lake	7/25/96	28
	Spanaway Lake	9/11/96	48
	Steilacoom Lake	8/26/98	46
	Tanwax Lake	9/12/96	29
	Whitman Lake	8/5/99	21
San Juan	Cascade Lake	9/9/97	54
	Mountain Lake	9/9/97	22
	Sportsman Lake	9/10/97	44
Skagit	Beaver Lake	9/15/99	49
	Big Lake	9/15/99	31
	Campbell Lake	8/13/96	85

County	Waterbody Name	Date	Alkalinity ($mg/l\ CaCO_3$)
		7/2/97	54
	Cavanaugh Lake	8/24/98	8
	Clear Lake (34N 5E 7)	9/15/99	27
	Erie Lake	7/2/97	52
	Heart Lake (35N-01E-36)	8/13/96	82
	Sixteen Lake	8/3/99	20
Skamania	Coldwater Lake	8/27/98	12
Snohomish	Blackmans Lake	8/5/98	18
	Goodwin Lake	6/20/95	25
	Howard Lake	7/20/99	26
Snohomish con't	Ki Lake	7/19/99	5
	Martha Lake (27N-04E-01)	8/5/98	23
	Martha Lake (31N 4E 18)	7/20/99	17
	Riley Lake	7/19/99	5
	Shoecraft Lake	8/15/96	25
Spokane	Liberty Lake	7/13/98	12
	Long Lake (Reservoir)	8/31/99	78
	Medical Lake	7/14/98	481
	Newman Lake	8/31/99	15
	West Medical Lake	7/14/98	263
	Williams Lake	9/16/97	112
Stevens	Deep Lake	7/30/97	165
	Deer Lake	7/29/97	32
		7/27/99	33
	Gillette Lake	7/27/99	11
	Jumpoff Joe Lake	7/29/97	109
	Loon Lake	9/25/96	85
		8/11/98	60
	Starvation Lake	7/26/99	117
	Waitts Lake	7/30/97	132
Thurston	Munn Lake	6/21/99	9
	Offutt Lake	7/7/98	14
	Ward Lake	7/6/98	2
Whatcom	Cain Lake	8/14/96	18
	Samish Lake (East Arm)	6/30/97	16
	Silver Lake	7/1/97	25
	Terrell Lake	8/14/96	38
	Toad (Emerald) Lake	7/3/97	29
	Whatcom Lake	6/21/95	19
	Wiser Lake	7/1/97	53
Whitman	Snake River at Little Goose Dam	8/5/97	43
Yakima	Dog Lake	7/30/98	18
	Leech Lake	7/30/98	19
	Wenas Lake	7/29/98	37

Appendix F

Plant Identification References

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Appendix G

Herbarium Specimens, Grouped by Family

Herbarium Specimens - Grouped by Family

Family	Scientific name	Common name
Alismataceae		
	Alisma gramineum	narrowleaf water-plantain
	Sagittaria cuneata	Arumleaf arrowhead, wapato
	Sagittaria graminea	slender arrowhead
	Sagittaria rigida	bur arrowhead
Apiaceae		
	Cicuta douglasii	western water-hemlock
	Hydrocotyle ranunculoides	water-pennywort
	Lilaeopsis occidentalis	lilaeopsis
Asteraceae		
	Megalodonta beckii	water marigold
Azollaceae		
	Azolla mexicana	Mexican water-fern
Boraginaceae		
	Myosotis laxa	small flowered forget-me-not
	Myosotis scorpioides	common forget-me-not
Brassicaceae		
	Rorippa nasturtium-aquaticum	water-cress
	Rorippa palustris	marsh yellowcress
	Subularia aquatica	awlwort
Butomaceae		
	Butomus umbellatus	flowering rush
Cabombaceae		
	Brasenia schreberi	watershield
	Cabomba caroliniana	fanwort
Callitrichaceae		
	Callitriche hermaphroditica	northern water-starwort
	Callitriche heterophylla	different-leaved water-starwort
	Callitriche stagnalis	pond water-starwort
	Callitriche verna	spring water-starwort
Campanulaceae		
	Lobelia dortmanna	water gladiole; water lobelia
Ceratophyllaceae		
	Ceratophyllum demersum	Coontail; hornwort
Characeae		
	Nitella sp.	stonewort
	Tolypella intricata	macro algae
Crassulaceae		
	Crassula aquatica	pygmy-weed

Family	Scientific name	Common name
Cyperaceae		
	Carex unilateralis	one-sided sedge
	Cyperus erythrorhizos	red rooted cyperus
	Dulichium arundinaceum	Dulichium
	Eleocharis acicularis	needle spike-rush
	Eleocharis sp.	spike-rush
	Scirpus acutus	hardstem bulrush
	Scirpus americanus	american bulrush
	Scirpus cyperinus	wool-grass
	Scirpus fluviatilis	river bulrush
	Scirpus maritimus	seacoast bulrush
	Scirpus nevadensis	Nevada bulrush
	Scirpus subterminalis	water clubrush
Elatinaceae		
	Elatine sp.	waterwort
	Elatine triandra	three-stamen waterwort
Equisetaceae		
	Equisetum fluviatile	water horsetail
Fontinalaceae		
	Fontinalis antipyretica	water moss
Haloragaceae		
	Myriophyllum aquaticum	parrotfeather
	Myriophyllum hippuroides	western watermilfoil
	Myriophyllum quitense	waterwort watermilfoil
	Myriophyllum sibiricum	northern watermilfoil
	Myriophyllum sp.	water-milfoil
	Myriophyllum spicatum	Eurasian water-milfoil
	Myriophyllum verticillatum	whorled watermilfoil
Hippuridaceae		
	Hippuris vulgaris	common marestail
Hydrocharitaceae		
	Egeria densa	Brazilian elodea
	Egeria najas	Asian anacharis
	Elodea canadensis	common elodea
	Elodea nuttallii	Nuttall's waterweed
	Hydrilla verticillata	hydrilla
	Vallisneria americana	water celery
Isoetaceae		
	Isoetes sp.	quillwort
Juncaceae		
	Juncus acuminatus	tapered rush
	Juncus bulbosus	bulbous rush

Family	Scientific name	Common name
Lamiaceae		
	Lycopus asper	rough bungleweed
Lemnaceae		
	Wolffia borealis	water-meal
Lentibulariaceae		
	Utricularia inflata	big floating bladderwort
	Utricularia macrorhiza	common bladderwort
	Utricularia minor	lesser bladderwort
	Utricularia sp.	bladderwort
	Utricularia vulgaris	common bladderwort
Menyanthaceae		
	Menyanthes trifoliata	buckbean
	Nymphoides peltata	water fringe
Najadaceae		
	Najas flexilis	common naiad
	Najas gradalupensis	Guadalupe water-nymph
Nymphaeaceae		
	Nuphar polysepala	spatter-dock, yellow water-lily
Onagraceae		
	Epilobium hirsutum	fiddle-grass
	Ludwigia hexapetala	water primrose
	Ludwigia palustris	water-purslane
Poaceae		
	Cinna latifolia	wood reed-grass
	Glyceria borealis	northern mannagrass
	Zizania aquatica	wild rice
Polygonaceae		
	Polygonum amphibium	water smartweed
	Polygonum hydropiper	marshpepper smartweed
	Polygonum hydropiperoides	common smartweed
Pontederiaceae		
	Heteranthera dubia	water star-grass
Potamogetonaceae		
	Potamogeton alpinus	red pondweed
	Potamogeton amplifolius	large-leaf pondweed
	Potamogeton crispus	curly leaf pondweed
	Potamogeton diversifolius	snailseed pondweed, diverse leaf
	Potamogeton epihydrus	ribbonleaf pondweed
	Potamogeton foliosus	leafy pondweed
	Potamogeton friesii	flat-stalked pondweed
	Potamogeton gramineus	grass-leaved pondweed
	Potamogeton illinoensis	Illinois pondweed
	Potamogeton natans	floating leaf pondweed

Family	Scientific name	Common name
	Potamogeton nodosus	longleaf pondweed
	Potamogeton obtusifolius	bluntleaf pondweed
	Potamogeton pectinatus	sago pondweed
	Potamogeton praelongus	whitestem pondweed
	Potamogeton pusillus	slender pondweed
	Potamogeton richardsonii	Richardson's pondweed
	Potamogeton robbinsii	fern leaf pondweed
	Potamogeton vaginatus	sheathing pondweed
	Potamogeton zosteriformis	eel-grass pondweed
Primulaceae		
	Lysimachia nummularia	creeping loosestrife
	Lysimachia thyrsiflora	tufted loosestrife
	Lysimachia vulgaris	garden loosestrife
Ranunculaceae		
	Ranunculus aquatilis	water-buttercup
	Ranunculus flammula	creeping buttercup
Ruppiaceae		
	Ruppia maritima	ditch-grass
Scrophulariaceae		
	Gratiola neglecta	hedge-hyssop
	Limosella acaulis	mudwort
	Limosella aquatica	mudwort
	Lindernia dubia	false-pimpernel
	Veronica anagallis-aquatica	water speedwell
Sparganiaceae		
	Sparganium angustifolium	narrowleaf bur-reed
	Sparganium eurycarpum	broadfruited bur-reed
	Sparganium nutans	small bur-reed
	Sparganium sp.	bur-reed
Typhaceae		
	Typha angustifolia	lesser cat-tail
Zannichelliaceae		
	Zannichellia palustris	horned pondweed