WASHINGTON STATE DEPARTMENT OF ECOLOGY

Aquatic Plant Technical Assistance Program

1995 Activity Report

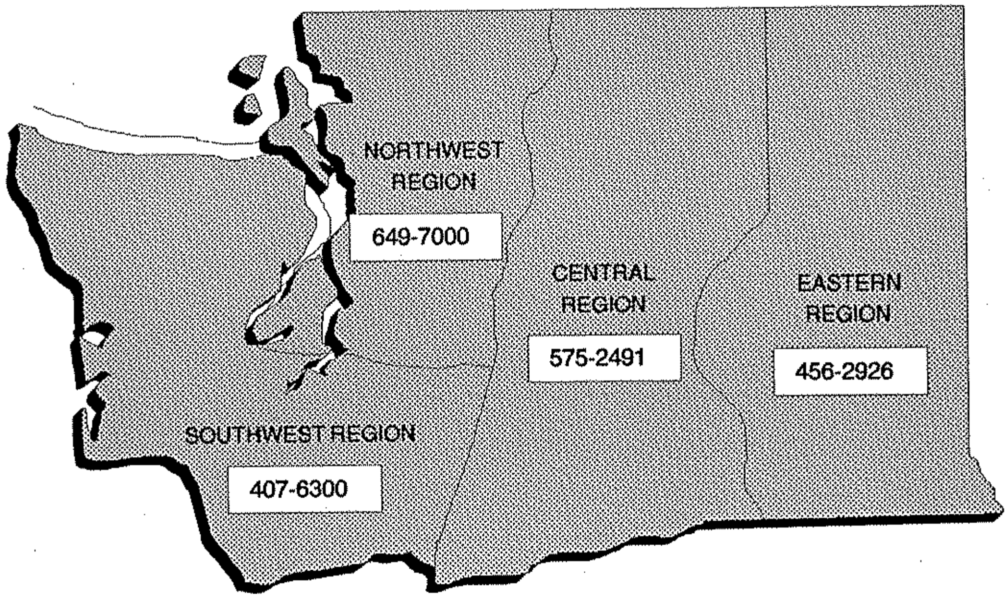
July 1996

Publication No. 96-332

Printed on Recycled Paper

For additional copies of this report, contact:

Department of Ecology
Publications
P.O. Box 47600
Olympia, WA 98504-7600
Telephone: (360) 407-7472



The Department of Ecology is an equal opportunity agency and does not discriminate on the basis of race, creed, color, disability, age, religion, national origin, sex, marital status, disabled veteran's status, Vietnam Era veteran's status, or sexual orientation.

For more information or if you have special accommodation needs, please contact Kim Douglas at (206) 407-6677. Ecology Headquarters telecommunications device for the deaf (TDD) number is (206) 407-6006. Ecology Regional Office TDD numbers are as follows:

SWRO (TDD) (360) 407-6306
NWRO (TDD) (206) 649-4259
CRO (TDD) (509) 454-7673
ERO (TDD) (509) 458-2055

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Aquatic Plant Technical Assistance Program

1995 Activity Report

Prepared by:
Jenifer Parsons

Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
Olympia, Washington 98504-7710

July 1996

Publication No. 96-332

Table of Contents

List of Tables

List of Figures

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 to document aquatic plant distribution and habitat through site visits, and to assist with evaluating projects supported by Freshwater Aquatic Weed Program grant money.

During the 1995 field season aquatic plant data were gathered during 83 site visits to 70 waterbodies located throughout the state. Several previously unknown populations of non-native aquatic plants were recorded during the field season. The most significant discovery was the presence of *Hydrilla verticillata* in the Pipe/Lucerne Lake system (King County). In response to this find, the Aquatic Plant Technical Assistance Program assisted with mapping locations of *Hydrilla*, assessing plant biomass and determining what control methods to employ. Other accomplishments during 1995 included gathering additional plants for the herbarium collection, providing educational and technical outreach on aquatic plants, reviewing 17 project applications for Freshwater Aquatic Weed Program grant money, and providing assistance and editorial comments for the "Aquatic Plant Field Identification Guide" project.

Introduction

Legislative action in 1991 (RCW 43-21A.660) established the Freshwater Aquatic Weed Account to provide additional 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 agency officials to adequately address them. To provide technical expertise for aquatic plants, one full-time position was created within the Environmental Investigations and Laboratory Services Program of the Department of Ecology. This position was filled in February 1994. The targeted objectives for this position were as follows:

- to provide technical assistance on aquatic plant identification and management to government agencies and the public;
- to conduct site visits to identify aquatic plants, evaluate plant community structure and identify the existence or potential for problems; and
- to 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 1995. A report on the program's results from 1994 is available in Parsons (1995a).

To simplify reporting, 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 peploides	water primrose
Lythrum salicaria	purple loosestrife
Myriophyllum aquaticum	parrot feather milfoil
Myriophyllum spicatum	Eurasian milfoil
Nymphaea odorata	fragrant water lily

Technical Assistance

In 1992 an external advisory committee identified technical assistance for aquatic plant taxonomy, ecology, and management as a high priority for the 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."

Fulfilling this goal involves working with public and private sectors to develop a broad understanding of the roles aquatic plants play in the ecosystem and how human behaviors influence 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, 1995 (Table 2). I have also assisted the public and local governments on an informal basis through phone conversations, identification of mailed plant specimens, and informal meetings which are not listed.

Table 2. Aquatic plant technical outreach activities - 1995.

Function	Date	Location	Role
Met with WDFW Region 5 biologist	05/11/95	Puget Island, Wahkiakum County	Plant identification and discussed control options for drainage canals
Met with King County Lakes Personnel	06/01/95	Pipe Lake, King County	Confirm presence of *Hydrilla verticillata*
Washington Lakes Protection Association newsletter	06/95		Article on *Hydrilla* biology and implications of the Washington population
Hydrilla public information meeting	07/06/95	Lake Wilderness Community Club	Presented information on *Hydrilla* biology to members of the Pipe/Lucerne Lake Communities
Aquatic Plant Management Society Annual Meeting	07/09-12/95	Bellevue	Chaired a session, attended presentations, took part on the *Hydrilla* Task Force
Met with WDFW Region 6 biologists	07/13/95	Mason County	Conducted informal plant identification training
Hydrilla biomass sampling	07/15/95 & 08/01/95	Pipe Lake, King County	Assisted personnel from Portland State University with attaining growth rate estimates for *Hydrilla*
Met with WDFW Region 3 biologist	07/18/95	Yakima County	Conducted informal plant identification training
Met with Nisqually Tribal Representative	07/21/95	Ecology Building, Lacey	Assisted with plant identification
Aquatic Plant Workshop	07/22/95	Issaquah, King County	Presented an aquatic plant identification talk
Field trip with Lewis and Thurston County Weed Control Personnel	07/27/95	Chehalis River, Lewis County	Surveying population of *Myriophyllum aquaticum*
Met with WDFW Region 1 Biologists	08/24/95	Spokane County	Conducted informal plant identification training
Washington Lakes Protection Association Annual Meeting	09/07-09/95	Ocean Shores, Grays Harbor County	Presented a talk on non-native aquatic plants in Washington, attended seminars, field trip

Table 2. Continued.

Function	Date	Location	Role
Ecology Anniversary Celebration	09/21/95	Ecology Building, Lacey	Assisted with tours of the Benthic Lab, explained the Aquatic Plant Technical Outreach Program
Met with WDFW Region 6 biologist	09/28/95	Bay Lake, Pierce County	Assisted with plant identification
Washington Lakes Protection Association newsletter	10/02/95		Aquatic Plant article - highlighted *Potamogeton pectinatus*
Met with Thurston County Lakes Personnel	10/18/95 11/02/95	Long Lake, Thurston County	Discussed rake sampling methods, observed bottom barrier installation
Met with WDFW Region 6 biologists	11/07/95	Lawrence Lake, Thurston County	Discussed *Nymphaea odorata* issue
Met with Jefferson County Extension agent, local citizen, WDFW Region 6	11/08/95	Leland Lake, Jefferson County	Discussed options for controlling the *Egeria densa* population
Seminar on New Zealand aquatic plant ecology	11/15/95	University of Washington, Seattle	Attended presentation and discussion with an aquatic plant researcher from New Zealand
Botanical Electronic News	12/01/95		Wrote article summarizing *Hydrilla* control efforts in Washington. Reprinted in Idaho Weed Control Assoc. Newsletter
Thurston County Lakes Reports	12/04/95		Reviewed Long Lake Summary Report and 1995 Survey Results Report
Distributed Herbarium specimens	fall 1995		Sent samples of invasive aquatic plants to weed board personnel, and samples of unusual aquatic plants to several university herbarium collections

Site Visits

Introduction

This section documents aquatic plant surveys conducted during the 1995 field season. The general purpose of site visits was to identify aquatic plants (targeting exotic invasive species), evaluate plant community structure, estimate the extent of, or potential for, aquatic plant problems, and suggest possible management options. Another important aspect of site visits was to expand the aquatic plant database and herbarium collection.

Site Visit Objectives

The objectives for the 1995 site visits were:

- to revisit selected lakes with exotic invasive plants to assess plant population changes since 1994;

- to conduct field surveys in selected lakes that were not surveyed during the 1994 field season;
- to confirm rare plant sightings from the 1994 field season; and
- to initiate a plant monitoring project on selected lakes.

Refer to the 1995 Aquatic Plant Technical Assistance Implementation Plan (Parsons, 1995b) for a more complete discussion of these objectives. During site visits, meetings with lake residents 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.

General Field Methods

For a detailed discussion of field methods and data quality control refer to Parsons (1995b). The main goal of site visits is to create the most comprehensive species list possible. This facilitates identification of potentially problematic aquatic plants. 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 using a weighted rake, by hand-pulling or by visual observation.

In addition, notes on species distribution, abundance, and maximum growth depth are made. This method was recommended by other aquatic plant researchers (Sytsma, 1994; Warrington, 1994) and was used successfully during 1994.

Some water quality and sediment data were collected on selected lakes (Table 3). This was ancillary to the plant data, so frequency of sample collection was limited by time and logistical constraints. These parameters were chosen because they have been shown to influence plant community type (Srivastava *et al.*, 1995; Smart, 1990; Barko and Smart, 1986; Barko, 1985; McKenna, 1984; Kadono, 1982; Hellquist, 1980). 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 using a digital titrator to determine phenolphthalein and total alkalinity as $CaCO_3$. Secchi depth was also measured in deep water. Sediment organic matter, density, and penetrability were collected in the littoral zone. Samples for laboratory analysis of organic matter and density were collected using a hand corer (clear plastic tubes). Penetrability was determined using an impact penetrometer designed for lake sediments (Coley *et al.* 1994). The penetrometer was tested on different substrate types for replicability of results early in the field season.

Table 3. Summary of water quality and sediment analyses.

Parameter	Method	Method Precision
Alkalinity	Hach field test kit using Phenolphthalein and a digital titrator	± 10 mg/L
Secchi depth	visual observation	± 0.1 m
Sediment percent organic matter	EPA method 160.4	± 1 mg/Kg
Sediment density	dry and weigh a known volume	± 1 mg/mL
Sediment penetrability	impact penetrometer	± 1 cm

Field visits occurred between late spring and early fall to correspond with the time of maximal growth and flowering. Sampling locations were recorded with a written description, visual placement on a map, and with a Global Positioning System (GPS) unit.

Collections were made of any unusual species and of 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 1995 field season 83 site visits were made to 70 waterbodies. Highlights of results from these surveys are provided in the following section. In addition, several special projects were undertaken which will be discussed in subsequent sections. These include:

- the discovery of *Hydrilla verticillata*;
- the expansion of *Egeria densa* in Leland Lake;
- the extent of *Myriophyllum aquaticum* in the Chehalis River;
- control efforts for *Myriophyllum spicatum* in Wapato Lake;
- the presence of other nonnative plants not listed on the noxious weed list; and
- results from the initial stages of a plant monitoring project.

General Results

Table 4 lists the lakes where aquatic plant data were gathered during the 1995 field season, the extent of the survey conducted, and any plants of concern that were found. Figures 1, 2, and 3 show where known populations of the noxious invasive aquatic plants *Myriophyllum spicatum*, *Egeria densa*, and *Myriophyllum aquaticum* occur in Washington.

The most significant finding was the discovery of *Hydrilla verticillata* through a combined effort of King County Surface Water Management and Ecology. This is the first known population of this invasive aquatic plant in Washington. Much field time was diverted from planned activities to deal with this problem (see *Hydrilla* section below). Of additional interest, one previously unknown population of *Myriophyllum spicatum* was found in Babcock Ridge Lake, Grant County. Also, two populations of *Myriophyllum aquaticum* in private lakes (in Snohomish County and Island County) and one population of *Myriophyllum spicatum* from a private pond in Clallam County were brought to my attention by Weed Board and other state agency personnel. Identification of these plants was confirmed from site visits or delivered plant material. There were two lakes for which *M. spicatum* had been reported, but upon inspection, none was found (Buffalo Lake, Okanogan County; Curlew Lake, Ferry County). Because the surveys are conducted from the surface, small populations of any plant may be overlooked. However, if these two lakes do contain *M. spicatum*, it was not growing at nuisance proportions. Additional information contained in the database can be provided upon request for any of the listed waterbodies.

Table 4. Site visit and results summary table.

County	Waterbody Name	WRIA	Date	Survey Extent	Plants of Concern
Chelan	Wapato Lake	47	6/27/95 8/8/95 9/11/95	whole littoral whole littoral whole littoral	*Myriophyllum spicatum*
Clallam	Unnamed (30N-04W-17)	18	7/13/95	ID from plant sample	*Myriophyllum spicatum*
Clark	Caterpillar Slough	28	8/15/95	spot check from boat	*Myriophyllum spicatum*
	Columbia River at Ridgefield	28	8/15/95	spot check from boat	*Myriophyllum spicatum* *Lythrum salicaria*
	Vancouver Lake	28	8/15/95	spot check from shore	none
Cowlitz	Silver Lake	26	9/19/95	several sites, from boat	none
	Solo Slough	25	8/16/95	from shore	*Cabomba caroliniana* *Egeria densa* *Ludwigia peploides* *Myriophyllum aquaticum* *Myriophyllum spicatum*
	Willow Grove Slough	25	8/16/95	several sites, from boat	*Cabomba caroliniana* *Lythrum salicaria* *Myriophyllum spicatum*
Ferry	Curlew Lake	60	8/22/95	5 sites, whole littoral	none
	Ellen Lake	58	8/23/95	whole littoral	none
	Trout Lake	58	8/22/95	whole littoral	none
	Twin Lakes	58	8/23/95	4 sites, both lakes	none
Franklin	Scooteney Reservoir	36	7/26/95	spot check from shore	*Myriophyllum spicatum*
Grant	Babcock Ridge Lake	41	7/24/95	2 sites, whole littoral	*Myriophyllum spicatum* *Lythrum salicaria*
	Billy Clapp Lake	42	8/30/95	4 sites, whole littoral	*Myriophyllum spicatum*
	Canal Lake	41	8/30/95	4 sites, whole littoral	*Lythrum salicaria*
	Corral Lake	41	7/25/95	whole littoral	*Lythrum salicaria*
	Crater Lake	41	7/24/95	spot check from shore	none
	Evergreen Lake	41	9/12/95	8 transects, whole littoral	*Myriophyllum spicatum* *Lythrum salicaria*
	Long Lake (17N-29E-32)	41	8/31/95	2 sites, whole littoral	none
	Quincy Lake	41	9/13/95	3 transects, whole littoral	*Lythrum salicaria*
	Soda Lake	41	7/25/95	whole littoral	none
	Warden Lake	41	7/25/95	2 sites, whole littoral	*Lythrum salicaria*
	Winchester Wasteway	41	7/26/95	spot check from shore	*Lythrum salicaria*
	Windmill Lake	41	8/30/95	south end	none
Grays Harbor	Duck Lake	22	9/9/95	2 sites, from shore	*Egeria densa*
Jefferson	Crocker Lake	17	6/14/95	whole littoral	none
	Leland Lake	17	10/3/95	whole littoral	*Egeria densa*
		17	6/14/95	whole littoral	
		17	11/8/95	Egeria site	
King	Lucerne Lake	9	6/9/95	outlet	*Hydrilla verticillata*
			7/15/95	spot check	*Myriophyllum spicatum*

Table 4. Continued.

County	Waterbody Name	WRIA	Date	Survey Extent	Weedy Exotic Plants
King (cont'd)	Pipe Lake	9	6/1/95 6/9/95	several sites, divers near boat launch, outlet	*Hydrilla verticillata* *Myriophyllum spicatum*
			7/12/95	from shore	
			7/15/95	6 sites, biomass samples	
			8/1/95	6 sites, biomass samples	
Kitsap	Kitsap Lake	15	8/3/95	2 sites, whole littoral	none
	Long Lake	15	3/17/95	6 transects, whole littoral	*Egeria densa* *Lythrum salicaria* *Myriophyllum spicatum*
	Panther Lake	15	8/2/95	whole littoral	none
	Wildcat Lake	15	10/4/95	4 sites, whole littoral	none
Klickitat	Columbia River at Bingen	29	8/14/95	spot check from shore	*Myriophyllum spicatum*
	Columbia River at Maryhill	30	8/14/95	spot check from boat	*Myriophyllum spicatum*
	Horsethief Lake	30	8/14/95	spot check from shore	*Myriophyllum spicatum*
Lewis	Chehalis River	23	7/27/95	shoreline, from boat	*Myriophyllum aquaticum*
Mason	Isabella Lake	14	8/2/95	checked for rare plant	none
	Limerick Lake	14	7/13/95	spot check, boat	*Egeria densa* *Utricularia inflata*
	Spencer Lake	14	7/13/95	spot check, boat	*Lythrum salicaria*
Okanogan	Alta Lake	48	6/29/95	whole littoral	none
	Big Twin Lake	48	8/9/95	most of littoral	none
	Buffalo Lake	53	8/21/95	3 sites, boat	none
	Davis Lake	48	8/9/95	whole littoral	none
	Green Lake	49	6/29/95	2 sites, whole littoral	none
	Little Twin Lake	48	8/9/95	whole littoral	none
	Palmer Lake	49	6/28/95	whole littoral	none
	Patterson Lake	48	8/10/95	2 sites, whole littoral	none
	Pearrygin Lake	48	8/10/95	3 sites, whole littoral	*Lythrum salicaria*
	Whitestone Lake	49	6/28/95	6 sites, whole littoral	*Myriophyllum spicatum*
Pierce	Bay Lake	15	9/28/95	whole littoral	none
Snohomish	Goodwin Lake	7	6/20/95	3 sites, littoral survey	*Myriophyllum spicatum*
	Nina Lake	7	6/20/95	2 sites, from shore	*Myriophyllum aquaticum*
	Roesiger (south arm) Lake	7	6/21/95	east side, littoral	*Sagittaria graminea*
		7	8/29/95	spot check, boat	
Spokane	Chapman Lake	34	8/24/95	3 sites	none
	Long Lake (Reservoir)	54	8/25/95	1 site	*Lythrum salicaria* *Nymphoides peltata*
	Silver Lake	34	8/24/95	2 sites	none
Thurston	Black Lake	23	4/18/95	1 site to test methods	none
	Hicks Lake	13	5/24/95	3 sample sites, shoreline	none
	Lawrence Lake	13	11/7/95	spot check from shore	none
	Long Lake	14	6/6/95 9/20/95	spot check milfoil site	maybe *M. spicatum*

Table 4. Continued.

County	Waterbody Name	WRIA	Date	Survey Extent	Weedy Exotic Plants
Thurston	Long Lake (continued)		10/18/95	spot check	maybe *M. spicatum*
			11/2/95	milfoil site	
Wahkiakum	Columbia River at Cathlamet	25	8/16/95	spot check, boat	*Lythrum salicaria* *Myriophyllum spicatum*
Wahkiakum	Puget Island Sloughs	25	5/16/95	2 sloughs, from shore	*Egeria densa*
					Myriophyllum aquaticum
Whatcom	Whatcom Lake	1	6/21/95	3 sites, littoral, west basin	*Myriophyllum spicatum*
Yakima	Giffin Lake	37	7/19/95	from shore	none (*Nymphaea odorata*)
	Morgan Lake	37	7/19/95	spot check, from shore	none (*Nymphaea odorata*)
	Unnamed pond (14N-19E-31)	39	7/18/95	spot check, from shore	none
	Unnamed Ponds (12N-19E-20)	37	7/18/95	spot check, from shore	*Myriophyllum spicatum*
	Yakima River	37	7/19/95	shoreline, from boat	none

Figure 1. Known locations of *Myriophyllum spicatum* in Washington.

County	No.	Waterbody Name	County	No.	Waterbody Name
Chelan	1	Chelan Lake	Kitsap	39	Long Lake
Chelan	2	Cortez (Three) Lake	Klickitat	40	Columbia River at Bingen
Chelan	3	Domke Lake	Klickitat	41	Columbia River at Maryhill
Chelan	4	Wapato Lake	Klickitat	42	Horsethief Lake
Clallam	5	Unnamed (30N-04W-17)	Lewis	43	Carlisle Lake
Clark	6	Caterpillar Slough	Lewis	44	Riffe Lake
Clark	7	Columbia River at Ridgefield	Lewis	45	Swofford Pond
Cowlitz	8	Willow Grove Slough	Okanogan	46	Osoyoos Lake
Franklin	9	Scooteney Reservoir	Okanogan	47	Whitestone Lake
Grant	10	Babcock Ridge Lake	Pend Oreille	48	Little Spokane River
Grant	11	Banks Lake	Pend Oreille	49	Pend Oreille River
Grant	12	Billy Clapp Lake	Pend Oreille	50	Sacheen Lake
Grant	13	Evergreen Lake	Pend Oreille	51	Trask Pond
Grant	14	Moses Lake	Pierce	52	Clear Lake
Grant	15	Potholes Reservoir	Skagit	53	Big Lake
Grant	16	Stan Coffin Lake	Skagit	54	Clear Lake (34N-05E-07)
Grant	17	Winchester Wasteway	Skagit	55	McMurray
Grant	18	Winchester Wasteway Ext.	Skagit	56	Sixteen Lake
Island	19	Goss Lake	Snohomish	57	Goodwin Lake
King	20	Angle Lake	Snohomish	58	Shoecraft Lake
King	21	Bass Lake	Snohomish	59	Silver Lake (28N-05E-30)
King	22	Desire Lake	Snohomish	60	Stevens Lake
King	23	Green Lake	Spokane	61	Eloika Lake
King	24	Lucerne Lake	Spokane	62	Liberty Lake
King	25	Meridian Lake	Stevens	63	Gillette Lake
King	26	Number Twelve Lake	Stevens	64	Heritage Lake
King	27	Otter (Spring) Lake	Stevens	65	Sherry Lake
King	28	Phantom Lake	Stevens	66	Thomas Lake
King	29	Pipe Lake	Thurston	67	Long Lake
King	30	Sammamish Lake	Wahkiakum	68	Columbia River at Cathlamet
King	31	Sawyer Lake	Whatcom	69	Whatcom Lake
King	32	Shadow Lake	Yakima	70	Byron Lake
King	33	Shady Lake	Yakima	71	Unnamed Ponds (12N-19E-20)
King	34	Ship Canal			
King	35	Steel Lake			
King	36	Union Lake			
King	37	Washington Lake			
King	38	Wilderness Lake			

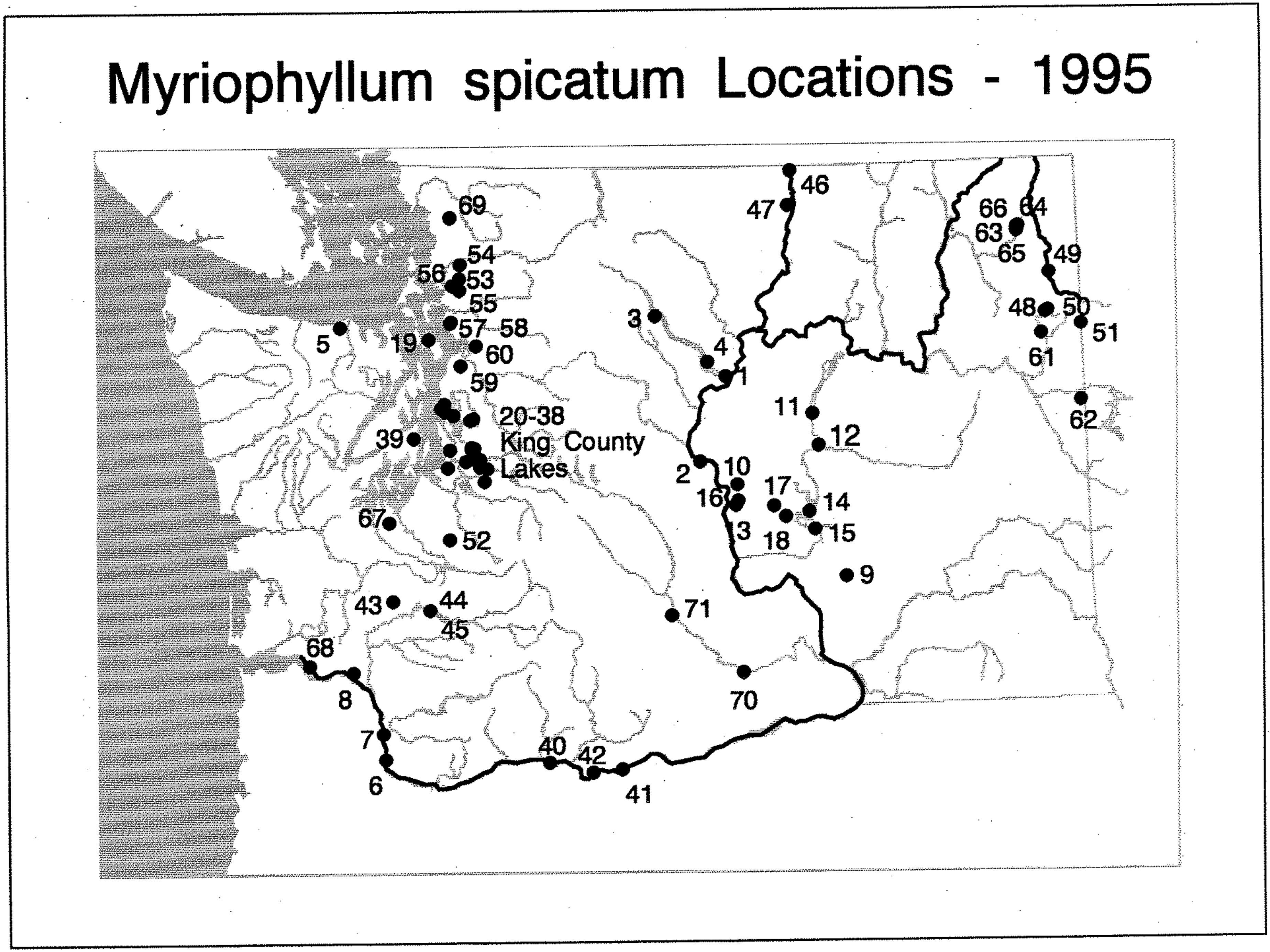


Figure 1. Continued.

Figure 2. Known locations of *Egeria Densa* in Washington.

County	No.	Waterbody Name
Clark	1	Battleground Lake
Clark	2	Lacamas Lake
Cowlitz	3	Solo Slough
Cowlitz	4	Willow Grove Slough
Grays Harbor	5	Duck Lake
Jefferson	6	Leland Lake
King	7	Fenwick Lake
Kitsap	8	Long Lake
Mason	9	Limerick Lake
Pacific	10	Black Lake
Skagit	11	Big Lake
Snohomish	12	Swartz Lake
Wahkiakum	13	Puget Island Sloughs

Egeria densa Locations - 1995

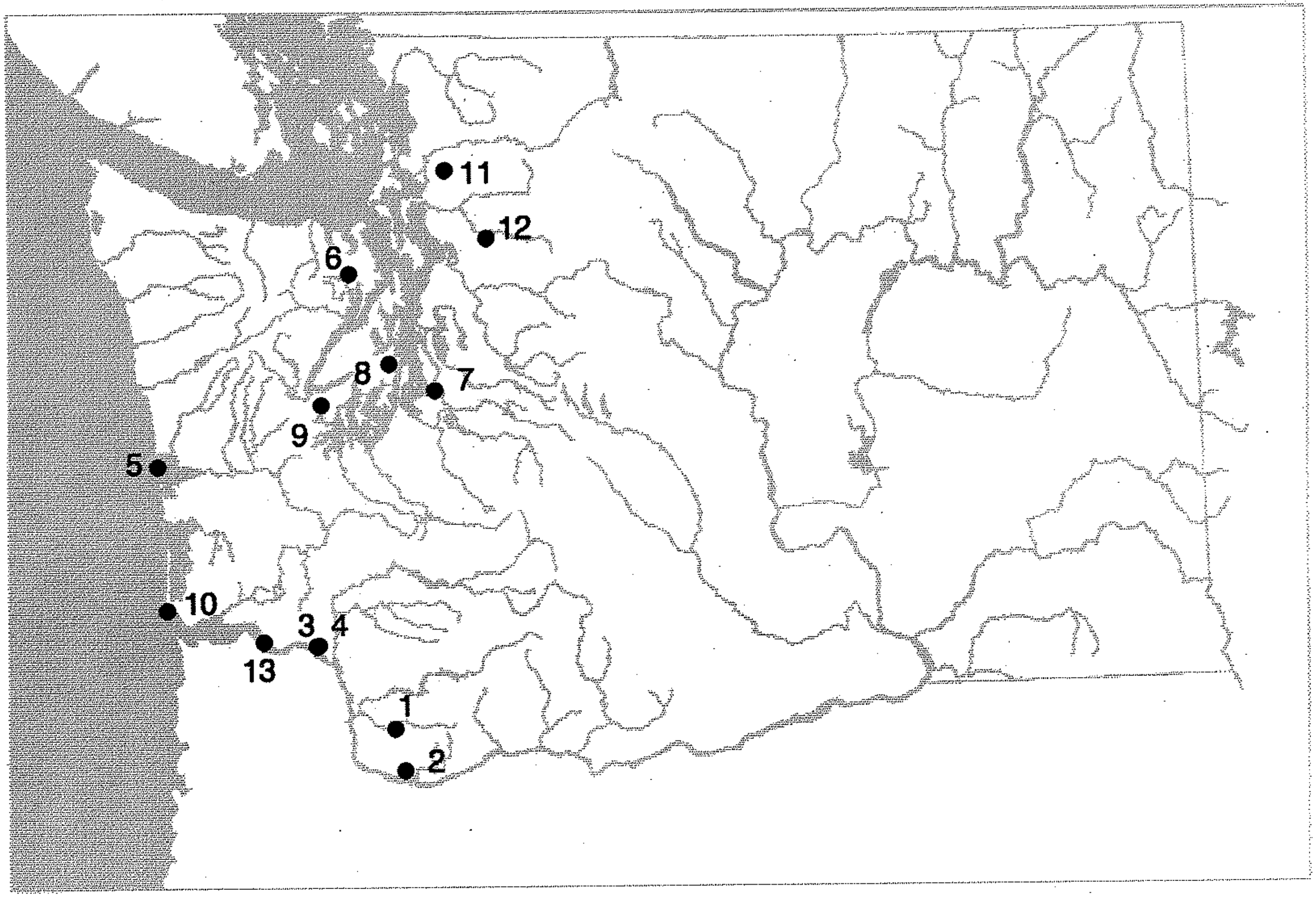


Figure 2. Continued.

Figure 3. Known locations of *Myriophyllum aquaticum* in Washington.

County	No.	Waterbody Name
Cowlitz	1	Solo Slough
Island	2	Unnamed Pond (31N-02E-35)
Lewis	3	Chehalis River
Snohomish	4	Nina Lake
Wahkiakum	5	Columbia River at Skamokowa
Wahkiakum	6	Puget Island Sloughs

Myriophyllum aquaticum Locations - 1995

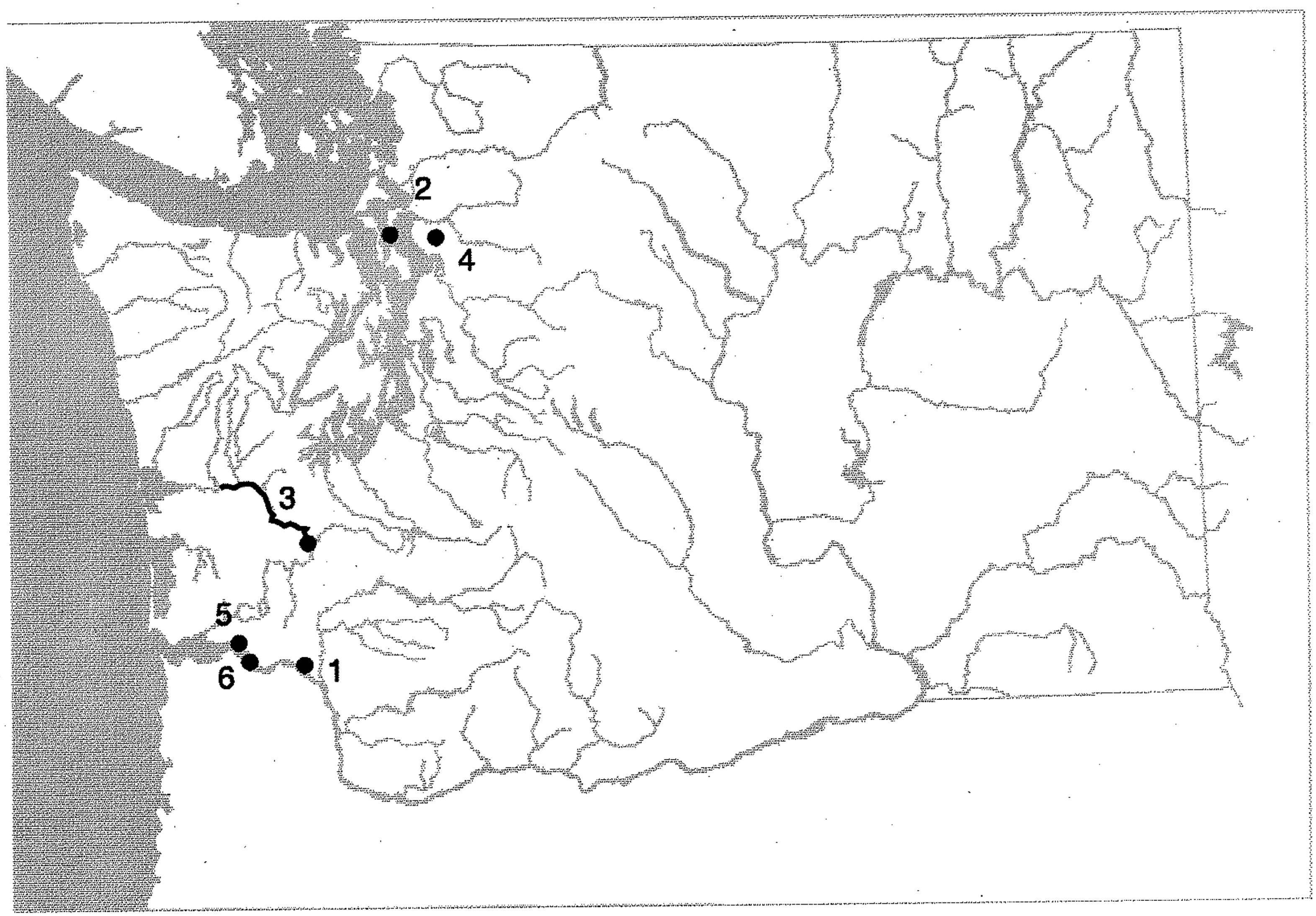


Figure 3. Continued.

Hydrilla Verticillata - Summary of Activities

The presence of *Hydrilla verticillata* was confirmed in Pipe Lake (King County) on June 1, 1995. *Hydrilla* is an aggressive nonnative aquatic plant which will out-compete the native vegetation if given the opportunity. Where it has become established (in the southern United States as far north as Delaware and west to California) its rapid growth has radically changed aquatic environments. Millions of dollars are spent each year attempting to control its growth (Langeland, 1990; Anderson, 1987). Because this is the first known population of *Hydrilla* in the northwest, aggressive action was taken to attempt its eradication.

The *Hydrilla* population is located in the 73 acre Pipe/Lucerne Lake system in southern King County (approximately 20 miles southeast of Seattle). Identification was confirmed by the presence of distinguishing tubers and through enzyme analysis conducted at the University of California, Davis. The enzyme analysis also indicated that this *Hydrilla* population is the monoecious variety (Ryan, 1995). The plants are well distributed throughout the lake, but were still in a pioneering stage. After the identification was confirmed, the Department of Ecology began working closely with personnel from King County Surface Water Management Division to decide on a plan of action. The following sequence of events ensued:

- A public meeting was held for community members, attended by more than 100 people. At the same time the media was notified, and several television stations and newspapers reported on the problem.

- The Aquatic Plant Management Society held their annual meeting in Bellevue, Washington, in early July. A *Hydrilla* Task Force was formed from scientists attending this meeting, all of whom have had experience dealing with *Hydrilla* in other parts of the country. The Task Force recommended treating the lake with aquatic herbicides and stocking sterile grass carp to eradicate the plant. Quarantining the lakes, screening the outlet, and posting signs about *Hydrilla* were also encouraged. (Note: the lakes are owned and managed by private community associations, so quarantining was not practical. Also, the outlet is seasonal and immaculately groomed by home owners, so screening was not undertaken.)

- An experienced dive team was hired to map the *Hydrilla* population (Figure 4) and to survey several lakes near Pipe/Lucerne Lake to see if the plant had spread. No other populations of *Hydrilla* have been found.

- An emergency rule was developed to list *Hydrilla* as a Class A weed on the State Noxious Weed List. This provides the state with more authority to control the plant.

- The lakes were treated with a systemic aquatic herbicide during August and September. The objective was to weaken the plants before they began setting tubers (which happens when day length shortens to less than 13 hours).

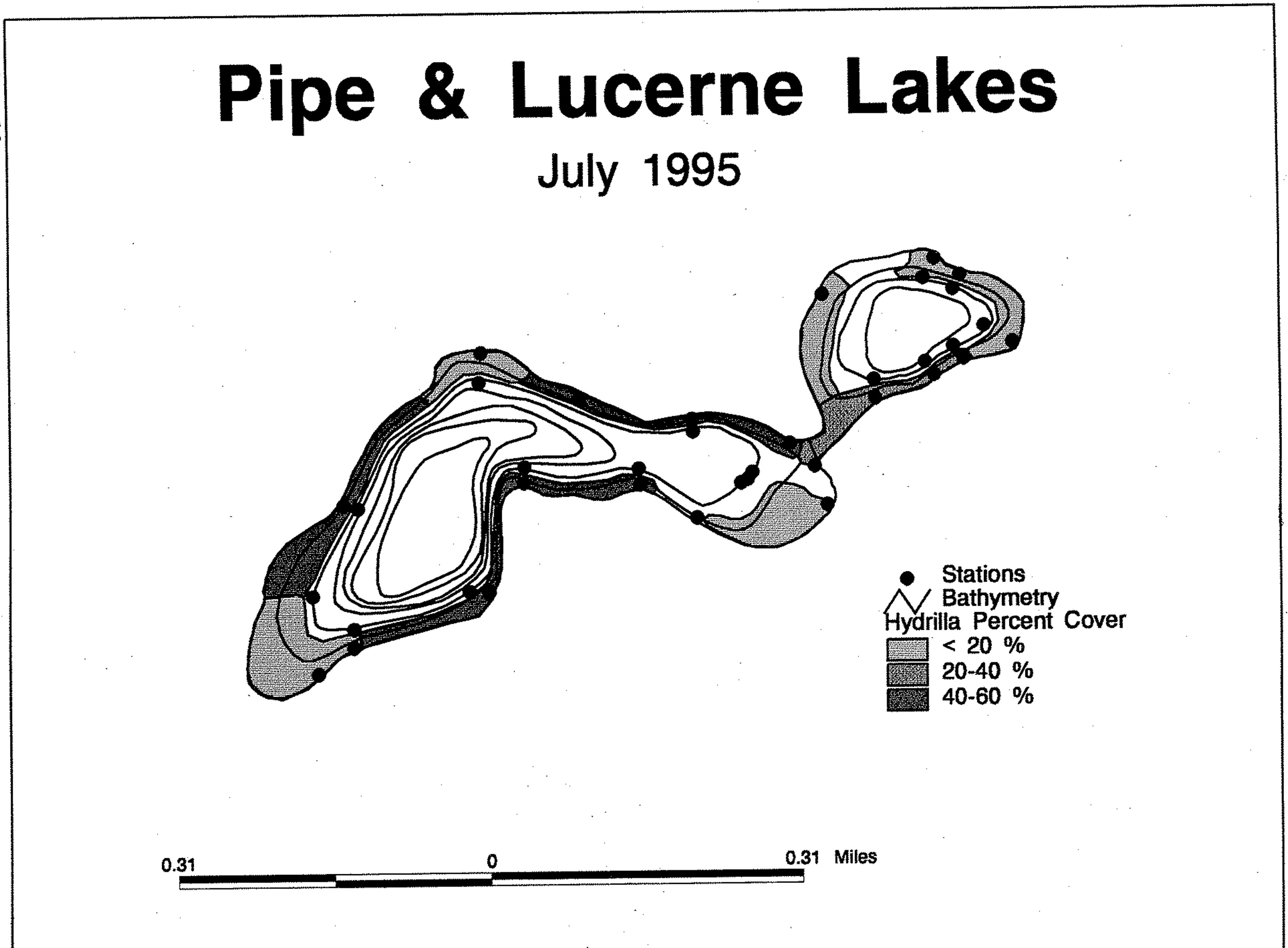


Figure 4. Percent cover of *Hydrilla* in Pipe and Lucerne Lakes.

- King County Surface Water Management personnel developed and posted informational signs at the boat launches.

- Another public meeting was held in the fall of 1995. At that time, the *Hydrilla* looked weakened, and what small tubers were produced did not appear viable (Hamel, 1995).

Because of *Hydrilla*'s many over-wintering and reproductive strategies (tubers, turions, seeds) it is doubtful that one season of herbicide treatment will eliminate it (Van and Steward, 1990). Successful eradication will be a long term project. Decisions will be made late next spring when the plants begin growth whether to continue with herbicide treatments, stock sterile grass carp, or both.

Egeria densa in Lake Leland

Lake Leland is a 110 acre shallow lake in rural eastern Jefferson County. It supports a diverse community of native vegetation which appears to host much wildlife. Casual observation disclosed newts laying eggs on native pondweeds, large duck flocks, and several wintering trumpeter swans. The fish biologist for this area stated that Lake Leland supports the best warm water fishery in the region (Collins, 1995). During the 1994 field season 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 the *Egeria* population boundaries were recorded with a GPS unit. As can be seen from the resulting maps (Figure 5), the population is expanding, and starting to encroach on the main lake body. During the fall, a meeting was convened with a lake resident and a Jefferson County Extension agent to discuss options for curtailing the weed's expansion.

Unfortunately, the *Egeria densa* has grown to proportions beyond feasible control using hand or mechanical means available to the lake residents. Additional meetings have been scheduled with the community residents to discuss control options, and to look at possible funding mechanisms.

Myriophyllum aquaticum in the Chehalis River: Lewis, Thurston, and Grays Harbor Counties

The Chehalis River *Myriophyllum aquaticum* population was initially discovered in 1990 or 1991 upstream of the Satsop River mouth in Grays Harbor County. The appropriate officials were contacted, but at that time no action was taken against the plant (Maynard, 1995). During 1994, Thurston County Noxious Weed Control personnel recognized this plant was causing problems near Centralia. In 1995, a river survey performed cooperatively by Thurston and Lewis County Noxious Weed Control personnel and the Chehalis River Council found that the plant had colonized the river from Centralia (approximately 2.5 miles downstream of Borst Park) to the mouth in Grays Harbor. Most plants occur in small colonies which have apparently started from fragments caught on overhanging vegetation or in backwater areas. There are also a few extensive sites where the plant has taken over entire slough areas. Until this discovery we had believed large populations of *M. aquaticum* in Washington were limited to the Columbia River.

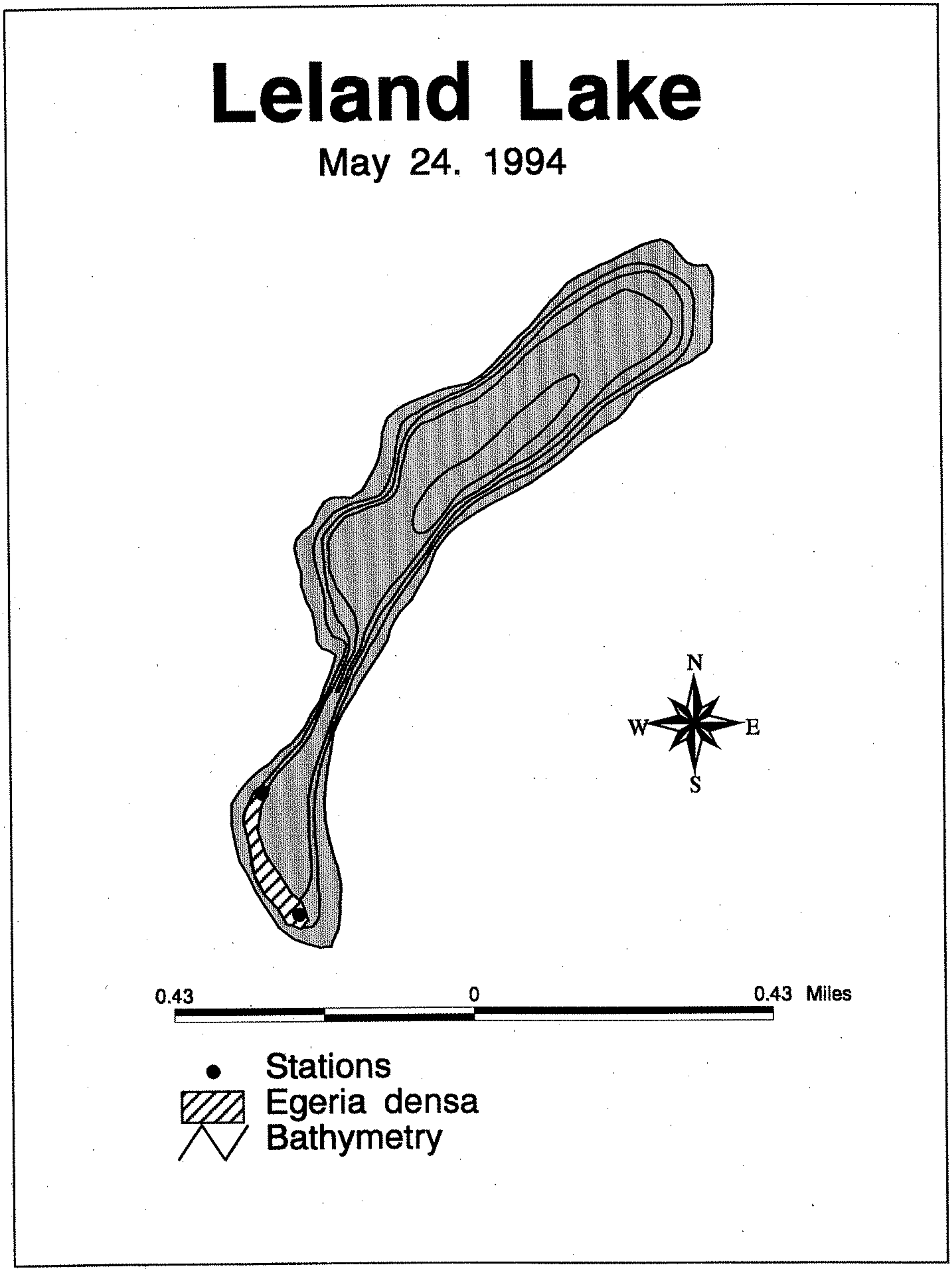


Figure 5. Leland Lake spread of *Egeria densa*.

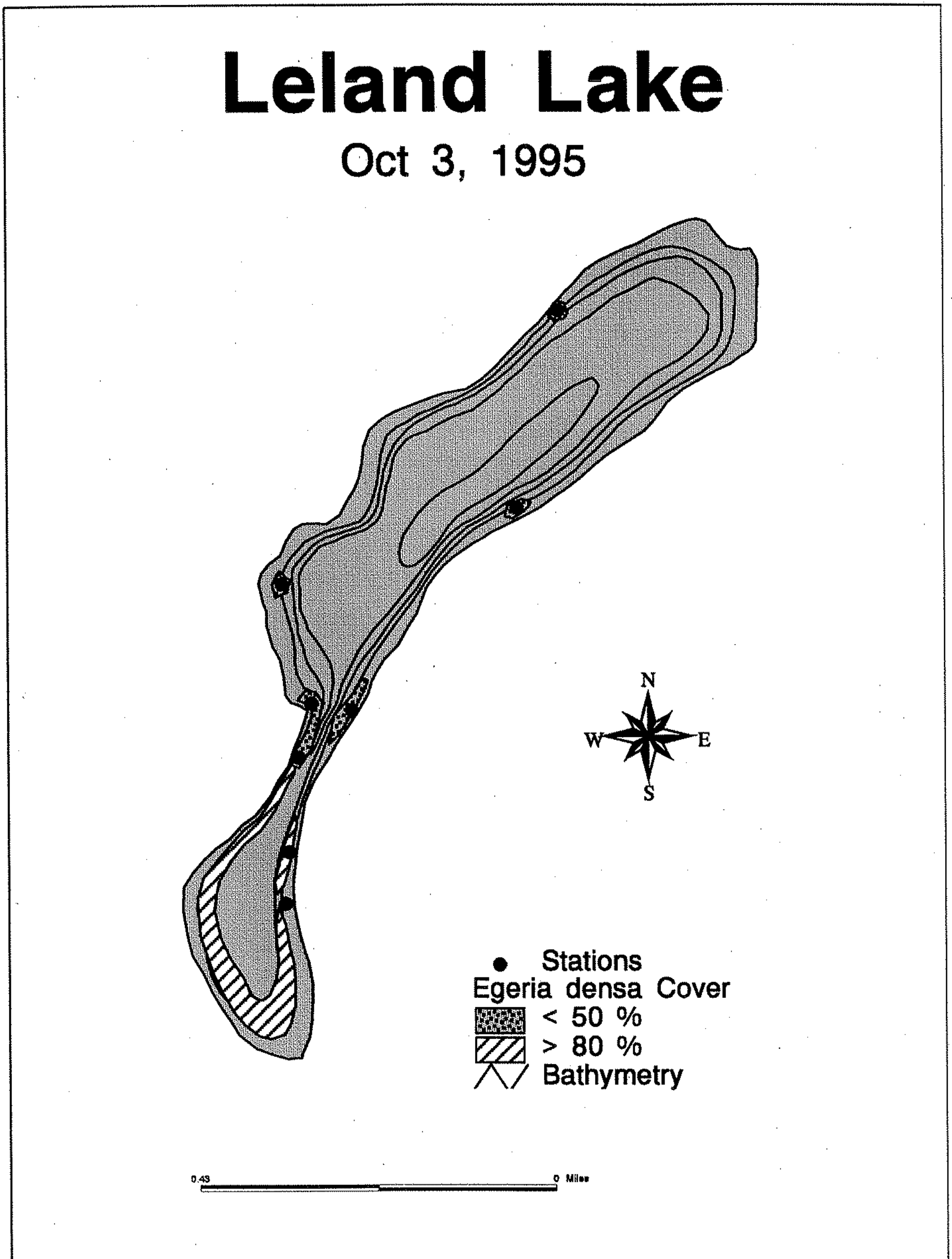


Figure 5. Continued.

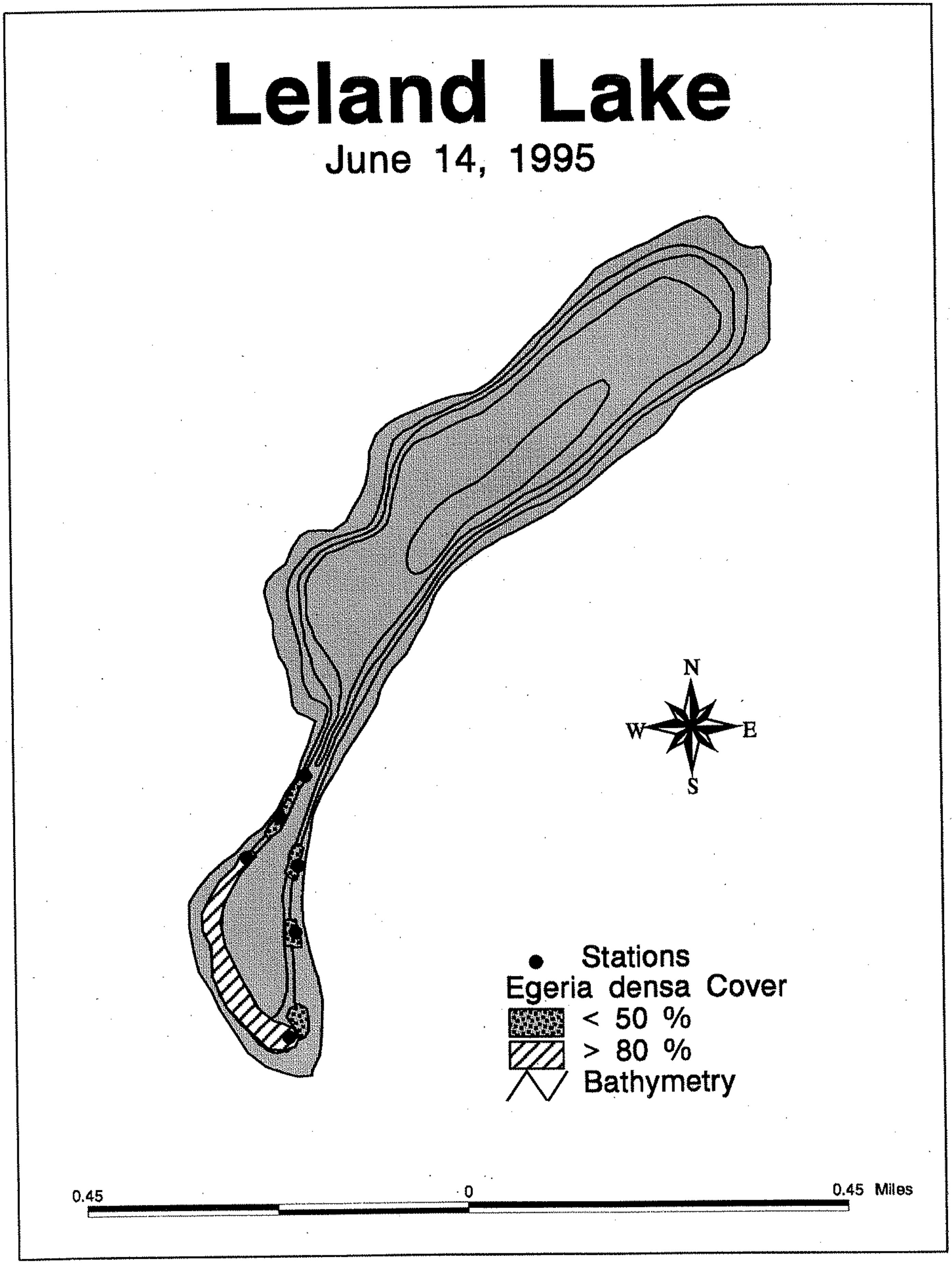


Figure 5. Continued.

During 1995, the Chehalis River Council, and Lewis and Thurston County Weed Control personnel organized volunteer crews to float the river and hand pull the smaller colonies. Because this plant threatens the river's hydrology and ecology, there is strong support to continue control efforts in the future. They plan to proceed with hand pulling small patches using volunteer crews. They are also forming a team of experts in aquatic plant management to devise a plan for long term control, and are applying for grant money from the Aquatic Plant Management Fund (and other sources) to finance the determined course of action (Wamsley, 1996)

Myriophyllum spicatum Control in Wapato Lake, Chelan County

During the 1994 field season, a small patch of *Myriophyllum spicatum* was discovered growing near the boat launch in Wapato Lake (near Lake Chelan, Chelan County). In 1995 this patch was hand pulled on two occasions, and another larger patch was discovered near the dock at the private campground. It is doubtful that these efforts will succeed in eradicating this population since *M. spicatum* will regrow from root crowns (Aiken *et al.*, 1979). Control efforts should be continued in future years, preferably using bottom barriers to cover known patches and any new ones which may develop.

Other Exotic Aquatic Species in Washington

The aquatic plant technical outreach program concentrates efforts on the several aquatic plants listed as noxious by the State Noxious Weed Control Board. These include *Hydrilla verticillata*, *Myriophyllum spicatum*, *Egeria densa*, *Cabomba caroliniana*, *Myriophyllum aquaticum*, and *Lythrum salicaria* (which we include in the aquatic plant program although it is traditionally thought of as a wetland plant).

However, several other adventive plants also occur in state waters. Many of these have apparently fit into the native plant communities, becoming naturalized (including *Vallisneria americana* and *Potamogeton crispus*, two widespread non-invasive plants). Nonetheless, there are a few which tend to become weedy, and which may require attention either occasionally or in the future. These include:

- *Nymphaea odorata* - or fragrant water-lily, native to the eastern United States. This plant has been in Washington for almost 100 years, comes in many horticultural varieties, and is a popular addition to water gardens. Through the years it has been introduced to many lakes throughout Washington. Occasionally it will grow to nuisance proportions, particularly if the waterbody has extensive shallow, muddy areas. Control efforts have been undertaken in several waterbodies.

- *Utricularia inflata* - a species of bladderwort native to the Eastern United States. This plant has been observed in several Western Washington lakes, and usually does not cause problems. However this year Limerick Lake in Mason County experienced a population boom. They controlled growth by hiring students to hand rake the floating vegetation from the water surface.

- *Nymphoides peltata* - a rooted floating leaved plant native to Europe and Asia with attractive yellow flowers. In Washington, it is known from the Long Lake Reservoir on the Spokane River west of Spokane. This plant is forming dense floating mats in water up to 3 m deep. It exhibits characteristics which could cause it to become a nuisance if introduced to lakes with extensive shallow water.

- *Sagittaria graminea* - an arrowhead that is native to the Eastern United States. It forms a thick meadow of submersed vegetation in Lake Roesiger, Snohomish County. It does not appear to grow to the surface except in shallow water. However, it does form near monocultures in certain areas of the lake, so it is impacting the native plant community.

- *Ludwigia peploides* - a rooted plant which forms sprawling mats on the water surface. This plant is native to South America and in Washington dense growth is found in sloughs along the lower Columbia River. During 1995, it appeared to dominate the plant community along slough banks even when growing with several other weedy species including *Cabomba caroliniana, Egeria densa, Myriophyllum aquaticum,* and *Myriophyllum spicatum*. This plant may be flourishing in this area due to exceptional vigor of the plant, to the habitat being particularly favorable, or management strategies may have tended to select for the *Ludwigia*. What ever the reason, this plant should be watched to see that its range does not expand.

Plant Monitoring Project

More in-depth macrophyte data were gathered during September on two isolated Grant County lakes: Evergreen Lake and Quincy Lake. These lakes were chosen because of their close proximity to each other and because Evergreen Lake has a widely distributed population of *Myriophyllum spicatum,* while Quincy Lake does not appear to support a *M. spicatum* population. On each lake, several transects were established running perpendicular to shore. Transect locations were recorded with a GPS unit and a written description. Plants were collected at 1 m depth intervals until the maximum depth of plant growth was reached (or the other side of the lake). The data were used to create bathymetric plant community maps (Figures 6, 7). These transects will be revisited in future years, and compared to see if the plant communities change over time (especially in relation to the dominance of *M. spicatum*).

Rare Plants

In addition to the weedy plants, populations of plants listed as rare by the Washington Natural Heritage Program (WNHP) were observed during the field surveys. *Limosella acaulis* (mudwort), was again observed in Grant County. *Hydrocotyle ranunculoides* was also found in a few Western Washington lakes. In addition, I attempted to confirm last year's sightings of *Ranunculus longirostris* in a Thurston County lake and that of *Potamogeton obtusifolius* in a Mason County lake. However, in both cases the plant could not be found at the phenotypic stage required for positive identification (usually mature fruit) even though the sites were visited late in the growing season. In general, plant vigor appeared lower this year than last year; perhaps cool weather prevented the plants from flowering. Return visits will be made next year to again attempt to observe mature specimens.

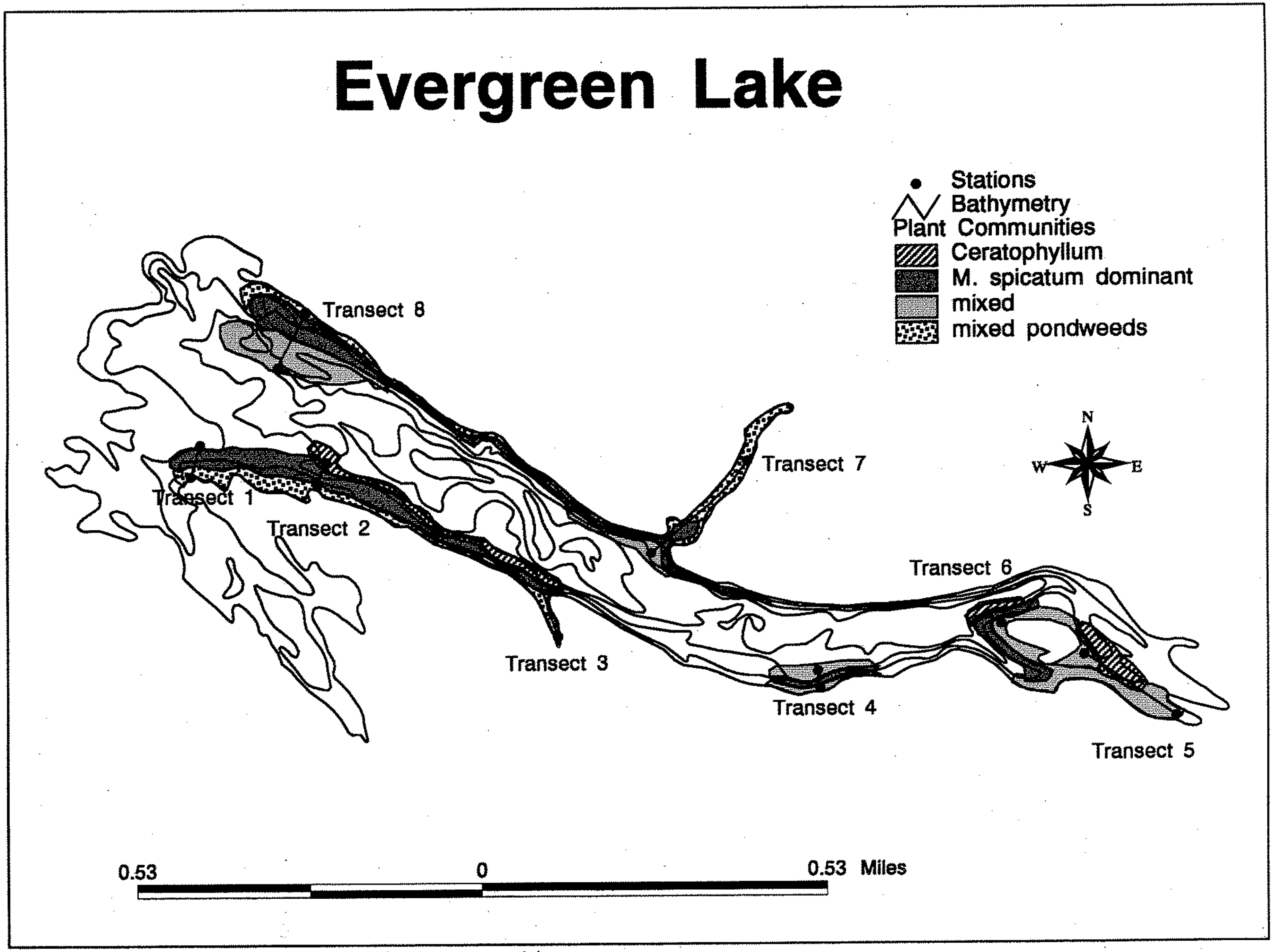


Figure 6. Evergreen Lake aquatic plant communities.

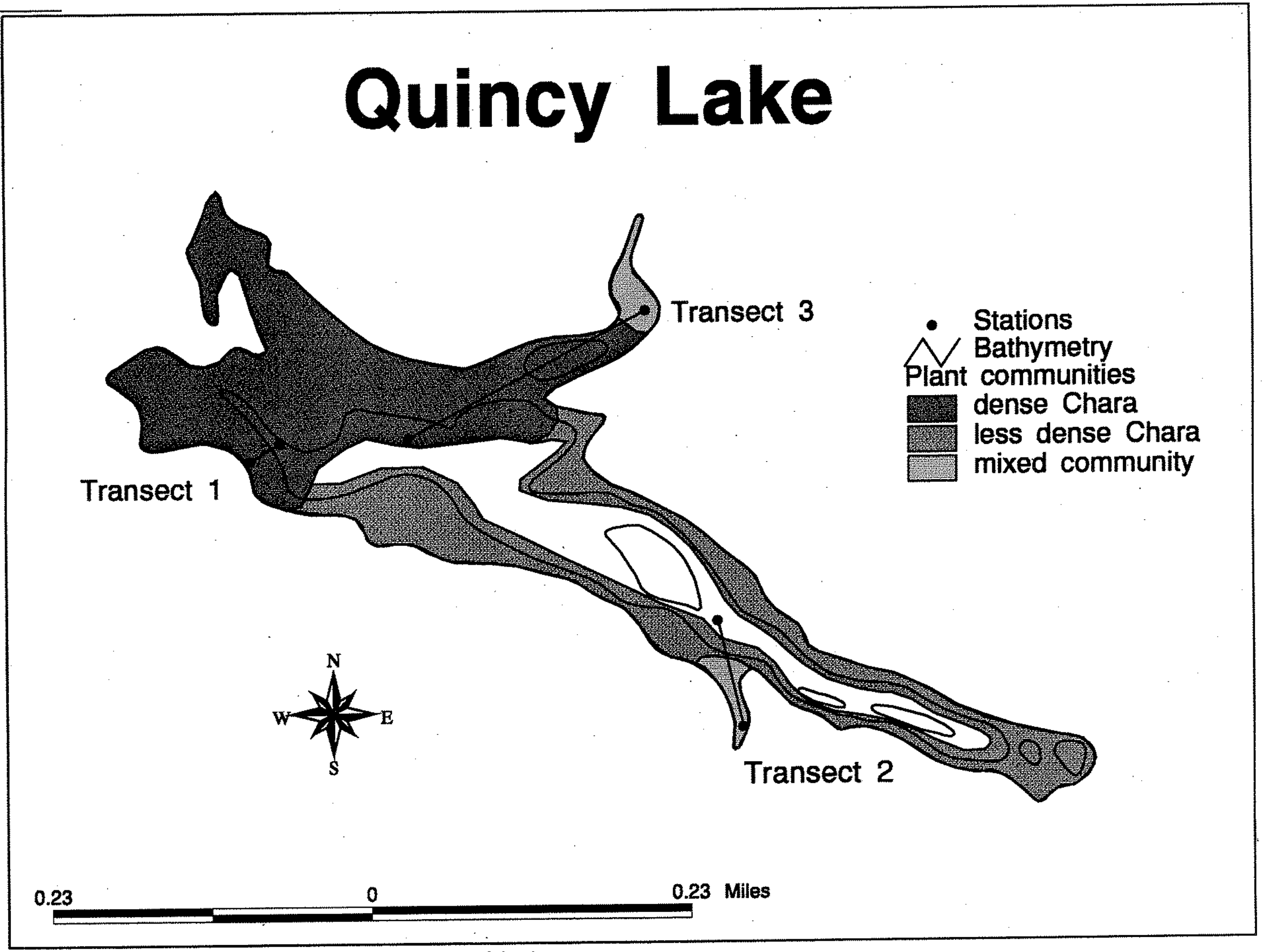


Figure 7. Quincy Lake aquatic plant communities.

Alkalinity Results

There is a wide range of alkalinity values reported for Washington lakes, with the general trend of lower values west of the Cascade Mountains. Table 5 lists results from the alkalinity data collected this year using a field test kit. For comparison, alkalinity data collected by the USGS during previous years is included (from Collings, 1973; Bortleson *et al.*, 1976; Dion *et al.*, 1976; Dion *et al.*, 1980).

The alkalinity data for plants which were observed in at least three different lakes are presented in Figure 8. Most species observed appear to have a broad range of tolerance. In a study of lakes in Japan, Kadono (1982) found *Myriophyllum spicatum,* and *Ceratophyllum demersum* more often in lakes with higher alkalinity (range of *M. spicatum* was 13 to 145 mg/L and *C. demersum* was 9 to 451 mg/L $CaCO_3$). In Washington lakes, *C. demersum* is found nearly throughout the range of alkalinity tested, and alkalinity values for lakes containing *M. spicatum* were within a very similar range to what Kadono found. However, there were several Washington plants associated with a higher median alkalinity value than that for *C. demersum* and *M. spicatum* (including *M. sibiricum, Polygonum amphibium, Ranunculus aquatilus* and *Scirpus americanus*) (Figure 8). These plants were not included in Kadono's study. In another study, Hellquist (1980) studied the correlations between *Potamogeton* species distribution and alkalinity in New England lakes. He found *P. pectinatus* between 30 to 280 mg/L $CaCO_3$, similar to the range it was found in Washington. He found *P. robbinsii,* and *P. amplifolius* in lakes with higher alkalinity than they were observed in this study, although in New England they were most commonly found in waters of low to moderate alkalinity (less than 50 mg/L $CaCO_3$). The other plants observed in both studies *(P. crispus, P. richardsonii* and *P. zosteriformis*) were found in similar alkalinity ranges. The species with the narrowest ranges of tolerance were *Isoetes lacustris, Potamogeton robbinsii, Potamogeton foliosus,* and *Zannichellia palustris*. However, these were also relatively rare in the lakes for which alkalinity data were collected (for instance, there were eight lakes with alkalinity less than 40 mg/L $CaCO_3$, but *Isoetes lacustris* was only seen in three of them). Because of this apparent relationship between number of observations and alkalinity range tolerance, no statistical analyses will be performed on the data until additional observations can be made.

Sediment Characteristics Results

Table 6 lists results from the penetrometer, sediment organic matter, and sediment density analysis. Because not all sediment samples were dried in total, density was not calculated for all lakes where sediment was collected.

In general, sediments from the lakes sampled had relatively low organic matter. With the exception of one sample from Kitsap Lake, all organic matter was 10% or less of the sediment weight. Barko and Smart (1986) found that sediments containing more than 20% organic matter were less supportive of macrophyte growth (Barko and Smart, 1986). If sediments from Washington follow this trend, the majority of the lakes for which these data were gathered do not contain sediment organic matter at levels which would inhibit macrophyte growth. The site in

Table 5. Alkalinity data results.

County	Waterbody Name	This Study		USGS Data	
		Date	Alkalinity mg/L CaCO3	Date	Alkalinity * mg/L CaCO3
Chelan	Wapato Lake	6/27/95	180	4/17/74	150
		8/8/95	172	5/22/74	160
				7/17/74	150
				9/25/74	150
Ferry	Curlew Lake	8/22/95	99		
	Ellen Lake	8/23/95	70		
	Trout Lake	8/22/95	82		
	Twin Lakes	8/23/95	33		
Grant	Babcock Ridge Lake	7/24/95	130		
	Billy Clapp Lake	8/30/95	51		
	Canal Lake	8/30/95	154	4/23/75	238
				5/29/75	233
				8/19/75	157
				9/17/75	227
	Corral Lake	7/25/95	230		
	Evergreen Lake	9/12/95	57		
	Long Lake (17N-29E)	8/31/95	118		
	Quincy Lake	9/13/95	233		
	Soda Lake	7/25/95	97	4/22/75	199
				5/28/75	200
				8/20/75	200
				9/16/75	193
Jefferson	Leland Lake	6/14/95	22		
	Leland Lake	10/3/95	30		
Kitsap	Kitsap Lake	8/3/95	36	2/9/70	34
				10/7/70	44
	Panther Lake	8/2/95	6		
	Wildcat Lake	10/4/95	18	2/10/70	17
				10/7/70	23
Okanogan	Alta Lake	6/29/95	91	5/1/75	136
				6/6/75	140
				8/27/75	132
				9/25/75	144
	Davis Lake	8/9/95	162		
	Green Lake	6/29/95	225		
	Little Twin Lake	8/9/95	163		
	Patterson Lake	8/10/95	79	4/16/74	120
				5/21/74	130
				7/16/74	120
				9/24/74	110
	Pearrygin Lake	8/10/95	114	4/15/74	180
				5/20/74	170
				7/15/74	150
				9/23/74	140
	Whitestone Lake	6/28/95	110		
Snohomish	Goodwin Lake	6/20/95	25	3/13/72	27
				5/12/72	26
				7/27/72	22
				10/10/72	24
Whatcom	Whatcom Lake	6/21/95	19		

* from water samples collected 1 meter below the surface

Figure 8. Box plot of alkalinity ranges for selected macrophytes.

Legend:

Median - is the bar within the box

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

Plant Name Codes (from bottom to top of plot):

Ceratophyllum demersum
Chara sp.
Elodea canadensis
Isoetes lacustris
Myriophyllum sibiricum
Myriophyllum spicatum
Najas flexilis
Nuphar lutea
Nymphaea odorata
Polygonum amphibium
Potamogeton amplifolius
Potamogeton crispus
Potamogeton foliosus
Potamogeton gramineus
Potamogeton illinoensis
Potamogeton pectinatus
Potamogeton praelongus
Potamogeton pusillus
Potamogeton richardsonii
Potamogeton robinsii
Potamogeton zosteriformis
Ranunculus aquatilus
Scirpus americanus
Zannichellia palustris

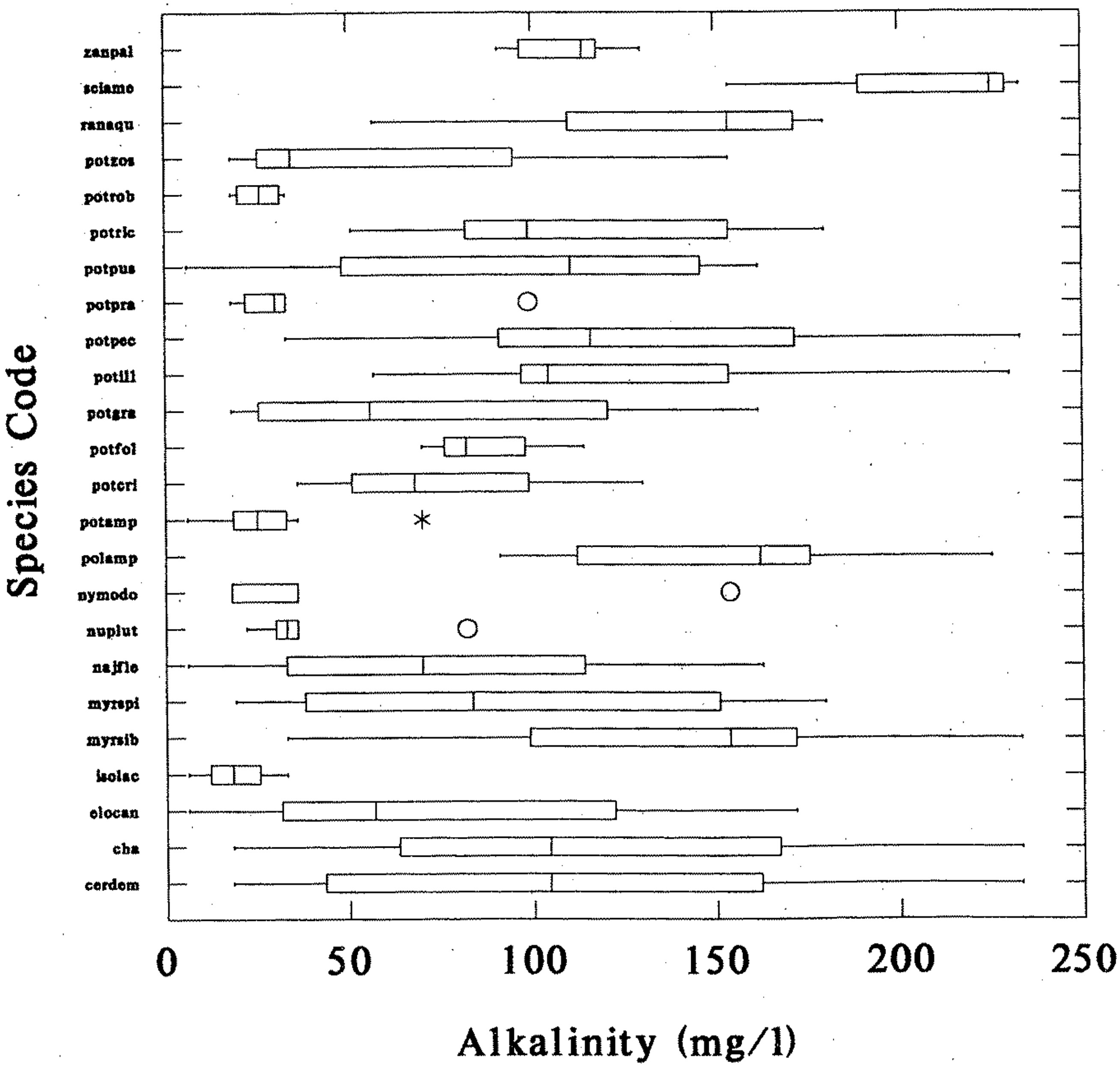


Figure 8. Continued.

Table 6. Sediment data results.

County	Waterbody Name	Date	Penetrometer (cm/strike-50 cm max)	% organic matter	density (g/mL)
Chelan	Wapato Lake	6/27/95	2.2		
		8/8/95		1.3	
Ferry	Curlew Lake	8/22/95	50	2.1	0.02
Grant	Babcock Ridge Lake	7/24/95	5		
	Canal Lake	8/30/95	50	1.7	0.14
	Corral Lake	7/25/95	5.4	5.2	
	Evergreen Lake	9/12/95	4.2	3.1	0.1
		9/12/95	2.4	1.6	0.39
		9/12/95	3.4	2.4	0.29
		9/12/95	4.8	0.2	0.25
	Long Lake (17N-29E-32)	8/31/95	3.2	1.9	0.25
	Quincy Lake	9/13/95	50	1.9	0.06
		9/13/95	9	1.9	0.2
		9/13/95	9.6	2.6	0.21
	Warden Lake	7/25/95	6.6	3.93	
Jefferson	Leland Lake	6/14/95	16.7		
		6/14/95	10		
King	Pipe Lake	8/1/95	3	10	
		8/1/95	2.4	1.86	
Kitsap	Kitsap Lake	8/3/95		30.3	
Mason	Isabella Lake	8/2/95	2.8		
Okanogan	Patterson Lake	8/10/95	2.8	5.3	
	Whitestone Lake	6/28/95	5.8		
Snohomish	Goodwin Lake	6/20/95	2.4		
	Roesiger (south arm) Lake	8/29/95	2.4	8.3	
Spokane	Long Lake (Reservoir)	8/25/95		0.7	0.45
Thurston	Hicks Lake	5/24/95	12.5		
		5/24/95	2.8		
		5/24/95	1.2		

Kitsap Lake where sediment organic matter was high (30%) supported a dense patch of *Nuphar lutea* and several species of *Potamogeton*, so apparently at least these species are able to grow in highly organic sediment.

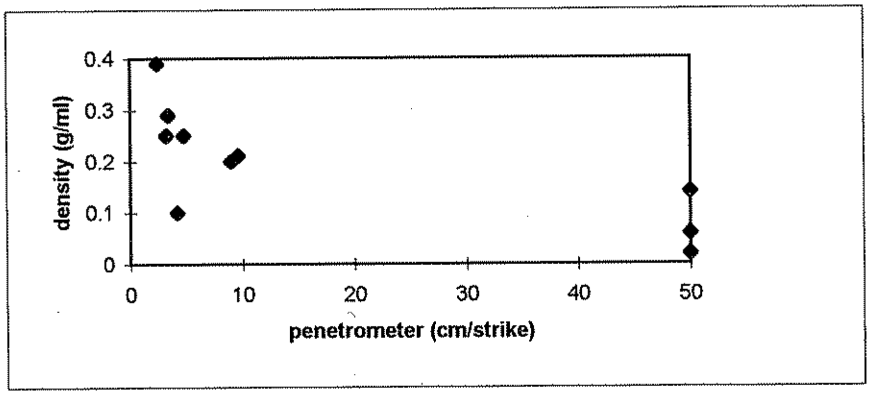
Barko and Smart (1986) also found that sediment density of less than 0.2 g/mL contributed to reduced plant growth. Samples from the following four lakes had low sediment density:

- The sampling site at the shallow southern end of Curlew Lake (0.02 g/mL) supported the fewest plants of all the sites sampled. In this area there was only sparse coverage of *Ceratophyllum demersum* (a non-rooted species) and *Potamogeton pectinatus*, with much bare sediment between plants.
- The site at Evergreen Lake with low density sediment (0.1 g/mL) also had patches of bare sediment, with fairly dense plant coverage in between (mostly *Myriophyllum spicatum*, and *Ranunculus aquatilis*).
- The site at Canal Lake with low density sediment (0.14 g/mL) had a thick layer of *Chara* overlying the sediment. *Chara* is a macroalgae, and has no true roots.
- The other sample with low density came from one site at Quincy Lake (0.06 g/mL). This site supported both rooted macrophytes (mostly *Myriophyllum sibiricum*) and *Chara*.

Additional data for these parameters should be collected in future field seasons for elucidation of any patterns.

The impact penetrometer was developed to measure sediment hardness (Coley *et al.*, 1994). It is expected that sediment hardness would correlate with sediment density (Figure 9). More data should be gathered for these parameters to fill in the mid-range penetrometer values. At that point it may be possible to perform a regression analysis and estimate density from penetrometer measurements.

Figure 9. Penetrometer values vs. sediment density.



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 gathered to use as cross references (Appendix). Kartesz (1994) and The Jepson Manual (Hickman, 1993) are used to ensure the taxonomy is current. In addition, several people from within and outside the agency are consulted in cases where identification is difficult. If this is not satisfactory, the plant is sent to taxonomic experts for an opinion.

In the case of questionable *Myriophyllum* species, samples were sent to the University of Minnesota for DNA analysis. During 1995 this mostly consisted of samples from Long Lake and Lois Lake, Thurston County. In this case, even the DNA analysis did not provide a definitive identification, mainly due to problems with primer amplification (Olfelt, 1995). As a result, Thurston County officials sent live plant samples to the Lewisville Aquatic Ecosystem Research Facility in Lewisville, Texas. Researchers there will grow the plants and expect to identify the species based on morphological and physiological characteristics. Even though the *Myriophyllum* in Long Lake was not confirmed to be *M. spicatum*, it was covered with bottom barrier material as a precautionary measure. (Refer to Thurston County Department of Water and Waste Management (1995) for additional details on the Long Lake project).

Methods Used in Collection and Preservation

The methods we followed are those of Haynes (1984). First, we collected all available parts of the plant (roots, stem, flowering parts) and sealed them 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.

The herbarium collection contains 86 unique taxa from 34 families (Table 7). There is a total of 224 specimens, in most cases more than one specimen represents each species. New specimens 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.

Table 7: 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
Apiaceae		
	Hydrocotyle ranunculoides	water-pennywort
Asteraceae		
	Megalodonta beckii	water marigold
Azollaceae		
	Azolla mexicana	mexican water-fern
Brassicaceae		
	Rorippa nasturtium-aquaticum	water-cress
	Rorippa palustris	marsh yellowcress
	Subularia aquatica	awlwort
Cabombaceae		
	Brasenia schreberi	watershield
	Cabomba caroliniana	fanwort
Callitrichaceae		
	Callitriche anceps	two-edged water-starwort
	Callitriche hermaphroditica	northern water-starwort
	Callitriche stagnalis	pond water-starwort
Campanulaceae		
	Lobelia dortmanna	water gladiole; water lobelia
Ceratophyllaceae		
	Ceratophyllum demersum	Coontail; hornwort
Characeae		
	Nitella sp.	stonewort
Cyperaceae		
	Carex unilateralis	one-sided sedge
	Cyperus erythrorhizos	red rooted cyperus
	Dulichium arundinaceum	Dulichium
	Eleocharis acicularis	needle spike-rush

Table 7. Continued.

Family	Scientific name	Common name
	Eleocharis parvula	small spike-rush
	Scirpus acutus	hardstem bulrush
	Scirpus americanus	american bulrush
	Scirpus cyperinus	wool-grass
	Scirpus fluviatilis	river bulrush
	Scirpus maritimus	seacoast bulrush
	Scirpus subterminalis	fescue scolochloa
Elatinaceae		
	Elatine triandra	three-stamen waterwort
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
	Elodea canadensis	common elodea
	Elodea nuttallii	Nuttall's waterweed
	Hydrilla verticillata	hydrilla
	Vallisneria spiralis	water celery, tapegrass
Isoetaceae		
	Isoetes lacustris	lake quillwort
Juncaceae		
	Juncus acuminatus	tapered rush
	Juncus supinus	bulbous rush
Lemnaceae		
	Wolffia sp.	water-meal

Table 7. Continued.

Family	Scientific name	Common name
Lentibulariaceae		
	Utricularia inflata	big floating bladderwort
	Utricularia minor	lesser bladderwort
	Utricularia sp.	bladderwort
	Utricularia vulgaris	common bladderwort
Menyanthaceae		
	Nymphoides peltata	water fringe
Najadaceae		
	Najas flexilis	common naiad
	Najas gradalupensis	Guadalupe water-nymph
Nymphaeaceae		
	Nuphar polysepalum	spatter-dock, yellow water-lily
Onagraceae		
	Ludwigia palustris	water-purslane
	Ludwigia uruguayensis	water primrose
Poaceae		
	Cinna latifolia	wood reed-grass
	Glyceria borealis	northern mannagrass
	Zizania aquatica	wild rice
Polygonaceae		
	Polygonum amphibium	water smartweed
	Polygonum hydropiperoides	common smartweed
Pontederiaceae		
	Heteranthera dubia	water star-grass
Potamogetonaceae		
	Potamogeton amplifolius	large-leaf pondweed
	Potamogeton crispus	curly leaf pondweed
	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
	Potamogeton nodosus	longleaf pondweed

Family	Scientific name	Common name
	Potamogeton pectinatus	sago pondweed
	Potamogeton praelongus	whitestem pondweed
	Potamogeton pusillus	slender pondweed
	Potamogeton richardsonii	Richardson's pondweed
	Potamogeton robbinsii	fern leaf pondweed
	Potamogeton zosteriformis	eel-grass pondweed
Primulaceae		
	Lysimachia nummularia	creeping loosestrife
Ranunculaceae		
	Ranunculus aquatilis	water-buttercup
	Ranunculus flammula	creeping buttercup
Ruppiaceae		
	Ruppia maritima	ditch-grass
Scrophulariaceae		
	Limosella acaulis	mudwort
	Veronica anagallis-aquatica	water speedwell
Sparganiaceae		
	Sparganium angustifolium	narrowleaf bur-reed
	Sparganium eurycarpum	broadfruited bur-reed
	Sparganium sp.	bur-reed
Zannichelliaceae		
	Zannichellia palustris	horned pondweed

Aquatic Weed Management Fund Related Activities

Several grant applications submitted to the Water Quality Financial Assistance Section for Aquatic Weed Management Fund (AWMF) Grant moneys were reviewed (Table 8). Recommendations on funding priorities were made. This year, for the first time, there were more qualified applicants than money available, so not all projects listed received funding. (For more information on project funding mechanisms contact the AWMF administrator at the Department of Ecology, Water Quality Program).

Table 8. Aquatic Weed Management Fund grant applications - 1995 (projects receiving at least partial funding are indicated by an asterisk).

Applicant	Project Title
Thurston County	Water lily control pilot project
Skagit County	Big Lake weed eradication project *
City of Ocean Shores	Duck Lake weed eradication project *
Skagit County	Lake McMurray plant management plan *
Skagit County	Lakes Campbell, Erie plant management plan
Okanogan County Noxious Weed Board	Purple loosestrife mapping & control project *
Grant County Noxious Weed Board	Purple loosestrife control project *
Pend Oreille County	Bio-control of milfoil pilot project
Stevens County Noxious Weed Board	Little Pend Oreille Lakes milfoil control *
University of Washington	Bio-control of milfoil pilot project *
City of Kent	Lake Meridian plan
King County	Lake 12 implementation project *
King County	Lake Wilderness plan *
Whatcom County Noxious Weed Board	Lake Whatcom milfoil mapping project
Whatcom County Noxious Weed Board	Purple loosestrife control project *
City of Everett	Silver Lake diver dredging project *
South Yakima Conservation District	Giffen Lake water lily control project

Aquatic Plant Field Guide

During 1994, money from the AWMF was targeted for development and production of an Aquatic Plant Field Guide. The guide will include approximately 120 aquatic plants with photographs, line drawings, written descriptions, and notes on the values and natural history of the plants. We selected a consultant team headed by Shapiro and Associates to develop the Guide. During 1995 this team has compiled photographs and drawings of the plants. At the end of the year, they were in the process of combining written descriptions with these illustrations. Each page is carefully reviewed by two Ecology reviewers for accuracy and readability. At the end of this initial review, the completed pages will be reviewed externally. The publication is expected in late 1996.

References

Aiken, S.G., P.R. Newroth, I. Wile, 1979. "The biology of Canadian weeds. 34." Myriophyllum spicatum L. Can J. Plant Science. 59:201-215.

Anderson, L.W.J., 1987. Exotic pest profile number 11: *Hydrilla verticillata*. California Department of Food and Agriculture. Sacramento, CA

Barko, J.W., 1985. Nutrition and Growth of Submersed Macrophytes: The Role of Bottom Sediments. U.S. Army Corps of Engineers publication A-85-1.

Barko, J.W. and R.M. Smart, 1986. "Sediment-related mechanisms of growth limitation in submersed macrophytes." Ecology 67(5):1328-1340.

Bortleson, G.C., G.T. Higgins, J.B. McConnell, and J.K. Innes, 1976. Data on Selected Lakes in Washington, Water Supply Bulletin 42, Part 3. United States Department of the Interior, Geological Survey, Tacoma, WA.

Coley, C.R., S.H. Kay, S.T. Hoyle, 1994. "Development of an impact penetrometer for evaluating compaction of littoral hydrosoils." Journal Aquatic Plant Management, 32:74-76.

Collings, M.R., 1973. Data on Selected Lakes in Washington, Part 1. United States Department of the Interior, Geological Survey. Tacoma, WA.

Collins, D., 1995. Washington Department of Fish and Wildlife. Personal Communication.

Dion, N.P., G.C. Bortleson, J.B. McConnell, and J.K. Innes, 1976. Data on Selected Lakes in Washington, Water-Supply Bulletin 42, Part 5. United States Department of the Interior, Geological Survey. Tacoma, WA.

Dion, N.P., G.C. Bortleson, and J.K. Innes, 1980. Data on Selected Lakes in Washington, Water-Supply Bulletin 42, Part 6. United States Department of the Interior, Geological Survey. Tacoma, WA.

Hamel, K., 1995. Washington Department of Ecology, Water Quality Program. Personal communication.

Haynes, R.R., 1984. "Techniques for collecting aquatic and marsh plants." Ann. Missouri Botanical Garden, 71:229-231.

Hellquist, Barre C., 1980. "Correlation of alkalinity and the distribution of Potamogeton in New England." Rhodora 82:331-344.

Hickman, J.C. ed., 1993. The Jepson Manual - Higher Plants of California. University of California Press. Berkeley, CA.

Kadono, Y., 1982. "Occurrence of aquatic macrophytes in relation to pH, alkalinity, calcium, chloride and conductivity." Japanese Journal of Ecology 32:39-44.

Kartesz, J.T., 1994. A Synonymized Checklist of the Vascular Flora of the United States, Canada and Greenland. 2nd ed, Vol. 1 and 2, Timber Press, Portland, OR.

Langeland, K.A., 1990. *Hydrilla*: a Continuing Problem in Florida Waters. University of Florida Center for Aquatic Plants. Gainesville, FL.

Maynard, C., 1995. Washington Department of Ecology, Water Quality Program. Personal communication.

McKenna, K.A., 1984. Relationships Between Aquatic Macrophytes and the Chemical and Physical Composition of the Substrate in Kahle Lake, Clarion-Venago Counties, Pennsylvania. Ecological Assessment of Macrophyton: Collection, Use, and Meaning of Data, ASTM STP843, W.M. Dennis and B.G. Isom, Eds., American Society for Testing and Materials, 76-87.

Olfelt, J., 1995. College of Natural Resources, University of Minnesota. Personal communication.

Parsons, J., 1995a. Aquatic Plant Technical Assistance 1994 Activity Report. Washington State Department of Ecology, Olympia, WA, Publication No. 95-331.

Parsons, J., 1995b. Aquatic Plant Technical Assistance Implementation Plan - 1995 Field Season. Washington State Department of Ecology, Olympia, WA, Publication No. 95-334.

Ryan, F., 1995. University of California, Davis. Personal Communication.

Smart, R.M., 1990. Effects of Water Chemistry on Submersed Aquatic Plants: a Synthesis. Miscellaneous Paper A-90-4, Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, Miss.

Srivastava, D.S., C.A. Staicer, B. Freedman, 1995. "Aquatic vegetation of Nova Scotian lakes differing in acidity and trophic status." Aquatic Botany 51: 181-196.

Sytsma, M., 1994. Oregon Department of Environmental Conservation. Personal communication.

Thurston County Department of Water and Waste Management, 1995. Long Lake Eurasian watermilfoil eradication project. Thurston County, WA.

Van, T.K., and K.K. Steward, 1990. "Longevity of monoecious hydrilla propagules." Journal of Aquatic Plant Management 28:74-76.

Wamsley, B., 1996. Lewis County Noxious Weed Control Board. Personal communication.

Warrington, P., 1994. British Columbia Ministry of the Environment. Personal communication.

Appendix

Plant Identification References

REFERENCES - PLANT IDENTIFICATION

Brayshaw, T.C. 1985. Pondweeds and Bur-reeds, and their relatives: Aquatic families of monocotyledons in British Columbia. British Columbia Provincial Museum, Occasional paper series, No. 26. Victoria, B.C.

Brayshaw, T.C. 1989. Buttercups, waterlilies and their relatives in British Columbia. Royal British Columbia Museum. Memoir No. 1. Victoria, B.C.

Coffey, B.T. and J.S. Clayton. New Zealand waterplants. Ruakaur Agricultural Centre, Hamilton, New Zealand

Cook, C.D.K. 1990. Aquatic plant book. SPB Academic Publishing. The Hague, The Netherlands.

Correll, D.S. and H.B. Correll. Aquatic and wetland plants of Southwestern United States Vol 1 & 2. Stanford University Press, Stanford, CA.

Crow, G.E. and C.B. Hellquist. 1981. Aquatic vascular plants of New England: Part 2. Typhaceae and Sparganiaceae. University of New Hampshire, Durham, N.H.

Crow, G.E. and C.B. Hellquist. 1982. Aquatic vascular plants of New England: Part 4. Juncaginaceae, Scheuchzeriaceae, Butomaceae, Hydrocharitaceae. University of New Hampshire, Durham, N.H.

Crow, G.E. and C.B. Hellquist. 1983. Aquatic vascular plants of New England: Part 6. Trapaceae, Haloragaceae, Hippuridaceae. University of New Hampshire, Durham, N.H.

Crow. G.E. and C.B. Hellquist. 1985. Aquatic vascular plants of New England: Part 8. Lentibulariaceae. University of New Hampshire. Durham, N.H.

Guard, J.B. 1995. Wetland Plants of Oregon and Washington. Lone Pine Press. Redmond, WA.

Hellquist, C.B. and G.E. Crow. 1982. Aquatic vascular plants of New England: Part 5. Araceae, Lemnaceae, Xyridaceae, Eriocaulaceae, and Pontederiaceae.

Hellquist, C.B. and G.E. Crow. 1984. Aquatic vascular plants of New England: Part 7. Cabombaceae, Nymphaeaceae, Nelumbonaceae, and Ceratophyllaceae. University of New Hampshire, Durham, N.H.

Hickman, J.C. ed. 1993. The Jepson manual - higher plants of California. University of California Press. Berkeley, CA.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle, WA.

Hotchkiss, C.L. 1967. Underwater and floating-leaved plants of the United States and Canada - Resource publication 44. Bureau of Sport Fisheries and Wildlife, US Fish and Wildlife Service. Washington, D.C.

Hotchkiss, N. 1972. Common marsh, underwater & floating-leaved plants of the United States and Canada. Dover Publications, Inc. New York.

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd ed. Vol. 1 and 2. Timber Press, Portland, OR.

Kirk. D.R. 1975. Wild edible plants of western North America. Naturegraph Publishers. Happy Camp, CA

Mühlberg, H. 1982. The complete guide to water plants. EP Publishing Ltd. Germany.

Pieterse and Murphy 1989. Aquatic Weeds. Oxford University Press.

Pojar, J. and A. MacKinnon. 1994. The Plants of the Pacific Northwest Coast; Washington, Oregon, British Columbia and Alaska. Lone Pine Publishing, Redmond, WA.

Prescott, G.W. 1978. How to know the freshwater algae. Wm. C. Brown Co. Publishers. Dubuque, Iowa.

Prescott, G.W. 1980. How to know the aquatic plants. Wm. C. Brown Co. Publishers. Dubuque, Iowa.

Rataj, K. and T.J. Horeman, 1977. Aquarium plants, their identification, cultivation and ecology. T.F.H. Publications, Neptune City, N.J.

Scheurmann, I. 1993. Aquarium Plants Manual. Barron's Educational Series, Inc. New York.

Schmidt, J.C. 1990. How to identify and control water weeds and algae 4th ed. Applied Biochemists, Inc. Milwaukee, WI.

Smith-Kuebel, C. and T.R. Lillybridge. 1993. Sensitive plants and noxious weeds of the Wenatchee National Forest. USDA Forest Service, Wenatchee National Forest. Wenatchee, WA.

Stodola, J. 1987. Aquarium plants, a complete introduction. T.F.H. Publications, Inc. Neptune City, N.J.

Stodola, J. 1967. Encyclopedia of water plants. TFH Publications, Inc Jersey City, N.J.

Steward, A.N.; L.J. Dennis, and H.M. Gilkey. 1963. Aquatic plants of the Pacific Northwest. Oregon State University Press, Corvallis, OR.

Tarver, D.P., J.A. Rodgers, M.J. Mahler, R.L. Lazor. 1979. Aquatic and wetland plants of Florida, 2nd ed. Bureau of Aquatic Plant Research and Control, Florida Department of Natural Resources, Tallahassee, FL.

Warrington, P.D. 1993. Identification keys to the aquatic plants of British Columbia. Unpublished manuscript.

Warrington, P.D. 1980. Studies on aquatic macrophytes part XXXIII; aquatic plants of British Columbia. Province of British Columbia, Ministry of Environment. Victoria, BC.

Westerdahl, H.E. and K.D. Getsinger eds. 1988. Aquatic plant identification and herbicide use guide; vol II: aquatic plants and susceptibility to herbicides. Technical report A-88-9, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Whitley, J.R., B. Bassett, J.G. Dillard, and R.A. Haefner. 1990. Water plants for Missouri ponds. Missouri Department of Conservation. Jefferson City, MO.

Winterringer, G.S., and A.C. Lopinot. 1977. Aquatic plants of Illinois. Illinois State Museum. Springfield, Ill.