Seven Lakes

Integrated Aquatic Plant Management Plan

February 1999

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Snohomish County
Public Works
Surface Water Management

Working together for people, streams & fish.

Persons with disabilities may request this information in alternate forms by calling (425) 388-3464 or 1-800-562-4367 ext. 3464.

Hearing/speech impaired please call Washington Relay Center at 1-800-833-6388.

SEVEN LAKES
INTEGRATED AQUATIC PLANT MANAGEMENT PLAN
(IAPMP)

Prepared by

Gene Williams and Heidi Reynolds
Snohomish County Surface Water Management

Dr. Harry L. Gibbons
KCM, Inc.

Development of this plan was funded in part through an Aquatic Weeds Fund grant from the Washington State Department of Ecology

SNOHOMISH COUNTY PUBLIC WORKS
SURFACE WATER MANAGEMENT DIVISION

FEBRUARY 1999

ACKNOWLEDGEMENTS

Snohomish County Executive
Robert J. Drewel

Snohomish County Council
Rick Larsen, Council District 1, Chair
Kirke Sievers, Council District 2
Gary Nelson, Council District 3
Barbara Cothern, Council District 4
Dave Somers, Council District 5

Department of Public Works
Peter Hahn, Director

Surface Water Management Division
Joan Lee, P.E., Director
Randy Cowart, Water Resource Planning Manager
Gene Williams, Project Manager
Heidi Reynolds, Associate Planner

Seven Lakes Milfoil Control Advisory Committee

Citizens
Ross Adler, Lake Goodwin
Stan Ball, Lake Ki
Bruce Black, Lake Shoecraft
Mike Bobin, Lake Goodwin
Becky Dionne, Lake Goodwin
Fred Dockendorf, Lake Shoecraft
Walt Feldheim, Lake Goodwin
Bill Frolli, Lake Shoecraft
Liv Frolli, Lake Shoecraft
John Heller, Lake Shoecraft
Jack Jenkins, Lake Shoecraft
Eugene Keene, Lake Goodwin
Deb Kocher, Lake Crabapple
Don Laufenberg, Lake Shoecraft
Mike Mack, Lake Shoecraft
Helen Massart, Lake Shoecraft
Dean McReynolds, Lake Goodwin
Bob Moore, Lake Goodwin
Jeanette Moore, Lake Goodwin
Jim Rogers, Lake Goodwin
Tim Schmidt, Lake Howard
Tom Smith, Lake Loma
Craig Thompson, Lake Shoecraft
Karen Thompson Lake Goodwin

Technical Support
Cliff Bengston, The Tulalip Tribes Hatchery
Harry Gibbons, KCM
Kathy Hamel, WA State Dept. of Ecology
Curt Kraemer, WA Dept. of Fish and Wildlife
Mark Webb, Wenberg State Park
Daryl Williams, Dept. of Natural Resources, The Tulalip Tribes

Dive Team
Don Carter
Marc Knobbs
James Minstrell
Steve Osmek
Paul Salop
Chad Schultz
Dave Wheeler, KCM

TABLE OF CONTENTS

	PAGE
Acknowledgements	i
Table of Contents	ii
List of Figures	iii
List of Tables	iii
EXECUTIVE SUMMARY	iv
INTRODUCTION	1
PROBLEM STATEMENT	3
MANAGEMENT GOALS	5
WATERBODY/WATERSHED FEATURES	6
BENEFICIAL USES	8
AQUATIC PLANT COMMUNITIES	11
PHASE I EARLY INFESTATION CONTROL ACTIONS	34
PUBLIC INVOLVEMENT IN PLAN DEVELOPMENT	37
IN LAKE CONTROL ALTERNATIVE EVALUATION	39
• Mechanical Control Methods	40
• Chemical Control Methods	46
• Biological Control Methods	52
• Physical Control Methods	55
INTEGRATED AQUATIC PLANT MANAGEMENT TREATMENT SCENARIOS	65
• Control Intensity	65
• Lake Shoecraft Control Scenarios	65
• Other Program Elements	73
SEVEN LAKES MILFOIL ACTION PLAN	77
LITERATURE CITED	83
APPENDICES	
• A. Public Involvement	
• B. Lake Shoecraft Herbicide Monitoring and Mitigation Protocols	

LIST OF FIGURES

FIGURE		PAGE
A	Lake Goodwin Areas of Milfoil Control	v
B	Lake Shoecraft Herbicide Treatment Areas	vii
1	Seven Lakes Area	2
2	Beneficial Uses	9
3	Lake Crabapple Aquatic Plants	14
4	Lake Howard Aquatic Plants	16
5	Lake Ki Aquatic Plants	18
6	Lake Loma Aquatic Plants	20
7	Lake Martha Aquatic Plants	22
8	Lake Shoecraft Aquatic Plants	24
9	South Lake Goodwin Aquatic Plants	26
10	North Lake Goodwin Aquatic Plants	27
11	Milfoil Locations Lower Lake Goodwin - 1996-1998	30
12	Milfoil Locations Upper Lake Goodwin - 1996-1998	31
13	Milfoil Locations Lake Shoecraft - Summer 1996	32
14	Milfoil Locations Lake Shoecraft 1997-1998	33
15	Lake Goodwin Areas of Milfoil Control	35
16	Lake Shoecraft Herbicide Treatment Areas	78

LIST OF TABLES

TABLE		PAGE
A	Action Plan Costs for Milfoil Eradication at Seven Lakes	ix
1	Background Data for the Seven Lakes	6
2	Major Aquatic Plant Species Found in the Seven Lakes	13
3	Summary of Available Aquatic Plant Management Techniques Available in Washington State	59
4	Treatment Scenarios for Lake Shoecraft	71
5	Estimated Costs of Seven Lakes Milfoil Follow-up and Prevention	75
6	Action Plan Costs for Milfoil Eradication at Seven Lakes	81

EXECUTIVE SUMMARY

The Eurasian Watermilfoil Problem in the Seven Lakes

Eurasian watermilfoil is a non-native invasive plant that has become established in Lake Goodwin and Lake Shoecraft during the 1990's. These lakes, connected by a short canal, are the two largest lakes in the Seven Lakes area of Snohomish County. The other nearby lakes are Crabapple, Howard, Ki, Loma, and Martha.

Eurasian watermilfoil is an aggressive plant that grows very densely in the shallow shoreline areas of lakes. It produces long tendrils that can tangle fishing lines and boat motors, and even entangle swimmers. By 1997, the Eurasian watermilfoil plants covered over two acres in Lake Goodwin and ten acres in Lake Shoecraft and were causing negative impacts to recreation, aesthetics, and habitat. Any further spread of Eurasian watermilfoil in these two lakes threatens to seriously degrade the use and enjoyment of the lakes by thousands of residents and other lake users. There is also a concern that Eurasian watermilfoil may spread to the other nearby lakes.

Actions Taken to Date

In 1996, Snohomish County began working with concerned citizens at Lake Goodwin and Lake Shoecraft to address the Eurasian watermilfoil problem. The County received a grant from the Washington State Department of Ecology to take early actions to control the Eurasian watermilfoil plants. Divers surveyed Lake Goodwin and Lake Shoecraft, as well as all the Seven Lakes, to create detailed aquatic plant maps and assess the extent of the Eurasian watermilfoil problem. Then, Snohomish County and a citizens' advisory committee developed a strategy for Phase I early control actions and adopted goals for the overall project. The primary goal of the project is to eradicate Eurasian watermilfoil from the Seven Lakes within 3 to 5 years.

The Phase I early actions focused on Lake Goodwin because of the smaller area covered by Eurasian watermilfoil plants and the limited grant funds available. During the summer of 1997, Snohomish County hired divers to place burlap bottom barriers over the dense Eurasian watermilfoil colonies in Lake Goodwin and to hand-pull plants in scattered locations. This work was successful, with up to 95% of the Eurasian watermilfoil controlled in Lake Goodwin. The divers returned in 1998 to follow-up with more hand-pulling. Figure A shows the areas where control efforts occurred during 1997 and 1998. Repeated efforts will be needed in Lake Goodwin every year to find and eradicate all the Eurasian watermilfoil plants.

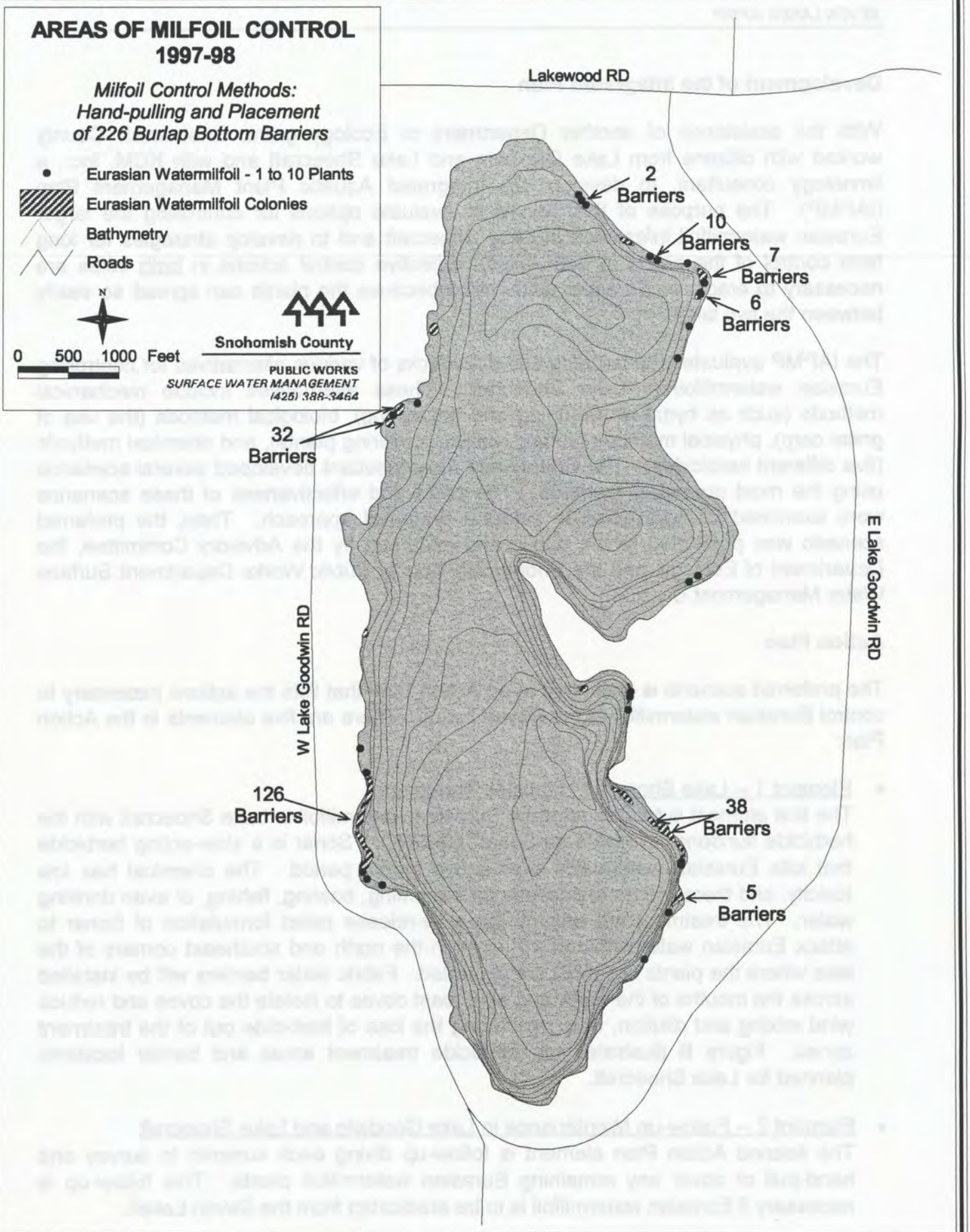


FIGURE A -- LAKE GOODWIN

Development of the Integrated Plan

With the assistance of another Department of Ecology grant, Snohomish County worked with citizens from Lake Goodwin and Lake Shoecraft and with KCM, Inc., a limnology consultant, to develop this Integrated Aquatic Plant Management Plan (IAPMP). The purpose of this plan is to evaluate options for controlling the larger Eurasian watermilfoil infestation in Lake Shoecraft and to develop strategies for long term control of the plants in both lakes. Effective control actions in both lakes are necessary to eradicate Eurasian watermilfoil because the plants can spread so easily between the two lakes.

The IAPMP evaluates the benefits and drawbacks of various alternatives for controlling Eurasian watermilfoil in Lake Shoecraft. These alternatives include mechanical methods (such as hydraulic dredging and harvesting), biological methods (the use of grass carp), physical methods (cutting, pulling, covering plants), and chemical methods (five different herbicides). The County and the consultant developed several scenarios using the most promising methods. The costs and effectiveness of these scenarios were examined in more detail to select a preferred approach. Then, the preferred scenario was presented to the public and endorsed by the Advisory Committee, the Department of Ecology, and the Snohomish County Public Works Department Surface Water Management Division.

Action Plan

The preferred scenario is described in an Action Plan that lists the actions necessary to control Eurasian watermilfoil in the Seven Lakes. There are five elements in the Action Plan:

- Element 1 -- Lake Shoecraft Herbicide Treatment
  The first element is treatment of the Eurasian watermilfoil in Lake Shoecraft with the herbicide fluridone, available as Sonar® (SePRO). Sonar is a slow-acting herbicide that kills Eurasian watermilfoil over a two month period. The chemical has low toxicity, and there are no restrictions for swimming, boating, fishing, or even drinking water. The treatment will employ the slow-release pellet formulation of Sonar to attack Eurasian watermilfoil on 18 acres in the north and southeast corners of the lake where the plants are most concentrated. Fabric water barriers will be installed across the mouths of the north and southeast coves to isolate the coves and reduce wind mixing and dilution, thus minimizing the loss of herbicide out of the treatment zones. Figure B illustrates the herbicide treatment areas and barrier locations planned for Lake Shoecraft.

- Element 2 -- Follow-up Maintenance in Lake Goodwin and Lake Shoecraft
  The second Action Plan element is follow-up diving each summer to survey and hand-pull or cover any remaining Eurasian watermilfoil plants. This follow-up is necessary if Eurasian watermilfoil is to be eradicated from the Seven Lakes.

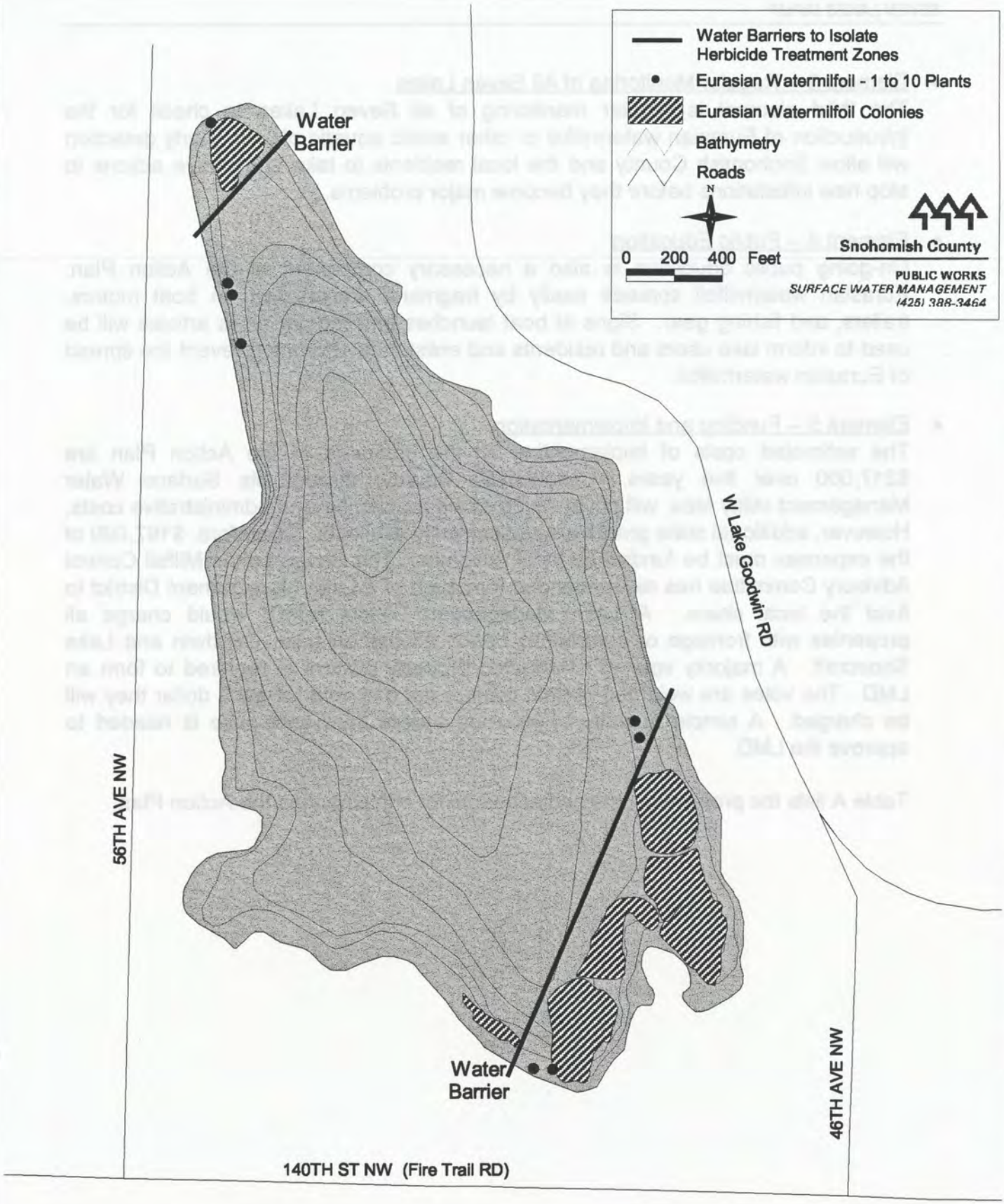


FIGURE B -- LAKE SHOECRAFT HERBICIDE TREATMENT AREAS

- Element 3 -- Regular Monitoring of All Seven Lakes
  The third element is regular monitoring of all Seven Lakes to check for the introduction of Eurasian watermilfoil or other exotic aquatic plants. Early detection will allow Snohomish County and the local residents to take aggressive actions to stop new infestations before they become major problems.

- Element 4 -- Public Education
  On-going public education is also a necessary component of the Action Plan. Eurasian watermilfoil spreads easily by fragments transported on boat motors, trailers, and fishing gear. Signs at boat launches and regular news articles will be used to inform lake users and residents and enlist their efforts to prevent the spread of Eurasian watermilfoil.

- Element 5 -- Funding and Implementation
  The estimated costs of implementing all the elements of the Action Plan are $217,000 over five years. Snohomish County, through its Surface Water Management utility fees, will cover much of the monitoring and administrative costs. However, additional state grants are not currently available. Therefore, $167,000 of the expenses must be funded by local residents. The Seven Lakes Milfoil Control Advisory Committee has recommended formation of a Lake Management District to fund the local share. A Lake Management District (LMD) would charge all properties with frontage or community beach access on Lake Goodwin and Lake Shoecraft. A majority vote of all affected property owners is required to form an LMD. The votes are weighted so that owners get one vote for each dollar they will be charged. A simple majority of returned ballots from each lake is needed to approve the LMD.

  Table A lists the projected costs and schedule for implementing the Action Plan.

TABLE A
ACTION PLAN COSTS FOR MILFOIL ERADICATION AT SEVEN LAKES
(ALL COSTS IN 1999 DOLLARS)

	1999	2000	2001	2002	2003	5-Year Total
LAKE SHOECRAFT						
Sonar Herbicide in Pellet Form						
• **Application (18 acres)**	$ 27,000					$ 27,000
• **Barrier (2,100 feet long)**	$ 21,250					$ 21,250
• **Monitoring (herbicide)**	$ 6,300					$ 6,300
• **Mitigation & Contingency**	$ 9,800					$ 9,800
• **Permitting & Administration**	$ 6,500	$ 1,500				$ 8,000
Hand pulling (6 days, yr 1 & 2)	$ 9,000	$ 9,000	$ 1,500	$ 1,600	$ 1,700	$ 22,800
Bottom barriers (3 days)	$ 4,600	$ 3,600				$ 8,200
Monitoring (follow-up)	$ 1,500	$ 3,000	$ 3,100	$ 3,200	$ 3,400	$ 14,200
Sub-Total	$ 85,950	$17,100	$ 4,600	$ 4,800	$ 5,100	$117,550
LAKE GOODWIN						
Follow-up diving/monitoring	$ 8,400	$ 8,800	$ 9,200	$ 9,700	$10,200	$ 46,300
OTHER ELEMENTS						
Monitoring Other Five Lakes	$ 2,500	$ 2,500	$ 2,700	$ 2,900	$ 3,100	$ 13,700
Public Education/Prevention	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 15,000
Formation/Billing of LMD	$ 10,800	$ 3,500	$ 3,500	$ 3,500	$ 3,500	$ 24,800
TOTAL	**$110,650**	**$34,900**	**$23,000**	**$23,900**	**$24,900**	**$217,350**

SEVEN LAKES INTEGRATED AQUATIC PLANT MANAGEMENT PLAN

INTRODUCTION

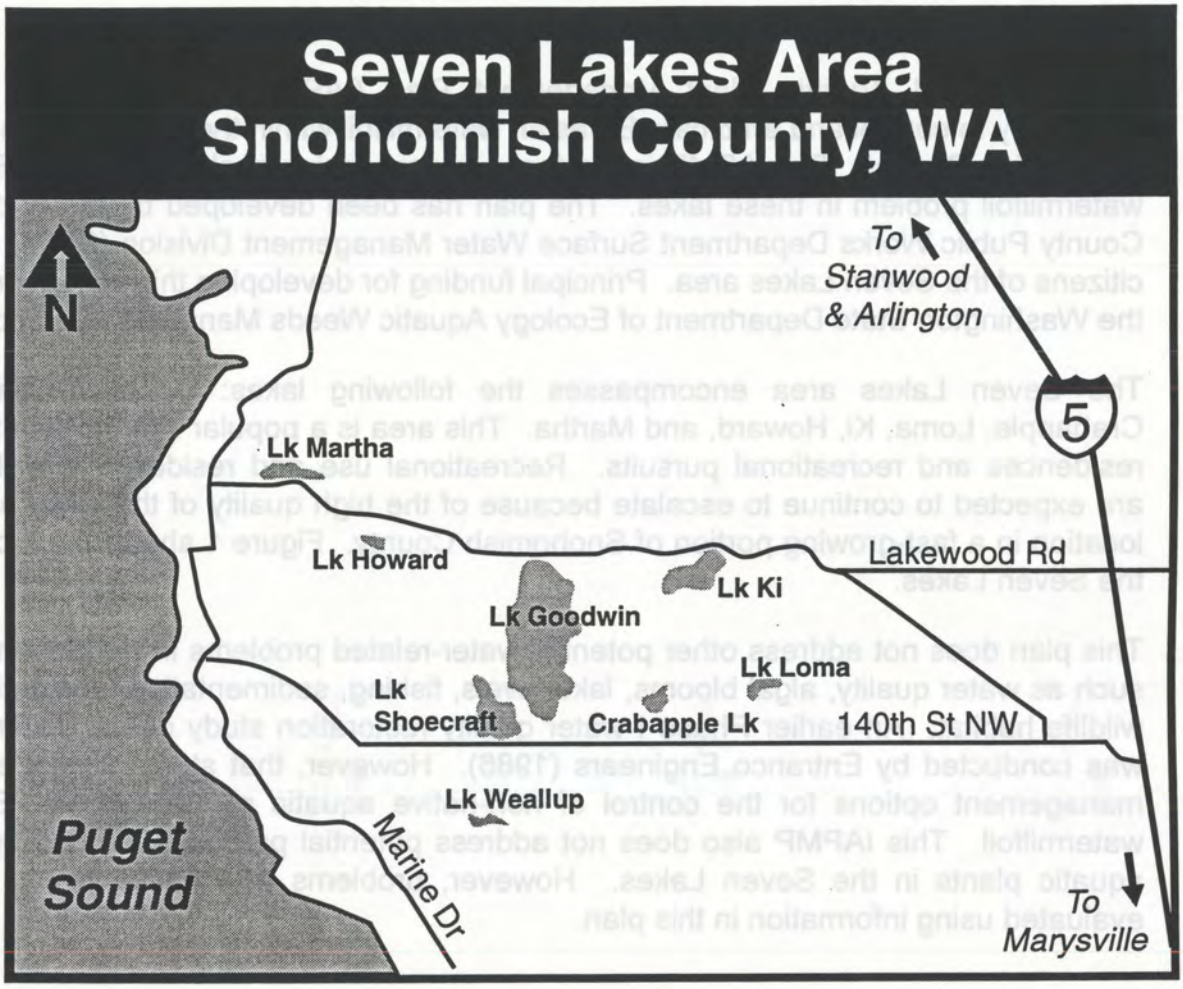
Eurasian watermilfoil is a non-native, invasive plant that has become established in Lake Goodwin and Lake Shoecraft. This invasion raises the possibility that Eurasian watermilfoil might spread throughout the shoreline areas of these two lakes, severely affecting the ecology and public use of these resources. There is also a concern that Eurasian watermilfoil may spread to other lakes within the Seven Lakes area.

This Integrated Aquatic Plant Management Plan (IAPMP) describes the actions necessary to control and eradicate Eurasian watermilfoil within the Seven Lakes area of Snohomish County. The IAPMP is the first comprehensive evaluation of the Eurasian watermilfoil problem in these lakes. The plan has been developed by the Snohomish County Public Works Department Surface Water Management Division (SWM) and the citizens of the Seven Lakes area. Principal funding for developing this plan comes from the Washington State Department of Ecology Aquatic Weeds Management Fund.

The Seven Lakes area encompasses the following lakes: Goodwin, Shoecraft, Crabapple, Loma, Ki, Howard, and Martha. This area is a popular site for both full-time residences and recreational pursuits. Recreational use and residential development are expected to continue to escalate because of the high quality of the lakes and their location in a fast-growing portion of Snohomish County. Figure 1 shows the location of the Seven Lakes.

This plan does not address other potential water-related problems in the Seven Lakes, such as water quality, algal blooms, lake levels, fishing, sedimentation, aesthetics, and wildlife habitat. An earlier Phase I water quality restoration study of the Seven Lakes was conducted by Entranco Engineers (1986). However, that study did not examine management options for the control of non-native aquatic plants such as Eurasian watermilfoil. This IAPMP also does not address potential problems created by <u>native</u> aquatic plants in the Seven Lakes. However, problems with native plants can be evaluated using information in this plan.

FIGURE 1


Seven Lakes Area
Snohomish County, WA
N
To
Stanwood
& Arlington
5
Lk Martha
Lk Howard
Lakewood Rd
Lk Ki
Lk Goodwin
Lk Loma
Lk
Shoecraft
Crabapple Lk
140th St NW
Lk Weallup
Puget
Sound
Marine Dr
To
Marysville

PROBLEM STATEMENT

Summary

Pioneering infestations of a non-native invasive plant, Eurasian watermilfoil, in Lake Goodwin and Lake Shoecraft are having a negative impact on recreation, aesthetics, and habitat in these lakes. Any further spread of this plant threatens to seriously degrade the use and enjoyment of these lakes for thousands of residents and other lake users. Eurasian watermilfoil is also a threat to spread to nearby lakes.

Aquatic Plant Species of Concern

Eurasian watermilfoil, *Myriophyllum spicatum*, is a non-native, invasive plant that can adversely affect the uses and enjoyment of a waterbody. The plant will out-compete native plants and attain densities that prevent other plants from growing. Dense Eurasian watermilfoil plant beds can interfere with swimming, fishing, and boating. The overgrown plant beds limit colonization by aquatic invertebrates and make it difficult for fish to move freely. In addition, dissolved oxygen concentrations within dense Eurasian watermilfoil beds can approach zero, severely limiting the habitat and changing the water quality of the area. Even more ominously, Eurasian watermilfoil has the ability to form aquatic plant beds where other plants have not previously grown. Eurasian watermilfoil is listed as a Class B Noxious Weed by the State of Washington.

Threatened Waterbodies and Beneficial Uses

Lake Goodwin is the second most important recreational lake in Snohomish County after Lake Stevens. Lake Shoecraft is also a large lake heavily used by water skiers and bass fishermen. The five other lakes in the area provide numerous beneficial uses as well, such as water supply, swimming, boating, fishing, aesthetics, wildlife habitat, and other active and passive recreational opportunities. All of the lakes support intensive residential development.

In addition to providing the most concentrated aquatic recreational opportunities in Snohomish County, most of the Seven Lakes are oligotrophic lakes. That is, they have very good to exceptional water quality. The lone exception is Lake Loma, which is more eutrophic and supports vigorous stands of native aquatic plants.

Current and Potential Impact of Eurasian watermilfoil

In the past decade, Eurasian watermilfoil has become established in both Lake Goodwin and Lake Shoecraft. By the summer of 1997, Eurasian watermilfoil plants covered between 2 and 3 acres of the littoral (shallow water) area of Lake Goodwin. Because of the limited extent and sparse density of these plants in much of this lake, the Eurasian watermilfoil invasion is considered an early infestation by the Department of Ecology. In the summer of 1997, a Phase I Early Infestation eradication program was completed in Lake Goodwin. Divers covered the dense portions of all identified areas of Eurasian watermilfoil with burlap bottom barriers to prevent growth, and removed the remaining individual plants by hand. More than 95 percent of the invasive plants in Lake Goodwin were removed in 1997. Yearly follow-up work will be necessary to complete the Eurasian watermilfoil eradication in this lake.

In contrast, Lake Shoecraft, connected to Lake Goodwin by a short canal, contains about 10 acres of Eurasian watermilfoil. The colonies in Lake Shoecraft are also more firmly established. Therefore, a more complex approach will be necessary to eradicate Eurasian watermilfoil in this lake.

The current infestation in these two lakes has already impaired recreational uses and aesthetics in localized areas. The primary concern of citizens at Lake Goodwin and Lake Shoecraft is that the Eurasian watermilfoil plants will eventually dominate the shallow waters of both lakes, severely affecting aesthetic enjoyment and recreational activities. The plants in Lake Goodwin and Lake Shoecraft could also serve as sources of fragments to spread Eurasian watermilfoil to the other five lakes in the Seven Lakes area.

MANAGEMENT GOALS

The purpose of the aquatic plant management goals for the Seven Lakes area is to provide clear guidelines for addressing the Eurasian watermilfoil problems in these lakes. The goals seek to balance actions to address Eurasian watermilfoil with the needs to protect beneficial uses of the lakes, to preserve ecological functions, to minimize environmental disturbances, and to control expenses. It should be noted that management goals are not the same as management methods. Goals are the ends that the community wants to achieve, while the methods are the specific means of attaining those goals. Proposed management methods are discussed later in this plan.

Seven Lakes IAPMP Goals

The goals of the Seven Lakes IAPMP are as follows:

- Eradicate Eurasian watermilfoil from Lake Goodwin and Lake Shoecraft within 3 to 5 years.
- Prevent Eurasian watermilfoil from spreading to new areas in Lake Goodwin and Lake Shoecraft and from re-establishing pioneer colonies.
- Prevent Eurasian watermilfoil from spreading to nearby lakes.
- Prevent the introduction of other exotic invasive aquatic plants in the Seven Lakes.
- Focus eradication activities on Eurasian watermilfoil.
- Inform and involve all residents and lake users in order to sustain Eurasian watermilfoil control for the long term.
- Develop long-term funding sources for integrated management.
- Keep management program costs affordable.
- Bring government agencies together to help implement the management plan.

WATERBODY/WATERSHED FEATURES

The Seven Lakes area is located in the northwestern portion of Snohomish County, west of Interstate Highway 5, northwest of Marysville, and south of Stanwood (see Figure 1). The area contains the most concentrated group of lakes in the county. The watersheds of several of the lakes are linked in chains. In the largest chain, Lake Loma drains into Lake Crabapple, which in turn flows into Lake Goodwin. Lake Goodwin then drains through a canal into Lake Shoecraft. Eventually this chain of lakes discharges into Tulalip Creek, which flows across the Tulalip Indian Reservation, through Weallup Lake, and into Possession Sound. Similarly, Lake Howard drains into Lake Martha to form a lake chain that flows out to Port Susan. The Lake Ki watershed stands alone. Its outlet drains into Portage Creek and then into the Stillaguamish River. Background characteristics for the Seven Lakes are listed in Table 1.

TABLE 1.
BACKGROUND DATA FOR THE SEVEN LAKES

Lake	Area (acres)	Maximum Depth (feet)	Mean Depth (feet)	Lake Volume (acre-feet)	Littoral Area (acres)	Elevation (feet)
Crabapple	35	49	18	650	17	410
Goodwin	560	50	23	13,000	220	324
Howard	28	50	29	790	7	238
Ki	98	70	33	3,300	30	414
Loma	21	28	11	230	16	565
Martha	62	70	33	2,000	23	186
Shoecraft	130	35	18	2,400	75	324

Source: Bortleson, G. C., et. al. 1976. Reconnaissance Data on Lakes in Washington, Washington Water Supply Bulletin No. 43, Volume 2.

The Seven Lakes are situated on a rolling, glacier-carved plateau. The watersheds and lake shores are heavily wooded, but the trees are being steadily removed to accommodate the residential development of recent decades. Currently, the Seven Lakes watersheds are about 30 to 40 percent developed, with single-family houses being the predominant land use. Almost 2,000 homes are found in these watersheds. Except for limited areas on Lake Martha and Lake Howard, the shorelines of the Seven Lakes are almost completely developed. Significant additional residential development is expected to occur in the Seven Lakes area in the future.

In spite of this on-going development, the water quality of the Seven Lakes is considered good to excellent. No significant water quality problems have been reported, although there have been occasional algal blooms at Lake Goodwin. Aquatic plants have also not presented significant problems in the past, except in Lake Loma, which is much more eutrophic than the other lakes.

It does not appear that current activities in the surrounding watersheds have a significant bearing on the occurrence and density of aquatic plants in the Seven Lakes. Nor will the expected future residential growth throughout the watersheds have an over-riding influence on potential aquatic plant problems. This is especially true for Eurasian watermilfoil and other non-native noxious weeds that might invade the region's lakes. On the other hand, growth and land use changes within the watersheds may have an important bearing on the community's ability to maintain good water quality in these lakes and prevent algal blooms in the future. The watershed best management practices needed to protect water quality will not, by themselves, have an effect on the non-native plant problem in these lakes. Therefore, this plan concentrates on in-lake treatment and maintenance methods to eradicate Eurasian watermilfoil at Lake Shoecraft and Lake Goodwin, and on education and monitoring methods to prevent its spread to other lakes.

BENEFICIAL USES

Beneficial uses are the specific activities and resources that a particular waterbody supports or provides. For example, if a lake is large enough to allow water skiing, that is a beneficial use; or if a lake is pure enough for water supply, that is also a beneficial use. The beneficial uses of a waterbody are those uses (both human and natural) that can be affected by or need to be protected from invasive plants, such as Eurasian watermilfoil.

Human Uses

The Seven Lakes are all multi-use resources, with each lake supporting a variety of human and wildlife uses. Recreational uses are the most visible. Each of the lakes offers many recreational opportunities for residents and visitors alike. Uses of the lakes include primary contact recreation—swimming, wading, and, in the case of Lake Goodwin and Lake Shoecraft, water skiing—and secondary contact recreation, such as fishing and boating. Recreational opportunities are available especially at Lake Goodwin, where year-round access is provided through Wenberg State Park. The State Park provides facilities for swimming, boating, picnicking, and camping. The State Park boat launch is also the likely site of Eurasian watermilfoil introduction to Lake Goodwin.

In addition, each of the other six lakes has a Washington Department of Fish and Wildlife boat launch that allows year-round access for boating and fishing. A Conservation License is required to use these boat launches. The fishing is varied, as all of the lakes support both cold water (trout) and warm water fisheries. Only non-motorized boating (no internal combustion engines) is allowed on Lake Martha, Lake Howard, Lake Crabapple, and Lake Loma. Motorized boats are limited to 8 mph on Lake Ki. General boating, water skiing, and personal watercraft (jet skis) are allowed on both Lake Goodwin and Lake Shoecraft.

Other beneficial human uses of the Seven Lakes include aesthetics, water supply, and residential living. Aesthetic use refers to people enjoying the beauty and peacefulness of the lakes and observing wildlife found at the lakes. Public water supply is provided through the Seven Lakes Water Association; however, some landowners also use the lakes to supply water for landscape irrigation and for domestic uses. These water intakes are individually controlled for private use only. Finally, the lake shores provide high-value sites for residential uses. Most of the lakes' perimeters have already been developed for single-family homes.

Figure 2 illustrates the beneficial use areas at Lake Goodwin and Lake Shoecraft. Similar maps of the other five lakes are not included because only preventative actions are proposed for those lakes.

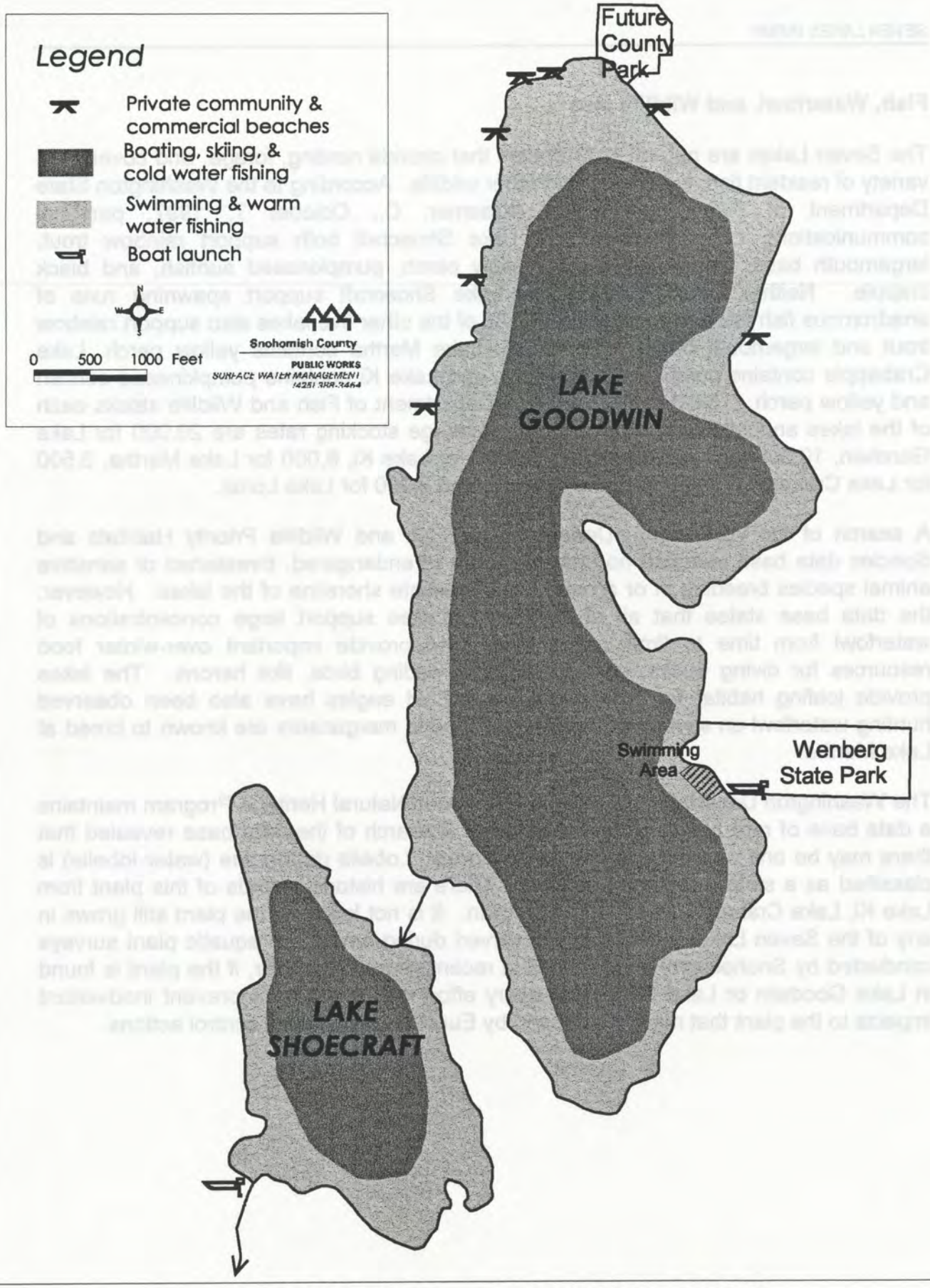


FIGURE 2 -- BENEFICIAL USES

Fish, Waterfowl, and Wildlife Use

The Seven Lakes are natural waterbodies that provide nesting, forage, and cover for a variety of resident fish, waterfowl, and other wildlife. According to the Washington State Department of Fish and Wildlife (Kraemer, C., October 7, 1997, personal communication), Lake Goodwin and Lake Shoecraft both support rainbow trout, largemouth bass, smallmouth bass, yellow perch, pumpkinseed sunfish, and black crappie. Neither Lake Goodwin nor Lake Shoecraft support spawning runs of anadromous fish (steelhead or salmon). All of the other five lakes also support rainbow trout and largemouth bass. In addition, Lake Martha contains yellow perch, Lake Crabapple contains pumpkinseed sunfish, and Lake Ki contains pumpkinseed sunfish and yellow perch. The Washington State Department of Fish and Wildlife stocks each of the lakes annually with rainbow trout. Average stocking rates are 20,000 for Lake Goodwin, 10,000 for Lake Shoecraft, 10,000 for Lake Ki, 6,000 for Lake Martha, 3,500 for Lake Crabapple, 3,000 for Lake Howard, and 2,000 for Lake Loma.

A search of the Washington Department of Fish and Wildlife Priority Habitats and Species data base revealed no current record of endangered, threatened or sensitive animal species breeding in or around the immediate shoreline of the lakes. However, the data base states that all of the Seven Lakes support large concentrations of waterfowl from time to time. The lakes also provide important over-winter food resources for diving ducks, cormorants, and wading birds, like herons. The lakes provide loafing habitat for other waterfowl. Bald eagles have also been observed hunting waterfowl on several of the lakes. Hooded mergansers are known to breed at Lake Martha.

The Washington Department of Natural Resources Natural Heritage Program maintains a data base of rare plants around the state. A search of the data base revealed that there may be one rare aquatic plant in the area. *Lobelia dortmanna* (water lobelia) is classified as a state threatened species. There are historic records of this plant from Lake Ki, Lake Crabapple, and Lake Goodwin. It is not known if the plant still grows in any of the Seven Lakes. It was not observed during any of the aquatic plant surveys conducted by Snohomish County SWM in recent years. However, if the plant is found in Lake Goodwin or Lake Shoecraft, every effort will be made to prevent inadvertent impacts to the plant that might be caused by Eurasian watermilfoil control actions.

AQUATIC PLANT COMMUNITIES

Distribution of Aquatic Plants in the Seven Lakes

In the summer of 1994, SWM staff conducted surface visual reconnaissance surveys of the aquatic plants in all the Seven Lakes--Loma, Crabapple, Ki, Howard, Martha, Goodwin, and Shoecraft. Eurasian watermilfoil was identified in Lake Goodwin and Lake Shoecraft, but no other exotic invasive plants were observed in any of the Seven Lakes.

In July 1997, SWM staff returned to Lakes Loma, Crabapple, Ki, Howard, and Martha with a diver to confirm the absence of exotic plants and to identify any significant changes in the native aquatic plant populations. This new survey found no Eurasian watermilfoil colonies in Lake Loma, Lake Crabapple, Lake Ki, Lake Howard, or Lake Martha, and no major changes in native plants. Several fragments of *Egeria densa* (Brazilian elodea), another exotic invasive plant, were found floating at the boat launch at Lake Loma. However, an exhaustive underwater search failed to discover any Brazilian elodea actually growing in the lake.

Figures 3 through 10 show the approximate locations and densities of the aquatic plant communities in each of the Seven Lakes. Table 2 lists the plant species found during the 1994 and 1997 surveys. The surveys found that Lake Crabapple supports the least diverse community of aquatic plants, while Lake Ki has the lowest overall densities. In general, the aquatic plant communities in six of the seven lakes are quite similar. In contrast, Lake Loma supports the highest density of aquatic plants and contains several species not found in the other lakes.

Table 2. Major Aquatic Plant Species Found in the Seven Lakes

PLANT SPECIES *Scientific name* Common name	GOODWIN	SHOECRAFT	LOMA	CRABAPPLE	KI	HOWARD	MARTHA
Myriophyllum spicatum Eurasian watermilfoil	X	X					
Elodea canadensis Common elodea		X		X	X	X	X
Potamogeton amplifolius Large leaf pondweed	X	X				X	
Potamogeton sp. Thin leaf pondweed	X	X	X		X		X
Nuphar polysepalum Yellow waterlily		X	X	X	X	X	X
Nymphaea odorata Fragrant waterlily		X	X		X	X	
Chara sp. Stonewort, Muskgrass	X	X			X	X	X
Nitella sp. Brittlewort	X			X			
Najas flexilis Naiad, water nymph	X	X					
Isoetes lacustris Lake quillwort					X	X	X
Vallisneria americana Tapegrass					X		
Myriophyllum hippuroides Native watermilfoil			X				
Ceratophyllum demersum Coontail			X				
Utricularia vulgaris Common bladderwort			X				
Fontinalis sp. Water moss			X				
Alisma gramineum Narrow-leaf waterplantain			X				

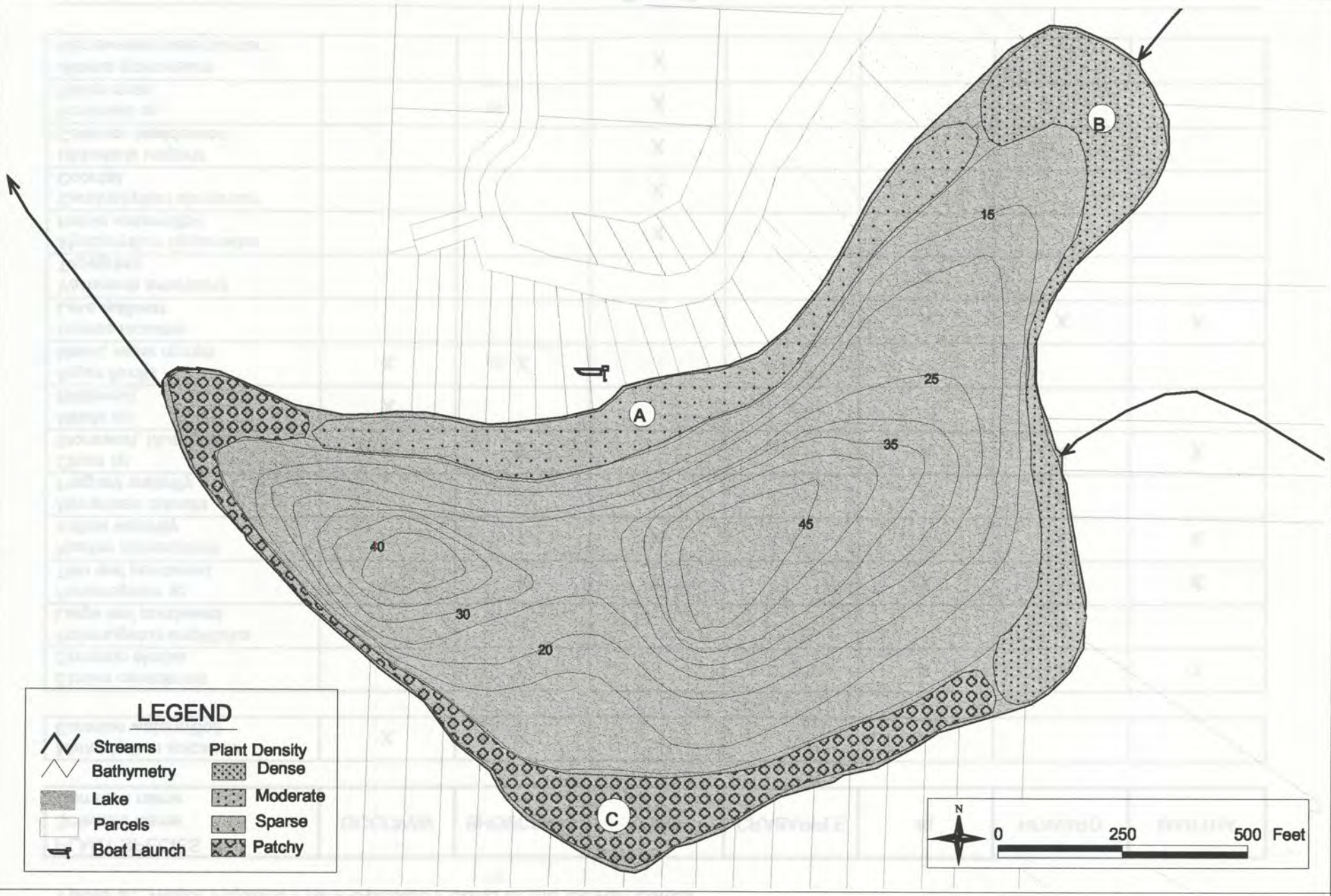


FIGURE 3 -- LAKE CRABAPPLE AQUATIC PLANTS

LAKE CRABAPPLE			
Section	Density	Dominant Plants	Other Plants
A	Sparse	*Nitella sp.* (Brittlewort)	*Elodea canadensis* (Common elodea) *Nuphar polysepalum* (Yellow water-lily)
B	Moderate	*Elodea canadensis* (Common elodea)	*Nuphar polysepalum* (Yellow water-lily)
C	Patchy	*Elodea canadensis* (Common elodea) *Nuphar polysepalum* (Yellow water-lily)	

FIGURE 4 -- LAKE HOWARD AQUATIC PLANTS

LAKE HOWARD			
Section	Density	Dominant Plants	Other Plants
A	Moderate	*Potamogeton amplifolius* (Large-leaf pondweed)	*Elodea canadensis* (Common elodea) *Chara sp.* (Stonewort, Muskgrass)
B	Sparse	*Nuphar polysepalum* (Yellow water-lily)	*Elodea canadensis* (Common elodea) *Chara sp.* (Stonewort, Muskgrass) *Potamogeton amplifolius* (Large-leaf pondweed)
C	Patchy	*Chara sp.* (Stonewort, Muskgrass)	*Elodea canadensis* (Common elodea) *Potamogeton amplifolius* (Large-leaf pondweed) *Isoetes lacustris* (Lake quillwort)
D	Sparse		*Elodea canadensis* (Common elodea) *Potamogeton amplifolius* (Large-leaf pondweed) *Nymphaea odorata* (Fragrant water-lily)

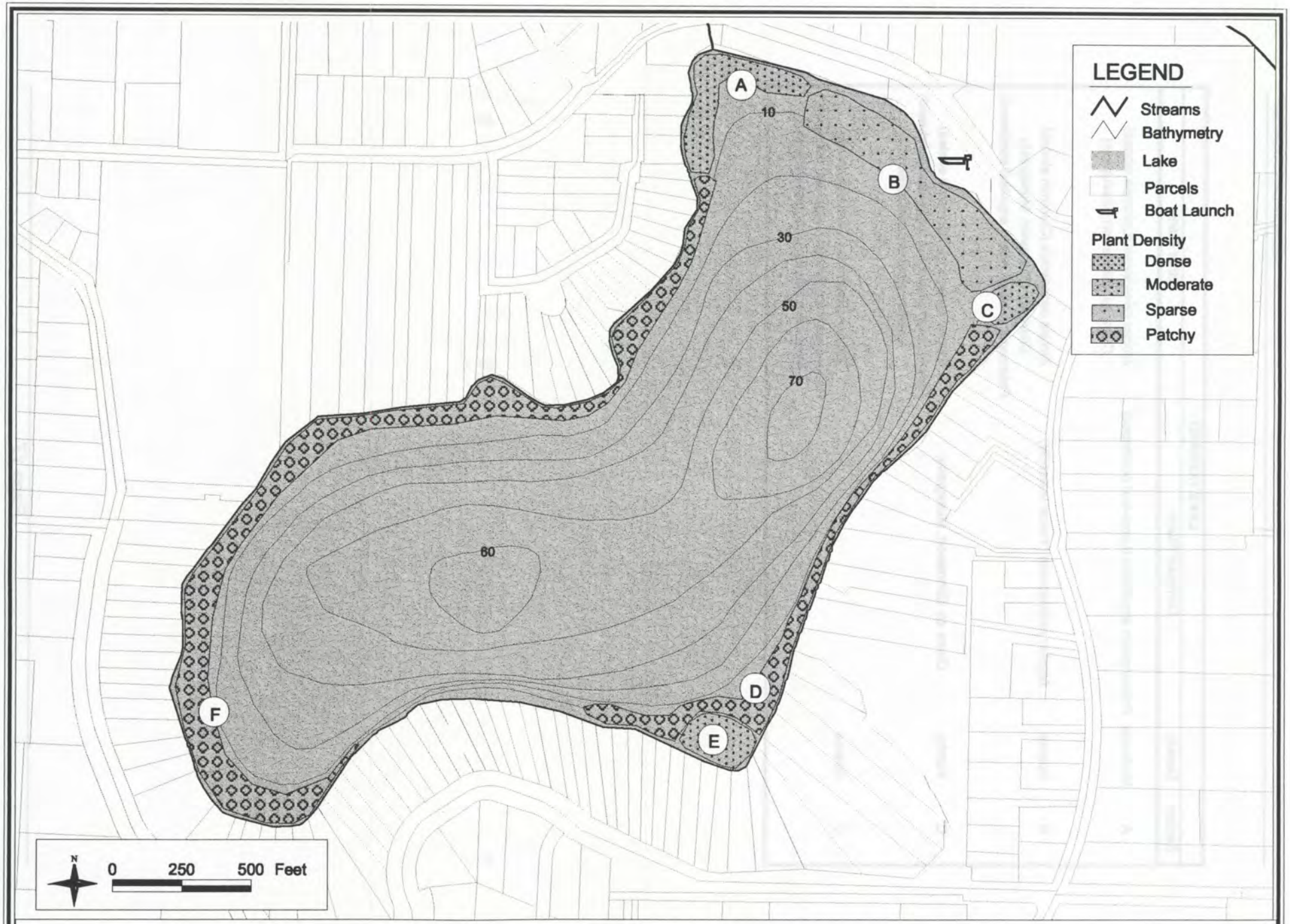


FIGURE 5 -- LAKE KI AQUATIC PLANTS

LAKE KI			
Section	Density	Dominant Plants	Other Plants
D, F	Patchy	*Nuphar polysepalum* (Yellow water-lily) *Elodea canadensis* (Common elodea) *Potamogeton sp.* (Thin-leaf pondweed)	
A, C	Moderate	*Nymphaea odorata* (Fragrant water-lily)	*Chara sp.* (Stonewort, Muskgrass) *Isoetes lacustris* (Lake quillwort)
E	Moderate	*Vallisneria americana* (Tapegrass)	*Elodea canadensis* (Common elodea) *Potamogeton sp.* (Thin-leaf pondweed)
B	Sparse	*Isoetes lacustris* (Lake quillwort) *Chara sp.* (Stonewort, Muskgrass)	*Vallisneria americana* (Tapegrass) *Elodea canadensis* (Common elodea)

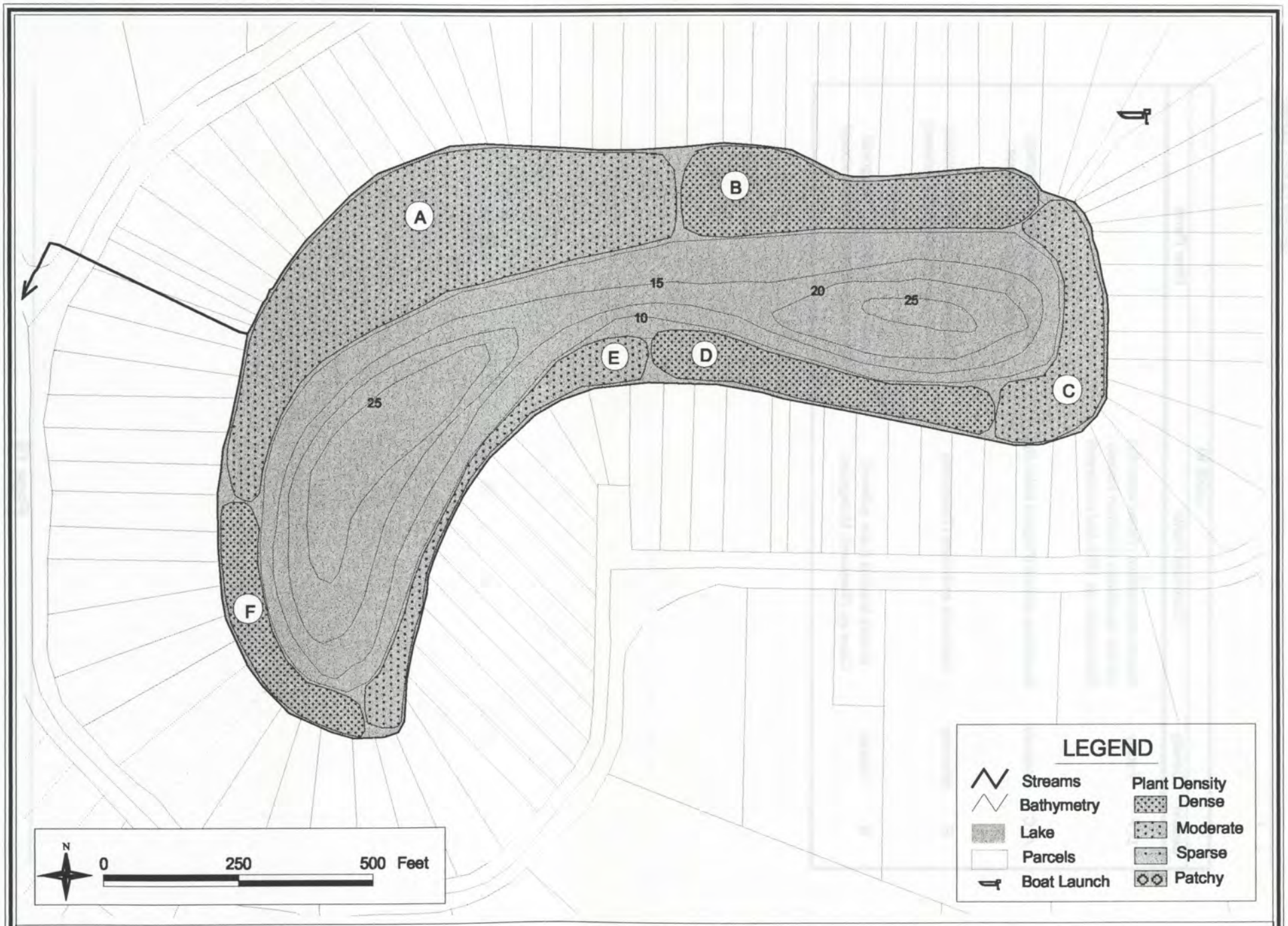


FIGURE 6 -- LAKE LOMA AQUATIC PLANTS

LAKE LOMA			
Section	Density	Dominant Plants	Other Plants
B, D, F	Dense	*Myriophyllum hippuroides* (Native water-milfoil) *Nuphar polysepalum* (Yellow water-lily)	*Nymphaea odorata* (Fragrant water-lily) *Potamogeton sp.* (Thin-leaf pondweed) *Fontinalis* sp. (Water moss) *Utricularia vulgaris* (Common bladderwort) *Ceratophyllum demersum* (Coontail) *Alisma gramineum* (Narrow-leaf plantain)
A, C, E	Moderate	*Myriophyllum hippuroides* (Native water-milfoil) *Nuphar polysepalum* (Yellow water-lily)	*Nymphaea odorata* (Fragrant water-lily) *Potamogeton sp.* (Thin-leaf pondweed) *Fontinalis* sp. (Water moss) *Utricularia vulgaris* (Common bladderwort) *Ceratophyllum demersum* (Coontail)

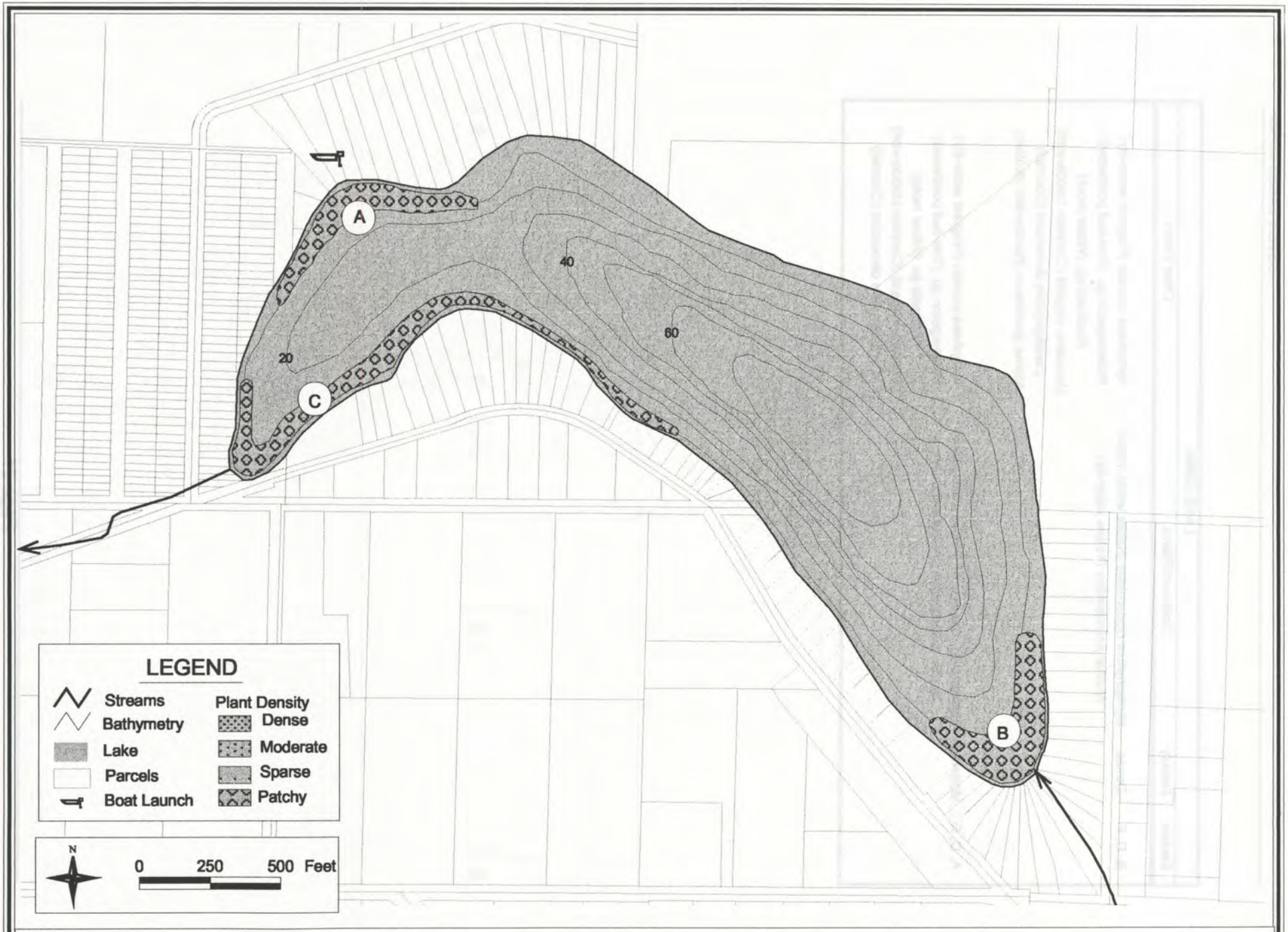


FIGURE 7 -- LAKE MARTHA AQUATIC PLANTS

LAKE MARTHA			
Section	Density	Dominant Plants	Other Plants
A	Patchy	*Potamogeton sp.* (Thin-leaf pondweed) *Elodea canadensis* (Common elodea)	*Isoetes lacustris* (Lake quillwort) *Chara sp.* (Stonewort, Muskgrass)
B, C	Patchy	*Elodea canadensis* (Common elodea) *Chara sp.* (Stonewort, Muskgrass) *Potamogeton sp.* (Thin-leaf pondweed)	*Nuphar polysepalum* (Yellow water-lily)

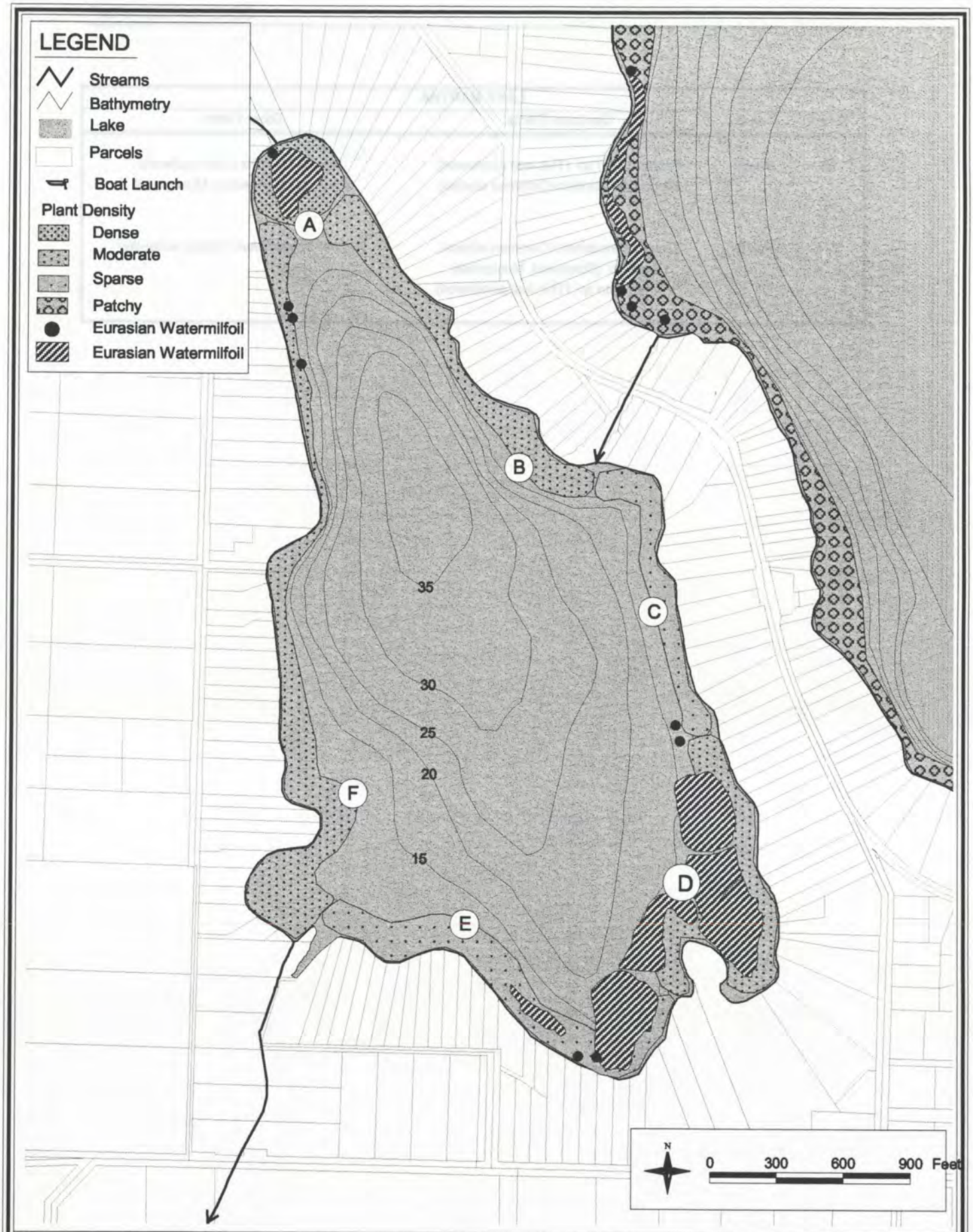


FIGURE 8 -- LAKE SHOECRAFT AQUATIC PLANTS

LAKE SHOECRAFT			
Section	Density	Dominant Plants	Other Plants
A	Dense	*Potamogeton sp.* (Thin-leaf pondweed) *Elodea canadensis* (Common elodea) *Chara sp.* (Stonewort, Muskgrass)	*Potamogeton amplifolius* (Large-leaf pondweed) *Najas flexilis* (Water-nymph, Naiad)
B, D, F	Moderate	*Chara sp.* (Stonewort, Muskgrass)	*Potamogeton sp.* (Thin-leaf pondweed) *Elodea canadensis* (Common elodea) *Potamogeton amplifolius* (Large-leaf pondweed) *Nymphaea odorata* (Fragrant water-lily) *Nuphar polysepalum* (Yellow water-lily) *Najas flexilis* (Water-nymph, Naiad)
C, E	Sparse	*Chara sp.* (Stonewort, Muskgrass)	*Potamogeton sp.* (Thin-leaf pondweed) *Elodea canadensis* (Common elodea) *Potamogeton amplifolius* (Large-leaf pondweed)
-	-	*Myriophyllum spicatum* (Eurasian water-milfoil)	

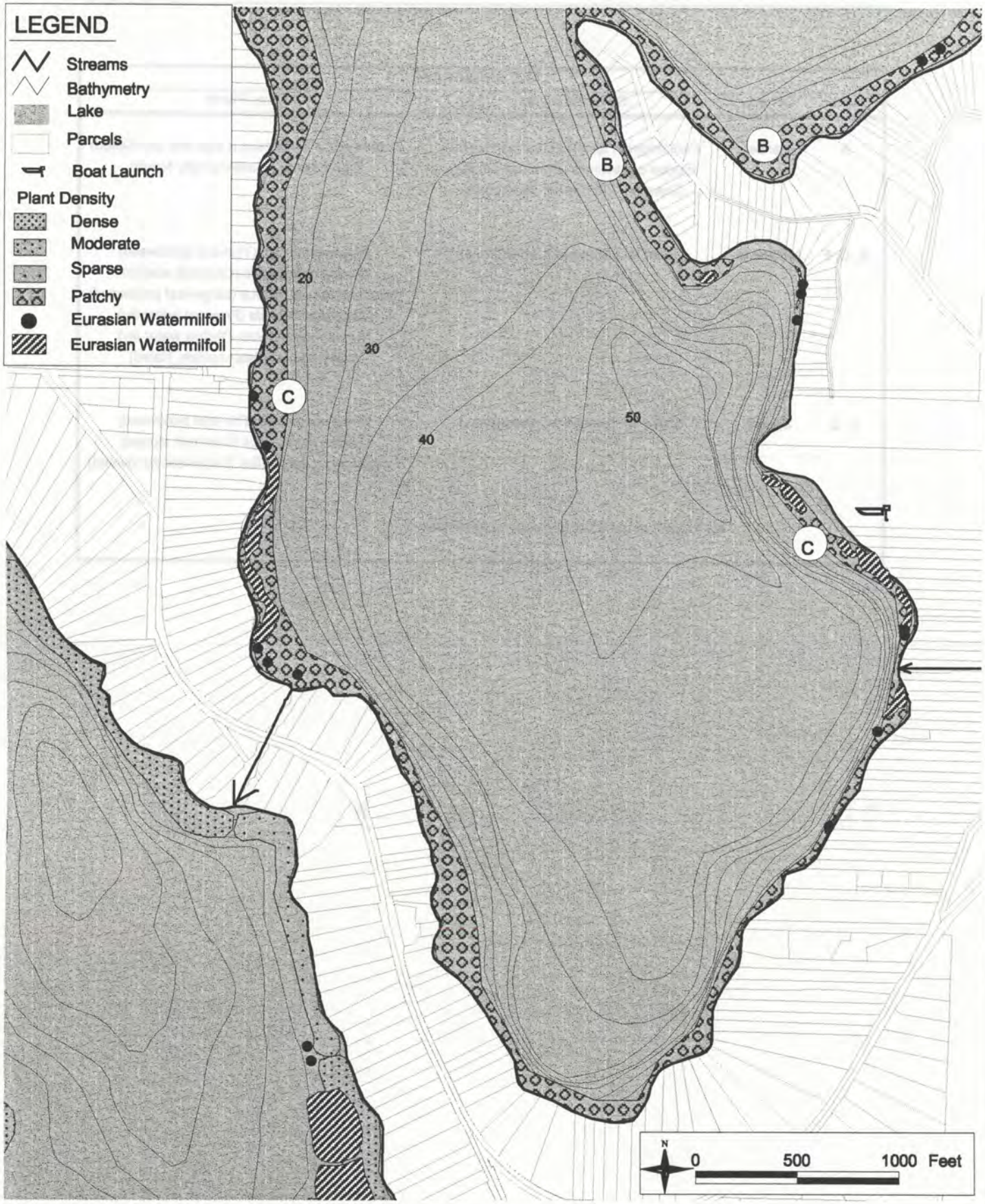


FIGURE 9 -- SOUTH LAKE GOODWIN AQUATIC PLANTS

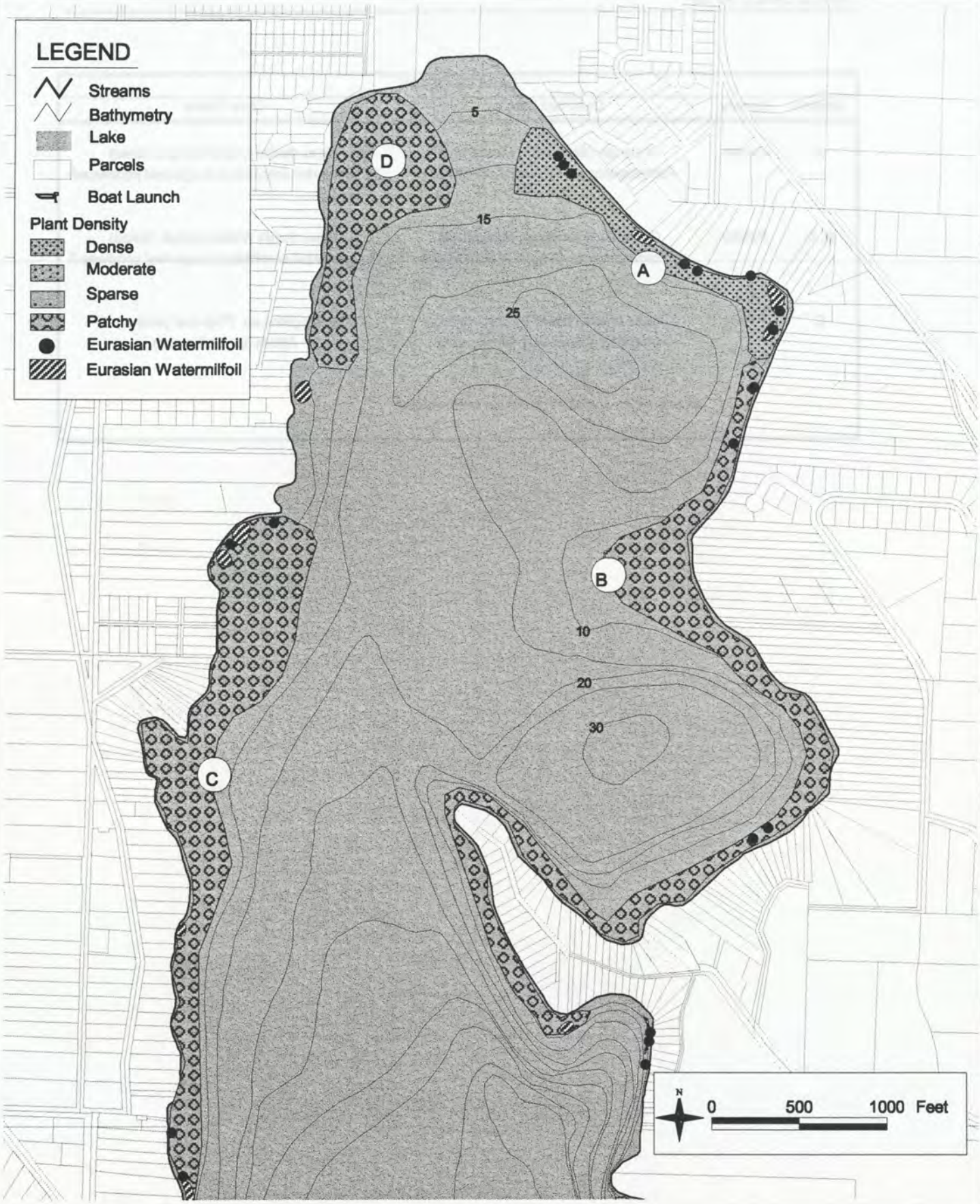


FIGURE 10 -- NORTH LAKE GOODWIN AQUATIC PLANTS

LAKE GOODWIN			
Section	Density	Dominant Plants	Other Plants
A	Dense	*Chara sp.* (Stonewort, Muskgrass) *Potamogeton sp.* (Thin-leaf pondweed)	*Najas flexilis* (Water-nymph, Naiad) *Potamogeton amplifolius* (Large-leaf pondweed)
B, D	Patchy	*Chara sp.* (Stonewort, Muskgrass) *Potamogeton sp.* (Thin-leaf pondweed)	*Najas flexilis* (Water-nymph, Naiad) *Potamogeton amplifolius* (Large-leaf pondweed)
C	Patchy	*Najas flexilis* (Water-nymph, Naiad) *Chara sp.* (Stonewort, Muskgrass)	*Potamogeton sp.* (Thin-leaf pondweed) *Nitella sp.* (Brittlewort)
-	-	*Myriophyllum spicatum* (Eurasian water-milfoil)	

Distribution of Eurasian Watermilfoil

Lake Goodwin

Staff from the Snohomish County Surface Water Management Division (SWM) surveyed Lake Goodwin using surface visual observation and divers in September 1996, specifically to map the density and extent of Eurasian watermilfoil. A global positioning system (GPS) unit was used to accurately map the locations of Eurasian watermilfoil colonies and isolated individual plants. Figures 11 and 12 show the locations and densities of the plant beds in Lake Goodwin. These maps have been updated based on more detailed information discovered during the summer 1997 Phase I work and summer 1998 follow-up diving in Lake Goodwin.

Lake Shoecraft

Lake Shoecraft was also surveyed by divers and from surface observations in September 1996. The locations of Eurasian watermilfoil beds were mapped with a GPS unit. Figure 13 shows the location and densities of Eurasian watermilfoil in Lake Shoecraft in late summer 1996.

SWM staff returned to Lake Shoecraft with a diver to re-survey Eurasian watermilfoil beds on July 16, 1997. That survey found that the locations of the plant beds corresponded closely to the areas mapped in 1996. This indicates that the infestation has not expanded significantly. However, the observed densities of individual Eurasian watermilfoil beds were somewhat different in 1997 than in 1996. These differences may be artifacts of the timing of the surveys and of climatic conditions. Figure 14 shows the results of the 1997 survey. A surface reconnaissance was also conducted by SWM staff in August 1998. This confirmed the 1997 survey results.

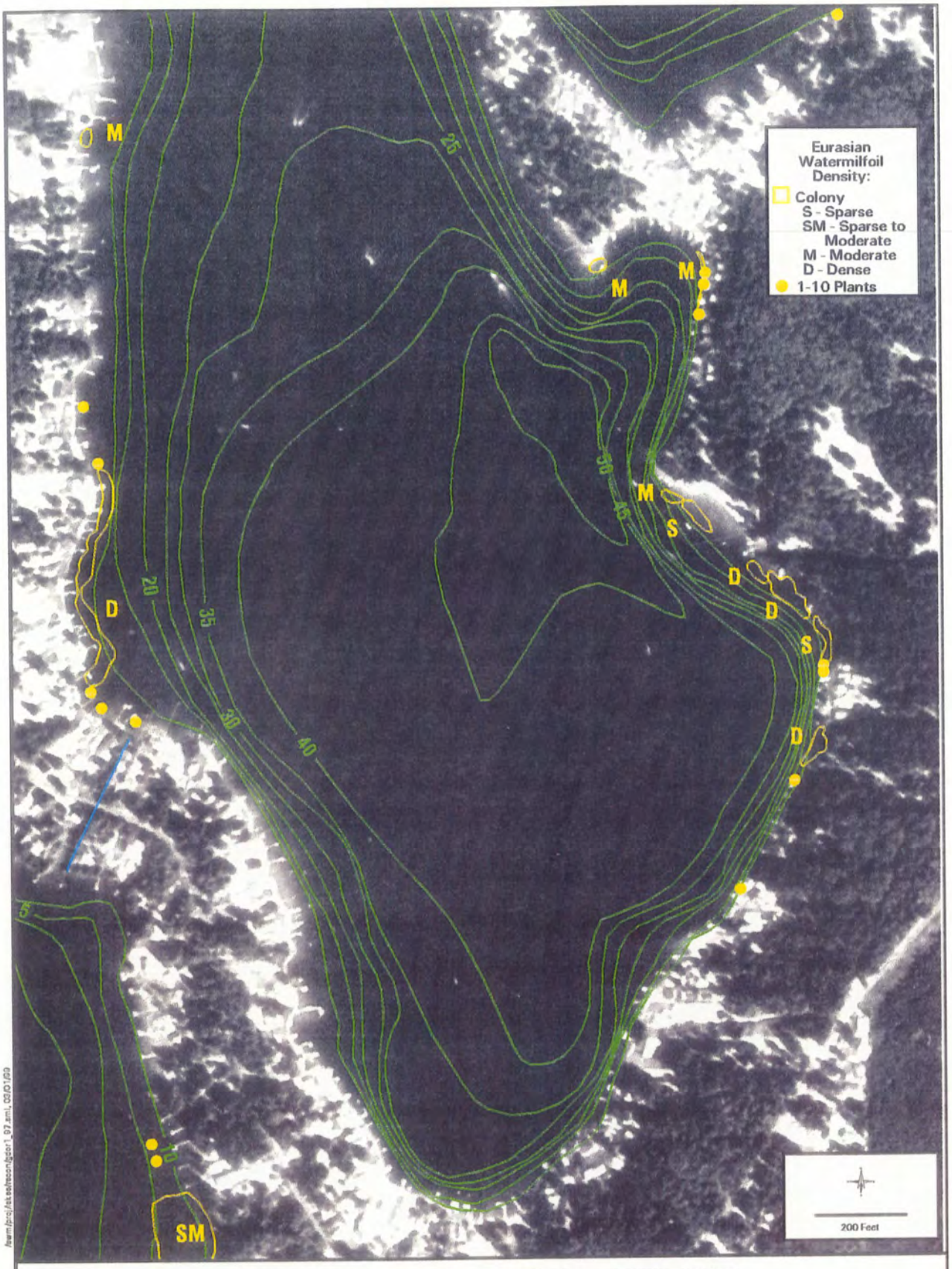


Figure 11 Lower Lake Goodwin - 1996-1998

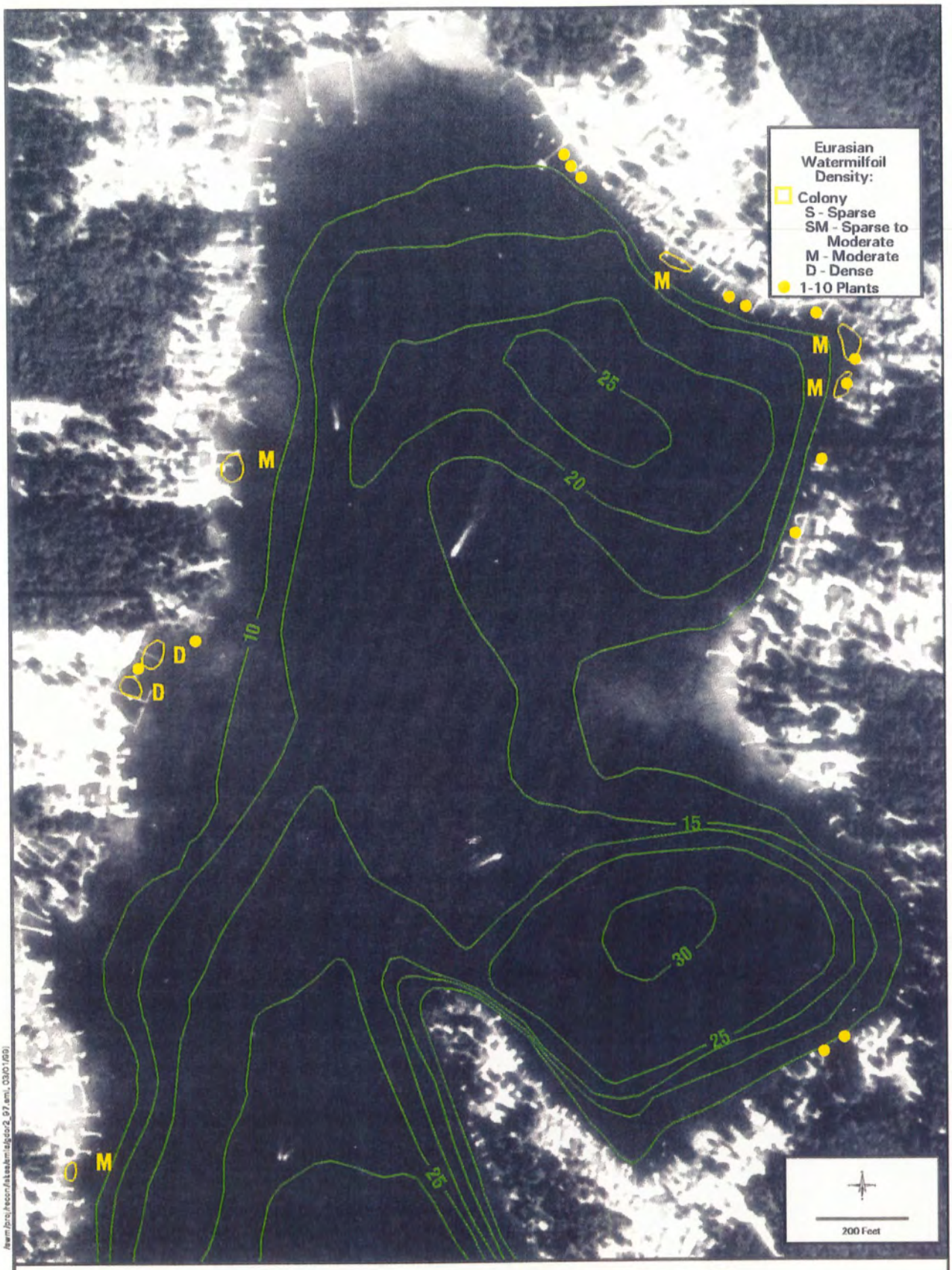


Figure 12 Upper Lake Goodwin - 1996-1998

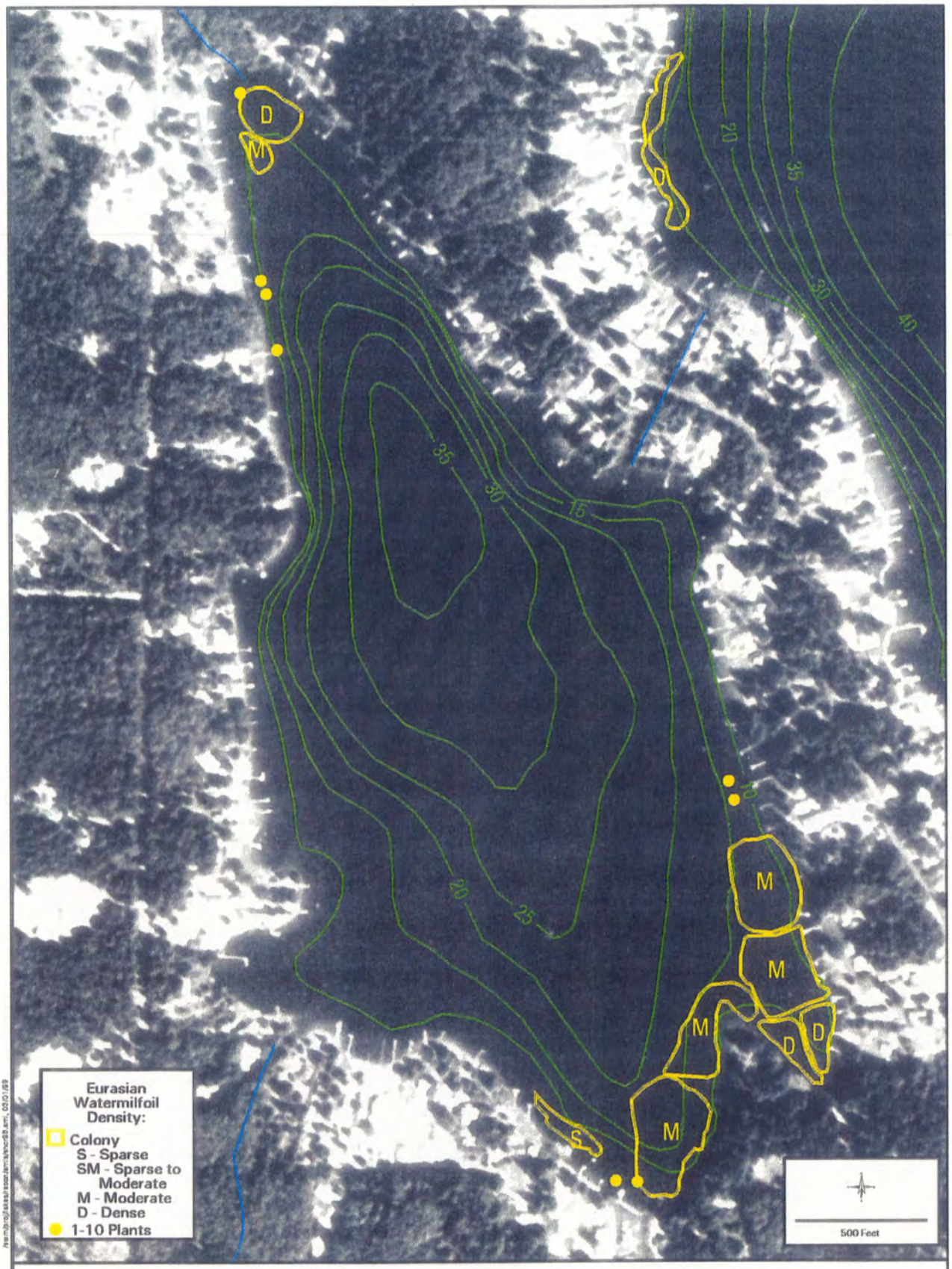


Figure 13 Lake Shoecraft - Summer 1996

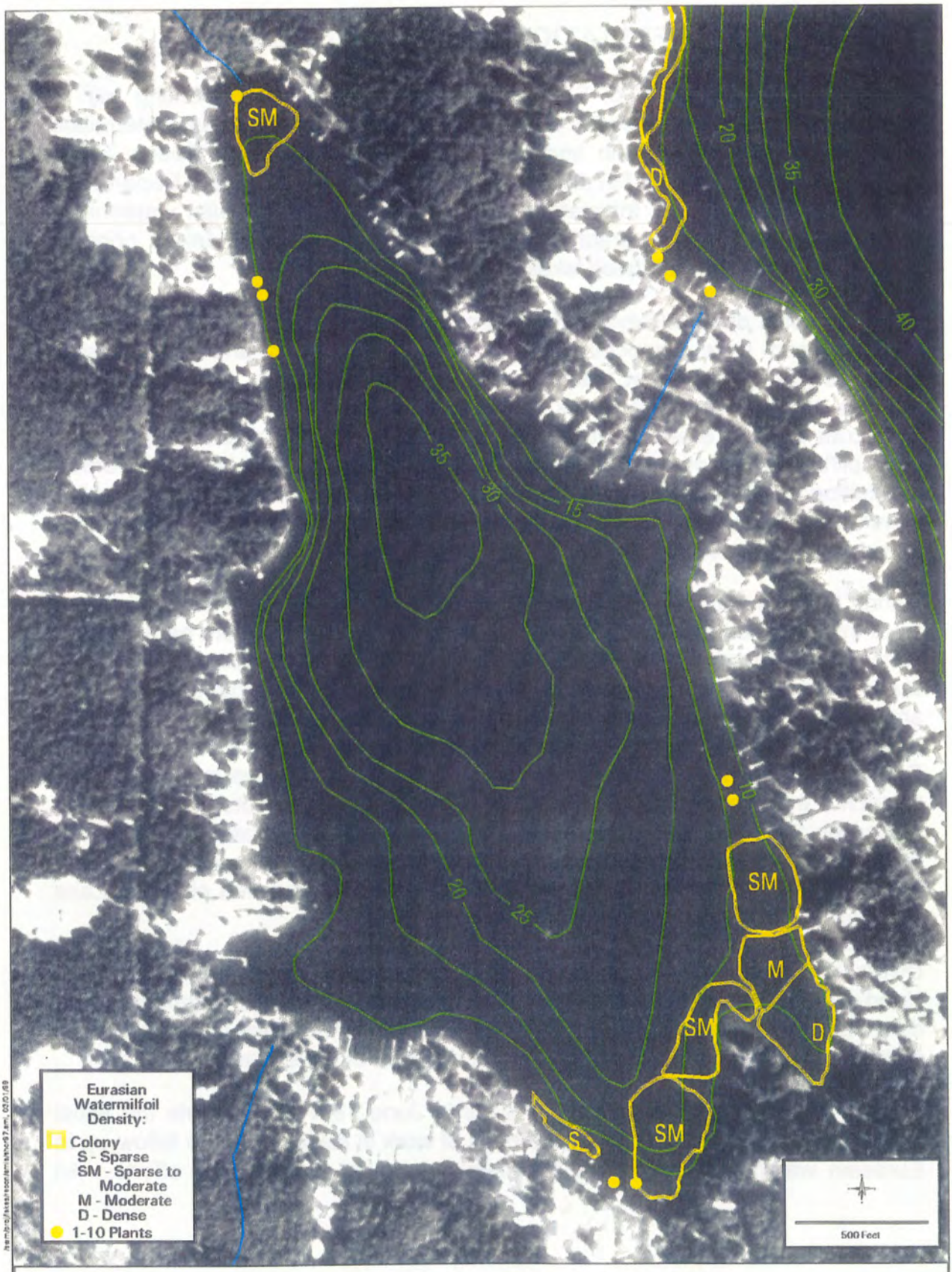


Figure 14 Lake Shoecraft - 1997-1998

PHASE I EARLY INFESTATION CONTROL ACTIONS

During the summer of 1996, Snohomish County SWM began working with a citizens' advisory committee to address the problem of Eurasian watermilfoil infestations in Lake Goodwin and Lake Shoecraft. Snohomish County SWM applied for and received a $67,000 grant from the Washington State Department of Ecology for an "Early Infestation" project to eradicate Eurasian watermilfoil from these lakes. This grant allowed control actions to be taken prior to completing an IAPMP for these lakes.

After the initial diver surveys of Eurasian watermilfoil were completed in Lake Goodwin and Lake Shoecraft, Snohomish County SWM and the advisory committee determined that these Phase I grant funds were only sufficient to address the two acres of plants in Lake Goodwin. The infestation in Lake Shoecraft was too extensive to be addressed by the Early Infestation program, and splitting the funds would not address the problem in either lake. Therefore, in addition to the Lake Goodwin work, an IAPMP (this document) was needed to develop a strategy to control Eurasian watermilfoil in Lake Shoecraft and prevent its spread to other lakes.

During the early fall of 1996 and the summer of 1997, Phase I control actions were implemented in Lake Goodwin. Scuba divers placed bottom barriers over concentrated Eurasian watermilfoil colonies and hand-pulled plants in less dense areas. The bottom barriers were made of tight weave burlap cloth sheets. Each sheet was 25 feet in length and 8.5 feet in width. Each sheet overlapped adjoining sheets by 1.5 to 3 feet and extended 2 to 3 feet beyond the edge of the Eurasian watermilfoil colony. Gravel-filled sand bags and native rock were used to anchor the barriers to the lake bottom. A total of 226 sheets of burlap were placed on the bottom of Lake Goodwin in eight separate locations. Figure 15 shows the number and location of the bottom barriers placed to control Eurasian watermilfoil beds, as well as the areas where divers hand-pulled plants in Lake Goodwin.

Divers removed individual plants in sparsely infested areas by hand-pulling. Hand-pulling included removing all stems, branches, roots, and fragments. The divers dug around and beneath the plants to gently lift the entire plants out of the sediment and placed the plants in bags for disposal at the surface.

From 3 to 5 divers worked during 9 days in June 1997 to complete the initial control actions. Divers returned for 5 days of work in August 1997 to follow-up in Eurasian watermilfoil areas not completely removed during initial efforts. All

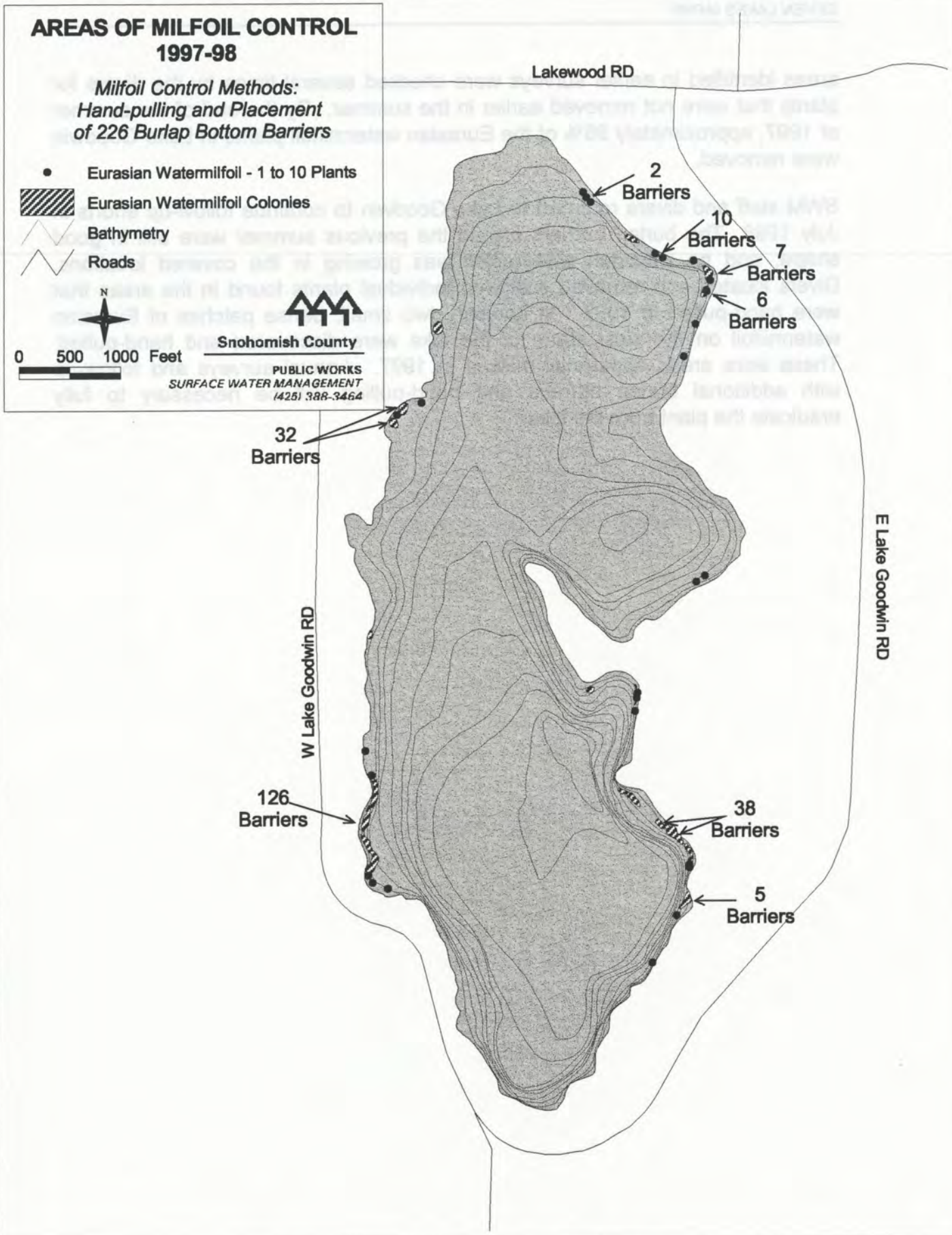


FIGURE 15 -- LAKE GOODWIN

areas identified in earlier surveys were checked several times by the divers for plants that were not removed earlier in the summer. By the end of the summer of 1997, approximately 95% of the Eurasian watermilfoil plants in Lake Goodwin were removed.

SWM staff and divers returned to Lake Goodwin to continue follow-up efforts in July 1998 The burlap barriers placed the previous summer were still in good shape, and no Eurasian watermilfoil was growing in the covered locations. Divers located and removed scattered individual plants found in the areas that were hand-pulled in 1997. In addition, two small, dense patches of Eurasian watermilfoil on the west shore of the lake were discovered and hand-pulled. These were areas apparently missed in 1997. Annual surveys and follow-up with additional burlap barriers and hand-pulling will be necessary to fully eradicate the plant from the lake.

PUBLIC INVOLVEMENT IN DEVELOPMENT OF THIS PLAN

The citizens of the Seven Lakes have been intimately involved in all aspects of Eurasian watermilfoil control efforts, including the development of this Integrated Plan. During 1996 and 1997, an Advisory Committee of citizens and agency representatives met numerous times to assist with the Early Infestation project. This Advisory Committee then continued to work on the IAPMP beginning in August 1997.

Members of the Advisory Committee included:

Ross Adler	Deb Kocher
Stan Ball	Don Laufenberg
William Benson	Michael Mack
Bruce Black	Helen Massart
Mike Bobin	Dean McReynolds
Fred Dockendorf	Bob Moore
Walt Feldheim	Jeanette Moore
Bill Frolli	Jim Rogers
Liv Frolli	Tim Schmidt
John Heller	Tom Smith
Jack Jenkins	Craig Thompson
Eugene Keene	Karen Thompson

Agency staff and others who assisted the committee included Kathy Hamel (WA Dept. of Ecology), Mark Webb (Wenberg State Park), Curt Kraemer (WA Dept. of Fish and Wildlife), Daryl Williams and Cliff Bengston (The Tulalip Tribes), Dr. Harry Gibbons (KCM, Inc.), and Heidi Reynolds and Gene Williams (Snohomish County Surface Water Management).

The Advisory Committee convened in October 1997 and again in January 1998 to review the results of the alternative analysis and the draft plan. The Advisory Committee selected the preferred alternative for Lake Shoecraft in-lake treatment based on the analyses contained in the draft plan.

A community-wide meeting was then held at the Lake Goodwin Community Club on April 1, 1998 to present the treatment alternatives and the proposed management option to the general public. Approximately 1800 notices were sent out to citizens in the Seven Lakes area to publicize this meeting. A large majority of the 50 citizens attending the meeting expressed support for the proposed option. In addition, many citizens in attendance completed a questionnaire about the proposed plan and their willingness to help fund the Eurasian watermilfoil control efforts.

The Advisory Committee met again in June 1998 to address funding strategies for the proposed plan. Subsequently, a sub-committee of citizens met several times through the summer and fall of 1998 to develop a viable funding strategy. This sub-committee consisted of Bill Frolli, Bruce Black, Craig Thompson, and Karen Thompson. The funding strategy described in the Action Plan is based on analysis by this group.

The general public around the Seven Lakes area was kept informed of progress on the IAPMP through publication of articles in two newsletters of the Seven Lakes Water Association. The Spring 1998 and Fall 1998 newsletters were each sent to 1800 residents of the area.

Appendix A includes minutes of the Advisory Committee and public meetings, the public notice, questionnaire results, and newsletter articles.

In addition to citizen involvement, the Tulalip Tribes have been involved in reviewing the proposed plan. The Tribes are naturally concerned that any Eurasian watermilfoil control actions in Lake Shoecraft or Lake Goodwin might have downstream impacts to Tulalip Creek and ultimately to the Tribes' fish hatchery on that stream. The Tribes were kept informed of the treatment alternatives and preferred option throughout the plan development process. Several discussions were held with the Tribes about the potential impacts of the proposed treatment option and possible mitigation measures. The Lake Shoecraft monitoring and contingency plan, described in the Action Plan section, is the result of this coordination with the Tulalip Tribes.

IN-LAKE CONTROL ALTERNATIVE EVALUATION

A variety of methods (chemical, mechanical, biological, physical) is currently available for treatment of nuisance aquatic plant populations to protect beneficial uses of a waterbody. These management methods run the gamut from very intensive removal of target species to less intensive, short-term control strategies (described as maintenance or cosmetic). Also, control methods for maximum effectiveness against a target plant species depend on the particular morphology and structure, physiology, growth requirements, and growth habit of that species. In other words, control methods that might be successful against one species may not be effective for another.

This section reviews treatment methods currently available for aquatic plant control in the State of Washington. The suitability of each treatment option for controlling Eurasian watermilfoil in Lake Shoecraft will be examined. Because the primary nuisance plant in Lake Shoecraft is a State Class B Noxious weed species, the review will focus on the most aggressive control methods, aimed at killing or removing the entire plant, including root system.

Potential options presented for review are the large-scale treatments: aquatic herbicide application (e.g. fluridone, endothall, glyphosate), hydraulic dredging, mechanical dredging coupled with drawdown, sterile grass carp introduction, and mechanical harvesting. Also considered are methods appropriate for smaller areas: hand-removal, bottom barrier application, and diver-assisted suction dredging.

These techniques vary with respect to intensity and effectiveness against rooted plants. Hydraulic suction (barge) dredging, hand removal, bottom barrier, and systemic chemical applications such as fluridone (Sonar®)and glysophate (Rodeo®) are intensive methods aimed at killing or removing all of these nuisance aquatic plants, including roots, and are considered aggressive methods with the potential of achieving long-term reduction. Use of herbivorous grass carp, offering potential long-term control of submersed aquatic vegetation, is also treated in the review, as a result of recent availability of this method in Washington State and its recent use in local waters (e.g., Silver Lake in Cowlitz County). Depending on target species, scale of problem, stocking rate, and other site-specifics, effective use of sterile grass carp can range from eradication of species to maintenance control. Mechanical harvesting and contact herbicides (e.g., Aquathol®) are useful for short-term removal of large areas of surfacing plants, and are included in the discussion as less intensive forms of maintenance control.

Other types of control methods, such as water column dyes, mechanical rotovation (bottom tillage), and lake-level drawdown by itself, are not considered appropriate for use in Lake Shoecraft due to site and species constraints, and are therefore not discussed. Drawdown by itself is ineffective in western Washington lowland lakes for

long-term control of invasive, non-native plants, and may be useful only when used in conjunction with appropriate dredging methods.

Each treatment alternative will be reviewed in terms of principal mode of action, effectiveness of treatment, human and environmental effects (safety, water quality, non-target organisms and plants), costs, and other special political and administrative concerns. A summary of comparative data on these treatment alternatives (including others not considered appropriate for use in Lake Shoecraft) is presented in Table 3. Potential mitigation measures will be presented along with estimates of mitigation costs, where possible.

Mechanical Control Methods

Hydraulic Dredging

Principle: This is an intensive technique that involves removal of littoral sediments and associated rooted aquatic plants using hydraulic dredging equipment. Lake sediment removal is most often performed by means of a cutter-head hydraulic pipeline dredge (Cooke et al., 1993). During operation, plants and sediment loosened by the cutter head travel to the pickup head. The slurry is suctioned up and carried back to the dredge barge through hoses. The sediment slurry is then piped off-site for disposal.

Control Effectiveness And Duration: Large-scale sediment removal techniques can often provide multiple benefits to an aquatic system (Cooke et al., 1993). Depending on the waterbody, possible enhancements include not only rooted macrophyte control, but also increased depth of the waterbody and removal of nutrients or toxic substances. Efficiency of removal depends on the equipment and sediment type and condition, with conventional dredges performing well on harder sediment. However, various types of portable hydraulic dredges available in the U.S. are more effective for small lakes with softer, flocculent substrate. Longevity of control depends on a number of factors, including sedimentation rate (the lower the better), watershed-to-surface-area ratios (at most 10:1), and hydraulic residence time (the longer the better).

Advantages: Dredging removes entire plants, including root systems, so regrowth is minimized. Plant pieces are collected and retained, and fragmentation spread is minimized (this is important for control of Brazilian elodea and Eurasian watermilfoil, which spread by fragments). Hydraulic dredging can be used to cover areas larger than practicable for diver-operated dredging or diver hand-removal, or where herbicides cannot be used. Human health and safety concerns are negligible where operations are prudently conducted.

Drawbacks: Hydraulic dredging is very expensive and highly disruptive to the local environment. A major problem often involves finding suitable off-site disposal areas and transporting dredged materials to these sites. As a result, specialized equipment and materials are required and the process is much more costly. Short-term environmental effects include resuspension of sediments and localized turbidity increases in the area of treatment. Release of nutrients and other contaminants from enriched sediments can also be a problem. In addition, some non-target aquatic organisms and vegetation will be inadvertently removed during the process. However, if only a portion of the lake bed is dredged, the impact on benthic aquatic life should be short-lived (Cooke et al., 1993).

Costs: Dredging costs can vary greatly, depending on the density and volume of sediment removed, equipment condition, transport requirements of dredged material, and eventual use of dredged material (Cooke et al., 1993). Hydraulic dredging costs typically range from a minimum of $\$3/m^3$ to $\$14/m^3$ (not including disposal costs), although figures as high as $\$20$ to $\$50/m^3$ have been reported in special cases.

Permits: In the State of Washington, use of suction dredging does require Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife (WDFW). Its use also requires a temporary modification of water quality standards from the Washington State Department of Ecology (Ecology) for increased turbidity. A shoreline management permit may also be needed. In addition, dredging would require a letter of approval from the Washington State Department of Natural Resources (DNR) which has jurisdiction over the lake bottom.

Applicability to Lake Shoecraft: The idea behind dredging for long-term aquatic plant control is to remove enough sediment to deepen the lake bottom at least below the photic zone (approximately 16 feet) so that plants can no longer receive enough light to grow. When used in such large-scale applications, this alternative is likely to produce highly effective immediate and long-term control, but is very costly and can result in extensive and immediate environmental impact.

In Lake Shoecraft, only one foot of sediment depth would have to be dredged to remove plants and roots of the Eurasian watermilfoil infestation. This would greatly reduce the cost of dredging. This alternative could be a highly effective solution. If a dredge spoil disposal site is found in the vicinity of Lake Shoecraft, the cost of treating a 10-acre area of plant beds would likely be in the neighborhood of $173,000, assuming a cost of $14 per cubic meter, including planning, engineering, environmental, and permitting costs.

Mechanical Dredging

Principle: Mechanical dredging is the physical excavation of sediments similar to hydraulic suction (barge-mounted) dredging described above, but using land-based mechanized equipment (e.g., drag-line dredges). This type of dredging can be used in conjunction with lake-level drawdown so that the equipment can operate more effectively, if optimal environmental, operational, and jurisdictional conditions are present.

Advantages, Drawbacks, Costs, Permits: These are similar to hydraulic dredging, with the added problem of access and higher costs.

Applicability to Lake Shoecraft: This alternative has limited potential for aquatic plant control at Lake Shoecraft because of access problems and the severe impact of drawing the lake level down fifteen feet--far enough to kill the plant roots.

Diver-Operated Suction Dredging

Principle: Diver dredging has been used since the late 1970s in British Columbia as an improvement over hand removal for sparse colonies of Eurasian watermilfoil. More recently, this method has been successfully used in several lakes in Washington State for small-scale removal of non-native plants. The technique employs a small barge or boat carrying portable dredges with suction heads that are operated by Scuba divers to remove individual plants (including roots) from the sediment. Divers physically dislodge the plants and roots with sharp tools or by hand. The plant/sediment slurry is then suctioned up and carried back to the barge through hoses operated by the diver. On the barge, plant parts are sieved out and retained for later off-site disposal. The water sediment slurry can be discharged back to the lake or piped off-site for upland disposal.

Control Effectiveness and Duration: Diver dredging can be highly effective under the proper conditions. Efficiency of removal depends on sediment condition, density of aquatic plants, and underwater visibility. It is best used for localized infestations of low plant density where fragmentation must be minimized. Depending on local conditions, removal efficiencies of 85 to 97 percent can be achieved by diver dredging. This technique is currently being used for aggressive control of Eurasian watermilfoil populations in Silver Lake (City of Everett), and is proposed for use in Long Lake (Thurston County).

Advantages: The method is species-selective and site-specific. Disruption of sediments are minimized. Plant pieces are collected and retained, and spread of fragments is minimized (which is important for control of Eurasian watermilfoil). Diver dredging can be used to cover areas larger than practicable for hand digging or diver hand removal, or where herbicides cannot be used. Diver-dredging can be conducted in tight places or around obstacles that would preclude the use of larger machinery.

Drawbacks: Diver-dredging is labor-intensive and expensive. In dense plant beds, the utility of this method may be much reduced and other methods (e.g., bottom barrier) may be more appropriate. Returning dredged residue directly to the water may result in some fragment loss through sieves. Where upland disposal of dredged slurry is used, more specialized equipment and materials are required and the process is much more costly. Short-term environmental effects can include localized turbidity increases in the area of treatment. Release of nutrients and other contaminants from enriched sediments can also be a problem. In addition, some sediment and non-target vegetation may be inadvertently removed during the process.

Costs: Dredging costs can vary greatly, depending on the density of plants, equipment condition, and transport requirements of dredged material. In addition, the use of contract divers for dredging work is subject to stringent State regulations on certification, safety, and hourly wage payment, which can affect total project cost. Costs range from a minimum of $1,100/day to upwards of $2,800/day (not including transport of dredged material). This corresponds to $6,000 to $20,000 per acre.

Permits: In the State of Washington, use of suction dredging requires an HPA from WDFW. Its use also requires a temporary modification of water quality standards from Ecology for increased turbidity. A shoreline management permit may also be needed. In addition, it may be necessary to obtain a letter of approval from DNR for dredging of the state-owned lake bottom.

Applicability to Lake Shoecraft: Diver-operated dredging may be useful in Lake Shoecraft to remove small, isolated patches of Eurasian watermilfoil, and to treat areas where herbicides cannot be used, such as on plants located near domestic water intakes. Its use in this lake is most appropriate for small-scale, supplementary work.

Mechanical Harvesting

Principle: Mechanical harvesting is considered a short-term technique to temporarily remove plants interfering with recreational or aesthetic enjoyment of a water body. Harvesting involves cutting plants below the water surface, with or without collection of cut fragments for onshore disposal. To achieve maximum removal of plant material, harvesting is usually performed during summer when submersed and floating-leafed plants have grown to the water's surface.

Conventional single-stage harvesters combine cutting, collecting, storing, and transporting cut vegetation into one piece of machinery. Cutting machines are also available that perform only the cutting function. Maximum cutting depths for harvesters and cutting machines range from 5 to 8.2 feet with a swath width of 6.5 to 12.1 feet. Cooke et al. (1993) summarize aquatic plant cutters and harvesters available in North America.

Control Effectiveness and Duration: Since harvesting involves physical removal and disposal of vegetation away from the water, the immediate effectiveness in creating open water areas is quite apparent. The duration of control is variable, however. Factors such as frequency and timing of harvest, water depth, and depth of cut influence the duration of control. Harvesting has not proved an effective means of sustaining long-term reductions in growth of Eurasian watermilfoil. Regrowth of plants to pre-harvest levels typically occurs within 30 to 60 days (Perkins and Sytsma, 1987), depending on water depth and the depth of cut. Aquatic plant researchers Johnson and Bagwell (1979) and Schiller (1983) also suggest probable short-term benefits provided by mechanical harvesting of nuisance aquatic plants, but caution against possible spread of infestation through stem fragmentation.

Advantages: Harvesting is most appropriate for large, open areas with few surface obstructions. There is usually little interference with the use of a water body during harvesting operations. Harvesting has the added benefit that removal of in-lake plant biomass eliminates a possible source of nutrients that can be released during the fall when aquatic plants die back and decay. This is an important consequence in water bodies with extensive plant beds and low nutrient inputs from outside sources. Furthermore, harvesting can reduce sediment accumulation by removing organic matter that normally decays and adds to the bottom sediments. Depending on species content, harvested vegetation can be easily composted and used as a soil amendment. Mechanical harvesting costs can be relatively low compared to other physical or mechanical techniques.

Drawbacks: Since harvesting removes only the upper stem material, regrowth from roots does occur, requiring annual, or more frequent, harvesting. Cut plant material requires collection and removal from the water. Harvesting also creates plant fragments. While pondweeds do not reproduce by fragmentation, Eurasian watermilfoil can rapidly disperse by stem breakage. Thus, where eradication or halting the spread of Eurasian watermilfoil is a program goal, harvesting would not be an appropriate technique. Harvesting can be detrimental to non-target plants and animals (e.g., fish, invertebrates), which are removed indiscriminately by the process. Harvesting can also enhance the growth of opportunistic plant species that invade treated areas. Capital costs for machine purchase are high and the equipment requires considerable maintenance. Rental arrangements would be too expensive for a multi-year program.

Costs: Harvesting program costs depend on factors such as program scale, composition and density of vegetation, equipment used, skill of personnel, and site-specific constraints. Detailed costs are not uniformly reported, so comparing project costs of one program with another can be difficult. However, average costs of local harvesting operations range from $200/acre to $700/acre, including capital amortization. Because harvesting is mainly a long-term maintenance operation, costs would continue year after year.

Permits: Mechanical cutting of aquatic plants (including with battery-operated equipment) requires an HPA from the WDFW. Local regulations may also apply to mechanical cutting operations.

Applicability to Lake Shoecraft: Harvesting produces plant stem fragments. Since Eurasian watermilfoil reproduces primarily by stem fragmentation, use of this mechanical option as a major, large-scale control element of this species in Lake Shoecraft is not recommended. Harvesting is also incompatible with the management objective of aggressive removal of Eurasian watermilfoil populations.

Chemical Control Methods

Historically, the use of aquatic herbicides was the principal method of controlling nuisance aquatic weeds in Washington. However, in recent years there has been a move away from widespread herbicide use, toward more selective herbicide use following a thorough review of effectiveness, and other environmental, economic, political, and social factors (Ecology, 1992).

The State of Washington currently permits use of only three aquatic herbicides to control aquatic weeds. They are the systemic herbicides Sonar (*fluridone)* and Rodeo (*glyphosate)*, and the contact herbicide Aquathol (*endothall)*. Systemic herbicides are absorbed by and translocated throughout the plant, which kills the entire plant, roots and shoots. In contrast, contact herbicides kill the plant surface with which it comes in contact, leaving roots alive and capable of regrowth. The systemic herbicide, Sonar, has the best potential for use in Lake Shoecraft. Systemic and contact herbicides are reviewed in more detail below.

Sonar® (Fluridone)

Principle: Fluridone, 1-methyl-3-phenyl-5-[3-trifluoromethyl)phenyl]-4(1H)-pyridinone, is a slow-acting, systemic herbicide. Fluridone is available as the EPA-registered herbicide Sonar®(a registered trademark of SePRO) for use in the management of aquatic plants in freshwater ponds, lakes, reservoirs, and irrigation canals. It is formulated as a liquid (Sonar 4AS) sprayed above or below surface, and in controlled release pellets (Sonar 5P, Sonar SRP) spread on the water surface. Sonar is effectively absorbed and translocated by both plant roots and shoots (Westerdahl and Getsinger, 1988).

Control Effectiveness and Duration: Sonar demonstrates good control of submersed and emergent aquatic plants, especially where there is little water movement. Its use is most applicable for lake-wide or isolated bay treatments to control a variety of exotic and native species. Eurasian watermilfoil is particularly susceptible to the effects of the herbicide. Sonar demonstrates "good" control of Brazilian elodea (*Egeria densa*), common elodea (*elodea canadensis*), and some pondweeds (*Potamogeton* spp.) (Westerdahl and Getsinger, 1988). Typical Sonar injury symptoms include retarded growth, "whitened" leaves, and plant death. The effects of Sonar treatment become noticeable 7 to 10 days after application, with control of target plants often requiring 60 to 90 days to become evident (Westerdahl and Getsinger, 1988). Because of the delayed nature of toxicity, the herbicide is best applied during the early growth phase of the target plant, usually spring or early summer.

Advantages: As a systemic herbicide, Sonar is capable of killing the roots and shoots of aquatic plants, thus producing a more long-lasting effect. Many emergent and submersed aquatic plants are susceptible to Sonar treatment. As a result of human health risk studies, it has been determined that use of Sonar according to label instructions does not pose any threat to human health (Ecology, 1992). This herbicide also has a very low order of toxicity to zooplankton, benthic invertebrates, fish, and wildlife.

Drawbacks: Sonar is a slow-acting herbicide, and its effects can sometimes take up to several months to become apparent. This means that the concentration of the herbicide in the lake must be kept at or above the effective level for as long as eight weeks, which often requires multiple applications. Because of this long uptake time, Sonar is not effective in flowing water situations. Also, lakes with high flushing rates (such as Lake Shoecraft) may reduce the effectiveness of the active ingredient and increase the risks of downstream impact on non-target plants. Because of the potential for drift out of the treatment zone, Sonar is not suitable for treating a defined area within a large, open lake. This is the situation in Lake Shoecraft, unless the water in the treated area can be contained.

With Sonar, the potential exists for release of nutrients to the water column and for consumption of dissolved oxygen from the decay of dying plants. Non-target plants may also be affected, as many plants show susceptibility to Sonar treatment. Mitigation of lost non-target vegetation may be necessary. As Sonar-treated water may result in injury to irrigated vegetation, there are label recommendations regarding irrigation delays following treatment.

Costs: Treatment costs (materials and application) by private contractor for any of the formulations are $1,500/acre or more, depending on the scale of treatment.

Permits: The use of aquatic herbicides requires receiving a short-term modification to State water quality standards from Ecology prior to treatment.

Applicability to Lake Shoecraft: Of the small number of aquatic herbicide tools permitted for use in Washington State, proper use of Sonar (at optimal rates and exposure) offers the most practical, potentially effective means of controlling large infestations of tenacious weeds such as Eurasian watermilfoil. The potential for success is increased with repeated, large-scale, intensive treatment, especially given the success of such a control regimen used against Eurasian watermilfoil (as in Long Lake, Thurston County). Treatments in successive years is a potential strategy for implementation in Lake Shoecraft. An alternative to successive year treatments is placing a barrier or screening the target area to reduce herbicide drift.

Rodeo® (Glyphosate)

Principle: Glyphosate (N-(phosphonomethyl)glycine) is a non-selective, broad spectrum herbicide used primarily for control of emergent or floating-leafed plants such as purple loosestrife and water lilies. It is not normally used for submersed plants, such as the Eurasian watermilfoil in Lake Shoecraft. Rodeo is a systemic herbicide that is applied to the foliage of actively growing plants. The herbicide is rapidly absorbed by foliage and translocated throughout plant tissues, affecting the entire plant, including roots. Glyphosate is formulated as Rodeo® (Monsanto) for aquatic application.

Control Effectiveness and Duration: Rodeo is effective against many emergent and floating-leafed plants, such as waterlilies (*Nuphar* and *Nymphaea* spp.) and purple loosestrife (*Lythrum salicaria*). According to the manufacturer, Rodeo is not effective on submersed plants or those with most of the foliage below water. The herbicide binds tightly to soil particles on contact and thus is unavailable for root uptake by plants. As a result, proper application to emergent foliage is critical for herbicidal action to occur. Symptoms of herbicidal activity may not be apparent for up to 7 days, and include wilting and yellowing of plants, followed by complete browning and death.

Advantages: As a systemic herbicide, Rodeo is capable of killing the entire plant, producing long-term control benefits. Rodeo carries no swimming, fishing, or irrigation label restrictions. The herbicide dissipates quickly from natural waters, with an average half-life of 2 weeks in an aquatic system. The herbicide has a low toxicity to benthic invertebrates, fish, birds, and mammals.

Drawbacks: As a non-selective herbicide, Rodeo treatment can have an effect on non-target plant species susceptible to it. While the possibility of drift through aerial application exists, it is expected to be negligible if application is made according to label instructions and permit conditions. Use is restricted where Rodeo is applied within 1/2 mile of potable intakes in either flowing or standing waters. Current label restrictions require that active potable water intakes be shut off for a minimum of 48 hours after application or until the laboratory-measured Rodeo level in intake water is below 0.7 ppm.

Costs: Treatment costs (materials and application) by private contractor for any of the formulations average approximately $300/acre, depending on scale of treatment.

Permits: Use of aquatic herbicides requires a short-term modification to State water quality standards from Ecology prior to treatment.

Applicability to Lake Shoecraft: Since Rodeo is most effective against certain emergent or floating-leafed plants, it is not appropriate for use on Eurasian watermilfoil in Lake Shoecraft.

Aquathol® (Endothall)

Principle: Endothall is a contact herbicide that is not readily translocated in plant tissues. Endothall formulations (active ingredient endothall acid, 7-oxabicyclo[2,2,1] heptane-2,3-dicarboxylic acid) are currently registered for aquatic use in Washington in either inorganic or amine salts. Aqueous or granular forms of the dipotassium salt of endothall, (Aquathol® - Elf Atochem), are permitted in State waters, with stringent use restrictions on water contact, irrigation, and domestic purposes over and above label restrictions. Due to its toxicity, the liquid amine form Hydrothol-191® is not permitted for use in fish-bearing waters.

Control Effectiveness and Duration: As a contact herbicide, Aquathol kills only plant tissues it contacts, usually the upper stem portions. Thus, the entire plant is not killed. It is therefore used primarily for short-term control of aquatic plants, not for complete eradication. Duration of control is a function of contact efficiency and regrowth from unaffected root masses. Effective reductions in plant biomass can range from a few weeks to several months. In some circumstances, season-long control can be achieved. Carryover effectiveness of Aquathol treatments into the following growth season is not typical.

Advantages: Contact herbicides such as Aquathol generally act faster than translocating herbicides such as Sonar; evidence of tissue death is often apparent in 1 to 2 weeks. There is usually little or no drift impact from proper application of this product. Overall costs of treatment are less than for Sonar applications over the same area.

Drawbacks: Because the entire plant is not killed, Aquathol causes only temporary reductions in aquatic plant growth. As a variety of aquatic plants is susceptible to Aquathol, non-target plant impact is possible. Although the recently amended label for Aquathol K has no swimming restriction (pending State approval), Washington State requires an 8-day swimming restriction following treatment. There are also label restrictions on fish consumption and non-food crop irrigation.

Costs: As with Sonar applications, Aquathol treatments vary with total area and dosage rate. Average costs for a small to moderate area application can run about $500 to 700/acre.

Permits: Use of Aquathol requires a short-term modification to State water quality standards from Ecology prior to treatment.

Applicability to Lake Shoecraft: Since Aquathol kills only the plant tissues it contacts, usually the upper stem portions, it is most appropriately used for short-term control of aquatic plants. Thus, Aquathol treatment is incompatible with the management objective of aggressive removal of Eurasian watermilfoil populations from Lake Shoecraft.

Renovate® (Triclopyr)

Principle: Triclopyr, 3,5,6-tricloro-2-pyridinyloxyacetic acid, triethylamine salt, is a rapidly absorbed systemic herbicide. Renovate®, the trade name for triclopyr, is manufactured by DowElanco, but is not an EPA registered herbicide at this time. Renovate is available for experimental use only. The EPA experimental use program allows for the use of Renovate to evaluate selective control of woody plants and certain annual or perennial plants in and around ponds, lakes, reservoirs, marshes, and wetlands. Renovate is applied to the surface or subsurface of the water as a liquid spray. The herbicide is absorbed and translocated by the plant roots and shoots during active growing seasons. It is best to apply triclopyr in spring and early summer.

Control Effectiveness and Duration: Renovate has demonstrated effective control of certain submersed and emergent aquatic plants, especially where there is little water movement. Its use is most applicable for lake-wide or isolated bay treatments to control a variety of exotic and native species. Eurasian watermilfoil is particularly susceptible to the effects of Renovate, as are all species of the genera *Myriophyllum*. Renovate is considered a selective herbicide because it can be used to control certain plants and not others. The effects of herbicide treatment occur within 10 to 14 days after exposure. Death can occur in 4 to 6 weeks.

Advantages: As a systemic herbicide, Renovate is capable of killing the roots and shoots of aquatic plants. It has been proven to be an effective eradication chemical for Eurasian watermilfoil at relatively low doses and short exposure time (DowElanco, 1997).

Drawbacks: This herbicide has a 30 day restriction for fishing within the treated area.

Costs: Treatment costs (materials and application) by private contractor are estimated at $1500/acre.

Permits: The use of aquatic herbicides requires a short-term modification to State water quality standards from the Department of Ecology. However, Renovate is not covered in the current statewide Environmental Impact Statement for plant control. An environmental assessment is being conducted as part of EPA's experimental use program, and this information may be used to develop an amendment to the Statewide EIS. The use of Renovate can be permitted within the state of Washington through EPA's experimental use program. In addition, EPA may issue an approved aquatic herbicide label for Renovate by 2000. If this occurs and the State completes environmental review, the chemical could become more available for aquatic plant control in Washington.

Applicability to Lake Shoecraft: The potential for success in eradicating Eurasian watermilfoil using Renovate is good in Lake Shoecraft. However, its use is dependent on obtaining an experimental use permit, which in turn depends on the State review, so it is not likely to be available for use at Lake Shoecraft.

2,4-D

Principle: 2,4-D, 2,4-dichlorophenoxyacetic acid, butoxyethyl ester, is a slow-acting systemic herbicide. Navigate®, manufactured for Applied Biochemists, is the available EPA-registered herbicide of the granular 2,4-D formulated low-volatile butoxyethyl ester for use in the management of aquatic plants in freshwater ponds, lakes, and reservoirs. Navigate is applied to the surface of the water as attaclay granules containing 2,4-D. These granules sink to the bottom of the water body where the herbicide is released near the root zone of the plants. The herbicide is absorbed and translocated by the plant roots and shoots during active growing seasons. It is best to apply 2,4-D in spring and early summer. In dense plant beds, a second application may be necessary in early August.

Control Effectiveness and Duration: 2,4-D demonstrates effective control of certain submersed and emergent aquatic plants, especially where there is little water movement. Its use is most applicable for lake-wide or isolated bay treatments to control a variety of exotic and native species. Eurasian watermilfoil is particularly susceptible to the effects of 2,4-D, as are all species of the genera *Myriophyllum*. Another affected plant is water stargrass (*Heteranthera dubia*). 2,4-D is considered a selective herbicide because it can be used to control certain plants and not others. The typical injury symptoms include accelerated unparallel growth that results in tumorous conditions and leads to plant death or reduced biomass. The effects of 2,4-D occur within 10 to 14 days after exposure. Death, if it occurs, will happen in 4 to 6 weeks. Used for control of Eurasian watermilfoil, a double application of 2,4-D within the same growth season will yield a 50 percent decline in biomass the following year.

Advantages: As a systemic herbicide, 2,4-D is capable of killing the roots and shoots of aquatic plants, although it is not been proven to be an effective chemical for permanent eradication Eurasian watermilfoil (Gibbons and Gibbons, 1985a).

Drawbacks: This herbicide is toxic to fish, and herbicide drift may adversely affect fish and non-target plants. 2,4-D should not be applied where water uses include irrigation, watering of animals, or domestic water supplies.

Costs: Treatment costs (materials and application) by private contractor are estimated at $600 to $800/acre.

Permits: The use of aquatic herbicides requires a short-term modification to State water quality standards from Ecology. However, 2,4-D is not covered in the current Environmental Impact Statement for plant control. Without the environmental assessment being conducted and included as an amendment to the Statewide EIS, no permit can be issued for 2,4-D without specific legislative action.

Applicability to Lake Shoecraft: The potential for success in eradicating Eurasian watermilfoil using 2,4-D in Lake Shoecraft is low to moderate. The primary drawbacks are the potential for downstream fish toxicity and the difficulty of obtaining a permit.

Biological Control Methods

Interest in using biocontrol agents for nuisance aquatic plant growth has been stimulated by a desire to find more "natural" means of long-term control as well as to reduce the use of expensive equipment or chemicals. The possibility of integrating biological controls with traditional physical, mechanical, or chemical methods is an appealing concept. While development and use of effective biocontrol agents for aquatic plant management is still in its childhood, potentially useful candidates have been identified, These include plant-eating fish or insects, pathogenic organisms, and competitive plants. Control of nuisance plants using biological agents is a gradual process, although the effects should be longlasting.

In the State of Washington, the only biological method currently available for aquatic plant control is the introduction of triploid (sterile) grass carp.

Triploid (Sterile) Grass Carp

Principle: Grass carp or white amur (*Ctenopharyngodon idella* Val.) are exotic, plant-consuming fish native to large rivers of China and Siberia. Known for their high growth rates and wide range of plant food preference, these fish can control certain nuisance aquatic plants under the right circumstances. In theory, grass carp are most appropriately used for lake-wide, low-intensity, long-term control of submersed plants. However, achieving and sustaining a desired plant density may be difficult if not impossible given the environmental variability over time at any lake. Appropriate fish stocking rates are difficult to estimate. Experience has shown that too few result in little or no plant control, while too many fish may cause all the plants to be eliminated from the water body. Stocking rates are determined based on climate, water temperature, type and extent of plant species, and other site-specific constraints. Grass carp require a permit from WDFW. To avoid problems encountered in other areas of the country, Washington State regulations adopted in 1990 require the following:

1. Only sterile (triploid) fish can be planted
2. Outlets and possibly inlets must be screened to prevent fish from getting into other water bodies
3. Stocking will be determined by WDFW based on the current planting model. This is to ensure that sufficient vegetation is retained for fishery and other habitat needs.

Control Effectiveness and Duration: Effectiveness of grass carp in controlling aquatic weeds depends on feeding preferences and metabolism; rates do appear to be temperature-dependent (Ecology, 1992; Cooke et al., 1993). Triploid grass carp exhibit distinct food preferences, which apparently vary from region to region in the U.S. Recent research suggests that feeding preference and rates can also depend on fish age, water chemistry, and plant composition (Pauley et al., 1994). Laboratory and field studies in Washington State have shown that some plant species appear to be highly preferred, such as the thin-leafed pondweeds (*Potamogeton crispus*, *P. pectinatus* and *P. zosteriformis)*; other plants were variably preferred, such as coontail (*Ceratophyllum demersum)*, and some plants were not preferred, such as waterlily (*Nuphar*) and watershield (*Brasenia schreberi)*. Grass carp appear to graze Brazilian elodea (*Egeria densa*) fairly effectively (Miller and Decell, 1984; Pine and Anderson, 1991). However, researchers in Washington State report in lab tests that *Egeria densa* was highly preferred by large fish, but nearly unpalatable to fingerlings (Pauley et al., 1994). Preliminary results of grass carp grazing in Silver Lake (Cowlitz County) suggest a drastic impact within two years on Brazilian elodea and Eurasian watermilfoil, as well as other species of pondweed, coontail, bladderwort, and watershield. Grass carp control effectiveness and duration are site-specific. Management studies in Washington waters indicate that substantial removal of vegetation by sterile grass carp may not become apparent until 3 to 5 years after introduction.

Advantages: Depending on the problem plant species and other site constraints, proper use of grass carp can achieve long-term reductions in nuisance growth of vegetation, although perhaps not immediately. In some cases, introduction of grass carp may result in improved water quality conditions, where water quality deterioration is associated with dense aquatic plant growth (Thomas et al., 1990). Compared to other long-term aquatic plant control techniques (e.g., systemic aquatic herbicides, bottom barriers), costs for grass carp implantation are relatively low.

Drawbacks: Since sterile grass carp exhibit distinct food preferences, they do not graze all plants equally well, limiting their applicability. The fish may avoid areas of the water body experiencing heavy recreational use, resulting in less plant removal. Plant reductions may not become evident for several years. Overstocking of grass carp could result in eradication of beneficial plants and may have a serious impact on the overall ecology of the water body. The full ecological impact of grass carp introductions in Northwest waters are still being determined. An escape barrier on the lake outlet is currently required to prevent movement of fish out of the system and avoid impact on downstream non-target vegetation. Fish loss due to predation, especially by ospreys and otters, is possible. Phytoplankton production in lakes with grass carp tends to increase, but this increase is not always observed based on turbidity of water. Another concern is that the introduced fish could be carriers of bacteria or other biological agents that could contaminate the hatchery downstream. Although grass carp can be treated before delivery to the site to reduce the risk of pathogenic introductions, spread of harmful bacteria or diseases could remain a concern.

Costs: Based on the few large-scale grass carp implantations made in the State of Washington since 1990, costs can range from approximately $50/acre to $2000/acre, at stocking rates ranging from 5 fish/acre to 200 fish/acre and average cost of $10/fish (range $7.50/fish to $15.00/fish).

Permits: WDFW requires a game fish planting permit prior to grass carp introduction to a water body. A State environmental policy checklist (SEPA) is required, describing the site to be stocked and the potential impact. In addition, if outlet screening is necessary, an HPA is required from the WDFW. The Department of Natural Resources Natural Heritage Program must be contacted for assessment of threatened or endangered plant species. Also necessary is a list of property owners with lots adjacent to the targeted waterbody and their approval of the proposed grass carp planting.

Applicability to Lake Shoecraft: Eurasian watermilfoil, the problem species in Lake Shoecraft, is not a preferred food item of grass carp. It is likely that the grass carp would harvest all other plants except lilies before Eurasian watermilfoil is eradicated. This means the lake would have to be stocked at a high rate to ensure that the Eurasian watermilfoil plants are removed by the grass carp. Additional constraints to using grass carp in Lake Shoecraft include a WDFW requirement for screening the outlet structure as well as inlet screening to prevent grass carp escape. The design and construction of these screens could add significant costs to the total project.

Physical Control Methods

Hand-Digging

Principle: Hand-digging and removal of rooted, submersed plants is an intensive treatment option. This method involves digging out the entire plant (stem and roots) with a spade or long knife, or by hand, and disposing of the residue on shore. In shallow waters less than 3 feet deep, no specialized gear is required. In deeper waters, hand removal can best be accomplished by divers using Scuba or snorkeling equipment and carrying collection bags for disposal of plants. The technique is most appropriately applied to small areas (i.e., area less than 5,000 sq ft).

Control Effectiveness and Duration: Efficacy of plant removal depends on sediment type, visibility, and thoroughness in removing the entire plant, particularly the roots. A high degree of control over more than one season is possible where complete removal has been achieved.

Advantages: The technique results in immediate clearing of the water column of nuisance plants. The technique is very selective in that individual plants are removed. It is most useful in sensitive areas where disruption must be kept to a minimum. Because the technique is highly labor-intensive, it is most suitable for small-area, low plant density treatments. In these cases, the technique is very useful for aggressive control of sparse or small pockets of rooted Eurasian watermilfoil. This method can also be useful for clearing rooted pondweeds or small patches of watershield from areas around docks and beaches.

Drawbacks: The technique is time-consuming and costly, especially where contract divers may be used. Diver visibility may become obscured by turbidity generated by swimming and digging activities. Also, it may be difficult for the laborer to see and dig out all plant roots. Environmental impact is limited to mostly short-term and localized turbidity increases in the overlying water and some bottom disruption.

Costs: Costs will vary depending on whether contract divers and laborers are used, or if removal activities are the result of volunteer efforts. In the case of contract divers and dive tenders, expenses can run upwards of $1,000 to $2,800/day, with the area covered depending on the density of plants. In other words, this can take three divers 2 to 6 days per acre of moderate density Eurasian watermilfoil.

Permits: Hydraulic project approval (HPA) from WDFW is required for hand-digging aquatic plants. The pamphlet, "Aquatic Plants and Fish" (#APF-1-98), describes the provisions that must be followed when hand-digging aquatic plants. The pamphlet serves as the HPA and must be available at the site. It is also important to check with Snohomish County regulatory agencies before beginning any activities.

Applicability to Lake Shoecraft: Hand digging of plant stems and roots could be used for small-scale, intensive removal of Eurasian watermilfoil around private dock areas and short shoreline segments. If root systems are completely removed, this technique provides a more long-term means of control (as compared to hand-cutting described below). Unfortunately, Lake Shoecraft has too large an infestation to be addressed by hand removal alone. Hand-pulling used in conjunction with other control methods, especially for follow-up efforts, is a likely approach.

Hand-Cutting

Principle: This technique is also a manual method, but differs from hand-digging in that plants are cut below the water surface. Because roots are not removed, this is a less intensive removal technique. Implements used include scythes, rakes, or other specialized devices that can be pulled through the weed beds by boat or several people. Mechanized weed cutters are also available that can be operated from the surface for small-scale control.

Control Effectiveness and Duration: Root systems and lower stems are often left intact. As a result, effectiveness is usually short-term because regrowth is possible from the uncut root masses. Duration of control is limited to the time it takes the plant to grow to the surface.

Advantages: The technique results in immediate removal of nuisance submerged plant growth. Costs are minimal.

Drawbacks: Like hand-pulling, this technique is time-consuming. Visibility may be reduced by turbidity generated by cutting activities. Also, since the entire plant is usually not removed, this technique does not result in long-term reductions in growth. Duration of control of rooted plants such as Eurasian watermilfoil would be minimal. Environmental impacts are limited to mostly short-term and localized turbidity increases in the water and some bottom disruption. Cut plants must be removed from the water.

Costs: Where volunteer efforts are employed, costs are mostly limited to purchase of a cutting implement. This can vary from under $100 for the Aqua Weed Cutter (Sunrise Corp.) to over $1,000 for the mechanized Swordfish (Redwing Products).

Permits: Hydraulic project approval (HPA) from WDFW is required for hand-cutting aquatic plants. The pamphlet, "Aquatic Plants and Fish" (#APF-1-98), describes the provisions that must be followed when hand-cutting aquatic plants. The pamphlet serves as the HPA and must be available at the site. Mechanical cutting (including battery-operated equipment) requires formal hydraulic approval by WDFW. It is also important to check with Snohomish County regulatory agencies before beginning any activities.

Applicability to Lake Shoecraft: Hand cutting of Eurasian watermilfoil plant stems in Lake Shoecraft would not be appropriate because it does not eradicate the plants and, through increased fragmentation, may actually spread the plant. Therefore, this technique will not meet the goals of the management plan.

Bottom Barriers

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

Control Effectiveness and Duration: Bottom barriers can provide immediate control of nuisance plant conditions upon placement. Duration of control depends on a variety of factors, including the type of material used, application techniques, and sediment composition. Elimination of nuisance plant conditions for at least the season of application has been demonstrated for synthetic materials such as Aquascreen and Texel. Where short-term control is desired for the least expense, burlap has been found to provide up to 2 to 3 years of relief from problematic growth before eventually decomposing (Truelson, 1985; 1989). After satisfactory control has been achieved (usually several months), some barrier materials can be relocated to other areas to increase benefits.

Advantages: Bottom barriers can usually be easily applied to small, confined areas such as around docks, moorages or beaches. They are hidden from view and do not interfere with shoreline use. Bottom barriers do not result in significant production of plant fragments (critical for Eurasian watermilfoil treatment). Bottom barriers are most appropriately used for localized, small-scale control where exclusion of all plants is desirable, where other control technologies cannot be used, and where intensive control is required regardless of cost.

Drawbacks: Depending on the material, major drawbacks to the application of benthic barriers include some or all of the following: high materials cost, labor-intensive installation, limited material durability, possible suspension of barriers due to water movements or gas accumulation beneath the fabric, or regrowth of plants above or below the material. Periodic maintenance of bottom barrier materials is required to remove accumulations of silt and any rooting fragments. In some situations, removal and relocation of barriers may not be possible (e.g., natural fiber burlap does decompose over time). Bottom barriers can also produce localized depression in populations of bottom-dwelling organisms such as aquatic insects.

Costs: Costs vary from approximately $0.30/sq. ft (Texel) to $0.35/sq. ft (Aquascreen) for materials, with an additional $0.25-0.80/sq. ft for installation. Locally, prices for rolled burlap material (available in fabric stores, outlets) average from $0.15 to $0.25/sq. ft for materials only.

Permits: Bottom barrier applications require an HPA from WDFW. In addition, barriers costing more than $2,500 may need a shoreline permit, so the Snohomish County Planning and Development Services Department (PDS) should be contacted regarding Shoreline Master Plan requirements.

Applicability to Lake Shoecraft: Because most of the better screening materials are costly and proper applications can be labor-intensive, bottom barriers are best suited for spot and limited area treatments. Thus, potential use in Lake Shoecraft would be limited to small areas; nevertheless, this approach will be an important part of a long-term integrated management program.

TABLE 3.

SUMMARY OF AQUATIC PLANT MANAGEMENT TECHNIQUES AVAILABLE IN WASHINGTON STATE

(Adapted from Gibbons et. al., 1994, costs updated to 1999 dollars)

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Mechanical							
Harvesting	Large-scale	Less than one season	Low-Mod	$200 to $1000/acre x3 if cutting is required 3 times per year (may vary with transport costs)	• Immediate plant removal to cutting depth (4 to 8 ft.) • Minimal bottom disturbance • Materials may be composted • Reduces internal loading of nutrients	• Plant disposal • Fragments produced • Fish and invertebrate impacts • Slow • High initial capital $ • Operating depth limited • Operations depend on weather • Not species specific	Yes
Rotovation/ Cultivation	Large-scale	2 to 3 years	Mod-High	$1000 to $1700/acre (depends on plant density and area of treatment)	• Winter treatment minimizes summer season recreation impacts • May increase species diversity	• Bottom disturbance /increased turbidity • Long-term efficacy only on perennials • Bottom obstructions limit use • Creates fragments • Not species specific	Yes
Hydraulic dredge	Large-scale	Potentially long	High	variable, average $3-$14/m3	• Removal of entire plant, including roots • Additional benefits of deepening lake, removal of enriched or toxic sediments	• Very costly • Temporary bottom disturbance and increased turbidity in water column • Not species specific, where mixed community	Yes

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Mechanical (Continued)							
Diver-operated dredge	Small-scale	Potentially long (Depends on availability of propagules for recolonization)	Mod-High	$1100-2800/day (for a treatment rate of 0.5 to 2.0 acres per day)	• Site specific • Species specific • No depth constraints • Used near obstacles	• Labor intensive • Slow • Potential fragment production • Temporary bottom disturbance and increased turbidity	Yes

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Chemical							
Fluridone (Sonar®)	Large-scale	> 1 year (depends on availability of propagules for recolonization)	High	$1000+/acre	• Systemic herbicide • Some species specificity with correct application rates • Non-toxic	• Requires long contact time • Off-site movement possible • Nutrient release and decrease in dissolved oxygen	Yes
Glyphosate (Rodeo®)	Large-scale	> 1 year (depends on availability of propagules for recolonization)	High	$300/acre	• Systemic herbicide • Non-toxic • No label restrictions on swimming and fishing	• Non-selective herbicide • Emergent plants only • Not appropriate for EWM	Yes
Endothall (Aquathol®)	Large-scale	Weeks to months	Moderate	$500 to $700/acre	• Short contact time required • Low toxicity • Low cost • Fast dissipation	• Contact herbicide • Temporary effect • Some label restrictions for swimming and domestic water use • Not appropriate for EWM	Yes
Triclopyr) (Renovate®)	Small-scale or Large-scale	> 1 year (depends on availability of propagules for recolonization)	High	$1,500/acre	• Systemic herbicide • Selective for milfoil • Short treatment time	• 30 day fishing restriction	Yes (not yet EPA or DOE approved)
2-4,D (Navigate®)	Large-scale	Weeks to months	Moderate	$600 to $800 /acre	• Systemic herbicide • Low cost	• Toxic to fish • Irrigation and water supply restrictions • Only moderate milfoil control	Yes (not DOE approved)

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Biological							
Grass carp	Large-scale	Potentially long	Considered all or none (total control or no control)	$50 to $200/acre (depending on stocking density) not including cost of outlet and inlet passage barrier	• Low maintenance • Large area covered • Triploid fish are sterile	• Stocking densities not well established • Difficult to fine-tune control; total control of all plants, or no control • Preference for native species over exotics • Containment structures required • Ecological impacts not fully known • Not site specific • Recapture problems • Containment structure costs • Susceptible to predation by wildlife or humans	Yes

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Physical							
Hand-pulling	Small-scale	Season or longer	Moderate to High (with complete removal)	$0 with volunteer labor $1000 to $2800/day for contract divers	• Site specific • Species specific • Minimum impact on native plants • Individual plant removal • Use near obstructions	• Slow, labor intensive, expensive • Short-term turbidity increase • Restricted to sparse-to-moderate plant density • Diver visibility can restrict effectiveness	Yes
Hand-cutting	Small-scale	< One season	Moderate	$100 to $1000 for equipment + labor	• Immediate plant removal	• Slow • Fragments generated • Does not kill plants, and regrowth will occur • Short-term increase in turbidity	Yes
Bottom Barriers	Small-scale	2 to 3 years	High	Burlap: $0.9-$1.2/sq yd Texel: $2.70/sq yd Aquascreen: $3.15/sq yd $0.25 to $0.80/sq. ft. for installation, or $1000 to $2800 per day for divers	• Immediate plant removal • Materials reusable • Site specific • Useful around obstructions	• Not species specific • Benthic organism impacts • Material costs • Maintenance required	Yes

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Physical (Continued)							
Drawdown	Large-scale	None to short-term limited biomass reduction	None to Low	Variable	• Useful for repair/ maintenance of shorelines and structures • May enhance growth of emergents (waterfowl habitat)	• Not species specific • May impact wetlands • Loss of recreation • Dissolved oxygen decrease • Benthic invertebrate impacts	Yes
Watershed Controls	Small-scale	None - long-term	Low	Low-mod	• Long-term improvement in water quality • May encourage rooted and discourage non-rooted species	• Does not address nutrient sources used by most aquatic plants • May encourage rooted/discourage non-rooted species •Sometimes difficult to implement	No
Water column dye	Large-scale	Weeks to months	Low	$12.50/acre-ft.	• Non-toxic • No special equipment needed • Colors water blue	• Shallow, closed systems only • Repeat treatments through growing season required • Not effective when plants near surface • No use in potable, flowing, or chlorinated water • Some classified as herbicides	Yes/No (Those classified as herbicides require a permit)

INTEGRATED AQUATIC PLANT MANAGEMENT SCENARIOS

Control Intensity

As discussed above, the overall objective of the Seven Lakes IAPMP is to eradicate Eurasian watermilfoil from Lake Shoecraft and Lake Goodwin, and to prevent its spread to other lakes in the area. Therefore, the alternative treatment scenarios for Lake Shoecraft described below all involve high intensity control of the Eurasian watermilfoil in the lake. However, Scenarios S-1 (Dredging), S-2 (Herbicide with Barrier), and S-6 (Physical Control) would limit treatment to the areas actually infested with the plant. To a lesser extent, Scenarios S-3 and S-4 (Herbicide without Barriers) would provide a high level of control in the areas where Eurasian watermilfoil is growing, but some impacts would occur outside the target areas. Scenario S-5 (Grass Carp) would result in a high level of aquatic plant removal throughout the entire lake.

The no-action alternative is not discussed because it would not meet the project goals. In addition, if the no-action alternative were to be followed, the environmental conditions at the lakes could decline due to the impact of this invasive plant on the aquatic habitat.

Lake Shoecraft Control Scenarios

Six different treatment scenarios for Eurasian watermilfoil in Lake Shoecraft are presented below. These strategies differ in scale of control, associated control intensity in the short term, and costs. All the treatment scenarios extend over a five-year period, with a review each year to make adjustments for the changing conditions at the lake. Also, each scenario includes follow-up monitoring, hand-removal, placement of bottom barriers, and administrative efforts that will be necessary to achieve full eradication of Eurasian watermilfoil over a period of years in Lake Shoecraft. Table 4 summarizes the elements and costs associated with each scenario.

It should be acknowledged that the benefits of any management alternative cannot be realized without some short-term adverse impacts. There is no ideal management alternative that is 100 percent effective against Eurasian watermilfoil only, absolutely environmentally safe, and also cost-effective. Therefore, the choice of a specific aquatic plant management strategy involves weighing all factors and achieving a balance between acceptable environmental disruption, cost-effectiveness, and community consensus.

Scenario S-1—Dredging

Lake hydraulic dredging is a long-term treatment alternative for complete eradication of Eurasian watermilfoil. It is also the most expensive treatment scenario and would require mitigation, such as an alum treatment, to minimize water quality problems generated by the disruption of sediments. Only the south and north ends of the lake, a total of 18 acres, can be dredged to effectively remove Eurasian watermilfoil from the lake. On the east and west shores of the lake, the Eurasian watermilfoil beds would be treated by bottom barriers and hand removal of the plants. Because of the high costs and non-target impacts, this scenario is not recommended.

Herbicide Treatments—Scenarios S-2, S-3, and S-4

A promising approach for the eradication of Eurasian watermilfoil from Lake Shoecraft is the use of the aquatic herbicide fluridone, available as the labeled herbicide Sonar. Sonar has proven to be very effective against Eurasian watermilfoil when applied properly. The herbicide can be applied directly to the water in a liquid form, or as a slow-release pellet. The slow-release pellet is Sonar-saturated clay pellets that, when applied to the surface of the lake, sink to the bottom and slowly release Sonar to the water and the surrounding sediment. For effective control of Eurasian watermilfoil, the herbicide concentration must be at least 10 micrograms per liter for eight weeks.

In order to keep the Sonar concentration at effective levels, the herbicide will have to be applied periodically during the exposure window. The following three scenarios address different approaches to maintaining adequate concentrations of herbicide in the water during the exposure period. Sonar is extremely soluble in water and drifts from the target area rapidly with water movement or by diffusion from the treated area to the untreated portions of a water body. In the case of Lake Shoecraft, only a small portion of the lake's volume would be treated by Sonar. This will maximize the potential loss of active chemical from the target area. Non-target plants within the treatment area may be affected by Sonar, as a variety of plants show degrees of susceptibility to the herbicide.

[There is a possibility that by 2000 the U.S. Environmental Protection Agency (EPA) will issue an aquatic herbicide label for another chemical, Renovate® (triclopyr), and that the Washington State Department of Ecology will complete its environmental review. If these steps occur, Renovate can be used as an alternative to Sonar. The action of Renovate is more specific to Eurasian watermilfoil, and the chemical requires lower exposure doses and shorter contact times to be effective (1 µg/L for 24 hours). If these regulatory approvals come about, Renovate will be considered as the herbicide in S-3. It is assumed that the costs are comparable to Sonar, but this will depend on availability and other

factors. Renovate may also become available and effective for small spot application; if so, it can replace the use of bottom barriers in future year maintenance.]

Scenario S-2

In this scenario, Sonar would be used in either liquid or pellet form. In addition, a water barrier would be used to isolate the treatment areas and reduce the loss of chemical from the treatment zones by inhibiting wind mixing and dilution with untreated lake water. By using the barrier and slow-release pellets, the risk of not being able to maintain effective exposure concentrations of Sonar is greatly reduced. In practice, the use of the liquid formulation with a barrier should also work, but there would be a greater need for frequent monitoring to ensure that effective concentrations are being maintained. The re-application frequency of the herbicide also may be greater than if the pellet formulation of Sonar is used. The water barrier would be made of silt screening material such as woven polypropylene with 4-inch-diameter microcell foam flotation along the top and a 3/8-inch coil chain for ballast. A 100-foot by 20-foot section of barrier would weigh 135 pounds. The sections would be linked together by rope lacing and webbing. Cost for installed barriers is estimated at $1,000 per section.

In this scenario, two areas would be isolated with barriers and treated with Sonar--the Eurasian watermilfoil beds in both the southeast and north ends of the lake. The length of the barriers would be 500 feet in the north and 1,600 feet in the south. The area of the proposed treatment includes all of the identified Eurasian watermilfoil colonies mapped in 1997. The herbicide-treated area (the area behind the barriers) is estimated to be about 18 acres. This is larger than the actual patches of Eurasian watermilfoil shown in Figure 14 because of the need to place the barriers in a relatively straight line.

In the first year of the S-2 scenario, the Eurasian watermilfoil within the barriers would be treated with Sonar for eight weeks, maintaining a concentration of at least 10 micrograms per liter and not more than 20 micrograms per liter. In areas (east and west littoral areas) where individual plants and small colonies of Eurasian watermilfoil exist, bottom barriers and hand removal would be used to remove or cover the existing plants.

Year two would be a follow-up year, with bottom barrier and hand removal of any Eurasian watermilfoil plants that may remain. In years three, four, and five, only re-invasive and small fragment-generated Eurasian watermilfoil plants should remain, and hand removal can be employed to eliminate these plants. Monitoring of the plant community will be needed throughout the program. Based on the results of the monitoring, the follow-up actions may have to be modified, depending on the effectiveness of the treatment efforts.

Scenario S-2 is the preferred management option for Lake Shoecraft.

Scenario S-3

In Scenario S-3, the liquid formulation of the herbicide Sonar would be used during the first year. As in S-2, only the south and north ends of the lake would be treated. However, no barriers would be constructed to control drift of the chemical out of the treatment area. This scenario would require increased monitoring and re-dosing of the lake to maintain the effective treatment concentration within the target area. The risk with this scenario is that more chemical would have to be used, and the targeted area might not receive the same level of control that could be achieved in the S-2 scenario. As in both the S-2 and S-4 scenarios, the Eurasian watermilfoil plants on the east and west littoral areas would be removed by using bottom barriers and hand removal.

The use of bottom barriers to control Eurasian watermilfoil in years 2 through 5 would most likely be required to completely control the plants in the lake. Barriers would be needed both outside the herbicide-treated areas and within the treated areas where Sonar concentrations were not maintained at effective concentrations for the full required exposure time of eight weeks. Follow-up could switch to hand removal whenever only small areas of Eurasian watermilfoil remain. Monitoring of the plant community will be needed throughout the program. Based on the results of the monitoring, the follow-up actions may have to be modified, depending on the effectiveness of the treatment efforts.

Scenario S-3 is an acceptable alternative for Lake Shoecraft. However, it would be less effective than Scenario S-2 during the first year and require more follow-up actions.

Scenario S-4

In Scenario S-4, the slow-release pellet formulation of the herbicide Sonar would be used during the first year of the program. As in S-2 and S-3, only the south and north ends of the lake would be treated. However, as in S-3, no barriers would be constructed to control drift of the compound out of the treatment area. This scenario would require increased monitoring and re-dosing of the lake to maintain the effective treatment concentration within the target area. The risk with this scenario is, as with S-3, that more chemical will have to be used and the targeted area may not be treated to the same level of control that can be achieved with the S-2 scenario. However, because the slow-release pellets of Sonar may not result in as rapid dilution as with the liquid formulation, the effectiveness of control may be greater with this formulation. As in both the S-2 and S-3 scenarios, the Eurasian watermilfoil plants on the east and west littoral areas will have to be removed by using bottom barriers and hand removal.

Because it is expected that the treatment effectiveness with pellets versus liquid will be greater, the need for intense follow-up treatment with bottom barriers should be somewhat reduced in subsequent years of the S-4 scenario, compared to Scenario S-3. Follow-up hand removal would still be necessary each year. Monitoring of the plant community would also be needed throughout the program.

Scenario S-4 is also an acceptable alternative for Lake Shoecraft. However, it would be less effective than Scenario S-2 during the first year. It would also require more follow-up actions than S-2, though less than Scenario S-3.

Scenarios S-5—Grass Carp

The only feasible bio-control alternative is the use of grass carp, also called white amur (*Ctenopharyngodon idella*). In Scenario S-5, grass carp would be the major control technique used to eliminate Eurasian watermilfoil. Although grass carp have been shown to eradicate Eurasian watermilfoil, it is not an instantaneous process. It might take 3 to 5 years before the plant would be eliminated from the lake. In addition, all of the other submersed plants would be eaten by the fish before the Eurasian watermilfoil is eliminated. This means that the direct effect of this scenario would be the elimination of all of submersed plants from the lake. On the other hand, if too few fish are stocked, it is possible that the Eurasian watermilfoil would not be controlled.

The total elimination of plants from the littoral habitat of Lake Shoecraft would necessitate the mitigation of that loss by installation of artificial structures to provide habitat for micro-invertebrates and fish. A simple structure that could be used is called a crib. These 4 by 4 by 4 foot structures are quickly installed and could be moved or removed if needed. Grass carp should eliminate all of the Eurasian watermilfoil from the lake; however, some small isolated plant colonies might survive. If this happened, hand removal would be necessary.

Another major drawback to the use of grass carp is their potential to leave the lake and move into other waterbodies. Therefore, installation of structures on the inlet and outlet of the lake would be required to prevent of the movement of grass carp out of Lake Shoecraft. Another concern is that the introduced fish could be carriers of bacteria or other biological agents that could contaminate the hatchery downstream. Although grass carp can be treated before delivery to the site to reduce the risk of pathogenic introductions, spread of harmful bacteria or diseases could remain a concern.

Because of these concerns about fish escape and the spread of micro-organisms, the Washington Department of Fish and Wildlife might require State

Environmental Policy Act (SEPA) review to evaluate the potential environmental impact. This could increase the cost of implementing this scenario by $15,000 to $50,000.

Scenario S-5 is not a preferred alternative for Lake Shoecraft because of the high costs of inlet and outlet structures, the unknown costs of permitting, and the impacts of eliminating all aquatic plants from the lake.

Scenario S-6—Physical Control

The physical removal of Eurasian watermilfoil from Lake Shoecraft is possible using bottom barriers and hand removal as was done at Lake Goodwin. Bottom barriers would be placed over all identified Eurasian watermilfoil colonies. At least 1200 burlap sheets covering from 5 to 7 acres would be needed. In addition, divers would remove approximately 3 to 5 acres of scattered Eurasian watermilfoil plants by hand-pulling.

The costs of physical control of Eurasian watermilfoil in Lake Shoecraft would be about five times as expensive as in Lake Goodwin. At the same time, the larger coverage of Eurasian watermilfoil in Lake Shoecraft would reduce the probability of successful control using physical methods. Significantly more follow-up work would be needed in years 2 through 5. Therefore, Scenario S-6 is not a preferred alternative for Eurasian watermilfoil control in Lake Shoecraft.

TABLE 4.
TREATMENT SCENARIOS FOR LAKE SHOECRAFT (YEARS 1-5)

Treatment Scenario	Scenario Elements	Cost Year 1	Cost Year 2	Cost Year 3	Cost Year 4	Cost Year 5	5-Year Total
S-1: Dredging							
	Dredging (hydraulic) (18 acres)	$ 958,000					$ 958,000
	Alum treatment	$ 115,000					$ 115,000
	Monitoring	$ 1,500	$ 3,000	$ 3,100	$ 3,200	$ 3,400	$ 14,200
	Hand pulling (6 days yr 1)	$ 9,000	$ 3,000	$ 1,500	$ 1,600	$ 1,700	$ 16,800
	Bottom barrier(3 days / 0.5 acres)	$ 4,600	$ 2,300				$ 6,900
	Permitting and administration	$ 50,000					$ 50,000
	Contingency	$ 100,000					$ 100,000
	S-1 Total	$1,238,100	$ 8,300	$ 4,600	$ 4,800	$ 5,100	$ 1,260,900
S-2: Fluridone							
	Sonar (liquid or pellet)						
	• Application (18 acres)	$ 27,000					$ 27,000
	• Barrier (2,100 feet total length)	$ 21,250					$ 21,250
	• Monitoring (herbicide)	$ 6,300					$ 6,300
	• Mitigation & contingency	$ 9,800					$ 9,800
	• Permitting & administration	$ 6,500	$ 1,500				$ 8,000
	Hand pulling (6 days yr 1 & 2)	$ 9,000	$ 9,000	$ 1,500	$ 1,600	$ 1,700	$ 22,800
	Bottom barriers (3 days)	$ 4,600	$ 3,600				$ 8,200
	Monitoring: follow-up	$ 1,500	$ 3,000	$ 3,100	$ 3,200	$ 3,400	$ 14,200
	S-2 Total	$ 85,950	$ 17,100	$ 4,600	$ 4,800	$ 5,100	$ 117,550
S-3: Fluridone							
	Sonar (liquid)						
	• Application (18 acres)	$ 40,300					$ 40,300
	• Monitoring (herbicide)	$ 5,000					$ 5,000
	• Mitigation & contingency	$ 11,000					$ 11,000
	• Permitting & administration	$ 4,500	$ 2,500	$ 1,000			$ 8,000
	Hand pulling (6 days—year 1 & 2)	$ 9,000	$ 9,000	$ 3,100	$ 1,600	$ 1,700	$ 24,400
	Bottom barriers (3 days yr 1 & 3; 10 yr 2)	$ 4,600	$ 18,000	$ 4,800	$ 1,700		$ 29,100
	Monitoring: follow-up	$ 2,300	$ 3,000	$ 3,100	$ 3,200	$ 3,400	$ 15,000
	S-3 Total	$ 76,700	$ 32,500	$ 12,000	$ 6,500	$ 5,100	$ 132,800

TABLE 4. TREATMENT SCENARIOS FOR LAKE SHOECRAFT (CONTINUED)

Treatment Scenario	Scenario Elements	Cost Year 1	Cost Year 2	Cost Year 3	Cost Year 4	Cost Year 5	5-Year Total
S-4: Fluridone							
	Sonar (pellet)						
	• Application (18 acres)	$ 34,500					$ 34,500
	• Monitoring (herbicide)	$ 5,000					$ 5,000
	• Mitigation & contingency	$ 10,000					$ 10,000
	• Permitting & Administration	$ 4,500	$ 2,300	$ 1,000			$ 7,800
	Hand pulling (6 days—year 1 & 2)	$ 9,000	$ 9,000	$ 2,400	$ 1,200	$ 1,200	$ 22,800
	Bottom barriers (3 days yr 1 & 3; 6 yr 2)	$ 4,600	$ 10,000	$ 4,800	$ 1,700		$ 21,100
	Monitoring: follow-up	$ 2,300	$ 3,000	$ 3,100	$ 3,200	$ 3,400	$ 15,000
	S-4 Total	$ 69,900	$ 24,300	$ 11,300	$ 6,100	$ 4,600	$ 116,200
S-5: Triploid Grass Carp							
	• Stocking	$ 15,500					$ 15,500
	• Outlet Barrier	$ 32,000					$ 32,000
	• Inlet barriers	$ 25,000					$ 25,000
	• Mitigation habitat structure		$ 12,000				$ 12,000
	• Monitoring	$ 3,000	$ 3,000	$ 3,100	$ 3,200	$ 3,400	$ 15,700
	• Mitigation & contingency	$ 15,000					$ 15,000
	• Permitting & administration	$20,000 to $50,000	$ 1,500				$21,500 to 51,500
	S-5 Total	$ 110,500 to 140,500	$ 16,500	$ 3,100	$ 3,200	$ 3,400	$136,700 to 166,700
S-6: Physical							
	Hand pulling (9 days yr 1,2; 6 days yr 3,4)	$ 13,500	$ 13,500	$ 9,300	$ 9,600	$ 1,700	$ 47,600
	Bottom barriers (50 days yr 1; 20 yr 2; 10 yr 3; 5 yr 4; 1 yr 5)	$ 95,000	$ 40,000	$ 18,000	$ 8,500	$ 1,800	$ 163,300
	Monitoring	$ 3,000	$ 3,000	$ 3,100	$ 3,200	$ 3,400	$ 15,700
	Contingency	$ 5,000					$ 5,000
	Permitting & administration	$ 4,500	$ 3,000	$ 2,700	$ 1,500		$ 11,700
	S-6 Total	$ 121,000	$ 59,500	$ 33,100	$ 22,800	$ 6,900	$ 243,300

a. Year 1 is assumed to be 1999
b. Activities and costs in years 3 -5 may not be necessary unless Eurasian watermilfoil is observed

Other Program Elements

In addition to one of the in-lake treatment scenarios for Lake Shoecraft, there are other elements that should be included in an IAPMP to achieve the goal of eradicating Eurasian watermilfoil and preventing its spread or re-introduction in the Seven Lakes. These elements are described below.

Maintenance

After the hand removal and bottom barrier efforts at Lake Goodwin in 1997, and implementation of one of the in-lake treatment scenarios for Lake Shoecraft, it will still be necessary to provide follow-up maintenance at both lakes each year. This includes annual surveys by divers and hand-pulling or placing bottom barriers over any Eurasian watermilfoil plants that are found. For maximum effectiveness, maintenance should occur twice each summer and extend many years into the future. Divers were used in the summer of 1998 in Lake Goodwin to follow-up the control efforts of the previous year. Table 5 lists estimated costs of maintenance for the next five years at Lake Goodwin. Maintenance costs at Lake Shoecraft are included in Table 4 above.

Monitoring

To prevent the introduction of Eurasian watermilfoil or other exotic aquatic plant species into the other nearby lakes, it is important to monitor each lake every year. Yearly monitoring of all but Lake Shoecraft and Lake Goodwin can be accomplished using boat surveys by Snohomish County staff and/or trained volunteers. In addition, divers should be employed every 3 or 4 years to conduct a more thorough survey of each of the Seven Lakes. Monitoring costs for the first five years are included in Table 5.

This monitoring should focus on identifying exotic plant species that might be introduced to the lakes. In addition to Eurasian watermilfoil (*Myriophyllum spicatum*), monitoring surveys should look for other potentially devastating plant species such as Brazilian elodea (*Egeria densa*), hydrilla (*Hydrilla verticillata*), parrotfeather (*Myriophyllum aquaticum*), fanwort (*Cabomba caroliniana*), and water hyacinth (*Eichhornia crassipes*). Purple loosestrife (*Lythrum salicaria*), an invasive emergent shoreline plant, can also be targeted. If any of these plant species are discovered, immediate actions should be taken to control the infestation.

Education and Prevention

The primary mechanism for introducing exotic aquatic plant species, such as Eurasian watermilfoil, into a lake is by transport on boats, trailers, and fishing gear. This appears to be the method which introduced Eurasian watermilfoil to Lake Goodwin. Therefore, public education of all lake users is necessary to prevent further infestation of exotic plants in the Seven Lakes.

Two activities are proposed as part of the Integrated Plan for the Seven Lakes. First, information signs should be placed at each of the public boat launches on the lakes. A large (4' x 6') Eurasian watermilfoil information sign was designed and installed at the Wenberg State Park boat launch on Lake Goodwin in 1998. Boat launches at the other lakes have small yellow signs urging boaters to check their equipment for milfoil fragments. Additional exotic species information signs will be placed at each of these locations during 1999.

The second educational activity is informational articles in the Seven Lakes Water Association newsletter that is distributed to almost all of the residents of the area. Informational articles were included in the 1997 and 1998 newsletters. Educational articles should be included in future years, as long as the Water Association is able to accommodate them.

Further prevention activities could be even more effective if volunteer support is available. In particular, volunteers could be trained to inspect boats and trailers entering or leaving Lake Goodwin and Lake Shoecraft, especially on busy summer weekends. While the inspections would be voluntary, they would provide an opportunity for educating the boat operators to prevent spread of exotic plants. Any such inspection program depends on significant volunteer commitment and must be coordinated with the Washington State Parks and Fish and Wildlife departments. Other outreach methods may also be used, such as distribution of informational door hangers to lakefront homes or informal public meetings.

Table 5 includes the costs of basic education at the Seven Lakes over the first five years.

TABLE 5
ESTIMATED COSTS OF SEVEN LAKES MILFOIL FOLLOW-UP AND PREVENTION

PROGRAM ELEMENT	Cost Year 1	Cost Year 2	Cost Year 3	Cost Year 4	Cost Year 5	5 Year Total
Lake Goodwin maintenance[a]	$ 8,400	$ 8,800	$ 9,200	$ 9,700	$ 10,200	$ 46,300
Monitoring Other Lakes[b]	$ 2,500	$ 2,500	$ 2,700	$ 2,900	$ 3,100	$ 13,700
Public Education/Prevention	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 15,000
TOTAL	$ 13,900	$ 14,300	$ 14,900	$ 15,600	$ 16,300	$ 75,000

a. Estimated costs of Lake Shoecraft maintenance and follow-up monitoring are shown in Table 4
b. Estimated costs of monitoring Crabapple, Howard, Ki, Loma, and Martha lakes

SEVEN LAKES MILFOIL ACTION PLAN

The Action Plan for the Seven Lakes Milfoil Eradication Project consists of five elements. These include

1) a herbicide treatment of Eurasian watermilfoil in Lake Shoecraft,
2) follow-up placement of bottom barriers and hand-pulling in Lake Shoecraft and Lake Goodwin,
3) regular monitoring of all Seven Lakes for Eurasian watermilfoil and other exotic invasive aquatic plants,
4) public education to prevent the spread or re-introduction of Eurasian watermilfoil in the Seven Lakes, and
5) funding and implementation of this action plan.

If fully implemented, the Action Plan should meet the goals set forth in this IAPMP, namely, to eradicate Eurasian watermilfoil from Lake Goodwin and Lake Shoecraft within 3 to 5 years and to prevent the spread or re-introduction of Eurasian watermilfoil in the Seven Lakes.

This Action Plan was developed and endorsed by the Seven Lakes Milfoil Control Advisory Committee and the Snohomish County Surface Water Management Division. In addition, the Lake Shoecraft herbicide treatment scenario, follow-up diving work, monitoring, and public education were presented to the Seven Lakes community as the "preferred alternative" at a public meeting on April 1, 1998. These proposals received strong support from citizens in attendance through comments and a questionnaire. The final measure of public support of this Action Plan will be endorsement by the Snohomish County Council and approval of a Lake Management District by a majority vote of the citizens at Lake Goodwin and Lake Shoecraft.

Element 1 -- Lake Shoecraft Herbicide Treatment

The first element of the Action Plan is treatment of the Eurasian watermilfoil in Lake Shoecraft with the herbicide Sonar. The treatment will employ the slow-release pellet formulation of Sonar to kill Eurasian watermilfoil on 18 acres in the north and southeast corners of the lake where the plants are most concentrated. Fabric water barriers will be installed across the mouths of the north and southeast coves to isolate the coves and reduce wind mixing and dilution, thus minimizing the loss of herbicide out of the treatment zones. Figure 16 illustrates the herbicide treatment areas and barrier locations planned for Lake Shoecraft.

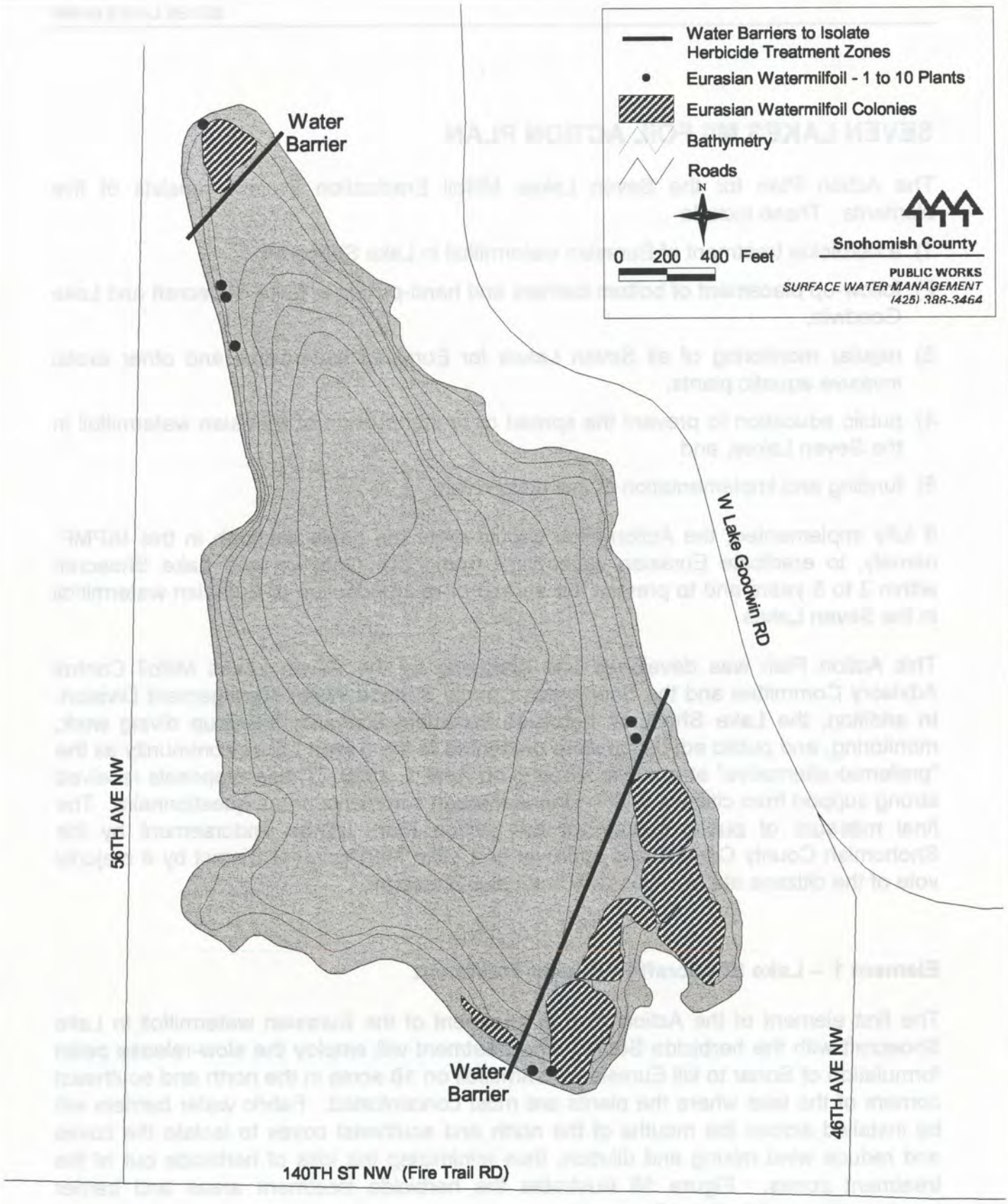


FIGURE 16 -- LAKE SHOECRAFT HERBICIDE TREATMENT AREAS

The Eurasian watermilfoil behind the barriers across the isolated coves of Lake Shoecraft will be treated with Sonar for eight weeks during the summer of 1999. Additional pellets will be applied as needed to maintain a herbicide concentration between 10 and 20 micrograms per liter. Sonar is a systemic herbicide of low toxicity that is slowly absorbed by the plant roots and stems and destroys the Eurasian watermilfoil from within.

The effectiveness and safety of the herbicide treatment will be monitored through an intensive sampling program. Appendix B describes this monitoring program in detail. Concentrations of Sonar will be monitored every day for the first four days and then weekly until two weeks after the treatment is completed. There will be six sampling locations within the treatment areas, six locations outside the barriers in the main body of Lake Shoecraft, and two locations at the outlet of the lake. A series of increasingly aggressive mitigation steps will be taken should the herbicide drift out of the treatment areas or be discharged from the lake. However, no harmful effects are anticipated in the main body of the lake or downstream because of the water barriers and the low concentrations of herbicide that will be used.

In addition to the areas of herbicide treatment in Lake Shoecraft, Element 1 of the Action Plan includes controlling the remaining small concentrations of Eurasian watermilfoil outside of the barriers. During the summer of 1999, divers will spend up to six days placing burlap bottom barriers or hand-pulling the scattered plants found in the remainder of the lake.

Element 2 -- Follow-up Maintenance in Lake Goodwin and Lake Shoecraft

Regular follow-up maintenance will be required in both Lake Goodwin and Lake Shoecraft to meet the goal of eradicating Eurasian watermilfoil in 3 to 5 years. Each summer divers will conduct surveys of the entire littoral areas of both lakes and hand remove or cover Eurasian watermilfoil plants with burlap. At least for the first three years, this maintenance will be performed in both the early and late summer.

The Action Plan provides for follow-up maintenance for five years. However, even if all Eurasian watermilfoil plants have disappeared from Lake Goodwin and Lake Shoecraft by the end of this period, annual diving surveys beyond the first five years will still be needed to ensure that Eurasian watermilfoil does not re-grow or re-infest these lakes.

Element 3 -- Regular Monitoring of All Seven Lakes

In order to prevent the introduction of Eurasian watermilfoil or other exotic aquatic plants into the Seven Lakes, the Action Plan includes yearly monitoring of the remaining five lakes. The surveys will be performed by trained staff and volunteers using a boat and an underwater viewer. Divers will also survey each of the five lakes--Crabapple, Howard, Ki, Loma, and Martha--at least once during the five year period.

The surveys will focus on identifying Eurasian watermilfoil plants, but will also look for other exotic, invasive plants. This includes Brazilian elodea, hydrilla, parrotfeather, fanwort, and water hyacinth. If any Eurasian watermilfoil or other exotic plants are found, immediate actions will be taken to control the infestation.

Element 4 -- Public Education

The Action Plan also includes a public education component. The first educational activity is installation of a large Eurasian watermilfoil information sign at the Wenberg State Park boat launch on Lake Goodwin (already accomplished) and installation of other information signs at the public boat launches of all seven lakes. The second activity is distribution of educational articles to all residents of the Seven Lakes area. This will be accomplished at least once per year through the Seven Lakes Water Association newsletter. If sufficient volunteers can be recruited, information will also be distributed to boat owners on busy weekends at the public boat launches. This will provide opportunities to encourage boat owners to check their boats, trailers, motors, and fishing gear for plant fragments. Public education of residents and lake users is the best method of preventing spread or re-introduction of Eurasian watermilfoil.

Element 5 -- Funding and Implementation

The costs of implementing the Seven Lakes Milfoil Control Action Plan are summarized in Table 6. Implementing all elements of the plan will cost approximately $217,000 for the first five years. State grants, which paid for a large percentage of the Phase I control actions at Lake Goodwin and the development of this IAPMP, are not currently available. Therefore, Snohomish County and the citizens of the Seven Lakes area must bear the costs if Eurasian watermilfoil is to be controlled.

Snohomish County's Surface Water Management Division is committed to funding the on-going aquatic plant monitoring of Crabapple, Howard, Ki, Loma, and Martha lakes, subject to budget approval by the Snohomish County Council and Executive. In addition, the County will fund approximately $36,000 of the remaining Action Plan costs using Surface Water utility fees. This leaves $167,000 in expenses at Lake Shoecraft and Lake Goodwin which must be funded by property owners at these lakes.

TABLE 6
ACTION PLAN COSTS FOR MILFOIL ERADICATION AT SEVEN LAKES
(ALL COSTS IN 1999 DOLLARS)

	1999	2000	2001	2002	2003	5-Year Total
LAKE SHOECRAFT						
Sonar Herbicide in Pellet Form						
• **Application (18 acres)**	$ 27,000					$ 27,000
• **Barrier (2,100 feet long)**	$ 21,250					$ 21,250
• **Monitoring (herbicide)**	$ 6,300					$ 6,300
• **Mitigation & Contingency**	$ 9,800					$ 9,800
• **Permitting & Administration**	$ 6,500	$ 1,500				$ 8,000
Hand pulling (6 days yr 1 & 2)	$ 9,000	$ 9,000	$ 1,500	$ 1,600	$ 1,700	$ 22,800
Bottom barriers (3 days)	$ 4,600	$ 3,600				$ 8,200
Monitoring (follow-up)	$ 1,500	$ 3,000	$ 3,100	$ 3,200	$ 3,400	$ 14,200
Sub-Total	$ 85,950	$17,100	$ 4,600	$ 4,800	$ 5,100	$117,550
LAKE GOODWIN						
Follow-up diving/monitoring	$ 8,400	$ 8,800	$ 9,200	$ 9,700	$10,200	$ 46,300
OTHER ELEMENTS						
Monitoring Other Five Lakes	$ 2,500	$ 2,500	$ 2,700	$ 2,900	$ 3,100	$ 13,700
Public Education/Prevention	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 15,000
Formation/Billing of LMD	$ 10,800	$ 3,500	$ 3,500	$ 3,500	$ 3,500	$ 24,800
TOTAL	**$110,650**	**$34,900**	**$23,000**	**$23,900**	**$24,900**	**$217,350**

The Seven Lakes Milfoil Control Advisory Committee has reviewed various options for funding the local costs of implementing the Action Plan. The Committee decided that formation of a Lake Management District (LMD) is the best method for funding Eurasian watermilfoil eradication efforts. An LMD is a funding mechanism established in State law (RCW 36.61) very similar to a local improvement district. Formation of an LMD requires a clear work plan, approval of the County Council, and a majority vote from affected property owners. Votes are weighted by the amount that each owner would be charged.

The LMD proposed by the Advisory Committee would include all properties bordering on Lake Goodwin or Lake Shoecraft, as well as properties with community beach access to the lakes. The LMD would last for five years, with lakefront properties paying a flat rate, community beach properties paying a lower rate, and public and commercial properties paying based on lake frontage. The costs of forming an LMD and billing property owners will be included in overall costs.

As required by RCW 36.61 when multiple lakes are included in a proposed LMD, property owners from each lake must approve the LMD. Therefore an LMD to fund implementation of this Action Plan can be formed only if the proposed LMD receives a majority vote from the affected property owners at <u>both</u> Lake Goodwin and Lake Shoecraft. Because no other State or County funding sources are readily available, successful eradication of Eurasian watermilfoil is contingent on approval of an LMD or formation of some other local funding district.

If an LMD is formed in a timely manner, implementation of the Action Plan will begin in the summer of 1999. Snohomish County will secure a State water quality permit and a State Hydraulic Project Approval for the proposed herbicide treatment and barriers in Lake Shoecraft. Follow-up maintenance work by divers will also begin in 1999 and be repeated each year. Table 6 shows the schedule of activities and expenditures for controlling Eurasian watermilfoil over the next five years.

LITERATURE CITED

Bortelson, G. C., Dion, N. P., McConnell, J. B. and L. M. Nelson. 1976. Reconnaissance Data on Lakes in Washington, Water Supply Bulletin 43, Volume 2. State of Washington Department of Ecology in cooperation with the U. S. Geological Survey.

Cooke G. D, E. B Welch, S. A. Peterson, and P. R. Newroth. 1993. Restoration and Management of Lakes and Reservoirs, Second ed. Lewis Publishers, Boca Raton. 548 pp.

DowElanco 1997. Experimental Use Permit Renewal Label Application Information. DowAgroSciences.

Gibbons, H. L. et al. 1984. Control of Eurasian Water Milfoil. Part I: Drift of 2, 4 - D DMA and Control of Eurasian Water Milfoil in Lake Osoyoos, and Part II: Carry-over Effects of 2, 4 - D DMA on Eurasian Water Milfoil in the Pend Oreille River. State of Washington Water Research Center. Report #59. p: 53.

Gibbons, M. V., and H. L. Gibbons. 1985a. Carry-over Effectiveness of 2, 4 - D DMA on Eurasian Water Milfoil in Lake Osoyoos, Washington. WATER Environmental Services, Inc. for Washington State Department of Ecology. p. 25.

____, 1985b. Eurasian Water Milfoil Control Program for the Pend Oreille River, Water Quality and Aquatic Plant Evaluation. WATER Environmental Services, Inc. p. 36.

Gibbons, M. V., H. L. Gibbons, and M. D. Sytsma. 1994. A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans, First ed. Washington Department of Ecology, No. 93-93.

Johnson, R. E., and M. R. Bagwell. 1979. Effects of Mechanical Cutting on Submersed Vegetation in a Louisiana Lake. *J. Aquat. Plant Manage.* 17: 54-57.

Miller, A. C. and J. L. Decell. 1984. Aquatic Plant Control Research Program. Use of the White Amur for Aquatic Plant Management. IRA-84-1, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Pauley, G. B., G. L. Thomas, S. A. Bonar, J. D. Frodge, D. A. Marino, S. L. Thiesfeld, S. Vecht, K. L. Bowers, and H. Sehgal. 1994. An Overview of the Use and Efficacy of Triploid Grass Carp *Ctenopharyngodon idella* as a Biological Control of Aquatic Macrophytes in Oregon and Washington State Lakes. *In*, Proceedings of the Grass Carp Symposium, March 7-9, 1994, Gainsville, FL, pp. 46-54. U. S. Army Corps of Engineers, WES, Vicksburg, MS.

Perkins, M. A. and M. D. Sytsma. 1987. Harvesting and Carbohydrate Accumulation in Eurasian Watermilfoil. *J. Aquat. Plant Manag.* 25: 57-62.

Pine, R. T. and L. W. J. Anderson. 1991. Plant Preferences of Triploid Grass Carp. *Jour. Aquatic Plant Manag.* 29: 80-82.

Schiller, D. H. 1983. An Evaluation of Three Methods to Control *Egeria Densa* in Hyco Reservoir. Final Report, Biol. Unit., Environ. Tech. Sec., Carolina Power and Light Co. New Hill, N.C. 55 pp.

Thomas, G. L., J. D. Frodge, S. A. Bonar, and G. B. Pauley. 1990. An Evaluation of Triploid Grass Carp Grazing on Ponds and Lakes of the Pacific Northwest. Washington Cooperative Fishery Research Unit, Univ. of Washington, Seattle, Washington. Fifth Progress Report prepared for Washington Department of Ecology.

Truelson, R. L. 1985. Assessment of the 1984 Eurasian Water Milfoil Control Program in Cultus Lake. Water Management Branch Rep. No. 3308. British Columbia Ministry of Environment.

____, 1989. Use of Bottom Barriers to Control Nuisance Aquatic Plants. Water Management Branch Rep. British Columbia Ministry of Environment.

Washington Department of Ecology (WDOE). 1992. Aquatic Plant Management Program for Washington State. Final Supplemental Environmental Impact Statement and Responsiveness Summary Vol. 1, January, 1992.

Westerdahl, H. E. and K. D. Getsinger. 1988. Aquatic Plant Identification and Herbicide Use Guide, Vol. II: Aquatic Plants and Susceptibility to Herbicides. Technical Report A-88-9, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

APPENDICES

APPENDIX A

PUBLIC INVOLVEMENT

(MEETING NOTES, PUBLIC NOTICES, NEWSLETTERS, SIGNS)

ASK THE AUTHORITY

Herald 8-21-97

County to prepare plan in battle against milfoil

Dear Authority,

We are residents on Lake Shoecraft and very much concerned about the milfoil that is growing like wildfire on the lake. It makes it unpleasant for swimming with the long tendrils constantly touching one's body.

We were told previously that the situation was being monitored and would be taken care of. Can you tell us and the other residents on the lake, when the county will be taking care of the situation?

It has become a hundred times worse this year than last.

Thank you for any information you can give us.

— Robert and Catherine Bell, Stanwood

Snohomish County senior planner Gene Williams said a plan will soon be developed to tackle the problem.

Milfoil's long tendrils, which can grow in up to 15 feet of water, tangle fishing lines, oars and swimmers' arms and legs. It quickly crowds out other plants trying to grow in the water.

Worst of all, it spreads like a weed, literally.

In August 1996, Lake Goodwin and Lake Shoecraft received a $67,000 grant funded by boat licensing taxes. Williams said part of the money was used to survey and found that there was about two acres of milfoil in Lake Goodwin, which is connected to Lake Shoecraft by a canal, and 10 acres in Lake Shoecraft.

There was enough grant money left this summer to pay for divers who pulled plants by hand and put burlap barriers over milfoil in Lake Goodwin.

An additional grant of $18,000 has been obtained to develop a plan for Lake Shoecraft, Williams said. He expected the planning process will include an advisory committee and lakeside residents and may conclude in October.

Have a question about government, schools or how things work around Snohomish and Island counties? We can help find an answer. Send questions by fax to 425 339-3435; e-mail to* newshound@heraldnet.com; *or address to Ask the Authority, P.O. Box 930, Everett, Wash., 98206. Include your name and phone number. For more information, call 425 339-3492.

7 LAKES MILFOIL ADVISORY COMMITTEE MEETING

OCTOBER 7, 1997 MINUTES

- REVIEW
  Gene Williams briefly reviewed the past history of the 7 lakes milfoil project:
  - Received an Early Infestation Grant, which included some money for early action. It was determined that this level of funding was enough to do the work in Lake Goodwin, but not enough to treat Lake Shoecraft.
  - Received a grant to do an Integrated Aquatic Plant Management Plan (IAPMP) at Lake Shoecraft to explore different treatment alternatives for eradicating Eurasian water-milfoil (EWM).
- SUMMER 1997
  SWM staff reported on progress during the summer of 1997. Staff showed slides and a video of work in Lake Goodwin.
  - Lake Goodwin
    - Spent 9 days in June, placing burlap fabric over dense milfoil beds and hand pulling individual plants where the coverage was sparse.
    - Went back in August to check the work done in June. It appeared that the areas covered in fabric were holding up well. However, when the divers went back over the hand pulled areas they found a few additional plants each time, even after 3-4 passes through an area.
    - At least 95 % of the EWM was covered or removed.
    - In order for treatment to be effective, it is very important to return to those areas in the lake every year for the next few years. Funds for maintenance are not provided for in the grants; citizens need to identify long-term funding sources.
  - Public Education
    - Produced a flyer to be distributed at the boat launch. Twice Eugene Keene spent time at the state park boat launch handing out flyers.
    - Newspaper articles were printed in the Marysville Globe and the Everett Herald about the work being done in Lake Goodwin.
    - Designed a large sign for the boat launch. Waiting for approval to produce and install the sign.
    - A tour by Snohomish County executive Bob Drewel included a meeting with citizens, Deb Kocher, Don Laufenberg and Eugene Keene at Lake Goodwin.
    - The 7 Lakes Water Association included some information about EWM in their regular mailing.
  - Maps
    - Produced GIS maps showing where the fabric was placed and pulling occurred in Lake Goodwin, and illustrating the changes in Lake Shoecraft from 1996 to 1997.
  - Field Work for IAPMP
    - Used diver to survey Lake Shoecraft again, as well as the other nearby lakes.
    - Good news is that the milfoil in Lake Shoecraft does not appear to be spreading rapidly and there was no sign of milfoil in Lakes Howard, Martha, Loma, Ki or Crabapple.

- Interestingly, found pieces of Brazilian Elodea (another noxious weed) floating in the water near the boat launch at Lake Loma. Found no additional sign of it anywhere in the lake, during the survey.
- The channel between the lakes contained some small plants. These were pulled in June by divers. It appeared that some plants were being blown by wind, from Lake Shoecraft to Lake Goodwin.

- DRAFT IAPMP
  - Gene Williams and Harry Gibbons presented a draft of goals for long term management; committee concurred with goals. The plan is for all 7 lakes, including action in Lake Shoecraft and prevention measures for the other lakes.
  - The IAPMP will include different alternatives and cost estimates as well as the pros and cons of each alternative. The recommendation may include a mix of two or more alternatives.
  - Harry Gibbons presented a summary of methods being evaluated for effectiveness and cost at Lake Shoecraft. Alternatives that will receive a detailed look include:

    Mechanical

    Hydraulic dredging - removing plants and 1 foot of sediment in infested areas. Would require a nearby disposal site.

    Physical

    Bottom barriers and hand pulling - could be spread over several years because slow spreading of EWM in Lake Shoecraft.

    Chemical

    Sonar - both whole lake and partial lake (with impermeable barriers to isolate infested areas); costs would be high because of 8 week treatment; potential downstream impacts; will eliminate all plants in treatment area.

    Biological

    Grass Carp - will eliminate all plants; fisheries mitigation and complete screening of inlet and outlet may be required.

- WHAT'S COMING UP?
  - Another advisory committee meeting, probably 1st week of November. Goal is to narrow alternatives down to one or two choices to have something to present at the large public meeting to be scheduled for the late fall.
  - Need to keep legislators in Olympia aware of your needs. Bruce Black suggested inviting representatives to the public meeting.
  - Part of the IAPMP will include regular checks of the other lakes as a way to prevent the spread of EWM by recognizing and eradicating any pioneer colonies. Curt Kraemer suggested talking to some bass clubs. Show them how to identify milfoil and use them as an early warning system.
  - Bill Frolli thought that a sign for Lake Shoecraft, similar to the one proposed at Lake Goodwin, was necessary.
  - Dean McReynolds expressed concern about potential financial burden on residents. However, everyone recognized the need to have long-term funding for maintenance and monitoring.

SEVEN LAKES MILFOIL ADVISORY COMMITTEE

MINUTES OF MEETING 1/22/98

In Attendance:

Lake Goodwin	Lake Shoecraft
Dean McReynolds	Bill Frolli
Karen Thompson	Liv Frolli
Ross Adler	Bob Moore
	Don Laufenberg
Lake Ki	Bruce Black
Stan Ball	Jack Jenkins
	Helen Massart
Lake Howard	William Benson
Tim Schmidt	

Others
Gene Williams (Snoh. Co. SWM)
Heidi Reynolds (Snoh. Co. SWM)
Mark Webb (Wenberg State Park)
Harry Gibbons (KCM, Inc.)

Integrated Aquatic Plant Management Plan

Gene Williams reviewed the milfoil situation in Lake Goodwin and Lake Shoecraft. He briefly summarized the work done during 1997 in Lake Goodwin. And, he reviewed the process of developing an Integrated Plan (IAPMP) for Lake Shoecraft. The rough draft of the IAPMP was mailed to all committee members before the meeting.

Harry Gibbons of KCM explained the different treatment scenarios considered in the plan:

- S-1 Dredging
  - Considered to be effective but also cost prohibitive.
- S-2, 3, 4 Fluridone (Sonar) Herbicide Treatment
  - Requires maintaining the concentration between 10-20 μg/L for approximately an 8 week exposure period. The herbicide treatment needs to be done during the growing season, which in this region is usually June and July.
  - Placing a synthetic fabric screen across the north and south bays could be used to control drift of the herbicide and keep the

concentrations steady without large scale re-applications (Scenario 2). However, the barriers will cause some problems for boats getting in and out of the area. There may be objections to the barriers by skiers and boaters. We also may need additional permits for the barriers. There is possible salvage value for the barrier material.

- S-5 Grass Carp
  - Grass carp will be effective. They will eliminate the milfoil in 2-3 years if we are allowed to stock them at the proper rates. However, with grass carp, there is some variability in results; we may get total eradication of all vegetation or not enough control if too few fish are planted.
  - There are concerns with fish escapement upstream and downstream. Also, there are concerns about fungi or other diseases that could threaten fish in the Tulalip hatchery downstream. Because of these concerns, we may have to do an Environmental Impact Statement as part of the permit process.
  - We would need to change the outlet structure and add an inlet structure to prevent fish escapement.
  - To compensate for eliminating all plants, we will need to provide some artificial habitat structures in the lake to give desirable fish species places to hide.
  - Because of the various concerns about grass carp, there will likely be permitting difficulties; we could spend $30,000 trying to get the required permits and then not get them.
- S-6 Hand pulling and bottom barriers
  - This would be very costly for this much area of milfoil (5 times the amount in Lake Goodwin).
  - These methods will be used in sparse, patchy areas of Lake Shoecraft along with any of the other scenarios.
- S-7 No action
  - This option doesn't meet our stated goals.

After discussion, there was unanimous preference among committee members present for Alternative S-2--using a barrier with the Sonar herbicide pellets. One written comment was received opposed to the use of herbicides. Alternative S-2 is the second cheapest option over a period of years (only slightly more than Sonar pellets without the barrier) but has a high probability of success. Use of the barriers will keep the herbicide concentration in the desired range for longer periods of time, without as much reapplication of herbicide.

Funding

We discussed funding options and timing of the actions in Lake Shoecraft. Gene Williams responded that State grant money will not be available for applications until the fall of 1998. So, no actions will occur in 1998 unless they are paid for completely with local money. Some funding options discussed included

volunteer contributions through the Lake Goodwin Community Club or the Seven Lakes Water Association, assessments by the Seven Lakes Association if approved in advance by citizen vote and the board, a Lake Management District (like an LID), and County SWM fees.

The citizens requested firmer estimates for total costs and evaluation of the chances for any grant money so that they can determine the level of local funding that is needed. Don L. and Bruce B. agreed to check into the possibilities of voluntary donations through the Lake Goodwin Community Club and assessments collected by the Seven Lakes Water Association.

Public Meeting

A public meeting will be scheduled for late March to discuss the Integrated Plan and preferred alternative for Lake Shoecraft. Gene will try to coordinate the meeting notice with the Seven Lakes Water Association newsletter. Also, we will try to add a page about water quality to the notice.

Harry suggested that we invite Mary Kautz from DOE (she is in charge of regional permitting) and Kathy Hamel of DOE (responsible for aquatic weed funding) to the large public meeting.

Tulalip Tribes Involvement

Gene reported that the Tulalips have chosen not to participate on the committee or comment on the draft plan. However, we need their involvement up front, rather than just comments on permits at a later date. Harry Gibbons suggested setting up a meeting with representatives from the Tulalip Hatchery to go over the preferred alternative. This would help to identify any of their concerns and gain input from them at an earlier stage.

Lake Water Level Issues

Gene Williams described the current situation regarding the control of the lake level at Lake Goodwin and Lake Shoecraft. There have been complaints almost every year about water levels being too high in the winter. The State Dept. of Fish and Wildlife owns the outlet at Lake Shoecraft. The current tentative arrangement is that citizens at both lakes monitor the levels and contact the DFW when they think boards need to be added or removed. DFW is supposed to contact the Tulalip Tribes and make a joint determination regarding adjustments; then someone from the tribes will come out and remove or replace boards. This arrangement may work, but there is no written agreement. Snohomish County SWM is installing staff gages at the two lakes and outlet to help monitor the levels.

What happens next?

- The integrated plan will be finalized in May 1998. If funding and permits are secured, milfoil control actions will take place in summer 1999.
- Public education will continue for lake residents and the public who come to use the lakes. (Go see the new milfoil sign at Lake Goodwin State Park.) Please remember to keep checking your trailers, boats, jet skis, and fishing gear to avoid spreading milfoil to other lakes.
- Many citizens have also expressed interest in learning more about protecting the water quality of the Seven Lakes. SWM has information on the use of fertilizers, care of septic systems, protection of streams, control of soil erosion, native landscaping, and other topics. Please call (425) 388-3464 for handouts. In addition, future Seven Lakes Water Association newsletters will feature a column on lake water quality protection.

Questions? Contact:

Gene Williams or Heidi Reynolds,
Snohomish County Public Works
Surface Water Management,
(425) 388-3464

(Hearing/speech impaired may reach all phone numbers by calling WA Relay Center at 1-800-833-6388.)

Project sponsored by:

WA State Dept. of Ecology

Snohomish County Public Works
Surface Water Management

Working together for people, streams & fish

Lake Goodwin Community Club

Bulk Rate
US Postage
PAID
Everett, WA
Permit No. 593

Snohomish County
Public Works
Surface Water Management
2930 Wetmore Avenue-Suite 101
Everett, WA 98201-4044

Seven Lakes Milfoil Update

PUBLIC MEETING

7:00 to 8:30 pm
Wednesday, April 1

Lake Goodwin Community Club
17323 - 42nd Ave. NW

What is this meeting about?

The meeting is to review a proposed plan to eliminate Eurasian Watermilfoil in Lake Shoecraft by using a herbicide. This method of milfoil eradication has been recommended by a citizens' committee and Snohomish County staff after studying various options. The plan also recommends ways to prevent the spread of milfoil to other lakes.

Accommodations for persons with disabilities will be provided upon request. Please make arrangements in advance by calling Gene Williams at (425) 388-3464, ext. 4563.

What is the problem?

Eurasian watermilfoil is an aggressive water weed that is found in Lake Goodwin and Lake Shoecraft. Milfoil is a foreign invader that grows very densely in lakes. It produces long tendrils reaching to the surface that can tangle fishing lines, boat motors, and swimmers.

In 1997, milfoil covered two acres in Lake Goodwin and about ten acres in Lake Shoecraft. Unless it is controlled, milfoil may spread throughout all the shallow areas of these lakes. It is also a threat to spread to nearby lakes because new milfoil plants are able to start from a single one-inch fragment transported by boat motors or trailers.

What's been happening?

Snohomish County received a State grant in 1996 to tackle this milfoil problem. Working with a citizens' committee, the Snohomish County Public Works Surface Water Management Division (SWM) adopted a goal to completely eliminate Eurasian watermilfoil from the Seven Lakes area within 3 to 5 years.

During 1996 and 1997, divers surveyed the exact locations of milfoil in Lake Goodwin and Lake Shoecraft and eradicated more than 95% of the milfoil in Lake Goodwin. Divers placed burlap bottom barriers over the plant beds and hand-pulled individual plants. Follow-up work is needed over the next few summers to completely eliminate the milfoil from Lake Goodwin.

Unfortunately, the milfoil beds in Lake Shoecraft are too large to be controlled using the same methods. So, SWM is now working with the citizens' committee to evaluate alternative control methods and to develop an integrated plan for eradicating milfoil in Lake Shoecraft and preventing its spread to other lakes.

What alternatives are being considered?

With the help of a lake expert, the committee and SWM examined more than two dozen possible methods to control milfoil in Lake Shoecraft. The four most promising alternatives were examined in depth:

- Hydraulic dredging—this would be very effective, but is much too expensive.
- Bottom barriers—covering the milfoil with barriers would take several years and cost about $250,000
- Herbicide (Sonar) application—this herbicide could be applied as a liquid or pellet to the infected portions of the lake. Depending on the exact method used, the cost estimate ranges from about $90,000 to $105,000.
- Grass carp—these fish could be stocked in the lake. They would eat all the milfoil and other plants growing in the lake. The costs would be about $130,000 to $150,000 depending on the difficulty of obtaining permits.

An important consideration is how to fund implementation of the preferred alternative. Grant funds may be available. However, local residents will be responsible for at least 25%, and perhaps as much as 90%, of the funds needed to control the milfoil.

What is the preferred alternative?

At this time, the citizens' committee and SWM believe that the most promising alternative for Lake Shoecraft is use of the herbicide Sonar combined with temporary installation of fabric barriers to block off the infected bays. The herbicide would be applied over an 8 week period in the early summer of 1999 to completely kill the milfoil. The fabric barriers would restrict boating access to the north and south bays of the lake during this period.

Is this herbicide safe?

Sonar is the least toxic chemical allowed by the State of Washington for controlling aquatic plants. There are no restrictions on swimming, boating, fishing, or even drinking water treated with Sonar. Sonar kills milfoil by interfering with pigments that allow the plant to make food and grow. Humans and animals do not have these pigments. A person would have to drink over 7000 gallons of treated lake water per day or eat almost 25,000 pounds per day of food contaminated with Sonar to receive a dose that might cause negative effects.

Environmental studies by the State of Washington have determined that Sonar is safe to use for treating aquatic plants in lakes and ponds. In recent years, Sonar has been successfully used to control weeds in Killarney, Steel, Twelve, Lucerne, and Pipe lakes in King County, Long Lake in Thurston County, and many other lakes around the state.

This paper is recycled & recyclable. 3/98

SEVEN LAKES MILFOIL
PUBLIC MEETING--APRIL 1, 1998
MEETING NOTES

Approximately 50 citizens attended the public meeting held at the Lake Goodwin Community Club.

Gene Williams of Snohomish County Surface Water Management made a presentation using slides and handouts. Key points of the presentation were:

- summary of the Eurasian watermilfoil problem in Lake Goodwin and Lake Shoecraft
    - where EWM has been found
    - the invasive nature of EWM
    - the problems EWM is beginning to cause and can cause
    - the potential to spread EWM to other lakes

- summary of what has been accomplished to date
    - the Early Infestation grant
    - surveys and mapping
    - formation of the Advisory Committee
    - development of goals for the project
    - summer 1997 diving work in Lake Goodwin to hand-pull and place fabrics
    - follow-up surveys of Lake Shoecraft
    - diving surveys of the other Seven Lakes

- summary of Integrated Aquatic Plant Management Plan components and process
    - compilation of mapping and survey information
    - identification and analysis of alternative treatment scenarios for Lake Shoecraft
    - maintenance, monitoring, and education efforts for all the Seven Lakes

Harry Gibbons of KCM then described in more detail the various alternatives that had been evaluated for in-lake EWM treatment at Lake Shoecraft:

- hydraulic dredging
- grass carp
- hand-pulling and bottom barriers
- herbicide (Sonar) in liquid or pellet without barriers across coves
- herbicide (Sonar pellets) with barriers across coves

Harry and Gene then described in detail the preferred management option recommended by the Advisory Committee for Lake Shoecraft, which is the use of Sonar pellets in the north and southeast coves of the lake together with fabric barriers to isolate the treatment areas. Harry and Gene then responded to questions about the toxicity and impacts of Sonar, the impacts to recreation from installing the barriers, the estimated costs, and the reasons for rejecting grass carp as the preferred option.

Gene Williams then described the potential source of funds for implementing the Lake Shoecraft treatment and the on-going maintenance. He stated that the Advisory Committee would be developing a funding strategy and completing the Integrated Plan over the next few months. He was clear that a substantial portion of the cost would have to be borne by local citizens, and that Lake Goodwin and Lake Shoecraft citizens must work together if the milfoil is to be controlled. Kathy Hamel of Washington Department of Ecology stated that recent developments meant that State funds would not be available for competitive grants until at least the year 2000. This was new information for the Advisory Committee and Snohomish County.

Gene Williams distributed a questionnaire to citizens. The purpose of the questionnaire was not for a vote on the proposed EWM strategy, but to receive feedback on the proposal and on possible funding options. (Thirty questionnaires were returned. 80% of the respondents supported the proposed Lake Shoecraft treatment. More than 50% of the respondents indicated that they were willing to contribute $100 or more per year for the EWM eradication project.)

30 Questionnaires Received April 1, 1998

MILFOIL CONTROL PROJECT QUESTIONNAIRE

(Please check one response for each question.)

1. I am 25 very concerned ...about Eurasian watermilfoil in the Seven Lakes.
   5 somewhat concerned
   0 not very concerned

2. I 17 strongly support ...the proposal to use herbicides on the milfoil in LakeShoecraft.
   7 somewhat support
   3 somewhat oppose
   2 strongly oppose

3. I prefer some other method of controlling milfoil in Lake Shoecraft. 8 Yes ____ No
   If yes, please describe your concerns and what you think should be done about the milfoil in Lake Shoecraft.

   Bottom barriers - 2

   Grass carp - 5

   Grass carp + Sonar - 1

4. Funding sources for eliminating milfoil in Lake Shoecraft, finishing treatment in Lake Goodwin, and monitoring all the Seven Lakes are not yet identified. However, local Seven Lakes residents must pay at least a portion of these costs.
   How much would you be willing to pay (probably for five years) for this milfoil program?

   4 $25 per year
   3 $50 per year
   1 $75 per year
   12 $100 per year
   0 $125 per year
   3 $150 per year
   ____ Other amount?

   1 - $100 for a period of time
   3 - $100 for 2 years
   1 - $50 for 2 yrs, then $10 for 10 yrs.
   1 - $240/yr
   1 - $25 for a limited time

5. I have (or had) Eurasian watermilfoil growing in the water in front of my house. 11 Yes 16 No

6. I live (or have property) on the waterfront at
   8 Lake Goodwin
   19 Lake Shoecraft
   2 Lake Ki
   0 Lake Loma
   0 Lake Crabapple
   0 Lake Howard
   1 Lake Martha

   I live in the Seven Lakes area, but not on a lakefront. 0

7. Additional comments or concerns? Please write them on the back.

--PLEASE RETURN THIS SHEET BEFORE YOU LEAVE TONIGHT. THANK YOU--

SEVEN LAKES WATER ASSN.
The Gallon Gazette

Spring/Summer 1998 Volume 2 Issue 2

Water conservation, what does that mean to you? Is the first thought "Oh, no, here comes the water restrictions!" or...does it mean good stewardship of the abundant resource we have? If your thoughts were with the "restrictive" response, hopefully the information to follow will be of help in thinking of conservation as doing your part to see to it we all can enjoy this resource for many years to come. There are several areas that can be touched on and the use of water inside the home has been written about in past issues. With spring here, use of water outside the home for flower and vegetable use would probably be a good idea to write about. There are three strategies to reduce water loss and conserve water. The first is understanding and monitoring the water status in soils and reducing soil surface evaporation. The second is understanding the critical times when plants need water and knowing how to apply water efficiently. The third is knowing the types of plants that can stand less water and using them in planning future landscapes and home grounds for more efficient water use.

- **Soil preparation for new plantings:** Prepare the soil as deeply as possible. The addition of organic matter will increase the water holding capacity of the soil, increasing the efficiency of water use. Do not add organic matter to the backfill of individual planting holes, instead add organic matter to an entire area, such as a landscape bed and mix with the soil as deeply as possible. Examples of organic matter to use include ground bark, compost, peat moss, well rotted manure and leaf mold. New transplants will need frequent irrigations until firmly established.
- **Conserving soil water:** Do anything you can to reduce evaporation from the soil surface. Mulching with up to 3 to 4 inches of ground bark, sawdust, wood shavings, wood chips, etc. is an excellent way to reduce irrigation frequency. New porous landscape fabrics are also suitable. Avoid using black plastic; it doesn't allow for water penetration. Rock mulches should also be avoided as they absorb, store and reradiate heat, usually increasing plant water loss. Removal of weeds saves soil water.
- **Watering landscape and vegetable plants:** The secret is to water slowly, deeply and less often. Deep, infrequent waterings encourage plant roots to grow as deeply as possible. The plants will be less likely to suffer in a drought. Water slowly. Water running off soil surface, turf area or puddles indicates the water is being added too fast. Use drip or trickle irrigation. This method wets the soil slowly. A perforated sprinkler hose, placed upside down (with holes down) makes a very good system. Up to 60% of the irrigation water can be saved using drip vs. conventional sprinkler irrigation. Irrigate in the early morning when the humidity is high. Also during a light rainfall to maximize the effect of both the rain and the irrigation. Collect roof water from downspouts in a pail or barrel for landscape use. Plants in soft growth in spring and early

see CONSERVATION, page 5

The Gallon Gazette is an official newsletter of Seven Lakes Water Association, Inc. It is published seasonally by the employees of Seven Lakes Water Association, Inc. For comments or suggestions please write Seven Lakes Water Assn., 17507 West Lake Goodwin Road, Stanwood WA 98292 (360) 652-8192 Fax (360) 652-6244

Seven Lakes Milfoil Update

Since our last newsletter, there has been several things done regarding the removal of milfoil in Lakes Goodwin and Shoecraft. Surveys were taken to find the exact locations of milfoil in both lakes. Lake Goodwin has had 95% of the milfoil eradicated. Divers placed burlap bottom barriers over the plant beds and hand-pulled individual plants. Follow-up work is needed over the next few summers to completely eliminate the milfoil from Lake Goodwin. Unfortunately, the milfoil beds in Lake Shoecraft are too large to be controlled using the same methods. The citizens' committee, the Snohomish County Pubic Works Surface Water Management Division (SWM) and a lake expert are now looking at four alternative control methods. An important consideration is how to fund the alternatives. Grant funds may be available. However, local residents will be responsible for at least 25%, and perhaps as much as 90%, of the funds needed to control the milfoil. The four alternatives are:

- **Hydraulic dredging**-much too expensive
- **Bottom barriers**-Would take years and costs about $250,000
- **Herbicide (Sonar) application**-can be applied liquid or pellet in the infected portions of the lake. Depending on the method used, cost estimate ranges from about $90,000 to $105,000
- **Grass carp**-stock the fish in the lake and they would eat all the milfoil and other plants growing in the lake. Cost between $130,000 and $150,000

The preferred alternative for Lake Shoecraft is the use of the herbicide Sonar combined with installation of temporary fabric barriers. The herbicide would be applied over an 8 week period in early summer of 1999 to completely kill the milfoil. The barriers would restrict boating access to the north and south bays of the lake during this period. **see Milfoil, page 5**

THE PRESIDENT'S CORNER
By Dale Steen

The following is submitted by Henry Hoffman, Vice President of Seven Lakes Water Association:

Being able to turn a faucet on and receive water is almost taken for granted, as is having the lights come on when turning on a light switch. We would only become aware of the difficulty in living without this when the power lines or water system fails.

The geographical area we live in is very beneficial to us because we have an abundant underground water supply that we are able to pump from the ground and use without having to filter or chlorinate it before it is used. Although it is not very easy, it takes a network of pipes (approximately 40 miles for our system), storage tanks, pressure reducers, pumps etc., to get the water to the faucet.

We should all do our part to protect the aquifer we receive our water from by not putting anything on the ground we would not want to eventually drink (waste oil, antifreeze, sewage effluent, etc.).

I can remember back 35 years ago, before Seven Lakes Water Association was formed, we used the water from the lake (as long as you boiled it first). We sure would not want to use it now. With all of us doing our part in protecting our ground water supply, hopefully our children and grandchildren will still be using the good water supply we all now enjoy.

Selling your house? Contact the office and we'll help you with the change in membership. We need to know who the buyer is, date of possession and escrow company. It's that easy!

CONSERVATION, from page 1

summer need more water than in late summer. Consequently, you may reduce watering in late summer. Plant vegetable plants closer together. Using this method decreases the amount of water needed per unit area, and reduces evaporation from the soil surface. For lawns in the summer, approximately 1 inch of water per week must be replaced by irrigation for good quality turf. (An empty tuna can placed on the lawn will be helpful in measuring)

- **Water conserving plants:** Most native Pacific Northwest plants need limited, if any, summer irrigation. They are better able to tolerate drier, summer periods than some exotic plants. Some examples are: rhododendrons, Rugosa rose, Mock orange and Kinnickinnick. Try to separate water conserving plants from the water demanding plants in your garden. This means you only have to irrigate part of the landscape frequently.

With a better knowledge of how water can be used in your garden, you can enjoy the spring and summer without being a slave to watering or having to pay a higher water bill.

Credit of the above information provided by:
Washington State University Cooperation Extension, publication EM 4834

Milfoil, from page 2

Sonar is the least toxic chemical allowed by the State of Washington for controlling aquatic plants. Environmental studies by the State of Washington have determined Sonar is safe to use for treating aquatic plants in lakes and ponds. There are no restrictions on swimming, boating, fishing or even drinking water treated with Sonar. Sonar has been successfully used to control weeds in Killarney, Steele, Twelve, Lucerne and Pipe lakes in King County, to name a few.

There was a meeting on April 1, 1998 at the Lake Goodwin CC to review a proposed plan using the herbicide method and reviewing recommended ways to prevent the spread of milfoil to other lakes. If you could not attend the meeting, you can contact Dean McReynolds from the Lake Goodwin CC at (360) 652-8197 for information on what was discussed at the meeting. For other questions regarding this issue you can contact Gene Williams or Heidi Reynolds, Snohomish County Public Works Surface Water Management, (425) 388-3464. Gene's extension 4563, Heidi's extension 4640.

Information provided by Snohomish County Public Works Surface Water Management milfoil project flyer.

Seven Lakes Water Assn. is looking for a well site north of Lakewood Road in the Happy Valley area. The site needs a 200 foot radius for a sanitary setback. It is not necessary to be a member of Seven Lakes Water Assn. Call Paul Lucas, manager, at the office if you have a lead or need more information. (360) 652-8192

Summertime Tips
Outside taps & hoses

Your garden hose can pour out 600 gallons or more in only a few hours. Remember that when you leave the sprinkler running all day or leave the hose unattended. Thousands of gallons can be lost in a very short time!

Check the outside taps for leaking water, particularly during the summer sprinkling season. A hose mistakenly left dribbling away in the grass or garden can waste thousands of gallons of water over the course of a summer. Remember to close outside faucets tightly every time you shut off the water.

Use a hose nozzle that can be shut off. To avoid leaks, shut off water at the house when finished.

SEVEN LAKES MILFOIL ADVISORY COMMITTEE
MEETING NOTES -- JUNE 9, 1998

The purpose of this committee meeting was to continue development of a funding strategy for the Eurasian watermilfoil eradication project. Specifically, two citizens from other lakes in Washington which have faced aquatic weed problems were invited to tell about their experiences and answer questions from the committee.

Mary Ann Straight, from Big Lake in Skagit County, explained how her community secured several grants, completed studies, formed a lake management district (LMD) to fund a herbicide program, and secured permits to treat the lake in 1998. Bob Zych of Long Lake in Thurston County explained how his community funded milfoil control efforts, treated the lake, and monitored the lake each year.

Mary Ann and Bob described the extent of the aquatic plant problems in their lakes, the process used to develop treatment and funding plans, the pros and cons of LMDs, their rejection of other funding approaches, the actual amounts charged land owners, the breakdown of costs for lake front, community beaches, and public properties, the on-going maintenance and diving that has been necessary, the methods used to build public support, and the support (if any) from local and state agencies. They also described the extensive roles played by their core citizen groups.

The comments of these guests were extremely insightful. They made it very clear that the citizens, and not government agencies, must own the aquatic plant problem and take responsibility for the solutions. They called for a core group of committed citizens to start working to mobilize community support and form an LMD. They stated that payments of hundreds of dollars per year per property were involved and that these investments were reasonable and necessary if projects like these are going to work. The speakers were enthusiastic and really energized the citizens on the committee.

The outcome of this meeting was that a small sub-committee of citizens (Karen Thompson, Eugene Keene, Bruce Black, Bill Frolli, and Craig Thompson) was formed to put together a funding package, as well as a strategy for forming an LMD at Lake Shoecraft and Lake Goodwin. A key objective is to include both Lake Shoecraft and Lake Goodwin citizens in funding the project, even though much of the work will be on Lake Shoecraft. The sub-committee will work over the summer and report back to the full committee sometime in the fall.

FUNDING ISSUES FOR MILFOIL CONTROL AT LAKE SHOECRAFT AND LAKE GOODWIN DISCUSSION AND BACKGROUND INFORMATION

The following is a summary of the funding sub-committee discussion at the meeting of October 6, 1998. *New information received since the meeting is shown in italics.*

Funding Approach

- revised cost estimates from the County show a total cost of about $108,000 in 1999 and $189,000 over five years
- these costs are for herbicide treatment in Lake Shoecraft, follow-up diving in Goodwin and Shoecraft, formation of a Lake Management District (LMD), and public education/ administrative costs
- the sub-committee supports formation of a Lake Management District (or other mechanism to charge property owners) to fund the major portion of this work; state grants are unlikely
- funding for the work program should be shared by residents of both Lake Goodwin and Lake Shoecraft; milfoil eradication will only work and be affordable if citizens at both lakes work together

Lake Management District

- sub-committee recommends that an LMD should spread the charges over five years
- each individual lake front lot should be charged the same (unless jointly owned lots can never be split); the sub-committee felt that the County's suggestion of charging by the lake frontage was too complicated and preferred that everyone be treated the same; however, there would be special rates for community beach lots and for public parcels
- Bill Frolli compiled maps from the County Assessor's office; his research shows that there are about 550 parcels located around the two lakes
- formation of the LMD requires five fairly complicated steps: petition from 15% of the owners; hearing by the County Council and approval of LMD process; vote of all affected property owners (1 vote for each dollar to be assessed); hearing by County Council to finalize assessment role; and official formation of the LMD
- the estimated costs of forming the LMD are $8,000, which would be charged as part of the overall costs
- by law the County could require a $5,000 bond or letter of credit from citizens to offset the LMD formation costs in case the LMD is defeated by vote; *the County Surface Water Management Division (SWM) recommends not requiring this bond and will seek County Council support for this approach*
- LMD billings would be performed by the County Treasurer's office; *the Treasurer will charge $4 per account to set up the billing and $4 per account per year to do the billing--these are new costs not included in the overall cost estimates summarized above*
- billings could not begin before the year 2000, so about $100,000 in loan would need to be available from the County to cover the work in 1999; Snohomish County SWM could issue revenue bonds (with interest paid by the LMD charges) or just loan funds for one year to the LMD; *the SWM Division supports loaning the funds for one year and is seeking authorization from the County Council to allow this approach*

County's SWM Fee

- sub-committee members expressed interest in the County raising SWM fees for lake front properties for five years as an alternative to forming a Lake Management District; advantages include avoiding the long procedural process of forming an LMD, avoiding the Treasurer's charges, and using an existing fee system

- Snohomish County has uniform SWM rates throughout the County and has never imposed specific fees for special areas, but logistically it is possible
- because this approach could occur with just County Council approval and no property owner vote, it might be a difficult political decision; Gene Williams speculated that the Council would probably want to see a petition with 50% or more of the property owners signing to consider such an action
- *SWM supports the approach of raising SWM rates for properties around the lakes rather than forming an LMD; SWM will present the issue to the County Council and ask what level of support the Council needs to be comfortable with this approach*
- the sub-committee suggested that the petition process could start this fall with the petition worded to allow either formation of an LMD or an increase in the SWM rates; this would avoid lost time if not enough signatures could be gathered to convince Council to raise SWM rates without a vote of property owners
- Gene Williams will work with SWM staff to develop a detailed database of properties around Lake Goodwin and Lake Shoecraft; the information will also be shown on maps by the current SWM rate categories

Public Share of Costs

- the sub-committee felt that public properties, including Wenberg State Park, the Shoecraft boat launch, and new County site on Lake Goodwin, should pay a reasonable share of the five year milfoil control costs; Gene W. explained that special rates for these properties can be adopted under either a Lake Management District or increased County SWM fees; however, it is not certain that we can convince these agencies to actually pay; other LMD's in the state have included boat launches and parks, but have not been successful in securing payments
- the committee also asked that a portion of the $30 SWM fee that property owners currently pay to the County be designated to offset some of the milfoil costs; Gene stated that those funds have paid for much of the milfoil work in the last two years and that some portion of the current fees could probably go toward the future work, in particular toward administrative costs; however, not as large a share of these funds would be available on a long term basis because of other County SWM activities in the area that must be funded; *SWM is currently evaluating the level of support that can be provided during the 5 year project*

Permits

- the only permit required for the herbicide application is one from WA Dept. of Ecology; processing time is relatively short
- an HPA permit will be required from WA Dept. of Fish and Wildlife for placement of the barriers; Earl Dorman of WDF stated that the permit should be no problem because the purpose is milfoil control
- a Shoreline Management permit might be required for placement of the barriers because there is no provision in the Shoreline program for temporary work; County Planning is looking into the issue. *Planning has now determined that the herbicide treatment and the barriers are exempt from Shoreline permits.*

Monitoring and Contingency

- County SWM developed a detailed monitoring plan with contingencies to ensure that the herbicide does not escape Lake Shoecraft and contaminate Tulalip Creek or the Tulalip fish hatchery; this includes multiple monitoring sites in the lake and downstream, as well as steps to interrupt the treatment if necessary; all herbicides would be carried *(by pickup truck)* overland to the treated coves to prevent spills at the boat launch; this monitoring and contingency plan was presented to the Tulalip Tribes and they have concurred with it; therefore, we do not anticipate objections by the Tulalip Tribes to permits for the project

SEVEN LAKES WATER ASSN.
The Gallon Gazette
Fall/Winter 1998 Volume 3 Issue 1

Are you ready for winter? Seems like this is a question being asked quite frequently now.

With the newspapers and radio telling us of colder than normal temperatures and increased rainfall to the Pacific Northwest, this is a good time to get you thinking of winterizing your home, especially any exposed water pipes.

- Find your main water shut-off valve and mark it with a visible tag. Look for the valve in the basement, garage, or outdoors by the foundation, often near the front faucet.
- Test the shut-off valve by closing it. Water should not continue to flow through faucets.
- If the valve is broken, or if your building does not have one, have your plumber repair or install a new one.
- Wrap with rags, newspapers, or other insulation materials any outdoor faucets, pipes and pipes in unheated areas. Cover with plastic and tie with a string or wire.
- Protect pipes that have frozen before with electric heat tape.
- In severe cold, drip warm water from an indoor faucet furthest from where water enters the house.
- If your home is unheated for extended periods; turn off the main shut-off valve and water heater. Open indoor and outdoor faucets to drain pipes.
- If the pipes freeze, wrap with rags and pour hot water over the rags until water is flowing again. When thawed, remove wet rags and re-wrap pipes with dry insulation.
- If the pipes break, immediately close the main shut-off valve and call your plumber.
- Locate your meter box and see if the meter could likely freeze and break. If so, the best way to keep this from happening is to simply use dirt or bark and fill up the box to where you read the numbers under the lens of the meter.

It is the member's responsibility for protecting water pipes from freezing and for repairing broken pipes on, or leading to, your property. If pipes break and you cannot close the main shut-off valve, we can turn the water off at the meter.

Quality On Tap!
Our Commitment Our Profession

Do you know where your meter box is located? It is very important to know where your water meter is located. If you suddenly lose water pressure you may have a break in your line and the water would need to be turned off at the meter quickly. There may be more than one meter inside the meter box, so if you are not sure which one is yours, call the office and we will assist you in making sure you know which meter is yours.

The Gallon Gazette is an official newsletter of Seven Lakes Water Association, Inc. It is published seasonally by the employees of Seven Lakes Water Association, Inc. For comments or suggestions please write Seven Lakes Water Assn., 17507 West Lake Goodwin Road, Stanwood WA 98292 (360) 652-8192 Fax (360) 652-6244

Seven Lakes Milfoil Update Fall 1998

Lake Goodwin: Divers returned to Lake Goodwin this summer in the continuing efforts to eradicate Eurasian watermilfoil from the lake. Milfoil is an invasive, non-native plant that, if left unchecked, can disrupt swimming, boating and fishing. During five days of diving in July 1998, the divers reported excellent results from the burlap barriers and hand-pulling that was performed in 1997. They also found and removed scattered individual milfoil plants and two small milfoil patches that were missed last year. With continued follow-up every year, milfoil should be eradicated from Lake Goodwin in the next few years. However, success can only be achieved if all boaters use extreme caution not to spread milfoil fragments that cling to trailers, motors and boats. In addition, until milfoil is eliminated in Lake Shoecraft, there is a good chance that it will spread right back to Lake Goodwin.

Lake Shoecraft: Eurasian watermilfoil still occupies over 10 acres of shallow water in Lake Shoecraft. This is too much milfoil to eradicate effectively with the same diving techniques used in Lake Goodwin. Therefore, a citizens' committee has been working with Snohomish County Surface Water Management staff since 1997 to develop a plan for eradicating milfoil in Lake Shoecraft. The draft plan recommends use of a herbicide, Sonar, to treat the infected portions of the lake. Citizens attending a public meeting in April generally supported the recommendation.

In recent months, the citizens' committee has been developing a strategy to fund the herbicide treatment in the summer of 1999 and to follow-up with monitoring and spot removal in Lake Shoecraft and Lake Goodwin in future years. Cost estimates are about $75,000 for the treatment and about $75,000 for all monitoring and follow-up for five years. At this point, State grant funds are not available, so most of these costs must be funded by residents of Lake Shoecraft and Lake Goodwin. The most likely funding method is formation of a "Lake Management District" by a vote of the affected property owners. More information will be available this fall or you can contact Bill Frolli (652-1498) for Lake Shoecraft or Karen Thompson (652-7530) for Lake Goodwin.

This article courtesy of Gene Williams, Snohomish County Surface Water Management.

Did you know.....???????

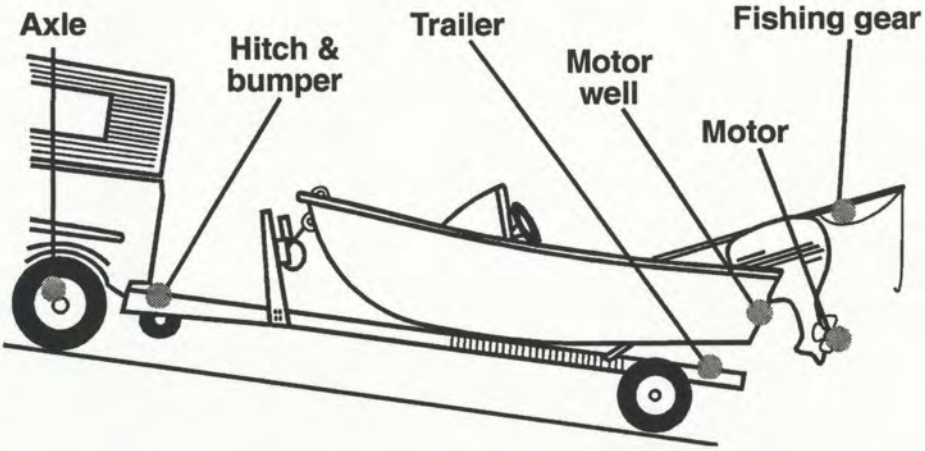
- One day's discharge at the mouth of the Amazon River—4.5 trillion gallons—could supply all U.S. households for more than five months. Compare this Amazon average flow rate with the peak all time Mississippi flow rate at St. Louis of just under 0.7 trillion gallons per day that occurred during the great flood of 1993.
- Walt Disney World's wastewater treatment plant reuses treated wastewater for golf courses and landscape irrigation, and saves 1.8 million gallons of groundwater a day.
- The residents of Denver, CO are among the nation's heaviest water users, while the folks in Buffalo, NY are among the least wasteful

Worried about your summer cabin in the winter? **Send the office a letter stating you want the water turned off by a certain date and we'll turn-off and lock the meter. When you want it turned back on before you come for the summer, do the same for the turn-on. The cost for this is $20 for each turn-off and turn-on. Not too much for the peace of mind it gives you.**

Spread the word, not the weed!

Help rid Lake Goodwin of milfoil:

- Please remove plant fragments from boats, trailers, and jet skis.



Milfoil weeds can:

- Entangle fishing lines, boat motors, and swimmers
- Spread rapidly to other lakes

Snohomish County
Public Works
Surface Water Management
(425) 388-3464

Working together for people, streams & fish.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

4'x 8' Sign
Installed at State Park Boat Launch

Spread the word, not the weed!

Help rid Lake Goodwin of milfoil:

- Please remove plant fragments from boats, trailers, and jet skis.

Milfoil weeds can:

- Entangle fishing lines, boat motors, and swimmers
- Spread rapidly to other lakes

Snohomish County
Public Works
Surface Water Management
(425) 388-3464

4'x 8' Sign
Installed at State Park Boat Launch

APPENDIX B

LAKE SHOECRAFT
HERBICIDE TREATMENT
MONITORING AND MITIGATION PROTOCOLS

Lake Shoecraft Milfoil Eradication
Herbicide Treatment
Application, Monitoring and Mitigation Protocols

Monitoring

The following is a description of the monitoring program to be executed in conjunction with the treatment of Lake Shoecraft with the aquatic herbicide fluridone (Sonar) for the control of Eurasian Watermilfoil. The purpose of the monitoring program is to track the levels of chemical within and outside of the treatment area, and to gather data on the efficacy of the herbicide application. The monitoring program will yield information in two directions. It will give the management team, including herbicide applicator, data that will be needed to make the correct decisions relative to maintaining proper concentration of sonar within the treatment area. The monitoring program will also generate data on the potential drift of herbicide outside of the targeted treatment area and the potential need for mitigation actions resulting from exposure of nontarget plants to sonar. All data generated by this program will be made immediately available to the Washington Department of Ecology and the Tulalip Tribes.

Monitoring during Application Period

Parameters - During the application of Sonar to Lake Shoecraft, the only needed parameter that would be necessary to sample is the herbicide itself. This is because the slow rate of metabolic disruption caused by the herbicide does not result in a large oxygen demand or any other direct adverse impact on the chemistry or biota (other than plants) of the lake. For example, unlike contact herbicides that kill plants within hours to days, it takes Sonar weeks to kill plants. The slow die-off of plants means that decay is also slow, spreading out the oxygen demand over a long period and resulting in little to no detectable change in the background oxygen demand. Also, there are no label or permit restrictions on swimming, boating, fishing or even drinking water during the herbicide treatment.

Methods - The specific sampling protocol will be that recommended by SePRO, the distributor of the herbicide and the laboratory that will conduct the analytical analysis, called FasTEST. FasTEST is an exclusive photometric water analysis for fluridone. The limit of detection for this test is 1 microgram per liter (ppb). In practice, the herbicide applicator will take water samples from predetermined areas by filling bottles supplied by SePRO. The samples will be sent Fed Ex to SePRO, and results will be ready within 48 hours.

Frequency - Sonar (fluridone) concentrations will be monitored during the application period and for two weeks after treatment. The first water sample will be taken 24 hours after application. In addition, during the first week of application, samples will be taken for fluridone at 48, 72, and 96 hours after application. This will generate data for the first four days after the initial dosing of the lake. Then, samples will be taken every Wednesday after that for nine more weeks. These data will be used to assess the drift and dilution potential of the herbicide within and outside of the treatment area.

Sampling Locations - Water samples for the FasTEST analysis will be taken as follows:

- Within the main treatment area in the south end of the lake, four samples will be taken, each representing approximately 25 percent of the area enclosed by the barrier.
- Within the north treatment area, two samples will be taken within the barrier, each one representing about 50 percent of the south treatment area.
- Outside of the treatment barrier three samples will be taken parallel to each barrier at 100 feet from the barrier toward midlake. Each sample should be spaced along approximately one-third the distance of the barrier.
- A sample will be taken at the upstream end of the outlet structure at the mouth of the bay leading to the outlet of Lake Shoecraft.
- A sample will also be taken approximately 100 feet downstream of the outlet structure.

Mitigation and Corrective Actions

The following corrective actions will be implemented based on monitoring results during fluridone treatment.

1. If Fluridone concentrations within the two treatment areas drop below 8 ppb (8 μg/L):
   - Additional Sonar will be added within the target areas of the lake in an attempt to maintain an average 10 ppb (10μg/L) concentration within the treatment areas. Addition of Sonar will take place on Fridays of the eight-week treatment period.

2. If the Fluridone concentration at the upstream outlet station exceeds 2 ppb then:
   - Inspect and adjust barriers as needed
   - Increase monitoring frequency and number of sampling stations, if there is any outlet flow from Lake Shoecraft at that time:
     - Sample daily all stations until fluridone concentration drops below 1 ppb
     - Add sampling station at midlake in Lake Shoecraft and at the inflow to Lake Weallup.

3. If Fluridone concentration in the lake downstream outlet station exceeds 2 ppb then:
   - Insert additional weir boards to restrict Lake Shoecraft outflow
   - Increase monitoring as outlined in #2 above
   - Add additional sampling at Lake Weallup (three locations to represent the lake area)

4. If Fluridone concentration in Lake Weallup exceeds 1 ppb (the limit of detection) then:
   - Stop Sonar application to Lake Shoecraft until concentration in Lake Weallup drops below 1 ppb
   - Add another sampling station at the outlet of Lake Weallup
   - Monitor aquatic plants in Lake Weallup to establish a baseline
   - Re-survey the aquatic plant community at Lake Weallup to check for herbicide damage after the treatment period.

5. If barriers are damaged or structural failure occurs:
   - Boards at outlet weir will be immediately installed to stop water outflow from lake
   - Barriers will be repaired as soon as possible
   - Sampling will follow protocols outlined in number 2 above.

6. To prevent a material spill, the contractor will be instructed to deliver the herbicide directly to the treatment areas by land transport. At the site, the herbicide will be loaded from the transport to the application boat. In this way, if a material spill does occur, only the targeted water can be potentially impacted.