Mason Lake

Integrated Aquatic Vegetation Management Plan

November 2003

Sponsored by:
The Mason Lake Milfoil Committee
Mason County Lake Management District #2
Washington State DOE, Water Quality Division

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ACKNOWLEGEMENTS

The Mason Lake Milfoil Committee and the Mason Lake LMD #2 wish to thank the members of the IAVMP Steering Committee for all their help in preparing our plan.

Staff from the Washington Department of Ecology also provided invaluable technical guidance during development of this document. Special thanks to Kathy Hamel of the Aquatic Weeds Management Fund for her timely and thorough response to all questions; and to Teri King from *UW Sea Grant Program*, who was an instrumental resource having knowledge in many areas of this plan. Arline Fullerton, our aquatic plant specialist and certified diver (through Doppler Enterprises), provided vital aquatic survey data as well as hands-on aquatic plant training for many of the lake's residents.

Finally, special thanks to the Mason Lake community of over 900 residents and supporters. Their enthusiasm and dedication to preserving the aesthetic beauty, recreational opportunities, and ecological integrity of Mason Lake is welcomed and inspiring.

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EXECUTIVE SUMMARY

Mason Lake, in the Kennedy-Goldsborough Basin WRIA-14 watershed in Mason County, Washington, is at this writing lightly infested with Eurasian watermilfoil (*Myriophyllum spicatum*), hereafter called EWM. This infestation containment is due to the early actions of the Mason Lake Milfoil Committee (MLMC) collaborating with the Washington DOE, Water Quality Division's, Kathy Hamel using a EWM Early Infestation Grant to reduce its spread. This was grant received in 1998 and funded initial eradication efforts, including several follow-up surveys and chemical control applications. This initial grant has been successfully completed.

Eurasian watermilfoil is a submersed aquatic noxious weed that proliferates to form dense mats of vegetation in the littoral zone of lakes and reservoirs. It reproduces by fragmentation, and is often spread as fragments that “hitchhike” on boat trailers from one lake to another. EWM can degrade the ecological integrity of a water body in just a few growing seasons. Dense stands of milfoil crowd out native aquatic vegetation, which in turn alters predator-prey relationships among fish and other aquatic animals. EWM can also reduce dissolved oxygen – first by inhibiting water mixing in areas where it grows, and then as oxygen is consumed by bacteria during decomposition of dead plant material. Decomposition of EWM also adds nutrients to the water that could contribute to increased algal growth and related water quality problems. Further, dense mats of EWM can increase the water temperature by absorbing sunlight, create mosquito-breeding areas, and negatively affect recreational activities such as swimming, fishing and boating.

Since complete eradication is very difficult to achieve, and reintroduction is likely, the community has organized a management structure and created the funding mechanism necessary to implement ongoing surveying, monitoring and control by creating the Mason Lake, Lake Management District #2 in 2002.

Based on aquatic plant surveys from 1998 through 2003, another invasive weed specie has been identified. It is quickly expanding on Mason Lake and threatens to degrade the ecological and recreational benefits of our system. Grass-leaved Arrowhead (*Sagittaria graminea*) is in a pioneering level of infestation, and is at this writing, well established at nine points around the shoreline. The MLMC applied for an Early Infestation Grant in September of 2003, through the Washington Department of Ecology, to fight this newly identified problem.

Not much is known regionally about Grass-leaved Arrowhead other than it is an emergent or submersed aquatic weed native to the eastern United States. It has become a serious pest plant in Australia and New Zealand. It has been established in two western Washington lakes, Lake Roesiger and Mason Lake. The plant increases density and spreads locally by its creeping root system. It spreads to other areas through seed carried by water, machinery, and wildlife as well as rhizome fragments being transported. It can form floating mats of vegetation that break up and take root elsewhere. It grows densely, inhibits the growth of native aquatic species, can seriously restrict water-flow in shallow waterways and increases sedimentation. Sedimentation is a process in which suspension settles out of a fluid, leaving the upper portion less concentrated and the lower portion heavily concentrated in the settled substance.

This Integrated Aquatic Vegetation Management Plan (IAVMP) is a planning document developed to ensure that the community has considered the best available information about the water body and water shed prior to initiating further control efforts. To tackle the task of generating community concern and action for an environmental issue, a core group of residents and lake users formed an IAVMP Steering Committee, which included many diverse parties having an interest in Mason Lake. Members of the Mason Lake Milfoil Committee, Mason Lake LMD # 2, Mason Conservation District, Allyn Salmon Enhancement Group, Department of Fish and Wildlife, Department of Ecology, Mason Lake residents, representatives of the Squaxin Indian Tribe and other interested lake users were contacted in person, in writing or via newspaper articles soliciting their input. Lake Stewardship Consulting worked with each of these members to acquire accurate, timely information to assist with the overall process. Through their work, the Steering Committee was able to educate the wider community about the issues facing the lake, to inspire them to contribute feedback about potential treatment options and explore ongoing methods of reducing human-introduced factors that promote the growth of undesirable aquatic vegetation (i.e., silt run-off, inorganic lawn fertilizers and phosphate-based detergents).

This plan presents lake and watershed characteristics, details of the aquatic weed problems at Mason Lake, the process for gaining community involvement, discussion of control alternatives, a multi-year treatment plan, and recommendations for ongoing control of non-native invasive aquatic weeds threatening Mason Lake.

The treatment plan was created and presented at the second Community Meeting. Its goals and methods were incorporated into a Letter of Support (Figure 2-1), which has received over 560 signatures and are available in Appendix C.

Lake Stewardship Consulting Recommendations

While gathering the information to compile this document, certain matters surfaced that LSC believes need to be addressed for the continued long-term health of Mason Lake. These three recommendations are solely being given by LSC. They do not necessarily reflect the views of the community at large, which should be taken into consideration when viewing the following.

1) To respond to the changing influences on Mason Lake, a position of a dedicated lake manager should be created. As witnessed over the last five years a variety of influences have started to affect Mason Lake. These include but are not limited to the following: Larger homes replacing smaller cabins which has increased demands on available property boundaries, potential septic system failure now and in coming years, introduction by Mason Lake residents of invasive aquatic plants and non-point source pollution to name a few. Ever changing county and state laws in response to lawsuits or environmental threats must also be considered. LSC respectfully recommends that a funding mechanism be put in place to hire a lake manager to address these issues. We believe that the volunteer organizations currently in place should continue to operate as a check and balance system for the community.

2) To establish a warmwater trophy fishery in Mason Lake, we believe that Sterile Tiger Musky should be introduced with help from the Department of Natural Resources, the Allyn Salmon Enhancement Group and the WA Department of Fish and Wildlife. Mason Lake is out of balance with predator and prey fish which has led to many, very small fish and a few large fish. Squaw Fish is a primary food source of these sterile musky and is the predominant predator fish in Mason Lake. Bringing these predators to a more reasonable level would help restore a much-needed balance. Sterile Tiger Musky would have the added benefit of not being able to procreate and have a limited life span. Salmon recovery efforts should be assessed to ensure that juvenile salmon traveling through the lake are not put at a higher than normal risk.

3) To keep this IAVMP a current, living document, it should be reviewed annually in October by the Steering Team to make additions, revisions and deletions as needed.

ACTION STATEMENT

The following is the action statement the Steering Team initiated. It has been agreed to by 171 attendees of the first public IAVMP meeting held Saturday, July 5, 2003 at the Mason Benson Center, Mason Lake, Washington.

"To maintain Mason Lake's environmental, recreational and property values, a well defined aquatic plant and water quality study and management plan of Mason Lake, are needed to create a baseline for future lake management efforts. This management plan should include aquatic plant control alternatives and discuss their sensitivity to environmental effects."

It was decided to call this portion the "Action Statement" as opposed to a "Problem Statement." It shows that the lake residents recognize that *action* is required on their part to handle the common *problem* of invasive weed control and to increase the common understanding of the health of Mason Lake.

In 2003, the two aquatic plants that threaten this lake are Eurasian watermilfoil (*M. spicatum*) and Grass-leaved Arrowhead (*S. graminea*). Other plants, through accidental spread or even intentional (albeit misguided) planting, may require management in the future. This action plan is intended to be open enough to allow the community the flexibility to respond to the challenges that lie ahead.

MANAGEMENT GOALS

The management goal is to control noxious aquatic weeds in Mason Lake in a manner that allows sustainable native plant and animal communities to thrive, maintains acceptable water quality conditions, facilitates recreational enjoyment of the lake and protects the surrounding property values.

There are four main objectives to ensure success in meeting this goal:

1. Inform and involve the community in each phase of management process;

2. Use the best available science to identify and understand likely effects of management actions on aquatic and terrestrial ecosystems prior to implementation;

3. Review the effectiveness of management actions annually or more frequently if acquired data shows a potential area of concern; and,

4. Adjust the management strategy as necessary to achieve our overall goal based on the previous objectives.

Specific details related to the implementation of management objectives are covered in subsequent sections of this plan.

COMMUNITY INVOLVEMENT

The dwellings of Mason Lake residents reflect the change from the Lake's use as a rustic summer retreat to more of a year round community. Residences have changed from small fishing cabins to the now common 3-4 bedroom, $400,000 and up homes. The community has also undergone a transformation from 50^{+} percent of property owners living at the lake full-time to less than 20 percent being full-time residents. Considering that there are approximately 850 property owners on the tax roll, it is a considerable shift from a long established network of families where almost everyone knows everyone else to a less personally connected community of independent residents.

What became apparent throughout our IAVMP process is that a large number of part-time residents contributed heavily in the preparation, participation and success of this project. Meetings were made up of many people that had not attended any other community functions or benefits. Volunteerism was very high as our in-kind contribution numbers will verify and hundreds of new participants volunteered and have requested further involvement as this document will confirm. The mixing of "old timers" and "newbies" was exciting to watch, work with and document.

Community History

In the preparation of this document, much historic data was uncovered and shared. It would be welcome news if history had shown that early pioneers held this place, its resources and beauty in high esteem, but that was not always the case. This document was prepared by the Skokomish Indian Tribe in June of 1980. It is believed that the period referred to is the mid 1890's.

> *"Years ago, over at Allyn, old man Sherwood had a mill over there at the mouth of the creek. His logs were hard to handle so he decided he would put up a log bulkhead clear across the creek, and so he did. He (Henry Allen) said the sockeye used to come in there and they'd go up to spawn in Mason Lake. He said those sockeye when they came in there……..they had no place to go, and he said they just laid out in there and died. He said they died by the millions. He said they wanted him (Sherwood) to make some way to let them go through, but he (Sherwood) said, "Oh, what's the difference? There's lots of fish. Those few don't make no difference." Well, that depleted it see.*
>
> Lem Roe, Interview, 1978

Recent history shows a diverse community of people becoming involved at many different levels. The oldest community concern, the Mason-Benson Club, was formed as a place to help residents gather, play, and better understand issues here at the lake. The Mason Lake Milfoil Committee formed in 1998, and their conscientious actions pre-empted widespread growth of Eurasian watermilfoil by early detection and control. In support of continued community commitment, the lake's residents worked hard to create the Mason Lake, Lake Management District #2 in 2002, which became a taxation base for invasive weed control.

Table 2-1. Mason Lake History Timeline

1890	• Mason Lake is Pioneer Territory • 2 Homes are built, in Little Hoquiam and up Schumocher Creek
1907-1930's	• America experiences a Car-Camping boom • Outdoorsy types rough it for occasional hunting and fishing
1922	• Repeat visitors center on Little Hoquiam area • Regular hunting and fishing begins • People use a fish box to introduce a variety of fish into the lake
1939-1942	• Cabins appear on the lake • Sub-divided private lots appear • Population grows and Little Hoquiam is sub-divided & developed
1946	• Madding buys large frontage parcel • Sunnyslope is developed, and Madding's Sunny Shores is sub-divided
1962	• World's Fair in Seattle, and Mason Lake living is advertised • Paradise Estates is laid out, built up and lots are sold as the first large-scale planned community development • Invasive non-native aquatic weeds start in appear in Washington waters
1960-1980's	• County codes are written as property owners clear land and build cabins and smaller homes • Many residents install private boat launches on their property
1990's	• Fishermen, boaters and seaplanes travel between lakes
1998	• Eurasian Watermilfoil (EWM), a noxious water weed, is found in Mason Lake by an Ecology survey team • An Ecology early infestation grant of nearly $50,000 was awarded soon after and treatment started. • Residents form the Mason Lake Milfoil Committee (MLMC) • Donations are made to help raise match to the Ecology grant and a certified contractor is paid to chemically treat the weed, this year and in 1999.
2000	• A Federal ruling on use of chemicals in lakes halts conventional treatment • Donations are raised, the remaining grant funds are applied and a certified contractor is paid to hand pull the Eurasian Milfoil (EWM).
2001	• Working closely with the federal, state and county agencies, MLMC is granted a permit to hire a certified contractor to chemically treat the EWM. • Donated funds are low; a few people continue to bear brunt of eradication costs
2002	• Mason Lake residents form Lake Management District #2 • Funds are assured for 5 years, for treatment of nonnative, invasive weeds only, long term plans are started. • MLMC applies for a grant to create a required aquatic management plan.
2003	• MLMC gets grant to create an IAVMP • MLMC hires *Lake Stewardship Consulting* to help produce the IAVMP

Community Commitment

A community can show its commitment in two very concrete ways - through its willingness to spend its time and its money.

Community participation has been an integral part of the development of the Mason Lake IAVMP. Valuable information was held by many parties, some of it technical and some anecdotal, but there wasn't a central collection point where it could be shared and given visibility. As questions were asked and needs expressed, people came forward willingly to share a treasure trove of information. The personal involvement was welcomed as much as the data. Personal connections and friendships were made, and a sense of "We're all in this together," was pervasive.

Mason Lake is fortunate to have a well-established social hub, the Mason-Benson Club, with a roster of property owners and mechanisms in place to contact and inform residents. Over many years, a core group of very involved residents have worked to provide aid beyond Mason Lake, through various charitable activities. When the request for assistance was made to help the lake itself, people responded with great enthusiasm. This enthusiam was infectious, and spread to many new arrivals to the lake and those not affiliated with the MBC. "Membership" hereby refers to the Mason Lake Community at large.

Some of these members became active through the Steering Team, the Mason Lake Milfoil Committee and LMD #2. Others rarely see their names on an agenda, but have been real heroes on the IAVMP project - circulating information, working at community meetings (notice boards, set up, baking and serving refreshments, tear-down and clean up,…), gathering signatures of support, attending plant identification classes and much more. Persuading people *why* they should volunteer was never an issue -- they just asked *when* and *where*.

The Sign In/ Attendee lists from both the Initial and Secondary Community IAVMP Meetings are available in Appendix C.

Throughout its history, the Mason Lake Community has demonstrated its commitment by funding actions that preserve the health and recreational quality of the lake. It has funded milfoil removal projects on Mason Lake in the past through donations made by property owners around the lake. Today's active Mason Lake Milfoil Committee (MLMC) works to unite the neighborhood and inform residents of environmental and safety hazards regarding the lake. These efforts are directly responsible for the newly created Lake Management District #2.

Community Goals

The success of noxious weed control efforts at Mason Lake rely on monitoring the success of control measures, surveying for noxious weed species each year, and responding to new infestations quickly to maintain a healthy lake. The best long-term solution will inevitably utilize multiple education, monitoring, surveying and response mechanisms.

Possible strategies include:

1. A coordinated list of resident "experts," to hold seminars on weed identification, whole lake monitoring, littoral zone monitoring, low-impact gardening and lawn care strategies, aquatic and terrestrial wildlife monitoring, et cetera.

2. Volunteer maintenance: Train residents to perform the surveying and removal efforts. There are currently certified divers resident on the lake. Funds could be raised by through community activities and the other lake committees to purchase necessary equipment and obtain training.

3. Organized work parties to dive/ hand-pull and dispose of weeds. The Clallam County Weed Board has agreed to share their experiences building an excellent volunteer weed-control program covering scheduling, tasks, safety practices, equipment, volunteer management and the other details necessary for effective community-based action.

We currently have volunteers who have:

- Developed and created a Lake Management District by majority vote;
- Have participated in plant education classes, in aquatic plant surveys conducted by boat and led by an aquatic plant specialist;
- Are committed to scuba diver training to engage in hand-pulling efforts, barrier application and weed identification;
- And have served the community by giving double the required in-kind contributions for this IAVMP grant.

Steering Committee, Outreach, and Education Process

Steering Team

The Steering Team was chosen from within the community at large as well as those within the county, state and region that may have an interest in Mason Lake. Some members participated at a more active level while others chose to participate at less visible levels. We believe this holds true in most organizations and our goals were met by the commitment shown.

The Steering Team was comprised of knowledgeable people bringing a diverse set of skills and experience to the project. This gave direct (and sometimes indirect) access to experts on aquatic weeds, fish populations and cycles, water clarity, regional wildlife, water body interaction, chemical control methods, tribal interests, treatment costs and funding, lake history, key contacts for volunteers and equipment donations, resident concerns and project organization. This document is a reflection of the efforts of this team.

Steering Team meeting agendas, attendance lists and meeting notes are contained in Appendix E.

Outreach

Outreach efforts have focused on education and motivating participation/ volunteerism. It included educating lake users about the potential problems posed by noxious aquatic weeds; about the beneficial native vegetation we need to conserve; and about the harmful effects residents and day-users can have through an increased nutrient load. Many people were unaware of the deleterious affect common houshold practices can have on aquatic plants, endangering wildlife, encouraging algae blooms and diminishing water clarity.

Plans were in place this Spring to begin raising community awareness. On Memorial Day weekend, boaters using the Public boat launch at Mason County Park were greeted by volunteers handing out American flags with the motto "Got Milfoil?" on the base. Advice on checking trailers and gear for watermilfoil was passed on as well.

A 15 minute video was produced to raise public awareness of the seriousness of the Eurasian watermilfoil problem, and shown at the Community Meetings. It included actual footage of unchecked watermilfoil infestation in a western Washington lake, as well as expert information on its history, identification and prevention. It is available to educate individuals and groups on why early treatment and containment is important.

Many residents requested a durable handout on milfoil/invasive weed information, a "best practices" guide they can mount at their private boat ramps and launches. These access points are used heavily in the summer, frequently by friends and associates that may be unfamiliar with the issue. One is in development, based on the laminated *Puget Sound Beach Guide* developed by Teri King with the People for Puget Sound.

The Mason-Benson Club newsletter is a terrific resource for getting information out into the community. With their database with the addresses of all property holders (not just members), their generosity in including weed-related articles in their newsletters, and giving time over to watermilfoil/ arrow-head/ IAVMP discussion at their bi-monthly meetings, the MBC has been invaluable.

The Mason Lake community website, www.masonlake.us, has been available since August and advertised through Community meetings, the MBC newsletter and various other public gatherings. Information is available there about current weed-related activities, as well as being the public depository of the Mason Lake IAVMP (when completed).

Public Comment

Lake users and residents were given ample opportunity to comment and respond throughout the IAVMP development process. Resident volunteers participated with the survey, diving and buoy placement activities, seeing firsthand the problems facing their lake. These concerns and feedback were collected, documented and discussed within the Steering Team. Where questions were expressed, research was done and subject matter experts were contacted to provide clear answers. The resulting document(s) were distributed at the second Community Meeting and are attached to this document in Appendix A.

Public Consensus

Public comments were encouraged and regarded as a guiding voice in where this lake needs to direct its priorities. They were kept in mind as treatment options were studied, and helped determine each's suitability for Mason Lake.
They formed the basis for the proposed Treatment Scenario and Integrated Treatment Plan.

There has been great community support for these efforts. The "Letter of Community Support" (Figure 2-1), has received over 560 signatures from informed, concerned and committed lake users.

These signatures are attached to this document in Appendix C.

Figure 2-1: Mason Lake Letter of Community Support

Mason Lake IAVMP
LETTER OF COMMUNITY SUPPORT

We, the Mason Lake Community of property owners and users, agree

- That Eurasian Milfoil, Grass-leaved Arrowhead and other listed aquatic noxious / invasive weeds present a serious threat to the natural beauty, ecological balance, safe recreational activities and property values on Mason Lake;

- That controlling these invasive / noxious weeds is an immediate priority and ongoing monitoring and control should be a high priority;

- That currently established community-based funding exists, through the Mason Lake's Lake Management District # 2, as well as the Mason Lake Milfoil Committee participation in the grant process to continue these efforts;

- That the treatment strategy outlined below is reasonable but may be altered by experts delegated by the community, in the future, to achieve the greatest likelihood of success.

Recommended Treatment Strategy

Treatment in Year One (2004)

Survey the entire littoral zone of Mason Lake, hand-pulling small infestations as found
Treat infested areas with 2-4D by certified applicator
Perform follow-up survey and spot treat as necessary
Hand-pull small aquatic weeds found after follow-up survey
Install bottom barriers where appropriate
Create and distribute educational materials on plant identification and best practices at boat launches and in limiting nutrient increases (inorganic fertilizers, phosphates …)
Create and Implement Plan for resident diver certification and plant control training

Treatment in Year Two (2005)

Survey the entire littoral zone of Mason Lake, hand-pulling small infestations as found
Treat large infested areas with 2-4D by certified applicator
Perform follow-up survey and spot treat as necessary
Resident diver's hand-pull remaining weeds install & maintain bottom barriers
Continue Community Education

Treatment in Years 3-5 (2006-2008)

Survey by resident divers - determine if conditions warrant chemical treatment*
Resident diver's hand-pull weeds install & maintain bottom barriers
Continue Community Education

*Treat infested areas with appropriate chemicals only as a last resort

Continuing Community Education

The public education program for Mason Lake will include two main elements that will be implemented concurrently:

1. Noxious Aquatic Weeds Prevention and Detection

Initial eradication and control efforts are only worth doing if future infestations are prevented, or detected and eliminated soon after detection. Since the reintroduction of milfoil and other weeds to Mason Lake is almost certain, a prevention and detection plan is essential. There are three main elements to the prevention and detection plan:

a. Annual distribution of educational materials. Steering Committee members will compile published materials and generate literature specifically related to Mason Lake to distribute to all community residents each year at the beginning of the growing season.

b. Annual aquatic plant identification workshops. Workshops will cover native plants as well as noxious aquatic weeds. Samples of our target weeds will be collected and pressed in Year 1,2004, as a permanent reference and education tool for the community. All watershed residents as well as lake-users will be invited and encouraged to expand our educational effort. Aquatic plant experts will be invited from the Department of Ecology or other applicable agencies. A better-educated community of residents and lake-users will be more likely to identify and report noxious aquatic weeds and recognize other potential problems prior to large scale expansion.

c. A minimum of two aquatic weed surveys of the littorial zone will be done each growing season. Aquatic plant specialist/certified divers will survey the shoreline and littoral zone to complement visual surveys from the surface and to take samples for identification and.

2. Lake Stewardship Education Program

All residents in the watershed affect Mason Lake, although sometimes the cause and effect relationships are not readily apparent. Educating community members and other lake users will help show that there is a direct connection between human behaviors and water quality. Each lake resident will be provided information on how to reduce the amount of pollutants entering the lake from their property. Property owners with lakeside lots will be provided information on lake-friendly landscaping, ensuring a healthier lake environment. Improved signs will be prepared for the private boat launches, as well as those currently posted at the public boat ramps to inform lake-users of the problems caused by noxious aquatic weeds and how to prevent spreading them from lake to lake.

The Steering Committee has generated some ideas for signage related to the transport of milfoil by boats and trailers. If the signs posted at the boat launch included step by step directions on how to properly clean boats and trailers, and why it is important, lake-users may be more apt to do the right thing. Obvious problems for boat cleaning involve questions of where it can be done and the right equipment to do the job.

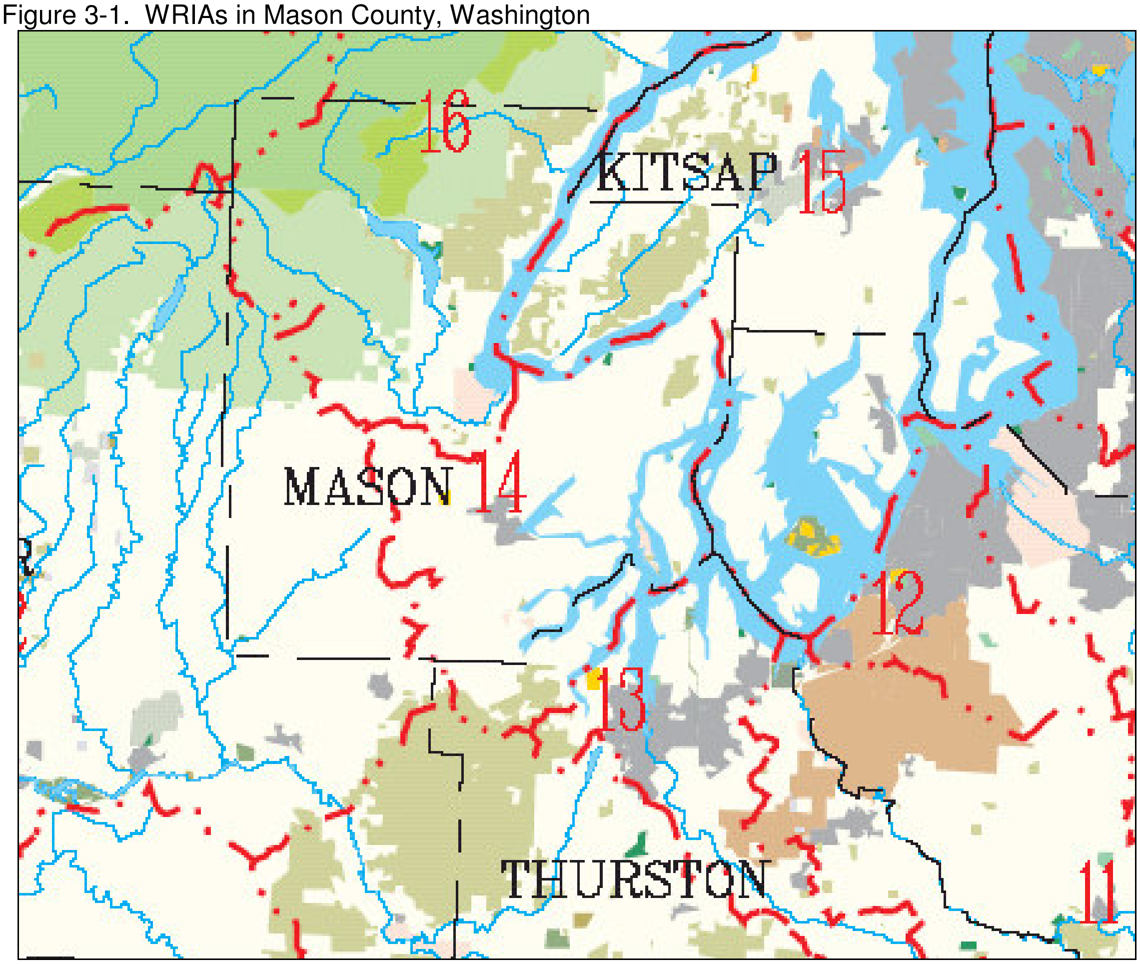
The public boat launch at the Mason County Park does not provide hoses/tools to perform this cleaning, and there is currently no plan to add such facilities. Without controlled drainage, adhering pollutants that are washed off while at the launch site could end up back in the lake. The Steering Committee may discuss the option of installing a Cleaning Station at the Mason County boat launch with a hose, hand pump, and a catchment and drain to encourage the proper cleaning of boats and trailers. The hand pump would hopefully discourage using the station for cleaning cars or other inappropriate uses. Mason Lake may pursue these issues with the Washington Department of Fish and Wildlife, which has just begun a program to address these concerns. Without cooperation and funding from Mason County and other government agencies, this undertaking would be far too costly for the lake residents to attempt themselves.

WATERSHED AND WATERBODY CHARACTERISTICS

Watershed Characteristics

Mason Lake is located in Mason County Washington, in the Kennedy-Goldsborough Basin, known as WRIA #14. A Water Resource Inventory Area, WRIA #14 comprises the southeast one-third of Mason County and a small portion of the northwest corner of Thurston County. (Figure 3-1) It consists of a number of independent low elevation streams that flow through the rolling foothills of the area and discharge into southern Puget Sound. Because there are no high elevation ice packs or snowfields to sustain flows, streams depend upon direct precipitation and ground water inflow to maintain flow levels. Stream flows, therefore, reflect seasonal variation in precipitation. In addition to directly contributing to stream flow maintenance, this precipitation also contributes to the storage in lakes, swamps, and ground water aquifers which serve as reservoirs, helping to regulate extreme high and low stream flow conditions.

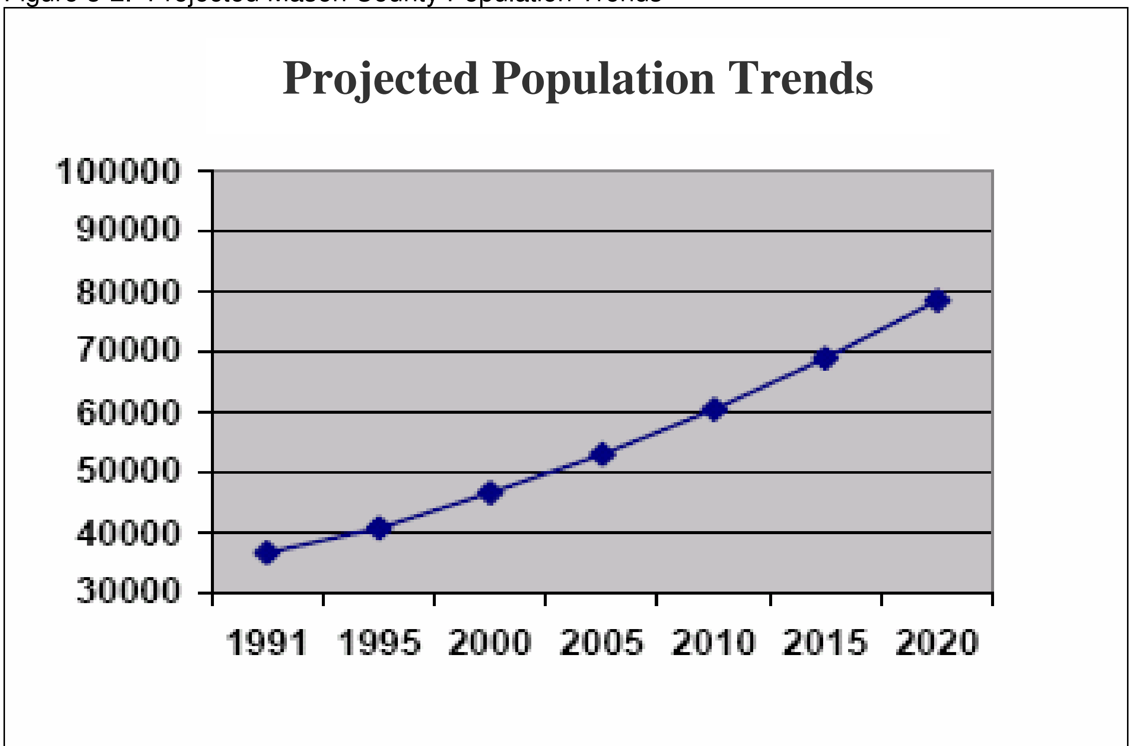
Figure 3-1. WRIAs in Mason County, Washington



Population

There are approximately 50,425 people living in the Kennedy-Goldsborough Basin. The primary population center is Shelton. The majority of people live in unincorporated areas. Located in southern end of Puget Sound, 85% of this basin lies in Mason County and the remaining 15% is in Thurston County. The basin covers 244,833 acres and is part of the Puget lowland. Current US Census numbers reflect that from 1990-2000 Mason County had a 28.9 % increase in population and there is no reason to believe that this will not continue as land is relatively inexpensive and plentiful compared to surrounding counties. (Figure 3-2)

Figure 3-2. Projected Mason County Population Trends

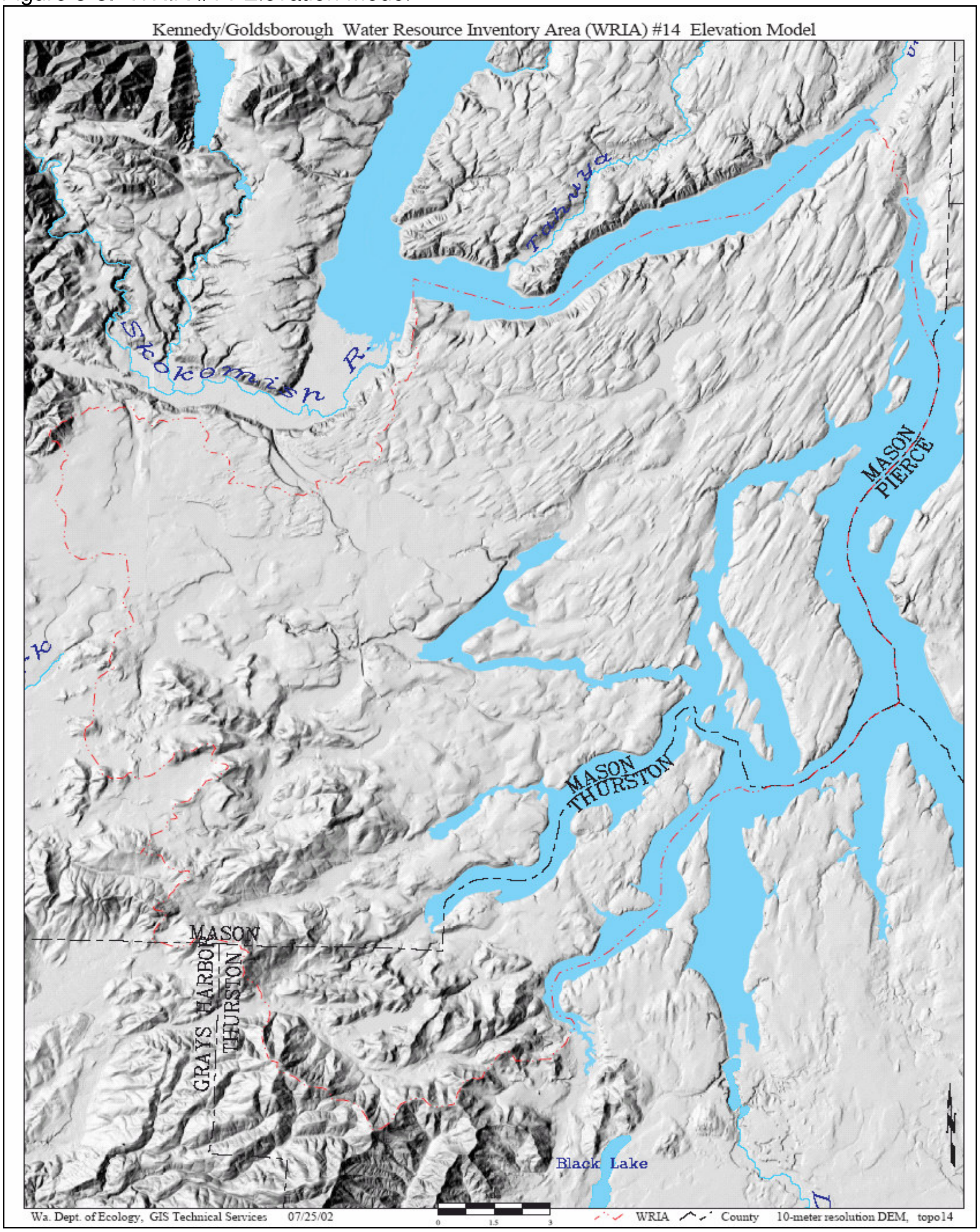


Terrain

The terrain consists of undulating glacial drift plains with lakes and small, sinuous streams. The coastline is irregularly shaped and is characterized by many bays and some cliffs. (Figure 3-3) The soils are deep well drained, gravelly sandy loam. Potential natural vegetation includes western hemlock, western red cedar, Douglas fir, and some red alder. The mean temperature ranges from 35/44° (winter) to 52/75° (summer).

Surface water in this WRIA is used for a variety of purposes. Shelton Springs, the headwaters of Shelton Creek, are the source of the municipal water supply for the City of Shelton. The creek is an urban stream, which flows through much of its length in concrete conduits beneath the town.

Figure 3-3. WRIA #14 Elevation Model



Goldsborough Creek, which also flows through Shelton, is used by the Simpson Timber Company for industrial water supply. Water in lakes and other creeks of WRIA #14 are also used for domestic supply, lawn and garden irrigation, some agricultural irrigation (Gosnel Cr.) and commercial uses.

Streams and lakes of the area serve as important production grounds for Coho, Chum, and a limited number of Chinook salmon. Steelhead and cutthroat trout also inhabit waters of this WRIA and are important to the recreational fishery of the area. Another major in stream use of water is recreation. Lakes of the region are especially utilized for boating, swimming, and sport fishing. In addition to recreational and fisheries resource use, streams and lakes are important for their scenic and aesthetic qualities as well as wildlife habitat and use.

Schumocher Creek originates in foothills approximately eight miles north of Shelton in the northernmost portion of WRIA #14. Schumocher Creek and its tributaries, including Trask Lake and large wetland areas, constitute the upper reaches of the stream system contributing inflow to Mason Lake. Sherwood Creek is formed from the outlet flows of Mason Lake and Prickett (Benson) Lake.

Water Quality

Water quality in the upper reaches of the streams of WRIA #14 is generally good since the streams originate in essentially unsettled, heavily timbered country. The lower reaches of streams flowing through urban or otherwise disturbed lands are subject to siltation and high turbidity resulting from storm runoff. Siltation of streams can be accentuated following road building and logging operations that remove the forest cover. In a heavily forested area, the soil's organic content - and hence its structure - is maintained by the decomposition of the forest litter. At the same time, the soil is held together by the elaborate network of roots which underlies the forest floor and is, thus, subject to minimum erosion. Once the forest cover has been removed, however, the roots rot away and there is no longer anything to hold the soil together. The soil - deprived of the forest litter - rapidly loses its structure, becoming very vulnerable to erosion by wind and water.

Mason Lake is located in the Case Inlet Sub-basin along with its major inflow, Schumocher Creek, and its primary outflow, Sherwood Creek. Sherwood Creek has a drainage area of 12.2 square miles and Mason Lake has a drainage area of 20.2 square miles. Both these creeks are included in the Mason County Shoreline Master Plan with a flow rate of at least 20 cfs. Both creeks are classified as Class 1 wetlands. Critical area assessment by the county will be completed in 2005.

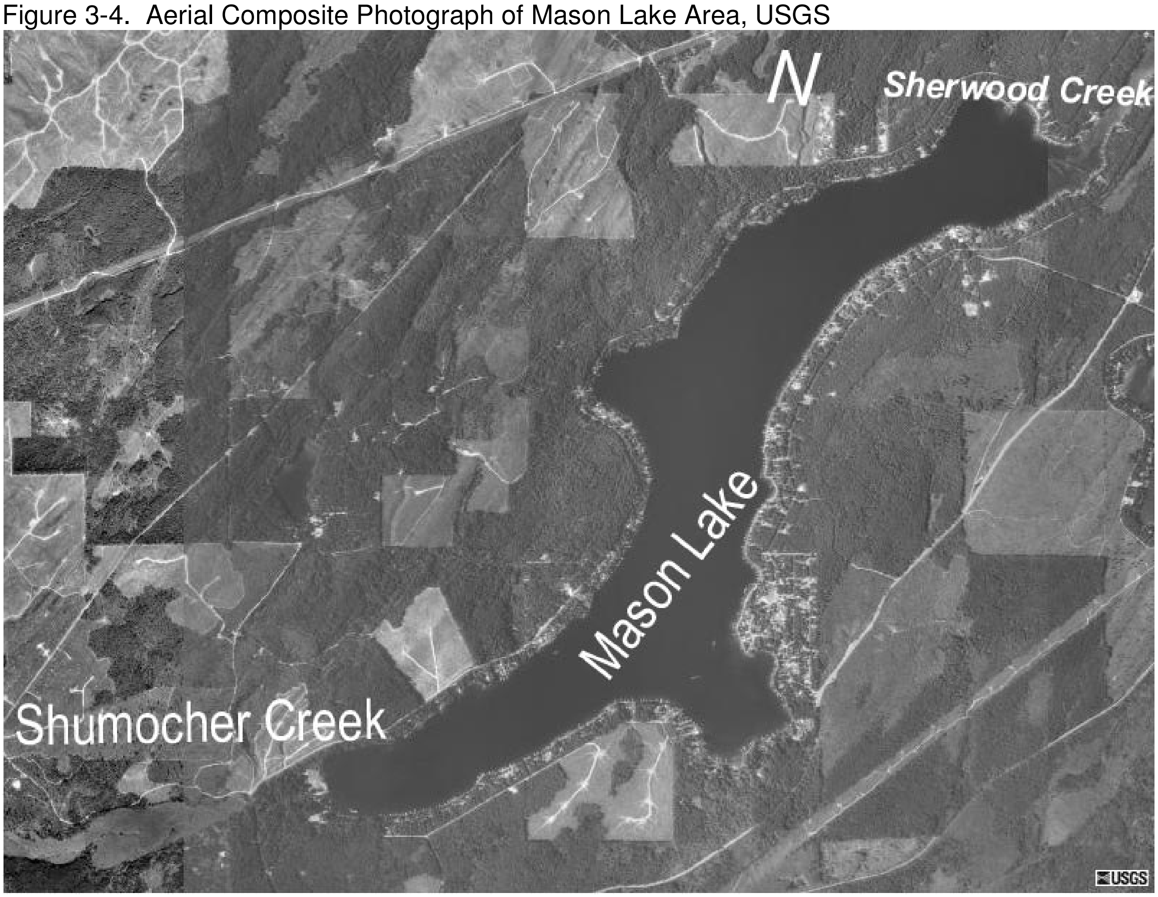
WATERBODY CHARACTERISTICS

The surface area of Mason Lake, the largest lake in WRIA #14, is 977 acres.
The lake is about four miles long and averages about one-half mile wide.
The lake has a mean depth of 45 feet and a maximum depth of 90 feet, with an estimated lake volume of 49,000 acre-ft. Mason Lake has 10.9 miles of shoreline.

There are several surface inflows, Schumocher Creek and numerous springs, to Mason Lake, with outflow into Sherwood Creek occurring year round into the natural outlet channel. (Figure 3-4) There are no manmade flood control structures. There is public boat access to the lake provided by a boat launch owned by Mason County located in the Mason County Park. A small millpond is located near the mouth of Sherwood Creek. This stream system is the largest in the Kennedy-Goldsborough Basin, containing 18.3 miles of streams and tributaries with an average summer flow of 10 to 20 cfs. Sherwood Creek discharges into the extreme north end of Case Inlet at North Bay near the community of Allyn.

Both Coho and Chum salmon utilize this stream. The Allyn Salmon Enhancement Group also contributes a large amount of time and effort to measuring, maintaining and mapping Sherwood Creek for preservation and enhancement of salmon populations. The ASEG, in support of WDFW, places eggs in remote incubators/tubes on Sherwood/Schumocher Creeks. All of the streams and lakes in the Sherwood Creek system are currently free of surface water limitations.

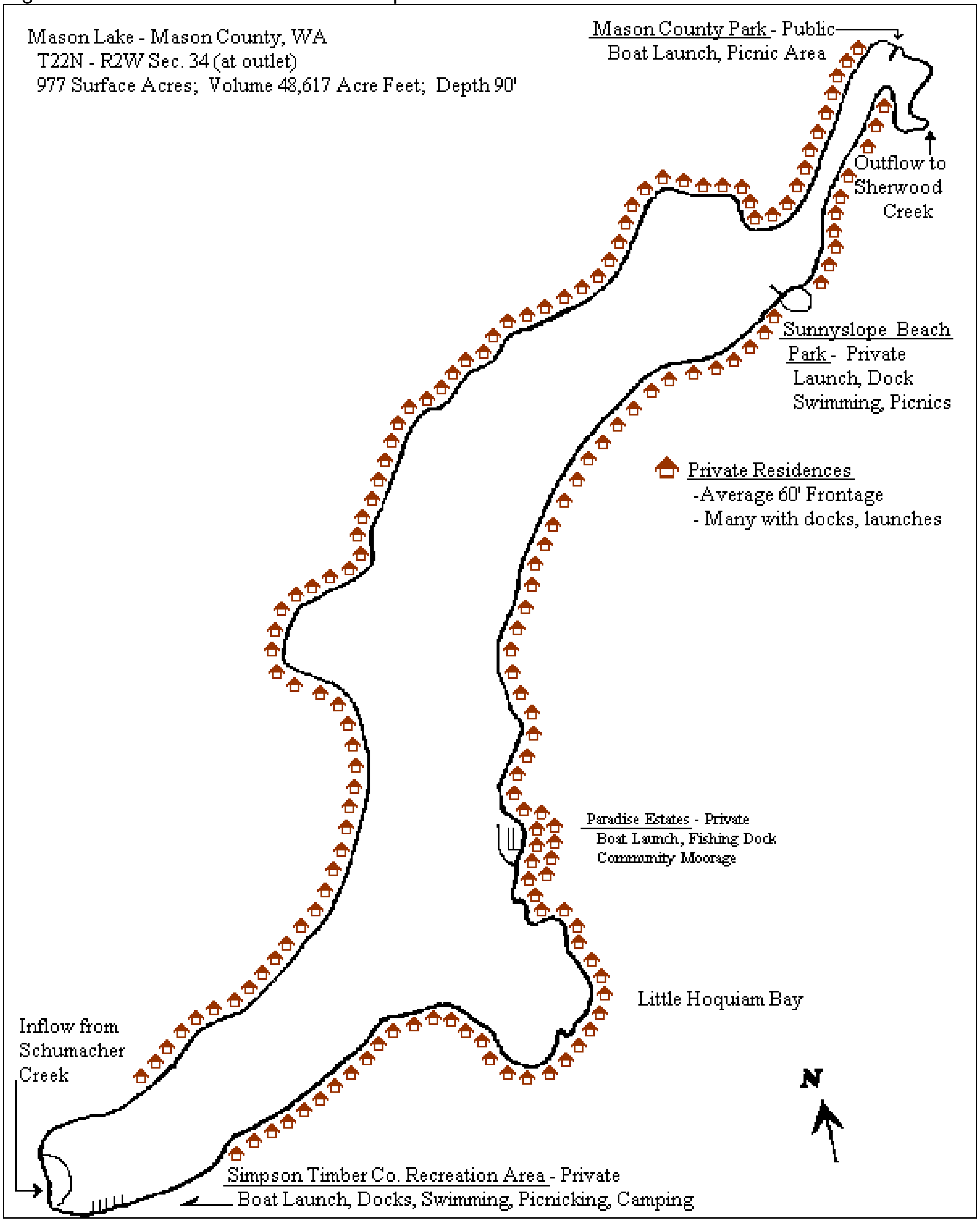
Figure 3-4. Aerial Composite Photograph of Mason Lake Area, USGS



There is a decreasing amount of shoreline that remains undeveloped at Mason Lake, including the large Class 1 wetland system in the northeast. However, as the number of nearshore houses has increased around Mason Lake, so has the clearing of buffering native vegetation along the shoreline to provide landscaping or to enhance lake access and views. (Figure 3-5).

Nonetheless, many of the residential properties have maintained a buffer strip, which helps to filter out nutrients and pollutants before they enter the lake, as well as providing habitat. Mason Lake Drive, which provides access to many of the homes on the lake, is set several hundred feet away from the water on the other side of the homes. Most of the runoff from the road filters through the lakeside properties, but not all. The public boat launch area is one point where a public road actually reaches the water. Another potential source of nonpoint-source pollution is unfiltered runoff from the numerous private boat ramps and launches. While many are simply clear lanes of access sloping down to the shoreline, with vegetation, earth, and gravel to slow and absorb run-off; others are paved and may be continuations of driveways, linking the road to the lake.

Figure 3-5. Mason Lake Structures Map



Water Quality

Mason County residents have participated in a volunteer monitoring program to create a long-term record of water quality for the region's small lakes. Provided with the raw data, experts from the Department of Ecology analyze the conditions and share their findings. (Table 3-1)

Table 3-1. Survey and Analysis 1999 - Trophic State Assessment

Trophic State Assessment

Lake:	Mason Lake	**TSI_Secchi:**	a 33
County:	Mason	**TSI_Phos:**	41
State:	Washington	**TSI_Chl:**	
Analyst:	Maggie Bell-McKinnon	**Narrative TSI:**	b OM

Summary Comments:

The general water clarity of Mason Lake was excellent in 1999. The Secchi depth readings ranged from 5.5 meters (18.0 feet) to 8.5 meters (28.0 feet) with a mean Secchi depth of 6.5 meters (21.4 feet). For comparison, in 1998 the mean Secchi depth was 7.2 meters (23.8 feet).

No geese and/or other waterfowl were seen on Mason Lake by the volunteer monitor during any of his sampling visits made between May and October.

The chemistry data collected for Mason Lake showed low phosphorus levels in the epilimnion. This level of phosphorus indicates a low level of productivity where algae growth does not usually become a problem.

Ecology staff made two site visits in 1999. Dissolved oxygen levels remained constant throughout the water column and no thermal stratification was observed during the first site visit (5/11/1999). During the second site visit (8/3/1999), low dissolved oxygen levels in the hypolimnion and thermal stratification were observed.

On 9/9/1999, Mason Lake was treated with an aquatic herbicide. Ecology staff conducted an aquatic plant survey on 9/22/1999.The only non-native plant observed consisted of two floating fragments of *Myriophyllum spicatum* (Eurasian milfoil). A rare aquatic plant, *Lobelia dortmanna* (water lobelia) was observed as being bleached out in one of the herbicide treated areas.

Based on the Secchi depth data, the phosphorus levels and the low dissolved oxygen in the hypolimnion, Mason Lake is classified as oligomesotrophic.

TSI Qualifiers: B or W-Secchi Disk hit bottom or entered weeds; J-Estimate; N-Fewer than the required number
E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic

Trophic State of Lakes

The trophic state of a lake is an indicator of its water quality. Lakes are categorized based on their nutrient levels and water clarity. There are three categories of trophic states: Oligotrophic, Mesotrophic, and Eutrophic. All lakes age, in that they start as oligotrophic lakes, and gradually change to eutrophic lakes. Because this change is ongoing, lakes may be described as at an interim stage between these states. Allowing nutrients into the lakes through agriculture, fertilizers, roads, sewage, and storm drains can speed up this process.

Oligotrophic Lakes

Oligotrophic Lakes are those that are generally clear, deep, and free of weeds and large algae blooms. These lakes are low in nutrients, have low primary production, and do not support large fish populations. The food chain in oligotrophic lakes is very structured, and is capable of sustaining a fishery of large game fish. These lakes tend to be the most aesthetically pleasing of lakes due to their clear blue water. In oligotrophic lakes, there is usually a very high Secchi disc reading (in relation to the depth of the lake), and low phosphorus and chlorophyll readings. <u>Supported Fish Communities</u>: trout, char

Mesotrophic Lakes

Mesotrophic lakes are in the boundary between oligotrophic lakes and eutrophic lakes. They have more nutrients and production than the oligotrophic lakes, but not nearly as much as eutrophic lakes. Mesotrophic lakes have some accumulated organic matter on the bottom of the lake, as well as an occasional algae bloom at the surface. Mesotrophic lakes are usually good lakes for fishing, as they are able to support a wide variety of fish. In the late summer, the hypolimnion can become depleted in oxygen, which limits cold-water fish and causes phosphorus cycling from the sediments. Mesotrophic Lakes have Secchi disc, phosphorus, and chlorophyll readings between those of eutrophic and oligotrophic lakes.
<u>Supported Fish Communities</u>: Smallmouth bass, yellow perch, northern pike

Eutrophic Lakes

Eutrophic Lakes are the most productive lakes, and thus support a very large biomass. These lakes are normally weedy and subject to frequent algae blooms yearly. There is often a large amount of accumulated organic matter on the bottom of the lake. Eutrophic lakes support large fish populations, however, rough fish, like carp, are common in these lakes. Eutrophic lakes are susceptible to oxygen depletion in the hypolimnion, and shallow eutrophic lakes may be vulnerable to winterkill situations. Eutrophic Lakes have low Secchi disc readings in relation to the depth of the lake, and high phosphorus and chlorophyll readings.
<u>Supported Fish Communities:</u> Largemouth bass, bluegill, channel catfish
(Hypereutrophic) Common carp, gizzard chad, gar

Beneficial and Recreational Uses

Mason Lake and its surroundings support a variety of uses to humans. Recreational activities include swimming, fishing, boating, bird watching, wildlife viewing, and hiking. Most residents can access the lake directly from any of the small private docks around the lake associated with the residential parcels. There are four larger areas of community lake access on Mason Lake, one being public for general access and three of which are privately held for members' use.

A public boat launch maintained by Mason County allows the public to benefit from this beautiful resource. There is no official swimming beach associated with the Mason County Park, which is equipped with a barbeque grill, picnic tables and restrooms. (Figure 3-6)

The three private residential-access areas are the Simpson Employee Recreation Area, Paradise Estates and Sunnyslope Beach Park. These areas are primarily used over the summer months, June, July and August, and remain inactive for the rest of each year. All have boat ramps and are heavily used to launch and retrieve many varieties of watercraft.

The Simpson property has a large family swim beach as well as numerous recreational campsites with boat docks, restrooms and a covered picnic area. This property is heavily used for these activities, as well as for fishing, during the summer. Simpson does not allow jet skis or other personal watercraft to be launched or retrieved on their property.

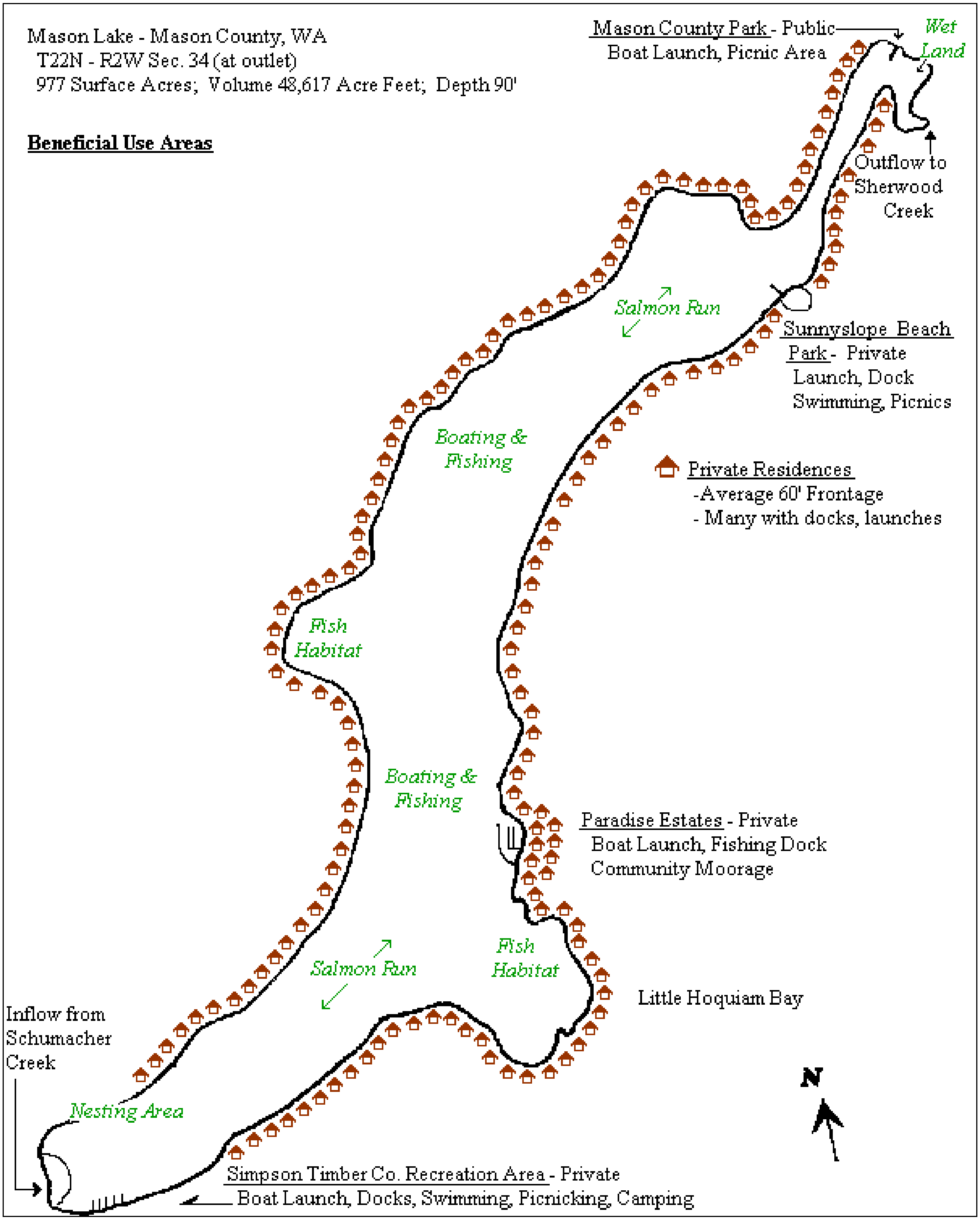
Passing through this property is the inflow to Mason Lake from Schumacher Creek. This inflow has been the focus of much attention from the Allyn Salmon Enhancement Group (ASEG) as well as the Squaxin Indian tribe concerning salmon enhancement activities. Just west of the inflow is a small, still cove of rushes, pond grasses, and very large, tall trees along the undeveloped shore that is available as a fish habitat and a nesting area for local bird species. This area extends approximately one third of a mile up the Southwestern shoreline. While scientifically collected data is not available to show the particular species and numbers of animals using this area, small fish and beaver are frequently spotted here. It is common to see eagles and osprey circling the sky overhead. Figures 3-10 and 3-12 reflect vegetation makeup and proposed treatment control intensity for this area.

Paradise Estates is a housing development that is laid out around a common water access. It is located on the Southeastern shore of Mason Lake. Its boating access is comprised of a private marina with parking and launch facilities and approximately twenty boat slips located on floating docks off the shoreline. A large elevated boardwalk for sunning, swimming and fishing access extends out over the water to define the lakeside boundary of the marina. Paradise Estates is one of the more concentrated areas of activity on the lake in summer, attracting many young people and anglers. The channel leading from the lake to the marina has recently been dredged, removing sediment to allow for easier boat access and to keep the channel useable by the marina. This private property, held by approximately two hundred lake residents, is gated and has fulltime supervision. Our initial Eurasian watermilfoil identification and eradication efforts started at Paradise Estates.

Farther up the Northeastern shoreline is the Sunnyslope Beach Park, a private facility held and maintained by an association of local property owners. It has several acres of groomed lawn that extends to the waters edge, a large dock and a boat launch ramp. The restroom facilities and a covered shelter for picnicking and private gatherings are located near the access road. This park serves approximately 100 members and is gated. There is anecdotal evidence that our initial infestation of Grass-leaved arrowhead originated in this area.

Internal combustion engines are allowed on Mason Lake, consequently there are ample activities such as water skiing and jet skiing. One consequence of this is that the isolated nature of the system have been made vulnerable to repeated infestation. Also, the system is open to potential pollution from petroleum releases and noise pollution. There is no hunting allowed on Mason Lake or in the adjacent Mason County Park.

Figure 3-6. Mason Lake Beneficial Use Areas Map



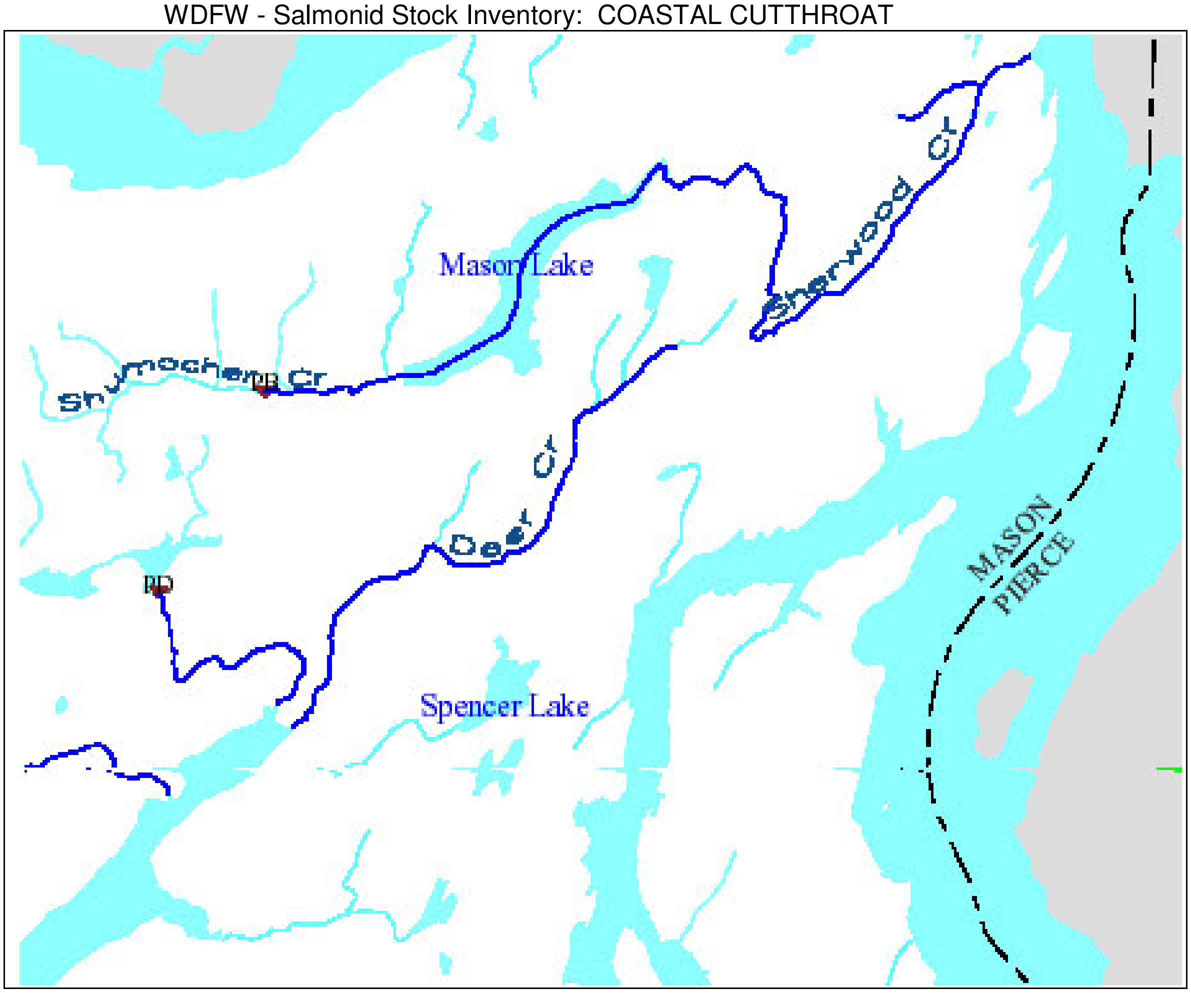
Fish and Wildlife Communities

Fish

Mason Lake supports cold water and warm water fish species as well as certain salmon species. Cold water fish include Kokanee salmon, Rainbow Trout, Coastal Cutthroat Trout. (Figure 3-7)

Warm water fish species such as Walleye, Largemouth and Smallmouth Bass, Yellow Perch, Black Crappie and Bluegill can also be supported. [Refer. The Washington Department of Fish and Wildlife website.]

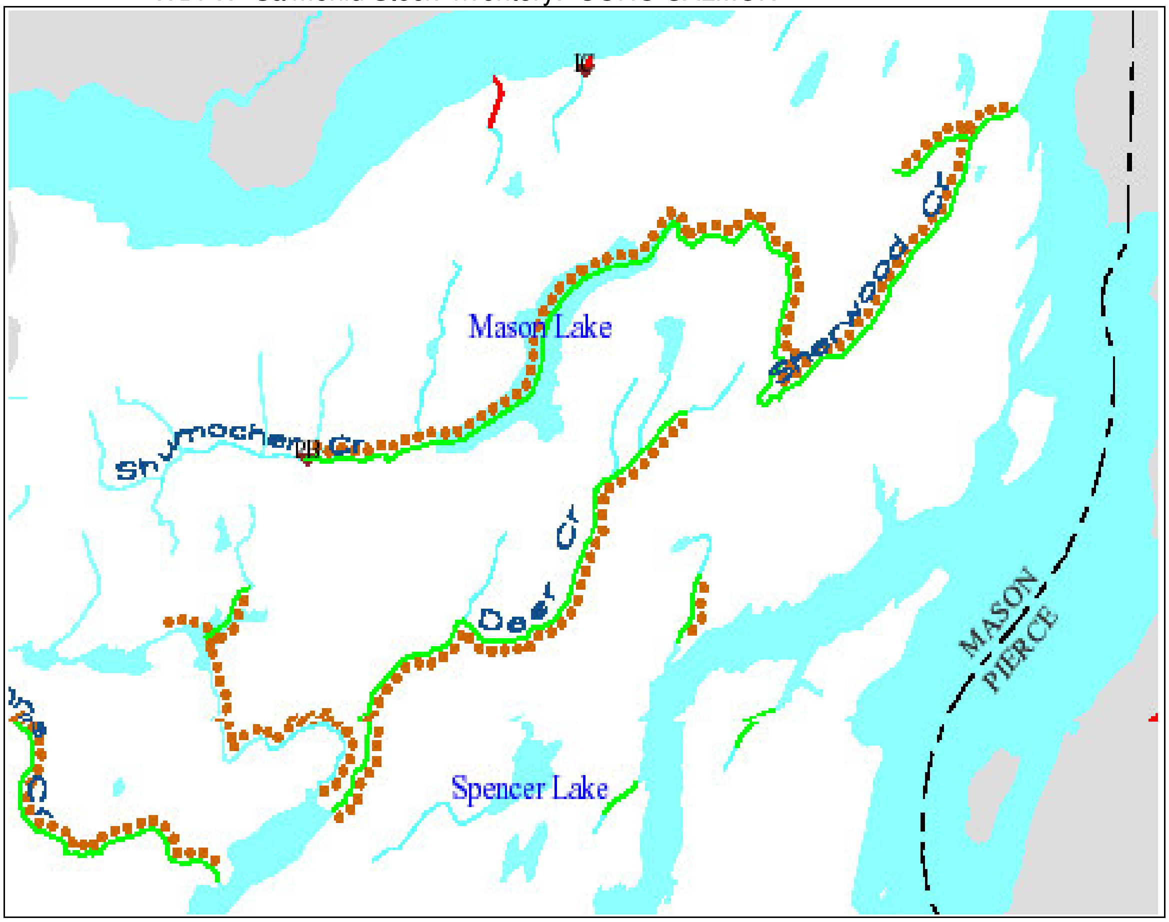
Figure 3-7. Kennedy/Goldsborough Water Resource Inventory Area (WRIA) #14
WDFW - Salmonid Stock Inventory: COASTAL CUTTHROAT



Several species of salmon have been traced through Mason Lake. Chinook spawners have been observed in the lower mile of Sherwood Creek and Anderson Lake Creek at a level of several dozen fish in the survey areas. Coho have been observed in Sherwood Creek, Schumocher Creek and Anderson Lake Creek throughout the stream survey areas. (Figure 3-8) [Refer. ASEG/ Allyn

Salmon Enhancement Group 2002 Baseline Habitat Study of Sherwood Creek.] While these salmon move through Mason Lake, none of the species rear here.

Figure 3-8. Kennedy/Goldsborough Water Resource Inventory Area (WRIA) #14
WDFW Salmonid Stock Inventory: COHO SALMON



Determining Factors for Fish

A healthy fish population depends on many characteristics of a water body, including climate, temperature, salinity, carrying capacity, nutrient types and levels, vegetation available for food and shelter, other predator and prey species. Lakes' ages are another variable, as they follow their life cycle from water body back to land. These factors influence each other continually to create the balance that provides a nurturing or limiting fish habitat.

All ponds or lakes have a particular carrying capacity, the total weight of fish that it can sustain. Weight can be distributed into many small fish or fewer large fish. The carrying capacity of a lake can be increased by addition of nutrients, which works to a point. Different fish species are better suited for differing levels of nutrients. Nutrients come in many forms, from both external and internal sources. Detergents, fertilizer runoff and septic system leakage are external sources, whereas aquatic plant and animal decay are an internal, natural source of nutrients. Phosphorus is considered a limiting nutrient, and the less introduced externally the better. With excess nutrients, algae populations shift from the more desirable green algae to the toxic forms of blue-green algae. All this has a direct effect on dissolved oxygen levels in the waterbody which directly support the fish. The desirable range of dissolved oxygen for most fish, such as salmon and trout, is above 5 ppm or above. Oxygen below 5 ppm are generally considered lethal, especially for salmon and trout.

As an oligomesotrophic water body, Mason Lake is a conducive habitat for smallmouth bass, yellow perch, kokanee salmon and juvenile salmon populations.

The following study used data obtained from a 1997 Mason Lake survey**.** It describes in detail the character of Mason Lake and the balance of its resident fish population.

THE WARM WATER FISH COMMUNITY OF A LAKE DOMINATED BY NON-GAME FISH *by Karl W. Mueller, Warmwater Enhancement Program, Washington Department of Fish and Wildlife.*

Although the spawning activities of the watershed's anadromous fishes have been monitored for decades, no recent information exists regarding the resident fish community of Mason Lake. Therefore, in an effort to assess the warmwater fishery, especially given the potential recreational opportunities at the lake (Dan Collins, WDFW, personal communication), personnel from WDFW's Warmwater Enhancement Program conducted a fisheries survey at Mason Lake in fall 1997. Mason Lake was surveyed by a three-person team during September 15 - 18, 1997.

Species composition
The dominant species in terms of biomass and number of fish captured was peamouth, *Mylocheilus caurinus* (Table 3-3). Together, largescale sucker (*Catostomus macrocheilus*) and northern pikeminnow (*Ptychocheilus oregonensis*) accounted for nearly 50% of the biomass captured, but less than 8% by number. Warmwater fishes accounted for about 13% of the biomass and 38% of the number captured. Of these, rock bass was dominant (Table 3-2).

Table 3-2. Length categories for warmwater fish species captured as Mason Lake (Mason County) during fall 1997. Measurements are minimum total lengths (mm) for each category (Willis et al. 1993).

	Size				
Type of fish	Stock	Quality	Preferred	Memorable	Trophy
Rock bass	100	180	230	280	330
Largemouth bass	200	300	380	510	630
Yellow perch	130	200	250	300	380

Balancing predator and prey fish populations is the hallmark of warmwater fisheries management. According to Bennett (1962), the term 'balance' is used loosely to describe a system in which omnivorous forage fish or prey maximize food resources to produce harvestable-size stocks for fishermen and an adequate forage base for piscivorous fish or predators. Predators must reproduce and grow to control overproduction of both prey and predator species, as well as provide adequate fishing. To maintain balance, predator and prey fish must be able to forage effectively. Evaluations of size structure, growth, and condition (*Wr*) provide useful information on the adequacy of the food supply (Kohler and Kelly 1991) and balance within a body of water. Characteristics of unbalanced populations include poor growth or condition, and low recruitment (Swingle 1950, 1956; Kohler and Kelly 1991; Masser *undated*).

Table 3-3. Species composition (excluding young-of-year) by weight (kg) and number of fish captured** at Mason Lake (Mason County) during a fall survey of warmwater fish.

	Species composition				
	by weight		by number		
Type of fish	(kg)	(%)	(#)	(%)	Size range (mm TL)
Peamouth (*Mylocheilus caurinus*)	59.76	40.17	464	51.67	101 - 315
Largescale sucker (*Catostomus macrocheilus*)	48.67	32.71	37	4.12	430 - 579
Northern pikeminnow (*Ptychocheilus oregonensis*)	21.43	14.40	32	3.56	109 - 585
Rock bass (*Ambloplites rupestris*)	7.59	5.10	172	19.15	70 - 215
Yellow perch (*Perca flavescens*)	5.65	3.80	74	8.24	136 - 242
Largemouth bass (*Micropterus salmoides*)	5.52	3.71	94	10.47	90 - 432
Sculpin (*Cottus* sp.)	---	---	18	2.00	---
Cutthroat trout (*Oncorhynchus clarki*)	0.08	0.06	1	0.11	230
Coho salmon (*Oncorhynchus kisutch*)	0.05	0.04	6	0.67	87 - 135
Total	148.75		898		

During fall 1997, Mason Lake showed indications of having an unbalanced fish community. For example, in terms of biomass, the lake was clearly dominated by non-game fish, primarily peamouth. The size structure and growth pattern of largemouth bass suggest that these predators were unable to reach an adequate size to control overproduction of the dominant non-game fish in the lake. The remaining warmwater fish species exhibited either below average growth, condition, or both. Furthermore, few quality size fish were captured, and several year classes were lacking or altogether absent.

Causes for the variation described above are complex and difficult to isolate from a single survey; however, some inferences can be drawn from previous studies. For example, the conditions observed during fall 1997 resemble those described by Swingle (1956) and Masser (*undated*) for populations experiencing inter- and intraspecific competition because of crowding. According to Swingle (1956), crowding in fish populations results in slow growth (less food per individual) and reduced or inhibited reproduction. This was evident in the warmwater forage fish populations at Mason Lake. Their size structure, growth pattern, and condition suggest that these fish were not able to feed effectively, possibly due to overcrowding and competition with the dominant peamouth.

The balance within Mason Lake may be restored by stocking a sufficient number of ‘super predators’ to reduce the dominant, non-game fish populations. This technique has been used with varied degrees of success for years (Bennett 1962; Noble 1981; Wahl and Stein 1988; Boxrucker 1992; Bolding et al. 1997). For example, stocking smallmouth bass (*Micropterus dolomieu*) or relatively few (< 1,000) sterile, yearling tiger musky (*Esox masquinongy* x *E. lucius*) might improve the density and growth of warmwater fish species through predation of the overabundant peamouth.

The steep, rocky shoreline of Mason Lake would provide a suitable habitat for smallmouth bass (Hubert and Lackey 1980; Pflug and Pauley 1984; Scott and Angermeier 1998). And though tiger musky generally fare well despite the forage base (Kohler and Kelly 1991), the predator prefers fusiform soft-rayed prey, such as peamouth, over deep-bodied spiny-rayed prey, such as rock bass (Tomcko et al. 1984; Wahl and Stein 1988). Moreover, tiger musky grow rapidly in Washington (WDFW 1996). Therefore, in addition to improving balance, stocking tiger musky may also provide a trophy fishing opportunity at Mason Lake (Storck and Newman 1992). Still, the risk to the watershed’s anadromous fishes should be addressed before stocking either of these predators.

Kokanee, a form of Sockeye that spends its entire life in freshwater, are found in Mason Lake, however the population fluctuates significantly from year to year and is inconsistent for sport fishery. Anadromous Sockeye have been absent in recent years, after being planted in Mason Lake in the 1930's. Allyn Salmon Enhancement Group and the Squaxin Tribe have expressed an interest in re-establishing a Sockeye run.

**Table 3-3 references fish captured during a fall survey of Mason Lake. The methods used were nighttime electrofishing and shoreline gillnets. The abundance of fish captured does not necessarily reflect accurately what is in the lake. The biomass of kokanee salmon and trout is probably much higher than what the report states simply because the capture techniques used does not target for these species which are more out in the open part of the lake.

Birds

The following lists the 109 bird species native to Coastal Western Washington and Mason County. While the specific number residing in the immediate Mason Lake / WRIA-14 area is not documented, many of the following can be found in the region by varying distributions. (Table 3-4)

Table 3-4. Birds of the WRIA-14, Mason Lake Area

Pied-billed Grebe, *Podilymbus podiceps*	Willow Flycatcher, *Empidonax traillii*
Pink-footed Shearwater, *Puffinus creatopus*	Warbling Vireo, *Vireo gilvus*
Sooty Shearwater, *Puffinus griseus*	Hutton's Vireo, *Vireo huttoni*
Double-crested Cormorant, *Phalacrocorax auritus*	American Crow, *Corvus brachyrhynchos*
Pelagic Cormorant, *Phalacrocorax pelagicus*	Northwestern Crow, *Corvus caurinus*
Great Blue Heron, *Ardea herodias*	Common Raven, *Corvus corax*
Turkey Vulture, *Cathartes aura*	Steller's Jay, *Cyanocitta stelleri*
Wood Duck, *Aix sponsa*	Gray Jay, *Perisoreus canadensis*
Northern Shoveler, *Anas clypeata*	Barn Swallow, *Hirundo rustica*
Mallard, *Anas platyrhynchos*	Cliff Swallow, *Petrochelidon pyrrhonota/ Hirundo pyrrhonota*
Redhead, *Aythya americana*	Tree Swallow, *Tachycineta bicolor*
Canada Goose, *Branta canadensis*	Violet-green Swallow, *Tachycineta thalassina*
Barrow's Goldeneye, *Bucephala islandica*	Black-capped Chickadee, *Poecile atricapilla*
Common Merganser, *Mergus merganser*	Chestnut-backed Chickadee, *Poecile rufescens*
Sharp-shinned Hawk, *Accipiter striatus*	Bushtit, *Psaltriparus minimus*
Golden Eagle, *Aquila chrysaetos*	Red-breasted Nuthatch, *Sitta canadensis*
Red-tailed Hawk, *Buteo jamaicensis*	Brown Creeper, *Certhia americana*
Northern Harrier, *Circus cyaneus*	Marsh Wren, *Cistothorus palustris*
Bald Eagle, *Haliaeetus leucocephalus*	Bewick's Wren, *Thryomanes bewickii*
American Kestrel, *Falco sparverius*	House Wren, *Troglodytes aedon*
Spruce Grouse, *Falcipennis Canadensis/ (Dendragapus canadensis)*	Winter Wren, *Troglodytes troglodytes*
Ring-necked Pheasant, *Phasianus colchicus*	American Dipper, *Cinclus mexicanus*
California Quail, *Callipepla californica*	Ruby-crowned Kinglet, *Regulus calendula*
American Coot, *Fulica americana*	Golden-crowned Kinglet, *Regulus satrapa*
Killdeer, *Charadrius vociferus*	Swainson's Thrush, *Catharus ustulatus*
Sanderling, *Calidris alba*	Varied Thrush, *Ixoreus naevius*
Short-billed Dowitcher, *Limnodromus griseus*	Townsend's Solitaire, *Myadestes townsendi*
Whimbrel, *Numenius phaeopus*	American Robin, *Turdus migratorius*
California Gull, *Larus californicus*	European Starling, *Sturnus vulgaris*
Ring-billed Gull, *Larus delawarensis*	Cedar Waxwing, *Bombycilla cedrorum*
Glaucous-winged Gull, *Larus glaucescens*	Yellow-rumped Warbler, *Dendroica coronata*
Western Gull, *Larus occidentalis*	Black-throated Gray Warbler, *Dendroica nigrescens*
Caspian Tern, *Sterna caspia*	Yellow Warbler, *Dendroica petechia*
Pigeon Guillemot, *Cepphus columba*	Townsend's Warbler, *Dendroica townsendi*

Common Murre, *Uria aalge*	Common Yellowthroat, *Geothlypis trichas*
Band-tailed Pigeon, *Columba fasciata*	Orange-crowned Warbler, *Vermivora celata*
Rock Dove, *Columba livia*	Wilson's Warbler, *Wilsonia pusilla*
Barn Owl, *Tyto alba*	Western Tanager, *Piranga ludoviciana*
Northern Saw-whet Owl, *Aegolius acadicus*	Dark-eyed Junco, *Junco hyemalis*
Long-eared Owl, *Asio otus*	Song Sparrow, *Melospiza melodia*
Great Horned Owl, *Bubo virginianus*	Savannah Sparrow, *Passerculus sandwichensis*
Northern Pygmy-Owl, *Glaucidium gnoma*	Spotted Towhee, *Pipilo maculatus*
Western Screech-Owl, *Otus kennicottii*	White-crowned Sparrow, *Zonotrichia leucophrys*
Common Nighthawk, *Chordeiles minor*	Black-headed Grosbeak, *Pheucticus melanocephalus*
Vaux's Swift, *Chaetura vauxi*	Red-winged Blackbird, *Agelaius phoeniceus*
Anna's Hummingbird, *Calypte anna*	Brewer's Blackbird, *Euphagus cyanocephalus*
Rufous Hummingbird, *Selasphorus rufus*	Brown-headed Cowbird, *Molothrus ater*
Belted Kingfisher, *Ceryle alcyon*	Pine Siskin, *Carduelis pinus*
Northern Flicker, *Colaptes auratus*	American Goldfinch, *Carduelis tristis*
Downy Woodpecker, *Picoides pubescens*	Cassin's Finch, *Carpodacus cassinii*
Hairy Woodpecker, *Picoides villosus*	House Finch, *Carpodacus mexicanus*
Olive-sided Flycatcher, *Contopus cooperi (Contopus borealis)*	Purple Finch, *Carpodacus purpureus*
Western Wood-Pewee, *Contopus sordidulus*	Evening Grosbeak, *Coccothraustes vespertinus*
Pacific-slope Flycatcher, *Empidonax difficilis*	House Sparrow, *Passer domesticus*
Hammond's Flycatcher, *Empidonax hammondii*	

Mammals

This following list and tables provide an example of the wildlife that is native to Coastal Western Washington and may be found in Mason County. While the specific number residing in the immediate Mason Lake / WRIA-14 area is not documented, many of the following animals can be found in the region by varying distributions.

The annual issuing and recording of hunting permits gives information about the presence of game species in the area. Department of Fish and Wildlife figures from 2002-2003 Game Harvest Reports indicate the animals taken in Mason County relative to the rest of the region. (Table 3-5, 3-6)

Virginia Opossum *Didelphis virginiana*

Grizzled white above; long white hairs cover black-tipped fur below. May appear grayish or blackish. Long, naked prehensile tail. Head and throat whitish; ears large, naked, black with pinkish tips. 25-40" (645-1,017 mm); tail 10-21" (250-535 mm).

Pacific Water Shrew *Sorex bendirii*

A large shrew. Dark brown above and below. Long tail. Hind feet lightly fringed with hair. 5 3/4-6 7/8" (147-174 mm); tail 2 3/8-3 1/8" (61-80 mm).

Masked Shrew *Sorex cinereus*

Brownish above; belly silvery or grayish. Long tail brown above, buff below; tail tufted, with terminal hairs of underside dark. 2 3/4-4 3/8" (71-111 mm); tail 1-2" (25-50 mm).

Trowbridge's Shrew *Sorex trowbridgii*

Grayish to brownish above; slightly paler below. Long, distinctly bicolored tail, dark above; nearly white below. White feet. 4 1/4-5 1/4" (110-132 mm); tail 1 7/8-2 3/8" (48-62 mm).

Vagrant Shrew *Sorex vagrans*

In summer: brownish to grayish above; grayish tinged with brown or red below. In winter: entirely grayish or blackish. Long tail uniform in color or grading to paler below. 3 3/4-4 5/8" (95-119 mm); tail 1 3/8"-2" (34-51 mm).

Shrew-mole *Neurotrichus gibbsii*

Gray fur. Long, hairy tail is about half total head and body length. White-tipped teeth. 4-5" (103-126 mm); tail 1 1/4-1 5/8" (32-43 mm).

Townsend's Mole *Scapanus townsendii*

Black fur. Short, thick, nearly naked tail. Nearly naked snout. Eyes tiny but visible. 7 3/4-9 1/4" (195-237 mm); tail 1 1/4-2" (34-51 mm).

Big Brown Bat *Eptesicus fuscus*

Brown above, from light (in deserts) to dark (in forests), usually glossy; belly paler, with hairs dark at base; wings and tail membrane black and furless. Short, broad, rounded lobe in ear. 4 1/8-5" (106-127 mm); tail 1 5/8-2" (42-52 mm).

Silver-haired Bat *Lasionycteris noctivagans*

Nearly black, with silvery-tipped hairs on back, giving frosted appearance.

Tail membrane lightly furred above. Short, rounded, naked ears. 3 5/8-4 1/4" (92-108 mm); tail 1 1/2-1 3/4" (37-45 mm).

Red Bat *Lasiurus borealis*
Males bright red to orange-red; females dull red to chestnut; both sexes frosted white on back and breast, with whitish patch on each shoulder. Ears small, rounded. Tail membrane furred above. 3 3/4-5" (95-126 mm); tail 1 3/4-2 3/8" (45-62 mm).

Hoary Bat *Lasiurus cinereus*
Pale brown above, with tips of fur heavily frosted white; throat buffy yellow. Ears short and rounded, with black, naked rims. Tail membrane well furred above. 4-6" (102-152 mm); tail 1 3/4-2 1/2" (44-65 mm).

Little Brown Bat *Myotis lucifugus*
Variable shades of glossy brown above, with tips of hairs burnished brown; buff below. Lobe in ear rounded and short. Hairs on toes project beyond ends of toes. 31/8-3 5/8" (79-93 mm); tail 1 1/4-1 5/8" (31-40 mm).

California Myotis *Myotis californicus*
Dull fur, light to dark brown with yellowish or orangish cast above, paler below; base of fur blackish. Ears, wings, and tail membrane dark. Foot tiny. 2 7/8-3 3/8" (74-85 mm); tail 1 3/8-1 5/8" (36-42 mm).

Long-eared Myotis *Myotis evotis*
Long, glossy fur, light brown to brown. Ears dark, usually black; longer than in any other myotis; when laid forward extend 1/4"(7 mm) beyond nose. Lobe inside ear long and thin. 3-3 3/4" (75-97 mm); tail 1 3/8-1 3/4" (36-46 mm).

Fringed Myotis *Myotis thysanodes*
Reddish brown or brown above; slightly paler below. Unique among myotis in having fringe of stiff hairs along edge of tail membrane. 3 1/8-3 3/4" (80-95 mm); tail 1 1/2-1 5/8" (37-42 mm).

Long-legged Myotis *Myotis volans*
A large myotis. Tawny or reddish to nearly black above; grayish to pale buff below. Underarm and tail membrane furred to elbow and knee. Ears short. 3 3/8-4" (87-103 mm); tail 1 1/2-1 7/8" (37-49 mm).

Yuma Myotis *Myotis yumanensis*
Short, dull fur; variable shades of brown above, paler below; throat sometimes whitish. 3 1/4-3 7/8" (84-99 mm); tail 1 1/4-1 3/4" (32-45 mm).

Black-tailed Jackrabbit *Lepus californicus*
Buffy gray or sandy above, peppered with black; white below. Tail has black stripe above, extending onto rump, with white border. Very long ears brownish with black tips. Very large hind feet. 18 1/4-25" (465-630 mm); tail 2-4 3/8" (50-112 mm).

Mountain Beaver *Aplodontia rufa*
Short heavy body, dark brown above; paler below. Blunt head; small ears and eyes; white spot below ear. Tiny tail. Short legs; first toe on front foot has flattened nail; others have long, strong claws. 9 3/8"-18 1/2" (238-470 mm); tail 3/4-2 1/8" (20-55 mm).

Hoary Marmot *Marmota caligata*
Silver-gray; brownish rump; whitish belly. Nose and patch between eyes whitish; black on forehead; often black band above nose. Tail reddish brown, bushy. Feet very dark; forefeet may have white spots. 17 3/4-32" (450-820 mm); tail 6 3/4-9 7/8" (170-250 mm).

Townsend's Chipmunk *Tamias townsendii*
Dark brown, often with indistinct blackish and pale stripes on head and body. Tail bushy; blackish above, with white-tipped hairs; bright reddish below, bordered with black, edged with white-tipped hairs. 8 3/4-14 1/4" (221-363 mm); tail 3 1/2-6" (90-152 mm).

Douglas' Squirrel *Tamiasciurus douglasii,* aka **Chickaree/Pine Squirrel**
Reddish- or brownish-gray; chestnut in mid-back. Blackish line on sides in summer. End of tail blackish above; below, tail is rusty, bordered by black band with whitish edge. Small ear tufts in winter. 10 5/8-14" (270-355 mm); tail 3 7/8-6 1/8" (100-156 mm).

Western Pocket Gopher *Thomomys mazama*
Reddish brown or various shades of gray to black, depending on soil color. Pointed ear, with dark patch behind it that is 5 times size of ear. 7 1/4-9 3/8" (183-239 mm); tail 2 1/8-3 1/8" (53-81 mm).

Southern Red-backed Vole *Clethrionomys gapperi*
Rust-reddish above; sides buff or grayish; gray to buff-white below. Tail short, slender, slightly bi-colored. Gray phase sometimes occurs in Northeast. 4 3/4-6 1/4" (120-158 mm); tail 1 1/8-2" (30-50 mm).

Long-tailed Vole *Microtus longicaudus*
A small vole with a long, bi-colored tail. Grayish brown above; light grayish below. Feet off-white. 6 1/8-8 3/4" (155-221 mm); tail 2-4 1/2" (50-115 mm).

Creeping Vole *Microtus oregoni*
Short-haired. Brown above; silvery below. Tiny eyes, only 1/8" (2 mm) in diameter. Short tail indistinctly bi-colored. Ears protrude from fur. 4 3/4-6 1/8" (120-156 mm); tail 1 1/8-2" (30-52 mm).

Townsend's Vole *Microtus townsendii*
Dark brown sprinkled with black above; grayish or grayish brown below. Long tail blackish, indistinctly bi-colored. Feet dusky. Large ears project well above the harsh fur. 6 small pads on soles of feet. 6 5/8-9 3/8" (169-238 mm); tail 1 7/8-3 3/8" (48-85 mm).

House Mouse *Mus musculus*
Grayish brown above; nearly as dark below. Tail dusky above and below; nearly hairless; less than half the body length. 5 1/8-7 3/4" (130-198 mm); tail 2 1/2-4" (63-102 mm).

Bushy-tailed Woodrat *Neotoma cinerea*
Often brownish peppered with black hairs above, but varies from pale grayish to blackish; whitish below. Tail squirrel-like, bushy, and flattened from base to tip. 11 1/2-18 1/2" (292-472 mm); tail 4 3/4 -9 1/4" (120-236 mm).

Common Muskrat *Ondatra zibethicus*
Dense, glossy fur, dark brown above, lighter on sides; paler below; whitish on throat. Long tail scaly, higher than wide, tapering to a point. Hind feet partially

webbed, larger than forefeet. Eyes and ears small. 16-24" (407-620 mm); tail 7-12" (180-305 mm).

Deer Mouse *Peromyscus maniculatus*
Varies greatly with location. Often grayish to reddish brown above; white below. Tail bi-colored, short-haired. Eastern woodland form: 4 5/8-8 3/4" (119-222 mm); tail 1 3/4-5" (46-125 mm). Prairie form: 4 1/8-6 3/8" (106-162 mm); tail 1 7/8-2 5/8" (48-68 mm).

Norway Rat *Rattus norvegicus*
Brownish gray above; grayish below. Scaly tail slightly less than half total length, darker above than below. Small eyes. Prominent ears. 12 3/8-18 1/8" (316-460 mm); tail 4 3/4-8 1/2" (122-215 mm).

Black Rat *Rattus rattus*
Brownish or grayish above; underparts grayish to whitish, but not white. Scaly, sparsely haired tail uniformly dark; longer than half total length. Prominent ears. 12 3/4-17 7/8" (325-455 mm); tail 6 3/8-10 1/8" (160-255 mm).

Pacific Jumping Mouse *Zapus trinotatus*
Yellow sides; dark band down middle of back; belly white, sometimes tinged yellow. Long tail darker above, whitish below. Very large hind feet. 8 3/4-9 3/8" (221-238 mm); tail 5 1/8-5 7/8" (131-149 mm).

Common Porcupine *Erethizon dorsatum*
Long guard hairs on front half of body; black or brown in East, yellowish in West. Quills on rump and tail. Feet have unique soles with small, pebbly-textured fleshy knobs and long, curved claws. 26-37" (648-930 mm); tail 5 7/8-11 3/4" (148-300 mm).

Nutria *Myocastor coypus*
Brown above; muzzle and chin whitish. Long, scaly, rounded tail. Ears and eyes small. Incisors dark orange, protruding beyond lips. Hind feet long, with inner 4 toes webbed. Male larger than female. 26-55" (67-140 cm); tail 11 3/4-17 1/4" (30-44 cm).

Coyote *Canis latrans*
Grizzled gray or orangish gray above, with buff underparts. Long, rusty or yellowish legs with dark vertical line on lower foreleg. Bushy tail with black tip. Ears prominent. Slender, pointed snout. 3' 5"-4'4" (105-132 cm); tail 11 3/4-15 1/4" (30-39 cm).

Common Gray Fox *Urocyon cinereoargenteus*
Grizzled gray above, reddish on lower sides, chest, and back of head; throat and belly white. Tail similarly colored, but has black "mane" on top and black tip. Legs and feet rust-colored. Ears prominent. 31-44" (80-113 cm); tail 8 5/8-17 3/8" (22-44 cm).

Common Raccoon *Procyon lotor*
Usually gray-brown or orange-brown above, with much black; grayish below. Face has black mask outlined in white. Tail bushy, with 4-6 alternating black and brown or brownish-gray rings. Ears relatively small. 24-37" (603-950 mm); tail 7-16" (190-406 mm).

Northern River Otter *Lutra canadensis*

Dark brown above; paler belly. Throat often silver gray. Ears and eyes small. Prominent whitish whiskers. Long tail thick at base, gradually tapering to a point. Feet webbed. Male larger than female. 35-52" (889-1,313 mm); tail 11 7/8 -20" (300-507 mm).

Short-tailed Weasel *Mustela erminea,* aka **Ermine**

Dark brown above; white below. Tail brown with black tip. Legs short; feet white. In north in winter, fur entirely white except for black tail tip. Male almost twice as large as female. 7 1/2 -13 1/2" (190-344 mm); tail 1 5/8-3 1/2" (42-90 mm).

Mink *Mustela vison*

Sleek, with lustrous chocolate-brown to black fur; white spotting on chin and throat. Tail long, somewhat bushy. Male larger than female. 19 3/8"-28" (491-720 mm); tail 6 1/4-7 5/8" (158-194 mm).

Striped Skunk *Mephitis mephitis*

Typically black with 2 broad white stripes on back meeting in cap on head and shoulders; thin white stripe down center of face. Bushy black tail, often white-tipped. Male larger than female. 20-31" (522-800 mm); tail 7 1/4 -15 1/2" (184-393 mm).

Mule Deer *Odocoileus hemionus,* aka **Black-tailed Deer**

Reddish- or yellowish-brown to grayish above; paler below. Throat, rump white. Large ears. Most have white tail, tipped with black; Pacific Coast race has blackish or brown tail. Juvenile spotted. Buck's antlers are branched equally. Ht 3' -3' 5" (90-105 cm).

White-tailed Deer *Odocoileus virginianus*

Tan or reddish brown to grayish. Belly, throat, noseband white. Tail brown edged with white above; white below. Black spots on sides of chin. Buck's antlers have main beam forward, unbranched tines behind, small brow tine. Fawn spotted. Ht 27-45" (68-114 cm).

Black Bear *Ursa americanus*

Wide range of colors including black, brown, bright blonde, smoky blue and even white. Length 4-6 feet, height at shoulder 2-3', weight 300-600 pounds.

Beaver *Castor canadensis*

Black to blonde. Length 4'; height at shoulder 8-12"; weight 40-60 pounds.

2003, eNature.com, a resource provided by the National Wildlife Federation

Table 3-5. Trappers Report of Catch 2002-2003 Season

TRAPPERS' REPORT OF CATCH
COUNTY SUMMARY FOR THE 2002-2003 SEASON

		BEAVER	COYOTE	MINK	MUSKRAT	NUTRIA	OTTER	RACCOON	SKUNK	WEASEL
REGION	**COUNTY**									
6	Clallam	31	0	0	6	0	35	0	0	0
	Gray's Harbor	142	0	26	29	15	64	16	0	0
	Jefferson	23	0	0	7	0	0	20	20	4
	Kitsap	19	0	1	0	0	8	12	0	0
	Mason	**108**	**0**	**1**	**24**	**0**	**55**	**45**	**0**	**0**
	Pacific	556	1	3	22	0	19	21	0	0
	Pierce	70	0	5	4	0	13	41	11	0
	Thurston	64	1	2	43	48	18	20	2	1
REGION TOTAL		1013	2	38	135	63	212	175	33	5

Table 3-6. Big Game Harvest Statistics, 2002 - Black Bear

WASHINGTON BIG GAME HARVEST STATISTICS FOR THE 2002 GENERAL HUNTING SEASON
BLACK BEAR MANAGEMENT UNIT - PUGET SOUND

GMU	UNIT NAME	MALE HARVEST	FEMALE HARVEST	TOTAL HARVEST	NO. HUNTERS	HUNTER SUCCESS	HUNTER DAYS	DAYS / KILL
407	North Sound	16	8	24	292	8.2	2933	122.2
410	Islands	1	0	1	36	2.8	186	186
454	Issaquah	24	10	34	365	9.3	3849	113.2
624	Coyle	9	7	16	205	7.8	1727	10739
627	Kitsap	10	5	15	200	7.5	1567	104.5
633	**Mason Lake**	**5**	**3**	**8**	**172**	**4.7**	**1275**	**159.4**
652	Puyallup	0	3	3	167	1.8	1310	436.7
666	Deschutes	6	0	6	130	4.6	789	131.5
667	Skookumchuk	6	12	18	598	3	4110	228.3
BMU TOTAL		77	48	125	2115	5.9	17746	142

Reptiles and Amphibeans

This list provides an example of the wildlife that is native to Coastal Western Washington and may be found around Mason Lake. While the specific number residing in the immediate Mason Lake / WRIA-14 area is not documented, many of the following animals can be found in the region by varying distributions.


© Jim Yuskavitch

Western Red-backed Salamander, *Plethodon vehiculum*
2 3/4-4 1/2" (7-11.5 cm). Red, yellow, green or tan stripe down back to tail tip. Some dark individuals lack stripe; others lack dark pigment and are largely color of stripe. Upper sides' dark brown or black; salt and pepper flecking on belly. 16 side grooves.


© E. R. Degginger

Rough-skinned Newt, *Taricha granulosa*
5-8 1/2" (13-23 cm). Warty skin, light brown to black above, with sharply contrasting yellow to orange belly. Breeding male temporarily develops smooth skin, swollen anus, compressed tail, and toes tipped with black horny layer. Small eyes; dark lower lids.


© E. R. Degginger

Western Toad, *Bufo boreas*
2 1/2-5" (6.4-12.8 cm). Gray to green, with light-colored stripe down middle of back. Warts tinged with red and surrounded by black blotches. Male has pale throat. Oval glands behind eyes; lacks cranial crests.


© Karl H. Switak

Pacific Treefrog, *Pseudacris regilla (Hyla regilla)*
3/4-2" (1.9-5.1 cm). Skin rough; varies greatly from green to light tan to black, often with dark spots. Black stripe through eye and usually a dark triangle between the eyes. Large toe pads. Male has gray throat.


© Michael P. Gadomski

Cascades Frog, *Rana cascadae*
1 3/4-2 5/16" (4.4-7.5 cm). Small,olive to brown, with black spots on back and legs. Folds of skin along upper sides. Dark mask bordered by light jaw stripe. Eardrum smooth. Underside yellow, becoming more intense toward rear. Toes not fully webbed.

© Suzanne L. & Joseph T. Collins

American Bullfrog, *Rana catesbeiana*
3 1/2-8" (9-20.3 cm). Largest frog in North America. Green to yellow above with random darker gray mottling. Large external eardrum; hind feet fully webbed except last joint of longest toe. No ridges down back. Belly cream to white, may be mottled with gray.

© David Liebman

Painted Turtle, *Chrysemys picta*
4-10" (10-25 cm). Upper shell olive or black; oval, smooth, flattened; seams of scutes (plates) bordered with olive, yellow, or red. Red bars or crescents on marginal scutes. Lower shell yellow, plain or patterned. Yellow and red stripes on neck, legs, tail.

© William P. Leonard

Northwestern Garter Snake, *Thamnophis ordinoides*
15-26" (38.1-66 cm). Brown, greenish, bluish, or black; usually with distinct red, orange, or yellow stripe down middle of back. Side stripe may be faint or absent. Sides occasionally dark-spotted. Belly yellow or gray, often with red blotches.

© William P. Leonard

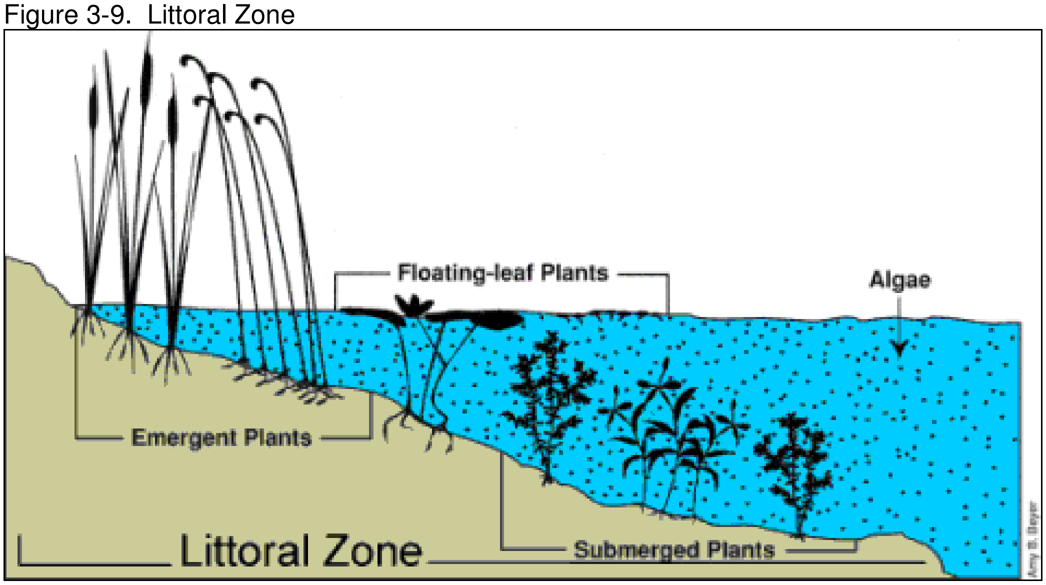
Common Garter Snake, *Thamnophis sirtalis*
18-51 5/8" (45.7-131.1 cm). Coloration highly variable, but back and side stripes usually well-defined. Red blotches or a double row of alternating black spots often present between stripes.

Characterization of Aquatic Plants in Mason Lake

The plant communities in and around Mason Lake represent a diverse set of ecotypes. Hundreds of species occur in specific habitats represented in the area. Aquatic plants grow in an area known as the littoral zone--the shallow transition zone between dry land and the open water area of the lake.

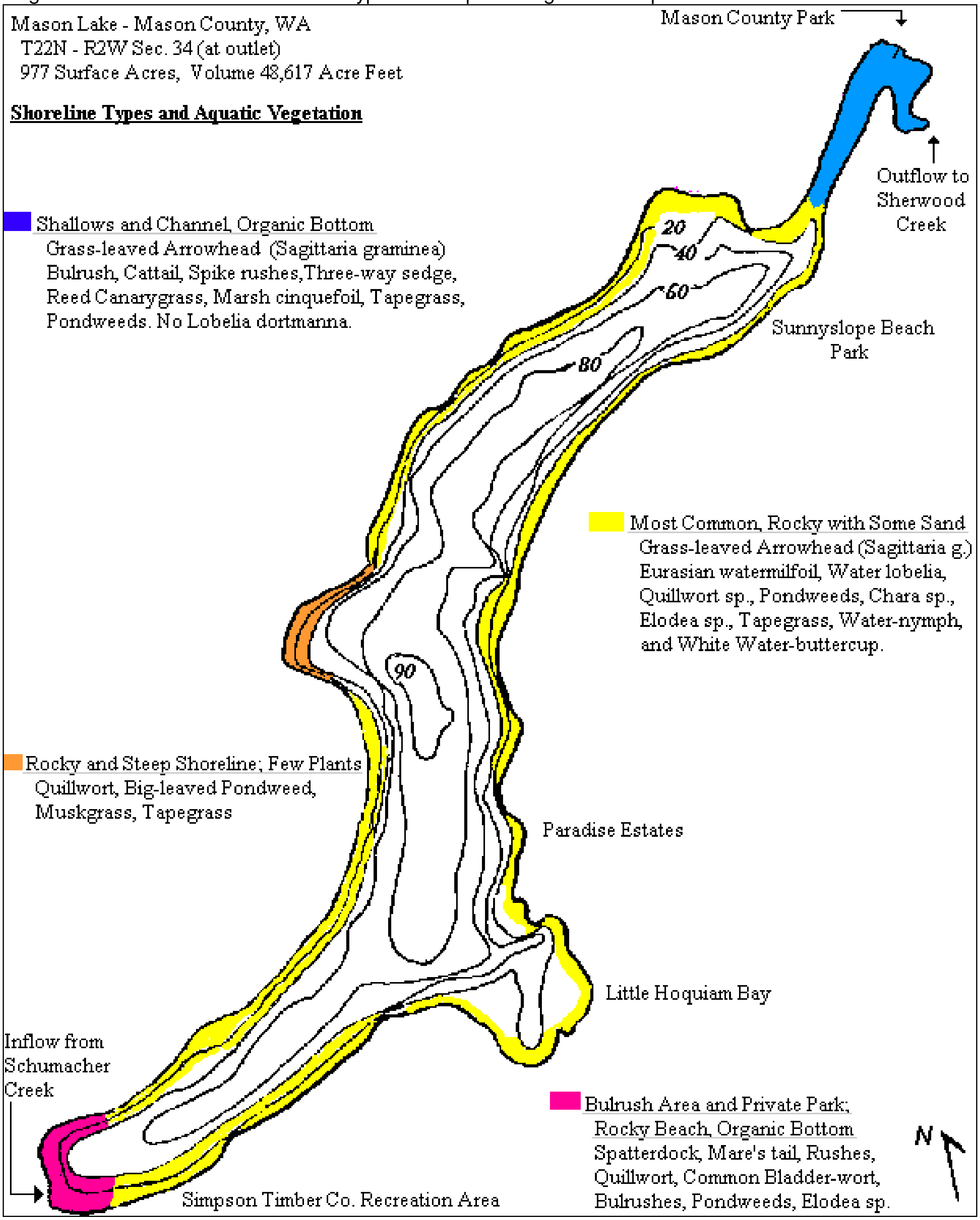
In Mason Lake, the littoral zone extends from the shore to a depth of about 20 feet, depending on water clarity. It is highly productive. The shallow water, abundant light, and nutrient-rich sediment provide ideal conditions for plant growth. The aquatic vegetation supports food chains, provides habitat for a variety of animal species, intercepts sediment, removes toxic compounds from runoff, and provides erosion control/bank stabilization for lakes and streams. Protecting the littoral zone is important for the health of many of a lake's fish and other animal populations. (Figure 3-9)

Figure 3-9. Littoral Zone



The most recent comprehensive aquatic plant survey of Mason Lake occurred on July 2, 2003. The surveys were conducted by boat using a 2-person crew, a trained diver and two volunteers. Each shoreline section was characterized. (Figure 3-10)

Figure 3-10. Mason Lake Shoreline Types and Aquatic Vegetation Map



Thirty-two plant species (Table 3-8) were identified at Mason Lake, including thirteen emergent types, eight rooted-floating types, nine submersed types and two plant-like algae. Emergents are plants that are rooted in the sediment at the water's edge but have stems and leaves which grow above the water surface. Floating rooted plants are rooted in the sediment and send leaves to the water's surface. Submersed plants are either freely-floating or are rooted in the lake bottom but grow within the water column.

Table 3-7. Aquatic Plant Inventory from Survey of Mason Lake, Conducted July 31 2003

Shallows & Channel: Organic bottom		*Carex* sp. (Bulrush) *Eleocharis* sp. (Spike rushes) *Dulichium arundin*aceum (Three-way Sedge) *Phalaris arundinacea* (Reed Canarygrass) Invasive *Potentilla palustris* (Marsh Cinqufoil) *Vallisneria americana* (Tapegrass) *Potamogeton amplifolius* (Big-leaved Pondweed) *Potamogeton natans* (Floating-leaved Pondweed) *Potamogeton gramineus* (Grass-leaved Pondweed) *Potamogeton sp.* (thinleaf) (Thin-leaved Pondweed) *Potamogeton sp*. (hybrid) (Pondweed) No *Lobelia dortmanna* (Water lobelia)
Rocky with some sand: Most common shoreline species		*Lobelia dortmanna* (Water lobelia) *Lilaeopsis occidentalis* *Quillwort* sp. *Potamogeton amplifolius* (Big-leaved Pondweed) *Potamogeton robbinsii* (Fern-leaved Pondweed) *Potamogeton gramineus* (Grass-leaved Pondweed) *Chara.* sp. (Muskgrass) *Elodea* sp. *Potamogeton* sp. (hybrid) (Pondweed) *Vallisneria americana* (Tapegrass) *Naja flexilis* (Common Water-nymph) *Ranunculus aquatilis* (White Water-buttercup)
Rocky & steep shoreline: Very few plants		Quillwort *Potamogeton amplifolus* (Big-leaved Pondweed) *Chara.* sp. (Muskgrass) *Vallisneria americana* (Tapegrass) No *Lobelia dortmanna* (Water lobelia)
Bulrush area & Private Park, Rocky beach, Organic bottom by Bulrush		*Nuphar polysepala* (Spatterdock) *Hippuris vulgaris* (Common Mares-tail) *Juncus* sp. (Rushes) *Carex* sp. (Bulrushes) *Potamogeton* robbinsii (Fern-leaved Pondweed) *Potamogeton amplifolus* (Big-leaved Pondweed) *Quillwort* sp. *Utricularia vulgaris* (Common Bladder-wort) *Elodea* sp. No *Lobelia dortmanna*

When a lake is surveyed, aquatic plants are assigned an Ecology Distribution Value (EDV). This describes quantity, density, relative population size and species dominance in an area. Table 3-8 shows the plant types and corresponding values determined in the Mason Lake, 2003.

Table 3-8. Mason Lake Aquatic Survey and Plant Inventory 2003

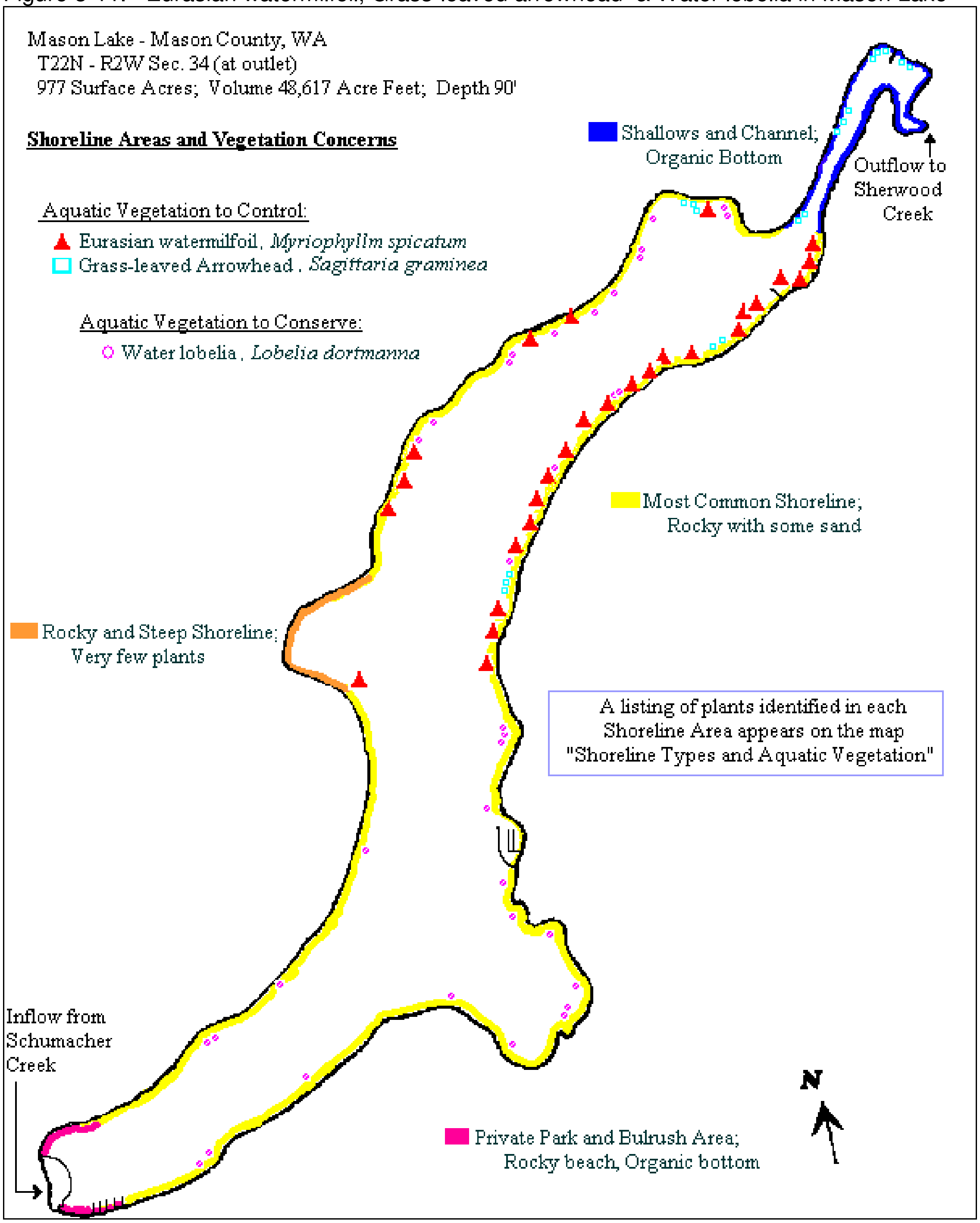
Ecology Distribution Value (EDV) Definitions

0 The value was not recorded (plant may not be submersed)
1 Few plants in only 1 or a few locations
2 Few plants, but with a wide patchy distribution
3 Plants growing in large patches, co-dominant with other plants
4 Plants in nearly mono-specific patches, dominant
5 Thick growth covering the substrate at the exclusion of other species

COMMON NAME	SCIENTIFIC NAME	EDV	COMMENTS
Emergent Plants			
Bulrush	*Scirpus* sp.	2	
Cattail	*Typha latifolia*	1	One small spot in the shallow north end of the lake.
Common Mares-tail	*Hippuris vulgaris*	1	One lg. Patch at south end, west of Simpson park.
Douglas Spirea	*Spirea douglasii*	2	
Grass-leafed Arrowhead	*Sagittaria graminea*	3	Monospecific patches marked with GPS
Marsh Cinquefoil	*Potentilla palustris*	1	
Reed Canarygrass	*Phalaris arundinacea*	3	Invasive
Rushes	*Juncus* sp.	2	
Spikerushes	*Eleocharis* sp.	2-3	
Thinleaf Pondweed	*Potamogeton* sp.	1	
Three-way Sedge	*Dulichium arundinaceum*	1	Shallow north end across from boat ramp
Water Horsetail	*Equisetum fluviatile*	1	
Yellow Flag	*Iris pseudacorus*	3	In front of many residences, dominant north & south end
Free-Floating Plants			
None			
Rooted, Floating-Leaved Plants			
Big-leaf Pondweed	*Potamogeton amplifolius*	3-4	One of dominant plants in lake.
Fragrant waterlily	*Nymphaea odorata*	1	Few patches in front of private residences
Floating-leaved Pondweed	*Potamogeton natans*	2	Mostly in shallow north end
Grass-leaved Pondweed	*Potamogeton gramineus*	2	Mixed with other Potamogetons
Ribbon-leaf Pondweed	*Potamogeton epihydrus*	1	
Spatterdock	*Nuphar polysepala*	2	Small patches growing mostly in shallow N. end
Unknown Pondweed	*Potamogeton* sp.	2	Located mostly in North half of lake
Water-shield	*Brasenia schreberi*	2	In shallow north end of lake by boat launch.
Submersed Plants			
Common Elodea	*Elodea canadensis*	3	Heavy growth in Little Hoquiam bay
Common Water Moss	*Fontinalis antipyretica*	*2*	
Common Water-nymph	*Naja flexilis*	2	
Eurasian Watermillfoil	*Myriophyllum spicatum*	2	Invasive. Locations marked with GPS & buoys
Fern-leaf Pondweed	*Potamogeton robbinsii*	3	Heavy growth in Little Hoquiam bay
Quillwort	*Isoetes* sp.	3	Growing in same areas as Lobelia.
Tapegrass	*Vallisneria americana*	2	Heavy growth in N. channel
Water Lobelia	*Lobelia dortmanna*	2-3	Rare Growing along all shorelines except N. channel & shallow north end, south end around Simpson Rec., and small bay on west side of lake.
White Water-buttercup	*Ranunculus aquatilis*	3	Heavy growth areas around several docks.
Plant-Like Algae			
Muskgrass	*Chara* sp.	2	
Nitella (Stonewort)	*Nitella* sp.	2	

Plant coverage was densest along the northeast channel where the vegetation has largely been left undisturbed and the silt layer is deepest. *Myriophyllum spicatum* was found throughout the north half of the lake's shoreline, and nine patches of *Sagittaria graminea* were found along the north end, channel and north eastern shoreline. *Lobelia dortmanna* is found throughout the most common shoreline area, the rocky/sandy areas along the north, east and western of the lake. (Figure 3-11)

Figure 3-11. Eurasian watermilfoil, Grass-leaved arrowhead & Water lobelia in Mason Lake



M. spicatum has been identified in the lake since 1998, when herbicide treatment was initiated to control this noxious weed. Comparison of aquatic vegetation inventories collected since 1996 does not show a reduction in the number or decline in condition of non-targeted vegetation. The aquatic herbicide 2,4-D is remarkedly selective for Eurasian watermilfoil which is very susceptible to this herbicide. (Table 3-9)

Table 3-9. Mason Lake Aquatic Plant Data Comparison Years 1996 - 2003

SPECIES LIST		**ECOLOGY DISTRIBUTION VALUE**					
Scientific Name	**Common Name**	1996	1998	1999	2000	2002	2003
Brasenia schreberi	Water-shield	2	1	2	1	1	1-2
Carex. sp.	Sedge	2	1		2	2	2-3
Callitriche sp.	Water-Starwort	1					
Chara sp.	Muskgrass			2	1		3
Dulichium arundinaceum	Three-way Sedge					1	1
Eleocharis sp.	Spikerushes	2		2		2-3	2-3
Elodea canadensis	Common Elodea	2	2	2	2	2	3
Equisetum fluviatile	Water Horsetail	2			1	1	1
Fontinalis antipyretica	Common Water Moss					2	*2*
Hippuris vulgaris	Common Mares-tail		1	2	1		1
Iris pseudacorus	Yellow Flag		2				2-3
Isoetes sp.	Quillwort	2	3	2	2	3	3
Juncus sp.	Rushes	2	2	2	2	2	2
Lilaeopsis occidentalis	Lilaeopsis	2	1				2
Lobelia dortmanna	**Water Lobelia**	**2**	**2**	**2**		**2**	**2-3**
Myriophyllum spicatum	**Eurasian watermillfoil**		**1**	**1**		**2**	**2-3**
Naja flexilis	Common Water-nymph	1				2	2
Nitella sp.	Nitella (Stonewort)	1	2		1	2	2
Nuphar polysepala	Spatterdock	2	1	2	2	2	2-3
Nymphaea odorata	Fragrant waterlily				1		1
Phalaris arundinacea	Reed Canarygrass	2				1	2
Potamogeton amplifolius	Big-leaf Pondweed	2	3	3	3	3	3-4
Potamogeton epihydrus	Ribbonleaf Pondweed	1	1	2		1	1
Potamogeton gramineus	Grass-leaved Pondweed	2	2	3	3	3	2
Potamogeton illinoensis	Illinois Pondweed					2	
Potamogeton natans	Floating-leaved Pondweed	1					2
Potamogeton nodosus	Long-leaf Pondweed				2	1	
Potamogeton robbinsii	Fern-leaf Pondweed	2	2	2	2	2	3
Potamogeton sp.	Thinleaf Pondweed					1	1-2
Potentilla palustris	Marsh Cinquefoil					1-2	1
Ranunculus aquatilis	White Water-buttercup	2	2	2	1	2	3
Ranunculus flammula	Creeping Buttercup					1	
Sagittaria graminea	**Grass-leafed Arrowhead**		**1**	**2**		**2**	**3-4**
Scirpus sp.	Bulrush				1	1	2
Spirea douglasii	Douglas Spirea					2	2
Typha latifolia	Cattail						1
Utricularia sp.	Bladderwort		1	2	1	1	1
Vallisneria americana	Water Celery, Tapegrass	2	2	2	3	2	2-3

Water lobelia (*Lobelia dortmanna)*

Water Lobelia was identified in Mason Lake's littoral zone in DOE aquatic plant survey in 1996. The 2003 aquatic survey shows that this plant is present along the west, north and eastern shorelines. It seems to be thriving. It is considered a rare species, with beneficial medicinal properties.
The following notes are for *Lobelia inflata* - this species is said to have similar actions.

> Medicinal Uses include: A solution of the plant product (fresh) can cure headaches and noises in the ears. The dried flowering herb and the seed are antiasthmatic, antispasmodic, diaphoretic, diuretic, emetic, expectorant and nervine. The plant contains the alkaline 'lobeline' which has proved to be of value in helping people to give up smoking tobacco. The alkaloids present in the leaves are used to stimulate the removal of phlegm from the respiratory tract. When chewed, the leaves induce vomiting, headache and nausea - in larger doses, it has caused death. The alkaloids first act as a stimulant and then as a depressive to the autonomic nervous system and in high doses paralyzes muscular action in the same way as curare. (Reference - *Plants for a Future* database search)

Upon learning of this threatened plant in Mason Lake, lake residents were concerned about any harmful effects the treatment of Eurasian watermilfoil would have the Water lobelia. Aquatic surveys from 1998 on were compared against our 2003 survey. A noted increase in plant numbers and density of Water Lobelia is now documented along almost the entire shoreline. There is no evidence that chemical treatments directed at Eurasian watermilfoil since 1999 have hindered the growth or expansion of Water Lobelia, based on this data. (See Table 3-9) The chemicals used on the Eurasian Watermilfoil seem to be selective enough to eradicate only the targeted weeds.

Over half of the lake with Water Lobelia on its shoreline remains in our No Control Zone. The areas of chemical damage concern (leaf damage, bleaching of foliage, etc.) most likely would be on the northern half of the lake. To minimize collateral damage, our plan will incorporate bottom barriers or diver handpulling instead of chemical applications near areas of Water Lobelia and Eurasian Watermilfoil wherever possible.

Chemicals are not the only damage that can be done to Water Lobelia. In the north end, both of Mason Lake's problem weeds grow in the same areas and compete for the same resources as the lobelia. Taking no action there would likely result in the Water lobelia being choked out in a losing battle for light, territory and resources.

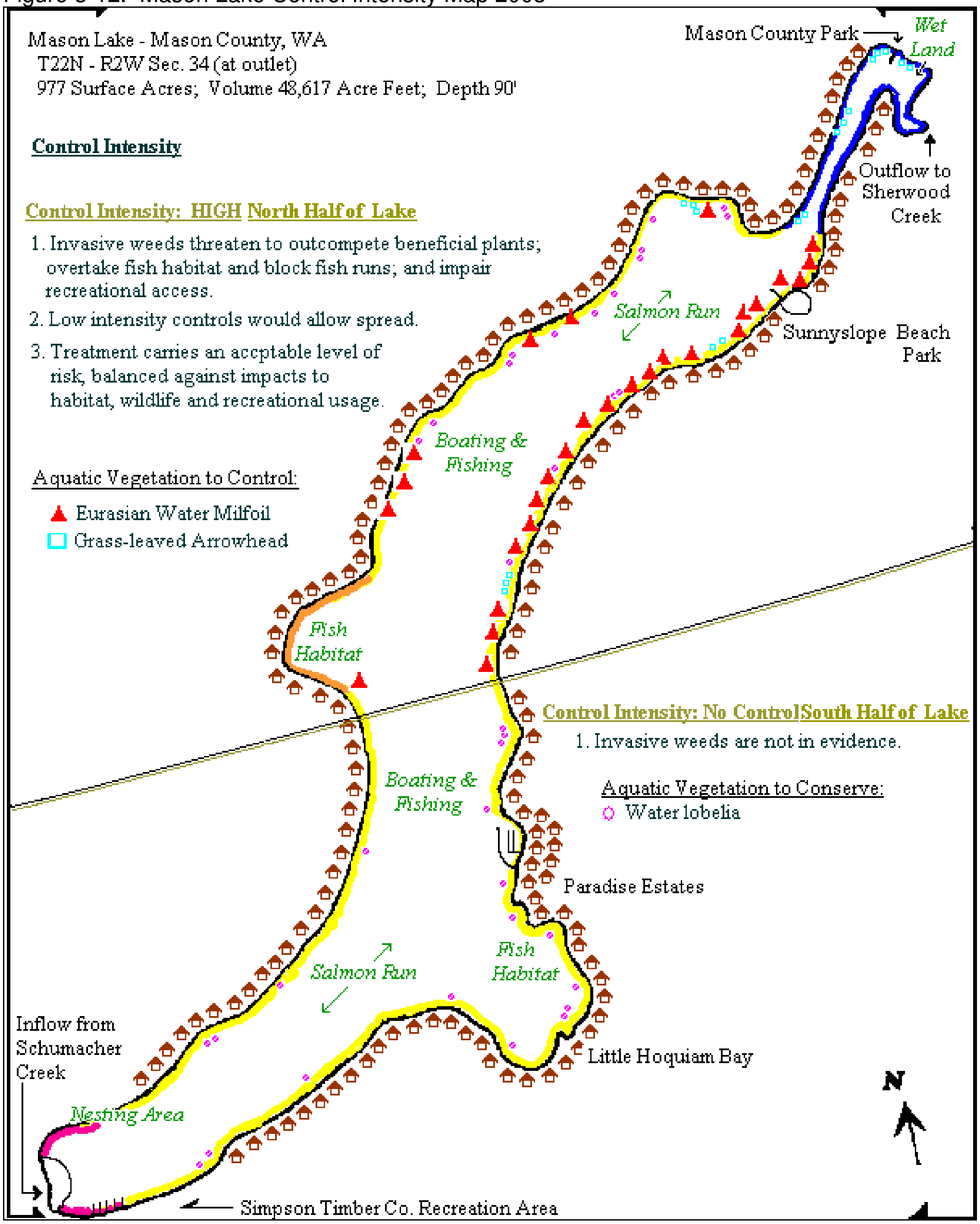
Problem Aquatic Weeds in Mason Lake

Table 3-8 and Figure 3-11 show the species found in the 2003 plant survey, including the locations of two listed invasive weed species: Eurasian watermilfoil (*Myriophyllum spicatum*), and Grass-leaved Arrowhead (*Sagittaria graminea*). These species will be the focus of the plant management efforts on Mason Lake.

The term “noxious weed” refers to those non-native plants that are legally defined by Washington’s Noxious Weed Control Law (RCW 17.10) as highly destructive, competitive, or difficult to control once established. Noxious weeds have usually been introduced accidentally as a contaminant, or as ornamentals. Non-native plants often do not have natural predators (i.e. herbivores, pathogens) or strong competitors to control their numbers as they may have had in their home range. WAC 16.750 sets out three classes (A, B, C) of noxious weeds based on their distribution in the state, each class having different control requirements. County Weed Boards are given some discretion as to setting control priorities for Class B and C weeds. At this writing Mason County has no active Weed Board at this time. Eurasian watermilfoil is a Class B Noxious Weed. Grass-leaved Arrowhead is so new to Western Washington lakes that it is still in the classification process.

Two main reasons to eradicate Eurasian watermilfoil and Grass-leaved Arrowhead are to maintain the health of the native aquatic plant community, and to maintain the viability of the lake for human recreational uses. Eradicating these species from Mason Lake also protects the health of nearby uninfested lakes by removing a potential source of infestation to these waterbodies. The nature of the control methods to be implemented will minimize impacts to native aquatic vegetation. The control will be conducted by methods designed to preserve and enhance or conserve the native plant communities. Based on these weeds' location, number and spreading habits, the control intensity has been determined to be "High" for the north half of Mason Lake, and "No Control" for the southern half (for as long as no invasive weed problems are found there. In the event of such a change in situation, action would have to be taken). [Figure 3-12]

Figure 3-12. Mason Lake Control Intensity Map 2003



Eurasian watermilfoil (*Myriophyllum spicatum*)

EWM (Eurasian watermilfoil) is native to Europe, Asia, and North Africa and also occurs in Greenland (Washington State Noxious Weed Control Board, 1995). The oldest record of EWM in Washington is from a 1965 herbarium specimen collected from Lake Meridian, King County. It was first identified causing problems in the 1970s in Lake Washington and proceeded to move down the I-5 corridor, probably transported to new lakes on boats and trailers.

EWM is among the worst aquatic pests in North America. M. spicatum is a submersed, perennial aquatic plant with feather-like leaves. It usually has 12 to 16 leaflets (usually more than 14) on each leaf arranged in whorls of 4 around the stem. Leaves near the surface may be reddish or brown. Sometimes there are emergent flower stalks during the summers that have tiny emergent leaves. In western Washington, EWM frequently over-winters in an evergreen form and may maintain considerable winter biomass.

This plant forms dense mats of vegetation just below the water's surface. In the late summer and fall, the plants break into fragments with attached roots that float with the currents, infesting new areas. Fragments can also be formed by waves and especially by boating activities. Disturbed plants will also fragment at other times of the year. A new plant can start from a tiny piece of a milfoil plant. *M. spicatum* was not previously thought to reproduce from seed in this region. However, aquatic plant experts are beginning to think that milfoil seeds might be playing a bigger role in repopulating lakes than was previously hoped. This is especially true if the lake dewaters. EWM starts spring growth earlier than native aquatic plants, and thereby gets a "head start" on other plants. It can degrade the ecological integrity of a water body in just a few growing seasons. Dense stands of milfoil crowd out native aquatic vegetation, which in turn alters predator/prey relationships among fish and other aquatic animals. Eurasian watermilfoil can also reduce dissolved oxygen – first by inhibiting water mixing in areas where it grows, and then as oxygen is consumed by bacteria during decomposition of dead plant material.

Decomposition of *M. spicatum* also releases phosphorus and nitrogen to the water that could increase algal growth. Further, dense mats of Eurasian watermilfoil can increase water temperature by absorbing sunlight, raise the pH, and create stagnant water mosquito breeding areas.

Eurasian watermilfoil will negatively affect recreational activities such as swimming, fishing, and boating. The dense beds of vegetation make swimming dangerous, snag fish hooks on every cast, and inhibit boating by entangling propellers or paddles and slowing the movement of boats across the water.
At Mason Lake, *M. spicatum* is currently light in density. The infestation is patchy with few high-density watermilfoil stands. Most of the patches are not yet causing enormous impacts. It is assured that the watermilfoil infestation will continue to expand if left untreated, dramatically increasing negative impacts to the beneficial uses of Mason Lake.

Grass-leaved Arrowhead, (*Sagittaria graminea*)

Also called Slender Arrowhead, this plant is a member of the water plantain family with the full scientific name of *Sagittaria graminea Michx.*

Sagittaria graminea is a large, widely distributed species found throughout the eastern half of the North America as far west as Wyoming and from Labrador to Cuba in the East. Depending on the taxonomic treatment one reads, members of a group of eight or nine related taxa have, at one time or other, been considered varieties within *S. graminea. S. graminea* or varieties of this species are listed as a threatened species in parts of its native range. It is also listed at some web sites as a weedy species.

A native of eastern North America, *Sagittaria graminea* has been introduced to many countries as an ornamental aquatic plant. It was first recorded at a field site in New Zealand (on Auckland's North Shore) in 1988. It also found in Australia. It is growing in Lake Roesiger, Snohomish County, Washington. The plant identification was confirmed by Dr. Hayned at the University of Alabama in May 1995. The USGS survey of Lake Roesiger in 1972 identified a "water plantain" and the environmental consultant KCM identified "water plantain – *Alisma spp*." in 1988. It is likely that both the USGS and KCM misidentified *Sagittaria graminea* as water plantain.

There is a densely growing population *Sagittaria graminea* in Lake Roesiger in Snohomish County. There is smaller population in Mason Lake in Mason County that was discovered in 1998. *Sagittaria graminea* is offered for sale over the Internet and at pond stores and may have been deliberately planted in Mason Lake.

Sagittaria graminea is an emergent or submersed perennial aquatic moncot. It grows best in shallow water up to two m deep (Lake Roesiger) in static or slow moving freshwater such as lakes, streams, and pond margins. *Sagittaria graminea* has both emergent and underwater leaves. Plants growing in deeper water (greater than 0.5 m) form only submersed leaves. The emergent leaves are linear to ovate, tapering abruptly to a point and can be as large as 10 to 25cm long and 2 to 8cm wide or as small as 1 cm to 5 cm long. The stems holding the emergent leaves are up to 55cm long, triangular in cross section, and are winged towards the base. The submerged leaves are strap-shaped, up to 50cm long and 2.5cm broad. The white or sometimes pink flowers are 3cm in diameter and are found in 2 to 12 groups of three-flowered whorls at the end of the flower stem. The flower stem is an emergent stalk to 1.2 m tall. The flowers are always below leaf height and produce clusters of fruitlets that contain oblong seeds, each 1.5 to 3mm long. The seeds germinate in the spring and grow slowly to produce profusely flowering stems in summer (July and August). Flowering continues until autumn with seed slowly maturing through autumn and winter. Most seeds fall close to the colony but some may be eaten by ducks and remain viable when excreted. Fleshy rhizomes are the major means of spread. They begin growing when the seedlings are about one month old and continue to grow slowly, producing tubers throughout the growing season. Tubers and rhizomes remain dormant through winter, producing buds in spring. Sometimes

Sagittaria graminea forms floating mats of vegetation that break up and take root elsewhere in the waterway. It is considered hardy from USDA Plant Growing Zones 4-10. The plant increases density and spreads locally by its creeping root system. It spreads to other areas through seed carried by water, machinery, and wildlife as well as rhizome fragments being transported. It also can be planted by aquatic plant enthusiasts who do not understand the ramifications of introducing non-native species to our natural ecosystems.

Sagittaria graminea is native to much of eastern North America, however, where it has been introduced outside of its native range; it has become a serious pest plant. It forms extensive infestations in shallow waterways, seriously restricting water flow and increasing sedimentation, thus aggravating flooding.

Its key identifying traits are:

- *Sagittaria graminea* can grow up to two meters above the water level.
- When growing in deeper water, *Sagittaria graminea* only forms submersed leaves.
- The leaves that grow below the water surface are long, thin and strap-like.
- The stems are erect and bear from 2 to 12 whorls of flowers during summer.
- The leaves growing above the surface are large, dark green, and spear-shaped. They have conspicuous radiating veins and are carried on upright spongy stalks. Our native *Sagittaria spp*. have arrow-shaped leaves.
- The flowers are about three cm in diameter with three white petals and a bright yellow center. The flowers have many stamens on hair-covered filaments.
- A fruit composed of numerous beaked seeds, about two cm in diameter is produced. The fruits are arranged in a ball-shaped cluster.
- *Sagittaria graminea* has a short brown and fleshy rootstock from which brown, branching fibrous roots grow. Attached to the rootstock are fleshy rhizomes and tubers.
- Members of this family (Alismataceae) often have similar leaf shapes. The flowers are required for identification to species.

Sagittaria graminea has established in two western Washington lakes. It is growing densely and inhibiting the growth of native aquatic species. Its occurrence in two widely separated lakes indicates that people are deliberately planting this species in Washington. It appears that this species is seriously weedy when introduced outside of its native range.

[References: Kathy Hamel, WA DOE personal communication.
http://www.agric.wa.gov.au/agency/pubns/infonote/infonotes/AO2693.html
www.loyno.edu/~hauber/Sagres.html]

AQUATIC PLANT CONTROL ALTERNATIVES

This section outlines common methods used to control aquatic weeds. Much of the information in this section is quoted directly from the Washington Department of Ecology's website:

http://www.ecy.wa.gov/programs/wq/plants/management/index.html

Control/eradication methods discussed herein include Aquatic Herbicides, Manual Methods, Mechanical Methods, Biological Controls and the No Action alternative.

Aquatic Herbicides

Description of Method

http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html

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

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants, or is applied to the water in either a liquid or pellet form. Systemic herbicides are capable of killing the entire plant by tranlocating from foliage or stems and killing the root. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and capable of re-growth (chemical mowing). Non-selective herbicides will generally affect all plants that they come in contact with, both monocots and dicots. Selective herbicides will affect only some plants (usually dicots – broad leafed plants like Eurasian watermilfoil will be affected by selective herbicides whereas monocots like Brazilian elodea and our native pondweeds may not be affected).

Because of environmental risks from improper application, aquatic herbicide use in Washington State waters is regulated and has certain restrictions. The Washington State Department of Agriculture must license aquatic applicators. In addition, because of a March 2001 court decision (Federal 9th Circuit District Court), coverage under a discharge permit called a National Pollutant Discharge Elimination System (NPDES) permit must be obtained before aquatic herbicides can be applied to some waters of the U.S. This ruling, referred to as the Talent Irrigation District decision, has further defined Section 402 of the Clean Water Act. Ecology has developed a general NPDES permit which is available for coverage under the Washington Department of Agriculture for the management of noxious weeds growing in an aquatic situation and a separate general permit for nuisance aquatic weeds (native plants) and algae control. For nuisance weeds (native species also referred to as beneficial vegetation) and algae, applicators and the local sponsor of the project must obtain a NPDES permit from the Washington Department of Ecology before applying herbicides to Washington water bodies.

Although there are a number of EPA registered aquatic herbicides, the Department of Ecology currently issues permits for four aquatic herbicides (as of 2002 treatment season). Several other herbicides are undergoing review and it is likely that other chemicals may be approved for use in Washington in the future. As an example, Renovate® (Triclopyr) has been approved by the U.S. EPA for aquatic use in November 2002, making it the first aquatic herbicide to receive registration since 1988. Renovate® (active ingredient triclopyr) was designed to be effective on both emergent and submersed plants. This herbicide formulation is being evaluated by the Department of Ecology's Environmental Impact Statement (EIS) process before it can be approved for use in Washington but it is expected that triclopyr will be available for use by the 2004 treatment season. It should prove very effective on Eurasian watermilfoil, purple loosestrife and may be used on Mason Lake in future years once approved. Another herbacide imazapyr (Habitat®) will likely be approved for use by 2004 treatment season. It should be effective for emergent plant control such as reed canarygrass. The chemicals that were permitted for use in 2003 are:

Aquatic Herbicides (see Appendix D for Herbicide Labels & MDSS)

- **Rodeo® or Aquamaster®** - Active ingredient **glyphosate**. This systemic nonselective herbicide is used to control floating-leaved plants like water lilies and shoreline plants like purple loosestrife and yellow flag iris. It is generally applied as a liquid to the leaves. **Rodeo® or Aquamaster®** does not work on underwater plants such as Eurasian watermilfoil. Although glyphosate is a non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Plants take several weeks to die. A repeat application is often necessary to remove plants that were missed during the first application. Note: there are now other glyphosate products available, like **Aquamaster®**, with the exact formulation as **Rodeo®** but with different trade names now that the patent has expired. Additional surfactants are always added by the applicator for the aquatic formulations to improve the penetration of the leaf cuticle and help the herbicide stay on the plant long enough to be effective. Those that may be used for emergent weed control include X-77, LI-700, and R-11 as approved by the SEPA process. Only LI-700 is approved for water lilly control control under the NPDES permit. It is likely that two other surfactants will be approved through the state process by the 2004 treatment season.

- **2,4-D** – 2,4-D is a systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species.

  - **Navigate® and AquaKleen®** - Active ingredient **2,4-D BEE**. These granular products contain the low-volatile butoxyethyl-ester (BEE) formulation of 2,4-D. 2,4-D is a relatively fast acting selective, systemic herbicide. It is applied in a granular formulation and can be effective for spot treatment of Eurasian watermilfoil. When used at a rate of 100 pounds per acre, 2,4-D has shown to be selective to Eurasian watermilfoil, leaving native aquatic species relatively unaffected.

- **DMA*4IVM®** - Dimethylamine Salt of 2,4-D. This is a liquid formulation that is labeled for aquatic weed control. Since 2,4-D DMA (like 2,4-D BEE) is rapidly converted to 2,4-D acid, the two products should be equally effective in controlling Eurasian watermilfoil. Previously, 2,4-D DMA was only registered for this use in dams and reservoirs of the Tennessee Valley Authority (TVA) System, but is now approved for use in Washington and other states. It has recently been used to successfully control Eurasian watermilfoil in parts of Lake Washington and in Spring Lake in King County.

- **Triclopyr** (brand name Renovate®) is a fairly quick acting, systemic, selective herbicide suitable for the control of plants like Eurasian watermilfoil and purple loosestrife. The main drawback is that there is a very long irrigation restriction which requires that water be tested prior to its use for irrigation. It may also be more expensive to use than 2,4-D.

- **Sonar®** and **Avast!** Active ingredient **fluridone**. Fluridone is a slow-acting systemic herbicide used to control Eurasian watermilfoil and other underwater plants. It may be applied in pelleted form or as a liquid. Fluridone can show good control of submersed plants where there is little water movement and an extended time for the treatment. Its use is most applicable to whole-lake or isolated bay treatments where dilution can be minimized. It is not effective for spot treatments. It may take six to twelve weeks before the dying plants fall to the sediment and decompose. When used to manage Eurasian watermilfoil, fluridone is applied several times during the summer to maintain a low, but consistent concentration in the water. Although fluridone is considered to be a non-selective herbicide, when used at low concentrations, it can be used to selectively remove Eurasian watermilfoil. Some native aquatic plants, especially pondweeds, are minimally affected by low concentrations of fluridone. Because fluridone is not generally non-selective, it may not be appropriate for use in Mason Lake because of the presence of a rare plant.

- **Aquathol®** - Active ingredient the dipotassium salt of **endothall**. **Aquathol®** is a fast-acting non-selective contact herbicide, which destroys the vegetative part of the plant but does not kill the roots. **Aquathol®** may be applied in a granular or liquid form. Generally endothall compounds are used primarily for short-term (one season) control of a variety of aquatic plants. However, there has been some recent research that indicates that when used in low concentrations, **Aquathol®** can be used to selectively remove exotic weeds, leaving some native species relatively unaffected. Because it is fast acting, **Aquathol®** can be used to treat smaller areas effectively. There are water use restrictions associated with the use of **Aquathol®** in Washington.

Generally, most aquatic herbicides have use restrictions, with irrigation restrictions being the most common.

- **Diquat** (Trade name Reward®). Diquat is a fast-acting non-selective contact herbicide which destroys the vegetative part of the plant but does not kill the roots. It is applied as a liquid. Typically, diquat is used primarily for short-term (one season) control of a variety of submersed aquatic plants. It is very fast-acting and is suitable for spot treatment. However, turbid water or dense algal blooms can interfere with its effectiveness. Diquat was allowed for use in Washington in 2003 and Ecology will be collecting information about its efficacy against Brazilian elodea in 2003.

Advantages

- Aquatic herbicide application can be less expensive than other aquatic plant control methods.
- Aquatic herbicides are easily applied around docks and underwater obstructions.
- 2,4-D DMA & 2,4-D BEE have been shown to be effective in controlling smaller infestations (not lake-wide) of Eurasian watermilfoil in Washington, and could also be used on purple loosestrife.
- Washington has had some success in eradicating Eurasian watermilfoil from some smaller lakes (320 acres or less) using **Sonar®**.
- Glyphosate is the recommended chemical for Reed Canary grass, water lily, Yellow flag iris and Purple loosestrife control.

Disadvantages

- Some herbicides have swimming, drinking, fishing, irrigation, and water use restrictions.
- Herbicide use may have unwanted impacts to people who use the water and to the environment.
- Non-targeted plants as well as nuisance plants may be controlled or killed by some herbicides.
- Depending on the herbicide used, it may take several days to weeks or several treatments during a growing season before the herbicide controls or kills treated plants.
- Rapid-acting herbicides like Aquathol® may cause low oxygen conditions to develop as plants decompose. Low oxygen can cause fish kills.

- To be most effective, generally herbicides must be applied to rapidly growing plants.

- Some expertise in using herbicides is necessary in order to be successful and to avoid unwanted impacts.

- Many people have strong feelings against using chemicals in water.

- Some cities or counties may have policies forbidding or discouraging the use of aquatic herbicides.

Permits

A National Pollutant Discharge Elimination System (NPDES) permit is needed for all applications of aquatic pesticides to state waters. There are two NPDES permits developed for lakes. The Noxious Weed NPDES permit is for the application of aquatic herbicides to state-listed noxious weeds or weeds that are on the Department of Agriculture's Quarantine list. The Nuisance Weed and Algae permit is for the application of herbicide to native plants or algae that are considered a nuisance. Both the noxious and nuisance NPDES permits require the development of Integrated Aquatic Vegetation Management Plans (IAVMP) by the third year of control work. Monitoring of herbicide levels in the water is required for all grant-funded lake herbicide projects starting in 2003, whether the chemical is applied directly to the water or along the shoreline where it may get into the adjacent water. For noxious weed control, the applicator must apply to the Washington Department of Agriculture (WSDA) for coverage under their NPDES permit each treatment season. There is no permit required or application fee to obtain NPDES coverage under Agriculture's permit for Noxious Weeds. Mason Lake is located in Mason County, which does not currently require a "Permit for Application in Sensitive Areas" prior to chemical application for aquatic plants. Mason County defers to existing state law on this issue.

Costs

Approximate costs for one-acre herbicide treatment (costs will vary from site to site):

- DMA*4IVM®: $250-350
- Navigate® and AquaKleen®: $500-700
- Rodeo® or Aquamaster® : $250
- Sonar®: $900 to $1,000
- Reward®: $300

Other Considerations

EPA studies yield the parameters LD50 (acute lethal dose to 50% of a test population), NOEL (No Observable Effect Level, which is the highest test dosage causing no adverse responses), and RfD (EPA Reference Dose determined by applying at least a 100-fold uncertainty factor to the NOEL). The EPA defines the RfD as the level that a human could be exposed to daily with reasonable certainty of no adverse effect from any cause, in other words, a "safe" dose. Exposures to bystanders or consumers are deemed safe when the RfD is not exceeded (Felsot, 1998). Since all substances, natural or manmade, may prove toxic at a sufficiently high dose, one should remember the old adage "dose makes the poison." The LD50 value is useful for comparing one compound with another and for grouping compounds into general hazard classes.

According to Felsot (1998), any pesticide, such as 2,4-D or glyphosate, that does not produce adverse effects on aquatic organisms until levels in water reach milligram per liter (i.e., mg/L, equivalent to a part per million, ppm) would be considered of comparatively low hazard. Substances that are biologically active in water at levels one thousand-fold less, (i.e., µg/L, parts per billion, ppb), are considered highly hazardous to aquatic life. Most pesticides falling in the latter category are insecticides rather than herbicides. Also, compounds that have half-lives less than 100 days are considered non-persistent compared to compounds having half-lives approaching one year or longer (for example, DDT). The half-life of 2,4-D is about 7 days in water, while that of glyphosate is about 12 days in water. Since there are multiple factors that modulate the pesticides' hazard, just focusing on the half-life itself is a bit misleading for hazard assessment. It is now known that the longer a residue remains in soil/sediment, the less likely it will be taken up by plants, leach, or runoff (Felsot, 1998). This phenomenon is called residue aging and involves changes in the forces governing interactions of the chemical with the soil matrix over time.

2,4-D

2,4-D may no longer be available as an aquatic weed control tool due to a lawsuit that the Toxics Coalition has against the EPA. Depending on how the decision is interpreted, alternatives will have to be found for the listed chemicals (including 2,4-D). While 2,4-D is the preferred aquatic herbicide at this time, triclopyr would be an alternative. The formulation and dosage used would be determined based on the plant(s), location(s), extent of spread, and density of growth.

As far as restrictions for aquatic 2,4-D applications, there is no swimming, fishing or fish consumption restrictions. However, three to five days after treatment using the granular formulation the water is generally below the drinking water standard (70ppb, irrigation standard is 100ppb for broad-leafed plants). Although 2,4-D should not damage grass or other monocots, it is not recommended that one use treated water to water lawns during this first three to five days since over-spray will kill ornamentals or plants such as tomatoes and grapes that are very sensitive to 2,4-D. There is no swimming restriction for 2,4-D use. Ecology advises that swimmers wait for 24 hours after application before swimming in the treatment area, but that is an advisory only. The choice is up to the individual.

The issue of legal water rights for irrigation or drinking purposes from Mason Lake has been addressed in past years. Historically, almost all cabins and homes used water for both these purposes. However, with most cabins gone after being replaced by larger and larger homes, individual and community wells have replaced the need for drawing water directly from the lake. Residents should note that drawing water for irrigation or drinking now requires a DOE permit. At this time, we do not believe any chemical application for aquatic weed treatment (as performed by a certified applicator using manufacturers' guidelines) would adversely affect drinking or irrigation water under this definition of water rights.

Human and General Mammalian Health

The oral LD50 for 2,4-D (acid) is 764 mg/kg and the dermal LD50 is >2000 mg/kg. This chemical has a low acute toxicity (from an LD50 standpoint, is less toxic than caffeine and slightly more toxic than aspirin). The RfD for 2,4-D (acid) is 0.01 mg/kg/d. Recent, state-of-the-art EPA studies continue to find that it is not considered a carcinogen or mutagen, nor does it cause birth defects. It has a relatively short persistence in water, since it tends to bind to organic matter in the sediments. The herbicide 2,4-D generally does not bioaccumulate to a great extent, and the small amounts which do accumulate are rapidly eliminated once exposure ceases (Washington State Department of Ecology, 2001b).

The risks to human health from exposure to aquatic 2,4-D applications were evaluated in terms of the most likely forms of contact between humans and the water to which the herbicide was applied. Ecology's Risk Assessment results indicate that 2,4-D should present little or no risk to the public from acute (one time) exposures via dermal contact with the sediment, dermal contact with water (swimming), or ingestion of fish (Washington State Department of Ecology, 2001b). Based on the low dermal absorption of the chemical, the dose of 2,4-D received from skin contact with treated water is not considered significant. Dose levels used in studies are often far beyond what an animal or human would experience as a result of an aquatic application. Many experiments have examined the potential for contact by the herbicide applicator, although these concentrations have little relevance to environmental exposure by those not directly involved with the herbicide application. Once the herbicide has entered the water, its concentration will quickly decline because of turbulence associated mixing and dilution, volatilization, and degradation by sunlight and secondarily by microorganisms (Felsot, 1998).

Results of chronic exposure assessments indicate that human health should not be adversely impacted by chronic 2,4-D exposure via ingestion of fish, ingestion of surface water while swimming, incidental ingestion of sediments, dermal contact with sediments, or dermal contact with water (Washington State Department of Ecology, 2001b). Pharmacokinetic investigations have demonstrated that 2,4-D is rapidly absorbed from the gastrointestinal tract and is quickly excreted. Animal toxicological investigations carried out at high doses showed a reduction in the ability of the kidneys to excrete the chemical, and resulted in some systemic toxicity. However, the high doses tested may not be relevant to the typical low dose human exposures resulting from labeled use. A review of the scientific and medical literature failed to provide any human case reports of systemic toxicity or poisoning following overexposure to these herbicide products when used according to label instructions (Washington State Department of Ecology, 2001b).

The risks to mammalian pets and wildlife should be closely related to these reported human risks, especially since many of the toxicity experiments are carried out on test animals by necessity.

The potential hazard to pregnant women and to the reproductive health of both men and women was evaluated. The results of the 2,4-D developmental or teratology (birth defects) and multigenerational reproduction studies indicate that the chemical is not considered to be a reproductive hazard or cause birth defects (teratogen) when administered below maternally toxic doses (Washington State Department of Ecology, 2001b). A review of the histopathological sections of various 2,4-D subchronic and chronic studies provides further support that the chemical does not affect the reproductive organs, except in some higher dose groups beyond the potential level of incidental exposure after an aquatic weed application.

Fish Health

Based on laboratory data reported in the Department of Ecology's Risk Assessment of 2,4-D, 2,4-D DMA has a low acute toxicity to fish (LC50 ?100 to 524 mg a.i./L for the rainbow trout and bluegill sunfish respectively). No Federally sensitive, threatened or endangered species were tested with 2,4-D DMA. However, it is likely that endangered salmonids would not exhibit higher toxic effects to 2,4-D DMA than those seen in rainbow trout. Since the maximum use rate of 2,4-D DMA would be no higher than the maximum labeled use rate (4.8 mg a.i./L) even the most sensitive fish species within the biota should not suffer adverse impacts from the effects of 2,4-D DMA. In conclusion, 2,4-D DMA will not effect fish or free-swimming invertebrate biota acutely or chronically when applied at typical use rates of 1.36 to 4.8 mg a.i./L (Washington State Dept. of Ecology, 2001b). However, more sensitive species of benthic invertebrates like glass shrimp may be affected by 2,4-D DMA, but 80 and 90% of the benthic species should be safe when exposed to 2,4-D DMA acutely or chronically at rates recommended on the label. Field work indicates that 2,4-D has no significant adverse impacts on fish, free-swimming invertebrates and benthic invertebrates, but well designed field studies are in short supply.

According to the Department of Ecology's Risk Assessment of 2,4-D, in the United States, 2,4-D BEE is the most common herbicide used to control aquatic weeds. 2,4-D BEE, has a high laboratory acute toxicity to fish (LC50 = 0.3 to 5.6 mg a.i./L for rainbow trout fry and fathead minnow fingerlings, respectively). Formal risk assessment indicates that short-term exposure to 2,4-D BEE should cause adverse impact to fish since the risk quotient is above the acute level of concern of 0.01 (RQ = 0.1 ppm/0.3 ppm = 0.33). However, the low solubility of 2,4-D BEE and its rapid hydrolysis to 2,4-D acid means fish are more likely to be exposed to the much less toxic 2,4-D acid. 2,4-D acid has a toxicity similar to 2,4-D DMA to fish (LC50 = 20 mg to 358 mg a.i./L for the common carp and rainbow trout, respectively). In contrast, formal risk assessment with 2,4-D acid indicates that short-term exposure to 2,4-D BEE should not cause adverse impact to fish since the risk quotient is below the federal level of concern of 0.01 (RQ = 0.1 ppm/20 ppm = 0.005).

To conclude, 2,4-D BEE will have no significant impact on the animal biota acutely or chronically when using applied rates recommended on the label (Washington State Dept. of Ecology, 2001b). Although laboratory data indicates that 2,4-D BEE may be toxic to fish, free-swimming invertebrates and benthic invertebrates, data indicates that its toxic potential is not realized under typical concentrations and conditions found in the field. This lack of field toxicity is likely due to the low solubility of 2,4-D BEE and its rapid hydrolysis to the practically non-toxic 2,4-D acid within a few hours to a day following the application.

If it becomes necessary to use other herbicides, an addenum will be added to the plan with toxicity data for these herbicides.

Glyphosate

Glyphosate only works on emergent or floating leaved plants like water lilies. Because of this, the chemical is not directly applied into the water. Actual water concentrations were measured by King County in 2003 after a water lily treatment in Spring Lake. No glyphosate was detected in the water 24 hours after treatment. Concentrations at one hour after treatment were: 30 ppb and 310 ppb.

Examination of mammalian toxicity has shown that the acute oral and dermal toxicity of glyphosate would fall into EPA's toxicity category III. This category characterizes slightly to moderately toxic compounds. Glyphosate is practically nontoxic by ingestion, with a reported acute oral LD50 of 5600 mg/kg in tested rats. The risks of incidental contact from swimming in treated water have also been judged as low with a dermal LD50 of 7940 mg/kg, a very high threshold. The RfD for glyphosate is 0.1 mg/kg/d. To place the level of hazard to humans in perspective, the commonly consumed chemicals caffeine (present in coffee, tea, and certain soft drinks), aspirin (acetylsalicylic acid), and nicotine (the neuroactive ingredient in tobacco) have acute oral LD50's of 192, 1683, and 53 mg/kg, respectively. Thus, the herbicides for the most part are comparatively less toxic than chemicals to which consumers voluntarily expose themselves (Felsot, 1998).

Since the shikimic acid pathway does not exist in animals, the acute toxicity of glyphosate is very low. Animal studies, which the Environmental Protection Agency has evaluated in support of the registration of glyphosate, can be used to make inferences relative to human health. The U.S. Forest Service's glyphosate fact sheet reports that the EPA has concluded that glyphosate should be classified as a compound with evidence of non-carcinogenicity for humans (Information Ventures, Inc.). This conclusion is based on the lack of convincing carcinogenicity evidence in adequate studies in two animal species. Laboratory studies on glyphosate using pregnant rats (dose levels up to 3500 mg/kg per day) and rabbits (dose levels up to 350 mg/kg per day), indicated no evidence of teratology (birth defects). A three-generation reproduction study in rats did not show any adverse effects on fertility or reproduction at doses up to 30 mg/kg per day. Glyphosate was negative in all tests for mutagenicity (the ability to cause genetic damage). Technically, glyphosate acid is practically nontoxic to fish and may be slightly toxic to aquatic invertebrates (EXTOXNET, 1996). Some formulations may be more toxic to fish and aquatic species due to differences in toxicity between the salts and the parent acid, or to surfactants used in the formulation. There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms. In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms.

In relation to shoreline applications, glyphosate is moderately persistent in soil, with an estimated average half-life of 47 days. It is strongly adsorbed to most soils, even those with lower organic and clay content. Thus, even though it is highly soluble in water, field and laboratory studies show it does not leach appreciably, and has low potential for runoff (except as adsorbed to colloidal matter). One estimate indicated that less than 2% of the applied chemical is lost to runoff (Malik et. al., 1989). Once glyphospahte is bound to sediment and soil, it is considered to be biologically unavailable. Microbes are primarily responsible for the breakdown of the product, and volatilization or photodegradation losses will be negligible.

Suitability for Mason Lake

Aquatic herbicides can provide an effective method for control and eventual eradication of noxious weeds. The use of a formulation of 2,4-D BEE granules (Aqua-Kleen®) provided excellent initial control of the Eurasian watermilfoil, reducing the required treatment to more-appropriate spot treatments in this scattered infestation. The product's granular form and the application tools used allow for treatment around obstacles such as docks and moored watercraft. (Where mechanical spreaders may miss obstructed areas, hand spreading can be done.) This treatment has the potential to kill the entire plant, primarily by stimulating plant stem elongation. Its efficacy is dependant on a sufficient contact time to ensure a good kill.

Based on experience over the last five treatment years, the controlled application of Aqua-Kleen® (2, 4-D BEE) has been a good fit for control of Eurasian watermilfoil (EWM). This is mostly due to the early identification and treatment of EWM at Mason Lake. The identification of smaller infestations, fewer in number, controlled quickly before a rampant spread of EWM starting in 1998 saved Mason Lake from being choked to death from this invasive plant.

Repeated applications of the same herbicide may leave some resistant plants to continue the spread. Comparing annual surveys, and noting where expected reductions show an increase in plants will indicate that varying treatment is in order. Treatment may be "rotated" between chemical applications (either between liquid and granular formulations, or by alternating with triclopyr), manual methods, or with whatever is best suited at that time for that location.

While Aqua-Kleen® has been shown to be a reliable Eurasian watermilfoil treatment; its plant-specific selectivity may not lend itself to the treatment of Grass-leaved Arrowhead. As a relatively recent introduction to Washington State, Grass-leaved Arrowhead has not been the subject of extensive eradication studies or experiments. Working closely with the Department of Ecology, Department of Fish and Wildlife and experts in the field of chemical control of aquatic weeds (such as Dr. Lars W. J. Anderson), representatives from the Mason Lake community will determine if there is a chemical treatment for Grass-leaved Arrowhead that will prove suitable and appropriate for the near term.

The community will remain alert to any changes found by observation, scientific data or best practices, and will be prepared respond to these changes by altering, limiting, and/or eliminating the use of chemical treatments in Mason Lake. The long-term goal is to control or eradicate noxious plant infestations without introducing new substances into the lake, by relying on manual control methods.

The following chemical treatments were found to be less suitable for the currrent situation.

- DMA*4IVM® is a liquid formulation of 2, 4-D. While it does not offer the same control of application, it is cost effective and treatment results from this formulation have been excellent.
- Aquathol® - Active ingredient the dipotassium salt of endothall, is not appropriate for this location. Due to the great diversity of aquatic vegetation, including Lobelia dortmanna, a non-selective herbicide is not the best choice for Mason Lake.
- Diquat - This is a non-selective contact herbicide. Application would have to be limited by location and closely controlled due to the prescence of a rare plant, *Lobelia dortmanna*, in Mason Lake.

Community concerns have been raised about product toxicity to people, fish and other plant life. There has been no evidence of fish kill, collateral plant damage, or negative human reaction specifically attributable to these toxicity concerns. With regard to these concerns, the following steps are taken:

- LMD # 2 does not allow treatment on weekends. Even though no swimming restrictions exist when the product is applied as directed by the manufacturer, application is scheduled only Monday through Thursday to reduce the number of bathers, swimmers and skiers potentially exposed to a treated area.

- No treatment is made that will knowingly endanger migrating fish. When determining the dates of chemical treatment, the cycle of salmon movement through Mason Lake is taken into account by the current applicator, LMD # 2, Washington DOE and the Department of Fish & Wildlife.

- Aquatic surveys conducted as a follow-up to treatment examine surrounding vegetation for unintended damage. Collateral plant damage has not been extensively reported or documented by our divers or aquatic plant specialists in the numerous surveys completed since 1998. While a limited number of *Lobelia dortmanna* plants showed bleached leaves following a granular 2,4-D treatment, the overall number and location of *L. dortmanna* plants has significantly increased since surveying began in 1998.

- To ensure that all residents who might draw water from the lake are aware of water use restrictions, there are announcements sent to all lakeside residents prior to each herbicide treatment. Announcements will be sent at the beginning of the summer with approximate dates of planned treatments, and subsequent announcements will be sent two weeks and 48 hours prior to each treatment, with exact dates of treatment and use restrictions.

MANUAL METHODS

Hand-Pulling

Hand-pulling aquatic plants is similar to pulling weeds out of a garden. It involves removing entire plants (leaves, stems, and roots) from the area of concern and disposing of them in an area away from the shoreline. In water less than three feet deep no specialized equipment is required, although a spade, trowel, or long knife may be needed if the sediment is packed or heavy. In deeper water, hand pulling is best accomplished by divers with SCUBA equipment and mesh bags for the collection of plant fragments. Some sites may not be suitable for hand pulling such as areas where deep flocculent sediments may cause a person hand pulling to sink deeply into the sediment.

Cutting

Cutting differs from hand pulling in that plants are cut and the roots are not removed. Cutting is performed by standing on a dock or on shore and throwing a cutting tool out into the water. A non-mechanical aquatic weed cutter is commercially available. Two single-sided, razor sharp stainless steel blades forming a “V” shape are connected to a handle, which is tied to a long rope. The cutter can be thrown about 20 – 30 feet into the water. As the cutter is pulled through the water, it cuts a 48-inch wide swath. Cut plants rise to the surface where they can be removed. Washington State requires that cut plants be removed from the water. The stainless steel blades that form the V are extremely sharp and great care must be taken with this implement. It should be stored in a secure area where children do not have access.

Raking

A sturdy rake makes a useful tool for removing aquatic plants. Attaching a rope to the rake allows removal of a greater area of weeds. Raking literally tears plants from the sediment, breaking some plants off and removing some roots as well. Specially designed aquatic plant rakes are available. Rakes can be equipped with floats to allow easier plant and fragment collection. The operator should pull towards the shore because a substantial amount of plant material can be collected in a short distance.

Cleanup

All of the manual control methods create plant fragments. It’s important to remove all fragments from the water to prevent them from re-rooting or drifting onshore. Plants and fragments can be composted or added directly to a garden.

Advantages

- Manual methods are easy to use around docks and swimming areas.
- The equipment is inexpensive.

- Hand-pulling allows the flexibility to remove undesirable aquatic plants while leaving desirable plants.

- These methods are environmentally safe.

- The same trained divers could also conduct plant surveys if the education was expanded.

- Manual methods don't require expensive permits, and can be performed on aquatic noxious weeds with Hydraulic Project Approval obtained by reading and following the pamphlet Aquatic Plants and Fish (publication #APF-1-98) available from the Washington Department of Fish & Wildlife

Disadvantages

- As plants re-grow or fragments re-colonize the cleared area, the treatment may need to be repeated several times each summer.

- Because these methods are labor intensive, they may not be practical for large areas or for thick weed beds.

- Even with the best containment efforts, it is difficult to collect all plant fragments, leading to re-colonization.

- Some plants, like water lilies which have massive rhizomes, are difficult to remove by hand pulling.

- Pulling weeds and raking stirs up the sediment and makes it difficult to see remaining plants. Sediment re-suspension can also increase nutrient levels in lake water.

- Hand pulling and raking impacts bottom-dwelling animals.

- The V-shaped cutting tool is extremely sharp and can be dangerous to use.

- Costs rise significantly when of hiring professional divers

Permits

Permits are required for many types of manual projects in lakes and streams. The Washington State Department of Fish and Wildlife requires a Hydraulic Project Approval permit for all activities taking place in the water including hand pulling, raking, and cutting of aquatic plants.

Costs

- Hand-pulling costs up to $130 for the average waterfront lot for a hired commercial puller.

- A commercial grade weed cutter costs about $130 with accessories. A commercial rake costs about $95 to $125. A homemade weed rake costs about $85 (asphalt rake is about $75 and the rope costs 35-75 cents per foot).

Other Considerations

- Does the community want to invest in weed rakes, other equipment?

Manual methods must include regular scheduled surveys to determine the extent of the remaining weeds and/or the appearance of new plants after eradication has been attained

Suitability for Mason Lake

These options, specifically hand-pulling, provides longer term solutions with the least amount of collateral environmental impact while exhibiting property owner volunteerism and commitment. It is highly desirable by the Mason Lake community, based on feedback from public meetings. Hand-pulling can be one of the most cost effective options, if well-trained volunteer divers do the work.
It is highly recommended that this control method be adopted by lake residents.

Costs for diver training could be absorbed by Lake Management District # 2 and the Mason Lake Milfoil Committee. The training would consist of becoming a certified diver and/or attending a class on identifying/collecting aquatic plants. As more residents are trained, the chemical use could decrease every year as residents take on more responsibility for noxious weed removal.

Prior to education on permit rquirements and potential impacts, some landowners manually removed (hand-pulled) some of the Grass-leaved Arrowhead in 2003. The areas have been staked to determine if that can contain the infestation at current levels. It has not been determined whether this, if done repeatedly over several seasons, could permanently kill the plants.

Some of the currently infested areas are too large to use manual techniques as the sole source of control for Eurasian watermilfoil and Grass-leaved Arrowhead. The deep sediment in the channel area alone would make collecting fragments extremely difficult after a large scale disturbance caused by cutting or raking. The unusually low water level, as well as the deep sediment, would cause any movement by a diver/wader to stir up and re-suspend enough sediment to block visibility for hand-pulling.

In the short term, manual control methods will be important additions to the chemical treatment currently in use, especially as the chemical control methods for Grass-leaved Arrowhead are being evaluated for their effectiveness. It is the goal of the Mason Lake community to reduce the extent and severity of the noxious weed infestations to the degree that manual methods, specifically hand-pulling, will be sufficient to control non-native and invasive weeds. The goal would be to eliminate chemical use for weed control in five years.

Diver Dredging

Diver dredging (suction dredging) is a method whereby SCUBA divers use hoses attached to small dredges (often dredges used by miners for mining gold from streams) to suck plant material from the sediment. The purpose of diver dredging is to remove all parts of the plant including the roots. A good operator can accurately remove target plants, like Eurasian watermilfoil, while leaving native species untouched. The suction hose pumps the plant material and the sediments to the surface where they are deposited into a screened basket. The water and sediment are returned back to the water column (if the permit allows this), and the plant material is retained. The turbid water is generally discharged to an area curtained off from the rest of the lake by a silt curtain. The plants are disposed of on shore. Removal rates vary from approximately 0.25 acres per day to one acre per day depending on plant density, sediment type, size of team, and diver efficiency. Diver dredging is more effective in areas where softer sediment allows easy removal of the entire plants, although water turbidity is increased with softer sediments. Harder sediment may require the use of a knife or tool to help loosen sediment from around the roots. In very hard sediments, milfoil plants tend to break off leaving the roots behind and defeating the purpose of diver dredging.

Diver dredging has been used in British Columbia, Washington, and Idaho to remove early infestations of Eurasian watermilfoil [site source]. In a large-scale operation in western Washington, two years of diver dredging reduced the population of milfoil by 80 percent (Silver Lake, Everett). Diver dredging is less effective on plants where seeds, turions, or tubers remain in the sediments to sprout the next growing season. For that reason, Eurasian watermilfoil is generally the target plant for removal during diver dredging operations.

Advantages

- Diver dredging can be a very selective technique for removing pioneer colonies of Eurasian watermilfoil.

- Divers can remove plants around docks and in other difficult to reach areas.

- Diver dredging can be used in situations where herbicide use is not an option for aquatic plant management.

Disadvantages

- Diver dredging is very expensive.
- Dredging stirs up large amounts of sediment. This may lead to the release of nutrients or long-buried toxic materials into the water column.
- Only the tops of plants growing in rocky or hard sediments may be removed, leaving a viable root crown behind to initiate growth.
- In some states, acquisition of permits can take years.

Permits

Permits are required for many types of projects in lakes and streams. Diver dredging requires Hydraulic Approval from the Department of Fish and Wildlife. Check with your city or county for any local requirements before proceeding with a diver-dredging project. Also diver dredging may require a Section 404 permit from the U.S. Army Corps of Engineers.

Costs

Depending on the density of the plants, specific equipment used, number of divers and disposal requirements, costs can range from a minimum of $1,500 to $2,000 per day.

Other Considerations

- Might be good spot control method in subsequent years (coordinated with diver survey)

Suitability for Mason Lake

The nature of the infestation (a large number of small plant groupings) does not require this large-scale effort. The high cost of this option makes it, while not entirely unsuitable, undesireable for Mason Lake. The re-suspension of sediments that can affect nutrient concentrations and algal production in the lake (see Disadvantages above), was a voiced concern of lake residents. With other techniques for removal more suitable and cost effective, this expensive and impactful option should not be considered at this time.

Bottom Screens

A bottom screen or benthic barrier covers the sediment like a blanket, compressing aquatic plants while reducing or blocking light. Materials such as burlap, plastics, perforated black Mylar, and woven synthetics can all be used as bottom screens. Some people report success using pond liner materials. There is also a commercial bottom screen fabric called Texel, a heavy, felt-like polyester material, which is specifically designed for aquatic plant control.

An ideal bottom screen should be durable, heavier than water, reduce or block light, prevent plants from growing into and under the fabric, be easy to install and maintain, and should readily allow gases produced by rotting weeds to escape without “ballooning” the fabric upwards.

Even the most porous materials, such as window screen, will billow due to gas buildup. Therefore, it is very important to anchor the bottom barrier securely to the bottom. Unsecured screens can create navigation hazards and are dangerous to swimmers. Anchors must be effective in keeping the material down and must be regularly checked. Natural materials such as rocks or sandbags are preferred as anchors.

The duration of weed control depends on the rate that weeds can grow through or on top of the bottom screen, the rate that new sediment is deposited on the barrier, and the durability and longevity of the material. For example, burlap may rot within two years, plants can grow through window screening material, and can grow on top of felt-like Texel fabric. Regular maintenance is essential and can extend the life of most bottom barriers.

Bottom screens will control most aquatic plants, however freely-floating species such as the bladderworts or coontail will not be controlled by bottom screens. Plants like Eurasian watermilfoil will send out lateral surface shoots and may canopy over the area that has been screened giving less than adequate control.

In addition to controlling nuisance weeds around docks and in swimming beaches, bottom screening has become an important tool to help eradicate and contain early infestations of noxious weeds such as Eurasian watermilfoil and Brazilian elodea. Pioneering colonies that are too extensive to be hand pulled can sometimes be covered with bottom screening material. For these projects, we suggest using burlap with rocks or burlap sandbags for anchors. By the time the material decomposes, the milfoil patches will be dead as long as all plants were completely covered. Snohomish County staff reported native aquatic plants colonizing burlap areas that covered pioneering patches of Eurasian watermilfoil. When using this technique for Eurasian watermilfoil eradication projects, divers should recheck the screen within a few weeks to make sure that all milfoil plants remain covered and that no new fragments have taken root nearby.

Bottom screens can be installed by the homeowner or by a commercial plant control specialist. Installation is easier in winter or early spring when plants have died back. In summer, cutting or hand pulling the plants first will facilitate bottom screen installation. Research has shown that much more gas is produced under bottom screens that are installed over the top of aquatic plants. The less plant material that is present before installing the screen, the more successful the screen will be in staying in place. Bottom screens may also be attached to frames rather than placed directly onto the sediment. The frames may then be moved for control of a larger area (see instructions for constructing and installing bottom screens).

Advantages

- Installation of a bottom screen creates an immediate open area of water.
- Bottom screens are easily installed around docks and in swimming areas.
- Properly installed bottom screens can control up to 100 percent of aquatic plants.
- Screen materials are readily available and can be installed by homeowners or by divers.

Disadvantages

- Because bottom screens reduce habitat by covering the sediment, they are suitable only for localized control.
- For safety and performance reasons, bottom screens must be regularly inspected and maintained.
- Harvesters, rotovators, fishing gear, propeller backwash, or boat anchors may damage or dislodge bottom screens.
- Improperly anchored bottom screens may create safety hazards for boaters and swimmers.
- Swimmers may be injured by poorly maintained anchors used to pin bottom
- screens to the sediment.
- Some bottom screens are difficult to anchor on deep muck sediments.
- Bottom screens interfere with fish spawning and bottom-dwelling animals.
- Without regular maintenance aquatic plants may quickly colonize the bottom screen.

Permits

Bottom screening in Washington requires hydraulic approval, obtained free from the Department of Fish and Wildlife. Check with your local jurisdiction to determine whether a shoreline permit is required.

Costs

Barrier materials cost $0.22 to $1.25 per square foot. The cost of some commercial barriers includes an installation fee.

Commercial installation costs vary depending on sediment characteristics and type of bottom screen selected. It costs up to about $750 to have 1,000 square feet of bottom screen installed. Maintenance costs for a waterfront lot are about $120 each year.

Suitability for Mason Lake

Infested areas are too scattered to use a bottom barrier as sole treatment without becoming cost prohibitive. Much of the shoreline has only small infestations and a series of bottom barriers could reduce habitat by covering the sediment, impacting beneficial vegetation and shelter for fish. However, if the infestations become dense and highly resistant despite diver removal and chemical treatment, bottom barriers could be very appropriate. The high degree of wave action caused by wind and watercraft on Mason Lake could spread sediment quickly over barriers, while the released nutrients would create an ideal environment for revegetation over the sites. This could be an advantage, if native plants establish themselves and restore habitat. Maintentance efforts should bear this in mind, which would impact required upkeep time and costs.

Barriers could be effective at sites in the channel to prevent re-infestation after initial control, or in areas that have dense watermilfoil/Arrowhead and have shown resistance to the herbicide. Burlap (with rocks or sandbags to hold it in place) would be the intended barrier. Residents with some diving expertise could place the burlap covers over plants without disturbing them, thus reducing the risk of fragmentation. Using rocks as anchors would limit the introduction of synthetic materials into the lake and keep the initial and maintenance costs down. We plan to consider installing a bottom barrier at selective sites to provide these benefits.

Automatic Plant Control Products (Sediment Agitation)

Description of Method

Several automatic plant control products are commercially available that mechanically disturb the lake bottom to remove aquatic plants and prevent their regrowth within a well-defined area. They sweep, roll, or drag repetitively over the plants and sediments to keep the area free of aquatic plant growth. These devices must be attached to a dock or post to work properly and each product requires electricity to operate. Depending on the product, up to a 42 foot radius around the dock or post can be controlled. Some products have a reserving capability, where as others spin around a post.

The Weed Roller uses a low-voltage power unit (attached to the dock) to slowly drive a long roller (metal cylinder or pipe) set on the lake bottom through an adjustable arc of up to 270 degrees. A reversing action built into the drive automatically brings the roller back to complete the cycle. Fin-like projections on the rollers help detach plants from the sediment and remove roots. The Beach Groomer attaches to a lawn pump to propel two seven-foot arms engineered with chains that turn to clear the lake bottom of weeds. The Lake Sweeper uses lightweight rakes and a submerged pump to clear the lake bottom of weeds.

The ease of installation and operation varies depending upon the product. The type of lake bottom also is an important factor in selecting an automatic plant control device. It is best to install and start operating these devices in the spring before plants begin actively growing. If they are operated after plants have grown, the detached plants should be removed from the water with a rake or gathered by hand. Some manufacturers suggest preparing the area before installation by removing weeds and debris from the site and some products do not work very well after the plants have grown.

Once the plants are cleared from the area, these products can be used as little as one day per week or less to keep plants from recolonizing the area. When not in use, the equipment should be stored along side a dock or in a place where people cannot accidentally injure themselves. Little maintenance is required, but these units must be removed from the water in winter in areas where lakes are expected to freeze.

Advantages

- Repetitive sediment agitation suppresses the regrowth of plants in areas where it is regularly used.
- Open water adjacent to docks can be created and maintained
- With some devices, the treatment area can be modified by adding additional cylinders or rakes or by adjusting the travel arc.
- Some products can easily be moved and can be shared by neighbors.
- Operating costs are low - about the same as operating an ordinary pump.

Disadvantages

- Repetitive sediment agitation will disturb some bottom dwelling animals and may interfere with fish spawning.
- If plants are present, sediment agitation will cause plant fragmentation, which may increase the spread of some invasive weeds.
- Sediment agitation devices can cause a depression to develop where the unit operates as the fine sediment is dispersed to other areas of the water body.
- When the cleared area is to be used for activities such as swimming or wading, the equipment should be unplugged from the power source, moved, and stored under or along side a dock. People may injure themselves if they step on the device.
- These products should be removed in the winter from lakes that freeze.

Permits

Installation of these sediment agitation devices in Washington requires hydraulic approval obtained free from the Washington Department of Fish and Wildlife. Check with your city or county to determine whether a shoreline permit is required.

Costs

Purchase cost varies between products. The Beach Groomer starts at $999, but you also need to purchase a one-to-two horsepower pump (about $300) to operate the unit. The other products cost approximately $2,000.

Suitability for Mason Lake

The situation in Mason Lake has not progressed to access-blocking conditions, and controlling plant spread is still a major focus. These machines are designed to clear small, weed-choked areas with repeated use. The costs per area covered are quite high; and with many property owners absent in off-seasons, the units are not likely to see monthly usage. In addition, the units design works counter to the goal of control by fragmenting and dispersing the weeds. The nutrients released from the sediment can even work to fertilize the new starts.

These issues -- along with the fragmentary natures of the problem weeds, and the secondary problems raised by agitating the sediment (release of settled nutrients, toxins, and disturbance of desirable vegetation) -- make these automatic products impractical for use in Mason Lake.

<u>Rotovation</u>

Description of Method

Rotovators use underwater rototiller-like blades to uproot Eurasian watermilfoil plants. The rotating blades churn seven to nine inches deep into the lake or river bottom to dislodge plant root crowns that are generally buoyant. The plants and roots may then be removed from the water using a weed rake attachment to the rototiller head or by harvester or manual collection.

In some waterbodies, rotovation can be used year-round to control milfoil growth. However, it is most effective in the winter and spring when plants have died back. Summer and fall rotovation usually requires the plants to be cut first since the longer plants wrap around the rototiller head, slowing the rotovation process.

Depending on plant density and sediment type, two to three acres per day can be rotovated. Because of the size of the equipment and high costs, rotovation is most suitable for use in larger lakes or in rivers.

Rotovation is effective for Eurasian watermilfoil removal. Experimental plots have shown that rotovation can produce a high level of milfoil control for up to two seasons. However, milfoil will gradually re-invade the cleared area from adjacent uncleared areas. In milfoil-removal test plots in the Pend Oreille River, the growth of native aquatic plants appeared to be stimulated by rotovation. Perhaps removing the milfoil canopy allowed light to penetrate so that native plant propagules could germinate without competition from milfoil. The action of the blades may also stimulate germination. Because of this, rotovation probably would not be a good management method for the control of native aquatic plant species. However, rotovation has also been used successfully in Washington to remove the rhizomes of the fragrant water lily (a non-native, invasive species in Washington).

Because rotovation disrupts the sediment, it can create harmful environmental effects:
Rotovation churns up the sediment causing water to become temporarily turbid with suspended sediments. Plant nutrients in the sediments, such as nitrogen and phosphorus, may be released into the water. Long-buried toxic materials in the sediment which may be present from land use activities such as boat building, storm water drainage, or combined sewage outfalls may be released into the water.

Rotovation may interfere with fish spawning or migration. Where salmon runs are present, there is only a limited time window where rotovation is allowed to take place in Washington.

For these reasons, the Washington Department of Ecology, the Washington Department of Fish and Wildlife, and other agencies require permits for rotovation. Although rotovation is used in British Columbia, Canada and on the Pend Oreille River in Washington, rotovation has not become a popular method of plant control in other areas.

Advantages

- Rotovation potentially removes the entire plant rather than just "mowing" off its top like harvesting and cutting.
- Plant density is generally decreased by successive treatments.
- Control generally lasts two growing seasons.

- In some water bodies, rotovation can be used year-round to control aquatic plants, depending on permit requirements.
- Rotovation may stimulate growth of some desirable native aquatic plants.

Disadvantages

- Rotovation is expensive and large machinery requires regular maintenance.
- Rotovation disturbs bottom dwelling animals.
- Some rotovators are difficult to maneuver around docks and in shallow water.
- Rotovation causes fragmentation which may increase the spread of invasive weeds like milfoil. For that reason, rotovation should only be used in systems where milfoil is already widespread.
- Rotovation is labor intensive. It may require cutting the plants and removing bottom obstacles like logs and rocks (check first with Fish and Wildlife before removing anything from a water body).
- Sunken logs can impede rotovation; however, some logs may be required to be left for fish and wildlife habitat.
- Underwater utilities, such as gas, water, sewer, telephone or water intake pipes, need to be located before rotovation begins.

Permits

Rotovation requires hydraulic approval from the Washington Department of Fish and Wildlife.
A shoreline permit from the appropriate local jurisdiction (city or county) may also be needed and may take up to six months to obtain.
A Section 404 permit obtained from the Army Corps of Engineers may be required.

Costs

Where contractors are not available, the purchase of a rotovation machine could exceed $200,000 and they are very expensive to run. This wouldn't include the additional manpower and disposal costs. Costs for a private contractor (if available) to harvest plants, remove obstacles, rototill, and collect and dispose of plants are estimated at $1,500 to $2,000 per acre. As plant density decreases and obstacles are removed, costs and time needed to rotovate each acre should decrease.

Suitability for Mason Lake

Rotovation is an effective method well suited to large, open bodies of water with a severe infestation problem. If the milfoil and arrowhead problems are allowed to spread unchecked, beyond hand-pulling and conservative chemical treatment's ability to control, rotovation could be considered as an expensive but practical solution. Currently, the problem weeds in Mason Lake are located in small pockets, around docks and near beneficial vegetation. For the time being, there are more conservative control methods better suited for Mason Lake.

Harvesting and Cutting

Description of Method

Mechanical harvesters are large machines which both cut and collect aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until disposal. A barge may be stationed near the harvesting site for temporary plant storage or the harvester carries the cut weeds to shore. The shore station equipment is usually a shore conveyor that mates to the harvester and lifts the cut plants into a dump truck. Harvested weeds are disposed of in landfills, used as compost, or in reclaiming spent gravel pits or similar sites.

Harvesting is usually performed in late spring, summer, and early fall when aquatic plants have reached or are close to the water's surface. Harvesters can cut and collect several acres per day depending on weed type, plant density, and storage capacity of the equipment. Harvesting speeds for typical machines range from 0.5 to 1.5 acres per hour. Depending on the equipment used, the plants are cut from five to ten feet below the water's surface in a swath 6 to 20 feet wide. Some modern harvesters can cut plants in a range of water depths. Because of machine size and high costs, harvesting is most efficient in lakes larger than a few acres. Harvesting can be an excellent way to create open areas of water for recreation and fishing access.

Along with plants, harvesters also collect a large number of small fish and invertebrates. Amphibians and turtles have been known to be collected as well. Conscientious operators are watchful for fish as the cut plants move up the conveyer belt. They can use a pole to flick fish from the belt into the lake before they reach the storage area.
When hiring harvesting services, ensure that the harvester has been thoroughly cleaned and inspected before allowing it to be launched into the waterbody. This is extremely important if the harvester has been working in waterbodies known to be infested with noxious species such as Eurasian watermilfoil, hydrilla, Brazilian elodea, or with exotic animals such as the zebra mussel or spiny water flea.

Mechanical weed cutters cut aquatic plants several feet below the water's surface. Unlike harvesting, cut plants are not collected while the machinery operates. There are several versions of underwater weed cutters commercially available, including:

- Battery operated weed cutters
- Portable, boat-mounted cutting units
- Specialized barge-like cutting machines

Cutting is generally performed during the summer when plants are near the surface.

Advantages

- Harvesting and cutting "mows" off the plant's top, clearing a path immediately.
- Harvesting removes most of the plant material, reducing the need for secondary gathering.
- In some water bodies, harvesting and cutting can be used year-round to control aquatic plants, depending on permit requirements.
- Specific areas can be treated, leaving other areas undisturbed.

Disadvantages

- Harvesting and cutting "mow" off the plant's top but do not remove the entire plant.
- Hiring the equipment is expensive, as is hauling away the large amount of plant debris.
- Plant density is not reduced and may increase.
- Harvesting disturbs fish, bottom dwelling animals and other vegetation.
- Some Harvesters are difficult to maneuver around docks and in shallow water.
- Harvesting causes fragmentation which may increase the spread of invasive weeds like milfoil. For that reason, it should only be used in systems where milfoil is already widespread.
- Cutting is labor intensive. It requires hand gathering and removing bottom obstacles like logs and rocks (check first with Fish and Wildlife before removing anything from a water body).
- Sunken logs can impede cutting; however, some logs may be required to be left for fish and wildlife habitat.

Permits

Hydraulic requires HPA approval from the Washington Department of Fish and Wildlife (covered by Aquatic Plants and Fish Handbook).
A shoreline permit from the appropriate local jurisdiction (city or county) may also be needed and may take up to six months to obtain.

Costs

Costs for a private contractor to harvest plants, remove obstacles, and collect and dispose of plants range from $1,000 to $2,000 per acre. As plant density decreases and obstacles are removed, costs and time needed to harvest each acre will decrease. Cutting will cost less, and varies widely depending on the amount of work the contractor does and how much volunteer labor is available for the gathering, transportation to a disposal facility and disposal fees. Because of fragment distribution, costs and material to be removed will likely increase over time.

Suitability for Mason Lake

Neither of these options are suitable for the level of infestation at Mason Lake. They are not eradication tools, but rather are used to manage and control heavy, widespread infestations of aquatic weeds. These processes create plant fragments, and therefore should not be used in systems where milfoil is not already widespread. In a light infestation such as Mason Lake, these methods would probably serve to spread and expand the infestation. According to Ecology, "There is little or no reduction in plant density with mechanical harvesting." Harvesting and cutting do not remove root systems, which is a prime method for spreading *S. graminea*. Since the aim of this project is to eliminate watermilfoil and Grass-leaved Arrowhead from the water system, these are not compatible or suitable control strategies for use in Mason Lake.

Biological Control

General Overview

Many problematic aquatic plants in the western United States are non-indigenous species. Plants like Eurasian watermilfoil, Brazilian elodea, and purple loosestrife have been introduced to North America from other continents. Here they grow extremely aggressively, forming monocultures that exclude native aquatic plants and degrade fish and wildlife habitat. Yet, often these same species are not aggressive or invasive in their native range. This may be in part because their populations are kept under control by insects, diseases, or other factors not found in areas new to them.

The biological control of aquatic plants focuses on the selection and introduction of other organisms that have an impact on the growth or reproduction of a target plant, usually from their native ranges. Theoretically, by stocking an infested waterbody or wetland with these organisms, the target plant can be controlled and native plants can recover.

Classic biological control uses control agents that are host specific. These organisms attack only the species targeted for control. Generally these biocontrol agents are found in the native range of the nuisance aquatic plants and, like the targeted plant, these biocontrol agents are also non-indigenous species. With classic biological control an exotic species is introduced to control another exotic species. However, extensive research must be conducted before release to ensure that biological control agents are host specific and will not harm the environment in other ways. The authors of Biological Control of Weeds – A World Catalogue of Agents and Their Target Weeds state that after 100 years of using biocontrol agents, there are only eight examples, world-wide, of damage to non-target plants, "none of which has caused serious economic or environmental damage…".

Search for a classical biological control agent typically starts in the region of the world that is home to the nuisance aquatic plant. Researchers collect and rear insects and/or pathogens that appear to have an impact on the growth or reproduction of the target species. Those insects/pathogens that appear to be generalists (feeding or impacting other aquatic plant species) are rejected as biological control agents. Insects that impact the target species (or very closely related species) exclusively are considered for release.

Once collected, these insects are reared and tested for host specificity and other parameters. Only extensively researched, host-specific organisms are cleared by the United States for release. It generally takes a number of years of study and specific testing before a biological control agent is approved.

Even with an approved host-specific bio-control agent, control can be difficult to achieve. Some biological control organisms are very successful in controlling exotic species and others are of little value. A number of factors come into play. It is sometimes difficult to establish reproducing populations of a bio-control agent.

The ease of collection of the biocontrol and placement on the target species can also have a role in the effectiveness. Climate or other factors may prevent its establishment, with some species not proving capable of over-wintering in their new setting. Sometimes the bio-control insects become prey for native predator species, and sometimes the impact of the insect on the target plant just isn't enough to control the growth and reproduction of the species.

People who work in this field say that the more biological control species that you can put to work on a problem plant, the better success you will have in controlling the targeted species. There are some good examples where numerous biological control agents have had little effect on a targeted species, and other examples where one biocontrol agent was responsible for the complete control of a problem species.

However, even when biological control works, a classic biological control agent generally does not totally eliminate all target plants. A predator-prey cycle establishes where increasing predator populations will reduce the targeted species. In response to decreased food supply (the target plant is the sole food source for the predator), the predator species will decline. The target plant species rebounds due to the decline of the predator species. The cycle continues with the predator populations building in response to an increased food supply.

Although a successful biological control agent rarely eradicates a problem species, it can reduce populations substantially, allowing native species to return. Used in an integrated approach with other control techniques, biological agents can stress target plants making them more susceptible to other control methods.

A number of exotic aquatic species have approved classic biological control agents available for release in the US. These species include Hydrilla, water hyacinth, alligator weed, and purple loosestrife.

In 1992 three beetles were released in Washington for purple loosestrife control. Their damaging impact on purple loosestrife populations was evident in the Winchester Wasteway area of Grant County in 1996. In 1998, 1999, and 2000, the Washington State Noxious Weed Control Board organized insect collection for state, local, and federal staff. Thousands of insects were collected and distributed to purple loosestrife sites throughout the state and even the United States. The Mason County Noxious Weed Control Program has placed *Galerucella* sp. from the Winchester Wasteway on a number of purple loosestrife sites. These sites were chosen because of a high density of the target plant and the fact that other control methods were impractical. The sites were in complex wetland habitats with a high presence of native vegetation that would be damaged by chemical applications or repeated foot traffic through the wetland to implement manual control methods.

Another type of biological control uses **general agents** such as grass carp (see below) to manage problem plants. Unlike classical bio-control agents, these fish are not host specific and will not target specific species. Although grass carp do have food preferences, under some circumstances, they can eliminate all submersed vegetation in a waterbody. Like classic biological control agents, grass carp are exotic species and originate from Asia. In Washington, all grass carp must be certified sterile before they can be imported into the state. There are many waterbodies in Washington (mostly smaller sites) where grass carp are being used to control the growth of aquatic plants.

During the past decade a third type of control agent has emerged. In this case, a native insect that feeds and reproduces on northern milfoil (*Myriophyllum sibericum*) which is native to North America, was found to also utilize the non-native Eurasian watermilfoil (*Myriophyllum spicatum*). Vermont government scientists first noticed that Eurasian watermilfoil had declined in some lakes and brought this to the attention of researchers. It was discovered that a native watermilfoil weevil (*Euhrychiopsis lecontei*) feeding on Eurasian watermilfoil caused the stems to collapse. Because native milfoil has thicker stems than Eurasian watermilfoil, the mining activity of the larvae does not cause it the same kind of damage. A number of declines of Eurasian watermilfoil have been documented around the United States and researchers believe that weevils may be implicated in many of these declines.

Several researchers around the United States (Vermont, Minnesota, Wisconsin, Ohio, & Washington) have been working to determine the suitability of this insect as a bio-control agent. The University of Washington and the Department of Ecology are conducting research into the suitability of the milfoil weevil for the biological control of milfoil in Washington lakes and rivers. Surveys have shown that in Washington the weevil is found more often in eastern Washington lakes and it seems to prefer more alkaline waters. However, it is also present in cooler, wetter western Washington. The most likely candidates for use as biological controls are discussed in the following section.

Grass Carp

http://www.ecy.wa.gov/programs/wq/plants/management/aqua024.html

The grass carp (*Cteno pharynogodon idella*), also known as the white amur, is a vegetarian fish native to the Amur River in Asia. Because this fish feeds on aquatic plants, it can be used as a biological tool to control nuisance aquatic plant growth. In some situations, sterile (triploid) grass carp may be permitted for introduction into Washington waters.

Permits are most readily obtained if the lake or pond is privately owned, has no inlet or outlet, and is fairly small. The objective of using grass carp to control aquatic plant growth is to end up with a lake that has about 20 to 40 percent plant cover, not a lake devoid of plants. In practice, grass carp often fail to control the plants, or in cases of overstocking, all the submersed plants are eliminated from the waterbody.

The Washington Department of Fish and Wildlife determines the appropriate stocking rate for each waterbody when they issue the grass carp-stocking permit. Stocking rates for Washington lakes generally range from 9 to 25 eight- to eleven-inch fish per vegetated acre. This number will depend on the amount and

type of plants in the lake as well as spring and summer water temperatures. To prevent stocked grass carp from migrating out of the lake and into streams and rivers, all inlets and outlets to the pond or lake must be screened. For this reason, residents on waterbodies that support a salmon or
steelhead run are rarely allowed to stock grass carp into these systems.

Once grass carp are stocked in a lake, it may take from two to five years for them to control nuisance plants. Survival rates of the fish will vary depending on factors like presence of otters, birds of prey, or fish disease. A lake will probably need restocking about every ten years.

Success with grass carp in Washington has been varied. Sometimes the same stocking rate results in no control, control, or even complete elimination of all underwater plants. Bonar et. al. found that only 18 percent of 98 Washington lakes stocked with grass carp at a median level of 24 fish per vegetated acre had aquatic plants controlled to an intermediate level. In 39 percent of the lakes, all submersed plant species were eradicated. It has become the consensus among researchers and aquatic plant managers around the country that grass carp are an all or nothing control option. They should be stocked only in waterbodies where complete elimination of all submersed plant species can be tolerated.

Grass carp exhibit definite food preferences and some aquatic plant species will be consumed more readily than others. Pauley and Bonar performed experiments to evaluate the importance of 20 Pacific Northwest aquatic plant species as food items for grass carp.

Grass carp did not remove plants in a preferred species-by-species sequence in multispecies plant communities. Instead they grazed simultaneously on palatable plants of similar preference before gradually switching to less preferred groups of plants. The relative preference of many plants was dependent upon what other plants were associated with them. The relative preference rank for the 20 aquatic plants tested was as follows:

> *Potamogeton crispus* (curly leaf pondweed) = *P. pectinatus* (sago pondweed) > *P. zosteriformes* (flat-stemmed pondweed) > *Chara* sp. (muskgrasses) = *Elodea canadensis* (American waterweed) = thin-leaved pondweeds *Potamogeton* spp. > *Egeria densa* (Brazilian elodea) (large fish only) > *P. praelongus* (white-stemmed pondweed) = *Vallisneria americana* (water celery) > *Myriophyllum spicatum* (Eurasian watermilfoil) > *Ceratophyllum demersum* (coontail) >*Utricularia vulgaris* (bladderwort) > *Polygonum amphibium* (water smartweed) > *P. natans* (floating leaved pondweed) > *P. amplifolius* (big leaf pondweed) > *Brasenia schreberi* (watershield) = *Juncus* sp.(rush) > *Egeria densa* (Brazilian elodea) (fingerling fish only) > *Nymphaea* sp. (fragrant water lily) > *Typha* sp. (cattail) > *Nuphar sp.* (spatterdock).

Generally in Washington, grass carp do not consume emergent wetland vegetation or water lilies even when the waterbody is heavily stocked or over stocked. A heavy stocking rate of triploid grass carp in Chambers Lake, Thurston County resulted in the loss of most submersed species, whereas the fragrant water lilies, bog bean, and spatterdock remained at pre-stocking levels.

A stocking of 83,000 triploid grass carp into Silver Lake Washington resulted in the total eradication of all submersed species, including Eurasian watermilfoil, Brazilian elodea, and swollen bladderwort. However, the extensive wetlands surrounding Silver Lake have generally remained intact. In southern states, grass carp have been shown to consume some emergent vegetation (Washington State Department of Ecology, 2002).

Grass carp stocked into Washington lakes must be certified disease free and sterile. Sterile fish, called triploids because they have an extra chromosome, are created when the fish eggs are subjected to a temperature or pressure shock. Fish are verified sterile by collecting and testing a blood sample. Triploid fish have slightly larger blood cells and can be differentiated from diploid (fertile) fish by this characteristic. Grass carp imported into Washington must be tested to ensure that they are sterile.

Because Washington does not allow fertile fish within the state, all grass carp are imported into Washington from out of state locations. Most grass carp farms are located in the southern United States where warmer weather allows for fast fish growth rates. Large shipments are transported in special trucks and small shipments arrive via air.

Here are some facts about grass carp:

- Are only distantly related to the undesirable European carp, and share few of its habits.? Generally live for at least ten years and possibly much longer in Washington State waters.

- Will grow rapidly and reach at least ten pounds. They have been known to reach 40 pounds in the southern United States.

- Feed only on plants at the age they are stocked into Washington waters.

- Will not eat fish eggs, young fish or invertebrates, although baby grass carp are omnivorous.

- Feed from the top of the plant down so that mud is not stirred up. However, in ponds and lakes where grass carp have eliminated all submersed vegetation the water becomes turbid. Hungry fish will eat organic material out of the sediments.

- Have definite taste preferences. Plants like Eurasian milfoil and coontail are not preferred. American waterweed and thin leaved pondweeds are preferred. Water lilies are rarely consumed in Washington waters.

- Are dormant during the winter. Intensive feeding starts when water temperatures reach 68^{o} F.

- Prefer flowing water to still waters (original habitat is fluvial).

- Are difficult to recapture once released.
- They may not feed in swimming areas, docks, boating areas, or other sites where there is heavy human activity.

Advantages

- Grass carp are inexpensive compared to some other control methods and offer longterm control, but fish may need to be restocked at intervals.
- Grass carp offer a biological alternative to other aquatic plant controls.

Disadvantages

- Depending on plant densities and types, it may take several years to achieve plant control using grass carp and in many cases control may not occur.
- If the waterbody is overstocked, all submersed aquatic plants may be eliminated. Removing excess fish is difficult and expensive.
- The type of plants grass carp prefer may also be those most important for habitat and for waterfowl food.
- If not enough fish are stocked, less-favored plants, such as Eurasian milfoil, may take over the lake.
- Stocking grass carp may lead to algae blooms.
- All inlets and outlets to the lake or pond must be screened to prevent grass carp from escaping into streams, rivers, or other lakes.

Permits

Stocking grass carp requires a fish-stocking permit from the Washington Department of Fish and Wildlife. Also, if inlets or outlets need to be screened, an Hydraulic Project Approval application must be completed for the screening project.

Costs

In quantities of 10,000 or more, 8 to 12 inch sterile grass carp can be purchased for about $5.00 each for truck delivery. The cost of small air freighted orders will vary and is estimated at $8 to $10 per fish.

The costs for researchers to locate, culture, and test bio-control agents is high. Once approved for use, insects can sell for $1.00 or more per insect. Sometimes it is possible to establish nurseries where weed specialists can collect insects for reestablishment elsewhere.

Other Considerations

- Would not achieve immediate results – takes time and is not guaranteed to work
- Community would have strong have concerns with introduced species
- Potential damage to the native plant community of the lake, which could result in the establishment of other aggressive plant species as pioneers
- Concerns from fishermen about grass carp
- Initial investment very expensive
- The introduction of grass carp has generally been discouraged by State agencies

Suitability for Mason Lake

Grass carp are not suitable for aquatic plant control in Mason Lake.

Their preferred food species include the dominant submersed aquatic species in Mason Lake, which would likely be grazed before the watermilfoil. They could remove many or all of the beneficial plants that support a healthy fish population. Without cover and the invertebrates associated with beneficial native aquatic vegetation, the system would be degraded and some species (invertebrates, fish, etc.) may be decimated.

The lake has major inflow and outlet streams that cannot be blocked due to salmon migration and other factors. Introducing it would be expensive in terms of stock, labor and permits; and most likely ineffectual in controlling Eurasian watermilfoil and Grass-leaved Arrowhead in this location.

Watermilfoil Weevil

The following information and citations on the watermilfoil weevil are taken from the Washington State Department of Ecology's website on Aquatic Plant Management.

http://www.ecy.wa.gov/programs/wq/plants/management/weevil.html

The milfoil weevil, *Euhrychiopsis lecontei*, has been associated with declines of Eurasian watermilfoil (*Myriophyllum spicatum*) in the United States (e.g. Illinois, Minnesota, Vermont, and Wisconsin). Researchers in Vermont found that the milfoil weevil can negatively impact Eurasian watermilfoil by suppressing the plants growth and reducing its buoyancy (Creed and Sheldon 1995). In 1989, state biologists reported that Eurasian watermilfoil in Brownington Pond, Vermont had declined from approximately 10 hectares (in 1986) to less than 0.5 hectares. Researchers from Middlebury College,
Vermont hypothesized that the milfoil weevil, which was present in Brownington Pond, played a role in reducing Eurasian watermilfoil (Creed and Sheldon 1995). During 1990 through 1992, researchers monitored the populations of Eurasian watermilfoil and the milfoil weevil in Brownington Pond. They found that by 1991 Eurasian watermilfoil cover had increased to approximately 2.5 hectares (approximately 55-65 g/m2) and then decreased to about 1 hectare (<15 g/m2) in 1992. Weevil abundance began increasing in 1990 and peaked in June of 1992, where 3 – 4 weevils (adults and larvae) per stem were
detected (Creed and Sheldon 1995). These results supported the hypothesis that the milfoil weevil played a role in reducing Eurasian watermilfoil in Brownington Pond.

Another documented example where a crash of Eurasian watermilfoil has been attributed to the milfoil weevil is in Cenaiko Lake, Minnesota. Researchers from the University of Minnesota reported a decline in the density of Eurasian watermilfoil from 123 g/m2 in July of 1996 to 14 g/m2 in September of 1996. Eurasian watermilfoil remained below 5 g/m2 in 1997, then increased to 44 g/m2 in June and July of 1998 and declined again to 12 g/m2 in September of 1998 (Newman and Biesboer, in press). In contrast, researchers found that weevil abundance in Cenaiko Lake was 1.6 weevils (adults and larvae) per stem in July of 1996. Weevil abundance, however, decreased with declining densities of Eurasian watermilfoil in 1996 and by September 1997 weevils were undetectable. In September of 1998 weevil abundance had increased to >2 weevils per stem (Newman and Biesboer, in press). Based on observations made by researchers in Vermont, Ohio and Wisconsin it seems that having 2 weevils (or more) per stem is adequate to control Eurasian watermilfoil. However, as indicated by the study conducted in Cenaiko Lake, Minnesota, an abundance of 1.5 weevils per stem may be sufficient in some cases (Newman and Biesboer, in press).

In Washington State, the milfoil weevil is present primarily in eastern Washington and occurs on both Eurasian and northern watermilfoil (*M. sibiricum*), the latter plant being native to the state (Tamayo et. Al. 1999). During the summer of 1999, researchers from the University of Washington determined the abundance of the milfoil weevil in 11 lakes in Washington. They found, that weevil abundance ranged from undetectable levels to 0.3 weevils (adults and larvae) per stem. Fan Lake, Pend Oreille County had the greatest density per stem of 0.6 weevils (adults, larvae and eggs per stem). The weevils were present on northern watermilfoil. These abundance results are well below the recommendations made by other researchers in Minnesota, Ohio, Vermont, and Wisconsin of having at least 1.5 – 2.0 weevils per stem in order to control Eurasian watermilfoil.

To date, there have not been any documented declines of Eurasian watermilfoil in Washington State that can be attributed to the milfoil weevil, although Creed speculated that declines of Eurasian watermilfoil in Lake Osoyoos and the Okanogan River may have been caused by the milfoil weevil. In Minnesota, Cenaiko Lake is the only lake in that state that has had a Eurasian watermilfoil crash due to the weevil; other weevil lakes are yet to show declines in Eurasian watermilfoil.

Researchers in Minnesota have suggested that sunfish predation may be limiting weevil densities in some lakes (Sutter and Newman 1997). The latter may be true for Washington State, as sunfish populations are present in many lakes in the state, including those with weevils. In addition, other environmental factors that may be keeping weevil populations in check in Washington, but have yet to be studied, include over-wintering survival and habitat quality and quantity (Jester et. Al. 1997; Tamayo et. Al., in press).

Although the milfoil weevil shows potential as a biological control for Eurasian watermilfoil more work is needed to determine which factors limit weevil densities and what lakes are suitable candidates for weevil treatments in order to implement a cost and control effective program.

Advantages

- Milfoil weevils offer a biological alternative to aquatic plant control.
- They may be cheaper than other control strategies.
- Biocontrols enable weed control in hard-to-access areas and can become selfsupporting in some systems.
- If they are capable of reaching a critical mass, biocontrols can decimate a weed population.

Disadvantages

- There are many uncertainties as to the effectiveness of this biocontrol in western Washington waters.
- There have not been any documented declines of Eurasian watermilfoil in Washington State that can be attributed to the milfoil weevil.

- Many of our lakes, including Mason Lake, have introduced sunfish populations that may predate on the milfoil weevils.
- Bio-controls often don't eradicate the target plant species, and there would be population fluctuations as the milfoil and weevil follow predator-prey cycles.

Permits

The milfoil weevil is native to Washington and is present in a number of lakes and rivers. It is found associated with both native northern milfoil and Eurasian watermilfoil. A company is selling milfoil weevils commercially. However, to import these out-of-state weevils into Washington requires a permit from the Washington Department of Agriculture. As of October 1, 2002 no permits have been issued for Washington. The Washington State Department of Ecology is concerned about introducing Mid-West weevils into the state (possible different genetics) as well as the potential for accidentally importing invasive animals such as the zebra mussel into Washington. A test project is underway in eastern Washington, but weevils are being collected and reared in-state. So far no results are available from this test lake.

Suitability for Mason Lake

Control of invasive plant species through bio-control agent, specifically the milfoil weevil, is entirely unsuitable for Mason Lake at this stage of milfoil infestation. It is uncertain how effective the weevil will be and whether populations per stem can be maintained at levels high enough to control Eurasian watermilfoil. Because milfoil weevils are species specific, no improvement in the infestation of Grass-leaved Arrowhead would be expected from stocking these insects. The costs are high, due in part because weevils would have to be reared by lake residents. By their very nature, biological controls are not suitable for eradication projects. Generally a low level population of the target plant is left. This is not acceptable in Mason Lake where the goal is eradication.

There are currently other proven, low-impact, and relatively low-cost options available to control Eurasian watermilfoil and (potentially) Grass-leaved Arrowhead. As with the grass carp, the situation in Mason Lake is not yet widespread enough to warrant further consideration of bio-control introduction.

Drawdown

Lowering the water level of a lake or reservoir can have a dramatic impact on some aquatic weed problems. Water level drawdown can be used where there is a water control structure that allows the managers of lakes or reservoirs to drop the water level in the waterbody for extended periods of time. Water level drawdown often occurs regularly in reservoirs for power generation, flood control, or irrigation; a side benefit being the control of some aquatic plant species.

However, regular drawdowns can also make it difficult to establish native aquatic plants for fish, wildlife, and waterfowl habitat in some reservoirs.

Suitability for Mason Lake

Drawdown is not a viable control strategy for Mason Lake. The outlet from Mason Lake is a natural stream through a wetland system that does not have a control structure installed. Not only would drawdown be difficult to achieve, it would also cause significant damage to the ecosystem. The amount of drawdown required to impact milfoil would dry out the littoral zone of the lake. This would damage native plants and animals in both the lake and the adjacent wetland and have many negative consequences for residents living around the lake.

Nutrient Reduction

Nutrient Reduction Alternative

At lakes in watersheds with identifiable sources of excess nutrients, a program to reduce nutrients entering the lake could possibly be an effective method of controlling aquatic vegetation. Sources of excessive nutrients might include failing septic tanks, storm water runoff, other accidental or planned wastewater effluent, or runoff from agricultural lands. If nutrient reduction were enacted as the primary method of weed control, extensive research would be necessary to determine the current nutrient budget for the lake and surrounding watershed, whether nutrient reduction would result in milfoil reduction, and to identify and mitigate the natural and human-mediated nutrient sources. By itself, nutrient reduction won't work as a technique for Eurasian watermilfoil control. Milfoil does quite well in ultra oligotrophic lakes like Tahoe and Chelan. Nutrient reduction is an excellent way to protect the lake quality from deteriorating. As more and more of the lake develops, it will likely experience more growth of native plants and more algae problems. Nutrient reduction efforts should be encouraged as a good way for helping prevent problems in the future.

Suitability for Mason Lake

Nutrient reduction is not appropriate as a sole control measure for invasive vegetation in Mason Lake, but has become an important area of focus for the lake's overall action plan.

While local failure of septic systems has not been identified as a problem, the resultant nutrients reaching the lake from landscape, garden and construction activities have been recognized as a factor in overall nutrient load levels. Education efforts are underway for the lake's residents and other interested parties in best practices for reducing the amounts and types of impactful substances used on the surrounding grounds and shoreline.

While water quality improvements would likely result if each watershed resident reduced or eliminated sources of nutrient input to the lake, this would not be an effective primary method of controlling aquatic weeds. There are already plenty of nutrients available in the sediment, where milfoil and other targeted aquatic weed species obtain more than 85% of their nutrients. Eventually, reducing the nutrient load of the sediment could have an impact, but that would be long after the plants had a chance to spread and flourish throughout the lake.

NO ACTION ALTERNATIVE

Overview

One option for managing aquatic weeds in Mason Lake is to let aquatic weeds continue to grow, and do nothing to control them. This “no action” alternative would acknowledge the presence of the aquatic weeds but would not outline any management plan or enact any planned control efforts. Effectively, a no action determination would preclude any integrated treatment and/or control effort, placing the choice and responsibility of aquatic weed control with lakefront property owners.

Suitability for Mason Lake

The No Action alternative is not considered suitable or appropriate by members of the greater Mason Lake community.

The Eurasian watermilfoil infestation is currently light to moderate in density; the Grass-leaved Arrowhead is present in seven-plus locations of varying maturity. Without control measures enacted, these are likely to increase each growing season until the entire littoral zone of the lake is dominated by these weeds. It is likely that county-wide weed infestations will continue to grow, making Mason Lake a prime source of milfoil fragments for other nearby lakes with public access and boat launch facilities, as well as a potential source of spread of Grass-leaved Arrowhead. Even if some of the residents chose to control the aquatic weeds near their properties, pockets of both weeds would remain. The surviving plants would fragment each autumn, spreading to other areas of the lake, including those that were treated by residents. The resultant loss of fish habitat, recreational access, wildlife and property values runs in direct opposition to values and goals expressed by concerned lake residents.

INTEGRATED TREATMENT PLAN

Overview

Mason Lake and its associated shoreline currently contain two non-native invasive weed species that should have control measures implemented to halt the spread of their invasions and prevent expected encroachment and resultant degradation.The two target species are Eurasian watermilfoil (*Myriophyllum spicatum*) and Grass-leaved Arrowhead (*Sagittaria graminea*). Although both species are highly aggressive and may be difficult to control / eradicate, the goal of initial control and continuing suppression at manageable levels is reasonable, and can we believe be attained within the time frame of the project.

The first species, Eurasian watermilfoil, has been sucessfully treated, although not eradicated in Mason Lake using well-documented methods and certified materials appropriate to our area and conditions. The second, Grass-leaved Arrowhead, is a relative newcomer to our state. There is little documentation on its control and no historical data specific to Western Washington lakes. The situation in Mason Lake opens opportunities for education through teamwork and partnering with Washington DOE, the Department of Fish & Wildlife, aquatic plant specialists, regional Salmon Enhancement groups, including the ASEG, the Squaxin Tribe and certified chemical applicators. Sharing data could be useful to all parties involved and provide additional knowledge in our joint fight against these noxious plants.

All circumstances for both plants were considered as each of the available aquatic plant control alternatives were reviewed. The recommended treatment plans are comprised of several of the alternatives: surveying, hand-pulling, bottom barriers, education and chemical treatment. It is currently planned to conduct certain treatments in parallel, in the interest of efficiency and cost effectiveness. For instance surveying and educational material costs could be shared but possibly not chemical costs or application timing. The following items will be combined for both plants. Seperate chemical controls specific to each plant will follow.

<u>2004 – 2008</u>

Permitting

The NPDES permit coverage requires notification and posting of the waterbody, proir to any chemical application. These specific protocols will continue to be followed as they apply to both plants.

Surveying

Surveys conducted by scuba and snorkel divers are a keystone in our IAVMP process. These are currently performed by our chemical applicator as well as a contracted aquatic plant specialist. Finding these noxious plants in the littorial zone is sometimes difficult because of water clarity, weather conditions, diver sediment displacement as well as other factors. In the past we have chosen to have our applicator conduct the initial survey as lake residents follow behind in another boat and record infestation locations on a GPS as well as place a red and white buoy over the infested area. GPS data is later downloaded to map locations and show the increase or decrease of the infestations. In 2003 we added a survey by an aquatic plant specialist to help track new infestations and their spread as well as check areas previously treated. This was done to ensure that collateral damage was minimised. In 2004 we are starting a training program for our own divers. Our experience shows that the more surveys completed the more aggresively the infestations can be treated and the more knowledge can be gained.

Hand Pulling / Bottom Barriers

As mentioned above in 2004 we are initiating a resident / user based diver training program. We will assist our volunteer diving members in becoming certified and also in training them in noxious aquatic plant recognition. This program will take several years to create the processes and procedures for adequate results to be achieved. Divers will be responsible for surveying the entire littorial zone of Mason Lake and will also re-survey treated areas for collateral damage as well as emergent plants. This team will be responsible for pulling small infestations of weeds at the time of initial discovery and throughout the treatment season. In addition to this our divers will also be responsible for placement of bottom barriers,where appropriate, as well as maintaining them.

Education

From the outset of this project our consultant urged us to consider this element as the most critical to the success of this process. We now concur.

We all are participants in lifelong learning. Choices change for the better the more we educate or teach ourselves about a certain subject. No new knowledge means making the same choices as in the past expecting a different result. Some residents and users may not understand that the water clarity of Mason Lake is directly related to the detergents they use, their septic systems ability to do it’s job, each plant in the waterbody, the trees and soil that are clearcut to the waterline and thousands of fish and other organisms that make up this place we call home.

Whether a newcomer or a long time resident, concerns about receiving additional educational materials were directed to our steering committee over and over again. Residents want to arrive at a balanced plan that most can agree to. They also are requesting more informative signs posted about problematic weeds, boat ramp guidelines for all boat ramps, more aquatic plant identification classes, more lake wide meetings and newsletters to continue the learning process. They also requested a website, which is currently being established at *masonlake.us* to showcase educational issues about the lake and it’s surroundings.
The majority of users and residents are willing to continue their lifelong learning in order to keep our lake and our property values from degrading like many others.

2004-2006

Chemical Controls
Eurasian watermilfoil (*Myriophyllum spicatum*)

Control of Eurasian watermilfoil is currently accomplished using an aquatic formulation of 2,4-D BEE in the form of Aqua-Kleen® granules in mid-July through mid September over the milfoil-infested areas found in the initial aquatic survey of Mason Lake's littoral zone. The certified contractor surveys the entire lake with divers, using a GPS and marking all the points that need treatment. The areas are then marked by lake volunteers on the water's surface with buoys. One to two weeks later the chemical application is performed by the same certified applicator from a specially equipped boat. Herbicide is directed over the specific plants by either spraying the chemicals or pellets from this boat, again based on GPS locations and buoy placement. No further surveys are conducted on this trip. Several weeks after treatment, a follow-up survey is done to identify plants that were missed or late emergents. A second or third spot-treatment may be performed at that time.

Plants that survive this level of treatment may have become resistant to the chemical herbicide. Any fragments they spread would also be resistant. Comparing annual surveys, and noting where expected reductions show an increase in plants will indicate that varying the treatment is in order. Treatment may be "rotated" between chemical applications (either between liquid and granular formulations, by alternating with triclopyr or by using a contact herbicide to ensure that no fragmentation takes place), employing other manual methods, or with whatever is best suited at that time for that location.

In years 2006 and beyond, diver and surface surveys will occur at a minimum of twice during the growing season. By this time, if our previous efforts have suceeded in reducing the plant populations to "manually manageable" levels, we plan to rely on hand-pulling by trained personnel, professional and volunteer, with localized bottom barriers as the control methods. If at any point we find that we are losing ground on eradication efforts, we will again perform spot herbicide applications. This will be done with the appropriate DOE recommended chemical(s). The MLMC's 2003 purchase of new GPS hardware and mapping software will allow for a systematic tracking of sites and standard comparison of collected data. Several residents have already studied its use to ensure consistent employment and interpretation. We will need to continue the bottom barrier maintenance and community education / outreach annually.

There should be no need to revegetate the areas of Eurasian watermilfoil after treatment. Removing the noxious invaders will halt the degradation of the system and allow the native plants to re-establish themselves.

Grass leaved Arrowhead (*Sagittaria graminea*))

Initial control of Grass-leaved Arrowhead commenced with the mapping of this invasive plant in Mason Lake in 2003. It was first observed by a DOE aquatic survey in 1998. From 1999 to 2002 it stayed in the same areas, grew slightly but it's spread was limited. In 2003 an aquatic plant specialist, Arline Fullerton, was consulted to determine if the weed was the invasive, non-native *Sagittaria graminea* and not the local resident *Vallisneria americana*. She found that not only was it *Sagittaria graminea* but that it had spread from a few plants to something less than three acres in a year. The specific locations and the extent of the infestation at each site have been recorded. In selected sites, the groupings have been photographed to record density and the perimeter marked with white tipped stakes to provide a benchmark by which to measure spread. An Early Infestation Grant was applied for by the Mason Lake Milfoil Committee in August 2003 through the Mason Conservation District and the Department of Ecology, to support education, treatment and control efforts.

Considering the quantity, locations and speed of spread of the Arrowhead plants, we believe an herbicide treatment is appropriate. There is currently no herbicide specifically tested and approved to control *Sagittaria graminea*. The aquatic formulation of 2,4-D BEE, Aqua-Kleen® used to treat Eurasian watermilfoil is not generally considered for treating monocots but has been used with some success on other submersed broad leaf plants.

Our consultant, Marshall Maring, spoke with Dr. Lars Anderson at a aquatic weed seminar in Portland, Oregon in September 2003. Mr. Anderson is the lead scientist for the United States Department of Agriculture, Exotic and Invasive Weed Research at U.C. Davis and his initial choice would be a fall spraying of liquid Rodeo® to the emergent plants (possibly imazapyr) accompanied by a summer application of fluridone (possibly Sonar® PR). Over a two year period we would probably keep this species contained, possibly eradicated. We may have Dr. Anderson visit our lake next year to assist with our study on *Sagittaria graminea*. Our applicator as well as DOE personnel are also looking into treatment possibilities and we plan to review these as they become available.

Any chemical application will be performed by a certified applicator to the chemical manufacturers specifications*, with regard for adjacent plants and obstructions. Scheduling the treatment will be done with consideration to the plants growth cycle, with awareness of development and migratory cycles of fish in the lake, and limited to weekday treatment. Several weeks after treatment, a follow-up survey will be done to identify plants that were missed or late emergents. A second spot-treatment may be performed following the same scheduling constraints. * At such time as new chemicals are incorporated into the lake's treatment plan, toxicity data, MDSS' and label information will be added to Appendix D.

Summary

Mason Lake has two invasive plants that are spreading in our lake currently, Eurasian Milfoil and the newly found Grass-leaved Arrowhead. We are aware of these invaders because of diligent aquatic surveying, by DOE personnel, the MLMC, and our lake management district (LMD) numerous times since 1998. We have used chemical controls on the Milfoil with satisfactory results since1999 and believe that Grass-leaved Arrowhead also must be dealt with initially by chemical treatment. The people who own property on the lake as well as people that use the lake have signed a "letter of support" after reviewing all curently available options for treatment, that express their wishes to move away from chemical treatment into a more lake friendly hands on treatment. In order to accomplish this we are in the early stages of developing resident based diver teams that will hand pick invasive weeds, build and maintain bottom barriers and survey the littorial zone of the lake. We believe that barring any catastrophic events, and employing a concerted and coordinated effort, we will reach this goal of having "chemically free treatments" within the next five years.

PLAN ELEMENTS, COSTS, AND FUNDING

Sources of Funding

Grant-Based Funding

There are several sources of funding available or in place for project implementation. Grants, through the Washington State Department of Ecology's Aquatic Weeds Management Fund (AWMF) have been used successfully by Mason Lake for Early Infestation of Eurasian Water Milfoil. This IAVMP is being funded by a grant from DOE Water Quality. In September 2003, the Mason Lake Milfoil Committee submitted an early infestation grant for *Sagittaria graminea,* an invasive aquatic weed from New Zealand. Table 6-1 indicates how funds from this grant might be spent over 5 years.

Table 6-1. E.I. Grant Fund Distribution Over Five Year Period

Early Infestation Grant					
Specie	***Sagittaria graminea***				
Year	**2004**	**2005**	**2006**	**2007**	**2008**
Diver Surveys	$ 1,100	$1,100	0	0	0
Chemical Treatment	5,000	2,500	1,000	0	
Administration Mason Conservation District (MCD)	900	900	900	900	900
Education	1,000	1,000	2,100	3,100	3,100
Diver Training	2,000	4,500	6,000	6,000	6,000
Annual Total	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000

Community-Based Funding

Table 6-2 outlines the tasks and estimated costs of Milfoil controls based on our experience since 1998. The funding chart below is from our Lake Management District which was formed over the last two years and took effect in 2003. Implementation of the Mason Lake IAVMP will span at least 5 years, at a total estimated cost of $61,800 based on projected revenues. The 2008 figures are drawn from current costs with the expectation of funding through a continuation of Mason Lake's LMD #2.

In 2007, the Mason Lake Milfoil Committee will act to continue the Lake Management District funding mechanism. Building on the success of the current 5-year LMD #2, this re-application through Mason County will aim for a longer term of 10 to 15 years.

Table 6-2. Projected Milfoil Treatment Costs Over Five Year Period

Mason Lake LMD # 2 Budgeted Funds					
Year	**2004**	**2005**	**2006**	**2007**	**2008**
Diver Surveys	$ 2,000	$ 2,000	0	0	0
Milfoil Treatment - Chemical -	4,500	2,500	$ 1,000	0	0
Education	1,400	1,400	1,400	$ 2,400	2,400
Diver Training	3,000	4,000	5,000	5,000	5,000
Administration Mason Conservation District (MCD) - Fixed Cost -	900	900	900	900	900
Mason County - Fixed Cost -	400	400	400	400	400
Bottom Barrier Mat'l & Maintenance		1,000	3,500	3,500	3,500
Total	$ 12,200	$ 12,200	$ 12,200	$12,200	$ 12,200

The community has looked at all options currently available and wishes to move away from a chemical-based treatment scenario to a more resident/user based scuba and snorkel hands-on approach. This answers many concerns that arose during the public input portion of the IAVMP process and is confirmed by over 500+ signatures on the Community Letter of Support included in this plan.

Dedicated Non-Grant Funds from Mason County

Mason County does not currently use it's resources to fund a weed control board.

In Kind or Matching Funds

The Mason Lake Milfoil Committee, LMD #2 and the community at large were offered the opportunity to meet the IAVMP/Education grant-specified $10,000 recipient's match in cash, in volunteer hours (in-kind) or with a combination thereof. Mason Lake's In-Kind/volunteer hours matching contributions have always met or exceeded such goals. During this IAVMP creation process, the Mason Lake Community projects doubling the $10,000 match to over $20,000 based on a $15 per hour volunteer wage. That's over 1300 volunteer hours (or it's equivalent) in just four months. Amazing!! Hundreds of Mason Lake residents and visitors took pride in achieving this impressive goal. Based on the commitment proven through past participation, the community's representatives are confident that any future In-Kind match will be met or exceeded.

Previous Eurasian watermilfoil treatment costs on Mason Lake may be found in the accompanying Appendix D: Treatment and Product Information.

IMPLEMENTATION AND EVALUATION

1. **Convene a Project Implementation Committee.** Some Steering Committee members have indicated their willingness to transition into this role.

2. **Review proposed plan and develop timeline with specific tasks.** The IAVMP will guide this process.

3. **Assign tasks to Implementation Committee members.**

4. **Determine personnel for weed survey and control work.** Review past contractor performance (issue Requests for Proposals if necessary).

5. **Secure necessary permits and grants.** Permit application will be coordinated with the contracted applicator. Grant application will be coordinated with the MLMC and Mason Conservation District.

6. **Implement community volunteer plan.**
   We will recruit residents to become certified divers also trained in aquatic plant recognition.

7. **Apply herbicide treatment**. Application will be completed as prescribed in IAVMP, unless consultation with Ecology and the applicator leads to changes in the plan based on new data.

8. **Conduct follow-up surveys**. Professional contractors and community members who have received training can complete this work.,

9. **Apply follow-up herbicide treatment if necessary.** Follow-up surveys will determine the extent to which this work is necessary.

10. **Conduct diver surveys, hand-pulling/bottom barriers as necessary**. Professional contractors and community members who have received training can complete this work, with community participation under professional supervision.

11. **Annual review of IAVMP plan**
    Steering team will review current treatment year, use lessons learned to meet plan goals in coming year.

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