CLEAR AND BEAVER LAKE

INTEGRATED AQUATIC VEGETATION

MANAGEMENT PLAN

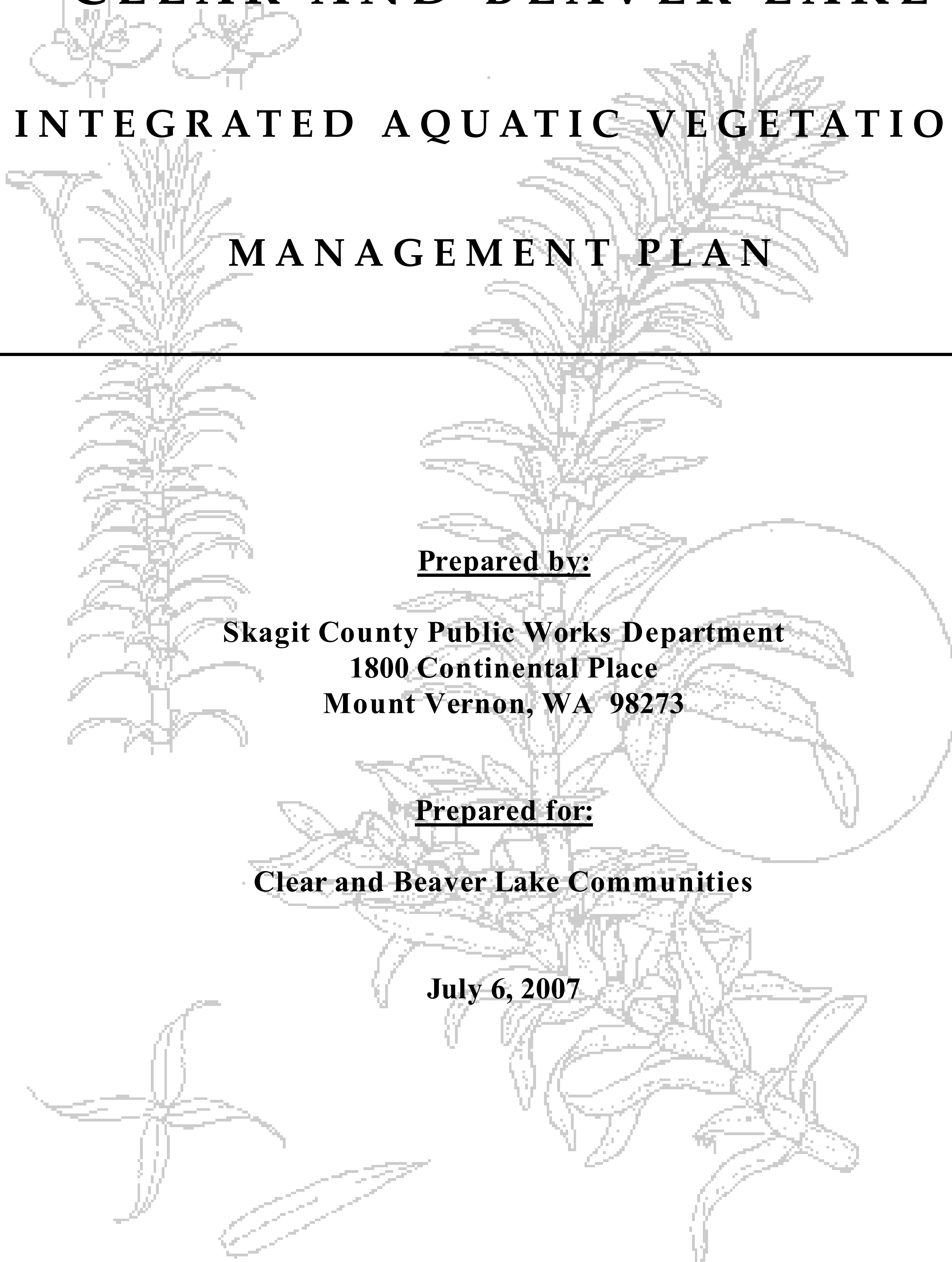
Clear Lake, Washington

Beaver Lake, Washington

CLEAR AND BEAVER LAKE

INTEGRATED AQUATIC VEGETATION

MANAGEMENT PLAN



Prepared by:

Skagit County Public Works Department
1800 Continental Place
Mount Vernon, WA 98273

Prepared for:

Clear and Beaver Lake Communities

July 6, 2007

Acknowledgements

Project Authors

- Stephanie Woolett
- Chris Kowitz
- Michael See

Project Funding

- Washington State Department of Ecology
- Skagit County

Project Support

- Kathy Hamel, Washington State Department of Ecology
- Josh Greenburg, Skagit County GIS
- Enviro Vision Corporation

Clear & Beaver Lakes Advisory Committee

- Brian Adams
- Stan Buchanan
- Stephen Burgess
- Burl Fox
- George Bellos
- Gretchen Hunter
- Rob Janicki
- Mike Janicki, Chair
- Lee Johnson
- Rita Johnson
- Susan Parker Swetman
- Rick Van Pelt
- Ron Walt

TABLE OF CONTENTS

LIST OF TABLES & FIGURES

EXECUTIVE SUMMARY

Clear and Beaver Lakes, located in the lower East Fork Nookachamps Watershed, are heavily infested with invasive aquatic plants, including Eurasian watermilfoil and Fragrant Water Lily. Citing a number of problems associated with the dense growth of aquatic plants, a group of lakeside residents from Clear Lake requested assistance from Skagit County Public Works to control Eurasian watermilfoil and Fragrant water lily to promote recreational, aesthetic, and environmental values of the lake. In 2005, the County received a Department of Ecology Aquatic Weed Management Fund grant to develop an Integrated Aquatic Vegetation Management Plan (IAVMP) for Clear and Beaver Lakes.

Eurasian watermilfoil (*Myriophyllum spicatum*), is a submersed aquatic noxious weed that proliferates to form dense surface mats of vegetation in the littoral zone of lakes and reservoirs. It reproduces by fragmentation and rhizomes, and is easily spread when fragments "hitch-hike" on boat props and trailers that move between lakes. Once introduced, *M. spicatum* can degrade the ecological integrity of a water body within 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 organisms. *M. spicatum* can also reduce dissolved oxygen concentrations by inhibiting mixing in areas where it grows. Oxygen levels are further depleted by bacteria that consume oxygen when the plant begins to decompose at the end of the growing season. Decomposing milfoil adds nutrients into the water that could potentially lead to increased algal growth and related water quality problems. Dense mats of *M. spicatum* can increase water temperatures by absorbing more sunlight, create mosquito breeding areas, and negatively affect recreation activities enjoyed by lake users including swimming, boating, and fishing.

Fragrant water lily (*Nymphaea odorata*) is a floating leaved, rooted aquatic plant that colonizes shallow areas of lakes, reservoirs, shallow ponds, and slow moving streams. *N. odorata* can be recognized by the fragrant white, pink to purple, flowers that float on the water surface and large round floating leaves that have a distinctive slit on one side. Although the roots, leaves, and seeds provide food for wildlife and waterfowl, *N. odorata* can be a nuisance in shallow lakes with a large littoral zone by decreasing water movement, increasing siltation rates, and impeding recreational opportunities for lake users.

This IAVMP is a comprehensive planning document that considers the best available information about the waterbody and watershed characteristics of Clear and Beaver Lakes prior to selecting and implementing a community-based integrated aquatic plant

control strategy. The IAVMP must be accepted by the Advisory Committee, then is presented to the Board of Skagit County Commissioners for formal adoption.

Once the communities have had a chance to review and comment on the IAVMP, the advisory committee will develop a rate structure to pay for the agreed upon implementation strategy that will extended for the next 10 years. For formation of a district, a vote by all landowners that would be affected by the assessment is held. The number of votes that each person receives is based upon the assessed value of his/ her property (ex. Assessed value of $10,000 receives 10,000 votes). If a majority of the landowners vote in favor of formation everyone must pay the assessment.

PROBLEM STATEMENT

Due to the prolific growth of the aquatic invasive species, Eurasian watermilfoil (*Myriophyllum spicatum*) and Fragrant water-lily (*Nympaea odorata*), Clear and Beaver Lakes experience degraded aesthetic, recreational, and ecological qualities that are valued by the lakeside community and public users. The recent discovery of a pioneering colony of Brazilian elodea (*Egeria densa*) poses an additional threat to natural and recreational resources of both lakes and downstream waterbodies. Located within the 100-year Skagit River floodplain, these highly invasive aquatic plants could potentially impact downstream waterways that provide important habitat for fish and wildlife by crowding out native plant species and degrading water quality. Implementation of aquatic plant management efforts to control Fragrant water-lily and eradicate Eurasian watermilfoil and Brazilian elodea would benefit the lake community by restoring natural lake conditions, as well as prevent the spread of invasive species to other waterbodies throughout the region.

The lakes are clustered approximately 6 miles south of Sedro Woolley on Hwy 9 near the Town of Clear Lake. The lakes are situated within a sub-basin of the Nookachamps Creek watershed, the first important salmon-producing tributary in the Skagit River watershed, which provides significant habitat for successful wild Coho salmon stocks (Skagit County Dept. of Planning 1995). Land use around Clear Lake is a combination of urban and rural residential development with large areas of private forest land and extensive freshwater forested/shrub and emergent wetlands along the east shoreline. There are two public[1] recreation facilities on Clear Lake: a public boat ramp on the north side of the lake and a swimming area maintained and operated by Skagit County Parks and Recreation. Beaver Lake, on the other hand is largely undeveloped due to the presence of extensive intact freshwater forested/shrub and emergent wetlands that have been mapped by the National Wetland Inventory. Lakeside parcels are privately owned with the exception of the WDFW public boat ramp, which provides fishing, hunting, and wildlife viewing opportunities for public users. Property owners of lakeside property around Beaver Lake either live outside of the area or are significantly set back from the shoreline and have limited direct lake access for recreation.

Eurasian watermilfoil was first observed in Clear Lake in 1994 during an aquatic vegetation survey conducted by the Department of Ecology; however, it is unclear when the invasive species was introduced. Large patches of Eurasian watermilfoil are present throughout the littoral zone in Clear Lake, especially at the fringes of the extensive bands of Fragrant water-lily that parallel the lake's shoreline.

Eurasian watermilfoil was first observed in Beaver Lake during an aquatic plant and milfoil weevil survey conducted in 1999 as part of the State-wide Lake Monitoring Program (Parsons 2005). The dense surface mats of milfoil at Beaver Lake are evenly distributed throughout the lake and inhibit boat access. A small pioneering colony of Brazilian elodea was discovered in a small cove along the northwest shoreline of Beaver Lake on September 8, 2005 by EnviroVision scientists conducting an aquatic vegetation survey of the lake. According to the survey, the patch of Brazilian elodea appears to be limited to less than a ¼ acre in size. Fragrant water-lily is not a significant management concern at Beaver Lake at this time. The extensive aquatic plant growth at Beaver Lake impedes recreational fishing opportunities.

A hardy, prolific plant species, Eurasian watermilfoil forms dense surface mats that crowd out native vegetation, reduce biodiversity, impair water quality, decrease valuable wildlife habitat, limit recreational access, and diminish aesthetics. Like Eurasian watermilfoil, Brazilian elodea is a prolific, non-native aquatic plant that forms monospecific stands that crowd out native aquatic plants, as well as inhibit recreational uses enjoyed by lake users and shoreline residents. Brazilian elodea is a highly adaptable plant that can grow in lakes, as well as slow moving streams. Infestations of Brazilian elodea are known to significantly increase plant biomass in lakes, alter water quality, limit water movement, and increase sedimentation rates. Eradication of Brazilian elodea is necessary to prevent its spread to other Skagit County lakes and waterways, as well as to restore the environmental quality of Beaver Lake. Left untreated, the infestation of Eurasian watermilfoil and Brazilian elodea will continue to significantly reduce the aesthetic, recreational, and ecological characteristics that are valued by lakeside residents and public users of the lakes.

As a group these invasive plants:

- Pose a safety hazard to swimmers and boaters by entanglement.
- Crowd out native plants, creating monocultures lacking in biodiversity.
- Impair water quality by decreasing dissolved oxygen and increasing temperature and pH.
- Significantly reduce fish and wildlife habitat important to the integrity of the lake ecosystem.

- Pose a threat to adjoining ecosystems.

The community at Clear Lake has expressed interest in restoring Clear and Beaver Lakes to their natural condition beginning with the eradication of noxious aquatic weeds, including Eurasian watermilfoil, Brazilian elodea, and Fragrant water-lily. As evidenced by the signing of a petition, the Clear Lake community is willing to explore the idea of forming a Lake Management District to finance the integrated control strategy identified in this Integrated Aquatic Vegetation Management Plan. Although Beaver Lake property owners are not opposed to the idea of eradicating Eurasian watermilfoil and Brazilian elodea in Beaver Lake, they do not benefit directly from the implementation of the project goals and are involved in the process to ensure that their community's values are considered in the development of this plan. The community recognizes the potential for re-infestation following the initial control efforts and is committed to developing an early detection and prevention program to prevent that occurrence.

MANAGEMENT GOALS

The overall management goal is to eradicate Eurasian watermilfoil (*Myriophyllum spicatum*) from Clear and Beaver Lakes and Brazilian elodea (*Egeria densa*) from Beaver Lake, to prevent the spread of the noxious weed to downstream waterbodies during flood events, as well as other lakes in Skagit County and Washington State, and to control Fragrant water-lily (*Nymphae odorata*) to facilitate increased access to the lake for recreational users. Implementation of this project will also allow native plant and animal communities to thrive, decrease negative impacts to water quality conditions, preserve the recreational opportunities provided by the lakes, and restore the aesthetic beauty of the lakes through the control and elimination of aquatic noxious weeds.

The five strategies identified below will ensure success in achieving the stated goal of the community:

1. Involve the community in the management process.

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

3. Evaluate the effectiveness of management actions.

4. Amend the management strategy as necessary to achieve the stated goals of the community.

5. Provide information about lake stewardship and aquatic plants to the community to sustain the lakes valuable resources while facilitating the prevention and early detection of aquatic invasive species in Clear and Beaver Lakes.

Details associated with the implementation of the management objectives are provided in subsequent sections of this plan.

PROJECT HISTORY

Community Involvement

In the summer of 2004, a group of residents contacted Skagit County Commissioner, Ted Anderson, regarding problems associated with the prolific growth of Eurasian watermilfoil (*Myriophyllum spicatum*) and fragrant water lily (*Nymphaea odorata*) at Clear Lake. Lakeside residents and lake users noted that dense stands of milfoil and extensive bands of Fragrant water-lily hinder lake access for recreation and visual enjoyment. In response, the County met with a small representative group of local residents to discuss the problem and potential alternatives, including planning requirements and financing options associated with aquatic plant management. At this meeting, it was determined that, due to the hydrological connectivity of Clear and Beaver Lakes, any successful treatment strategy to eradicate invasive species in Clear Lake must address the infestation at Beaver Lake.

The lakeside residents at Clear Lake demonstrated willingness to plan for and implement an Integrated Aquatic Vegetation Management Plan (IAVMP) to control and/or eradicate noxious aquatic plants, as evidenced by the signing of a petition (Appendix I). Subsequently, Skagit County applied for and received a grant from the State's Aquatic Weed Management Fund that supports the Clear and Beaver Lakes IAVMP Development Project. An advisory committee composed of lakeside residents representing both lake communities was established to guide the development of the IAVMP.

Summaries of planning and public meetings held are provided below. The agendas, sign-in sheets, and minutes are provided in Appendix II.

Planning Meeting #1 – May 9, 2005

Property owners interested in aquatic plant management at Clear Lake met with Skagit County staff during this meeting to review the process for developing an IAVMP and forming an Advisory Committee.

County staff informed those present that the County successfully acquired grant funding for the IAVMP. To assist the community, the County would provide the required matching fund. Following a discussion regarding the process for developing the IAVMP, several questions were raised about aquatic plant control techniques, as well as funding mechanisms for implementing the IAVMP once completed.

The next meeting was scheduled to take place on June 13th, 2005 at 2:00pm.

Planning Meeting #2 – June 13, 2005

The purpose of this meeting was to discuss progress made on forming an Advisory Committee and to draft a problem statement for the IAVMP.

The group decided that Advisory Committee representation should be diverse and include property owners from both lake groups at differing locations around each lake. This measure will help to ensure that all viewpoints will be represented during Advisory Committee meetings. The group decided to hold a community meeting at the Rita and Lee Johnson's residence to seek approval for members and address questions associated with aquatic plant management. It was decided that County staff would not be present at that meeting.

Members present participated in brainstorming ideas for the problem statement. The group listed several user groups and identified four categories that embody the main problems posed by noxious aquatic plants. Safety impairment due to dense stands of submerged and floating leaved plants was the most important issue identified. Ecology of the lakes was identified as an important issue for the group. Disruption of predator/prey relationships, water quality degradation, and habitat loss were among the specific ecological concerns referenced. Loss of recreation opportunities at Clear Lake represents a concern for the lake community because dense plant populations around the lake margins interferes with swimming, boating, and fishing activities enjoyed by lakeside residents and public users. At Beaver Lake, dense Eurasian milfoil growth throughout the lake prohibits public lake access for motorized boating and severely impairs fishing opportunities. Lakeside residents enjoy the aesthetic benefits of living near Beaver Lake; however, they do not have docks and do not utilize the lake for fishing or boating activities. Finally, Clear Lake residents complained about the unsightliness of fragrant water lily and Eurasian watermilfoil.

Following the discussion of problems faced by the lakes, the group discussed the long-term management goals for the lakes. At Clear Lake, there is interest in conducting a whole-lake restoration project that includes water quality and ecological improvements. Specific mention was given to removing the pilings remnant of the Georgia Pacific mill operation. These pilings are known to alter predator/prey relationships among fish.

Mention was also given to reducing nutrient inputs associated with lakeside development, especially leaky septic systems.

The meeting ended after the group decided to meet on July 18, 2005 to review the draft problem statement, solidify the management goals, and begin discussing the forum for the first public meeting.

Planning Meeting #3 – July 18, 2005

The purpose of this meeting was to discuss the results of the previous community meeting, review the draft problem statement, solidify the management goals, and discuss the forum for the first public meeting.

Due to the presence of new faces, a brief overview of the project history and the aquatic plant management process was provided. The individuals representing Beaver Lake expressed that they were not interested in providing financial support for aquatic plant management because they would not derive a direct benefit from such efforts. The process for Lake Management District (LMD) formation, according to RCW 36.61 was briefly reviewed, and it was explained that the community will have a good measure of flexibility in determining the LMD assessment rate structure if a LMD is approved.

During the review of the problem statement and management goals, Beaver Lake residents present requested that the language be modified to clearly show that the goals of the Beaver Lake community do not reflect those at Clear Lake. The residents from Beaver Lake expressed that they do not experience any problems associated with noxious weed growth and reiterated that they do not support any effort that would require their financial commitment.

The draft management goals were reviewed and everyone present agreed that the goals, as stated, would ensure the success of the IAVMP if implemented.

A date for the first public meeting was set for September 20, 2005 at 6:00 p.m. at the Clear Lake Covenant Church. The purpose of the public meeting would be to introduce the IAVMP planning progress and solicit feedback from the community.

Planning Meeting #4 – September 12, 2005

This meeting represented the first official meeting of the Advisory Committee. The meeting was called to update new members in the planning group to the progress made on the IAVMP to date, as well as to discuss changes to the problem statement due to the discovery of Brazilian elodea in Beaver Lake.

During the review of progress made on the IAVMP residents from Beaver Lake clearly stated that any benefit derived from the aquatic plant management efforts at Beaver Lake would be fish and wildlife habitat improvement and noxious weed re-infestation prevention for Clear Lake. When asked if the management goals should be explained differently for the IAVMP, the majority of the group indicated that the section should not be changed.

Beaver Lake residents also called into question the ownership of the lake. Due to the court's ruling in a 1964 lawsuit, one Beaver Lake resident indicated that the lake is privately owned, despite the presence of a WDFW public boat ramp. Copies of the lawsuit were distributed to Stephanie Woolett, Rob Janicki, Ron Walt, and Stan Buchanan.

The public meeting scheduled for September 20, 2005 was postponed due to problems with the venue and short advertising notice. The group suggested that it would be helpful to have a guest speaker from one of the Skagit LMDs to talk about the successes and challenges faced by his/her lake community. This would facilitate greater understanding of the process.

At the close of the meeting, Stephanie indicated that she will work with the County's GIS Department to develop a Beneficial Use Area map that shows spawning areas, shellfish beds, fishing grounds, and swimming areas.

Public Meeting #1 – November 3, 2005

The purpose of this meeting was to introduce the IAVMP Development project and to solicit community feedback regarding the Problem Statement and Management Goals. In total, there were 19 community members and County staff present.

The meeting began with the introduction of Stephanie Woolett, the Skagit County Water Resources Technician, primary author of the IAVMP.

Following a brief project history, Woolett delivered a presentation using PowerPoint to provide an overview of the local watershed and the pros and cons of managing the plant life within it. For clarification, she explained that the initial efforts began with goal of controlling invasive aquatic plants at Clear Lake; however, the hydrological connectivity of Clear & Beaver Lakes necessitates the inclusion of Beaver Lake in order to achieve success at Clear Lake.

Subsequent to describing the elements of an IAVMP and providing an overview of the Problem Statement and Management Goals, the community was provided the opportunity to ask questions and comment on the project.

A brief summary of questions and comments regarding the presentation are provided below:

- One citizen inquired about the timeline of the IAVMP. Woolett explained the process could take up to June 2006. Once the plan is completed, it will be reviewed by the Department of Ecology for the State's approval, and then be adopted by the Board of Skagit County Commissioners. Implementation of the plan is contingent upon a positive vote of the community to form a Lake Management District (LMD). An LMD is a self-taxing district established by the affected community that will provide the primary financing mechanism for aquatic plant control at the lakes. Additional funding for the IVAMP will be sought through state grant applications.

- A Beaver Lake resident raised the point that implementing an aquatic plant control strategy would need to be paid for by the community. Members should consider that not all lakeside property owners enjoy lake access, as is the case with Beaver Lake. In the event a LMD is formed, homeowners would be subject to penalties for not paying the tax on time, such as a lien. Woolett acknowledged the concern and indicated that these are considerations that the community should be mindful of when determining whether or not to support LMD formation.

- A Beaver Lake resident inquired about the lake's ownership and stated that Beaver Lake residents are not in agreement that plants should be managed. He expressed his belief that the lake is privately owned and that, according to a lawsuit brought forward in the early 1960's, aquatic plant management is not permissible. Woollett indicated that all surface waters are owned by the state and that she will look into the lawsuit.

- Another resident questioned the length of time it takes for an infestation to occur. Woollett replied that infestations of Eurasian watermilfoil and Brazilian elodea can be very rapid, possibly occurring within one growing season.

Marsha Flowers, the Advisory Committee chairperson for Lake Management District #3, spoke about the aquatic plant management efforts undertaken by the lakeside community at Lakes Erie and Campbell. The purpose of this presentation was to provide the audience with the opportunity to hear from someone who has been personally involved in lake management in her own community. She explained that like Clear and Beaver Lakes, Lakes Erie and Campbell are hydrologically connected by a small stream that is a conduit for plant fragment transport between the lakes. The lake community developed an IAVMP and implemented a treatment strategy that included herbicide treatments to remove the plants, as well as grass carp stocking to maintain a plant community that balances benefits to fish, wildlife, and recreation. The success of aquatic plant management efforts at Lakes Erie and Campbell is due to the community's willingness to stay involved. Volunteers hand out educational brochures, clean the fish screens, and hand-remove early infestations of weeds when observed.

To conclude the meeting, the Advisory Committee was introduced to the community. Everyone present was provided with a form for written comments to facilitate greater communication regarding the IAVMP Development project.

Public Meeting #2 – February 8, 2006

The main objective of this public forum was to present the control alternatives available to combat Eurasian watermilfoil, Brazilian elodea, and fragrant water lily. Community feedback provided during the meeting was used to develop the integrated control strategy to manage the problem plants.

During this meeting, several questions were raised by community members regarding the cost and environmental impacts of aquatic plant control alternatives. Due to the small size of the lakeside community, it is important that the control alternatives implemented to control noxious weeds are affordable. Furthermore, the lakeside property owners at Beaver Lake represented their view that aquatic plant management charges should only be assessed against properties at Clear Lake that enjoy lake access. Water use restrictions for the aquatic herbicides were another popular topic because of concerns relating to health and environmental effects of the chemicals.

Planning Meeting #5 – February16, 2006

The purpose of the meeting was to review past business regarding the IAVMP status, finalize the Problem Statement and Management Goals, and review the control alternatives for noxious weed control for both Beaver and Clear Lakes. Lastly, the development process of a Lake Management District was discussed.

The first item discussed was Woolett's departure from the County. Ric Boge, Skagit County Public Works Surface Water Manager, explained that Chris Kowitz, Water Resources Technician, would be the interim contact.

Woolett provided an overview of the progress on the IAVMP and what's next in the process. She talked briefly about the public meeting held on February 8, 2006 regarding control alternatives. Each control alternative was discussed and then a verbal "yes" or "no" from the committee was recorded. No one was in favor of the 'no action' alternative; although, there was discussion and questions about what would happen if the committee did nothing. Everyone concured that the 'preventative' alternative should be examined, but no implementation strategy was decided upon. The 'chemical' alternative was chosen as the main mechanism for controlling noxious plants in both lakes: Glyphosate, Sonar, and Diquat were the chemicals agreed upon. Manual control was discussed and will be used to control Brazilian Elodea in Beaver Lake. It was also decided that this may be used around docks and obstructions for water lilies. In the event new infestations of Eurasian milfoil or Brazilian elodea are discovered following the initial herbicide treatments, hand removal should be employed; however, care must be taken to collect and properly dispose of all plant fragments. The group decided to include the purchase of one hand-cutting devise as part of the integrated strategy. This will be an experiment and more may be purchased depending on its success for localized lily control. Some interest was expressed in using the Mifoil Weevil as a biological control, especially if they are native to Northwest lakes. Stephen Burgess motioned to include the control methods listed above in the integrated strategy for the IAVMP, Brian Adams seconded it, and the motion carried with none opposed.

Woolett read the Management Goals and Problem Statement to the group and asked for feedback. It was suggested that an amendment be added to include common names for the noxious aquatic plants. Adams made a motion to accept the Management Goals and Problem Statement, Burgess seconded the motion, and it carried with none opposed. Boge then suggested that the group elect a Chairperson and note-taker. Mike Janicki was nominated for Chairperson by Adams, Gretchen Hunter seconded the motion and it carried with none opposed. The group decided to table nominations for a note-taker until a later date.

Numerous issues were discussed throughout the meetings that were not directly related to the meeting's objectives. There were questions and discussions regarding lake ownership, liability and who actually owns the water and lake bottom. Ron Walt was under the impression that he did, in fact, own the lake bottom on his parcels around Beaver Lake. Adams said he would send Woolett an RCW regarding liability in water-bodies. Water rights versus water ownership were also discussed at length. Further clarification on these issues was requested by the Committee.

The Beaver Lake community members on the Committee once again reiterated the point that they do not feel like they should be taxed for this work. Some also thought the County should pick up some, if not all, of the cost associated with noxious weed removal. Janicki indicated that the group should agree that Beaver Lake residents, because they do not have docks for lake access, do not benefit from aquatic plant management and should not have to pay. Burgess voiced his disagreement, citing that removal of noxious weeds may increase property values and that this matter should be investigated prior to agreeing that Beaver Lake residents should not be included in the assessment pool for a proposed Lake Management District (LMD).

Lastly, Woolett passed out copies of RCW 36.61, the statute for Lake Management Districts. She asked the Advisory Committee to review these documents before the next meeting. The committee requested that a warm-water fisheries biologist from WDFW be present at the next meeting to answer questions about fisheries management at Clear & Beaver Lakes. Specific reference was given to warm water versus cold water fisheries management.

Planning Meeting #6 – May 18, 2006

The purpose of this meeting was to receive a presentation from the WDFW Inland Fish Biologist, review and approve the final draft IAVMP, and discuss the next step in the LMD formation process.

Mark Downen provided a presentation to the Advisory Committee on the warm water fish management of Clear and Beaver Lakes. Downen discussed past rehabilitation efforts at Clear Lake and the current fish populations. Regarding vegetation management, Downen emphasized that neither too much vegetation nor too little will provide a healthy fish habitat. Following a brief description of the Clear and Beaver Lakes IAVMP by the Advisory Committee, Downen expressed support for the goal to eradicate noxious weeds like Eurasian Milfoil and Brazilian elodea.

Mike Janicki (Chair) asked the Committee if anyone had comments or questions regarding the final IAVMP draft comments that were submitted after the last meeting. With no questions from the members present, Janicki asked if there was a motion to skip the comment by comment review and to adopt the draft as written. Hunter made a motion to adopt the plan as written. Susan Swetman then seconded the motion. As a result, the final draft of the IAVMP was officially accepted by the Advisory Committee.

Planning Meeting #7 – June 8, 2006

The Clear & Beaver Lakes Advisory Committee meeting commenced at 2:25 p.m. at the Skagit County Public Works office. The purpose of this meeting was to review the draft funding scenarios for Clear and Beaver Lakes as compared to the existing three LMDs and to discuss available possibilities.

Matt Barrett, Surface Water Management Intern, prepared four possible funding scenarios for the treatment strategy outlined in the IAVMP. These four scenarios were based on the roll and rate structure for the existing three lake management districts. Barrett presented these scenarios to the Advisory Committee and answered related questions.

The Advisory Committee determined that the Lake Campbell/Erie (LMD#3) most closely matched the financial need for the proposed treatment strategy. The Advisory Committee made several modifications to the original LMD #3 scenario. The revised scenario includes the following information:

- a.) Residential and undeveloped parcels are assessed $195 ($195 x 1 unit)
- b.) Public and private parcels that provide access to the lakes are assessed $390 ($195 x 2 units)
- c.) Parcels zoned as "Open Space Farm and Agriculture" are assessed $390 ($195 x 2 units)
- d.) Commercial parcels are assessed $975 ($195 x 5 units)
- e.) Public boat launches are assessed $3,900 ($195 x 20 units)
- f.) Beaver Lake parcels, except WDFW are assessed $0.

Janicki proposed that he be assessed for the number of zoned lots, not necessarily the number of parcels. This would result in Janicki (Cultus View, LLC) being assessed an additional 14 units for parcel #P23290. Furthermore, the Advisory Committee formally determined that Beaver Lake parcels, with the exception of public boat launches and public access, will be assessed $0.

Walt expressed his concern that he was not notified of the May 18, 2006 meeting in which the final draft IVAMP was approved by the Committee. Walt informed the Committee that he was disappointed to miss the speaker from WDFW and that his comments to the plan were not seriously reviewed. Janicki informed Walt that his concerns would be addressed at the public meeting and See stated that the draft comments would be included in the final IAVMP appendices.

Public Meeting #3 – June 14, 2006

The purpose of this meeting was to present the draft IAVMP and action strategy to the community for its concurrence. The goal was to solicit feedback and make amendments to the IAVMP in the event community feedback warrants changes. Approximately 17 individuals attended in which a slide show describing the plan was presented. Community members were informed of an upcoming community vote to show support for the plan. A question and answer period followed the presentation.

Public Meeting #4- July 12, 2006

The purpose of this meeting was to provide another opportunity to present the draft IAVMP and action strategy to the community. Approximately 18 individuals attended. A community vote was held to show support for the IAVMP goals and treatment strategy. Written ballots were handed out to everyone in attendance. When counted, all 16 ballots, that were submitted, were in support of the plan

Plan adoption by the Board of County Commissioners- T.B.D.

Following community consensus to approve the plan, it must be taken before the Board of Skagit County Commissioners for formal adoption. It must also be acknowledged that the plan implementation is contingent upon grants and/or dedicated funding for this purpose.

LAKE AND WATERSHED FEATURES

Lakes are complex ecosystems that include their entire drainage basin or watershed. A watershed consists of all the surrounding land and water areas that drain toward a central collector at a lower elevation, such as a river, stream or lake. Water inputs to lake ecosystems come from precipitation, surface water runoff, and ground water seepage. As water travels throughout the watershed it collects dissolved and suspended materials from the land that impact the water and habitat quality of a lake. Nutrients phosphorus and nitrogen are important because they are the primary nutrients that fuel aquatic plant and algae growth. Development in a watershed increases the likelihood that erosion and increased surface water runoff will add unwanted pollutants to downstream waterbodies like lakes. This section provides an overview of the known physical and biological characteristics of Clear and Beaver Lakes and their associated watersheds.

Set against the backdrop of Cultus Mountain and surrounding hills, Clear and Beaver Lakes are clustered in a low-lying area in the Nookachamps Creek watershed, in the Skagit River Basin (Township 34 North, Range 5 East, Section 7, W.M.). Small, shallow lakes of glacial origin, Clear and Beaver Lakes are hydrologically connected and drain into an unnamed stream that empties into Turner Creek, a tributary of East Fork Nookachamps Creek. The local climate is characteristically mild with wet, cool winters and dry, warm summers. According to the Western Regional Climate Center, the average annual rainfall recorded at Sedro Woolley, just north of Clear and Beaver Lakes, is 46.17 inches per year. Historically, the largest amounts of precipitation for the region typically occur during November and December while the driest months of the year are July and August (Western Regional Climate Center).

Clear and Beaver Lakes are infested with several state-listed noxious weeds, including Eurasian milfoil (*Myriophyllum spicatum*), Brazilian elodea (*Egeria densa*), Fragrant water-lily (*Nymphaea odorata*), and yellow-flag iris (*Iris pseudacorus*). Non-native or invasive aquatic plants can pose serious problems to lake ecosystems. Unlike their native counterparts, whose balance has been established through a long process of evolution, there are no diseases or insects to keep invasive aquatic plant growth in check (Ecology, 1994). As a result, invasive species like Eurasian watermilfoil can flourish, crowding out native plants that provide food, shelter, and nesting sites for fish, waterfowl, and other animals. Additionally, dense invasive aquatic plant growth can impair water quality, as well as limit access for recreation and other beneficial uses. Developing an understanding of basic lake and watershed dynamics will facilitate the identification and implementation of the most efficient aquatic plant control strategy to successfully restore beneficial uses to Clear and Beaver Lakes.

CLEAR LAKE

Physical Description

Clear Lake is 200-acres with a mean depth of 23-feet and a maximum depth of 44-feet. The shoreline totals 2.4 miles in length and is regularly shaped with few coves or other shoreline irregularities. A seasonal stream enters the lake from the northeast and represents the only surface water body that feeds the lake. Lakeside residents have reported that groundwater seeps feed the lake; however, there are no records indicating the extent and location of ground water inputs. The outlet located along the southern shoreline provides a connection to Beaver Lake and likely serves as a conduit that facilitates the spread of plant fragments between the lakes during rain and flood events. Extensive wetlands around the lake have been mapped by National Wetland Inventory (NWI) and provide valuable habitat for fish and wildlife.

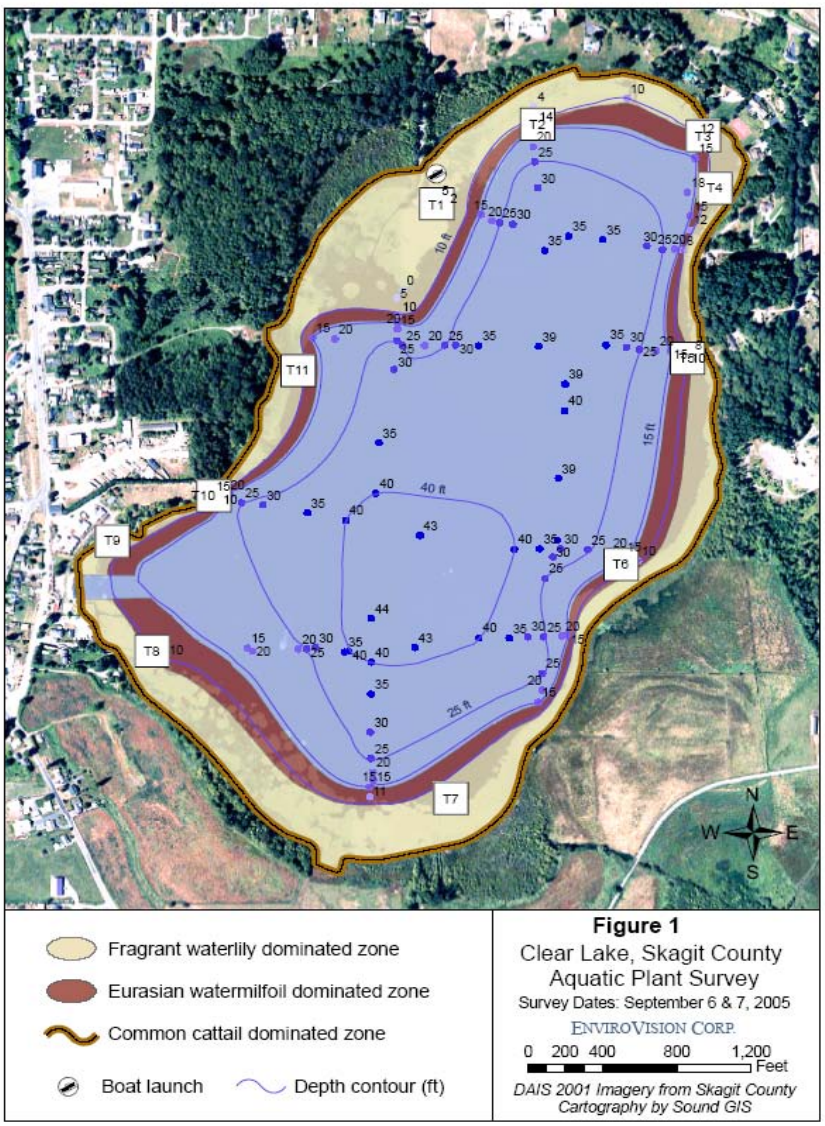
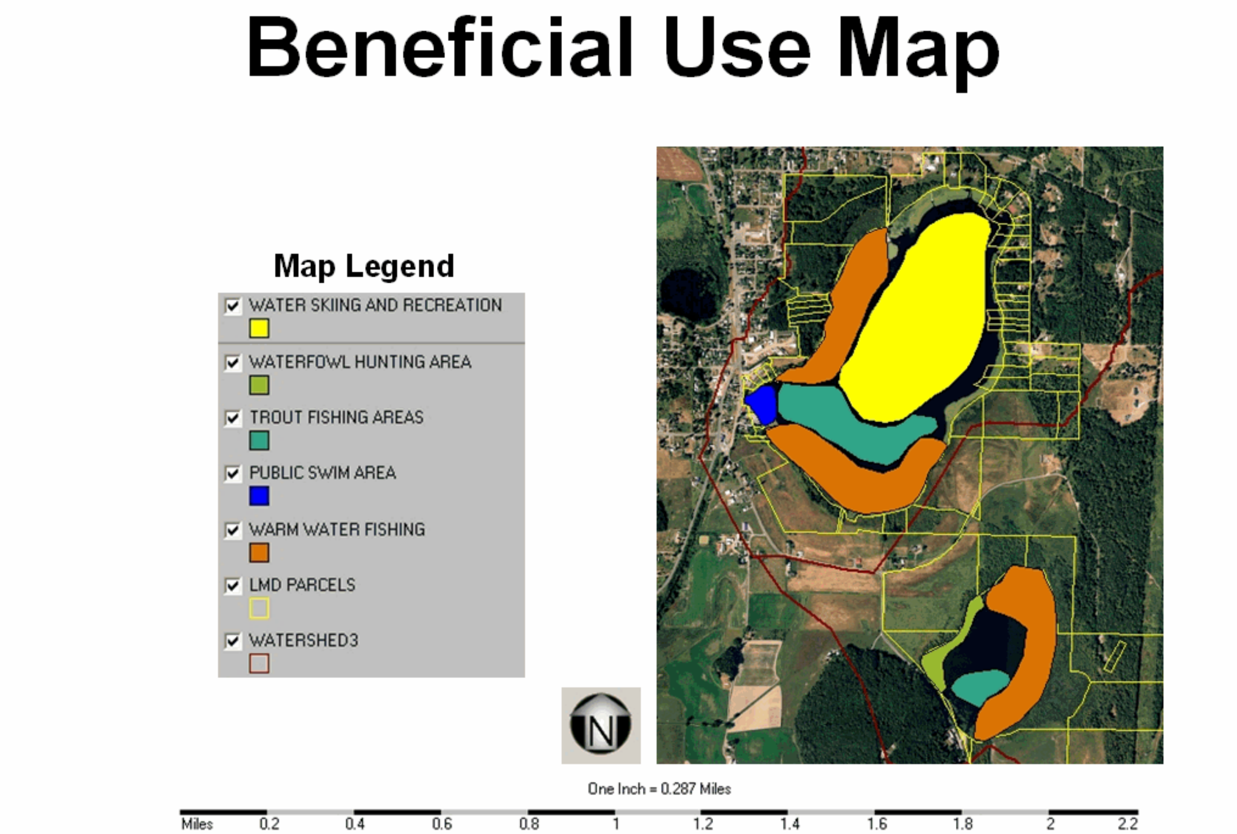


Figure 1
Clear Lake, Skagit County
Aquatic Plant Survey
Survey Dates: September 6 & 7, 2005

Land Use

The land adjacent to Clear Lake is rural in nature with low density development overall and low to moderate intensity uses that include residential, commercial, agricultural, and recreational development (Skagit County Planning & Development Services). Due to wetland areas along the lake shoreline, the land use pattern around the lake consists of large tracts of open space with intermittent residential development. Most of the development around the lake occurs within the Clear Lake town limits, along the western shoreline, which supports low to moderate density residential development. A public boat launch on the lake provides access for fishing, waterskiing, boating, and wildlife viewing. A County-owned recreation facility provides lake access for swimmers.

Figure 3.



Aquatic Plants

Clear Lake is heavily infested with Eurasian watermilfoil and Fragrant water-lily. These plants are known to pose a significant safety hazard, impede recreation, negatively impact the ecological integrity of the lake ecosystem, and reduce aesthetic enjoyment of the lake. Aquatic plants are a vital component of lake ecosystems. In addition to providing food and shelter for fish and wildlife, native aquatic plants can help protect water quality and provide natural shoreline protection. When a lake becomes infested with a non-native species it can spread rapidly and out-compete native species. Non-indigenous species have the ability to proliferate because there are no diseases or insects that keep their growth in check. The result can be a lake characterized by monospecific stands of invasive aquatic plants.

Eurasian watermilfoil

Eurasian watermilfoil is native to Europe, Asia, and North Africa and also occurs in Greenland (Washington State Noxious Weed Control Board 1995). Eurasian watermilfoil is among the worst aquatic pests in North America. *M. spicatum* is a submersed, perennial aquatic plant with feather-like leaves. It 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 produce tiny leaves. In western Washington, Eurasian watermilfoil frequently over-winters in an evergreen form and may maintain considerable winter biomass (King County 2003). This plant forms dense mats of vegetation just below the water's surface. In late summer and fall, the plants break into fragments with attached roots that float with the currents, infesting new areas. Disturbed plants will also fragment at other times of the year, which may increase the extent of the infestation since 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 believe that milfoil seeds might be playing a bigger role in repopulating lakes than previously thought. Milfoil starts spring growth earlier than native aquatic plants, and thereby gets a "head start" on other plants. Eurasian watermilfoil can degrade the ecological integrity of a waterbody 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 from decomposition of dead plant material at the end of the growing season. Decomposition of *M. spicatum* also releases phosphorus and nitrogen nutrients into the water, which can increase algae growth. Additionally, dense mats of Eurasian watermilfoil can increase water temperature by absorbing sunlight, raise the pH, and create stagnant water mosquito breeding areas. Eurasian watermilfoil negatively impacts recreation, including swimming, boating, and fishing. The dense vegetation makes swimming dangerous, snags fish hooks, and inhibits boating by entangling propellers or paddles and slowing the movement of boats across the water.

Fragrant water-lily

Nymphaea odorata is a floating-leaved, rooted plant that occupies shallow areas of lakes, ponds, and slow moving streams. It is native to the eastern part of North America and is a popular gardening plant. As an introduced species, it can be problematic in lakes with extensive shallow areas because it restricts water movement, impairs recreation, and increases siltation, temperature, and water loss through high evapotranspiration rates.

The Fragrant water-lily produces 6 to 12cm flowers with many white, pink, or purple petals that float on the water, and leaves that are large and round with a large notch on one side. The leaves can reach 30cm in diameter, have a thick and leathery texture, and often have red or purplish undersides with many veins. The floating leaves and flowers are attached to the plant roots by straight flexible stalks that are rooted to the lake bottom. Thick rhizomes that range from 2 to 3 cm in diameter make up the root system, which represents one of the plants reproductive pathways. Propagation also occurs by seeds. According to Joseph DiTomasi and Evelyn Healy, in their book, *Aquatic and Riparian Weeds of the West*, seed germination requires light and the presence of ethylene, a gas that is produced when plants are crowded together (DiTomasi and Healy 2003). Due to the requirement for light, lakes with extensive shallow areas, like Clear Lake, may be more susceptible to the proliferation of this species.

Clear Lake Aquatic Plant Community

Eurasian milfoil was initially documented in Clear Lake in 1994 when the Department of Ecology staff conducted an assessment of the water quality and aquatic plant community. No control efforts were implemented to address the lake-wide infestation; however, in 1994 Skagit County Parks and Recreation began a program of localized control at the public swimming area. Implementing a control program at this location was a proactive measure to prevent swimmers from becoming entangled in the dense aquatic weed growth (Adams, Personal Communication). Initially, the County utilized the bottom barrier as the primary control method. This proved problematic so the County elected to adopt the use of herbicides as the primary control strategy.

The aquatic plant community at Clear Lake is largely comprised of non-native species including Eurasian milfoil (*Myriophyllum spicatum*), Fragrant water-lily (*Nymphaea odorata*), yellow flag iris (*Iris pseudacorus*), and reed canary grass (*Phalaris arundinacia)*; although several native species were observed during the aquatic vegetation survey conducted in September 2005 (See Table 1). The survey revealed two general plant distribution patterns: one that is dominated by Fragrant water-lily and one that is dominated by Eurasian watermilfoil. Characteristics of each generalized plant community are provided below (See Table 1).

The Fragrant water-lily plant community exists in a solid band around the lake and extends 300-feet from the shoreline in areas that lie within the 8 to 10-foot depth contours. This plant community encompasses approximately 53 surface acres of the

Table 1. Clear Lake Aquatic Plant & Macroalgae Species List	
Common Name	**Scientific Name**
EMERGENT PLANTS	
Jewelweed	*Impatiens sp.*
Yellow flag iris	*Iris pseudacorus*
Reed canarygrass	*Phalaris arundinacia*
Water bulrush	*Scripus subterminalis*
Bulrush	*Scripus sp.*
Common cattail	*Typha latifolia*
FLOATING-LEAVED PLANTS	
Watershield	*Brasenia schreberi*
Yellow pondlily	*Nuphar polysepala*
Fragrant water-lily	*Nymphaea odorata*
SUBMERSED PLANTS	
Coontail; hornwort	*Ceratophyllum demersum*
Common elodea	*Elodea sp.*
Eurasian watermilfoil	*Myriophyllum spicatum*
Water-nymph	*Najas sp.*
Big-leaf pondweed	*Potamogeton amplifolius*
Grass-leaved pondweed	*Potamogeton gramineus*
Fernleaf pondweed	*Potamogeton robbinsii*
Thinleaf pondweed	*Potamogeton sp.*
Flat-stem pondweed	*Potamogeton zosteriformis*
Common bladderwort	*Utricularia vulgaris*
Water-celery	*Vallisneria americana*
ALGAE	
Nitella	*Nitella* sp.

lake, or 27% of the lake surface area. Recreational access, water circulation, and native plant habitat are impacted by the extensive surface mat of fragrant water lily.

The Eurasian milfoil plant community comprises 23 surface acres or 11% of the lake's total surface area. Plants in this zone grow between the 8 and 14-foot depth contours and produce dense surface mats when the plant flowers. An extensive milfoil patch was observed in the southwest corner of the lake. A large portion of this monoculture stand forms a surface mat, impacting navigational ability, while the rest remains just below the water surface. With the exception of two areas around the lake, dense milfoil stands colonize the lake. The areas characterized by low milfoil density are located near the Skagit County Parks and Recreation swimming area, as well as the area adjacent to the abandoned sawdust burner, which is located along the west shoreline north of the swimming area and south of the public boat launch.

The southeastern shore is largely undeveloped and may provide beneficial habitat for fish and waterfowl, as evidenced by the presence of snags and coarse woody debris in the nearshore area. Because dense stands of Eurasian milfoil and Fragrant water-lily impede access by fish and waterfowl areas with low density milfoil and lily growth may provide some adequate habitat. Removal of noxious weeds in Clear Lake, especially along the southeast shoreline, may increase the amount of quality habitat available to support native plants and animals.

Water Quality

A 1976 study conducted by the United States Geological Survey (USGS) measured several water quality parameters and surveyed aquatic plants to characterize the lake and determine its trophic status. The study concluded that Clear Lake was an Oligo-mesotrophic lake. At that time, the secchi depth measured 15-feet and 0-10% of the lake surface was covered by floating and submerged aquatic plants. Another survey was conducted in September 2005 to map the distribution of aquatic plants and collect basic water quality data for several parameters, including dissolved oxygen, conductivity, salinity, temperature, and secchi depth. Although the measurements collected in 2005 provide a snapshot of the lake's condition at the time of the survey, insufficient information was gathered to make conclusions about the overall water quality and trophic status of the lake.

The secchi depths were taken at two locations, one at the midpoint of the littoral zone and the other at the center of the lake. The average visibility measured 7-feet and 4-inches, which is a reduction of about ½ the visibility that was recorded in 1976 (See Table 2: Comparison of Clear Lake Water Quality Measurements). Nutrient and fecal coliform data were not collected during the 2005 summer survey. Large quantities of filamentous algae and some cyanobacteria blooms were observed by the survey team.

Table 2. Clear Lake Water Quality Data: 1976 & 2005

Year	DO (% Sat)	DO (mg/L)	Specific Conductance (μs)	Temp (C)	Secchi Depth
1976	n/a	9.4	87.0	8.5	15′ 0″
2005-T2	65.5	5.93	85.4	20.1	n/a
2005-T3	74.5	7.43	86.0	20.1	n/a
2005-T6	76.5	6.93	85.9	20.1	n/a
2005-T6	64.0	5.89	86.0	19.7	n/a
2005-T9	91.1	8.20	86.1	20.7	7′ 1″
2005-Ctr	n/a	n/a	n/a	n/a	7′ 7″

Water Rights

A search was performed to determine active surface and ground water rights and claims that are within the Clear Lake Watershed. In order to find this information, a search of the Washington Department of Ecology's Water Rights Applications Tracking System was performed. Ecology issues a disclaimer when providing this information that states "*Because of unauthorized changes or non-use, Ecology cannot guarantee the validity of Permits and Certificates.*" This search indicated only two certified and three uncertified claims for surface water rights listing Clear Lake as their source, see Appendix E (WDOE 2004). In addition to those listing Clear Lake as their source, there are an additional 29 claims that are located within the Clear and Beaver Lakes watersheds. At this time it is unknown how many un-registered residents use the lake water for irrigation. However, all lakeside residences are notified prior to herbicide treatments as required by the State permit.

Watershed Features

Clear Lake's watershed is a small sub-basin within the Nookachamps Creek Watershed in the Skagit River Basin. The system of WRIAs are frequently used by state resource agencies to refer to major watershed basins within Washington State. Clear Lake is located within Water Resource Inventory Area (WRIA) 3, the Lower Skagit-Samish combined watershed, and includes Lake McMurray, Big Lake, Beaver Lake, Nookachamps Creek, East Fork Nookachamps Creek, and the City of Mount Vernon.

Topographically, the Clear Lake watershed consists of low-elevation mountains, which are located to the north and east of the lake. Steep slopes adjoin the lake along the north eastern half of the lake, which is mapped as geological hazard associated with unstable slopes by the County's critical areas program. The shoreline in this area is largely undeveloped and characterized by coarse woody debris. Land to the south and west of Clear Lake is low-lying flat land, which is part of the Skagit River floodplain. The National Wetlands Inventory (NWI) maps extensive wetlands around the lake, which provide important habitat for fish and waterfowl. In addition, wetlands help filter pollutants and provide flood mitigation by acting as sponges that soak up excess water.

Land use in the Clear Lake watershed primarily consists of forestry, open-space, agriculture, rural, and residential development. The highest density of residential development within the drainage basin is located adjacent to the lake within the Clear Lake town limits (population: 942; 2000 census). The Skagit County Shoreline Master Program (SMP) divides the shoreline areas into two categories: Rural and Rural Residential. Rural shoreline areas are characterized by low density, and low to moderate intensity residential, agricultural, or outdoor recreational development (Skagit County Planning Dept. 1983).

Currently no public sewage treatment plant services the area, so all biological waste is treated by on-site septic systems. Leaky septic systems, impervious surface areas, sedimentation, and storm water runoff are factors that increase nutrient loading in waterbodies. Although much of the land within Clear Lake's watershed is used primarily for forest practices and rural residential development, increased nutrient input from sedimentation, storm water runoff, and leaky septic systems could contribute to an increased nutrient loading that could result in cultural eutrophication.

Fish & Wildlife

Visitors at Clear Lake enjoy a variety of activities, many of which are dependent on the lake's abundant fish and wildlife populations. Rainbow trout (*Oncorhynchus mykiss*), largemouth bass (*Microterus salmoides*), yellow perch (*Perca flavescens*), cutthroat trout (*Oncorhynchus clarki*), and bullhead catfish (*Ameiurus nebulosus*) are common fish species caught from Clear Lake. In 2005, the Department of Fish and Wildlife planted over 1,000 triploid rainbow trout into Clear Lake. Triploid fish are not able to reproduce; however, they typically grow faster than diploid fish.

Other wildlife, especially the avian communities, brings large crowds of bird watchers to Clear Lake. The National Audubon Society submitted a survey of the bird community that can be found throughout the year (Appendix A).

Threatened or Endangered Plants and Animals

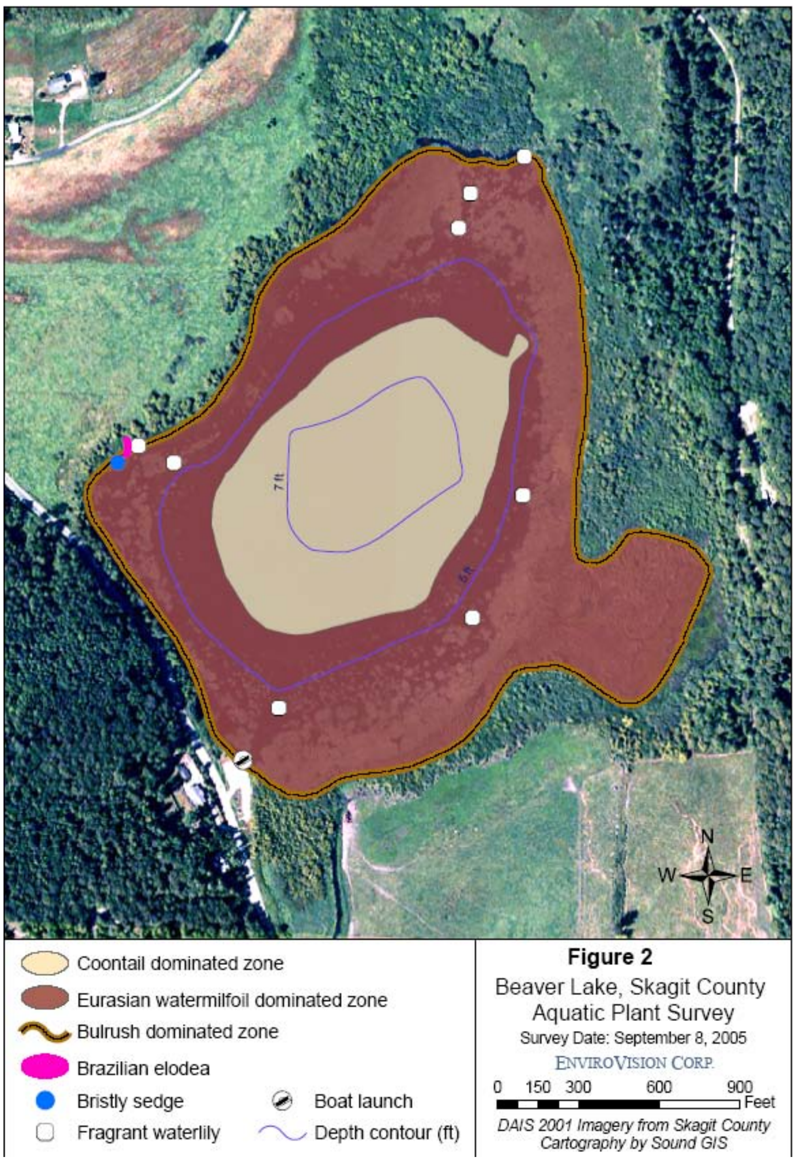
The Washington Natural Heritage Program (WNHP) was researched to determine if Clear Lake currently provides habitat for any state listed rare plant species (WDNR 2006). No rare plants were listed to be found in or adjacent to Clear Lake. In addition to the WNHP, the Washington Department of Fish and Wildlife Priority Habitat Database was searched to find information on rare, threatened or endangered animal species and priority habitats in or adjacent to Clear Lake. The results from the search indicated that the majority of shoreline surrounding Clear Lake is identified as breeding habitat for Bald eagles (*Haliaeetus leucocephalus*). In addition, the Southeast corner of Clear Lake's shoreline is designated as priority wetland habitat by WDFW (WDFW, 2006).

In addition, Coho Salmon (*Oncorhynchus kisutch*) are identified to show a healthy presence in Clear Lake. *O. kisutch* possibly use the lake as rearing habitat and may spawn in tributaries that feed Clear Lake. Currently *O. kisutch* are listed as a species of "Concern" with the Endangered Species Act (ESA) and as "Threatened" on the state ESA listing (WDOE 2007). As a result of the identification of these species, any future treatment plans will be subject to WDFW fish timing windows for aquatic herbicide treatments.

BEAVER LAKE

Physical Description

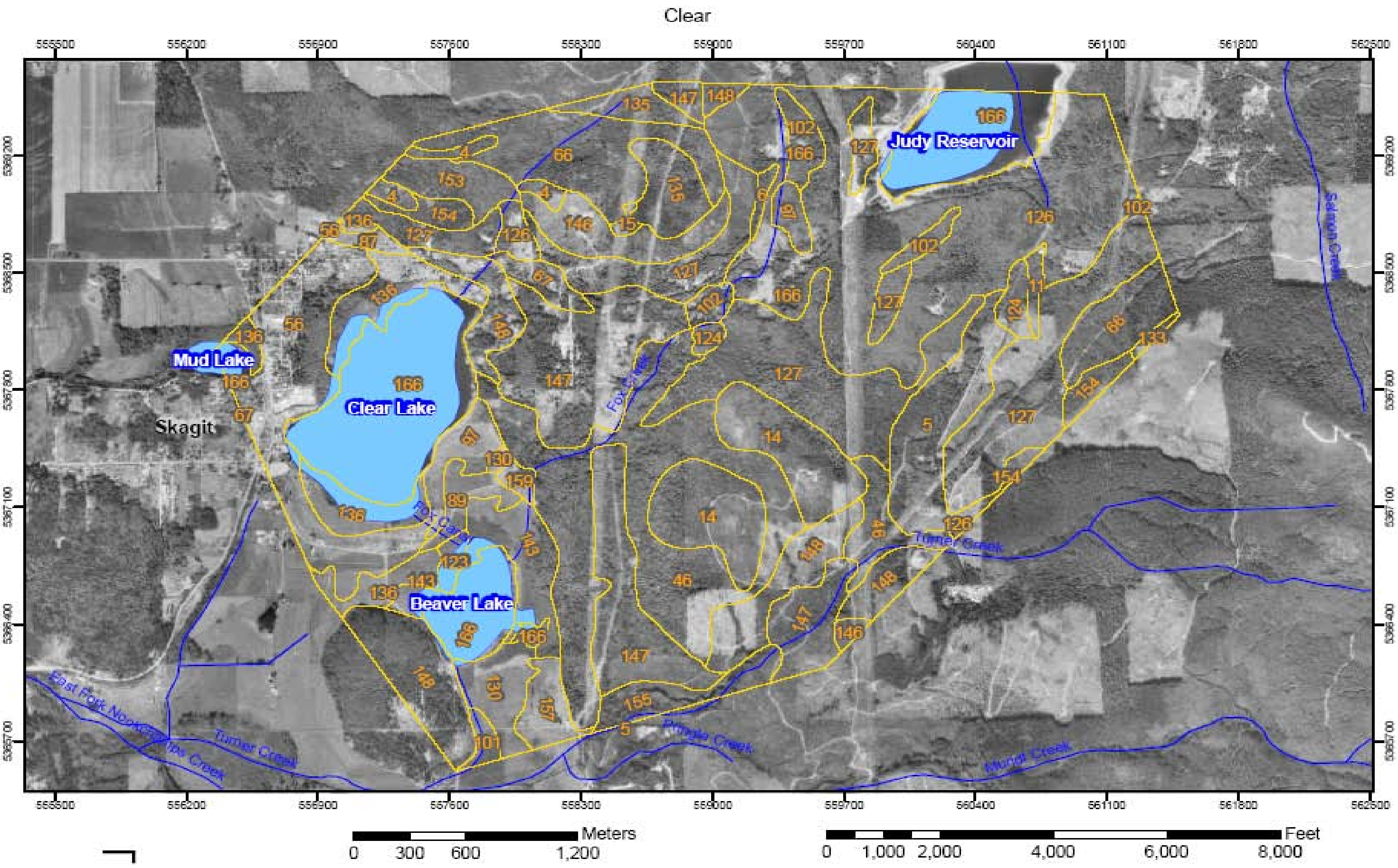
Beaver Lake, located immediately south of Clear Lake, totals 75-acres in surface area. This small lake holds 400-acre feet in volume and has a 5-foot mean and 10-foot maximum depth. Due to the shallow nature of the lake, the littoral zone encompasses the entire lake area. With the exception of a keyhole bay near the southeast corner of the lake, Beaver Lake is regularly shaped. The shoreline spans 1.5 miles.



Drainage from Clear Lake empties into Fox Creek, which enters Beaver Lake on the northeast shoreline and provides the only consolidated surface water input to Beaver Lake. Groundwater seeps provide additional water inputs at Beaver Lake. The outlet, located at the southwest end of the lake, connects to Turner Creek, a tributary of East Fork Nookachamps Creek. Based on field observations, the outlet allows constant drainage from Beaver Lake and could potentially transport noxious weed fragments downstream or potentially re-infest Beaver Lake and/or Clear Lake during flood events when the Nookachamps system backs up with Skagit River water.

Figure 4.

SOIL SURVEY OF SKAGIT COUNTY AREA, WASHINGTON



USDA Natural Resources Conservation Service

9/9/2005
Page 1 of 4

Table 3.

Map Unit Legend Summary

Skagit County Area, Washington

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
101	Nookachamps silt loam	9.6	0.3
102	Norma silt loam	43.1	1.2
11	Bellingham mucky silt loam	8.6	0.2
123	Skagit silt loam	10.4	0.3
124	Skipopa silt loam, 0 to 3 percent slopes	21.8	0.6
126	Skiyou gravelly silt loam, 3 to 15 percent slopes	514.0	14.3
127	Skiyou gravelly silt loam, 15 to 30 percent slopes	445.5	12.4
130	Snohomish silt loam	45.9	1.3
133	Sorensen very gravelly silt loam, 30 to 65 percent slopes	4.1	0.1
135	Squires very gravelly silt loam, 30 to 65 percent slopes	67.4	1.9
136	Sumas silt loam	127.9	3.6
14	Blethen very gravelly silt loam, 30 to 65 percent slopes	157.0	4.4
143	Terric Medisaprists, 0 to 2 percent slopes	71.3	2.0
146	Tokul gravelly loam, 0 to 8 percent slopes	63.0	1.8
147	Tokul gravelly loam, 8 to 15 percent slopes	312.7	8.7
148	Tokul gravelly loam, 15 to 30 percent slopes	216.3	6.0
15	Borohemists, 0 to 3 percent slopes	4.0	0.1
153	Vanzandt very gravelly loam, 0 to 15 percent slopes	38.1	1.1
154	Vanzandt very gravelly loam, 15 to 30 percent slopes	42.7	1.2
155	Vanzandt very gravelly loam, 30 to 65 percent slopes	41.3	1.2
157	Wickersham silt loam, 0 to 8 percent slopes	29.9	0.8
159	Wiseman channery sandy loam, 0 to 8 percent slopes	8.2	0.2
166	Water	365.5	10.2

Soil Survey of Skagit County Area, Washington

Skagit County Area, Washington

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
4	Andic Xerochrepts, warm-Rock outcrop complex, 65 to 90 percent slopes	21.3	0.6
46	Dystric Xerochrepts, 45 to 70 percent slopes	346.8	9.7
5	Barneston gravelly loam, 0 to 8 percent slopes	100.0	2.8
56	Field silt loam	181.8	5.1
6	Barneston very gravelly sandy loam, 8 to 30 percent slopes	6.1	0.2
66	Heisler gravelly silt loam, 30 to 65 percent slopes	179.2	5.0
67	Hoogdal silt loam, 8 to 15 percent slopes	20.5	0.6
87	Larush fine sandy loam	9.5	0.3
89	Larush variant silt loam	24.6	0.7
97	Mukilteo muck	47.8	1.3

Land Use

Consistent with the land use designations established in the Skagit County Comprehensive Plan, open space, rural residential and agricultural developments are the primary uses immediately adjacent to the lake. The presence of extensive National Wetland Inventoried wetland areas precludes shoreline development, so the majority of the shoreline remains in a natural condition. According to the Skagit County Shoreline Master Program, the shoreline areas have "Conservancy" designation, which affords the area the highest level of environmental and resource protection. A boat launch owned and maintained by WDFW provides public access for recreational uses including fishing, hunting, and wildlife viewing.

Table 4. Beaver Lake Aquatic Plant & Macroalgae Species List

Common Name	Scientific Name
EMERGENT PLANTS	
Bearded sedge	*Carex camosa*
Jewelweed	*Impatiens sp.*
Yellow flag iris	*Iris pseudoacorus*
Reed canary grass	*Phalaris arundinacea*
Common smartweed	*Polygonum hydropiperoides*
Marsh cinquefoil	*Potentilla palustris*
Hardstem bulrush	*Schoenoplectus acutus*
Softstem bulrush	*Schoenoplectus tabernaemontani*
Bulrush	*Scirpus sp.*
Bittersweet nightshade	*Solanum dulcamara*
Narrow leaf bur-reed	*Sparganium angustifolium*
Common cattail	*Typha latifolia*
Cattail	*Typha sp.*
FLOATING-LEAVED PLANTS	
Lesser duckweed	*Lemna minor*
Water purslane	*Ludwigia palustris*
Yellow pond-lily	*Nuphar polysepala*
Fragrant water-lily	*Nymphaea odorata*
Giant duckweed	*Spirodela polyrhiza*
Water-meal	*Wolffia sp.*
SUBMERSED PLANTS	
Coontail; hornwort	*Ceratophyllum demersum*
Brazilian elodea	*Egeria densa*
Common elodea	*Elodea sp.*
Eurasian watermilfoil	*Myriophyllum spicatum*
Big-leaf pondweed	*Potamogeton amplifolius*
Ribbonleaf pondweed	*Potamogeton epihydrus*
Grass-leaved pondweed	*Potamogeton gramineus*
Floating leaf pondweed	*Potamogeton natans*
Thinleaf pondweed	*Potamogeton sp.*
Flat-stem pondweed	*Potamogeton zosteriformis*
Sago pondweed	*Stuckenia pectinata*
Common bladderwort	*Utricularia vulgaris*
ALGAE	
Nitella	*Nitella sp.*

Aquatic Plants

Beaver Lake is infested with the non-native aquatic plants Eurasian watermilfoil, Brazilian elodea, and fragrant water lily. These plants pose problems for fishing and hunting activities and are unsightly for wildlife viewers and other lake users.

Brazilian elodea

Native to South America, Brazilian elodea (*Egeria densa*) is a submersed freshwater perennial aquatic plant, which is generally found growing up to depths of 20-feet or drifting. Although it is most commonly found in lakes, ponds, and ditches, Brazilian elodea can also thrive in slow moving streams. It was first introduced worldwide through the aquarium trade and was commonly sold in Washington pet stores as an aquarium species under the name 'anacharis' until it was banned for sale in 1996 (WDOE 2003). Prevention and early detection of this species is important because of its prolific nature and the potential for it to negatively impact local waterways.

Brazilian elodea is robust, bright green, leafy submersed aquatic plant that grows to the surface and forms dense surface mats. The simple or branched cylindrical stem produces minutely serrated and linear leaves that are 1-8 cm long and up to 5 mm wide. The leaves are arranged in whorls of 4 to 8 around the stem and tend to become more densely organized around the stem toward the crown of the plant. Brazilian elodea produces small white flowers (approximately 18-25 mm) with three petals that float on or rise above the water's surface. Populations of Brazilian elodea in the United States consist of only male plants so propagation occurs when plant fragments consisting of double nodes are dispersed. These double node fragments are the only part of the plant that produce branches and roots. Brazilian elodea thrives in acidic to alkaline waters from 1m to 7m depth. The plant can tolerate high turbidity levels and grows best under low light conditions; however, Brazilian elodea can only survive short periods of time under ice and it is susceptible to iron deficiency. Although typically found in lakes, ditches, and ponds, elodea will infest slower moving waterways. Like other invasive submersed perennials, such as Eurasian milfoil, dense populations of Brazilian elodea will alter aquatic ecosystem dynamics and impair recreational uses.

In September 2005, a survey team from EnviroVision Corporation conducted an aquatic plant survey to characterize the native and non-native aquatic plant community. Emphasis was placed on determining the extent of the non-native species Eurasian watermilfoil (*Myriophyllum spicatum*) and Fragrant water-lily (*Nymphaea odorata*) to support the development of this IAVMP. The survey revealed that two general plant communities describe the aquatic plant community at Beaver Lake. One includes a plant community or zone that is dominated by Eurasian watermilfoil and another that is dominated by Coontail (*Ceratophyllum demersum*). A pioneering infestation of Brazilian elodea (*Egeria densa*) was discovered near a small cluster of rare bristly sedge plants (*Carex camosa*), which is a state-listed "sensitive" emergent species.

The two plant zones identified characterize the general aquatic plant distribution at Beaver Lake. The community dominated by Eurasian watermilfoil consists of 52 acres or 70% of the lake area and extends from the shoreline to the 6-foot depth contour (EnviroVision, 2005). Other species observed in this plant zone include but are not limited to coontail, common elodea, yellow pond-lily, fragrant water lily, common bladderwort. Coontail dominates the second plant zone, which occupies the remaining 28 acres of lake area (EnviroVision 2005).

Despite the high density of Eurasian watermilfoil throughout the lake, the survey revealed a diverse population of native aquatic plants (See Table 3). Of these, coontail was the most prevalent. Yellow pond lily (*Nuphar polysepala*), common elodea (*Elodea* *sp.*), and common bladderwort (*Utricularia vulgaris*) were distributed in large patches throughout the lake as well (EnviroVision 2005).

The pioneering colony of Brazilian elodea is located in a small cove along the North West shoreline approximately 200 yards east of Beaver Lake Road. At the time the survey was conducted, the elodea population was limited to 0.03 acres of lake area; however, this is a hardy, productive species and is known to spread rapidly by fragments. The significance of this discovery is associated with the aggressive nature and high cost of controlling this non-native plant, as well as the increased potential for it to be spread to other waterways in Skagit County and Washington State. The County has received an early infestation grant from the Department of Ecology to fund removal of this plant before it proliferates and spreads to nearby waterways.

One challenge facing aquatic plant control efforts to control the Brazilian elodea infestation is the presence of Bottle-brush sedge (*Carex camosa*) plants along the shoreline adjacent to the Brazilian elodea colony. This species is a rare vascular plant recognized by the State as "sensitive." Any control strategy must account for its presence and protection measures must be implemented.

Shoreline plant surveillance was not the goal of this aquatic plant survey; but the emergent plant zone consisted largely of reed canarygrass (*Phalaris arundinacia*) mixed with bulrush (*Schoenoplectus*) and cattails (*Typha sp.*) (EnviroVision 2005).

Water Quality

There is little water quality data available for Beaver Lake. In 1974 the USGS conducted a lake-specific study and sampled basic water quality parameters to determine the trophic status of the lake. The study reported that Beaver Lake was a meso-eutrophic lake at the time the survey was conducted. Although water quality data was not collected during the 2005 survey, the high density of aquatic plants observed, as well as the reduced water clarity may indicate that the lake has aged since the USGS study was conducted in the 1970's (See Table 3).

Table 5. Beaver Lake Water Quality Data: 1974

Year	DO (% Sat)	DO (mg/L)	Specific Conductance (μs)	Temp (C)	Secchi Depth
1974 (3′)	n/a	9.7	92	18.5	> 7′
1974 (7′)	n/a	9.6	92	18.5	> 7′
2005	n/a	n/a	n/a	n/a	2.8′

Adjacent agriculture fields currently used to pasture cows, forest practices, and inputs from Clear Lake may account for increased nutrient loading. Additional water quality monitoring would better quantify changes in trophic status.

Water Rights

A search was performed to determine active surface and ground water rights and claims that are within the Beaver Lake Watershed. In order to find this information, a search of the Washington Department of Ecology's Water Rights Applications Tracking System was performed. Ecology issues a disclaimer when providing this information that says "*Because of unauthorized changes or non-use, Ecology cannot guarantee the validity of Permits and Certificates.*" This search did not list any certified or uncertified claims that list Beaver Lake as their source, see Appendix E (WDOE 2004). This search revealed 5 claims listing Clear Lake as their source and 29 other claims that are located within the watersheds of Beaver and Clear Lakes. At this time it is unknown how many un-registered residents use the lake water for irrigation. However, all lakeside residences are notified prior to herbicide treatments as required by the State permit.

Watershed Features

The Beaver Lake watershed is a sub-basin in the Nookachamps watershed in the Skagit River basin. Sedro-Woolley is the closest incorporated area. Beaver Lake is located within WRIA 3, the Lower Skagit-Samish combined watershed and includes Clear Lake, Lake McMurray, Big Lake, Nookachamps Creek, East Fork Nookachamps Creek, and the City of Mount Vernon.

Beaver Lake's watershed ranges in size from 1,734-acres to 2,764-acres. This is due to the fact that Clear Lake drains into Beaver Lake seasonally when water levels are high. Most of the drainage basin is on low elevation mountains. The north east flanks of Cultus Mountain (elevation: 3993 feet), the highest of all the peaks within the watershed, drains into Beaver Lake via Fox Creek.

Land use in the immediate watershed is characterized by rural, agricultural, open space, and forestry. There is very little residential development surrounding Beaver Lake. Although, seasonal inputs from the Clear Lake watershed impact Beaver Lake when water levels facilitate drainage from Clear Lake.

Fish & Wildlife

Beaver Lake attracts people for different reasons than Clear Lake. Since Beaver Lake is shallower than Clear Lake, the fish and wildlife distributions differ. Beaver Lake is primarily a warm-water fishery containing a variety of species. In a 2001 stock assessment survey conducted by the Washington State Department of Fish and Wildlife, it was determined that Largescale suckers contributed nearly 90% of the fish biomass sampled in the lake. Largemouth bass (*Microterus salmoides*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), and pumpkinseed (*Lepomis gibbosus*) are also resident species (WDFW 2002). Summertime water temperatures become nearly lethal to cold water species such as rainbow trout (*O. mykiss*), but they are still present in relatively small numbers.

Aquatic plants, both native and non-native, nearly cover the entire lake surface. If invasive aquatic plants are not eradicated or controlled, a viable fishery may not be sustainable at Beaver Lake. As previously mentioned, invasive plant species disrupt or accelerate many natural lake processes such as water chemistry, temperature, habitat structure, sediment transport, lake aging, predator-prey relationships, and others. As the lake ages, more of the lake will fill in and become a wetland, thus reducing habitat potential for aquatic organisms.

The National Audubon Society also submitted a copy of their avian population survey on Beaver Lake (Appendix B).

Threatened or Endangered Plants and Animals

The Washington Natural Heritage Program (WNHP) was researched to determine if Beaver Lake currently provides habitat for any state listed rare plant species (WDNR 2006). No rare plants were listed to be found in or adjacent to Clear Lake. The search results identified a small population of Bristly sedge (*Carex comosa*) along the Southwest corner of Beaver Lake. This plant was originally identified during the 2005 vegetation survey performed by Environvison for this project (Environvison 2005). Extreme care will be given when performing herbicidal treatment in this area. Because of this concern, the Southwest corner of Beaver Lake will be designated as an area of low level control to avoid indirect herbicide damage. If herbicide treatments are performed in the close proximity of *Carex comosa*, all efforts will be made to identify and protect the plants.

In addition to the WNHP, the Washington Department of Fish and Wildlife Priority Habitat Data was searched to find information on rare, threatened or endangered animal species and priority habitats in or adjacent to Clear Lake. The results from the search indicated that the majority of shoreline surrounding Beaver Lake is identified as priority wetland habitat. In addition, breeding habitat for Bald eagles (*Haliaeetus leucocephalus*), was identified along the Southwest corner of Beaver Lake (WDFW 2006).

In addition, Coho Salmon (*Oncorhynchus kisutch*) are also identified to show a healthy presence in Beaver Lake. *O. kisutch* possibly use the lake as rearing habitat and may spawn in Fox Creek, a tributary that feeds Beaver Lake from the northeast. Currently *O. kisutch* are listed as a species of "Concern" with the Endangered Species Act (ESA) and as "Threatened" on the state ESA listing (Appendix I). In order to protect these species, any future treatment plans will be subject to WDFW fish timing windows for aquatic herbicide treatments.

AQUATIC PLANT CONTROL ALTERNATIVES

This section provides an outline of available methods used to control aquatic weeds. Much of the information in this section is quoted directly from the Washington Department of Ecology website:

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

AQUATIC HERBICIDES

Description of Method

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

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

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants or are applied to the water in either a liquid or pellet form. Systemic herbicides are capable of killing the entire plant. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and able to re-grow. Non-selective, broad spectrum herbicides will generally affect all plants with which they come in contact. Selective herbicides will affect only some plants (often dicots - broad leafed plants like Eurasian watermilfoil (*Myriophyllum spicatum*) will be affected by selective herbicides whereas monocots like Brazilian elodea (*Egeria densa*) may not be affected). Most aquatic plants are monocots.

Because of environmental risks from improper application, aquatic herbicide application in Washington state waters is regulated and has the following restrictions:

- Applicators must be licensed by the Washington State Department of Agriculture.
- 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 the waters of the state.
- Notifications and postings are required, and there may be additional mitigations proposed to protect rare plants or threatened and endangered species.

Washington DOE has developed a general NPDES permit for the management of noxious weeds growing in aquatic environments and a separate general permit for nuisance aquatic weeds (native plants) and algae control. For nuisance weeds (native species) 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 waterbodies. For noxious weed control, applicators and their sponsors can obtain coverage under the Washington Department of Agriculture NPDES permit for noxious weed control.

The Department of Ecology currently issues permits for seven aquatic herbicides (as of 2004 treatment season) for aquatic weed treatment for lakes, rivers, and streams. Weed control in irrigation canals is covered under another permit. The chemicals that are permitted for use in 2004 are:

Aquatic Herbicides

- **Glyphosate** - (Trade names for aquatic products with glyphosate as the active ingredient include: Rodeo®, AquaMaster®, and AquaPro®). This systemic broad spectrum herbicide is used to control floating-leaved plants like water-lilies and shoreline plants like purple loosestrife. It is generally applied as a liquid to the leaves. Glyphosate does not work on underwater plants such as Eurasian watermilfoil. Although glyphosate is a broad spectrum, non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Plants can take several weeks to die and a repeat application is often necessary to remove plants that were missed during the first application.

- **Fluridone** – (Trade names for fluridone products include: Sonar® and Avast!®). Fluridone is a slow-acting systemic herbicide used to control Eurasian watermilfoil and other underwater plants. It may be applied as a pellet 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 of areas less than five acres. It is slow-acting and may take six to twelve weeks before the dying plants fall to the sediment and decompose. When used to manage Eurasian watermilfoil in Washington, fluridone is applied several times during the spring/summer to maintain a low, but consistent concentration in the water. Although fluridone is considered to be a broad spectrum herbicide, when used at very 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.

- **2,4-D** – There are two formulations of 2,4-D approved for aquatic use. The granular formulation contains the low-volatile butoxy-ethyl-ester formulation of 2,4-D (Trade names include: AquaKleen® and Navigate®). The liquid formulation contains the dimethylamine salt of 2,4-D (Trade name - DMA*4IVM). 2,4-D is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species. Both the granular and liquid formulations can be effective for spot treatment of Eurasian watermilfoil. 2,4-D has been shown to be selective to Eurasian watermilfoil when used at the labeled rate, leaving native aquatic species relatively unaffected.

- **Endothall - Dipotassium Salt** – (Trade name Aquathol®) Endothall is a fast-acting non-selective contact herbicide which destroys the vegetative part of the plant but generally does not kill the roots. Endothall may be applied in a granular or liquid form. Typically 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, endothall can selectively remove exotic weeds; leaving some native species unaffected. Because it is fast-acting, endothall can be used to treat smaller areas effectively. Endothall is not effective in controlling Canadian waterweed (*Elodea canadensis*) or Brazilian elodea.

- **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 collected information about its efficacy against Brazilian elodea in 2003. A littoral zone treatment in Battleground Lake in Clark County Washington resulted in nearly complete removal of Brazilian elodea in that water body.

- **Triclopyr** - (Trade name Renovate3 & Renovate OTF®). There are two formulations of triclopyr. It is the TEA formation of triclopyr that is registered for use in aquatic or riparian environments. Triclopyr, applied as a liquid, is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species such as purple loosestrife. Triclopyr can be effective for spot treatment of Eurasian watermilfoil and is relatively selective to Eurasian watermilfoil when used at the labeled rate. Many native aquatic species are unaffected by triclopyr. Triclopyr is very useful for purple loosestrife control since native grasses and sedges are unaffected by this herbicide. When applied directly to water, Washington DOE has imposed a 12-hour swimming restriction to minimize the possibility of eye irritation. Triclopyr received its aquatic registration from EPA in 2003 and was allowed for use in Washington in 2004.

- **Imazapyr** - (Trade name Habitat®). This systemic broad spectrum, slow-acting herbicide, applied as a liquid, is used to control emergent plants like spartina, reed canary grass, and phragmites and floating-leaved plants like water lilies. Imazapyr does not work on underwater plants such as Eurasian watermilfoil. Although imazapyr is a broad spectrum, non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Imazapyr was allowed for use in Washington in 2004.

Surfactants

- There are seven surfactants allowed for use under the NPDES permits. These include: R-11® , LI-700® , Agri-Dex® , Class Act Next Generation®, Competitor®, Dyne-Amic®, and Kinetic®.

Advantages

- Aquatic herbicide application can be less expensive than other aquatic plant control methods, especially when used in controlling wide-spread infestations of state-listed noxious aquatic weeds.

- Aquatic herbicides are easily applied around docks and underwater obstructions.

- Washington has had some success in eradicating Eurasian watermilfoil, a state listed noxious weed, from some smaller lakes (350 acres or less) using fluridone products.

- 2,4-D has been shown to be effective in controlling smaller infestations (not lake-wide) of Eurasian watermilfoil in Washington.

Disadvantages

- Some herbicides have swimming, drinking, fishing, irrigation, and water use restrictions (check the label and general permit).
- 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 endothall and diquat 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. It is important to find out what your neighbors think about chemical use before deciding to treat your water plants with herbicides.
- Some cities or counties may have policies forbidding or discouraging the use of aquatic herbicides. Check before hiring an aquatic herbicide applicator.

Permits

A NPDES permit is needed to apply any aquatic pesticide (including herbicides) to waters of the state. Both the noxious aquatic weed and nuisance plant and algae NPDES permits require the development of integrated aquatic vegetation management plans before the third season of treatment. Additional plan guidance was developed in 2004 and this guidance can be seen at: http://www.ecy.wa.gov/pubs/0410053.pdf. Some herbicide residue monitoring may also be required.

Cost

Table 6: Cost Breakdown for Chemical Control	
Herbicide	**Cost Per Treated Acre**
Systemic	
Glyphosate	$250 to $350
Fluridone	$900 to $1,100
2,4-D	$275 to $700
Triclopyr	$1,700
Imazapyr	Unknown at this time
Contact	
Diquat	$300 to $400
Endothall	$650

Suitability for Clear and Beaver Lakes

Due to the dense, prolific nature of the noxious weed infestations at Clear and Beaver Lakes, aquatic herbicide use will be a key component to any eradication/control strategy for Eurasian watermilfoil (*Myriophyllum spicatum*), Brazilian elodea (*Egeria densa*), and Fragrant water-lily (*Nymphaea odorata*). Use of aquatic herbicides is appropriate for these lakes for the following reasons:

1) Aquatic herbicides are the most cost effective measure for large scale infestations like at Clear & Beaver Lakes.

2) Northwest Washington lakes have experienced success in eradicating Eurasian milfoil with Sonar.

3) Due to the large extent of the Fragrant water-lily, control with Glyphosate would be the most time and cost effective in restoring beneficial uses.

4) Diquat has proven to be an effective control against Brazilian elodea. In the event that the pioneering infestation is not adequately controlled by hand removal, the community could use Diquat as a back up measure.

5) Aquatic herbicides have the highest potential in achieving long-term control and/or eradication of the aquatic noxious plants present in Clear and Beaver Lakes.

6) Compared to other control methods, aquatic herbicides will restore beneficial uses more quickly than if other methods were utilized as the primary control.

To control Eurasian watermilfoil, Sonar® is the most appropriate choice for eradication. Follow-up spot treatments for small scale re-infestations with 2,4-D is a cost effective contingency measure.

Diquat has proven successful in controlling Brazilian elodea; however, chemical control is not the preferred strategy against this plant at Beaver Lake due to the presence of three bristly sedge plants located near the pioneering infestation. In order to avoid non-target plant impacts to the rare bristly sedge, manual control alternatives will be implemented first. Use of diquat should be considered only as a contingency method or if the Brazilian elodea population proliferates and becomes a significant threat to adjacent waterways.

According to the survey report prepared by EnviroVision in 2005, there are 53 acres of Fragrant water-lily along the margins of Clear Lake. Due to the large scale infestation observed at Clear Lake, aquatic herbicides represent the most appropriate control method available for long-term control of fragrant water lily. To avoid the formation of peat islands, the community should develop a lakescape plan to remove the lilies in areas of high intensity use and then clear channels for fishing, recreational, and shoreline access.

Floating peat islands or tussocks can form when decomposing aquatic plants rooted in deep sediments float to the surface. Treatments with herbicides can expedite the formation of tussocks, which can form naturally as a lake ages and becomes more nutrient rich. In the event tussocks form at Clear & Beaver Lakes, they may prove to be more costly and problematic to treat than the existing bands of fragrant water lily.

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 device. 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 toward 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 is important to remove all fragments from the water to prevent them from re-rooting or drifting onshore. Plants and fragments can be composed 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.
- Manual methods do not require expensive permits and can be performed on aquatic noxious weeds with Hydraulic Project Approval (HPA) 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.

Permits

Permits are required for most types of manual projects in lakes and streams. The Washington State Department of Fish & 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 $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 or other equipment?

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

Suitability for Clear and Beaver Lakes

The primary management goal at Clear & Beaver Lakes is to eradicate Eurasian watermilfoil and Brazilian elodea and to control the vast populations of fragrant water lily at Clear Lake. Due to the large extent of the noxious weed infestations at both lakes, sole use of manual controls is not an appropriate strategy to achieve the community's stated goal; however, hand removal, cutting, and raking are appropriate measures to achieve localized control of water lilies and to remove pioneering re-infestations of fragrant water lily, as well as Eurasian milfoil and Brazilian elodea subsequent the initial treatments.

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 plant; 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, which defeats the purpose of diver dredging.

Diver dredging has been used in British Columbia, Washington, and Idaho to remove early infestations of Eurasian watermilfoil. 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 pioneering colonies of Eurasian watermilfoil.
- Divers can remove plants around docks and in other areas that are difficult to reach.
- Diver dredging can be used in situations in which 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 most types of projects in lakes and streams. Diver dredging requires Hydraulic Project Approval from the Department of Fish & Wildlife. Lake communities should check with their city of 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

The cost for a diver dredging operation will vary depending on the density of the targeted plants due to variations in specific equipment used, number of divers needed, and disposal requirements necessary. A minimum of approximately $1,500 to $2,000 may be charged per day for diver dredging projects.

Other Considerations

Small diver dredging operations could serve as a feasible method for spot treatments when coordinated with a diver survey.

Suitability for Clear and Beaver Lakes

Diver dredging would not be an appropriate control method to achieve eradication of Eurasian milfoil or fragrant water lily in either lake because the nature of the infestations makes this alternative cost prohibitive. Use of this method to help remove the pioneering infestation at Beaver Lake, however, would be appropriate for the following reasons:

1) The infestation is less than half of an acre, so the labor costs would be reasonable.

2) Diver dredging removes the entire plant, so there is the potential for success in achieving eradication.

3) Based on site visits, it is apparent that Beaver Lake is composed of soft sediments in the area of infestation so the plants would likely release from the sediments with greater ease.

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 is durable, heavier than water, reduce or block light, prevents plants from growing into and under the fabric, 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 checked regularly. 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, and plants can grow through window screening material, as well as 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. Freely-floating species such as the blatterworts 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 milfoil and Brazilian elodea. Pioneering colonies that are too extensive to be hand pulled can sometimes be covered with bottom screening material. For these projects, burlap with rocks or burlap sandbags for anchors is suggested. By the time the material decomposes, the milfoil patches are 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 milfoil. 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 the summer, cutting or hand-pulling the plants first will facilitate bottom screen installation. Research has shown that more gas is produced under bottom screens when 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.

Advantages

- Bottom screen installation 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 for only 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 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 Project Approval from the Washington Department of Fish & Wildlife. A shoreline substantial development permit is also required by Skagit County Planning & Development Services to install bottom barriers. In the event the Department of Fish & Wildlife considers the proposal a fish and wildlife enhancement project, the project can be processed as a shoreline exemption.

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 the type of bottom screen selected. Installation of 1,000 square feet of bottom screen costs approximately $750; in addition, maintenance costs for a waterfront lot are about $120 per year.

Other Considerations

None.

Suitability for Clear and Beaver Lakes

Bottom barriers are not an appropriate method for achieving eradication of the invasive aquatic plants in Clear or Beaver Lakes. Localized control may be achieved with bottom barriers, except, this method would prove more costly and problematic due to the presence of coarse woody debris on the lake bottom.

Skagit County Parks and Recreation (SCPR) attempted to install a bottom barrier in the swimming area owned and operated by the County on the west side of Clear Lake. SCPR installed the device in 1994 or 1995 and had to replace portions of it in 2001. Herbicide treatments were required to provide adequate control of the plants for the safety of patrons using the site. There are reports that the bottom is irregular and has large logs and debris, which would increase the failure rate and the maintenance costs of bottom barriers in the lakes.

Rotovation, Harvesting, and Cutting

Rotovation

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.

Harvesting

Mechanical harvesters are large machines that 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 weeds to shore.

Cutting

Mechanical weed cutters cut aquatic plants several feet below the water's surface. Unlike harvesting, cut plants are not collected while the machinery operates.

Suitability for Clear and Beaver Lakes

Mechanical controls, including Rotovation, harvesting, and cutting are not suitable methods for eradication or localized control. Plant fragmentation could increase the risk of spreading Eurasian watermilfoil and Brazilian elodea to other areas of the lake and/or other waterways. In addition, these methods would have high capital costs and would be cost prohibitive for the small lakeside community.

BIOLOGICAL METHODS

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. 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. Only insects that exclusively impact the target species, or very closely related species, 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 lakes 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 bio-control and placement on the target species can also have a role in its 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 is not enough to control the growth and reproduction of the species.

Even when biological control works, a classic biological control does not completely 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.

Another type of biological control uses general agents such as grass carp (see below) to manage problem plants. Unlike 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 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 in 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 is 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 seems to prefer more alkaline waters. Despite this, though, it is also present in cooler, wetter western Washington. The most likely candidates for use as biological control are discussed in the following section.

Grass Carp

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

The grass carp (*Cteno pharynogodon*), 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 target plants, or in cases of overstocking, all the submersed plants are eliminated from the waterbody.

The Washington Department of Fish & 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 fish per vegetated acre. These fish are typically 8 to 11 inches long. The number of fish will depend on the density 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 multi-species 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 other plants 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 or common waterweed) = thin-leafed pondweeds *Potomogeton* spp. > ***Egeria densa*** **(Brazilian elodea) (large fish only)** > *P. praelongus* (white stemmed pondweed) = *Vallisneria Americana* (water celery) > ***Myriophyllum spicatum*** **(Eurasian watermilfoil)** > *Ceratophyllum demersum* (coontail) > *Utriculata 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 82,000 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 carp 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.

Provided below are some facts about grass carp:

- They are only distantly related to the undesirable European carp, and share few of its habits.
- Grass carp generally live for at least ten years and possibly much longer in Washington state waters.
- Grass carp will grow rapidly and reach at least ten pounds. They have been known to reach 40 pounds in the southern United States.
- They will not eat fish eggs, young fish or invertebrates; although baby grass carp are omnivorous.
- The grass carp eat 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 because hungry fish will eat organic material out of the sediment.

- Grass carp have definite taste preferences. Plants like Eurasian watermilfoil and coontail are **not** preferred; water lilies are rarely consumed in Washington waters.
- During winter, grass carp become dormant. Intensive feeding starts when water temperatures reach 68°F.
- Grass carp prefer flowing water to still waters (original habitat is fluvial).
- Once released, grass carp are difficult to recapture.
- Grass carp may avoid feeding 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 long-term control, but fish may need to be restocked at intervals.
- Grass carp offer a biological alternative to aquatic plant control.

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 & Wildlife. A Hydraulic Project Approval application must be completed for any necessary inlet/outlet screening projects.

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.

Other Considerations

- Bio-control would not achieve immediate results, it takes time and is not guaranteed to work.
- The community may have concerns with introduced species.
- Bio-control agents could potentially damage the native aquatic plant communities, which could result in the establishment of other pioneering aggressive plant species.
- Fishermen may have concerns about grass carp.
- The initial investment is very expensive.
- Grass carp introduction has generally been discouraged by State agencies.

Suitability for Clear and Beaver Lakes

Biological control is desirable to maintain low levels of aquatic plants in nutrient rich waters; however, introducing triploid grass carp is not a feasible option for Clear & Beaver Lakes. This is true because grass carp cannot be introduced to waterways that cannot be adequately screened to prevent the fish from escaping into salmon bearing streams. Clear and Beaver Lakes are located within the Skagit River 100-year floodplain. During flood events, Skagit River water backing up in the Nookachamps Creek watershed causes increased water levels and backflow into Beaver Lake and Clear Lake. During these events, grass carp would have the opportunity to leave the lakes and negatively impact important salmon habitat.

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). From 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/m^2) 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/m^2 in July of 1996 to 14 g/m^2 in September of 1996. Eurasian watermilfoil remained below 5 g/m^2 in 1997, then increased to 44 g/m^2 in June and July of 1998 and declined again to 12 g/m^2 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; although, 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 abundant 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 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 the 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 the factors that limit weevil densities, and which 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.
- Bio-controls enable weed control in hard-to-access areas and can become self-supporting in some systems.
- If they are capable of reaching a critical mass, bio-controls can decimate a weed population.

Disadvantages

- There are many uncertainties regarding the effectiveness of this bio-control in western Washington waters.
- There have not been any documented declines of Eurasian milfoil in Washington State that can be attributed to the milfoil weevil.
- Bio-controls often do not eradicate the target plant species. Population fluctuations can occur 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. 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.

Cost

The cost 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.

Suitability for Clear and Beaver Lakes

This alternative is not appropriate for eradication of Eurasian watermilfoil. The potential for successful aquatic plant control using this alternative for control is unknown because milfoil weevils are still experimental. The success rate in western Washington's lakes is still highly variable. In the event this method becomes a viable alternative, it should be considered at the lakes because it is a low cost alternative that could provide long term control of Eurasian milfoil.

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. One benefit of drawdown is the control of some aquatic plant species. It should be noted that regular drawdowns can also make it difficult to establish native aquatic plants for fish, wildlife, and waterfowl habitat in some reservoirs.

Suitability for Clear and Beaver Lakes

Water level drawdown at these lakes is not a viable alternative. In 1964, landowners seeking reductions in water levels were denied their request by the Skagit County Superior Court. This alternative may also negatively impact native aquatic plant communities. This alternative is not likely to achieve success and the cost of exploring the idea of implementing this measure may prove costly and is not favored by the lakeside community, as evidenced by the opposition expressed in the 1964 lawsuit.

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 can include failing septic tanks, 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. Nutrient reduction would result in invasive species eradication, and identifying and mitigating the natural and human-mediated nutrient sources.

Suitability for Clear and Beaver Lakes

Nutrient reduction is not a suitable control alternative to eradicate invasive aquatic plants at Clear and Beaver Lakes for the following reasons:

1) It is not an eradication method.

2) There is no evidence that there is significant point-source nutrient loading at Clear and Beaver Lakes.

3) There is no evidence that reducing nutrient loads to the water column would impact Eurasian watermilfoil, Brazilian elodea, and Fragrant water-lily growth.

Utilizing Best Management Practices to reduce non-point source nutrient loading within the watershed should be a practice to improve water quality and avoid increased aquatic plant growth rates over time. Implementation of a Lake Stewardship Program should be developed and implemented to promote the awareness of land use practices involved Best Available Science to reduce nutrient loading in Clear and Beaver Lakes.

NO ACTION ALTERNATIVE

No action to control or eradicate invasive aquatic plants could occur if the community is not successful in finding a financing mechanism to implement this IAVMP. Although, there would be no costs associated with surveys and treatments, invasive aquatic plants would continue to impair safety, recreation, environmental, and aesthetic qualities valued by lakeside residents and lake users. Additionally, the unchecked growth and continued use of the lakes by recreational boating and fishing increases the risk of spreading Eurasian watermilfoil, and Brazilian elodea to other waterways in Skagit County and Washington State.

Suitability for Clear and Beaver Lakes

Since the management goals for Clear Lake is to eradicate Eurasian watermilfoil and control fragrant water lily and because successful Eurasian watermilfoil eradication at Beaver Lake is necessary to achieve success at Clear Lake, the no action alternative is not suitable for these lakes.

INTEGRATED TREATMENT STRATEGY

Clear and Beaver Lakes, located in the lower East Fork of the Nookachamps Watershed, are heavily infested with noxious aquatic plants including Eurasian watermilfoil (*Myriophyllum spicatum*), Fragrant water-lily (*Nymphae odorata*), Brazilian elodea (*Egeria densa*). Due to the hydrological connectivity of Clear and Beaver Lakes, both water bodies must be treated simultaneously to achieve effective treatment.

Beaver Lake

Considering the infestation of *E. densa* is confined to a 0.5 acre patch in Beaver Lake, the treatment goal is complete eradication. Beginning in the spring/summer of 2007, an initial aquatic vegetation survey will be performed to re-assess the specific size of the infestation and to determine if the *E. densa* has spread to other locations in the lake. A detailed water quality analysis will be performed following the initial vegetation survey. Skagit County will obtain a contractor to perform site specific applications of Reward (Diquat) to identified populations of *E. densa*. Reward will be applied using weighted drip lines. By keeping the drip lines a minimum of 24" from any *Carex camosa* plant there will be little to no impact to any emergent sedges including *C. camosa* (Neatherland 2007) & (Syngenta 2007).

After the initial treatment for *E. densa* a whole lake Fluridone (Sonar) or liquid 2,4-D treatment will be performed on Beaver Lake to eradicate the lake wide infestation of Eurasian watermilfoil (*Myriophyllum spicatum*) and eliminate any surviving *E. densa* plants. A liquid form of Sonar will be applied at a rate of 8-10ppb. Detailed conservations with herbicide experts such as Dr. Mike Neatherland of the USACE and representatives of the SePRO Corporation (makers of Sonar) indicate that this treatment plan will have little to no impact on the emergent vegetation *C. camosa* (Neatherland 2007) & (SePRO 2007). Immediately following the lake wide treatment of Beaver Lake Skagit County will require the contractor to perform a detailed water quality analysis and herbicide residue sampling.

A second aquatic vegetation survey will be performed post treatment in the fall and continue during the first five years of this plan. During years 4-10 of this plan, only one detailed aquatic vegetation survey will be performed. If additional *E. densa* or *M. spicatum* are located, additional hand pulling and/or herbicide spot treatments using a liquid form of 2,4-D or Diquat will be performed. If any herbicide treatments are made, a post treatment vegetation survey will be conducted to determine the effectiveness.

The extensive bands of *Nymphae odorota* will be controlled gradually over a 5 year period by performing surface applications of Glyphosate. Control of *N. polysepalum* and *N. odorota* will focus primarily around developed docks, beaches, and boat access areas. Care will be taken on Beaver Lake to avoid surface Glyphosate applications within 300 feet of the identified *C. camosa* population.

Clear Lake

Beginning in the spring/summer of 2007 an initial aquatic vegetation survey will be performed by the selected contractor to determine the extent of the noxious weed infestation and provide an appropriate treatment recommendation to Skagit County Staff and the Clear and Beaver Lakes Advisory Committee.

Following the initial survey, Skagit County will select a contractor to perform a whole lake treatment to eradicate *M. spicatum* from Clear Lake. A liquid form of Sonar (Fluridone) or 2,4-D will be applied sub-surface using weighted drip lines and an application rate of 8-10ppb. More than one treatment may be applied since it will be necessary to keep low concentrations of the chemical in the lake. If needed, the contractor will perform follow up spot treatments in the second year of this plan. Following the initial lake wide herbicide treatment the selected contractor will be required to perform a detailed water quality analysis and herbicide residue sampling.

During the fall of years 1 & 2 of this plan, the selected contractor will be required to perform a second post treatment aquatic vegetation survey to determine the effectiveness of the previous treatments. During years 3-10 of this plan, annual spring vegetation surveys will be performed to identify the need for additional spot treatment. If *M. spicatum* is identified, a selected contractor will perform hand pulling or herbicide treatments as needed. In years where herbicide treatment is not needed, only one survey may need to be conducted

As in Beaver Lake, Clear Lake has extensive bands of *Nymphae odorata* surrounding the shoreline of the lakes. The goal is to control *N. odorata* gradually over years 1-5 of this plan focusing around developed docks, beaches, and boat access areas. The Clear and Beaver Lakes Advisory Committee has not determined Yellow flag iris (*Iris pseudocorus*) to be a problem and will not target it for control.

Table 7: Summary of Estimated Costs for IAVMP Implementation

INTEGRATED STRATEGY	2007	2008	2009	2010	2011-2016	Total 10-Year
Ongoing Monitoring & Mapping						
Aquatic Plant Monitoring & Mapping	3,500	3,500	3,500	3,500	21,000	35,000
Primary Treatment Strategy						
Sonar Treatment – Eurasian milfoil - Clear Lake	33,000					33,000
Sonar Treatment – Eurasian milfoil - Beaver Lake	33,000					33,000
Glyphosate Spot Treatments – Fragrant Water Lily	5,000	-	5,000	-	15,000	25,000
Contingency Treatment Strategy						
Diquat Spot Treatments – Brazilian elodea	-	-		-	10,000	10,000
2,4-D Spot Treatments – Eurasian milfoil	-	-	10,000		20,000	30,000
Manual Control: Cutter, Weed Rake	150				300	450
Biological Control: Milfoil Weevil						???
Miscellaneous Treatment Costs						
Treatment Permits	350	350	350	350	2,100	3,500
Herbicide Residue Sampling	5,000		2,000		4,000	11,000
Education & Administration						
Signs/Training/Educational Materials	500	500	500	500	3,000	5,000
Brochures/mailing	500	500	500	500	3,000	5,000
Administrative Costs	5,000	5,000	5,000	5,000	30,000	50,000
Annual Total	86,000	9,850	26,850	9,850	108,400	240,950

BIBLIOGRAPHY

Birkel, K. 2000. Integrated Aquatic Plant Management Plan for Lakes Erie and Campbell. Skagit County Public Works Department, Surface Water Management. October 2000.

Creed, R.P. Jr., and S.P. Sheldon. 1995. Weevils and watermilfoil: Did a North American herbivore cause the decline of an exotic weed? Ecological Applications 5(4): 1113-1121.

DiTomasi, J.M., Healy, E.A. 2003. Aquatic and Riparian Weeds of the West. University of California, Agriculture and Natural Resources. Publication 3421.

Enviro Vision Corp. 2005. Clear and Beaver Lakes Aquatic Vegetation Survey. Olympia, WA.

Hammel, Kathy. 2006. Personal (Electronic Mail) Communication (2006). Washington State Department of Ecology.

King County Lake Stewardship Program. 2003. Spring Lake Integrated Aquatic Vegetation Management Plan. February 2003.

King County Lake Stewardship Program. 2004. Pipe and Lucerne Lakes Integrated Aquatic Vegetation Management Plan. May 2004

Madsen, John D. 2000. Advantages and Disadvantages of Aquatic Plant Management Techniques. North American Lake Management Society, LakeLine v. 20 no.1, pp22-34. Spring 2000.

Neatherland, Michael. 2007. Personal (Phone and Electronic Mail) Communication. US Army Corps of Engineers.

North American Lake Management Society. 2001. Managing Lakes and Reservoirs, Third Edition.

SePRO Corporation. 2007. Personal (Phone) Communication.

Skagit County Planning Department. 1976. "Skagit County Shoreline Management Master Program. Reprinted December 1983.

Skagit County Department of Planning and Community Development. 1995. Nookachamps Watershed Nonpoint Action Plan.

Syngenta Corporation. 2007. Personal (Phone) Communication.

USDA Soil Conservation Service. 1989. Skagit County Soil Survey [On-Line]. Available: http://soildatamart.nrcs.usda.gov/Manuscripts/WA657/1/wa657_text.pdf

Washington State Department of Ecology (WDOE). 2006. Water Rights Accounting & Tracking System (WRATS). Olympia, WA.

Washington State Department of Ecology (WDOE). 2001. An Aquatic Plant Identification Manual for Washington's Freshwater Plants. Publication 01-10-032.

Washington State Department of Ecology (WDOE). 1994. A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans. Pub#: 93-93.

Washington State Department of Fish and Wildlife (WDFW). 2006. Habitats & Species Report in the Vicinity of T34R05E & T34R04E. Olympia, WA.

Washington Department of Fish and Wildlife (WDFW). 2002. 2001 Beaver Lake Survey: The Warmwater Fish Community of a Lake Dominated by Non-game Fish and Aquatic Vegetation. Pub # FPT02-11. Olympia, WA.

Washington State Department of Natural Resources (WDNR). 2006. Habitats and Species Report in the Vicinity of T34R05E & T34R04E. Olympia, WA

Wetzel, R. G. 2001. Limnology: Lake and River Ecosystems, Third Edition.

Zalewesky, B., Bilheimer, D.. 2004. Lower Skagit River Tributaries Temperature Total Maximum Daily Load Study. Washington State Department of Ecology Environmental Assessment Program. Pub # 04-03-001.

Appendix A: Clear Lake Bird List

Blackbirds, Orioles, Grackles
Red-winged Blackbird
Brewer's Blackbird

Chickadees and Tits
Black-capped Chickadee

Cormorants
Double-crested Cormorant

Crows and Jays
Steller's Jay
American Crow

Ducks, Geese, Swans
Trumpeter Swan
Canada Goose
American Wigeon
Gadwall
Green-winged Ted
Mallard
Northern Pintail
Northern Shoveler
Canvasback
Ring-necked Duck
Lesser Scaup
Common Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
Redhead Ducks
Wood Duck

Falcons and Caracaras
American Kestrel

Finches, Siskins, Crossbills
House Finch
American Goldfinch
Pine Siskin

Grebes
Pied-billed Grebe
Western Grebe

Gulls
Ring-billed Gull

Hawks, Eagles, Kites
Bald Eagle
Share-shinned Hawk
Cooper's Hawk
Red-tailed Hawk

Herons, Egrets, Bitterns
Green Heron

Hummingbirds
Anna's Hummingbird

Kinglets
Golden-crowned Kinglet

Long-Tailed Tits
Bushtit

Loons
Common Loon

Old World Sparrows
House Sparrow

Osprey
Osprey

Pigeons and Doves
Rock Dove
Kingfishers
Belted Kingfisher

Plovers and Lapwings
Killdeer

Rails, Gallinules, Coots
American Coot
Virginia Rail

Swallows
Tree Swallow
Violet-green Swallow
Barn Swallow

Saltators, Cardinals, Allies
Black-headed Grosbeak

Sandpipers
Wilson's Pipe

Sparrows, Towhees, Juncos
Song Sparrow
White-crowned Sparrow
Harris's Sparrow
Dark-eyed Junco

Starlings
European Starling

Thrushes
Swainson's Thrush
American Robin
Varied Thrush

Wood Warblers
Wilson's Warbler

Woodpeckers
Red-breasted Sapsucker
Downy Woodpecker
Northern Flicker

Wrens
Marsh Wren
Winter Wren

Appendix B: Beaver Lake Bird

Blackbirds, Orioles, Grackles
Red-winged Blackbird
Brewer's Blackbird

Chickadees and Tits
Black-capped Chickadee

Cormorants
Double-crested Cormorant

Crows and Jays
Steller's Jay
American Crow
Common Raven

Dippers
American Dipper

Ducks, Geese, Swans
Trumpeter Swan
Canada Goose
American Wigeon
Gadwall
Green-winged Teal
Mallard
Northern Pintail
Northern Shoveler
Canvasback
Ring-necked Duck
Lesser Scaup
Greater Scaup
Common Goldeneye
Barrow's Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
Redhead Ducks
Wood Duck
Cinnamon Teal

Falcons and Caracaras
American Kestrel

Finches, Siskins, Crossbills
Purple Finch
House Finch
American Goldfinch
Pine Siskin

Grebes
Pied-billed Grebe
Western Grebe

Gulls
Ring-billed Gull

Hawks, Eagles, Kites
Bald Eagle
Northern Harrier
Red-tailed Hawk

Herons, Egrets, Bitterns
Great Blue Heron
Green Heron

Hummingbirds
Rufous Hummingbird

Kingfishers
Belted Kingfisher

Kinglets
Golden-crowned Kinglet
Ruby-crowned Kinglet

Long-Tailed Tits
Bushtit

Loons
Common Loon

New World Vultures
Turkey Vulture

Old World Sparrows
House Sparrow

Owls
Northern Pygmy-Owl

Pigeons and Doves
Rock Pigeon

Plovers and Lapwings
Killdeer

Rails, Gallinules, Coots
American Coot
Virginia Rail

Sandpipers
Whimbrel
Dunlin

Shrikes
Northern Shrike

Sparrows, Towhees, Juncos
Song Sparrow
Spotted Towhee
Dark-eyed Junco
Savannah Sparrow
White-crowned Sparrow
Golden-crowned Sparrow

Starlings
European Starling

Swallows
Tree Swallow
Violet-green Swallow
Barn Swallow
Violet-green Swallow
Northern Rough-winged Swallow
Cliff Swallow

Thrushes
Swainson's Thrush
American Robin
Varied Thrush

Tyrant Flycatchers
Willow Flycatcher

Vireos and Allies
Warbling Vireo

Wagtails and Pipits
American Pipit

Waxwings
Cedar Waxwing

Wood Warblers
Wilson's Warbler
Yellow Warbler
Yellow-rumped Warbler
Common Yellowthroat

Woodpeckers
Red-breasted Sapsucker
Downy Woodpecker
Northern Flicker
Williamson's Sapsucker
Pileated Woodpecker

Wrens
Bewick's Wren
Marsh Wren
Winter Wren

Appendix C: Written Comments to Draft Plan

Appendix D: Herbicide Product Labels

Appendix E: Water Rights List

Appendix F: Petitions/Ballots of Support

Appendix G: Priority Habitat Map

Appendix H: Agendas & Minutes

Appendix I: Salmonid Stock Inventory