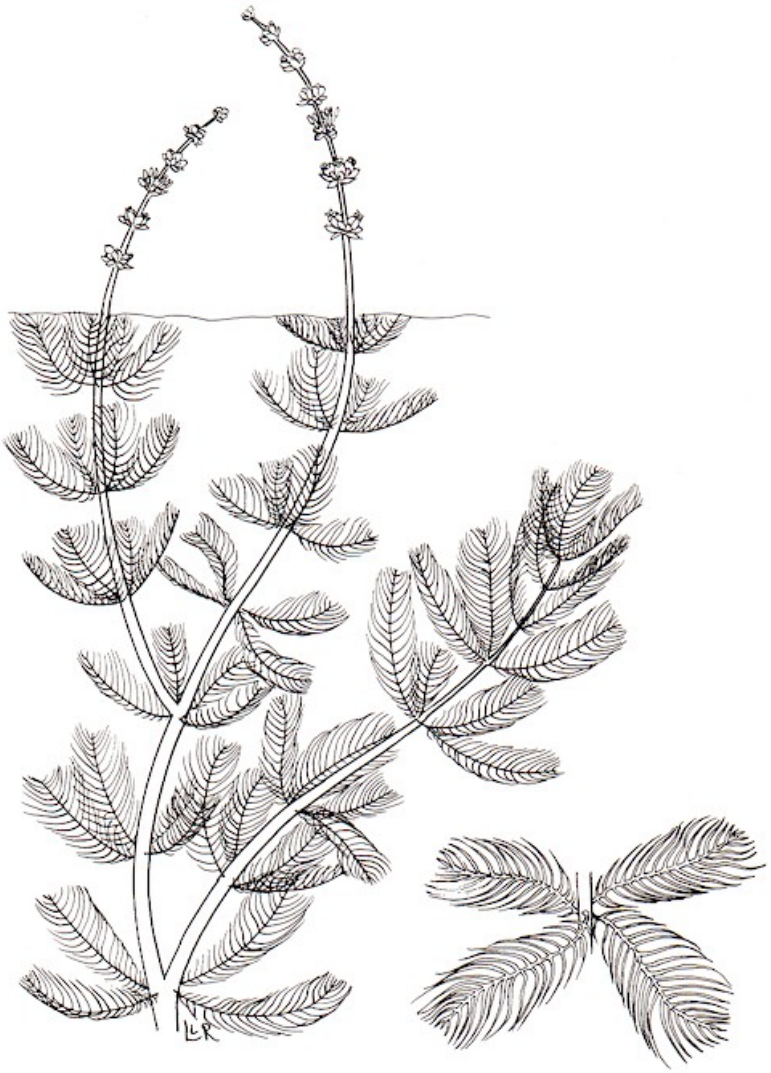
Integrated Aquatic Plant Management Plan

for Early Infestations of Eurasian Watermilfoil (*Myriophyllum spicatum*)



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Definition of an Early Infestation

An early milfoil infestation is a situation in which the state-listed freshwater noxious weed Eurasian watermilfoil (*Myriophyllum spicatum*) is discovered in pioneer stages of growth in a water body where milfoil has not previously been present. Early action is essential to prevent rapid colonization of the water body through fragmentation of the pioneering plants. Generally pioneer infestations of milfoil occupy less than one to five percent of the littoral zone (the area in a water body where rooted plants can grow). These infested areas may occur in patches or as individual plants along a shoreline, but if all the areas were gathered together the total milfoil-infested area would be a small percentage of the littoral zone. Although milfoil can flourish in reservoirs, river backwaters, and sloughs, this plan is targeted towards early milfoil infestations in lakes and ponds where there are impacted residents. This Integrated Aquatic Plant Management Plan (IAPMP) outlines actions to take once pioneering colonies of milfoil are detected in a water body.

Milfoil must be detected in its early stages of invasion to be able to initiate early action. The Washington Department of Ecology (Ecology) has an aquatic plant survey program for Washington's lakes and rivers. Data from these surveys can be seen at: http://www.ecy.wa.gov/programs/eap/lakes/aquaticplants/index.html. Some counties have lake and/or weed board staff that survey their water bodies on a regular basis. One of the best ways to discover early invasions is to have an educated and involved lake community trained to identify milfoil and other freshwater noxious weeds who actively survey their water body each year.

Problem Statement

Eurasian watermilfoil (milfoil) is a Class B state-listed freshwater noxious weed. To be listed as a noxious weed, the plant must be non-native and invasive, and must cause problems in Washington. The premise of this IAPMP is that milfoil is a problematic invasive species that degrades water bodies where it has become established and that early action to eradicate or contain its growth is desirable. This website provides information about why milfoil is a problem species in Washington and throughout the northern tier of North America: http://www.ecy.wa.gov/programs/wq/plants/weeds/aqua004.html.

The Washington Department of Ecology's (Ecology's) on-line database shows that milfoil was found in 135 of 424 survey locations in Washington (as of October 2004) and that milfoil is geographically widespread throughout the state. Past experience has demonstrated that milfoil is extremely difficult to eradicate once it establishes within a water body and that once established milfoil generally degrades the ecosystem and impacts beneficial uses.

Because it is widely distributed and difficult to control, milfoil is considered to be the most problematic freshwater plant in Washington. The introduction of milfoil can drastically alter a water body's ecology. Milfoil forms very dense mats of vegetation on the surface of the water. These mats interfere with recreational activities such as swimming, fishing, water skiing, and boating. In eastern Washington milfoil interferes with power generation and irrigation by clogging water intakes.

The sheer mass of plants can cause flooding and the stagnant mats can create good habitat for mosquitoes. Milfoil mats can rob oxygen from the water by preventing the wind from mixing the oxygenated surface waters to deeper water. The dense mats of vegetation can also increase the sedimentation rate by trapping sediments. Milfoil also starts spring growth sooner than native aquatic plants and can shade out these beneficial plants. When milfoil invades new territory, typically the species diversity of aquatic plants declines. While some species of waterfowl will eat milfoil, it is not considered to be a good food source.

Milfoil reproduces extremely rapidly and can infest an entire lake within two years of introduction to the system. Although milfoil produces many seeds, the role of seeds for milfoil reproduction in Washington waters is poorly understood. However, milfoil is able to reproduce very successfully and rapidly through the formation of plant fragments. In the late summer and fall the plants become brittle and naturally break apart. These fragments will float to other areas, sink, and start new plants. Milfoil will also grow from fragments created by boaters or other disturbances during any time of year. A new plant can start from a tiny piece of a milfoil plant. This is why milfoil can so easily be transported from lake to lake on boat trailers or fishing gear. Once established in its new home, water currents may carry milfoil fragments and start new colonies within the same waterbody.

There are a few water bodies in Washington where milfoil has been eradicated, but that is the exception rather than the rule. For smaller water bodies (350 acres or less in size), even where milfoil is widely established, it is possible to eradicate or maintain milfoil at reduced populations such that it does not cause detrimental impacts to beneficial uses. However, once milfoil has entered a water body and especially once it has become widely established, there can be significant economic and environmental costs to return the system to pre-milfoil conditions. In larger water bodies (350 acres or more in size), milfoil can be maintained at low levels if it is discovered in its early infestation stage. Once milfoil becomes established in larger water bodies, such as the Columbia River or Lake Washington, only localized control is economically and environmentally feasible. Taking rapid and early action when milfoil is first detected in a water body can minimize environmental impacts to the system and lessen the economic impacts to the community.

Plan Goal

The goal of this Integrated Aquatic Plant Management Plan (IAPMP) is to develop a set of strategies that when implemented will lead to the eradication of milfoil from the water body. Eradication may take a number of years and require a sustained concerted effort on the part of the local government and lake group. Some groups may lack the resources to sustain the level of effort to reach eradication; in those instances the group may agree that maintaining milfoil at extremely low levels in the water body is an acceptable alternative to eradication. Maintenance will require the development of long-term funding sources and continuous management. It should be understood that once an invasive species like milfoil enters a water body, management activities, such as surveys, must generally be continued in perpetuity. Even if eradication is achieved, milfoil or other invasive species can be easily reintroduced.

Plan Objectives

The objective of this plan is to provide information and guidance to local governments and lake groups to assist them with selecting appropriate control methods for the complete removal of milfoil plants while allowing native plant and animal species and the ecosystem to remain unharmed to the greatest possible extent. The methods should be safe, effective, cost-effective, and sustainable over a long time frame. This plan also outlines the steps to follow and important things to consider when an early infestation of milfoil is discovered.

The following narrative outlines the steps needed when pioneering colonies of milfoil are first discovered in a water body.

I. Notification

If local authorities or lake residents find milfoil in a water body, they should consult Ecology's on-line freshwater plant database to see if milfoil has already been reported from the water body (http://www.ecy.wa.gov/programs/eap/lakes/aquaticplants/index.html). If milfoil is not listed in this database, they should alert Ecology staff. Call Kathy Hamel at (360) 407-6562 or e-mail at kham461@ecy.wa.gov or Jenifer Parsons at (509) 457-7136 or e-mail at jenp461@ecy.wa.gov. Kathy and Jenifer can provide immediate technical assistance. If Ecology staff find milfoil in a previously uninfested water body during a routine survey, staff will immediately contact the county weed board and/or lake staff and the local lake association (if any).

II. Verification of Species

There are aquatic plants including native milfoil species that may be mistaken for Eurasian watermilfoil. It is important that the pioneering plants be verified as non-native before any actions are taken. Ecology staff can generally determine whether the plant is Eurasian watermilfoil by examining it; however, there have been situations where even aquatic plant specialists need to use DNA testing to distinguish between milfoil species. Appendix D has information about how to identify milfoil, a line drawing, and color photographs of milfoil. Because of the difficulty of determining native milfoil species from non-native milfoil species, Washington residents may send aquatic plants to Ecology for identification. We request that you follow the mailing methods as outlined in this website: http://www.ecy.wa.gov/programs/wq/plants/plantid/mail.html.

III. Decision to Take Action

Ecology can help local governments take immediate action to control milfoil by providing technical assistance and funding for grant-eligible projects, but Ecology does not have the staff or capability to control the infestation itself. Action must be initiated by the local government jurisdiction (counties or cities) in concert with the lake community. Once the milfoil infestation has been confirmed as non-native, the local government and/or lake group must decide whether they want to take immediate action to remove the pioneering colonies of milfoil. They may choose to pursue funding from Ecology (if they have an eligible water body), fund the action themselves, or take no action (not recommended). Ecology has a grant program in place to help finance early infestation projects in lakes with publicly-provided boat ramps (see information in the box below).

Financial assistance from Ecology's Aquatic Weeds Management Fund is available on a year-round basis for early infestation projects. The goal of these projects is the eradication or containment of new invasions of non-native, freshwater, aquatic weeds. The early infestation fund program enables Ecology to assist public bodies in responding to early infestations of these weeds when **immediate corrective action is likely to effectively achieve eradication or containment**. Because it is essential to proceed quickly, applications for early infestation projects may be submitted at any time, although funding is allocated on a first-come-first-served basis. Applicants with early infestation projects may receive grants of up to 87.5 percent of total eligible costs. To get more information about the early infestation grant program see: http://www.ecy.wa.gov/programs/wq/plants/grants/index.html or call Kathy Hamel at (360) 407-6562 or by email at kham461@ecy.wa.gov.

IV. Notify Others about the Milfoil Infestation

Outreach activities should begin immediately. Washington lake residents are generally aware of milfoil and the problems that it can cause in a water body. Most will be supportive of immediate action because they understand the threat that milfoil poses to their enjoyment of the water body. Most will also expect that the state or somebody else will control the milfoil. This will not happen! The state does not have the capability to take action itself, but it does have staff that can provide technical assistance and a program that may provide funding for eligible projects. The more quickly that all lake residents and interested parties are informed about the early infestation of milfoil the more rapidly control can occur. Some lake groups have formal associations and newsletters and in these cases communication may be simple, since mailing/e-mail lists or community websites may already exist. Other ways of getting the word out can include: holding a public meeting, getting the local media to publicize the discovery of milfoil, direct mailing to lake residents, telephone trees, and posting notices at local businesses or on community bill boards.

Outreach is a continuing effort and many of the other activities listed in this IAPMP can occur simultaneously with outreach. Lake residents and interested parties should be updated on management methods selected, timing of control activities, and fund raising events and should be provided with regular progress reports. Interested parties in addition to lake residents or property owners may include user groups such as:

- Fishing groups, water ski groups, other outside recreational users as appropriate;
- State, federal, and local agencies with an interest in the water body (Department of Fish and Wildlife, Department of Natural Resources, etc.);
- Tribes with an interest in the water body;
- Environmental groups;
- Private interests such as resorts, church camps, scout camps, etc.; and
- Elected officials.

V. Survey the Extent of the Infestation

If a decision is made to control the pioneering infestation of milfoil, the local government/lake group surveys the water body to determine the extent of the milfoil infestation. Survey methods can be seen at this website: http://www.ecy.wa.gov/programs/wq/plants/management/survey.html. Milfoil locations should be drawn on a water body map and, if possible, Global Positioning System (GPS) points should be recorded for each location so that milfoil plants can be easily found later for removal or treatment. If the infestation occupies less than one to five percent of the littoral zone, obtaining an early infestation grant from Ecology may be possible. Sometimes what appears to be an early infestation of milfoil may turn out to be more extensive than expected. If the infestation is larger, it has advanced past the pioneering stages. These larger infestations require different management strategies than are outlined in this plan. In any event, a decision should be made as to whether or not to manage the milfoil infestation whatever its size.

VI. Review Appropriate Control Methods

A number of aquatic plant control methods exist (read about the various methods at this website: http://www.ecy.wa.gov/programs/wq/plants/management/index.html), however, for early infestation of milfoil where the goal is eradication, the number of successful methods is typically limited to manual removal methods (hand pulling and bottom barriers) or chemical methods (aquatic herbicides). Other methods are suitable for use in water bodies with wide-spread infestations where eradication may not be an option. A thorough description and discussion of each method appropriate for early infestations is discussed in detail in Appendix A. Other methods are briefly evaluated and an explanation of why they are not suitable for early infestation projects is provided in Appendix B.

VII. Evaluate Water Body, Control Methods, Environmental and Human Factors

If the survey confirms that the infestation is in its early stages, the local government and lake group need to:

- Consider funding options;
- Evaluate environmental factors in the water body that could affect the selection of control options such as:
    - Presence of rare plants or animals in the water body. Contact the Department of Natural Resource Heritage Program to determine whether rare plants are present in the water body. See their website at: http://www.dnr.wa.gov/nhp/index.html.
    - Presence of endangered species in the water body. See this site to get information about priority species: http://wdfw.wa.gov/wlm/diversty/soc/concern.htm. Please note that Fish and Wildlife charges a fee to search their database for this information.
    - Important waterfowl nesting areas or other important wildlife habitat areas in the water body. Contact your local Fish and Wildlife office for information. http://wdfw.wa.gov/reg/regions.htm.
    - Significant wetland areas associated with the water body. This information is often available from your local government http://access.wa.gov/government/local.aspx or from the Department of Natural Resources Natural Heritage Program website.

- Significant fisheries in the water body or downstream. Contact your local Fish and Wildlife office for a list of fish in the water body and locations of fish rearing and spawning areas. http://wdfw.wa.gov/reg/regions.htm
- Water use such as drinking or irrigation water intakes or stock watering. Ecology regional offices keep a database of water right holders, but the best way to determine who is using the water is by asking the lake residents. Many water rights are no longer being used and Ecology's database is out of date. Sometimes people using the water have no legal rights to do so, but are doing so anyway.
- Stream inlets or outlets or springs in the water body. Ecology has some lake information available at: http://www.ecy.wa.gov/programs/eap/fw_lakes/lk_list.html or many times local governments or residents will have relevant information.
- Significant recreational facilities such as public swimming beaches, children's summer camps, water-skiing courses, etc.

- Consider social perceptions that could affect the selection of control options such as:
  - Desire to use no chemicals. Some people are adamantly opposed to any herbicide use while others have natural concerns about using chemicals in a water body. If herbicides are selected, it is important to ensure that all people have a chance to express their concerns and have their questions about herbicides answered. This plan provides web links to herbicide labels, Ecology's risk assessments, Ecology's Environmental Impact Statement and other relevant information about aquatic herbicides.
  - Desire to use only chemicals. Some people strongly believe that any control method other than herbicides are a waste of time, uneconomical, ineffective, spread fragments, and can never result in eradication. However, some lake groups have managed early infestations of milfoil very well by using no chemicals. One of Washington's milfoil eradication successes resulted from only using hand removal and bottom barrier installation. Hand pulling can be economical if volunteer groups are used. Fragment spread can be controlled. Often an integrated approach of using herbicides for larger areas of milfoil and hand pulling the smaller infestations works very well.
  - Belief that the water body is different from others and milfoil won't become a problem. Milfoil is an extremely adaptable plant, able to tolerate and even thrive in a variety of environmental conditions. It grows in still to flowing waters, can tolerate salinities of up to 15 parts per thousand (half the salinity of Puget Sound), grows rooted in water depths from 1 to 10 meters (regularly reaching the surface while growing in water three to five meters deep), and can survive under ice. It is able to tolerate pHs from 5.4-11 (acid to alkaline). Milfoil grows in very pristine lakes like Lake Chelan and Lake Tahoe and in very nutrient-rich lakes too. Shallow lakes are impacted more by milfoil infestations because the area of the lake that can support milfoil growth (littoral zone) is larger in shallow lakes than the littoral zone in very deep and steep-sided water bodies. Whatever type of water body, most lake residents find that the presence of milfoil detracts from their enjoyment of recreational and other water-based activities.
- After exploring the above factors, consider the various control options and select the management method or methods most suited to the water body and the community.

- Mitigate environmental impacts though various means such as timing to avoid fish and waterfowl use, using hand removal in sensitive areas or around rare plants, providing drinking or irrigation water to affected users, etc. (See Appendix C for some mitigation suggestions).

IIX. Acquire Appropriate Permits

The state has streamlined permit acquisition to facilitate the control of noxious weeds, however all control methods, even a simple method such as hand pulling, require permits.

Hand Pulling and Bottom Screening: The Washington Department of Fish and Wildlife issues a type of permit called Hydraulic Project Approval (HPA) for work in natural waters of the state. Both hand pulling and bottom barrier installation require an HPA before work starts. To facilitate noxious weed removal projects, Fish and Wildlife has developed a pamphlet called Aquatic Plants and Fish that serves as the permit for milfoil and other noxious weed removal projects. As long as the pamphlet provisions are followed, an individual HPA is not usually needed for control activities for early infestations of milfoil. Copies of the pamphlet can be obtained from the regional offices of Fish and Wildlife at http://wdfw.wa.gov/reg/regions.htm. Sometimes local jurisdictions such as King County have additional permits for shoreline work. It's important to check with the local jurisdiction to ensure that no local permits are required before starting the project.

Aquatic Herbicides: Aquatic herbicides are considered to be restricted use pesticides in Washington State. These herbicides can only be applied by Washington Department of Agriculture certified applicators or persons under the direct supervision of a certified licensed applicator. Ecology maintains a list of certified applicators who have indicated an interest in contracting their services for aquatic plant control projects. This list is available upon request. Contact Kathy Hamel at kham461@ecy.wa.gov for an electronic copy. In addition to requiring a certified applicator to apply aquatic herbicides, a permit called a National Pollutant Discharge Elimination System Permit (NPDES) permit is needed to treat water bodies with aquatic herbicides. Herbicide applications for milfoil control (and for other noxious weeds) are covered under the Noxious Weed permit.

Ecology has issued the Noxious Weed Permit to the Washington State Department of Agriculture (WSDA) who provides free coverage to other entities (governments or individuals) who wish to treat noxious weeds under this permit. The permit covers all noxious weed control activities where herbicides are applied directly into surface waters of the state of Washington. To be in compliance with the permit, all permit provisions and procedures must be followed by all entities and individuals obtaining coverage. Not following these provisions will result in the entity or individual being out of compliance and subject to penalties or the potential of a third party citizen lawsuit. You can see a copy of the permit at this web link: http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxiouspermitmayfinal.pdf. Coverage under WSDA's NPDES permit for noxious weed control can be readily obtained for early infestation milfoil projects and WSDA has a seven-working-day turnaround to issue coverage. There is a 10-to-21-day notification period to affected shoreline residences that also must be complied with. Click here for more details of the permitting process.

IX. Initiate Action

The following actions need to be competed before the project can proceed:

- Select methods;
- Secure funding;
- Acquire all permits and permissions;
- Notify all lake residents and interested parties, and ensure that they understand the proposed actions, and obtain consensus if possible;
- Identify and protect any rare plants and/or endangered animal species that may be impacted by the milfoil management activities;
- Mitigate other environmental impacts; and
- Procure contractors and/or volunteers and ensure that they are ready to proceed.

These actions all need to take place rapidly so that the milfoil does not have an opportunity to fragment and spread. Whatever method or methods selected, each milfoil plant must be controlled. Missed plants, especially larger multi-stemmed plants, readily fragment and each fragment has the potential to become a new plant. Be systematic in ensuring that all plants are identified. Survey often and mark the locations of new plants. For best results, control activities may need to occur several times during the growing season.

X. Evaluate Effectiveness and Revise Methods if Needed

It is important to evaluate whether the selected methods are effective in removing milfoil plants in the water body. For example, if after extensive hand pulling efforts there are many remaining plants, you need to determine why hand pulling hasn't been effective. Hand pulling might be ineffective because:

- Hand pulling should occur more frequently;
- More people need to be involved with the effort;
- More training on pulling methods needs to be conducted;
- A more systematic approach to hand pulling is needed;
- Better surface surveys should be conducted prior to the hand removal efforts;
- Water clarity doesn't allow divers enough visibility to see the plants;
- Dense growth of native plants obscures the milfoil plants;
- The sediments are too hard, allowing the tops of the plants to be removed, but leaving the root crown behind to resprout;
- Fragments need to be more effectively removed from the water column.

After evaluation it may be possible to correct the problem, but it may also mean that another approach is needed. Reduced removal rates could indicate that it is time to install bottom barriers over the bigger patches of plants or maybe aquatic herbicides are needed.

Evaluation after herbicide use should include determining the estimated percentage of removal. If the removal rates are low, an evaluation about why this occurred should be made. Reasons could include:

- Not enough contact time between the herbicide and milfoil;
- Herbicide resistant plants are being selected for;
- The pre-treatment survey failed to locate all the milfoil plants;

- Underground springs diluted the herbicide or moved it away from the treatment area;
- The treatment timing was unsuitable;
- Pellets became buried in the sediment.

With decreased efficacy of treatment, perhaps a different formulation of the same herbicide or another type of herbicide should be used next time or perhaps hand removal would be more effective.

XI. Continue Management until Milfoil is Not Detected for Three to Five Years

Active management and surveys should continue for at least three to five years after no milfoil is detected in the water body. Even after this time period, Ecology advises that the water body be surveyed at least once or twice each year to detect any newly introduced milfoil plants or other noxious weeds, like Brazilian elodea. Ecology staff would appreciate being notified of the status of the eradication effort.

Appendix A

Methods Suitable for Milfoil Early Infestation Projects

I. Hand Pulling and Installation of Bottom Barriers

Hand Pulling: Hand pulling milfoil is similar to pulling weeds out of a garden. During hand pulling, milfoil plants are manually removed from the lake bottom. Mature milfoil plants develop a compact fleshy mass of roots called a root crown. This entire root crown must be removed or the plant may regrow. Care should be taken to not create fragments. 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. Removed plants must be disposed of in an area away from the shoreline.

Bottom Barriers: Bottom barriers are materials that are laid over the top of milfoil beds and are analogous to using landscape fabric to suppress the growth of weeds in yards. 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. An ideal bottom screen should be durable, heavier than water, reduce or block light, prevent plants from growing into and under the fabric, be easy to install and maintain, and should readily allow gases produced by rotting weeds to escape without "ballooning" the fabric upwards. Even the most porous materials may billow due to gas buildup. Therefore, it is very important to anchor the bottom barrier securely to the bottom. Unsecured barriers can create navigation hazards and are dangerous to swimmers. Natural materials such as rocks or sandbags are preferred as anchors. Anchors must be effective in keeping the material down and must be regularly checked.

Pioneering colonies of milfoil that are too extensive to be hand pulled can sometimes be covered with bottom screening material. For these projects, we suggest using burlap with anchors of rocks or burlap sandbags. By the time the burlap decomposes (generally within a two-to-three-year period), the milfoil patches will be dead as long as all plants were completely covered. When using this technique for milfoil 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. Click here to learn more about bottom barriers and their environmental impacts. Click here for installation information.

Water Bodies Suitable for Hand Pulling and Bottom Barrier Installation: Due to the expense, labor, and time intensive nature of manual methods, sites suitable for hand pulling and bottom screening are limited to lakes or ponds only lightly infested with milfoil. To be cost-effective, generally the total amount of milfoil in the waterbody should be three acres or less in area, if all the milfoil plants were grouped together in one location. If the infestation has advanced beyond this point, it is generally more effective to consider other eradication techniques such as aquatic herbicides. Manual methods may also be applicable in waterbodies where no herbicide use can be tolerated such as in water bodies used for municipal drinking water or where lake residents are very opposed to chemical use. Theoretically, hand pulling and bottom barrier installation could be used in any waterbody to eradicate milfoil; however the costs for large scale projects are prohibitive for most lake groups and effectiveness of the method is reduced as the area of infestation increases.

Factors that affect the success of hand pulling include: size of the infestation, water clarity, sediment type, complete removal of all milfoil fragments, density of native aquatic plants, and effort expended. It is especially important to have good visibility for the divers to locate milfoil plants. Sometimes diving is only effective in the spring or fall when water clarity may be better, the native plants may not be present in great density, or during periods between algal blooms. If water clarity is very poor, manual eradication methods may not be suitable for the water body. Hydraulic Project Approval is required for hand pulling and bottom barrier projects in natural waters (see permitting information section).

Description of Hand Pulling and Bottom Barrier Projects: Lakes where manual methods are being used for milfoil eradication typically have milfoil lightly scattered singly or in small patches within the littoral zone. To determine the extent of the infestation, the littoral zone of the lake is surveyed immediately prior to starting control work and milfoil locations are mapped and Global Positioning System (GPS) points established. The survey can be conducted prior to the removal effort or take place during the removal effort.

Hand pulling can begin as soon as milfoil can be easily seen and identified - generally in the spring or as soon as it is discovered in the lake. Despite milfoil's tendency to fragment more readily during the fall, removal should be undertaken as soon as possible after the discovery of milfoil in the lake, no matter how late in the season.

Survey Techniques: Both surface and underwater surveys should be conducted several times during the growing season. During the surface survey, a surveyor moves slowly through the littoral zone in a boat, looking into the water (often using a viewing tube), and marking the locations of milfoil plants with buoys (buoys can be inexpensively constructed from empty half gallon plastic juice containers). Surveyors advise wearing wide-brimmed hats, polarized sunglasses, and looking straight down into the water. Wind, rain, or surface disturbances, such as boat wakes, interfere with the ability to see. Because of these factors, morning to noon is often the most suitable time for survey work.

The surface survey is immediately followed by an underwater diver survey. Because known milfoil locations have been marked during the surface surveys, the divers can concentrate their efforts at these locations. Since diver time is expensive, it can be cost-effective to conduct surface surveys before underwater surveys.

Arline Fullerton, an experienced scientific diver, describes the survey techniques used by Thurston County to locate pioneering colonies of milfoil in Long Lake. "In Western Washington, the weather is usually so mild throughout the winter months that the milfoil plants don't completely die back and are still recognizable. For this reason, the diving schedule on Long Lake begins in March, when divers have the opportunity to carefully survey water lily areas for milfoil before the lilies start growing. Using two certified divers each day, the goal is to systematically examine the entire littoral zone of the lake a section at a time. The diver's support system is a specially designed dive barge operated by another certified diver who stays close to the working divers at all times. The two working divers cover the entire shoreline depth in two sections: zero to seven feet deep and six feet to the edge of the plant line which is usually between ten and fourteen feet in Long Lake. Working substantially in tandem, they swim tight transects,

continuously looking side to side for plants. They notify the barge operator of any milfoil finds so the location can be recorded. Plants are pulled and placed in the divers' "goodie" bag. In large shallow areas the barge operator might drop buoys marking appropriate width lanes for each diver to cover so as not to miss any area accidentally. It is advantageous for the divers to use a compass to keep a straight course. Following the silt trail from the previous transect can also guide the diver. The barge operator uses a map of the lake with all the hot spots (areas where milfoil was found) from the previous year to aid in alerting divers." Some lake groups report good luck in using snorkelers in the shallow water and reserving the more expensive diver time for the deeper water.

Hand Pulling Techniques: During hand pulling, the divers dig around and beneath the plant roots with their hands or with a tool and gently lift the entire plant out of the sediment. The ease of removal is dependent on sediment type. Milfoil plants can be readily removed from loose or flocculent sediments. In hard sediments or rocky substrate, hand tools must be used to loosen the root crown before the plant can be dislodged. Sometimes fine roots are left behind; these will not regrow, but it is important to remove the root crown (the fleshy, fibrous roots at the base of the stem). Once plants are removed, the diver places them into bags for transportation to the surface. Sometimes divers may use a suction device to deliver the plant to the surface (generally using a modified gold-mining dredge). The plant is sucked up into the boat where it is retained in a sieve and the water is discharged back into the lake. However, suction devices create many fragments that are difficult to completely remove from the water column. Because of fragment creation, suction devices are much more suitable for use in lakes where milfoil is already very widespread.

In locations with denser milfoil colonies, divers should make several passes through the area to ensure that all plants have been located and removed. As the divers work, the people in the support boat mark the locations of milfoil plants. An accurate location is important since these areas need to be resurveyed a few weeks later. There have been instances when small fragments or plants have been overlooked and have become large plants upon resurvey. Removed plants can be used for compost rather than having to be discarded as solid waste.

If colonies are too large for efficient hand pulling or if repeated visits to the same site indicate that too many fragments or plants are being missed, bottom barriers should be installed. Burlap bottom barrier (or other biodegradable material) should be placed over the plants and anchored to the lake bottom using natural materials such as rocks or sandbags. The burlap should cover and extend well beyond the growth zone of the plants. Burlap or other natural materials are preferred because they will naturally decompose over a two- to three-year period. Snohomish County staff have reported that native aquatic plants readily colonize the burlap.

Some lake groups hire contract divers and surveyors to conduct manual plant removal activities. This can become expensive. Other lakes have relied on volunteer efforts. If volunteers are used, they must be trained in plant identification and proper removal methods. An excellent example of a lake group that has used volunteer divers to manage an early infestation of milfoil is the Lake Sutherland group in Clallam County. Lake Sutherland is a beautiful 360-acre lake nestled in the foothills of the Olympic Mountains. In the summer of 2000 an early infestation of milfoil was found in the lake and a decision was made to take action. The lake group and Clallam County decided to use non-chemical controls to manage this early infestation of milfoil.

The County noxious weed coordinator learned to dive and many volunteer divers were recruited. The coordinator also trained the divers in milfoil identification and proper removal and disposal techniques. The lake was divided into 21 sections and a contact person took responsibility for each section. Volunteer diver/boat teams surveyed their assigned lake sections, removing small milfoil patches and individual plants as they were discovered. Burlap barriers were also laid to smother the larger patches. Although this program has not yet achieved milfoil eradication, it has resulted in maintenance of low levels of milfoil. Milfoil populations have never become problematic in Lake Sutherland because of these efforts. In 2004, the lake group formed a Lake Management District to collect an annual assessment on property owners to continue funding this effort. Although control costs are minimal because this is a volunteer effort, they still need to purchase air for the divers and bottom screening supplies.

General Impacts of Hand Pulling: Special care must be taken to prevent the release of milfoil fragments. At certain times of the year (generally after flowering), milfoil plants can fracture into hundreds of fragments, each having the potential to form a new plant. To help contain the fragments, individual plants may be covered with a mesh bag before they are pulled. The driver of the diver support boat must also be careful not to create additional fragments by keeping the boat and propeller out of the milfoil plants. People in the support boat should use net skimmers to retrieve any fragments accidentally released by the divers. Hand pulling may increase turbidity in the area of removal. This can affect the efficacy of removal if the turbidity interferes with the ability of the divers to see the milfoil plants.

A Description of Diver Hand Pulling in a Diver's Own Words: Arline Fullerton, scientific diver, provides this advice: "When a large plant is located, the diver must approach slowly; taking note of any small fragments that may have rooted nearby. Once the diver enters the area and removes a plant the disturbed silt may make visibility next to impossible. Marking the spot with a buoy or a long stake helps the diver locate the exact spot later when the silt settles. Milfoil fragments can be wind blown into very shallow water and be hidden behind logs, sticks, rocks or shore grass. In the case of a large pioneer infestation it is advisable to have someone on the surface in a canoe, kayak, or small boat, catching any escaping fragments as the plants are dug up. Note of the wind direction should be made as wind direction may indicate the next place one will find new plants. Sometimes plants that have died back may be difficult to identify. They can look like a black stick with roots, but they are not dead. The diver’s motto for milfoil removal projects is, “when in doubt, pull it out.” Over the years I have become familiar with the look of milfoil roots as opposed to other lake plants and have used the roots as guides. As a milfoil plant matures, its shorter side stem growth may develop white roots while still attached to the mother plant. A slight current caused by wind, or, even the wake of a passing duck’s foot, will dislodge this growth. Being already rooted, it is instantly ready for life as a viable new plant. This ability to easily fragment needs to be considered when a diver tries to dig up the root system to remove a whole plant. It is important to discuss the diver’s ability to achieve neutral buoyancy. This is the point at which the diver is neither too heavy nor too light, but can maintain position in exactly the right position to work effectively without disturbing the plant. If it is a very large plant, five or six feet high, the ability to hover motionless can be an advantage. Also an advantage is the ability to hover in a slight feet up-head down position. Then if the diver needs to change position, the moving fins are less likely to disturb the plant and cause it to scatter. When wearing a dry suit, this can be done with some air trapped in the diver’s boots. Plants that will

fragment easily can be recognized by the multiple stems and many rooted side branches. Sometimes some of the stems have collapsed and sunk into the surrounding vegetation rendering them practically invisible. If a diver simply pulled up what could be seen without some investigation, then stems would be broken off and left to root again. Depending on the size of the plant, the diver may elect to simply pick off some of the rooted fragments until the plant is of a size that can be more easily handled.

Divers have developed several different techniques for removing plants. One way is to grab hold of the top of the plant and wind it around the hand as you move down the stem toward the bottom. Then, with the other hand dig up the roots and transfer the whole plant to the "goodie" bag. Another method is to carefully locate the bottom of the stem, loosen the roots and then wind the rest of the plant around the hand. Yet another method of capturing a fragmenting plant is to use the "goodie bag" as a butterfly net and cast the open bag carefully over the entire plant, dropping it down to the bottom and then freeing up the root system. Each method is effective under different conditions and the diver quickly learns which condition is best served by which method."

Costs: If contract divers are used, costs can be up to $1,000 per day. These costs generally include two divers and a boat tender. If volunteer divers are used, the costs can be negligible.

Long Term Follow-up is the Key: Once milfoil is discovered in a lake, it generally requires continual maintenance to keep it at low levels. Even if milfoil appears to have been eradicated, it may be reintroduced by boaters. As long as the lake group continues surveying, new introductions can be identified quickly and targeted for removal before milfoil can reestablish in the lake. Although labor intensive, these manual techniques have been used to successfully eradicate milfoil in a drinking water reservoir in Washington. In lakes treated with aquatic herbicides where the lake group has continued diver and surface inspections, milfoil remains at extremely low levels, without impacts to habitat or recreational activities.

II. Aquatic Herbicides

Two herbicides (2,4-D and triclopyr) are particularly useful for spot treatment of early infestations of milfoil. (If more than spot-treatment is needed, then the infestation is no longer in the pioneering stage and this IAPMP is not suitable.) Generally the development of a site-specific IAPMP is recommended when a milfoil infestation is past the pioneering phase. Ecology has listed some milfoil eradication strategies for all stages of infestation on its website at: http://www.ecy.wa.gov/programs/wq/plants/management/milfoil_strategies.html.

Both 2,4-D and triclopyr are fast-acting herbicides that only need a 24-48-hour contact time with the plant. Both herbicides are also selective and target broad-leaved plants like milfoil. Since many other aquatic plants are monocots (grass-like), they are generally unaffected by 2,4-D or triclopyr treatments. Luckily, milfoil has proven to be very susceptible to herbicides and generally herbicides can be very effectively used at much less than the maximum label rate. Both 2,4-D and triclopyr herbicides meet this IAPMP objective of targeting the invasive species milfoil while leaving most native aquatic plants unharmed.

2,4-D's mode of action is primarily as a stimulant of plant stem elongation. This disrupts the normal growth of the plant and eventually kills it. Navigate® and Aqua-Kleen® are granular 2,4-D products registered for aquatic use and DMA®4IVM is an aquatic-labeled liquid formulation. Click here to see Ecology's risk assessment for the environmental and human health impacts of 2,4-D.

The triethylamine salt (TEA) formation of triclopyr is registered for use in aquatic or riparian environments. Like 2,4-D, triclopyr will generally kill the entire plant, although neither chemical is 100 percent effective. Triclopyr appears to have a similar mode of action to 2,4-D by mimicking a plant hormone and disrupting normal growth. The aquatic-labeled triclopyr is sold under the brand name Renovate3®. See this website for questions and answers about triclopyr http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/triclopyr_faq.pdf. See Ecology's risk assessment for the environmental and human health impacts of triclopyr.

Waterbodies Suitable for Herbicide Treatment: Sites suitable for herbicide treatment include lakes or ponds where the extent of the milfoil infestation is beyond what can be removed by hand pulling or bottom screening or where poor visibility does not allow effective hand removal. Herbicides like 2,4-D and triclopyr that are effective for spot treatment can be used to reduce the amount of milfoil so that hand pulling can be used to remove any milfoil plants that are not killed. There are a few lakes where, for economic or for philosophical reasons, the lake groups refuse to use manual methods even on scattered milfoil populations remaining after herbicide treatment. This is not a recommended strategy, since herbicides typically are not 100 percent effective.

Special Considerations:

- Water users must be identified prior to herbicide application. Both herbicides have irrigation restrictions and drinking water restrictions. Water within the treatment areas cannot be used for drinking until 2,4-D concentrations have declined to 70 ppb at the intake and water used for irrigation cannot be used until the concentrations are 100 ppb or less at the intake. Water cannot be used for irrigation until triclopyr in the water intakes is undetectable by laboratory analysis. Drinking water can not be used until triclopyr is 40 ppb or less measured at the intake. The triclopyr label allows for treatment dependent on setback distances from functioning water intakes. The current 2,4-D labels do not allow for setback distances. If water users do not have other water sources, the project proponents must arrange for alternative water supply during the time that the herbicide is in the water.
- Ecology has imposed a 12-hour swimming restriction after treatment with triclopyr and Ecology recommends that swimmers stay out of the treatment area for 24-hours after 2,4-D treatment.
- Ground water or sediment monitoring is required prior to the third application of triclopyr on a previously treated site within a three-year period.
- A Washington State Department of Agriculture (WSDA) certified licensed applicator must be used to apply herbicides to the water.
- A National Pollutant Discharge Elimination System Permit (NPDES) permit is needed to treat water bodies with aquatic herbicides. All permit provisions must be followed to be in compliance with the permit. These provisions include notification of shoreline residents 10-21 days prior to treatment and posting the areas adjacent to treatment the day of treatment.

- Herbicide use and timing of herbicides is also dependent on salmon usage (many water bodies do not support salmon). Fish and Wildlife have developed "work windows" for water bodies where salmon are present. Activities such as herbicide application can generally take place within these work windows. Under a court decision, only the liquid formulation of 2,4-D can be applied to salmon-bearing waters. The granular formulations of 2,4-D cannot be applied to these waters. See EPA's website to see which water bodies in Washington are impacted by the court decision at: http://www.epa.gov/oppfead1/endanger/wtc/maps.htm. View the fish timing windows at the following website: http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/noxious_index.html to determine whether the water body is subject to work windows for salmonid species. The timing windows for bass spawning do not apply to noxious weed control activities.
- Triclopyr is not subject to timing and can be applied outside of the salmon work windows.
- Herbicide use can be controversial and project proponents must be prepared to address human health and environmental concerns about chemicals from lake residents and the public.
- Non-target native dicots (broad-leaved plants) have the potential to be impacted by these herbicides. It is very important to identify and protect any rare or threatened plants in the water body.

Description of an Early Infestation Project Using Herbicides: Lakes where spot treatments of aquatic herbicides are being used for milfoil eradication typically have milfoil scattered in heavy to dense patches within the littoral zone. The lake is surveyed immediately prior to herbicide application and milfoil locations are mapped and Global Positioning System (GPS) points established. (See the section on manual methods for tips on surveying the lake.)

Herbicide application can begin as soon as milfoil starts rapidly growing. Effective treatments can be made as early as April or May and as late as October (timing may depend on salmon usage or other environmental factors). Herbicide treatment in the spring/summer should be followed by a late summer survey and possible retreatment if large patches remain or if more milfoil is discovered in untreated areas of the lake. A month after the initial herbicide treatment, the littoral zone of the lake should be thoroughly inspected by divers to identify and map remaining milfoil plants. Sparse populations of remaining milfoil plants should be hand pulled or covered with bottom barrier. Larger, denser patches may need to be treated again with herbicides, although in that case some assessment should be made as to why the initial treatment was ineffective. Diver and surface inspections should continue at least twice a year during the growing season. Survey work should be as frequent as can be afforded since small milfoil plants may be easily overlooked within the native plant beds. Often divers report finding two- to three-foot-tall milfoil plants in areas that they had extensively searched only three weeks earlier. Lake managers often report no milfoil present in the spring and early summer surveys, but by mid-to-late summer milfoil is reported.

If the project is funded by an Ecology grant or if there are irrigation or drinking water concerns, monitoring will be required. See Ecology's lakes monitoring plan for details about monitoring requirements at:
http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/monitoring_data/lakesmonitoring_plan.html

2,4-D Granular Treatment: The granular formulation of 2,4-D is 2,4-D butoxyethyl ester. The granules are generally applied at the labeled rate of 100-200 pounds per acre using bow-mounted centrifugal or blower-type spreaders. The granules are uniformly spread over the water above the milfoil beds and slightly beyond. The clay particles sink to the bottom or are caught up in the plants and the herbicide slowly releases from the clay over the next few days. A study conducted in Loon Lake, Washington showed that milfoil was the only aquatic plant whose growth was statistically reduced by granular 2,4-D application (Parsons, et. al, 2001). In this study, up to 98 percent of the milfoil biomass in the treatment plots was removed after the July treatment. Recent data collected from Washington lakes show that 2,4-D concentrations from granular applications remain very low; generally below irrigation (100 ppb) and drinking water (70 ppb) restrictions, even within the treatment areas. See this website to see Washington lake water concentrations of 2,4-D measured after treatment with granular 2,4-D:
http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/monitoring_data/monitoring_index.html.
There is speculation that the granular formulations work best in dense milfoil beds where the granules get caught up by and release the herbicide into the plant canopy. In sparser milfoil beds, the liquid formulation may give better results, since without the plant canopy to catch the granules they may become buried in the sediment. A specimen label for Navigate® can be seen at this website: http://www.appliedbiochemists.com/Navlb02.pdf. Navigate® and AquaKleen® are identical products and are the only two granular formulations registered for aquatic use.

2,4-D Liquid Treatment: The liquid formulation of 2,4-D is the dimethylamine salt of 2,4-D. This formulation is applied using subsurface trailing hoses to give a water concentration of 2-4 ppm. The amount of gallons used per treatment depends on the water depth at the treatment sites. Concentrations of 2,4-D in Washington lakes after the application of the liquid formulation are generally higher than those found after treatment with granular 2,4-D with values well above the drinking water standard (70 ppb) and remaining above these levels for several weeks. See results from Washington lakes at the following website:
http://www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/monitoring_data/monitoring_index.html. However, efficacy of milfoil removal appears greater when using the liquid formulation. In 2003, Spring Lake was treated with liquid 2,4-D for an established, but not widespread, infestation of milfoil (the lake was not considered early infestation). In 2004, no milfoil was detected in either the spring or the summer survey. In lakes with irrigation or drinking water intakes, granular 2,4-D might be a better choice, since in-lake concentrations generally remain below the irrigation and drinking water standards. In lakes where water use is not an issue, the liquid formulation may be appropriate. Also only the liquid formulation is allowed to be used in lakes with salmon populations. A specimen label for DMA®4VM can be seen at this website: http://www.cdms.net/ldat/ld4JS000.pdf.

Triclopyr Treatment: Triclopyr is a liquid formulation and is applied using subsurface trailing hoses to achieve a water concentration of 0.75 to 2.5 ppm. The total amount of gallons used depends on the water depth in the treatment area. The greater the water exchange in the water body, the higher the application rate needs to be. Areas may need to be treated twice; however, the amount of triclopyr applied cannot exceed 2.5 ppm per treatment area for the growing season. Capitol Lake in Thurston County was treated with triclopyr in July 2004 to remove an extensive infestation of milfoil and preliminary results indicate excellent, selective removal of milfoil from the system. A specimen label for Renovate3® can be seen at this website: http://www.sepro.com/documents/Renovate_Label.pdf.

Costs: Costs can be variable. The liquid formulation of 2,4-D is the least expensive product at about $300 per acre. The granular formulation is more expensive at about $600 per acre. The treatment costs will vary with the number of acres to be treated, the herbicides used, the water depth in the treatment sites, the travel time for the applicator, the number of households notified, etc.

General Impacts after Treatment: One day to a few days after herbicide treatment, observers will see the growing tips of milfoil plants begin to twist. Over time these plants become brownish in appearance, leaves may fall off, and sometimes only bare stems will be left. The plants will eventually sink to the sediments, usually within one to three weeks of treatment. Unless treatment takes place in extremely dense beds of milfoil, it is unlikely for low oxygen conditions to develop. Oxygen has been monitored after 2,4-D and triclopyr treatments for milfoil in Washington lakes and rivers and no significant oxygen sags have been seen. Results of spot treatment may be variable depending on water movement, size of treatment plot, density of milfoil, weather conditions, underwater springs, treatment timing, etc. However, most lakes report low efficacy to be in the 80 percent removal range. Spring Lake reported 100 percent removal of milfoil one year after treatment. There should be no direct toxicity to fish and wildlife, pets, or humans when these herbicides are used appropriately. Because these herbicides are selective, most native plants should continue to grow and even thrive with the competition from milfoil removed.

Follow-up: Follow-up is essential to ensure the success of eradication. Used alone, 2,4-D or triclopyr are generally not eradication tools. Some plants typically survive the treatment and regrow, so these plants must be removed by other means. Even a few milfoil fragments can start a new infestation, or boaters may reintroduce milfoil into the lake. Diver and surface inspections should continue at least twice a year during the growing season. Survey work should be as frequent as can be afforded, since small milfoil plants or fragments may be easily overlooked, especially within native plant beds. Surveys done in Minnesota indicated that 2,4-D use by itself did not result in eradication of milfoil over the long term (Crowell, 1999). Treated lakes for which there was no follow up survey work or treatment eventually ended up with milfoil throughout the littoral zone. There is some anecdotal evidence that repeated treatments may select for plants that are more resistant to 2,4-D. If this occurs and the plant population is too large to be hand removed, consider using triclopyr. There is also some anecdotal evidence that milfoil may germinate from seeds in areas where water levels dropped and then returned. This may happen in low rainfall or low runoff years. It is important to check those areas when the water returns in order to remove any milfoil that may have germinated.

References:

Crowell, W.J. 1999. Minnesota DNR tests the use of 2,4-D in managing Eurasian watermilfoil. Aquatic Nuisance Species Digest. 3(4):42-46.

Parsons, Jenifer K.; K.S. Hamel, J.D. Madsen and K.D. Getsinger. 2001. *The Use of 2,4-D for Selective Control of An Early Infestation of Eurasian Watermilfoil in Loon Lake, Washington*. J. Aquat. Plant Manage. 39:117-125.

Appendix B

Methods Considered Not Suitable for Milfoil Early Infestation Projects

All of the methods below are described in more detail at the following website: http://www.ecy.wa.gov/programs/wq/plants/management/index.html.

I. Manual Methods

Raking or cutting: plants are cut (generally just above the sediment) using a hand tool or a battery-operated cutting device. The roots are not removed. The cut plants generally float and must be removed from the water. Raking is performed by throwing a modified rake into the weed bed and then pulling it along the lake bottom with a rope. Raking literally tears plants from the sediment, breaking some plants off and removing some roots as well.

Suitability for Early Infestation Projects: Neither raking nor cutting is suitable for early infestation projects, because it is very difficult to capture and contain the large numbers of plant fragments that are produced. Each fragment has the potential to grow into a new plant. Both methods leave roots behind to regrow into new plants. Although not suitable for early infestations of noxious weeds, raking and cutting are suitable methods for the control of native nuisance weeds for individual homeowners.

II. Mechanical Methods

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

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

Rotovators use underwater rototiller-like blades to uproot milfoil 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 by using a weed rake attachment to the rototiller head or by harvester or manual collection.

Suitability for early infestation projects: All of these mechanical methods create great numbers of fragments which are ineffectively removed from the water body. Using these machines to control an early infestation of milfoil would likely increase the rate of spread of this plant. These machines are suitable only in water bodies where milfoil has entirely colonized all habitat area. In those situations, additional fragments do not increase the spread of the plant because once milfoil reaches sufficient biomass, each plant can form and shed hundreds of fragments. Fragmentation is milfoil’s primary mode of reproduction. Harvesting and cutting may also be suitable methods for the management of native nuisance vegetation.

III. Biological Methods

Grass carp and the milfoil weevil: the grass carp, 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. Research has indicated that grass carp have food preferences and will consume more palatable plant species, such as pondweeds and waterweed, before they will eat milfoil. Grass carp are generally not recommended for milfoil control because milfoil is not highly preferred. A concern is that grass carp grazing may enhance milfoil growth by eating the native plants and opening up more areas for milfoil to colonize. In Washington, grass carp can be used for milfoil eradiation/control only in water bodies where the eradication of ALL submersed aquatic plants can be tolerated. Sites where grass carp may be suitable for milfoil control are rare in Washington.

The milfoil weevil, *Euhrychiopsis lecontei*, has been associated with declines of milfoil in the United States. Researchers in Vermont found that the milfoil weevil, which is native to North America, can negatively impact milfoil by suppressing the plant's growth and reducing its buoyancy. In Washington, the milfoil weevil is present primarily in eastern Washington and is found feeding on both Eurasian and northern milfoil (*M. sibiricum*), the latter plant being native to the state. Although the milfoil weevil shows potential as a biological control for Eurasian watermilfoil, more work is needed to determine which factors limit weevil densities and what lakes are suitable candidates for weevil treatments. Other insects have been associated with Eurasian watermilfoil, but at this time none appear suitable for biological control.

Suitability for early infestation projects: Generally biological controls are used to manage extensive populations of the target weed and are not suitable for early infestations. Even when biological control is successful, a biological control agent usually does not totally eliminate all target plants. Grass carp are suitable for controlling aquatic plant growth in small ponds. They are generally only allowed to be stocked into natural waters after careful review by Washington Department of Fish and Wildlife (WDFW) staff. The milfoil weevil is still experimental and is not recommended for early infestation projects at this time.

IV. Water Level Drawdown

Water level drawdown can be used where there is a water control structure that allows the managers of lakes or reservoirs to lower the water level in the water body for extended periods of time. Dropping the water level of a lake or reservoir can have a dramatic impact on some aquatic weeds, particularly plants that do not rely on seeds or tubers for propagation. Milfoil can be susceptible to drawdowns if sufficient conditions for freezing and desiccation occur. However, these conditions are not possible to predict. Generally, warmer and wetter western Washington winters do not provide adequate freezing or desiccation to occur. Even in colder, dryer eastern Washington, drawdown is often not successful. This method is not recommended to be used by itself for an early infestation for the following reasons:

- Most water bodies do not have outlet controls that allow drawdown to occur.
- If the proper climate conditions occurred, only the plants in the drawdown zone would be impacted; plants outside of the drawdown zone would need to be removed by other means.

- There can be significant environmental impacts to native plants and animals.

Suitability for Early Infestation: In lakes and reservoirs with outlet structures, this method could be used in conjunction with hand pulling, bottom barrier installation, and aquatic herbicides. Even if the exposure did not kill the milfoil, it could potentially make the plants more susceptible to other methods. However, the environmental impacts of water level drawdown can be very severe, so drawdown should only be used in water bodies where these impacts can be tolerated.

Appendix C

Possible Mitigation Measures for Early Infestation Projects

Several suggestions for mitigation measures are presented below.

- Salmon Present in the Water Body:
  - Consult Washington Department of Fish and Wildlife (WDFW) to determine when and if salmon use the water body.
  - Conduct milfoil removal activities only during the fish timing work windows provided by WDFW.
  - Identify any salmon spawning gravels and remove milfoil plants under guidance from a salmon biologist to avoid disturbing the redds (salmon nests).
  - If herbicides are used, use only the amine formulation of 2,4-D or triclopyr and treat at the lowest effective concentrations.

- Water Intakes:
  - If herbicides are used, identify all irrigation and drinking water intakes prior to treatment. If possible avoid treating near these intakes by using hand pulling or installing bottom barriers.
  - If treatment is unavoidable due to dense milfoil growth, identify the owners of the intakes and ask them to turn off the intakes during and after treatment.
  - Arrange to provide the intake owner with alternative water supply if necessary.
  - Test the water around the water intakes to ensure that the water concentrations are below irrigation or drinking water standards for the herbicide used before turning the water intakes back on.

- Rare Plants are Present:
  - Consult the Department of Natural Resources (DNR) Natural Heritage Program to determine if rare plants are present in the water body.
  - Survey the water body to locate the rare plants and consult with DNR to determine the best methods for protecting the species.
  - Try to use only hand pulling methods for milfoil removal in areas where the rare plant is growing.
  - Research the herbicides and determine which herbicide and what concentration will have the least impact on the rare plant (sometimes not treating is not an option, because milfoil left to itself may also displace the rare plant).
  - If herbicides are used, obtain baseline data about the rare plant before and after treatment to determine the impacts of the treatment. Some rare plants may be very resistant to the impacts of herbicides.
  - Consider removing the rare plants to suitable habitat before the milfoil eradication program begins.
  - Always stay in touch with the botanists at DNR during the milfoil eradication project.

- Significant Wetlands are Present in the Water Body:
  - Identify all significant wetlands in the water body.
  - If milfoil is present in the wetland area, use the least intrusive management method.

- Bird Nesting Areas and Rare Animals:
  - Identify significant habitat areas for bird nesting and rare animals.
  - Avoid intrusive management methods during nesting/breeding season.
  - Work with Washington Department of Fish and Wildlife (WDFW) biologists to develop effective milfoil management methods that have the least impact on water fowl and rare animals.

- Recreation:
  - Conduct removal projects immediately before big events, such as fishing tournaments, sailing races, triathlons, etc. to avoid spreading milfoil.
  - Conduct activities when they will least impact planned events.
  - Be sensitive about not applying herbicides before holidays like the 4th of July or even before weekends.

Appendix D

Milfoil Information

Eurasian Watermilfoil (*Myriophyllum spicatum* L.)

Description

Eurasian watermilfoil (milfoil) has finely dissected leaves that form in whorls of four around the stem. Milfoil leaves fall off as they age, so occasionally you may find less than four leaves in a whorl, especially near the bottom of the plants. Leaves near the surface are often a reddish or brown color. Milfoil generally has 12-16 divisions per leaflet and these divisions have a feather-like arrangement. It is often difficult to distinguish milfoil from its native cousins – northern milfoil and whorled milfoil. Calling an expert at Ecology may be the best way to positively identify your milfoil specimen.

Growth Habit

Milfoil is the culprit in many noxious aquatic plant cases in Washington. It has been the subject of much research and its growth habits are well known. Milfoil overwinters as short bright-green stems from a few inches to a few feet long that are rooted in the sediments. In eastern Washington, milfoil tends to die back to the fleshy root crowns over the winter. Milfoil stores energy and nutrients in its roots ready to start growth in the spring. In early spring, plants grow rapidly to the surface where they can form a mat or canopy of branches. Rapid spring growth and canopy formation allows milfoil to outgrow and shade out other more desirable native plants.

Propagation

Milfoil, a native of Europe and Asia, is primarily spread by stem fragments. Fragments are formed when pieces of the plant are cut off of the main plant body, such as by a boat propeller or during harvesting operations. These stem fragments can root and produce new plants. Milfoil also fragments naturally. In the late summer, the stems of milfoil become quite brittle and roots begin to form on the stem. Wave action or a duck paddling through a milfoil bed can cause stems to break.

Control

Prevention of milfoil invasion requires control of fragment spread. Some management techniques, harvesting for example, can create fragments and contribute to the spread of milfoil. Milfoil is susceptible to several herbicides. With the proper herbicide and application rate, milfoil can be selectively removed from an aquatic system, leaving more desirable aquatic plant species. Other intensive methods, such as bottom barrier placement and diver-dredging are effective against small-scale infestations of milfoil. Milfoil is relatively unpalatable and is low on the grass carp preference scale. Other biological controls of milfoil are under intensive investigation. A native weevil shows some promise as a biological control for milfoil.

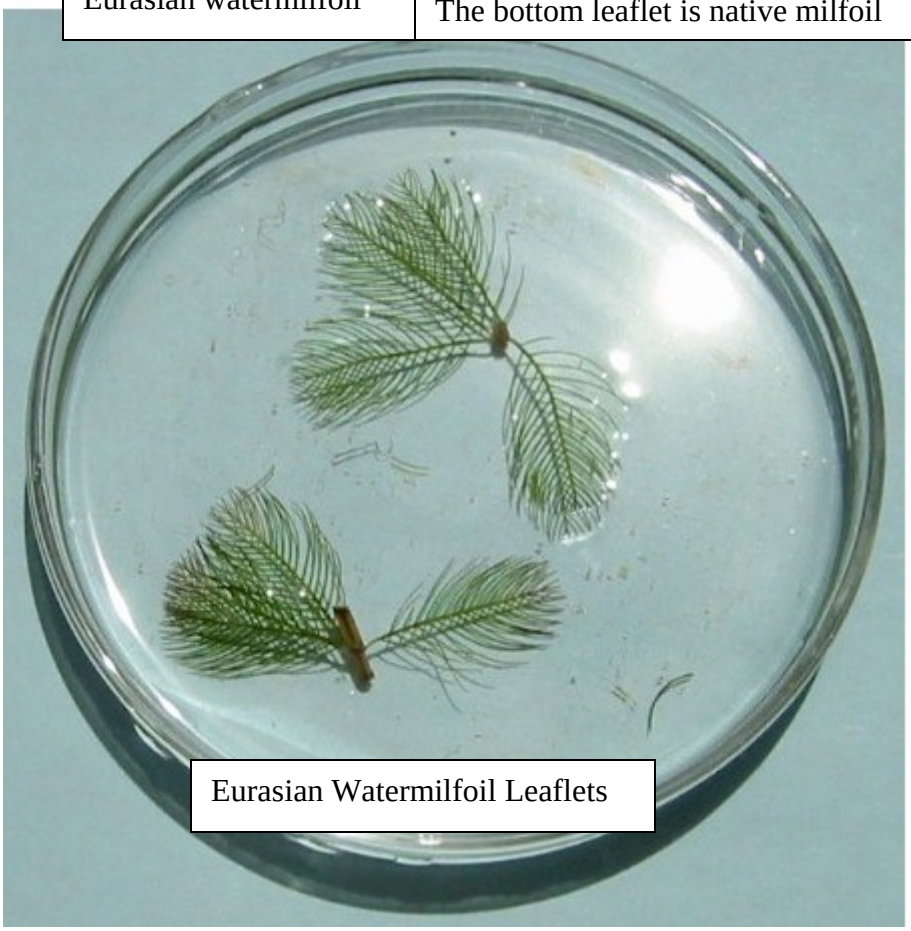
Eurasian Watermilfoil
(Myriophyllum spicatum)

Key Features

- 12 to 16 leaflets on each leaf
- Emergent flower stalks sometimes present during the summer
- Milfoil leaflets look like feathers
- No emergent leaves
- Leaves near the surface may be reddish or brown

Eurasian watermilfoil

The top leaflet is Eurasian milfoil
The bottom leaflet is native milfoil



Eurasian Watermilfoil Leaflets

Eurasian Watermilfoil Plants

A Milfoil Infested Lake