Deer Lake, Stevens County, WA

Integrated Aquatic Vegetation Management Plan

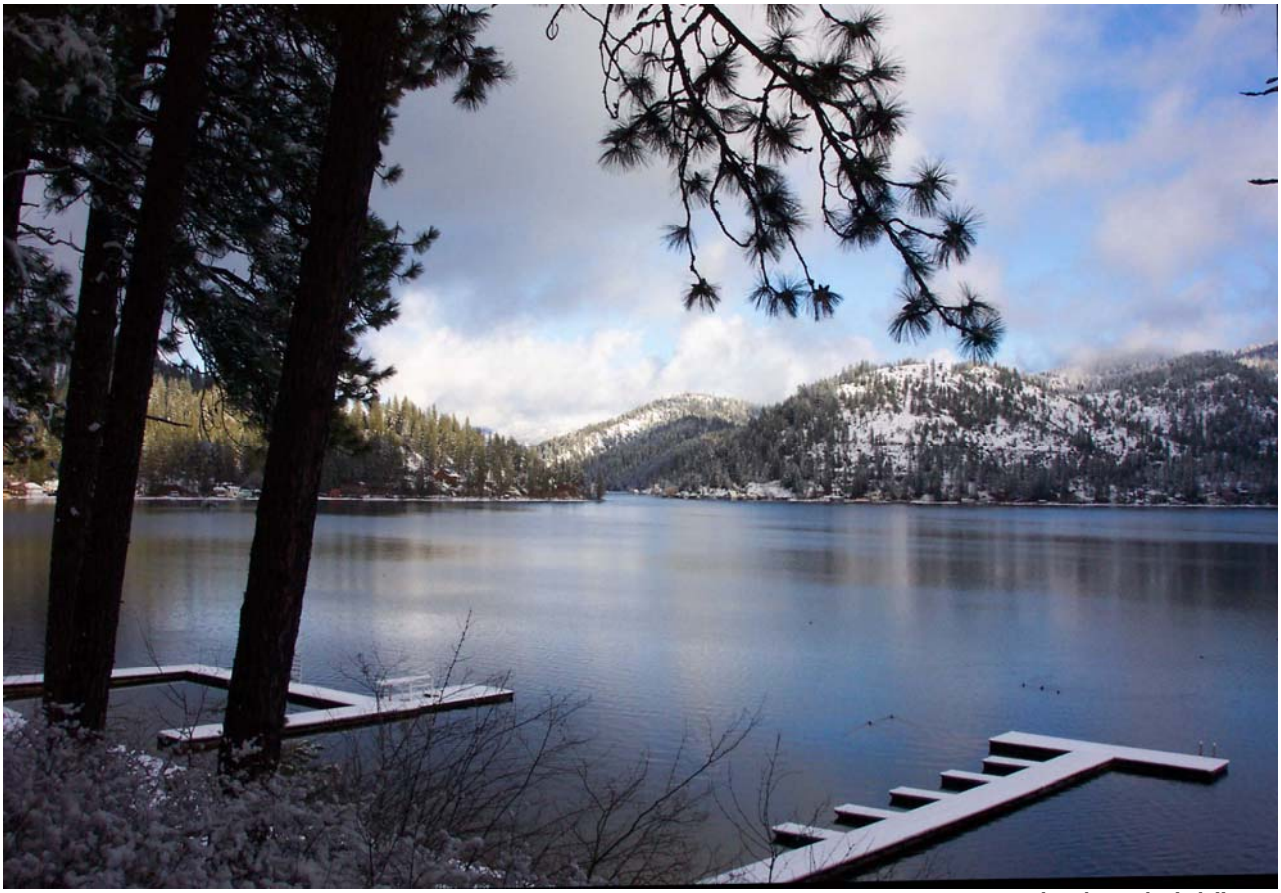

Photo by Michael Phillips

Prepared for the

Deer Lake Property Owners Association

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By

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INTRODUCTION

This Integrated Aquatic Vegetation Management Plan (IAVMP) has been prepared as an effort to develop a holistic, integrated approach to controlling and managing the growth of Eurasian watermilfoil, (*Myriophyllum spicatum*, referred to simply as 'Milfoil' herein) in Deer Lake, Stevens County, Washington. This IAVMP is, thus, an organized effort to protect the beneficial uses of this lake, including wildlife habitat and water quality. The process followed in the preparation of this Plan is outlined in the Washington Department of Ecology (WDOE) Aquatic Weeds Management Fund Program Guidelines (**WDOE 2001a**) and the publication titled "A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans" (**WDOE 1994**).

A vicinity map of Deer Lake is shown in **Figure 1**. The lake is just over 1,100 acres in size, has generally exceptional water quality, and as a result, supports a variety of beneficial uses including fishing, wildlife observation, swimming, water skiing and boating. This lake is heavily used by lakeshore residents and visitors. The lake is highly regarded as an amenity by the local community, with property values around the lake being influenced by this condition. There is one public boat launch on the lake which is open year-round and non-resident use of lake is considered moderate to heavy.

The Deer Lake residents have organized themselves into two key community organizations for the purpose of protecting the lake. The Deer Lake Property Owners Association (DLPOA) is the original group which was formed in 1973. Following the initial finding of a pioneering infestation of milfoil in the lake in 2008, the DLPOA was the primary local group that led the efforts to plan and implement the initial control work. During 2010 - 2011, representatives of the Deer Lake community worked with the Stevens County Commissioners to create the Lake Management District of Deer Lake, a local taxing entity, authorized under Washington State statue (Title 36 RCW, Chapter 36.61). The LMD was initially formed for a five- year period to address the milfoil presence. DLPOA Board members responsible for the review and approval of this Plan are Ken ring, Mike Phillips, Mike Egan, Dennis DeMattia, Bill Bajadali, John Gregerson, Jerry Groom, Brian Humphrey, Rich Jarvis, Bill Meulink, Jerry Rasley, Jim Santora, Ron Watson and Skip Wells.

The contributions of an agency representative are gratefully acknowledged for assisting with this IAVMP. Sue Winterowd, Coordinator of the Stevens County Noxious Weed Control Board (SCNWCB), has been actively involved with the Deer Lake residents from even before the initial infestation was identified. Progress made on the control efforts can be largely attributed to the technical assistance and moral support she provided throughout the planning, permitting, surveying and initial treatment efforts.

This IAVMP report was prepared by David Lamb, Lake Management Specialist (referred to as the Consultant herein) under contract with Stevens County. In addition, many volunteer hours have been contributed to this effort by the DLPOA members.

Figure 1. Map of the Deer Lake vicinity showing geo-physical features (from Google Earth).

PROBLEM STATEMENT

Lake User Groups

The primary lake "user group" active in the determination of the problem statement and management goals for this IAVMP was the lake residents, represented by the DLPOA Board. A second, overlapping group, the Lake Management District Committee, was formed to foster communication among the lake residents and to focus on developing a funding mechanism for milfoil control efforts.

Citizen and Agency Input

Public Meetings

In order to provide opportunities for residents, management agencies and the general public to learn about and provide specific input into the development of this IAVMP and proposed aquatic plant controls, notices were distributed, and two public meetings were held. The initial public meeting took place on November 10, 2011 at the Salvation Army Camp Gifford.

A notice about the November meeting was mailed along with a questionnaire to the lake residents prior to the first public meeting (see copies in Appendix A). An article about the IAVMP planning process was prepared by the Consultant and distributed through the DLPOA's e-mail and postal mailing lists. During the first public meeting an overview of the IAVMP process was presented by the Consultant and participant questions were answered. Attendance at this meeting was 54. The meeting notices, agenda, Project Summary handout, and meeting minutes are presented in Appendix A. A summary of the questionnaire responses is presented below.

The key result of the initial public meeting was the bringing together of people from around the lake and the exchange of thoughts on the management of aquatic vegetation.

The key result of the second public meeting (which was held in conjunction with the DLPOA Annual Meeting) was that the attendees supported the IAVMP, as outlined in the meeting Agenda / handout. A few questions were asked of Mr. Lamb, primarily related to the use of herbicide in the lake.

Resident Questionnaires

Summary of Questionnaire responses

In addition to the initial public meeting notice, a questionnaire was mailed out to landowners around the lake and provided to State regulatory agencies (WDOE, WDFW and WDNR) in November, 2011. Some of the questions on this had standard answers that could be circled and other questions gave space for people to write in their own thoughts. The 110 completed questionnaires were reviewed and the following summary prepared. Questionnaire results are included in **Appendix A**.

- Personal involvement in Deer Lake: 109 were 'Property Owners' and one was a 'Manager/agency Representative' (WDFW representative).
- Water Quality rating: 24 chose 'Fair' and 85 chose 'Good'. There was one questionnaire with no reply to this question.

- Most Important Factor about Water Quality: Most questionnaires indicated swimming and clean / clear water (see **Table 1** below for summarization of all questionnaire results.)
- Effect of aquatic plants on usability of lake: 36 circled 'Significant Effect', 40 circled 'Moderate Effect' and 28 circled 'Little Effect'. There were six questionnaires with no reply to this question.
- Most important factor about aquatic plants: Most questionnaires indicated control of growth invasives and maintenance of native plants and ecosystems (see **Table 1**).
- Overall usability of lake: 95 circled 'Good and 12 'Poor'. There were three questionnaires with no reply to this question.
- Most important factor about usability: Most questionnaires indicated clean and clear water, aquatic vegetation control and swimmability (see **Table 1**).
- Uses of the lakes: 83 circled 'Fishing', 100 circled 'Swimming", 99 circled 'Boating' and 77 circled 'Wildlife Observation'. In addition, one person wrote in "water skiing", two wrote "canoeing", two wrote "hiking", two wrote "diving or snorkeling", two wrote "relaxation" and five wrote in "aesthetics". There were 10 questionnaires with no reply to this question.
- Other comments (see **Table 1**).

Conclusions from Questionnaire Responses

The conclusions drawn from the questionnaire responses are that this lake system has many informed and caring residents, good water quality, a range of recreational opportunities as well as good fish and wildlife habitat, and a presence of the invasive aquatic weed Eurasian milfoil. The questionnaire responses also indicated that the DLPOA has good support among the residents for its lake management activities.

Table 1. Summary of write-in responses to Deer Lake IAVMP questionnaire, November 2011.

Question #	Deer Lake IAVMP questionnaire results summary	# of questionnaires
3	**Most Important Factor about Water Quality**	
	Swimmable / safe for contact recreation	37
	Clean / uncontaminated	28
	Clear / no algae blooms	25
	Milfoil / aquatic weeds and algae under control	14
	Fish habitat / fishing / edible	14
	Good wildlife habitat	6
	No flooding	1
	High property values	1
	Good sewer system	1
	Aesthetics	1
5	**Most Important Factor about plants**	
	Control / miminize growth of invasives	54
	Maintain native plants ecosystems	29
	Don't impact recreation incl fishing and swimming	8
	Boating / weed tangles in boat props	3
	Pile up on shoreline	1
	Cost of control of invasives	1
7	**Most important factor about usability**	
	Clear / clean water	29
	Swimmability	15
	Aquatic vegetation under control	12
	Boating	10
	Fishing	8
	Wildlife / aesthetics / ecosystem balance	6
	Uncrowded	4
	Shoreline protection / debris control	3
	Public boat access usability	3
	Access to water	3
	Taxes / costs	2
	Active DLPOA	2
9	**Other Comments**	
	Appreciate DLPOA efforts	6
	Reduce boat traffic / enforce boat regulations	6
	Concerned about cosdt of milfoil control	5
	Water depth and weeds at WDFW access	2
	Dust in water at Southwood Shores Road	2
	request fish tissue toxicity information	1
	Benefit of sewer system	1
	Request for PWC impact information	1
	Request for swimmers itch information	1
	Boat washing station be installed	1
	Request for Aquatic plant ID information	1

Problem Categories

Discussions about the presence of Eurasian watermilfoil and the control or elimination of this pest have been discussed by the DLPOA and the community at large. These discussions led to the following Problem Categories being described for Deer Lake:

- Current and potential hindrance to swimming because of excessive plant growth,
- Potential hindrance to boating and water skiing,
- Potential degradation of fishing and fish habitat,
- Potential reduction in aesthetic appeal of the lake,
- Potential decrease in property values.

Effected Beneficial Uses

Following from the discussion of the questionnaire responses, above, the following beneficial uses were identified (in order of preference, based on the number of returned questionnaires listing each use):

- Swimming
- Boating,
- Fishing, and
- Wildlife observation,

Other general "Characteristic uses" of waters of the State, as defined in Water Quality Standards for Surface Waters of the State Of Washington (WAC Chapter 173-210A) likely apply to Deer Lake:

- Primary contact recreation (swimming, wading, diving, water skiing),
- Agricultural water supply,
- Stock watering,
- Wildlife habitat, and
- Aesthetic values.

Specific beneficial use areas are indicated on **Figure 3**, below.

Problem Statement

The Problem Statement developed for this Plan is: Deer Lake is host to low density growths of Eurasian watermilfoil (*Myriophyllum spicatum*, referred to as simply "milfoil" herein) at various locations in the lake (see AQUATIC PLANT CHARACTERIZATION section, below). These low density growths, if not controlled, have the capacity to impact (degrade) the human, fisheries and wildlife uses of the lake. The Deer Lake Property Owners Association (DLPOA), being aware of both the local presence of milfoil (primarily in nearby Loon Lake) and the risks that this weed poses should it become introduced to Deer Lake, were on the lookout for this weed ever since the infestation was discovered in Loon Lake and had funded diver surveys in 2004 and 2006. Unfortunately, milfoil was discovered in the north arm

of the lake in August 2007 during a routine Ecology survey. Following that finding, and in consideration with the apparent limited ("pioneering") extent of the growth, the DLPOA in conjunction with the Stevens County Noxious Weed Control Board (SCNWCB), applied for and received an Early Infestation grant from Ecology in 2008.

With the help of the Early Infestation grant funding, a contractor was hired to perform diver surveys, as well as small scale diver hand removal, bottom barrier and herbicide treatments, in 2008, 2009 and 2010. Because milfoil was not eradicated following these efforts, the DLPOA decided to proceed with the formation of a Lake Management District to help provide local funding for the needed ongoing survey and control efforts. This IAVMP provides guidance to the DLPOA in controlling (or eradicating) this weed in the short and long terms using the best available methods.

Eurasian watermilfoil is one of the most invasive aquatic plant pests in North America and every possible effort should be made to prevent the spread of this plant. Uncontrolled milfoil growth in Deer Lake could cause impacts to all of the beneficial use described above. The problems that dense growth of milfoil could cause on these beneficial uses include: physical hindrance to swimming and boating, degradation of fish rearing and spawning habitat, hindrance to wildlife uses, water quality impacts such as oxygen depletion and nutrient release and reduction in aesthetic values through sight and smell of dense milfoil beds.

Management Goals

The management goals described below must cover *at least five years*. As managers of waters of the state, the goals must be protective of all of the "characteristic uses" of the lake. Characteristic uses of waters of the state are defined in the Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC. The development of the Problem Statement, the assessment of watershed and lake characteristics and the determination of desired beneficial uses have led to the following management goals specific to Deer Lake:

1. Maintain fish habitat for rearing, spawning and harvesting (as appropriate given WDFW fishery management activities).
2. Maintain "primary contact recreation" opportunities, *i.e.*, activities where a person would have direct contact with water including, but not limited to wading, swimming, diving and water skiing.
3. Domestic and commercial water supply.
4. Maintain wildlife habitat (to the extent that this could be impacted by uncontrolled milfoil growth).
5. Maintain boating / navigation opportunities.
6. Maintain aesthetic values (as these pertain to near shore, submersed aquatic plant areas).
7. Choose aquatic plant control techniques which have the widest public support, a low cost to benefit ratio and prevent adverse environmental problems either in the lake or in the associated wetland areas.
8. To the extent possible, reduce milfoil growth to the point that chemical herbicides are not needed during each successive year.

9. Establish and maintain an Advisory Committee through the Lake Management District to ensure that aquatic weed surveys and control measures continue as needed.

The "action limit" for Eurasian watermilfoil in Deer Lake is zero plants; that is, controls are recommended whenever milfoil is found in the lake. Eurasian milfoil is to be treated wherever it is found using, initially, the moderate or high intensity controls as outlined in this Plan.

WATERSHED and LAKE CHARACTERISTICS

In order to fully understand the lake system, with its uses and problems, and the opportunities for its protection and management, the watershed and waterbody must be described. The following discussion summarizes the available information on Deer Lake.

Watershed

Watershed Physical Features

The Deer Lake watershed is located in Stevens County, WA at latitude 48° 6' 28" longitude 117° 36'18" and within Township 30 North and Range 41 East Willamette Meridian. The watershed is 18.2 square miles in size (Dion et al, 1976) and is within the Colville River basin (WRIA #59). The primary inlet to Deer Lake, an unnamed intermittent stream, enters at the northeast corner flowing through a significant wetland area that has been a source of nutrient enrichment to the lake (see Lake section below). Non-point sources of inflow off the adjacent land have not been specifically identified but would be expected to include the entire near-shore area.

Watershed Land Use

Land use within the Deer Lake watershed is given by Dion et al. (1976) as 4% suburban, 4% agricultural, 82% forest or unproductive and 10% lake surface. The primary lake inlet enters the lake at the northeast corner, where there is a large wetland area (see **Figures 1 and 3**). Dion et al. (1976) indicates that there were 358 near shore homes in the early 1970's. Shoemaker (1976) in his Water and Sewage Facilities Plan for Deer Lake indicated that there were 550 plus shoreline homes in 1975. The current DLPOA / LMD property owner listing indicates 531 lakeshore parcels (Michael Phillips, DLPOA, personal communication).

Zoning and Shoreline Designations

Following a communication with the Steven's County Planning Department, the lakeshore areas are essentially all zoned rural ('RA5'). Exceptions are where "resort overlays" are applied to four "resort" areas (Deer Lake Resort, West Bay Resort, Sunrise Point and Zack's Shacks; see **Figure 3**).

The Stevens County Shoreline Program designation of the Deer Lake shoreline is "suburban" except for two properties owned by the DLPOA along the Northeast Wetland shoreline. Unofficial "environmentally sensitive areas" reported by County Planning Department staff are the Northeast wetland, the Northwest wetland and the shallow bay where the WDFW public access is located.

Lake

Physical Features.

The lake surface elevation is approximately 2,474 feet above sea level, the lake area is 1,100 acres, the lake volume is 57,000 acre-feet and the maximum depth is approximately 75 feet (Dion et al. 1976). A bathymetric map of the lake is presented as **Figure 2**. Lake sediment types have not been surveyed or mapped but likely include organic muck in some shoreline areas and decomposed granite gravel to rock in deeper areas.

Inflow, Outflow and Water Budget

Shoemaker (1976) in the water and sewage facilities plan for Deer Lake presented information on the water budget of the lake. He reported that surface runoff (5,300 acre-feet annually) accounts for 55% of the annual inflow to the lake. As indicated above, the primary inlet is an unnamed intermittent stream located at the northeast corner of the lake. There are several other unnamed, intermittent streams that contribute water to the lake which are shown on Figure 3 (the Beneficial Use Area map). The other 45% of the lakes water inputs is attributed to precipitation (2,000 acre-feet) and groundwater (2,300 acre feet). Annual surface outflow was estimated to be only 800 acre-feet, indicating a "closed" lake basin. Annual underground seepage (5,400 acre-feet) was reported as the largest loss of water. Based on the lake volume and these annual water inputs, the water retention time (flushing rate) is approximately nine years (Soltero and Buchanan1991). Based on the lack of surface water outflow, there are no downstream plants or animals that may be impacted by any management activities in the lake itself.

The USGS has operated a water level gauge on Deer Lake in the past but this data was not reviewed for this project. According to Michael Phillips, there are several conflicting indications of the normal, full pool lake level. The DLPOA is planning on resolving this issue in the near future.

Water Quality

The first known water quality analysis of Deer Lake was made in 1911 by Kemmerer et al. (1924). Kemmerer and his colleagues described Deer Lake as being thermally stratified with oxygen present at the lake bottom and an algal community comprised of diatoms and blue-green algae.

The next water data for Deer Lake was presented in a 1969 memorandum to the Washington Water Pollution Control Commission regarding a water quality survey of Loon, Deer and Diamond Lakes (Lee. 1969). This study indicated a Secchi Disk water clarity reading of 33 feet (indicating a low level of algae and other suspended material), moderate levels of coliform bacteria and a low potential for production of algae (based on testing for nitrogen and phosphorus compounds).

In a 1973 publication by R.A. Bishop contained lake water data from 1971 and 1972 again from Deer, Loon and Diamond lakes. This report indicated that these three lakes were in "early stages of eutrophication" although Deer appeared to be in a "less advanced stage" than Loon and Diamond. This conclusion was based on the appearance of blue-green algae in late summer, and on nitrate concentrations in the 1972 data. Recommendations for these three lakes were given as 1) assessment of nutrient sources and algal growth potentials so that nutrient budgets could be established, 2) testing of lake waters for coliform bacteria to determine safety for human contact, 3) documentation of present and future distribution of fish species and related aquatic life in relation to eutrophication and 4) continuation of water quality surveillance. Further the density of the human population should be

monitored to determine when a sewage collection system should be installed to carry wastewater away from the lake.

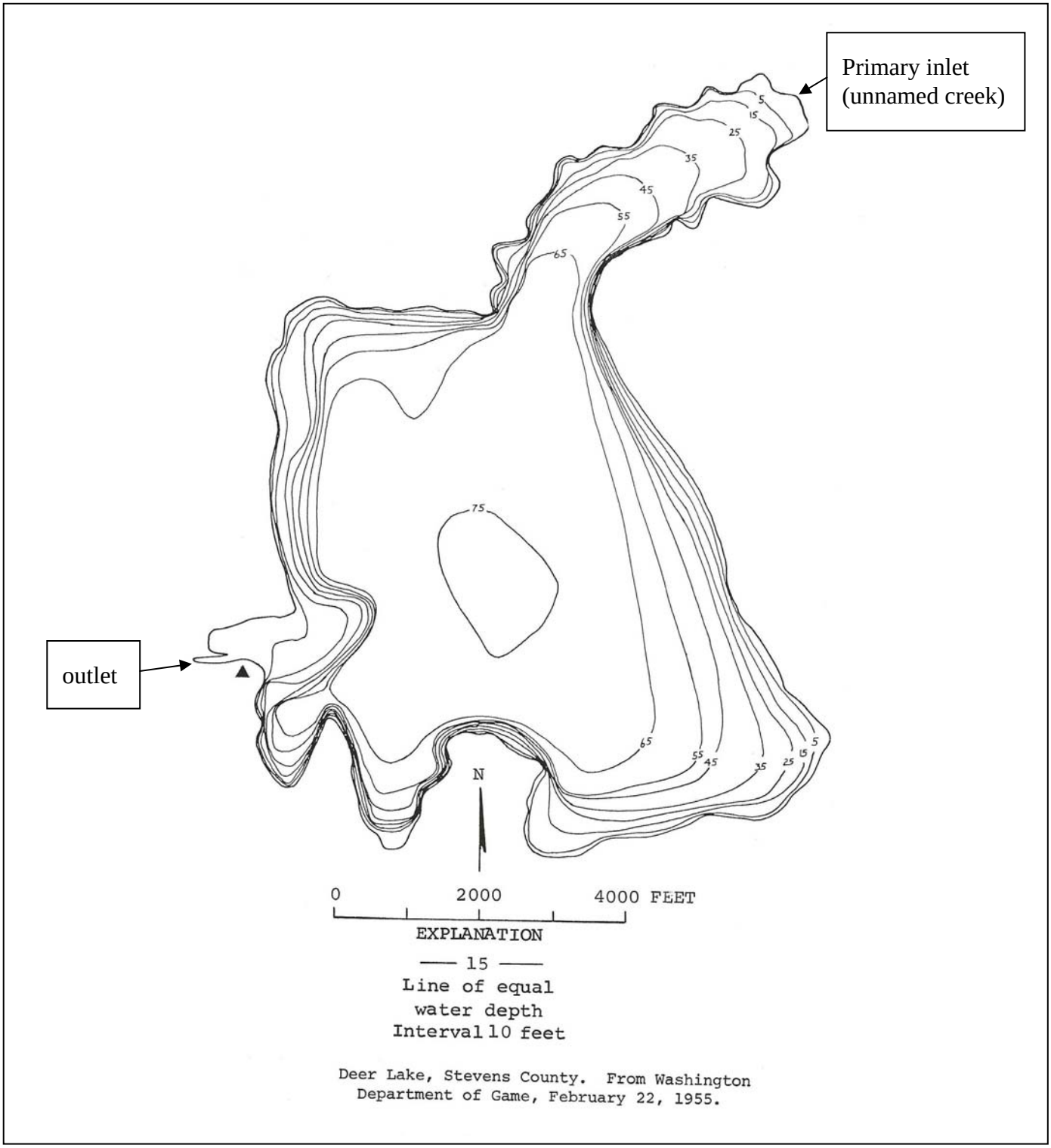

Figure 2. Bathymetric map of Deer Lake (Dion et al. 1976).

Shoemaker (1976) in his Water and Sewage Facilities Plan for Deer Lake was the first to attempt to identify sources and quantities of phosphorus entering the lake. He estimated that 75% of the phosphorus load came from septic tank leachate. However, Shoemaker also noted the potential contribution of phosphorus from cattle grazing along the lake's primary inlet.

In 1980, Singleton and others published another assessment of the trophic status of these three lakes based on data from 1978. This report indicated that the three lakes were "mesotrophic", each having nutrient and chlorophyll *a* concentrations below the established threshold for eutrophic waters. The data collected for this report indicated that mean nutrient concentrations and the extent of deep water oxygen consumption ("hypolimnetic anoxia") appeared to be unchanged for those evident in the Bishop (1973) study. This report indicated that algal numbers were significantly increased over those seen in1972, but stated that different collection techniques used in the two studies may have biased these results.

A 1991 report by Eastern Washington University and Entranco Engineers (Soltero and Buchanan 1991) described a more detailed look at Deer Lake's water quality. Following a shoreline wastewater leachate survey, the authors found no conclusive information to implicate the failure of on-site treatment systems (septic tanks), or at least a low potential for bacterial and nutrient contamination to enter the lake. Inflows from the primary inlet and surrounding wetlands were found to be significant sources of nutrients to the lake. Comparison of data collected from the various studies performed to date did, however, substantiate a trend of declining water quality in the lake. Recommendations following from this study concerned the control of phosphorus entering the lake from the area surrounding the primary inlet and referred to as the "Northeast Meadows".

The Deer Lake residents concern over the apparent declining water quality led to several significant management efforts. The first was the DLPOA purchase of 20 acres of near-shore habitat in the Northeast Meadows inlet area to prevent cattle grazing near the lake. The second effort was the sewering of the developed areas around the lake. The sewer was designed and constructed under the auspices of the local Public Utility District. Completed in 1991 this system carries wastewater to the Loon Lake treatment facility which is outside the Deer Lake watershed. The third, and perhaps, most important to the immediate protection of water quality in the lake was the purchase of more of the Northeast Meadows area in 1996-1997 by the USDA Natural Resource Conservation Service and US Fish and Wildlife Service. This former heavily grazed area is now actively maintained by the Washington Department of Fish and Wildlife as a wetland wildlife habitat and has seen various stream channel restoration, re-vegetation and pond construction efforts in recent years.

The Northeast Meadows restoration work, in particular, is believed to be the cause of observed improved water quality conditions in recent years. However, the residents are still concerned about nutrient additions from their fish rearing net pen operations and about the long term effects of near drought conditions which have prevented there being much surface water outflow since the 1997 high water year (Mike Phillips, personal communication 2005). As a result of this concern, the DLPOA commissioned a study in 2005 to update the understanding of the lake's water quality. This study was performed by Spokane Tribal Labs (STL 2005).

The STL study of water quality monitoring performed in May and August 2005 provided a good view of physical, chemical and biological characteristics of Deer Lake waters. Data from the primary inlet stream were not particularly insightful due to the difficulty of sampling close enough to the lake to catch

the various sub-watershed tributaries. However, the Northeast Meadow appears to be decreasing the nutrient loading into the lake due to the higher nutrient levels detected in the inlets. No parameter measured in 2005 indicated the presence of a water quality problem or health related issue. In addition, comparison of 2005 data with various previous study results did not indicate any significant change in any parameter. However, the apparent slight elevation of in-lake total phosphorus levels in August of 2005 warrants that future monitoring efforts be conducted in the two to four year time frame.

303d Listing

Deer Lake is listed on the State 303d list of "Impaired" water bodies for phosphorus, Category 2. O'Neal et al. (2001) concluded that designated uses are not being supported and that total phosphorus levels exceed the recommended lake-specific criterion. A lake segment or grid will be placed in Category 2 when fewer than four sample values are available from a single season or critical period, and at least one value is greater than the criteria or action value for that waterbody.

The selected integrated action plan for milfoil control is in line with the control of phosphorus inputs as long as herbicide containing phosphorus are not used and as long as diver activities do not re-suspend large amounts of lake sediments. If Eurasian milfoil is not controlled in Deer Lake it is likely that more phosphorus will be moved from the lake sediments into the overlying waters through the growth and senescence of these plants.

Water Rights

A search of the WDOE's Water Rights Applications Tracking System made on February 3rd, 2012, resulted in the Water Right listing presented in **Appendix C.** A summary of the listed rights is presented in Table 3.

Wetland Areas

Northeast Meadows Wetlands

This is the key wetland area, shown in **Figure 3**, that contributes to good water quality in Deer Lake, thanks, in part, to the prohibition of grazing and habitat improvements in that area. The DLPOA purchased 20 acres along the lake shoreline of this wetland in 1986 for the specific purpose of protecting the lake water quality.

In 1998 the landowner enrolled 500 acres of this wetland, with some adjacent uplands, in the Wetland Reserve Program through the Natural Resources Conservation Service. In the 1999 to 2001 period, the landowner worked with the NRCS and with Ducks Unlimited to survey the wetland and to implement some habitat improvements (tree and shrub planting and pond construction).

In 2000, the US Fish and Wildlife Service purchased 700 acres of this wetland area using Bonneville Power Administration mitigation funds. The USFWS now manages this area as part of the Little Pend Oreille National Wildlife Refuge system (Jerry Kline, USFWS Refuge Manager, personal communication).

The Northeast Meadows wetland is listed on the WDFW Priority Habitats and Species information obtained for this project (see below).

Northwest Meadows Wetlands

This 30 acre wetland area is located on intermittent stream which enters Deer Lake at the northeast corner of the lake (see **Figure 3**). The Camp Gifford property protects much of this wetland area.

Bird, Wildlife and Fish Usage

Birds and Wildlife

Birds, waterfowl and wildlife seen in the Deer Lake area have been documented by a number of lake residents of nearby Loon Lake. **Table 4** presents a listing of commonly seen species, some of these being resident and others migratory or temporary residents of the lake area. It is expected that all of these species would also occur around Deer Lake.

Table 1. Summary of listed Water Rights for Deer Lake, Stevens County, WA. Data from Washington Department of Ecology database 2/3/12.

Purpose	Purpose Code	Number of Listed Water Rights
Domestic General	DG	31
Domestic Multiple	DM	6
Domestic Single	DS	98
Fire Protectiion / DS	FR/DS	6
Municipal	MU	4
Irrigation	IR	6
Irrigation / DG	IR/DG	8
Irrigation / DM	IR/DM	2
Irrigation / DS	IR/DS	2
Irrigation / FR	IR/FR	3
Total Rights Listed=		166

Table 2. Bird, mammal and reptile species observed on or near Loon Lake, Washington by lake residents Ginger Gumm, Daniel Poleschook, Jr., and others during 1993 to 2003.

Resident and Nesting Birds		
blackbird, Brewer's	goldeneye, common	osprey
blackbird, red-winged	goldfinch, American	owl, barred
blackbird, yellow-headed	goose, Canada	phalarope, Wilson's
bluebird, western	grebe, pied-billed	pheasant, ring-necked
chickadee, black-capped	grebe, red-necked	quail, California
chickadee, mountain	grosbeak, evening	rail, Virginia
coot, American	gull, ring-billed	raven, common
cormorant, double-crested	hawk, red-tailed	robin, American
cowbird, brown-headed	heron, great blue	sandpiper, spotted
crow, American	junco, dark-eyed	snipe, common
dove, mourning	kestrel, American	sora
dove, rock	killdeer	sparrow, song
duck, muscovy	kingbird, eastern	swallow, tree
duck, ring-necked	kingfisher, belted	swallow, violet-green
duck, ruddy	hummingbird, black-chin	swift, Vaux's
duck, wood	hummingbird, calliope	teal, cinnamon
eagle, bald	hummingbird, rufous	teal, green-winged
finch, Cassin's	magpie, black-billed	turkey, wild
finch, house	mallard	woodpecker, downy
flicker, northern	meadowlark, western	wren, house
gadwall	nighthawk, common	wren, marsh
goldeneye, Barrow's	nuthatch, red-breasted	
Migratory and Irruptive Birds		
canvasback	loon, Pacific	siskin, pine
grebe, eared	merganser, common	scaup, lesser
grebe, horned	merganser, red-breasted	swan, trumpeter
grebe, red-necked	pintail, northern	waxwing, cedar
grebe, western	redhead	wigeon, American
loon, common	redpoll, common	
Mammals		
beaver	coyote	lion, mountain*
bear, black*	deer, white-tailed	muskrat
Reptiles / Amphibians		
turtle		

Fish

The following, extracted from McLellan et al. (2007) describes the fish population in Deer Lake:

> An assessment of the fish populations inhabiting Deer Lake, Stevens County, WA was conducted from 29 August - 7 September 2005. The survey was conducted to provide information to Regional Management Biologists to help improve the fishing opportunities in Deer Lake and provide general fish distribution information for the Joint Stock Assessment Project (JSAP). Fish occupying the littoral zone of the lake were sampled using WDFW's standardized warm water survey protocol. Standard fish collection methods include boat electrofishing, gill netting, and fyke netting. A hydroacoustic and gill net survey was conducted to assess the limnetic fish populations. There were 12 species of fish collected in Deer Lake. All 12 species were represented in the littoral survey. Smallmouth bass had the highest biomass (% of catch by weight) in the littoral sample (38.4%) and yellow perch had the highest relative abundance (31.9%). Five species were captured in limnetic gill nets: black crappie, kokanee, lake trout, rainbow trout, and yellow bullhead. Lake trout dominated the species composition (66.7%). Yellow perch, smallmouth bass, and pumpkinseed had the highest CPUE values in littoral electrofishing, gill net, and fyke net samples, respectively. Lake trout had the highest CPUE in limnetic gill net samples. Hydroacoustic density estimates were expanded to total lake volume resulting in a lake-wide abundance estimate of 33,535 (± 6,258; 2SE) fish with target strengths between –55 and –28 dB (~30-800 mm total length). The total kokanee (age-1 and older) and lake trout (> 400 mm) abundance estimates were 342(± 64; 2 SE) and 214 (± 40; 2 SE), respectively. Low catch rates of small fish (< 100 mm) and the high frequency of acoustic targets between 30 and 100 mm (81 %), limited abundance estimates of age-0 fish, most likely kokanee fry stocked in the spring. The growth of each species of fish captured in the littoral survey was similar when compared to the 2000 survey. The densities (based on CPUE) and stock density values of bass and panfish were characteristic of a "big bass" management strategy. The low densities and relative weights of salmonids indicated an overabundance of predators. Most kokanee and rainbow trout were likely consumed shortly after stocking, and the subsequent shortage of prey fish was likely resulting in low relative weights among lake trout. In addition to lake trout, warm water fish species were also suspected to have contributed to the high mortality of stocked salmonids through predation."

To supplement the fish population in Deer Lake, the DLPOA operates three fish net pens which are anchored in place in the narrows area. The number of fish and species raised in these pens varies from year to year but generally, they release 10,000 to 15,000 Rainbow trout from one pen and 20,000 to 30,000 Kokanee or Rainbow from the other two pens.

The Washington Department of Fish and Wildlife also operates a fish supplementation (stocking) program in Deer Lake. WDFW representative Bill Baker (District 1 Fish Biologist) provided stocking information for 2010 and 2011 to illustrate the extent of this program. In 2010 the stocking was: 250 Rainbow Trout "Jumbos" (two to four pounds, 17 to 18 inches long each), plus 2,800 Rainbow "Triploids" (1.5 pounds, 12 to 13 inches long each) and 58,650 Rainbow "Spring Fingerlings" (four fish per pound, 8 to 10 inches long each). These fish were stocked in the March to April time period. 2011 stocking was similar (250 "Jumbos", 2,073 "Triploids" and 39,000 "Spring Fingerlings" stocked in March - April) with the addition of 25,000 "Spring Fry" Kokanee. The Kokanee were raised in the DLPOA net pens and released when they reached 60 fish per pound (about three inches long each).

Rare, Threatened or Endangered Species.

WDFW Priority Habitats and Species Information

The WDFW maintains a number of databases that contain information about the locations of important fish and wildlife species that should be considered in land use decisions and activities. For the Deer Lake IAVMP project, a request was submitted to the Priority Habitats and Species (PHS) program which provides detailed 1:24,000 scale Habitats and Species maps with standard explanatory reports describing the resources of concern. The result of this request was one map showing all of Deer Lake and indicating the following habitat / species which are on the Priority Habitats and Species List or on the Species of Concern List:

PHS Form #: 900150. Site Name: Colville Valley, South Stevens County General Description: "White-tail deer winter range medium use by resident populations with frequent migrations".

PHS Form #: 902968. Site Name: deer Lake wetlands General Description: "Wetland waterfowl nesting and great blue heron foraging area. Red-necked grebe nesting".

PHS Form #: 912554. Site Name: Loon Lake and Deer Lake General Description: "Common loon concentrations in spring migration".

PHS Form #: 912556. Site Name: Stevens County lakes General Description: "Red-necked grebe breeding areas".

In addition to these listed priority species and habitat, the WDFW provided a listing from the Priority List Report from the Washington Lakes and Rivers Information System (WLRIS) database. The one species listed (kokanee salmon) is considered to be a priority for conservation and management by WDFW.

It does not appear that aquatic vegetation management work performed at Deer Lake will have any effect on these species or the wetland habitat. However, the timing of milfoil control treatments must take these species into consideration, especially red-necked grebe nesting and Loon migration. Treatments must also consider the kokanee, especially the net pens when they are in use.

WDNR Natural Heritage Program

A request was made to the Washington Department of Natural Resources for information that they might have on the presence of rare plants or high quality ecosystems at Deer Lake. The letter reply (see copy in Appendix B) indicated that there are no known occurrences in the project area.

Beneficial Use Areas

Beneficial use areas on Deer Lake were identified for this planning effort and are indicated on the Beneficial Use Area map, **Figure 3**. The paragraphs which follow present descriptions of the variety of beneficial use areas around Deer Lake. Many recreational lake beneficial uses are present throughout the lake, such as fishing and water skiing.

WDFW Boat launch

The WDFW public access is a boat launching facility located at the southwest corner of Deer Lake (see **Figure 3**).

Figure 3. Beneficial use areas, significant wetlands and road access to Deer Lake (from US Geological Survey Deer Lake and Nelson Peak Quadrangles, 7.5 Minute series maps, 1965 and 1992, respectively).

Deer Lake Resort

Deer Lake Resort occupied 650 feet of lakefront. This resort includes 20 cabins for rent, 16 tent sites, four covered wagons (overnight accommodation), 45 RV sites, three docks with 46 boat slips and a store / restaurant. (Information provided by Mrs. Sharon Crum, Owner, 509-233-2081.)

Camp Gifford

Camp Gifford is a summer youth camp owned and operated by The Salvation Army in Spokane and it occupies 400 feet of lakefront. Camp Gifford also offers retreat and conference facilities to rental groups. The camp's accommodations include nine A-frame cabins, four cottages and 11 hotel-style rooms. Other facilities include a dining hall, meeting hall, recreation room, two sports fields, volleyball and basketball courts, mini golf course, swim beach and dock for canoe and paddleboat use. (Information provided by Mr. Michael Phillips, Manager, 509-233-2510.)

Pinelow Nazarine Park

Located just north of the WDFW access site is the Pinelow Nazarine Park which occupies land on both sides of the Deer Lake Road and approximately 1,400 feet of lakefront. This camp has 18 cabins for rent along with five lodges and three A-frames. There is a dining hall, two chapels a baseball diamond and soccer fields. The shoreline includes a swim area and boat dock. (Information provided by Mr. Doyle Knight, Manager, 509-233-2367.)

Sunrise Point Resort

Sunrise Point Resort occupies 1,600 feet of lakefront. This resort has 54 trailer / RV spots, seven cabins, dock space for 25 boasts and a swim beach. (Information provided by Mr. Marion Ballard, Owner, 509-233-3010.)

West Bay RV Park

West Bay is a gated community / private park which occupies approximately 500 feet of lakefront along Deer Lake. It has 63 RV spots, three docks accommodating about50 boats, a swim beach, picnic area and recreation center for the use of the residents and their guests. (Information provided by Mrs. Mareitta Innes, Owner, 509-233-2342.)

Zaks Shacks

This is reportedly a private family resort with four to five cabins. (Information provided by Mrs. Sharon Crum, Owner of deer Lake Resort, 509-233-2081.)

Julius Terrace

This is a neighborhood access dock and beach area.

Wanakawin

This is a neighborhood access dock and beach area.

General Developed Shoreline Areas

Residential development along the shorelines of Deer Lake is the primary development around the lake, especially along the eastern and southern shores.

History of Lake Management Efforts

No actual lake management activities were performed at Deer Lake prior to the finding of milfoil in the lake (unless one considers the sewering as a lake management effort). However the DLPOA was aware of past water quality studies performed on the lake and commissioned the 2005 Spokane Tribal Labs study in order to keep tabs on any changes in the water quality.

The Deer Lake Property Owners Association (DLPOA), was aware of the local presence of milfoil (primarily in nearby Loon Lake but also in other Stevens County Lakes to the north, in the Little Spokane River watershed to the east and in the Spokane River system to the south) and also the risks that this weed poses should it become introduced to Deer Lake. The DLPOA was therefore on the lookout for this weed ever since the infestation was discovered in Loon Lake (in 1996), and had funded diver survey efforts in 2004, 2006 and 2007. Unfortunately, milfoil was discovered the Northeast Wetland shoreline in August 2007 during a routine WDOE survey. This discovery was in an area heavily overgrown with native aquatic plants. Following that finding, and in consideration with the apparent limited ("pioneering") extent of the growth, the DLPOA in conjunction with the Stevens County Noxious Weed Control Board (SCNWCB), applied for and received an Early Infestation grant from Ecology in 2008.

With the help of the Early Infestation grant funding, a contractor was hired to perform diver surveys, as well as small scale diver hand removal, bottom barrier and herbicide treatments, in 2008, 2009 and 2010. The following is extracted from a 2010 ACE Diving report to the DLPOA:

> 2008:
>
> From July 14 through the 18th a thorough diver survey was conducted. A rather large dense area of milfoil was detected in the swim area of Deer Lake Resort. It is difficult to explain why this infestation had not been discovered in previous surveys. We can conclude that swim areas are not normally indicated as priority for survey. Most lake property owners association members are knowledgeable of the effects of milfoil in their waterways and help monitor the near-shore areas. Our survey techniques consist of pulling divers behind a boat to look for the milfoil in depths unable to be detected by shoreline or dock surveillance. Also, this infestation was very young. The substrate and the nutrient loading may have contributed to a very fast growing infestation, which was not detectable in previous surveys.
>
> It was determined that the resort infestation was large enough to justify another form of control. Bottom barriers are framed, weighted panels of spun nylon, which are designed to be placed over dense beds of EWM. 20, 100 square foot panels were placed over the infestation in the resort swim area. This covered about 80% of the milfoil there. The remaining milfoil was diver dredge removed and the area was left fairly clean. It is difficult to know how much milfoil will come up throughout the remaining growing season. It was recommended that more work on the lake be done later in the season.
>
> 2009:
>
> During the week of July 5, 2009 the lake wide plan of search and remove was again implemented. The areas previously found to have milfoil were prioritized and searched thoroughly. The Deer Lake

Resort area had little milfoil so some of the bottom barriers were removed and some diver removal was completed. The lake survey during this time frame showed little milfoil in the lake except for the narrows. Due to the difficulty in diver removal in these dense beds of native plants it is becoming increasing predictable that some form of chemical application may be needed to control this area.

From Aug 18th through 22nd, 2009 more survey and removal was done on the lake. The Deer Lake Resort swim area was again prioritized. 2,000 square feet of barrier panels were added to the area to help get a handle on the spread. The remaining milfoil in the resort and throughout the lake was again removed by diver controlled suction device. The narrows continues to be difficult to control. This late in the season much of the milfoil is in very dense native plants in very shallow, not diver accessible, water. There is discussion about getting permits and applying for chemical treatment of this area.

From Oct 12th through 16th, 2009 a lake-wide survey and removal was used to determine a plan for control to be used in 2010. The Resort area continues to be a priority problem area. The bottom barriers were again moved and the remaining area hand pulled. Very little milfoil was found anywhere else in the lake except the Narrows. At this point, 10 barriers were placed in the Narrows to allow for an open area to possibly stage chemical treatments in 2010. At the completion of the 2009 season a few barriers remain in place in the Resort area. It was recommended that an area from ½ to one acre be slated for chemical treatment in the northern narrows in 2010.

2010

ACE Diving surveyed the infested Narrows area on May 10th. The contracted chemical applicators, Spokane ProCare, met with two representatives from ACE Diving and determined they would apply sometime in July. ACE representative concurred and agreed to do a post treatment survey later in the season. A map of the area was formulated from the survey by Starlight Business Systems and supplied to the applicators (see IAVMP **Appendix C**).

From July 12th to the 20th the first search and remove survey for this year was completed by ACE Diving. The normal areas of milfoil findings were reviewed and little milfoil was found. The only exception was the Deer Lake Resort area. As in the past the milfoil was still prevalent and the decision was made to move the remaining bottom barriers here in an attempted to continue control of the infestation. After moving the 20 barriers in the area and hand pulling the few remaining plants the area is thought to be under control. The chemical treatment area in the Narrows was surveyed and determined the chemical had not had enough time to destroy the plants. Later surveys are expected.

Included in the surveyed area was a new finding of approximately 1,000 square feet of dense milfoil near Julius Terrace on the east side of the lake. The area was determined to use diver removal so an extra two days was used during this time period to remove the milfoil from the swim area. During this removal process some local interest produced some interesting information. A local property owner told the ACE representative that he had known of the infestation for many years. This prompted us to think there may have been a breakdown of communication. Our company as well as the WDOE had missed this infestation over a few years. The infestation was with-in a roped off area in shallow water and had not been survey by our divers. As previously indicated, we believed the property owners were helping with our surveying by keeping an eye out in the shallow, off dock areas difficult for the divers to access. Given this new information our divers have widened the area of survey. This does add difficulty and more time needed for lake survey. ACE recommends re-

opening the communication with the DLPOA in order to reduce the area of the lake needed to send divers or WDOE representative to survey.

October 18th through the 21st the final survey of 2010 was completed. The resort area had some rather large very healthy plants growing around the remaining bottom barriers. It was too soon to move said barriers so the divers removed the milfoil from the area by hand. The milfoil in the Julies Terrace area had been significantly reduced and the divers were able to remove the remaining visible plants. A survey of the lake produced some fragment findings near the public boat launch but few attached plants were found. The chemical application area was surveyed. That area had an algae outbreak which made it very difficult to determine what type of vegetation survived. The native plants were prevalent but no milfoil could be detected. Further investigation will need to be conducted in 2011 to determine the effectiveness of the treatment.

Because milfoil was not eradicated following these efforts, the DLPOA decided to proceed with the formation of a Lake Management District to help provide local funding for the needed ongoing survey and control efforts.

In 2010 and 2011 the DLPOA augmented the milfoil control efforts by adding a small herbicide application to the Northeast wetland shoreline. This area was particularly difficult for divers to treat due to dense native vegetation and shallow water. This treatment was performed by a lake resident Kevin Schroeder, a licensed applicator, through an agreement with Spokane Pro-Care, Inc. The herbicide Navigate was used (granular 2,4-D) at the maximum label application rate of 200 pounds per acre. In 2010 less than one acre was thus treated and in 2011 1.5 acres was treated.

AQUATIC PLANT CHARACTERIZATION

WDOE Aquatic Plant Survey Results

Biologists from the WDOE have surveyed aquatic vegetation in Deer Lake in the following years: 1997, 1999, 2000, 2003, 2005, 2007, 2008 and 2009. These surveys were (and will hopefully continue to be) conducted to identify overall aquatic plant species present, evaluate plant community structure and detect the existence or potential for problems, particularly as they relate to invasive non-native aquatic plants. Survey methods used at Deer are surface observations from a boat and rake sample collection. The species lists presented below and in **Appendix C** indicate a diverse population of native emergent species (see **Table 3**) and submersed plants including pondweeds (*Potamogeton* species), Coontail (*Ceratophyllum demersum*), common Elodea (*Elodea Canadensis*) and native northern milfoil (*Myriophyllium sibericum*)(see **Table 4**). The only noxious or invasive species found in the emergent assemblage are the yellow flag iris (listed noxious weed, but not required control in Stevens County) and cattails (invasive but not a listed noxious weed). Eurasian watermilfoil, and a hybrid milfoil (*M. sibericum* x *M. spicatum*) are the only invasive / noxious plants found in the submersed assemblage.

Eurasian watermilfoil was first discovered in the lake in August 2007 along the shoreline near the Northeast wetland area (see **Figure C-1**). No other Eurasian milfoil was found in the lake at that time. However, in 2008 Eurasian milfoil was found again in the Narrows, plus off the Deer Lake Resort, at two locations on the east shoreline and in the bay near the WDFW boat launch (see **Figure C-2**). The

2009 WDOE survey results indicate invasive milfoil only off the Northeast Wetland and near the Deer Lake resort. It should be noted that this year, in addition to *M. sibericum* and *M. Spicatum* being found, the hybrid (*M. sibericum* x *M. spicatum*) was also found. This hybrid is also known to present invasive growth and resulting problems.

Table 3. Emergent Aquatic plant species list for Deer Lake from WDOE (found at website http://www.ecy.wa.gov/apps/watersheds/aquaticplants/lakereport.asp?id=128).

Common name	Scientific name
sedge	*Carex sp.*
yellow flag	*Iris pseudacorus*
rush	*Juncus sp.*
mint	*Mentha sp.*
small flowered forget-me-not	*Myosotis laxa*
willow	*Salix sp.*
hardstem bulrush	*Schoenoplectus acutus*
naked-stemmed bulrush	*Schoenoplectus sp.*
bulrush	*Scirpus sp.*
nightshade	*Solanum sp.*
bur-reed	*Sparganium sp.*
common cat-tail	*Typha latifolia*
cat-tail	*Typha sp.*

ACE Diving Aquatic Plant Survey and Control Results

The DLPOA has contracted with ACE Diving to perform diver surveys of the entire lake near-shore "euphotic" zone. These are accomplished using a pontoon boat equipped with a platform off the bow on which a diver can lay and observe the plants growing on the lake bottom. Thanks to the various treatments that were implemented (see description in preceding section) the Eurasian milfoil has been kept at generally low levels in Deer Lake, although it continued to appear in new areas, as indicated by **Figures C-3 and C-4**.

Problem Algae

At the time of this writing there are no problem species or concentrations of algae known of in Deer Lake.

Problem Species Characterization

To quote from the *Aquatic Plant Identification Manual for Washington's Freshwater Plants*:

> Eurasian milfoil, an invasive non-native plant, is one of the worst aquatic plant pests in North America. Like native aquatic milfoils, it has feather-like underwater leaves and emergent flower spikes. Usually leaf shape and size can be used to distinguish it from other milfoil species. However,

Table 4. Submersed Aquatic plant species list for Deer Lake from WDOE (found at website http://www.ecy.wa.gov/apps/watersheds/aquaticplants/lakereport.asp?id=128).

Common name	Scientific name
Beck's water-marigold	*Bidens beckii*
watershield	*Brasenia schreberi*
water-starwort	*Callitriche sp.*
Coontail; hornwort	*Ceratophyllum demersum*
muskwort	*Chara sp.*
spike-rush	*Eleocharis sp.*
common elodea	*Elodea canadensis*
waterweed	*Elodea sp.*
water moss	*Fontinalis antipyretica*
water star-grass	*Heteranthera dubia*
quillwort	*Isoetes sp.*
small grass-like plants	*Juncus sp. or Eleocharis sp.*
duckweed	*Lemna minor*
northern watermilfoil	*Myriophyllum sibiricum*
water-milfoil	*Myriophyllum sp.*
Eurasian water-milfoil	*Myriophyllum spicatum*
common naiad	*Najas flexilis*
water-nymph	*Najas sp.*
stonewort	*Nitella sp.*
yellow water-lily	*Nuphar polysepala*
fragrant waterlily	*Nymphaea odorata*
water smartweed	*Polygonum amphibium*
large-leaf pondweed	*Potamogeton amplifolius*
ribbonleaf pondweed	*Potamogeton epihydrus*
leafy pondweed	*Potamogeton foliosus*
grass-leaved pondweed	*Potamogeton gramineus*
floating leaf pondweed	*Potamogeton natans*
slender pondweed	*Potamogeton pusillus*
fern leaf pondweed	*Potamogeton robbinsii*
thin leaved pondweed	*Potamogeton sp (thin leaved)*
eel-grass pondweed	*Potamogeton zosteriformis*
water-buttercup	*Ranunculus aquatilis*
sago pondweed	*Stuckenia pectinata*
common bladderwort	*Utricularia vulgaris*
water celery	*Vallisneria americana*
water speedwell	*Veronica anagallis-aquatica*

Eurasian milfoil is a variable species, often making it difficult to identify without chemical or DNA analysis. Because it is an extremely invasive plant, it is important to distinguish Eurasian milfoil from the native milfoils. Every effort should be made to prevent the spread of this plant. Eurasian watermilfoil is invasive because it does not have otherwise natural controls on its growth in North American waters. It starts growth earlier in the spring than most native plants (i.e. at cooler water temperatures), it grows faster, up to an inch a day. But its reproduction by fragmentation really gives it a chance to spread. As the plants become mature, the growing tips can be seen to start growing roots and then become detached and float with wind and water movements. In lakes used by power boats, there is a significantly increased chance that plant fragments will be generated through disturbance by boats and their propellers. Eurasian milfoil can grow on many types of substrates, from organic muck to sand to gravel and even rocky bottoms. Milfoil, like other aquatic plants gets much of its growth nutrients from the sediment so it may not grow lushly in low-nutrient sediments but given time, this species can fill in most submersed habitats down to the depth where light limits its growth. Thus, effective milfoil surveys must conscientiously inspect all areas between approximately one foot and 25 feet of depth.

CONTROL ALTERNATIVES

General Considerations and Permitting

This section of the IAVMP presents information on available techniques which can be used in the management of aquatic plant growth. Much of this information is excerpted from A Citizen's Manual for Developing Integrated Aquatic Plant Management Plans (WDOE 1994) and the Supplemental Environmental Impact Statements for the Department of Ecology's Aquatic Plant Management Program (WDOE 2001b, 2002). Additional information on new and developing control technologies is also presented where it appears to be appropriate in the near future (two to five years). While all possible techniques are addressed here, only those which are specifically applicable to Deer Lake, the developed Problem Statement and the Management Goals are discussed in detail. Following the review of appropriate techniques, an "Action Plan" has been developed which is presented in the next main section of this Management Plan.

•• Note: essentially all aquatic plant control activities require a permit from one or more State agencies. All manual, mechanical, and physical techniques described herein require issuance of a WDFW Hydraulic Project Approval. Application of chemicals to State waters to control algae or aquatic plants must be covered under a National Pollutant Discharge Elimination System (NPDES) permit. A NPDES permit has been issued to the Washington Department of Agriculture for control of State-listed noxious weeds and individual treatments must request coverage under this permit and certain monitoring must be performed. There is currently a permit issued for Deer Lake and the permit holder is the herbicide applicator, Spokane ProCare. Dredging may require a permit from the US Army Corps of Engineers. Permit guidance in the "Aquatic Plants and Fish" pamphlet (WDFW 1998) was developed in recognition of the importance of controlling aquatic noxious and nuisance weeds, the need to protect the aquatic resource and to facilitate the approval process for HPA projects. This guidance does not include efforts related to the NPDES permit.

Submersed Plant Controls

The No-Action Alternative

The focus of this IAVMP is on the plant species which has been shown, or has the potential, to negatively affect the beneficial uses in Deer Lake; that is, Eurasian watermilfoil. Based on the public opinion that there is a problem with aquatic plants, this Plan has investigated options for controlling or eliminating this problem. In order to maintain a perspective on the costs and benefits of various plant control options, the costs and benefits of the “no-action” alternative also must be kept in mind.

If organized action is not taken against noxious or nuisance submersed plant growth, it is likely that the problem will get worse. Therefore, the "no-action" alternative is not acceptable due to the potential impact to the beneficial uses of the lake and potential negative environmental impacts (i.e. fish habitat degradation). The impact of continued, excessive submersed plant growth on fish habitat could include effects on water quality, on fish themselves and on fish food organisms. Impacts on water quality include pronounced stratification of temperature due to interception of solar radiation and reduction in circulation, as well as changes in chemical factors such as dissolved oxygen, pH and alkalinity due to daily cycles of photosynthesis and respiration. Perhaps a more significant impact to water quality can result from the rapid die-off (senescence) of dense plant beds, and concomitant reduction in dissolved oxygen and release of nutrients, which can happen on a seasonal basis. Release of nutrients, especially phosphorus, can foster excessive growth in free-floating algae which, in turn, can have other adverse effects on the lake. The reduction in oxygen levels can have direct negative effects on fish and fish food organisms. Low oxygen also causes the production of hydrogen sulfide and ammonia, both of which can also have toxic effects on fish and fish food.

Maintenance of dense beds of submersed plants can also foster the growth of mosquitoes and possibly other nuisance organisms.

Advantages of No-Action alternative:

- no treatment cost,
- no short-term hindrance to recreation or other lake uses due to treatment implementation.

Disadvantages of No-Action alternative:

- lake quality will decline,
- recreational opportunities will decline,
- fish and wildlife habitat will likely be reduced or impaired,
- property values will likely decline.

Appropriateness for Deer Lake:

- The No-action alternative is not appropriate due to the degradation that uncontrolled milfoil growth will cause and the desire of the lake residents to protect the identified beneficial uses described herein.

Currently Available Techniques - Preventive

Watershed Controls

The preventative techniques which may have utility in Deer Lake's milfoil control efforts focus on the control of inputs of the growth nutrient phosphorus. These techniques include both structural and non-structural (Best Management Practice) options which generally work to prevent erosion and sediment generation in the watershed by controlling surface runoff.

Advantages of Watershed Controls (in general):

- reduce nutrient loading at their sources,
- provides shade and lowers stream temperatures,
- reduces stream bank erosion and sedimentation in lake,
- reduces toxic chemicals and other pollutants in streams and the lake,
- provides benefits over wider area than the lake.

Disadvantages of Watershed controls (in general):

- may require changes in land use,
- may require construction or modification of facilities, purchasing of property and hiring of maintenance personnel,
- may require regulatory support and personnel.

Costs of Watershed Controls:

- vary greatly (not determined)

Appropriateness for Deer Lake:

- Watershed controls are appropriate for water quality protection at Deer Lake but would not be expected to effect the growth of milfoil in either the short or long term. This is due in part to the fact that milfoil, like most aquatic plants, draws nutrients out of the sediments (as opposed to the water column) and also the apparent fact that milfoil can grow well in low nutrient (oligotrophic) as well as high nutrient (eutrophic) lakes. Therefore, watershed controls are not recommended for inclusion in the Integrated Treatment Action Plan.

In-Lake Nutrient Controls

The primary focus of many of the lake management alternatives is the reduction in nutrients (primarily phosphorus) as a means of limiting algae and aquatic plant growth. This is a valid approach and should be considered, especially for long-term reduction in productivity. It is, however, beyond the scope of this IAVMP to evaluate the technical merit or costs of these nutrient-focused alternatives. Several recommended techniques will be discussed herein, however, because they also control or remove the actual aquatic plant growth.

Public Awareness and Involvement Program

The understanding and involvement of lake and watershed residents and lake users will be necessary if the process of aquatic plant growth controls is to succeed. Therefore, a public education and awareness

program is strongly recommended for Deer Lake. Such a program would focus on, and promote, lake stewardship but would also keep the lake "community" informed about measures that are to be, and have been, performed in and around the lake. Especially important will be evaluation of control program effectiveness and program adjustments over time. Through newsletters, public meetings, exhibits at fairs and local media coverage (to name a few), information on the lake should be disseminated and opportunities given for reply from the community.

Some subjects which can interest lake residents and users are: simplified algae and aquatic weed information, sources of and solutions to nutrient enrichment, shoreline stabilization and re-vegetation, options for lawn fertilizer use, pet waste management, non-phosphate detergent use, and discouraging bird and waterfowl feeding. Training to teach plant identification can be very pertinent as well.

Whenever possible, the lake community should be directly included in information collection and synthesis as part of the public involvement program. This can include citizen representatives performing monitoring (data collection) efforts.

Advantages of a Public Awareness and Involvement Program:

- provides education and public awareness,
- provides opportunity to gather consensus and public support,
- provides opportunity to involve the lake residents and users in the lake management process.

Disadvantages of a Public Awareness and Involvement Program:

- requires committed organization to implement and provide continuity.

Costs of a Public Education and Awareness Program:

- $1,000 to $4,000 per year.

Appropriateness for Deer Lake:

- An ongoing Public Awareness and Involvement Program is very appropriate for Deer Lake and is recommended to be included in the Integrated Treatment Action Plan described below.

Currently Available Techniques - Physical Control

These techniques include manual or mechanical efforts that can remove, cover, shade or dry out all or part of problem plant growth.

Hand Removal

Removal of submerged vegetation by hand digging or pulling is a labor-intensive but generally small-scale management option. This method involves removing the entire plant (leaves, stems and roots) by hand or with a hand-held gardening tool, collecting the plant materials in a storage bag for transport and disposal on shore. In water depths greater than about three feet, the use of SCUBA divers is typically needed to effectively manage a location.

The effectiveness of plant removal depends on sediment type, visibility (water clarity), plant type, the density of target and non-target vegetation and thoroughness in removing the plant roots. Based upon these variables, the level of plant control can vary from one month to multi-year management.

Advantages of Hand Removal:

- immediate clearing of the water column,
- highly selective technique, in that individual plants are removed,
- can be implemented in sensitive area where disruption must be kept to a minimum,
- effective in aggressive control of sparse or small infestations in the lake, around docks or in swim areas.

Disadvantages of Hand Removal:

- technique is time consuming and labor intensive,
- visibility may become obscured by the disturbance of sediments during harvesting thus delaying plant removal or missing smaller plants,
- potential for spreading milfoil due to release of plant fragments,
- management can be costly in deeper water, especially when divers are used,
- control may only be short-term or seasonal; based on location and surrounding infestations.

Costs of Hand Removal:

- no cost if performed by volunteers,
- $800 - $1,600 per day for two divers and a support boat & operator,
- typical coverage from 400 to 2,000 square feet per day.

Appropriateness for Deer Lake:

- Hand removal is appropriate for small scale control of Eurasian and northern milfoil control in Deer Lake. Therefore, hand removal is included in the Integrated Treatment Action Plan described below.
- Hand removal is not considered appropriate for large areas which may come to support extensive growth of milfoil.

Bottom Barrier Installation

Bottom barriers are highly effective in the small to moderate scale control of aquatic vegetation. The barriers are typically synthetic (geo-textile) fabrics, or burlap, but a variety of other materials have been used including sand and gravel, polyethylene, polypropylene, synthetic rubber, fiberglass screens and nylon film. These materials cover the lake sediments and existing plants and prevent further growth. By covering the lake bottom that the plants emerge from, all plants are effectively prevented from growing in those areas. Washington State typically allows the use of burlap when covering native plant areas and burlap or synthetic material when covering noxious weed areas. These barriers are typically 100% effective in the installed areas initially and installation can be conducted at any depth with the assistance of divers and a support vessel for deeper installations. Bottom conditions do not typically impede most barrier installations, but logs and debris are typically cleared from the area. Duration of control is dependent upon type of material used, application techniques, sediment deposition and WDFW permit requirements.

Since gases are produced in the sediments under the barrier, the barrier must be attached or weighted to the bottom and allow these gasses to pass through it. Over time, these barriers can lose effectiveness if sediment builds up on them, providing a substrate for plants to root. Yearly maintenance by a dive team can prolong the effectiveness of this technique indefinitely (except with burlap which will decompose and must be replaced to maintain effectiveness). Note that permit requirements will mandate that barriers be moved or removed after a period of time.

Bottom barriers are expensive when used on a large scale and very labor intensive to remove after being in place for the time needed to kill milfoil. In addition, there can be environmental impacts if large areas of a lake bottom are covered with these materials blocking fish access to the bottom. Bottom barriers are most applicable for individual properties and are recommended for around docks. Bottom barriers may not work well in swimming areas when placed over soft sediments, however. If swimmers walk on them, they tend to push the mats into the sediment which in turn allows them to billow up with gas accumulation under them.

Recent research conducted in Coeur d'Alene Lake for the Idaho Milfoil Task Force resulted in a determination that bottom barriers should be left in place for eight to ten weeks in order to kill milfoil (IMTF, 2005). This group used geotextile material mounted on ten foot by ten foot PVC pipe frames filled with sand to hold the barrier panels on the bottom. After the necessary treatment time, these barriers can be moved to other areas or removed from the lake and cleaned to be re-used.

Advantages of Bottom Barriers:

- no toxic chemicals are placed in the water,
- provides immediate removal of nuisance plant conditions upon placement,
- easily applied to small, confined areas around docks, moorage's or beaches,
- they are hidden from view (in deeper waters),
- effective in isolated management practices, especially in milfoil control,
- some materials are reusable.

Disadvantages of Bottom Barriers:

- potentially high material cost for synthetic products,
- labor intensive and high costs for utilizing divers,
- limited durability of certain materials,
- not species specific,
- potential permit restrictions on location of barrier (spawning areas), type of material, type of plants attempting to control and length of time barrier will be allowed in place,
- gas accumulation under barrier can cause barrier to be lifted hindering boat passage or swimmers,
- periodic maintenance needed to remove sediment build up and secure placement,
- may need to be removed after two years to allow native vegetation to re-establish.

Costs of Bottom Barriers:

- $0.35 to $0.85 per square foot for materials (burlap or geo-textile),
- $0.35 to $0.60 per square foot for labor to place barriers,
- $0.30 to $0.50 per square foot for labor to remove barrier.

Appropriateness for Deer Lake:

- Bottom barriers are appropriate for small scale control of Eurasian milfoil control in Deer Lake. Therefore, bottom barriers are included in the Integrated Treatment Action Plan described below.
- Bottom barriers are not considered appropriate for large areas due to the difficulty and thus cost of removing them.

Water Column Dyes

This technique involves the addition of dark colored dyes to the lake to suppress aquatic growth by shading plants or algae from sunlight. These can be blue or a blend of blue and yellow to absorb key portions of the visible light spectrum needed by submersed plant and algae growth. Dyes are most effective at depths of two feet and greater. Use of this technique is limited to lakes or ponds which have minimal dilution with clear water and no outflow.

Advantages of Water Column Dyes:

- treatment could control both aquatic plants and algae,
- no water use restrictions; treated water will not harm fish, waterfowl, pets or wildlife,
- no special equipment or applicator certification required.

Disadvantages of Water Column Dyes:

- not species specific (can affect all plants and algae),
- not effective when plants or algae are near surface,
- dilution from inflowing creeks would necessitate frequent reapplication,
- dyes may not be allowed due to outflow and domestic water rights.

Costs for Water Column Dyes:

- $12.00 to $15.00 per acre foot for materials.

Appropriateness for Deer Lake:

- Water column dyes are not appropriate for use at Deer Lake due to their lack of target specificity and their limited expected efficacy in large lakes.

Sediment Removal

Removal of lake sediments can provide a nutrient and plant control option in lakes and ponds. Stormwater inputs, surface runoff, stream inputs and erosion can all contribute to the build-up of sediments in lakes. These sediments contain a pool of nutrients which can stimulate the growth of aquatic plants and algae. In shallow lakes (or shallow parts of lakes), the establishment of significant aquatic plant populations can result in accelerated accumulation of sediments and filling of the lake. The purposes of sediment removal, therefore, are to remove nutrients and aquatic plants and to deepen

shallow areas so that future plant growth is reduced (both by reducing nutrient availability and by increasing the water depth and thus shading).

Sediment removal operations can be conducted using a variety of mechanical equipment from backhoes and drag lines, which dig the sediment from the shore, to floating barge hydraulic systems that remove a slurry of sediment and water and pump it to a settling pond on-shore. A significant consideration with sediment removal is the disposal of removed sediments and water. Lakes act as sinks for not only nutrients but also potentially toxic materials. Sediment testing is often required prior to establishing an appropriate sediment disposal plan. The water contained in the removed sediment is often substantial as well, which adds to the challenge.

Advantages of Sediment Removal:

- effective in removing existing plants and nutrient rich sediments,
- increases the depth of the system and reduces the areas available for plant growth,
- site specific management.

Disadvantages of Sediment Removal:

- operation costs are typically expensive and labor intensive,
- problems with equipment access and location for disposal,
- potential for turbidity release and short-term impacts to water quality,
- not species specific,
- potential permitting requirements,
- may remove beneficial habitat.

Costs for Sediment Removal:

- $200,000 to $400,000 for design, inspection, environmental monitoring,
- $0.15 to $0.80 per cubic foot for hydraulic dredge,
- disposal costs not possible to estimate; would be significant.

Appropriateness for Deer Lake:

- Sediment removal is not considered appropriate for milfoil control at Deer Lake due to the lack of target specificity, the need for sediment disposal areas and the high cost.

Water Circulators

Water circulators, some of which are also aerators, are well known in water treatment, and are particularly useful for algae control. One such device (or series of devices) is the SolarBee™. This is a floating solar-powered circulator. Depending on the model, the SolarBee is 10-17 feet in diameter and generates a flow rate of 1,250-10,000 gallons per minute. The SolarBee creates a four to six-foot diameter column of rising water below the machine and spreads this water gently across the top of the lake or reservoir in a long-distance flow pattern. While most mixers and aerators can influence only 0.5 surface acres, SolarBee's can reportedly impact up to 45 surface acres per machine. The SolarBee's mixing action reportedly has many positive effects on the water quality in lakes, wastewater ponds, and potable water reservoirs.

SolarBee™ (2008) indicates that its models have utility in reducing invasive aquatic weed growth. The continual oxidation of littoral sediments and overlying waters is believed to negatively impact the health and growth of invasive submerged aquatic plants by limiting ammonia-N availability. Since the science of controlling aquatic vegetation using the SolarBee is undergoing further study, this technique warrants additional investigation.

Advantages of water circulators:

- non-toxic,
- potential long-term effectiveness.

Disadvantages of water circulators:

- no documentation of effectiveness on aquatic plants.

Costs of water circulators:

- (not determined).

Appropriateness for Deer Lake:

- Due to the lack of documented use to control macrophytes, water circulators are not considered appropriate for milfoil control at Deer Lake.

Water Level Drawdown

Drawdown (or pump down) of the lake water levels, especially during the winter months, can have a dramatic impact on some aquatic weed problems. This methodology is possible where there is a water control structure which will allow lakes or reservoirs to be drained. Alternatively, high capacity pumps must be used to draw water levels down.

Drawdowns will expose the lake sediments to loss of water and, depending on location, to freezing. Freezing in particular can eliminate aquatic plants that have no over-wintering structure like seeds, turions, tubers or winter buds. The impact on the root crowns of prolonged exposure to sub-zero temperatures is often fatal. As the lake is refilled re-growth from these crowns either does not occur or is severely stunted. There can also be a reduction in some other types of problematic vegetation using this technology if the drawdown is prolonged. The loss of water, and concurrent sediment compaction that can result from drawdown can also be a benefit as it can slow the colonization and growth of some rooted plants.

This technique is not one that can claim eradication normally and plants will survive in portions of the lake where water remains over the sediments. If the drawdown can extend to the deep edge of the plant communities it is obviously more effective than shallower drawdown that can only expose near-shore areas.

Drawdown can have minimal cost if an outlet control structure of sufficient height is in place. This is not the case in the Deer Lake. Given the lake size, bottom topography and minimal potential for re-filling, it is unlikely that the lake could be drawn down without pumping, and pumping would likely be impractical. Finally, this technique can negatively impact the fish and wildlife habitat in the lake and would have obvious implications for water rights users.

Advantages of Drawdown:

- no addition of toxic chemicals to the water,

- useful to allow repair and maintenance of shoreline features.

Disadvantages of Drawdown:

- likely adverse environmental impacts,
- temporary loss of recreation,
- low probability of success given lake morphology and levels of inflows (capacity to refill lake after drawdown).

Costs of Drawdown:

- (not determined).

Appropriateness for Deer Lake:

- Drawdown is not considered appropriate for Deer Lake due to the lack of target specificity, the significant impacts that this would have to the lake biota (and potentially water quality), the potential difficulty in refilling the lake to ensure recreation uses will be available and the costs of pumping.

Currently Available Techniques - Mechanical Control

Hand Cutting

This technique involves cutting of plants below the water surface, but roots are not generally removed. Tools used in cutting include scythes, thin cables, rakes or other specialized devices that can be pulled through the weed beds by boat or from shore. One popular device consists of two single-sided stainless steel blades forming a "V" shape which are connected to a four foot handle and tied to a rope.

Advantages of Hand Cutting:

- immediate removal of nuisance submerged plant growth,
- costs are minimal,
- can be performed throughout the season as needed.

Disadvantages of Hand Cutting:

- labor intensive and time consuming,
- generally not species specific,
- visibility may become impaired by turbidity generated by cutting,
- short-term plant control as the root system is not removed; cutting is typically needed multiple times each season,
- may be difficult to contain and remove plant fragments.

Costs of Hand Cutting:

- cutting devices range from $50 to $800,

- no labor cost if performed by volunteers.

Appropriateness for Deer Lake:

- Hand cutting is not considered appropriate for Deer Lake milfoil control due to the likelihood that plant fragments would be released, thus spreading the infestation, and the difficulty in cutting milfoil in the many rocky areas of the lakes' shoreline.

Mechanical Harvesting

An extension of the hand cutting discussed above involves the use of larger equipment that can cut or mow aquatic plants below the water surface. Barge mounted weed cutters, for instance, will cut the stems of submerged vegetation over large areas, with that vegetation typically floating off or being collected by the operator with some other implement. Aquatic weed harvesters are an improved version of a large weed cutter. These systems cut, collect and transport the vegetation for disposal on shore. A typical weed harvesting system will consist of the harvester and a shore station for unloading the harvested vegetation into a transport system for disposal.

Aquatic harvesters have a number of cutting blades located on the harvesting head and a conveyor system behind the blades that collects the plants and deposits them on a barge. There is typically a storage / conveyor system that the plants fall onto when cut that facilitates unloading the machine at the shore station. The shore station equipment is usually either a land based conveyor that connects to the harvester and lifts the cut plants into a dump truck or other transport vehicle, or a trailer conveyor that performs the same function as well as transports the harvester from lake to lake. Harvesting systems normally cut the plants from five to seven feet below the surface and can harvest up to two acres per day depending on the distances to off-loading sites.

Aquatic plant harvesters work well at cutting the plants and removing the bulk of the plant material from the lake. They do allow some plant fragments to escape, however, and they do not necessarily inhibit the continued growth of the cut plants. Harvesting is not species specific (unless used in single species dominated areas) and aquatic plant harvesters can remove significant amounts of young fish and invertebrates during harvesting operations. Harvesters should not be used on lakes that are infested with milfoil in the pioneering or early colonization stages since additional fragments will accelerate the spread of the plant.

Advantages of Mechanical Harvesting:

- no chemicals added to lake,
- immediate removal of plants and contained nutrients,
- limited interference with use of the water body,
- minimal bottom disturbance,
- reduction in sediment accumulation by removing organic matter which normally decays and adds to the bottom sediments
- harvested plants can be used as compost.

Disadvantages of Mechanical Harvesting:

- slow process (two acres per day under ideal operating conditions), dependent on availability of off-loading sites,

- labor and equipment intensive; must involve cutting and collection of plant material,
- typically requires repeat cutting for full season control with fast-growing plants (such as Eurasian milfoil),
- creates plant fragments which have potential to spread and establish in other portions of the lake (especially a concern with exotic species),
- non-selective and can be detrimental to non-target plants and animals,
- high capital costs for machine purchase or use by management consultant.

Costs of Mechanical Harvesting:

- $600 to $900 per acre for contract commercial aquatic plant harvesters,
- $100,000 to $180,000 for harvester/off-loader purchase,
- cost of disposal not determined.

Appropriateness for Deer Lake:

- Mechanical harvesting is not considered appropriate for Deer Lake because of the need for regular, repeat cuttings, the difficulty in cutting effectively in rocky shoreline areas, potential fragment spreading, potential for unintentional removal of fish and fowl and the cost.

Rotovation

Rotovation, or underwater cultivation, is a newer concept in mechanical aquatic plant management. It can provide for longer term control of some aquatic plants (than with harvesting) and it can remove plants to greater depths than conventional harvesters (approximately 12 feet versus five to seven feet) can. Rotovators are basically underwater rototillers which churn the bottom sediments to a depth of up to 12 inches. This action dislodges plants and root crowns. Typical rotovation will provide one to three years of acceptable weed control.

Dislodged plants must be collected as they float to the surface. As with plant cutting or harvesting, rotovation should not be considered in lake or river systems where plants are in the pioneering stages of an infestation and/or spread by fragmentation. Rotovation would not be expected to control non-rooted plants such as Coontail (*Ceratophyllum demersum*).

Advantages of Rotovation:

- removes entire plant including roots,
- longer effectiveness than with harvesting,
- plant density becomes reduced after successive treatments.

Disadvantages of Rotovation:

- does not collect plants or fragments which are uprooted,
- temporarily destroys bottom habitat and potentially fish spawning areas,
- causes turbidity and potential release of nutrients,

Costs of Rotovation:

- $2,000 to $3,000 per acre for contract commercial operator.

Appropriateness for Deer Lake:

- Rotovation is not considered appropriate for Deer Lake due to the lack of target specificity, the potential that this will significantly spread the problem through fragment generation and the difficulty in using this technique in rocky shoreline areas.

Sediment Agitation

Several automatic plant control products are commercially available that mechanically disturb the lake bottom to remove aquatic plants and prevent their re-growth within a well-defined area. They sweep, roll, or drag repetitively over the plants and sediments to keep the area free of aquatic plant growth. These devices must be attached to a dock or post to work properly and each product requires electricity to operate. Depending on the product, up to a 42 foot radius around the dock or post can be controlled. The Weed Roller®, manufactured by the Crary Company, uses a low-voltage power unit (attached to a dock) to slowly drive a long roller (metal cylinder or pipe) set on the lake bottom through an adjustable arc of up to 270 degrees. A reversing action built into the drive automatically brings the roller back to complete the cycle. Fin-like projections on the rollers help detach plants from the sediment and remove roots. The BeachGroomer®, by BeachGroomer Systems, Inc., attaches to a lawn pump to propel two seven-foot arms engineered with chains that turn to clear the lake bottom of weeds. The Lake Sweeper®, by Lake Restoration, Inc., uses light-weight rakes and a submerged pump to clear the lake bottom of weeds.

The ease of installation and operation varies depending upon the product. The type of lake bottom also is an important factor in selecting an automatic plant control device. It is best to install and start operating these devices in the spring before plants begin actively growing. If they are operated after plants have grown, the detached plants should be removed from the water with a rake or gathered by hand. Some manufacturers suggest preparing the area before installation by removing weeds and debris from the site and some products don't work very well after the plants have grown. Once the plants are cleared from the area, these products can reportedly be used as little as one day per week or less to keep plants from re-colonizing the area. When not in use, the equipment should be stored beside a dock or in a place where people cannot accidentally injure themselves. Little maintenance is required, but these units must be removed from the water in winter in areas where lakes are expected to freeze.

Advantages of Sediment Agitation:

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

Disadvantages of Sediment Agitation:

- repetitive sediment agitation will disturb some bottom dwelling animals and may interfere with fish spawning,

- if plants are present, sediment agitation will cause plant fragmentation, which may increase the spread of some invasive weeds,
- sediment agitation devices can cause a depression to develop where the unit operates as the fine sediment is dispersed to other areas of the waterbody,
- when the cleared area is to be used for activities such as swimming or wading, the equipment should be unplugged from the power source and moved and stored under or beside a dock. People may injure themselves if they step on the device,
- these products should be removed in the winter from lakes that freeze.

Costs for Sediment Agitation:

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

Appropriateness for Deer Lake:

Sediment agitation devices are only appropriate for small scale control of all plant growth such as around docks or other near-shore features.

Diver directed suction removal

Diver suction removal has been used since the 1970s as an improvement to hand removal of sparse colonies of milfoil. The technique utilizes a small barge or boat carrying a portable pump with a suction hose that are directed by a SCUBA diver. Divers dislodge the plant tissue and root system from the sediments and basically vacuum up the plant material which is carried back to the barge. On the barge, plant parts are sieved out and retained for land disposal while water and sediment materials are allowed to drop back into the lake.

Diver suction removal can be highly effective under the appropriate conditions. Efficiency of removal is dependent on sediment condition, plant size and density, and underwater visibility. It is best used for localized infestations of low plant density where fragmentation must be minimized. This technique is also selective in that divers can target a single species in a mixed population area.

An environmental concern with diver suction removal is that of turbidity and nutrient release from disturbed sediments. This is primarily applicable with light, organic sediments that often accumulate in heavy weed bed areas. However, the divers typically do not let the suction intake come near the sediments, rather they pull the target plants up out of the sediment and direct the plant into the suction intake. While sediment curtains can be used to minimize the drift of re-suspended sediment materials and also escaped plant fragments, there is no practical way of controlling nutrient release. Placement of sediment curtains is also time consuming and, thus, costly.

Advantages of Diver Suction Removal:

- species selective and site-specific control,
- minimal disruption of sediments and surrounding habitat with non-rooted plants,
- minimal release of plant fragments,
- no depth constraints, effective near obstacles,

- effective in covering large areas with light plant growth.

Disadvantages of Diver Suction Removal:

- labor intensive and expensive,
- may not be appropriate control method in dense plant beds,
- potential release of nutrients and sediments, potential short-term increased turbidity,
- may not work well in gravelly or rocky areas due to the difficulty in pulling up all root fragments.

Costs of Diver Suction removal:

- $1,000 to $2,000 a day for two divers and support boat,
- typical coverage from 0.25 to 1.0 acres per day.

Appropriateness for Deer Lake:

- Diver operated suction removal has some applicability at Deer Lake and this is therefore included in the Integrated Treatment Action Plan described below. However, due to the expected cost of this type of treatment it is considered only as a backup technique.

Currently Available Techniques - Biological Control

The biological control of aquatic plants focuses on the selection of organisms that have an impact on the growth of a target plant. By stocking a lake with these organisms, or "agents", the population of the target plant can be reduced. Biological control is not an exact science at this time. There have been a number of dramatic success stories with the control of aquatic weeds using some organisms. There have also been some undesirable effects from their use. The majority of the tools in this field are in the experimental or review stage at this time.

Biological control agents are generally of two types. There are general agents like grass carp that will consume most aquatic vegetation. As such, they are of limited use when trying to target specific plants. The second type of "biocontrol" agent are those that are target-specific for problematic species. Many of these agents focus on exotic plants that have been introduced to this country. Research typically starts in the region of the world where these plants are from, and focuses on the organisms that keep it in check there. Once identified, these organisms are brought through a quarantine protocol into this country where further research is conducted to determine if there is operational potential for control. At this time there are no biological control agents available in Washington State which are effective against milfoil other than grass carp.

Grass Carp

Grass carp (or White Amur) are plant consuming fish native to China and Siberia. There are many aquatic plants that these fish will eat, but they have definite feeding preferences and will generally eat the plants they prefer first. Stocking rates are dependent on climate, water temperature, type and extent of plant species and other site-specific conditions. The recommended maximum stocking rate in Washington is 25 fish per acre (Bonar et al. 1996) and the typical stocking rate is nine fish per acre (Hamel 2002). A study of grass carp usage in Washington has indicated that in most cases grass carp either have little effect or will eat all submersed plants.

Periodic restocking is generally necessary to replace fish lost to predation or disease and to maintain the number of young, actively growing (and thus actively eating) fish. Only triploid (sterile) fish can be planted in Washington and by WDFW permit only. Grass carp must be imported by approved suppliers and be certified to be disease and Zebra mussel free and sterile. Inlets and outlet screens must be installed in the lake and be approved by WDFW biologists prior to stocking.

Water quality is seen to generally improve after introduction of grass carp; with the elimination of large mats of vegetation, bottom dissolved oxygen levels generally increase from levels lethal to fish and pH generally decreases with decreases in photosynthesis (WDFW 1990). However, water turbidity increases have also been documented due to grass carp stirring up bottom sediments. Effectiveness of grass carp in controlling aquatic weeds depends on feeding preferences and metabolism which vary from region to region. Some plant species which appear to be preferred include pondweed species, Coontail and common waterweed. Plant control effectiveness is site specific and significant control of vegetation may not be apparent until two to four years following introduction.

Advantages of Grass Carp:

- non-toxic,
- long-term effectiveness.

Disadvantages of Grass Carp:

- may not control the milfoil that is problematic in Deer Lake,
- may alter composition of plant community without decreasing overall biomass,
- may decimate submersed aquatic plants and result in worse algae problems, and disruption of native fish habitat,
- inlet and outlet screens must be constructed and must allow passage of native salmonid fishes,
- carp foraging may cause turbidity and foster algal growth through re-suspension of sediment materials,
- Stocking permit required from WDFW.

Costs of Grass Carp:

- $10.00 to $15.00 per fish (plus delivery),
- typical stocking rates are 9 to 15 fish per acre,
- inlet / outlet screen costs not determined.

Appropriateness for Deer Lake:

- Grass carp are not considered appropriate for use in Deer Lake due to their uncontrollable nature, lack of target specificity and, thus, potential adverse effects on the native plant populations and fish habitat in the lake.

Milfoil Weevils

A potential biological control agent that has received considerable research attention in several northwest, northeast and mid-western States, including Washington, is the aquatic weevil *Euhrychiopsis lecontei*. This organism has been associated with declines of milfoil in the United States (e.g. Illinois,

Minnesota, Vermont, and Wisconsin). Researchers in Vermont found that this weevil can negatively impact milfoil by suppressing the plant's growth and reducing its buoyancy (Creed and Sheldon 1995).

The following description is excerpted from University of Minnesota, Department of Fish and Wildlife website (http://fwcb.cfans.umn.edu/research/milfoil/milfoilbc/weevil.html):

> The milfoil weevil is native to North America and is a specialist herbivore of watermilfoil. Adult weevils live submersed and lay eggs on milfoil meristems. The larvae eat the meristem and bore down through the stem, consuming the cortex, and then pupate (metamorphose) lower on the stem. Development from egg to adult occurs in 18-30 days at summer temperatures. The consumption of meristem and stem mining by larvae are the two main effects of weevils on the plant and this damage can suppress plant growth, reduce root biomass and carbohydrate stores and cause the plant to sink from the water column. Although the weevil has been quite effective at some sites, it has not been effective at other sites. Currently, we cannot predict when, where and how the weevils will or will not be effective.

In Washington State, the milfoil weevil is present primarily in eastern Washington (including Fan and Sacheen Lakes) and occurs on both milfoil and northern watermilfoil (*M. sibiricum*), which is 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 at 0.6 weevils (adults, larvae and eggs per stem) although the weevils there were present on northern watermilfoil not Eurasian milfoil. These abundance results are well below the recommendations made by other researchers in Minnesota, Ohio, Vermont, and Wisconsin of having at least 1.5 - 2.0 weevils per stem in order to control milfoil.

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

The WDOE is currently involved in culturing milfoil weevils for use in experimental treatments on milfoil control. At the time of this writing there were still a number of factors related to the growth and survival of the weevil and their efficacy in causing declines in milfoil growth that need to be better understood before this organism can be seen to be an effective option.

Advantages of weevils:

- non-toxic,
- potential long-term effectiveness.

Disadvantages of weevils:

- weevils may not control milfoil in lakes with populations of native watermilfoil,
- weevil densities may be reduced below effective levels due to predation by sunfish and other environmental factors,
- Stocking weevils must be performed by divers who place live milfoil stems containing weevil eggs and or larvae into milfoil beds. This involves transportation of live milfoil stems from a culture facility to the lake, which may be a violation of Washington Noxious Weed Law.

Costs of milfoil weevils:

- milfoil weevils currently cost $1 each from commercial producers.

Appropriateness for Deer Lake:

- Milfoil weevils are not currently appropriate for use in Deer Lake. This technique should be re-evaluated when more is known about their growth and effect on milfoil.

Currently Available Techniques - Chemical Control

Chemical herbicides are one of the leading methods of controlling, and in some cases eliminating, noxious aquatic plant growth. The herbicides which are approved for aquatic use by the USEPA are well reviewed and considered compatible with the aquatic environment when used according to label directions. In addition to the review and regulation provided by the EPA, the WDOE completed an Environmental Impact Statement (EIS) in 1992 for the aquatic plant management program which allows for the introduction of a number of compounds into State waters. This EIS was recently updated by WDOE and information contained in the Supplemental EIS documents (WDOE 2001b) have been used in the preparation of this IAVMP. Note that the application of chemicals for aquatic pest control can only be performed by a licensed pesticide applicator with an aquatics endorsement.

There are two general types of aquatic herbicides in use; referred to as “contact” and “systemic” products. Contact herbicides kill susceptible plant leaves and stems, generally leaving roots and some reproductive structures alive and capable of re-growth. As such, a contact herbicide is generally considered a maintenance tool, one that can provide relief from aquatic plant problems, but not something that can eliminate the problem from the lake system. Systemic herbicides are absorbed and carried throughout the plants thereby making them capable of killing the entire plant.

The contact herbicides approved for use in Washington State are Endothall and Diquat. The three systemic herbicides registered and approved for use in Washington are Fluridone, 2,4-D and Triclopyr. Glyphosate, another approved systemic product, is not appropriate for control of submersed plants and will not be discussed in this IAVMP.

Diquat

Diquat dibromide is a fast acting, broad spectrum contact herbicide and algaecide found in the product Reward® which is manufactured by Syngenta (formerly Zeneca Ag Products, Inc.). A Reward® label is included in **Appendix D**. The WDOE completed in 2002 a formal Risk Assessment and Final Supplemental EIS for Diquat (WDOE 2002) which has additional information on this chemical.

Diquat is effective on a variety of submersed plants, including milfoil, and also some types of filamentous algae. Diquat's mode of action is to generate "reactive oxygen radicals" which disrupt photosynthesis. Diquat kills plants rapidly so depletion of oxygen and release of nutrients from plant decay is a potential problem. As with all contact herbicides, plant roots are not affected and repeated applications may be needed for complete season control.

Contrary to this general efficacy, Diquat was reported to have been used in Hayden Lake, ID with some apparent systemic effect. In this case, Reward® was applied by a diver or a "drop hose" to the lower third of plants in dense milfoil beds. The diver used a wand and nozzle connected to a pressure tank onboard a nearby support boat to treat one acre while the drop hose treatment involved holding the wand

and nozzle down into the water while traveling in a boat across a two-acre bed. Follow-up diver inspection of these treatment areas one year later found only occasional milfoil sprigs (new plants) in the diver-treated area and approximately one-half acre of live plants in the boat treatment area (Daniel 2002).

Diquat has slight toxicity to most animals and freshwater fish. It is slightly to highly toxic to aquatic invertebrates. It is for this reason that Diquat was not permitted by WDOE for use in Washington State waters from 1992 to 2003. The effectiveness of Diquat on target plants such as Eurasian watermilfoil is found to be heightened through the use of tank mixes with copper containing products (which are not currently approved for use in Washington).

Water use restrictions which would be in force with Diquat applications for milfoil control (two gallons Reward® per surface acre) are three days for drinking, one day for livestock drinking, three days for irrigation to turf and ornamentals and five days for irrigation to food crops. There is no restriction for fishing or swimming in treated water (Syngenta 2008).

Advantages of Diquat:

- effective against many plant species,
- rapid action,
- no fishing or swimming restriction,
- inexpensive.

Disadvantages of Diquat:

- persistent, especially in sediments,
- water use restrictions in place,
- potentially toxic to aquatic organisms,
- repeat applications needed to maintain control,
- rapid action may cause oxygen depletion and rapid release of nutrients into water.

Costs of Diquat:

- $300.00 per acre applied.

Appropriateness for Deer Lake:

- Reward® (Diquat) is considered appropriate for use at Deer Lake. However, due to the lack of systemic action and the lack of target specificity this chemical is not the preferred product.

Endothall

Endothall is a contact herbicide available in the United Phosphorus, Inc. products Aquathol K® (a liquid formulation), Aquathol Super K® (a granular formulation), and Hydrothol 191® (both liquid and granular formulations). A product label for Aquathol K® is included in Appendix D as an example of an Endothall-containing product.

Endothall compounds are used primarily for short-term (one season) control of a variety of aquatic plants (and algae in the case of Hydrothol 191®). The mode of action of Endothall is not fully understood although the hypotheses indicate that this chemical disrupts biochemical processes at the

cellular level (WDOE 2001b). Target plants for Aquathol K® and Aquathol Super K® include milfoil (United Phosphorus, Inc. 2010). Duration of control with Endothall products is dependent upon target species, contact efficiency, lake conditions and regrowth from unaffected root masses. Endothall application has been reported to result in systemic action on milfoil in some cases (Hamel, 2004).

The use of Endothall involves several water use restrictions and it can be toxic to fish although there is a wide margin of safety between allowed application rates and rates that are toxic. At application rates needed to control milfoil (2.0 to 4.0 ppm) the water use restrictions are: do not use fish from treated areas for food for three days and do not use water from treated areas for watering livestock, preparing agricultural sprays for food crops, for irrigation or for domestic purposes for seven to 14 days after application. There is no swimming restriction for Endothall products. Fish toxicity is not a factor, according to the product labels, at doses below 100 ppm (United Phosphorus, Inc. 2010).

Advantages of Endothall:

- fast acting injury to plant tissue which is typically apparent in one to two weeks,
- little or no off-target drift impacts,
- spot treatments possible.

Disadvantages of Endothall:

- only provides temporary reductions in plant growth,
- non-target plant impacts are difficult to mitigate as this is a fairly broad spectrum herbicide,
- water use restrictions in place,
- rapid action may cause oxygen depletion and rapid release of nutrients into water.

Costs of Endothall:

- $650.00 per acre applied

Appropriateness for Deer Lake:

- Endothall products are not considered appropriate for use at Deer Lake due to the lack of systemic action and the lack of target specificity.

2,4-D

2,4-D is a fast-acting systemic herbicide with two formulations approved for freshwater applications in Washington State. The two formulations are the butoxyethyl ester (BEE) formulation found in the granular product Navigate® (marketed by Applied Biochemists); and the dimethylamine (DMA) formulation found in the liquid product DMA4® IVM, produced by Dow AgroSciences LLC. Product labels for Navigate® and DMA 4® are included in Appendix D.

The mode of action of this chemical is primarily as a stimulant of plant elongation and cell division (WDOE 2001b). 2,4-D is a post-emergent herbicide that is primarily used to control watermilfoil and water stargrass. Typical submersed monocot plants (i.e. the pondweeds) are not susceptible to 2,4-D so this product can be used for selective plant control.

2,4-D can be effectively used in spot-treatment programs in lakes or ponds. Effectiveness of the treatment is dependent upon the timing of the application and density of the target plant community.

Two treatments may be required when targeting dense communities. Susceptible plants will begin to show signs of injury one to two weeks after treatment, followed by plant breakdown and death.

There are no fishing or swimming restrictions associated with the use of 2,4-D although the WDOE recommends "that due to risk of dermal contact, a swimming advisory shall be posted advising swimmers to wait 24 hours before re-entering directly treated areas to allow time for granules to disperse" (WDOE 2001b). 2,4-D cannot be used in waters used for irrigation, agricultural sprays, watering dairy animals or domestic water supplies (Dow Agrosciences 2010). Deer Lake landowner permission must be obtained for treatments to take place in waters used for irrigation, dairy animals or domestic water supplies (i.e. water withdrawals must be discontinued during the time of the treatment). The risk assessment prepared for WDOE as part of the 2001 Final Supplemental Environmental Impact Statement for the aquatic plant management program (WDOE 2001b) indicated that "no significant adverse impacts on fish, free swimming invertebrates or benthic invertebrates" should be expected from 2,4-D (either formulation) applications at appropriate label rates.

Advantages of 2,4-D:

- fast-acting systemic herbicide which is effective in removing selected plants with little or no impact on certain non-target plants at labeled rates,
- applications conducted easily with granular or liquid material in a large or small scale applications,
- treated waters can be used for swimming,
- no fish consumption restrictions.

Disadvantages of 2,4-D:

- application must be conducted 0.5 miles or greater from active drinking/domestic water withdrawals (unless approved by WDOE),
- treatment windows apply to areas were Endangered Species Act (ESA) listed salmonids occupy (according to WDFW specifications),
- public perception (equating this with DDT or Agent Orange).

Costs of 2,4-D:

- $770 per acre granular formulation applied, target dose 2 ppm.
- $500 per acre liquid formulation applied, target dose 2 ppm.

Appropriateness for Deer Lake:

- 2,4-D (either of the listed formulations) is appropriate for use in Deer Lake due to the specificity for the target species, the rapid systemic action and dissipation of the herbicide, the demonstrated efficacy in Deer and the general acceptance of this chemical based on past uses. This is the preferred treatment method as described in the Integrated Treatment Action Plan, below.

Fluridone

Fluridone is available in the SePRO Corporation products Sonar AS® (a liquid formulation), Sonar SRP® (a slow release pellet formulation), Sonar Q® (a pellet formulation) and Sonar PR® (a "precision release"

pellet formulation). Fluridone is also available in the Griffin LLC liquid product Avast®. Product labels for Sonar AS® and Sonar PR® are included in Appendix D as examples of fluridone products.

Fluridone can show good control of submersed and emergent plants, including milfoil, where there is little water movement and an extended time for the treatment. It is most applicable to whole-lake or isolated bay treatments where dilution can be minimized. Because of the eight- to ten-week recommended contact period, treatments should take place in early spring or fall.

Fluridone interferes with the synthesis of RNA, proteins and carotenoid pigments and thereby affects photosynthesis (WDOE 2001b). Use of fluridone does not pose a threat to human health or to fish and wildlife when used according to the labels (SePRO 2009 and 2009b). While there is a short term (seven to 30 days) precaution when using treated waters for irrigation, there are no other water use restrictions when using the liquid formulation of fluridone.

Advantages of Fluridone:

- systemic herbicide, will kill entire target plant,
- variety of plants are susceptible, based on treatment rates and program design,
- species specificity with correct application rates,
- non-toxic to humans, pets, fish and wildlife,
- no water use restrictions for fishing, swimming or livestock/pet consumption.

Disadvantages of Fluridone:

- long exposure period required in order to effectively control plants (many times requiring multiple application or minimizing water movement),
- potential for drift from application area, requires whole lake or enclosed area treatments,
- high cost.

Costs of Fluridone:

- Sonar AS: $650 per acre applied*
- Sonar PR: $800 per acre applied*
- Sonar Q: $700 per acre applied*

  * (assuming eight foot average depth in treatment area and three-20 ppb applications)

Appropriateness for Deer Lake:

- Fluridone products are not considered appropriate for use in Deer Lake at this time due to the limited but spread out extent of the Eurasian milfoil infestation (i.e. the need for spot treatments) and the cost.

Triclopyr

This is a systemic herbicide produced by SePRO Corporation and also marketed by Vegetation Management, LLC. EPA registration was completed in 2003 for the product Renovate® which is a water soluble triethylamine salt formulation containing three pounds of triclopyr acid equivalent per gallon. An generic liquid product is now available under the trade name Ecotriclopyr (see product label

in Appendix D). A granular formulation of renovate, the 'OTF' is also available (see product label in Appendix D). Triclopyr was approved for use in Washington by WDOE 2004.

Triclopyr is a product that has been tested extensively and found to be effective on broad-leafed (dicotyledonous) plants such as milfoil. This product is specific for this type of plant and can be used in habitat recovery programs focusing on selective removal of these plant pests. It will not affect plant species in the monocot family, which is the majority of native aquatic and wetland plant types. Renovate® is a liquid product with a contact time requirement of 24 to 48 hours so it has applicability in spot treatments. Susceptible submersed plants exhibit epanasty (bending and twisting of plant tissue) in six to 12 hours after treatment. Treated plants begin to sink slowly three to five days after treatment and one to three weeks later plants should be well below the surface, often near the bottom.

Photo degradation is the major route of triclopyr degradation in aquatic environments. The first order half-life for Renovate® is 0.5 - 3.0 days. No accumulation occurs in sediment and no bioconcentration is believed to occur in sport fish or bottom feeding species. Toxicity testing on fish and other non-target organisms performed by or for the manufacturer has indicated that Renovate® has a low toxicity potential (SePRO Corporation 2008).

Advantages of Triclopyr:

- selective for broad leafed plants,
- short contact time needed,
- systemic action so entire plant is killed.

Disadvantages of Triclopyr:

- long period of water use restriction for irrigation,
- higher cost.

Costs of Triclopyr:

- $1,700 per acre, applied (water depth of eight feet and target dose of 1.5 ppm).

Appropriateness for Deer Lake:

- Renovate® (triclopyr) is appropriate for use in Deer Lake, due to its short contact time requirement. The current cost of this chemical is substantially higher than the preferred 2,4-D.

Copper Compounds

There are currently two products containing copper that may be used for control of aquatic weeds although copper compounds are not currently allowed in Washington State. They are: Nautique®, manufactured by SePRO Corporation, and Komeen®, manufactured by Griffen. These are both "chelated" or complexed compounds.

Although copper is an essential element for plant growth, high concentrations of copper will inhibit photosynthesis and result in death of plants and algae. Chelated copper complexes where developed to maintain concentrations of the copper ion in water column over a longer period of time. The extended exposure of the copper ion in solution provided improved control of plants and algae. Copper products for aquatic weed control are applied by subsurface injection. Effectiveness of applications is enhanced by warm temperatures and sunlight. These conditions stimulate copper uptake by plant cells and increase the rate at which the plants will be controlled.

Given the known toxicity of copper compounds to aquatic life, primarily fish, and given the recent Endangered Species Act listings of several salmonid species in Washington State waters, the WDOE made a policy decision in March 2000 to disallow the use of copper in salmon-bearing waters.

Advantages of Copper:

- relatively low cost treatments,
- no water use restrictions,
- provide effective and rapid control of algae blooms.

Disadvantages of Copper:

- acts as contact herbicide therefore does not kill plant roots,
- not allowed for use in waters discharging to or occupied by salmonid species (requirement of WDOE, not part of EPA label),
- remains bound to sediments and organic matter over a long period of time,
- limited to treatments in hard water lakes and ponds,
- may require extensive water testing and monitoring in systems with outflow.

Costs of Copper:

- $730 per acre for Nautique®, applied (water depth of 8 feet and target dose of 0.8 ppm).

Appropriateness for Deer Lake:

- Copper compounds are not considered to be appropriate for use in Deer Lake due to their lack of systemic actions, the WDOE restriction on their use and potential environmental concerns over accumulation.

Developing Techniques

There are a number of techniques which are under investigation as possible plant control agents; these being primarily biological agents. These include plant pathogens, herbivorous insects, competitive plants and plant growth regulators. The research with these agents has focused primarily on their effect on noxious submersed plants such as Eurasian watermilfoil and Hydrilla.

Pathogens.

In 1994 a classical pathogen biological control effort was launched by the US Army Corps of Engineers Waterways Experiment Station. Survey work was initiated in Europe for milfoil pathogens (Harvey and Evans, 1997) and in China for milfoil and Hydrilla (Shearer, 1997a). The China survey, in particular, offered the opportunity to search for potential biocontrol agents in temperate areas where climatic conditions more closely match areas in the US where these plants have invaded.

Following the China survey, 200 fungal isolates were collected and returned to the US for testing. Of these, 67 were submitted to the screening using 15 cm milfoil apical segments and 48 were found to induce some damage in the initial screen (Shearer, 1999). The seven isolates which induced the most significant damage were re-tested and of these five produced comparable disease ratings. Only three of the five isolates could be induced to grow before the second screening, and these three were all

identified as *Mycoleptodiscus terrestris*, or '*Mt*'. *Mt* is commonly isolated from both hydrilla and milfoil within the US and has been intensively investigated as a biocontrol agent (Shearer 1997b). Interestingly, *Mt* was not isolated during the European survey work (Harvey and Evans, 1997). Thus *Mt* is one fungal pathogen that is being submitted for additional evaluations.

In a recent review of plant pathogen issues, Hoagland (1996) stated that although many pathogens have been characterized as bioherbicidal, most lack the aggressiveness to overcome weed defense mechanisms and achieve adequate control. However, some herbicides and plant growth regulators can act to weaken natural plant defense systems making them more susceptible to pathogen attack (Hoagland, 1996). As a result, studies have been performed using *Mt* and various herbicides on both milfoil and hydrilla. A growth chamber study using 2,4-D and *Mt* indicated that herbicide and pathogen combinations provide better control of milfoil than either agent used alone (Nelson and Shearer, 2005). However, a mesocosm study which submitted several plants to combinations of fluridone and *Mt* found that there was no advantage to integrating the two on milfoil (Nelson et al. 1998). Obviously, the use of *Mt* or other fungal pathogens is not ready for field usage.

Herbicide Combinations

There is another realm of developing milfoil control techniques which is receiving some research attention and that is the combining of contact and systemic herbicide chemistries. As described under the 'Currently Available Techniques - Chemical Control' section above, there are two general types of herbicides, 'contact' and 'systemic'. Contact herbicides are fast acting, typically causing extensive cellular damage at the point of uptake but not affecting areas untouched by the herbicide (such as the roots). Contact herbicides generally relieve nuisance problems quickly, but may allow re-growth of nuisance plants. Alternatively, systemic herbicides often will kill the entire plant through translocation of the active ingredient to plant tissue not affected by contact herbicides. Systemic herbicides, although effective in killing the entire plant, are generally slower acting and limited by short contact times.

Studies conducted in small plots and whole lake scenarios have documented the efficacy of a range of rates for the systemic herbicides 2,4-D and triclopyr, as well as selectivity in removing *M. spicatum* populations and leaving native plant communities (Getsinger et al. 1982, Getsinger et al. 1997, Poovey et al. 2004). Similarly, empirical evidence suggests that some selectivity may be achieved when applying the contact herbicide Endothall (Skogerboe and Getsinger, 2002, Parsons et al. 2004).

A recent study by Madsen et al (2008 review draft) looked specifically at the effectiveness of mixtures of Endothall with 2,4-D and Endothall with triclopyr. The objective of this study was to determine whether combinations of a contact and a systemic herbicide might exploit the strengths of each herbicide class, and minimize their weaknesses. This study found that combinations of Endothall with either 2,4-D or triclopyr provided the benefits of immediate action and complete control within four weeks. Triclopyr and 2,4-D alone provided 100% control after two to three weeks, but initial control was less than 20%. With Endothall alone, there was greater than 60% reduction in milfoil biomass one week after treatment but this dropped to 52% by two weeks after treatment and re-growth was evident. Thus, it appeared from this research that the combinations of these herbicides had additive or synergistic effect with one another and could lead to increased efficacy in large-scale treatments or reduce the amount of herbicide needed to achieve similar control using only one of these products alone. The effect of such combinations on non-target plants has not been determined, however. Thus more research is needed before herbicide combinations can be used in full scale field treatments.

Note that a relatively new product is available which combines triclopyr and 2,4-D as active ingredients. This product, Renovate Max G, is an aquatic herbicide technology innovation for selective and systemic control of broadleaf aquatic weeds. SePRO has developed and formulated this first combination herbicide registered in aquatics with proven synergy in one formulation (patent pending). Renovate Max G is formulated on an biodegradable granule (SePRO Corporation 2012). This product was not specifically evaluated for this IAVMP due to the availability of other products containing these active ingredients.

INTEGRATED TREATMENT ACTION PLAN

Overview

Integrated Aquatic Vegetation Management Plans (IAVMPs) are designed to be site specific based on the type of plant problem present and the needs of the waterbody users. An IAVMP reviews all control options available and selects the best mix to apply to the problem over time. An IAVMP is not a one-year management tool; it must evolve as conditions in the lake or river system change. For example, if a lake has a major Eurasian watermilfoil infestation, the first years of the program may focus on that problem and select tools to target that plant. In later years, there may still be problematic weed growth, but it could be from native plant communities or from different aquatic weed species. Different tools might be considered in these cases and applied. The management plan should have both short-term and a long-term strategies.

Control Intensity

The current aquatic plant problem at Deer Lake is related to the presence of Eurasian watermilfoil. Specific problem areas are the littoral zones (i.e. areas with a typical depth of less than 18 feet). As a result, preventative and high intensity controls are recommended for the short term and preventative and low intensity controls are recommended for the long term. These controls (detailed in the Recommended Control Strategy section below) are:

- **Short Term (2012-2017)**: Institute Education / Awareness Program, institute 2,4-D applications in conjunction with diver directed suction removal, bottom barriers and diver hand removal, institute monitoring effort.
- **Long Term:** Re-evaluate the need for milfoil controls and update IAVMP as necessary. Continue Public Awareness and Involvement Program, institute and continue locally funded milfoil control maintenance activities focusing on non-chemical methods to the extent possible.

Recommended Control Strategies

The management of aquatic plants at Deer Lake must work within the limitations of what is feasible based on the physical, chemical and biological state of the lake, financial resources and the political and regulatory environment.

Public Awareness and Involvement Program

The Deer Lake residents have indicated their concern for the protection of the beneficial uses of "their" lake and also their willingness to be involved in lake management efforts at various levels. As a result, it is highly recommended that residents be given as many options as possible to continue and/or increase their involvement. These options should include training in aquatic vegetation identification, milfoil survey and removal techniques, involvement in professional survey and removal efforts and also involvement in monitoring and data collection. More specifically, volunteers can participate in lake monitoring and diver removal efforts (either as divers or as boat crews) and helpers may be needed for both the diver removal work and surveying efforts. It is expected that most property owners around the lake will have the greatest interest in their own shoreline area, so individual or small group efforts with this local focus should be fostered. Much of the property owner participation is also expected to be simply attendance at meetings and training sessions so these sessions should be made as interesting and focused as possible to maintain or expand this level of participation as well.

The Public Awareness program should be addressed to the general public as well as the lake residents. This could take the form of information signs and brochures placed at public access points, articles written for publication in newspapers of wider local distribution (the Spokane Spokesman Review for instance). Programs brought to the schools can also have a great impact on public awareness.

The Public Awareness and Involvement Program can be initially designed and implemented by lake residents. However, it is anticipated that at some point professional services will be needed to help with the development of informational materials and activities.

Annual Surveillance and Mapping

The annual milfoil surveillance efforts performed at Deer Lake should be continued into perpetuity. This should include consultant diver surveys as well as resident inspections of near-shore areas (i.e. visual observations from boats or the shoreline and weed rake surveys in deeper waters).

The preferred schedule for the annual surveillance work is early in the growing season, typically during June. This timing will usually allow the surveyors to see the milfoil at a time when it is actively growing; the particular green color of the leaves and reddish stems are fairly distinctive and noticeable. This time is also usually early enough to allow planning for treatments that same growing season (i.e. in July). In years that control treatments are performed, it may be advantageous to also perform a post-treatment survey during August or September to determine treatment efficacy. While late-season surveys can be used to plan the next season’s treatments, it should be noted that milfoil will continue to fragment and become established to some extent during the fall, winter and early spring months. Thus, spring surveys will give a more accurate and current picture of the presence of the target plant.

Past surveys have included the use of Global Positioning System (GPS) equipment to help document the locations of the milfoil infestations, either individual plants or dense patches of plants. The GPS data is typically imported into a Geographic Information System computer program and milfoil distribution map(s) prepared. This can also be done using Google Earth®. It is recommended that GPS mapping be performed as a regular component of the annual surveillance. The GIS map(s) produced and an explanatory report should be prepared and provided to the Deer Lake residents as part of the Public Awareness and Involvement program.

Herbicide Applications

Based on past milfoil control efforts at a number of Eastern Washington and Northern Idaho lakes, as well as the information presented in the CONTROL ALTERNATIVES section of this Plan, it appears that spot applications of a fast-acting systemic herbicide combined with surveys and diver removal (suction removal / bottom barrier placement / hand removal), present the greatest opportunity to break the current milfoil growth cycle and meet the Management Goals stated above. The herbicide active ingredients that present the greatest chance of controlling the milfoil growths in Deer Lake are 2,4-D (found in products Navigate® and DMA 4 IVM®) and triclopyr (found in the Renovate® line of products and EcoTriclopyr®). The liquid formulation of 2,4-D, DMA 4 IVM®, is the recommended chemical to be used initially at Deer Lake. It should be noted, however, that the Goals presented in this IAVMP indicate that it is desirable that milfoil control does not involve chemical applications every year.

2,4-D was first registered for use in the United States in 1947 and it was used for water hyacinth at that time. The approval to use 2,4-D in Washington came in 1999 through RCW 90.48.448. This chemical has been used throughout Washington with good success and this is the preferred product for Deer Lake's initial milfoil control treatments. There have been no adverse impacts noted due to 2,4-D use in any local lakes.

The 2,4-D treatments performed around the lake to date used the granular formulation of the chemical (Navigate®). The typical application rate of this product for Eurasian milfoil control is 100 pounds per acre; the maximum allowed for this plant by the product label is 200 pounds per acre. The Deer Lake treatments performed to date used an application rate of 200 #/ac, the maximum label rate. Water monitoring of herbicide residues performed in other area lakes (Sacheen Lake in Pend Oreille County and Coeur d'Alene Lake), however, seems to indicate that the target concentration of 2,4-D (2 ppm) was not always achieved by the 100 pounds per acre application rate (Lamb 2008). This might be the result of sediment absorption of the chemical, when the granules fall to the lake bottom in sparsely infested areas. In any event, it appears that the liquid formulation of 2,4-D (DMA 4 IVM®) might have a greater efficacy because it is immediately mixed through the water column and perhaps more completely available for absorption by the milfoil.

Herbicide treatments performed at Deer Lake to date have been done by a lake resident who has an applicator's license and only charges for chemical used (not labor or other expenses). Due to the need for the herbicide treatments to be performed by experienced and State licensed (and insured) personnel, it will be necessary for the DLPOA (or any other lake management group) to contract with a lake management contractor for this work at some point in time. To accomplish this, it will be necessary to advertise for Statements of Qualification / Proposals. It is acknowledged that at the time of this writing, there are few firms in Washington that are set up to perform both the survey and treatment work. For this reason, and because of the cost and effort involved in going through a competitive bid process, this is recommended to be undertaken on an infrequent basis (i.e. every three to five years). In order to ensure that a true competitive process is followed, it is recommended that a public notice be placed in a newspaper of fairly wide distribution, at a minimum, the Spokane Spokesman Review. The Statement of Qualifications / Proposal solicitation process should begin as early in the winter as possible (October or November) so that it can be completed and a contractor Agreement finalized well before the following survey / treatment season (i.e. before April). It is recommended that the DLPOA / LMD obtain the assistance of the WDFW or the Stevens County Noxious Weed Control Board in reviewing submitted proposals. It is further recommended that any monitoring that is desired or required relative to the milfoil treatments should be conducted by the DLPOA / LMD with oversight by a qualified water quality or lake management specialist, or by a qualified, independent lake management specialist.

It should be reiterated that there are water use restrictions indicated on the herbicide labels that the lake residents and users must be made aware of. While public and resident notification requirements will be described in the WDOE aquatic weed NPDES permit, the following are applicable to the use of 2,4-D in aquatic systems:

- "Unless an approved assay indicates the 2,4-D concentration is 100 ppb (0.1 ppm) or less … do not use water from treated areas for irrigating plants or mixing sprays for agriculture or ornamental plants."
- "Unless an approved assay indicates the 2,4-D concentration is 70 ppb (0.07 ppm) or less, do not use water from treated areas for potable water (drinking water)."

There are no fishing or swimming restrictions stated on the product labels but, as noted in the 2,4-D section above, the WDOE recommends that "due to risk of dermal contact, a swimming advisory shall be posted advising swimmers to wait 24 hours before re-entering directly treated areas to allow time for the chemical to disperse".

2,4-D is recommended for initial treatments of Eurasian milfoil in Deer Lake. The cost estimate for Deer Lake treatments is based on using 100% of the maximum label rate for these treatments following information provided by the applicator used in 2010 and 2011.

Note that herbicide applications should be performed as early in the summer season as possible, when the target plant biomass (size and weight) is low. This helps prevent possible low oxygen levels which can result from the bacterial decomposition of the plants that are killed by the herbicide. Early season treatments can reduce the potential release of nutrients, especially phosphorus, from dying plants which fosters algae growth. The growth of excessive algae not only clouds the lake water but in some cases algae (particularly the blue-green species) can produce chemicals which are toxic to humans and pets. Thus, the control of potential algae growth is an important concern in lakes such as Deer Lake.

Diver Treatments

There is a need for a back-up treatment option because of lake resident opinion that treatments should not always rely on a chemical addition to the lake. This back-up method is recommended to be one or more diver treatments. The costs of substituting diver directed suction removal or bottom barrier placement or diver hand removal for 2,4-D applications are substantially higher (see below). It is recommended that a professional diving company (such as ACE Diving) be requested to develop an annual scope-of-work and cost proposal detailing which treatments are needed for how many days at which specific sites based on the most recent survey results. This should be done in the fall so that the DLPOA / LMD can plan for the coming year's treatment activities. Even if a survey is to be included in the diver's scope-of-work, it is beneficial if a written proposal is reviewed and accepted prior to the start of work. Also, if possible, it is preferred if a different diving company perform the survey work than does the treatments to avoid the self-accessing of treatment effectiveness.

Diver Suction Removal

Diver suction removal can be performed at areas where milfoil is identified in a survey and the technique is determined to be the most effective means of removing the milfoil there. This treatment technique can also be performed as a "search and remove" effort in areas where survey data is lacking. Diver suction removal (or hand removal) may be appropriate for touch-up in areas previously treated with herbicide.

If diver operated suction removal of milfoil is undertaken it can involve a considerable effort that will span much of the summer. Therefore, it is recommended that a qualified, experienced contractor be hired to manage and implement this work, including providing and operating / maintaining one or more boat-mounted suction units. It is also important that collected vegetation be disposed of at an approved location away from the lake. It is not expected that water monitoring will be required or necessary in conjunction with this milfoil control measure but if it is this should be performed by the DLPOA / LMD with appropriate oversight and local labor if possible.

Diver Hand Removal

Diver hand removal is recommended to be performed in areas of sparse milfoil infestation. An effort of five to ten days per season is recommended, based on current levels of milfoil infestation. This work could be contracted out (included in herbicide application or diver suction removal contracts for ease of administration) or performed with local labor, if available. If this work is done with local labor, there should be a designated manager who will coordinate and direct this effort following the results of the herbicide or diver suction work. It is not expected that water monitoring will be needed for this effort.

Bottom Barrier Placement and Removal

Bottom barriers are best when used in areas of moderate milfoil presence and where milfoil is mixed with high densities of native vegetation. The square footage of barriers desired must be identified during the diver surveys. Use of bottom barriers must comply with WDFW guidance presented in the pamphlet titled *Aquatic Plants and Fish* (WDFW 1998). While this guidance does not require that barriers be removed, it is advised that barriers (except burlap which will decompose naturally) be removed after six to eight weeks. If left in place longer, barrier material will block fish usage of the lake bottom and silt accumulation on top of the barrier material can allow plants to root through the material, making eventual removal difficult.

Expected Environmental Impacts of Recommended Control Strategy

The recommended milfoil control efforts are expected to have no significant negative environmental impact on the lake environment, including the wetlands, groundwater or adjacent upland areas. This assumes that all in-lake treatment work will be performed following currently accepted protocols and regulatory requirements.

The herbicides recommended are very target-specific, especially the 2,4-D and triclopyr. This limits the potential impact to beneficial vegetation. The recommended herbicides have been thoroughly tested to determine their potential impact to fish, birds, animals (wildlife and pets) and to humans. At the label-described application rates, no effects to fish, birds, animals or humans are expected. The use of pre-treatment diver inspections allows for precise placement of herbicides and thus a control on the amount of chemical that is used at any one time. The use of systemic products further limits the amount of chemical used because susceptible target plants do not re-grow if they receive a lethal dose of the chemical. Finally, each of the recommended herbicides has a limited life in the lake; these chemicals are broken down into harmless compounds by sunlight and microbial action.

Impacts from diver treatments are minimized because the divers direct these efforts to individual target plants, avoiding other vegetation. While some sediment materials can be picked up with the suctioning and released of excess water near the lake surface, these materials generally settle fairly quickly back to the lake bottom and do not leave a long-term plume of turbidity. Re-suspension of sediment during diver suctioning is also minimized by the fact that the divers actually lift the milfoil root wad up to the

suction intake as opposed to placing the intake into the sediments to collect the milfoil roots. Due to the typically high cost of diver suction removal, this is seldom used for large-scale milfoil control, thus minimizing the aerial extent of the intrusion into the aquatic habitat. Diver hand removal of milfoil, as well as bottom barriers, is not typically used for large-scale milfoil removal thereby minimizing lake habitat disruption.

The wetland areas are not expected to be impacted by milfoil control treatments because the treatments are focused on the lake and there are few opportunities for potentially degrading 'elements' (either chemicals or human disruption) to move into the wetlands. As indicated herein, the Deer Lake wetlands are vegetated primarily by grasses and grass-like plants which are not susceptible to either 2,4-D or triclopyr.

SEPA Environmental Checklist

A State Environmental Policy Act (SEPA) Environmental Checklist has been prepared for the recommended control strategies and this is presented in **Appendix E**. This checklist should be reviewed for accuracy and submitted to the appropriate agencies and the public prior to initiating the project.

Monitoring and Evaluation

Continued monitoring of aquatic plant populations and lake quality will be necessary to help guide the implementation of desired control measures and to evaluate the effectiveness of these measures. Monitoring should focus on an annual submersed plant survey and periodic sampling/analysis of basic water quality parameters. The following is a recommended program which should become an integral part of the submersed plant control program. Estimated costs associated with this work are provided in the Costs section below.

In addition to the monitoring of conditions in the lake, a periodic re-evaluation of this IAVMP is recommended. This re-evaluation should include a review of the monitoring results and discussion of possible changes in the methods to be implemented. The discussion should involve participation of all interested groups including the DLPOA, the LMD Steering Committee, WDFW, WDOE and any other affected parties. Changes in the plan could be desired following changes in funding availability, regulatory changes, new or revised treatment techniques or other factors.

Aquatic Plant Surveillance and Mapping

This should include diver inspection of the lake's littoral area through boat tows (parallel to shore) and snorkeling / surface inspections (between docks and in shallow areas). The combination of diver and non-diver survey methods is necessary to expedite the complete coverage of the littoral areas. Information on milfoil presence and relative density should be collected and maps should be prepared every year (preferably using GPS / GIS technology due to its greater accuracy) and to build a historical record of conditions and responses (i.e. efficacy of the treatments). This survey should be performed at least once a year after plants have come up in the early summer (June). Secondary surveys performed late in the summer could provide additional information on the short-term effectiveness of treatments.

It is also recommended that surveys be performed periodically (every three to five years) to document the presence of native aquatic plant species. This effort is important to document the on-going health of the native species and the continued lack of adverse effects of the herbicide treatments.

If GPS / GIS mapping is desired (or required) for this surveillance, it will be necessary to contract with a consultant firm (or team) that has this capability, in addition to having experienced diver staff who can identify the range of plant species present. Again, due to the expected annual cost of this work, a competitive solicitation process will be necessary. It is recommended that this surveillance and mapping work be included in the solicitation for a treatment contractor but made an option so that applicator/diver only firms may respond as well as surveillance/mapping only firms. This will at least make the most of the cost of the public notices.

Herbicide Treatment Monitoring

Herbicide residue analysis of surface water (lake and stream) samples are only required, currently, for control projects funded by WDOE. For these efforts the monitoring results are reported to the US EPA as part of the NPDES permit compliance. However, monitoring of herbicide residues in the lake is highly recommended to be able to respond to concerns expressed by residents or visitors about the usability of the water or potential non-target impacts of the herbicide.

The minimum recommended program for this is to collect four depth-composited samples following each treatment. The first two samples should be collected the day after treatment, one sample from within a treated area and one sample outside (within 200 feet of) that treated area. Two additional samples should be collected from the same two locations three to four days after treatment. All samples would be submitted to an accredited laboratory for analysis on the day of collection. If more than one area is treated at the same time, the minimum sampling should be conducted at the largest treatment area.

All samples should be composites of the water column at the sampling location. This requires the use of a device that can determine the depth at a location and also a device that can be lowered into the water to collect samples at desired depths. Separate samples should be collected from the lower, middle and upper third of the water column and equal volumes of each placed in bottles provided by the analytical laboratory.

Sampling and analytical methods used must conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in 40 CFR Part 136 or to the latest revision of the *Standard Methods for Examining Water and Wastewater* (APHA). In addition, sampling shall be performed by, or with oversight by, a qualified water quality specialist. Volunteer involvement in sampling and monitoring is encouraged and volunteer training is an important aspect of a public awareness program. Water sampling and analysis equipment must be made available; this should be discussed with Sewer District since they have performed monitoring work in the past and a cooperative effort should be investigated.

Water Quality Monitoring

It is strongly recommended that standard, routine water quality analyses be performed annually following treatment implementations. While the recommended control measures are not expected to have negative impacts, water quality data will allow for this to be documented.

This effort should consist of field data collection at regular depth intervals (i.e. every two meters) from the surface to the bottom of the same sites that herbicide residues are collected. Additional sites should be added so that data is obtained from representative areas within and outside of treated areas. Parameters to be determined in the field are temperature, dissolved oxygen, pH and conductivity (specific conductance). The Secchi Disk transparency should be determined at each site. If desired, water samples should be collected and submitted for laboratory analysis of total phosphorus and total nitrogen content. The nutrient testing will provide important indications of the overall productivity of the water bodies.

Environmental Mitigation

The Integrated Treatment Action Plan described above is considered to be consistent with environmental protection of the various resources and beneficial uses in Deer Lake and as a result environmental mitigation is not necessary. The proposed diver and herbicide control strategies will be compatible with the protection of fisheries, waterfowl, wildlife, water use, wetlands and the ecology of the water body if performed as described herein.

Project Costs

The milfoil controls described above focus on treating areas infested with Eurasian milfoil for five years. After that, it will be necessary to re-evaluate the presence of this or other invasive plants and the need for treatments. A summary of the anticipated costs associated with this survey, treatment, monitoring and public awareness project (2012 dollars) is provided in **Table 5**. The notes at the bottom of the table give the sources of the calculated costs for 2012; after that a 20% inflation rate is used for each successive year's costs.

Local Funding Strategy

Funding can be a limiting factor in an organization's ability to effectively manage noxious aquatic weeds or other lake-wide problems. At this time, there are no known grant programs, aside from the WDOE Aquatic Weeds Management Fund, which provide financial assistance for the type of project outlined in this Plan. However, with the formation of the Lake Management District, the Deer Lake residents will have a long-term program in place to provide necessary funding for all milfoil control efforts.

Table 5. Summary of costs associated with 2012 - 2016 milfoil control project implementation at Deer Lake, Stevens County, WA.

Task or Cost Item	2012	2013	2014	2015	2016
Public Awareness and Involvement Program[1]	$2,000	$2,100	$2,205	$2,315	$2,431
Annual Surveillance and Mapping[2]	$4,160	$4,368	$4,586	$4,816	$5,057
Herbicide treatments[3]	$2,500	$2,625	$2,756	$2,894	$3,039
Diver Treatments[4]	$6,240	$6,552	$6,880	$7,224	$7,585
Water monitoring[5]	$690	$725	$761	$799	$839
LMD Admin costs[6]	$4,000	$4,200	$4,410	$4,631	$4,862
DLPOA cost payback[7]	$2,416	$2,537	$2,664	$2,797	$2,937
LMD "non-collected"[8]	$1,200	$1,260	$1,323	$1,389	$1,459
Misc unanticipated costs	$1,000	$1,050	$1,103	$1,158	$1,216
TOTALS =	$24,206	$25,416	$26,687	$28,021	$29,423

Notes:

1. from 2012 - 2016 LMD budget
2. 4 Days (32 hours) @ $130/hr from ACE 2012 proposal = $4,160
3. (2.1 ac/yr Navigate @ $1,000 per ac Applic rate) plus permit fee ($400) from Mike Phillips and Kevin Schroeder = $1,900
4. 6 days (48 Hrs) @ $130/hr combined diver sucion removal and bottom barrier moving from 2012 ACE proposal. No new bottom barriers to be purchased.
5. herbicide residues (2 samples @ 250 each), water quality (2 comp samples for NH3, NO2, NO3,TKN, TP and OP @ $140 each). First year purchase or make Secchi disk ($50) otherwise use field equipment from Loon Lake / PUD. Total for 2012 = $690
6. LMD budget provided by Mike Phillips
7. from Mike Phillips; for milfoil treatment costs in 2011, prior to finalization of LMD
8. Estimated 4% loss per year due to non-payment of assessed LMD costs

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