Integrated Aquatic Vegetation Management Plan

Bead Lake

Pend Oreille County, Washington

Prepared with grant funding from:

DEPARTMENT OF ECOLOGY
State of Washington

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Acknowledgement

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Contents

List of Appendices

Ecology Aquatic Plants, Combined Surveys
Ecology Aquatic Plants, Individual Site Surveys
Water Rights Holder List
Written findings of the Washington State Noxious Weed Control Board.
BLCWA 2019 Annual Meeting Minutes
BLCWA Letter to Property Owners

List of Acronyms

BLCWA - Bead Lake Clean Water Association
Ecology - Washington State Department of Ecology
EWM - Eurasian Water Milfoil
Weed Board - Pend Oreille County Weed Board
IAVMP - Integrated Aquatic Vegetation Management Plan
DASH - Diver Assisted Suction Harvesting

Executive Summary

Bead Lake is a relatively small 720-acre lake located about 8 miles north of the town of Newport, Pend Oreille County, Washington. More specifically, the lake is located within the scenic Selkirk Mountains and its 10.5 miles of shoreline is surrounded on the north, east and south sides by steep, heavily timbered terrain. Approximately 15% of the lake shoreline is privately owned.

In 2010, it was discovered that Bed Lake contained one Class B noxious weed species, Eurasian watermilfoil (*Myriophullum spicatum*) herein referred to as EWM. To date, the infestation has been inadequately addressed, creating a potential for the infestation to get out of control. If left unchecked, EWM will greatly hinder recreational activities and decrease habitat and water quality at Bead Lake.

Members of the Bead Lake community realized the importance of controlling the noxious weed and preventing further spread and amelioration of the damage that has already been done. As a group they decided to apply for an Aquatic Weeds Management Fund grant through the Washington Department of Ecology (Ecology).

Private funds and grant money received from Ecology, along with matching hours from Bead Lake volunteers, has funded eradication efforts since 2010. However, the persistence and spread of the noxious weed demonstrated that an Integrated Aquatic Vegetation Management Plan (IAVMP) for Bead Lake needed to be prepared and implemented.

This IAVMP is a planning document developed to ensure that the Bead Lake community has considered the best available information about the waterbody and watershed prior to initiating comprehensive control efforts. Members of the BLCWA worked in partnership with the Bead Lake IAVMP Steering Committee to develop this IAVMP.

To address the task of generating community appreciation for and action towards these important ecological, aesthetic and recreational issues, the BLCWA, along with several Bead Lake residents and homeowners formed an IAVMP Steering Committee. The Committee was able to educate the community about the problem, inspire feedback about different treatment options, gather volunteer hours towards the project and garner the necessary financial support.

In development of the IAVMP control goals were prioritized, focusing on the problems that could be addressed, based on funding and other resource limitations. The community ultimately agreed on an IAVMP plan which incorporates an integrated treatment strategy to control EWM. Control activities targeting this noxious weed will combine seasonal application of aquatic herbicide followed by manual control methods. These control activities will be performed by a combination of hired contractors and Bead Lake community volunteers.

This IAVMP presents: an overview of the aquatic weed problem, details about the community planning process, ecological characteristics of the watershed and lake, a review of suitable control options, a comprehensive management plan, and the estimated budget and funding for implementation. There is also an Appendix section that contains background and supporting documents.

Section 1. Watershed and Lake Characteristics

1.1 Location and General Conditions

Bead Lake is a 720-acre oligotrophic lake located in Pend Oreille County, Washington, about 48 miles south of the Canadian border and 4 miles west of the border between Washington and Idaho. It is located within Water Resource Inventory Area (WRIA) 62. The lake covers portions of T32N R45E Sections 3,4,9, and 10; and T33N R45E Sections 33 and 34. The nearest incorporated community is Newport, Washington, located approximately 8 miles southeast of the lake.

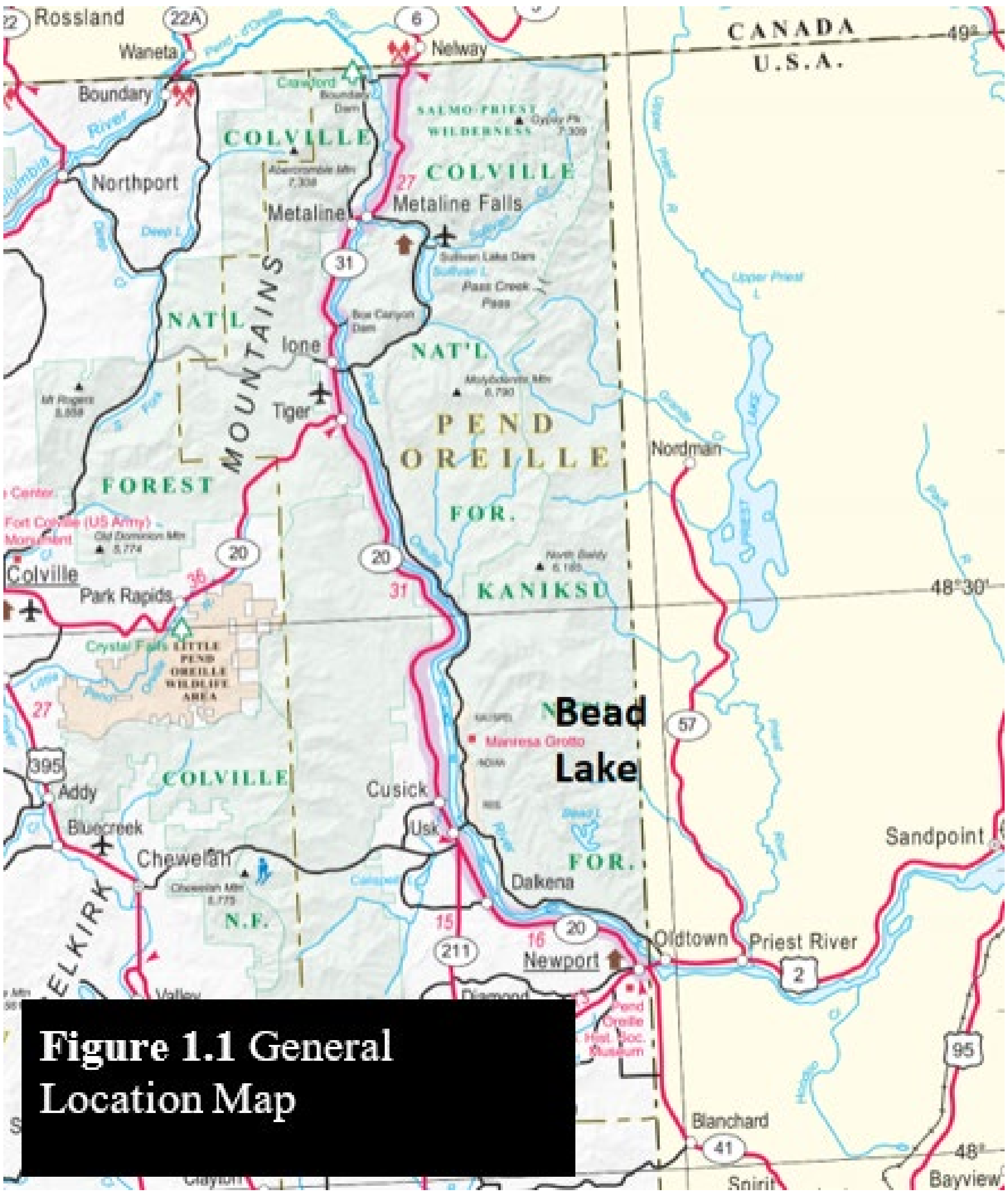

Figure 1.1 General Location Map

Situated within the scenic Selkirk Mountains, the lake is surrounded on the north, east and south sides by steep, heavily timbered terrain. The southwesterly edge of the watershed is a Kame Terrace formed during the last ice age by the Pend Oreille lobe of the Cordilleran glacier. This topography creates an isolated solitary watershed of approximately 10.5 square miles in area located entirely within the Colville National Forest of northeast Washington. Similarly formed lakes are nearby in their own isolated watersheds: Marshall, Shearer, and Freeman. A topographic map of the Bead Lake watershed and the surrounding area is included below (Figure 1.2).

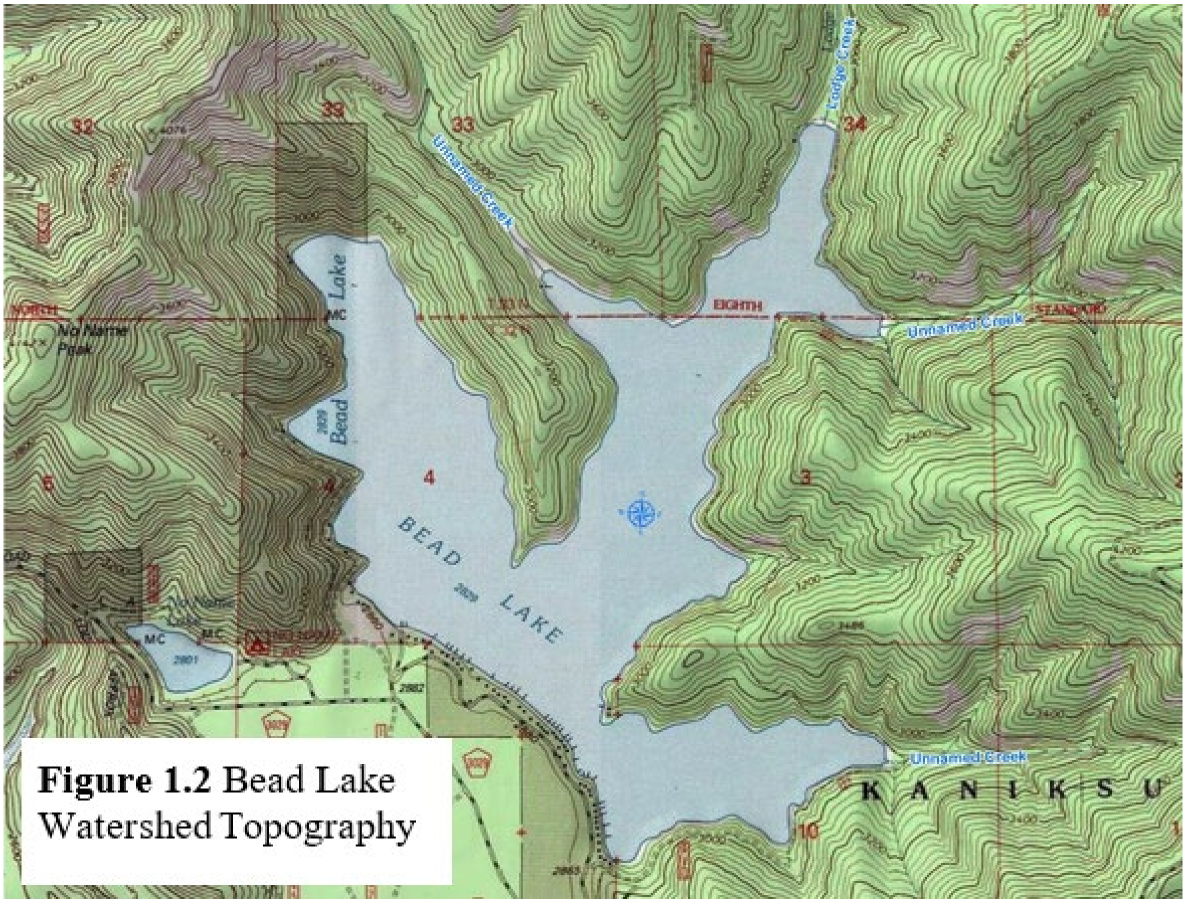

Figure 1.2 Bead Lake Watershed Topography

Lodge Creek, located at the north end of Lodge Bay, is the only year around surface water influent source to the lake. There are several other seasonally intermittent small streams in other bays. Small wetlands exist adjacent to the mouths of each stream.

There is no surface water discharge from the lake. The only discharge is subsurface percolation into and through the aforementioned Kame Terrace. This porous glacial moraine forms the southwesterly shoreline of the lake.

The average surface water elevation of Bead Lake is 2850 feet. The maximum water depth is 170 feet and the mean depth is 52 feet, yielding a volume of 77,708-acre feet. (Wolcott, Lakes of Washington Vol II, Eastern Washington, 1973, pages 411-412.) Of particular relevance to this plan is the steep, near shore, subaqueous topography. The bottom of the lake plunges so rapidly that within 30 feet of much of the shoreline the lake is over 30 feet deep. This rapid submergence tends to reduce the amount of area conducive to aquatic plant life. Refer to the bathymetric map below (Figure 1.3).

As previously noted, the only year around surface water source into Bead Lake is Lodge Creek, located at the north end of Lodge Creek Bay. Since there is no surface water outlet, the lake surface only fluctuates seasonally about 5 to 8 feet. The flushing rate has been estimated at 39 years.

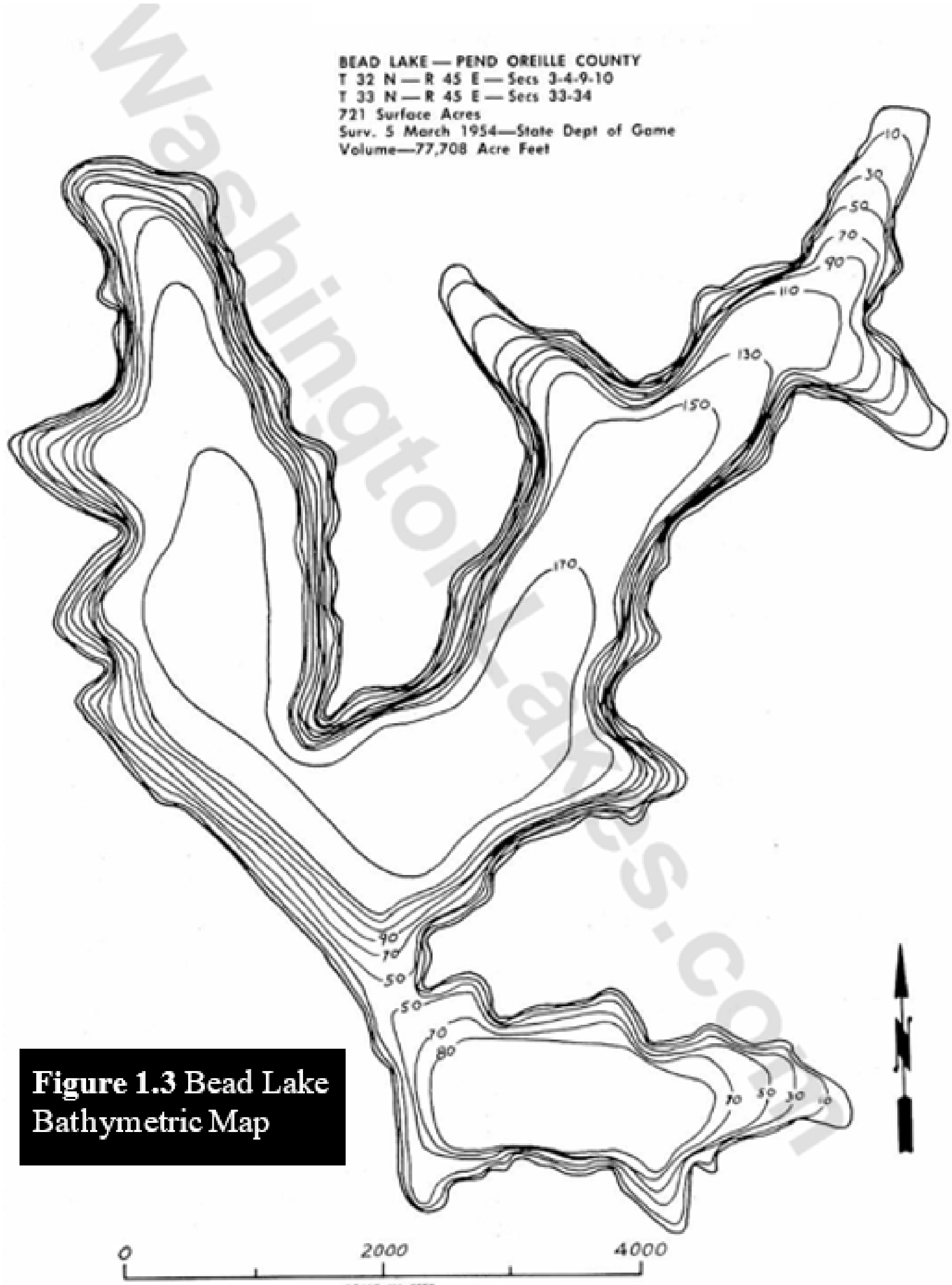

Figure 1.3 Bead Lake Bathymetric Map

1.2 Land Use

The southerly and westerly shorelines of the lake have been developed as private residential and seasonal recreational property. This amounts to about 15 percent of the shoreline. All of the remaining shoreline is National Forest Service property. Refer to Figure 1.4 below.
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There are approximately 165 private parcels of land located along the westerly side of the lake. Three homeowner associations represent most of these private property owners. The most northerly group is the Cunningham Resident Association. The central group is the Crystal Shores Resident Landowners Association. The most southerly group is represented by the Diamond Match Bead Lake Association. Most of these residents pump their potable water directly from the lake and dispose of wastewater to private septic tanks and drain fields. A list of water right holders is included in the Appendix.

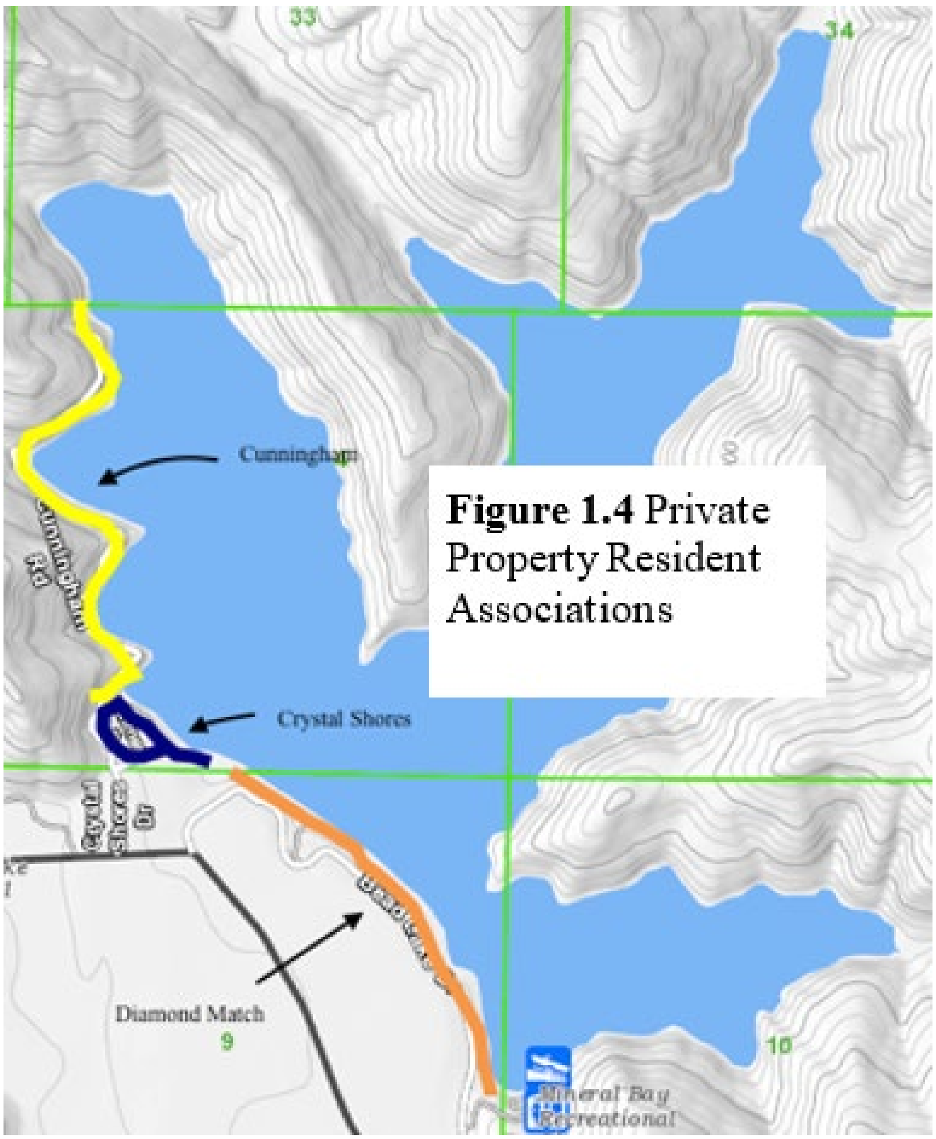


Figure 1.4 Private Property Resident Associations

A US Forest Service boat launch is located at the southernmost end of the lake in Mineral Bay. Constructed in 1997, this is the only public boat launch on the lake. Additionally, the three HOA's each operate a private boat launch for the exclusive use of their respective members and guests.

The remainder and vast majority of the land surrounding the lake is National Forest Service land managed by the Colville National Forest. Refer to Figure 1.5 below. It is steep, mountainous terrain that is heavily forested primarily with mature native conifers: ponderosa pine, tamarack, fir, and cedar. Deciduous trees comprised mostly of cottonwoods, alders, vine maples, and aspen can be found along the shoreline and within the riparian zones of the adjacent intermittent streams. The shoreline is classified as "natural" under the county's Shoreline Master Plan.

Figure 1.5 Aerial Photo of Bead Lake

1.3 Fish and Wildlife

Due to its location, adjacent forest, wetlands, range and riparian habitats, and climate, the Bead Lake watershed supports an abundant variety of wildlife. Big game observed in the watershed includes white tailed deer, mule deer, elk, moose, black bears, mountain lions and wolves. Small game animals include coyote, porcupine, beaver, muskrat, snowshoe hares, skunks, and raccoons. A variety of upland game birds exist in the watershed, these include ruffed grouse, blue grouse, and wild turkey. In addition, the watershed holds a diverse array of migratory and resident waterfowl.

These include Mergansers and Canada geese. Cormorants have also been observed at the lake. Non-game raptors include bald eagles and osprey. At least one active bald eagle nesting site is present on the north side of Mineral Bay and adult and juvenile eagles are routinely observed.
According to the Washington Department of Fish and Wildlife (WDFW), common loons visit Pend Oreille County. There are no documented loon nesting sites on Bead Lake, although there is good habitat for several. The data base also lists western grebes, terns, great blue heron, wood duck, Barrow's and common goldeneye, buffleheads, harlequin ducks, phalaropes, stilts, avocets and upland sandpiper, as having breeding populations in the county. There are no known nesting sites or rookeries for these birds at the lake.

From 1933 through 1948 the Washington Department of Game (now WDFW) planted and attempted to establish a variety of game fisheries in Bead Lake. Eighty-seven different plantings were performed during that 16-year period. Most of the efforts centered on Kokanee (Silver Trout) and Mackinaw (Lake Trout); although Eastern Brook Trout, Rainbow Trout, and Brown Trout were also attempted.

In 1963 Don Earnest, the District Fisheries Biologist, prepared a detailed report describing the fish planting efforts (A History of Fisheries Management in Bead Lake Pend Oreille County with a Proposal for an Improved Fishery). This report states: "Draining as it does, an infertile mountainous terrain, Bead Lake itself is a relatively infertile body of water. The lack of shoal areas and the extreme average depth (100 feet), together with the infertility of the water, limits the potential fisheries resources of Bead Lake. So far as is known there were no game fishes native to Bead Lake. There are several species of cyprinids indigenous to the region which have inhabited this lake for many years – perhaps since before recent history. Kokanee (silver trout) and mackinaw trout have become established as a result of planting."

The report's author goes on to observe that Kokanee are efficient lake spawners because they do not require running water for reproduction. The Kokanee are observed in the late fall spawning and dying in the shallow areas adjacent to the southwesterly shoreline of the lake. Concurrently, eagles have been observed feeding on the fish carcasses.

The author also notes that the Mackinaw are a predacious trout whose diet is almost exclusively Kokanee. Therefore, survival of the Mackinaw depends on the Kokanee and survival of the Kokanee depends on the availability of near shore shallow spawning areas. This relationship has sustained a viable stock of both game fish species for at least 70 years.

Other species of fish that have been identified in Bead Lake include pike minnows, pygmy whitefish, largescale suckers, burbot, pea mouth, and redside shiners.

1.4 Water Quality

Potential nutrient sources to the lake include stream inflows and private residential wastewater septic system leaks. Although no logging and road building has been conducted within the up-gradient portions of the watershed for many years, these activities would also have the potential to contribute nutrients to the lake during spring runoff. Lastly, forest fire activity within the watershed could potentially add nutrients to the Lake.

Multiple limnology studies of Bead Lake were conducted by different investigators spanning the years of 1978 through 2001. Most of this work was performed by the Eastern Washington University (EWU) Department of Biology. Consistent analyses included total and ortho-phosphates, NH_3, NO_3, NO_2, DO, Temperature, Transparency by Secchi disc, fecal coliform counts, and Chlorophyll A. All of these parameters remained stable and showed no degradation over the 23-year period of study other than a trend of slightly decreasing dissolved oxygen concentrations. Midsummer peaks of Chlorophyll A were highest in the 1996 samples and have been declining since then.

EWU studies conducted by Sexton, Soltero and Lantzer in 1997 and again in 2001 present the most thorough assessment of the lake's trophic condition. Trophic State Indices (TSI) spanning 1978 to 2001 are tabulated below (Table 1.1). The upper oligotrophic limit for the indices is 41. If the mean TSI exceeds 41, the lake is no longer considered oligotrophic. As shown in the table, the mean trophic state indices for all parameters remained below 41.

Table 1.1 Trophic State Indices

Date of Investigation	Secchi disk	TSI Total P	Chl a	Mean
2001	26	29	33	29
2000	27	27	33	29
1999	28	40	30	33
1997	29	39	36	35
1996	28	58	35	40
1995[1]	25	30	37	31
1987[2]	24	46	18	29
1978[3]	20	24	•	

[1]Wasson, pers. comm. (1996)
[2]Nichols and Gibson (1988)
[3]Gibbons and Gibbons (1978)
• no data

These authors concluded that Bead Lake is oligotrophic, and nitrogen limited. Oligotrophic lakes generally host very little aquatic vegetation and are relatively clear.

1.5 Aquatic Plants

Ecology has conducted routine plant surveys at Bead Lake from 1997 through 2017. Over this 20-year period a number of aquatic plant species were observed at various shoreline locations around the lake. A comprehensive list of these aquatic plants, as documented by Ecology, is included in the appendix. According to the data provided by Ecology and the Washington Department of Natural Resources (DNR), there are no sensitive, threatened or endangered aquatic plant species within Bead Lake or along the lake shoreline.

EWM is the primary problem species on the Washington State Noxious Weed List that has been found in the lake. EWM was first detected by Ecology in Mineral Bay in 2010 and control actions were immediately initiated.

Since the initial EWM detection, Ecology has surveyed the lake periodically to monitor and document changes in the locations and densities of EWM infestation. These surveys can be found in section 5. ACE Diving, A company specializing in EMW removal, was retained in 2010 by the Weed Board to conduct annual subsurface EWM eradication actions and to document the effects of these efforts. Of particular significance is the much higher concentration and extent of the plants observed underwater and removed by the diving contractor as compared to surface observations made from a boat. Clearly, subaqueous monitoring provides the most accurate assessment of the plant's locations and extent.

Section 2. Beneficial and Recreational Uses

Bead Lake is well known throughout NE Washington for its recreational and scenic values. Recreational activities at the lake include fishing, swimming, motor boating, water-skiing, wake boarding, jet skiing, kayaking, canoeing, paddle boarding, camping and hiking.

2.1 Boating

Approximately 15 percent of the lake shoreline is privately owned and there are three private boat launches and one public boat launch. The private boat launches are operated by three respective resident associations serving a total of approximately 165 private land owners at the lake. No record is maintained regarding the numbers or types of users of the private launches. There are also numerous private docks and several individual private boat ramps that provide recreational access to the lake for the property owners and their guests.

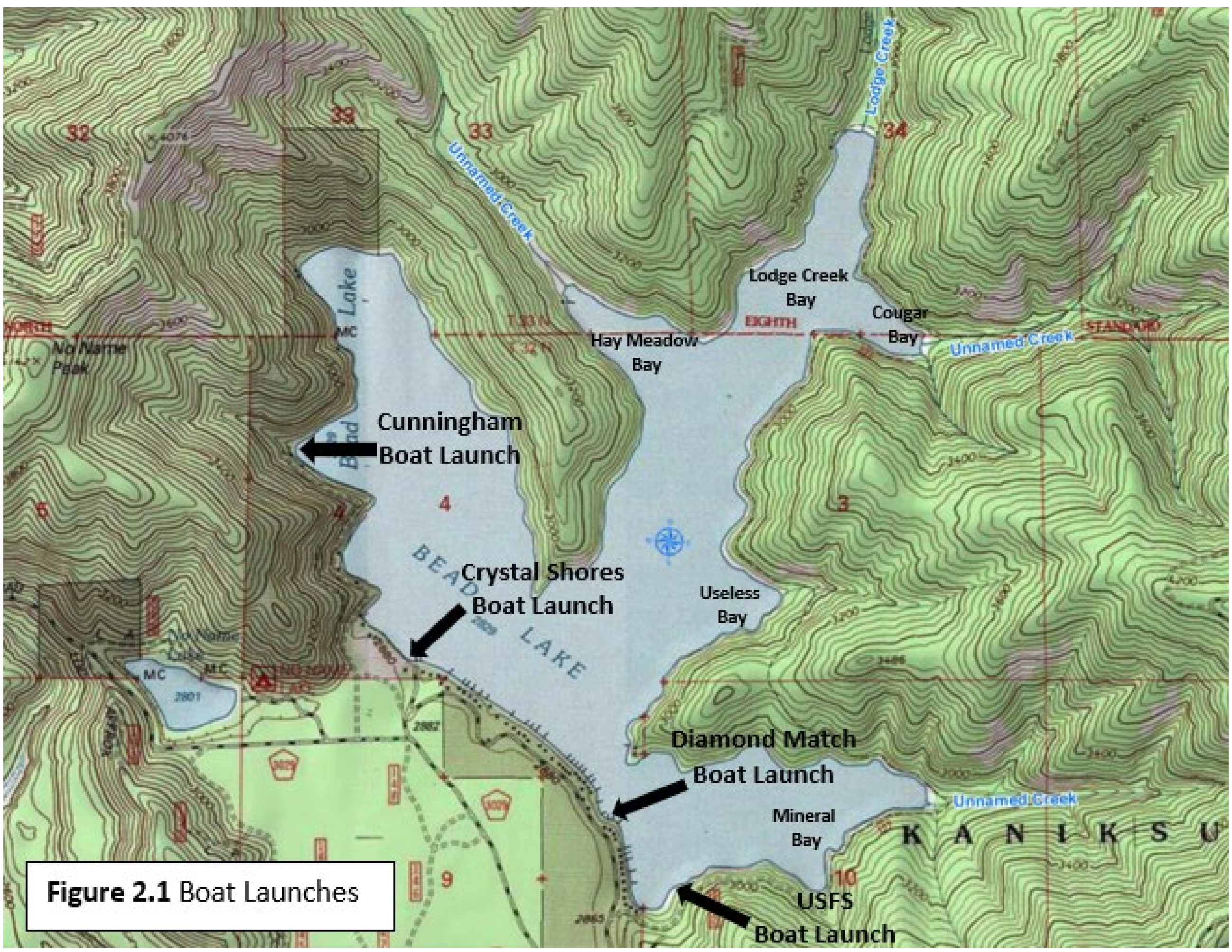


Figure 2.1 Boat Launches

The US Forest Service has operated the one public boat launch (situated at the south end of Mineral Bay) since 1999. The facility is comprised of a single lane paved entrance road, volunteer host campsite with utilities, paved parking area for up to 12 vehicles, a single lane paved road down to the edge of the lake and a single lane concrete boat ramp. No overnight use is permitted. This boat launch is open from April 15th through October 31st each year and the Forest Service compiles the number of motorized and non-motorized boaters using the boat launch:

Table 2.1 Forest Service Boat Launch Usage

Year	Annual Launches		
	Motorized	Non-Motorized	Total
2010	282	166	448
2011	375	270	645
2012	366	191	557
2013	381	239	620
2014	434	285	719
2015	179	172	351
2016	331	353	684
2017	407	437	844

As shown in these usage figures, the number of boats launched at the Forest Service facility has increased significantly over the past 10 years. Also, the non-motorized boats (canoes, kayaks, paddle boards) now comprise approximately half of all launches. While the Forest Service does not track the specific type of craft that is launched, the agency does report that the primary activities in which the boaters participate are: fishing, paddling and accessing lake shore camping sites. The Forest Service reports that organized groups that use either the public launch or the nearby trail system include: church, scout, canoe/kayak, hiking, mountain biking and scuba diving.

2.2 Hiking and Camping

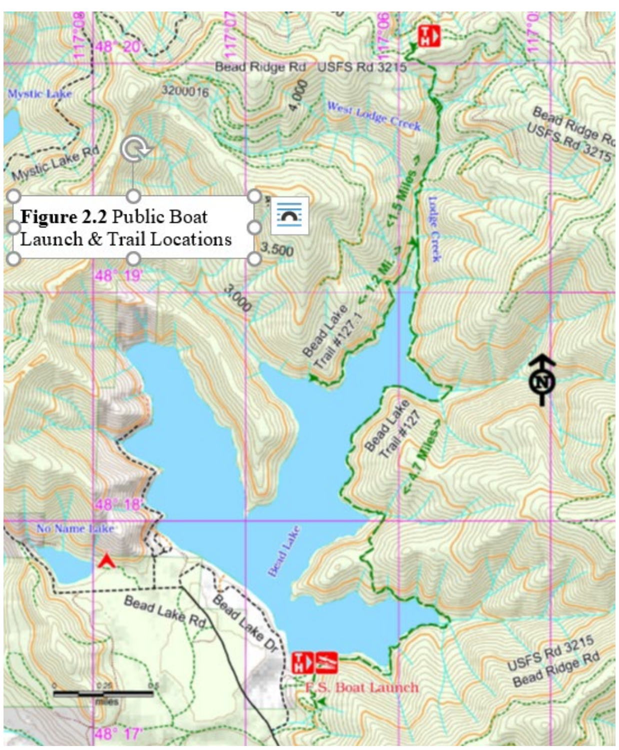


Figure 2.2 Public Boat Launch & Trail Locations

Bead Lake Trail #127 is one of the most popular hikes in the Colville National Forest. As shown on the figure below, this scenic trail commences above the Forest Service boat launch, parallels the lake's shoreline around Mineral Bay, crosses the peninsula into Lodge Creek Bay, circles Cougar Bay and finally climbs up out of the basin along Lodge Creek ending at a trailhead on Bead Ridge Road (USFS Rd 3215). The Forest Service does not collect trail user information but there are voluntary user registration boxes. Most of the trail use is day hiking and mountain biking.

2.3 Private Water Use

There are ninety-two water right holders within Water Resource Inventory Area (WRIA) 62 who use Bead Lake as their sole source of water. The full water right holders list is included in the Appendix. The water is delivered primarily using submersible pumps, installed along the lake shoreline, pumping to tanks installed within or near the property owners' residences. These water rights are active according to the *Water Rights Application Tracking System*. The primary purpose(s) for withdrawal from the lake are for general domestic use, limited irrigation and potrntial fire suppression. These ninety-one water right holders are dispersed along the southwesterly shoreline. Virtually all of the other private property owners on the lake also use potable water directly from the lake.

2.4 Fire Suppression

Pend Oreille County Fire District 6 reports that Bead Lake presents several benefits to the District. The primary benefit is as a source of water for firefighting. Bead Lake is the only water source available for many miles that can be immediately accessed and used by the District for both structural and wild land fires. The Fire District installed a dry hydrant at the base of the Diamond Match Bead Lake Association's private boat launch to use as its primary emergency pumper supply. In addition, a boat with a portable fire pump is maintained by local residents on the lake to protect lake homes as well as the remote, inaccessible shoreline areas. There has been one documented case in which this craft was used to stop a fire in Cougar Bay.

2.5 Fish Habitat and Sport Fishing

Because of Bead Lake's oligotrophic nature, it has been historically challenging to establish game fish within the lake. Native fish species present in the lake include: burbot, pygmy whitefish, suckers and pike minnow.

The Washington Department of Fish and Wildlife (WDFW) reports that Bead Lake is one of only nine lakes in Washington (2 in Pend Oreille County) that currently support the pygmy whitefish, a state Sensitive species under WAC 232-12-014 and -011. WDFW notes that the habitat for pygmy whitefish in small lakes, such as Bead and Sullivan, is particularly vulnerable to introduced predators, water quality changes and watershed changes.

Between 1933 and 1948 the Washington Department of Game conducted annual game fish plantings in Bead Lake. Hundreds of thousands of Kokanees, Mackinaw, rainbow trout, brown trout, eastern brook trout, cutthroat trout and silver salmon were planted. Besides the native species, only the Kokanee and Mackinaw survived. In 1963, the State Fisheries Biologist wrote a summary of these efforts and he concluded that the Kokanee were surviving because they do not require moving water to spawn and the Mackinaw were surviving by consuming the Kokanee. He concluded that no other imported game fish species could survive in Bead Lake.

No further game fish plantings were conducted after 1948 and today the lake supports a viable Kokanee and Mackinaw fishery plus some native burbot. Fishing is a popular year-around sport at the lake. Anglers typically use boats with small engines to troll for the fish. In the winter, after the lake has frozen sufficiently, ice fishing is also popular. During the fall, Kokanee are often observed spawning in the shallow water along the shoreline adjacent to the private cabins and Eagles then feed upon the spawned-out fish.

2.6 Scenic and Passive Recreation

Bead Lake offers residents and visitors alike a peaceful environment for those who want to relax and just enjoy nature. Due to the lake's location, surrounding forest, mountainous topography, depth, extreme clarity and wetland and riparian habitats, the Bead Lake watershed supports an abundant variety of wildlife. The seasonal wetlands located at the ends of Lodge Creek Bay, Cougar Bay, Hay Meadow Bay and Mineral Bay all provide isolated protected nesting habitat for migratory and resident waterfowl.

Figure 2.3 Southerly View Towards Mineral Bay

Big game to be observed in the watershed include white tailed deer, mule deer, elk, moose, black bears, mountain lions and, most recently, wolves. Small animals include coyotes, porcupines, beavers, muskrats, rabbits, bats, skunks and raccoons. Other aquatic animals including crayfish, frogs, toads and snakes are commonly observed in and around the lake.

2.7 Upland Game Birds and Waterfowl

A variety of upland game birds exist in the watershed, including grey partridge, ruffed grouse, blue grouse, and wild turkey. In addition, the watershed supports a diverse array of migratory and resident waterfowl.

One species of waterfowl that is of particular significance is the red-necked grebe. This is a state monitor species, and, on a state-wide basis, distribution of nesting red-necked grebes is limited to NE Washington. WDFW reports that Bead Lake provides the habitat requirements necessary to support nesting, brood rearing, and migratory stop-over for this species. Survey data indicates that nesting occurs on the lake.

The most numerous and prolific waterfowl on the lake are hooded mergansers. These birds nest in many of the protected small bays and cruise the shallow shorelines diving for and consuming fish. Other waterfowl commonly observed on the lake include mallard ducks, cormorants and Canada geese. Non-game raptors include bald eagles, osprey, red-tailed hawks, short-eared owls, and great horned owls. One pair of bald eagles established a nest on the west side of Mineral Bay over 10 years ago and has annually produced eaglets since then.

Figure 2.4 Easterly View Towards Lodge Creek Bay

2.8 Hydrologic Benefits

As mentioned previously, Bead Lake has no natural outlet. The only discharge from the lake is through exfiltration into the permeable aquifer that comprises the glacial moraine along the southwesterly side of the lake. As shown on Figures 2.1 and 2.2, nearby No Name Lake also has no natural inlet or outlet. With a water surface elevation approximately 25 feet lower than Bead Lake, No Name Lake clearly depends partially on a ground water supply from Bead Lake.

Similarly, Indian Creek lies several hundred yards further west of Bead Lake. This creek is partially supplied by groundwater exfiltrating from the Lake. Indian Creek flows southwesterly eventually discharging into the Pend Oreille River. The hydraulic sustenance of Indian Creek depends on the ground water supply originating in Bead Lake.

2.9 Property Owners' Recreational Preferences

The Weed Board conducted a survey of all of the lake property owners at the outset of this study in 2017. One objective was to assess the owners' perceptions and preferences related to recreational uses at the lake. Here are some of the findings:

- 84% of the respondents indicated that they are part time residents.
- Three quarters have owned their property for more than 10 years.
- Three quarters stated that their favorite lake activities include swimming, scenic viewing, hiking, boating, and canoeing/kayaking.
- Fifty percent ranked fishing as a favorite activity.
- Water skiing, jet skiing and wake boarding were all ranked lower.

The single most important long-term concern acknowledged by the survey respondents was the desire for low waterfront maintenance. Section 11 provides a comprehensive discussion of public participation in this planning effort.

Section 3. Problem Statement

EWM a non-native invasive species listed on the Washington state noxious weed list, was first discovered along the shores of the eastern and southern bays of Bead Lake in 2010. Initially considered an early and not well-established infestation, it was thought that the EWM could be mitigated if addressed quickly and aggressively. Instead, the EWM in the lake has proven to be very difficult to eradicate and, given the lake's unique conditions, the EWM persists despite the best efforts by the BLCWA, contractors and Pend Oreille County personnel.

The Bead Lake Clean Water Association (BLCWA) was established in 1978 and is comprised of a group of approximately 80 lake households whose purpose is to:

- Help maintain the ecological purity of the water in Bead Lake
- Help maintain the physical, natural aesthetic qualities of the shoreline
- Maintain the quality of the water so that residents can continue to use it as a drinking water source
- Provide information to members regarding any development plans
- Maintain lake serenity
- Speak for members on issues regarding Bead Lake

The association was notified of EWM infestation following a lake survey by an Aquatic Plant Specialist with Ecology and the Coordinator of the Pend Oreille County Weed Board (Weed Board) in July 2010. The board of the BLCWA and its members acted swiftly in collaboration with the Weed Board and Ecology trying to mitigate the situation. BLCWA continues to collaborate with the Weed Board in the ongoing effort to maintain the quality and clarity of the Bead Lake water.

3.1 Early Action

Following initial detection in 2010, EWM eradication became the primary focus of the BLCWA. The initial survey in 2010 revealed that EWM was growing in the middle finger, or eastern most side, of Bead Lake. Specifically, multiple plants were found along the shoreline of Hay Meadow Bay and Lodge Creek Bay, with single plants found in Useless Bay and Mineral Bay.

Ace Diving of Spirit Lake, ID was hired by the US Forest Service to begin EWM removal. The Weed Board immediately applied for, and with the backing of the BLCWA, was awarded, an Early Infestation grant by Ecology (Grant #G1100168), in the amount of $58,134. The purpose of the grant was to fund immediate eradication actions. BLCWA was responsible for 12.5% of the effort through in-kind service. This funding allowed for more control work to be performed by Ace Diving and it enabled another contractor, Aquatechnex, to be hired to apply the herbicide Diquat in Hay Meadow Bay, the area of the largest and most dense infestation, in early October of that year.

BLCWA worked with the Weed Board and was informed in 2011 that, due to the oligotrophic nature of the lake, clarity, and late season action (October 2010), contact herbicide eradication was not working as hoped toward eradication. Despite hand-pulling and manual vacuum suctioning methods also being utilized, dense infestation was found in four bays of the lake and was growing.

Annual surveys throughout the summer months of 2011 through 2014 revealed the EWM to be resistant to chemical eradication, and the plant was particularly stubborn and prone to quick propagation. The plants found in Hay Meadow and Lodge Creek Bays easily fragmented, allowing the plant to grow more quickly and spread easily to other parts of the lake (up to about 50 feet in depth, given lake clarity). Fragmentation was thought to be aggravated by the use of both motorized fishing boats and speed boats that regularly moor close to the shores in all of the bays of Bead Lake.

3.2 Recent Eradication and Mitigation Efforts

BLCWA and the Weed Board were awarded a control grant (WQAIP00009/G1400599) in 2015 in the amount of $50,227, with 25% of the grant to be matched with in-kind services (surveying, mapping etc.) performed by members of the BLCWA. The Weed Board contracted with ACE Diving (Spirit Lake, ID) through a bid proposal to perform the field work. The grant was extended in 2017 and continues to fund eradication, mitigation, and community education efforts at Bead Lake.

2015 and 2016 were particularly difficult infestation years. Doug Freeland, of ACE Diving, cited clear water, warmer water temperatures, low water levels, and lake nutrients as contributors to earlier than normal EWM growth in the lake. He noted that EWM plants throughout the lake easily fragmented due to high winds and boat activity. Fragments were regularly found floating along the shores, especially along the residential shoreline areas.

Sediment in the lake is considered less dense by Mr. Freeland than in other lakes around the region, creating more fragile plants, thus making fragmentation easier. Mr. Freeland witnessed plants ‘exploding’ into fragments upon casual contact; bays would be cleared of growth only for him to return in 10 days or so to find the bay ‘carpeted’ with small (4”-6”) plants. According to Mr. Freeland, "Fish and crawdads can swim by and frag a plant."

Surveying by both residents and ACE Diving revealed large patches of small plants in areas of shallow water. Residents also detected small amounts of plant growth along the shallow areas near the Forest Service boat launch and in the Cunningham Association shoreline area.

In 2016, bottom benthic barriers were placed over plant patches in Hay Meadow, Lodge Creek, Cougar, and Mineral Bays in an effort to choke large swaths of growth. These mats remained in place (or were moved slightly as determined appropriate) through much of the 2017 season. Diquat was once again used in October 2016 in Hay Meadow and Lodge Creek Bays. Diquat use in the 2016 season proved moderately successful for single stemmed plants. In all, approximately 4,000 pounds of EWM were removed or covered in both 2015 and 2016.

Diver surveying and activity was increased in the 2017 season, resulting in better understanding of EWM growth patterns in the lake and in the effectiveness of eradication efforts. Hand-pulling and diver vacuuming commenced earlier than in prior years. 2017 yielded better mitigation results thanks in part to cooler temperatures and higher water levels, particularly in Hay Meadow Bay and Lodge Creek Bay. Approximately 2,000 plants were removed from all bays during 2017. Plants were mostly smaller in size (< 6 inches in height) and were removed by hand or vacuum pulling. However, divers would clear an area only to return in three weeks' time to find more small plants. Diquat was not used during this cycle but may be used again if surveys reveal widespread and dense patches. Overall, EWM conditions were much improved by the fall of 2017 over previous years.

During the EWM removal process in 2018 the diver, Doug Freeland, noted that the plants had tripled in size and had already fragmented between the late spring and mid-summer. Since they also typically fragment in the early fall, it appears that multiple seasonal fragmentations are occurring. How to manage this additional challenge is further addressed in Section 7 Aquatic Plant Control Alternatives.

The 2019 season DASH efforts got off to a later start due to funding and contracting issues. Because of this, the DASH diver reported areas that were considered under control at the end of 2018, were now negatively impacted by early fragmentation and increased growth. The first application of the chemical ProcellaCOR® was applied in late summer 2019. Unfortunately, the plants appeared unaffected by the treatment. The reasons for this are still being investigated in order to determine if ProcellaCOR® is still an option for future management, perhaps earlier in the growing season.

3.3 Impacts on Beneficial and Recreational Uses

The many beneficial and recreational uses attributed to Bead Lake are described in Section 2. Most of these uses will suffer significant adverse impacts if EWM is allowed to persist in the Lake.

EWM reproduces and spreads prolifically in Bead Lake. Eventually, if unimpeded, the plant could infest all of the shallow waters along the shoreline. The littoral zone is defined as the near shore area where sunlight penetrates all the way down to the sediment allowing plants to grow.

Figure 3.1 Littoral Zone

In Bead Lake the littoral zone is wider than in many other lakes because the extreme water clarity permits solar light penetration to depths approaching 50 feet. This condition is conducive to EWM growth even though the lake is oligotrophic.

As the density of the plant growth increases, in time it can potentially displace the free water that it inhabits. Dense floating EWM will eventually restrict light penetration into the water. Further, as the plants die the residue will settle to the lake bottom where it will bio-degrade. The bacteria responsible for the biodegradation will consume the oxygen in the water while the deteriorating plant residue will penetrate and seal the granular sediment. There are multiple potential impacts from this process.

The most immediate and obvious potential impact is the degradation of fish habitat. If oxygen in the water is depleted by decomposing EWM, then the fish must migrate to better habitat in order to survive. The kokanee and the rare native pygmy white fish depend on the shallow dense granular sediment along the shoreline for spawning. This is particularly important along the residential shoreline because the shallower depths extend much further out into the lake than elsewhere. If the spawning areas are sealed off by the EWM, then these fish cannot propagate. Since the mackinaw rely on these smaller fish for food, the mackinaw also cannot survive. The native waterfowl including the rare red-necked grebes, the mergansers, as well as the eagles and the osprey, consume the fish. If the fish cannot survive, then these birds must, out of necessity, leave the lake to find other reliable food sources. Thus, the entire complex biologic interdependence of these fish and wildlife could be severely disrupted.

Another related potential impact is the effect that the dense plants could have on the residential water supply pumps installed in the lake. Virtually all of the domestic water pump intakes are located within the littoral zone adjacent to the residential areas. Therefore, if the EWM proliferates in these areas, it could result in degradation of the water quality being pumped. This could, in turn, necessitate the addition of water treatment. In a worst-case scenario, the dense EWM could result in pump plugging and the loss of the basic water supply. This same condition could also impact the Fire District’s primary fire suppression water supply pump.

Since the lake’s only mode of hydraulic discharge is exfiltration through the glacial moraine forming the lake’s west side embankment, EWM poses the potential to reduce the seasonal rate of discharge. While this would certainly require a dense, uncontrolled plant proliferation, the severity of the outcome cannot be ignored. If the rate of subsurface discharge is significantly restricted, then it could result in seasonally higher water elevations in the lake. The shoreline flooding could, in turn, damage docks and structures while further submerging the fish spawning areas and the adjacent riparian habitat. Concurrently, the reduced lake hydrogeologic discharge could reduce the water supply to Indian Creek, which is designated critical habitat for the federally listed as threatened bull trout that currently occupy the creek.

Last, but certainly not least, is the effect that the infestation could have on the lake's various recreational uses. Fishing could be dramatically impacted by the loss of Kokanee and Mackinaw. The subsequent departure of waterfowl and raptors would impact the overall passive scenic experience of the lake. Also, the surface density, width, breadth and depth of the plant growth could restrict boating, canoeing, kayaking, waterboarding and even swimming.

3.4 Conclusions

Unlike other regional lakes, EWM in Bead Lake is fragmenting year-round, and this is attributed to the 'ideal' growing environment as noted previously. EWM grows in the shallower parts of the various bays and, thus far, has been found in water depths of up to approximately 25-30 feet in the lake. It is believed that a thermal demarcation line is encountered at approximately 25 feet, and water temperatures below this level are significantly lower and, perhaps, less conducive to plant growth.

Early growth, ideal growing conditions, easy fragmentation, and increased boat traffic all contribute to a plant that has proven to persist and easily spread to many areas in the lake. If allowed to infest and become established in the bays and in the shallow sediment along the cabins' shoreline, the plant could become almost impossible to eradicate.

BLCWA is committed to maintaining the purity of the water in Bead Lake and sustaining the lake's physical and natural aesthetic qualities. Funds in the 2015 control grant were expended through the 2017 season, and BLCWA realized that efforts must continue in order to achieve long-term mitigation and ultimately eradication. The Association, to that end, applied for and was granted funds ($28,117 total with a 25% match) by Ecology to research and create an Integrated Aquatic Vegetation Management Plan. A steering committee, composed of many of the lake residents, was formed to help coordinate and eventually implement the comprehensive plan.

The EWM in Bead Lake is persistent and tenacious and, while considered to be somewhat "in control" after the 2017/2018 season, consistent monitoring, surveying, and professionally overseen aggressive hand-pulling and vacuuming must continue to prevent the plant from overtaking vast sections of the lake. Seasonal application of an herbicide may also be necessary.

The 2019 season DASH efforts got off to a later start due to funding and contracting issues. Because of this, the DASH diver reported areas that were considered under control at the end of 2018, were now negatively impacted by early fragmentation and increased growth. The first application of the chemical ProcellaCOR® was applied late summer 2019. Unfortunately, the plants appeared unaffected by the treatment. The reasons for this are still being investigated in order to determine if ProcellaCOR® is still an option for future management, perhaps in the earlier growth seasons.

All mitigation/eradication activities will have to be carefully scheduled and closely monitored to prevent deleterious effects to the fish and the waterfowl sharing the aquatic environment.

Section 4. Aquatic Plant Management Goals

Since EWM was first discovered in Bead Lake in 2010, Ecology has conducted boat surveys of the aquatic plants in the lake to evaluate the extent and potential growth of EWM. Ace Diving (Spirit Lake, ID), under contract to the Pend Oreille County Weed Board, has also performed diving surveys of Bead Lake, coupled with extensive EWM eradication efforts. These have included hand extraction, vacuuming DASH, benthic barriers and selective application of the herbicides.

Despite these efforts, the EWM has proven to be extremely tenacious and dispersive. By the end of the 2019 management season, the numbers of plants observed finally declined to the lowest levels since first discovered in 2010. There were only a few small plants remaining in Mineral and Hay Meadow Bays and no plants were visible at the boat launch. However, Lodge Creek and Cougar Bays are still problematic with numerous plants remaining. These two bays will need to be the top priority heading into the 2020 management season.

This demonstrates that the treatment techniques can be effective if applied vigorously and consistently every year. It is a major concern of the Weed Board and the BLCWA that, if the EWM dispersion and density are allowed to increase, the plant could potentially impede human recreation, destroy aquatic habitat, degrade water quality and even impact the hydrogeology of the area.

The BLCWA values the lake's health, water quality, and the associated concerns of all of the lake's beneficiaries. For that reason, the BLCWA has developed a set of goals for the IAVMP. These goals take into consideration the lake's characteristics, the interests of the adjacent residents and property owners, the interests of other users and beneficiaries, and the associated costs for plan implementation. The goals are outlined as follows:

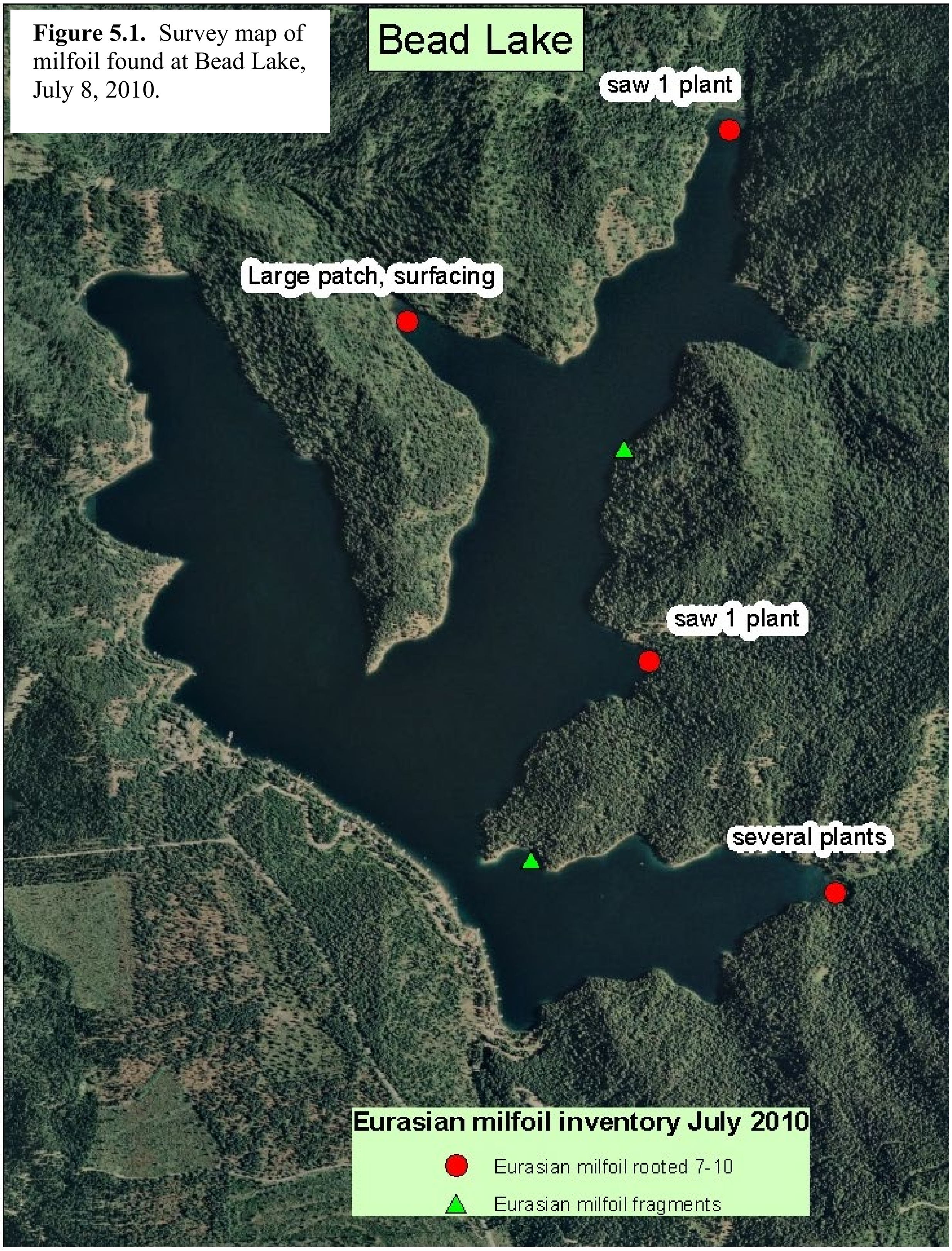
1. Establish and implement a plan to suppress and control EWM at as low a density as is environmentally and economically feasible.
2. Identify and implement methods to prevent the introduction and spread of additional EWM into the lake from other aquatic sources.
3. Seek a balanced approach for treatments and diver harvests, while targeting prevalent EWM growth areas and potential areas of expansion.
4. Take into consideration all beneficial uses including recreation, passive scenic experience, the fishery, wildlife habitat, and water pumping for household consumption and fire suppression.
5. Identify and implement methods to maintain the oligotrophic state of the lake.
6. Establish annual lake water quality monitoring and data collection, comparing results with existing baseline data, identifying adverse deviations, and pursuing appropriate remedial actions.
7. Conduct annual surveillance of plants within and adjacent to the lake shoreline, in order to intercept and prevent the establishment of other invasive species.
8. Continue and broaden the Bead Lake IAVMP Advisory Committee to encourage active participation by all three of the resident associations.
9. Establish an ongoing community outreach and public education program.
10. Establish equitable funding mechanisms to continue long-term control of invasive aquatic plants.

Section 5. EWM Surveys and Past Aquatic Plant Management Efforts

2010 EWM Survey and Mitigation efforts

In July of 2010, the Weed Board was notified by Ecology Aquatic Plant Specialist, Jenifer Parsons, and the USFS Colville National Forest fisheries lead, Tom Schuda, that EWM, had been discovered in Bead Lake during a routine aquatic plant survey performed by Ms. Parsons.

Figure 5.1. Survey map of milfoil found at Bead Lake, July 8, 2010.



The USFS had a current project at neighboring Marshall Lake to remove EWM under contract with Doug Freeland, owner of ACE Diving, by employing DASH. Mr. Schuda offered to move some of the funding to Bead Lake to start removal of the newly discovered plants. At the same time, Sharon Sorby, Coordinator of the County Weed Board, started an application to Ecology for an Early Infestation Project grant. The BLCWA was recruited by the Weed Board to become involved. At the annual BLCWA meeting in August 2010, the group voted to assist with the grant application and project implementation. The grant was awarded with an August 13, 2010 start date.

Mr. Freeland was able to commence DASH removal the week of August 23, 2010, and complete removal at the identified locations except for Hay Meadow Bay where the infestation was too large and too dense for effective DASH removal. Mr. Freeland recommended an herbicide treatment to the bay. As the lake had been previously covered under the county's National Pollution Discharge Elimination System (NPDES) permit for herbicide application, it was only necessary to get approval from Ecology for covering the expense of an herbicide application as it was not included as a management option in the original grant proposal.

Figure 5.2 Hay Meadow Bay milfoil treatment map, Bead Lake, October 5, 2010.

Dr. Kurt Getsinger of the US Army Corps of Engineers, Vicksburg, MS Engineer Research and Development Center, was engaged to assist with an herbicide recommendation. Ideally, a systemic herbicide treatment, capable of killing the plants at the roots, would have been an option, but the season had progressed to the point the plants were entering senescence and auto-fragmentation had started. It was determined that a contact herbicide, diquat, that could render the fragments unviable was a better option. On October 5, 2010, Aquatechnex performed a treatment using subsurface injection application technique.

Through the ensuing years of management efforts including DASH removal, benthic barrier installation and targeted herbicide application, the EWM infestation level at first expanded, and then more recently, has diminished to a more easily managed level. An observation by Mr. Freeland of the EWM being in a constant friable state gives a deeper understanding of how the infestation was able to expand despite intensive management efforts, leading to changes in management timing for methods employed, resulting in more successful control. The observation also guided message development for informing lake users to avoid disturbing the EWM beds to help prevent anthropogenic fragmentation and further spread.

2011 EWM Survey and Mitigation efforts

The question remained as to the cause of the constantly friable state of the EWM. Is it a genetic variation or an environmental factor causing this phenomenon? Genetic sequencing was conducted on plants collected from the original survey. No variation was found. The Weed Board obtained plants from the lake to grow in two aquaria, one with an intense light source, the other with only ambient light. After two months, the EWM in the tank with ambient light started to senesce, the stems growing roots and easily fragmenting under minor disturbance. After three months, the EWM stems in the tank with an intense light source remain green, without root growth or fragmenting under minor disturbance. It seems the low light level afforded Bead Lake due to its location nestled within a steep valley surrounded by tall mountains is likely to play a role in the friability of EWM growing in the lake. In 2011, Mr. Freeland recommended that herbicide treatments take place in Hay Meadow, Lodge Creek

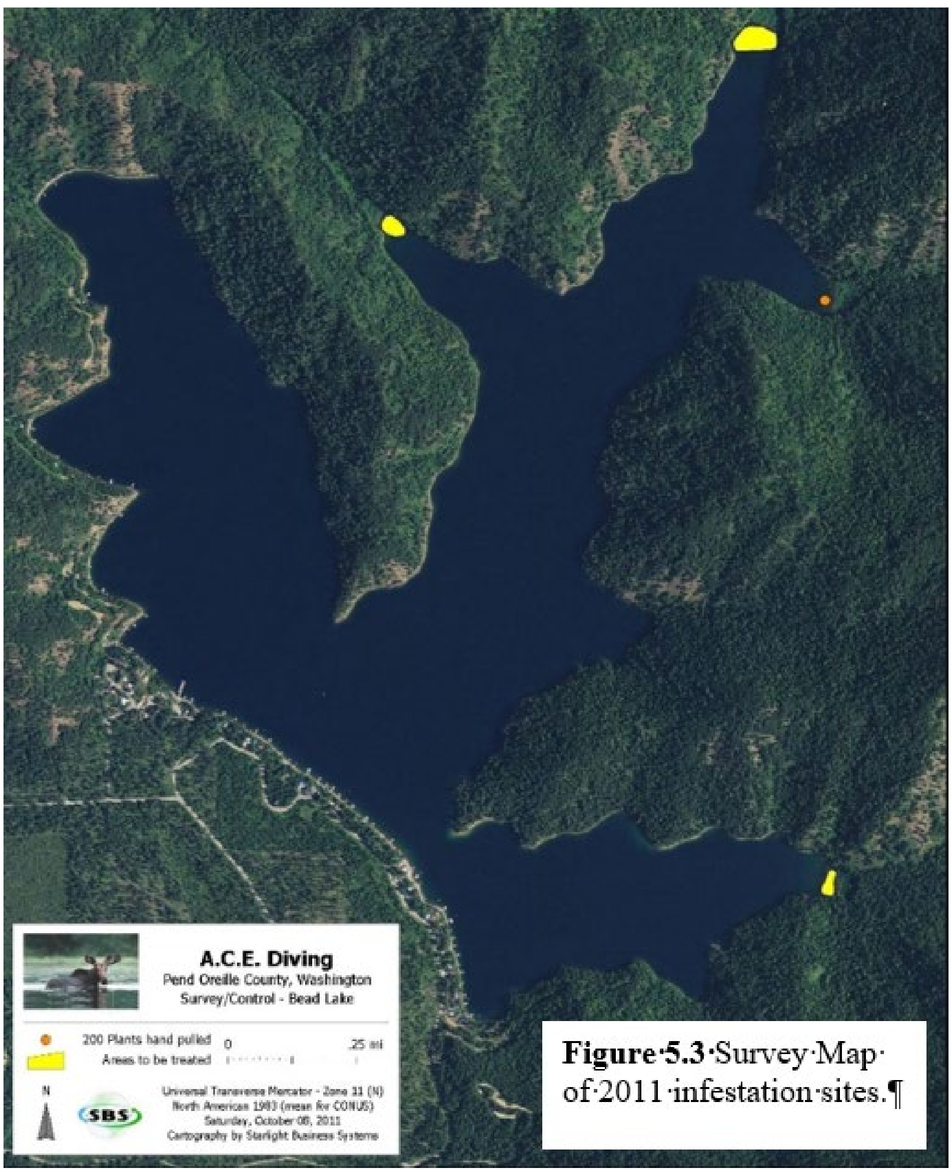


Figure 5.3 Survey Map of 2011 infestation sites.

and Mineral Bays. He was able to remove approximately 200 plants he had discovered from Cougar Bay, utilizing DASH. Herbicide treatments were performed by Aquatechnex and consisted of the contact herbicide Diquat in Lodge Creek and Mineral Bays and the systemic herbicide, Renovate, in Hay Meadow Bay.

Figure 5.4 Treatment Map of 2011 infestation sites, Lodge Creek and Mineral Bay, 1.5 acres total, September 12, 2011, Hay Meadow Bay, 1.25 acres, September 13, 2011.

2012 EWM Survey and Mitigation Efforts

In 2012, Mr. Freeland recommended that herbicide treatments take place in Hay Meadow and Mineral Bays. On August 13, 2012, he was able to remove plants he had discovered from Lodge Creek and Cougar Bays, utilizing DASH.

Figure 5.5 Survey and Treatment Map of 2012 infestation sites. Milfoil removed from Lodge Creek and Cougar Bays, during September, 2012. Hay Meadow and Mineral Bays, treated with the systemic herbicide Renovate, 3 acres total, September 10, 2012.

Herbicide treatments were performed by Aquatechnex and consisted of the systemic herbicide, Renovate, in Hay Meadow and Mineral Bays on September 10, 2012.

2013 EWM Survey and Mitigation Efforts

Ecology Aquatic Plant Specialist, Jenifer Parsons, surveyed the entire shoreline on August 6, 2013. Five new locations were identified, and a small patch of yellow flag iris was discovered along the north shore on the point of land closest to the developed south shoreline (Geaudreau's Point).

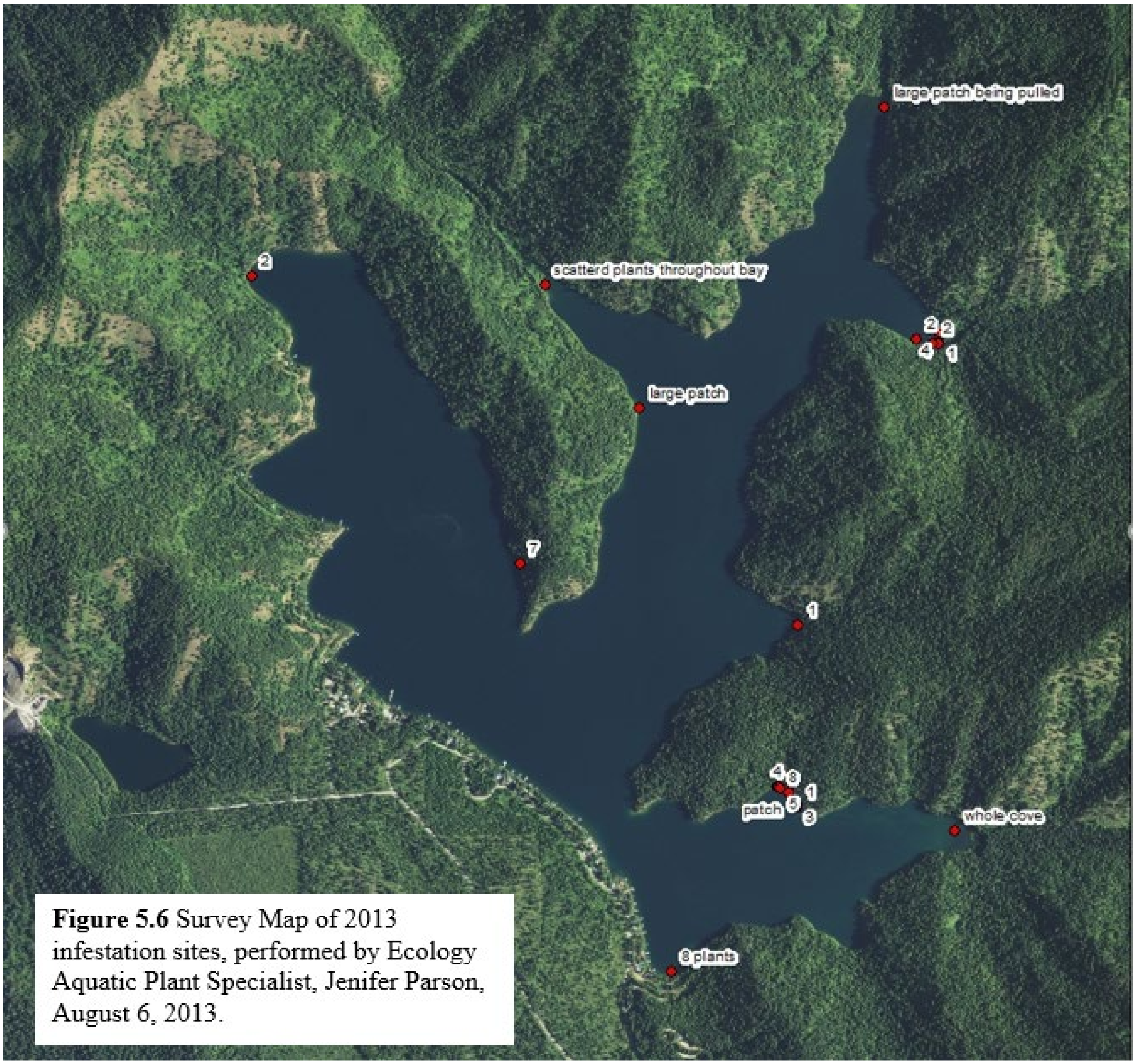


Figure 5.6 Survey Map of 2013 infestation sites, performed by Ecology Aquatic Plant Specialist, Jenifer Parson, August 6, 2013.

Mr. Freeland recommended that herbicide treatments again take place in Hay Meadow and Mineral Bays. Over the course of eight days, from July 12 through September 10, 2013, he was able to remove plants from the discovered sites, utilizing DASH. The infestation site along the north shore to the west of Mineral Bay was treated by installing benthic barriers over the site.

Herbicide treatments were performed by Aquatechnex and consisted of the systemic herbicide, Renovate MaxG, in Hay Meadow and Mineral Bays on August 6, 2013.

Mr. Freeland followed up all treatment areas with a survey on October first and did not find any EWM in Hay Meadow or Mineral Bays that had been treated with herbicide. He checked to make sure the benthic barrier was secure for the winter and did not see any EWM in the DASH treated areas. He did express his frustration that many of the infested areas had plants less than three inches in height, making 100% discovery and removal impossible as they were often mixed in with native vegetation and hidden from view.

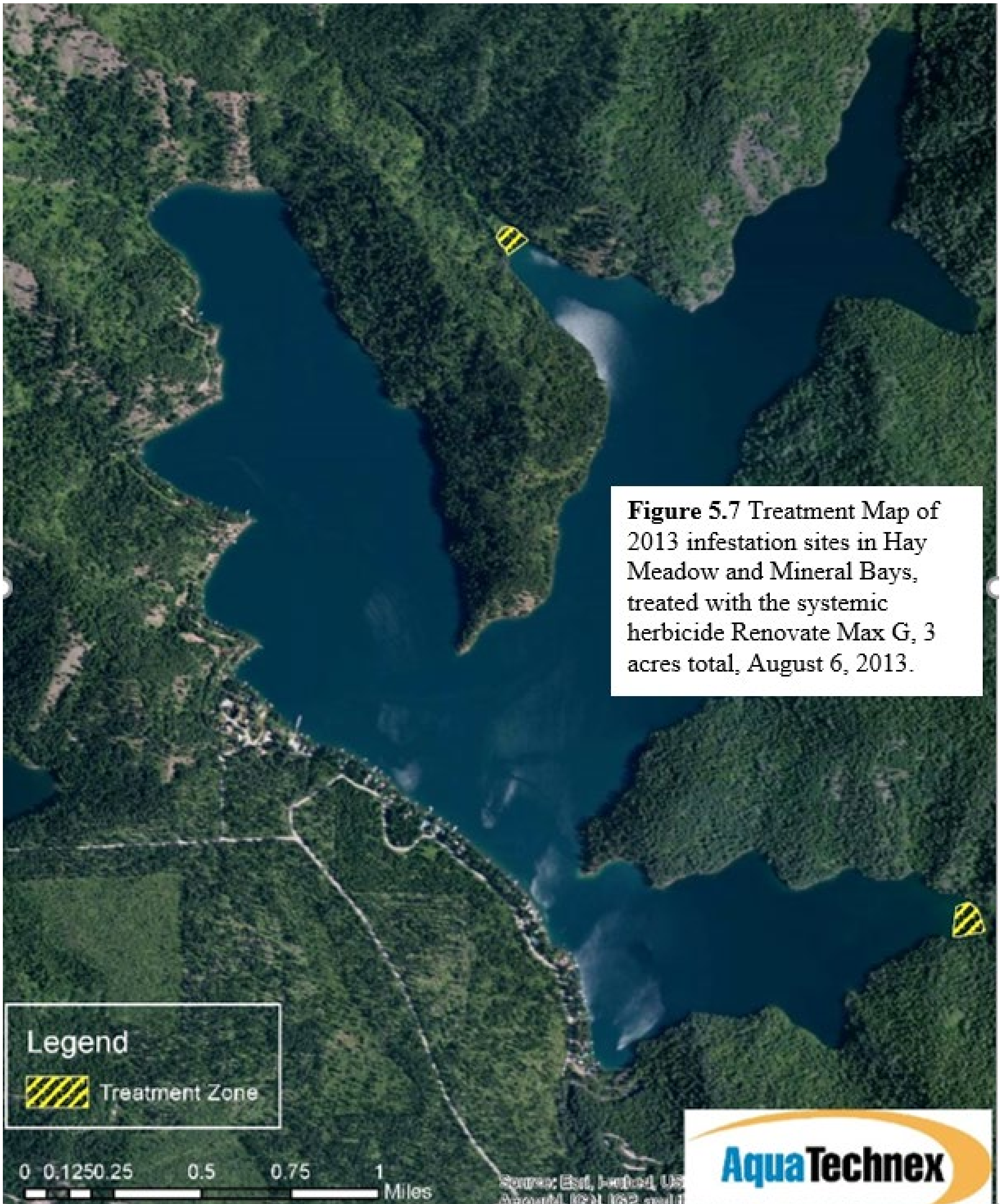


Figure 5.7 Treatment Map of 2013 infestation sites in Hay Meadow and Mineral Bays, treated with the systemic herbicide Renovate Max G, 3 acres total, August 6, 2013.

2014 EWM Survey and Mitigation Efforts

The 2014 season experienced an increase in the number (five) of infestation sites, but the previously treated areas experienced a significant decrease in density levels. Some of the new infestation discoveries were found at greater water depth (20 feet) than is normally seen with EWM. The water clarity of Bead Lake is exceptional (45 feet) which could be a causative factor for this phenomenon. This finding instructs us to survey at greater water depth which is sometimes as much as 300 feet from shore. In July and August, high speed windstorms hit the lake, resulting in extensive free-floating and beached fragments. The landowners spent many hours this season cleaning the fragments from their beaches and boating around the lake, netting up the floating fragments.

Mr. Freeland did not recommend any herbicide treatments. He treated all sites with DASH and installed (or moved those previously set) benthic barriers. In Mineral Bay, 27 barriers were installed and over 7,000 plants were removed by DASH. Seven barriers were installed in Lodge Creek Bay and approximately 1,500 plants were removed by DASH. Approximately 6,000 plants were removed by DASH from Hay Meadow Bay. There were five benthic barriers installed in the area to the south and east of Hay Meadow Bay in the 2013 season. These were reset in 2014 and approximately 100 plants were removed by DASH. Eight barriers were installed over the new infestation along the south shore of Geaudreau's Point, and the plants not covered were removed by DASH.

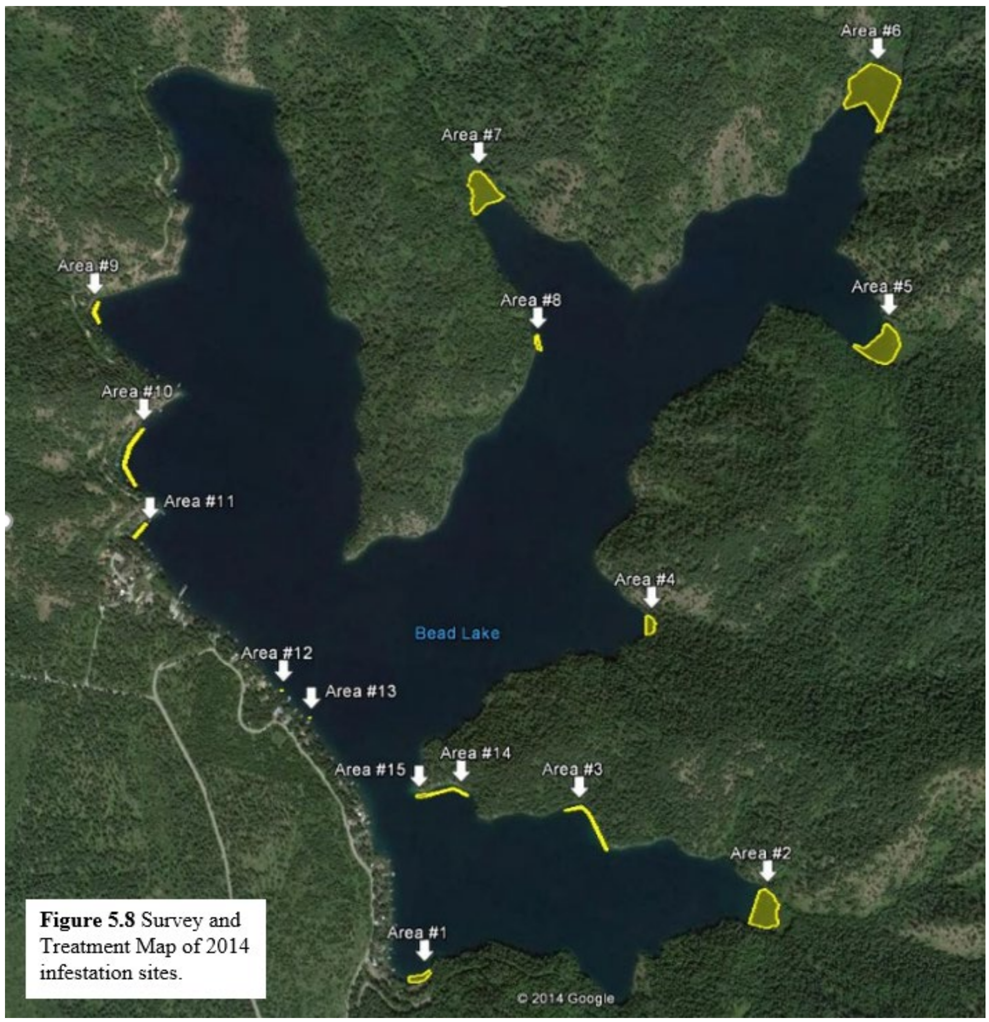


Figure 5.8 Survey and Treatment Map of 2014 infestation sites.

2015 EWM Mitigation Efforts

The primary setbacks of the 2015 season included low water levels and early auto-fragmentation causing the plants to seemingly explode upon touch, both preventing effective DASH removal. The work took place August through September, ending on the 29th. By the end of the season, over two tons of plant material were removed and over 80 benthic barriers were installed or reset.

2016 EWM Survey and Mitigation Efforts

The 2016 season experienced rapid and dense recolonization of areas previously knocked back in size and density, although all the small areas discovered and cleaned the previous season remained

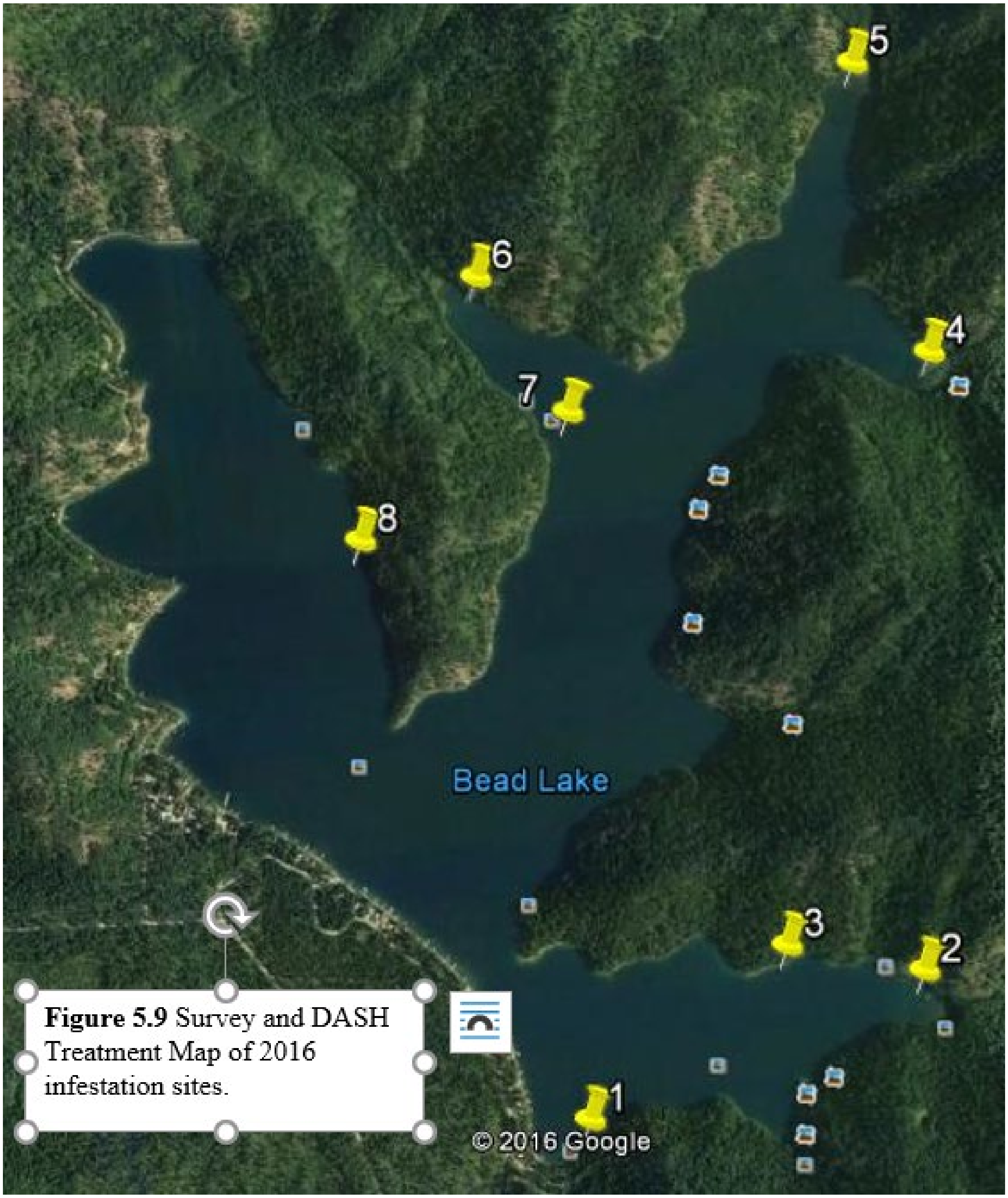
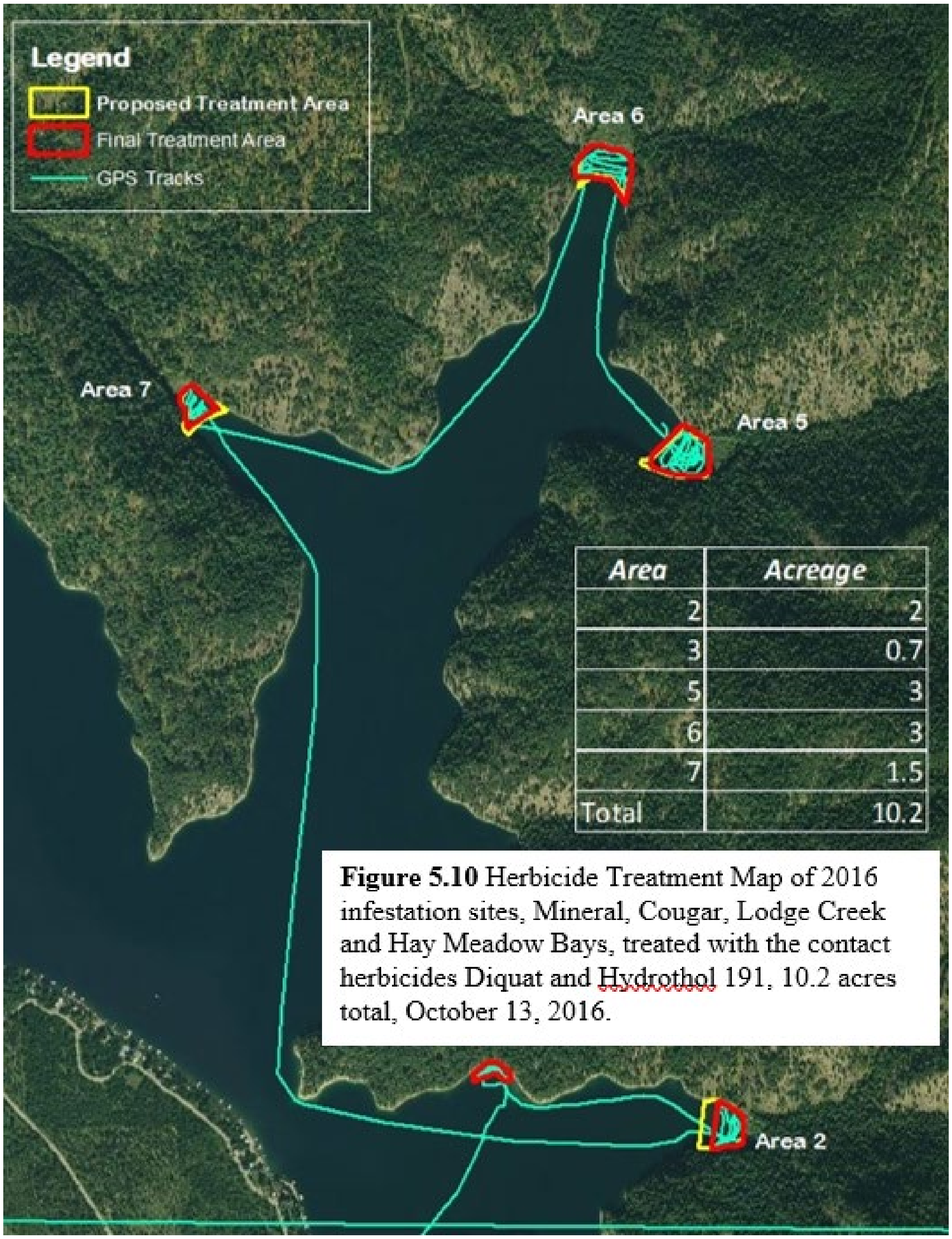


Figure 5.9 Survey and DASH Treatment Map of 2016 infestation sites.

without further infestation or comparatively small ones. The boat launch had only three plants that were removed by DASH, as opposed to the 100 plants removed the previous season; the area to the east of Hay Meadow Bay, over 100 pounds were removed in 2015, only 10 plants were found this season; the one new area, found to the south and around the point from the previous site, had only 40 plants that were removed by DASH.



Area	Acreage
2	2
3	0.7
5	3
6	3
7	1.5
Total	10.2

Figure 5.10 Herbicide Treatment Map of 2016 infestation sites, Mineral, Cougar, Lodge Creek and Hay Meadow Bays, treated with the contact herbicides Diquat and Hydrothol 191, 10.2 acres total, October 13, 2016.

Mr. Freeland spent over two weeks applying Dash removal to the discovered sites of infestation, removing over two and a half tons of plant material. At that point, he realized he would not be able to succeed in complete removal and recommended an herbicide treatment.

On October 13, 2016, Lakeland Restoration Services, LLC applied the contact herbicides diquat bromide and mono salt of endothall, to treat 10.2 total acres in Mineral, Cougar, Lodge Creek and Hay Meadow Bays; and, a small area of dense infestation along the north shore to the west of Mineral Bay.

2017 EWM Survey and Mitigation Efforts

Work in the 2017 season started June 14th with survey and benthic barrier removal from Mineral and Useless Bays, no EWM was detected upon removal. Five barriers were removed from Hay Meadow Bay along with 30 small plants while 50 plants were removed from Lodge Creek Bay.

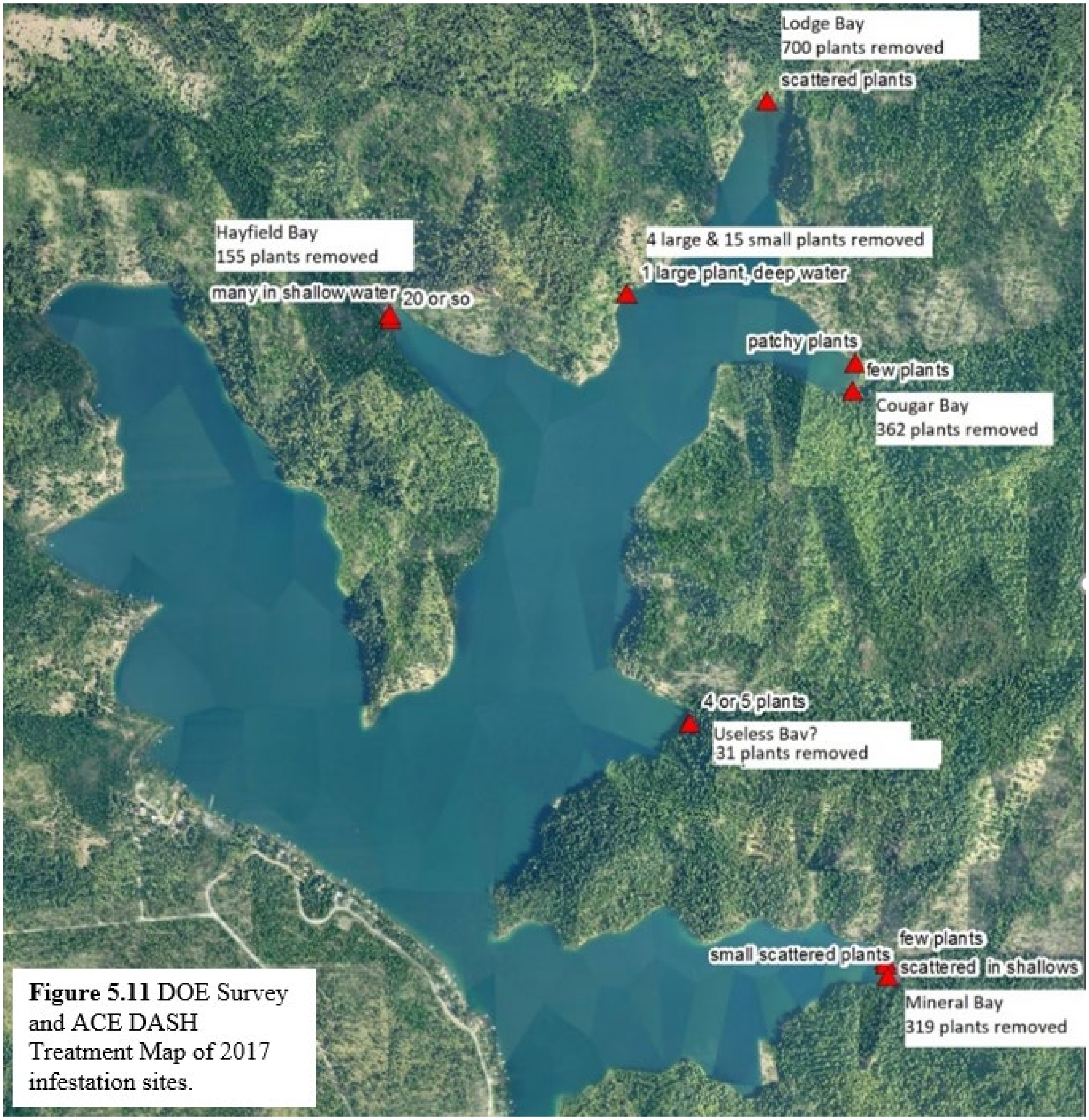


Figure 5.11 DOE Survey and ACE DASH Treatment Map of 2017 infestation sites.

This process verified Mr. Freeland's earlier prediction that the EWM in Bead Lake acts differently than any other lake where he has worked. Once a plant gets about six inches tall, it begins to fragment. When a plant over a foot tall is encountered, searching within a few square meters around the plant will find many fragments lying on the bottom under the native plant cover. It is very unusual for EWM to fragment continuously which is why it has been so hard to control. This finding makes the task of getting the EWM under control very difficult. After an area is cleared of

EWM plants, upon return a couple weeks later, many new plants, two to six inches tall are found. Upon removal, more starts are found a couple of weeks later. This process is time consuming and a little frustrating to all.

Mr. Freeland returned in mid-September with the location information of plant findings from the survey performed by Ecology in August. He removed 155 plants from Hay Meadow Bay, many of them less than six inches. A plant was identified from the survey as in deep water just outside of Lodge Creek Bay. The contractor removed four large plants and 15 small plants from this location, showing the importance of diving to find all of an infestation. Lodge Creek Bay had an area of fairly heavy infestation of plants less than three inches. In total, over 700 plants were removed from the bay. In Cougar Bay, 362 plants were removed, 31 plants were removed from Useless Bay, and 319 plants were removed from Mineral Bay.

Figure 5.12 The bin on the left contains a little over 100 plants, the bin on the right contains the 362 plants removed from Mineral Bay.

The contractor's last return to Bead Lake was in early October where they found only 30 plants across the five bays. These plants were removed. With the drop in water temperature and decreased sunlight, the contractor did not anticipate further growth in the 2017 season.

Mr. Freeland offered to train a "Milfoil Strike Force" team, organized from interested Bead Lake property owners, to use professional survey and management techniques for early detection and rapid response (EDRR) management deployment. Such a team could offer significant cost-savings for meeting future management objectives as they would be able to find and remove small plants before the opportunity to fragment and spread the infestation.

2018 EWM Mitigation Efforts

The 2018 control season was short, with a late start, due to budgetary constraints. Survey and removal did not start until August and was completed in early September. Through this season, over 2,500 pounds of EWM were removed, a significant increase. Mr. Freeland believes this is due to the late start allowing early plants to fragment and generate a larger infestation before removal could start. By the end of the season, all discovered plants were removed from the infestation areas except Lodge Creek Bay, as available funding ran out before complete removal could happen.

2019 EWM Survey and Mitigation Efforts

The 2019 season DASH efforts got off to a later start due to funding and contracting issues. Because of this, the DASH diver reported areas that were considered under control at the end of 2018, were now negatively impacted by early fragmentation and increased growth. The first application of the chemical ProcellaCOR® was applied on late summer 2019. Unfortunately, the plants appeared unaffected by the treatment. The reasons for this are still being investigated in order to determine if ProcellaCOR® is still an option for future management seasons.

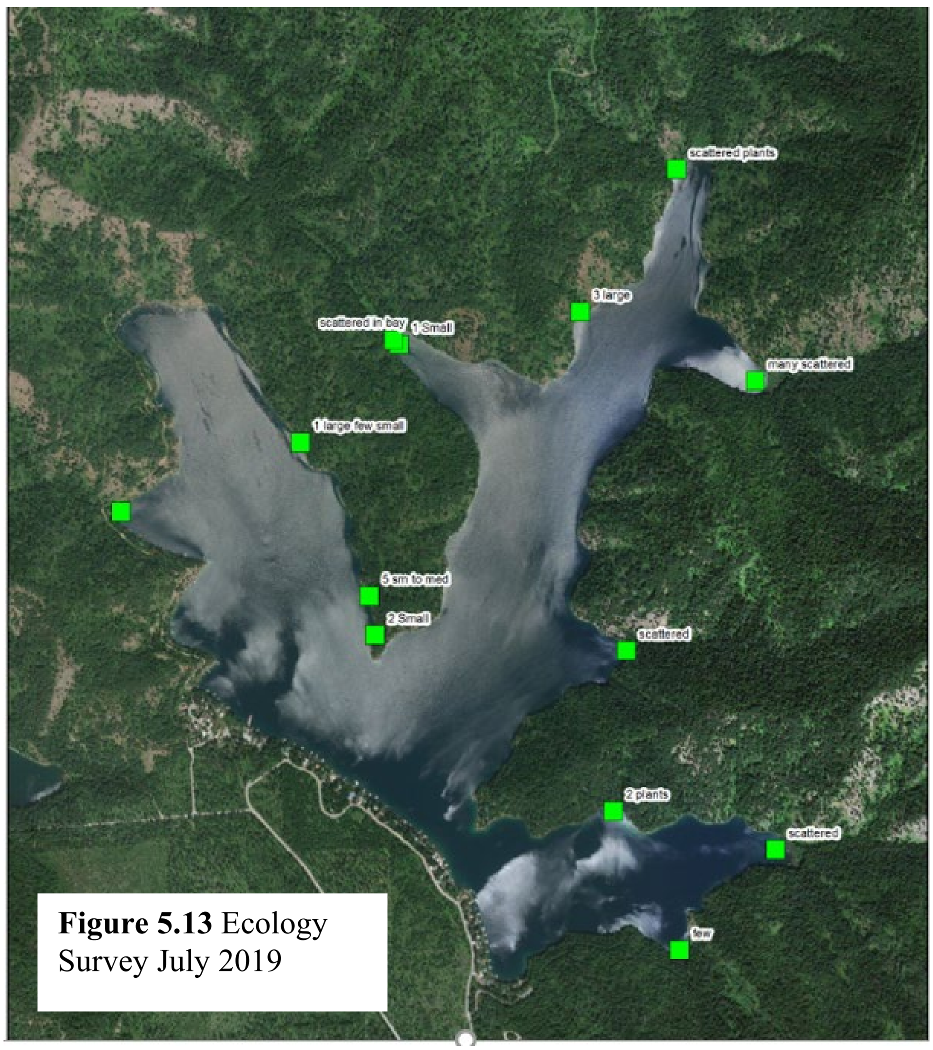


Figure 5.13 Ecology Survey July 2019

The EWM in Bead Lake has shown its capacity to infest the entire perimeter and increase in density. Such an infestation level could crowd out the limited native vegetation, diminish aquatic habitat and property values as well as impede human recreation. In response to the management history and these numerous concerns, fortified by its history of active involvement, BLCWA has a strong affinity to protect the lake and with assistance from the County Weed Board, is endeavoring to evaluate all control options and means of management for suppression and future control of EWM within Bead Lake.

Section 6. Aquatic Plant Characterization

Information in the section is from the *Written findings of the Washington State Noxious Weed Control Board,* which is located in the appendix.

6.1 Description and Variation

EWM is a submersed perennial plant with feather-like submersed leaves and flower stems with small flowers and very small leaf-like bracts that typically rise above the water surface. There are several native water-milfoil species that look similar to EWM so identification can be challenging. In addition, it will hybridize with the native northern watermilfoil (*Myriophyllum sibiricum* Kom.) (herein called 'hybrid') and have intermediate characteristics that can overlap with both parents (Table 1). Therefore, genetic analysis is sometimes relied on for definitive species identification. Unless otherwise noted, below descriptions are from Scribailo and Alix 2014, and Douglas et al. 1999.

Figure 6.1

LEFT: Eurasian watermilfoil mat with flower stems, MIDDLE: typical stem and stem cross-section showing 4 leaves, RIGHT: close-up of leaves, bottom two are Eurasian watermilfoil, top leaf is native northern watermilfoil (*M. sibiricum*) (Photos J. Parsons).

Table 6.1 Comparison of three similar watermilfoil species and the hybrid.

	Number of leaflets/leaf	**Leaf length (mm)**	**Winter buds (turion)**	**Bracts on Inflorescence**
Eurasian watermilfoil (EWM)	24-36 (typical) 20-42 (possible)	18-32 (typical) 14-36 (possible)	No	1-2.3 mm long Margin smooth to shallowly toothed or lobed toward tip
Hybrid	16-28	16-44	Occasional	Assumed same as Eurasian and northern
Northern watermilfoil	6-26	13-32 (typical) 3-44 (possible)	Yes	1-2.3 mm long Margin smooth to shallowly toothed or lobed toward tip
Whorled watermilfoil	12-22 (typical) 9-34 (possible)	12-30 (typical) 7-46 (possible)	yes	2-5 (15) mm long Pectinate with (9) 12-20 segments

Roots: fibrous, with slender, short rhizomes. Also forms adventitious roots at leaf nodes, especially on fragments. Rhizomes (sometimes considered stolons) are important in vegetative reproduction (Madsen and Smith 1997)

Stems: terete (round in cross-section), glabrous (without hairs) from pale greenish tan to red in color, often highly branched at or near the water surface, up to 6 m long.
Leaves: Usually grow in whorls of 4, though occasionally 3 to 5. Either sessile or on very short petioles (to 0.4 mm). Two types – submersed leaves are feather-like (pectinate), wider in outline toward the middle and tip than at the base (obovate), typically 18 to 32 (14-36) mm long by 10-20 (to 30) mm wide, and with a blunt to rounded tip. There are generally 24 to 36 (20-42) narrow linear segments, with the longest segments up to 26 mm (though smaller leaves with fewer segments are sometimes present on early season growth). The segments are usually parallel and form an angle of less than 45° with the central axis. Emergent leaves are small (1 to 2.3 mm long by 0.6 to 1 (1.5) mm wide) and turn into floral bracts toward the top (with flowers in the axils). Lower one's feather-shaped or deeply toothed then abruptly changing to entire (smooth-margined) or shallowly tooth leaves with the widest part toward the pointed or rounded tip. The hybrid leaf has 16 -28 leaf segments and is 16 - 44 mm long (Table 1).

Winter buds (turions): absent in EWM, occasionally present in the hybrid (R. Thum, personal communication 2015).

Inflorescence: Many flowers are borne on an unbranched stalk to 15 cm long, usually rising above the water surface. Female flowers are at the bottom, and male flowers are at the top, with bisexual flowers in between. Bracts and bracteoles present. Bracts described with emergent leaves, bracteoles are paired, tiny (0.5 x 0.4 mm to 0.9 x 0.7 mm), cream to purple color with a reddish to brown margin that is entire or toothed or sometimes tipped with a membranous fringe. Flowers are wind pollinated.

Flowers: male and female flowers, either separate or together, sessile in the axils of bracts. Usually in whorls of 4. 4 sepals and petals, small (to 1 mm), cream to purplish, often deciduous. Stamens 8. Pistils to 1.2 mm with 4 styles.

Fruits: 4 rounded mericarps, with dorsal ridges and bumps, to 2.2 mm long

6.2 Geographic Distribution

EWM is native to Europe, Asia and northern Africa. It was introduced to North America by at least 1942 (Couch and Nelson 1985) and has spread to 4 Canadian provinces and 45 States (Scribailo and Alex 2014).

6.3 Habitat

EWM is an adaptable plant, able to tolerate and even thrive in a variety of environmental conditions. It will grow in still to flowing water, including irrigation canals, but won't tolerate high flow or areas prone to high wave action (Arshid and Wani 2013, Smith and Barko 1990). It will grow in water to 10 m deep and can reach the surface in water up to 5 m deep (Aiken et al. 1979). It tends to form nuisance growths in moderately clear water with moderate nutrient levels. In lakes with very low nutrients, growth will generally be limited to zones with relatively high sedimentation rates and nutrients, such as the mouths of creeks or areas with groundwater upwelling (Smith and Barko 1990). In Washington it has invaded lakes with a wide alkalinity range (11 to close to 200 mg/l $CaCO_3$), but very low or high alkalinity will limit or exclude its growth (Smith and Barko 1990). It has been reported to tolerate pH from 5.4 to 10 (Aiken et al. 1979). It grows best on fine-textured inorganic sediments of intermediate density (Smith and Barko 1990). Ice scour will prevent it from growing in shallow water of lakes that regularly freeze in winter. It will not survive complete desiccation or freezing (Smith and Barko 1990). Though it can survive extended periods out of the water if damp (Jerde et al2012) and will develop a terrestrial growth form if stranded on damp sediment for an extended period (Aiken et al. 1979). It can tolerate salinities of up to 15 ppt (about half of sea water) (Aiken et al. 1979), and can survive in estuaries where salinity is low, however, at salt concentrations approaching its tolerance (15 ppt) decreased reproductive success in both seed and fragments results, reducing the competitive advantage of EWM in those environments (Martin and Valentine 2014)

EWM reproduces primarily by "auto fragmentation" of the stems and propagating root crowns, thus it does not rely on seed for reproduction. This reproduction allows the plant fragments to be dispersed and carried by water currents and wind or inadvertently picked up by boaters. Seed production has been documented but is considered a minor reproductive mechanism under typical growth conditions. "Milfoil reproduces extremely rapidly and can infest an entire lake within two years of introduction to the system" (Ecology, 2003). EWM is most commonly transported via boats, motors, trailers, bilges, live wells, waterfowl, or bait buckets, and if moist can stay alive for weeks.

EWM is very invasive and can provide only a single habitat by replacing the native plant species and in turn threatening the integrity of aquatic communities. It also inhibits the aesthetic and recreational uses like swimming, boating, and fishing. Severely infested waters display a dense yellow-green matt of vegetation and give off the appearance that the water is "infested" or "dead".

The decomposition of the plant mass at the end of the season results in nitrogen and phosphorus loading, and "the cycling of nutrients from sediments to the water column by EWM may lead to deteriorating water quality and algae blooms of infested lakes" (Wisconsin Department of Natural Resources, 2003).

EWM was believed to have been introduced to the eastern United States around the 1940s, but it may have arrived as early as the late 1800s. The first known herbarium EWM specimen in Washington was collected from Lake Meridian near Seattle in 1965 (Ecology, 2003). However, it has been known from the Pend Oreille River since 1964, when a local concerned citizen began voicing his concern and seeking management options. He was able to get a 2,4-D treatment that did not yield positive results due to the current not allowing adequate contact time for the herbicide to work. It then took until 1986 to choose, permit and procure the Aquamog for the county's treatment program.

6.4 Growth and Development:

EWM is essentially evergreen, though dies back in winter. It forms no specialized overwintering structures such as turions. Instead, some shoots persist through the winter and new shoots form in the fall, but do not elongate until spring. Carbohydrate storage occurs throughout these overwintering shoots and roots (Smith and Barko 1990, Madsen 1997). It can initiate growth when water temperatures are still cool (10° C), so can start rapid spring growth earlier than some native species (Smith and Barko 1990). Its growth rate will continue to increase with increasing temperature, with optimum growth at about 32° C (Smith and Barko 1990). However, prolonged periods of high-water temperature (over 30° C) can cause die-back from temperature stress, as is seen in mid-summer biomass reductions in southern populations and sometimes in shallow lakes of northern populations (Madsen 1997). When EWM reaches the surface, shoots branch, forming a surface canopy. Flowering occurs at the surface, as flowers are wind pollinated. As stems elongate, lower leaves are typically shed (Budd et al. 1995). After peak biomass stems will autofragment (see reproduction below), and biomass will decline (Madsen and Smith 1997).

6.5 Reproduction

EWM reproduces by both sexual and vegetative means.

6.6 Vegetative reproduction

Vegetative spread is generally considered the major method of reproduction within a waterbody, and is accomplished by three mechanisms, stolons (rhizomes), autofragments and allofragments. Stolons are the most successful, and account for the majority of colony expansion in the immediate area of parent plants. Autofragments are typically created in late summer when short (15 to 20 cm) sections of the stem tips will develop roots and automatically separate from the parent plants. Allofragments are created by mechanical disturbance of plants such as from wave action or boat propellers. Those broken sections of stem will then form roots and settle to the bottom. The autofragments are higher in energy reserves, and thus will have higher success in developing into new plants than allofragments (Madsen and Smith 1997). Autofragment creation is higher on low nutrient sediments, thus allowing plant fragments to float off and seek different environments. On higher nutrient sediments, the plants put more energy into root and stem growth, allowing for expansion in the immediate area (Smith et al. 2002).

6.7 Seed Production

Genetic analysis shows that sexual reproduction occurs frequently in EWM and the hybrid and can facilitate spread through seed in addition to the well known vegetative spread by fragments (Zuellig and Thum 2012). EWM seed production can be significant. In one study, up to 48 flowers were produced per flower stem with an average percent seed set between 1 and 24% (Madsen and Boylen 1989). Seed production was higher in a low nutrient lake when compared with a moderately eutrophic lake, indicating that plants put more resources into long-distance dispersal by seed when resources are limited (Madsen and Boylen 1989).

Seed germination requires water temperatures above 10° C, with a maximum germination rate reached at about 20° C with 14 hours of daylight (although seeds also germinate without light). Drying decreases the ability of seeds to germinate. However, even after 36 weeks of dry time, some seeds were still viable; indicating that seed production can be a means for drought survival (Standifer and Madsen 1997). Seeds buried under greater than 2 cm of sediment showed a much-reduced germination rate, as did seeds in areas of high-water movement from waves or recreational disturbance. Thus, seedlings are more likely to establish in areas of deep calm water (Hartleb et al. 1993).

Section 7. Aquatic Plant Control Alternatives

This section outlines common aquatic weed control methods that have been considered for Bead Lake. For each method, the effectiveness, potential environmental impact, human health risk, and cost is described where relevant. Each alternative also includes a determination of the control methods' applicability to Bead Lake. A summary of the control methods can be found in Table 7 at the end of this section.

Much of the information provided in this section was obtained from the December 2019 Cranberry Lake IAVMP. It is important to note that this plan is intended to be a living document. In the future, additional management strategies or approved herbicides may become available for use in Bead Lake. As implementation of this plan progresses, adaptive management should occur such that these options are continually sought out and considered for inclusion as part of the management plan.

7.1 No Action

The no action method would entail taking no control measures to manage EWM in Bead Lake. This alternative would not specify a treatment plan to combat infestations of invasive aquatic vegetation. Bead Lake is host to a variety of beneficial uses (see Section 2) that are currently impacted by the prevalence of EWM. Existing impacts to these beneficial uses would not be alleviated under a no action alternative and it is possible that these uses could degrade further over time if the infestation of EWM becomes even more prevalent in the lake.

Applicability to Bead Lake

This management plan is primarily focused on controlling or eradicating nuisance aquatic vegetation to preserve and protect the beneficial uses of Bead Lake. A no control alternative is incompatible with this goal.

7.2 Hand Pulling and Cutting

Hand pulling aquatic plants involves removing entire plants (leaves, stems, and roots) from the area of concern and disposing of them in an area away from the shoreline. In water less than three feet deep, no specialized equipment is required, although a spade, trowel, or long knife may be needed if the sediment is packed or heavy. Hand pulling can be used to temporarily control invasive EWM in a small area if repeated on a regular basis. Hand pulling will likely not eradicate the plant from a water body and is impractical for large infestations. All pulled plant parts must be removed from the water, and a Hydraulic Project Approval (HPA) permit is required. Several years of monitoring are needed for signs of plants growing from plant fragments. Watermilfoil can be composted on dry land or placed in yard waste bins.

Diver hand pulling involves the use of divers to carefully pull and bag entire milfoil plants. Divers specifically target milfoil plants and carefully search the area for missed plants. Diver hand pulling is an expensive course of action, though may provide an effective targeted treatment on a small scale.

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

Applicability to Bead Lake

Due to the risk of fragmentation, manual methods are most suitable for the “No Action” alternative, that leaves landowners to fend for themselves. However, the currently infested areas in Bead Lake are still small enough that manual techniques could supplement other methods if employed by a well-trained and committed crew. Hand or diver harvesting is the most applicable manual method for the supplemental control of milfoil in Bead Lake.

Much of the littoral zone around Bead Lake is composed of relatively dense, rocky, compacted sediments that make manual methods and tools less effective. Also, manual methods should be used with caution as they have the potential for missing EWM plants, (especially after stirring up sediments) and for fragmentation, exacerbating the existing EWM problem.

7.3 Raking

Plant biomass is raked from the surface of the water using a rake. A rope may be attached to the rake to extend its reach, and floats may be attached to facilitate collection of plant material and fragments. While raking will tear plant material from the sediment and remove some root material, fragmentation and left-behind roots are inevitable. As a result, while raking can provide immediate relief to the impacts of infestation in localized areas, regrowth is imminent. There is also the potential for plant fragments to drift and further spread the infestation.

Applicability to Bead Lake

Raking is not a viable long-term control option for Bead Lake. This method creates substantial risk of further spreading the infestation via fragmentation and drift. Additionally, the murky bottom where the majority of the milfoil infestation is located increases the risk of losing sight of fragmented pieces.

7.4 Benthic Barriers

Benthic barriers are usually used to control dense, pioneer infestations of an invasive species or as a maintenance weed control strategy around boat docks and swimming areas. The bottom barriers control aquatic plants through compression and by blocking sunlight. Barriers specifically manufactured for aquatic weed control are usually made from materials that are heavier than water, such as PVC, fiberglass and nylon. Other fabrics used in landscaping and construction have also been tried. Barriers are typically anchored in place with a variety of fastening pins or anchoring devices. Some of the most common anchors used are lengths of steel rebar encased in capped PVC pipes, which eliminates any sharp edges that could tear the barriers or become hazardous to swimmers. Sandbags, bricks and steel pins are also commonly used as anchors. Larger panels installed in water depths greater than four feet usually require SCUBA divers for proper installation. Several different mechanisms have been devised to unroll the barriers in place during the installation process. Solid fabric barriers often need to be cut or vented to allow gasses to escape and to prevent billowing.

Large installations (greater than one acre) are often impractical due to the high cost associated with purchasing, installing, and maintaining the barrier. Benthic barriers should be left in place for a minimum of one to two months to ensure that target plants are controlled (AERF 2014), but barriers must be regularly removed and cleaned of silt; otherwise, plants may begin to root on top of or through the barriers. Depending on the timing of application, the length of placement necessary to achieve control of target plants may be closer to two years. Removal, cleaning, and re- deployment is usually required everyone to three years depending on the rate of silt accumulation. Volunteer divers in some lakes have attached barriers to lightweight frames to facilitate rapid deployment and retrieval. Barriers non-selectively control aquatic vegetation and may impact fish and other benthic organisms, which is another reason they are usually used for small localized areas.

Applicability to Bead Lake

The EWM infestation at Bead Lake is still relatively small, primarily localized within specific bays. Consequently, the bays have offered some good specific localities for barrier installation, although bottom debris has caused some challenges, as well as some steeper, rockier shorelines.

Most of the lakeshore residences have not yet experienced EWM infestation so benthic barriers could be applicable if these properties were to become infested with small colonies provided they would not significantly reduce habitat and native vegetation. Barriers could also be effective in preventing re-infestation after other initial control methods, or in areas that have dense milfoil that have shown resistance to herbicide control. The public boat launch is a suitable location for benthic barriers to limit the spread of milfoil to other waterbodies and reduce the transfer of other aquatic macrophytes.

7.5 Mechanical Harvesters

Mechanical harvesters are powered by side-mounted paddle wheels which operate independently in forward or reverse. As a result, these harvesters are highly maneuverable around docks and boat houses. Also, the machines can operate in as little as 12 to 18 inches of water. These harvesters cut plants off at depths of five feet and in swaths eight feet wide with a hydraulically operated cutter head and convey the cut plants into a storage compartment on the harvester. When the harvester is full, it offloads harvested plants onto a transport barge by conveyer belts and the transporter takes the vegetation to shore, where it is dropped onto a conveyor to elevate the load to a truck for disposal. All this equipment may not be necessary, as mechanical harvesting is obviously tailored to a particular situation and is very site-specific.

Also, some harvester trailers have been modified to allow them to transport cut weeds to the disposal site. This system, or a setup with similar equipment, has been used for 50 years in lakes from New England to California, but it is mostly employed in northern lakes where one or two harvests during spring and summer can provide weed-free conditions for the seasonal summer use of these lakes.

The waterbody can be used immediately following treatment. Also, plants are removed during mechanical harvesting and do not decompose slowly in the water column as they do after herbicide application. In addition, oxygen content of the water is generally not affected by mechanical harvesting, although turbidity and water quality may be affected in the short term. Mechanical harvesters are not selective and remove native vegetation along with target weeds. Regrowth of cut vegetation can occur quickly.

The area that can be harvested in a day depends on the size of the harvester, transport time, distance to the disposal site, and density of the weeds being harvested. These factors can result in a wide range of costs. The cost of harvesting is site-specific, but mechanical harvesting is generally more expensive than other weed control methods due to the variables noted above and the generally high capital output required to purchase equipment that may only be used for three or four months per year.

Applicability to Bead Lake

Large machinery options are not suitable for the level of infestation at Bead Lake. They are not eradication tools, but rather are used to manage and control dense, widespread infestations of aquatic weeds. This process creates plant fragments and should not be used in systems where milfoil is not already widespread. In a low to moderate infestation such as Bead Lake, these methods would probably serve to spread and expand the infestation. According to Ecology, “There is little or no reduction in plant density with mechanical harvesting.” Since the overall goal is to eliminate milfoil from the system, this is not a compatible control strategy. Additionally, harvesting does not remove root systems, which is a key factor to prevent further spreading.

7.6 Mechanical Weed Cutters

Mechanical weed cutter boats are used to control emergent and floating plants. The most common type of shredder is the “cookie cutter,” which consists of two spinning blades (three to four feet wide) that are mounted behind a steel hood on the front of a small but powerful barge. The boat is propelled by hydraulically raising and lowering the blades and changing the direction of the blades. Recently, bow mounted high-speed flail mower blades have been tested for chopping and shredding floating and emergent plants. As with other mechanical control equipment, shredder boats are non-selective, specialized pieces of equipment and create many plant fragments; however, they work well when used in areas for which they are designed. They are frequently used in wetland restoration projects, where removal of cut vegetation is too expensive or not feasible.

Applicability to Bead Lake

Mechanical harvesting is not suitable for use in Bead Lake. EWM in Bead Lake is heavily interspersed with desirable, native aquatic vegetation, such that mechanical harvesting would have substantial unavoidable impacts to desirable vegetation. Additionally, fragmentation and drift pose serious risks, and have the potential to worsen the infestation, rather than alleviate it.

7.7 Rotovators

Rotovators are highly specialized, large aquatic rototillers. The rotovator head is lowered into the lake or river bottom and "tills" the sediments, which chops up and cuts loose submersed plants. A floating boom is usually placed around the work area while the rotovator spins on the lake bottom. Uprooted plants float to the surface and are removed from the barrier by hand or mechanical means. Rotovators have mostly been used in the Pacific Northwest, where the submersed weed grows in rocky bottom areas and roots in the shallow soil between and among small rocks. The rotovator head moves the rocks around and uproots the weeds from the shallow soils and rock crevasses.

Applicability to Bead Lake

While the use of rotovators can be an effective method to disrupt the root systems of nuisance aquatic vegetation, it is not suitable for the long-term treatment of EWM in Bead Lake. Rotovation is indiscriminate in its impacts to vegetation and would have significant impacts to the native vegetation which is interspersed through most infested areas. Additionally, rotovation causes severe short-term impacts to water quality and turbidity, with potentially longer-term impacts to habitat features associated with the lakebed. The suitability of rotovation for Bead Lake is severely limited due to the interspersion of desirable vegetation and EWM, and the relatively intact and sensitive habitat features within and associated with the lake.

7.8 Diver Assisted Suction Harvest (DASH)

Diver assisted suction harvest (DASH) is a method whereby SCUBA divers use hoses attached to small dredges (usually a modified version of the dredge used by miners for mining gold from streams) to suck manually loosened or uprooted plant material from the top layer of the sediment and water column. The purpose of DASH is to remove all parts of the plant including the roots. A good operator can accurately remove target plants while leaving native species untouched.

The suction hose pumps the plant material and adhered sediments to the surface where they are deposited into a screened basket. The water and sediment are returned to the water column, and the plant material is retained. If necessary, turbid water can be discharged to an area curtained off from the rest of the lake by a silt curtain. The plants are collected into a waste receptacle and disposed of on shore. Removal rates vary from approximately 0.25 acres per day to one acre per day, depending on plant density, sediment type, size of team, and diver efficiency. DASH is more effective in areas where softer sediment allows easy removal of entire plants, although water turbidity is increased with softer sediments. Harder sediment may require the use of a knife or tool to help loosen sediment from around the roots. In very hard sediments, if adequate care is not taken, milfoil plants can break off leaving the roots behind, defeating the purpose of the DASH method.

DASH has been used throughout the west to remove early infestations of EWM. DASH can be a less successful eradication method on long-term infestations of aquatic plant species where seeds, turions, or tubers remain in the sediments to sprout the next growing season. For that reason, DASH can be very successful at eradicating an early EWM infestation or managing a smaller infestation to a level that does not result in significant impacts to resources or beneficial uses.

DASH can be a very selective technique for removing pioneer colonies of invasive aquatic vegetation, such as EWM. Divers can remove plants around docks and in other areas that are difficult to manage using other methods. Furthermore, it is an effective management option that can be used in situations where herbicides are not an option for aquatic plant management.

Unfortunately, DASH is very slow and expensive and can stir up large amounts of sediment, that may lead to the release of nutrients or long-buried toxic materials into the water column. Depending on specific equipment used, the number of divers, and disposal requirements, costs can range from a minimum of $1,500 to $2,700 per day per equipped and crewed boat.

As part of a mitigation strategy, DASH is an ideally suited management method for areas that are sparsely infested or have a low number of plants. DASH can also be a good spot control method in subsequent years (coordinated with diver surveys) following other treatment methods.

Application for Bead Lake
DASH is a suitable management method for areas that are sparsely infested or have a low number of plants. The less dense sediments in Mineral Bay, Cougar Bay, Lodge Creek Bay and Hay Meadow Bay would make this method effective. Elsewhere, especially along the steep littoral shorelines, the sediments are quite dense making this removal technique more expensive. If other management techniques are more suitable, DASH should not be considered for these specific areas. DASH could be used after herbicide applications to selectively remove plants that were missed or unaffected by an herbicide treatment.

7.9 Mechanical Dredging

Mechanical dredging involves the removal of sediment and associated plant material from the bottom of the lake as a means of controlling aquatic vegetation. This method relies on large, barge-mounted suction equipment to remove plant material and sediment. Dredged material must then be hauled off-site for disposal. Mechanical dredging results in severe impacts to water quality, turbidity, in-water habitat, and vegetative structure, as it is not a selective method of control. Costs associated with mechanical dredging are very high and permitting can be difficult or infeasible to obtain.

Applicability to Bead Lake
The ecological impacts associated with mechanical dredging are substantial and severe; therefore, mechanical dredging is not considered a suitable control method for Bead Lake.

7.10 Milfoil Weevil

The milfoil weevil (*Eurychiopsis lecontei*) is generally considered to be the most important biocontrol agent of EWM from an operational perspective; even though it is a native insect, this weevil prefers EWM over its native natural host. The life cycle of the weevil is completed in about 30 days; adults feed on leaves and stems, whereas larvae are stem borers that consume apical meristems. Feeding damage causes the stems to break apart, and heavy feeding by the insects prevents the formation of surface mats. High populations of milfoil weevil have been associated with declines of populations of EWM in some northeastern and midwestern states, but fish predation may prevent this weevil from reaching its full biocontrol potential. Control efficacy by naturally occurring populations is highly variable and is not a tool to achieve eradication of nuisance populations. Additionally, the milfoil weevil is no longer commercially available for import into the state of Washington.

Applicability to Bead Lake
Milfoil weevils are not considered a suitable control method for Bead Lake. Although naturally occurring milfoil weevils may provide good control of EWM, relying on the weevils is not a suitable tool for eradication of EWM. Additionally, weevils are not commercially available for import into the state of Washington. Transferring milfoil weevils from naturally occurring in-state populations is not a cost-effective alternative.

7.11 Aquatic Herbicide

The use of registered aquatic herbicides is a technique that is widely employed by aquatic plant managers in both private and public water bodies throughout the United States. Treatments can range in size from backpack spray applications for individual plants or small clusters of plants, up to large-scale treatments from boats or helicopters that may target an invasive weed throughout an entire lake. In addition, the objective of some treatments is broad spectrum control of numerous plant species, while most treatments target a specific invasive plant or algal species.

Contact products work quickly and kill the plant rapidly on contact (hence the designation “contact”). Systemic compounds, on the other hand, usually work slowly by affecting biochemical pathways and must be absorbed by the plant before providing control; therefore, systemic compounds may require days or weeks to kill the weed. The application method is the same for both systemic and contact herbicides—the compound is applied directly to the foliage of the plant. Foliar herbicides are used to control floating, floating-leaved, and emergent aquatic weeds.

Submersed herbicides are applied as concentrated liquids, granules, or pellets. Liquid treatments are often mixed with water to facilitate application and to ensure even distribution and are applied to achieve an entire water volume concentration to control submersed weeds and planktonic algae. Some dry formulations (wettable powders and water dispersible granules) are mixed with water and applied similar to liquids, but many granular and pelleted products are applied using granular spreaders. Aquatic herbicide applicators must determine the volume of the water to be treated before applying submersed herbicides to ensure that the appropriate and effective amount of herbicide is used. The following constants are needed to calculate the volume of water before treatment with submersed herbicides:

The volume of a body of water is calculated in acre-feet, which is a function of area and depth; for example, a lake with an area of one acre and a depth of six feet has a volume of six acre-feet. A single acre-foot of water comprises around 326,000 gallons of water and weighs around 2.7 million pounds. The volume (in acre-feet) of a body of water or treatment site is used to determine the amount of herbicide needed to control a particular weed. For example, if the label of an herbicide specifies an application rate of one part per million (ppm), then 2.7 pounds of the herbicide's active ingredient must be applied for each acre-foot of the water to effectively control the target weed. This results in a concentration of one ppm since 2.7 pounds of herbicide are mixed with million pounds of water in each acre-foot. Most herbicide labels include a table that lists application rates, but it may be necessary to perform calculations similar to those described above to ensure that the correct dosage of herbicide is applied. The labels of aquatic herbicides clearly state how these calculations are performed.

Because of environmental risks from improper application, aquatic herbicide use in Washington State waters is regulated and has certain restrictions. The Washington State Department of Agriculture must license aquatic applicators. In addition, an Aquatic Plant and Algae Management General Permit is required from Ecology for herbicide applications. This permit is a combined National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit. It covers the in-water and shoreline (including roadsides and ditch banks) treatment of native and invasive plants and algae. The permit allows the discharge of a specific list of aquatic labeled herbicides, algaecides, biological water clarifiers, adjuvants, marker dyes, and nutrient inactivation products into the freshwaters of Washington (Ecology 2019a).

Although there are several herbicides registered for aquatic use by the US Environmental Protection Agency (EPA), Ecology sets more stringent standards. Only herbicides known to be effective on EWM were considered for this plan. A brief discussion of the four primary herbicides considered for use in Bead Lake follows below and in Table 6.

Florpyrauxifen-benzyl (ProcellaCOR®) – ProcellaCOR® is a new class of selective systemic herbicide that received full EPA registration in February of 2018 and has been approved for use within Washington State as of July 2019. ProcellaCOR® shows excellent selectivity for invasive aquatic vegetation, including EWM, with few or limited impacts to native aquatic plants such as aquatic grasses, bulrush, cattail, pondweeds, naiads, and tapegrass. In its review, EPA also noted that the overall profile for the herbicide appears favorable when compared to currently registered alternative herbicides (e.g. 2,4-D, endothall, triclopyr) for this aquatic use pattern (Ecology 2019a). Further, Ecology has placed no swimming restrictions on the water body following the use of ProcellaCOR®.

The potential for off-site transport or mobility is considered minimal based on known characteristics of the herbicide, including its high affinity for surface sediments and organic matter—which substantially reduces the mobility of the chemical in a water body—its solubility, persistence, and rapid dissipation and degradation. Additionally, these characteristics suggest that potential hazards associated with groundwater infiltration are not expected (Ecology 2019a; Travis Fuller, personal communication, September 26, 2019).

Early indications suggest that ProcellaCOR® could be a highly effective herbicide for the treatment of EWM in Bead Lake, while minimizing impacts to desirable native vegetation; however, 2019 is the first year that lake managers in Washington have been able to use it. As such, field data of its efficacy is sparse. An evaluation of its efficacy in the field should be conducted prior to the decision to utilize ProcellaCOR® in Bead Lake.

Triclopyr –There are two formulations of triclopyr. The triethylamine salt (TEA) formation of triclopyr is registered for use in aquatic or riparian environments. Triclopyr, applied as a liquid or in granular form, is a relatively fast-acting, systemic, and selective herbicide for the control of broadleaf plants. In Washington, it is most commonly used for the control of EWM. Triclopyr is very useful for aquatic vegetation control since native grasses and sedges are unaffected by this herbicide. When applied directly to water, Ecology has imposed a 12-hour swimming restriction to minimize eye irritation. Triclopyr received its aquatic registration from the EPA in 2003 and was allowed for use in Washington in 2004. Trade names include Garlon 3A® and Renovate 3®.

2,4-D – There are two formulations of 2,4-D approved for aquatic use. The granular formulation contains the low-volative butoxy-ethyl-ester formulation of 2-4-D. The liquid formulation contains the dimethylamine salt of 2-4-D. 2,4-D is a relatively fast- acting, systemic, selective herbicide used for the control of EWM and other broad-leaved species. Both the granular and liquid formulations can be effective for spot treatment of EWM. 2,4-D has been shown to be selective to EWM when used at the labeled rate, leaving native aquatic species relatively unaffected. By court-order, the butoxy-ethyl-ester formulation of 2,4-D cannot be used in waters with threatened and endangered salmon in the Pacific Northwest. Trade names for the granular formulation include AquaKleen® and Navigate®, and trade names for the liquid formulation include DMA*4IVM®. However, 2,4-D is not considered appropriate for Bead Lake due to its relatively higher levels of toxicity, persistence, and mobility relative to ProcellaCOR® or triclopyr.

Diquat – Trade name Reward®. Diquat is a fast-acting non-selective contact herbicide that destroys the vegetative part of the plant but does not translocate to kill the roots. It is applied as a liquid, typically used for short-term (one season) control of a variety of submersed aquatic plants. It is very fast acting and can be suitable for spot treatment or late season fragment control. Research and field experience have shown when used in combination with 2,4-D, both at lower than label rates, selectivity for milfoil can be maintained and efficacy increased over either used alone. Turbid water or dense algal blooms can interfere with diquat's effectiveness. https://www.greenbook.net/alligare-llc/diquat

Table 7.11. Summary of herbicide application restrictions and approximate costs.

Herbicide	Restrictions/ Advisories	Treatment Limitations	Other Specific Restrictions	Approximate Cost Per Acre
Florpyrauxifen -benzyl (ProcellaCOR®)	None	None	None	$600-900
Triclopyr TEA	Swimming advisory during treatment, and for 12-hours post-treatment (in the treated area)	Aerial applications are not allowed.	No action	$700 - $1,000
2,4-D	Swimming advisory during treatment, and for 24 hours post-treatment (in the treated area)	Do not apply within 400 feet of an outlet stream if there is an outflow.	Consult FIFRA product label for water use restrictions.	$700
Diquat	None	None	Consult FIFRA product label for water use restrictions.	$300-$500

7.12 Toxicology Overview

EPA studies yield the parameters LD50 (acute lethal dose to 50% of a test population), NOEL (No Observable Effect Level, which is the highest test dosage causing no adverse responses), and RfD (EPA Reference Dose determined by applying at least a 100-fold uncertainty factor to the NOEL).

The EPA defines the RfD as the level that a human could be exposed to daily with reasonable certainty of no adverse effect from any cause, in other words, a "safe" dose. Exposures to bystanders or consumers are deemed safe when the RfD is not exceeded. Since all substances, natural or manmade, may prove toxic at a sufficiently high dose, one should remember the old adage "dose makes the poison."

The LD50 value is useful for comparing one compound to another and for grouping compounds into general hazard classes. The higher the LD50 value, the less toxic the substance is. Any herbicide, such as 2,4-D, glyphosate or triclopyr TEA, that does not produce adverse effects on aquatic organisms until levels in water reach the milligram per liter level (i.e., 1 mg/L, equivalent to a part per million (ppm)) would be considered of comparatively low hazard. Substances that are biologically active in water at levels one thousand-fold less, (i.e., 1 µg/L, parts per billion, ppb), are considered highly hazardous to aquatic life.

Compounds that have half-lives less than 100 days are considered non-persistent compared to compounds having half-lives approaching one year or longer. Since there are multiple factors that modulate an herbicide's hazard, just focusing on the half-life itself is a bit misleading for hazard assessment. It is now known that the longer a residue remains in soil/sediment, the less likely it will be taken up by plants, leach, or runoff. This phenomenon is called residue aging and involves changes in the forces governing interactions of the chemical with the soil matrix over time.

Table 7.12 Half-lives in water of selected herbicides.

Product	Time Span	Time Unit
Florpyrauxifen -benzyl (ProcellaCOR®)	2-6	Days
Triclopyr	7	Days
2,4-D	7	Days
Diquat	48	Hours

Applicability to Bead Lake

The selective, targeted use of aquatic herbicide can provide an effective method of controlling EWM in Bead Lake. Aquatic herbicides are among the most cost- effective control methods discussed in this plan, and unlike many manual control methods, aquatic herbicides can easily be applied to aquatic plant populations in the entirety of the littoral zone, including near and around obstructions (i.e., fishing docks and woody debris).

Successful aquatic vegetation control is dependent on several factors, including using the proper formulation, the timing of the application, and the application method. Adaptive management and follow-up surveys will be critical to determine the efficacy of herbicide treatments and to adjust the herbicide and/or concentration as necessary to achieve the desired level of control.

While the characteristics of ProcellaCOR® discussed above suggest that there is little risk to nontarget plant species and habitats in and adjacent to the lake, the sensitive nature of these features requires that a greater degree of confidence be developed prior to treating more widely. Specifically, potential impacts to certain plant species are of particular concern. SePRO Corporation maintains a database of observed impacts to plant species associated with treatments of ProcellaCOR®. In the development of this plan, the information about impacts to plant species identified in Bead Lake was obtained from SePRO. This data suggests that the herbicide exhibits a high degree of selectivity.

Extensive toxicity testing of ProcellaCOR® has also shown little evidence of acute or chronic toxicity in mammals, fish, and avian species, even at rates and exposure times significantly higher than those potentially applied to Bead Lake, per the label specifications.
Researchers have also conducted a comprehensive human health and ecological risk assessment for triclopyr, including triclopyr TEA, and found that neither terrestrial nor aquatic applications of triclopyr TEA pose substantial risks to aquatic animals across the range of labeled application rates. An overview of the toxicology information indicates that triclopyr shows only a low degree of systemic toxicity based on findings from a variety of acute, subchronic, and chronic toxicology studies.

Any herbicide applications must be conducted by an experienced and licensed aquatic herbicide applicator. This will ensure that EWM is targeted directly to the greatest extent possible, minimizing damage to desirable vegetation, and that herbicide levels in Bead Lake do not exceed the concentrations specified by the EPA on the product label, avoiding and minimizing hazards to the public and aquatic habitat and wildlife.

The BLCWA has chosen florpyrauxifen-benzyl, trade name ProcellaCOR® and diquat as the best chemical options for the Integrated Treatment Action Strategy (see Section 8) for Bead Lake.

Table 7. Summary of aquatic plant control alternatives.

Category	Method	Description	Advantages	Disadvantages
None	No action	No control measures taken.	No cost	No vegetation control
Manual and Environmental Manipulation Methods	Hand-pulling	Plants are removed by pulling out by hand.	No equipment necessary	Labor intensive Feasible for small infestations only
	Cutting	Plant biomass is cut above the roots and removed from the lake.	Little equipment necessary Immediate relief from many impacts of infestations	Labor intensive Feasible for small infestations only Imminent regrowth and drift
	Raking	Plant biomass is raked from the surface of the water using a rake.	Little equipment necessary Immediate relief from many impacts of infestations	Labor intensive Feasible for small infestations only Imminent regrowth and drift
	Bottom Barrier	Barrier installed on bottom of lake to prevent plant growth.	Very effective in small areas	Must be removed within 2 years Moderate cost
Mechanical Methods	Mechanical Harvesters	Plant biomass is cut and removed using barge-mounted equipment.	Fragments collected	Limitations on areas of usability (depth, obstructions, etc.) Risk of spreading infestation via drift
	Mechanical Weed Cutters	Plant biomass is cut below the water surface and is not collected.	Low cost	Limitations on areas of usability (depth, obstructions, etc.) Risk of spreading infestation via drift
	Rotovators	Rotovators are used to disturb the lakebed and uproot plants.	Disrupts root systems	Impacts to sediment and water quality Limitations on areas of usability (depth, obstructions, etc.) Risk of spreading infestation via drift
Chemical Methods	Aquatic Herbicide	Herbicide applied directly to plants or to the lake to restrict plant growth and promote mortality.	Cost effective Good control	Potential impacts to non-target plant species Potential impacts to aquatic habitat and wildlife
Dredging Methods	Mechanical Dredging	Sediment and plant material removed from lakebed using barge-mounted suction equipment.	Removes roots and seed bank	High cost Impacts to native vegetation Impacts to water quality
	Diver-Assisted Hand Suctioning	Plant material removed from lakebed using diver-operated suction hose.	Complete root removal	High cost Impacts to water quality
Biological Methods	Milfoil Weevil	Milfoil weevils are introduced to the lake.	Low cost	Low level of control Lack of availability

Section 8. Integrated Control Strategy

8.1 Introduction

The BLCWA and the Weed Board have worked in tandem since 2010 in an effort to mitigate the growth and spread of EWM within the lake. Multiple control techniques have been implemented and success has been mixed, depending upon water conditions in any given year. Unique lake conditions, as described in Section 1, and low water years that tend to exacerbate growth of the aquatic weed, will dictate control activities and techniques to be executed in the next three to five years.

An integrated control strategy and treatment plan is the overarching program to comprehensively address EWM issues at Bead Lake. The integrated management approach involves considering weed control alternatives with regard to the following (as adapted from Cottage Lake IAVMP, 2018):

- The extent of the problem plants
- The scale, intensity, and timing of the treatment
- The effectiveness against the target plants
- Duration of controls (short term vs. long term)
- Human health concerns related to treatment activities or no-action
- Environmental impacts of treatments and mitigation if needed
- Program costs, both initial treatment(s) and long-term maintenance
- Permit requirements (Washington Department of Fish and Wildlife, Ecology, local, landowner permission)

When control activities are evaluated while considering these factors, control techniques appropriate for the waterbody and community can be selected. Eradication of EWM in Bead Lake is the long-term goal, however management and high-intensity control strategies to drastically reduce the aquatic weed are more realistic goals given the plant's growing characteristics and the unique qualities of the lake. Along with the benefits of each activity, careful consideration should be given to the cost of activities (both monetary and environmental).

8.2 Lake-wide Strategy for EWM

Multiple techniques will be used in the control strategy effort throughout the lake and particularly in bays that are most heavily infested. The single most important factor in this effort is an early season start. EWM in Bead Lake, as indicated in Section 3, has an unusual growth pattern, in that the plant grows, fragments, and propagates not only in early fall, as is typical of the plant, but *additionally* in the late spring and early summer (or essentially year-round). The following is a range of methods and techniques to be utilized in the control and mitigation in Bead Lake:

- Comprehensive early season surveying by certificated diving agency
- Diver Assisted Suction Harvesting (DASH) and Hand-Pulling (Diver Harvesting) as required
- Bottom barriers
- Chemical treatment

- Volunteer/community surveying during summer months
- Milfoil “Hazard” buoys
- Increased signage and informational materials

8.3 Comprehensive early season surveying by certificated diving agency

Comprehensive lake surveys provide the most accurate information regarding previous year’s mitigation efforts and new plant growth from season to season. Given the unique nature of the EWM in Bead Lake, it is vital to survey the shoreline and bays well before activity increases on the lake. Early season surveying and plant detection, beginning in April/May after lake ice has melted, directly determines treatment and control decisions. Late season (late June and beyond) surveying and diving start times allow the EWM to fragment, leading to greater growth and spread. Mapping out and recording survey results will provide accurate data to analyze progression in treatment strategies.

8.4 Diver Assisted Suction Harvesting (DASH) and Hand-Pulling

The most effective control method for the aquatic weed in Bead Lake thus far is DASH and hand-pulling where the water is too shallow for the suction apparatus to function. EWM fragments easily within the waters of Bead Lake, often “exploding” just with the pass of a fish or a lake current. Hand-pulling and DASH allow a professional diver/aquatic species specialist to remove plants while young. Plants that fragment typically have six or more small plants around the base, greatly increasing the possibility of widespread growth. This method, when performed in the early season and then regularly throughout the summer months, diminishes future growth and decreases the need to use chemical treatments.

DASH is contracted to and performed by a certified aquatic weed specialist. The diver(s) uses specialized suction equipment and is able to remove multiple plants, including their roots, from a bay in just a few hours. Plants are contained in bags aboard a motorized boat and then composted at an off-site location.

Given the nature of the plant in its current state within the waters of Bead Lake, it is recommended that only a certified diver, with experience in EWM removal, perform hand-pulling and suction diving. Volunteers, while intending to provide a good service for the lake, could exacerbate the problem by using inappropriate pulling methods, thus inadvertently causing plants to fragment and spread. The only permit required for hand pulling is the Aquatic Plants and Fish Pamphlet (HPA) permit available for free from the Washington Department of Fish and Wildlife (WDFW).

8.5 Benthic barriers

Benthic or bottom barriers, secured to the lake floor, have been, and will continue to be, a suitable long-term method of controlling areas of growth within Bead Lake. Barrier material has been a breathable woven geotextile, and one trial using rolled out burlap but the EWM was able to grow through the loose weave and it was abandoned. Barriers can be used over a significant area of the lake floor within a bay, effectively depriving the EWM of sunlight. Fragmentation is eliminated as a threat during the growth season. Barriers can and should be removed at the end of season to reduce unintended impacts on other aquatic organisms. Bottom barriers are relatively inexpensive and cost effective over the course of a season. This method is useful for relatively flat areas free of fallen tree/log debris.

8.6 Chemical treatment

Given the unusual growth patterns of EWM within Bead Lake, the use of systemic aquatic herbicide is warranted as an effective short-term method of controlling the more stubborn, widespread growth areas in chronically infested bays, most particularly Mineral Bay, Lodge Creek Bay and Hay Meadow Bay, should the need arise.

Diquat, a non-selective contact herbicide, has been used since 2010 on higher growth areas as a fast-acting treatment in the fall (early to mid-October) to prevent viable fragment formation and thus limit growth in the spring. The last treatment occurred in 2016 in combination with mono salt of endothall. Diquat has proved effective as a late season knock down to prevent viable fragments that could increase the infestation extent and density the following spring. Continued use, as deemed necessary by a certified diver/weed specialist, is an option to maintain to prevent reproduction through fragmentation in the fall.

The systemic herbicide Renovate, active ingredient triclopyr, was used in early September 2011 and 2012 to treat the more densely infested Hay Meadow and Mineral (2012) Bays. In early August 2013, Hay Meadow and Mineral Bays received herbicide treatment using Renovate Max G, active ingredients triclopyr and 2,4-D Amine. These treatments helped in diminishing the infestation to a level where the diver was able to keep up with DASH and barrier treatments for the next two years.

A new aquatic herbicide, ProcellaCOR®, active ingredient florpyrauxifen-benzyl, has become available for use in Washington State waters in 2019. Trials and applications in other areas have shown it to be specific to EWM (and other aquatic noxious weeds) and extremely effective at low rates. It was registered with EPA as a "Reduced Risk" herbicide based on toxicity and carcinogenicity tests for humans and all categories of aquatic lifeforms.

The manufacturer of ProcellaCOR®, SePro Corporation, is maintaining tight control of its product, only selling it to applicators who have been certified to apply it through the company's training program. This may be due to trying to maintain the product integrity, but also because the company offers a three-year warranty on the application. The per acre cost of ProcellaCOR®, about $700, is comparable to several other systemic herbicides.

With the promising efficacy of ProcellaCOR®, its reduced risk status, comparable per acre cost and the manufacturer's warranty, BLCWA and the Weed Board recommend it as the first choice when an herbicide treatment is deemed necessary.

8.7 Other chemical options

As herbicide resistance has become a problem in terrestrial weed management programs, the best way to prevent it is to periodically switch-up and combine herbicides with different modes of action. Triclopyr, 2,4-D and florpyrauxifen-benzyl all work with the same mode of action of mimicking the plant growth hormone, auxin, causing uncontrolled and disorganized plant growth that ultimately leads to plant death. Therefore, it is prudent to maintain the option of using an herbicide with a different mode of action.

Imazamox works to stop growth and kill the plants by inhibiting acetolactate synthase (ALS), necessary for the production of the branched chain aliphatic amino acids, required for DNA synthesis and growth. As only plants have ALS, imazamox is also classified as a "Reduced Risk" herbicide, as determined by the toxicity and carcinogenicity tests for humans and all categories of aquatic lifeforms. The one caveat is that imazamox is not a selective herbicide, meaning it will kill native plants as well as EWM. A degree of selectivity can be attained by targeted application.

Ideally, a systemic herbicide is best applied earlier in the season, preferably before the end of June, so that is the timing window recommended in this plan when herbicide application is deemed necessary.

8.8 Volunteer/community surveying during summer months

Season-long surveying in Bead Lake is vital, given the plant characteristics and boat usage during the busy summer months. Plants are found in mid-summer where they might have been small or easily missed in the spring. Low-water years exacerbate this particular situation. Therefore, volunteer surveying allows the BLCWA and Weed Board to gain timely information when new growth is spotted and direct the aquatic weed specialist/diver to the given area.

8.9 Milfoil "Hazard" buoys

Bays are heavily utilized by boats and personal watercraft during the summer months. EWM "Hazard" buoys placed in the busier bays – Lodge Creek Bay, Hay Meadow Bay, Cougar Bay, and Mineral Bay – will alert watercraft and fisherman of EWM infestation. Buoys should lessen, or at best prevent, motor use and mooring in the shallow parts of the bays. The "Right of Entry" permit, issued by the State Department of Natural Resources, to moor buoys in the lake is anticipated to be issued prior to the adoption of this plan. The permit will be held by the Weed Board, has a duration of five years, costs $875.78, and is renewable. The buoys are designed to be pulled at the end of the boating season and re-deployed at the beginning of the following season as they are not sufficient to withstand winter ice.

8.10 Increased signage and informational materials

Informational materials and signage at the US Forest Service boat ramp, and the boat ramps in Diamond Match are essential to inform day use boaters of the presence and dangers of EWM within Bead Lake. Additionally, signage along the Bead Lake Trail is necessary, especially for those hikers, swimmers, and campers accessing the bays along the trail. Most non-resident users are unaware of the extent of the EWM presence; equally, they are unaware of the damage that boats and activities that stir up the plants can cause.

Boat washing stations are a common feature of many public boat launches in Washington State. Cleaning and inspection of watercraft prior to launch prevents reintroduction of EWM into lakes. The Bead Lake public launch site is not conducive to installing a full wash station. Therefore, inspection of watercraft by USFS personnel at the Bead Lake ramp could be a first step. Pend Oreille Fire District is currently investigating the possibility of building a new fire station in the Bead Lake area; BLCWA has requested that a boat washing station be included in those plans.

Informed lake users will more likely engage in boating and other activities that limit the possibilities of fragmenting EWM. It will therefore be important to keep all of the property owners informed regarding the risks posed by the EWM and the actions being employed to manage and hopefully reduce those risks. This will be a collaboration of the County Weed Board, the BLCWA and the lake associations.

8.11 Long-term management

The EWM in Bead Lake is persistent and tenacious and, while considered to be somewhat "in control" after the 2018 season, consistent monitoring, surveying, and professionally overseen aggressive DASH and barrier placement must continue to prevent the plant from overtaking more of the lake' littoral zone. The long-term strategy to keep the EWM plant largely eradicated from the lake depends on the ability to make adaptive management decisions yearly, especially early in the spring season. Diligent and purposeful surveying, DASH, barrier placement and herbicide use over the next three to five years should drastically reduce the large growth areas in the most affected bays. Long-term, these techniques should decrease the infestation to the point where only intermittent hand-pulling is necessary in any given year.

Section 9. Public Outreach

9.1 Introduction

Preventing a weed infestation is the first step in a well–rounded IAVMP. It is the most economical method – if you prevent the weeds from infesting the lake, then no money needs to be spent on other methods. Educating the lake users is the cornerstone of prevention; outreach is the means of getting their attention and engaging them to care.

9.2 Survey

An effective way to initiate the education and outreach program is to start with a survey of the lake residents in order to tailor the outreach to meet their needs and desires. In the fall of 2017, BLCWA and the Weed Board collaborated in the preparation and distribution of a survey of association members and other homeowners. (Refer to the Appendix). Survey questions were developed to better understand owners' priorities and to help shape a subsequent outreach program.

Based on the survey, private citizens at Bead Lake indicated low property maintenance, no boat regulations and wildlife preservation were the issues of main concern. Refer to the Appendix for the tabulation of results. Information from the survey answers were included in the preparation of an annual brochure to be sent to all residents that would show potential impacts of the EWM infestation. In the same brochure easy identification and current known infestation areas were provided as well as a phone number or email to report new EWM locations.

Brochure Mailed to Property Owners Summer 2019

Also based on the survey, it was concluded that public land adjacent to the lake is mostly accessed via the public boat launch and hiking trails. To better inform public users of EWM presence, signs were posted at the public boat launch and a warning was also painted on the pavement at the launch access.

9.3 Volunteers

The survey and BLCWA annual meetings enabled BLCWA to develop a volunteer list for various tasks from EWM surveying, collection and disposal of floating fragments and researching various aspects of the IAVMP. Volunteers are a key component in helping BLCWA meet the in-kind match on state grant funds. In 2015 volunteers surveyed the complete shoreline searching for any signs of EWM.

9.4 Private Landowners

Brochures and signage were developed by the Weed Board. The brochures were mailed or emailed in the summer of 2019 to all landowners. They were made available at the public and three private boat launches. The BLCWA will also send yearly updates on the EWM management program to the residents.

Other forms of communication being considered include a BLCWA Web site with a reporting form such as “Nextdoor” on the Internet and a cell phone application such as “Share” that provides updates on EWM control efforts as well as providing a means of reporting new plants.

9.5 Public Users

There are also methods to better inform public visitors of the problems EWM can cause and the steps they can take to prevent introduction and spread. BLCWA and the Weed Board have partnered to post signs at the four boat launches with specific instructions on how to identify the plant, and information on how to clean boats and trailers to prevent spread.

A community message board was placed at the intersection of Bead Lake drive and Bead Lake Road where the brochure was posted to reach walkers and vehicular traffic. Warning signs were posted along the hiking trail and at unofficial camping sites along the shore and only reachable by boat buoys with the signal words "**MILFOIL HAZARD AREA**" will be placed in vulnerable bays in the spring of 2020.

9.6 Conclusion

Education and outreach programs are only as effective as the message extended to the intended audience – programs that actually apply to their lifestyle are the most effective. BLCWA and the Weed Board have endeavored to impart to private residents and public visitors a "how-to" knowledge and a fierce desire to protect Bead Lake.

Section 10. Plan Elements, Costs and Funding

10.1 Plan Elements

All of the mitigation actions necessary for comprehensive management of the EWM infestation in Bead Lake were identified and explained in Section 8. The estimated unit costs for their application were also presented. These actions include:

- Early season survey by a certified diving agency.
- Diver Assisted Suction Harvest (DASH)
- Seasonal benthic barriers
- Chemical treatment
- Volunteer Surveying
- EWM hazard buoys
- Signage and public information materials.

As can be seen on the lake survey, the EWM infestation continued to survive the prior mitigation efforts that the County and BLCWA performed in 2018. As a consequence, it was decided to move forward aggressively with the comprehensive mitigation program presented here. The application of ProcellaCOR®, a new very safe and effective herbicide recently approved by Ecology was added to the mitigation regimen. Table 10.1 below presents the mitigation undertaken in 2019.

Table 10.1 Mitigation 2019

Site of Mitigation	*Extent of Infestation (sf)*	*Mitigation Method*	*Effort (hours)*	*2019 Goal*	*Control Intensity Low/Med/High*
Boat Launch Area	2000	DASH – aprox 20 plants	2	Clean	Low
Mineral Bay	5000	DASH	30/40	Clean	High
Useless Bay	1000	DASH	2	Clean	Low
Cougar Bay	15000	4000 sf Chemical and DASH	10/15	Clean	High
Lodge Creek Bay	20000	6000 sf Chemical and DASH	15/20	Clean	High
Hay Meadow Bay	6000	DASH	8	Clean	Med
True's Bay	1000	DASH	1	Clean	Low
Homeowner's Beachfront	Survey needed	DASH	3	Clean	Low

10.2 Six Year Plan Estimated Costs

A 6-year plan has now been developed for EWM mitigation and eradication in Bead Lake. The plan includes all of the mitigation methods summarized above. The estimated annual levels of effort required for the various mitigation actions are based on recent experience gained on Bead Lake coupled with guidance from Ecology. The unit prices for the actions are based on recent bid amounts secured by Ecology and the Weed Board. Table 10.2 Estimated Six Year Budget presents an itemized list of all of the planned EWM mitigation actions. As shown in the table, it is anticipated that the first 2 years of the program will be the costliest. By the fourth year, the distribution and density of the plants should be substantially reduced. After that, the program should transition into much less costly long-term routine maintenance.

Table 10.2 Estimated Six Year Mitigation Costs

Mitigation Actions	First Biennium			Second Biennium			Third Biennium			TOTAL 7/1/2019 - 6/30/2025
	7/1/2019 - 6/30/2020	7/1/2020 - 6/30/2021	**Subtotal 7/1/2019 - 6/30/2021**	7/1/2021 - 6/30/2022	7/1/2022 - 6/30/2023	**Subtotal 7/1/2021 - 6/30/2023**	7/1/2023 - 6/30/2024	7/1/2024 - 6/30/2025	**Subtotal 7/1/2023 - 6/30/2025**	
Milfoil Treatment										
Milfoil Survey	$900	$900	**$1,800**	$900	$900	**$1,800**	$900	$900	**$1,800**	**$5,400**
ProcellaCOR	$4,188	$3,625	**$7,813**	$3,000	$2,325	**$5,325**	$800	$825	**$1,625**	**$14,763**
DASH	$10,000	$10,000	**$20,000**	$8,000	$6,000	**$14,000**	$4,000	$2,000	**$6,000**	**$40,000**
Benthic Barriers										
Haymeadow Bay	$0	$0	**$0**	$0	$0	**$0**	$0	$0	**$0**	**$0**
Lodgcreek Bay	$900	$900	**$1,800**	$750	$0	**$750**	$0	$0	**$0**	**$2,550**
Cougar Bay	$900	$900	**$1,800**	$600	$0	**$600**	$0	$0	**$0**	**$2,400**
Mineral Bay	$750	$750	**$1,500**	$0	$0	**$0**	$0	$0	**$0**	**$1,500**
Useless Bay	$0	$0	**$0**	$0	$0	**$0**	$0	$0	**$0**	**$0**
Other Areas	$750	$750	**$1,500**	$600	$300	**$900**	$0	$0	**$0**	**$2,400**
Total Benthic Barriers	$3,300	$3,300	**$6,600**	$1,950	$300	**$2,250**	$0	$0	**$0**	**$8,850**
Total Treatment Cost	$18,388	$17,825	**$36,213**	$13,850	$9,525	**$23,375**	$5,700	$3,725	**$9,425**	**$69,013**
Education and Outreach										
Training volunteers and public meetings	$0	$0	**$0**	$0	$0	**$0**	$0	$0	**$0**	**$0**
Signage, brochures and Stencil at boat launches	$100	$100	**$200**	$100	$100	**$200**	$100	$100	**$200**	**$600**
Warning Buoys	$1,500	$0	**$1,500**	$0	$0	**$0**	$0	$0	**$0**	**$1,500**
Total Education and Outreach	$1,600	$100	**$1,700**	$100	$100	**$200**	$100	$100	**$200**	**$2,100**
Total Plan Costs	$19,988	$17,925	**$37,913**	$13,950	$9,625	**$23,575**	$5,800	$3,825	**$9,625**	**$71,113**

10.3 Plan Funding

This mitigation plan is intended to be rigorously implemented each year for 6 years. It is hoped that grant funds from the Ecology will continue to be available to help pay for much of but not all of the plan implementation.

Grant Funds

Ecology is responsible for a grant program called the Aquatic Weed Management Fund. The money to fund the program is collected from a fee included with the boat trailer registration fee. Therefore, only waters with public launches able to accommodate a boat trailer for launch are eligible to receive grants from this source.

Only government, Special Purpose Districts or tribal entities are eligible to apply for these funds. The grant can be requested annually, and it is awarded for two fiscal years (July 1-June 30). The maximum an entity can request is $75,000. A 25% local match of the requested grant amount is required.

The grant cycle opens each fall, and this is when proposals are submitted. The proposals are reviewed and ranked by Ecology and an offer or rejection is mailed to the applicant in March. If the proposal is approved for funding, a grant contract is offered by the DOE to the applicant agency. Once the contract is executed, funding becomes available on July first for expenditure and local match.

The grant application proposal presents all of the project tasks to be performed and their corresponding budgets, allocated by fiscal year. The tasks include the Weed Board's grant administration and all of the in-water mitigation actions. If a significant educational effort is needed, then it is also included as a budgeted task.

Since only governmental entities can apply for the funding, pursuit of Bead Lake EWM mitigation grant funding is the responsibility of the Weed Board, local city, or county or Conservations District or other registered Special Purpose District. The BLCWA has worked closely with the Weed Board to develop the content of the grant proposals and to manage much of the field implementation of the tasks. The BLCWA's responsibilities are specified in a separate agreement with the Weed Board.

Over the past 9 years, the Ecology has approved approximately $173,000 in Aquatic Weed Management Fund grants to Pend Oreille County for management of the EWM infestation in Bead Lake. With the completion of this Integrated Aquatic Vegetation Management Plan, it is anticipated that Ecology will continue to support the mitigation and eradication efforts. Table 10.3 presents the estimated net local share of funding that will be needed to perform the mitigation plan including anticipated grant funding from the Ecology.

Table 10.3- Estimated Local Funding Requirement

Mitigation Actions	First Biennium			Second Biennium			Third Biennium			TOTAL 7/1/2019 - 6/30/2025
	7/1/2019 - 6/30/2020	7/1/2020 - 6/30/2021	Subtotal 7/1/2019 - 6/30/2021	7/1/2021 - 6/30/2022	7/1/2022 - 6/30/2023	Subtotal 7/1/2021 - 6/30/2023	7/1/2023 - 6/30/2024	7/1/2024 - 6/30/2025	Subtotal 7/1/2023 - 6/30/2025	
Total Mitigation Costs	$19,988	$17,925	$37,913	$13,950	$9,625	$23,575	$5,800	$3,825	$9,625	$71,113
Grant Administration	$1,667	$1,667	$3,334	$1,667	$1,667	$3,334	$1,000	$1,000	$2,000	$8,668
Total Plan Costs	$21,655	$19,592	$41,247	$15,617	$11,292	$26,909	$6,800	$4,825	$11,625	$79,781
Less Estimated Grant reimbursement	(14,625)	(10,000)	(24,625)	(10,000)	(8,469)	(18,469)	(5,100)	(3,619)	(8,719)	(51,813)
Net Local Funding Required	$7,030	$9,592	$16,622	$5,617	$2,823	$8,440	$1,700	$1,206	$2,906	$27,968

Local Funds

The local share of funding needed to carry out the mitigation plan can be secured either by the creation of a Lake Management District and management by the County or by direct implementation and funding by the local beneficiaries of the plan.

Lake Management Districts

Chapter 36.61 Revised Code of Washington (RCW) authorizes any county to create "lake management districts" to finance the improvement and maintenance of lakes or beaches located within the county's boundaries of the county, and to impose "special assessments" or "rates and charges" on the property included within the district to finance lake or beach improvement and maintenance activities. Such improvement and maintenance activities may include, among other things, "controlling or removing aquatic plants and vegetation."

Land owned by the federal government in a lake management district would not be subject to special assessment and the federal government could not be compelled to pay rates and charges. Land owned by the State of Washington within a lake management district would be subject to special assessments and rates and charges, but State-owned property could not be subjected to liens to secure payment of the assessments or rates and charges.

To impose special assessments, the county would be required to show that the fair market value of each assessed property in the District had increased as a result of the improvement or maintenance activity.

A lake management district can be created by either the adoption of a resolution by the county commissioners or by the filing of a petition by the landowners. If a landowner petition is proposed, the county may require the posting of a bond to finance the county's costs in administering the process. Following a public hearing process, a simple majority of the landowners within the proposed District would vote to approve the District formation.

After the lake management district is formed, the county would prepare one or more special assessment rolls listing the amounts to be assessed against each parcel of land in the district. After approval of the assessment roles, the county would impose a lien on each property owner for the unpaid amount of such owner's assessment. That lien could be foreclosed upon if the special assessment is not paid. In addition to the special assessments, the County could impose other "rates and charges" by adopting a "roll of rates and charges" and holding a public hearing on such roll which would also be included in the lien on the properties within the District.

The county would have the sole authority to determine which improvements and maintenance activities would occur in the lake management district and how much each property owner would be required to pay for those activities. The county then would oversee the improvements and maintenance activities.

Homeowner Funding

As discussed in Section 2, the primary beneficiaries of the IAVMP will be the property owners adjacent to the lake. Representatives of the Bead Lake resident associations were present at the BLCWA 2019 annual meeting, during which the overall management plan was explained and the estimated costs for its implementation were presented. Refer to the meeting minutes in the Appendix. The meeting participants agreed that local management and funding of the EWM mitigation plan was the preferred approach. It was further unanimously agreed that the plan would be initially funded with a financial assessment of $300 per household for the 2019/2021 biennium. Future financial assessments will be brought to the BLCWA annual meetings for vote.

Section 11. Public Participation & Education Projects

While there are three resident associations on Bead Lake, they are locational in nature. In other words, each association represents property owners along unique portions of the lake shoreline. Refer to Figure 1.4 in Section 1. In addition, there is a large umbrella resident association, open to all lake residents and it is the oldest of the four associations. It was begun in 1978 in response to the threat of condos being built at the site of the old Bead Lake resort. This organization, Bead Lake Clean Water Association (BLCWA), was the one approached by a representative of the Pend Oreille County Noxious Weed Control Board when EWM was discovered in the lake by Ecology in the summer of 2010.

Since then BLCWA has taken the lead in the effort to eradicate EWM from the lake. Its Annual Meeting in August 2010 drew 47 attendees, drawn by the word “milfoil” in the meeting announcement. The Weed Board Coordinator visited the meeting and displayed pictures and samples of EWM. It was agreed at that meeting to join the Weed Board as the resident organization to fulfill the match requirement of the Ecology grant for EWM eradication that the Weed Board had secured. BLCWA’s responsibility was to provide $12,050 matching funds with the option of providing it through volunteer services and property use donations; approximately 23 % of the grant value.

Every year since 2010 the BLCWA has kept its members informed, recounting grant status and EWM eradication efforts, through meetings, minutes and other articles in the annual newsletter. In 2014, BLCWA sent a letter to all lake residents stressing the seriousness of the EWM problem and encouraging non-members to join the association and the fight (refer to appendix). At the BLCWA 2015 annual meeting, a presentation was made to attendees identifying ways residents could volunteer:

- surveying the lake shore
- developing leaflets and signage
- assisting the diver
- planning for buoys

Many people signed up and the shoreline was completely surveyed by 18 volunteers who made maps identifying when and where they discovered EWM. A new grant was applied for with BLCWA’s matching responsibility being $16,800.

In 2017 the BLCWA members, at the annual meeting, voted to apply for a grant to fund an Integrated Aquatic Vegetation Management Plan. A volunteer agreed to chair a committee of nine people (more were added later). BLCWA’s matching share of this plan grant was $7,079. In the fall of that year, a survey was developed and sent to all lake residents to determine their knowledge and interest in EWM eradication as well as their values that would motivate them to participate in prevention and management strategies. This allowed development of educational material with messaging specific to the residents.

By the summer of 2018, the first four sections of the plan had been drafted by the committee and were made available online to people at the annual meeting who indicated an interest. Willing volunteers, attending meetings and working at eradication, have consistently exceeded the association's grant matching responsibility with in-kind efforts for all three grants mentioned above.

EWM alert stencils were painted on the pavement at the public boat launch access and signs were placed there also. At an intersection of Bead Lake Road and Bead Lake Drive, a notice board was placed where walkers and hikers could gain information on the eradication efforts and meeting notices. In 2018 geocaches were placed around the lake trails with identifying pamphlets and EWM themed boxes.

Only a very few owners at the lake live there permanently. Owners' permanent residences range across the state of Washington as well as Idaho and Oregon. It is remarkable that BLCWA annual meetings have drawn an average of 30 members each meeting, showing the interest held by the members. BLCWA membership in 2010 was 65 properties and by 2018 had grown to 77 properties, a growth of 18%, evidencing the positive correlation of the association's outreach and efforts.

Meeting the goals of this integrated aquatic vegetation management plan will depend on aggressive implementation of the selected mitigation methods, coupled with active participation of all of the stakeholders. This includes not only the local property owners but also all of the people who enjoy the lake's many attributes. The biggest threat to success will be the ignorance of the beneficiaries; therefore, it is critically important the public outreach be pursued just as aggressively as the mitigation methods. Only then will long term success be achieved.

Aquatic Plants Documented by Ecology - Combined Surveys

Waterbody Name: Bead Lake **County:** Pend Oreille

Date: ***8/12/1997*** ***Comments:*** Sunny, calm / slight breeze. Water levels higher than usual. Met with locals and visited several coves and the proposed launch area. Water clear and deep, most of shorelinne is rocky, steep sided. Plants only observed in coves. Many small fish.

Scientific name	*Common name*	*Distribution Value**	*Comments*
Carex sp.	sedge	2	on lake margins in protected areas
Cicuta douglasii	western water-hemlock	1	on shoreline in coves
Eleocharis sp.	spike-rush	2	on shoreline in coves
Elodea canadensis	common elodea	2	locally common in deeper water of coves
Equisetum sp.	horse tail	2	on shore in coves
Fontinalis antipyretica	water moss	2	in shallow water
Glyceria sp.	mannagrass	2	shallow water and shorelines
Juncus sp. or Eleocharis sp.	small grass-like plants	1	shallow water of coves
Mentha sp.	mint	2	shallow water of southeast cove
Nitella sp.	stonewort	2	deeper water of coves
Nuphar polysepala	yellow water-lily	2	patches of coves
Persicaria amphibia	water smartweed	2	shallow wate of coves
Potamogeton epihydrus	ribbonleaf pondweed	1	only saw in northeast end, could be a hybrid
Potamogeton robbinsii	fern leaf pondweed	2	locally common in deep water of coves
Potamogeton sp (thin leaved)	thin leaved pondweed	1	only saw in northeast cove

Date: ***7/23/2002*** ***Comments:*** Clear, breeze. Went around the whole lake. Water a soft teal color. Ron Stipe accompanied them during the inventory (a lake resident). The lake was divided into eight sections for the inventory. They surveyed every public and private launch site, found no M. spicatum, shores very rocky, few to no plants in rocky areas. Saw some turtles

Scientific name	*Common name*	*Distribution Value**	*Comments*
Callitriche sp.	water-starwort	2	
Carex sp.	sedge	2	
Eleocharis sp.	spike-rush	9	
Elodea sp.	waterweed	2	

* 1 = scarce; in 1 or a few locations
2 = common, with a wide patchy distribution
3 = large patches, codominant with other species
4 = dominant, but other species present
5 = monospecific, dense growth excluding other species
9 = value was not recorded

Equisetum fluviatile	water horsetail	2	
Fontinalis antipyretica	water moss	2	
Glyceria sp.	mannagrass	2	
Juncus sp. or Eleocharis sp.	small grass-like plants	9	
Nitella sp.	stonewort	1	
Nuphar polysepala	yellow water-lily	2	
Persicaria amphibia	water smartweed	3	
Phalaris arundinacea	reed canarygrass	3	
Potamogeton epihydrus	ribbonleaf pondweed	2	
Potamogeton natans	floating leaf pondweed	9	
Potamogeton robbinsii	fern leaf pondweed	2	
Potamogeton sp (thin leaved)	thin leaved pondweed	2	small clumps
Potamogeton sp.	pondweed	9	may be more P. natans
Ranunculus flammula	creeping buttercup	2	
Rumex sp.	dock	3	
Scirpus sp.	bulrush	1	
Spiraea sp.	spirea	2	
unknown plant	unknown	1	loopy, creeping, growing on bottom (may be R. flammula)

Date: ***7/18/2010*** ***Comments:*** Weather sunny, calm to breezy. Boated along entire shoreline in about 5.5 hours. Found Eurasian milfoil in cove areas, dense in one cove, a few scattered plants in others (see map). Water very clear and turquoise, suspended sediment where waves wash shore. Big fish, bald eagle. Most of shoreline is steep and rocky with no plants, submersed plants mainly restricted to coves. The county got early investation money and with the Forest Service started diver hand pulling the milfoil.

Scientific name	***Common name***	***Distribution Value****	***Comments***
Carex sp.	sedge	2	
Chara sp.	muskwort	2	
Cicuta douglasii	western water-hemlock	1	
Eleocharis sp.	spike-rush	2	
Elodea canadensis	common elodea	3	

* 1 = scarce; in 1 or a few locations
2 = common, with a wide patchy distribution
3 = large patches, codominant with other species
4 = dominant, but other species present
5 = monospecific, dense growth excluding other species
9 = value was not recorded

Equisetum sp.	horse tail	1	
Glyceria sp.	mannagrass	2	
Juncus sp.	rush	2	
Mentha sp.	mint	2	
Myriophyllum spicatum	Eurasian water-milfoil	2	in scattered areas, see map
Nuphar polysepala	yellow water-lily	2	
Potamogeton epihydrus	ribbonleaf pondweed	2	
Potamogeton robbinsii	fern leaf pondweed	2	
Potamogeton sp (thin leaved)	thin leaved pondweed	1	
Ranunculus flammula	creeping buttercup	1	
Sparganium sp.	bur-reed	1	
Typha latifolia	common cat-tail	1	

Date: ***8/6/2013*** ***Comments:*** Weather sunny to partly cloudy, light breeze. Water clear. Boated along all of shore, but did not examine all of it closely. Eurasian milfoil found in several locations, mapped. Observed bald eagle, several geese, mergansers. ACE diving here hand pulling milfoil during our survey.

Scientific name	*Common name*	*Distribution Value**	*Comments*
Carex sp.	sedge	2	shallow water, no flowers
Chara sp.	muskwort	2	
Elodea nuttallii	Nuttall's waterweed	2	
Iris pseudacorus	yellow flag	1	one patch, see map
Myriophyllum spicatum	Eurasian water-milfoil	2	collected for DNA analysis, result confirmed ID as Eurasian milfoil (Moody, Thum).
Nuphar polysepala	yellow water-lily	2	
Persicaria amphibia	water smartweed	2	in coves
Potamogeton epihydrus	ribbonleaf pondweed	2	in coves
Potamogeton robbinsii	fern leaf pondweed	1	
unknown plant	unknown	2	grass, maybe Glyceria sp

Date: **9/6/2017** **Comments:** Weather smoky, calm to light breeze. Boated along shore all around the lake. Eurasian milfoil seen in bays where it had been seen before, and one new location, all marked with GPS. Most plants were small, a few larger ones. We hand pulled some in shallow water in NW and N bay, but diver will return later this fall to hand pull again. Submersed plant growth mainly limited to shallows of bays.

Scientific name	Common name	Distribution Value*	Comments
Carex sp.	sedge	2	shoreline
Chara sp.	muskwort	2	
Elodea sp.	waterweed	2	looked like E. canadensis
Glyceria sp.	mannagrass	2	shallow water of bays
Myriophyllum spicatum	Eurasian water-milfoil	2	scattered plants in bays, mostly small, pulled some in shallow water
Nitella sp.	stonewort	2	
Nuphar polysepala	yellow water-lily	2	in some bay areas
Persicaria amphibia	water smartweed	2	in bays and infow areas
Potamogeton epihydrus	ribbonleaf pondweed	2	with floating leaves in some areas
Potamogeton robbinsii	fern leaf pondweed	1	in east bay
Potamogeton sp (thin leaved)	thin leaved pondweed	2	patches, low growing, no seeds
Ranunculus flammula	creeping buttercup	1	in north bay

* 1 = scarce; in 1 or a few locations; 2 = common, with a wide patchy distribution
3 = large patches, codominant with other species; 4 = dominant, but other species present
5 = monospecific, dense growth excluding other species; 9 = value was not recorded

Aquatic Plants Documented by Ecology - Individual Site Surveys

Waterbody Name: Bead Lake **County: Pend Oreille**

Date: 8/12/1997 *Comments:* Sunny, calm / slight breeze. Water levels higher than usual. Met with locals and visited several coves and the proposed launch area. Water clear and deep, most of shorelinne is rocky, steep sided. Plants only observed in coves. Many small fish.

Station ID: PN1E5 *Sample Area Description:* Proposed USFS launch, south end of lake

Scientific name	Common name	Distribution value*	Comments
Fontinalis antipyretica	water moss	2	forming a mat in shallow water near a log
Glyceria sp.	mannagrass	2	emergent, shallow water
Juncus sp. or Eleocharis sp.	small grass-like plants	1	in shallow water, not blooming
Elodea canadensis	common elodea	2	in deeper water

Station ID: PN2E7 *Sample Area Description:* Cove on southeast side, Beaver Bay

Scientific name	Common name	Distribution value*	Comments
Nuphar polysepala	yellow water-lily	2	in patches
Persicaria amphibia	water smartweed	2	common in shallows, forming a floating mat
Mentha sp.	mint	2	growing submersed, water is higher than usual
Juncus sp. or Eleocharis sp.	small grass-like plants	2	rhizomatous, not blooming, somewhat Limosella-like
Fontinalis antipyretica	water moss	2	smaller than usual
Elodea canadensis	common elodea	3	common in deeper water
Cicuta douglasii	western water-hemlock	1	shoreline
Potamogeton robbinsii	fern leaf pondweed	3	common in deeper water

Station ID: PN9E9 *Sample Area Description:* northeast cove

Scientific name	Common name	Distribution value*	Comments
Nitella sp.	stonewort	2	
Potamogeton sp (thin leaved)	thin leaved pondweed	1	no achenes

* 1 = scarce; in 1 or a few locations 2 = common, with a wide patchy distribution
3 = large patches, codominant with other species 4 = dominant, but other species present
5 = monospecific, dense growth excluding other species

Carex sp.	sedge	2	on shore
Eleocharis sp.	spike-rush	2	on shore
Equisetum sp.	horse tail	2	on shore
Nuphar polysepala	yellow water-lily	2	
Persicaria amphibia	water smartweed	2	
Potamogeton epihydrus	ribbonleaf pondweed	3	looks like a cross with gramineus, some leaves wider and tapered
Potamogeton robbinsii	fern leaf pondweed	2	deeper water
Elodea canadensis	common elodea	3	deeper water

Date: **7/23/2002** *Comments:* Clear, breeze. Went around the whole lake. Water a soft teal color. Ron Stipe accompanied them during the inventory (a lake resident). The lake was divided into eight sections for the inventory. They surveyed every public and private launch site, found no M. spicatum, shores very rocky, few to no plants in rocky areas. Saw some turtles

Station ID: PN1E5 *Sample Area Description:* Proposed USFS launch, south end of lake

Scientific name	***Common name***	***Distribution value****	***Comments***
Nitella sp.	stonewort	1	
Spiraea sp.	spirea	3	
Ranunculus flammula	creeping buttercup	3	
Potamogeton epihydrus	ribbonleaf pondweed	1	fragment
Juncus sp. or Eleocharis sp.	small grass-like plants	2	short submersed, grass-like
Glyceria sp.	mannagrass	2	
Fontinalis antipyretica	water moss	2	
Elodea sp.	waterweed	2	
Carex sp.	sedge	1	
Callitriche sp.	water-starwort	2	
Potamogeton sp (thin leaved)	thin leaved pondweed	2	

Station ID: PN2E7 Sample Area Description: Cove on southeast side, Beaver Bay

Scientific name	Common name	Distribution value*	Comments
Persicaria amphibia	water smartweed	1	
Glyceria sp.	mannagrass	2	
unknown plant	unknown	2	loopy creeping species
Nuphar polysepala	yellow water-lily	2	
Equisetum fluviatile	water horsetail	2	
Callitriche sp.	water-starwort	3	
Eleocharis sp.	spike-rush	2	
Fontinalis antipyretica	water moss	1	

Station ID: PN5E1 Sample Area Description: first cove north from launch, western shore

Scientific name	Common name	Distribution value*	Comments
Spiraea sp.	spirea	2	

Station ID: PN7E1 Sample Area Description: larger cove on north part of west shore

Scientific name	Common name	Distribution value*	Comments
Spiraea sp.	spirea	3	

Station ID: PN7E9 Sample Area Description: shadow cove, on east side of northeast arm

Scientific name	Common name	Distribution value*	Comments
Potamogeton epihydrus	ribbonleaf pondweed	3	
Potamogeton robbinsii	fern leaf pondweed	4	
Persicaria amphibia	water smartweed	1	
Nuphar polysepala	yellow water-lily	3	
Nitella sp.	stonewort	3	

* 1 = scarce; in 1 or a few locations 2 = common, with a wide patchy distribution
3 = large patches, codominant with other species 4 = dominant, but other species present
5 = monospecific, dense growth excluding other species

Elodea sp.	waterweed	4	

Station ID: PN8E5 Sample Area Description: Granger's Cove (old Granger's cabin), west cove on north east arm of lake

Scientific name	Common name	Distribution value*	Comments
Spiraea sp.	spirea	3	
Eleocharis sp.	spike-rush	2	
Elodea sp.	waterweed	4	
Glyceria sp.	mannagrass	3	
Nitella sp.	stonewort	3	
Persicaria amphibia	water smartweed	2	
Phalaris arundinacea	reed canarygrass	2	
Potamogeton sp.	pondweed	2	maybe P. natans
Scirpus sp.	bulrush	2	
Rumex sp.	dock	1	
Callitriche sp.	water-starwort	2	
Potamogeton robbinsii	fern leaf pondweed	4	

Station ID: PN9E2 Sample Area Description: True's Bay (end of the north arm)

Scientific name	Common name	Distribution value*	Comments
Spiraea sp.	spirea	2	
Scirpus sp.	bulrush	2	
Rumex sp.	dock	2	Rumex crispus
Phalaris arundinacea	reed canarygrass	2	
Elodea sp.	waterweed	4	

* 1 = scarce; in 1 or a few locations 2 = common, with a wide patchy distribution
3 = large patches, codominant with other species 4 = dominant, but other species present
5 = monospecific, dense growth excluding other species

Station ID: PN9E9 Sample Area Description: northeast cove

Scientific name	Common name	Distribution value*	Comments
Rumex sp.	dock	1	
Glyceria sp.	mannagrass	3	
Nitella sp.	stonewort	2	
Nuphar polysepala	yellow water-lily	2	
Persicaria amphibia	water smartweed	2	
Potamogeton epihydrus	ribbonleaf pondweed	3	
Potamogeton natans	floating leaf pondweed	1	
Equisetum fluviatile	water horsetail	2	
Potamogeton sp (thin leaved)	thin leaved pondweed	1	
Spiraea sp.	spirea	2	
unknown plant	unknown	2	creeping looping species
Potamogeton robbinsii	fern leaf pondweed	3	
Callitriche sp.	water-starwort	3	
Elodea sp.	waterweed	4	

Date: 7/18/2010 Comments: Weather sunny, calm to breezy. Boated along entire shoreline in about 5.5 hours. Found Eurasian milfoil in cove areas, dense in one cove, a few scattered plants in others (see map). Water very clear and turquoise, suspended sediment where waves wash shore. Big fish, bald eagle. Most of shoreline is steep and rocky with no plants, submersed plants mainly restricted to coves. The county got early investation money and with the Forest Service started diver hand pulling the milfoil.

Station ID: W0 Sample Area Description: composite of data from whole lake

Scientific name	Common name	Distribution value*	Comments
Glyceria sp.	mannagrass	2	
Potamogeton robbinsii	fern leaf pondweed	2	

* 1 = scarce; in 1 or a few locations 2 = common, with a wide patchy distribution
3 = large patches, codominant with other species 4 = dominant, but other species present
5 = monospecific, dense growth excluding other species

Carex sp.	sedge	2	
Typha latifolia	common cat-tail	1	
Sparganium sp.	bur-reed	1	
Elodea canadensis	common elodea	3	
Potamogeton sp (thin leaved)	thin leaved pondweed	1	
Eleocharis sp.	spike-rush	2	
Juncus sp.	rush	2	
Mentha sp.	mint	2	
Myriophyllum spicatum	Eurasian water-milfoil	2	in scattered areas, see map
Nuphar polysepala	yellow water-lily	2	
Potamogeton epihydrus	ribbonleaf pondweed	2	
Ranunculus flammula	creeping buttercup	1	
Cicuta douglasii	western water-hemlock	1	
Chara sp.	muskwort	2	
Equisetum sp.	horse tail	1	

Date: **8/6/2013** *Comments:* Weather sunny to partly cloudy, light breeze. Water clear. Boated along all of shore, but did not examine all of it closely. Eurasian milfoil found in several locations, mapped. Observed bald eagle, several geese, mergansers. ACE diving here hand pulling milfoil during our survey.

Station ID: W0 *Sample Area Description:* composite of data from whole lake

Scientific name	***Common name***	***Distribution value****	***Comments***
Potamogeton epihydrus	ribbonleaf pondweed	2	in coves
Chara sp.	muskwort	2	
Elodea nuttallii	Nuttall's waterweed	2	
Iris pseudacorus	yellow flag	1	one patch, see map
Myriophyllum spicatum	Eurasian water-milfoil	2	collected for DNA analysis, result confirmed ID as Eurasian milfoil (Moody, Thum).

* 1 = scarce; in 1 or a few locations 2 = common, with a wide patchy distribution
3 = large patches, codominant with other species 4 = dominant, but other species present
5 = monospecific, dense growth excluding other species

Nuphar polysepala	yellow water-lily	2	
Persicaria amphibia	water smartweed	2	in coves
unknown plant	unknown	2	grass, maybe Glyceria sp
Potamogeton robbinsii	fern leaf pondweed	1	
Carex sp.	sedge	2	shallow water, no flowers

Date: **9/6/2017** *Comments:* Weather smoky, calm to light breeze. Boated along shore all around the lake. Eurasian milfoil seen in bays where it had been seen before, and one new location, all marked with GPS. Most plants were small, a few larger ones. We hand pulled some in shallow water in NW and N bay, but diver will return later this fall to hand pull again. Submersed plant growth mainly limited to shallows of bays.

Station ID: W0 *Sample Area Description:* composite of data from whole lake

Scientific name	***Common name***	***Distribution value****	***Comments***
Chara sp.	muskwort	2	
Persicaria amphibia	water smartweed	2	in bays and infow areas
Myriophyllum spicatum	Eurasian water-milfoil	2	scattered plants in bays, mostly small, pulled some in shallow water
Nuphar polysepala	yellow water-lily	2	in some bay areas
Nitella sp.	stonewort	2	
Glyceria sp.	mannagrass	2	shallow water of bays
Carex sp.	sedge	2	shoreline
Ranunculus flammula	creeping buttercup	1	in north bay
Potamogeton epihydrus	ribbonleaf pondweed	2	with floating leaves in some areas
Elodea sp.	waterweed	2	looked like E. canadensis
Potamogeton robbinsii	fern leaf pondweed	1	in east bay
Potamogeton sp (thin leaved)	thin leaved pondweed	2	patches, low growing, no seeds

* 1 = scarce; in 1 or a few locations 2 = common, with a wide patchy distribution
3 = large patches, codominant with other species 4 = dominant, but other species present
5 = monospecific, dense growth excluding other species

APPENDIX 1.1

Water Right Holder List

(All surface claims are from Bead Lake unless otherwise specified)

Holder Name	Purpose	Source
Pemsco Trust Company, et al	Domestic & Irrigation	Surface
Pend Oreille Public Utility District, Number 1	Municipal	Well
Larry Wriggle	Domestic	Surface
Sherry Finnigan	Domestic & Irrigation	Surface
J Mike Muhm	Domestic & Irrigation	Surface
Stephen Gilbert	Domestic	Surface
John & Jewel A Andrew	Domestic	Surface
Crystal Shores Association	Irrigation	Surface
Ralph E Johnson	Domestic	Surface
Glen R Powell	Domestic & Irrigation	Surface
H L Rehn	Domestic	Surface
Fred E Forgey	Domestic	Surface
Richard R Cunningham	Domestic. Irrigation & Stock watering	Surface
Robert M Snyder	Domestic & Irrigation	Surface
Jewel H Ownbey	Domestic	Surface
Richard G Oakley	Domestic	Surface
Stanley L Van Orman	Domestic	Surface
Clement V Duenwald	Domestic	Surface
Clyde E Bauer	Domestic	Surface
Thomas R Stuart	Domestic	Surface

Robert G Shauvin	Domestic, Irrigation & Fire Protection	Surface
D Doyle	Domestic	Surface
Willis C Beckstrom	Domestic & Fire Protection	Surface
Robert L Wakeley	Domestic	Surface
James L Bryan	Domestic	Surface
Lorenzo L True	Domestic	Surface
Vernon G Payne	Domestic & Irrigation	Surface
Kenneth E Duncan	Domestic	Surface
Lawrence G Evanoff	Domestic	Surface
James R Sloan	Domestic	Surface
Michael A Nigretti	Domestic, Irrigation & Fire Protection	Surface
Don V Jones	Domestic	Surface
Jacob H Reidt	Domestic	Surface
Art D Marshall	Domestic	Surface
Orlan C Knuth	Domestic	Surface
Frank L Mitchell	Domestic	Surface
Donald J Lanoue	Domestic	Surface
Tony M Merrick	Domestic	Surface
Eleanor J Telheedy	Domestic & Fire Protection	Surface
Edmund T Brigham	Domestic, Single & Multiple	Surface
M L Reed	Domestic	Surface
Phillip S Morrison	Domestic	Surface
Ronald L Stipe	Domestic	Surface
Lloyd C Dinwoodie	Domestic	Surface

Larry Garwood	Domestic	Surface
Mace L Reed	Domestic	Surface – Unnamed Spring
Preston H Challender	Domestic	Surface
Russell V Cowan	Domestic	Surface
Tadahiko Hasebe	Domestic	Surface
Camilla English	Domestic	Surface
Rick Franklin & Ward David Coble	Domestic	Surface
Bertille McInturff	Domestic	Surface
John P Hindley	Domestic & Fire Protection	Surface, Bead Lake & Unnamed Stream
Norman E Kilgore	Domestic	Surface
Ralph J Asseby	Domestic	Surface
Allen S Chappell	Domestic	Surface
Edward A Moline, Estate	Domestic	Surface
Robert P Fries	Domestic Multiple	Surface
Gerald D Dowd	Domestic & Fire Protection	Surface
Larry E Mullinix	Domestic	Surface
W J Haskins	Domestic	Surface
O McLaughlin	Domestic & Irrigation	Surface
Denny Elmes	Domestic Multiple	Well
James M Hines	Domestic	Surface
Bruce F Howard	Domestic	Surface
Gregory T Doughty	Domestic & Irrigation	Surface
Phillip S Morrison	Domestic	Surface
Art & Marci Barrett	Domestic, Irrigation & Fire Protection	Surface

Gary L Dinwoodie	Domestic & Irrigation	Surface
Jack R Beck	Domestic & Irrigation	Surface
R Steven Heaps	Domestic	Surface
Christopher Billingsea	Domestic Multiple & Fire Protection	Surface
Marion Benner	Domestic & Irrigation	Surface
Robert A Spencer	Domestic & Irrigation	Surface
Robert Benner	Domestic & Irrigation	Surface
Gerald Dickerson	Domestic & Irrigation	Surface
Shelly R White	Domestic, Irrigation & Fire Protection	Surface
Kathy Dernbach	Domestic & Fire Protection	Surface
Ruth V Duenwald Estate	Fire Protection	Surface
Leora M Tatman Estate	Domestic, Irrigation & Fire Protection	Surface
Richard E Layton	Domestic, Irrigation & Fire Protection	Surface
Swanson Miller Lewis, LLC	Domestic, Irrigation & Fire Protection	Surface
W Dwaine Van Patter	Irrigation & Fire Protection	Surface
Peter R Mortnsen	Domestic, Irrigation & Fire Protection	Surface
John C Kroker	Domestic	Surface
John D Oakley	Domestic, Irrigation & Fire Protection	Surface
Gary Simpson	Domestic, Irrigation & Fire Protection	Surface
Cherylon Knuth	Domestic & Irrigation	Surface
Bonnie J Warren	Domestic	Surface

Timothy E Neely	Domestic & Irrigation	
Robert I Lang	Domestic	Surface, Bead Lake & Unnamed Stream
Correll Revocable Living Trust	Domestic	Surface, Bead Lake

WRITTEN FINDINGS OF THE
WASHINGTON STATE NOXIOUS WEED CONTROL BOARD

Scientific Name: *Myriophyllum spicatum* L.

Common Name: Eurasian watermilfoil, Eurasian milfoil

Family: Haloragaceae

Legal Status: Class B:
(a) Region 1 except Pacific and Mason Counties
(b) Island and San Juan Counties of Region 2
(c) Clark and Cowlitz Counties of Region 3
(d) Chelan and Okanogan counties and all lakes with public boat launches except Fan Lake in Pend Oreille County of Region 4
(e) Adams and Lincoln counties of region 5
(f) Asotin, Columbia and Garfield counties of region 6

Additional Listing: Washington State quarantine list (WAC16-752)

LEFT: Eurasian watermilfoil mat with flower stems, MIDDLE: typical stem and stem cross-section showing 4 leaves, RIGHT: close-up of leaves, bottom two are Eurasian watermilfoil, top leaf is native northern watermilfoil (*M. sibiricum*) (Photos J. Parsons).

Description and Variation:

Eurasian watermilfoil (EWM) is a submersed perennial plant with feather-like submersed leaves and flower stems with small flowers and very small leaf-like bracts that typically rise above the water surface. There are several native water-milfoil species that look similar to EWM so identification can be challenging. In addition, it will hybridize with the native northern watermilfoil (*Myriophyllum sibiricum* Kom.) (here-on called 'hybrid') and have intermediate characteristics that can overlap with both parents (Table 1). Therefore genetic analysis is sometimes relied on for definitive species identification.

Unless otherwise noted, below descriptions are from Scribailo and Alix 2014, and Douglas et al. 1999.

Roots: fibrous, with slender, short rhizomes. Also forms adventitious roots at leaf nodes, especially on fragments. Rhizomes (sometimes considered stolons) are important in vegetative reproduction (Madsen and Smith 1997)

Stems: terete (round in cross-section), glabrous (without hairs) from pale greenish-tan to red in color, often highly branched at or near the water surface, up to 6 m long.

Leaves: Usually grow in whorls of 4, though occasionally 3 to 5. Either sessile or on very short petioles (to 0.4 mm). Two types – submersed leaves are feather-like (pectinate), wider in outline toward the middle and tip than at the base (obovate), typically 18 to 32 (14-36) mm long by 10-20 (to 30) mm wide, and with a blunt to rounded tip. There are generally 24 to 36 (20-42) narrow linear segments, with the longest segments up to 26 mm (though smaller leaves with fewer segments are sometimes present on early season growth). The segments are usually parallel, and form an angle of less than 45° with the central axis. Emergent leaves are small (1 to 2.3 mm long by 0.6 to 1 (1.5) mm wide), and turn into floral bracts toward the top (with flowers in the axils). Lower ones feather-shaped or deeply toothed then abruptly changing to entire (smooth-margined) or shallowly tooth leaves with the widest part toward the pointed or rounded tip. The hybrid leaf has 16 -28 leaf segments, and is 16 - 44 mm long (Table 1).

Winter buds (turions): absent in EWM, occasionally present in the hybrid (R. Thum, personal communication 2015).

Inflorescence: Many flowers are borne on an unbranched stalk to 15 cm long, usually rising above the water surface. Female flowers are at the bottom, and male flowers are at the top, with bisexual flowers in between. Bracts and bracteoles present. Bracts described with emergent leaves, bracteoles are paired, tiny (0.5 x 0.4 mm to 0.9 x 0.7 mm), cream to purple color with a reddish to brown margin that is entire or toothed or sometimes tipped with a membranous fringe. Flowers are wind pollinated.

Flowers: male and female flowers, either separate or together, sessile in the axils of bracts. Usually in whorls of 4. 4 sepals and petals, small (to 1 mm), cream to purplish, often deciduous. Stamens 8. Pistils to 1.2 mm with 4 styles.

Fruits: 4 rounded mericarps, with dorsal ridges and bumps, to 2.2 mm long

Table 1: comparison of three similar watermilfoil species and the hybrid.

	Number of leaflets/leaf	Leaf length (mm)	Winter buds (turion)	Bracts on Inflorescence
Eurasian watermilfoil	24-36 (typical) 20-42 (possible)	18-32 (typical) 14-36 (possible)	No	1-2.3 mm long Margin smooth to shallowly toothed or lobed toward tip
Hybrid	16-28	16-44	Occasional	Assumed same as Eurasian and northern
Northern watermilfoil	6-26	13-32 (typical) 3-44 (possible)	Yes	1-2.3 mm long Margin smooth to shallowly toothed or lobed toward tip
Whorled watermilfoil	12-22 (typical) 9-34 (possible)	12-30 (typical) 7-46 (possible)	yes	2-5 (15) mm long Pectinate with (9) 12-20 segments

Similar Species and Variations:

Occasionally other submersed species with finely divided submersed leaves are confused with EWM. Presence of the feather-shaped leaf will distinguish milfoil species that are found in Washington from other submersed plants.

About eight species of *Myriophyllum* are found in Washington State, three of which are invasive, non-native listed noxious weeds (EWM, parrotfeather (*Myriophyllum aquaticum*) and variable leaf milfoil (*Myriophyllum heterophyllum*)). Unfortunately several of the species are similar in appearance, and some are known to hybridize. Therefore, correct identification is critical.

The species most commonly confused with EWM is northern milfoil. Northern milfoil can be distinguished from EWM by the number of leaflets (less than 24 per leaf) and more triangular overall leaf shape, with the leaflets often perpendicular to the central axis. However, these traits can be variable, and plants with close to 24 leaflets are especially tricky (Table 1). Early season leaf growth and leaves on floating fragments of EWM often resemble northern milfoil. In the late summer and fall, northern milfoil will form turions (overwintering buds) at the stem tips that look like short segments of dark, densely crowded leaves (EWM does not form turions).

Hybrids will form between EWM and northern watermilfoil, and are increasingly common in Washington State. They have intermediate characteristics, including a variable number of leaflets usually in a range of overlap between northern and Eurasian milfoil, and some genetic strains may form turions, while others will not (R. Thum, personal communication, 2015). Hybridization occurs frequently, and therefore the hybrids have variable characteristics relative to their parents. Also, second generation hybrids have been found, where the hybrid backcrossed with one of the parents, leading to additional physical traits and potential complications where management is concerned (Zuellig and Thum 2012). Genetic analysis is required to be certain of the species when hybridization is suspected (Moody and Les 2002).

LEFT: Leaf variability in northern (top row), hybrid (middle row) and Eurasian watermilfoil (bottom row). Photo credit: S. Parks (Parks et al. 2014). RIGHT: Turion at the stem tip of northern milfoil. Photo credit U Wisconsin Extension.

The other milfoil species sometimes confused with EWM is whorled watermilfoil (*Myriophyllum verticillatum*). When flowering, whorled watermilfoil will have emerged leaves/bracts that are feather-shaped and longer than those of EWM (Table 1). In late summer, whorled watermilfoil makes turions that are some-what club-shaped on stem branches.

As a species EWM can vary considerably in leaf size, shape, internode length, and stem color depending on the growing conditions (Arshid and Wani 2013). Plants impacted by herbicide will sometimes form oddly shaped leaves with fused-looking leaflets (Aiken et al. 1979). A terrestrial form of EWM will develop where water levels decrease gradually and sediment remains damp. Leaves will be smaller, stiffer and have fewer divisions. When they are re-submersed new growth will gradually transition to typical submersed leaves (Aiken et al. 1979). In flowing water, EWM will have shorter spaces between the leaf whorls and more extensively branched roots resulting in more compact looking plants (Arshid and Wani 2013).

Eurasian milfoil terrestrial growth form (photo K. Messick)

Economic/Ecosystem Importance:

In some lakes and rivers in Washington State, EWM does not grow to reach the water surface or dominate the plant community (usually due to water level variation or suppression by native herbivorous insects, see control section below). In those cases its impact is similar to other native aquatic plant species. However, EWM growth is problematic when dense growth approaches the surface and branches to form a surface mat. Then it can have the following effects:

- impacts dissolved oxygen, and pH due to impeded wind mixing and plant photosynthesis during daylight and respiration at night (Frodge et al. 1990, Aiken et al. 1979)
- Impacts nutrient dynamics of the waterbody (Smith and Barko 1990)
- Increases water temperature (Aiken et al. 1979)
- shades out native vegetation (Madsen et al. 1991)
- impacts habitat for fish and invertebrates:
    - there is evidence that EWM produces chemical defenses that will keep cause some fish and invertebrates to avoid it (Schultz and Dibble 2012)
    - Stunted populations of panfish such as bluegill can result from dense plant beds
    - Piscivorous fish can have reduced fitness due to difficulty catching prey in dense plant beds
    - Native trout and salmon species may be negatively impacted if plants colonize spawning gravels or if they provide increased habitat to invasive predatory fish (Newroth 1985, Dibble et al. 1996, Schultz and Dibble 2012)
- Decreased availability of native plant species that may be more palatable to waterfowl (Aiken et al. 1979)
- Dense growth at or near the surface impedes recreation
- Actual or perceived safety hazard
- Detrimental to property values. One study found a 19% decline in values of lake front property on lakes with EWM in the Seattle area (Olden and Tamayo 2014)
- Costs to manage invasive EWM growth are borne by local citizens or state and local governments.

Geographic Distribution

Eurasian milfoil is native to Europe, Asia and northern Africa. It was introduced to North America by at least 1942 (Couch and Nelson 1985) and has spread to 4 Canadian provinces and 45 States (Scribailo and Alex 2014).

Habitat

Eurasian watermilfoil is an adaptable plant, able to tolerate and even thrive in a variety of environmental conditions. It will grow in still to flowing water, including irrigation canals, but won't tolerate high flow or areas prone to high wave action (Arshid and Wani 2013, Smith and Barko 1990). It will grow in water to 10 m deep, and can reach the surface in water up to 5 m deep (Aiken et al. 1979). It tends to form nuisance growths in moderately clear water with moderate nutrient levels. In lakes with very low nutrients, growth will generally be limited to zones with relatively high sedimentation rates and nutrients, such as the mouths of creeks or areas with groundwater upwelling (Smith and Barko 1990). In Washington it has invaded lakes with a wide alkalinity range (11 to close to 200 mg/l $CaCO_3$), but very low or high alkalinity will limit or exclude its growth (Smith and Barko 1990). It has been reported to tolerate pH from 5.4 to 10 (Aiken et al. 1979). It grows best on fine-textured inorganic sediments of intermediate density (Smith and Barko 1990). Ice scour will prevent it from growing in shallow water of lakes that regularly freeze in winter. It will not survive complete desiccation or freezing (Smith and Barko 1990). Though it can survive extended periods out of the water if damp (Jerde et al. 2012), and will develop a terrestrial growth form if stranded on damp sediment for an extended period (Aiken et al. 1979). It can tolerate salinities of up to 15 ppt (about half of sea water) (Aiken et al. 1979), and can survive in estuaries where salinity is low, however, at salt concentrations approaching its tolerance (15 ppt) decreased reproductive success in both seed and fragments results, reducing the competitive advantage of EWM in those environments (Martin and Valentine 2014)

History

Eurasian watermilfoil may have been introduced to the North American continent at Chesapeake Bay in the 1880's, although Couch and Nelson (1985) present evidence that the first collection was made in the Washington D.C. area in 1942. By 1985 EWM had been found in 33 states and 3 Canadian provinces, and by 2014 it was known from 45 states and 4 provinces (Scribailo and Alix 2014). Genetic analysis has revealed presence of at least two strains of EWM in the US, leading to the assumption that it was introduced from two parent populations (Zuellig and Thum 2012). The first known record of EWM in Washington State is from an herbarium specimen collected from Lake Meridian in King County in 1965. However, state officials became aware of EWM as a problem plant in 1974 when EWM moved downstream from the Canadian Okanogan Lakes into Lake Osoyoos on the U.S. border. In spite of efforts to prevent its spread, EWM moved downstream into the Okanogan River and the Columbia River. From there it spread to many other lakes and rivers in eastern Washington. In western Washington EWM was found in Lake Washington in 1974 and has spread from there into many additional lakes. In 2014 EWM was known from over 150 lakes throughout the state, the Columbia, Pend Oreille and Snake Rivers, as well as other smaller creeks, rivers and canal systems.

Growth and Development:

Eurasian watermilfoil is essentially evergreen, though dies back in winter. It forms no specialized overwintering structures such as turions. Instead, some shoots persist through the winter and new shoots form in the fall, but do not elongate until spring. Carbohydrate storage occurs throughout these overwintering shoots and roots (Smith and Barko 1990, Madsen 1997). It can initiate growth when water temperatures are still cool (10° C), so can start rapid spring growth earlier than some native species (Smith and Barko 1990). Its growth rate will continue to increase with increasing temperature, with optimum growth at about 32° C (Smith and Barko 1990). However, prolonged periods of high water temperature (over 30° C) can cause die-back from temperature stress, as is seen in mid-summer biomass reductions in southern populations and sometimes in shallow lakes of northern populations (Madsen 1997). When EWM reaches the surface, shoots branch, forming a surface canopy. Flowering occurs at the surface, as flowers are wind-pollinated. As stems elongate, lower leaves are typically shed (Budd et al. 1995). After peak biomass stems will autofragment (see reproduction below), and biomass will decline (Madsen and Smith 1997).

Note on hybrid: the some aggressive hybrid strains will branch more profusely than EWM, leading to dense surface growth and flowering (Thum personal communication 2015).

Reproduction

Eurasian watermilfoil reproduces by both sexual and vegetative means.

Vegetative reproduction

Vegetative spread is generally considered the major method of reproduction within a waterbody, and is accomplished by three mechanisms, stolons (rhizomes), autofragments and allofragments. Stolons are the most successful, and account for the majority of colony expansion in the immediate area of parent plants. Autofragments are typically created in late summer when short (15 to 20 cm) sections of the stem tips will develop roots and automatically separate from the parent plants. Allofragments are created by mechanical disturbance of plants such as from wave action or boat propellers. Those broken sections of stem will then form roots and settle to the bottom. The autofragments are higher in energy reserves, and thus will have higher success in developing into new plants than allofragments (Madsen and Smith 1997). Autofragment creation is higher on low nutrient sediments, thus allowing plant fragments to float off and seek different environments. On higher nutrient sediments, the plants put more energy into root and stem growth, allowing for expansion in the immediate area (Smith et al. 2002).

Jerde et al. (2012) found that EWM fragments survived well after one hour of drying, and fragments that were coiled around something like a prop survived up to 5 hours of desiccation. Temperature and humidity would influence this survival, but this is ability has led to vegetative spread between lakes.

Note on Hybrid: Northern milfoil does not form autofragments (Aiken et al. 1979) (though fragments formed by disturbance will root and start new plants). It is assumed the hybrid would be variable in this characteristic. In studies on the hybrid, it has been noted to readily root from fragments (Thum, personal communication 2015).

Seed Production

Genetic analysis shows that sexual reproduction occurs frequently in EWM and the hybrid, and can facilitate spread through seed in addition to the well known vegetative spread by fragments (Zuellig and Thum 2012). Eurasian watermilfoil seed production can be significant. In one study, up to 48 flowers were produced per flower stem with an average percent seed set between 1 and 24% (Madsen and Boylen 1989). Seed production was higher in a low nutrient lake when compared with a moderately eutrophic lake, indicating that plants put more resources into long-distance dispersal by seed when resources are limited (Madsen and Boylen 1989).

Seed germination requires water temperatures above 10° C, with a maximum germination rate reached at about 20° C with 14 hours of daylight (although seeds also germinate without light). Drying decreases the ability of seeds to germinate. However, even after 36 weeks of dry time, some seeds were still viable; indicating that seed production can be a means for drought survival (Standifer and Madsen 1997). Seeds buried under greater than 2 cm of sediment showed a much reduced germination rate, as did seeds in areas of high water movement from waves or recreational disturbance. Thus seedlings are more likely to establish in areas of deep calm water (Hartleb et al. 1993).

Control Strategies

Many studies have taken place on EWM control. The best results are usually attained by using a combination of methods, a practice known as Integrated Pest Management. The methods chosen should depend on the characteristics of the water body where the EWM is growing, the size of the EWM population, and the desired end result.

Note on hybrids. Hybrid milfoil is present in many Washington lakes, and their presence has the potential to confound control. Identification can be very difficult, requiring genetic analysis to be certain (see Description and Variation section). The hybrid is really a genetically diverse group of many unique crossings and back-crossings of Eurasian and northern milfoil, leading to the potential for variable responses to control methods. Both herbicide control response and response to herbivorous insects have been shown to be variable depending on the hybrid strain. Therefore, recent recommendations include testing for hybrid strains prior to treatment, particularly with herbicides, to potentially tailor treatment and reduce the chance of selecting for more tolerant hybrid strains (Parks et al. 2014, Schulte and Thum 2014)

Cultural Methods

Bottom barrier - Covering patches of EWM with geotextile fabric or other similar woven material can be an effective control method. One study showed control of EWM was achieved while native species grew back with an 8-week cover period. They also found that EWM fragments would root and establish with 4 cm (1.5 inches) of sediment on top of the barrier material, so barrier maintenance is required (Laitala et al. 2012). Barriers can also trap gas from decomposing plants beneath them and balloon up, requiring additional maintenance.

Drawdown – Water level reduction to expose plant beds to extended drying or freezing can be an effective EWM control method. Winter drawdown is the most commonly used method, and will kill existing EWM so long as the plants and roots freeze. Snow pack or residual water can protect plants and reduce effectiveness (Stanley 1976). Winter drawdown is used annually in Lake Spokane and other reservoirs in Eastern Washington to control EWM.

Hot Water – Blumer et al. (2009) found that water temperature of 60° C (140 F) was required to consistently kill EWM fragments. This research was to determine effectiveness of hot water washing to clean boats.

Manual and Mechanical Methods

All methods of EWM control that involves physically handling plants requires careful containment and removal of plant fragments.

Hand Pulling - Hand harvesting by divers successfully controlled EWM in a large lake in New York, but costs were high (about $350,000/year for intensive management during the first years of the program, and $150,000/year for maintenance) (Kelting and Laxon 2010). Divers are often used to successfully control or eliminate small populations of EWM in Washington lakes – either when a population is small or after using another control method such as herbicides to reduce its size. These divers often use a barge-mounted suction hose to take plants from where they are hand pulling to the boat to increase efficiency. Hand pulling while wading or snorkeling can be effective in shallow areas so long as the roots are removed.

Cutting and Harvesting - Mechanical harvesters, cutters and raking will generally not remove the roots, so the plants will grow back. These methods also lead to extensive fragmentation, so should only be used where EWM is already widespread. These methods are sometimes used to provide immediate relief from extensive surface mats.

Rotovation - Rotovation is like underwater rototilling, and will remove milfoil roots. Use of these machines is restricted due to the high level of sediment disturbance. A rotovator has been used for many years in the Pend Oreille River, with milfoil control generally lasting two years after treatment.

Biological Control

Biological control is the use of natural enemies such as insects and diseases to reduce the damage caused by a pest such as an invasive non-native plant. Over the years research on biocontrol agents in Eurasian watermilfoil's native range have been conducted by various agencies, but a promising insect proved elusive. During that time, natural declines in EWM abundance in the Northeast US and British Columbia led to research on herbivorous insects already present in the US.

The most promising of those insects was the milfoil weevil, *Euhrychiopsis lecontei.* This weevil is native to the northern part of the United States, including Washington (Tamayo et al. 1999). The weevil's native host is northern watermilfoil; however, if the weevil is reared on EWM it will prefer it over northern milfoil. The weevils spend their entire life cycle on milfoil. The adults eat leaves on the growing tips, and larvae mine into the stem causing a reduction in plant buoyancy (Newman 2004).

Other insects that have been shown to reduce EWM growth include the milfoil midge *Cricotopus myriophylli*, the caddisfly *Triaenodes tardus,* and the moth larvae *Acentria ephemerella*. The weevil, midge and caddisfly are all known from Washington State, and have shown they can be effective at reducing EWM abundance (Parsons 2012). In fact, if their numbers are high, EWM will be a relatively minor member of the submersed plant community. However, the insects are vulnerable to fish predation and various other environmental factors that limit their abundance, so they cannot thrive under all conditions. This is evidenced by the fact that EWM is still a problem in some areas.

Note on hybrid: Hybrid milfoil can respond variably to herbivores such as the milfoil weevil. Some studies have found the hybrid to be less susceptible to grazing, while other studies have found the hybrid to have a similar response to EWM. This variation likely results from variability in the genetic make-up of various hybrid strains (Borrowman et al. 2015).

Most biological control programs rely on releases of a relatively small number of insects as founding populations, then allow natural reproduction to build over the course of several years to accomplish a reduction in the host plant. Because the insects known to control EWM are naturally occurring, and because rearing them is time consuming and sometimes difficult, and there is no local source to purchase them at this time, we rely on natural dispersion to aid with EWM control.

Triploid grass carp are a non-host specific biocontrol alternative. However, these fish do not prefer EWM over native species, so will typically eat the native plants prior to EWM. Therefore they are not recommended for EWM or hybrid milfoil control.

Herbicide Control

Note: Use of pesticides in water is regulated in Washington State. All applicators must have an aquatic endorsement on their pesticide applicators license, which is issued by the Washington Department of Agriculture. In addition, coverage under a permit issued by the Department of Ecology is required. See http://www.ecy.wa.gov/programs/wq/pesticides/index.html for details.

Many herbicide trials have shown that several products are effective at controlling EWM. Keep in mind that when applied directly to water, herbicides will dissipate. Therefore, both the herbicide concentration, and the amount of time the plants are exposed to the herbicide can influence efficacy. Factors such as current, wind, and sub-surface springs can all affect exposure times. Also, the depth of the lake's thermocline will affect herbicide mixing (Getsinger et al. 2001), and often plants in cold deep water will not be controlled. For some products, studies have been done to recommend different concentrations based on expected exposure time (Table 2).

Note on hybrid: Herbicide control response has been shown to be variable for hybrid milfoil. Therefore, recent recommendations include testing for hybrid strains prior to treatment to potentially tailor treatment rates, and reduce the chance of selecting for more tolerant hybrid strains (Parks et al. 2014, Schulte and Thum 2014)

Below is a summary by herbicide type and active ingredient, but refer to the literature for more complete details. Only herbicides allowed for use in water under Washington's NPDES permits are included.

Contact Herbicides - typically 'burn' the plant back, but don't translocate to roots so may not kill the entire plant. Plants will die back quickly, so treating early in the season prior to peak biomass will reduce the risk of low oxygen as plants break down. If the target weed patches are large, treat incrementally to further reduce risks of problems (fish stress or kills) from low oxygen.

- Carfentrazone-ethyl: Used alone, there have been conflicting outcomes in the literature. Its effectiveness is affected by temperature and pH, so those variables may be part of the reason for the inconsistency. However, one study got excellent EWM control using Carfentrazone at 100 µg/l combined with a low rate of 2,4-D (100 µg/l) (Gray et al. 2007).
- Flumioxazin: Used alone, concentrations of 200-400 ppb ai (active ingredient) are recommended. Glomski and Netherland (2013) saw little difference in EWM response between those two concentrations. Flumioxazin breaks down quickly if pH is more than 8.5, thus test pH prior to use, and treat early in the morning when pH is lowest (pH can swing widely in plant beds due to the photosynthetic process) (Valent Professional Products 2012 a).
- Diquat: Excellent control resulted from experimental treatments at both .37 mg/l and .19 mg/l (Wersal et al. 2010). Diquat binds quickly to sediment, so is not recommended for treatment in turbid water conditions.
- Endothall (dipotasium salt): Endothall can provide excellent control of EWM. See Table 2 for recommended concentration and exposure times (Netherland et al. 1991). In an experiment on a small Washington lake, endothall at low concentrations (1.5 mg/l) was selective, and provide at least three years of EWM control while leaving most native aquatic plants unharmed (Parsons et al. 2004)

Systemic Herbicides – will move throughout the plant tissue, therefore generally provide good long-term control. However, often less than 100% of the EWM will be killed with one application due to water movement or other issues, so repeat treatments or follow-up with hand pulling may be necessary to achieve eradication. Some are selective for certain types of plants (e.g. broadleaf plants like EWM) or selectivity can be achieved by using low rates.

- 2,4-D (amine and ester): 2,4-D selectively kills broadleaf plants, thus can be used to kill EWM while leaving native pondweeds and rushes. There are two formulations, an ester and an amine. The ester has more use restrictions (see http://www.ecy.wa.gov/programs/wq/pesticides/postTreatmentGuidelines.html). Studies have been done to determine concentration and exposure time recommendations (Table 2). The use of even lower rates can also be effective if exposure times are extended (Glomski and Netherland 2010). 2,4-D has also been combined with contact herbicides such as endothall, carfentrazone-ethyl and flumioxazin to reduce both the concentration of herbicide required and the exposure time. 2,4-D has been used to successfully control and even eradicate EWM from several Washington lakes. Hybrid milfoil has the potential to develop resistance to 2,4-D (Schulte and Thum 2014). If a population isn't responding as anticipated, genetic analysis and testing for sensitivity of that particular population is warranted.

- Bispyribac-sodium is a slow acting systemic herbicide which requires a long exposure time (60 to 90 days). Applications are commonly done multiple times, with the initial application followed by 'bump' applications to maintain the herbicide concentration, similar to fluridone. Therefore this product is not for use in flowing water situations (Hamel 2012). The product label (Tradewind ®) lists EWM as one of the submersed plants it controls (Valent Professional Products 2012 b).
- Fluridone is a slow acting systemic herbicide. It can be used at low rates (5 µg/l) for selective lake-wide EWM control so long as that concentration is maintained for the contact time (> 60 days). This generally requires an initial herbicide application followed by 'bump' applications, and utilization of a water test to determine herbicide concentrations during treatment. In Washington, whole lake fluridone treatments followed by spot treatment of surviving patches with faster acting herbicides or hand pulling have successfully eradicated EWM. However, on a cautionary note, one hybrid strain has been found that is more tolerant to fluridone than EWM, while other hybrids are not (Thum et al 2012).
- Imazamox is a somewhat selective fast acting systemic herbicide. While imazamox typically controls grasses more effectively than broad-leaf plants, the product label (Clearcast ®) includes EWM as susceptible at concentrations of 50 to 200 ppb if applied early in the growing season when plants are actively growing (SePRO Corp 2013 a). Several studies have shown imazamox to provide EWM control at rates between 100 to 200 ppb (Hamel 2012).
- Penoxsulam is a slow acting systemic herbicide similar to Bispyribac-sodium. It requires a 60 to 120 day contact time, with longer times required when plants are not rapidly growing. Typical application rates for penoxsulam are 10-20 ppb in an initial treatment with additional "bump" applications of 5-10 ppb to keep the water concentrations at 5-10 ppb for 45 to 90 days. The sum of all applications may not exceed 150 ppb per year (Hamel 2012). The product label (Galleon SC®) includes EWM in its list of controlled plants (SePRO Corp 2013 b).
- Triclopyr is a selective herbicide that targets broad leaf plants and works well for EWM control while leaving native pondweeds unharmed. Concentration and exposure time studies have been done (Table 2) to improve predictability of results. In addition, early season treatments can improve selectivity if exposure times are adequate (Netherland and Glomski 2014). The use of even lower rates can also be effective if exposure times are extended (Glomski and Netherland 2010). Triclopyr has been combined with contact herbicides to also increase efficacy with reduced contact times (Getsinger et al. 2013).

Herbicide combinations have been shown to often provide more effective control with lower concentrations of herbicide. Combinations that have been shown to work well for EWM are:
Carfentrazone-ethyl + 2,4-D (Gray et al. 2007)
Endothall + triclopyr (Getsinger et al. 2013)

Table 2: Concentration and exposure time recommendations for three herbicides.

Herbicide	Degree of Control	concentration	exposure
Triclopyr (Netherland and Getsinger 1992)	excellent control (>85% biomass reduction)	.25 mg/l	72 hr
		0.5 mg/l	48 hr
		1 mg/l	36 hr
		1.5 mg/l	24 hr
		2 mg/l	18 hr
endothall (dipotasium salt) (Netherland et al. 1991)	excellent control (85% biomass reduction)	0.5 mg/l	48 hr
		1 mg/l	36 hr
		3 mg/l	18 hr
		5 mg/l	12 hr
2,4-D Green and Westerdahl 1988)	control (near 100%)	1 mg/l	48 hr
		2 mg/l	36 hr
	severe injury	0.5 mg/l	72 hr
		1 mg/l	36 hr
		2 mg/l	24 hr

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Bead Lake Community Survey

Is your property on Bead Lake your full time or part time residence?

Answered: 45
Skipped: 0

ANSWER CHOICES	RESPONSES
Part-Time	84.44% 38
Full-Time	11.11% 5
I don't own a residence on Bead Lake	4.44% 2
TOTAL	45

Q2

How many years have you lived on Bead Lake?

Answered: 43
Skipped: 2

ANSWER CHOICES	RESPONSES
0 years	4.65% 2
1-3 years	9.30% 4
4-6 years	4.65% 2
7-9 years	6.98% 3
10+ years	74.42% 32
TOTAL	43

Q3

How long have you been visiting Bead Lake?

Answered: 45
Skipped: 0

ANSWER CHOICES	RESPONSES	
1-3 years	4.44%	2
4-6 years	0.00%	0
7-9 years	2.22%	1
10+ years	93.33%	42
TOTAL		45

Q4

What are some of your favorite ways to utilize Bead Lake's resources?

Answered: 45
Skipped: 0

ANSWER CHOICES	RESPONSES	
Swim	95.56%	43
Scenic Viewing	93.33%	42
Hike	82.22%	37
Boat	80.00%	36
Canoe/ Kayak	80.00%	36
Bird and Wildlife Viewing	64.44%	

	29
Fish	53.33% 24
Water ski/ Wakeboard	48.89% 22

Total Respondents: 45

Q5

How important are these Bead Lake assets to you?

Answered: 45
Skipped: 0

	NOT IMPORTANT	SOMEWHAT IMPORTANT	IMPORTANT	VERY IMPORTANT	TOTAL	WEIGHTED AVERAGE
Water quality	0.00% 0	0.00% 0	2.22% 1	97.78% 44	45	2.98
Natural scenery	0.00% 0	2.22% 1	4.44% 2	93.33% 42	45	2.93
Wildlife habitat	0.00% 0	13.33% 6	15.56% 7	71.11% 32	45	2.71
Recreational use	2.22% 1	8.89% 4	22.22% 10	66.67% 30	45	2.64
Hiking trails	0.00% 0	18.18% 8	40.91% 18	40.91% 18	44	2.41
Private community	6.67% 3	28.89% 13	26.67% 12	37.78% 17	45	2.31
Fish population	4.44% 2	33.33% 15	33.33% 15	28.89% 13	45	2.24
Ease of lake access	28.89% 13	33.33% 15	22.22% 10	15.56% 7	45	1.87

Q6

What boats do you use the most on Bead Lake?

Answered: 45
Skipped: 0

ANSWER CHOICES	RESPONSES	
Bass boat	0.00%	0
I don't use any boats on Bead Lake	2.22%	1
Jet ski	4.44%	2
Wake board boat	6.67%	3
Pontoon boat	15.56%	7
Small outboard engine boat	24.44%	11
Paddle Board	31.11%	14
Ski boat	53.33%	24
Kayak or canoe	73.33%	33

Total Respondents: 45

Q7

What future matter is most important to you?

Answered: 43

Skipped: 2

ANSWER CHOICES	RESPONSES	
Low waterfront property maintenance	27.91%	12
No water craft regulations	25.58%	11
Hiking trail maintenance	18.60%	8
No wake limitations	16.28%	7
Ease of boat launch access	9.30%	4
Public access	2.33%	1
TOTAL		43

Q8

How much of a threat do you think Milfoil poses to your personal lifestyle?

ANSWER CHOICES	RESPONSES	
Somewhat of a threat	46.67%	21
A huge threat	42.22%	19
Very little threat	11.11%	5
No threat at all	0.00%	0
TOTAL		45

Q9

How informed would you say you are about milfoil and the risk it poses?

Answered: 45

Skipped: 0

ANSWER CHOICES	RESPONSES	
Very informed	60.00%	27
Somewhat informed	35.56%	16
A little informed	4.44%	2
Not informed	0.00%	0
TOTAL		45

BEAD LAKE CLEAN WATER ASSOCIATION
Annual Meeting
August 10, 2019

After a social time, the meeting was called to order at 9:30 a.m. by President, Eileen Nave. Those attending introduced themselves

2018 Minutes – These minutes had been previously sent to the membership. Lars Larson moved they be approved as sent. The motion was seconded by Dan Muhm and passed.

Treasurer's Report – Lori Guerrero, reporting for Ron Stipe, reported $4811.04 in the treasury and that $1.300 had been paid to the diver, Doug Freeland, for work he did at the lake in May.

Milfoil Report - Sherry Finnigan gave a brief history of the association and of the discovery and treatment of milfoil in the lake since 2010.

Nave reported on the current milfoil status. With the low water, it was important that the diver begin early in the spring. She listed the methods he had been employing and samples of milfoil were passed around Right now Lodge Creek and Cougar Bays are the most affected but Doug did not feel benthic barriers were necessary this year –yet. She explained why it was necessary to use BLCWA monies to pay for the May work. She reported that buoys, warning of milfoil, are being prepared to place in the affected bays. She also mentioned that there is still hope that a boat wash will be placed in the new Bead Lake area fire .station – when and if it is built.

Jim Correll, chair of the Integrated Aquatic Vegetation Management Plan for the lake gave a brief summary of work on the plan done since his last report in August, 2018. At that time four section were complete but it has been a struggle to get the next seven finished. One section is still not begun. (Section 8 in draft form was sent to all members prior to this meeting). Section 8 is concerned with control strategies that include early surveying, suction harvesting and hand-pulling, bottom barriers, chemical treatment, volunteer surveying, buoys and increased signage. These strategies have been chosen to contain or eradicate milfoil in our lake. Jim explained in great detail a new herbicide, PorcellaCor, just approved by the EPA, that affects milfoil with no negative effects on people and wildlife. It has a short half-life but is expensive. The Weed Board director has received accreditation to apply this herbicide and is prepared to do so in concert with Doug Freeland

Nave then proceeded to explain options to finance this plan and the control strategies. A Lake Management Plan (like a Local Improvement District) puts all monies in the hands of the county and would leave BLCWA with no control A 501c3 is probably not a worthy idea, given the new tax laws. The best option would be volunteer donations from members and non-members. At this time, BLCWA is receiving about 60% of its assessments so a donation strategy would entail an aggressive outreach.

Questions and answers and discussion followed. The committee was asking for direction for completing the plan. **Bev Doleac moved that BLCWA move forward with the IAVMP as outlined today by Jim Correll. The motion was seconded by Jane Buehler and passed unanimously.**

Gary Dinwoodie moved that BLCWA move forward with the financial plan as presented [volunteer donations] with property owners to split the $300 cost per the biennium with $200 this year and $100 in 2020. Seconded by Jane Buehler and passed unanimously

Karen Leinen moved that the board reach out to members not in attendance, and to non-members to become members, and to participate in the volunteer financial program. Seconded by Linda Coffield and passed unanimously

It was suggested that the board contact the three lake associations and let the leadership know what has been decided today.

Mindy Brooks pointed out that she had notice an invasive weed, Japanese Knot Weed, on a walk on Bead Lake Dr. by the Morrison's home. She feels yhis plant is hazardous and should be removed.

The meeting was adjourned.

Respectfully submitted,

Sherry Finnigan

Attending: Lori Guerrero, Gene Mead, Joe Finnigan, Jack Beck, Bill & Sally Bean, Linda and Gary Coffield, Scott & Karen Leinen, Gina Reidt, Andy & Cheryl Haynes, Howard & Helen Jones, Patti & Jim Correll, Mindy Brooks, Gary & Darlene Dinwoodie, Lars and Linda Larson, Kathy Bagley, Jacob Reidt, Mike & Bev Doleac, Jackilyn Kemmish, LeAnne Kemmish, Jean Hines, Jane Buehler, Sherry Finnigan and Eileen Nave.

BEAD LAKE CLEAN WATER ASSOCIATION
AUGUST, 2014

IMPORTANT NOTICE TO RESIDENTS OF BEAD LAKE

- **Bead Lake is infested with milfoil.**

- In 2010, milfoil was discovered in Bead Lake. The Bead Lake Clean Water Association (BLCWA) entered into a contract with Pend Oreille County as part of an Early Infestation Grant (EIG) to try to eradicate the weed. **Despite pulling plants and applying herbicide, the amount of milfoil documented in Bead Lake has not diminished. In fact, new areas of the lake have been found to be infested.**

- The EIG grant has been extended to 2016 and money still remains to fund the eradication process for the next two years. Sharon Sorby from the county Noxious Weed Board suggested at the BLCWA meeting August 9th, that residents at the lake prepare to write an Aquatic Management Plan that would insure continued support and maintenance by the County and State to help continue support for milfoil control. This would require applying for a new grant and approval by June, 2016. Time is of the essence as the opening/closing for grant applications is October, 2014.

- Those attending the August 9th meeting agreed unanimously that such a plan is needed and that work should be done to apply for the grant. **It should be noted here that attendance at this meeting was low, with very few Bead Lake residents in attendance. The milfoil issue is *real* and the infestation will continue to worsen unless all residents are aware, diligent, and proactive.**

- **What do we do from this point forward?** It is obvious that just treating and pulling is not working to eradicate the milfoil. Suggestions from the attendees included:
  1. Apply for the grant.
  2. Buoy off infested areas of the lake so boats are not cruising into those bays and spreading the milfoil to non-infested areas of the lake.
  3. Put a boat wash station at the public access requiring mandatory wash before entering Bead Lake; we are discussing this with the Forest Service.
  4. Signage at the public and private boat launches notifying boaters of the infestation problem.
  5. Pulling milfoil plants when they are encountered and disposing of them in an acceptable manner.
  6. Notify all residents that everyone must become educated and take an interest in the milfoil problem. **The milfoil problem will not go away on its own.**

- **The BLCWA board members value your support and opinion.** Everyday knowledge of the lake is needed to write the plan and the BLCWA Board asks you to get involved. Those that want to get involved can contact Eileen Nave at EileenNave@comcast.net or 509-270-2227 (call or text)

- **What else can you do?** If you haven't already done so, pay your 2014 $10 assessment (due now). These assessments will be used to for milfoil eradication. Send to Ron Stipe, 532 Bead Lake Drive, Newport, WA 99156