Lake Windermere
Aquatic Invasive Plant Sampling
2015

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Table of Contents

List of Tables

List of Figures

1. **Introduction/Background**

Invasive species are thought to be the second largest threat to global biodiversity, second only to habitat loss. Aquatic invasive plants can destroy wildlife habitat and silt fish spawning beds, alter natural wetland processes, reduce water flow and quality, disrupt recreational activities, cause socio-economic problems and reduce biodiversity of native plants/animals (Fisheries and Oceans Canada, n.d.). In a 2007 report conducted by Canadian Wildlife Service, it was determined that of the two possible ecosystem level threats to the Columbia Wetlands (globally recognized Ramsar site), invasive species are by far the most likely to exist and pose the greatest potential negative consequences to the wetlands system. Additionally, the growing popularity of boating in Lake Windermere may pose the greatest risk for the introduction and spread of aquatic invasive species (AIS) into the Columbia Wetlands system; motor vessels are common vectors for transmitting aquatic weeds.

In order to collect baseline data on invasive plants in the Columbia Wetlands region and to determine if aquatic invasive plant species were present or absent, Wildsight's Columbia Headwaters Invasive Plant Species Project (CHIPSP)was successfully implemented in 2008 (Wildsight, 2014). The CHIPSP operated as an effective inventory and management project for the Columbia Wetlands Wildlife Management Area (CWWMA) and the surrounding region from 2008-2012. This program was required since previous to this study, little to no baseline data existed for invasive plant species in this area.

There has been a two-part historic study completed on the aquatic macrophytes of Lake Windermere, neither of which reported the detection for any aquatic invasive plants (Hawthorn, 1973; Hawthorn & McCormick, 1972). In 2009, Wildsight conducted baseline aquatic plant monitoring surveys on Lake Windermere, Columbia Lake, and multiple other regional lake systems for aquatic invaders. Goldeneye Ecological Services took over monitoring efforts in 2014; no aquatic invasive plants been found to date within the entire Columbia Wetlands ecosystem. However, we must be diligent in our efforts of detection within all water bodies that have the potential for invasions as this can enable for a rapid response to any aquatic invader detected.

This year (2015) marked the sixth successive year (with the exception of 2013) where aquatic plants were sampled along multiple locations along the Lake Windermere shoreline. This year also saw the first year of AIS sampling from a boat at offshore locations, including veliger sampling for invasive mussels (quagga and zebra). The provincial Ministry of Environment had also begun sampling for invasive mussels on Lake Windermere in 2015 (Linda McVetty, personal communication, September 17, 2015). These mussels have being wreaking environmental and economic havoc with their rapid spread across North American since their introduction to the Great Lakes in the mid-80's (Ludyanskiy, McDonald, & MacNeil, 1993).

The major goal for Lake Windermere's AIS's program is to conduct on-going inventories to determine the presence/absence for AIS in the ecosystem, allowing for a rapid response for any detected AIS.

2. Study Area

Lake Windermere (UTM: 571182; 5590080) is basically a large widening in the Columbia River Wetlands ecosystem. Its south end is located about 30kms north (downstream) of the source for the Columbia River. The village of Windermere (pop: 1300) is located along the east side of the lake; Invermere (pop: 4000 permanent residents) sits at its northern end. The community of Invermere's summer population swells to approximately 40,000 people on summer weekends (Wikipedia, 2015). Lake Windermere extends for approximately 14 kilometers, and is approximately 1-2kms across depending upon ones proximity. It is relatively shallow lake, with its deepest section located near the northwest end of lake and measuring about 5.5 meters deep (Megan Peloso, personal communication, September 17, 2015).

Lake Windermere resides within the Columbia Wetlands, a Ramsar site recognized for its international significance. Most of the Columbia Wetlands have been designated as a Wildlife Management Area (WMA); Lake Windermere is excluded from the WMA boundaries. However, it is governed by the Regional District of East Kootenay's (RDEK) Lake Windermere Official Community Plan (OCP) and a Lake Windermere Management Plan was subsequently developed (RDEK, 2008). The lake is especially important to humans for a variety of purposes including freshwater provisioning, but also for its significant cultural ecosystem service values such as aesthetic views, fishing, birding, recreational boating, and cross-country skiing.

There is a large population of migratory birds that use Lake Windermere as stopover grounds during both the spring and fall migration; several at-risk bird species use this lake as a critical migration staging area for resting and/or feeding: Western Grebe, Horned Grebe, American White Pelican (especially at the south end of the lake). Aquatic plants are an important dietary component for migrating waterfowl. Aquatic plants of Lake Windermere are also used during the bird breeding season as food, shelter and for nesting materials. Lake Windermere appears to have a healthy diversity and abundance of native aquatic plants, but some plants have been considered a nuisance. Hawthorn (1073) reported that *Potamogeton natans* is the species that interferes the most with recreational opportunities in the lake. Recreational opportunists of Lake Windermere often complain about the native milfoil species, mistaking it for invasive Eurasian Milfoil.

3. Methods

3.1 Shoreline sampling

In an effort to make sampling methodology more consistent across British Columbia, the sampling methods differed in 2015 when compared to previous survey methodology for AIS. Previous years of sampling methodology for aquatic invasive plants (AIP) on Lake Windermere's shoreline included the use of a thatched rake with five rake pulls occurring at each high risk station. Immediately after each rake pull, all aquatic plant species were identified to the genus level (or species level where possible). GPS coordinates were taken at each site. Priority lake locations were originally chosen in 2009, based upon suggestions from the 2009 Lake Windermere Ambassadors (LWA) Project staff, as well based upon ease of accessibility.

Sampling effort has always focused on areas that have the greatest potential to introduce AIS, i.e. areas with higher levels of boat traffic, which is a key pathway for introducing AIS.

In 2015, we followed the survey methods as outlined in the new guide entitled 'British Columbia Aquatic Invasive Species Survey Methods' (Inter-Ministry Invasive Species Working Group (IMISWG), 2015). For shoreline plant sampling we surveyed at six high risk survey stations. This included rake pulls 100m upstream and downstream from initial sample points at each station; 25m intervals with three upstream and three downstream from initial feature (e.g. boat launch). In total seven locations were sampled at each high risk survey site. In some cases, it was not possible to sample at seven locations due to obstructions, e.g. thick riparian vegetation. We used a thatched rake with 2 rake throws/site. Rake throws were measured to be between 8-12m from the shoreline per toss.

All shoreline sampling was conducted over an eight hour period on September 11, 2015. The six shoreline locations were as follows: Baltac Beach, Fairmont Side Channel (in Fairmont), Rushmere Community Docks, end of Rault Road, Calgary Beach, Althalmer/Pete's Marina. Additionally, we attempted to sample at the large docks located along Ash Road in Windermere (Akiskinook Docks), but these were private docks with multiple 'no trespassing' signs posted. We sampled from this high risk station by boat during subsequent offshore sampling on September 16, 2015.

3.2 Offshore sampling

Offshore sampling for aquatic plants was conducted at 11 stations over a two day period on September 16 and 17, 2015 for a total of approximately 11 hours. Two surveyors were present on the first date (Rachel Darvill and Megan Peloso), three were present on September 17 (Rachel Darvill, Megan Peloso, Linda McVetty). Offshore surveys were especially useful for conducting surveys near high risk sites that were private docks not accessible from the land, for instance the Akiskinook Docks. Surveying was conducted with the use of a small aluminum boat that was lent to our monitoring team by the District of Invermere, through the LWA. With the exception of one sampling pilot project (conducted in 2011 by the LWA), to the best of the authors knowledge this was the first effort made to conduct a boat-based survey in order to monitor specifically for the presence of AIS.

We selected high risk sites for surveying from the water by looking for all high risk locations (e.g. boat docks), and were aided by a map highlighting all boat docks. The map was provided by the Ministry of Forests, Lands and Natural Resource Operations. In order to enable surveys to be repeatable over time, we followed IMISWG (2015) methods for lake boat sampling when possible. However, we did not have an underwater viewer, snorkelling or scuba gear. Additionally, given the large spatial scale of Lake Windermere and limited human/financial resources, we were not able to survey every 100m as recommended in the IMISWG (2015) protocol. Rather we focused our survey efforts at high risk sites as described above, where two rake pulls per site was conducted, alternating throws off each side (right and left) of the boat. All additional species seen from the boat at the surveys stations were also recorded in the notes/observations.

In total, we surveyed at a total of 12 high risk offshore locations. Eight locations were surveyed on September 16th: Rushmere, Lakeshore Resort, Rault Road, Indian Beach, Threthewey Docks, Akisknook Docks, Coy Road, Baltac Beach. This was followed by surveys at four locations on September 17th: Baltac Beach, Lakeview Meadows, Calgary Beach, Althalmer Docks/Pete's Marina.

On September 16th, we also conducted underwater visual observations to optimize the potential for detecting small isolated infestations (IMISWG, 2015). This was achieved by conducting 100m transects along high risk locations, starting at the initial stations and moving parallel to the shoreline. This was not possible on September 17th, as the water had small waves/ripples (hindering visibility) and we did not have an underwater viewer.

3.3 Mussel veliger sampling

An East Kootenay Invasive Plant Council (EKIPC) staff member conducted veliger sampling to detect the presence of any zebra or quagga mussels. Methods followed the protocol as outlined by IMISWG, 2015. Using a plankton tow net, vertical plankton tows were conducted at two station locations: 1) four samples were collected at the centre of Lake Windermere (UTM: 0571044; 5590679, 3m of water column collected) and placed into a jar; 2) four samples were collected 80m offshore Calgary Beach (UTM: 0569448; 5595038, 12.2m collection of water column). Additionally, a horizontal plankton tow was conducted at Athalmer/Pete's Marina (UTM: 0569511; 5596463). All samples were put into glass jars and shipped to a lab by the EKIPC.

4. Results

4.1 Shoreline sampling

No aquatic invasive plants were detected. While AIS detection was the primary focus, we did record all native aquatic plants detected to at least the family level, species level when possible. Tables 1 and 2 list all native aquatic plant species that were detected at each of the six high risk locations where monitoring was conducted. In total we identified 12 species of native aquatic plants using shoreline sampling techniques: *Chara sp., Elodea canadensis, Potamogeton richardsonii, Potamogeton natans, Potamogeton praelongus, Myriophyllum sp., Najas sp., Potamogeton robbinsii, unknown Potamogeton sp.* (likely *P.gramineus), Uticularia sp.,Potamogeton pectinatus, Sagittaria cuneate*. The Najas sp. (water nymphs) detected were likely *Najas flexilis*, since previous reports document this species (Hawthorn, 1973). We also detected aquatic moss, small fish, molluscs (i.e. clams).

4.2 Offshore sampling

No aquatic invasive plant species were detected. While AIS detection was the primary focus, we did record all native aquatic plants detected to at least the family level, species level when possible. Table 3 lists all native aquatic plant species that were detected at each of the 11 high risk locations where monitoring was conducted from a boat. In total we identified 12 species of native aquatic plants using the thatched rake pull technique and visual observations from a boat: Chara sp., *Elodea canadensis, Myriophyllum sp., Potamogeton richardsonii, Potamogeton sp. (*likely *P. vaginatus), Potamogeton praelongus, Potamogeton amplifolius* Tuckerman,

Potamogeton natans, Ranunculus aquatilis, Najas sp. (likely *N. flexilis*), *Hippuris vulgari, Potamogeton zosteriformis.* We also saw aquatic moss and small fish from the boat. Previous reports also document the following species in Lake Windermere, but they were not detected during our surveys in 2015*: Potamogeton canfervoides, Nitella sp., Ceratophyllum demersum*. However, *C. demersum* has been detected by the author in previous years of sampling Lake Windermere. The other species may be present but have not been detected.

4.3 Mussel veliger sampling

No invasive mussel veligers were reported from the lab.

Table 1. Results of the Lake Windermere shoreline sampling for aquatic invasive plants.

Site	AIS sampling location	Aquitic Plants Identified (ranked in order of % in the pull)	Observations
1. Baltac Beach	Launch (Public Boat Launch) UTM: 0570760; 5593601	**Pull 1**: *Chara* sp. **Pull 2**: no plants	Could see *Myriophyllum sp* . from shoreline
	South 1 (25m) UTM: 0570752; 5593581	**Pull 1:** *Chara* sp. **Pull 2:** *Chara sp.*	Could see *Myriophyllum* sp., *Najas* sp., *Potamogeton pectinatus* from shoreline
	South 2 (50m) UTM: 0570760; 5593559	**Pull 1**: no plants. **Pull 2**: no plants.	Directly beside small private dock couls see *Najas* sp., *Myriophyllum* sp.
	South 3 (75m) UTM: 0570783; 5593541	**Pull 1:** no plants. **Pull 2**: no plants	Rocky substrate. Could see *Chara* sp. And *Najas* sp. from shoreline.
	North 1 (25m) UTM: 0570741; 5593638	**Pull 1**: no plants. **Pull 2:** no plants.	Could see *Myriophyllum sp* . from shoreline
	North 2 (50m) UTM: 0570731; 5593655	**Pull 1:** *Chara sp.* **Pull 2**: *Chara sp.*	N/A
	North 3 (75m) UTM: 0570719; 5593670	**Pull 1:** *Chara sp., Myriophyllum sp.* **Pull 2:** no plants	Seen from shoreline: C*hara sp., Myriophullum sp., Hajas sp.*
2. Rushmere Community Docks	Launch (centre of private docks) UTM: 0574650; 5585360	**Pull 1:** no plants. **Pull 2**: no plants	Could see the following from shoreline: *Myriophyllum sp., Nuphar polysepala Engelm, Potamogeton praelongus,* Aquatic moss*, Potamogeton natans, Elodea canadensis, Ceratophyllum demersu.* Pull done off a small dock.
	South 1 (25m) UTM: 0574658; 5585340	**Pull 1**: aquatic moss, *Chara sp.* **Pull 2**: aquatic moss, *Chara sp., Myriophyllum sp., Utricularia sp., Potamogeton sp.* (Likely P.gramineus)	Pull done off of a small dock.
	South 2 (50m) UTM: 0574666; 5585324	**Pull 1:** *Chara sp., Utricularia sp.* , aquatic moss. **Pull 2:** *Chara sp., Utricularia sp., Potamogeton robbinsii*	*Najas sp* . seen from shoreline
	South 3 (75m)	No data.	Could not conduct this pull due to extensive plants obstructing sampling location.
	North 1 (25m) UTM: 0574634; 5585384	**Pull 1**: no plants. **Pull 2**: no plants	Can see more of the thin-leaved Potamogeton sp.
	North 2 (50m) UTM: 0574628; 5585395	**Pull 1:** aquatic moss, *Chara sp.* **Pull 2**: C*hara sp., Utricularia sp.* , aquatic moss	N/A
	North 3 (75m) UTM: 0574610; 5585416	**Pull 1:** *Chara sp., Sagittaria cuneata, Potamogeton pectinatus,* aquatic moss, *Elodea canadensis* **Pull 2:** *Chara sp., Utricularia sp.,* aquatic moss	N/A
3. Fairmont Side Channel	Launch UTM: 0580442; 5577287	**Pull 1:** *Chara sp., Potamogeton sp.* (likley P. vaginatus) **Pull 2:** *Chara sp.*	N/A
	North 1 (25m) UTM: 0580449; 5577315	**Pull 1:** *Chara sp., Potamogeton sp. (likley P. vaginatus)* **Pull 2:** *Chara sp.*	N/A
	Additional Notes: It was not possible to sample at more than two locations at Fairmont Side Channel due to steep riparian banks, private houses/lots, as well as a large group of people (15-20) who were preparing for a canoe trip for an extended time.		

Table 2. Results of the Lake Windermere shoreline sampling for aquatic invasive plants (con't).

Site	AIS sampling location	Aquitic Plants Identified (ranked in order of % in the pull)	Observations
4. End of Rault Road	Launch UTM: 0580442; 5577287	**Pull 1:** *Chara sp., Elodea canadensis* **Pull 2***: Chara sp.*	substrate = sandy with rocks. Lots of uprooted plants, mainly *Myriophyllum sp.*
	North 1 (25m) UTM: 0572619; 5587672	**Pull 1**: *Chara sp* . **Pull 2:** *Chara sp., aquatic moss, Potamogeton richardsonii*	Lot of washed up dried plants omm shoreline. Mainly *Myriophyllum sp. And Chara sp.*
	South 1 (25m) UTM: 0572665; 5587654	**Pull 1**: *Chara* sp., **Pull 2:** no plants	Abundance of dried up plants along shoreline. Hard to ID due to decaying pieces.
	South 2 (50m) UTM: 0572684; 5587648	**Pull 1:** *Chara sp* ., **Pull 2:** *Potamogeton sp.* (likely *P.gramineus*)	Abundance of plants dried up and tangled on fallen tree in water: *Myriophhyllum sp., Potamogeton natans, Potamogeton richardsonii* . Also saw several small fish (15-20).
	South 3 (75m) UTM: 0572708; 5587634	**Pull 1**: no plants **Pull 2**: no plants	
	Additional Notes: Could not go further north beyond the 25m because of extensive shoreline plants, i.e. did not peform rake pulls 50m north (North 2), or 75m north (North 3) at end of Rault Road Site.		
5. Calgary Beach	Launch UTM: 0569393; 5595024	**Pull 1:** no plants **Pull 2**: *Potamogeton natans*	Could see a fully developed submerged aquatic plant bed offshore.
	North 1 (25m) UTM: 0569385; 5595046	**Pull 1**: *Chara sp., Potamogeton praelongus, Elodea candensis, Potamogeton sp* . (likely P.gramineus). **Pull 2:** *Myriophyllum sp* ., *Najas sp* .	
	North 2 (50m) UTM: 0569371; 5595065	**Pull 1:** *Najas sp., Chara sp. Potamogeton sp.* (likely *P.gramineus), Potamogeton robbinsii, Myriophyllum sp.* **Pull 2:** *Najas sp., Potamogeton sp. (likely P.gramineu),*	
	North 3 (75m) UTM: 0569355; 5595086	**Pull 1:** *Chara sp., Potamogeton sp., Najas sp.* **Pull 2***: Chara sp., Potamogeton sp.*	
	South 1 (25m) UTM: 0569384; 5594991	**Pull 1:** *Najas sp., Chara sp.* **Pull 2:** no plants	Only one piece of each species each came up with first pull.
	South 2 (50m) UTM: 0569387; 5594965	**Pull 1**: *Chara sp., Potamogeton sp., Najas sp* . **Pull 2**: *Chara sp., Uticularia sp., Najas sp.*	One piece of *Uticularia* and *Najas* in Pull 2
	Left 3 (75m) UTM: 0569400; 5594939	**Pull 1:** *Chara sp., Najas sp., Myriophyllum sp* . **Pull 2:** *Chara sp.*	Abundance of dead washed up dried plants on shoreline, mainly *Myriophyllum sp* .
6. Althalmer/ Pete's Marina	Launch UTM: 0569527; 5596341	**Pull 1:** *Myriophyllum sp., Najas sp., Elodea canadensis, Potamogeton richardsonii* **Pull 2***: Potamogeton praelongus, Myriophyllum sp., Najas sp., Elodea canadensis, Chara sp.*	Busiest public boat launch access on Lake Windermere.
	South 1 (30m) UTM: 0569539; 5596307	**Pull 1:** *Najas sp., Myriophyllum sp., Elodea canadensis.* **Pull 2:** *Elodea candensis, Potamogeton robbinsi*	Very busy location with boats coming and going from water at launch.
	South 2 (50m) UTM: 0569540; 5596282	**Pull 1:** *Najas sp., Myriophyllum sp., Chara sp., Potamogeton rishardsonii, Potamogeton pectinatus* **Pull 2:** *Chara sp., Najas sp., Potamogeton rishardsonii, Myriophyllum sp., Potamogeton petinatus*	Abundance of submerged aquatic plants present at this site.
	South 3 (75m)	No data.	Could not conduct this pull due to extensive riparian plants obstructing sampling location.
	North 1 (25m) UTM: 0569520; 5596391	**Pull 1**: *Potamogeton praelongus, Elodea canadensis, Potamogeton pectinatus, Myriophyllum sp* . **Pull 2:** *Chara sp., Najas sp., Myriophyllum sp., Elodea canadensis*	
	North 2 (50m) UTM: 0569500; 5596421	**Pull 1:** *Elodea canadensis, Potamogeton praelongus, Myriophyllum sp., Chara sp., Najas sp., Potamogeton pectinatu.* **Pull 2:** *Chara sp., Elodea canadensis, Myriophyllum sp., Potamogeton praelongus, Najas sp.*	Directly under the Althalmer Bridge.
	North 3 (75m) UTM: 056489; 5596441	**Pull 1:** *Myriophyllum sp., Elodea canadendis* . **Pull 2:** Myriophyllum sp., Elodea canadendis	Just north of Althamler Bridge, at the secondary public boat launch at the Althamler Docks/Pete's Marina.

Table 3. Aquatic plant data from Lake Windermere boat surveys on September 16, 2015

Site Name	Distance from shoreline (m)	GPS coordinates	Time	Water Depth (m)	Sediment type	Rake Pull #	Aquatic Plant Species	Notes/Observations
Rushmere	361	0574915; 5585589. End of 100 m transect=not recorded	1030	2.13	N/A	1 2 100m transect	*Myriophyllum* sp. (native milfoil), *Chara* sp. (muskweed), *Potamogeton amplifolius* Tuckerman *Potamogeton amplifolius* Tuckerman *Potamogeton natans, Elodea canadensis, Potamogeton richardsonii, Potamogeton praelongus, Ranunculus aquatilis*	Offshore from private community docks. 100m transect north completed with naked eye due to calm water. Dense beds of submerged plants along transect.
Lakeshore Resort	100	0574768; 5586574. End of 100 m transect=0574708; 5586660	1103	1.83	sand/ silt	1 2 100m transect	*Chara sp., Myriophyllum sp.* (native milfoil), Najas sp. *Chara sp.* *Chara sp., Potamogeton natans*	Offshore from small private docks with moorage. Little vegatation present. 100 m transect was completed in front of
Rault Rd.	60	0573116; 5587269. End of 100m transect=0572289; 5589154	1134	2.06	N/A	1 2 100m transect	*Myriophyllum sp., Chara sp., Potamogeton praelongus, Hippuris vulgari, Potamogeton richardsonii* *Chara sp., Myriophyllum sp.* *Elodea canadensis, Potamogeton natans*	Very dense bed of submerged vegetation along transect; 100m transect north completed with naked eye due to calm water.
Indian Beach	116	0572372; 5589079. End of 100m transect= 0572289; 5589154	1214	1.82	sand/ silt	1 2 100m transect	*Chara sp., Najas sp. Potamogetan natans,* aquatic moss *Potamogeton natans, Chara sp.* *Myriophyllum sp., Najas sp.*	Little aquatic plant life on lake bottom. 100m transect north completed with naked eye due to calm water.
Trethewa y Docks	99	0571753; 5589727. End of 100m transect=0571658; 5589763	1245	0.66	and/sil	1 2 100m transect	Chara sp. *Chara sp.* *Elodea canadensis, Myriophyllum sp.*	Very little aquatic plant life in front of multiple private boat slips.
Akisknook Docks	96	0571276; 5591409. End of 100m transect=0571241; 5591502	1350	3.3	N/A	1 2 100m transect	*Chara sp., Myriophyllum sp.* *Chara sp., Myriophyllum sp.* *Potamogeton richardsonii*	100m transect conducted along private boat docks.
End of Coy Road	56	0570113; 5590946. End of 100m transect=0570167; 5590865	1412	0.68	N/A	1 2 100m transect	*Chara sp., Potamogeton sp.,* aquatic moss *Chara sp., Najas sp., Elodea canadensi, Potamogeton zosteriformis* *Potamogeton natans, Potamogeton praelongus, Potamogeton pectinatus,*	Signifacant amount of Chara sp. And P.zosteriformis on the lake bottom.

Table 4. Aquatic plant data from Lake Windermere boat surveys on September 17, 2015

Site Name	Distance from shoreline (m)	GPS coordinates	Time	Water Depth (m)	Sediment type	Rake Pull #	Aquatic Plant Species	Notes/Observations
Baltac Beach	108	0571058; 5593411	1020	3.5	sand/ mud	1	*Chara sp.*	100m transect not possible due to wave action and stirred sediments. Unmanaged moorage
						2	no plants	
Lakeview Meadows	34	0570172; 5594068	1050	1.4	N/A	1	*Elodea canadensis, Chara sp., Myriophyllumsp., Potamogeton richardsonii*	100m transect not possible due to wave action and stirred sediments.
						2	*Elodea canadensis, Myriophyllum sp., Potamogeton richardsonii*	
Calgary Beach	83	0569448; 5595038	1130	5.3	N/A	1	*Chara sp.*	100m transect not possible due to wave action and stirred sediments.
						2	*Chara sp.*	
Althalmer /Pete's Marina	12	0569567; 5596341	1210	1.2	sand/ rocky	1	*Potamogeton sp. (likley P. vaginatus, Myriophyllum sp., Chara sp., Potamogeton praelongus*	100m transect not possible due to wave action and stirred sediments. All plants were coated in a green filamentous algae not previously seen. A specimen was collected and sent to Biodiversity Museum at UBC.
						2	*Chara sp., Myriophyllum sp.*	

4.3 Unknown specimen detected

One unknown microfilamentous algae species was detected at two locations and collected for future identification; it was found attached to rocks along the rock weir south of Althalmer and attached to native aquatic plants in front of the Althalmer Boat Docks/Pete's Marina (see Figures 1a and 1b); the busiest public boat launch location on Lake Windemere. One specimen was collected at each of two sites, they were wrapped in damp paper towels within a ziplock bag and placed into a cooler on ice. The samples had had the collection date, collector name, water body name, UTM coordinates listed with permanent marker. Later that day, the samples were dried and subsequently sent to Linda Jennings at the Beaty Biodiversity Museum for identification.

Linda Jennings is not sure of its species identification. Multiple experts were sent photographs of the specimen, but no positive ID has come back leaving inconclusive results for what this microfilamentous algae is. The images went to the following aquatic plant specialists: Frank Lomer, Adolf Seska, Chris Harkness, Becky Brown, Gisele Mitrow. One response came from Paul Hamilton (personal communication, October 13, 2015) from the Phycology Museum of Nature in Ottawa whom stated:

> "*It is hard to tell without a microscope examination of the filaments. It is a green filamentous alga, likely Oedigonium. If you can send me a picture of the filaments under a microscope, I can make a better identification.*"

However, we did not have the resources to take a picture of the filaments under a microscope.

Additionally, Thomas Woolf (personal communication, September 22, 2015) suspects that the algae is a result of the warm and sunny summer that we've had. Woolf suggests that in the fall the native plants start to senesce and release nutrients as they degrade. This can trigger algae blooms, especially if the water is still warm in combination with sun. Woolf reported seeing quite a bit of algae late in the 2015 field season in Idaho, he thought that was a result of a very warm summer.

a) 

b) 

Figure 1a and 1b. Unknown filamentous algae collected with a thatch rake in front of Athalmer/Pete's Marina

5. Discussion

For the purposes of this study, it is not necessary to identify all native plants to species level since the main objective is to look for aquatic invasive plants, which are relatively easily to identify at the genus level. Some species (e.g. variety of native Myriphyllum spp.) require DNA analysis for positive ID, which can be very expensive and time consuming.

On rare occasion (which is becoming more frequent in Idaho and Washington), there is a hybrid species (Eurasian Milfoil crossed with a native Milfoil) that can become very aggressive and invasive (Thomas Woolf, personal communication, 2011). There are some sites on Lake Windermere that have aggressively growing beds native milfoil species. However, you cannot definitively differentiate between some native milfoil species, milfoil hybrid, or Eurasian milfoil species unless they are analyzed using DNA techniques. Therefore, in 2011, we sampled from aggressive milfoil beds on Lake Windermere (as well as on Columbia Lake) and sent them to a specialized lab in Michigan for DNA analysis. We sampled from five aggressive beds of milfoil in Lake Windermere in 2011 (Pete's Marina, Calgary Beach, Coy Rd., Windermere Dock and Lakeview Meadows). All of these samples came back positively as Northern Watermilfoil species; native species to the Lake Windermere and Columbia Lake ecosystems. Therefore we can be certain that we did not detect any Eurasian Watermilfoil on Lake Windermere or Columbia Lake in 2011. There was no change in the appearance or aggressiveness of milfoil species sampled in either 2012, 2014 or 2015, and no invasive *Myriphyllum* spp. (Eurasian Milfoil) have been located. We can therefore assume that all *Myriophyllum* spp. located during 2015 surveys were native milfoil species.

Native aquatic plants are important to maintain for a variety of purposes; there are a number of uses and benefits of aquatic plants. For instance, they provide food and shelter for many animals, including imperilled species such as the Horned and Western Grebe. They also provide habitat for many small animals such as snails, macro invertebrates, and crustaceans, which in turn provide food for additional wildlife such as waterfowl species (Department of Ecology, State of Washington, n.d.). Native aquatic plants are also important to maintain for purposes of erosion control, nutrient cycling and for resisting invasion to alien invaders (Department of Ecology, State of Washington, n.d.), which to the best of our knowledge, are currently being kept at bay.

In regards to the unknown filamentous algae, it is suspected to be Oedogonium. This is a commonly found filamentous green-algae that can be found either attached to other plants (as was the case at Althalmer), or it can be found free-floating. However, this has not been previously detected in Lake Windermere, so it would good to monitor this species distribution and abundance in subsequent years. A study by McCraken, Gustafson, & Adams (1974) on Oedogonium found that, "algal mat development was related both to the presence of Myriophyllum and proximity to nutrient-rich runoff from storm sewer entries to the lake." Since Althalmer is the busiest boat dock on Lake Windermere with a high level of human traffic, future monitoring efforts are warranted.

6. Recommendations

6.1 Continued Monitoring

If any invasive plants become established on Lake Windermere, the chances of eliminating the infestation from the lake becomes much lower the longer the infestation has the opportunity to become established. Monitoring is critical for early detection enabling for a rapid response and for improving our knowledge of exiting plant populations (IMISWG, 2015). Therefore, in order to determine if any infestations are present, it is highly recommended to continuing sampling aquatic plants on an annual basis from popular boating docks (high risk locations) located along Lake Windermere.

In order to reduce the issue of inaccessibly, private docks, and/or the time required to talk to individual land owners for access permission, it is recommended that not only shoreline sampling continue at high-use locations, but that a boat be utilized in order to cover a greater proportional area of the lake. This will also allow for a greater proportional area of the lake be surveyed for aquatic invasive plants. It is also recommended to continue monitoring the presence of the microfilamentous algae detected during this study, and obtain a microscopic image of the algae that could be used for positive species confirmation. It would be advantageous if the LWA purchased an underwater viewer, so that volunteers and LWA staff can continue to monitor the microfilamentous algae. The underwater viewer can also be used for transects on future offshore surveys.

Additionally, it is highly advised that the LWA purchase a plankton tow net, in order to conduct monthly sampling for zebra and quagga mussel veliger's. Damage caused from aquatic invasive mussels will be irreversible and economically costly. Additionally, significant recreational opportunities will be reduced if zebra or quagga mussels are introduced into Lake Windermere. Ecological consequences could be devastating. The protocol for monitoring veligers is relatively straightforward.

6.2 Permanent boat washing station

Due to the severe negative consequences (economic, environmental and social) that Eurasian Milfoil, zebra/quagga mussels and other aquatic invasive species could have on Lake Windermere and the Columbia Wetlands, it is recommended that a permanent boat washing station be developed for the Lake, along with associated education and outreach activities. The best location for a permanent boat washing location would be at Althalmer/Pete's Marina. On occasion, a mobile boat washing station has gone to Pete's Marina. However, it would be advantageous for boaters to always have the option available to wash their boat prior to entering Lake Windermere.

6.3 Outreach

Outreach activities have begun on Lake Windermere through both the LWA and the EKIPC. In addition to promoting the 'Clean, Drain, Dry' messaging, outreach may be facilitated by the development of a brochure that speaks specifically to Lake Windermere and the importance of native aquatic plants to this ecosystem, as well as to how Lake Windemere is currently devoid of invasive plants. This may help to dispel the local myth that Lake Windemere is full of 'weeds'. Furthermore, additional signage should be installed on Lake Windermere, since there is currently limited signage and messaging on the dangers of AIS, as well as a lack of messaging on Lake Windermere around the 'Clean,Drain,Dry' messaging. Education is amongst the best form of preventing the invasion of alien species into Lake Windermere.

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