Lake Windermere
Aquatic Invasive Plant Species Inventory
2019

Prepared for the Lake Windermere Ambassadors
December 2019

Prepared by Rachel Darvill, BSc., MSc., RPBio

goldeneye
ECOLOGICAL SERVICES

Table of Contents

List of Figures

1. Introduction/Background

Invasive species are the second largest threat to biodiversity decline and extinctions worldwide, and they contribute to huge losses of habitat. An invasive species is considered to be a plant, animal, or fungus species that is deliberately or unintentionally introduced into an area that is outside of their natural habitat (ISCBC, 2017). Numerous accounts link invasive species to severe economic losses (Pimentel, Zuniga, & Morrison, 2005; Xu et al., 2006). Many invasive wildlife species are reservoirs of infectious diseases and pathogens, which threaten human health and domestic animals (Daszak, Cunningham, & Hyatt, 2000). Furthermore, they can negatively impact recreational pursuits, crops, and infrastructure such as hydroelectric power facilities (Province of British Columbia (BC), 2015), which is of special concern in BC given the large number of these facilities present.

On the other hand, beds of indigenous freshwater aquatic vegetation are comprised of a beneficial suite of species important to maintain for the health of shallow water lake ecosystems. While dense beds of aquatic macrophytes (i.e. plants) are often considered to be a nuisance to boaters and swimmers, submerged aquatic vegetation is a vital component of a balanced aquatic environment and provide necessary ecosystem services such as erosion control, nutrient absorption and cycling, and turbidity reduction (Hasler & Jones, 1949; Timms & Moss, 1984; Van den Berg et al., 1998). A healthy, biodiverse, functioning indigenous freshwater aquatic ecosystem is also more resistant to invasion by non-indigenous species.

Submerged aquatic vegetation is a vital food source for a number of wildlife species including beaver, painted turtles, invertebrates, ducks and geese. The abundance and diversity of birds has been shown to be higher in vegetated areas of lakes (Scheffer, 1998). Aquatic plants provide housing supplies to birds, for instance grebe species build floating nests comprised of emergent vegetation such as cattail (*Typha spp.*) and floating waterlily (*Nuphar spp*.); along with cover and food for amphibians, aquatic invertebrates (e.g. dragonfly larvae) and young fish. Materials from emergent vegetation have been used by Indigenous people for thousands of years for cultural traditional practices such as basket making and mat weaving, and some aquatic vegetation has been (and is presently) used by humans as a medicinal food source.

In 2007, the Canadian Wildlife Service determined that there were three possible ecosystem level threats to the Columbia Wetlands: invasive species, pollution events, and severe erosion (Hammond, 2007). Invasive plant and animals species were determined to be the most likely to occur in the Columbia Wetlands and if introduced, would pose the “greatest potential consequence” to the natural ecology (Hammond, 2007). Draft revisions to the Management

Plan for the Columbia Wetlands Wildlife Management Area reflect this concern, and include the management of invasive species as a top priority (Phase II Ventures Ltd., 2019). Furthermore, in the newly created strategic framework for the Columbia Wetlands Stewardship Partners, the importance of monitoring invasive species was highlighted and includes actions such as "[c]onduct periodic monitoring for invasive plants, animals and pathogens in the wetlands (Mahr, 2019)."

The Lake Windermere Aquatic Invasive Plant Species Inventory project has been operational since 2013. The project conducts shoreline and offshore inventories to determine the presence or absence of aquatic invasive plant species. Aquatic invasive plants can be transported through a variety of ways, but one of the main vectors of introduction is through recreational pursuits using a variety of equipment, e.g. kayaks, paddle boards, motorized boats. Lake Windermere appears to receive the highest amount of boating traffic within the entire Upper Columbia or contiguous Columbia Wetlands ecosystem, therefore ongoing diligence in monitoring the lake for the introduction of aquatic invasive plants is imperative.

2. Study Area

Lake Windermere (UTM: 571182; 5590080) is located near the headwaters of the Columbia River, a river system that begins in Canal Flats located about 30kms south of the most southerly end of Lake Windermere. Located within the Regional District of East Kootenay (RDEK), Lake Windermere is found in the Rocky Mountain Trench and Columbia River Valley within southeastern BC. The largest community sits at the northern end of the Lake and is called Invermere, which has a population of approximately 4000 permanent residents with that number growing during busy summer months. The village of Windermere (pop: 1,259) is located along the east side (Wikipedia, 2017). Lake Windermere is important to humans for a variety of purposes including freshwater provisioning and its significant cultural ecosystem services such as aesthetic views, fishing, birding, recreational boating, and cross-country skiing.

Lake Windermere extends for approximately 17.7 kilometers and is 0.7 to 2 kilometers wide. Much of Lake Windermere is classified as a shallow open water wetland, a transition zone between lakes and marshes where the depth of water is often less than 2 meters (Alberta Wetland Policy, 2017). There are some deeper sections, with the greatest depth being approximately 5.5 meters and located near the northwest end. There is a high diversity and abundance of biodiversity found at Lake Windermere and in the Columbia Wetlands, including a number at species at risk. Lake Windermere has been documented as important stopover habitat for large congregations of waterbirds during both spring and fall bird migration (Darvill, 2017a). There have been 165 bird species recorded at Lake Windermere, including 17 listed as

species-at-risk such as the red-listed Western Grebe (*Aechmophorus occidentalis*), red-listed American White Pelican (*Pelecanus erythrorhynchos*), federally Threatened Bank Swallow (*Riparia riparia*) and blue-listed California Gull (*Larus californicus*) (Darvill, 2019).

The first 180 kilometers of the Columbia River are known as the Columbia Wetlands, a Ramsar site recognized for its international significance. Lake Windermere is considered to be a part of the contiguous Columbia Wetlands ecosystem, but the Ramsar designation excludes both Lake Windermere and Columbia Lake from this status. Other designations currently being pursued for the Columbia Wetlands, including both Lake Windermere and Columbia Lake, are 'Important Bird and Biodiversity Area' and 'Key Biodiversity Area'.

3. Methods

3.1. Shoreline surveys

Shoreline surveys were completed on September 13, 2019 and lasted seven hours. Survey methodology was consistent with previous years of survey effort and adhered to the protocol outlined in the 'Canadian Columbia Basin Regional Framework for an Aquatic Invasive Species Program: 2015 to 2020' (Inter-Ministry Invasive Species Working Group (IMISWG), 2015). Shoreline sampling occurred at six pre-established survey stations, which were selected because those sites pose a higher risk of invasion compared to other shoreline locations since there are higher levels of use. High-risk sites included locations that are known to have higher amounts of trailered boat traffic (boats coming in from other areas that could be affected by aquatic invasive species) on public land.

Principal consultant and biologist R. Darvill conducted the aquatic invasive plant sampling at each station, with the assistance of a volunteer. A thatched rake with a 9.7 meter long rope was use for sampling aquatic plants in the water. The rake was tossed into the water as far as possible and pulled back to the shoreline. The rake collected plants below the surface of the water at the specific location where it was thrown. Rake pulls occurred at the initial feature (e.g. public boat launch) as well as at three sites located 100 meters upstream of the initial feature, and at three sites located 100 meters downstream of the initial feature. All upstream and downstream sampling sites were separated by 25 meters. Two rake throws were conducted at each of the seven sites.

While aquatic invasive plant detection was the primary focus of this study, all indigenous aquatic plants were identified to the species level when possible. In total, seven sites were sampled at each of the six survey station locations. However, at two of the survey stations (i.e.

Fairmont Side Channel, End of Ruault Road), it was not possible to sample at seven sites due to obstructions such as private property (i.e. Fairmont Side Channel), or bushy riparian vegetation. The six shoreline survey stations were sampled in the following order: Baltac Beach, Fairmont Side Channel, Rushmere Community Docks, end of Ruault Road, 'Unofficial boat launch near Bayshore Condos', and Althalmer/Pete's Marina.

3.2. Offshore surveys

The 2019 offshore surveys utilized the IMISWG (2015) methods for sampling aquatic invasive plants on the lake from a boat. Using IMISWG methodology ensures that inventories can be repeatable over time to maintain consistency with previous years of survey effort. Given the relatively large spatial scale of Lake Windermere and given limited resources, a modification is made to the IMISWG protocol each year. The IMISWG protocol recommends that continuous surveys be conducted every 100 meters. However, this project's scaled-down survey effort continues to focus at 11 high-risk locations, which was also done during the 2015-2018 years of survey effort.

An aluminum boat with outboard motor (provided by the District of Invermere), was used to conduct offshore surveys. A crew of two people conducted the surveys: R. Darvill, S. McGinty. All offshore sampling occurred on September 17, 2019 at 11 pre-established survey stations considered to be at high-risk for introduction of aquatic invasive plant species. As with shoreline surveys, high risk locations were considered to be those areas with an increased incidence of trailered boat traffic (boats coming from other waterbodies), public boat launches, and boat marina's. At each survey location, four rake pulls were conducted (two off the right side and two off left side of boat). In previous years of survey effort, only one rake toss was conducted off each side of the boat (Darvill, 2018). The rake was tossed into the water as far as possible and pulled back to the boat, enabling the rake to collect plants present on the lake bottom. An additional four rake toss/pulls were conducted at the end of a 100 meter transect, two off the right and two off the left hand side of boat.

All aquatic plants collected on the thatched rake were recorded to the family level and where possible to the species level. During the 100 meter transect and between the two rake toss sites, when possible a single observer would record all of the additional plant species seen with the naked eye from the boat. For all 100 meter transects, the boat travelled northward, parallel to the shoreline. The 11 survey stations were sampled in the following order: Rushmere, Indigenous Beach (formally referred to as Indian Beach in previous years or survey effort), Lakeshore Resort, Ruault Road, Tretheway Docks, Akiskinook Resort, end of Coy Road,

Baltac Beach, Lakeview Meadows, 'unofficial boat launch near the Bayshore Condos' and Althalmer/Pete's Marina.

4. Results

4.1. Shoreline surveys

No aquatic invasive plant species were detected during shoreline surveys. A list of indigenous aquatic plant species that were observed using rake pull methodology are listed in Appendix 1. There was a notable lack of aquatic plants detected at the following survey stations: Baltac Beach, End of Ruault Rd, and Unofficial boat launch near Bayshore Condos. For the aquatic plants that were detected, common species included *Myriophyllum sp*. (indigenous milfoil species) and *Chara sp*. (muskgrass).

All watermilfoil species (*Myriophyllum sp*.) detected during surveys had nine (or less) leaflet pairs per leaf. Indigenous watermilfoil species have 5-10 leaflet pairs, whereas invasive Eurasian Watermilfoil (*Myriophyllum spicatum*) has leaves with 12-21 leaflet pairs (Minnesota Sea Grant, 2016). Therefore, all watermilfoil species detected in 2019 were assumed to be indigenous aquatic plant species. The Potamogeton species identified in the excel table (Appendix 1 and 2) with parenthesis stating 'short/narrow leaves', could be either *P. gramineus* or *P. obtusifolious*, or possibly another related Potamogeton species. Potamogetons can be hard to identify, depending on condition/stage of the plant and they hybridize fairly frequently to produce plants with hybrid characteristics (Thomas Wolf, personal communication, 2017). Since the purpose of these surveys is to detect invasive plants, species level determination is not required.

4.2. Offshore surveys

No aquatic invasive plant species were detected during offshore surveys. As with previous years of survey effort, dense areas or beds of indigenous aquatic plants were observed in specific locations such as Ruault Road and Althalmer/Pete's Marina (Figure 1). There were some survey stations that were essentially devoid of aquatic plant communities, such as Baltac Beach, Unofficial boat launch near Bayshore Condos, and Tretheway Docks. While not a part of this study, during an aerial survey conducted on April 8, 2019 by the principal consultant during an annual bird survey, photographs of Lake Windermere were taken indicating that motor boats could be having an influence on the indigenous plant communities of Lake Windermere (Figures 2 and 3).

Figure 1. Image of dense indigenous aquatic plant beds detected at the Ruault Rd survey station during offshore surveys.

Figure 2. Aerial photograph taken on April 8, 2019 showing effects of motorboats on aquatic vegetation at Lake Windermere.

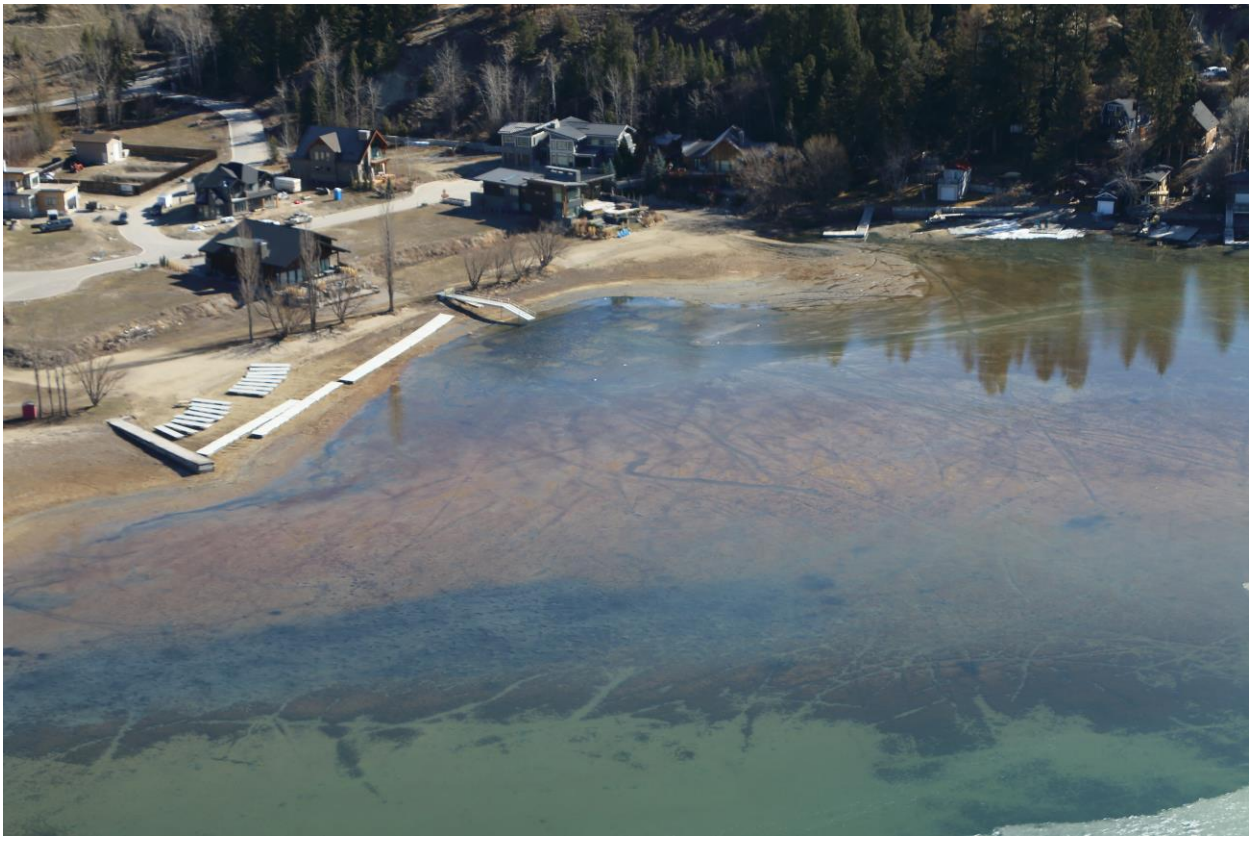

Figure 3. Aerial photograph taken on April 8, 2019 showing effects of motorboats on the aquatic plant community of Lake Windermere.

5. Discussion/Recommendations

Similar to previous years of survey effort, no aquatic invasive plant species were detected in 2019. To the best of the principal consultant's knowledge, no aquatic invasive plant species have been observed previously in Lake Windermere, or within the Columbia Wetlands ecosystem, with the exception of one Purple Loosestrife (*Lythrum salicaria*) infestation at Burgess and James Gadsden Provincial Park located north of Golden; this loosestrife infestation is managed annually by BC Parks. It is important to note that four non-indigenous fish species (i.e. Northern Pike, Smallmouth Bass, Largemouth Bass, Pumpkinseed Fish) have previously been documented to occur in Lake Windermere (Craig, 2015). Aligned to a previous recommendation made by the author (Darvill, 2017b), it is still recommended that a fish

inventory of Lake Windermere be completed, in order to determine the abundance and distribution of invasive fish, as well as the impacts that these species may be having on the ecology and wildlife of Lake Windermere, including potential effects felt by indigenous fish populations.

While assessing the distribution or abundance or aquatic plants was beyond the scope of this study, it was noted through aerial photography that recreational boats appear to effecting on the beds of aquatic macrophytes (or plants) in the lake. A study that took place in the Stockholm archipelago of the Baltic Sea, it was observed that:

> *"In inlets used as harbours for private boats (marinas) or adjacent to ferryboat routes, vegetation cover and species richness declined significantly more with depth than in reference inlets not exposed to disturbance by boating activities. In marinas, turbidity was significantly higher than in reference inlets. Accordingly, a canonical correspondence analysis showed that the abundance of species sensitive to poor light conditions, such as Chara spp. and Ruppia spp. were negatively correlated with marinas while Myriophyllum spicatum and Ceratophyllum demersum that are common in nutrient rich turbid habitats were positively correlated with marinas. (Eriksoon, Sandstrom, Isaeus, Schreiber, & Kara, 2004)."*

During the 2019 Lake Windermere Aquatic Invasive Plant Species Inventory, the most common species at many of the survey stations were indigenous species of *Myriophyllum* and *Chara sp.* Chara was often found in low amounts at boat launch locations where little other plant life was detected. However, at some marina's surveyed (e.g. Althalmer/Pete's Marina, Akisknook Docks), there was a high abundance of indigenous *Myriophyllum spp*. (milfoil) observed. The findings of the 2019 Lake Windermere surveys support the work completed by Eriksoon, Sandstrom, Isaeus, Schreiber, & Kara (2004), in that Myriophyllum seems to be found in higher abundance at boat dock locations or marinas.

Research has shown that motorboats can dramatically reduce aquatic plant biomass either through direct cutting or through scouring of the substrate where plants are rooted (Asplund & Cook, 1997). Since aquatic vegetation is essential for ecological integrity and for several wildlife species, it is recommended that assessing potential impacts of recreational activities on the aquatic plant communities of Lake Windermere be investigated. In a study by Van Nes et al., (1999) it was suggested that in areas where there are competing interests between nature conservation and recreation, that a compromise can be achieved by assigning certain areas of a lake to recreation and other parts should be left for nature conservation. This may be an important consideration to make in order to achieve more of a recreational/ecological balance

at Lake Windermere, and in order to ensure that the ecological values of Lake Windermere are able to persist alongside human use well into the future. This compromise may also be realistic and achievable for Lake Windermere because the areas that have a high diversity and abundance of aquatic vegetation are typically the areas that are not desirable for recreational boating, for instance plants can clog intakes on motors. Furthermore, if it is of interest to quality the historical changes of submerged aquatic vegetation in Lake Windermere, it is recommended to conduct a study that focuses specifically on this. This type of research would use different methodology such as rake sampling combined with aerial photographinterpretation and hydroacoustics (Zhu et al., 2007).

6. Acknowledgements

I would like to thank the Lake Windermere Ambassadors (LWA) Program Coordinator Shannon McGinty for participating on the aquatic invasive plant surveys and for working to secure funding for the work to get done. Goldeneye Ecological Services acknowledges the financial contributions of the Regional District of East Kootenay's Columbia Valley Local Conservation Fund, RBC Foundation, as well as the in-kind support of the District of Invermere for the use of their small motorized boat in order to conduct offshore surveys.

7. References

Asplund, T. R., & Cook, C. M. (1997). Effects of motor boats on submerged aquatic macrophytes. *Lake and Reservoir Management*, *13*(1), 1-12.

Alberta Wetland Policy. (2017). Canadian wetland classification system. Retrieved from: http://www.wetlandpolicy.ca/canadian-wetland-classification-system

Craig, J. (2015). Canadian Columbia Basin regional framework for an aquatic invasive species Program: 2015 to 2020. Retrieved from: http://www.friendsofkootenaylake.ca/wp-content/uploads/2016/02/Final-CBAIS_Regional_Program_Framework_1June2015.pdf

Darvill, R. (2017a). Columbia Wetlands waterbird survey 2015-2017: Progress report. Retrieved from http://wildsight.ca/wp-content/uploads/2016/01/Columbia-Wetlands-Waterbird-Survey_2017-Progress-Report_FINAL_Dec2017.pdf

Darvill, R. (2017b). Lake Windermere aquatic invasive species inventory 2017. Retrieved from:

Darvill, R. (2018). Lake Windermere aquatic invasive plant species inventory 2018. Retrieved from: http://www.lakeambassadors.ca/lwawp/wp-content/uploads/2018/12/2018_Lake-Windermere-IP-Inventory_FINAL-REPORT_NOV2018.pdf

Darvill, R. (2019) Insight into the waterbirds of Lake Windermere. Retrieved from: http://www.lakeambassadors.ca/lwawp/wp-content/uploads/2019/01/Lake-Windermere-Bird-Report_-Jan-21-2019_FINAL-REPORT.pdf

Daszak, P., Cunningham, A. A., & Hyatt, A. D. (2000). Emerging infectious diseases of wildlife--threats to biodiversity and human health. *Science*, *287*(5452), 443-449.

Eriksson, B. K., Sandström, A., Isæus, M., Schreiber, H., & Karås, P. (2004). Effects of boating activities on aquatic vegetation in the Stockholm archipelago, Baltic Sea. *Estuarine, Coastal and Shelf Science*, *61*(2), 339-349.

Hammond, B. (2007). The conservation rationale for regulating the use of navigable waters in British Columbia's columbia wetlands. Canadian Wildlife Service, Environment Canada. Delta, British Columbia, Canada.

Hasler, A. D. & E. Jones. (1949). Demonstration of the antagonisticaction of large aquatic plants on algae and rotifers. *Ecology* 30:346–359

Inter-Ministry Invasive Species Working Group (IMISWG). (2015). British Columbia aquatic invasive species survey methods. Retrieved from https://www.for.gov.bc.ca/hra/invasive-species/Publications/BC_Aquatic_Sampling_March2015.pdf

Invasive Species Council of BC (ISCBC) (2017). Invasive species. Retrieved from https://bcinvasives.ca/invasive-species/about/

Phase II Ventures Ltd. (2019). Columbia Wetlands Wildlife Management Area Management Plan. Unpublished report.

Pimentel, David, Rodolfo, Zuniga, & D. Morrison. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States." *Ecological economics* 52.3: 273-288.

Province of BC. (2015). Plants & animals: Status of invasive species in B.C. Retrieved from: http://www.env.gov.bc.ca/soe/indicators/plants-and-animals/invasive-species.html

Mahr, M. (2019). Strategy document for conserving and managing the columbia wetlands of the Upper Columbia Valley. Retrieved from: https://wetlandstewards.eco/resources/

Minnesota Sea Grant. (2016). Eurasian watermilfoil. Retrieved from: http://www.seagrant.umn.edu/ais/watermilfoil

Scheffer, M. (1998). Ecology of shallow lakes. Chapman and Hall, London: 357 pp.

Timms, R. M. & B. Moss. (1984). Prevention of growth of potentially dense phytoplankton populations by zooplankton grazing in the presence of zooplanktivorous fish in a shallow wetland ecosystem. *Limnol.Oceanogr.* 29: 472–486.

Van den Berg, M. S., H. Coops, M. L. Meijer, M. Scheffer & J.Simons. (1998). Clear water associated with a dense Chara vegetation in the shallow and turbid Lake Veluwemeer, the Netherlands. In Jeppesen, E., Ma. Sondergaard, Mo. Sondergaard & K. Kris-toffersen. (eds), Structuring Role of Submerged Macrophytes in Lakes. *Springer-Verlag*, New York: 339–352

Van Nes, E. H., van den Berg, M. S., Clayton, J. S., Coops, H., Scheffer, M., & van Ierland, E. (1999). A simple model for evaluating the costs and benefits of aquatic macrophytes. In *Biology, Ecology and Management of Aquatic Plants* (pp. 335-339). Springer, Dordrecht.

Wikipedia. (2017). *Columbia River*. Retrieved from: https://en.wikipedia.org/wiki/Columbia_River

Xu, H., Ding, H., Li, M., Qiang, S., Guo, J., Han, Z., ... & Wan, F. (2006). The distribution and economic losses of alien species invasion to China. *Biological Invasions*, *8*(7), 1495-1500.

Zhu, B., Fitzgerald, D. G., Hoskins, S. B., Rudstam, L. G., Mayer, C. M., & Mills, E. L. (2007). Quantification of historical changes of submerged aquatic vegetation cover in two bays of Lake Ontario with three complementary methods. *Journal of Great Lakes Research*, 33(1), 122-135.

8. Appendices

Appendix 1. Results from the Lake Windermere shoreline surveys for aquatic invasive plants on September 13, 2019.

Survey Station	AIS sampling location	Aquatic Plants Identified (ranked in order of % in the pull)	Observations/Notes
1. Baltac Beach	Launch (Public Boat Launch) UTM: 0570748; 5593608	**Pull 1:** No plants **Pull 2:** Chara sp.	Small Chara sp. fragment.
	South 1 (25m) UTM: 0570750; 5593583	**Pull 1**: No plants **Pull 2:** No plants	
	South 2 (50m) UTM: 0570760; 5593559	**Pull 1**: No plants **Pull 2:** No plants	
	South 3 (75m) UTM: 0570779; 5593544	**Pull 1:** No plants. **Pull 2**: No plants	
	North 1 (25m) UTM: 0570739; 5593631	**Pull 1**: *Elodea candensis* (1 fragment) **Pull 2:** *Chara* sp. (1 fragment), *Myriophyllum sp.* (1 fragment)	
	North 2 (50m) UTM: 0570728; 5593656	**Pull 1:** *Myriophyllum sp., Najas sp.* **Pull 2**: *Chara sp.*	
	North 3 (75m) UTM: 0570714; 5593672	**Pull 1:** *Chara sp.* **Pull 2:** *Chara sp.*	
2. Rushmere Community Docks	Launch (centre of private docks) UTM: 0574650; 5585352	**Pull 1:** *Myriophyllum sp.* **Pull 2**: No plants	
	South 1 (25m) UTM: 0574659; 5585334	**Pull 1**: *Utricularia sp, Hippuris vulgaris, Chara sp.* **Pull 2**: *Hippuris vulgaris, Chara sp., Myriophyllum sp., Potamogeton sp.* (short/narrow leaves)	Rake pulls conducted from a small dock.
	South 2 (50m) UTM: 0574666; 5585311	**Pull 1:** *Chara sp., Myriophyllum sp., Najas sp.* **Pull 2:** *Ranunculus aquatilis*	
	South 3 (75m) UTM: 0574674; 5585287	**Pull 1:** *Chara sp., Myriophyllum sp.* **Pull 2:** *Elodea canadensis, Chara sp.*	Large aquatic plant diverstity washed up ph shore. Large raft of American Coots nearby (350).
	North 1 (25m) UTM: 0574637; 5585375	**Pull 1**: *Ranunculus aquatilis, Myriophyllum sp.* **Pull 2**: *Ranunculus aquatilis, Myriophyllum sp.*	
	North 2 (50m) UTM: 0574623; 5585394	**Pull 1:** *Chara sp., Myriophyllum sp., Elodea canadensis, Najas sp., Hippuris vulgaris* **Pull 2:** *Chara sp.*	
	North 3 (75m) UTM: 0574611; 5585417	**Pull 1:** *Chara sp., Potamogeton sp.* (short/narrow leaves) **Pull 2:** *Utricularia, Chara sp., Myriophyllum sp., Najas sp.*	Mainly bare substrate.
3. Fairmont Side Channel	Boat launch UTM: 0580441; 5577289	**Pull 1:** *Potamogeton sp.* (likely *P. vaginatus), Chara sp.* **Pull 2:** *Potamogeton sp.* (likely *P. vaginatus), Chara sp.*	Outhouse, picnic tables, garbage cans.
	South 1 (25m) UTM: 0580421; 5577269	**Pull 1:** *Potamogeton sp.* (likely *P. vaginatus*), *Chara sp.* **Pull 2:** *Potamogeton sp.* (likely *P. vaginatus*), *Chara sp.*	Could not go further south to sample; private property. Did not sample here 2015-2019.
	North 1 (25m)	**Pull 1:** *Potamogeton sp.* (likely *P. vaginatus), Chara sp.* **Pull**	

	UTM: 0580450; 5577309	**2:** *Potamogeton sp.* (likely *P. vaginatus), Potomogeton richardsonii*	
	North 2 (50m) UTM: 0580451; 5577332	**Pull 1:** *Potamogeton sp.* (likely *P. vaginatus), Potamogeton richardsonii, Chara sp.* **Pull 2:** *Potamogeton sp.*(likely *P. vaginatus), Potamogeton richardsonii, Chara sp.*	
	Additional Notes: It was not possible to sample at more than three locations at Fairmont Side Channel due to private property.		
4. End of Ruault Road	Boat Launch UTM: 0572641; 5587665	**Pull 1:** *Chara sp., Myriophyllum sp., Najas sp.* **Pull 2:** *Chara sp., Potamogeton richardsonii*	
	North 1 (25m) UTM: 0572619; 5587674	**Pull 1:** *Chara sp., Myriophyllum sp.,* **Pull 2:** *Chara sp., Myriopphyllum sp.,*	Bulrushes located north of 25 m did not enable for pulls further north. Did not sample here in 2015-2019.
	South 1 (25m) UTM: 0572664; 5587657	**Pull 1**: *Chara sp., Myriophyllum sp., Megalodonta beckii* **Pull 2:** *Chara sp., Myriophyllum sp., Najas sp.*	Much Myriophyllum washed up on shoreline.
	South 2 (50m) UTM: 0572687; 5587647	**Pull 1**: No plants **Pull 2:** *Myriophyllum sp*. (1 fragment)	Very rainy and windy conditions during pull.
	South 3 (75m) UTM: 0572711; 5587639	**Pull 1**: No plants **Pull 2**: No plants.	Very rainy and windy conditions during pull.
	Additional Notes: Could not sample northwards beyond the 25m north survey station due to extensive shoreline plants.		
5. Unofficial boat launch near Bayshore Condos	Launch UTM: 0569389; 5595010	**Pull 1:** No plants **Pull 2:** No plants	
	North 1 (25m) UTM: 0569390; 5595037	**Pull 1**: No plants **Pull 2:** No plants	
	North 2 (50m) UTM: 0569380; 5595059	**Pull 1:** *Najas sp.* (1 fragment) **Pull 2:** *Najas sp., Potamogeton sp.* (short/narrow leaves)	
	North 3 (75m) UTM: 0569363; 5595076	**Pull 1:** *Najas sp., Chara sp.* **Pull 2***: Chara sp., Najas sp.*	
	South 1 (25m) UTM: 0569390; 5594986	**Pull 1:** No plants **Pull 2:** No plants	
	South 2 (50m) UTM: 0569389; 5594972	**Pull 1:** *Chara sp.* **Pull 2:** *Myriophyllum sp., Chara sp.*	
	South 3 (75m) UTM: 0569401; 5594942	**Pull 1:** *Chara sp.* **Pull 2:** *Chara sp*.	
6. Althalmer/ Pete's Marina	Boat Launch UTM: 0569527; 5596336	**Pull 1:** *Elodea canadensis, Myriophyllum sp., Najas sp.* **Pull 2***: Myriophyllum* (1 fragment)	Most heavily used public boat launch access point on Lake Windermere.
	South 1 (25m) UTM: 0569536; 5596313	**Pull 1:** *Myriophyllum sp., Najas sp., Potamogeton richardsonii, Chara sp., Elodea canadensis* **Pull 2:** *Chara sp., Myriophyllum sp., Potamogeton sp.*(short/narrow leaves), *Potomogeton richardsonii, Najas sp.,*	
	South 2 (50m) UTM: 0569543; 5596290	N/A	No survey; extensive riparian shrubs obstructing sampling location.
	South 3 (75m)	N/A	No survey; extensive riparian shrubs obstructing sampling location. Did not sample here in 2015-2019.
	North 1 (25m) UTM: 0569523; 5596361	**Pull 1**: *Najas sp., Chara sp., Potamogeton richardsonii, Myriophyllum sp., Elodea canadensis* **Pull 2:** *Najas sp., Chara sp., Potamogeton richardsonii, Myriophyllum sp., Elodea canadensis*	

	North 2 (50m) UTM: 0569515; 5596382	**Pull 1:** *Najas sp., Myriophyllum sp., Potamogeton richardsonii, Chara sp.* **Pull 2:** *Najas sp., Myriophyllum sp., Potamogeton richardsonii, Chara sp., Elodea canadensis*	
	North 3 (75m) UTM: 0569507; 5596414	**Pull 1:** N/A **Pull 2:** N/A	Did not throw the rake as there were several salmon here spawning. Could see well through shallow clear water, saw the following: *Potamogeton sp.*(short/narrow leaves), *Elodea canadensis, Potamogeton richardsonii, Chara sp., Najas sp., Myriophyllum sp., Sago, Ranunculus aquatilis, Potamogeton pectinatus, Potamogetan vaginatus.*

Appendix 2. Results from the rake pulls conducted during offshore aquatic invasive plant inventories at 11 survey stations on Lake Windermere, on September 17, 2018.

Survey Station	GPS coordinates (UTM)	Distance from shore (m)	Rake Pull # or transect survey	Aquatic Plant Species
Rushmere	0574794; 5585427	N/A	1	*Chara sp., Potamogeton natans*
Rushmere	0574794; 5585427	N/A	2	*Chara sp., Potamogeton natans*
Rushmere	0574794; 5585427	N/A	3	*Chara sp., Potamogeton natans*
Rushmere	0574794; 5585427	N/A	4	*Potamogeton natans, aquitic moss, Chara sp.*
Rushmere	N/A	N/A	100 m transect	*Chara sp., Potamogeton natans*
Rushmere	0574733; 5585505	159	1	*Chara sp., Elodea canadensis, Potamogeton natans, Potamogeton sp.* (short/narrow leaves), *aquatic moss*
Rushmere	0574733; 5585505	159	2	*Chara sp. Potamogeton natans, Potamogeton richardsonii*
Rushmere	0574733; 5585505	159	3	*Chara sp., Potamogeton natans*
Rushmere	0574733; 5585505	159	4	*Chara sp., Potamogeton natans, Myriphyllum sp., Potamogeton sp.* (short/narrow leaves)
Lakeshore Resort	0574820; 5586547	46	1	*Chara sp.*
Lakeshore Resort	0574820; 5586547	46	2	*Chara sp.*
Lakeshore Resort	0574820; 5586547	46	3	*Chara sp., Utricularia sp., Najas sp., Myriophyllum sp.*
Lakeshore Resort	0574820; 5586547	46	4	*Chara sp., Potamogeton sp.* (leaves disintegrated), Potamogeton sp. (short/narrow leaves)
Lakeshore Resort	N/A	N/A	100m transect	No additional plant species seen.
Lakeshore Resort	0574729; 5586612	124	1	*Chara sp., Najas sp.,* aquatic moss*, Potamogeton sp.* (leaves disintegrated)
Lakeshore Resort	0574729; 5586612	124	2	*Najas sp., Potamogeton sp. (*leaves disintegrated*), Megalodonta beckii, Chara sp.*
Lakeshore Resort	0574729; 5586612	124	3	*Chara sp.Potamogeton sp.* (leaves disintegrated)*, Najas sp.*
Lakeshore Resort	0574729; 5586612	124	4	*Chara sp., Potamogeton sp.* (leaves disintegrated)*, Myriophyllum sp.*
Ruault Road	0573140; 5587220	30	1	*Elodea canadensis, Myriophyllum sp., Megalodonta beckii*
Ruault Road	0573140;	30	2	*Elodea canadensis, Myriophyllum sp., Potamogeton richardsonii, Megalodonta beckii*

	5587220			
Ruault Road	0573140; 5587220	30	3	*Elodea canadensis, Myriophyllum sp., Potamogeton richardsonii*
Ruault Road	0573140; 5587220	30	4	*Elodea canadensis, Myriophyllum sp., Potamogeton richardsonii, Potamogeton praelongus, Ranunculus aquatilis*
Ruault Road	N/A	N/A	100m transect	Only additional plant was *Potamogeton natans*. Diverse and abundant beds of aquatic vegetation.
Ruault Road	0573085; 5587309	119	1	*Myriophyllum sp., Potamogeton natans*
Ruault Road	0573085; 5587309	119	2	*Myriophyllum sp., Potamogeton praelongus, Potamogeton natans, Megalodonta beckii*
Ruault Road	0573085; 5587309	119	3	*Myriophyllum sp., Potamogeton richardsonii*
Ruault Road	0573085; 5587309	119	4	*Myriophyllum sp., Utricularia sp., Potamogeton richardsonii*
Indigenous Beach	0572504; 5589039	110	1	No aquatic plants.
Indigenous Beach	0572504; 5589039	110	2	No aquatic plants.
Indigenous Beach	0572504; 5589039	110	3	*Chara sp., Najas sp., Potamogeton sp.* (short/narrow leaves), *Elodea canadendis, Myriophyllum sp.*
Indigenous Beach	0572504; 5589039	110	4	*Chara sp., Potamogeton sp.* (leaves disintegrated), *Potamogeton sp.* (short/narrow leaves), *Myriophyllum sp.*
Indigenous Beach	N/A	N/A	100m transect	Additional speciest: *Potamogeton natans, Potamogeton richardsonii.* Sandy substrate, little plant life.
Indigenous Beach	0572416; 5589115	59	1	*Chara sp.,* aquatic moss
Indigenous Beach	0572416; 5589115	59	2	*Chara sp.,* aquatic moss
Indigenous Beach	0572416; 5589115	59	3	*Chara sp.*
Indigenous Beach	0572416; 5589115	59	4	*Chara sp., Potamogeton sp. (short/narrow leaves), Najas sp.*
Tretheway Docks	0571745; 5589729	104	1	*Chara sp.*
Tretheway Docks	0571745; 5589729	104	2	*Chara sp.,Myriophyllum sp.* (1 fragment)
Tretheway Docks	0571745; 5589729	104	3	*Chara sp.,Myriophyllum sp., Elodea canadensis*
Tretheway Docks	0571745; 5589729	104	4	*Chara sp.*
Tretheway Docks	N/A	N/A	100m transect	No additional plant species seen. Sandy substrate with little plant life detected.
Tretheway Docks	0571645; 5589790	N/A	1	No aquatic plants. Sandy substrate with some rocks and freshwater mussels present.
Tretheway Docks	0571645;	N/A	2	No aquatic plants. Sandy substrate with some rocks and freshwater mussels present.

	5589790			
Tretheway Docks	0571645; 5589790	N/A	3	No aquatic plants. Sandy substrate with some rocks and freshwater mussels present.
Tretheway Docks	0571645; 5589790	N/A	4	No aquatic plants. Sandy substrate with some rocks and freshwater mussels present.
Akisknook Docks	0571281; 5591443	69	1	*Myriophyllum sp.*
Akisknook Docks	0571281; 5591443	69	2	*Myriophyllum sp.*
Akisknook Docks	0571281; 5591443	69	3	*Myriophyllum sp., Najas sp.*
Akisknook Docks	0571281; 5591443	69	4	*Myriophyllum sp., Elodea candensis, Potamogeton pectinatus*
Akisknook Docks	N/A	N/A	100m transect	Deep water, could not see lake bottom during transect.
Akisknook Docks	0571236; 5591551	84	1	*Myriophyllum sp., Elodea canadensis, Najas sp.*
Akisknook Docks	0571236; 5591551	84	2	*Myriophyllum sp., Elodea canadensis, Potamogeton richardsonii*
Akisknook Docks	0571236; 5591551	84	3	*Elodea canadensis, Myriophyllum sp.*
Akisknook Docks	0571236; 5591551	84	4	*Myriophyllum sp., Elodea canadensis,*
End of Coy Road	0570204; 5590738	77	1	*Chara sp., Najas sp., Myriophyllum sp.*
End of Coy Road	0570204; 5590738	77	2	*Chara sp., Najas sp., Myriophyllum sp., Potamogeton vaginatus*
End of Coy Road	0570204; 5590738	77	3	*Chara sp., Najas sp., Myriophyllum sp., Potamogeton sp.* (short/narrow leaves)
End of Coy Road	0570204; 5590738	77	4	*Chara sp., Najas sp., Potamogeton sp.* (short/narrow leaves)
End of Coy Road	N/A	N/A	100m transect	No additional plant species seen.
End of Coy Road	0570174; 5590838	84	1	*Chara sp., Elodea canadensis, Potamogeton sp.* (short/narrow leaves), *Megalodonta beckii*
End of Coy Road	0570174; 5590838	84	2	*Chara sp., Potamogeton sp.* (short/narrow leaves)
End of Coy Road	0570174; 5590838	84	3	*Chara sp., Megalodonta beckii, Potamogeton sp.* (short/narrow leaves)
End of Coy Road	0570174; 5590838	84	4	*Chara sp.*
Baltac Beach	0571112; 5593401	91	1	*Chara sp.*
Baltac Beach	0571112; 5593401	91	2	No aquatic plants detected.
Baltac Beach	0571112;	91	3	No aquatic plants detected.

	5593401			
Baltac Beach	0571112; 5593401	91	4	*Chara sp.*
Baltac Beach	N/A	N/A	100m transect	No additional plant species seen. Sandy substrate with little plant life; mussels present on lake bottom.
Baltac Beach	0571009; 5593448	64	1	*Chara sp., Potamogeton sp.* (leaves disintigrated)
Baltac Beach	0571009; 5593448	64	2	*Chara sp.*
Baltac Beach	0571009; 5593448	64	3	No aquatic plants detected.
Baltac Beach	0571009; 5593448	64	4	No aquatic plants detected.
Lakeview Meadows	N/A	N/A	1	*Elodea candensis, Chara sp., Najas sp., Myriophyllum sp., Megalodonta beckii, Potamogeton sp.* (short/narrow leaves)*, Potamogeton pectinatus*
Lakeview Meadows	0570183; 5594068	N/A	2	*Chara sp, Potamogeton pictinatus, Potamogeton vaginatus, Najas sp., Elodea candensis, Megalodonta beckii, Myriophyllum sp.*
Lakeview Meadows	0570183; 5594068	N/A	3	*Chara sp., Potamogeton vaginatus, Najas sp., Potamogeton sp.* (short/narrow leaves)
Lakeview Meadows	0570183; 5594068	N/A	4	*Chara sp., Myriophyllum sp., Elodea canadensis, Potamogeton sp.* (short/narrow leaves)
Lakeview Meadows	N/A	N/A	100m transect	Dense beds of Myriophyllum seen. Glare off water; hard to ID plants.
Lakeview Meadows	0570189; 5594172	96	1	*Chara sp., Myriophyllum sp.*
Lakeview Meadows	0570189; 5594172	96	2	*Chara sp.*
Lakeview Meadows	0570189; 5594172	96	3	*Chara sp.*
Lakeview Meadows	0570189; 5594172	96	4	*Chara sp., Elodea canadensis*
Unofficial boat launch near Bayshore Condos	0569449; 5595035	101	1	*Myriophyllum sp., Chara sp.*
Unofficial boat launch near Bayshore Condos	0569449; 5595035	101	2	*Myriophyllum sp., Chara sp.*
Unofficial boat launch near Bayshore Condos	0569449; 5595035	101	3	*Chara sp., Potamogeton praelongus, Potamogeton pectinatus*
Unofficial boat launch near Bayshore Condos	0569449; 5595035	101	4	*Chara sp., Myriophyllum sp., Potamogeton pictinatus*
Unofficial boat launch near Bayshore Condos	N/A	N/A	100m transect	Deep water, could not see lake bottom during transect.
Unofficial boat launch near Bayshore Condos	0569427; 5595149	97	1	*Chara sp.*
Unofficial boat launch near Bayshore Condos	0569427; 5595149	97	2	*Chara sp.*

Unofficial boat launch near Bayshore Condos	0569427; 5595149	97	3	*Chara sp.*
Unofficial boat launch near Bayshore Condos	0569427; 5595149	97	4	*Chara sp.*
Althalmer/Pete's Marina	0569572; 5596300	22	1	No plants.
Althalmer/Pete's Marina	0569572; 5596300	22	2	Myriophyllum sp.
Althalmer/Pete's Marina	0569572; 5596300	22	3	*Myriophyllum sp., Najas sp., Potamogeton vaginatus , Potamogeton pectinatus, Potamogeton richardsonii*
Althalmer/Pete's Marina	0569572; 5596300	22	4	*Myriophyllum sp., Potamogeton sp.* (leaves disintigrated)*, Chara sp., Potamogeton pectinatus*
Althalmer/Pete's Marina	N/A	N/A	100m transect	Winds with ripples on water, could not ID underwater plants.
Althalmer/Pete's Marina	0569538; 55996404	19	1	*Chara sp., Potamogeton richardsonii*
Althalmer/Pete's Marina	0569538; 55996404	19	2	*Chara sp., Myriophyllum sp., Potamogeton pictinatus,Potamogeton vaginatus*
Althalmer/Pete's Marina	0569538; 55996404	19	3	*Chara sp., Potamogeton pectinatus, Myriophyllum sp., Elodea candensis*
Althalmer/Pete's Marina	0569538; 55996404	19	4	*Myriophyllum sp., Chara sp., Potamogeton pictinatus, Potamogeton vaginatus, Potamogeton richardsonii*