COLUMBIA VALLEY LOCAL CONSERVATION FUND (CVLCF)
FINAL REPORT
2019

General Instructions

- Final reports must be submitted **by 4:00 pm MT January 31, 2020** to the Kootenay Conservation Program. Email final report to info@kootenayconservation.ca.
- All areas of the final report must be answered.

Section A – GENERAL INFORMATION	
1. Project Title (as indicated in application): Lake Windermere Community-Based Watershed Monitoring Project	
2. Proponent	
a) Legal Name: Lake Windermere Ambassadors Society	
b) Organization Registration #: S-57451	
c) Mailing Address: PO Box 601, 625 4th Street, Invermere BC	Postal Code: V0A 1K0
d) Contact: Shannon McGinty	
e) Telephone #: (250) 341 6898	f) Fax #:
g) Email: info@lakeambassadors.ca	
3. Partner *(if applicable)*	
a) Legal Name:	
b) Organization Registration #:	
c) Mailing Address:	Postal Code:
d) Contact:	
e) Telephone #:	f) Fax #:
g) Email:	

Section B – PROJECT INFORMATION
1. Project Location: Lake Windermere, District of Invermere, RDEK Area F (ie: RDEK area, watershed, direction from major centre, etc)
2. Total Project Value: $43,203.00
3. CVLCF Contribution: $10,000.00
4. Non-CVLCF Contribution: $33,203.00
5. Single or multiple year project: Single year funding requested; project is multi-year ongoing

Section C – PROJECT SUMMARY

1. Please provide a single paragraph describing your project, its objective (goals) and the results. As this summary will be used in CVLCF communications, clearly state the issues addressed and avoid overly technical descriptions. Maximum 2000 characters (~290 words).

Our project had three main goals/objectives:
1) To empower citizens and decision-makers with current, comprehensive, and reliable data about Lake Windermere's water quality and ecological health;
2) To strengthen a community ethic of stewardship and conservation in the Lake Windermere watershed;
3) To promote support for science-based management on behalf of local and regional governments.

We were able to achieve these goals through:
- continuing to collect scientific data about the lake, creeks, and public beaches (as per MOE guidelines);
- continuing to collect information about waterfowl populations using the lake;
- building on our preliminary attempts at flow monitoring by improving our flow logger setup and continuing to collect data to develop a rating curve for Windermere creek and Abel creek;
- collecting data that will lead to preparation of a State of the Lake report in 2020 (analyzing at least 10 years of data and highlighting long-term changes to water quality, sensitive habitat and foreshore areas, and summarizing our current understanding of water quantity/flows and fish and wildlife populations) and beginning work on the State of the Lake Report;
- continuing to update our water data portal website with graphs, tables, and information that can be used as an educational tool for classrooms and individuals; and,
- compiling all of this information into resources for stewardship and conservation education and outreach, targeting opportunities to improve water quality, restore and protect fish and wildlife habitat, and provide management recommendations that will help preserve ecological integrity of shorelines and upland areas.

2. OPTIONAL: If your project lends itself to sparking interest through a compelling sound bite (for potential use in CVLCF communications), please tell us what that would be. Maximum 1050 characters (~150 words).

Support received from the CVLCF has been instrumental in the Lake Windermere Ambassadors being able to continue to deliver and grow our programming. We have been able to collect extensive baseline water quality and quantity data over the past nine years, build connections for the community with the health of Lake Windermere, create projects to improve ecological condition of Lake Windermere, and manage threats to the watershed as they arise.

3. Biodiversity Targets (please list, maximum 90 words):

1) Monitoring and protection of large and small hydro-riparian systems (Columbia River/Lake Windermere/Windermere Creek/Abel Creek)
2) Monitoring and protection of shallow open water (shallow areas of Lake Windermere/transition to north and south portions of the Columbia Wetlands) We aim to reduce threats to these systems through ongoing monitoring and community-based action to help improve water quality, shoreline health, and wildlife habitat, and thus help protect important flora and fauna of these ecosystems.

4. IUCN Threats to Target (please list, maximum 90 words):

1) Invasive and Problematic Species – Work with EKISC and Aquatic Invasive Plant Survey completed in fall
2) Climate Change (Droughts, Temperature Extremes, and Storms/Floods) - improved our flow and temperature monitoring and communication about water conservation and irrigation practices in summer.
3) Pollution (Run Off) - improved our understanding of how storm runoff impacts tributary stream quality through weekly monitoring, and increased our water quality monitoring to look at a wider range of pollutants in Lake Windermere including heavy metals
4) Recreational Disturbance - Ongoing education and outreach to the boating community about the relationship between responsible boating practices and lake health

Section D – PROJECT DELIVERABLES AND RESULTS

1. Identify the deliverables outlined in your application in the table below (50 words/field) and list the results of each. Please include copies of any relevant communications products (brochures, posters, videos, websites, photos of signage, etc.) resulting from this project. Add an attachment if you need more room.

Deliverables	Results
≥ 40 Citizen science volunteers trained in water monitoring, invasive species ID, and/or fish and grebe ID or survey procedures	Annual Creek and Lake monitoring program saw a total of 24 volunteers who contributed 67.5 hours total. These volunteers were trained as Citizen Scientists in water monitoring. Throughout the fall we had an additional 16 volunteers trained through our fall creek sampling (3) and Lake Keepers Workshop (13) for a total of 40 Citizen Scientists
≥ 1,000 Individuals reached by educational stewardship information at public events, markets, boat launches, and other venues	Since March of this year The Ambassadors have interacted with 1,422 individuals through events such as shoreline cleanups, Wings Over the Rockies Presentation, Paddle Palooza Festival, Farmers Market, local classroom visits and field trips, boat launch outreach, and free kids summer camps.
≥ 5 Educational articles or pieces in local media highlighting monitoring project, results, and/or stewardship education, plus CVLCF funding contribution ≥ 1 Educational brochure or handout related to improving water quality and/or taking direct action to reduce impacts to biodiversity	Since April of 2019 the Ambassadors have published monthly education articles in the pioneer and on our website, totaling 11. The Ambassadors developed and printed two educational brochures related to water quality and stewardship this summer, and printed our Green Boating Guides.
≥ 1 Management recommendation for local governments or citizens to improve water quality and conservation ≥ 3 Presentations to decision-makers about water quality results and management recommendations ≥ 2 Presentations to non-decision makers about results	4 Management recommendations were provided to DOI and 3 were provided to RDEK, progress of recommendations is being tracked. We have provided a total of 3 water quality presentations, for the public, DOI, and RDEK, additionally we provided many lakeshore communities with a written update and will be presenting at their AGM's this spring
≥ 1 Grebe and/or waterbird surveys ≥ 1 Fish counts ≥ 1 New or expanded partnership with fishing community to help “crowd source” information about fish catches/sightings and undertake fish counts /under-ice observations	One Grebe study is scheduled for October of this year. The Ambassadors have connected with a consulting firm to conduct fish counts. We have developed a relationship with the LWRGC to share data, and have crowd sourced information on fish populations through distribution of surveys to fisher people.
1 Final report in fall 2019 summarizing annual findings Develop rating curve for Windermere Creek Track website traffic and # of visitors to water data site	The 2019 Water Quality Report has been completed and shared. We are working with local experts to develop the rating curve on Windermere Creek. We are continuously tracking website traffic and spent much time this year updating our water data site to provide visitors with the most available up to date information relating to water quality

Section E – PROJECT EFFECTIVENESS

1. Please evaluate the effectiveness of the project using objective standards, quantifiable criteria and/or quality control measures identified in your application/proposal. Maximum 2000 characters (~290 words).

This project continues to deliver benefits to the residents and visitors of the Lake Windermere watershed. In 2019 we were able to empower citizens and decision-makers with current, comprehensive, and reliable data about Lake Windermere's water quality and ecological health. This was accomplished through four types of monitoring efforts (lake, creeks, beaches, and specialized surveys), performed weekly and seasonally from April to October. Empowerment came through the sharing of results by a variety of means including presentations, workshops, published reports, articles, and "pulse checks", and online data access. We were also able to strengthen a community ethic of stewardship and conservation in the Lake Windermere watershed. While hard to measure we feel we met this objective through our community outreach and citizen science programs. We trained 40 new citizen scientists of all ages in water sampling procedures (both on the lake and creeks), and interacted directly with 1,422 individuals at a variety of events to share stewardship information on Lake Windermere. Lastly, we promoted support for science-based management on behalf of local and regional governments. This was accomplished through the publishing of two scientific reports (2019 Annual Water Quality Report, and 2019 Aquatic Invasive Plant Survey), a total of 7 management recommendations based on this year's findings and the Lake Windermere Management Plan made to the District of Invermere and Regional District of East Kootenay (while also following up on prior year recommendations), and continuing to act as the Lake Management Committee for both local governments.

2. What are the top 3 lessons learned from the project that would be important to communicate to others doing similar work throughout the RDEK? Maximum 1050 characters (~150 words).

1. Data Sharing is essential and builds efficiencies. We work closely with several groups (Living Lakes Canada, BC Lake Stewardship Society, East Kootenay Invasive Species Council) and are constantly learning about what is happening within the watershed that has an impact on Lake Windermere. Without these open lines of communication there would be much duplication in works being done
2. Take a step back and look at the bigger picture. We know that the climate is changing, with this there is a lot of uncertainty around how it will effect freshwater resources. We began our 10 Year State of the Lake Report this year and are still working on it, but being able to step back and look at everything provides a lot of direction on where to focus moving forward.
3. Leverage the funding. We were able to leverage additional funding support from several sources to help support future programs, all thanks to the initial investment by the CVLCF

Section F – FURTHER COMMENTS

1. Please provide any further comments including recommendations for future conservation efforts. If your project produced a narrative or scientific report or additional project products (e.g. maps, photos), attach them as an Appendix (maximum 90 words).

See attachments

Section G – FINANCIAL REPORT

1. Please submit a financial report for the project outlining revenue and expenditures with a comparison to the budget submitted with your CVLCF application. **Use the Final Budget Reporting form provided.** Details on any discrepancies from the budgeted amounts or items are required (maximum 90 words).

Columbia Valley Local Conservation Fund (CVLCF) Final Reporting Budget

Proponent: Lake Windermere Ambassadors Society

Project Title:

Please include both cash and in-kind amounts, and itemize all projected revenues and expenditures, confirmed and pending (including in-kind contributions). Please ensure revenues and expenses balance.

Be sure to identify the specific component(s) of the project allocated to the Columbia Valley Local Conservation Fund. Record them in the "CVLCF Funding" column.

Please remove all green text upon completion of this Budget Form.

REVENUES:

	APPLICATION		FINAL REPORTING		
Funders	Estimated Cash Amount	In-kind Amount	Actual Funds Received	Actual In-kind	Additional Comments
CVLCF	$10,000.00		$10,000.00		
Columbia Valley Community Foundation	$6,000.00		$5,000.00		Staff hours, public outreach & education, kids' programs, etc.
Columbia Basin Trust	$8,000.00		$10,325.00		Sample shipping / lab analysis, data analysis, final report preparation, some admin
Donations (Local Businesses, Individual Donors)	$445.00		$810.00		From farmer's markets, fundraisers, requests for support, membership donations
District of Invermere - Fee For Service	$1,000.00		$1,000.00		Supports core expenses (e.g. rent, admin fees)
Regional District of East Kootenay - Development Tax	$1,000.00		$1,000.00		Supports core expenses (e.g. rent, admin fees)
Volunteer work hours		$2,100.00		$2,080.00	130 hours @ 16.00 / hour
Volunteer boat donation for lake tours & sampling events		$1,200.00		$1,600.00	Boat driving time, boat use, and fuel costs (4 outings)
Local business support		$500.00		$273.00	Advertising and equipment donations
Interior Health Authority		$1,500.00		$1,500.00	Sampling fees & shipment, hosting Swim Beach app & website info
East Kootenay Invasive Species Council		$1,000.00		$1,000.00	Towards veliger (mussels) sampling & education
District of Invermere - use of tin boat and fuel		$5,875.00		$5,025.00	At least 16 lake sampling excursions and 2 aquatic invasives excursions ($270 per outing), plus delivery & fuel
Living Lakes Canada, Columbia Basin Watershed Network, Columbia Lake Stewardship Society, BC Lake Stew. Society		$1,500.00		$2,300.00	Professional support and advising (hours & mileage), equipment/Resource sharing
Goldeneye Ecological Services		$800.00		$1,290.00	Towards aquatic invasives sampling
Total Amounts	$26,445.00	$14,475.00	$28,135.00	$15,068.00	
TOTAL REVENUE	$40,920.00		$43,203.00		

EXPENSES:

		APPLICATION				FINAL REPORTING				
Expense Items	Details (if applicable)	Cash	In-kind	Total Budget	CVLCF Funding	Actual Cash Spent	Actual In-Kind	Actual Total Budget	CVLCF Funding	Explaination
Bookkeeping	$100/month * 12 months plus $500 for payroll	$1,700.00		$1,700.00	$300.00	$2,804.00		$2,804.00	$300.00	Changed plans to have more accurate bookkeeping
Professional support, advising, and resource sharing	From relevant program partners (CBWN, EKISC, LLC, BCLSS, CLSS)		$1,500.00	$1,500.00			$1,500.00	$1,500.00		
Office Utilities	$280/month X 12 months	$3,360.00		$3,360.00	$500.00	$3,080.00		$3,080.00	$500.00	
Telephone & Internet	$110/month X 12 months	$1,320.00		$1,320.00	$200.00	$496.00		$496.00	$200.00	Received Non-Profit Discount
Advertising, media promotions, equipment donations	Local business support		$500.00	$500.00			$273.00	$273.00		
Contingency	Unexpected expense	$150.00		$150.00	$40.00	$150.00		$150.00	$40.00	
Lake Monitoring										
Program Coordinator	80 hrs X $30/hr (60 hours sampling + 10 hours volunteer coordination/logistics + 10 hours equipment calibration / care / troubleshooting)	$2,400.00		$2,400.00	$1,200.00	$2,400.00		$2,400.00	$1,324.15	
Summer Student	72 hrs X $16/hr (12 outings @ 6 hours per outing)	$1,152.00		$1,152.00	$600.00	$1,152.00		$1,152.00	$600.00	
Volunteer Labour	85 hours X $16/hr (17 outings @ 5 hours per outing)		$1,360.00	$1,360.00			$1,360.00	$1,360.00		
Volunteer boat driving time, boat use, and fuel	3 days X $400/day, for sampling or events		$1,200.00	$1,200.00			$1,600.00	$1,600.00		Had additional volunteer boats, totalling 4 days
Boat delivery (DOI Public Works)	30 hrs X $35/hr		$1,035.00	$1,035.00			$1,035.00	$1,035.00		
Use of boat and fuel (DOI Public Works)	At least 17 outings with boat @ $210 per outing (half day)		$3,570.00	$3,570.00			$3,990.00	$3,990.00		Had a total of 19 outings
Mileage	10 km X 17 sample trips = 170 km X $0.53/km Plus shipping samples from Cranbrook courier (x3), at 260km round trip = 260 km X $0.53/km	$500.00		$500.00	$200.00	$500.00		$500.00	$200.00	
Printing for data sheets & final report	Waterproof Paper, printer ink, field sheets & notebooks & professional report printing (at least 20 hard copies)	$300.00		$300.00	$100.00	$770.00		$770.00	$515.56	Final reports higher than anticipated cost
Project Supplies	Pens/markers, labels, Batteries, Replacement Chemicals & Calibration Liquids	$550.00		$550.00	$50.00	$550.00		$550.00	$149.48	Reallocated funds to purchase necessary project supplies
Shipping	$60/shipment X 5 shipments	$300.00		$300.00	$100.00	$200.00		$200.00	$100.00	New shipping company, lower fees
Lab Analysis (anions, metals, nutrients, coliforms, alkalinity, TDS)	$350/shipment X 3 shipments (April, May, September)	$1,050.00		$1,050.00	$1,050.00	$1,050.00		$1,050.00	$422.81	Received additional funding to cover lab work, reallocated to Printing and Project Supplies
Contractor - Annual Data Review & Reporting	35 hrs X $30/hr	$1,050.00		$1,050.00	$475.00	$1,050.00		$1,050.00	$475.00	
Beach Monitoring								$0.00		
Program Coordinator	5 hrs X $30/hr	$150.00		$150.00	$50.00	$200.00		$200.00	$87.42	Reallocated based on work distribution, Summer Student spent
Summer Student	15 hrs X $16/hr	$240.00		$240.00	$100.00	$190.00		$190.00	$62.58	more time on Outreach Program
Data sheets, sample shipment & analysis fees	Interior Health Authority in-kind support		$1,500.00	$1,500.00			$1,500.00	$1,500.00		
Mileage	20km * 13 sample trips = 260km @ 0.53¢/km	$138.00		$138.00		$138.00		$138.00		
Tributary Monitoring										
Program Coordinator	30 hours X $30/hr (5 months @ 6 hours per month)	$900.00		$900.00	$600.00	$1,100.00		$1,100.00	$800.00	Reallocated based on work distribution, Summer Student spent
Summer Student	30 hours X $16/hr	$480.00		$480.00	$200.00	$280.00		$280.00	$0.00	more time on Outreach Program
Volunteer Labour	20 hours X $16/hr		$320.00	$320.00			$320.00	$320.00		
Printing for data sheets & final report	Paper & ink	$50.00		$50.00		$50.00		$50.00		
Mileage	120 km X $0.53/km (6 round trips to Windermere) Plus shipping samples from Cranbrook courier (x4) at 260 km round trip	$620.00		$620.00	$200.00	$620.00		$620.00	$200.00	
Shipping	4 shipments X $60/shipment (April, May, June, September)	$240.00		$240.00	$100.00	$200.00		$200.00	$71.46	New shipping company, lower fees, reallocated remaining balance to Professional Fees
Lab Analysis (TSS, Metals, Alkalinity, E. coli)	$350/shipment X 4 shipments	$1,400.00		$1,400.00	$770.00	$1,400.00		$1,400.00	$0.00	Had additional funding for streams, reallocated remaining balance to Professional Fees
Invertebrate taxonomy analysis & shipment	Vancouver-based invertebrate taxonomist	$700.00		$700.00	$200.00	$500.00		$500.00	$0.00	Taxonomist fees less than anticipated reallocated within same portion of project
Contractor - Data Review/CABIN entry & Reporting	25 hrs X $30/hr	$750.00		$750.00	$300.00	$950.00		$950.00	$500.00	
Public Outreach								$0.00		
Program Coordinator	60 hours X $30/hr	$1,800.00		$1,800.00		$1,800.00		$1,800.00		
Summer Student	80 hours X $16/hr	$1,280.00		$1,280.00		$1,500.00		$1,500.00		
Volunteers	25 hours X $16/hr		$400.00	$400.00			$400.00	$400.00		
Printing for outreach materials	Brochures, signage, banners for display booth	$1,000.00		$1,000.00		$1,000.00		$1,000.00		
Aquatic Invasives Sampling Program								$0.00		
Program Coordinator	10 hours X $30/hr	$300.00		$300.00	$100.00	$300.00		$300.00	$100.00	
Professional Fees	50 hrs X $40/hr	$2,000.00	$800.00	$2,800.00	$2,000.00	$3,200.00	$800.00	$4,000.00	$3,351.54	Able to expand project work and allocate funds to be spent on contractors for State of the Lake Report and much desired Fish surveys on Lake Windermere
Travel	700 km X $0.53/km	$370.00		$370.00	$370.00	$370.00		$370.00	$0.00	Covered by other funders, Reallocated to Professional Fees
Meals	3 days X $65/day	$195.00		$195.00	$195.00	$135.00		$135.00	$0.00	Covered by other funders, Reallocated to Professional Fees
Motorized vessel, sampling equipment, ID books and GPS	Boat ($500/ full day X 2 days) + fuel + sampling equipment		$1,290.00	$1,290.00			$1,290.00	$1,290.00		
Veliger (invasive mussels) staff time, sampling equipment and lab fees	East Kootenay Invasive Species Council		$1,000.00	$1,000.00			$1,000.00	$1,000.00		
Total Expenses		$26,445.00	$14,475.00	$40,920.00	$10,000.00	$28,135.00	$15,068.00	$43,203.00	$10,000.00	
						$43,203.00				

2019 Annual Report

www.lakeambassadors.ca
625 4th Street, PO Box 601, Invermere, BC, V0A1K0
(250) 341 6898

Prepared by Shannon McGinty, BSc
Program Coordinator, Lake Windermere Ambassadors

Published December 2019

Thank you to our funders and supporters

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Lake Windermere Ambassadors are a society of community volunteers and cross-sector stakeholders representing local business, recreation, tourism, commercial marinas, water stewardship, ecological conservation, second homeowners, year-round residents, First Nations, two local governments, and youth. The Ambassadors evolved from foundations created by the highly successful Lake Windermere Project which ran from 2005-2010. Since 2010, our organization has been monitoring water quality and working with stakeholders in the Lake Windermere watershed in pursuit of our vision.

Our mandate is the protection of Lake Windermere in perpetuity. We aim to achieve this through our Vision and Mission Statements:

Vision: *An ecologically healthy Lake Windermere with balanced management approaches that support recreation and traditional uses, high fish and wildlife values, and economic prosperity in the region.*

Mission: *Through collaboration of representatives of key community sectors, the Lake Windermere Ambassadors will serve as a resource for future projects benefiting the health of Lake Windermere.*

The Lake Windermere Ambassadors have been designated the Lake Management Committee by the Regional District of the East Kootenay and the District of Invermere. The primary role of the Lake Management Committee is to assist each district in implementing the recommendations in the Lake Windermere Management Plan and providing comment on development referrals.

This report details highlights and project work completed from January to December 2019.

Healthy water for healthy communities

MESSAGE FROM THE PROGRAM COORDINATOR

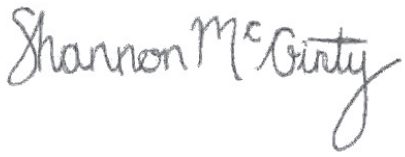
The Lake Windermere Ambassadors have undergone many projects over the past eight years, and this year was no different. As Lake Windermere faces new threats, challenges, and opportunities we adapt our programming to match them. In 2019 the Ambassadors engaged the community through outreach and education, monitored water quality and quantity, and built and maintained partnerships with a variety of water stewardship organizations to improve both our programming and assist in theirs.

The Ambassadors main focus has been community outreach and education; this allows all of our other work to have a meaningful impact. This year we employed a variety of methods to reach as much of the community as possible. We used many traditional methods, including newsletters, articles in the paper and Farmers Market outreach, along with some more involved methods including free summer camps, boat launch outreach, and signage installations. Through each method we were able to share the importance of Lake Windermere to our community and provide direction on keeping the lake healthy.

Our next largest focus area is on water quality and quantity monitoring. We were able to expand our monitoring program this year to include water quantity which hasn't been included in previous years. Although we are still developing this side of the program we were able to collect a full season's worth of input data on Windermere and Abel Creeks. As the understanding of water quality is ever expanding we too are adapting our program to be relevant and useful to the Lake Windermere watershed.

As a new addition to The Ambassadors in late 2018, I was excited for the 2019 year, and prepared to do a lot of learning. Moving into 2020 I am continuing to learn, but optimistic that I will be able to continue to improve on The Ambassadors programming. We are planning to publish a ten-year State of the Lake Report, complete an updated Sensitive Habitat Inventory Map, improve public access, and continue to grow our outreach and education this year, along with our ongoing programming.

I am truly honoured to be a part of The Ambassadors and to be able to contribute to the work being done to protect and improve this critical resource in our community.



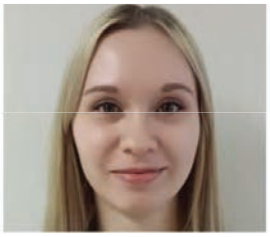
Shannon McGinty, BSc.
Lake Windermere Ambassadors
Program Coordinator

lake windermere ambassadors
healthy water for healthy communities

THE TEAM

Paul Christy
President

Shawn Ridsdale
Vice President

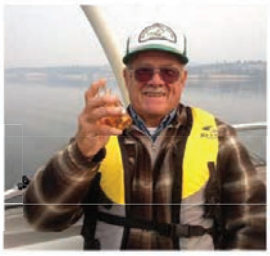


Jennifer Beverley
Secretary

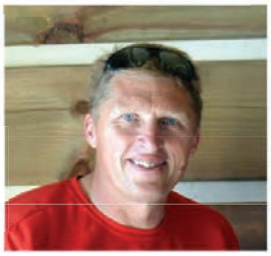
Taoya Schaefer
Treasurer

Gurmeet Brar
Director at Large

Paola Albano
Director at Large



Buzz Harmsworth
Director at Large



Max Fanderl
Director at Large

Katie Watt
Director at Large

Keri Malanchuk
Water Stewardship Intern

Shannon McGinty
Program Coordinator

Local Government Advisors

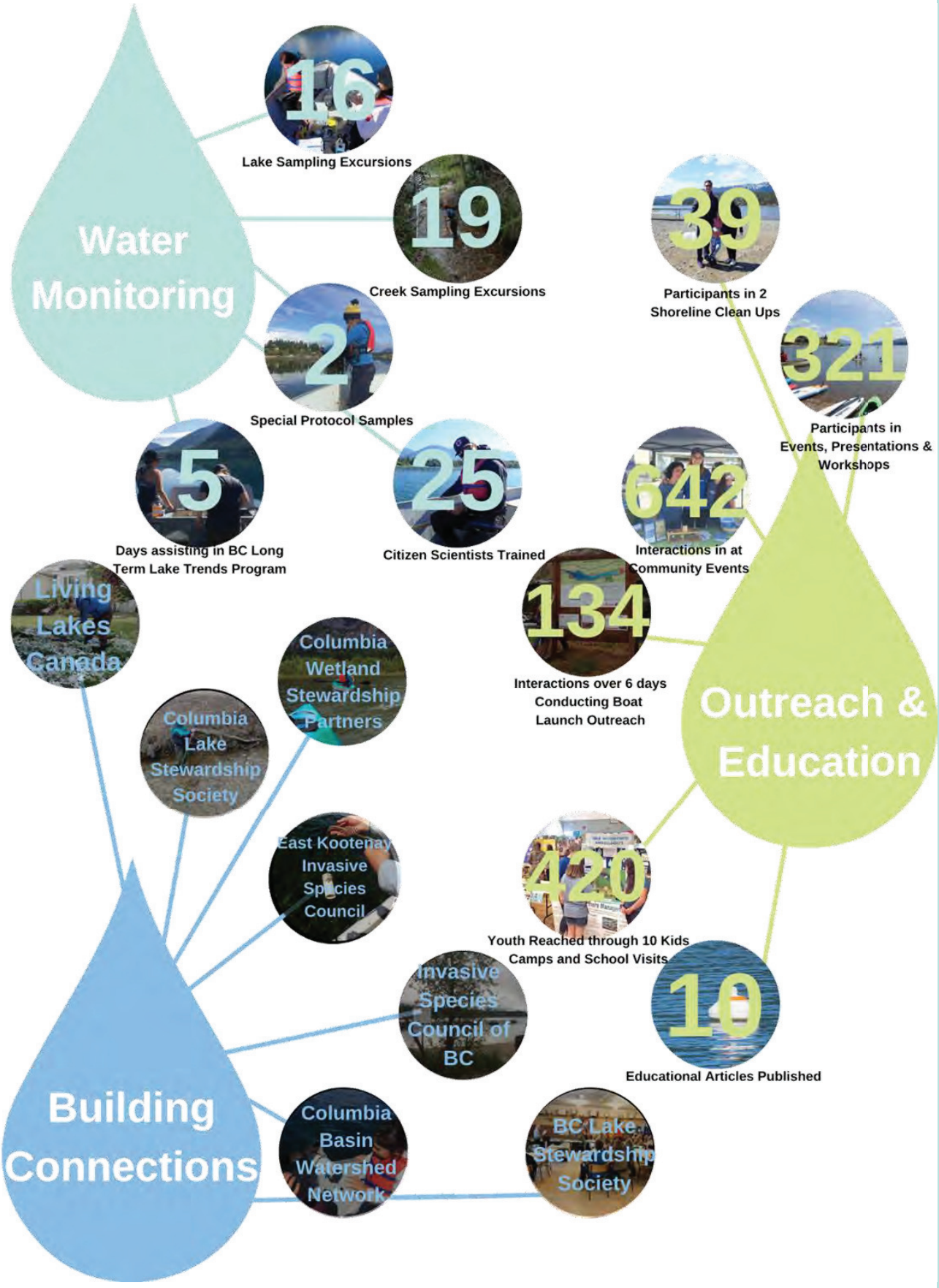
Susan Clovechok
Regional District of East Kootenay

Ute Juras
District of Invermere

Mark Thomas
Shuswap Band

VACANT
Akisqnuk First Nation

HIGHLIGHTS


Water Monitoring
16
Lake Sampling Excursions
19
Creek Sampling Excursions
2
Special Protocol Samples
5
Days assisting in BC Long Term Lake Trends Program
25
Citizen Scientists Trained
39
Participants in 2 Shoreline Clean Ups
321
Participants in Events, Presentations & Workshops
642
Interactions in at Community Events
134
Interactions over 6 days Conducting Boat Launch Outreach
Outreach & Education
420
Youth Reached through 10 Kids Camps and School Visits
10
Educational Articles Published
Living Lakes Canada
Columbia Wetland Stewardship Partners
Columbia Lake Stewardship Society
East Kootenay Invasive Species Council
Invasive Species Council of BC
Building Connections
Columbia Basin Watershed Network
BC Lake Stewardship Society

PROJECT WORK

The Ambassadors focussed this year's work in three main project areas: Outreach and Education; Water Monitoring; and Building Connections. Through each avenue, we were able to meet our work plan goals and see success in our program.

Outreach and Education

In 2019 the Ambassadors engaged with the community through a many methods of outreach. We had an overall impression reaching approximately 6,500 community members and visitors; we directly interacted with 1,556 individuals. Below is a list of every thing we did and participated in this year to connect with the community:

- Whiteway Outreach
- Snowflake Festival
- Invermere Coffee and Tea Festival
- Winter Whiteway Clean Up
- 8th Annual General Meeting
- Spring Shoreline Clean Up
- JA Laird Shoreline Clean Up
- Wings Over the Rockies Creek Sampling Demonstrations
- 2nd Annual Paddle Palooza
- Laird Environmental Education Fair
- Presentation at 2020 BC Budget Consultations
- Farmers Markets
- Boat Launch Outreach
- Educational signage installations
- Canada Day Festival
- Free Kids Summer Camps
- Valley Appreciation Day
- Community Paddle Night
- Lake Windermere Aquathon
- Salmon Festival
- BC Rivers Day Paddle and Film
- Kootenay Conservation Program Annual Fall Gathering
- BC Lake Stewardship Society Annual Meeting
- Columbia River Treaty Negotiation Update Meetings
- Columbia River Transboundary Conference
- Vancouver International Film Fest
- Windermere Valley Ski Swap
- Toby Creek Nordic Ski Club Annual General Meeting
- Columbia Basin Watershed Network Annual Meetings
- Community Water Quality Presentation
- Water Quality Presentation to District of Invermere Mayor and Council
- Online presence
- Educational Articles
- Columbia Basin Alliance for Literacy Presentation
- Columbia Valley Community Foundation Annual General Meeting
- Classroom Presentation at Eileen Madson Primary
- Partnership with Wildsight on Know Your Watershed education
- LakeKeepers Workshop

Boat Launch Outreach and Educational Signage Installations

This year the Ambassadors were able to bring a project that began in 2017 to completion, although the effect of the project will continue for the foreseeable future. In 2019, the Ambassadors published our updated Green Boating Guides. These include information for boaters, both motorized and non-motorized, of how to minimize your impact while still enjoying the lake. We handed out 63 Green Boating Packages (include the Green Boating Guide, and other relevant information), and have many more to hand out next year!

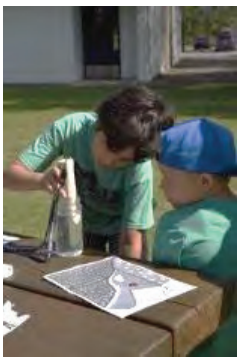
Paired with the education we were able to install a large lake map sign, provided in part by the District of Invermere and the Sign Artist, and four Clean, Drain, Dry signs, provided by the Invasive Species Council of BC. The large lake sign can be found adjacent to Pete's Marina at the public Athalmer Motorized Boat Launch, while the Clean, Drain, Dry signs are located at:

- Public Athalmer Motorized Boat Launch
- Public Athalmer Non-Motorized Boat Launch
- Bayshore Boat Launch
- Windermere Beach

Overall we found the public to be receptive to the education being provided and often interested in learning more about the health of the lake, changes over the past few years, public access opportunities, enforcement of zoning and structures on the lake, and plant growth in the lake.

Free Kids Summer Camps

2019 was the second year that we ran free kids summer camps. We were able to expand our offering to six public camps held at James Chabot Provincial Park, and two at Shady Brook Resort in July and August. Our camps covered a variety of topics all related to the Lake Windermere watershed. We had 87 kids participate over the whole summer, some of that being repeat attendees at multiple camps. Providing we continue to have the capacity, we will continue to run these camps for the community.



Educational Articles

From April to November we published monthly articles in the Newspaper and a couple supplementary articles on our website. These articles ranged in topics but aimed to provide the community with information related to Lake Windermere and watershed health. The table below outlines articles published and topics covered:

Date	Location	Title	Author
April 18, 2019	Columbia Valley Pioneer	Critters of the Lake	Shannon McGinty
May 16, 2019	Columbia Valley Pioneer	Slow Down to Avoid Watery Conflicts	Shawn Ridsdale
May 23, 2019	Columbia Valley Pioneer	Finding Fish	Shannon McGinty
June 13, 2019	www.lakeambassadors.ca	All Plastics Lead to the Ocean	Keri Malanchuk
June 27, 2019	Columbia Valley Pioneer	Just What are we Testing for in These Waters?	Shannon McGinty
July 11, 2019	Columbia Valley Pioneer	What is Swimmers Itch?	Shannon McGinty
August 8, 2019	www.lakeambassadors.ca	Mooring Buoy Info	Keri Malanchuk
August 22, 2019	Columbia Valley Pioneer	What's in your Sunscreen	Shannon McGinty
September 12, 2019	Columbia Valley Pioneer	Not so Golden to have Goldfish in the Lake	Shannon McGinty
October 17, 2019	Columbia Valley Pioneer	Columbia River Treaty Meeting to Come to Town	Shannon McGinty
November 14, 2019	Columbia Valley Pioneer	Watching our Water Foot Print	Shannon McGinty

In addition to these articles, we published weekly "Pulse Checks" from April to September highlighting the findings from that week's water monitoring and providing education on water monitoring parameters.

Lake Keepers Workshop

In partnership with the BC Lake Stewardship Society (BCLSS), we hosted a Lake Keepers Workshop in late October 2019. This workshop focussed on:

- Lake Ecology
- Lake Monitoring – Parameters & Program Design
- Care and Management of Lakes and Riparian Areas
- Aquatic Plants
- Watershed Assessments & Planning
- Invasive Species

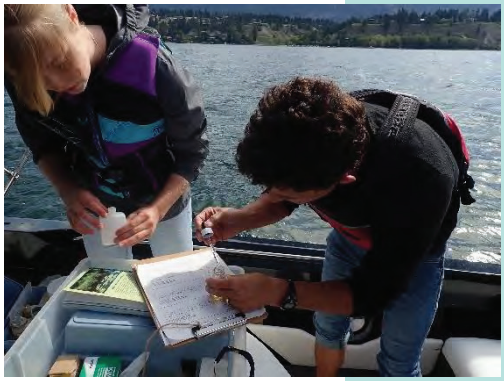
Ten individuals completed the two-day workshop that consisted of one full day in class and one day in the field. We were lucky enough to have Norm Zirnhelt of BCLSS host and lead the workshop, and Jess Paloposki of the East Kootenay Invasive Species Council provide a guest presentation on the effects of invasive species and mitigation efforts.

Water Monitoring

2019 marked the ninth year of sampling for the Lake Windermere Ambassadors, with baseline data collected for four years prior during the Lake Windermere Project. This year we were able to continue our annual program, and expand to cover more areas becoming more pertinent in a changing climate. The program continued to focus on the lake, tributaries, and beaches.

Lake Windermere Monitoring

Our 2019 sampling season began with our participation in the BC Government Long Term Lake Trends project on April 19, 2019, collecting detailed freshet data. We then continued our weekly Lake Monitoring starting on May 21, 2019 through to September 24, 2019. During this time, we completed 18 excursions, and trained 25 citizen scientists, who gave a total of 84.5 volunteer hours. Our standard sampling regime was conducted in accordance with recommendations from the Ministry of Environment in the updated Water Quality Objectives for Lake Windermere, released November 2010. This includes weekly measurements of specific conductivity, pH, temperature, dissolved oxygen, and turbidity. Weekly field observations for air temperature, water depth, water clarity, wind speed and direction, and cloud cover were also recorded. Lastly, total and dissolved phosphorous were tested monthly. A continuous water temperature logger was installed near Fort Point to collect more accurate and representative water temperature data.



In addition to our standard sampling regime, we completed two special protocol excursions, and monitored for invasive mussels. The two special protocol excursions were an Aquatic Invasive Plant survey on September 17, 2019, and a Water Bird Survey on October 10, 2019. Monitoring for invasive mussels was done with Substrate Samplers installed at six locations on the east side of the lake, Lakeview Meadows, Terra Vista Community Association, Akiskinook Resort, Windermere Public Beach, Cardif Cove Marina, and Lakeshore Campground. Through this sampling, no invasive species were found to be present in Lake Windermere.

Results and interpretations from all lake sampling will be shared in our 2019 Water Quality Report, and will be used toward completing our 2020 State of the Lake Report. Both reports will be shared locally, provided to stakeholder groups, made available online

(our website, social media, and Ministry of Environments Eco-Catalogue), and through presentations and community outreach.

Tributary Monitoring

Similar to lake monitoring we monitored two tributaries that flow into Lake Windermere. Windermere Creek and Abel Creek received weekly monitoring from May 22, 2019 to September 4, 2019, plus one final collection on October 18, 2019. Our sampling protocol followed the Columbia Basin Water Quality Monitoring Project's protocols, which are closely aligned to the Canadian Aquatic Biomonitoring Network's sampling methodology. Weekly measurements taken include streamflow, specific conductivity, pH, temperature, dissolved oxygen, and turbidity. Weekly field observations for air temperature, wind speed and direction, and cloud cover were also recorded. Total and dissolved phosphorous were tested monthly, and invertebrate samples were collected monthly for eDNA analysis. Both Windermere and Abel creek have HOBO Water Level Loggers on them collecting continuous data.

This data is currently being shared through our Data Portal website, and will be used in the 2020 State of the Lake Report.

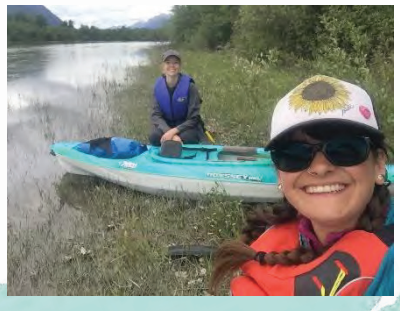
Public Beach Monitoring

In collaboration with the Interior Health Authority, we collected weekly beach water quality samples from Kinsmen, James Chabot, and Windermere Beach May 13, 2019 to August 19, 2019 (excluding long weekends). Samples were analyzed for *E.coli* through the Interior Health Authority laboratories. All public beaches met Ministry of Environment objectives for total *E. coli* counts throughout the summer season.

Building Connections

Much of the work we do is not possible without the support and collaboration with other similar groups. We work with other groups both locally and at a provincial level. Some key projects we received support with this year include:

- Living Lakes Canada Ground Water Monitoring Project providing data sharing opportunities to better understand the flow of water into and out of Lake Windermere
- Columbia Wetlands Stewardship Partners water sample collections to be analyzed for groundwater analysis
- East Kootenay Invasive Species Council providing both educational opportunities and collecting water samples on Lake Windermere to monitor for invasive species



- Columbia Basin Watershed Network providing Summer Mapping Program and Equipment Replacement Grants

Lake Management Committee

From everything in this report to installation of the Slow/No Wake Buoys in Taynton Bay, recommendations to local government and increasing public access opportunities the Ambassadors continue to complete work related to the implementation of the non-regulatory Lake Windermere Management Plan. We did not receive any referrals from the District of Invermere or Regional District of East Kootenay for development and crown land tenure applications on the foreshore of Lake Windermere in 2019. We are confident that we will continue to receive these as they do come in, and will respond to each accordingly.

Financials

The fiscal year for the Ambassadors runs from October 1st to September 30th each year. This year the Ambassadors saw comparable income and spending to previous years, with an annual cash flow of approximately $94,000 supporting this program.

Full financial statements can be found online at lakeambassadors.ca or can be requested from our office at info@lakeambassadors.ca (250) 341 6898.

CONCLUSIONS

2019 was another successful year for the Lake Windermere Ambassadors completing our education, outreach, and monitoring duties as the Lake Management Committee while continuing to grow and expand our programming where appropriate.

ACKNOWLEDGEMENTS

The work we do could not happen without our collaborators, partners, and mentors:

- Adventure Paddle School
- AG Valley Foods
- Akiskinook Resort
- Akisqnuk First Nation
- BC Lakes Stewardship Society
- Black Star Studios
- Café Allium
- Cardiff Cove Marina
- Canada Summer Jobs
- Canadian Freshwater Alliance
- Columbia Basin Trust
- Columbia Basin Watershed Network
- Columbia Lake Stewardship Society
- Columbia River Paddle
- Columbia Valley Community Foundation
- Columbia Valley Escape Rooms
- Columbia Wetlands Stewardship Partners
- Community Donors
- District of Invermere
- Fairmont Pizza and Ice Cream
- Fire Vixen
- East Kootenay Invasive Species Council
- Gerrys Gelati
- Golden Eye Ecological Services, Rachel Darvill
- Hearth2Homes
- Home Hardware
- Hopkins Harvest
- Invasive Species Council of BC
- Invermere Bakery
- Katie Watt, 2018-19 Whiteway Ambassador
- Keri Malanchuck, Water Stewardship Assistant
- Kootenay Conservation Program
- Kootenay River Runners
- Lakeshore Resort
- Lakeview Meadows
- Lake Windermere Aquathon Society
- Leo Burrito
- Living Lakes Canada
- LUSH Charity Pot
- Om Organics
- Our Committed Board of Directors
- Peppis Pizza
- POLIS
- Pynelogs Cultural Centre
- Rainbow Donkey Kids Clothing
- RBC Foundation
- Real Estate Foundation of BC
- Regional District of East Kootenay
- Shady Brook Resort
- Sign Artist
- Shuswap Indian Band
- Terra Vista Community Association
- Toby Creek Nordic Ski Club
- Ullr Bar
- Wildsight Invermere
- Windermere Community Association

lake windermere ambassadors
healthy water for healthy communities

Lake Windermere Community Based Water Quality Monitoring Program

2019 Final Report

January 2020

Report prepared by: Shannon McGinty, BSc.
Program Coordinator, Lake Windermere Ambassadors

Lake Windermere Ambassadors (LWA)
www.lakeambassadors.ca
625 4th Street, PO Box 601, Invermere, BC, V0A 1K0
(250) 341-6898

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Executive Summary

The Lake Windermere Ambassadors direct a Community-Based Water Monitoring and Citizen-Science Education program within the Lake Windermere watershed. 2019 marked the thirteenth year of lake monitoring since the Lake Windermere Project began collecting water quality data in 2006.

In 2019, the Lake Windermere Ambassadors collected physical and chemical water quality parameters at three sample sites on Lake Windermere once weekly during the summer, from late May to September. The lake sampling regime included water temperature, turbidity/clarity, pH, conductivity, depth, and dissolved oxygen. Once monthly from May to September we collected Total Dissolved Phosphorus and Total Phosphorous. In addition, the LWA monitored substrate samplers at six sites on the east side of Lake Windermere for invasive mussels, as well as monitoring tributary flows and water quality at the outlet of Windermere Creek and Abel Creek. *E. coli* data was collected at public swim beaches weekly, from May until September, excluding weeks with a statutory holiday Monday, in partnership with the Interior Health Authority. Lastly, Goldeneye Ecological Services was contracted to complete an aquatic plant survey, and fall waterbird survey on Lake Windermere.

Findings from 2019 show that Lake Windermeres water quality continues to support aquatic life and recreation. The only parameter that deviated from the Ministry of Environment objectives was temperature on one occasion in June. Specific Conductivity and pH were both observed to be outside of the optimal range for aquatic life, but may have been impacted by faulty equipment. The three public swim beaches (Windermere, James Chabot Provincial Park, and Kinsmen) met Interior Health Authority guidelines for recreational quality during all sample collection dates in 2019. The annual aquatic plant survey found no invasive species in Lake Windermere for the tenth year of sampling. While overall there is a healthy abundance of vegetation throughout the lake there were a couple sites of concern that saw less healthy vegetation, particularly where sites saw higher boat traffic (Darvill, 2019). Further to last year's newly developed waterbird survey protocol and investigative report, this year's fall waterbird survey found 18 species observed, 889 individuals, with a number of them being rare sightings and species at risk. Invasive mussel larvae (veligers) were not detected in Lake Windermere as sampled for by the East Kootenay Invasive Species Council in 2019 (BC Conservation Officer Service, 2019).

Our major funders for this project and its final report include the Columbia Valley Local Conservation Fund, the District of Invermere, the Regional District of East Kootenay, the Columbia Basin Trust's Environment Large Grants program, LUSH Charity Foundation, and Royal Bank of Canada Foundation. Additional funding support for our 2019 programs came from the Columbia Valley Community Foundation, the Real Estate Foundation of BC, Canada Summer Jobs, the Columbia Basin Watershed Network, and BC Community Gaming Grants.

Questions about this report?

Contact: Lake Windermere Ambassadors
info@lakeambassadors.ca
250-341-6898

1. Introduction

Lake Windermere is one of two headwaters lakes located at the source of the Columbia River in southeast British Columbia, Canada. The "lake" itself is not a true lake and rather a long widening of the Columbia River, with an average depth of ~3-4m (10-13ft).

Historically, Lake Windermere has supported several species of fish, and is used by hundreds of species of resident and migratory birds (McPherson and Hlushak, 2008). Birds, fish, and wildlife all depend on the lake and its outflows to the Columbia Wetlands, which are one of the longest intact wetlands in North America and a wetland of international importance (Ramsar, 2004).

Humans also depend on Lake Windermere for its social, cultural, environmental, and economic values. Not only is it a drinking water source, but the lake is heavily used for recreation, motorized and non-motorized, in the summer and winter, for business opportunities, and traditional values.

1.1 - Climate

Lake Windermere sits within the Southern Rocky Mountain Trench in the Interior Douglas Fir (IDF) biogeoclimatic zone (Braumandl and Curran, 2002). The region is temperate and experiences all four seasons, characterized by relatively mild, cool winters and dry, hot summers.

Average annual precipitation is in the range of 300-400 mm (Urban Systems 2012; District of Invermere 2017), and most rainfall historically occurs between May and June. Spring freshet usually occurs between late May and early July.

The warmest days of the year have historically been recorded in July and August. 2019 varied from 2017 and 2018, which had been noted as being hot summer years, with significant forest fire activity and minimal summer precipitation. During the 2019 summer season, the region saw increased precipitation, cooler temperatures, and limited forest fire activity.

1.2 - Watershed Characteristics

Lake Windermere sits at approximately 800masl, and is bordered east and west by two distinct mountain ranges, the Purcells and the Rockies. The lake flows from south to north as part of the main channel of the Columbia River, which exits Columbia Lake approximately 20km upstream. Lake Windermere flushes on average every 47 days, contributing to its relatively good water quality (McKean and Nordin, 1985).

The main tributary entering Lake Windermere is Windermere Creek, a fourth-order mountain stream that drains an area of approximately 90 km² (NHC, 2013). Some of the major developments within the Lake Windermere watershed include an active gypsum mine, railroad, roads and highway, agricultural and grazing activities, golf courses, ski hills, urban and residential development, and historical forest harvesting (McPherson et al., 2018).

1.3 - Community-Based Water Monitoring

Concerns about increased development and changes to Lake Windermere in the early 2000's prompted the creation of a community-based water quality-monitoring program and watershed stewardship education initiative, in the form of the Lake Windermere Ambassadors.

The Lake Windermere Ambassadors (LWA) are a community-led, charitable non-profit society formed in 2010 with the mandate of protecting Lake Windermere in perpetuity. The LWA have overseen a Community-Based Water Monitoring program on Lake Windermere since their inception, using the assistance of volunteers, and substantial baseline data collected by Wildsight's Lake Windermere Project. Since 2010, the LWA have added to the monitoring program based on needs and available resources, including, tributary monitoring, invasive species monitoring, and wildlife surveys.

From 2006 to 2009, the Lake Windermere Project worked to assess the quality of Lake Windermere's waters for wildlife and human recreational uses. In 2010, the BC Ministry of Environment took those four years of data, and determined an updated list of Water Quality Objectives for Lake Windermere. These objectives are a benchmark against which the LWA can compare present conditions to evaluate if the lake water quality continues to be suitable for recreational and ecological needs.

By continuing to test lake water quality on a weekly basis in the summer, the LWA now have thirteen years of water quality data for Lake Windermere. This data allows the LWA to detect seasonal and annual changes in water quality, and to communicate information about Lake Windermere that will help inform sustainable watershed planning and restoration initiatives in the Upper Columbia watershed.

1.4 - Sample Sites

Water quality is sampled at three locations on Lake Windermere, which have been in the past monitored by the BC Ministry of Environment and by the Lake Windermere Project. These locations include North (Timber Ridge/Fort Point), Middle (Windermere) and South (Rushmere) sample sites (Figure 1).

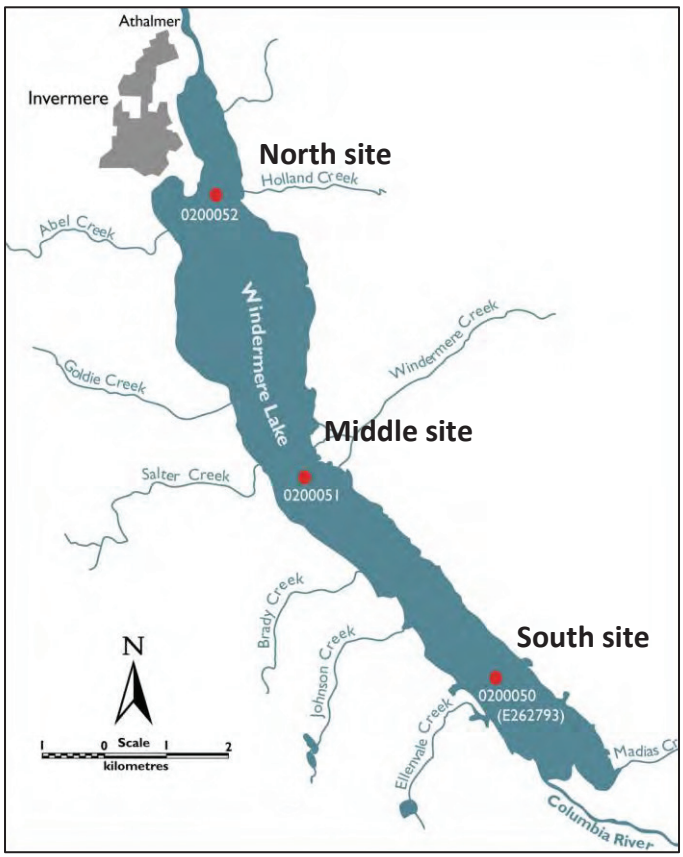


Figure 1: Lake Windermere Sampling Sites: North (0200052), Middle (0200051), and South (0200050). (Image Source: Neufeld et al., 2010)

2. Lake Windermere Water Quality Results

2.1 - Temperature

Overview

Water temperature is critically important to lake health as it has direct impacts on water chemistry (ex. Dissolved oxygen, specific conductivity, water density) and influences the rate of chemical and biological reactions. This effects the ability for aquatic life to grow, survive, and reproduce in an environment (Alberta Regional Aquatics Monitoring Program, 2008).

Due to the shallow depth of Lake Windermere, it has a naturally elevated temperature relative to other freshwater lakes (Neufeld et al., 2010). Unlike deep lakes, Lake Windermere does not stratify into different layers of temperature and density within the water column (McKean and Nordin, 1985).

Summer Student, Keri Malanchuk (right), and volunteer, Shelly Hopkins (left), measuring water temperature and specific conductivity

Warm and clear water makes Lake Windermere a desirable lake for human recreation. However, average summer water temperatures have historically exceeded the BC Ministry of Environment's (MOE) Temperature Guidelines for the protection of freshwater aquatic life (Neufeld et al., 2010). For example, many of the freshwater fish species observed in this lake have optimum temperature ranges below 18°C for rearing, spawning, and incubation (Ministry of Environment, 2017a), whereas historical monthly water temperatures in Lake Windermere have been recorded up to 25°C (Neufeld et al., 2010).

To adjust for the naturally warmer temperatures in Lake Windermere, the MOE set the maximum allowable average monthly water temperatures at 20°C, 25°C, and 23°C in June, July, and August respectively (Neufeld et al., 2010). These guidelines are based on the MOE recommendation that lake water temperatures should remain within ± 1°C of natural conditions.

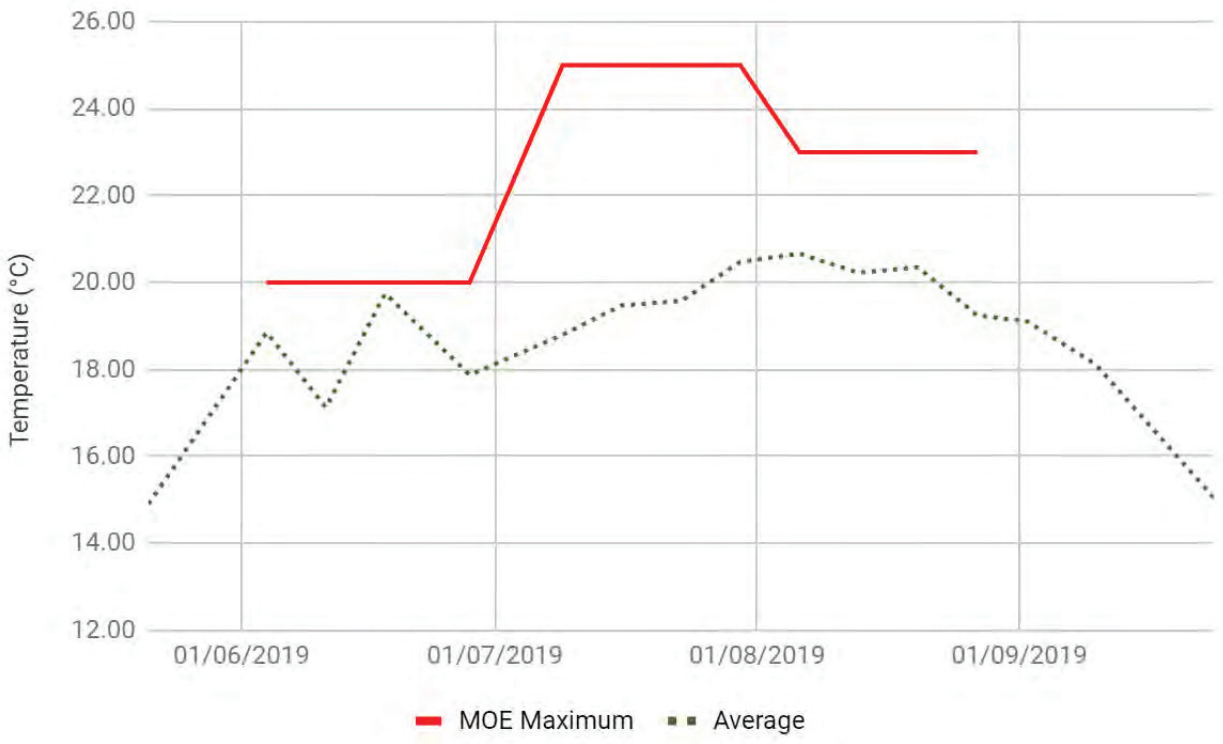
Results

During the 2019 summer season, there was only one instance where the water temperature exceeded the maximum threshold at the North and Middle sample stations. Average monthly temperatures remained consistently below the maximum threshold recommended by MOE (Figure 2a).

The highest temperature measured in 2019 was 22.6°C, recorded on August 6th at the North sample station (Figure 2b). For comparison, the highest temperature measured in 2018 was 23.6°C, on July 31st at the Middle sample site.

To address concerns related to sample time bias, we were able to install a continuous temperature logger located near the North sample site (Figure 2c). Data collected from this device indicated the highest temperature to be 21.89°C on August 9th, which remained in line with the results from our weekly monitoring.

(a)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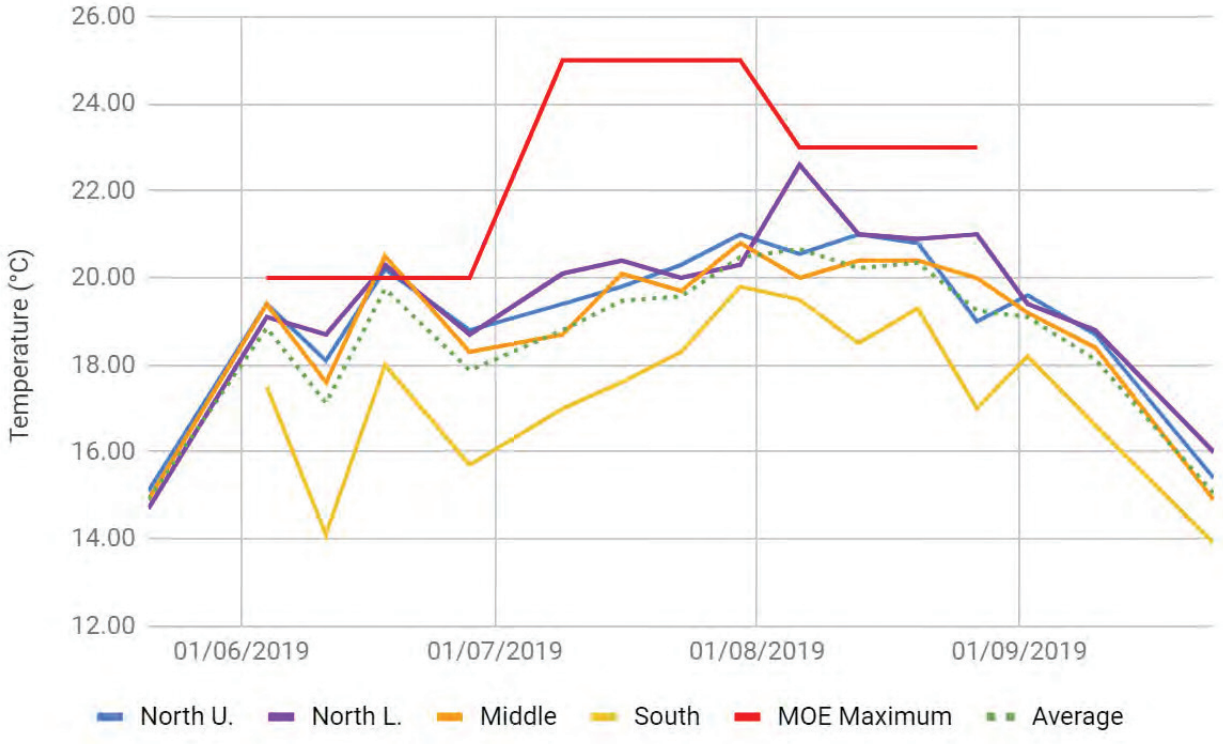
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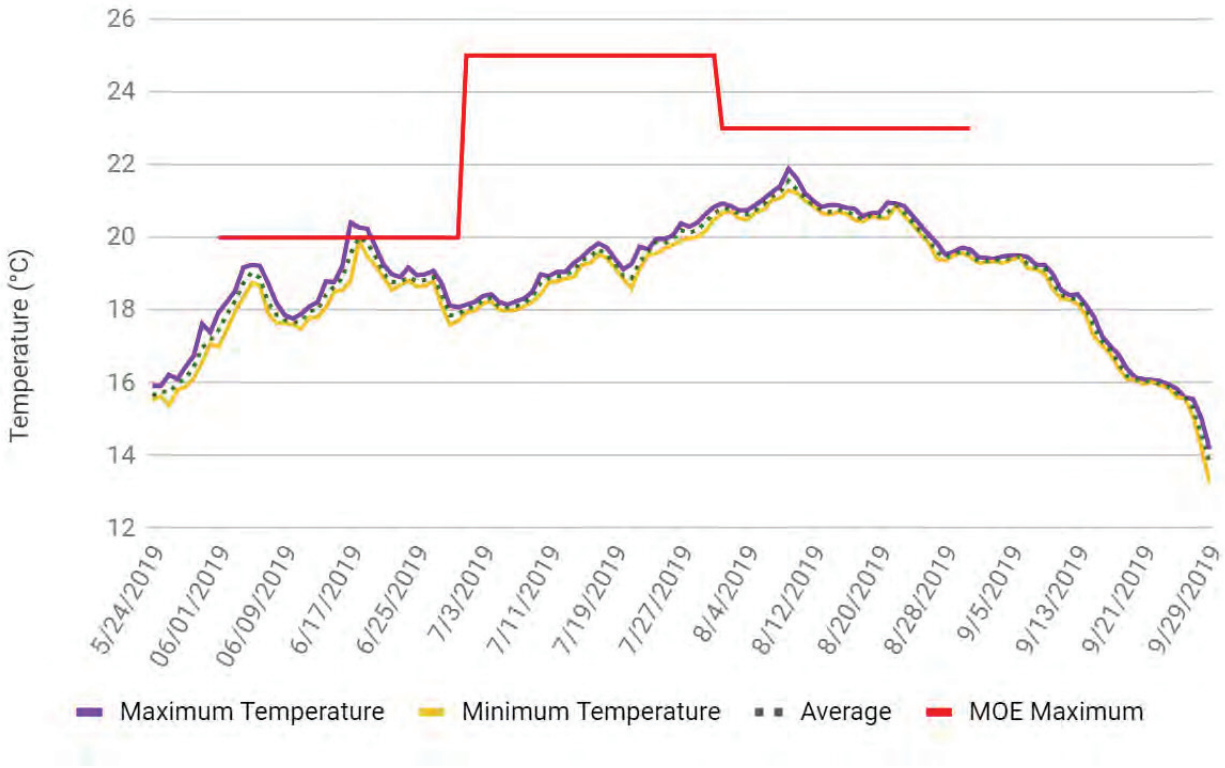
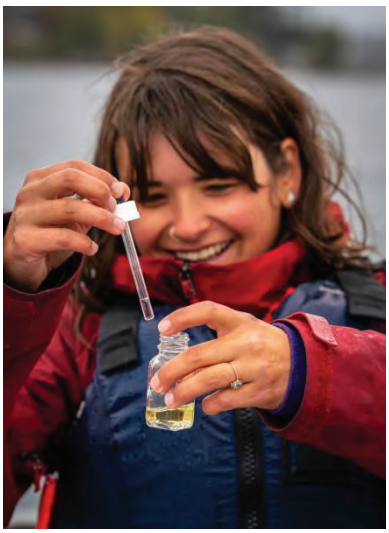


Figure 2: (a) Average water temperature for Lake Windermere, measured weekly from May 20 to September 24, 2019. (b) Water temperature results separated by sample site. (c) Water temperature measurements recorded by continuous temperature logger from May 24 to September 29, 2019.
Note: Lines are for interpretation only, and do not represent continuous measurements.

2.2 - Dissolved Oxygen



Program Coordinator, Shannon McGinty, performing DO Titration. Photo by Pat Morrow

Overview

Dissolved Oxygen (DO) is another name for the free oxygen gas that has dissolved in water. Some amount of DO is required for almost all species of aquatic life to survive, but too much or too little oxygen can harm aquatic life and negatively affect water quality (Ministry of Environment, 2017a).

Oxygen can be transferred to water from the atmosphere or produced by submerged aquatic plants during photosynthesis. It is then removed from the water by respiration in aquatic plants and animals, chemical reactions, and organic decomposition. For example, a large amount of decomposing plant material within a lake can decrease DO concentrations in the water, because the oxygen is consumed during the decomposition process (Neufeld et al., 2010).

The capacity for water to hold dissolved oxygen is inversely related to water temperature. Meaning, warmer water holds less oxygen, and cooler water holds more oxygen (Ministry of Environment, 2017a).

The MOE recommends that DO should never drop below an instantaneous minimum of 5 mg/L, and the guideline for an average of five samples taken over a 30-day period is 8 mg/L (Neufeld et al., 2010; Truelson, 1997). It is also recommended that DO not exceed a maximum of 15 mg/L, in order to prevent negative effects of toxicity (Neufeld et al., 2010).

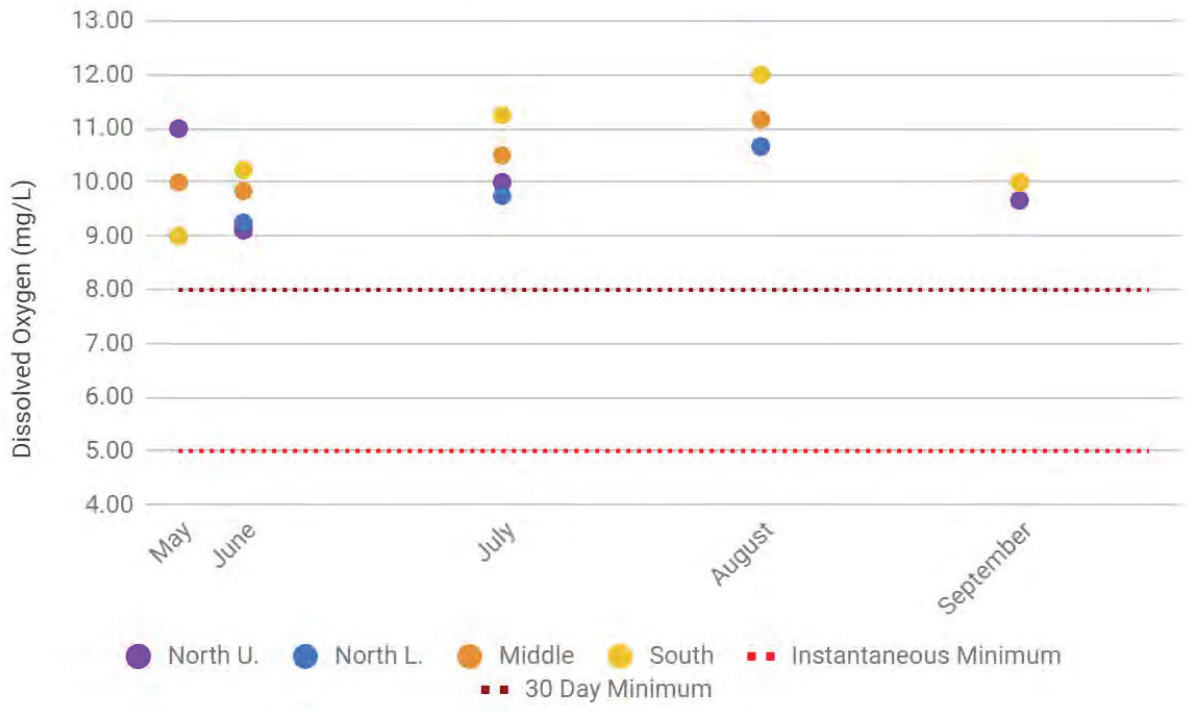
Results

During the 2019 summer season, DO values in Lake Windermere never dropped below the 5 mg/L minimum threshold recommended by MOE (Figure 3a). Instantaneous values ranged between a low of 8 mg/L and a high of 11.32 mg/L (Figure 3b).

The South sample site typically had higher DO values than the other sites. This may be due to the proximity to the Columbia wetlands, which have an abundance of aquatic plant life that are photosynthesizing and contributing oxygen to the water. It may also be due to the slightly cooler temperatures of water flowing out of the wetlands, since cooler water holds more oxygen.

It is important to acknowledge the Winkler titration method used for collecting DO results can come with significant human error if completed or interpreted incorrectly in the field. In previous years we have compared field titration results with readings from a YSI Pro20 Dissolved Oxygen meter, and found the titration results to be within ± 2mg/L of the calibrated meter. This is a significant variation, suggesting the LWA should invest in a DO meter to independently verify the titration readings performed by citizen scientists and ensure a higher level of accuracy in future.

(a)



(b)

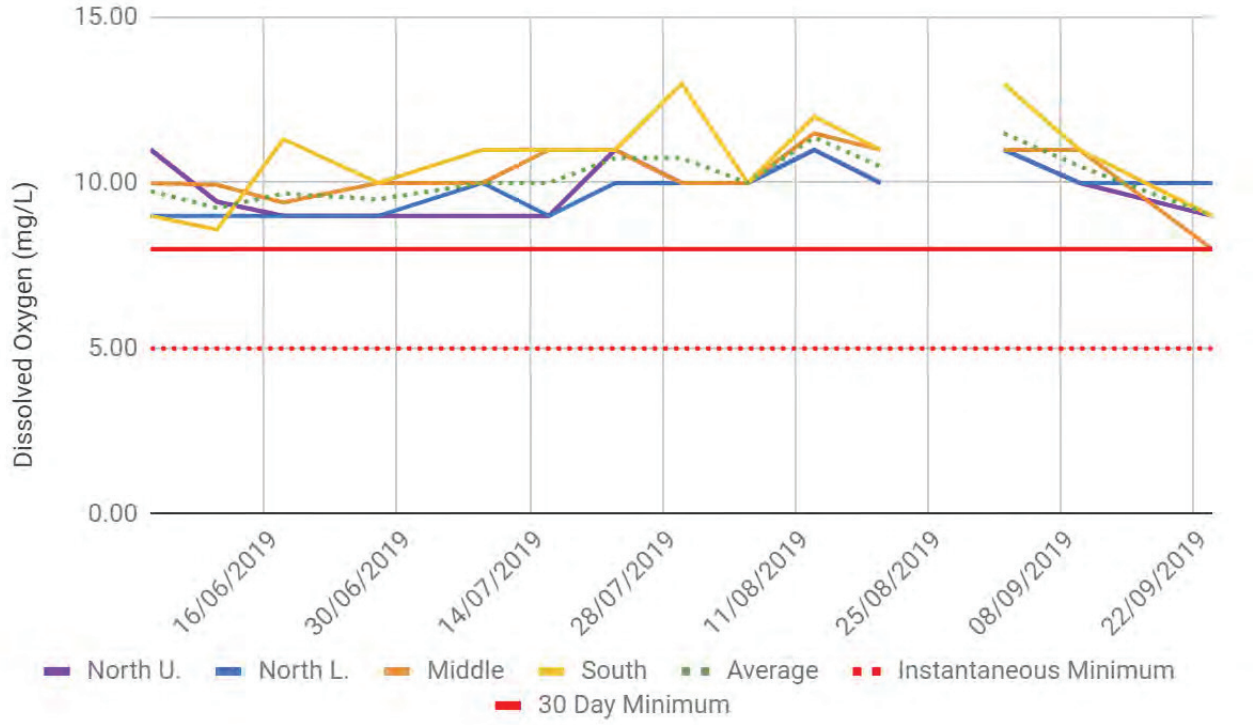


Figure 3: (a) 30-day mean values for dissolved oxygen, calculated for seventeen weeks between May 20 and September 24, 2019. (b) Weekly dissolved oxygen data for Lake Windermere, measured from May 20 to September 24, 2019 (missing data from the week of August 20, 2019).
Note: Lines are for interpretation only, and do not represent continuous measurements.

2.3 - Turbidity

Overview

Turbidity is a measure of the light scattered by particles suspended in water, and indicates the clarity of the water. When waters are highly turbid, such as when they are filled with lots of suspended sediment, light does not penetrate as easily to reach aquatic plants, which reduces photosynthesis. Fish can become stressed due to reduced ability to navigate, clogging of gills, and other physiological stressors (Ministry of Environment, 2017a).

Volunteer Terri Eacrett measuring Turbidity

Since aquatic life in Lake Windermere has adapted to seasonal flushes of sediment into the lake, the acceptable amount of turbidity depends on the time of year. The most turbid waters typically occur during "freshet" (the spring runoff period), or after heavy rainfalls.

The turbidity objectives for Lake Windermere are set to protect recreational water quality and aquatic life (Neufeld et al, 2010). During freshet (May 1 to August 15), in what is known as the "turbid flow period", the 95th percentile of turbidity measurements taken in 5 days over a 30-day period should not exceed 5 NTU (turbidity units). During the "clear flow period" (August 16 to April 30), the maximum turbidity at any time

should be less than or equal to 5 NTU. Additionally, the objective for "clear flow" is that the average of 5 samples over 30 days should not exceed 1 NTU (Neufeld et al, 2010).

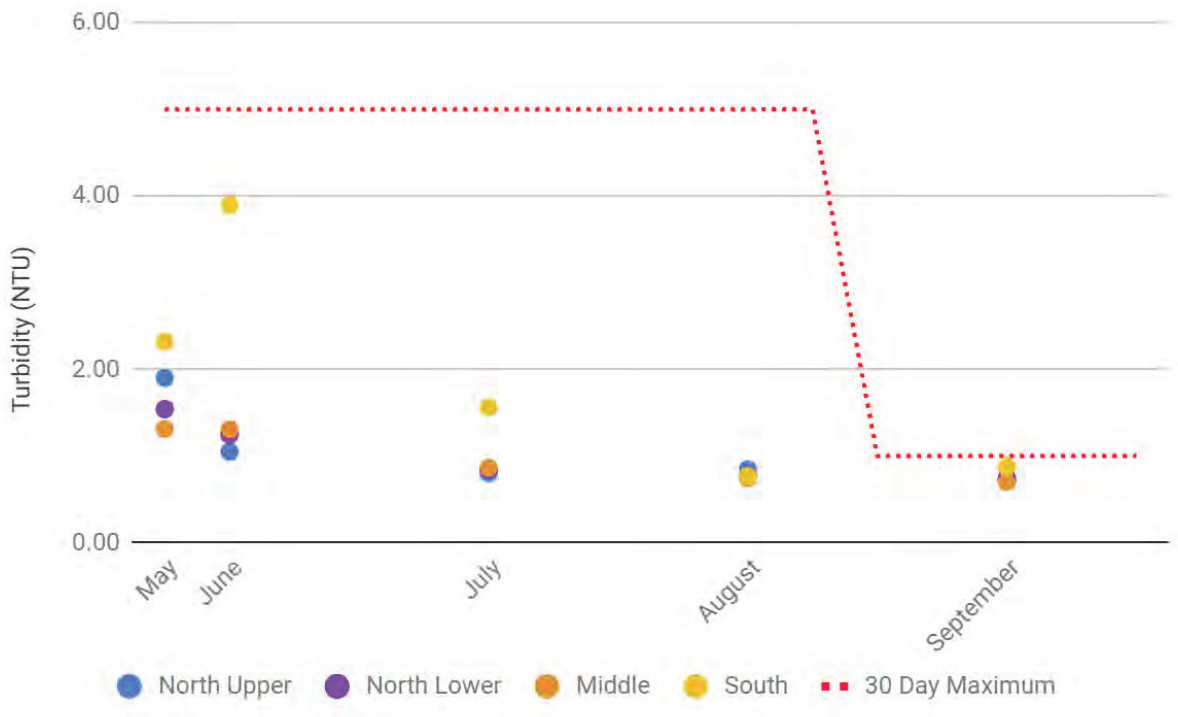
Results

Overall, turbidity in 2019 remained well within the acceptable ranges for recreational water quality and aquatic life. The mean 30-day turbidity values for 2019 did not exceed MOE Recommendations (Figure 4a).

The South sample site saw the highest peaks in turbidity (Figure 4b) likely due to sediment entering the Columbia River through Dutch Creek, and settling out in Lake Windermere. Wetlands usually help to attenuate high turbidity by slowing flows and allowing sediment to settle out; however, the sediment loads coming in through the wetlands in June may have been too high for this to occur. The result is that the South sample site exceeded maximum turbidity values on June 4th, with a reading of 6.75 (Figure 4b). This type of turbidity response is not uncommon for many river systems during freshet, because of the high volumes of meltwater runoff, which can erode lower-order stream channels and carry large amounts of sediment downstream.

During the clear flow period, we saw two instances where readings exceeded MOE objectives, August 20th North sample site 1.07 NTU and September 10th South sample site 1.08 NTU. This might have been due to the high wind events and rain showers in the seven days leading up to sampling, which could have caused sediment runoff into tributary streams and heavy mixing of the lake water to occur because of wave action.

(a)



(b)

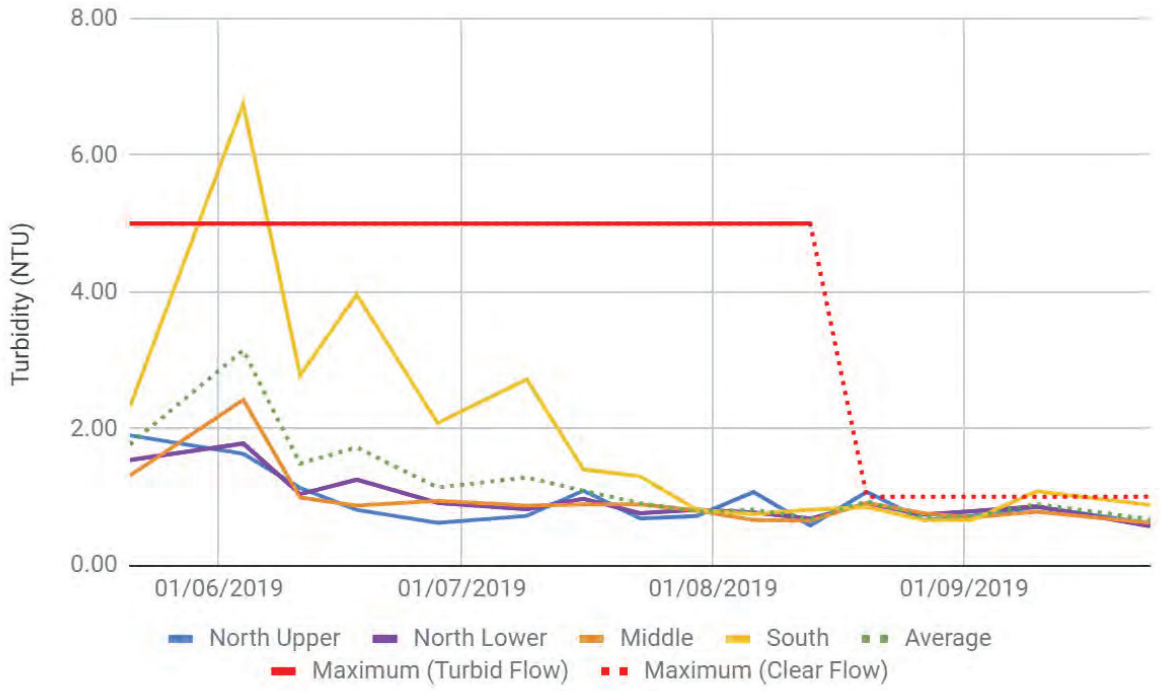
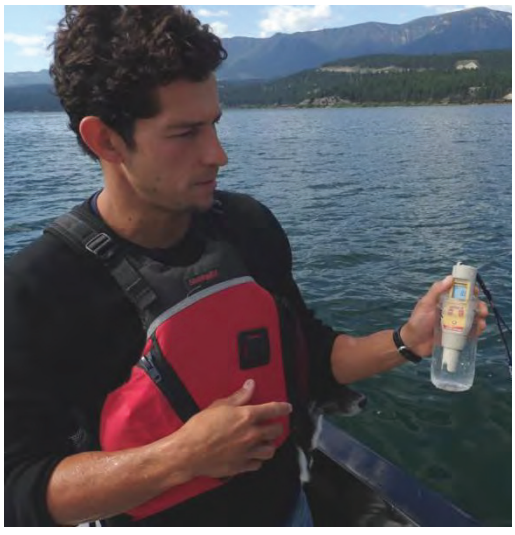


Figure 4: (a) 30-day mean values of turbidity for Lake Windermere, measured weekly from May 14 to September 24, 2019. (b) Weekly turbidity results separated by sample site.
Note: Lines are for interpretation only, and do not represent continuous measurements.

2.4 - pH

Overview

pH is a measure of the free hydrogen ion concentration (H^+) of a solution. pH is reported on a scale from 0 to 14. Solutions with a pH between 0-7 represent an acidic environment, and solutions with a pH between 7-14 represent a basic or alkaline environment.



Volunteer Lorin Inglis measuring pH

pH is reported in logarithmic units, meaning a change in one unit of pH represents a ten-fold change in the actual pH of the solution. For instance, water with a pH of 4.5 is ten times more acidic than water with a pH of 5.5, while water with a pH of 3.5 is one hundred times more acidic than water with a pH of 5.5.

The pH of natural lakes is rarely neutral, because of the presence of dissolved salts and carbonates, aquatic plants, and the mineral composition of the surrounding soils. pH can fluctuate daily as well as seasonally.

Many aquatic species are sensitive to sudden changes in pH, however most species have adapted to deal with the natural pH fluctuations of a lake that are spread over time. If the pH of a lake changes dramatically within a short time frame, it could

be an indicator of a pollution event or some other form of disturbance.

The water in Lake Windermere consistently trends towards slightly alkaline (pH values around 8.5), which is characteristic of lakes fed by water flowing over limestone bedrock materials present in the Canadian Rockies (BC Ministry of Health, 2007; Rollins, 2004). There is no MOE Objective set for pH in Lake Windermere; however, the majority of aquatic organisms prefer a habitat where pH stays within 6.5-9.0 (Neufeld et al, 2010).

Results

pH measured in 2019 was comparable to measurements taken in 2018, which ranged from 8.0 to 9.0. pH measurements for 2019 were recorded to be between 6.80 and 9.10 with an increasing trend as the summer went on (Figure 5a). pH may have an inverse relationship with turbidity, with less turbidity, there are fewer particles available to scatter sunlight that enters the water, and with greater amounts of light reaching submerged aquatic plants then sunlight would not be a limiting factor to photosynthesis or plant growth. This could have increased the bulk photosynthetic rate within the lake, removing more CO_2 from the water and causing the pH to rise over time.

pH is a difficult parameter to accurately measure in the field and the equipment used by the LWA is over ten years old. On May 21st it was observed that from the South sample site to the North sample site there was a change in 1 unit of pH, this is highly unlikely in a lake of this size. It is suspected that readings may not be entirely accurate and it is suggested that lab tests be done to determine the level of accuracy. If this information is found to be accurate it is recommended to look further into the cause of the increase.

(a)

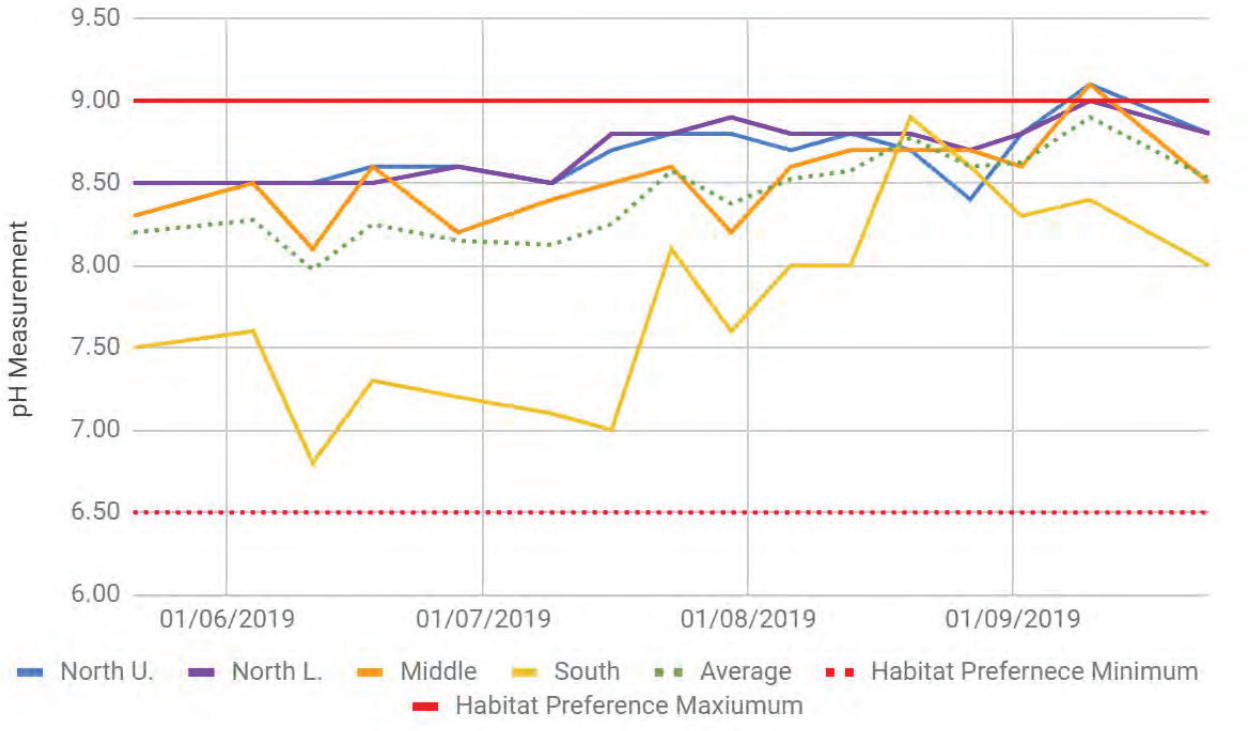


Figure 5: (a) Average pH for Lake Windermere as measured weekly between May 20 and September 24, 2019. *Note: Lines are for interpretation only, and do not represent continuous measurements.*

2.5 - Specific Conductivity

Overview

Specific conductivity measures the ability of water to conduct an electrical current. It is affected by the presence and mobility of ions in the water. Conductive ions include dissolved salts and inorganic compounds, like chlorides, sulfides, and carbonates. For this reason, a measure of conductivity in water may be used as an indicator of water pollution.

Conductivity of water is directly related to water temperature, the warmer the water, the faster the mobility of the ions, and so the higher the conductivity (Behar, 1997). To account for this, we measure the Specific Conductivity which is corrected for the temperature. Specific conductivity of water is also affected by the bedrock geology of the surrounding area, with more weathering-prone bedrock (such as limestones or clays) giving rise to higher conductivity values than more stable bedrock (such as granite).

Volunteer Kris Nickerson measuring water temperature and specific conductivity

Specific conductivity can provide insights about pollutants such as sewage (because the addition of chloride, phosphate, and nitrate rapidly increases conductivity), road salts (high in chloride salts), or an oil spill (oil's organic nature and higher resistance to conducting electricity will reduce the conductivity).

Since specific conductivity values have remained consistent over time in Lake Windermere (on average between 200-300 µS/cm), there are no MOE objectives. It is, however, still important to monitor and observe if changes in conductivity are occurring which might negatively affect aquatic health. Freshwater streams can support diverse aquatic life with a conductivity range of 150 - 300 µS/cm (Behar, 1997; Weaver and Northrup, 2016). Therefore, readings above or below these values should be treated with caution and possibly investigated further.

Results

Specific conductivity in Lake Windermere ranged between 169.90 to 361.60 µS/cm in 2019 (Figure 6a). Specific conductivity was lowest at the South sample site, which is near the outlet of the southern wetlands.

Data gaps on August 6th and 27th are due to equipment failure; a temporary fix solved this problem for August 13th and 20th, but after the second failure it was determined our equipment was no longer sufficient. An identical unit was borrowed from Columbia Lake Stewardship Society for the remaining September sampling sessions.

(a)

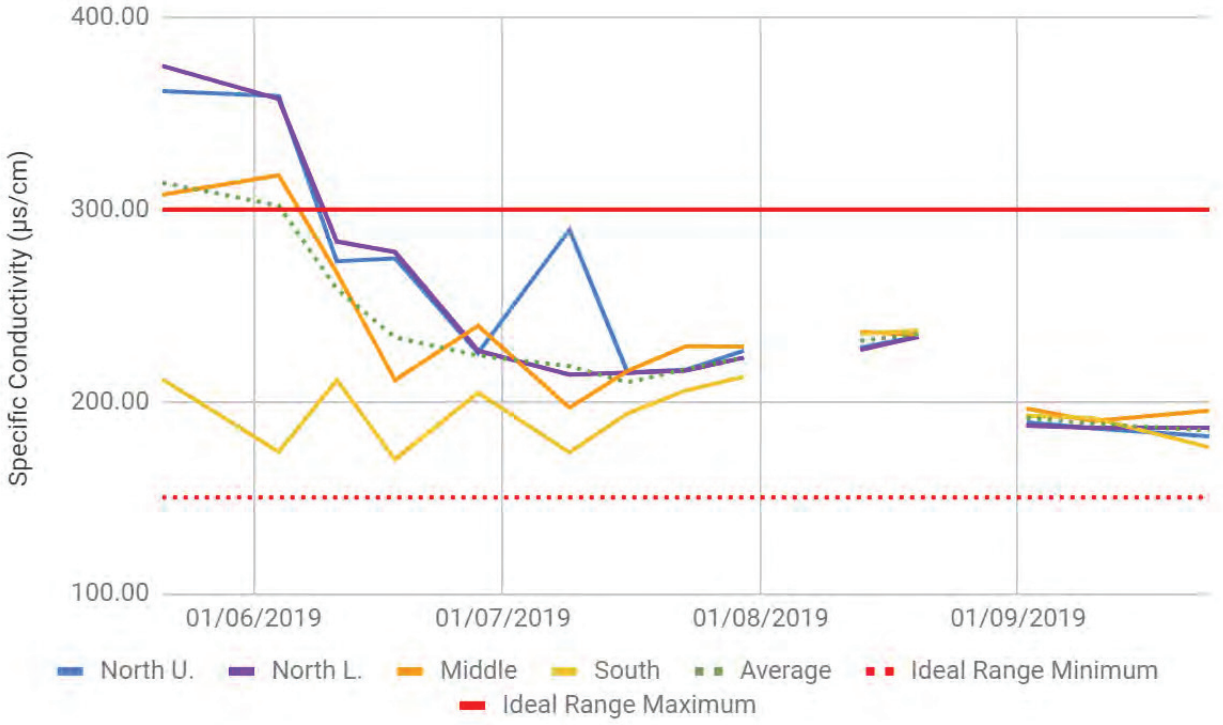


Figure 6: (a) Weekly specific conductance values separated by sample site measured from May 20 to September 24, 2019 (missing data from the week of August 6 and 27, 2019).
Note: Lines are for interpretation only, and do not represent continuous measurements.

2.6 - Phosphorus

Overview

Phosphorus (P) is a nutrient essential for life. P is used by plants and aquatic animals for processes involved in photosynthesis and metabolism. When present in low quantities, this nutrient can limit the growth of aquatic life. When present in high quantities, it can lead to excessive algae growth and overproduction of bacteria, which can severely compromise other forms of aquatic life and human health.

P exists in two main forms in water: dissolved and particulate. Dissolved P is readily available to algae and aquatic plants for growth and photosynthesis (US EPA, 2012). Particulate P is attached to particles in the water, and is not always available to aquatic plants or animals. "Total P" is a combined measurement of both the dissolved and particulate forms, and is often the parameter monitored during water quality objective studies.

Summer Student, Keri Malanchuk, demonstrating to volunteer, Emma Albano, how to use a Van Dorn to collect water sample form depths below the surface

Two major human-caused inputs of P to waterways in North America include agricultural runoff and wastewater. Within the Lake Windermere watershed, possible sources of P to the tributaries and the lake include: agricultural runoff, golf course and resort fertilizer runoff, waterfront lawn & garden fertilizer runoff, municipal stormwater runoff containing detergents and other phosphate-bearing chemicals, or leaky shoreline septic systems. Natural sources of P include nutrient cycling when plants and animals die and decompose, and soil mineral transport.

Historic sampling results indicate that Lake Windermere is "oligotrophic." This means that low nutrient levels and clear waters have been the norm in this lake, and phosphorous is often limiting to the growth of aquatic life. As recently as 2015, however, the LWA found that water samples just after ice-off were significantly exceeding the MOE recommendations for total phosphorous concentrations in Lake Windermere. The Ministry of Environment (MOE) recommends Total Phosphorus in Lake Windermere not exceed a concentration of 10 µg/L (0.01 mg/L) in order to protect drinking water sources and aquatic life.

Results

2019 saw favourable results for Total and Dissolved P levels. The highest recorded value for Total P was 10.00 µg/L at the North sample site on July 16th, and the lowest value being 2.00 µg/L on May 21st at the South sample site (Figure 7a).

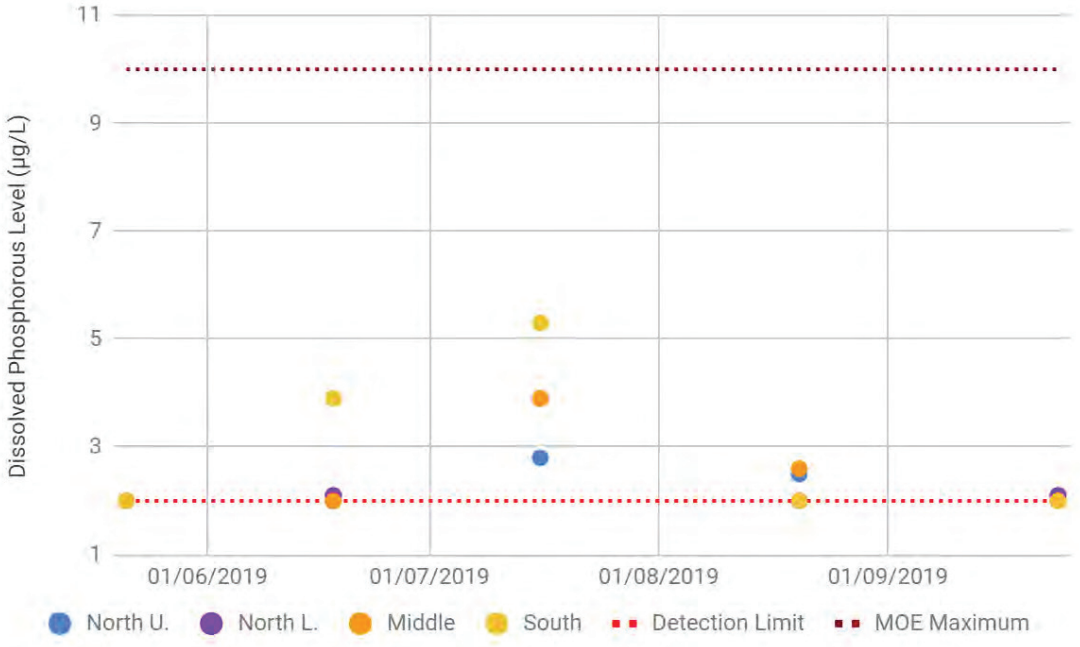
It is expected that Total Phosphorous be higher when turbidity is highest, this was not seen to be the case during the 2019 Sampling Season. This may indicate that throughout the season the sources of phosphorous to the Lake Windermere system fluctuated. It is difficult to point to the source of phosphorous as it occurs both naturally and through human inputs. It is important to continue to watch this trend for future management strategies.

The highest ever-recorded value of Total P by the LWA was 67 µg/L, on August 20th 2013 at the Middle sample site. This was more than six times the recommended limit, and prompted the LWA to increase monitoring for phosphorous. Since that date, twelve samples have exceeded for Total P and six have exceeded for Dissolved P (Figure 7c)

(a)


11.00
9.00
7.00
5.00
3.00
1.00
Total Phosphorous Level (µg/L)
01/06/2019
01/07/2019
01/08/2019
01/09/2019
North U.
North L.
Middle
South
Detection Limit
MOE Maximum

(b)


11
9
7
5
3
1
Dissolved Phosphorous Level (µg/L)
01/06/2019
01/07/2019
01/08/2019
01/09/2019
North U.
North L.
Middle
South
Detection Limit
MOE Maximum

(c)

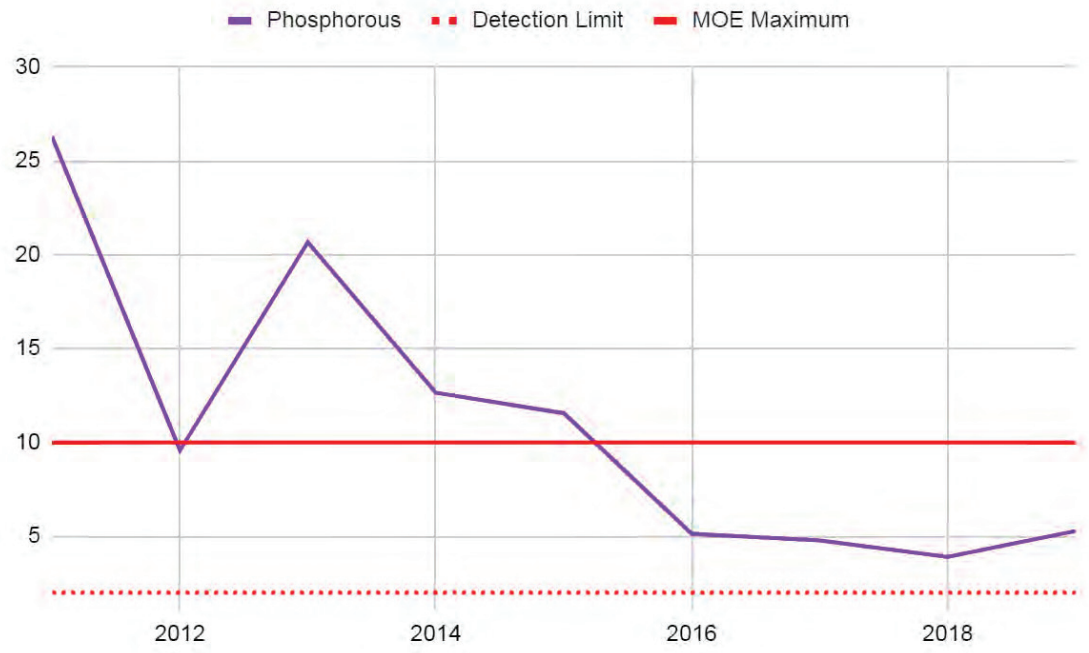


Figure 7: (a) Monthly Total Phosphorus, collected from Lake Windermere between May 21 and September 24, 2019. (b) Monthly Dissolved Phosphorous, collected from Lake Windermere between May 21 and September 24, 2019. (c) Average Total Phosphorous data, 2011-2019.
Note: Lines are for interpretation only, and do not represent continuous measurements. The "Detection limit" is the limit at which the extraction procedure can detect phosphorous in water; values below this line were considered "undetectable".

2.7 - Secchi Depth

Program Coordinator, Shannon McGinty, taking a Secchi reading on Dorothy Lake during an algae bloom in mind June 2019.

Overview

Secchi depth, like turbidity, is a measure of the suspended particles in the water. These suspended particles can be a combination of zooplankton, phytoplankton, algae, pollutants, or sediment (clay and silt).

Clear water lets a beam of light penetrate more deeply into the lake than murky water. Sunlight is needed for aquatic plants to photosynthesize, and for phytoplankton to grow and reproduce (Ministry of Environment, 2017a).

Secchi data collected year after year can provide information about trends in water clarity. Secchi depth generally follows the inverse pattern of turbidity — that is, when turbidity is high, the Secchi depth is low because it is difficult to see deep into the water.

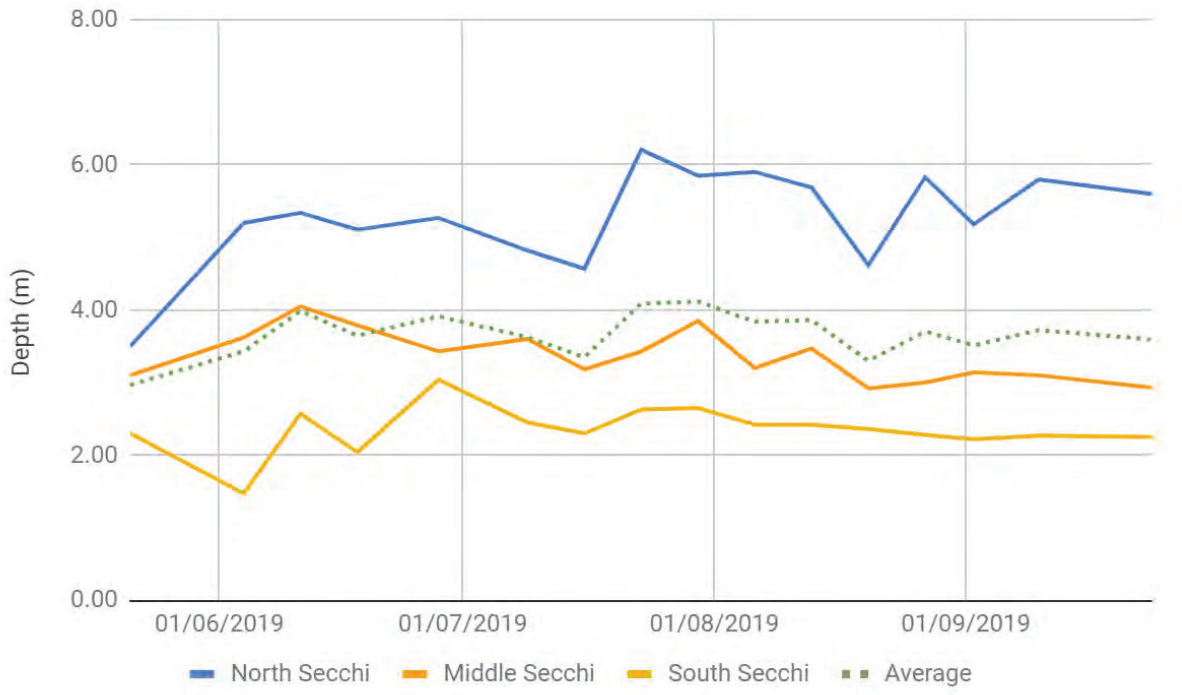
There is no objective set for Secchi depth in Lake Windermere (Neufeld et al., 2010). Following the objectives for turbidity, we should expect the Secchi depth to be lower in the spring during freshet, and higher in the summer as the lake flushes out over time.

Results

The average Secchi depth in 2019 across all sample sites was 3.67m (Figure 8a). Secchi depth was highest from July 23rd to September 24th, which corresponded with a low turbidity at this site during this time (Figure 8b).

Secchi depth tends to appear lower in the South sample site, simply because this site is much shallower than the North site. We can compare Secchi depth to Total depth to get a more accurate picture of how clear the water column is (Figure 8b); if the Secchi depth is the same as total depth, that means we were able to see all the way to the bottom of the lake. This is most common at the South sample site near the end of summer, when the water level gets lower and it is easier to see the bottom of the lake.

(a)



(b)

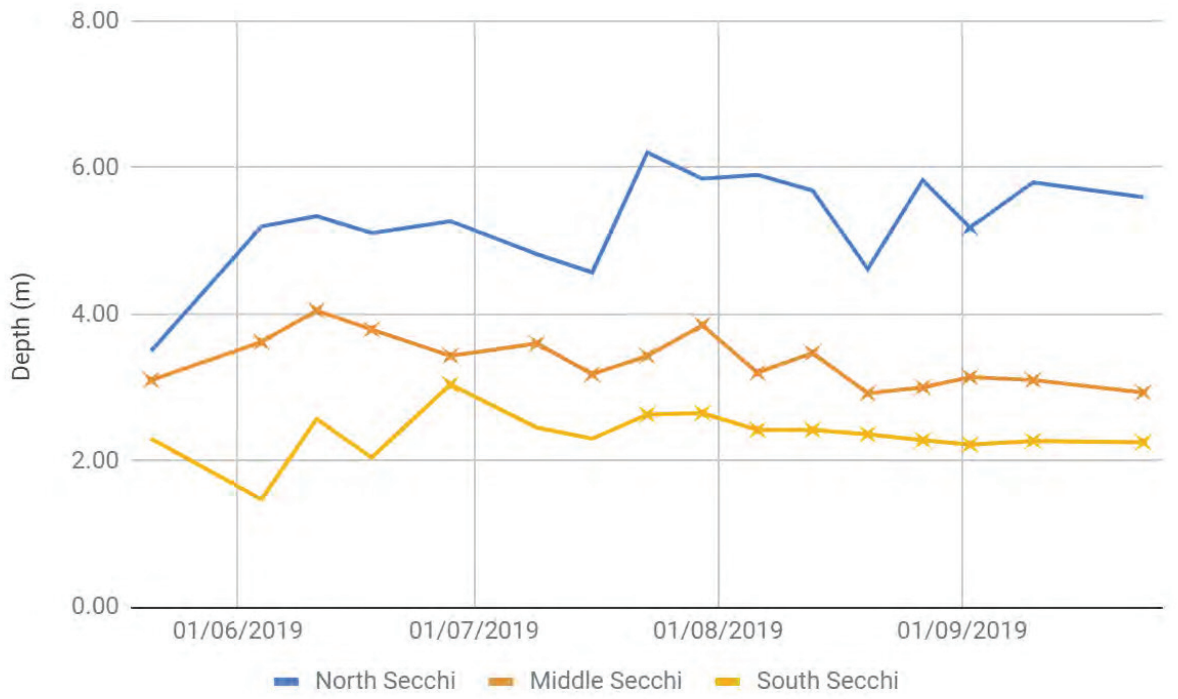


Figure 8: (a) Secchi depth (in metres) measured weekly for the sampling period May 21 to September 24, 2019. (b) Secchi and Total depth at each sample site, "X" represents where Secchi depth was same as Total depth. *Note: Lines are for interpretation only, and do not represent continuous measurements.*

2.8 - Total Depth

Overview

Lake Windermere is a widening of the main Columbia River channel, meaning it is different from typical lakes you might find in southern BC. The main difference is that it is very shallow - on average, between 3-4m depth in mid-summer. It also flushes much more quickly than an average lake, and has a better capacity to carry sediments and nutrients downstream because of this faster flow.

We do report the average water depth for all three sample sites in the lake, but this is not very representative of Lake Windermere as a whole. This is because the South end, where water flows in from the Columbia Wetlands, tends to be much shallower than the other two sites. The North sample site is measured at the deepest point in the lake, on average between 6-7m in depth.

In deeper lakes, the water will separate into layers with cooler denser water falling to the bottom. When water is separated into lighter and denser layers like this, it is called "stratification". Lake

Volunteer Megan Lochhead measuring lake depth

Windermere does not stratify, so we usually don't see a very large difference between the North Upper and North Lower water quality samples.

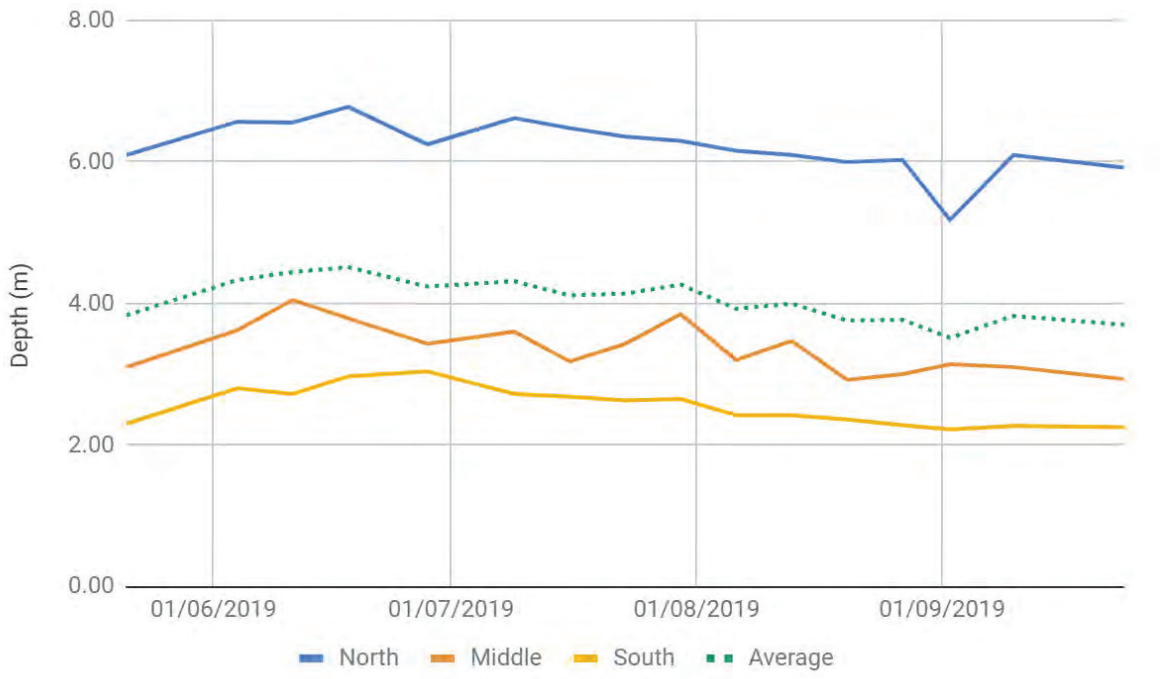
Depth can be an important consideration for aquatic life as well as for recreational boaters and drinking water users. Shallow water poses more risks because boaters can more easily be caught on sediment bars or clog their motors with aquatic vegetation growing up from the bottom of the lake. Shallower water also warms up more quickly, which can pose issues for drinking water quality and for the survival of aquatic life. There is no objective set for lake depth in Lake Windermere, but levels below 2m generally cause concern.

Results

Lake depth in 2019 followed the expected trend of being higher in spring during freshet, and gradually declining through the late summer due to less input from snowmelt runoff/precipitation and increased evaporation effects (Figure 9a). This trend was less pronounced than previous years due to a low snow pack winter, and increased precipitation throughout the summer season.

The deepest value, measured at the North sample site, was 6.78m on June 18th. The highest recorded value at this site since monitoring began in 2006 has been 7.3m, recorded in July 2012 and June 2013. Steeper rates of decline in water level have been recorded in recent years (Figure 9b). 2019 did not see as steep of a rate of decline as 2017 or 2018, but was observed to be an abnormal year based on recent weather patterns.

(a)



(b)

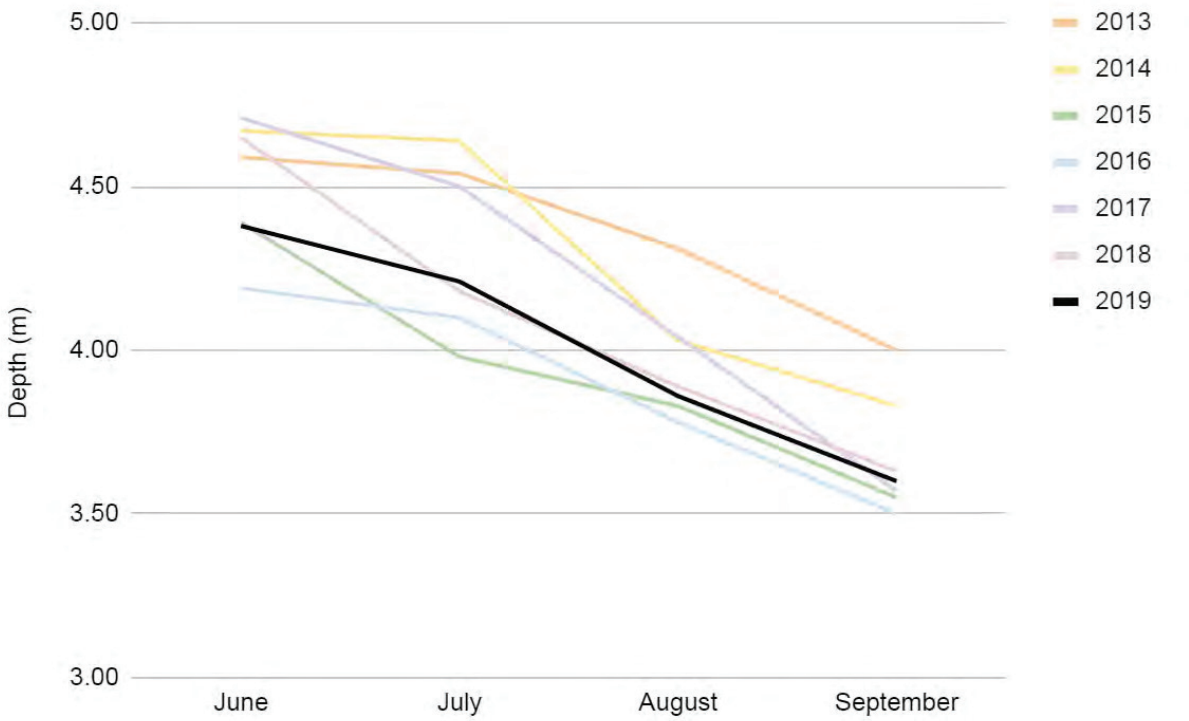


Figure 9: (a) Lake depth (in metres) measured weekly for the sampling period May 21 to September 24 2019. (b) Average lake depth across all sites, 2013-2019.
Note: Lines are for interpretation only, and do not represent continuous measurements. Middle site moved locations in 2013, data collected prior to this date is not comparable.

3. Aquatic Plant Survey, Invasive Mussel and Veliger Sampling

Summer Student, Keri Malanchuk, checking substrate sampler at Lakeview Meadows

3.1 - Background

Being relatively clear and shallow throughout the summer, Lake Windermere allows for good light penetration, which helps promote aquatic plant growth beneath the surface. Aquatic plants improve water quality by filtering out nutrients that might otherwise be used for algae blooms, and by trapping sediments that would be disturbed by motorized boat and wave action. Without rooted aquatic plants to help hold sediment in place, increased turbidity can result which degrades water quality (Rideau Valley Conservation Authority, 2016). Excess plant growth, however, can impede motorized boating and provide shaded habitat for predatory fish species such as largemouth bass.

Zebra and quagga mussel species have already caused significant environmental, social, and economic damage throughout North America due to their rapid spread and devastation of entire lake ecosystems (Darvill, 2017). Until recently, invasive mussels were mostly confined to Eastern Canada and

the Southern United States; however, in 2016, invasive mussels were detected in two reservoirs in Montana (Ministry of Environment, 2017b) and in 2013 were found introduced in Lake Winnipeg, Manitoba (Lake Winnipeg Foundation, n.d.). This proximity to BC has increased the risk that an infected boat can pass through the border into BC waters, and Lake Windermere's proximity to two main borders of the province as well as its high recreational use further increase this risk of introduction.

Biologist, Rachel Darvill, identifying plants during AIS Inventory Project

Invasive species out-compete most other native species if allowed to establish. This often results in a loss of biodiversity and native species, which can have a cascading effect on water quality and fish & wildlife populations. The introduction and spread of invasive aquatic plants or mussels would not only be devastating to the economy, ecology and biodiversity of Lake Windermere, but to the entire Columbia Valley.

The LWA initiated an Aquatic Invasive Species (AIS) Inventory Project in 2009, which has seen an annual plant and veliger (mussel larvae) sampling occur on the lake in all years except 2013. Rachel Darvill (Goldeneye Ecological Services) was the lead biologist for aquatic plant sampling while Danny Smart (East Kootenay Invasive Plant Council) led the veliger sampling in 2019. In 2019, LWA installed six substrate samplers along the east side of Lake Windermere that were monitored monthly from June to August for zebra and quagga mussels.

3.2 - 2019 Sample Results

The 2019 survey marked the tenth year of invasive species sampling and included eleven lake-bottom (offshore) sampling locations and six shoreline-sampling locations, all at high-risk areas for invasive introduction around the lake.

No invasive species (plants, mussel larvae or mussels) were found during the offshore, shoreline plant surveys, substrate sampler monitoring, or the veliger testing.

It was noted that some survey sites (ex. Baltac Beach, Bayshore Condos, and Tretheway Docks) were almost completely devoid of aquatic plant communities (Darvill, 2019). The full 2019 AIS Inventory Report, published by Rachel Darvill, can be found on the LWA website under "Documents".

Boat scars on lake bottom observed by Rachel Darvill during aerial swan surveys for Columbia Wetlands Waterbird Surveys. Photo by Rachel Darvill.

4. Waterbirds

4.1 - Background

In 2018, LWA conducted their first Waterbird Survey, complete with a report highlighting the findings. This project was taken on to learn more about the bird populations using Lake Windermere. It was found that Lake Windermere provides significant bird habitat for large migrant flocks and breeding birds (Darvill, 2018). The lake is especially important for large flocks of migratory birds, such as American coots (Fulica americana), as well as four species of grebe - three of which are considered at-risk species (Darvill, 2018).

The LWA and Goldeneye Ecological Services undertook a boat survey in September 2019 to continue learning about bird populations on Lake Windermere.

4.2 - 2019 Sample Results

During the 2 hour and 48 minute survey 889 individuals were recorded, from a total of 18 different species. Of these sightings, the Surf Scooter, Cackling Goose, Greater Scaups, and large number of both Pied-billed Grebes and Red-necked Grebe's were rare sightings. Lastly, the Surf Scoter, California Gull, Horned Grebe, Western Grebe are all considered to be species at-risk that were recorded during this survey. The full survey inventory can be found here.

It is strongly recommended that management strategies be designed that can work to accommodate both human-use values and bird conservation for Lake Windermere. Specific recommendations to achieve this balance of conservation and human uses include:

- undertaking additional breeding season and fall migratory bird studies for Lake Windermere,
- factoring waterbird and wetland conservation into land-use decisions for Lake Windermere,
- improving signage about motorized boating regulations in the Columbia Wetlands WMA, and
- improving public education about the use of eBird and the importance of conserving habitat values of Lake Windermere for migratory and at-risk bird species.

5. Swim Beach Water Quality

5.1 - Background

Escherichia coli (E. coli) is a type of fecal coliform bacteria found in the intestines of most healthy animals. *E. coli* in water can be an indicator of sewage or animal waste contamination, or it may come naturally from the soil. Most strains of *E. coli* are harmless, though some can produce toxins that cause illness in people. The count of *E. coli* colonies per 100mL of water is a common way to measure how much bacteria is present in the water; however, it is important to know that this value represents a total count of all colonies, and does not necessarily contain any strains that are capable of producing toxins that affect humans. A higher *E. coli* count simply increases the probability that the water may contain a toxin-producing strain.

The LWA have an ongoing agreement with the Interior Health Authority (IHA) to collect public beach water samples, samples are analyzed by the IHA laboratory for *E. coli* bacteria, in compliance with Health Canada Guidelines. This assesses whether swim beach water quality meets recognized health standards.

Samples are collected at three public beaches around the lake: James Chabot Provincial Park (Athalmer), Kinsmen Beach (Invermere), and Windermere Beach (Windermere).

The Health Canada Guidelines for recreational water used for "primary contact" activities (e.g., swimming):

- Geometric Mean Concentration (minimum of five samples taken over 30 days): ≤200 *E. coli*/100mL
- Single Sample Maximum Concentration: ≤400 *E. coli*/100mL

5.2 - 2019 Sample Results

The geometric mean did not exceed the Health Canada recommended limit of 200 colonies of *E. coli*/100 mL for any of the public beaches tested, nor did any single sample exceed 400 colonies of *E. coli*/100 mL. For Lake Windermere, the highest geometric mean values over a 30-day period were as follows:

James Chabot Provincial Park	15.5 *E. coli*/100 mL
Kinsmen Beach	27.17 *E. coli*/100 mL
Windermere Beach	8.67 *E. coli*/100 mL

The highest single sample in 2019 was 65 *E. coli* /100mL, recorded on August 12th at the East side of Kinsmen Beach. This is a popular dog swimming area, which might explain the slightly higher bacterial concentration at this location.

Results of swim beach sampling are updated throughout the summer season and can be found by searching for Kinsmen, James Chabot or Windermere beaches at
https://www.interiorhealth.ca/YourEnvironment/DrinkingWater/Pages/WaterSamples.aspx

6. Tributary inflow - Windermere and Abel Creek

6.1 - Background

Besides the main Columbia River channel, Windermere Creek is the major source of inflow into Lake Windermere. This tributary stream drains an area of approximately 90 km^2, and provides important fish spawning habitat (NHC, 2013). While Abel Creek is a much smaller tributary than Windermere Creek monitoring efforts are made as Abel Creek runs into Lake Windermere from the Paddy Ryan Lakes Reservoir used by the District of Invermere.

From 2007 to 2018, the Columbia Basin Water Quality Monitoring Program (CBWQM) ran on Windermere Creek. This project oversaw scientific data collection in streams of the East and West Kootenay, through fieldwork that was undertaken by local volunteers and non-profit organizations. LWA have continued monitoring of Windermere Creek, and additionally now monitor Abel Creek as well as a continuation of this project.

Water chemistry follows similar protocols and uses the same equipment as the lake water quality monitoring, with data collected for dissolved oxygen, specific conductivity, pH, turbidity, and temperature.

Flow/velocity measurements are crude, and taken using a meter stick to obtain surface velocity based upon the principle of conversion of kinetic to potential energy. This overestimates average channel flow, but underestimates actual surface flow due to friction. While not exact, if measured carefully and repeated the same way each time, this measurement can give us a general idea on how flow volumes change seasonally within a given area of stream.

In 2018, the LWA obtained four HOBO U20-L Water Level Loggers. In September 2018, the first logger was installed in a stilling well in Windermere Creek; the second was installed in April 2019 in Abel Creek. The third will be installed on the Athalmer Bridge at the outflow of the Columbia River from Lake Windermere.

The fourth is used as an atmospheric pressure gauge located at the LWA Office. These loggers measure water temperature and pressure to provide a reading on flow measurements to be used in compliment with surface velocity measurements.

2019 creek sampling results are still being analyzed and will be provided in a supplementary report.

Program Coordinator, Shannon McGinty, collecting eDNA Sample on Windermere Creek.

7. Acknowledgements

The 2019 Lake Windermere community-based water quality-monitoring project was made possible thanks to generous funding support from:

- Columbia Valley Local Conservation Fund
- District of Invermere
- Regional District of East Kootenay
- Columbia Basin Trust's Environment Large Grants program
- LUSH Charity Foundation
- Royal Bank of Canada Foundation
- Columbia Valley Community Foundation
- Real Estate Foundation of BC
- Canada Summer Jobs
- Columbia Basin Watershed Network
- BC Community Gaming Grants

In-kind support provided by the District of Invermere through use and delivery of the tin boat and fuel. Additional in-kind support provided by community volunteers Gavin Jacobs, Lorin Inglis, and Ken Hoover through use of their personal boats, and by the Interior Health Authority for swim beach samples.

Big thanks goes out to all of our citizen scientists! This year's community volunteers included:

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- Ken Hoover
- Albertas Zalais
- Tara Booty
- Nathan Li
- Clark Carpio
- Shelly Hopkins
- Lorin Inglis
- Terri Eacrett
- Tina Friedenberg
- Gavin Jacobs
- Bob and Jean Hage
- Erika S
- Stacey and Dyaln McIntosh
- Paola and Emma Albano
- Kris Nickerson
- Baiba and Pat Morrow
- Shawna McKay
- Meaghan Lochland

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- Ashley Dubois, Living Lakes Canada
- Raegan Mallison, Living Lakes Canada
- Kat Hartwig, Living Lakes Canada
- Norm Zirnhelt, BC Lakes Stewardship Society
- Rick Nordin, BC Lakes Stewardship Society
- Bill Thompson, Columbia Lake Stewardship Society
- Tom Dance, Columbia Lake Stewardship Society

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Appendix A

Sampling methodology

Water Quality

Lake Windermere is sampled following the BC Ministry of Environment Water Quality Assessment and Objectives for Lake Windermere (Neufeld et al. 2010). Water quality laboratory analysis was completed by CARO Analytical (Kelowna, BC). The following water quality data were collected at all three sample sites:

a. Weekly (May - September) - in situ (field measured) data including depth, Secchi depth, water temperature, specific conductivity, pH, dissolved oxygen (DO), and turbidity.
b. Monthly (April - September) - Total Phosphorous and Total Dissolved Phosphorous.

The North site was sampled at two depths (Upper and Lower) since this is the deepest part of the lake. The Upper water sample was collected at arms' reach approximately 30cm below the surface, while the Lower water sample was collected 1m above the lake bottom using a vertical VanDorn sampler. The Middle and South sites were sampled at arms' reach 30cm below the surface only.

Water sampling took place within a four-hour timeframe on Tuesday mornings, from May to September 2019. Volunteer citizen scientists were joined by at least one trained LWA staff member for all lake excursions and assisted with field data collection.

Lake Sample sites were first located by boat using a hand-held Garmin eTrex20 GPS and preprogrammed coordinates that align with the sample sites in Figure 1. Once at a sample site, depth and Secchi depth measurements were taken using a weighted Secchi disk and meter line. Water temperature and conductivity were read using a YSI Pro30 conductivity meter. pH was read using a Eutech Waterproof pHTestr 10. Dissolved Oxygen was collected using the Winkler titration method with a Hach Model OX-2P (0.2-20mg/L) Test Kit. Turbidity was read using a Hach 2100Q Portable Turbidimeter calibrated to 10 NTU.

When monthly phosphorous samples were collected, a cooler containing sample bottles was brought on board the boat. Water samples were collected into bottles, which were then kept, on ice while being shipped via ACE Courier to CARO laboratories in Kelowna for analysis.

Aquatic Plants

Please see Darvill (2019).

Waterbirds

Please see Darvill (2018).

Swim Beaches

Bacteriology samples were collected on Mondays between June and early September (excluding long weekend holidays) before 1:00pm from three public beaches (Windermere (3 site), James Chabot (3 sites), and Kinsmen (3 sites)). Sample bottles were filled using a triple-rinsed beaker dipped inverted below the water's surface then turned upright within the middle of the water column. Filled bottles were immediately kept on ice until delivery to the Invermere Health Unit located at 110 10 St, Invermere, BC with a copy of each associated requisition form. From there, custody of samples was transferred to the IHA and samples were sent to their labs for analysis.

Data analysis and QA/QC

Raw data were first subjected to a quality control evaluation, to assess the accuracy and validity of the laboratory and field methods. Field sampling protocols followed those outlined above.

Water Quality

For in situ data collection, water quality instruments were calibrated once monthly as per manufacturer's specifications and expired or outdated solutions were discarded and replaced. All data was reviewed by the LWA for consistency and anomalies before being analyzed. Data was analyzed by plotting parameters over time in Google Sheets, for the current sampling year and past sampling years whenever possible. Geometric means of samples were taken where indicated, and included all samples taken within a 30-day period between start and end of sampling.

CARO laboratory's analysis for Total and Total Dissolved Phosphorous was completed using Persulfate Digestion / Automated Colorimetry (Ascorbic Acid) referencing the Guidelines for Canadian Drinking Water Quality (Health Canada Feb 2017). CARO assessed accuracy through use of laboratory control samples, trip blanks, and duplicate samples.

Aquatic Plants

Please see Darvill (2019).

Waterbirds

Please see Darvill (2018).

Swim Beaches

Sample results were obtained from the Interior Health Authority (IHA) and analyzed for geometric mean as well as individual sample result over time. Please contact the IHA if you have specific questions about their QA/QC protocol for lab samples.

https://www.interiorhealth.ca/FindUs/_layouts/FindUs/info.aspx?type=Location&loc=Invermere%20Health%20Centre&svc=&ploc=

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

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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.

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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*