



Lake Windermere and Columbia Lake Shoreline Fisheries Assessment, August 2021



Final Report

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Prepared by

Lotic Environmental Ltd.
101 Kootenay Street N
Cranbrook, BC
V1C 3T5

Executive Summary

The Lake Windermere Ambassadors (LWA) and the Columbia Lake Stewardship Society (CLSS) secured limited funding to conduct research on native fish populations within Lake Windermere and Columbia Lake (in British Columbia), in 2021. These organizations reached out to Lotic Environmental Ltd. (Lotic), to design a sampling program based on the funding available, with equal effort conducted in each lake. The purpose of this study was to sample nearshore areas of Windermere and Columbia lakes and compare the results to past studies, in the attempt to provide information on current fish populations and changes over time. Sample sites were chosen to represent different habitat types and disturbance levels, as well as to facilitate comparisons to past studies. Sample methods used were beach seine, minnow trap, and snorkel surveys. Lake Windermere was sampled from August 10 to 12 and Columbia Lake was sampled from August 13 to 15. During the study, water temperatures in the lakes ranged from 19 to 23.3°C.

The overall fish species assemblage in Lake Windermere in 2021 [Northern Pikeminnow = 133 (40.9%), Largemouth Bass = 99 (33.9%), Redside Shiner = 18 (6.5%), Mountain Whitefish = 17 (6.2%), Largescale Sucker = 15 (5.4%), Peamouth Chub = 12 (4.4%), Burbot = 1 (0.4%), and Prickly Sculpin = 1 (0.4%)] was similar to that recorded during the summer of 2007 (McPherson and Hlushak 2008). Additional research is needed to determine if differences between years was due to natural variation, the primary sample methods used (snorkel surveys in 2007; beach seining in 2021) or represent changes to the species assemblage of Lake Windermere.

The overall fish species assemblage in Columbia Lake in 2021 [Largemouth Bass = 87 (35.5%), largescale Sucker = 47 (19.2%), Redside Shiner = 33 (13.5%), Peamouth Chub = 26 (10.6%), Mountain Whitefish = 19 (7.8%), Northern Pikeminnow = 15 (6.1%), Pumpkinseed Sunfish = 9 (3.7%), and Prickly Sculpin = 9 (3.7%)] was similar to that recorded during the summer of 2009 (McPherson et al. 2010). As in Lake Windermere, additional research is needed to determine if the differences between years was due to natural variation, the primary sample methods used, differences in areas sampled, or represent changes to the species assemblage of Columbia Lake.

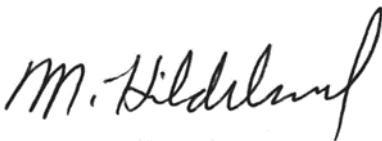
Additional research over multiple seasons (and likely years) is required to determine if any of the changes in fish use recorded during the present study represent actual changes versus natural variation, and to properly determine differences in fish use between habitat types and different disturbance levels. It seems clear that the introduction of Largemouth Bass and Pumpkinseed to the system has resulted in changes to the fish assemblage. These species are better suited to warmer waters and may be displacing/out-competing Salmonids in the lakes. In addition to warming waters affecting the fish assemblage of these lakes, other factors such as habitat disturbance, angling pressure, and increasing urbanization also likely play a role.

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Prepared by:

We trust that this document provides adequate information to describe fish use of shoreline habitats in Lake Windermere and Columbia Lake. Please do not hesitate to contact us with any inquiries about this document.



Michael Hildebrand, BSc, RPBio
Senior Fisheries Biologist
michael.hildebrand@lotic.co

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This report was prepared by Lotic Environmental Ltd. for the exclusive use of the Lake Windermere Ambassadors and the Columbia Lake Stewardship Society. The material in it reflects the best judgement of Lotic Environmental Ltd. considering the information available to it at the time of preparation. Any use that a third party may make of this report, or any reliance on or decisions made based on it, is the responsibility of the third parties. We disclaim responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

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1 Introduction

The Lake Windermere Ambassadors (LWA) and the Columbia Lake Stewardship Society (CLSS) secured funding to conduct research on native fish populations within Lake Windermere and Columbia Lake, in 2021. Funding, although limited, was secured, and these organizations reached out to Lotic Environmental Ltd. (Lotic), who designed a sampling program based on the funding available, with equal effort conducted in each lake.

Lake Windermere is a shallow, moderately sized lake located in the southern interior of British Columbia (BC; Figure 1). The towns of Windermere and Invermere are located on the shores of the lake. Lake Windermere has a surface area of 16.1 km² (approximately 14 km long, with an average width of approximately 1.2 km), a perimeter length of 36.3 km, a mean depth of 3.4 m, and a maximum depth of 6.4 m (McPherson and Hlushak 2008). As such, 95% of the lake is classified as littoral, which means that light can penetrate to the lake bottom, allowing aquatic macrophytes to grow. The lake provides a diversity of values to humans (local and tourists), fish and wildlife. These values have been impacted as a result of increased development pressures in recent years; for example, the lake appears to be becoming more eutrophic over time, due to nutrient enrichment (Masse and Miller 2005).

Columbia Lake, located about 15 km south of Lake Windermere between the villages of Canal Flats and Fairmont Hot Springs, is the largest warm water lake (average July water temperature 18°C) in the East Kootenays (Figure 2). Columbia Lake has a surface area of 27.6 km², is approximately 13.5 km long with a perimeter length of approximately 43.3 km, an average depth of 2.9 m, and a maximum depth of 5.2 m (McPherson et al. 2010). The Columbia Lake area is of great importance to the Ktunaxa First Nation, provides important habitat for many fish, wildlife, and plant species, and is important to local residents. The lake is also facing increased pressure from growing recreational use and development.

1.1 Purpose and Objectives

The purpose of this study was to sample Windermere and Columbia lakes and compare the results to past studies, to provide information on current fish populations and changes over time. Sample sites were chosen to represent different habitat types and disturbance levels, as well as to facilitate comparisons to past studies.

1.2 Study Area and Period

The study areas were Lake Windermere (Figure 1), which was sampled from August 10 to 12 and Columbia Lake (Figure 2), which was sampled from August 13 to 15, 2021.

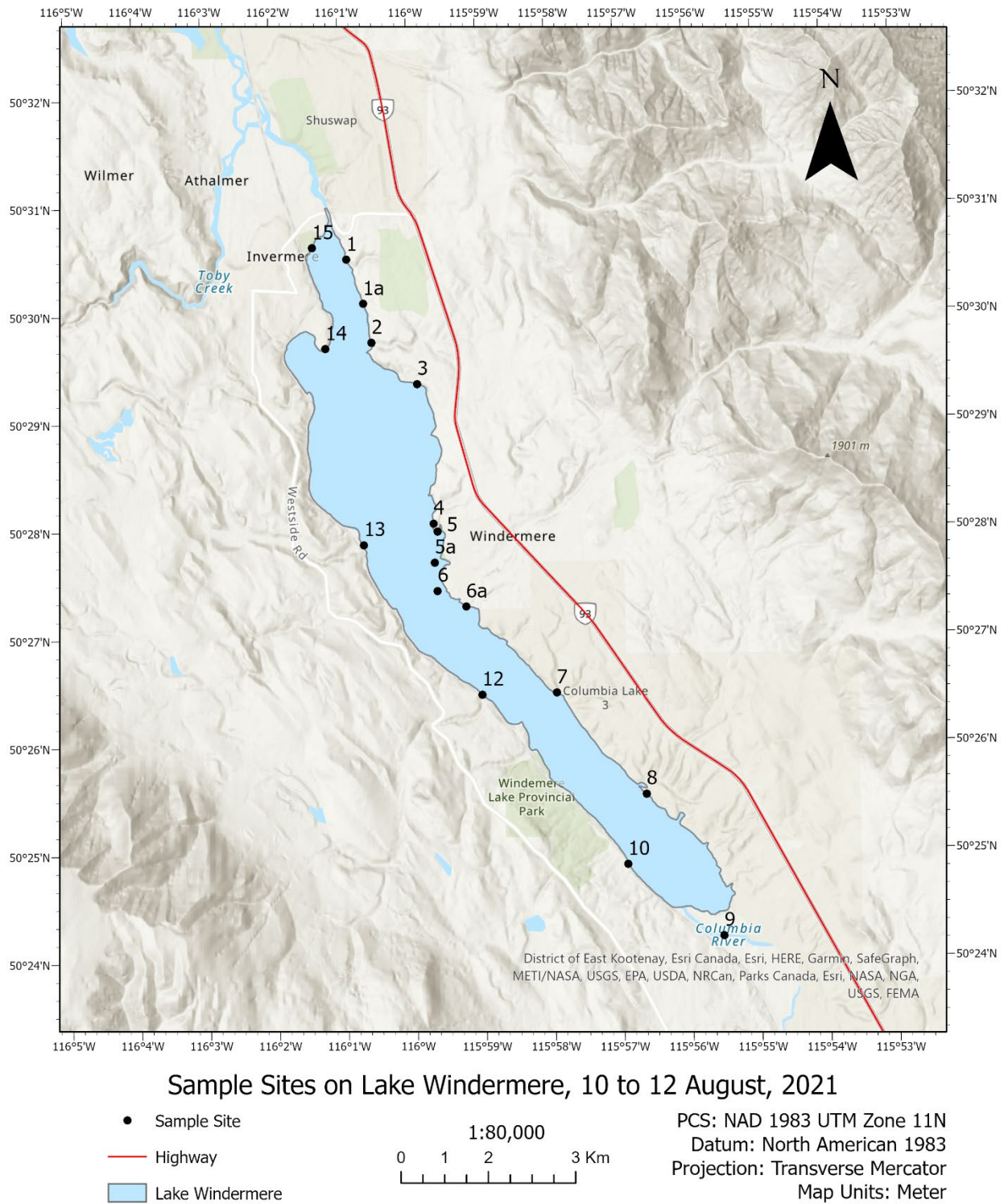


Figure 1: Sample sites on Lake Windermere, 10 to 12 August 2021.

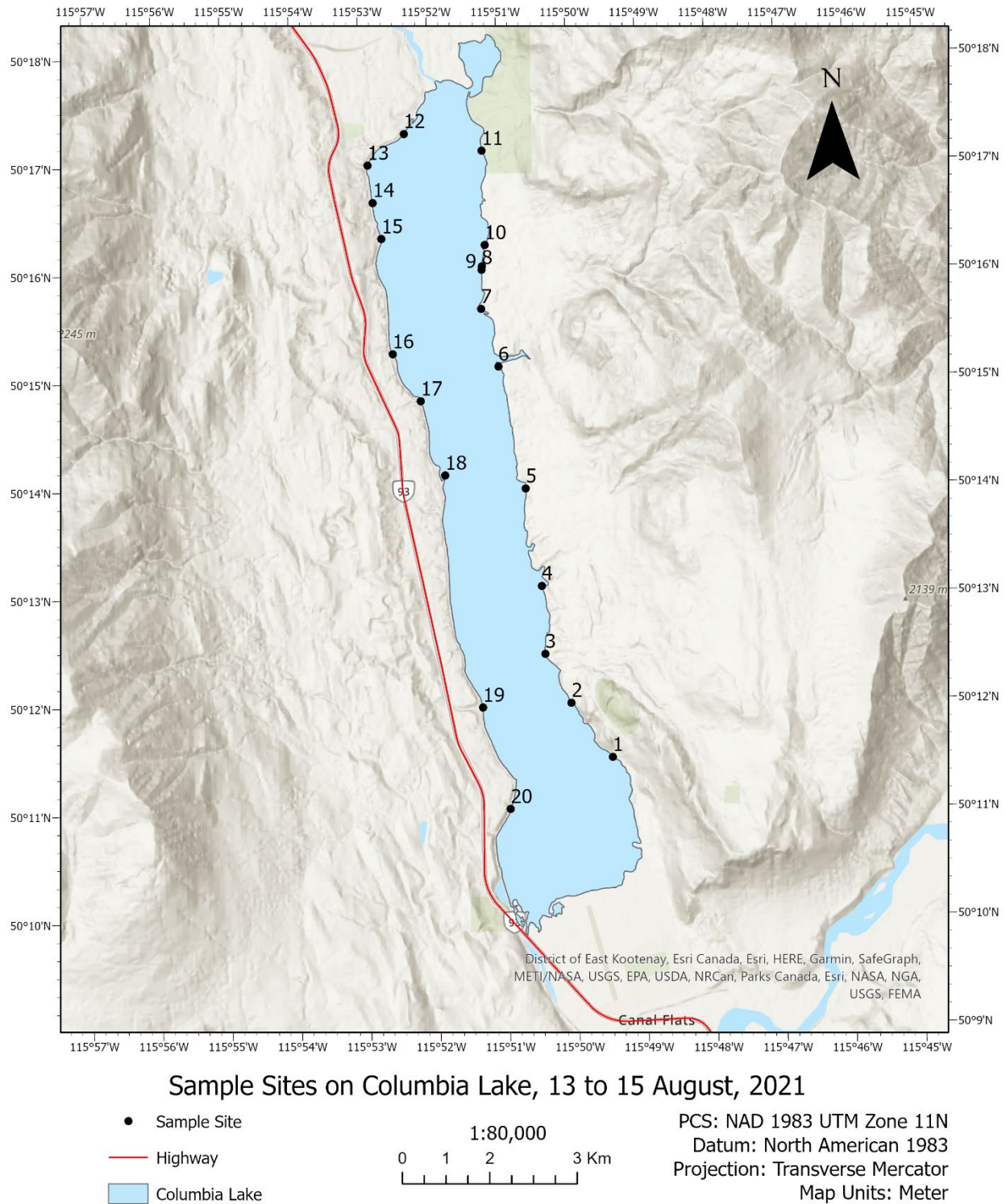


Figure 2: Sample sites on Columbia Lake, 13 to 15 August 2021.

2 Methods

Sample sites chosen for the present study were based on sites sampled during the 2007 Windermere Lake Foreshore Fish and Wildlife Habitat Assessment (McPherson and Hlushak 2008; Appendix A, Table A1). A variety of habitat types at differing levels of disturbance (i.e., low, moderate, high) were sampled.

2.1 Beach Seining

A 10 m long beach seine was used to sample near shore habitats. Lengths and area sampled depended on site conditions (50 to 320 m² sampled). The seine was either hauled parallel to the shore or perpendicular to shore from out deep into shore. Captured fish were held in a bucket to which lake water was frequently added, identified to species, measured for fork length (FL), weighed, and released in the same area captured. Photos were taken of some fish, and all abnormalities observed. Additional data collected at each sample site included site photos, UTM coordinates, length and width sampled, mean and maximum depth sampled, dominant and subdominant substrate, water temperature, and amount of aquatic vegetation.

2.2 Minnow Traps

Minnow traps were used to supplement data obtained from beach seine sampling. Standard minnow traps were baited with cat food, tied to shore, placed on the lake bottom, and fished overnight. Captured fish were sampled as with beach seine captures and released in the same location they were captured. Data recorded at each site included site photos, UTM coordinates, depth, dominant and subdominant substrate, and amount of aquatic vegetation.

2.3 Snorkel Surveys

Snorkel surveys were conducted on an opportunistic basis during the last (third) day of sampling on each lake, to supplement beach seine and minnow trap data, and facilitate comparisons to past studies. Observed fish were identified to species and assigned to 10 cm FL bins (i.e., < 10 cm, 10 to 20 cm, etc.). Additional data recorded included start and end times, start and end UTM coordinates, substrate type, aquatic vegetation type and amount, mean and maximum depth, length and width sampled, water temperature, and visibility. Length surveyed varied from 50 to 200 m, depending on site and lake conditions.

2.4 Data Analysis

Data was not analysed using statistical methods because the sampling program was designed to fit within available funding and allow for simple analyses such as presence/absence, calculation of means, and catch-per-unit-effort (CPUE). Statistical analyses would have required substantially more effort/replication.

3 Results

3.1 Lake Windermere

During the present study, 16 of the 18 sites from the 2007 study were sampled (Appendix A, Table A1). Site 4 and site 9 were not sampled during the present study due to accessibility issues, lack of seinable habitat, and/or time constraints. In total, sampling was conducted in six high disturbance sites, five moderate disturbance sites, and five low disturbance sites. Life history data collected from captured fish is provided in Appendix A, Table A2.

3.1.1 Water Temperature

From August 10 to 12, 2021, water temperatures recorded in Lake Windermere ranged from 19.1 to 23.3°C (Appendix A, Table A3). There was variation in water temperatures in areas sampled, but in general water temperatures were between 19 and 20°C in the morning and warmed by several degrees throughout the day to between 22 and 23°C.

3.1.2 Beach Seining

During the present study, 19 seine hauls were conducted at 16 sites, which resulted in 2050 m² of shallow water habitat being sampled (two seine hauls were conducted at three sites; Appendix A, Table A4). In total, 204 fish were captured using this method, comprised of:

- 90 Largemouth Bass (LMB);
- 62 Northern Pikeminnow (NPC);
- 15 Mountain Whitefish (MW);
- 15 Redside Shiner (RSC);
- 12 Peamouth Chub (PCC);
- 9 Largescale Sucker (CSU); and,
- 1 Prickly Sculpin (CAS).

The overall use (i.e., by all fish species) of sites with different levels of disturbance was similar. Some differences were noted in some fish species' use of areas based on disturbance levels, but additional study is required to determine if these are actual trends as opposed to random variation (Table 1). Largemouth Bass and Northern Pikeminnow were common in all disturbance levels, however Northern Pikeminnow were about three times as common in highly disturbed sites than in sites with moderate or low disturbance. Mountain Whitefish, Redside Shiner, Peamouth Chub, and Largescale Sucker appear to prefer low disturbance sites, but as noted above, additional study is required to confirm these results.

Table 1: Beach seine catch and catch-per-unit-effort (CPUE; no. fish/100 m² sampled) of sample sites with differing levels of disturbance, August 10 and 11, 2021.

Disturbance Level	Area (m ²)	LMB	MW	NPC	RSC	CAS	PCC	CSU	All
High	625	35 (5.6)		38 (6.1)					73 (11.7)
Mod.	670	32 (4.8)	1 (0.1)	14 (2.1)		1 (0.1)	1 (0.1)		49 (7.3)
Low	755	23 (3.0)	14 (1.9)	10 (1.3)	15 (2.0)		11 (1.5)	9 (1.2)	82 (10.9)
All	2050	90 (4.4)	15 (0.7)	62 (3.0)	15 (0.7)	1 (0.05)	12 (0.6)	9 (0.4)	204 (10.0)

3.1.3 Minnow Traps

During the present study 17 minnow traps were deployed overnight for a total sample duration of 352.6 hours (Appendix A, Table A5). In total, 13 fish were captured by minnow traps, comprised of 10 Northern Pikeminnow, 2 Redside Shiner, and 1 Burbot. Given the low numbers of fish captured, in-depth analysis was not conducted on minnow trap data. The method did provide useful supplemental data in that the presence of Burbot in the lake was confirmed during the present study.

3.1.4 Snorkel Surveys

Snorkel surveys were not completed in sufficient numbers to warrant statistical analyses. A total of 10 snorkel surveys were completed in Lake Windermere, which resulted in a surveyed area of 7400 m² and 59 fish observed (Appendix A, Table A6). The 59 fish observed were: 41 Northern Pikeminnow (38 juveniles), 9 Largemouth Bass (7 juveniles), 6 largescale Sucker juveniles, 2 Mountain Whitefish juveniles, and 1 Redside Shiner.

Differences were noted between the number of fish observed in high disturbance sites when compared to moderate and high disturbance sites (Table 2). During snorkel surveys, fish abundance was substantially higher in low disturbance sites (1.6 fish/100 m²), than in moderately (0.7 fish/100 m²) and highly (0.1 fish/100 m²) disturbed sites. This differed from beach seine results, where the high CPUE was recorded at high disturbance sites (11.7 fish/100 m²), followed by low (10.9 fish/100 m²) and moderate disturbance sites (7.3 fish/100 m²). It is difficult to draw conclusions from these results, other than the differences are likely due to natural variation, and additional research is required to further determine patterns of fish use.

Table 2: Summary of snorkel survey results (with rough abundance/100 m²), Lake Windermere, August 12, 2021.

Disturbance Level	Area (m ²)	LMB	MW	NPC	RSC	CSU	All
High	1600			1 (0.06)			1 (0.06)
Mod.	4050	3 (0.07)	2 (0.05)	18 (0.44)	1 (0.02)	6 (0.15)	30 (0.74)
Low	1750	6 (0.34)		22 (1.26)			28 (1.60)
All	7400	9 (0.12)	2 (0.03)	41 (0.55)	1 (0.01)	6 (0.08)	59 (0.80)

3.2 Columbia Lake

During the present study, 20 sites were sampled on Columbia Lake from August 13 to 15, 2021 (Appendix B, Table B1). In total, sampling was conducted in 7 high disturbance sites, 3 moderate disturbance sites, and 10 low disturbance sites. In general, the shoreline of Columbia lake exhibits less overall disturbance than the shoreline of Lake Windermere. Life history data from captured fish is provided in Appendix B, Table B2.

3.2.1 Water Temperature

From August 13 to 15, 2021, water temperatures recorded in Columbia Lake ranged from 19.2 to 22.6°C (Appendix B, Table B3). There was variation in water temperatures in areas sampled, but in general water temperatures were around 20°C in the morning and warmed by two or more degrees throughout the day to between 22 and 23°C.

3.2.2 Beach Seining

During the present study, 20 seine hauls were conducted in Columbia Lake (one per site), which resulted in 2075 m² of shallow water habitat being sampled; Appendix B, Table B4). In total, 172 fish were captured using this method, comprised of:

- 72 Largemouth Bass (LMB);
- 44 Largescale Sucker (CSU);
- 19 Mountain Whitefish (MW);
- 15 Northern Pikeminnow (NPC);
- 8 Pumpkinseed Sunfish (PSS);
- 7 Redside Shiner (RSC); and,
- 7 Prickly Sculpin (CAS).

Much like results from Lake Windermere, overall use of sites with different disturbance levels by all fish species was similar (Table 3). Differences were noted in some fish species' use of areas based on disturbance levels, but additional study is required to determine if these are actual trends as opposed to random variation. Mountain Whitefish, Largescale Sucker and Prickly Sculpin were more frequently recorded in high disturbance sites. Largemouth Bass, Pumpkinseed Sunfish,

Northern Pike minnow, and Redside Shiner were more frequently recorded in lower disturbance sites. As noted previously, additional study is required to verify these trends.

Table 3: Beach seine catch and catch-per-unit-effort (CPUE; no. fish/100 m² sampled) of sample sites in Columbia Lake with differing levels of disturbance, August 13 and 14, 2021.

Disturbance Level	Area (m ²)	LMB	MW	PSS	NPC	RSC	CAS	CSU	All
High	700	3 (0.4)	15 (2.1)		2 (0.3)	1 (0.1)	5 (0.7)	35 (5.0)	61 (8.8)
Mod.	300			1 (0.3)	7 (2.3)	5 (1.7)	1 (0.3)	8 (2.7)	22 (7.3)
Low	1075	69 (6.4)	4 (0.4)	7 (0.7)	6 (0.6)	1 (0.1)	1 (0.1)	1 (0.1)	89 (8.3)
All	2075	72 (3.5)	19 (0.9)	8 (0.4)	15 (0.7)	7 (0.3)	7 (0.3)	44 (2.1)	172 (8.3)

3.2.3 Minnow Traps

During the present study 18 minnow traps were deployed overnight in Columbia Lake for a total sample duration of 375.5 hours (Appendix B, Table B5). In total, 11 fish were captured by minnow traps, comprised of 4 Largemouth Bass, 3 Largemouth Sucker, 2 Prickly Sculpin, 1 Pumpkinseed Sunfish, and 1 Redside Shiner. Given the low numbers of fish captured, in-depth analysis was not conducted on minnow trap data.

3.2.4 Snorkel Surveys

A total of 6 snorkel surveys were completed in Columbia Lake, which resulted in a surveyed area of 3800 m² and 62 fish observed (Appendix B, Table B6). The 62 fish were all observed within one site and were comprised of: 26 Peamouth Chub, 25 Redside Shiner, and 11 Largemouth Bass.

Based on snorkel survey results (Table 4), fish were most abundant in low disturbance sites, but given the low sample size and that all fish were observed in one site (Site 8), more study is required to determine if this trend is significant.

Table 4: Summary of snorkel survey results (with rough abundance/100 m²), Columbia Lake, August 15, 2021.

Disturbance Level	Area (m ²)	LMB	RSC	PCC	All
High	1050				0
Moderate	500				0
Low	2250	11 (0.5)	25 (1.1)	26 (1.2)	62 (2.8)
All	3800	11 (0.3)	25 (0.7)	26 (0.7)	62 (1.6)

4 Discussion

4.1 Lake Windermere

The overall fish species assemblage in Lake Windermere in 2021 was similar to that recorded during the summer of 2007 (McPherson and Hlushak 2008). Species recorded in both years include Mountain Whitefish, Largemouth Bass, Redside Shiner, and Largescale Sucker (Table 5). During the summer of 2007, 133 Cyprinids were recorded, but not identified to species. It is considered likely that Northern Pikeminnow and Peamouth Chub were among the Cyprinid species recorded in 2007. Additional research is needed to determine if the differences between years was due to natural variation, the primary sample methods used (snorkel surveys in 2007; beach seining in 2021 due to funding restrictions) or represent changes to the species assemblage of Lake Windermere. For example, the difference in the numbers of Northern Pikeminnow and Redside Shiner recorded are not considered to represent a large increase in the Northern Pikeminnow population within the lake from 2007 to 2021, nor a large decrease in Redside Shiner numbers.

Table 5: Summary of fish recorded in Lake Windermere during sampling in the summers of 2007 and 2021.

Species	Scientific Name	Species Type	2007	2021
Largemouth Bass	<i>Micropterus salmoides</i>	Non-native	181 (7.1%)	99 (33.9%)
Mountain Whitefish	<i>Prosopium williamsoni</i>	Native	22 (0.9%)	17 (6.2%)
Burbot	<i>Lota lota</i>	Native		1 (0.4%)
Pumkinseed Sunfish	<i>Lepomis gibbosus</i>	Non-native	44 (1.7%)	
Northern Pikeminnow	<i>Ptychocheilus oregonensis</i>	Native		133 (40.9%)
Redside Shiner	<i>Richardsonius balteatus</i>	Native	2138 (84.1%)	18 (6.5%)
Peamouth Chub	<i>Mylocheilus caurinus</i>	Native		12 (4.4%)
Largescale Sucker	<i>Catostomus macrocheilus</i>	Native	3 (0.1%)	15 (5.4%)
Prickly Sculpin	<i>Cottus asper</i>	Native		1 (0.4%)
Cyprinids not identified to species			133 (5.2%)	
Suckers not identified to species			4 (0.2%)	
Sculpin not identified to species			15 (0.6%)	
Total			2540	276

The sculpin that were not identified to species in 2007 are considered likely to be Prickly Sculpin. Pumpkinseed Sunfish were recorded in 2007, but not in 2021, and Burbot were recorded in 2021, but not in 2007. Both species were known to be present within the lake in the other year of study, however.

Based on a literature review of past studies conducted by McPherson and Hlushak (2008), Bull Trout (*Salvelinus confluentus*), Rainbow Trout (*Oncorhynchus mykiss*), Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*), and Kokanee (*Oncorhynchus nerka*) were species considered possible to inhabit or use the Lake. None of these species were recorded during the present study. Bull Trout (two observed from the dock near a creek mouth) and Kokanee (about 30 observed from the boat, likely migrating) were observed in the fall of 2007, but Rainbow Trout and

Westslope Cutthroat Trout were not recorded in the summer or fall of 2007. It is anticipated that use of the lake by these species may still occur sporadically, but was likely also limited in the past, especially during the summer, due to high water temperatures. Factors such as competition and predation by non-native sportfish and/or native non-sportfish, habitat limitations, increased angling pressure, urbanization, and increasing water temperatures due to climate change will continue to result in low use of Lake Windermere by these species.

Species that were considered likely to be present in Lake Windermere (McPherson and Hlushak 2008), but were not recorded in 2007 or 2021 included Longnose Sucker (*Catostomus catostomus*), Longnose Dace (*Rhinichthys cataractae*) and Torrent Sculpin (*Cottus rhotheus*). These species are considered possible to use the lake, but likely in low numbers if so. Eastern Brook Trout (*Salvelinus fontinalis*), Chiselmouth Chub (*Acrocheilus alutaceus*), and Lake Chub (*Couesius plumbeus*), were considered unlikely to be present in Lake Windermere based on the literature search and were not recorded in 2007 or 2021.

4.2 Columbia Lake

The overall fish species assemblage in Columbia Lake in 2021 was similar to that recorded during the summer of 2009 (McPherson et al. 2010). Species recorded in both years include Mountain Whitefish, Pumpkinseed Sunfish, Redside Shiner, and Northern Pikeminnow (Table 6). During the summer of 2009, 2108 Cyprinids were recorded, but not identifies to species. It is considered likely that Peamouth Chub were among the Cyprinid species recorded in 2009. As in Lake Windermere, additional research is needed to determine if the differences between years was due to natural variation, the primary sample methods used (snorkel surveys in 2009; beach seining in 2021), differences in areas sampled, or represent changes to the species assemblage of Columbia Lake.

Table 6: Summary of fish recorded in Columbia Lake during sampling in the summers of 2009 and 2021.

Species	Scientific Name	Species Type	2009	2021
Largemouth Bass	<i>Micropterus salmoides</i>	Non-native		87 (35.5%)
Mountain Whitefish	<i>Prosopium williamsoni</i>	Native	21 (0.9%)	19 (7.8%)
Burbot	<i>Lota lota</i>	Native		
Pumkinseed Sunfish	<i>Lepomis gibbosus</i>	Non-native	1 (<0.1%)	9 (3.7%)
Northern Pikeminnow	<i>Ptychocheilus oregonensis</i>	Native	14 (0.6%)	15 (6.1%)
Redside Shiner	<i>Richardsonius balteatus</i>	Native	121 (5.3%)	33 (13.5%)
Peamouth Chub	<i>Mylocheilus caurinus</i>	Native		26 (10.6%)
Largescale Sucker	<i>Catostomus macrocheilus</i>	Native		47 (19.2%)
Prickly Sculpin	<i>Cottus asper</i>	Native		9 (3.7%)
Cyprinids not identified to species			2108 (92.3%)	
Suckers not identified to species			16 (0.7%)	
Sculpin not identified to species			2 (0.1%)	
Total			2283	245

The sculpins that were not identified to species in 2009 are considered likely to be Prickly Sculpin and the suckers were likely Largescale Sucker. Burbot were not recorded in either study year and Largemouth Bass were recorded in 2021, and in the fall of 2009, but not the summer of 2009. Given that they were recorded in Lake Windermere in the years that they were not in Columbia Lake, it is likely that both species were present in Columbia Lake, but potentially in low numbers and/or during other seasons.

Based on past studies (McPherson et al. 2010), and the similarity and connectivity of Lake Windermere and Columbia Lake, Bull Trout (*Salvelinus confluentus*), Rainbow Trout (*Oncorhynchus mykiss*), Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*), and Kokanee (*Oncorhynchus nerka*) were species considered possible to inhabit or use Columbia Lake. These species were not recorded during 2009 or 2021. It is likely that use of the lake by these species may still occur sporadically, but similar to Lake Windermere, factors such as competition and predation by non-native sportfish and/or native non-sportfish, habitat limitations, increased angling pressure, forest harvesting, urbanization, and increasing water temperatures will likely continue to result in low use of Columbia Lake by these species.

Species that were considered likely to be present in Columbia Lake (McPherson et al. 2010), but were not recorded in 2009 or 2021 included Longnose Sucker (*Catostomus catostomus*), Longnose Dace (*Rhinichthys cataractae*) and Torrent Sculpin (*Cottus rhotheus*). These species may use the lake, but likely in low numbers. These three species were also not recorded in Lake Windermere in 2007 or 2021. Eastern Brook Trout (*Salvelinus fontinalis*), Chiselmouth Chub (*Acrocheilus alutaceus*), and Lake Chub (*Couesius plumbeus*), were considered unlikely to be present in Columbia Lake based on past studies. Similar to Lake Windermere, these species were not recorded in Columbia lake in 2009 or 2021.

4.3 Conclusion and Recommendations

Additional research over multiple seasons (and likely years) is required to determine if any of the trends/changes in fish use recorded during the present study represent actual changes versus natural variation, and to properly determine differences in fish use between habitat types and different disturbance levels. It seems clear that the introduction of Largemouth Bass and Pumpkinseed to the system has resulted in changes to the fish assemblage. These species are better suited to warmer waters and may be displacing Salmonids in the lakes. Warmer waters also provide Cyprinids a competitive advantage over Salmonids. In addition to warming waters affecting the fish assemblage of these lakes, other factors such as habitat disturbance, angling pressure, and increasing urbanization also likely play a role.

Recommendations for future studies include:

- Conduct seasonal sampling (spring, summer, fall) using additional methods (e.g., electrofishing, gill nets, hoop traps) over multiple years.
 - This would provide information on fish use of the lakes during different conditions and a more complete picture of overall fish use of the lakes.
- Prior to potential future sampling, conduct an in-depth literature review of previous fisheries studies conducted in the lakes.
 - This would provide a better picture of past fish use and a baseline to which future results could be compared, and direction for future sampling efforts.

5 Literature Cited

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Appendix A: Lake Windermere

Appendix B: Columbia Lake