Windermere Creek Water Quality Monitoring Report 2009 – 2012

A Columbia Basin Water Quality Monitoring Project

Final Report

Prepared by Lotic Environmental Ltd.

For Wildsight

2014

LOTIC ENVIRONMENTAL

Columbia Basin Watershed Network

COLUMBIA BASIN TRUST
a legacy for the people

Acknowledgements

The project was funded by the Columbia Basin Trust. The field data collection was led by Heather Leschied of Wildsight. Field support was provided by Kalista Pruden also of Wildsight, Kirsten Harma of the Lake Windermere Ambassadors and Raegan Mallinson of Living Lakes Canada. The project received valuable support from the Columbia Basin Water Quality Monitoring project coordinators, Jim and Laura Duncan.

We wish to thank the following individuals for their support throughout the project: Heather Mitchell (Columbia Basin Trust) and Tim Hicks (Columbia Basin Trust), Stephanie Strachen (Environment Canada), Hans Schreier (UBC Professor Emeritus) and Ken Hall (UBC Professor Emeritus).

We also wish to acknowledge the valued contributions from the technical team who helped with analysis, and preparation of reporting tools for the Columbia Basin Water Quality Monitoring Project. This includes: Guy Duke, Kevin Grant, and Tom Rutherford of GrandDuke Geomatics Ltd; and Katie Burles.

Contact Information

For more information:
Wildsight
Heather Leschied
heather@wildsight.ca

Columbia Basin Water Quality Monitoring Project Coordinators:
Jim and Laura Duncan
gardenlaura@shaw.ca or jim.duncan9@me.com

Columbia Basin Trust Coordinator
Tim Hicks, Manager Water and Environment
thicks@cbt.org

The Water Quality Monitoring Project is part of the Columbia Basin Watershed Network. The Columbia Basin Watershed Network Database is located at: www.cbwn.ca

Suggested Citation

McPherson, S., K. Kuchapski, and R. MacDonald. 2014. Windermere Creek 2009-2012, water quality monitoring report. A Columbia Basin Water Quality Monitoring Project. Prepared by Lotic Environmental Ltd. for Wildsight.

Cover photo – Windermere Creek monitoring Site 4 (NAWIN04), by Heather Leschied.

Project Highlights

- The health of Windermere Creek was reviewed using the results of benthic invertebrate and water quality monitoring from 2009 to 2012. Monitoring was conducted at four sites on the mainstem, representative of the upstream section of the creek, the mid-stream section, and the furthest downstream section.
- Overall, the monitoring results showed variability in the health of the Windermere Creek. Indications of stress were apparent throughout the creek at various times. The most apparent water quality impact with the potential to impair benthic community health was elevated turbidity. Monitoring results showed how stream health can recover under improved conditions.
- The upstream site (NAWIN01) was stressed in 2010 but only potentially stressed in following years. The stressed condition was indicated by several macroinvertebrate community indices. The stressed macroinvertebrate condition was attributed to habitat impacts which caused reduced depth and velocity, and increased embeddedness of dominant substrate with fine substrate. The cause of these conditions is unknown.
- The initial mid creek study site (NAWIN02) was only monitored in 2009 and 2010, since it was buried by an erosion event in 2011. The event is an example of ongoing erosion concerns in the watershed. Prior to this event, the site was unstressed with no water quality concerns. Its replacement (NAWIN04) provided another example of conditions improving with time. NAWIN04 was potentially stressed in 2011, and was similar to reference condition in 2012. Water quality remained consistent through this period.
- The downstream site (NAWIN03) located near the Windermere Creek outlet to Windermere Lake was found to be in good condition (potentially stressed) in 2010. The site showed a dramatic decline in benthic community health in 2011 and 2012 as a result of extreme sediment loading. The decline was evident as no to very low abundance of invertebrates. Water quality sampling at NAWIN03; however, revealed that there have been elevated turbidity values periodically since 2011. Transport and deposition of excessive suspended sediments in streams is detrimental to aquatic organisms including plants, invertebrates, and fish. Additionally, elevated turbidity in streams is a concern for raw drinking water. Erosion sources have been identified with evidence that they will persist into the future (McCleary 2012). Thus, options to stabilize the channel should be sought.
- Sediment quality (only monitored at NAWIN03) revealed elevated arsenic concentrations relative to guidelines in 2011 and 2012. The likelihood of effects on the biological community was uncertain at the concentrations measured. This is because arsenic exceeded the low effect guideline, above which adverse biological effects are expected to only rarely occur (CCME 2001). The probable effect level guideline, above which adverse biological effects are expected, was not exceeded.
- Stream temperature at NAWIN01 was generally lower than NAWIN03 and monthly average stream temperature values were within the optimal range for westslope cutthroat trout and bull trout rearing.

Contents

Table of Tables

Table of Figures

Table of Appendices

1 Introduction

Community-based water quality monitoring in the Columbia River basin plays an important role in preserving watershed function for sustainable communities and ecosystems. It is imperative that current and future water quality and quantity concerns be assessed in the Columbia River basin as environmental change poses substantial risk to ecosystem and societal health. Changes in landuse and climate pose the greatest threat to both water quality and water quantity in the Columbia River basin. Current and future reductions in snow accumulation (Barnett *et al*. 2008) and glacial ice (Jost *et al*. 2012) have been shown to result in reduced water supply in the Columbia basin, particularly for the low flow summer periods (Burger *et al*. 2011). Lower streamflow leads to a reduced ability for streams to dilute pollution, potentially resulting in substantial water quality issues. In addition to climate change, the diverse land uses of the Columbia River basin, including: recreational and industrial development, streamflow regulation, municipal and industrial waste water, and non-point source pollution present a challenge for community-based water quality management.

A first step in addressing present and future water quality and quantity issues is developing community awareness and involvement. The Columbia Basin Watershed Network (CBWN) is an environmental stewardship project funded by the Columbia Basin Trust (CBWN 2012). The CBWN provides support to organizations, individuals and local water stewardship groups that undertake activities to conserve and monitor rivers and lakes throughout the Canadian Columbia River Basin (CBWN 2009). In response to local support, the CBWN has developed a long-term Water Quality Monitoring Project (WQMP), with the following goals (CBWN 2009):

1. Develop a science-based model for community-based water quality monitoring;
2. Establish online accessibility to water quality data; and,
3. Link the monitoring project with community awareness activities.

In order to meet these goals, Wildsight, through its now complete Lake Windermere Project, have been conducting water quality monitoring in Windermere Creek from 2009 to 2012. Monitoring has included benthic macro-invertebrate assessment, water and sediment quality assessment, and continual temperature monitoring.

1.1 Monitoring sites

Windermere Creek is proximal to the District of Invermere in the East Kootenay Region. Windermere Creek was chosen for sampling because it is the largest tributary to Windermere Lake other than the Columbia River. Monitoring sites were selected to obtain an understanding of water quality effects potentially resulting from several developments in the area. There have been four sites sampled on Windermere Creek (Figure 1):

- Site 1 (NAWIN01) is the farthest upstream sampling site and is located upstream of a gypsum mine. The site does not stay wetted year round, it typically dries up in the winter.
- Site 2 (NAWIN02) is located downstream of a gypsum mine, and upstream of a golf course. Site 4 was established to replace it because a large erosion event occurred upstream of this site in the spring of 2011.
- Site 3 (NAWIN03). Is the furthest downstream site. Kokanee spawn at Site 3, but a barrier at Hwy 93/95 precludes access further upstream (H. Leschied pers. comm). Upstream influences include a gypsum mine, golf course, agriculture and residential development.

- Site 4 (NAWIN04). Site 4 is located downstream of the gypsum mine and replaced Site 2 in 2011.

In addition to the above mentioned developments, other potential influences on water quality in the Windermere Creek watershed, include: water licenses (≥45 which generally are not monitored for withdrawals), some logging high in the watershed, and mining roads.

1.2 Fish community

The fish community in Windermere Creek is comprised of five native and one non-native species (Table 1). Westslope cutthroat trout are recognized as a species of Special Concern in BC and are listed as a species of Special Concern throughout their range in British Columbia under the federal Species at Risk Act (SARA). Kokanee are only known to occur near the mouth of Windermere Creek due to a culvert that acts as a barrier to upstream migration.

Table 1. Fish species in Windermere Creek. Source: BC Ministry of Environment (2013)

Species - common name	Scientific name
Native species	
Westslope cutthroat trout	*Oncorhynchus clarkii lewisi*
Rainbow trout	*O. mykiss*
Kokanee	O. *nerka*
Mountain whitefish	*Prosopium williamsoni*
Sculpin spp.	*Cottus spp*
Non – native (naturalized)	
Eastern brook trout	*Salvelinus. fontinalis*

1.3 Objectives

The objectives of this water quality monitoring report are as follows:

1. Present CABIN, sediment and water quality, and continual stream temperature data collected to date in a format that can be used for analysis and ongoing assessment.
2. Analyse biological monitoring data (CABIN). Complete the analysis using the analytical tools in the CABIN database by classifying benthic invertebrate community stress at sampling sites according the Reference Condition Approach and calculating invertebrate community metrics.
3. Analyse water and sediment quality data to identify if there were any parameters of potential concern in the study area. Complete this review by comparing monitoring results to applicable federal and provincial guidelines for the protection of aquatic life and drinking water, where available.
4. Analyse stream temperature data obtained from the continual data logger(s).
5. Relate biological results to water/sediment quality and stream temperature findings.
6. Provide recommendations for future stream health data collection including applicable data to be collected, locations to be sampled, and procedures.

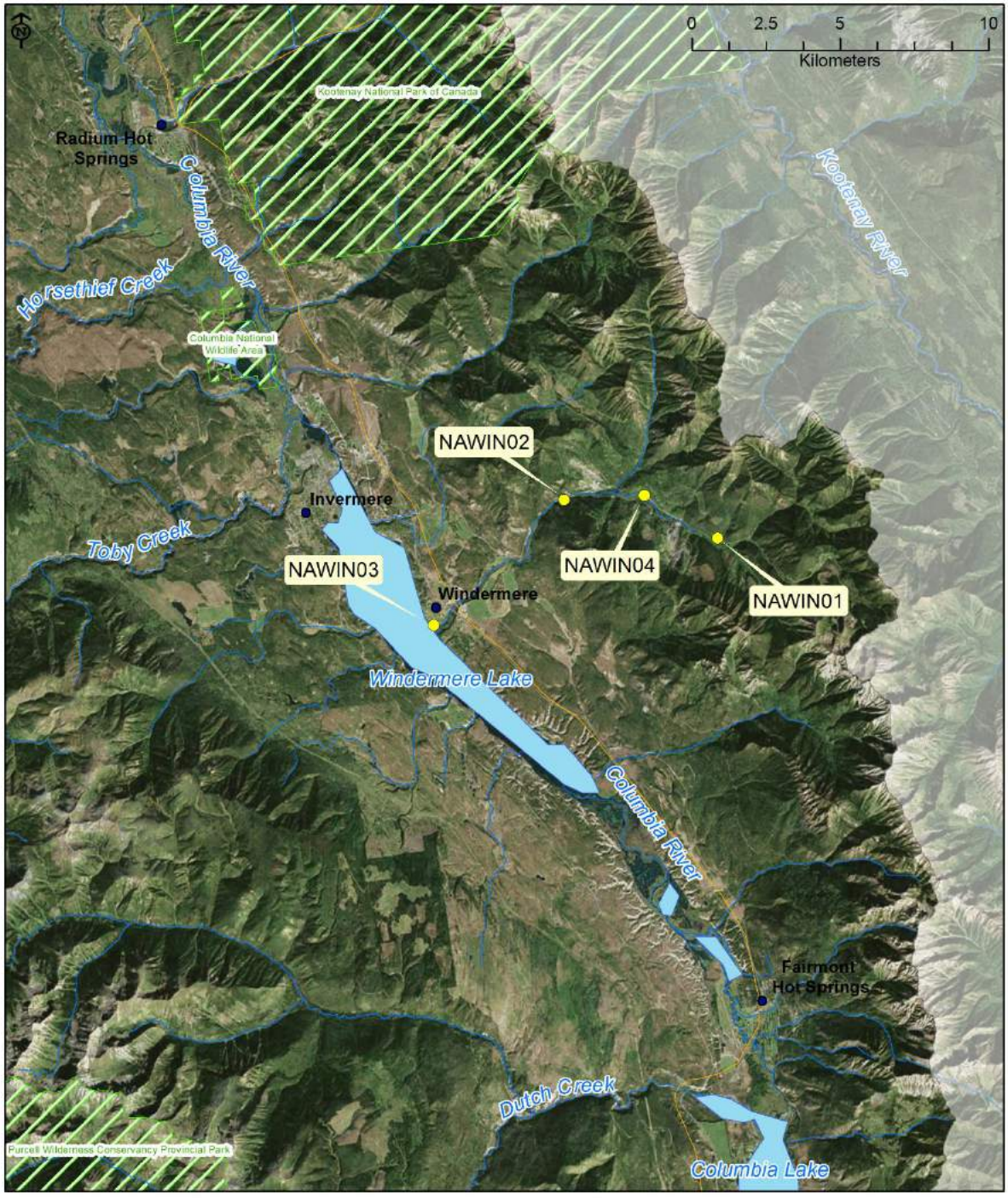


Figure 1. Windermere Creek water quality monitoring sites

2 Methods

2.1 General data collection

Canadian Aquatic Biomonitoring Network (CABIN) techniques were used to collect data on benthic macro-invertebrates, habitat and water quality. Data were collected following the CABIN Field Procedures for Wadeable Streams (Environment Canada 2012a) and the CBWQMP Operating Procedures (CBWQMP 2012). CABIN sampling was conducted once a year in the fall at all three sites between 2010 and 2012 (Table 2). Invertebrate samples were analysed by EcoAnalysts[1] following CABIN laboratory methods (Environment Canada 2012b). All data were entered into the online CABIN database which was used to analyse findings and provide site reports.

Table 2. Summary of monitoring completed.

		Site Code			
		NAWIN01	**NAWIN02**	**NAWIN03**	**NAWIN04**
Location		Upstream site	Middle site	Downstream site	Middle site(#2)
Development Pressures		Logging, roads	Logging, roads, gypsum mine	Logging, roads, gypsum mine, golf course, residential development	Logging, roads, gypsum mine
Year Monitored	**CABIN (annually)**	2009-2012	2009, 2010	2010, 2011, 2012	2011, 2012
	WQ-non metals	2009-2013 (annually)	2009, 2010 (annually)	2009-2013 (monthly)	2011-2013 (annually)
	***WQ - metals**	-	-	2009, 2010 (annually)	-
	Sediment Quality	-	-	2011-2013 (annually)	-
	Temp. (hourly)	Jun-Nov 2009 May-Oct 2010 Jun to Oct 2011 Jun to Nov 2012	-	Jul-Nov 2009 May to Oct 2010 Jun to Oct 2011 Jun to Nov 2012	Jun to Nov 2012

*WQ – water quality

Water and sediment quality data was collected following CBWQMP Operating Procedures (CBWQMP 2012). The frequency and type of data collected was variable and are summarized in Table 2. Water quality parameters measured in the field (*in situ*) included temperature, turbidity, pH, specific conductivity, and dissolved oxygen. Parameters analysed in the laboratory included inorganics, nutrients, and metals. Maxxam (Burnaby, BC) completed laboratory water and sediment quality analysis.

Hourly stream temperature (°C) was measured using HOBO Pro V2 temperature loggers. Table 2 summarizes the period of collection for each site.

[1] www.ecoanalysts.com

2.2 General data analysis

The Reference Condition Approach (RCA) in CABIN was used to determine the condition of the benthic invertebrate community at the test sites by comparing each test site to a group of reference sites with similar environmental characteristics.

Using the Analytical Tools in the CABIN database, four analyses were used to review invertebrate test site data (Steps 1a – 1d in Figure 2): BEnthic Assessment of SedimenT (BEAST), River Invertebrate Prediction and Classification System (RIVPACS), community composition metrics, and habitat metrics.

The reference model used in the RCA analysis was the Preliminary Okanagan-Columbia Reference Model (2010) provided in the online CABIN database. Because the model was still considered preliminary, with some potential data gaps, caution was exercised when interpreting RCA results (obtained from Steps 1a to 1d). Furthermore, it was important that all subsequent analyses (Steps 2 and 3) were conducted.

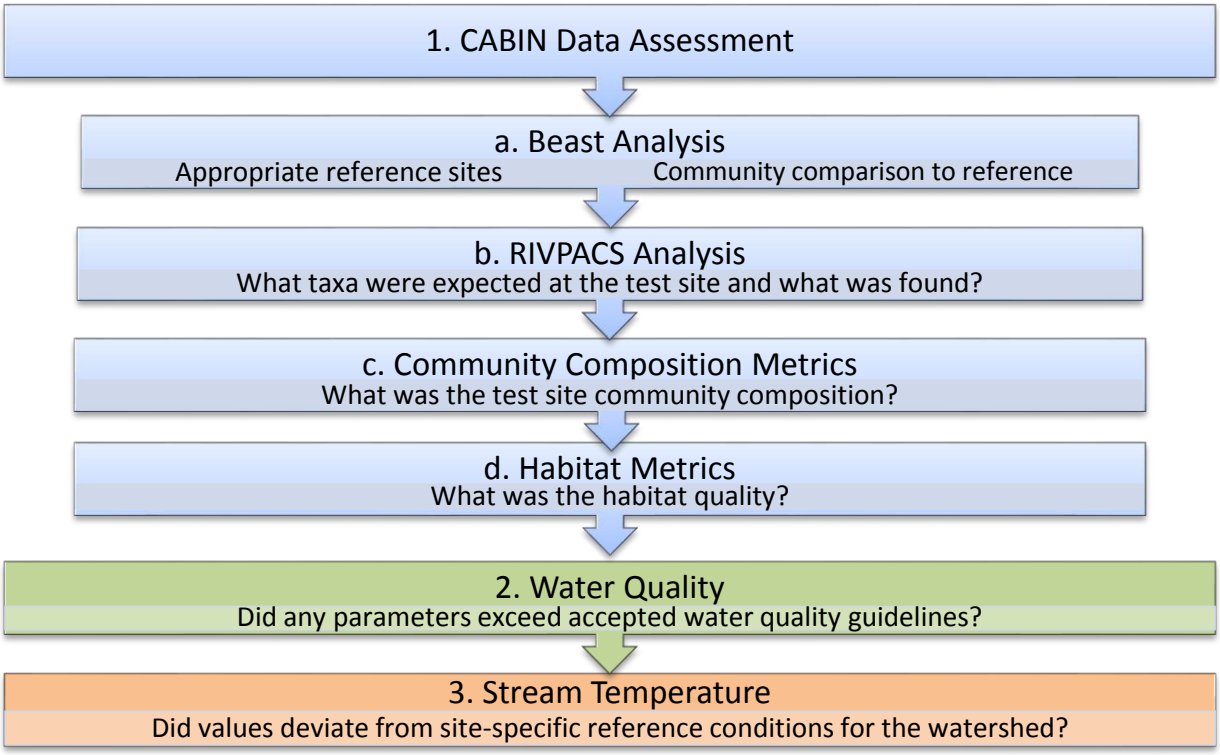


Figure 2. Stream condition analysis steps.

2.3 CABIN data analysis

2.3.1 Reference Condition Approach: BEAST analysis and site assessment

BEAST analysis was used to compare test sites to a reference group from the preliminary Okanagan-Columbia reference model provided by Environment Canada through the CABIN database. BEAST uses a classification analysis that determines the probability of test site

membership to a reference group based on habitat variables (Rosenberg *et al.* 1999). Habitat variables used to predict group membership in the Okanagan-Columbia reference model include latitude, longitude, percent area of watershed with a gradient <30%, percent area of watershed with permanent ice cover, and average channel depth.

CABIN model hybrid multi-dimensional scaling ordination assessment was then used to evaluate benthic community stress based on divergence from reference condition. This analysis placed test sites into assessment bands corresponding to a stress level ranging from unstressed to severely stressed. In the ordination assessment, sites that are unstressed fall within the 90% confidence ellipse around the cloud of reference sites which means that their communities are similar or equivalent to reference (Rosenberg *et al.* 1999). Potentially stressed, stressed and severely stressed sites fall outside of the 90%, 99% and 99.9% confidence ellipses and indicate mild divergence, divergence, or high divergence of the benthic community from reference condition (Rosenberg *et al.* 1999).

2.3.2 RIVPACS analysis

RIVPACS ratios were calculated in the Analytical tools section of the CABIN database. RIVPACS analysis relies on presence/absence data for individual taxa. The RIVPACS ratio determines the ratio of observed taxa at test sites to taxa expected to be present at the test site based on their presence at reference sites. A RIVPACS ratio close to 1.00 indicates that a site is in good condition as all taxa expected to be present were found at the test site. A RIVPACS ratio >1.00 can indicate community enrichment while a ratio <1.00 can indicate that a benthic community is in poor condition.

2.3.3 Community composition metrics

Benthic community composition metrics were calculated in the CABIN database using the Metrics section of the Analytical Tools menu. A collection of relevant measures of community richness, abundance, diversity and composition were selected to describe the test site communities. Using metrics, indicator attributes were used to interpret the response to environmental disturbances. Metrics are complimentary to an RCA analysis.

2.3.4 Habitat metrics

Physical stream habitat characteristics are measured as part of standard CABIN Field protocols (Environment Canada 2012a). These characteristics include channel width, depth and velocity, riparian vegetation amount and type, periphyton and canopy coverage, and substrate embeddedness. Habitat characteristics were compared between years at each site in order to identify any variation in habitat with the potential to influence benthic invertebrate community composition and health.

2.4 Water quality data analysis

2.4.1 Water quality QA/QC

Raw data were first subjected to a quality control evaluation to assess the accuracy and precision of the laboratory and field methods. For all sediment and water samples analysed, the laboratory assessed accuracy through the use of matrix spike, spiked blank, and method blank samples. As well, the laboratory measured precision through duplicate sample analysis. As per standard practice, all laboratory quality control results were reviewed and confirmed to meet standard criteria prior to proceeding with processing of field samples (Maxxam 2012).

Field duplicates were submitted to the laboratory to measure both field sampling error plus local environmental variance. Duplicate review was based on relative percent difference (RPD) as determined by Equation 1. For duplicate values at or greater than five times the MDL, a RPD values >20% indicates a possible problem, and > 50% indicates a definite problem, most likely either contamination or lack of sample representativeness (BC MoE 2003). An RPD value greater than or equal to 30% was considered an alert level (Horvath pers. comm.). Where RPD values were greater than 30%, the source of the problem was determined, and the impact upon the sample data ascertained (BC MoE 2003). If data were found to be within acceptable ranges, subsequent analyses included only the first of the duplicate samples.

Equation 1: Duplicate sample quality control

Relative Percent Difference = (Absolute difference of duplicate 1 and 2/average of duplicate 1 and 2)*100

$$RPD = \left(\frac{\text{Duplicate 1} - \text{Duplicate 2}}{(\text{Duplicate 1} + \text{Duplicate 2})/2} \right) \text{X } 100$$

Field blank data were collected to monitor possible contamination prior to receipt at the laboratory. Field blanks were compared using Equation 2. Field blank values that were 2 times greater than the reportable detection limit were considered levels of alert (Maxxam 2012, Horvath pers. comm.). Field blank values that exceeded the alert level were reviewed in more detail to identify the potential source(s) for contamination; as well other data on that day were compared to historical data to identify if there were anomalies possibly related to contamination.

Equation 2: Field Blank sample quality control

$$\text{Blank x difference} = \frac{\text{Field Blank Value}}{\text{Reportable Detection Limit (RDL)}}$$

2.4.2 Guideline review

A guideline is a maximum and/or a minimum value for a characteristic of water, sediment or biota, which in order to prevent specified detrimental effects from occurring, and should not be exceeded (Nagpal 2001). Water quality results were compared to the applicable provincial and federal guidelines for the protection of aquatic life and drinking water (Table 3). Sediment quality results

were also compared to the applicable British Columbia and Canadian guidelines for the protection of aquatic life.

Table 3. Provincial and federal guidelines applicable to the protection of aquatic life (sediment and water quality) and drinking water (water quality only).

Document	Sediment Quality – Aquatic Life	Water Quality – Aquatic Life	Water Quality – Drinking Water
Federal			
Canadian Water Quality Guidelines (CCME 1999a)		X	
Guideline for Canadian Drinking water quality (Health Canada 2012)			X
Canadian Sediment Quality Guidelines (CCME 1999b)	X		
Provincial			
Approved Water Quality Guidelines (Government of BC 2013)	X	X	X
Working Water Quality Guidelines for BC (Nagpal et al. 2006)	X	X	X

* CCME - Canadian Council of Ministers of the Environment

When long-term and short-term exposure guidelines were available, the long-term guideline was used in the review, since sampling was assumed to have occurred under 'normal' conditions. As well, to characterize water and sediment quality, all guideline thresholds were considered in this review. An exceedance of any of the thresholds was flagged to provide an understanding of the potential risks to aquatic organisms.

The transpose add-in tool created by GranDuke Geomatics (2013a) was used to automate the addition of new water quality data from Maxxam into existing CBWN datasets. Using Visual Basic for Applications (VBA) users opened MS Excel files from Maxxam and chose which MS Excel file to append the new data into. The add-in matches parameter names between files and converts units (e.g., between µm and mg) flagging the data cells that were successfully transferred. The Automated Guideline Assessment Tool for High-speed Analysis (AGATHA), also developed by GranDuke Geomatics (2013b) was then used to compare measured water and sediment quality values to the applicable published guidelines. The interface to AGATHA for the CBWQMP was provided through Microsoft Excel. AGATHA highlighted values that were above or below published guidelines and provided links to guidelines where further information could be attained. AGATHA automatically monitors the national and provincial guidelines for changes, ensuring guideline checks are up-to-date into the future.

2.5 Stream temperature analysis

HOBOware was used to process the data and Microsoft Excel was used for the stream temperature analysis. Daily stream temperature data were analyzed using descriptive statistics (average, standard deviation). Monthly averages of daily average and standard deviations were

derived for each year and site. The monthly average of daily average stream temperature values were compared against the optimal thermal ranges for the rearing life history stage of westslope cutthroat trout and bull trout.

3 Results

3.1 CABIN results

3.1.1 Reference Condition Approach: BEAST analysis and site assessment

Through a comparison of habitat and landscape predictor variables, CABIN BEAST analysis assessed Sites 1 and 2 to Reference Group 5 (Table 4). Sites 1 and 2 are located in the Western Continental Ranges Ecoregion. Reference Group 5 was comprised of 33 sites, including sites from this ecoregion. The landscapes of the test sites and the reference group were thus comparable. Sites 3 and 4 were predicted to Reference Group 3. Reference Group 3 includes 17 sites, which include locations in the Western Continental Range eco-region, the ecoregion of Site 4. Reference Group 3 did not include any reference sites from the Southern Rocky Mountain Trench Ecoregion, which is where Site 3 is situated. However, other predictor variables were important in confirming the applicability of the reference groups to the test sites, including for example, mean average channel depth. Reference groups 3 and 5 had the shallowest mean channel depths of any reference groups (21.5 cm and 22.5 cm respectively) and are therefore most similar to average channel depths at Windermere Creek test sites which ranged from 2.3-26.0 cm.

Through a comparison to reference conditions, the CABIN model assessed Site 1 as ranging from unstressed (or similar to reference) to stressed (divergent from reference) over the period from 2009-2012. Site 2 was classified as potentially stressed (mildly divergent from reference) in both 2009 and 2010, and Site 3 was assessed as potentially stressed in 2010 and highly stressed (highly divergent from reference) in 2011[2] and 2012. The 2011 stress rating was assumed Assessment ordination plots along with community composition and habitat details are included in the Site Assessment Reports in Appendix A.

Table 4. CABIN model assessment of test sites against reference condition, and in brackets, applicable Okanagan-Columbia reference group and probability of match.

Site	2009	2010	2011	2012
NAWIN01	**Unstressed** (Group 5, 40.4%)	**Stressed** (Group 5, 40.9%)	**Potentially Stressed** (Group 5, 40.5%)	**Potentially Stressed** (Group 5, 40.4%)
NAWIN02	**Potentially Stressed** Group 5, 37.4%	**Potentially Stressed** (Group 5, 38.6%)	-	**-**
NAWIN03	**-**	**Potentially Stressed** (Group 3, 35.8%)	**Highly Stressed**	**Highly Stressed** (Group 3, 35.4%)
NAWIN04	**-**	**-**	**Potentially Stressed** (Group 3, 37.9%)	**Unstressed** (Group 3, 38%)

[2] The 2011 stress rating was applied to this site as no invertebrates were present during sampling.

3.1.2 RIVPACS analysis

The RIVPACS Observed:Expected ratios partially support the condition reported through the CABIN model. The high RIVPACS ratios (>0.62) generally corresponded with sites/years that were either unstressed or potentially stressed (Table 5). These healthy conditions occurred at almost all sites and years with the exception of NAWIN01 in 2010 and NAWIN03 in 2011 and 2012, which were found to be stressed and severely stressed respectively. The RIVPACS ratios do not explain the NAWIN01 2010 and NAWIN03 2012 stressed ratings, as they were greater than 0.62, which corresponded with healthy conditions at other sites. NAWIN03 in 2011 was distinctive in that there were no invertebrates present during sampling. Thus, the site was attributed a 0 RIVPACS ratio.

At all sites, taxa that were expected (based on a probability of >70% occurrence at reference sites) but that were absent, were of the orders Ephemeroptera, Plecoptera or Trichoptera (EPT taxa). However, the absent taxa as identified through RIVPACS analysis, were not always a direct indicator of health since similar taxa were absent both at the healthy sites and at the stressed sites (e.g., chloroperlidae, taeniopterygidae, hydropsychidae).

Table 5 RIVPACS Observed:Expected ratios of taxa at test sites. Taxa* were listed that had a probability of occurrence >70% at reference sites but were not observed at the test site. Condition indicated as shaded background**

Site	2009	2010	2011	2012
NAWIN01	**0.83** CHLO, HYDR	**0.73** CHLO, RHYA, TAEN	**0.62** CHLO, HYDR, RHYA, TAEN	**0.83** CHLO, PERLO
NAWIN02	**0.73** CHLO, EPHE, HYDR	**0.83** CHLO, HYDR, TAEN	-	-
NAWIN03	-	**0.62** HYDR, PERLO, RHYA, TAEN	**0.0** BAET, CHIR, CHLO, EPHEM, HEPT, HYDR, NEMO, PERL, RHYA, TAEN	**0.62**
NAWIN04	**-**	-	**1.04**	**1.04**

*Macroinvertebrate family abbreviations:

Order Ephemeroptera: BAET- Baetidae, EPHE-Ephemerellidae, HEPT-Heptageniidae
Order Plecoptera: CHLO-Chloroperlidae, NEMO-Nemouridae, PERLO-Perlodidae, TAEN-Taeniopterygidae
Order Trichoptera: HYDR-Hydropsychidae, RHYA-Rhyacophilidae
Order Diptera: CHIR-Chironomidae

**** Condition:** unstressed, potentially stressed, stressed, severely stressed.

3.1.3 Community composition metrics

The site level community composition metrics reflected the CABIN model results showing that there were several indices of invertebrate community composition that corresponded with the ratings of stream health (Table 6). The stressed rating for NAWIN01 in 2010 corresponded with the lowest total abundance reported for the site (669 organisms). Also, the percent EPT was 39% in 2010; a value nearly half that exhibited in 2009 when this site was rated as unstressed (Figure 3). In 2010, the percent of chironomidae was also highest for the site at 50%.

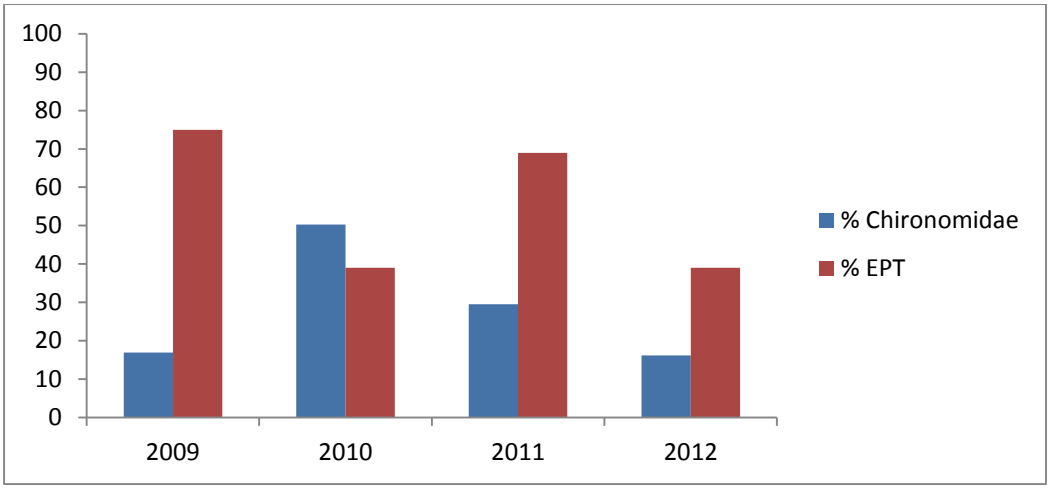


Figure 3. Select community composition metrics at site NAWIN01.

The severely stressed rating at NAWIN03 in 2011 corresponds with no invertebrates being present during sampling. Similarly, at NAWIN03 in 2012, the severely stressed conditions corresponded with an extremely low abundance of benthic invertebrates. The count of 48 was only a small fraction of the second lowest abundance at all sites (7% of NAWIN01 in 2010) and of the previous abundance recorded at NAWIN03 (1% in 2010).

There were several sites classified as potentially stressed: NAWIN01 2011, and 2012; NAWIN02 2009 and 2010; NAWIN03 2010, and NAWIN04 2011. This rating indicates that there may be influences causing mild divergence to benthic community health from reference condition. However, because benthic invertebrate communities vary naturally from year to year, variation caused by water quality or habitat alterations is difficult to differentiate from natural variation when the divergence is mild. The metrics should continue to be monitored as yearly data is collected to identify any emerging trends.

Table 6. Benthic invertebrate community composition metrics measured in 3 min kicknet samples taken at Windermere Creek CABIN sites between 2009 and 2012. Condition indicated as shaded background*

Year	NAWIN01				NAWIN02			NAWIN03		NAWIN04	
	2009	2010	2011	2012	2009	2010	2010	2011	2012	2011	2012
% Chironomidae	16.9	50.3	29.5	16.2	2.9	56.6	6.8	0	18.8	3.2	8.8
% Ephemeroptera	31.5	36.9	6.4	11.2	27.1	18.4	46.8	0	10.4	65.5	57.7
% Ephemeroptera that are Baetidae	44.4	89.2	52.4	77.5	25.3	75.7	95.6	0	60.0	69.5	62.9
% of 2 dominant taxa	38.2	83.2	89.3	75.7	51.6	70.5	62.8	0	52.1	60.2	59.3
% of dominant taxa	21.3	50.3	59.9	59.5	37.9	56.6	44.8	0	33.3	45.5	36.3
% Plecoptera	42.6	1.52	62.3	67.9	13.1	16.1	19.8	0	52.1	19.5	26.1
% Trichoptera	0.6	0.6	0	0.8	41.8	0.53	0.9	0	4.2	5.0	2.2
% EPT	75	39	69	39	82	35	67	0	67	90	86
Ephemeroptera taxa	4	4	3	11	4	4	3	0	2	4	4
No. EPT taxa	9	9	6	10	15	10	9	0	6	15	11
# EPT/#Chironomids+ #EPT	0.8	0.4	0.7	0.8	1	0.38	0.9	0	0.8	1.0	0.9
Plecoptera taxa	4	3	3	4	4	5	5	0	3	6	4
Shannon-Wiener Diversity	2.1	1.3	1.1	1.4	2.2	1.6	1.7	0	2.0	1.9	1.9
Simpson's Diversity	0.9	0.6	0.5	0.6	0.8	0.6	0.7	0	0.8	0.7	0.8
Total Abundance	713	669	1370	2106	5099	3800	5733	0	48	1900	4550
Total No. of Taxa	13	14	10	15	26	21	16	0	11	22	18
Trichoptera taxa	1	2	0	3	7	1	1	0	1	5	4

*** Condition:** unstressed, potentially stressed, stressed, severely stressed

3.1.4 Habitat Metrics

The habitat metrics were compared between the stressed years/sites to select unstressed or potentially stressed years to identify potential influences (Table 7). The average channel depth and average velocity at NAWIN01 in 2010 were low compared to other sampling years. The average depth in 2010 was 2.3 cm compared to values ranging from 4.3 - 4.9 cm during other years at this site. In 2010, the average velocity was 0.09 m/s, while the other years ranged from 0.16 to 0.25 m/s. NAWIN01 also had an increased embeddedness in 2010 relative to the other years monitored. This was evident as the dominant substrate being buried approximately 50% by smaller particles (course sand). Infilling of habitat with finer materials, causing shallower depths and lower velocities very likely contributed to the decline in invertebrates at NAWIN01 in 2010.

The habitat data do not help describe the cause of the severely stressed conditions at NAWIN03 in 2012. In fact, the conditions appeared to improve since embeddedness decreased from 75% in 2010 to 0% in 2011 and 2012. However, the comments provided in the 2011 CABIN report at this site describe that a major landslide occurred upstream of the site in August; and that a tremendous amount of sediment continued to travel downstream. The crew were unable to kick for 3 minutes because the net filled with sand.

Table 7. Select habitat indices at NAWIN01 and NAWIN03. Condition indicated as shaded background*

Site	Year	Average Depth (cm)	Average velocity (m/s)	Wetted width (m)	Bankfull width (m)	Embededd-ness (%)	Dominant Substrate/ subdominant
NAWIN01	2009	4.9	0.25	1.6	3.4	25	Large pebble/gravel
	2010	2.3	0.09	1.2	3.0	50	Gravel/large pebble
	2011	4.3	0.22	2.2	3.6	25	Small pebble/large pebble
	2012	4.9	0.16	1.8	3.2	25	Large pebble/small pebble
NAWIN03	2010	18.2	1.03	2.9	4.3	75	Gravel/large pebble
	2011	26.7	1.05	3.24	-	0	Pebble/gravel
	2012	26.0	1.15	3.2	3.5	0	Large pebble/small pebble

*** CABIN model condition:** unstressed, potentially stressed, stressed, severely stressed.

3.2 Water quality results

3.2.1 Water quality QA/QC

The quality control evaluation of water quality data determined that the laboratory and field methods were accurate and precise (Appendix B-1). All duplicate sample data were within the recommended relative percent difference criteria of less than or equal to 30. Field blank data revealed only one value (bicarbonate) to be higher than the alert level of 2 x method detection limits. The 'regular sample' bicarbonate values were within the normal range, suggesting no contamination.

3.2.2 Guideline review

All water quality data are provided in Appendix B.

Non-metal. Of the non-metal parameters reviewed, dissolved oxygen was the only parameter with values that did not meet the guidelines for the protection of aquatic life (Table 8). Dissolved oxygen values were below the BC Approved guideline of 8 mg/L at NAWIN03 on December 20, 2011 (6 mg/L) and at NAWIN04 on October 25, 2011 (7 mg/L).

Table 8.Summary of guideline exceedances for water and sediment quality data for the protection of aquatic life (aq. life) and drinking water (drinking).

Parameter Type	Site	Years assessed	Exceedance (intent*, source**): date
Water, non metals	NAWIN01	2009 – 2013 (annually)	none
	NAWIN02	2009, 2010 (annually)	none
	NAWIN03	2009-2013 (monthly)	Dissolved Oxygen (Aq. Life, BC Appr.): Dec 2011
	NAWIN04	2011, 2012, 2013 (annually)	Dissolved Oxygen (Aq. Life, BC Appr.): Oct 2011
Water, metals	NAWIN03	2009, 2010	none
Sediment, metals	NAWIN03	2011, 2012, 2013	Arsenic (aquatic life, CCME ISQG): 2011, 2012

Legend:
*Intent: **Aq. Life** = Guideline for the protection of aquatic life; **Drinking** = Guideline for the protection of drinking water.
**Source:
BC Appr. = BC Approved Water Quality Guidelines (Government of BC 2013)
BC Work = BC Working Water Quality Guidelines (Nagpal et al. 2006)
CCME = Canadian Water Quality Guidelines (CCME 1999a)
CCME (ISQG or PEL) = Canadian Sediment Quality Guidelines (CCME 1999b)
HC = Drinking Water Quality Guidelines (Health Canada 2013)

Monthly sampling at NAWIN03 (2010-2013) revealed that turbidity values were often elevated relative to background conditions. Turbidity is a measure of the lack of clarity or transparency of water. Turbidity increases as the amount of suspended or dissolved material in the water increases. The BC guideline for the protection of aquatic life during the period of naturally turbid waters (typically mid May through mid July in the Region), is exceeded when induced turbidity

(e.g., caused by a development) increases higher than 5 NTU from background levels at any one time (Caux *et al*. 1997). During the clear flow period, the guideline is that induced turbidity should not increase 8 NTU from background for a duration of 24 hours, and/or 2 NTU from background for a 30 day period.

Even though continual monitoring (daily) with monthly average data was not collected, the basis of the guideline was compared to the data collected to provide a measure to assess turbidity results. By reviewing the results of all four sites, the clear flow period background turbidity was estimated to normally be less than 2 NTU (Figure 4). Thus, during the clear flow period, an induced increase to 4 NTU averaged over a 30 day period or an increase to 10 NTU over a 24 hour period would be cause for potential concern.

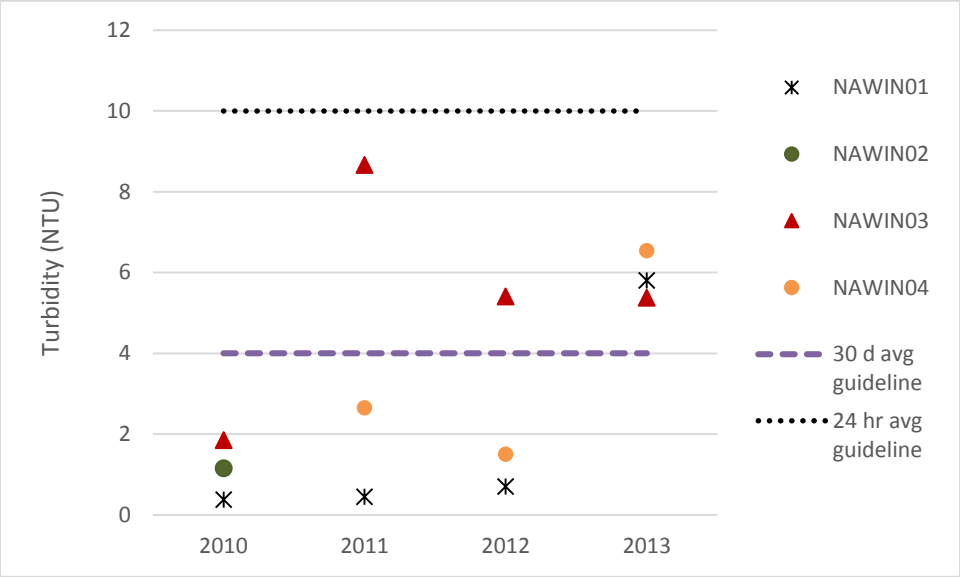


Figure 4. Average turbidity during clear flow period (mid July to mid May) in Windermere Creek and estimated guidelines for the protection of aquatic life. At NAWIN01 n=1 (2010 – 2013); NAWIN02 n=2; NAWIN03 n=10 in 2010 and 2011, n=9 in 2012, n=11 in 2013.

The monthly turbidity values at NAWIN03 during the clear flow period were compared to the estimated turbidity guidelines to provide a general indication of potential concerns. Elevated turbidity have been observed since 2011 (Figure 4). Between 2011 and 2013, the 4 NTU (30 day average guideline) was exceeded 48% of the time, and the 10 NTU (24 hour guideline) was exceeded in 18% of samples.

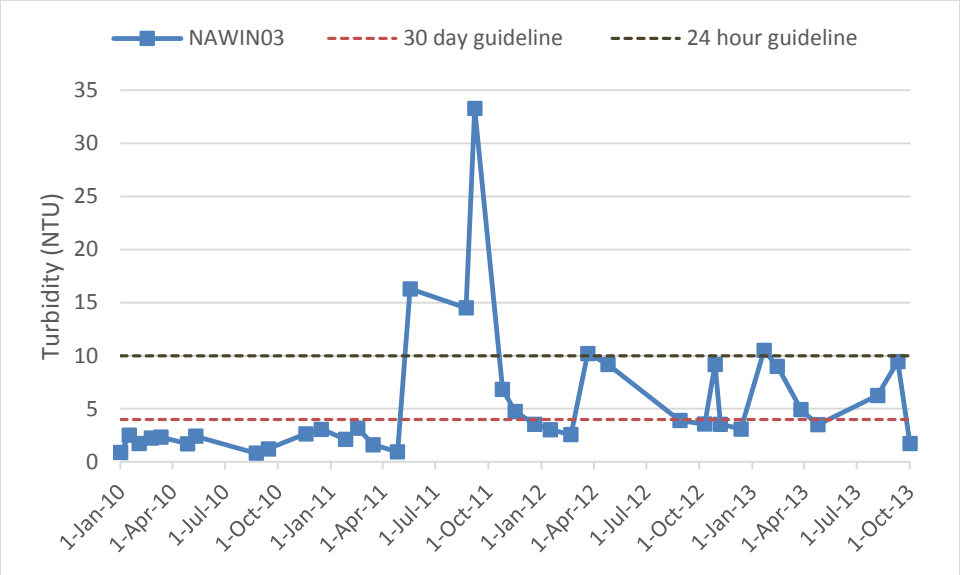


Figure 5. Turbidity during the clear flow period (Mid July to mid May) at NAWIN03, relative to the estimated guidelines for the protection of aquatic life.

Turbidity levels measured during the turbid flow period at NAWIN03 indicate a range from 12 to 359 NTU (Table 9). In recent years, Leschied (pers comm.) has observed that turbidity is often elevated following heavy rainfall; the 2011 erosion event was one example. In 2012, water licence holders were unable to draw water due to the elevated suspended sediment in the creek (Leschied pers. comm). From this limited data set, it was difficult to determine what the normal background turbidity would be during the turbid period. However, at other watersheds, it is typically below 20 NTU.

Table 9. Turbidity measured at NAWIN03 during the turbid period (mid May to mid July).

Date	Turbidity (NTU)
15-Jun-11	179.0
19-Jul-11	207.0
30-May-12	26.1
19-Jul-12	359.0
14-May-13	40.8
11-Jun-13	28.6
8-Jul-13	12.0

Metal water quality data collected at Site 3 in 2009 and 2010 revealed no exceedances of guidelines for the protection of aquatic life or drinking water.

Sediment quality data which was collected annually at NAWIN03 from 2011 to 2013 revealed one parameter which exceeded available guidelines for the protection of aquatic life. Arsenic concentrations in 2011 and 2012 were approximately 2 times higher than the CCME ISQG guideline. The ISQG refers to the Interim Sediment Quality Guideline which is the concentration below which adverse biological effects are expected to rarely occur (i.e., fewer than 25% adverse

effects occur below this level) (CCME 2001). The CCME probable effect level (PEL) guideline, above which adverse effects are expected to occur frequently, was not exceeded for this metal. At the levels exhibited at NAWIN03, the impacts on the biological community are uncertain.

3.3 Stream temperature results

Monthly average stream temperature at NAWIN01 (upstream site) was generally lower relative to NAWIN03 (downstream site), with higher variability (Figure 6 and Figure 7). The inter-annual variation in monthly average stream temperature at both sites was within 2°C for all months. Monthly average stream temperature was highest in August for all years at site NAWIN01, July and August values did not substantially differ at site NAWIN03. Monthly average stream temperature values were within the optimal range for westslope cutthroat trout and bull trout rearing, which are 7°C to 14°C and 6°C to 14°C, respectively.

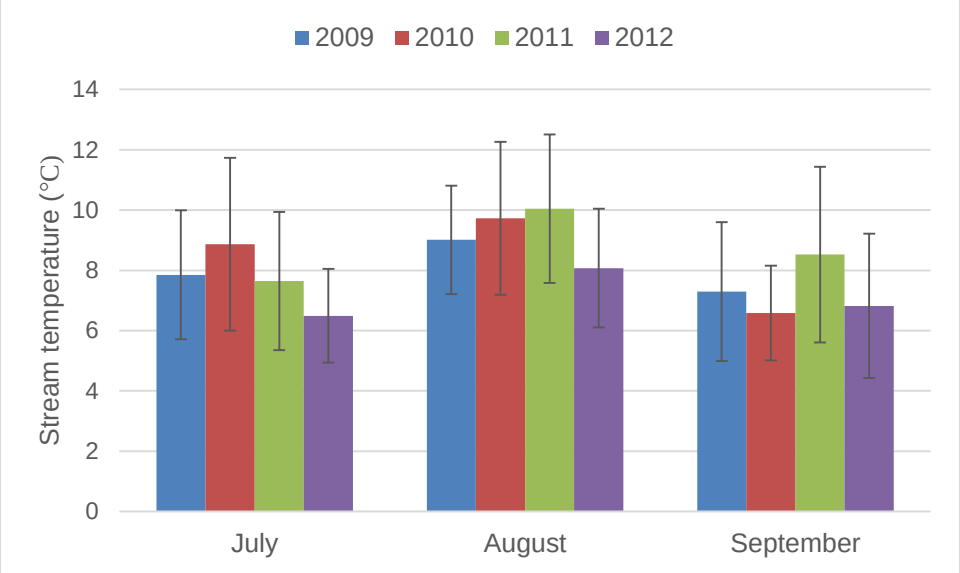


Figure 6. Monthly average stream temperature for July, August, and September from 2009 to 2012 at NAWIN01. The error bars represent +- 1 standard deviation.

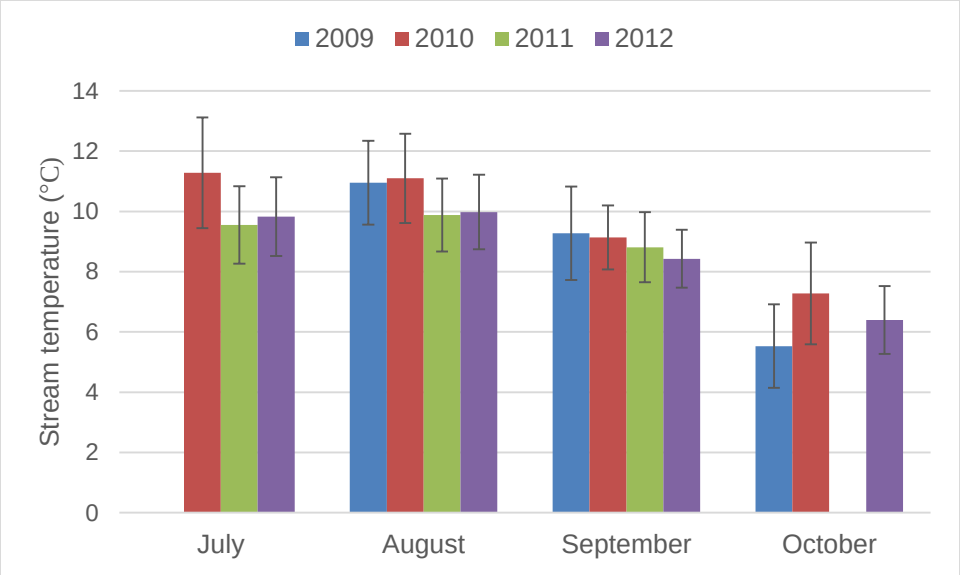


Figure 7. Monthly average stream temperature for July, August, September, and October from 2009 to 2012 at NAWIN03. The error bars represent +- 1 standard deviation.

4 Discussion

Overall, the monitoring results showed variability in the health of Windermere Creek. Indications of stress were apparent throughout the stream at various times, as represented by the four sites sampled from 2009 to 2012. The most apparent water quality impact likely to be impairing benthic community health was elevated turbidity. Monitoring results showed how conditions can recover following impact if conditions improve.

NAWIN01:

The upstream site (NAWIN01) was stressed in 2010 but only potentially stressed in following years. The stressed condition, was indicated by the macroinvertebrate community which exhibited increased numbers of chironomidae, decreased % EPT and decreased total abundance of organisms. Chironomidae (non-biting midges) are an indicator of potentially declining condition since they are moderately to highly tolerant of pollution (Environment Canada 2013). EPT taxa are often used as an indicator of good water quality because most are intolerant of pollution (Environment Canada 2013). Total abundance of organisms may decrease in response to water quality changes (Rosenberg and Resh 1993). Annual non-metal data, did not indicate elevated concentrations relative to water quality guidelines.

The stressed benthic invertebrate community appeared to be related to habitat condition. Channel depth/stream flows were lower in 2010, which is supported by stream temperature in 2010 being higher (MacDonald et al. 2013). Some organisms, especially those with external gills and high dissolved oxygen requirement (some EPT), need fast flowing highly oxygenated water. The dominant substrate was 50% embedded with course sand in 2010. Embeddedness can impact macroinvertebrates by decreasing the surface area available for shelter, spawning, and egg

incubation (EPA 1998). The cause of the habitat change is unknown. The benthic community has recovered since.

NAWIN02 and NAWIN04:
The initial mid creek study site as represented by NAWIN02 was monitored only in 2009 and 2010 since it was buried by an erosion event in 2011. Prior to this event, the site was unstressed with no water quality concerns. Its replacement (NAWIN04) provided another example of conditions improving with time. NAWIN04 was potentially stressed in 2011 and similar to reference condition in 2012. Water quality remained consistent throughout this period.

NAWIN03:
The downstream site (NAWIN03) located near the Windermere Creek outlet showed a dramatic decline in aquatic health in 2012 relative to 2010. This was evidenced with no invertebrates in 2011 and a very low abundance of invertebrates in 2012. These impacts were the result of a noted erosion event that occurred in 2011 higher in the watershed (Leschied pers. comm.). This event is an example of ongoing erosion concerns in the watershed. Data from NAWIN03 revealed that there have been elevated turbidity values in the watershed since 2011. Transport and deposition of excessive suspended sediments in streams is detrimental to aquatic organisms including plants, invertebrates, and fish (Caux *et al.* 1997). Some effects on fish include clogging and abrasion of gills, resistance to disease, and reduced egg-to-fry survival (Singleton 1985). Elevated turbidity in streams also is a concern for raw drinking water, with guidelines closely following those for the protection of aquatic life. The main sediment source affecting downstream areas was determined to be in the lower watershed (McCleary 2012). Severe downcutting of the channel was evidenced in a 400 m stretch of the creek and this was expected to likely continue to result in sedimentation events for some time before the site stabilizes (McCleary 2012). The site had a low variance in stream temperature.

Sediment quality, which was only monitored at NAWIN03, revealed elevated arsenic concentrations relative to guidelines in 2011 and 2012. The likelihood of effect on the biological community was uncertain given the concentrations measured. This is because arsenic exceeded the ISQG guideline, above which adverse biological effects are expected to only rarely occur (CCME 2001).

5 Recommendations

As CABIN data have only been collected for four years at Windermere Creek, it is not possible to identify definite trends. Longer term sampling will help confirm biological health and water quality conditions. Recommendations for future work are as follows:

1) Continue to use CABIN to monitor the benthic invertebrate community condition. Preferably maintain sites at the upstream, mid-stream and downstream location to aid in determining the source for any impacts identified.

2) Water quality information is a valuable tool to understand the health of the benthic invertebrate community. Continued water quality monitoring is thus recommended, which should include:

    - *In situ* water quality data, preferably collected monthly. This would continue to include dissolved oxygen, temperature, conductivity and turbidity. These are informative water quality parameters that can help describe benthic invertebrate community trends. Collecting this data at all the CABIN sites monthly would be beneficial.

    - Given the turbidity and sedimentation issues seen through this study, it would be valuable to develop prescriptions to stabilize eroding banks in Windermere Creek.

    - Non-metal water quality data, annually at all sites and monthly at the downstream site with the highest degree of potential anthropogenic influences. There were no values of concern related to these parameters, so their continued collection should not be considered a high priority. However, they may continue to be collected at the discretion of the project management team. Total phosphorus would be a valuable parameter to collect, because it would provide information on nutrient contributions which could influence productivity.

      Metal water quality data at the downstream site over three years did not reveal any elevated levels of concern. Additional metal water quality data is thus not seen as a priority to continue to collect at this time. This data will, however, provide an important baseline to return to for comparison in the future.

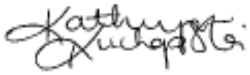
      Although there was one exceedance of the guidelines (arsenic), there may be limited benefits of collecting additional annual sediment data at this time. Similarly to the metal water quality recommendation, sediment data may be best used as a baseline for which to compare findings into the future at a predetermine time.

3) We recommend that continuous stream temperature monitoring be conducted year-round at NAWIN01, NAWIN03, and NAWIN04. HOBO loggers should be downloaded at least three times per year (prior to freshet, post freshet, and prior to winter).

Closing

We greatly appreciate the opportunity to contribute to the CBWQMP stewardship efforts. This program provides valuable information on the environmental condition of water bodies in the Columbia Basin.

Sincerely,



Sherri McPherson
Sr. Aquatic Biologist, BSc, RPBio
Sherri.mcpherson@lotic.co

Ryan MacDonald
Sr. Hydrologist, PhD
ryan.macdonald@lotic.co

Kathryn Kuchapski
Aquatic Biologist, MSc

6 References

Barnett, T., D.W. Price, H.G. Hidalgo, C. Bonfils, B.D. Santer, T. Das, G. Bala, A.W. Wood, T. Nozawa, A.A. Mirin, D.R. Cayan, and M.D. Dettinger. (2008) Human-induced changes in the hydrology of the western United States, Science 319: 1080-1803.

BC Ministry of Environment. 2013. Fish Information Summary System. Website: http://a100.gov.bc.ca/pub/fidq/main.do;jsessionid=31f493fcb8d91d759539bbbaf51d5deeb30bb2a7b641610f3d1f4a0e1ab70fcc.e3uMah8KbhmLe3iLbNaObxmSay1ynknvrkLOlQzNp65In0

BC Ministry of Environment (BC MoE). 2003. Water quality field sampling manual. Government of British Columbia

BC CDC (BC Conservation Data Centre). 2013. BC Species and Ecosystems Explorer. B.C. Ministry of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed November, 2013).

Burger, G., J. Schulla., and T. Werner. 2011. Estimates of future flow, including extremes, of the Columbia River headwaters. Water Resources Research, 47: W10520, doi:10.1029/2010WR009716.

Caux, P.Y., D.R.J. Moore and D. MacDonald. 1997. Ambient Water Quality Guidelines (Criteria) for Turbidity, Suspended and Benthic Sediments, Technical Appendix. Prepared for BC Ministry of Environment, Lands and Parks.

CCME (Canadian Council of Ministers of the Environment). 2001. Canadian sediment quality guidelines for the protection of aquatic life: Introduction. Updated. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 1999a. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Introduction. Updated 2001. Cited in Canadian Environmental Quality Guidelines,1999 (plus updates), Canadian Council of Ministers of the Environment, Winnipeg. Accessed at: http://cegg-rcge.ccme.ca/

CCME. 1999b. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life: In Canadian Environmental Quality Guidelines. 1999 (plus updates). Canadian Council of Ministers of the Environment. Winnipeg. Accessed at: http://cegg-rcge.ccme.ca/

CBWQMP (Columbia Basin Water Quality Monitoring Program). 2012. Operating Procedures

EcoAnalysts Inc. 2012. Standard metric output guidance document. Moscow, Idaho.

Environment Canada. 2013. Quick facts - summary documents attained through the Canadian Aquatic Biomonitoring Network course.

Environment Canada. 2013b. CABIN Module 3 – sample processing and introduction to taxonomy and benthic micro invertebrates.

Environment Canada. 2012a. Canadian Aquatic Biomonitoring Network: Wadeable Streams Field Manual. Accessed at: http://ec.gc.ca/Publications/default.asp?lang=En&xml=C183563B-CF3E-42E3-9A9E-F7CC856219E1

Environment Canada. 2012b. Canadian Aquatic Biomonitoring Network Laboratory Methods: Processing, Taxonomy and Quality Control of benthic Macroinvertebrate Samples. Accessed at: http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=CDC2A655-A527-41F0-9E61-824BD4288B98

Environmental Protection Agency (EPA). 1998. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition. Accessed at http://water.epa.gov/scitech/monitoring/rsl/bioassessment/upload/0000_00_00_monitoring_rbp_wp61pdf_ch_05.pdf

Government of British Columbia. 2013. British Columbia Approved Water Quality Guidelines. Accessed at: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html

GranDuke Geomatics. 2013a. Microsoft Excel add-in to transpose Maxxam water quality data into CBWN Excel format. Version 1.2 (Beta Release).

Granduke Geomatics 2013b. AGATHA- Automated guideline assessment tool for high speed analysis. Version 0.9.0 (Beta Release).

Health Canada. 2013. Guideline for Canadian Drinking Water Quality. Accessed at: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/2012-sum_guide-res_recom/index-eng.php

Jost, G., R.D. Moore, D. Gluns, and R.S. Smith. 2012. Quantifying the contribution of glacier runoff to streamflow in the upper Columbia River basin, Canada. Hydrology and Earth Systems Science 16: 849-860, DOI:10.5194/hess-16-1-2012.

MacDonald, R.J., S, Boon, J.M, Byrne, and U. Silins. 2013. A comparison of surface and sub-surface controls on summer temperature in a headwater stream. Hydrological Processes. DOI: 10.1002/hyp.9756

Maxxam Analytics. 2012. Environmental QA/QC Interpretation Guide (COR FCD-00097/5).

McCleary Aquatic Systems Consulting Inc (McCleary). 2012. Windermere Creek Sediment Source Survey. Completed for Mike Dubois, Shadybrook Resort, Windermere, BC.

Nagpal, N.K., L.W. Pommen and L.G. Swain. 2006. A Compendium of Working Water Quality Guidelines for British Columbia. Environmental Protection Division, Ministry of Environment, Government of BC.

Nagpal, N.K. 2001. Ambient Water Quality Guidelines for Selenium. Water Protection Branch, Ministry of Water, Land and Air Protection, Victoria, BC.

Rosenberg, D.M., T.B. Reynoldson and V.H. Resh. 1999. Establishing reference conditions for benthic invertebrate monitoring in the Fraser River Catchment British Columbia, Canada. Fraser River Action Plan, Environment Canada, Vancouver BC Accessed at: http://www.rem. sfu.ca/FRAP/9832.pdf

Rosenberg, D.M. and V.H. Resh. 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman and Hall, New York. pp.199.

Singleton, H.J. 1985. Water quality criteria for particulate matter; Technical Appendix. Ministry of Environment, Lands and Parks, Victoria, BC. pp 82.

Personal Communications

Horvath, Steve. Senior lab officer. Water and air monitoring & reporting section, BC Ministry of Environment, Surrey.

Leschied, Heather. Program manager. Lake Windermere Project. Wildsight.

Appendix A. CABIN data

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN01
Sampling Date	Sep 23 2009
Know Your Watershed (KYW) Basin	Lake of the Woods
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Western Continental Ranges Ecoregion
Coordinates (decimal degrees)	50.47642 N, 115.84508 W
Altitude	4268
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.0%	0.1%	31.3%	28.2%	40.4%
CABIN Assessment of NAWIN01 on Sep 23, 2009	Similar to Reference				

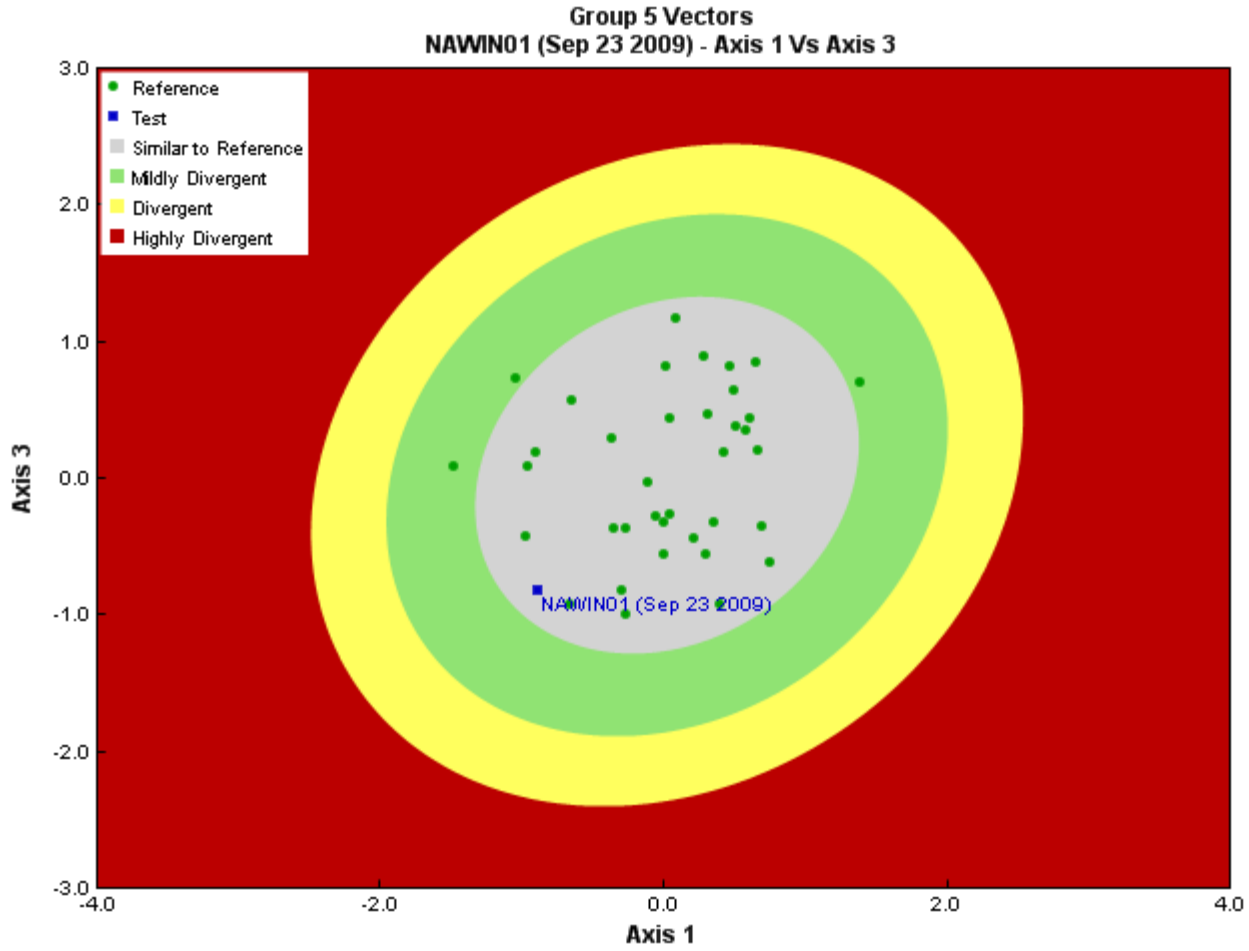


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Eco Analsyts, EcoAnalysts
Identification Date	February 26, 2010
Subsampling Device	Marchant Box
Proportion Subsampled	44/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Annelida	Clitellata	Haplotaxida	Enchytraeidae	8	18.2
Arthropoda	Arachnida			1	2.3
		Sarcoptiformes		4	9.1
	Insecta	Diptera		1	2.3
			Chironomidae	53	120.4
			Simuliidae	16	36.4
			Tipulidae	2	4.5
		Ephemeroptera	Ameletidae	29	65.9
			Baetidae	44	100.0
			Ephemerellidae	16	36.4
			Heptageniidae	10	22.7
		Plecoptera	Capniidae	13	29.5
			Nemouridae	53	120.4
			Perlodidae	1	2.3
			Taeniopterygidae	67	152.3

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
		Trichoptera	Rhyacophilidae	2	4.5
			Total	320	727.2

Site Metrics

Metric Name	NAWIN01	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.52	0.4 ± 0.1
Number Of Individuals		
% Chironomidae	16.9	4.6 ± 5.0
% Ephemeroptera	31.5	44.9 ± 17.3
% Ephemeroptera that are Baetidae	44.4	26.1 ± 20.5
% EPT Individuals	74.8	93.7 ± 5.3
% of 2 dominant taxa	38.2	60.2 ± 11.4
% of dominant taxa	21.3	39.3 ± 12.3
% Plecoptera	42.7	42.9 ± 17.2
% Tricoptera	0.6	5.8 ± 5.7
No. EPT individuals/Chironomids+EPT Individuals	0.8	1.0 ± 0.1
Total Abundance	713.6	2163.4 ± 1274.2
Richness		
Ephemeroptera taxa	4.0	3.7 ± 0.5
EPT taxa (no)	9.0	12.3 ± 1.9
Plecoptera taxa	4.0	5.5 ± 1.1
Shannon-Wiener Diversity	2.1	1.9 ± 0.3
Simpson's Diversity	0.9	0.8 ± 0.1
Total No. of Taxa	13.0	16.0 ± 3.0
Trichoptera taxa	1.0	3.2 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN01
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.85
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.87
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.97

RIVPACS : Expected taxa P>0.50	11.99
RIVPACS : Observed taxa P>0.50	9.00
RIVPACS : O:E (p > 0.5)	0.75
RIVPACS : Expected taxa P>0.70	9.61
RIVPACS : Observed taxa P>0.70	8.00
RIVPACS : O:E (p > 0.7)	0.83

D. Habitat Description

Variable	NAWIN01	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	4.9	21.5 ± 9.7
Depth-Max (cm)	6.5	31.0 ± 16.5
Reach-%CanopyCoverage (PercentRange)	3.00	1.54 ± 1.28
Velocity-Max (m/s)	0.31	0.80 ± 0.48
Width-Bankfull (m)	3.4	13.7 ± 16.4
Width-Wetted (m)	1.6	9.0 ± 13.1
Landcover		
Sediment Chemistry		
Substrate Data		

D. Habitat Description

Variable	NAWIN01	Predicted Group Reference Mean ±SD
Dominant-1st (Category(0-9))	5	7 ± 1
Dominant-2nd (Category(0-9))	3	6 ± 1
Embeddedness (Category(1-5))	4	4 ± 1
SurroundingMaterial (Category(0-9))	2	4 ± 2
Topography		
Water Chemistry		
General-Alkalinity (mg/L)	0.5000000	68.5944444 ± 52.1098452
General-DO (mg/L)	13.0000000	11.0635135 ± 0.9899052
General-pH (pH)	8.6	7.7 ± 0.7

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN01
Sampling Date	Aug 24 2010
Know Your Watershed (KYW) Basin	Lake of the Woods
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Western Continental Ranges Ecoregion
Coordinates (decimal degrees)	50.47642 N, 115.84508 W
Altitude	4268
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.0%	0.1%	31.3%	27.7%	40.9%
CABIN Assessment of NAWIN01 on Aug 24, 2010	Divergent				

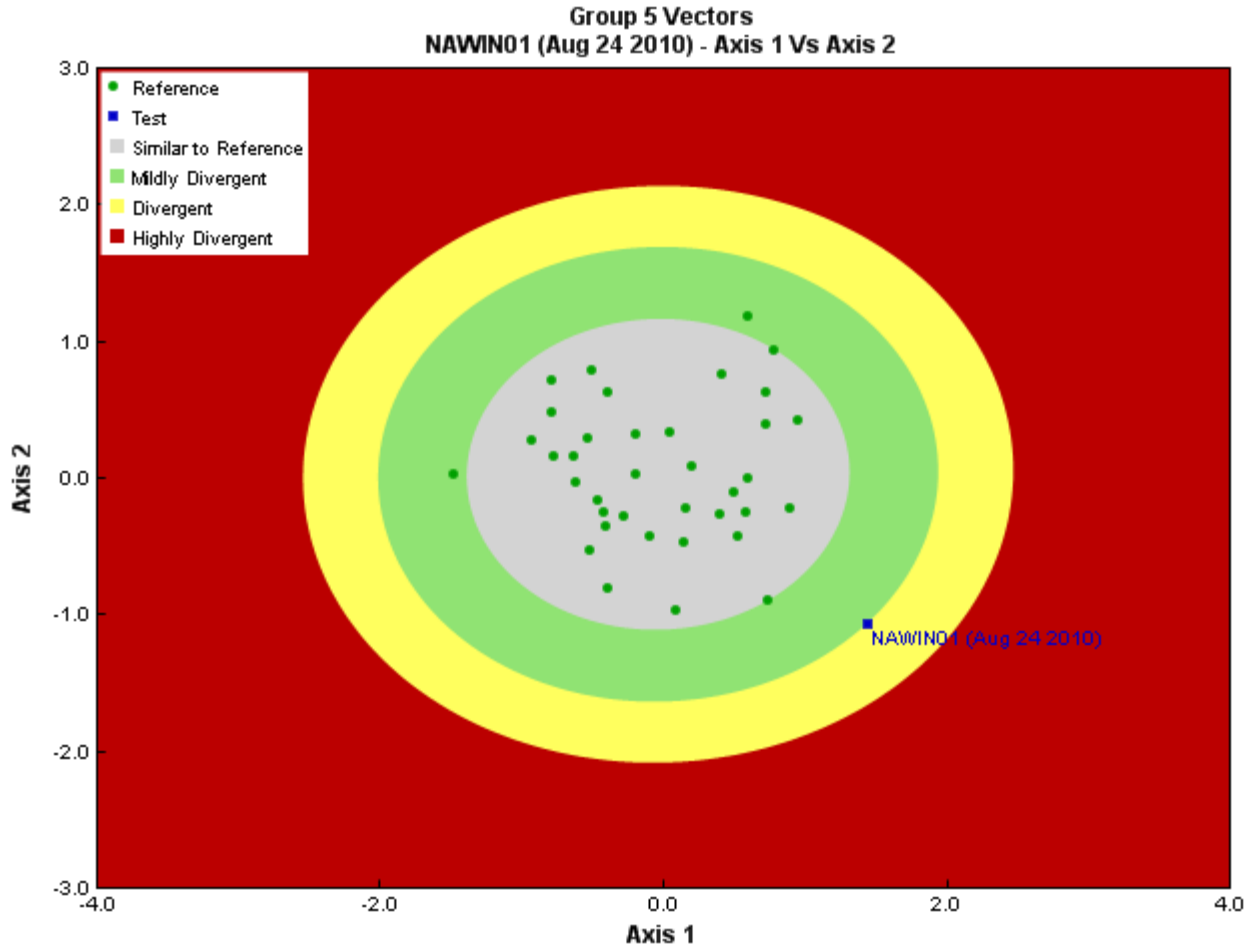


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Gary Lester, Ecoanalysts Inc.
Identification Date	March 09, 2011
Subsampling Device	Marchant Box
Proportion Subsampled	49/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Annelida	Clitellata	Haplotaxida	Enchytraeidae	27	55.1
Arthropoda	Insecta	Diptera		1	2.0
			Chironomidae	165	336.7
			Dixidae	3	6.1
			Empididae	2	4.1
			Tipulidae	3	6.1
		Ephemeroptera	Ameletidae	3	6.1
			Baetidae	108	220.4
			Ephemerellidae	6	12.2
			Heptageniidae	4	8.2
		Plecoptera	Capniidae	1	2.0
			Nemouridae	3	6.1
			Perlodidae	1	2.0
		Trichoptera	Hydropsychidae	1	2.0
			Limnephilidae	1	2.0

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
			Total	329	671.1

Site Metrics

Metric Name	NAWIN01	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.76	0.4 ± 0.1
Number Of Individuals		
% Chironomidae	50.3	4.6 ± 5.0
% Ephemeroptera	36.9	44.9 ± 17.3
% Ephemeroptera that are Baetidae	89.3	26.1 ± 20.5
% EPT Individuals	39.0	93.7 ± 5.3
% of 2 dominant taxa	83.2	60.2 ± 11.4
% of dominant taxa	50.3	39.3 ± 12.3
% Plecoptera	1.5	42.9 ± 17.2
% Tricoptera	0.6	5.8 ± 5.7
No. EPT individuals/Chironomids+EPT Individuals	0.4	1.0 ± 0.1
Total Abundance	669.4	2163.4 ± 1274.2
Richness		
Ephemeroptera taxa	4.0	3.7 ± 0.5
EPT taxa (no)	9.0	12.3 ± 1.9
Plecoptera taxa	3.0	5.5 ± 1.1
Shannon-Wiener Diversity	1.3	1.9 ± 0.3
Simpson's Diversity	0.6	0.8 ± 0.1
Total No. of Taxa	14.0	16.0 ± 3.0
Trichoptera taxa	2.0	3.2 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN01
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.85
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.86
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.97

RIVPACS : Expected taxa P>0.50	11.99
RIVPACS : Observed taxa P>0.50	9.00
RIVPACS : O:E (p > 0.5)	0.75
RIVPACS : Expected taxa P>0.70	9.61
RIVPACS : Observed taxa P>0.70	7.00
RIVPACS : O:E (p > 0.7)	0.73

D. Habitat Description

Variable	NAWIN01	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	2.3	21.5 ± 9.7
Depth-Max (cm)	3.3	31.0 ± 16.5
Reach-%CanopyCoverage (PercentRange)	2.00	1.54 ± 1.28
Velocity-Max (m/s)	0.28	0.80 ± 0.48
Width-Bankfull (m)	3.0	13.7 ± 16.4
Width-Wetted (m)	1.2	9.0 ± 13.1
Landcover		
Substrate Data		
Dominant-1st (Category(0-9))	3	7 ± 1
Dominant-2nd (Category(0-9))	5	6 ± 1

D. Habitat Description

Variable	NAWIN01	Predicted Group Reference Mean ±SD
Embeddedness (Category(1-5))	3	4 ± 1
SurroundingMaterial (Category(0-9))	2	4 ± 2
Topography		
Water Chemistry		
General-Alkalinity (mg/L)	2.8000000	68.5944444 ± 52.1098452
General-DO (mg/L)	13.0000000	11.0635135 ± 0.9899052
General-pH (pH)	8.6	7.7 ± 0.7
General-SpCond (uS/cm)	404.6000000	160.3567568 ± 118.4083015

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN01
Sampling Date	Oct 12 2011
Know Your Watershed (KYW) Basin	Lake of the Woods
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Western Continental Ranges Ecoregion
Coordinates (decimal degrees)	50.47642 N, 115.84508 W
Altitude	4268
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.0%	0.1%	31.3%	28.1%	40.5%
CABIN Assessment of NAWIN01 on Oct 12, 2011	Mildly Divergent				

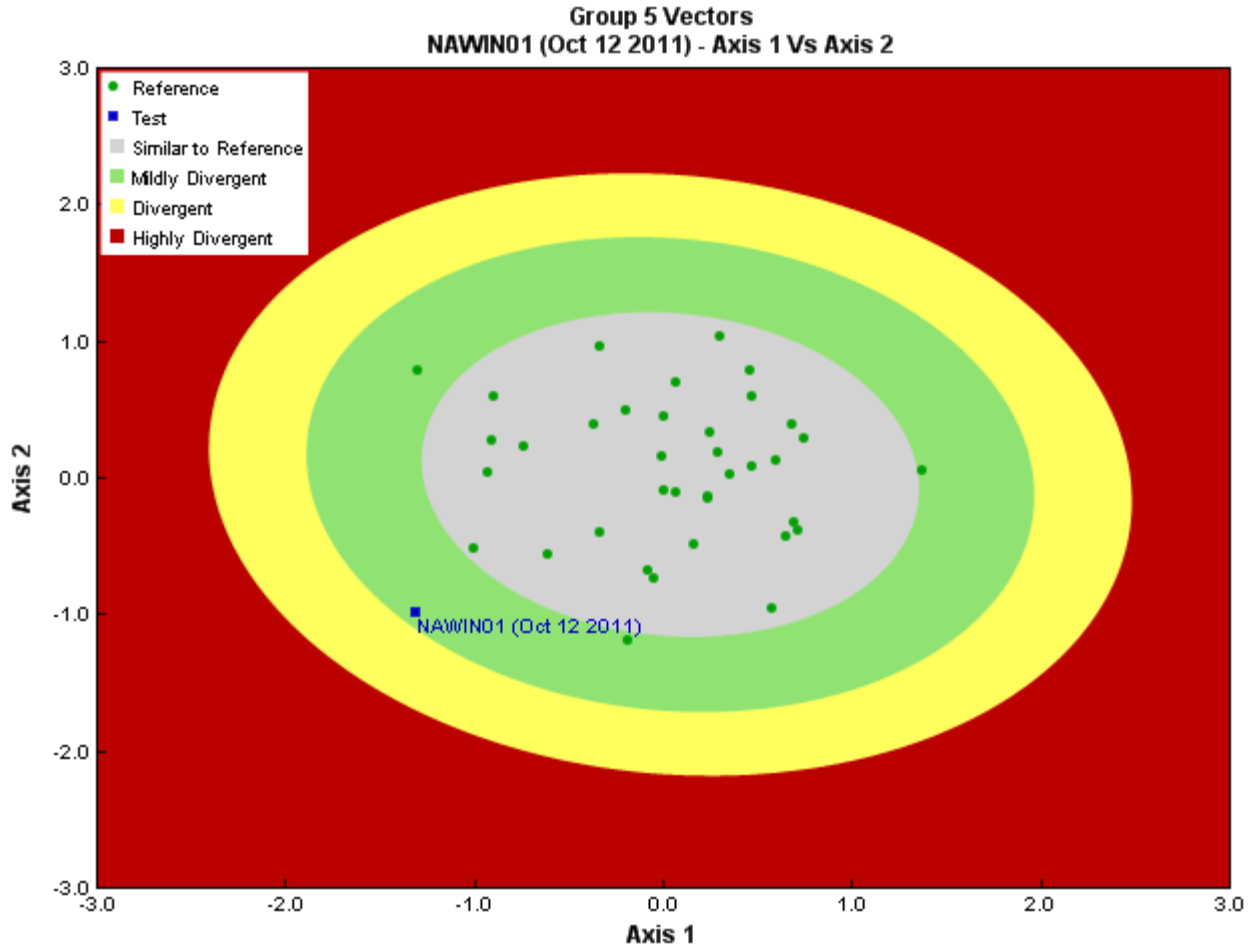


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Eco Analsyts, EcoAnalysts
Identification Date	January 27, 2011
Subsampling Device	Marchant Box
Proportion Subsampled	24/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Annelida	Clitellata	Haplotaxida	Enchytraeidae	1	4.2
Arthropoda	Arachnida			1	4.2
	Insecta	Diptera	Chironomidae	97	404.2
			Psychodidae	2	8.3
			Simuliidae	3	12.5
		Ephemeroptera	Baetidae	11	45.8
			Ephemerellidae	6	25.0
			Heptageniidae	4	16.7
		Plecoptera	Capniidae	5	20.8
			Nemouridae	197	820.8
			Perlodidae	3	12.5
			Total	330	1,375.0

Site Metrics

Metric Name	NAWIN01	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.8	0.4 ± 0.1
Number Of Individuals		
% Chironomidae	29.5	4.6 ± 5.0
% Ephemeroptera	6.4	44.9 ± 17.3
% Ephemeroptera that are Baetidae	52.4	26.1 ± 20.5
% EPT Individuals	68.7	93.7 ± 5.3
% of 2 dominant taxa	89.4	60.2 ± 11.4
% of dominant taxa	59.9	39.3 ± 12.3
% Plecoptera	62.3	42.9 ± 17.2
% Tricoptera	0.0	5.8 ± 5.7
No. EPT individuals/Chironomids+EPT Individuals	0.7	1.0 ± 0.1
Total Abundance	1370.8	2163.4 ± 1274.2
Richness		
Ephemeroptera taxa	3.0	3.7 ± 0.5
EPT taxa (no)	6.0	12.3 ± 1.9
Plecoptera taxa	3.0	5.5 ± 1.1
Shannon-Wiener Diversity	1.1	1.9 ± 0.3
Simpson's Diversity	0.6	0.8 ± 0.1
Total No. of Taxa	10.0	16.0 ± 3.0
Trichoptera taxa	0.0	3.2 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN01
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.85
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.86
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.97

RIVPACS : Expected taxa P>0.50	11.99
RIVPACS : Observed taxa P>0.50	7.00
RIVPACS : O:E (p > 0.5)	0.58
RIVPACS : Expected taxa P>0.70	9.61
RIVPACS : Observed taxa P>0.70	6.00
RIVPACS : O:E (p > 0.7)	0.62

D. Habitat Description

Variable	NAWIN01	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	4.3	21.5 ± 9.7
Depth-Max (cm)	6.3	31.0 ± 16.5
Reach-%CanopyCoverage (PercentRange)	3.00	1.54 ± 1.28
Velocity-Max (m/s)	0.40	0.80 ± 0.48
Width-Bankfull (m)	3.6	13.7 ± 16.4
Width-Wetted (m)	2.2	9.0 ± 13.1
Landcover		
Substrate Data		
Dominant-1st (Category(0-9))	4	7 ± 1
Dominant-2nd (Category(0-9))	5	6 ± 1
Embeddedness (Category(1-5))	4	4 ± 1
SurroundingMaterial (Category(0-9))	3	4 ± 2
Topography		
Water Chemistry		
General-DO (mg/L)	12.0000000	11.0635135 ± 0.9899052

D. Habitat Description

Variable	NAWIN01	Predicted Group Reference Mean ±SD
General-pH (pH)	8.2	7.7 ± 0.7
General-SpCond (uS/cm)	638.0000000	160.3567568 ± 118.4083015

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN01
Sampling Date	Nov 06 2012
Know Your Watershed (KYW) Basin	Lake of the Woods
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Western Continental Ranges Ecoregion
Coordinates (decimal degrees)	50.47642 N, 115.84508 W
Altitude	4268
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.0%	0.1%	31.3%	28.2%	40.4%
CABIN Assessment of NAWIN01 on Nov 06, 2012	Mildly Divergent				

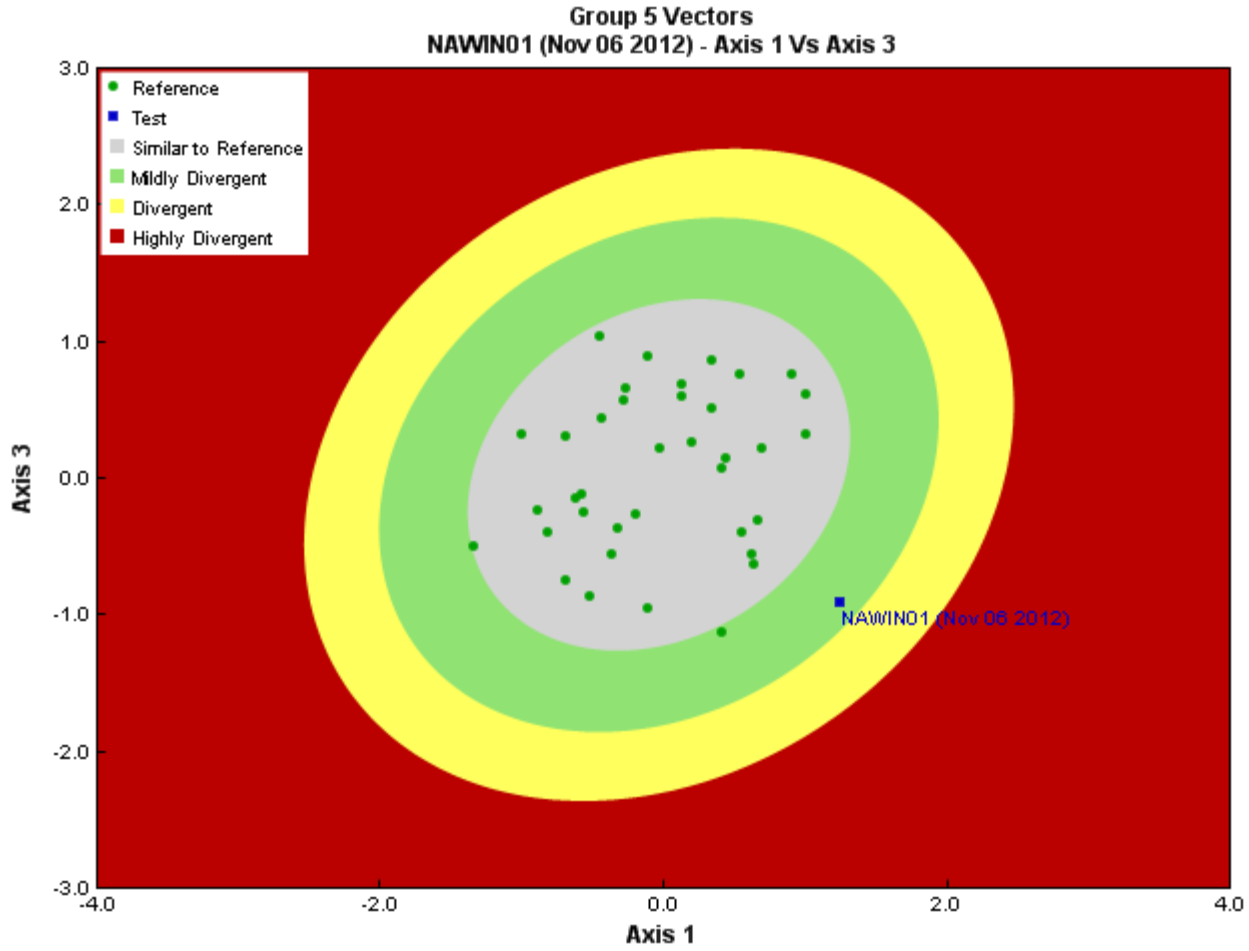


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Eco Analsyts, EcoAnalysts
Identification Date	February 13, 2013
Subsampling Device	Marchant Box
Proportion Subsampled	17/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Arthropoda	Arachnida	Sarcoptiformes		5	29.4
		Trombidiformes	Sperchontidae	1	5.9
	Insecta	Diptera	Ceratopogonidae	1	5.9
			Chironomidae	58	341.2
			Simuliidae	8	47.0
			Tipulidae	4	23.5
		Ephemeroptera	Baetidae	31	182.4
			Ephemerellidae	1	5.9
			Heptageniidae	8	47.0
		Plecoptera	Capniidae	12	70.6
			Leuctridae	1	5.9
			Nemouridae	213	1,252.9
			Taeniopterygidae	17	100.0
		Trichoptera	Hydropsychidae	1	5.9
			Lepidostomatidae	1	5.9

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
			Rhyacophilidae	1	5.9
			Total	363	2,135.3

Site Metrics

Metric Name	NAWIN01	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.72	0.4 ± 0.1
Number Of Individuals		
% Chironomidae	16.2	4.6 ± 5.0
% Ephemeroptera	11.2	44.9 ± 17.3
% Ephemeroptera that are Baetidae	77.5	26.1 ± 20.5
% EPT Individuals	79.9	93.7 ± 5.3
% of 2 dominant taxa	75.7	60.2 ± 11.4
% of dominant taxa	59.5	39.3 ± 12.3
% Plecoptera	67.9	42.9 ± 17.2
% Tricoptera	0.8	5.8 ± 5.7
No. EPT individuals/Chironomids+EPT Individuals	0.8	1.0 ± 0.1
Total Abundance	2105.8	2163.4 ± 1274.2
Richness		
Ephemeroptera taxa	3.0	3.7 ± 0.5
EPT taxa (no)	10.0	12.3 ± 1.9
Plecoptera taxa	4.0	5.5 ± 1.1
Shannon-Wiener Diversity	1.4	1.9 ± 0.3
Simpson's Diversity	0.6	0.8 ± 0.1
Total No. of Taxa	15.0	16.0 ± 3.0
Trichoptera taxa	3.0	3.2 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN01
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.85
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.87
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.97

RIVPACS : Expected taxa P>0.50	11.99
RIVPACS : Observed taxa P>0.50	11.00
RIVPACS : O:E (p > 0.5)	0.92
RIVPACS : Expected taxa P>0.70	9.61
RIVPACS : Observed taxa P>0.70	8.00
RIVPACS : O:E (p > 0.7)	0.83

D. Habitat Description

Variable	NAWIN01	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	4.9	21.5 ± 9.7
Depth-Max (cm)	7.0	31.0 ± 16.5
Reach-%CanopyCoverage (PercentRange)	2.00	1.54 ± 1.28
Velocity-Max (m/s)	0.24	0.80 ± 0.48
Width-Bankfull (m)	3.2	13.7 ± 16.4
Width-Wetted (m)	1.8	9.0 ± 13.1
Landcover		
Substrate Data		
Dominant-1st (Category(0-9))	5	7 ± 1

D. Habitat Description

Variable	NAWIN01	Predicted Group Reference Mean ±SD
Dominant-2nd (Category(0-9))	4	6 ± 1
Embeddedness (Category(1-5))	4	4 ± 1
SurroundingMaterial (Category(0-9))	2	4 ± 2
Topography		
Water Chemistry		
General-DO (mg/L)	11.0000000	11.0635135 ± 0.9899052
General-pH (pH)	8.4	7.7 ± 0.7
General-SpCond (uS/cm)	626.3000000	160.3567568 ± 118.4083015

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN02
Sampling Date	Sep 30 2009
Know Your Watershed (KYW) Basin	Lake of the Woods
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Western Continental Ranges Ecoregion
Coordinates (decimal degrees)	50.49381 N, 115.91586 W
Altitude	3579
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.0%	0.1%	33.9%	28.6%	37.4%
CABIN Assessment of NAWIN02 on Sep 30, 2009	Mildly Divergent				

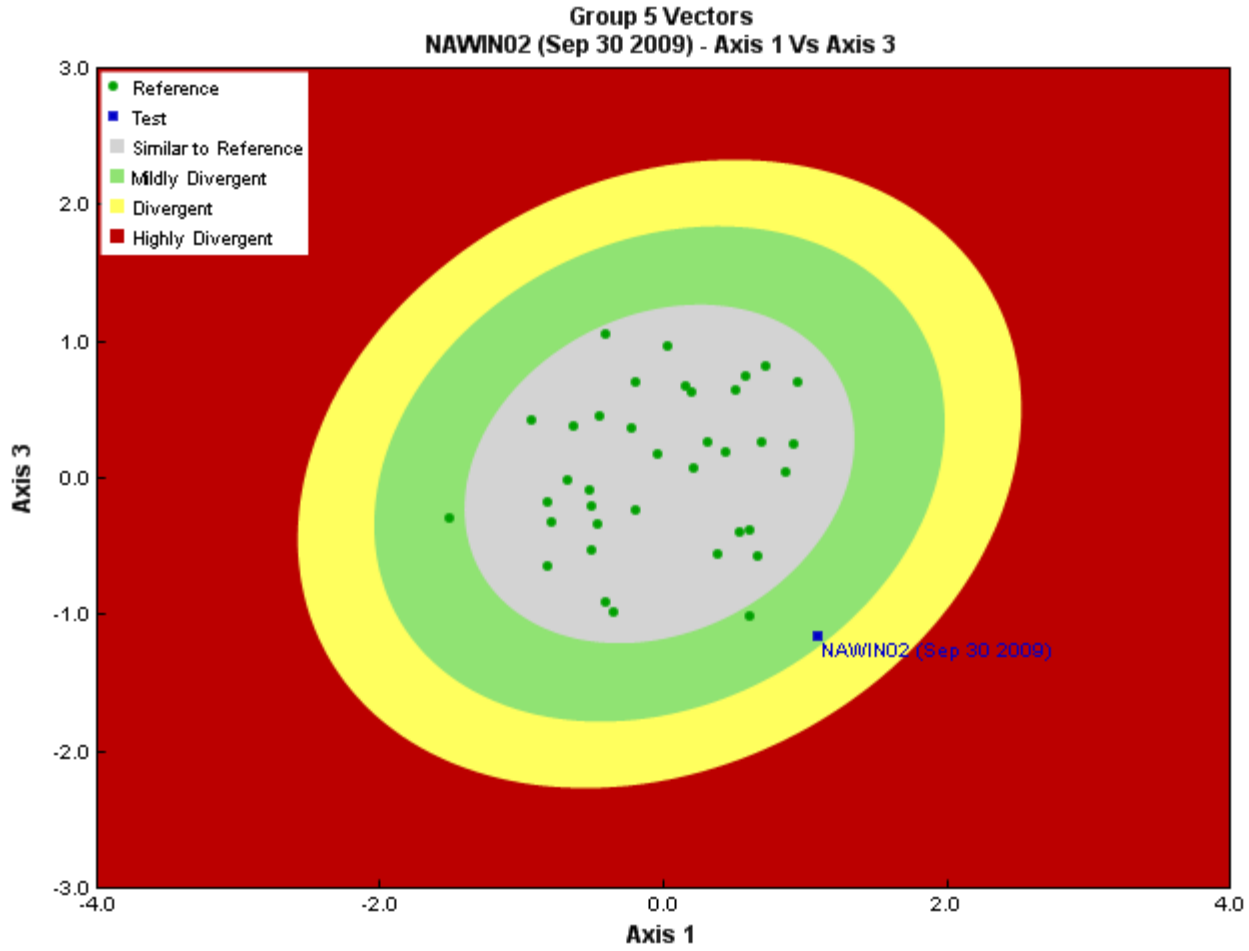


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Eco Analsyts, EcoAnalysts
Identification Date	February 26, 2010
Subsampling Device	Marchant Box
Proportion Subsampled	17/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Annelida	Clitellata	Haplotaxida	Enchytraeidae	1	5.9
Arthropoda	Arachnida	Trombidiformes	Lebertiidae	1	5.9
			Sperchontidae	1	5.9
			Torrenticolidae	1	5.9
	Insecta	Diptera	Chironomidae	12	70.6
			Dixidae	1	5.9
			Empididae	6	35.3
			Tipulidae	1	5.9
		Ephemeroptera	Baetidae	206	1,211.8
			Heptageniidae	6	35.3
		Plecoptera	Capniidae	3	17.6
			Nemouridae	55	323.5
			Perlidae	1	5.9
			Perlodidae	13	76.5
			Taeniopterygidae	1	5.9

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
		Trichoptera	Rhyacophilidae	5	29.4
			Total	314	1,847.2

Site Metrics

Metric Name	NAWIN02	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.74	0.4 ± 0.1
Number Of Individuals		
% Chironomidae	3.8	4.6 ± 5.0
% Ephemeroptera	67.5	44.9 ± 17.3
% Ephemeroptera that are Baetidae	97.2	26.1 ± 20.5
% EPT Individuals	92.4	93.7 ± 5.3
% of 2 dominant taxa	83.1	60.2 ± 11.4
% of dominant taxa	65.6	39.3 ± 12.3
% Plecoptera	23.2	42.9 ± 17.2
% Tricoptera	1.6	5.8 ± 5.7
No. EPT individuals/Chironomids+EPT Individuals	1.0	1.0 ± 0.1
Total Abundance	1847.0	2163.4 ± 1274.2
Richness		
Ephemeroptera taxa	2.0	3.7 ± 0.5
EPT taxa (no)	8.0	12.3 ± 1.9
Plecoptera taxa	5.0	5.5 ± 1.1
Shannon-Wiener Diversity	1.2	1.9 ± 0.3
Simpson's Diversity	0.5	0.8 ± 0.1
Total No. of Taxa	16.0	16.0 ± 3.0
Trichoptera taxa	1.0	3.2 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN02
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.85
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.87
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.97

RIVPACS : Expected taxa P>0.50	11.98
RIVPACS : Observed taxa P>0.50	10.00
RIVPACS : O:E (p > 0.5)	0.83
RIVPACS : Expected taxa P>0.70	9.61
RIVPACS : Observed taxa P>0.70	7.00
RIVPACS : O:E (p > 0.7)	0.73

D. Habitat Description

Variable	NAWIN02	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	13.8	21.5 ± 9.7
Depth-Max (cm)	18.5	31.0 ± 16.5
Reach-%CanopyCoverage (PercentRange)	2.00	1.54 ± 1.28
Velocity-Max (m/s)	0.89	0.80 ± 0.48
Width-Bankfull (m)	4.4	13.7 ± 16.4
Width-Wetted (m)	3.0	9.0 ± 13.1
Landcover		
Sediment Chemistry		
Substrate Data		

D. Habitat Description

Variable	NAWIN02	Predicted Group Reference Mean ±SD
Dominant-1st (Category(0-9))	4	7 ± 1
Dominant-2nd (Category(0-9))	3	6 ± 1
Embeddedness (Category(1-5))	3	4 ± 1
SurroundingMaterial (Category(0-9))	1	4 ± 2
Topography		
Water Chemistry		
General-Alkalinity (mg/L)	0.5000000	68.5944444 ± 52.1098452
General-DO (mg/L)	11.0000000	11.0635135 ± 0.9899052
General-pH (pH)	8.7	7.7 ± 0.7

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN02
Sampling Date	Aug 24 2010
Know Your Watershed (KYW) Basin	Lake of the Woods
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Western Continental Ranges Ecoregion
Coordinates (decimal degrees)	50.49381 N, 115.91586 W
Altitude	3579
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.0%	0.1%	34.1%	27.2%	38.6%
CABIN Assessment of NAWIN02 on Aug 24, 2010	Mildly Divergent				

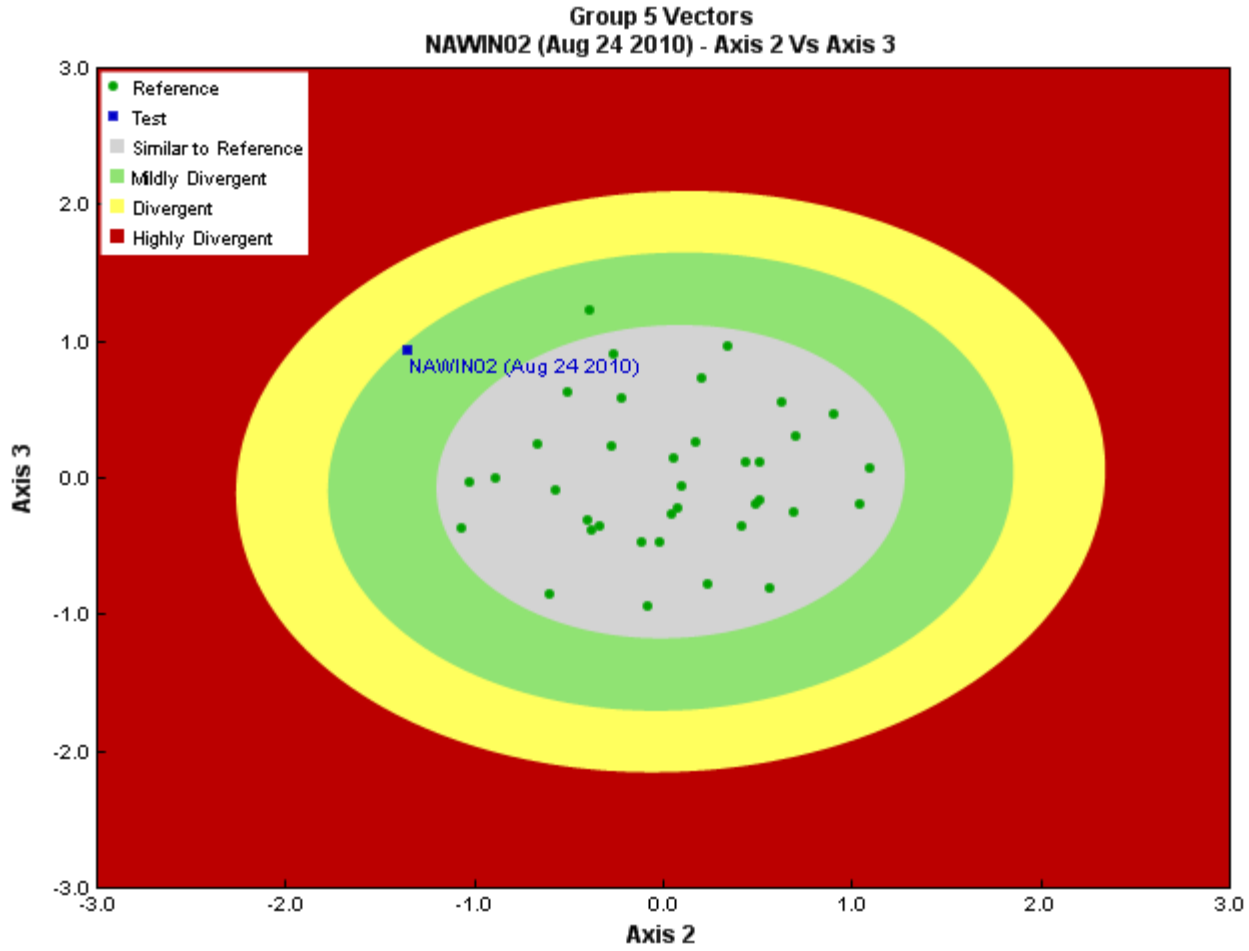


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Gary Lester, Ecoanalysts Inc.
Identification Date	March 09, 2011
Subsampling Device	Marchant Box
Proportion Subsampled	10/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Arthropoda	Arachnida			1	10.0
		Trombidiformes	Aturidae	1	10.0
			Hygrobatidae	1	10.0
			Lebertiidae	2	20.0
			Torrenticolidae	1	10.0
	Insecta	Diptera	Ceratopogonidae	2	20.0
			Chironomidae	215	2,150.0
			Empididae	11	110.0
			Pelecorhynchidae	2	20.0
			Psychodidae	6	60.0
			Simuliidae	1	10.0
			Tipulidae	5	50.0
		Ephemeroptera	Ameletidae	12	120.0
			Baetidae	53	530.0
			Ephemerellidae	1	10.0

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
			Heptageniidae	4	40.0
		Plecoptera	Capniidae	12	120.0
			Chloroperlidae	2	20.0
			Nemouridae	40	400.0
			Perlidae	1	10.0
			Perlodidae	6	60.0
		Trichoptera	Rhyacophilidae	2	20.0
			Total	381	3,810.0

Site Metrics

Metric Name	NAWIN02	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.83	0.4 ± 0.1
Number Of Individuals		
% Chironomidae	56.6	4.6 ± 5.0
% Ephemeroptera	18.4	44.9 ± 17.3
% Ephemeroptera that are Baetidae	75.7	26.1 ± 20.5
% EPT Individuals	35.0	93.7 ± 5.3
% of 2 dominant taxa	70.5	60.2 ± 11.4
% of dominant taxa	56.6	39.3 ± 12.3
% Plecoptera	16.1	42.9 ± 17.2
% Tricoptera	0.5	5.8 ± 5.7
No. EPT individuals/Chironomids+EPT Individuals	0.4	1.0 ± 0.1
Total Abundance	3800.0	2163.4 ± 1274.2
Richness		
Ephemeroptera taxa	4.0	3.7 ± 0.5
EPT taxa (no)	10.0	12.3 ± 1.9
Plecoptera taxa	5.0	5.5 ± 1.1
Shannon-Wiener Diversity	1.6	1.9 ± 0.3
Simpson's Diversity	0.6	0.8 ± 0.1
Total No. of Taxa	21.0	16.0 ± 3.0
Trichoptera taxa	1.0	3.2 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN02
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.85
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.87
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.97

RIVPACS : Expected taxa P>0.50	11.98
RIVPACS : Observed taxa P>0.50	10.00
RIVPACS : O:E (p > 0.5)	0.83
RIVPACS : Expected taxa P>0.70	9.61
RIVPACS : Observed taxa P>0.70	8.00
RIVPACS : O:E (p > 0.7)	0.83

D. Habitat Description

Variable	NAWIN02	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	6.4	21.5 ± 9.7
Depth-Max (cm)	7.5	31.0 ± 16.5
Reach-%CanopyCoverage (PercentRange)	1.00	1.54 ± 1.28

D. Habitat Description

Variable	NAWIN02	Predicted Group Reference Mean ±SD
Velocity-Max (m/s)	0.51	0.80 ± 0.48
Width-Bankfull (m)	3.3	13.7 ± 16.4
Width-Wetted (m)	2.7	9.0 ± 13.1
Landcover		
Substrate Data		
Dominant-1st (Category(0-9))	4	7 ± 1
Dominant-2nd (Category(0-9))	5	6 ± 1
Embeddedness (Category(1-5))	3	4 ± 1
SurroundingMaterial (Category(0-9))	1	4 ± 2
Topography		
Water Chemistry		
General-Alkalinity (mg/L)	0.2500000	68.5944444 ± 52.1098452
General-DO (mg/L)	11.0000000	11.0635135 ± 0.9899052
General-pH (pH)	8.4	7.7 ± 0.7
General-SpCond (uS/cm)	974.0000000	160.3567568 ± 118.4083015

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN03
Sampling Date	Aug 24 2010
Know Your Watershed (KYW) Basin	Upper Columbia
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Southern Rocky Mountain Trench Ecoregion
Coordinates (decimal degrees)	50.46163 N, 115.98558 W
Altitude	3093
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.1%	0.1%	35.8%	30.2%	33.7%
CABIN Assessment of NAWIN03 on Aug 24, 2010	Mildly Divergent				

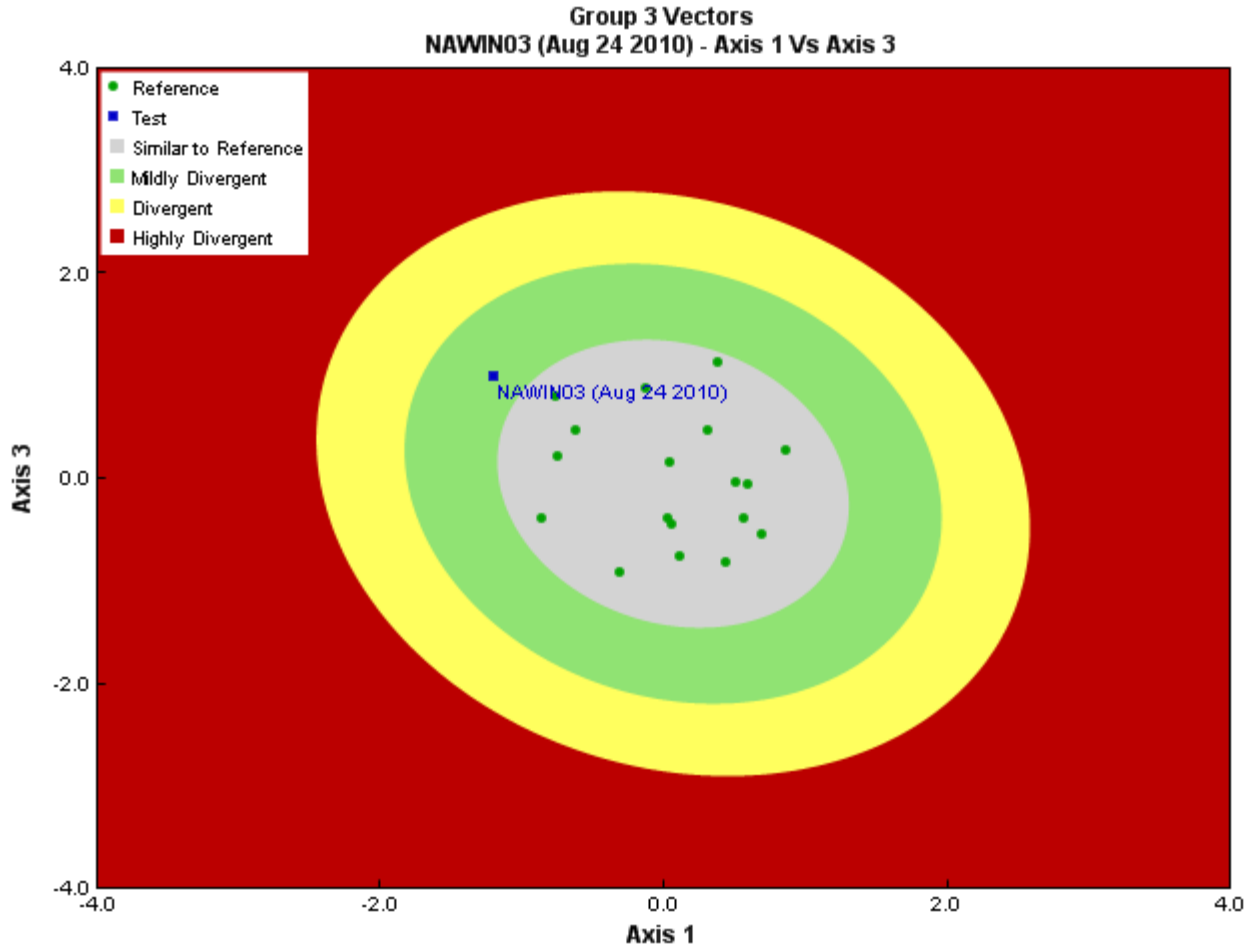


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Gary Lester, Ecoanalysts Inc.
Identification Date	March 09, 2011
Subsampling Device	Marchant Box
Proportion Subsampled	6/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Annelida	Clitellata	Haplotaxida	Enchytraeidae	2	33.3
			Naididae	62	1,033.3
		Lumbricina		1	16.7
Arthropoda	Arachnida	Sarcoptiformes		1	16.7
	Insecta	Coleoptera	Elmidae	2	33.3
		Diptera	Chironomidae	23	383.3
			Empididae	17	283.3
			Tipulidae	2	33.3
		Ephemeroptera	Baetidae	154	2,566.7
			Ephemerellidae	5	83.3
			Heptageniidae	2	33.3
		Plecoptera	Capniidae	1	16.7
			Chloroperlidae	1	16.7
			Leuctridae	1	16.7
			Nemouridae	61	1,016.7

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
			Perlidae	4	66.7
		Trichoptera	Brachycentridae	3	50.0
Mollusca	Bivalvia	Veneroida	Pisidiidae	4	66.7
			Total	346	5,766.7

Site Metrics

Metric Name	NAWIN03	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.81	0.4 ± 0.2
Number Of Individuals		
% Chironomidae	6.7	8.2 ± 13.6
% Ephemeroptera	46.8	43.5 ± 15.9
% Ephemeroptera that are Baetidae	95.7	33.9 ± 27.7
% EPT Individuals	67.4	85.3 ± 14.4
% of 2 dominant taxa	62.8	59.2 ± 10.0
% of dominant taxa	44.8	39.7 ± 10.9
% Plecoptera	19.8	34.8 ± 17.8
% Tricoptera	0.9	6.9 ± 8.6
No. EPT individuals/Chironomids+EPT Individuals	0.9	0.9 ± 0.1
Total Abundance	5733.3	5757.3 ± 4889.9
Richness		
Ephemeroptera taxa	3.0	3.4 ± 0.5
EPT taxa (no)	9.0	11.5 ± 1.2
Plecoptera taxa	5.0	5.3 ± 0.9
Shannon-Wiener Diversity	1.7	1.9 ± 0.3
Simpson's Diversity	0.7	0.8 ± 0.1
Total No. of Taxa	16.0	17.1 ± 2.4
Trichoptera taxa	1.0	2.8 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN03
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.85
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.87
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.96

RIVPACS : Expected taxa P>0.50	11.99
RIVPACS : Observed taxa P>0.50	9.00
RIVPACS : O:E (p > 0.5)	0.75
RIVPACS : Expected taxa P>0.70	9.62
RIVPACS : Observed taxa P>0.70	6.00
RIVPACS : O:E (p > 0.7)	0.62

D. Habitat Description

Variable	NAWIN03	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	18.2	22.5 ± 10.5
Depth-Max (cm)	20.5	32.9 ± 17.9
Reach-%CanopyCoverage (PercentRange)	1.00	0.94 ± 0.80
Velocity-Max (m/s)	1.17	0.75 ± 0.28
Width-Bankfull (m)	4.3	15.6 ± 12.8
Width-Wetted (m)	2.9	10.2 ± 7.0
Landcover		

D. Habitat Description

Variable	NAWIN03	Predicted Group Reference Mean ±SD
Substrate Data		
Dominant-1st (Category(0-9))	3	6 ± 2
Dominant-2nd (Category(0-9))	5	6 ± 2
Embeddedness (Category(1-5))	2	4 ± 1
Topography		
Water Chemistry		
General-Alkalinity (mg/L)	3.6000000	121.5944444 ± 36.7225924
General-DO (mg/L)	10.0000000	10.4922222 ± 0.8833463
General-pH (pH)	8.4	8.0 ± 0.6
General-SpCond (uS/cm)	982.0000000	214.2437500 ± 77.1891440

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN03
Sampling Date	Nov 06 2012
Know Your Watershed (KYW) Basin	Upper Columbia
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Southern Rocky Mountain Trench Ecoregion
Coordinates (decimal degrees)	50.46163 N, 115.98558 W
Altitude	3093
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.4%	0.1%	35.4%	31.7%	32.4%
CABIN Assessment of NAWIN03 on Nov 06, 2012	Highly Divergent				

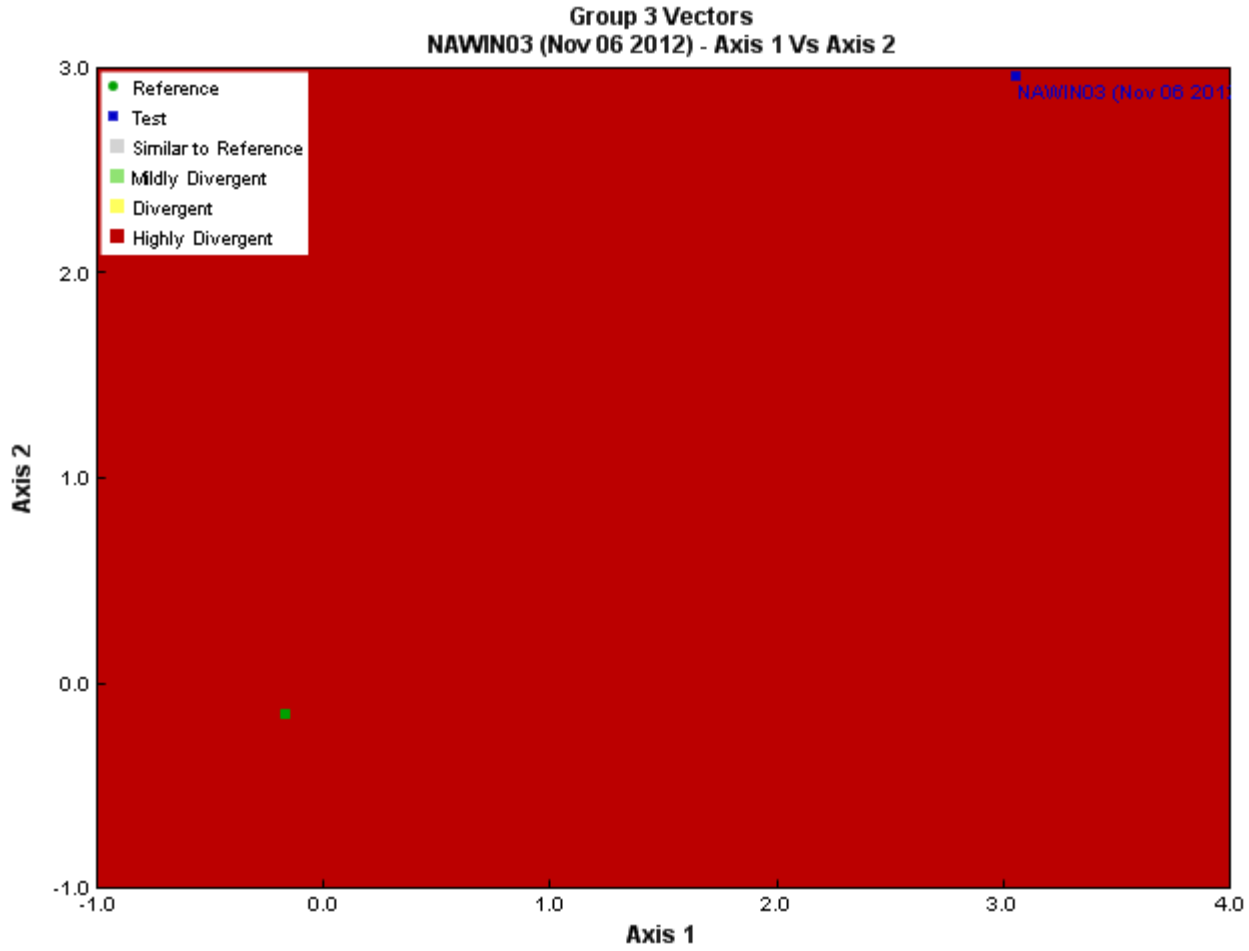


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Eco Analsyts, EcoAnalysts
Identification Date	February 12, 2013
Subsampling Device	Marchant Box
Proportion Subsampled	100/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Annelida	Clitellata	Haplotaxida	Enchytraeidae	1	1.0
Arthropoda	Arachnida			1	1.0
		Trombidiformes	Torrenticolidae	1	1.0
	Insecta	Diptera	Chironomidae	9	9.0
			Simuliidae	4	4.0
			Tipulidae	1	1.0
		Ephemeroptera	Baetidae	3	3.0
			Ephemerellidae	2	2.0
		Plecoptera	Capniidae	16	16.0
			Nemouridae	5	5.0
			Perlodidae	4	4.0
		Trichoptera	Rhyacophilidae	2	2.0
			Total	49	49.0

Site Metrics

Metric Name	NAWIN03	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.98	0.4 ± 0.2
Number Of Individuals		
% Chironomidae	18.8	8.2 ± 13.6
% Ephemeroptera	10.4	43.5 ± 15.9
% Ephemeroptera that are Baetidae	60.0	33.9 ± 27.7
% EPT Individuals	66.7	85.3 ± 14.4
% of 2 dominant taxa	52.1	59.2 ± 10.0
% of dominant taxa	33.3	39.7 ± 10.9
% Plecoptera	52.1	34.8 ± 17.8
% Tricoptera	4.2	6.9 ± 8.6
No. EPT individuals/Chironomids+EPT Individuals	0.8	0.9 ± 0.1
Total Abundance	48.0	5757.3 ± 4889.9
Richness		
Ephemeroptera taxa	2.0	3.4 ± 0.5
EPT taxa (no)	6.0	11.5 ± 1.2
Plecoptera taxa	3.0	5.3 ± 0.9
Shannon-Wiener Diversity	2.0	1.9 ± 0.3
Simpson's Diversity	0.8	0.8 ± 0.1
Total No. of Taxa	11.0	17.1 ± 2.4
Trichoptera taxa	1.0	2.8 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN03
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.85
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.87
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.96

RIVPACS : Expected taxa P>0.50	11.99
RIVPACS : Observed taxa P>0.50	7.00
RIVPACS : O:E (p > 0.5)	0.58
RIVPACS : Expected taxa P>0.70	9.62
RIVPACS : Observed taxa P>0.70	6.00
RIVPACS : O:E (p > 0.7)	0.62

D. Habitat Description

Variable	NAWIN03	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	26.0	22.5 ± 10.5
Depth-Max (cm)	29.0	32.9 ± 17.9
Reach-%CanopyCoverage (PercentRange)	1.00	0.94 ± 0.80
Velocity-Max (m/s)	1.27	0.75 ± 0.28
Width-Bankfull (m)	3.5	15.6 ± 12.8
Width-Wetted (m)	3.2	10.2 ± 7.0
Landcover		
Substrate Data		
Dominant-1st (Category(0-9))	5	6 ± 2
Dominant-2nd (Category(0-9))	4	6 ± 2
Embeddedness (Category(1-5))	5	4 ± 1
SurroundingMaterial (Category(0-9))	3	4 ± 2
Topography		
Water Chemistry		
General-DO (mg/L)	10.0000000	10.4922222 ± 0.8833463

D. Habitat Description

Variable	NAWIN03	Predicted Group Reference Mean ±SD
General-pH (pH)	8.2	8.0 ± 0.6
General-SpCond (uS/cm)	925.0000000	214.2437500 ± 77.1891440

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN04
Sampling Date	Oct 25 2011
Know Your Watershed (KYW) Basin	Lake of the Woods
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Western Continental Ranges Ecoregion
Coordinates (decimal degrees)	50.49156 N, 115.87781 W
Altitude	3799
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.2%	0.1%	37.9%	28.6%	33.1%
CABIN Assessment of NAWIN04 on Oct 25, 2011	Mildly Divergent				

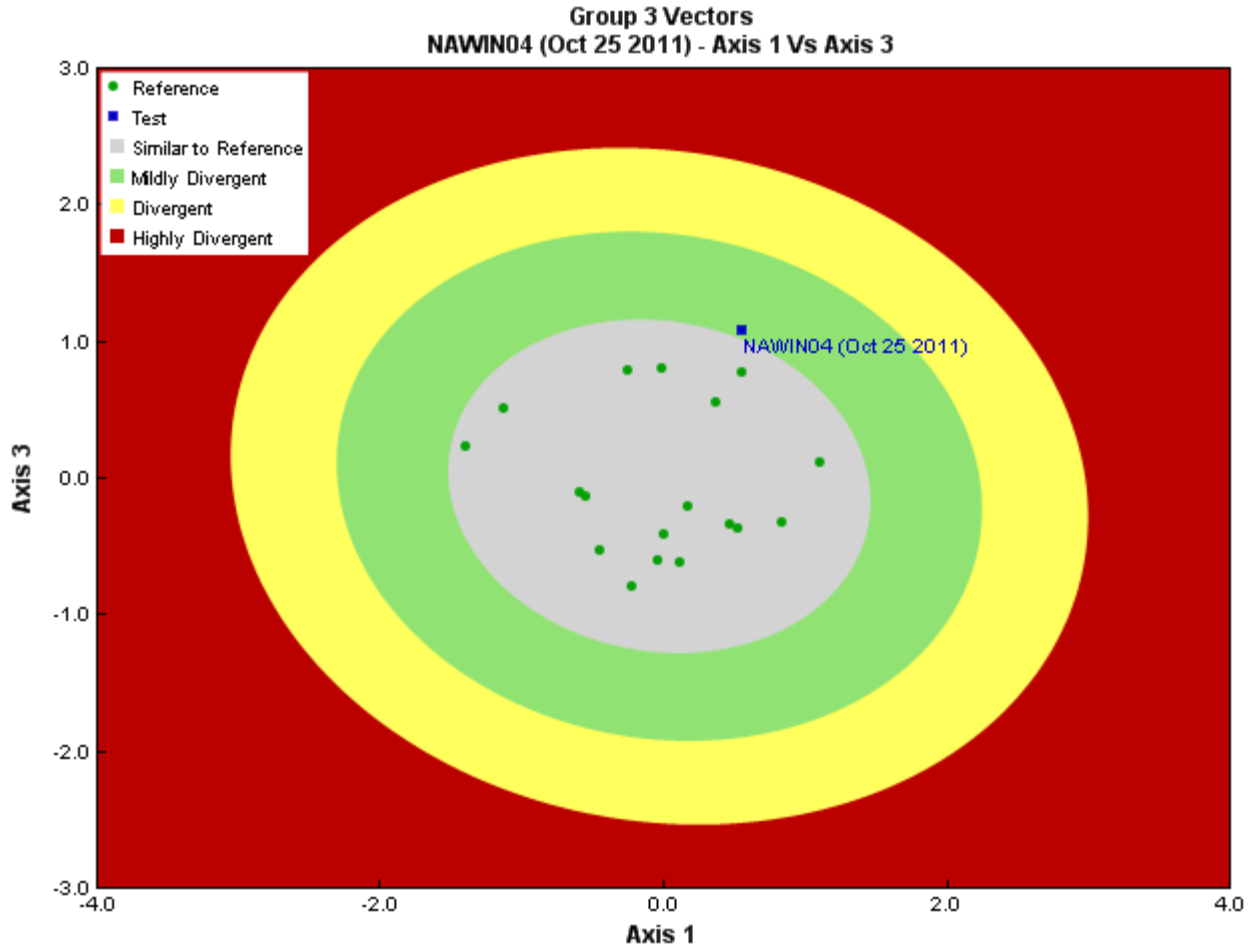


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Eco Analsyts, EcoAnalysts
Identification Date	January 27, 2011
Subsampling Device	Marchant Box
Proportion Subsampled	20/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Annelida	Clitellata	Lumbriculida	Lumbriculidae	11	55.0
Arthropoda	Arachnida	Trombidiformes	Hygrobatidae	2	10.0
			Torrenticolidae	1	5.0
	Insecta	Coleoptera	Elmidae	2	10.0
		Diptera	Chironomidae	12	60.0
			Empididae	5	25.0
			Simuliidae	5	25.0
		Ephemeroptera	Ameletidae	2	10.0
			Baetidae	173	865.0
			Ephemerellidae	30	150.0
			Heptageniidae	44	220.0
		Plecoptera	Capniidae	1	5.0
			Chloroperlidae	3	15.0
			Nemouridae	56	280.0
			Perlidae	3	15.0

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
			Perlodidae	9	45.0
			Taeniopterygidae	2	10.0
		Trichoptera	Brachycentridae	4	20.0
			Glossosomatidae	1	5.0
			Hydropsychidae	9	45.0
			Philopotamidae	1	5.0
			Rhyacophilidae	4	20.0
			Total	380	1,900.0

Site Metrics

Metric Name	NAWIN04	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.53	0.4 ± 0.2
Number Of Individuals		
% Chironomidae	3.2	8.2 ± 13.6
% Ephemeroptera	65.5	43.5 ± 15.9
% Ephemeroptera that are Baetidae	69.5	33.9 ± 27.7
% EPT Individuals	90.0	85.3 ± 14.4
% of 2 dominant taxa	60.3	59.2 ± 10.0
% of dominant taxa	45.5	39.7 ± 10.9
% Plecoptera	19.5	34.8 ± 17.8
% Tricoptera	5.0	6.9 ± 8.6
No. EPT individuals/Chironomids+EPT Individuals	1.0	0.9 ± 0.1
Total Abundance	1900.0	5757.3 ± 4889.9
Richness		
Ephemeroptera taxa	4.0	3.4 ± 0.5
EPT taxa (no)	15.0	11.5 ± 1.2
Plecoptera taxa	6.0	5.3 ± 0.9
Shannon-Wiener Diversity	1.9	1.9 ± 0.3
Simpson's Diversity	0.7	0.8 ± 0.1
Total No. of Taxa	22.0	17.1 ± 2.4
Trichoptera taxa	5.0	2.8 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN04
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.84
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.87
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.97

RIVPACS : Expected taxa P>0.50	11.97
RIVPACS : Observed taxa P>0.50	12.00
RIVPACS : O:E (p > 0.5)	1.00
RIVPACS : Expected taxa P>0.70	9.61
RIVPACS : Observed taxa P>0.70	10.00
RIVPACS : O:E (p > 0.7)	1.04

D. Habitat Description

Variable	NAWIN04	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	23.1	22.5 ± 10.5
Depth-Max (cm)	34.0	32.9 ± 17.9
Reach-%CanopyCoverage (PercentRange)	2.00	0.94 ± 0.80

D. Habitat Description

Variable	NAWIN04	Predicted Group Reference Mean ±SD
Velocity-Max (m/s)	1.33	0.75 ± 0.28
Width-Bankfull (m)	5.2	15.6 ± 12.8
Width-Wetted (m)	3.4	10.2 ± 7.0
Landcover		
Substrate Data		
Dominant-1st (Category(0-9))	5	6 ± 2
Dominant-2nd (Category(0-9))	6	6 ± 2
Embeddedness (Category(1-5))	4	4 ± 1
SurroundingMaterial (Category(0-9))	3	4 ± 2
Topography		
Water Chemistry		
General-DO (mg/L)	7.0000000	10.4922222 ± 0.8833463
General-pH (pH)	8.2	8.0 ± 0.6
General-SpCond (uS/cm)	921.0000000	214.2437500 ± 77.1891440

Site Assessment Report

A. Site Description

CABIN Study Name	CBWN-Lake Windermere
CABIN Site Code	NAWIN04
Sampling Date	Nov 06 2012
Know Your Watershed (KYW) Basin	Lake of the Woods
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera Ecozone Western Continental Ranges Ecoregion
Coordinates (decimal degrees)	50.49156 N, 115.87781 W
Altitude	3799
Feature Name	Windermere Creek
Stream Order	4

B. CABIN Assessment Results

REFERENCE MODEL SUMMARY	
Model Name	Columbia-Okanagan Preliminary March 2010
Analysis Date	December 04, 2013
Taxanomic Level	Family
Predictor Variables	Depth-Avg Latitude Longitude Reg-Ice SlopeLT30%

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	9	43	17	12	33
Group Error Rate	22.2%	24.5%	22.2%	25.0%	32.4%
Overall Model Error Rate	26.4%				
Probability of Group Membership	0.2%	0.1%	38.0%	28.6%	33.1%
CABIN Assessment of NAWIN04 on Nov 06, 2012	Similar to Reference				

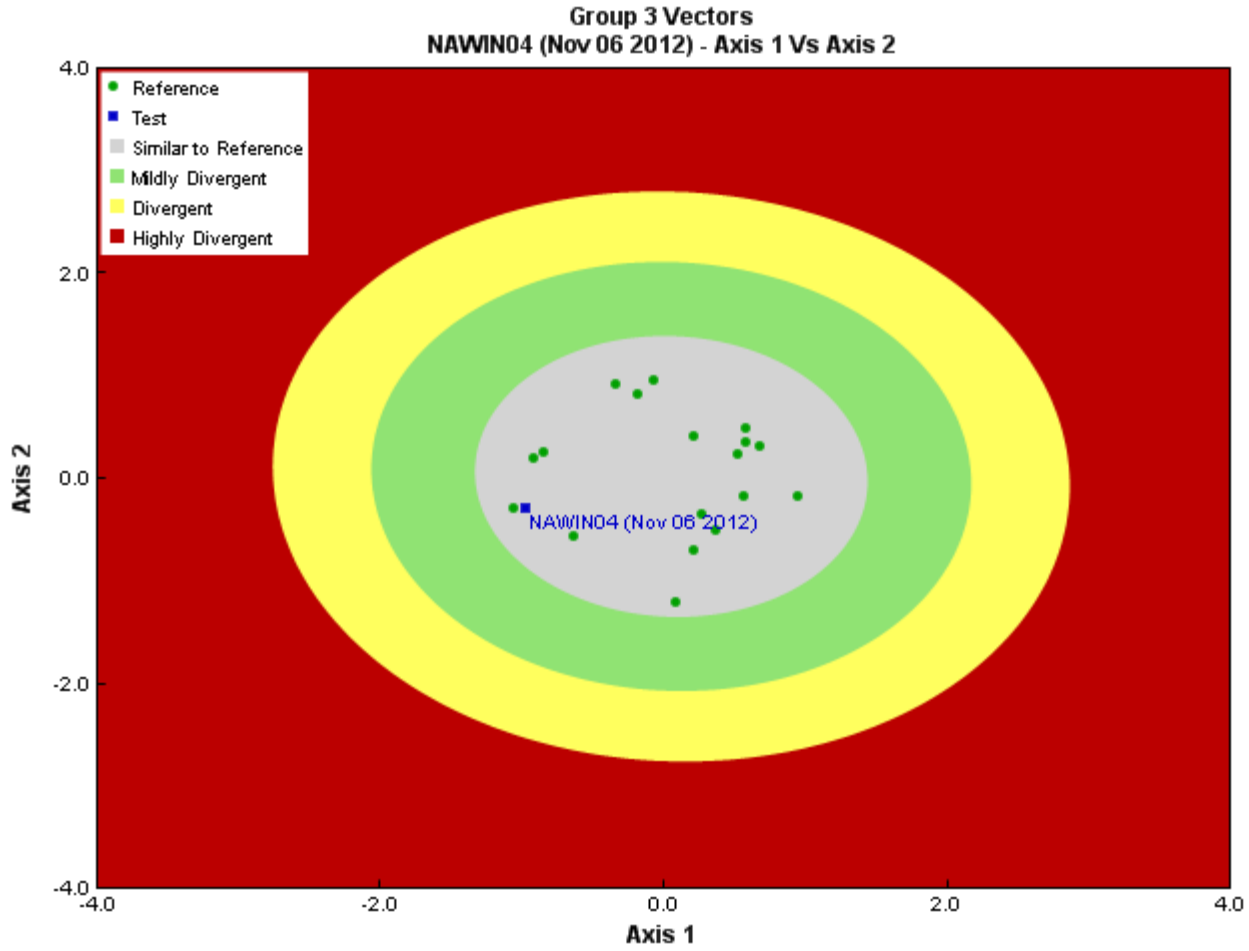


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Eco Analsyts, EcoAnalysts
Identification Date	February 13, 2013
Subsampling Device	Marchant Box
Proportion Subsampled	8/100

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
Arthropoda	Insecta	Coleoptera	Elmidae	1	12.5
		Diptera	Chironomidae	32	400.0
			Empididae	2	25.0
			Psychodidae	5	62.5
			Simuliidae	10	125.0
			Tipulidae	1	12.5
		Ephemeroptera	Ameletidae	3	37.5
			Baetidae	132	1,650.0
			Ephemerellidae	41	512.5
			Heptageniidae	34	425.0
		Plecoptera	Chloroperlidae	2	25.0
			Nemouridae	84	1,050.0
			Perlodidae	8	100.0
			Taeniopterygidae	1	12.5
		Trichoptera	Glossosomatidae	1	12.5

Community Structure Sample Data

Phylum	Class	Order	Family	Raw Count	Mean Count
			Hydropsychidae	1	12.5
			Lepidostomatidae	1	12.5
			Rhyacophilidae	5	62.5
			Total	364	4,550.0

Site Metrics

Metric Name	NAWIN04	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.57	0.4 ± 0.2
Number Of Individuals		
% Chironomidae	8.8	8.2 ± 13.6
% Ephemeroptera	57.7	43.5 ± 15.9
% Ephemeroptera that are Baetidae	62.9	33.9 ± 27.7
% EPT Individuals	86.0	85.3 ± 14.4
% of 2 dominant taxa	59.3	59.2 ± 10.0
% of dominant taxa	36.3	39.7 ± 10.9
% Plecoptera	26.1	34.8 ± 17.8
% Tricoptera	2.2	6.9 ± 8.6
No. EPT individuals/Chironomids+EPT Individuals	0.9	0.9 ± 0.1
Total Abundance	4550.0	5757.3 ± 4889.9
Richness		
Ephemeroptera taxa	4.0	3.4 ± 0.5
EPT taxa (no)	12.0	11.5 ± 1.2
Plecoptera taxa	4.0	5.3 ± 0.9
Shannon-Wiener Diversity	1.9	1.9 ± 0.3
Simpson's Diversity	0.8	0.8 ± 0.1
Total No. of Taxa	18.0	17.1 ± 2.4
Trichoptera taxa	4.0	2.8 ± 1.0

Frequency and Probability of Taxa Occurence

Reference Model Taxa	Frequency of Occurence in Reference Sites					Probability Of Occurrence at NAWIN04
	Group 1	Group 2	Group 3	Group 4	Group 5	
Baetidae	100%	100%	100%	100%	97%	0.99
Chironomidae	100%	100%	100%	100%	95%	0.98
Chloroperlidae	78%	88%	94%	100%	100%	0.98
Ephemerellidae	78%	100%	100%	100%	100%	1.00
Heptageniidae	100%	100%	100%	100%	100%	1.00
Hydropsychidae	11%	92%	78%	92%	86%	0.84
Nemouridae	100%	100%	100%	100%	100%	1.00
Perlodidae	78%	78%	89%	92%	81%	0.87
Rhyacophilidae	100%	92%	100%	100%	95%	0.98
Taeniopterygidae	89%	49%	100%	92%	97%	0.97

RIVPACS : Expected taxa P>0.50	11.97
RIVPACS : Observed taxa P>0.50	11.00
RIVPACS : O:E (p > 0.5)	0.92
RIVPACS : Expected taxa P>0.70	9.61
RIVPACS : Observed taxa P>0.70	10.00
RIVPACS : O:E (p > 0.7)	1.04

D. Habitat Description

Variable	NAWIN04	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	23.0	22.5 ± 10.5
Depth-Max (cm)	35.5	32.9 ± 17.9
Reach-%CanopyCoverage (PercentRange)	1.00	0.94 ± 0.80
Velocity-Max (m/s)	1.13	0.75 ± 0.28
Width-Bankfull (m)	5.1	15.6 ± 12.8
Width-Wetted (m)	4.1	10.2 ± 7.0
Landcover		

D. Habitat Description

Variable	NAWIN04	Predicted Group Reference Mean ±SD
Substrate Data		
Dominant-1st (Category(0-9))	4	6 ± 2
Dominant-2nd (Category(0-9))	5	6 ± 2
Embeddedness (Category(1-5))	5	4 ± 1
SurroundingMaterial (Category(0-9))	3	4 ± 2
Topography		
Water Chemistry		
General-DO (mg/L)	10.0000000	10.4922222 ± 0.8833463
General-pH (pH)	8.1	8.0 ± 0.6
General-SpCond (uS/cm)	921.0000000	214.2437500 ± 77.1891440

Appendix B. Water quality data

Table B-1. Field blank and duplicate results with corresponding quality control review (red highlighting indicates value outside criteria).

Sample Date (mm/dd/yy)	Site Code*	Site Name	Alkalinity (Total as CaCO3)	Alkalinity (PP as CaCO3)	Bicarbonate (HCO3)	Carbonate (CO3)	Hydroxide (OH)	Nitrite (N)	Nitrate (N)	Orthophosphate (P)	Nitrate plus Nitrite (N)	Conductivity	pH	Turbidity
		Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**uS/cm**	**pH units**	**NTU**
		Reportable Detection Limit (RDL)	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.005**	**0.02**	**0.005**	**0.02**	**1**		**0.1**
2010-05-11	**NAWIN03 REG**	Windermere Ck. Site 3	170	<0.5	210	<0.5	<0.5	<0.005	0.16	<0.005	0.16	**1071**	**8.42**	**0.30**
2010-05-11	**NAWIN03 REP**	Windermere Ck. Site 3	180	<0.5	210	<0.5	<0.5	<0.005	0.17	<0.005	0.17	1060	8.3	0.3
	Duplicate QC	**Calculated RPD (%)**	-5.7	0.0	0.0	0.0	0.0	0.0	-6.1	0.0	-6.1	n/a	n/a	n/a
2010-05-11	**NAWIN03 BLK**	Windermere Ck. Site 3	0.6	<0.5	0.8	<0.5	<0.5	<0.005	<0.02	<0.005	<0.02	2	5.9	<0.1
	Blank QC	**X times > than RDL**	1.2	1.0	1.6	1.0	1.0	1.0	1.0	1.0	1.0	2.0	n/a	1.0
2011-07-19	**NAWIN03 REG**	Windermere Ck. Site 3	170	<0.5	200	<0.5	<0.5	0.007	0.13	<0.005	0.14	**757**	**8.39**	**207**
2011-07-19	**NAWIN03 REP**	Windermere Ck. Site 3	170	<0.5	200	<0.5	<0.5	0.008	0.15	<0.005	0.16	747	8.25	166
	Duplicate QC	**Calculated RPD (%)**	0.0	0.0	0.0	0.0	0.0	-13.3	-14.3	0.0	-13.3	n/a	n/a	n/a
2011-07-19	**NAWIN03 BLK**	Windermere Ck. Site 3	0.6	<0.5	0.7	<0.5	<0.5	<0.005	<0.02	<0.005	<0.02	1	5.81	<0.1
	Blank QC	**X times > than RDL**	1.2	1.0	1.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	n/a	1.0
2012-07-19	**NAWIN03 REG**	Windermere Ck. Site 3	163	<0.50	199	<0.50	<0.50	<0.0050	0.135	<0.0050	0.135	**738**	**8.03**	**359**
2012-07-19	**NAWIN03 REP**	Windermere Ck. Site 3	168	<0.50	205	<0.50	<0.50	<0.0050	0.139	<0.0050	0.139	737	8.14	333
	Duplicate QC	**Calculated RPD (%)**	-3.0	0.0	-3.0	0.0	0.0	0.0	-2.9	0.0	-2.9	n/a	n/a	n/a
2012-07-19	**NAWIN03 BLK**	Windermere Ck. Site 3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.0050	<0.020	<0.0050	<0.020	<0.1	5.14	<0.10
	Blank QC	**X times > than RDL**	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	n/a	1.0
2013-04-24	**NAWIN03 REG**	Windermere Ck. Site 3	156	<0.50	191	<0.50	<0.50	<0.0050	0.145	<0.0050	0.145	**1022**	**8.47**	**4.92**
2013-04-24	**NAWIN03 REP**	Windermere Ck. Site 3	157	<0.50	192	<0.50	<0.50	<0.0050	0.136	<0.0050	0.136	1020	8.06	1.47
	Duplicate QC	**Calculated RPD (%)**	-0.6	0.0	-0.5	0.0	0.0	0.0	6.4	0.0	6.4	n/a	n/a	n/a
2013-04-24	**NAWIN03 BLK**	Windermere Ck. Site 3	0.89	<0.50	1.09	<0.50	<0.50	<0.0050	<0.020	<0.0050	<0.020	1.3	5.88	<0.10
	Blank QC	**X times > than RDL**	1.8	1.0	2.2	1.0	1.0	1.0	1.0	1.0	1.0	1.3	n/a	1.0

QA/QC Alert Crieria:

Duplicate (or REP for replicate) review based on relative percent difference (RPD) = Recommended alert if RPD ≥30% for general chemistry. Relative percent difference limit (RPD)= [(Result 2 - Result 1) / mean] * 100.

Field Blank (BLK), recommended alert = 2X reporting limit (RDL)

Table B-2. Water chemistry data (non-metal), with comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Site Name	Nitrite (N)	Nitrate (N)	Alkalinity (Total as CaCO3)	Alkalinity (PP as CaCO3)	Bicarbonate (HCO3)	Carbonate (CO3)	Hydroxide (OH)	Orthophosphate (P)
		Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**µg/L**
		Guideline	CCME: 0.060. HC Drinking: 1	CCME: 3. HC Drinking: 10	no guideline	no guideline	no guideline	no guideline	no guideline	no guideline
23-Sep-09	NAWIN01	Windermere Ck. Site 1				<0.50				
24-Aug-10	NAWIN01	Windermere Ck. Site 1	<0.0050	0.05	150	2.8	170	3.4	<0.50	<5
12-Oct-11	NAWIN01	Windermere Ck. Site 1	<0.0050	0.05	150	<0.50	180	<0.50	<0.50	<5
6-Nov-12	NAWIN01	Windermere Ck. Site 1	<0.0050	0.083	144	<0.50	176	<0.50	<0.50	<5
1-Oct-13	NAWIN01	Windermere Ck. Site 1	<0.0050	0.059	141	<0.50	172	<0.50	<0.50	<5
30-Sep-09	NAWIN02	Windermere Ck. Site 2			150	<0.50	180	<0.50	<0.50	
11-May-10	NAWIN02	Windermere Ck. Site 2								
24-Aug-10	NAWIN02	Windermere Ck. Site 2	<0.0050	0.09	150	<0.50	190	<0.50	<0.50	<5
23-Sep-09	NAWIN03	Windermere Ck. Site 3			170	<0.50	210	<0.50	<0.50	
16-Jan-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.16	140	<0.50	180	<0.50	<0.50	<5
2-Feb-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.19	170	<0.50	200	<0.50	<0.50	<5
23-Feb-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.19	170	<0.50	210	<0.50	<0.50	<5
12-Mar-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.14	170	<0.50	210	<0.50	<0.50	<5
27-Apr-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.17	170	<0.50	200	<0.50	<0.50	<5
11-May-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.16	170	<0.50	210	<0.50	<0.50	<5
6-Jul-10	NAWIN03	Windermere Ck. Site 3								
24-Aug-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.10	170	3.6	200	4.3	<0.50	<5
14-Sep-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.11	170	<0.50	210	<0.50	<0.50	<5
18-Nov-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.14	170	1.3	200	1.5	<0.50	<5
15-Dec-10	NAWIN03	Windermere Ck. Site 3	<0.0050	0.17	150	<0.50	180	<0.50	<0.50	<5
26-Jan-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.18	160	<0.50	200	<0.50	<0.50	<5
16-Feb-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.19	160	<0.50	190	<0.50	<0.50	<5
15-Mar-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.18	160	<0.50	200	<0.50	<0.50	<5
26-Apr-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.16	160	<0.50	200	<0.50	<0.50	<5
18-May-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.17	170	<0.50	200	<0.50	<0.50	<5
15-Jun-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.14	160	<0.50	190	<0.50	<0.50	<5
19-Jul-11	NAWIN03	Windermere Ck. Site 3	0.007	0.13	170	<0.50	200	<0.50	<0.50	<5
23-Aug-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.1	170	<0.50	200	<0.50	<0.50	<5

Table B-2. Water chemistry data (non-metal), with comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Site Name	Nitrite (N)	Nitrate (N)	Alkalinity (Total as CaCO3)	Alkalinity (PP as CaCO3)	Bicarbonate (HCO3)	Carbonate (CO3)	Hydroxide (OH)	Orthophosphate (P)
		Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**µg/L**
		Guideline	CCME: 0.060. HC Drinking: 1	CCME: 3. HC Drinking: 10	no guideline	no guideline	no guideline	no guideline	no guideline	no guideline
7-Sep-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.12	150	<0.50	180	<0.50	<0.50	<5
25-Oct-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.13	170	<0.50	200	<0.50	<0.50	<5
16-Nov-11	NAWIN03	Windermere Ck. Site 3								
20-Dec-11	NAWIN03	Windermere Ck. Site 3	<0.0050	0.163	159	<0.50	194	<0.50	<0.50	<5
16-Jan-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.181	156	<0.50	191	<0.50	<0.50	<5
21-Feb-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.164	161	<0.50	196	<0.50	<0.50	<5
21-Mar-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.173	163	<0.50	198	<0.50	<0.50	<5
25-Apr-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.184	159	<0.50	193	<0.50	<0.50	<5
30-May-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.148	161	<0.50	197	<0.50	<0.50	<5
21-Jun-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.113	178	<0.50	217	<0.50	<0.50	19.7
19-Jul-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.135	163	<0.50	199	<0.50	<0.50	<5
28-Aug-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.169	169	<0.50	206	<0.50	<0.50	<5
10-Oct-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.172	170	<0.50	208	<0.50	<0.50	<5
28-Oct-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.155	167	<0.50	203	<0.50	<0.50	<5
6-Nov-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.157	166	<0.50	203	<0.50	<0.50	<5
12-Dec-12	NAWIN03	Windermere Ck. Site 3	<0.0050	0.172	166	<0.50	203	<0.50	<0.50	<5
21-Jan-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.202	164	<0.50	200	<0.50	<0.50	<5
13-Feb-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.187	164	<0.50	200	<0.50	<0.50	<5
26-Mar-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.198	169	<0.50	207	<0.50	<0.50	<5
24-Apr-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.145	156	<0.50	191	<0.50	<0.50	<5
14-May-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.175	159	1	191	1.2	<0.50	<5
11-Jun-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.125	159	<0.50	193	<0.50	<0.50	<5
8-Jul-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.15	166	<0.50	203	<0.50	<0.50	<5
6-Aug-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.12	169	<0.50	206	<0.50	<0.50	<5
10-Sep-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.133	139	<0.50	170	<0.50	<0.50	<5
1-Oct-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.136	165	<0.50	202	<0.50	<0.50	<5
17-Oct-13	NAWIN03	Windermere Ck. Site 3	<0.0050	0.152	161	<0.50	197	<0.50	<0.50	<5
25-Oct-11	NAWIN04	Windermere Ck. Site 4	<0.0050	0.13	170	<0.50	200	<0.50	<0.50	<5

Table B-2. Water chemistry data (non-metal), with comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Site Name	Nitrite (N)	Nitrate (N)	Alkalinity (Total as CaCO3)	Alkalinity (PP as CaCO3)	Bicarbonate (HCO3)	Carbonate (CO3)	Hydroxide (OH)	Orthophosphate (P)
		Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**µg/L**
		Guideline	CCME: 0.060. HC Drinking: 1	CCME: 3. HC Drinking: 10	no guideline	no guideline	no guideline	no guideline	no guideline	no guideline
6-Nov-12	NAWIN04	Windermere Ck. Site 4	<0.0050	0.139	161	<0.50	196	<0.50	<0.50	<5
1-Oct-13	NAWIN04	Windermere Ck. Site 4	<0.0050	0.119	159	<0.50	194	<0.50	<0.50	<5

BC Approved Water Quality Guidelines (Government of BC 2013)

BC Working Water Quality Guidelines (Nagpal et al. 2006)

Canadian Water Quality Guidelines (CCME 1999a)

Table B-2. Water chemistry data (non-metal), with comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Nitrate plus Nitrite (N)	Dissolved Oxygen	Conductivity	pH	Turbidity	Water Temperature	Air Temperature	Total Hardness (CaCO3)
		mg/L	mg/L	µS/cm	ph units	NTU	◦C	◦C	mg/L
		no guideline	BC App: 8 (all stages other than embryo) and 11 (buried embryo)	no guideline (note this is Specific Conductivity)	no mean guideline - CCME & BC Appr. no significant change from normal (e.g., 6.5-9.0)	BC Appr. (induced realtive to background, clear flow period): 8 NTU (24 hours), 2 NTU (30 day)	Max. daily 19°C. Max. incubation (spring/fall) is 12 °C.	no guideline	no guideline
23-Sep-09	NAWIN01		**13**	**558**	**8.55**		**6.7**	**15.5**	
24-Aug-10	NAWIN01	0.05	**13**	**404.6**	**8.57**	**0.38**	**6.0**	**12.5**	
12-Oct-11	NAWIN01	0.05	**12**	**638**	**8.22**	**0.45**	**3.0**	**7.0**	
6-Nov-12	NAWIN01	0.083	**11**	**626.3**	**8.42**	**0.70**	**1.0**	**3.0**	
1-Oct-13	NAWIN01	0.059	**12**	**507.85**	**8.30**	**5.80**	**0.5**	**8.5**	
30-Sep-09	NAWIN02		11	940	**8.67**		9.5	14.5	
11-May-10	NAWIN02		**11**	**1106**	**8.47**	**1.25**	**6.7**	**15.0**	
24-Aug-10	NAWIN02	0.09	**11**	**974**	**8.41**	**1.04**	**9.3**	**21.0**	
23-Sep-09	NAWIN03		11	956	**8.52**		10.9	23.5	590
16-Jan-10	NAWIN03	0.16	**11**	**997**	**8.42**	**0.89**	**9.3**	**13**	
2-Feb-10	NAWIN03	0.19	**13**	**1037**	**8.49**	**2.50**	**4.5**	**2.0**	
23-Feb-10	NAWIN03	0.19	**13**	**1056**	**8.47**	**1.73**	**3.1**	**5.0**	
12-Mar-10	NAWIN03	0.14	**13**	**1068**	**8.50**	**2.25**	**7.1**	**12.0**	
27-Apr-10	NAWIN03	0.17	**11**	**1065**	**8.51**	**2.33**	**8.6**	**12.0**	
11-May-10	NAWIN03	0.16	**11**	**1071**	**8.42**	**1.70**	**8.4**	**14.5**	
6-Jul-10	NAWIN03		**12**	**959**	**8.42**	**4.43**	**9**	**14.5**	
24-Aug-10	NAWIN03	0.10 (1)	**10**	**982**	**8.44**	**2.42**	**12.7**	**23.5**	
14-Sep-10	NAWIN03	0.11	**11**	**1000**	**8.43**	**0.81**	**9.3**	**13.5**	556
18-Nov-10	NAWIN03	0.14	**12**	**1032**	**8.53**	**1.23**	**2.9**	**<-5**	
15-Dec-10	NAWIN03	0.17	**13**	**1052**	**8.49**	**2.64**	**3.6**	**1**	
26-Jan-11	NAWIN03	0.18	**13**	**1021**	**8.46**	**3.06**	**4.2**	**3**	
16-Feb-11	NAWIN03	0.19	**12**	**1077**	**8.41**	**2.13**	**4.3**	**4.0**	
15-Mar-11	NAWIN03	0.18	**12**	**1083**	**8.54**	**3.19**	**5.0**	**6.0**	
26-Apr-11	NAWIN03	0.16	**10**	**1087**	**8.66**	**1.62**	**8.0**	**12.0**	
18-May-11	NAWIN03	0.17	**10**	**1070**	**8.49**	**0.93**	**8.0**	**19.0**	
15-Jun-11	NAWIN03	0.14	**9**	**670**	**8.57**	**179.00**	**8.0**	**12.0**	
19-Jul-11	NAWIN03	0.14	**9**	**757**	**8.39**	**207**	**10.4**	**15**	
23-Aug-11	NAWIN03	0.1	**10**	**833**	**8.26**	**16.3**	**11.8**	**27**	

Table B-2. Water chemistry data (non-metal), with comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Nitrate plus Nitrite (N)	Dissolved Oxygen	Conductivity	pH	Turbidity	Water Temperature	Air Temperature	Total Hardness (CaCO3)
		mg/L	mg/L	µS/cm	ph units	NTU	◦C	◦C	mg/L
		no guideline	BC App: 8 (all stages other than embryo) and 11 (buried embryo)	no guideline (note this is Specific Conductivity)	no mean guideline - CCME & BC Appr. no significant change from normal (e.g., 6.5-9.0)	BC Appr. (induced realtive to background, clear flow period): 8 NTU (24 hours), 2 NTU (30 day)	Max. daily 19°C. Max. incubation (spring/fall) is 12 °C.	no guideline	no guideline
7-Sep-11	NAWIN03	0.12	**10**	**856**	**8.42**	**14.50**	**10.9**	**29.0**	
25-Oct-11	NAWIN03	0.13	**11**	**912**	**8.35**	**33.30**	**7.5**	**11.5**	
16-Nov-11	NAWIN03		**10**	**926**	**8.58**	**6.83**	**2.0**	**-4.5**	
20-Dec-11	NAWIN03	0.163	**6**	**984**	**8.46**	**4.75**	**3.5**	**2.5**	
16-Jan-12	NAWIN03	0.181	**13**	**1019**	**8.37**	**3.54**	**1.0**	**2.0**	
21-Feb-12	NAWIN03	0.164	**12**	**1013**	**8.31**	**3.03**	**4.2**	**6.0**	
21-Mar-12	NAWIN03	0.173	**12**	**1016**	**8.36**	**2.56**	**4.5**	**3.5**	
25-Apr-12	NAWIN03	0.184	**11**	**1038**	**8.26**	**10.2**	**9.7**	**18.0**	
30-May-12	NAWIN03	0.148	**8**	**833**	**8.12**	**26.1**	**7.5**	**15.0**	
21-Jun-12	NAWIN03	0.113	**8**	**616**	**8.07**	*****	**9.2**	**21.0**	
19-Jul-12	NAWIN03	0.135	**10**	**738**	**8.03**	**359**	**10.5**	**24.0**	
28-Aug-12	NAWIN03	0.169	**10**	**833**	**8.12**	**9.18**	**8.5**	**17.0**	
10-Oct-12	NAWIN03	0.172	**11**	**896**	**8.18**	**3.89**	**7.7**	**15.5**	
28-Oct-12	NAWIN03	0.155	**11**	**909**	**8.16**	**3.56**	**5.5**	**7.0**	
6-Nov-12	NAWIN03	0.157	**10**	**925**	**8.20**	**9.18**	**5.0**	**3.5**	
12-Dec-12	NAWIN03	0.172	**10.5**	**937**	**8.44**	**3.55**	**3.8**	**-1.0**	
21-Jan-13	NAWIN03	0.202	**11**	**998**	**8.32**	**3.10**	**2.0**	**7.0**	
13-Feb-13	NAWIN03	0.187	**11**	**1002**	**8.54**	**10.50**	**4.7**	**4.5**	
26-Mar-13	NAWIN03	0.198	**11**	**1026**	**8.44**	**9.00**	**4.9**	**8.0**	
24-Apr-13	NAWIN03	0.145	**11**	**1022**	**8.47**	**4.92**	**6.6**	**11.5**	
14-May-13	NAWIN03	0.175	**11**	**707**	**8.40**	**40.80**	**7.8**	**12.0**	
11-Jun-13	NAWIN03	0.125	**12**	**682**	**8.30**	**28.60**	**8.4**	**19.0**	
8-Jul-13	NAWIN03	0.15	**10**	**709**	**8.40**	**12.00**	**9.4**	**19.5**	
6-Aug-13	NAWIN03	0.12	**10**	**761**	**8.30**	**3.50**	**12.2**	**26.5**	
10-Sep-13	NAWIN03	0.133	**11**		**8.30**	**6.26**	**11.0**	**29.0**	
1-Oct-13	NAWIN03	0.136	**10**	**914**	**8.30**	**9.45**	**7.5**	**12.0**	
17-Oct-13	NAWIN03	0.152	**11**	**837**	**8.40**	**1.73**	**7.5**	**12.0**	
25-Oct-11	NAWIN04	0.13	**7**	**921**	**8.15**	**2.65**	**4.0**	**-0.5**	

Table B-2. Water chemistry data (non-metal), with comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Nitrate plus Nitrite (N)	Dissolved Oxygen	Conductivity	pH	Turbidity	Water Temperature	Air Temperature	Total Hardness (CaCO3)
		mg/L	**mg/L**	**µS/cm**	**ph units**	**NTU**	**◦C**	**◦C**	**mg/L**
		no guideline	BC App: 8 (all stages other than embryo) and 11 (buried embryo)	no guideline (note this is Specific Conductivity)	no mean guideline - CCME & BC Appr. no significant change from normal (e.g., 6.5-9.0)	BC Appr. (induced realtive to background, clear flow period): 8 NTU (24 hours), 2 NTU (30 day)	Max. daily 19^{o}C. Max. incubation (spring/fall) is 12 ^{o}C.	no guideline	no guideline
6-Nov-12	NAWIN04	0.139	**10**	**921**	**8.13**	**1.50**	**5.0**	**3.5**	
1-Oct-13	NAWIN04	0.119	**10**	**918**	**8.20**	**6.54**	**7.0**	**8.5**	

Table B-2. Water chemistry data (non-metal), with comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Dissolved Hardness (CaCO3)	Total Nitrogen (N)	Total Phosphorus (P)	Notes	Total Suspended Solids	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)
		mg/L	mg/L	µg/L		mg/L	mg/L	mg/L
		no guideline	no guideline	CCME: 1.5x trophic range. HC Drinking =10	CCME: trophic range (based on backgrd values for site).	No mean guideline	no guideline	no guideline
23-Sep-09	NAWIN01		0.08		4-10 Oligotrophic	<4		
24-Aug-10	NAWIN01				4-10 Oligotrophic			
12-Oct-11	NAWIN01				4-10 Oligotrophic			
6-Nov-12	NAWIN01							
1-Oct-13	NAWIN01							
30-Sep-09	NAWIN02	523	0.14	<5	4-10 Oligotrophic	<4	150	35.8
11-May-10	NAWIN02				4-10 Oligotrophic			
24-Aug-10	NAWIN02				4-10 Oligotrophic			
23-Sep-09	NAWIN03	540	0.18	<5	4-10 Oligotrophic	<4	153	38.7
16-Jan-10	NAWIN03				4-10 Oligotrophic			
2-Feb-10	NAWIN03				4-10 Oligotrophic			
23-Feb-10	NAWIN03				4-10 Oligotrophic			
12-Mar-10	NAWIN03				4-10 Oligotrophic			
27-Apr-10	NAWIN03				4-10 Oligotrophic			
11-May-10	NAWIN03				4-10 Oligotrophic			
6-Jul-10	NAWIN03				4-10 Oligotrophic			
24-Aug-10	NAWIN03				4-10 Oligotrophic			
14-Sep-10	NAWIN03				4-10 Oligotrophic			
18-Nov-10	NAWIN03				4-10 Oligotrophic			
15-Dec-10	NAWIN03				4-10 Oligotrophic			
26-Jan-11	NAWIN03				4-10 Oligotrophic			
16-Feb-11	NAWIN03				4-10 Oligotrophic			
15-Mar-11	NAWIN03				4-10 Oligotrophic			
26-Apr-11	NAWIN03				4-10 Oligotrophic			
18-May-11	NAWIN03				4-10 Oligotrophic			
15-Jun-11	NAWIN03				4-10 Oligotrophic			
19-Jul-11	NAWIN03				4-10 Oligotrophic			
23-Aug-11	NAWIN03				4-10 Oligotrophic			

Table B-2. Water chemistry data (non-metal), with comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Dissolved Hardness ($CaCO_3$)	Total Nitrogen (N)	Total Phosphorus (P)	Notes	Total Suspended Solids	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)
		mg/L	mg/L	µg/L		mg/L	mg/L	mg/L
		no guideline	no guideline	CCME: 1.5x trophic range. HC Drinking =10	CCME: trophic range (based on backgrd values for site).	No mean guideline	no guideline	no guideline
7-Sep-11	NAWIN03				4-10 Oligotrophic			
25-Oct-11	NAWIN03				4-10 Oligotrophic			
16-Nov-11	NAWIN03				4-10 Oligotrophic			
20-Dec-11	NAWIN03				4-10 Oligotrophic			
16-Jan-12	NAWIN03				4-10 Oligotrophic			
21-Feb-12	NAWIN03				4-10 Oligotrophic			
21-Mar-12	NAWIN03				4-10 Oligotrophic			
25-Apr-12	NAWIN03				4-10 Oligotrophic			
30-May-12	NAWIN03				4-10 Oligotrophic			
21-Jun-12	NAWIN03				4-10 Oligotrophic			
19-Jul-12	NAWIN03				4-10 Oligotrophic			
28-Aug-12	NAWIN03							
10-Oct-12	NAWIN03							
28-Oct-12	NAWIN03							
6-Nov-12	NAWIN03							
12-Dec-12	NAWIN03							
21-Jan-13	NAWIN03							
13-Feb-13	NAWIN03							
26-Mar-13	NAWIN03							
24-Apr-13	NAWIN03							
14-May-13	NAWIN03							
11-Jun-13	NAWIN03							
8-Jul-13	NAWIN03							
6-Aug-13	NAWIN03							
10-Sep-13	NAWIN03							
1-Oct-13	NAWIN03							
17-Oct-13	NAWIN03							
25-Oct-11	NAWIN04				4-10 Oligotrophic			

Table B-2. Water chemistry data (non-metal), with comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Dissolved Hardness ($CaCO_3$)	Total Nitrogen (N)	Total Phosphorus (P)	Notes	Total Suspended Solids	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)
		mg/L	**mg/L**	**µg/L**		**mg/L**	**mg/L**	**mg/L**
		no guideline	no guideline	CCME: 1.5x trophic range. HC Drinking =10	CCME: trophic range (based on backgrd values for site).	No mean guideline	no guideline	no guideline
6-Nov-12	NAWIN04							
1-Oct-13	NAWIN04							

Table B-3. Water chemistry (metals) and comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Site Name	pH	Total Hardness (CaCO3)	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)
		Units	ph units	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
		Guideline			CCME: 100 when pH is > 6.5. HC: 100 (max)	BC Work: 20. HC: 6 (max)	BC App: 5. HC: 10 (max)	BC Work (mean) 1000. HC: 1000 (max)	BC Work: 5.3. BC Work: 4.0 (max)	no guideline
23-Sep-09	NAWIN03	Windermere Ck. Site 3	8.1	590	21	<0.5	2.5	33	<0.1	<1
14-Sep-10	NAWIN03	Windermere Ck. Site 3	8.43	556	9	<0.5	1.4	30	<0.1	<1

BC Approved Water Quality Guidelines (Government of BC 2013)

BC Working Water Quality Guidelines (Nagpal et al. 2006)

Canadian Water Quality Guidelines (CCME 1999a)

Value — Drinking water Guidelines (HC; Health Canada 2012 or BC Approved, BC Work as indicated)

*all drinking water guidelines and exceedances are underlined.

Table B-3. Water chemistry (metals) and comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Total Boron (B)	Total Cadmium (Cd)	Notes	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)
		µg/L	µg/L		mg/L	µg/L	µg/L	µg/L	µg/L
		BC App: 1200. HC: 5000 (max)	CCME and BC Working: (10^0.86[log10(Hardness)]-3.2). HC: 5 (max)	CCME Guideline Value	no guideline	HC: 50 (max)	BC App: 4.0	BC App: 2.0 µg/L when hardness is ≤50 mg/L; and 0.04*hardness when hardness ≥50 mg/L. BC App. 500 (max)	CCME: 300, BC App. 1000. HC: 300 (aesthetic)
23-Sep-09	NAWIN03	55	<0.01	0.15	169	<1	<0.5	<0.2	47
14-Sep-10	NAWIN03	<50	0.03	0.14	159	<1	<0.5	<0.2	11

Table B-3. Water chemistry (metals) and comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Total Lead (Pb)	Notes	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)	Notes	Total Mercury (Hg)	Total Molybdenum (Mo)	Total Nickel (Ni)
		µg/L		µg/L	mg/L	µg/L		µg/L	µg/L	µg/L
		BC App. when hardness ≥8: (3.31 + e(1.273 ln [hardness] - 4.704). HC: 10 (max)	BC App. guideline calculation	BC Work: 14	no guideline	BC App. = (0.0044*hardness+0.605)*1000. HC: 50 (aesthetic)	BC App. guideline calculation	CCME 0.026	BC App. 1000; CCME 73. BC App: 250 (max)	CCME: $e^{0.76[\ln(\text{hardness})]+1.06}$
23-Sep-09	NAWIN03	<0.2	33.8	7	40.8	4	3201.0	<0.02	2	<1
14-Sep-10	NAWIN03	<0.2	31.6	7	38.8	3	3051.4		1	<1

Table B-3. Water chemistry (metals) and comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Sulphur (S)	Total Thallium (Tl)	Total Tin (Sn)
		µg/L	mg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L	µg/L	µg/L
		BC App. 15.	BC Work: 372-432 mg/L	BC App. 2.0. HC and BC App: 10 (max)	no guideline	BC App. 1.5 if hardness>100, 0.05 if hardness is <100. CCME 0.1.	HC: 200 (aesthetic)	no guideline	no guideline	CCME and BC Work: 0.8. BC Work: 2.0	no guideline
23-Sep-09	NAWIN03		1.03	0.1	3740	<0.02	3.03	1910	143	<0.05	<5
14-Sep-10	NAWIN03		0.94	0.1	3770	<0.05	3.04	1850	130	<0.05	<5

Table B-3. Water chemistry (metals) and comparison to guidelines for the protection of aquatic life and drinking water, Windermere Creek.

Sample Date (dd/mm/yy)	Site Code	Total Titanium (Ti)	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Notes	Total Zirconium (Zr)
		µg/L	µg/L	µg/L	µg/L		µg/L
		BC Work: 2000	CCME: 15. BC Work 300. HC: 20 (max)	BC Work: 6	BC App: 7.5 +0.75 * (hardness - 90). HC:5000 (aesthetic)	BC App. calculated guideline	no guideline
23-Sep-09	NAWIN03	<5	1.4	<5	20	382.5	<0.5
14-Sep-10	NAWIN03	<5	1.3	<0.5	<5	357	<5

Table B-4. Sediment quality and comparison to guidelines for the protection of aquatic life, Windermere Creek.

Sample Date (dd/mm/yy)	Site code	Site Name	Soluble (2:1) pH	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Cadmium (Cd)
		Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	Guideline		no guideline	no guideline	no guideline	CCME and BC Working ISQG 5.9, PEL 17	no guideline	no guideline	no guideline	CCME and BC Working ISQG 0.6, PEL 3.5
16-Nov-11	NAWIN03	Windermere Ck. Site 3	8.35	2920	0.33	11.9	462	<0.40	<0.10	0.084
6-Nov-12	NAWIN03	Windermere Ck. Site 3	8.46	3030	0.15	10.1	688	<0.40	<0.10	<0.050
17-Oct-13	NAWIN03	Windermere Ck. Site 3	8.43	1510	<0.10	5.57	255	<0.40	<0.10	0.107

Guideline exceedance legend for the protection of freshwater aquatic life:

- BC Approved Water Quality Guidelines (Government of BC 2013)
- BC Working Water Quality Guidelines, lowest effect (Nagpal et al. 2006)
- BC Working Water Quality Guidelines, severe effect (Nagpal et al. 2006)
- Canadian Sediment Quality Guidelines - ISQG (CCME 1999b)
- Canadian Sediment Quality Guidelines - PEL (CCME 1999b)

Table B-4. Sediment quality and comparison to guidelines for the protection of aquatic life, Windermere Creek.

Sample Date (dd/mm/yy)	Site code	Total Calcium (Ca)	Total Chromium (Cr)	Total Cobalt (Co)	Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)	Total Mercury (Hg)
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	Guideline	no guideline	ISQG 37.3, PEL 90	no guideline	ISQG 35.7, PEL 197	BC Work: low 21,200, severe 43,766	CCME and BC Working ISQG 35, PEL 91.3	no guideline	no guideline	BC Work: low 460, severe 1100	ISQG 0.17, PEL 0.486
16-Nov-11	NAWIN03	225000	4.7	2.02	4.26	5,050	7.14	5.5	30300	141	<0.050
6-Nov-12	NAWIN03	170000	5.5	1.82	3.75	5,480	5.11	6	34500	139	<0.050
17-Oct-13	NAWIN03	160000	2.3	0.93	2.15	3,480	3.20	<5.0	18200	79.8	<0.050

Table B-4. Sediment quality and comparison to guidelines for the protection of aquatic life, Windermere Creek.

Sample Date (dd/mm/yy)	Site code	Total Molybdenum (Mo)	Total Nickel (Ni)	Total Phosphorus (P)	Total Potassium (K)	Total Selenium (Se)	Total Silver (Ag)	Total Sodium (Na)	Total Strontium (Sr)	Total Thallium (Tl)	Total Tin (Sn)	Total Titanium (Ti)
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	Guideline	no guideline	BC Work: low 16, severe 75	no guideline	no guideline	BC App. 2	BC Work 0.5	no guideline	no guideline	no guideline	no guideline	no guideline
16-Nov-11	NAWIN03	1.23	9.88	272	732	<0.50	<0.050	<100	483	0.138	0.12	22.5
6-Nov-12	NAWIN03	1.22	7.31	279	279	<0.50	<0.050	<100	332	0.115	0.26	23.0
17-Oct-13	NAWIN03	0.66	3.94	134	363	<0.50	<0.050	<100	331	0.070	0.15	15.4

Table B-4. Sediment quality and comparison to guidelines for the protection of aquatic life, Windermere Creek.

Sample Date (dd/mm/yy)	Site code	Total Uranium (U)	Total Vanadium (V)	Total Zinc (Zn)	Total Zirconium (Zr)
		mg/kg	mg/kg	mg/kg	mg/kg
	Guideline	no guideline	no guideline	CCME and BC Working ISQG 123, PEL 315	no guideline
16-Nov-11	NAWIN03	0.782	14.3	45.6	0.7
6-Nov-12	NAWIN03	0.688	14.0	39.7	1.39
17-Oct-13	NAWIN03	0.448	6.7	27.3	0.77