Slocan Valley Wetland and Assessment Program

Wetland Invertebrate Assessment Tool

(W-F16-10)

Prepared for:
the Fish and Wildlife Compensation Program

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May 30, 2016

Prepared with financial support for the FWCP on behalf of BC Hydro, Province of BC, Environment Canada, Columbia Basin Trust, BC Wildlife Federation, Royal BC Museum, First nations & stakeholders.

This project was undertaken with the financial support of the Government of Canada.
Ce projet a été réalisé avec l'appui financier du gouvernement du Canada.

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Abstract

The Slocan Wetland Mapping and Assessment Project (SWAMP) is a local initiative that brings together professional biologists and citizen scientists to identify sensitive wetlands and establish priorities for restoration and protection in the Slocan Watershed. SWAMP is a collaboration of three societies, Slocan Solutions, Slocan River Streamkeepers and Slocan Lake Stewardship.

The invertebrate component of SWAMP uses Environment Canada's modified CABIN (Canadian Aquatic Biomonitoring Network) protocols to assess wetland condition across a gradient of human activity or stress. The importance of Slocan Valley wetlands have been identified at a grassroots-level by Slocan Valley communities and recognized by regional, provincial and national agencies. The project will be developed under Environment Canada's guidance using modified Canadian Aquatic Biomonitoring Network (CABIN) for wetlands with advice from Dr. Rebecca Rooney of the University of Waterloo. The project will use quantitative measures of wetland stress and biological indicators of wetland health to create a strategic list of wetland priorities based on the Index of Biotic Integrity for the Slocan Watershed to aid in management decisions about restoration and conservation.

We developed quantitative tools to rate wetland stress and biotic integrity that can be used to assess wetlands in the Slocan Watershed to make management decisions about restoration and conservation. We used a multimetric index of biotic integrity (IBI) approach that used macroinvertebrate metrics as an indicator of wetland health.

We identified an initial list of candidate sites that are low in wetland stress and high in biological integrity that are best-case scenario reference conditions for future work and restoration goals. Our work addresses this priority in a quantitative and scientifically valid method.

We calculated a quantitative stress gradient based on chemical and physical stresses using an objective approach. We tested the effect of different scoring methods on the performance of the stress gradient. We attempted to minimize the use of subjective measures with a focus on statistically measured results.

Five macroinvertebrate metrics were selected as indicators of wetland stress across a range of wetland types including: Simpson's Diversity Index, percent *Callibaetis* sp., the number of Clitellata taxa, % Abundance collector-gatherers Number of intolerant taxa, % Diversity of amphipods to (amphipods + bivalves + gastropods). An Index of Biotic Integrity for macroinvertebrates calculated from these indicator metrics showed a strong significant response to increasing wetland stress. However, an increased number of sites are required for further testing, and validation.

All stress gradient scores were effective at separating highly (contaminated sites) and moderately stressed sites from reference sites using all scoring methods. Assessment of stress scores suggested that that three of the six scoring methods that varied in standardization and weighting techniques may be the best methods for wetlands with gradients in metals levels including:

(1) z-score transformation methods with weighting by principle component scores

(2) percentile binning with weighting by principle component scores and
(3) z-score transformation methods with weighting by category.

Stress gradient performance also requires further calibration and validation using land cover and population-based GIS variables. This document provides an outline of methodologies for the first stages in developing an index of biotic integrity based on wetland invertebrates as part of the SWAMP project. Further development and research will refine this methodology for the SWAMP program.

1 Introduction

Macroinvertebrates are important wetland indicators of anthropogenic-induced stresses such as habitat degradation, development and contaminants (Kovalenko 2014, Mazzacano 2011, Uzarski et al. 2011, Archer et al. 2010, and Apfelbeck 2000). Few studies of wetlands in British Columbia have included bioassessments of macroinvertebrates with the exception of Adama et al. (2013) and Miller and Hawkes (2013). Assessments of macroinvertebrates provide a unique approach to assessing biointegrity and fit well with methods currently being used by SWAMP (Durand 2014, Durand 2015, and Durand 2016). Macroinvertebrates can also be used an educational tool by local monitoring programs that can facilitate community engagement, integral to long-term conservation and restoration of wetland habitats.

Bioassessments using macroinvertebrates in wetlands have been successfully carried out under the Canadian Aquatic Biomonitoring Network, CABIN, (Tall et al. 2008, Bailey and Reynoldson 2009, Emily McIvor pers. Com. 2015) and other programs in Canada (Adama et al. 2013, Miller and Hawkes 2013, Archer et al. 2010, Eaton 2005) and the United States (Kovalenko et al. 2014, Uzarski et al. 2011, Mazzancano 2011, Jepson et al. 2007, Apfelbeck 2000). These methodologies have the potential to provide further inference about the status of wetlands in the Slocan Valley.

The current SWAMP program has conducted sampling of wetlands using a three Phase process. Phase I involved the identification and mapping of wetlands (Durand 2014). In Phase II and III, a subset of the wetlands identified in 2014 wetland mapping was assessed in site visits (Durand 2015 and 2016). Each wetland surveyed in Phase II and III was classified (MacKenzie, W. and J. Moran. 2004). The SWAMP Steering Committee suggested that macroinvertebrate samples could be integrated with Phase I-III wetland assessments with the objective of developing a protocol for wetland assessment in the Slocan Valley and the West Kootenays. Information from Phase II and II of SWAMP will provide some validation of the macroinvertebrate component of SWAMP (Archer et al. 2010, and Adama et al. 2013).

Currently, the invertebrate component of SWAMP has sampled 24 sites with funding contributions from the National Wetland Conservation Fund, the Fish and Wildlife Compensation Program, the Columbia Basin Trust and the Columbia Basin Watershed Network.

Rebecca Rooney of the University of Waterloo has agreed to provide direction in regards to her work on multimetric wetland indicators that may aid in (1) the assessment phases of planning (Rooney and Azeria 2015, Rooney and Bayley 2012 & 2010) and (2) the evaluation of performance indicators for restoration projects (Bayley et al. 2014).

The goals of the SWAMP invertebrate sampling project are:

- Develop a protocol for wetlands ecosystem assessment based on modified CABIN methods to prioritize opportunities for wetland restoration, conservation and compensation.
- Quantify wetland water resources based on mapping, water/sediment quality and a biological index to assess the health of wetlands in the Slocan Valley.
- Report findings to the larger Slocan Community, the Kootenay Region and the Columbia Basin.

The Objectives of the project are to:

- Carry out water/sediment quality and macroinvertebrate sampling at selected wetlands within the Slocan Watershed.
- Investigate methods to help assess impacts and prioritize wetland restoration opportunities.
- Develop methods under CABIN for invertebrates and water/sediment quality to rate wetland health.
- Assess wetlands in reference condition as well as those affected by invasive species, mining, agriculture and development.
- Develop a multi-metric Index of Biotic Integrity for wetland macroinvertebrates specific to the Kootenay Region.
- Facilitate dialogue between agencies, non-profits and private landowners with regards to sensitive wetland habitats and water resources.

2 Macroinvertebrate Index of biotic integrity: Stress Gradient

In the initial phases of this project, we have taken a multimetric approach to data analysis. However, all field methods were carried out using Environment Canada's CABIN draft protocols for wetlands. As a result, as the sample size increases for our project, our data could also be analysed using the Reference Condition Approach (Bailey and Reynoldson 2009, Bailey et al. 2004, Yates and Bailey 2010a and 2010b) and other multivariate techniques. In addition, Dr. Rebecca Rooney of the University of Waterloo has agreed to provide direction in regards to her work on multimetric wetland indicators (Rooney and Azeria 2015, Rooney and Bayley 2012 & 2010) and restoration evaluation (Bayley et al. 2014).

The steps that we will follow to develop an Index of Biotic Integrity based on wetland macroinvertebrates (Figure 1) include:

1. Development of a quantitative stress gradient.
2. Relating calculated invertebrate metrics to the stress gradient.
3. Sum and scale metrics to produce an index of biotic integrity based on macroinvertebrates.
4. Test and validate the index.

The present progress report focusses on Step 1 to Step 3 (Figure 1), the development of a quantitative stress gradient and the Index of Biotic Integrity in an exploratory manner using methods recommended by Rooney and Bayley (2010).

"Stress Gradient" has been termed by Rooney and Bayley (2010) to refer to quantitative ranking of wetland habitats that includes: (1) natural wetland stress that may limit the distribution of invertebrates and (2) anthropogenic activity that may drive alterations in the environmental variables (R. Rooney pers. com. 2016). These methods summarize the variance for large blocks of data that co-vary from physiochemical, habitat, hydro-geomorphic and land cover sources using data reduction techniques (Rooney, pers com. 2016). A smaller number of indicator variables that are highly correlated with independent gradients from the original larger dataset were then combined to create a stress gradient indicative of the physiological stress of the wetland (R. Rooney pers. com. 2016). This quantitative ranking system overcomes issues of subjectivity and expertise-based rating methods (EPA 2002) and can used to independently assess and validate the index of biotic integrity (Rooney and Bayley 2010).

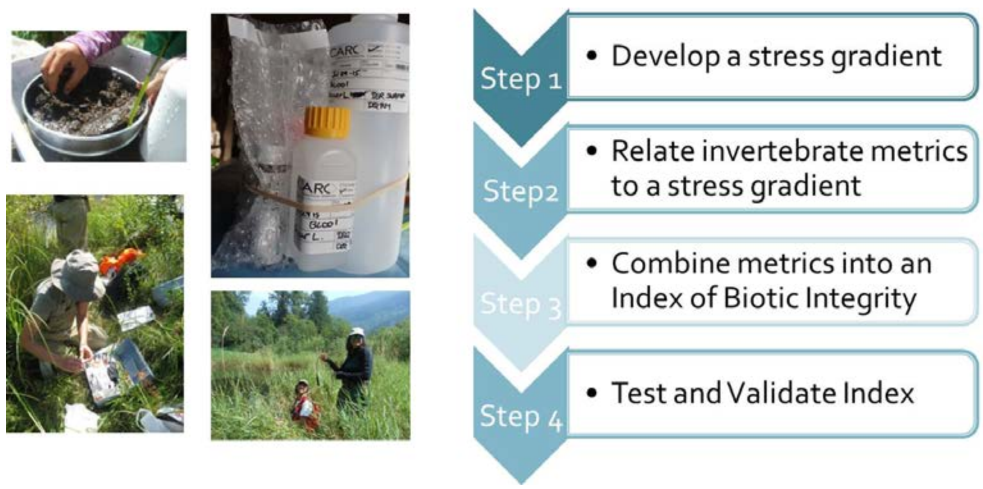

Figure 1. Steps in developing an Index of Biotic Integrity for Macroinvertebrates

3 Field and Laboratory Methods

3.1 Macroinvertebrate protocols

The field protocols used for the SWAMP macroinvertebrate monitoring program follow methods developed by Environment Canada described in Tall et al. (2008) and Baily and Reynoldson (2009). These methods were recommended by Emily McIvor and Alain Armellin of Environment Canada so that data from SWAMP could contribute to the development of a general wetland protocol within CABIN at a National level.

Macroinvertebrate sampling focused on characterizing the community that inhabits the emergent zone of the wetlands. Macroinvertebrates collected from emergent vegetation have been used to differentiate reference sites from impacted sites in bioassessments of wetland habitats on the wetlands of the St. Lawrence River (Tall et al. 2008), Great Lakes coastal wetlands (Uzarski et al. 2011), marshes in the Niagara area (Archer et al. 2010) and wetlands in Montana (Apfelbeck 2000) and Oregon (Mazzacano 2011). In addition, kick samples of the emergent zone (similar to Tall et al. 2008) are currently being used as part of methods in Environment Canada's Prairie, Quebec and Oil sands protocols (E. McIvor 2015). The kick sampling procedure in wetlands involves a gentle disturbance of bottom sediments and three minute sweeps of the water column in a zig-zag pattern over a 5 m by 5 m quadrat. Thus, macroinvertebrates are collected from the water column, bottom sediments and aquatic plants at each site within the emergent zone.

3.2 Field sampling

A total of 24 sites have been sampled over the course of two years with four sites sampled in 2014 and twenty in2015 (Figure 2, Appendix 1). A field sheet was provided by Environment Canada's CABIN program (June 2015) from their developing field protocol and was used as a basis for field measurements. We sampled upper and lower elevation sites associated with riverine, lacustrine and palustrine wetland types ranging from reference condition to wetlands impacted by mining, agriculture, forest operations, invasive species and development (Appendix 1 and 2).

Sampling occurred in late August in 2014 with funding for only four sites. Further, funding allowed us to sample 20 sites in 2015. We adjusted our sampling months to June and July in 2015 because of a warm spring, low snow pack and low peak stream flows that resulted in low water in associated lakes and wetlands. As a result, we resampled three of the four wetland complexes sampled in 2015 that were sampled in 2014 to examine seasonal variation within the wetlands.

Water and sediment samples were analysed by CARO Analytical Services in Kelowna and Vancouver including a quality control/quality assurance program. Invertebrate samples were sent to Rhithron Associates Inc. for taxonomic analysis. Rhithron invertebrate taxonomists collectively hold 34 Level-II certifications from the Society for Freshwater Science. Rhithron has completed identifications, and prepared and shipped the voucher collection to the Royal BC Museum.

Additionally, we have identified a potential restoration candidate on private land, created a dialogue with private landowners and have buy-in and enthusiasm with regards to restoring their non-functioning wetland. Funding for the restoration project has been obtained from the Fish and Wildlife Compensation Program.

3.3 Emergent zone kick samples

Macroinvertebrates were sampled from the near shore of the emergent zone (≥10% emergent vegetation cover) at a depth of approximately 0.5-1 m using a CABIN kick-net of length 45.7 cm, width 25.4 cm, and depth 25.4 cm with a 500 µm mesh net (Environment Canada 2007, Tall et al 2008). The samples were collected in a 5 m by 5 m plot in a timed three minute kick sample similar to protocol used for Quebec wetlands (Tall et al. 2008) and Prairie Wetland Protocol (conference call, Emily McIvor and Allen Armellin, 2014). This technique involves a gentle disturbance of bottom sediments and sweep in a zig-zag pattern within the water column quadrat at each site.

Photo 1: Field sampling of wetlands in the Slocan River Watershed.

3.4 Handling and preservation of macroinvertebrate samples

Following field sampling, the volume of sediment/vegetative matter in each sample was reduced by gently washing the nets in water well away from sampling area or sample can be taken back to the laboratory and further reduced. All amphibians were removed from nets following (Ministry of Environment, 2008) protocol for safe handling of amphibians. Material was gently poured through a 500 µm sieve and further rinsed.

Sample material was transferred to one litre jars with 80% ethanol used as a preservative. Sample material comprised no more than 50% of the jar. Ethanol was replaced with fresh 80% ethanol (Mazzacano 2011, Jepsen et al. 2007) and this procedure was repeated as an extra precaution. All samples were checked with a hydrometer so as to verify preservation at 80% ethanol prior to shipping and Rhithron reported that the samples were well preserved when they arrived.

3.5 Macroinvertebrate habitat data

Estimates of the relative proportion of vegetation were made within the 5 x 5 m quadrat in the emergent zone. The percent cover of each plant species was measured. The 5 x 5 m quadrat was marked with cedar stakes following water and macroinvertebrate collection so as not to disturb or damage emergent plants prior to assessment.

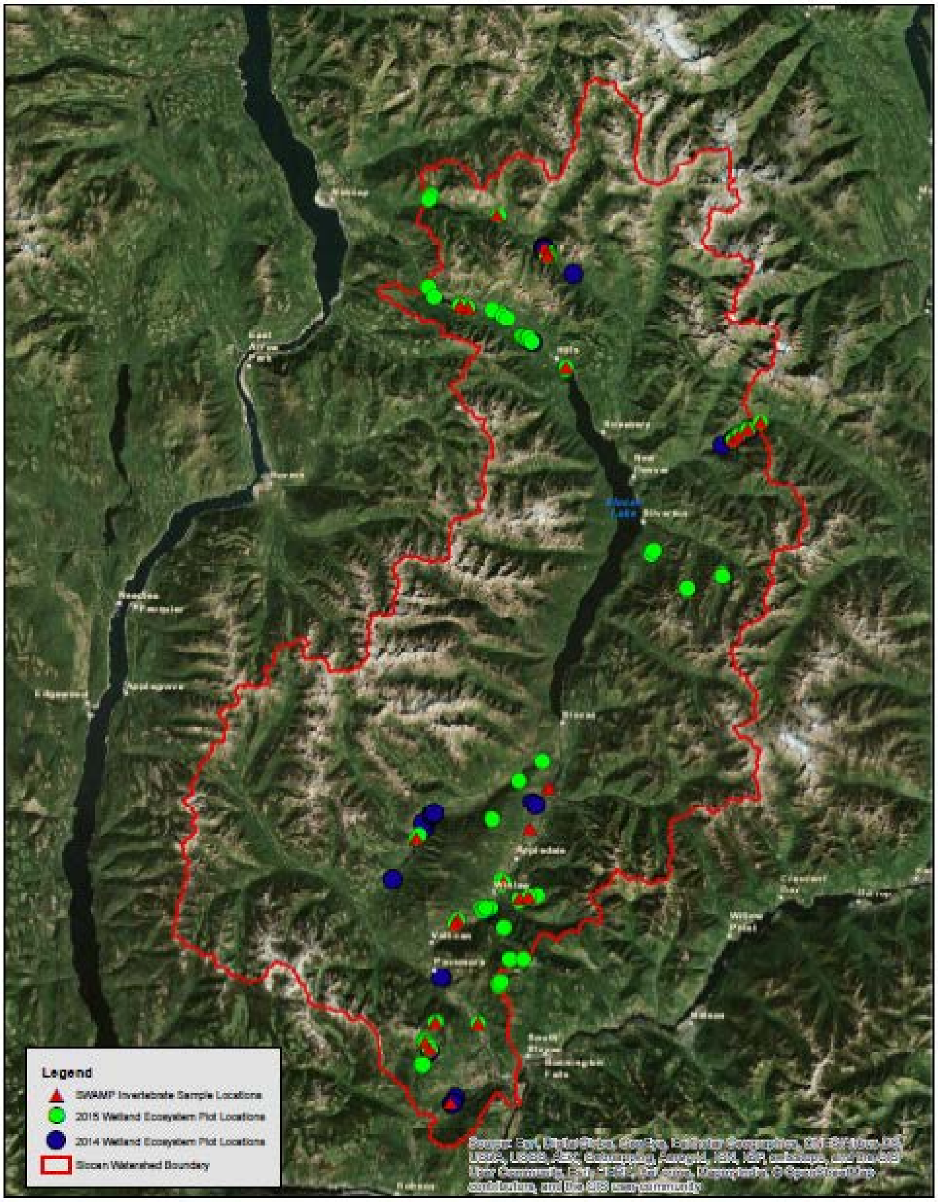

Figure 2. Overview of wetlands described in Phase 3 of SWAMP (map from Ryan Durand)

3.6 Taxonomic identifications of macroinvertebrates

Rhithron, a professional taxonomist based in Missoula, Montana was used for the identification work. Samples collected for the CABIN database were sent to a certified taxonomist that follow procedures outlined in Environment Canada (2012). All laboratory techniques and quality control were carried out according to CABIN methods (Environment Canada 2012).

In addition, the taxonomist shipped the collection of specimens to the Royal BC Museums. Project methods met museum specifications for collection, taxonomic identification and storage of specimens (CABIN 2007 and 2012). In addition to assessing the health of wetlands, this project will help to increase our understanding of the Slocan River watershed and improve our knowledge on the biodiversity of invertebrates in British Columbia.

3.7 Water and sediment physiochemistry

Field measurements of water quality and surface water samples were collected prior to other sampling to prevent contamination of samples using methods of Duncan and Duncan (2012), Uzarski et al. (2011), Bailey and Reynoldson (2009), Clark (2013) and Cavanagh et al (1997) . Field measurements of water quality included: temperature, pH, conductivity, and dissolved oxygen carried out using field meters. These parameters were taken at each of the emergent zone stations. These measurements in addition to turbidity and hardness were repeated at Passmore laboratories using HACH Water Ecology Kit Model AL 36B and bench top meters for pH, specific conductance and turbidity with the exception of dissolved oxygen (field only).

Surface water samples were collected for the following parameters in 2015 including: Phosphorus (measured as total unfiltered Phosphorus), Nitrogen (Total Keldhal Nitrogen, Nitrate, Nitrite, and Ammonia), Alkalinity, Major ions (e.g. Ca, Mg, Na, and K), Total Suspended Solids (TSS), Sulfate, Chlorine, and Dissolved Organic Carbon (Appendix 3). A subset of these parameters was monitored in 2014 when funding was very limited (Appendix 3). One of the goals in 2015 was to evaluate the number of parameters required for monitoring in order to assess the potential to reduce costs for future sampling.

Grab samples of surface sediment were collected using methods described in Duncan and Duncan (2012), Marvin-DiPasquale (2009), and Clark (2013). Total metals from the metals scan carried out by Maxxam (2014) and CARO Laboratories (2015) included: Aluminium, Antimony, Arsenic , Barium , Beryllium , Boron, Bromine , Cadmium, Barium, Chromium, Cobalt, Copper, Fluorine, Iron, Lead, Lithium Manganese, Mercury, Molybdenum , Nickel, Phosphorus, Potassium, Selenium, Silicon, Silver, Strontium, Sulphur, Thallium, Tin, Titanium, Uranium, Vanadium, and Zinc. Heavy metals concentrations were measured in sediment only in 2014 when funding was limited (Appendices 3 and 4). In 2015, metals concentrations were measured in water and sediment along with grain size, and carbon content for sediment.

Prior to sampling for water and sediment quality, all jars were labeled, packed and transported to sites in a field cooler in ziplock bags by site. At each site field personnel labeled all sample jars with site code, time and all other relevant information. Water surface samples were taken wearing latex gloves in a non-disturbed area prior to completing the full wetland invertebrate protocols. The sample jars were wrapped in bubble wrap and immediately put in a cooler with ice packs and sent to CARO and Passmore Laboratories within 24 hours of collection. After water quality samples were collected, sediment samples were taken in the same vicinity at all sites.

3.8 Quality Control

Duplicate sampling of ten percent of the water samples (n=2) sent to Passmore Laboratories of was carried out for parameters that included turbidity (meter) and Hach kit measurements for alkalinity, conductivity, pH and acidity. Duplicate sampling of five percent (n=1) of the water and sediment samples was conducted for samples sent to CARO for a full scan of water quality (51 parameters) and sediment quality parameters (37 parameters).

All data was screened and quality control measures were conducted to assess field and laboratory data collection methods according to quality assurance and quality control field sampling protocols in Clark (2013).

Trip blanks were collected to assess any possible contamination from sample containers, collection at the site, and transport. Field blanks were evaluated using the following equation (Clark 2003):

Blank x difference = Field Blank Value/Method Reporting Limit.

Field Duplicates were evaluated based on absolute relative percent difference (RPD) using the following equation:

RPD= (Abs. Difference of Duplicate 1 minus Duplicate 2)/(Average of Duplicate 1 plus Duplicate 2)*100.

Duplicate values that were greater than five times the method reporting limit (MRL) with RPD values of 20-50% (Clark 2013) were inspected and values of greater than 25% were further considered as alerts on possible contamination or lack of representativeness. All internal quality control for laboratory methods and results provided by the labs were reviewed and evaluated.

The quality control information on the macroinvertebrate sorting and subsampling is presented in the technical report by Rhithron (section 10.2)

4 Data Analysis

4.1 Initial trends in physiochemistry

Water and sediment quality data were evaluated using a number of methods including: hierarchical cluster analysis of sediment and water quality, Stiff diagrams of water quality, and comparisons to applicable sediment and water quality guidelines.

Hierarchical cluster analysis (agglomerative hierarchical classification) using all water or sediment quality parameters combined were used to explore initial clustering of sites according to water and sediment quality. Euclidean distance and Ward's linkage method were applied (R Development Core Team. 2016). Clustering of sites was examined with untransformed and transformed (log(x+1)) in an initial inspection of the site data and to assess how sites were distributed across a range of constituents. Untransformed data was highly biased towards major ions, particularly calcium concentrations and specific conductance. Average values were used to replace missing values for water sampled in 2014.

Richard Johnson of Opus Petroleum Engineering used Stiff diagrams, graphical representations of the ion concentrations (Stiff, H.A., 1951), to look at the composition of the water quality data collected in our project (Section 10.1). Opus plotted the ion concentrations, in milliequivalents, using a logarithmic scale, added an axis for Potassium and recorded nitrate levels for each site.

4.2 Stress gradient: Reduction of variables using PCA

We used principal components analysis (PCA) to reduce redundancy in the number of explanatory variables to create a stress gradient (R Development Core Team. 2016). PCA allowed us to identify blocks of correlated variables and reduce correlated variables which tend to skew an index in the direction of these variables (Falcone et al. 2010). At this point in our project with a sample size of 24, we used PCA in an exploratory manner in order to investigate potential relationships in the data.

Our initial data set consisted of 50 water quality parameters, 40 sediment quality parameters and 15 variables that reflected visual estimates of physical stress. Variables were ordinated in four categories including; water (n=14), sediment (n=11), physical (n=14), and chemical inputs in sediment and water (n=40). We ran a PCA on a cross-product matrix of correlation coefficients for each of these categories to produce new synthetic variables that are linear combinations of the original data (similar to Rooney and Bayley 2010). This was carried out to create new variables or synthetic variables that represented suites of our original variables that were functionally related, best explained the variance in the data and reduced the number of variables required to explain the observed variance. We then decided how many components from the PCA were significant based on two criteria; (1) the number of axes required to explain 80% of the variation, (2) use of the Kaiser-Guttmann criterion in computing the mean of all eigenvalues and including the axes that are larger than the mean (Borcard et al. 2011).

All PCA runs were based on transformed data using a correlation matrix which scales data prior to carrying out the PCA. Water and sediment chemistry variables were transformed by log(x+1) prior to running PCA. Percent physical stresses were transformed using the Ancombe's arcsine transformation prior to running PCA (Anscombe 1948, described in Zar 1984) given as asin(sqrt((value+3/8)/(100+3/4))). Univariate normality was tested using the Shapiro-Wilkes test for normality before and transformation on all variables.

Variable selection based on PCA of the water and sediment quality data was carried out independent of disturbance categories. Water quality at detection levels was replaced with values that were one half the detection limits. Missing values were replaced with average values for replicates within a wetland type. The concentration of metals in sediment was used as the main indicator of legacy mining because water chemistry typically has greater seasonal variability and because of missing values for water in 2014 when funding was limited.

Variable selection based on visual estimates of physical stress from the CABIN field sheet for wetlands (from Emily McIvor 2015) included percent disturbances of wetted area and margin of the wetlands due to cattle, farmyard, urban, roads, mining, total and percent canary reed grass. Visual estimates of disturbance were carried out by Rhia MacKenzie. Thus, rapid visual human disturbance gradient rankings and estimates of disturbance were carried out by separate individuals based on best professional judgement (BPJ). GIS variables will also be used to quantify population, roads and land cover for the final report. These variables have been recently completed by Ryan Durand and will be incorporated into the report for the NWCF due April 31. Rapid visual estimates of disturbance rankings were used for the purposes of this interim report.

We selected variables with the largest Eigen-value for each significant component to be representative of each component (Falcone et al. 2010, and Rooney and Bayley 2010). We then used correlation analysis to evaluate whether site scores on significant components from the PCA and representative variables (Table 1) showed a significant correlation with a simple visual ranking based on professional judgement for human activity (EPA 2002). All rankings for the rapid Human Disturbance Gradient were carried out by Darcie Quamme.

4.2.1 Variable standardization and weighting

Variables were standardized by both percentile binning and z-scoring methods. Percentile binning allows improved resolution at intermediate stressed sites and attenuates the influence of outliers relative to other methods that retain the distribution of values such as the z-scoring (reviewed in Falcone et al. 2010 and in Rooney and Bayley 2010). Many of the wetlands in the Slocan Valley are predicted to have moderate effects due to urbanization, development, farmlands and roads. However, most of the highly stressed sites were associated with legacy mining and can be considered extreme values. Contaminated sites will also be assessed relative to metals levels assessed using a number of techniques.

Z-transformation was performed on untransformed data in our initial exploration of the data. Percentile binning does not require transformation of the data because the calculation of percentiles is distribution-free (Rooney and Bayley 2010). However, non-parametric statistics are required to analyze stress scores because (1) percentile-binning tends to create a wide peak around the mean with thinner tails (platykurtic distribution) and (2) non-parametric statistics help to resolve tied scores using the average of the ranks that tied values would have received had they not been tied.

Individual variable scores were weighted, summed and rescaled to 100 after transformation. Weightings were of three types including: equal weighting by variable (score summed for all variables with equal weighting), weighting by percent variance from PC axis for each representative variable selected by PCA (scores weighted by % variance from PCA and then summed) and weighting by category including water, sediment, contaminant and physical stress (variables averaged for each category and summed).

4.2.2 Validation

Stress score methods were evaluated in a preliminary manner with respect to four statistical methods: (1) Spearman rank correlation among calculation methods, (2) Kruskall Wallis tests between contaminated sites and least impacted sites, (3) inferences of post-hoc pairwise comparisons using Kruskall-Wallis Nemenyi-test with tied Chi-squared approximation for independent samples, corrected for ties, (4) Akaike Information criteria on simple linear regression analysis of metals levels (not included in calculation of scores) versus the Stress score.

We used Spearman rank correlation coefficients to evaluate the correlation between the six combinations of standardization and weighting methods. In addition, non-parametric Kruskall-Wallis analysis was employed to discriminate among sites classified by Best Professional Judgement (PBJ) with a rapid Human Disturbance Gradient, HDG (EPA 2002). BPJ Categories corresponded to rapid Human Disturbance Scores of 0-24 (Low, n=13), 25-74 (Moderate, n=8) and 75-100 (High, n=3). The High category was comprised of three sites contaminated by legacy mining on the Seaton Creek wetland. Variables from PCA reduction independent of wetland HDG score. Thus, the quantitative Stress Score was evaluated with respect to how well the Stress score discriminated between contaminated (HDG=High) and reference sites (HDG=Low). Sites with Moderate stress were also included in the analysis. However, physical stresses impacted human activities from agriculture, development and roads will be better used to validate the Stress Index when GIS variables are available.

4.3 Index of Biotic Integrity for macroinvertebrates

4.3.1 Metric selection

The steps used to screen metrics for inclusion in the Index of Biotic Integrity are outlined below. Metrics were retained if:

- The metric had a significant relationship with wetland stress in analysis of covariance of metrics versus wetland stress.
- The metric showed low redundancy with other metrics as evaluated by Pearson's Correlation coefficient.
- The metric had the best fit with wetland stress relative to other redundant metrics (evaluated by r^2 value with wetland stress in least squares of macroinvertebrate metric versus wetland stress score).

We screened metric response to wetland stress using analysis of covariance, ANCOVA, (Milliken and Johnson 2002) in order to explore associations of the invertebrate metrics with stress score, wetland type, pH, and TOC. Of most interest was the relationship with stress score, however, we suspected there was potential covariance of stress score with wetland type, pH and TOC and therefore these predictor variables were also considered. ANCOVA was used to select metrics for inclusion in the Index of Biotic Integrity to consider whether other predictors beyond stress score influence response metrics and how these other predictors might covary with stress score.

Models were run using batch loops in program SAS with statistical significance determined by Wald Chi-Square tests, and type 3 tests which are less sensitive to predictor variable ordering. Count data was modelled using Poisson regression (SAS Institute 2000) (McCullough and Nelder 1989) with a log-link therefore accounting for likely relationship between the mean and variance of counts. Proportion data was transformed using Anscombe's arc-sin square root and modelled assuming a normal distribution. R-square values were generated using proc GLM in SAS. As an initial cut, variables with type 3 p-values of 0.05 or less were considered as candidate metrics from the analysis from the analysis of covariance.

A Pearson correlation table of candidate metrics was further evaluated for redundancy. Pairs of metrics with Pearson correlation coefficients ≥0.65 were then inspected and the metric with the higher adjusted r^2 value (better fit) in least squares regression in response to wetland stress was retained.

4.3.2 Index of Biotic Integrity

A preliminary version of the macroinvertebrate Index of Biotic integrity (IBI) was calculated based on a continuous scoring technique (Rooney and Bayley 2010) that assigned scores as a linear interpolation between the maximum and minimum values. However, our goal following the 2016 field season is to score the IBI relative to a subset reference values (Rooney and Bayley 2010) as sample size increases because Rooney and Bayley (2010) found that these scoring were correlated however that scoring the IBI relative to reference values may be more theoretically valid. In addition, we decided to use a continuous method of scoring rather than percentile binning because it has been shown to be potentially more sensitive (Blocksom 2003) or have no effect on IBI values (Rooney and Baily 2010).

5 Results

5.1 Quality Control

Overall the quality control and quality assurance program indicated a high level of field and analytical precision (Appendices 3-9).

Two sets of duplicates collected on August 6, 2016 and analysed for alkalinity, total acidity, turbidity and specific conductance at Passmore laboratories were within the required RPD range of 20-50%. Forty-five of the fifty parameters analysed by Caro in a duplicate sample collected at SEAT003 on August 16, 2015 were below the RPD limit of 25%. Five of the fifty parameters exceeded an RPD limit of 25% in some cases because one of the values was near detection (see Appendix 9). Of these, only two parameters including total lead and total manganese in water exceeded the additional criteria that the difference between duplicates should be less than two times the method detection limit when duplicates are less than five times detection (Clark 2013).

Two field blanks collected on July 21 and August 6, 2016 and analysed for alkalinity, total acidity, turbidity and specific conductance at Passmore laboratories were less than two times the method detection limit for all parameters. Forty-four of the fifty parameters analysed from a Field Blank collected at Bonanza Creek Marsh (BON001) and analysed by CARO for a full scan of metals and basic water quality parameters were below detection. Six of the parameters were above detection including: Dissolved Organic Carbon, Ammonia, TKN, Total P, Total Dissolved P and Total Nitrogen. Of these, only Total and Dissolved Phosphorus were greater than two times the Method Detection Limit. As a result, the replicate samples that were collected at SEAT003 were closely inspected for Total and Dissolved Phosphorus. The difference between the duplicates was less than two times the Method Detection Limit for both parameters. This criterion was used because all values were below five times the Method Reporting Limit.

These analytical discrepancies did not interfere with the main results. Additional blanks and replicates will be used in 2016 in order to verify that there is no contamination during the sampling process.

The quality control and assurance data for macroinvertebrate identifications and subsampling is presented in a technical report by Rhithron in section 10.2.

5.2 Preliminary trends in physiochemistry

5.2.1 Hierarchical cluster analysis

Results of hierarchical cluster analysis (agglomerative hierarchical classification) using forty-one water quality parameters (Euclidean distance and Ward's linkage method) showed two main clusters that corresponded to two types of bedrock including gneiss and shale/limestone underlying soils in the Slocan Watershed. Data runs on normalized, log transformed data in water showed a cluster pattern between the two types of geological formation with a cluster that was highly significantly different and included: BON001, TY001, SUM001, SUM001, ELD001 and HAY001 (Figure 3).

The bedrock in the Slocan watershed is mainly composed of igneous and metamorphic clastics. These rocks do not directly impact the water chemistry until they are weathered and form part of the soil and aquifers. Anomalous mineralization of bedrock is site specific and can, under certain conditions, impact water chemistry. Limestone bedrock in the Slocan watershed does affect the water chemistry directly. Wetland sites in ours study with shale/limestone bedrock tended to have higher ionic strength, conductivity and pH (Figure 4) due to greater weathering rates of constituent minerals.

Wetland sites were fairly evenly distributed between the two types of geological formations (Figure 4). Thus, the sampling design provided good coverage of the soil types, as well as north-south, east-west and elevational gradients given the sample size (n=24). Additionally, one site that was impounded by a railroad (near Fomi's Bakery) and located downslope from the highway had higher levels of sodium and chloride than all other sites (Figure 5).

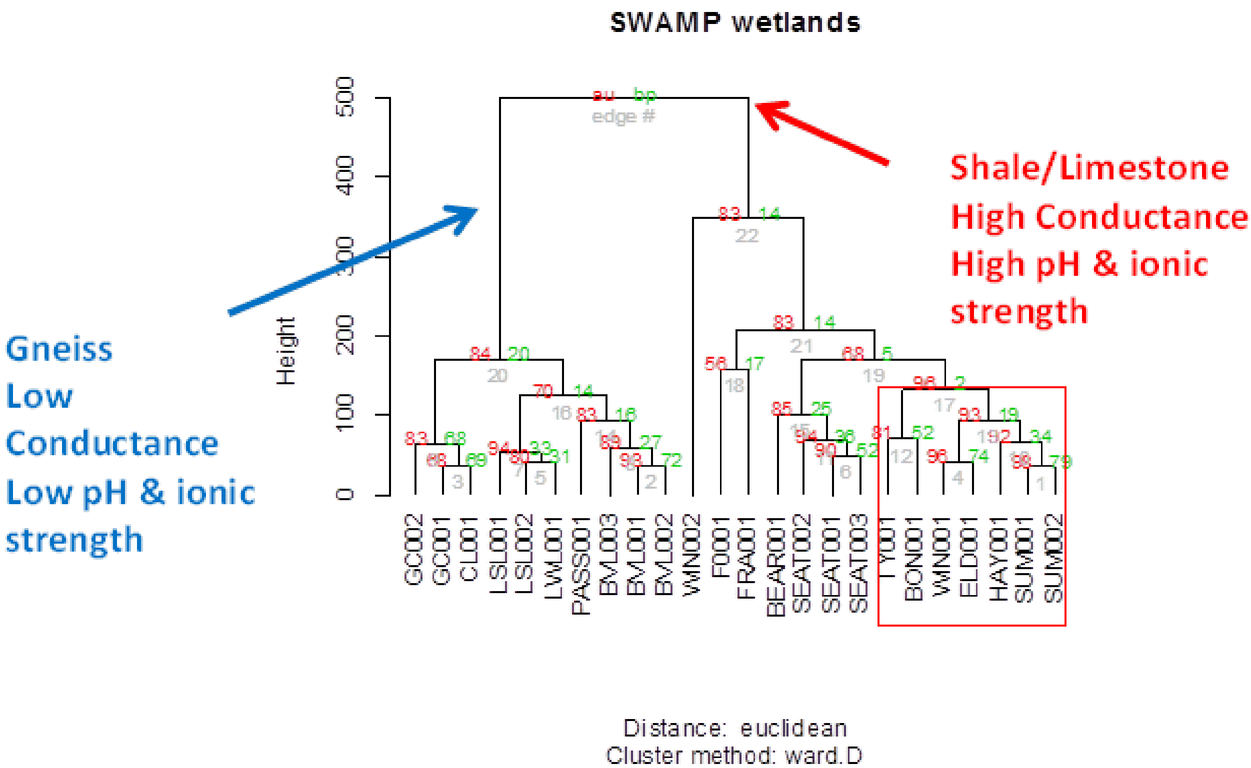

Figure 3. Agglomerative hierarchical classification using 41 water quality parameters on normalized and log transformed variables. Euclidean distance and Ward's linkage method were applied. Clusters with high "Approximately Unbiased" values (AU in red), >0.95, are strongly supported by the data. BP (green) refers to raw "Bootstrap Probabilities" before statistical adjustments based on 1000 runs. Average values were used for missing data in 2014.

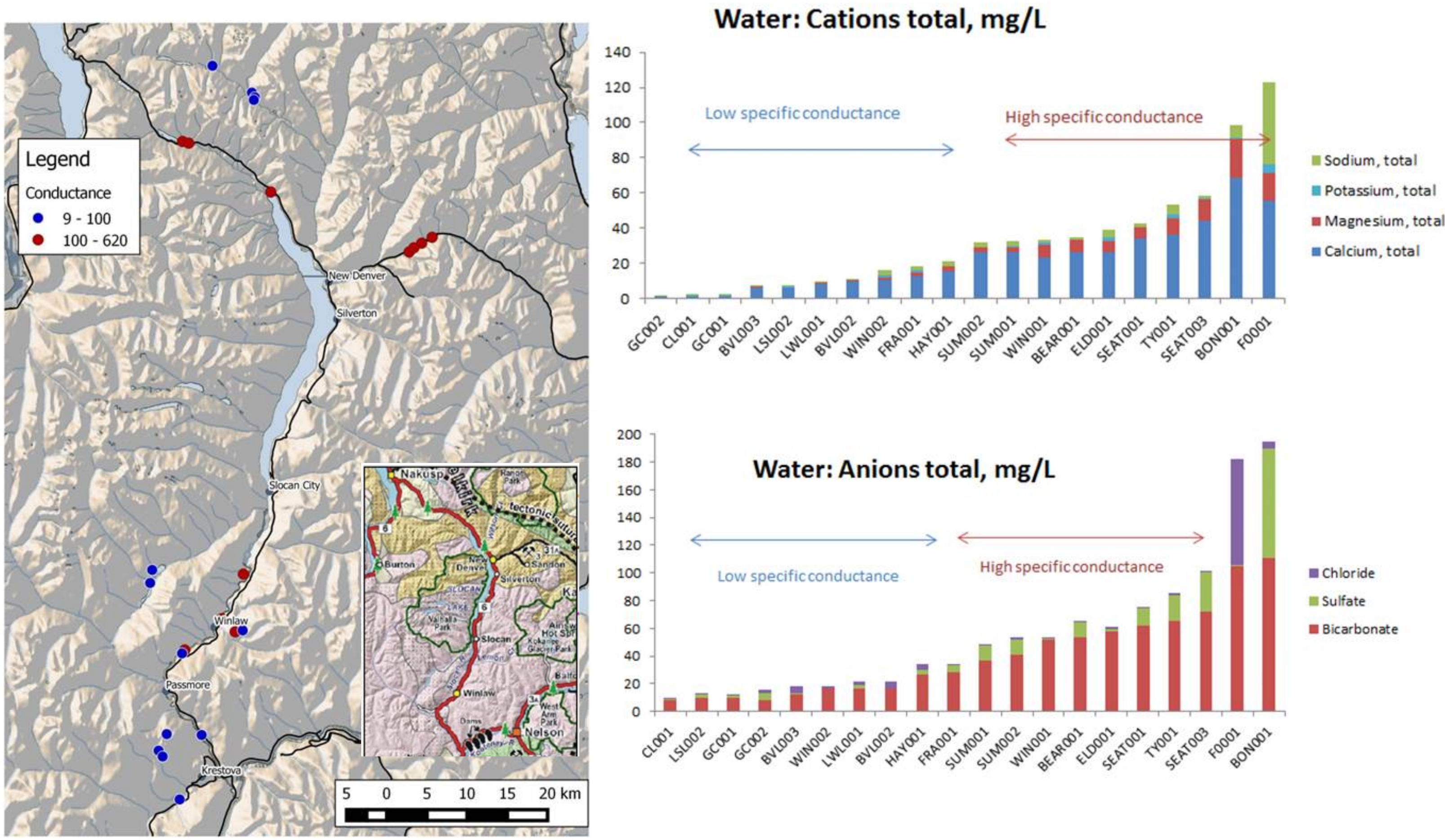

Figure 4. Map of wetland sites coloured by specific conductance ranges 9-100 uS/sec (blue) and 100-620 uS/sec (red). Inset from Turner et al. (2009) indicates soils underlain by shale, limestone, till and glacial debris (beige/brown) and gneiss (pink). Graphs of concentrations (mg/L) of anion and cation forming parameters at each site as monitored from unfiltered water samples ordered by specific conductance.

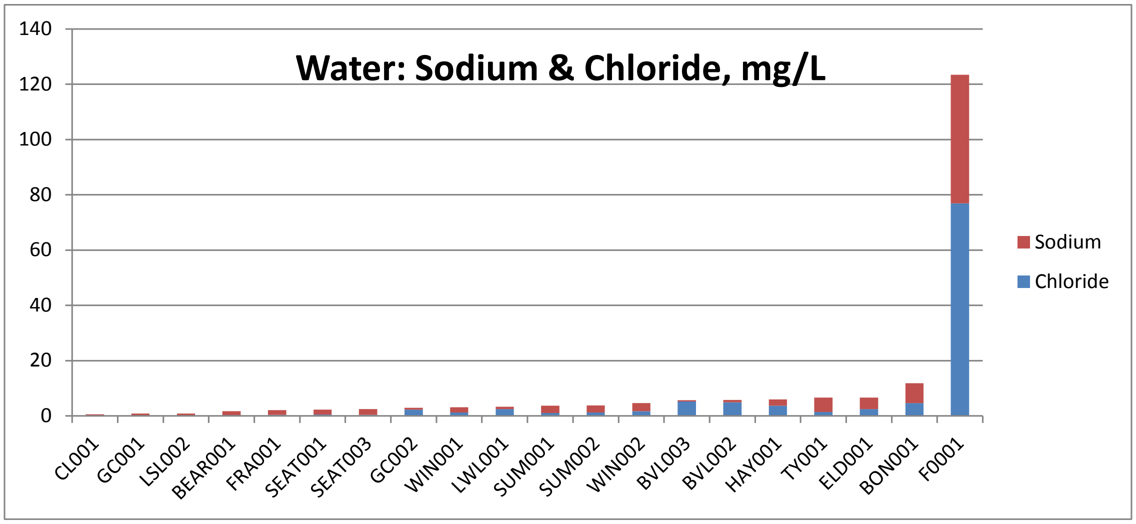

Figure 5. Sodium and chloride concentrations (mg/L) from unfiltered water samples. BC. Guidelines for chloride aquatic life (Nagpal et al 2003): 150 mg/L 30-day average, 600 mg/L Max, Natural waters in BC vary from 1 to 100 mg/L. Significant effect on amphibians: 200 mg/L (Sadowski 2005).

Results of hierarchical cluster analysis (agglomerative hierarchical classification) using forty sediment quality parameters (Euclidean distance and Ward's linkage method) showed two main clusters that corresponded to sites contaminated by legacy mining (Seaton Creek wetland) and all other sites (Figure 6). In addition, bar charts (Figures 7 and 8) indicate cumulative toxic units (CTU). CTUs represent the synergistic effect of contaminants on the biota and are calculated by the summing concentration of each metal divided by its guideline for each site.

The contaminated sites were 168 to 225 times guidelines and greater than ten CTUs (using criteria based on Probable Effect Levels, PEL) for zinc, lead, arsenic, copper and cadmium indicating significant pollution (Clements et al 2000). Six other sites (Cooley Lake, Elder's wetland, Bear Lake outflow, Goose Creek fen, Summit Lake outflow, and Hay's wetland) had levels greater than two times criterion values above which metals levels may influence benthic community structure and cause mortality in sensitive species.

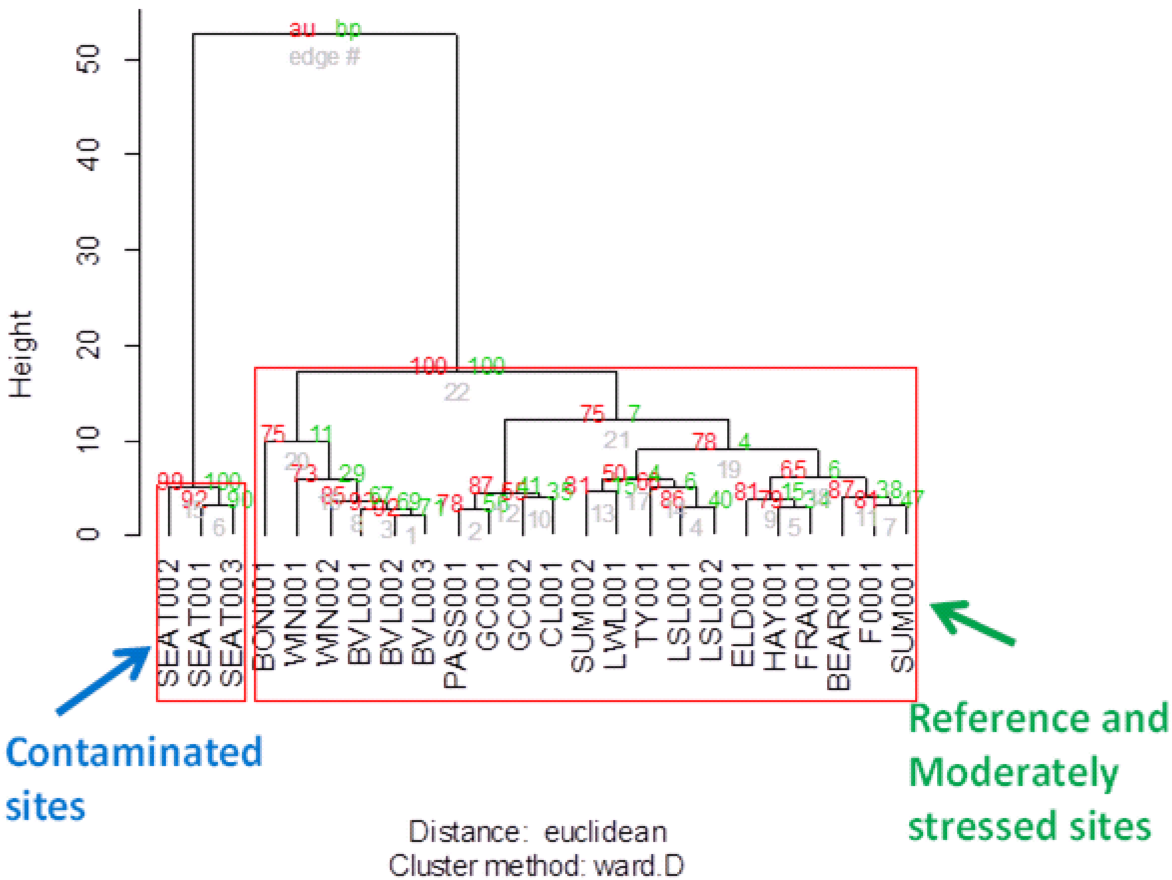

Figure 6. Agglomerative hierarchical classification using 40 sediment quality parameters normalized and (log +1 transformed). Euclidean distance and Ward's linkage method were applied. Clusters with high “Approximately Unbiased” values (AU in red), >0.95, are strongly supported by the data. BP (green) refers to raw “Bootstrap Probabilities” before statistical adjustments, 1000 runs.

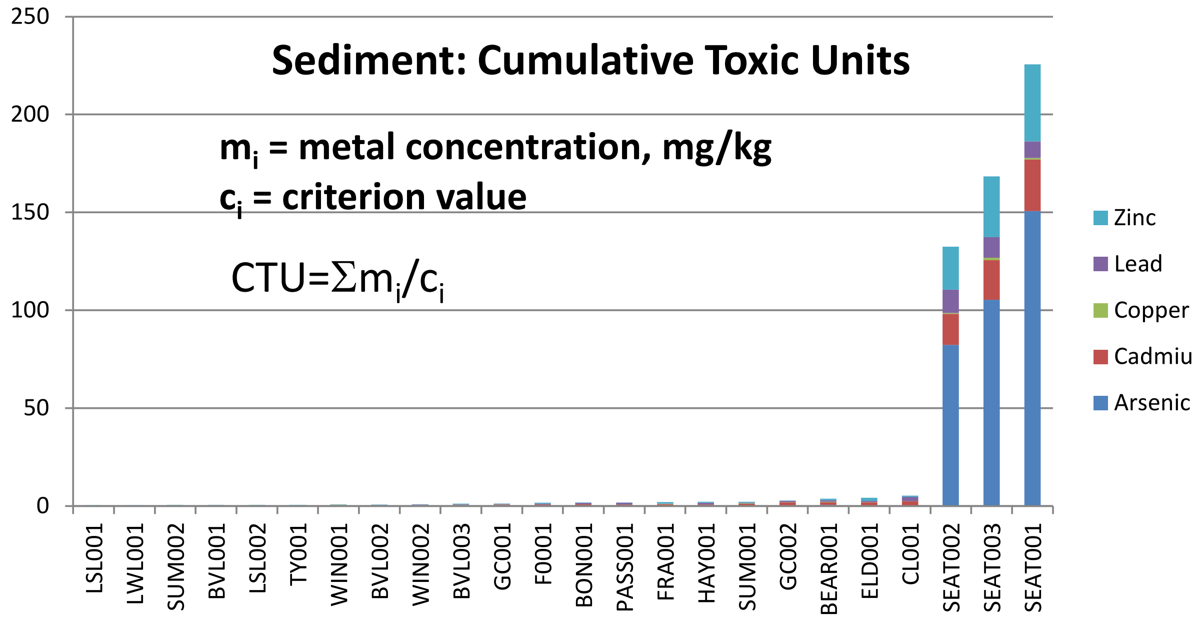

Figure 7. Graph of cumulative toxic units of Zinc, Lead, Copper, Cadmium and Arsenic by parameter from sediment samples.

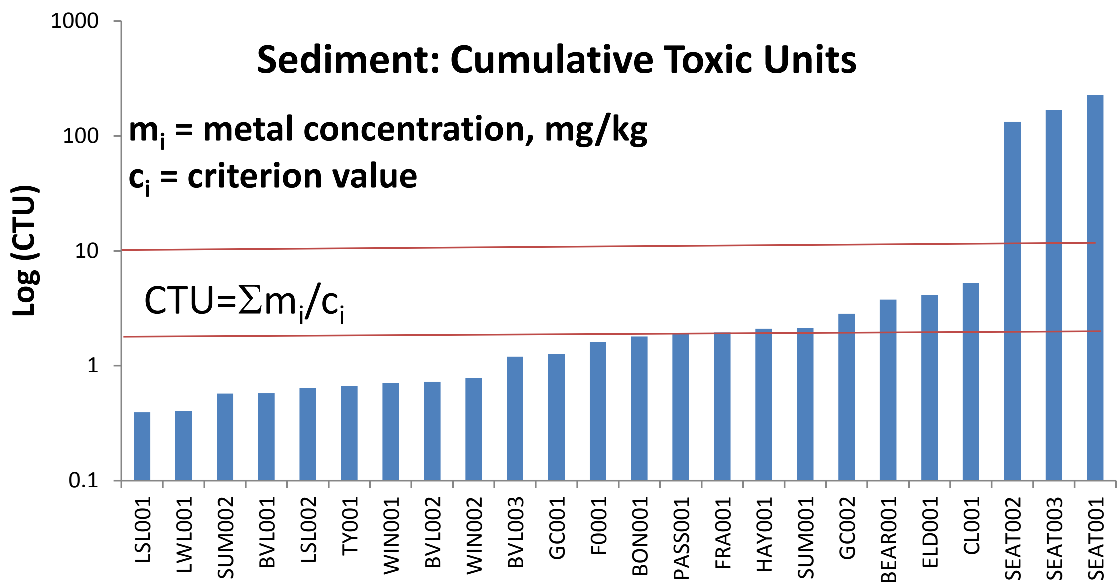

Figure 8. Graph of cumulative toxic unit of Zinc, Lead, Copper, Cadmium and Arsenic in sediment. Lines in red indicate (1) two times criterion values above which metals levels may influence benthic community structure and cause mortality in sensitive species and (2) ten times criterion value which is considered significantly polluted (Clements et al. 2000).

5.2.2 Stiff Diagrams of water quality

Stiff diagrams confirmed trends described above for each site. With increasing specific conductance and total dissolved solids (TDS), the shape of the Stiff diagram changed from a "diamond" into a "kite", with both shapes typical of surface water quality.

The variations in these shapes indicated contributions of solutes that may result from human activity. The sample F0001 (near Fomi's Bakery) showed human created contamination which may originate from surface run-off from the nearby residences, the rail to trail or the highway above the site.

The sample collected from Bonanza Marsh (BON001) displayed a high sulfate concentration when compared to the other samples in this study. Bonanza Marsh is fed by springs and streams flowing over fractured limestone bedrock. Although the sodium is present, the cation balancing the sulfate is probably calcium, indicating a gypsum or anhydrite source. This may from be normal dissolution of these minerals in the limestone, or may be man-made. One of the Seaton Creek sites (SEAT003) impacted by legacy mining effects also exhibited elevated sulfate levels. However, the Seaton Creek site (SEAT001) which had the highest levels of metals in sediment showed lower concentrations of sulfate and metals in water likely due to high groundwater inputs from the Bear Lake.

Nitrate concentrations in the Beaver Lake samples, BVL002 and BVL003 and Little Wilson Lake (LWL001) were slightly elevated compared to other sites in the Slocan Valley particularly given the underlying granitic bedrock formation. Initial inquiries found that forest fertilization took place in 1995 in the Little Wilson Lake area (pers. com George Edney). Further investigation into the exact location/blocks, concentration of fertilization treatments need to be tracked down and evaluated with regards to the potential for detection in 2015.

5.2.3 Comparison of water and sediment quality to guidelines

All water and sediment samples were reviewed in accordance to applicable provincial and federal guidelines (see Appendices 5 and 6 for summarized water and sediment guidelines). A number of sites were found in excess of the guidelines, the number of parameters exceeding guidelines per site is given in Figure 9. In water, sites varied from 0-4 exceedances of guidelines including: aluminum (total monitored not dissolved), Arsenic, Cobalt, Iron, Lead, Copper, and Zinc (Appendix 7).

Provincial and federal sediment quality guidelines for the protection of aquatic life were reviewed and of the thirty-seven sediment quality parameters monitored twelve parameters have associated guidelines including: arsenic, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium, silver, mercury and zinc.

For sediment, 14 sites exceeded sediment guidelines for 0-2 parameters including: TY001, LSL001, BVL001, WIM001, WIN002, GC001, LWL001, BVL002, GC002, HAY001, LSL002, SUM002 and BVL003. Additionally, there were six sites not directly affected by legacy mining impacts that exceeded sediment guidelines for 3-8 parameters including CL001, BON001, F001, SUM001 and ELD001. The three sites directly impacted by historical mining had exceedances of guidelines by 10 parameters (BEAR001, SEAT001, SEAT002 and SEAT003). While wetlands associated with the outflow of Bear Lake (BEAR001), likely affected by mining activities, exceeded guidelines for seven parameters monitored.

All sites affected by legacy mining were high in arsenic, cadmium, copper, iron, lead, manganese, nickel, silver, selenium and zinc. Similar to the water quality guideline review TY001 was the one site that did not exceed guidelines and mercury was the only metal that showed no exceedances at any site (Appendix 8).

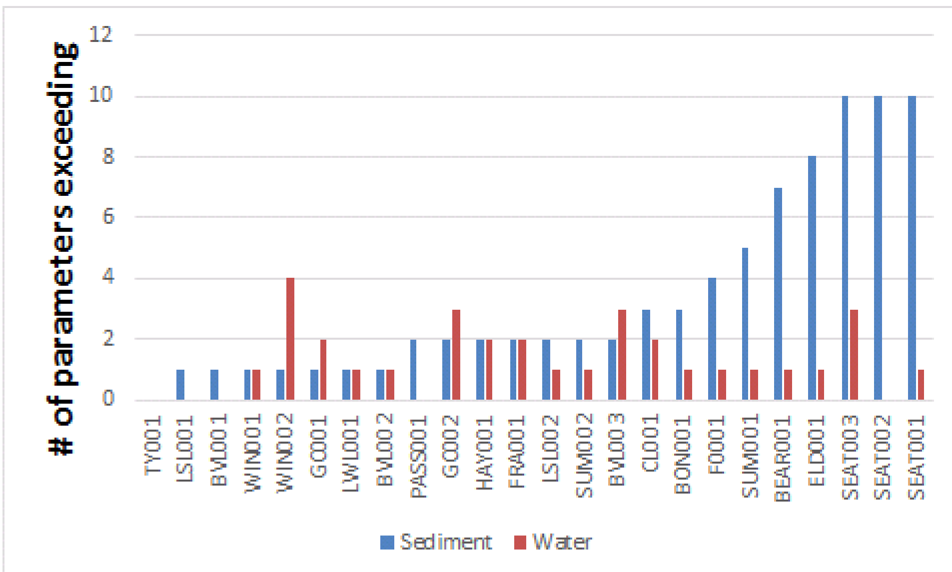

Figure 9. Number of parameters exceeding at least one guideline at each site for water and sediment. Four sites including SEAT002, PASS001, BVL001, LSL001 were not assessed (for water) in 2014 because of limited sampling relative to 2015.

5.3 Stress Gradient: Variable selection using principal components analysis.

5.3.1 Normality and transformation of data

All data was transformed prior to carrying out principle components analysis (PCA) using log(x+1) for continuous variables and Anscombe's arcsine square root transformation for percentages (Anscombe 1948, described in Zar 1984). Univariate normality was also tested using the Shapiro-Wilkes test for normality before and after transformation.

Log transformation improved normality for 43% of water and sediment parameters. Variables that were not improved with log transformation were explainable by the outliers in high levels of chemical inputs at some of the sites and the small data set (n=24). These high values resulted in high skewness (>1.3, Zar 1984) to the right tail of the data for 22% of parameters.

Ancombe's arcsine transformation slightly improved normality for 78% of the physical parameters but none of the 14 variables met normality with transformation. The lack of normality was generally due to the small data set (n=24) and the fact that some disturbances were identified at only a few of the sites. For example, impacts due to cattle were present at only one site. This resulted in high skewness (absolute value >1.3, Zar 1984) for 22% of parameters and likely undue weight in the PCA. As a result, we included total disturbance (sum of the disturbance types) within the wetted area and within the margin of the wetland as variables within the PCA.

The use of PCA on a sparse data set is not ideal but we proceeded with PCA in an exploratory manner in order to assess potential candidate variables for developing a stress gradient while recognizing that more robust analyses will be carried out as sample size increases following the 2016 field season.

5.3.2 Water

The first three axes cumulatively explained 82.3% of the total variance in the 14 basic water quality variables. Axis 1 (Figure 10) with an eigenvalue = 5.25 explained 38.9% of the variance and represented nutrient levels including Kjeldahl-N, total N, TP (absolute eigenvectors >0.3). We selected Total Nitrogen with the second largest eigenvalue (0.38) to represent this axis. Axis 2 (Figure 10) explained 30.2% of the variance with an eigenvalue of 3.5. Axis 2 represented the ionic strength of water including the concentration of total calcium, pH, hardness, and alkalinity. All of these parameters had eigenvectors greater than 0.3 and total calcium was selected to represent this axis with an eigenvector of 3.91. Axis 3 (Eigenvalue=1.83, eigenvectors >0.5) explained 13.1% of the variance and was represented by turbidity and TSS. Turbidity was selected to represent this axis with an eigenvector of 0.57.

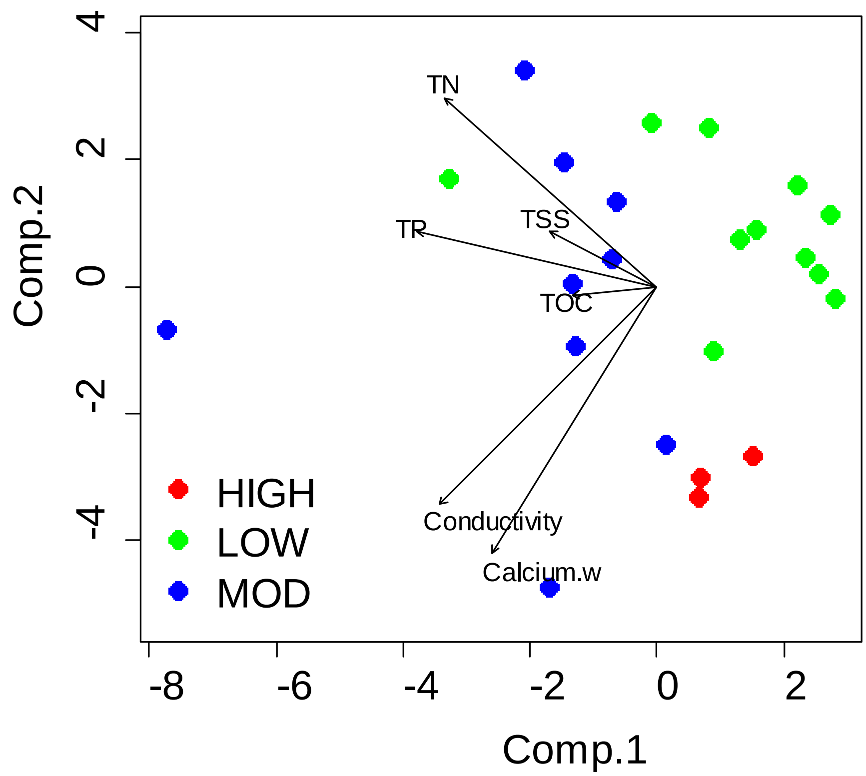

Figure 10. Biplot of scores from Principle Component 2 versus Principle Component 2 on a correlation matrix of 14 parameters from water sampled at 24 sites. Sites are coloured according to ratings based on best professional judgement corresponding to rapid Human Disturbance Scores (EPA 2002) of 0-24 (Low, n=13), 25-74 (Moderate, n=8) and 75-100 (High, n=3). The High category also corresponded to three sites contaminated by legacy mining.

5.3.3 Sediment

The first three axes were significant and represented 83.7% percent of the overall variance. The first component (Figure 11) explained 43.8% of the variance (eigenvalue 4.7) and corresponded to sediment concentrations of sulphur, calcium, and aluminum (absolute eigenvectors >0.39) reflective of differences in the geology of the area and differences in weathering rates of underlying granitic or shale/limestone bedrock. The second axis (Figure 11) explained 22.5% of the variance (eigenvalue 2.1) was representative primarily of total organic carbon (eigenvector =0.56). The third axis (eigenvalue 1.7) explained 17% of the variance was indicative of phosphorus in sediment (eigenvector=0.58).

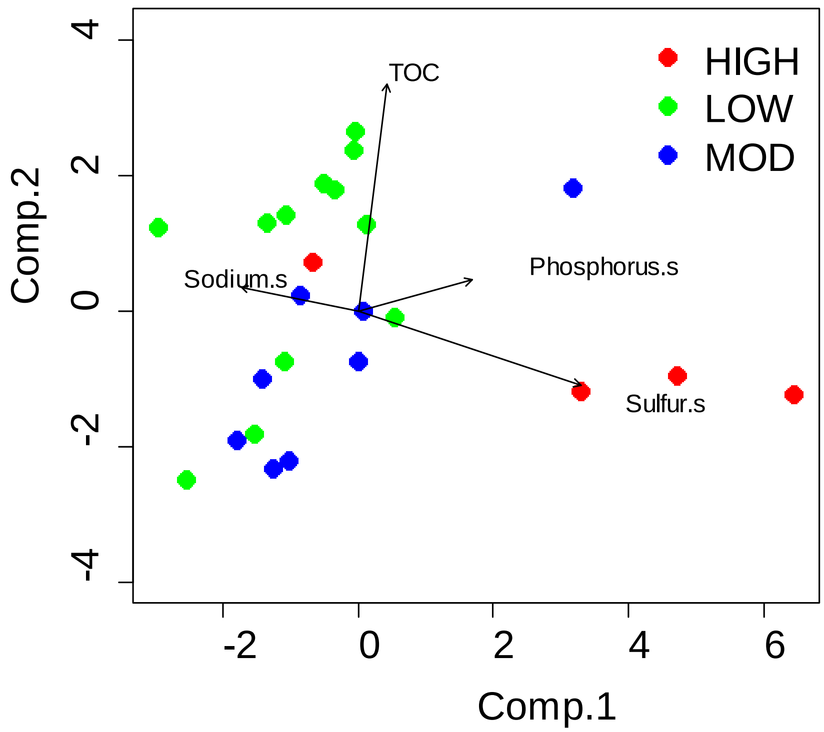

Figure 11. Biplot of scores from Principle Component 2 versus Principle Component 2 on a correlation matrix of 11 parameters from sediment sampled at 24 sites. Sites are coloured according to ratings based on best professional judgement corresponding to rapid Human Disturbance Scores (EPA 2002) of 0-24 (Low, n=13), 25-74 (Moderate, n=8) and 75-100 (High, n=3). The High category also corresponded to three sites contaminated by legacy mining.

5.3.4 Chemical inputs

Chemical inputs included 40 variables including 4 water quality variables (chloride, nitrate and sulfate) and 38 variables from the metals scan carried out on sediment. The metals in sediment were used as the main indicator of chemical inputs because metals in in sediments were higher in value and less susceptible to seasonal fluctuations.

Again, given that this year's work was an exploration of the data we retained principle components that explanation approximately 80% of the variance in order to include a variety of possible contaminants including sodium chloride which showed a weak gradient due to sparse data. Rooney et al. (2010) recommends selecting principle components that explain 60% of the variance in order to reduce redundancy and blocks of contaminants that covary. However, we were concerned that sodium chloride varied along an independent gradient to metals concentration. Given that the present work is an exploratory analysis, we decided to retain principle components that explained

80% of the variance to include sodium and chloride. The first five axes explained 79.7% of the variance. The first component (Figure 12) explained 43.5% of the variance (eigenvalue=10.5) and could be represented by arsenic concentrations in sediment (eigenvector=0.295). This component serves an indicator of metals from legacy mining including: arsenic, cadmium, copper, iron, lead, manganese, nickel, silver, selenium and zinc (Appendix 8). The second component (Figure 12) explained 16.8% of the variance (eigenvalue=3.05) and was represented by chromium in sediment (eigenvector=0.46). The third component explained 11% of the variance (eigenvalue=2.21) and was indicative of mercury in sediment (eigenvector=0.49). However, chromium and mercury indicators of the 2^{nd} and 3^{rd} principal components never exceeded guidelines in sediment. Reference and moderately impacted sites exceeded guidelines in sediment for 0-8 parameters. Six sites in particular exceeded sediment guidelines for 3-8 parameters including CL001 (Cd, Pb, Zn), BON001 (Cd, Pb, Se), F0001 (Cd, Ni, Pb, Se), SUM001 (As, Cd, Ni, Se, Zn) and ELD001 (Ag, Cd, Cr, Cu, Fe, Ni, Pb, Zn), Appendix 8. The fourth component explained 8.4% (eigenvalue=2.12) and corresponded to sodium (eigenvector=0.58) and chloride (eigenvector=0.39) in water.

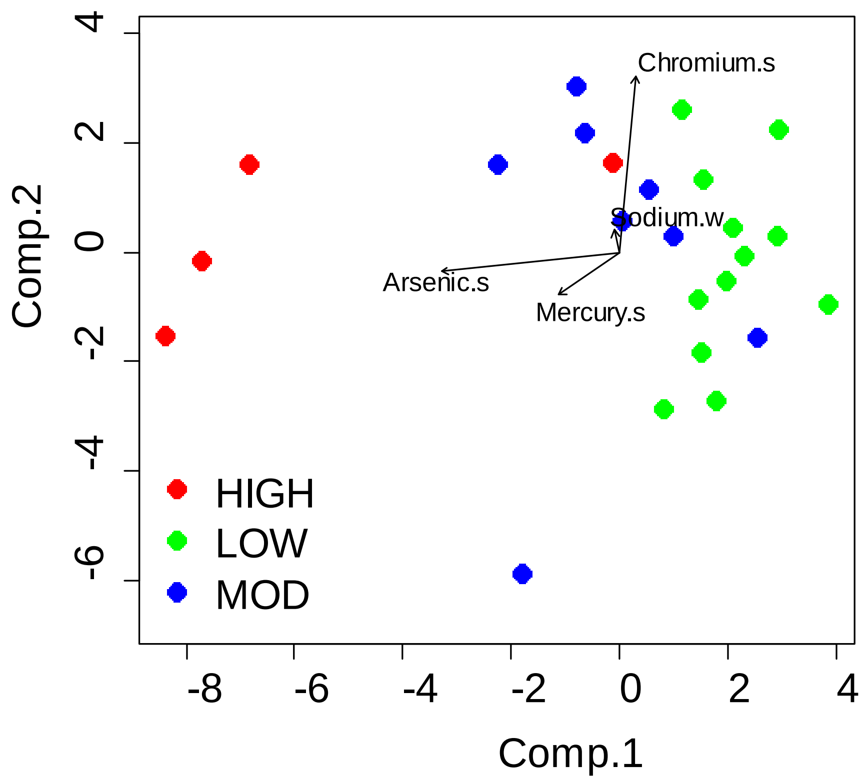

Figure 12. Biplot of scores from Principle Component 2 versus Principle Component 2 on a correlation matrix of 11 contaminants sampled at 24 sites. Sites are coloured according to ratings based on best professional judgement corresponding to rapid Human Disturbance Scores (EPA 2002) of 0-24 (Low, n=13), 25-74 (Moderate, n=8) and 75-100 (High, n=3). The High category also corresponded to three sites contaminated by legacy mining.

5.3.5 Physical stress

The first four axes cumulatively explained 87.2% of the total variance in 15 variables of visual estimates of physical disturbance to the wetted area and margin of the wetland including percent *Phalaris sp*. (canary reed grass) within the 5x5m quadrat. Axis 1 (Figure 13) with an eigenvalue = 5.44 explained 36.3% of the variance and represented total disturbance to the wetted area and margin and percent disturbance to the margin due to mining (absolute eigenvectors >0.39). Total disturbance to the wetted area had the highest absolute eigenvector 0.397 with total disturbance to the margin (eigenvector=0.394). Axis 2 (Figure 13) explained 21.3% of the variance with an eigenvalue of 3.20. Axis 2 represented the percentage of canary reed grass and percent farm yard, mining, urban disturbances to the wetland margin and roads near the wetted area. All of these parameters had absolute eigenvectors greater than 0.3 and % farmyard at the margin of the wetland had the highest absolute eigenvector (0.449) while percent canary reed grass had the second highest eigenvector (0.407). Axis 3 (eigenvalue=2.42, eigenvectors >0.423) explained 16.1% of the variance and was represented by percent urban disturbance, percent disturbance due to grazing in the wetted area and margin of the wetland and percent roads on the margin of the wetland. Percent urban disturbance to the margin of the wetland had the highest absolute eigenvector (0.449). Axis 4 (eigenvalue=2.01) explained 13.4% of the variance with disturbance to the wetted area and margin due to filling with absolute eigenvectors of 0.561.

The total disturbance to the margin of the wetland was selected to represent the sum of physical stresses including the first component because: (1) total disturbance was associated with the PCA component that explained the most variance (2) it was the variable that best approached normality (Shapiro-Wilkes test, p=0.02), (3) skewness was less than 1.3, and (4) other disturbances were incorporated into this measure with the exception of percent canary reed grass. In the future, variables with numerous zeros will be excluded from the PCA.

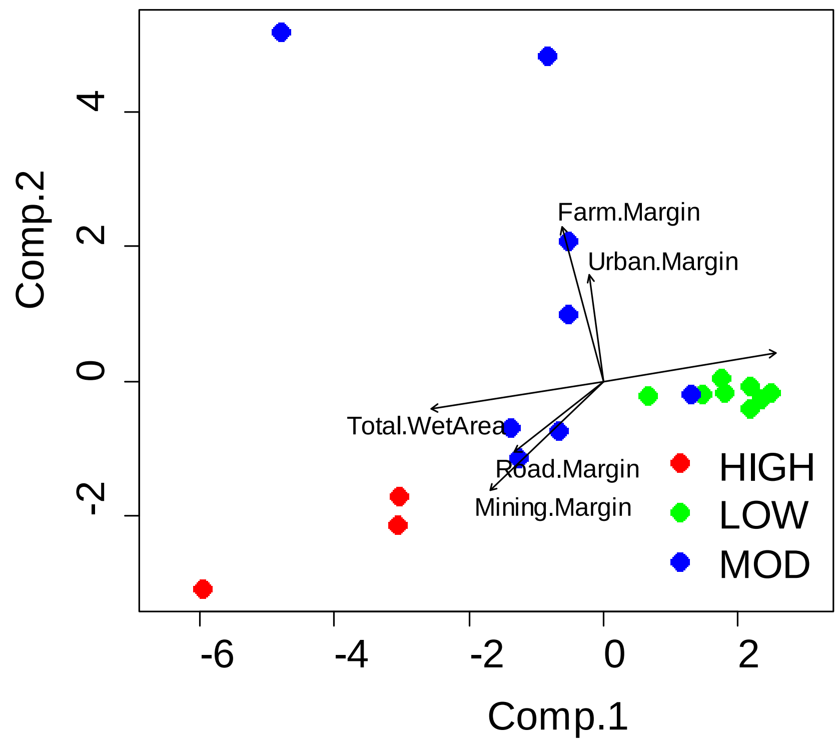

Figure 13. Biplot of disturbance scores to wetted area and margin from Principle Component 2 versus Principle Component 2 on a correlation matrix of 14 parameters sampled at 24 sites. Sites are coloured according to ratings based on best professional judgement corresponding to rapid Human Disturbance Scores (EPA 2002) of 0-24 (Low, n=13), 25-74 (Moderate, n=8) and 75-100 (High, n=3). The High category also corresponded to three sites contaminated by legacy mining.

5.3.6 Variable selection

Eleven variables representing the eleven principle components and explaining 80% of the variance from four categories (water, sediment, contaminants, and physical stress) were selected for inclusion in the stress gradient including: (1) Total Nitrogen, Total Calcium and Turbidity from water, Sulfur, (2) Total Organic Carbon and Total Phosphorus in sediment, (3) Arsenic, Chromium and Mercury (sediment) and sodium (water) as contaminants and (4) total disturbance to the margin of the wetland as physical stress. PCA was used to minimize the redundancy within the Stress scores although it is likely not possible to eliminate these correlations. Of 110 paired comparisons, 87% (95 pairs) of correlation coefficients from the Spearman rank test were less than 0.6 (rho<0.6, Figure 14).

Results of the Spearman rank correlation of these variables with a rapid Human Disturbance Gradient score (EPA 2002, Table 1) showed that Calcium and PC2 in water, PC1 and PC2 in sediment, PC1 and Arsenic from contaminants, and PC1 and total disturbance were significantly correlated with the Human Disturbance Gradient score $p<0.05$ (unadjusted for multiple comparisons).

However, more importantly least squares regression of all candidate variables versus human disturbance scores (HDG) was carried out for each parameter and residuals were scrutinized for correlations with the human disturbance gradient in order to assess correlated error with increasing wetland stress. There were no significant regressions of the residuals of candidate variables versus the human disturbance gradient. However, parameters that were indicators of legacy mining were highly skewed and residuals will be better analysed in greater detail with further data.

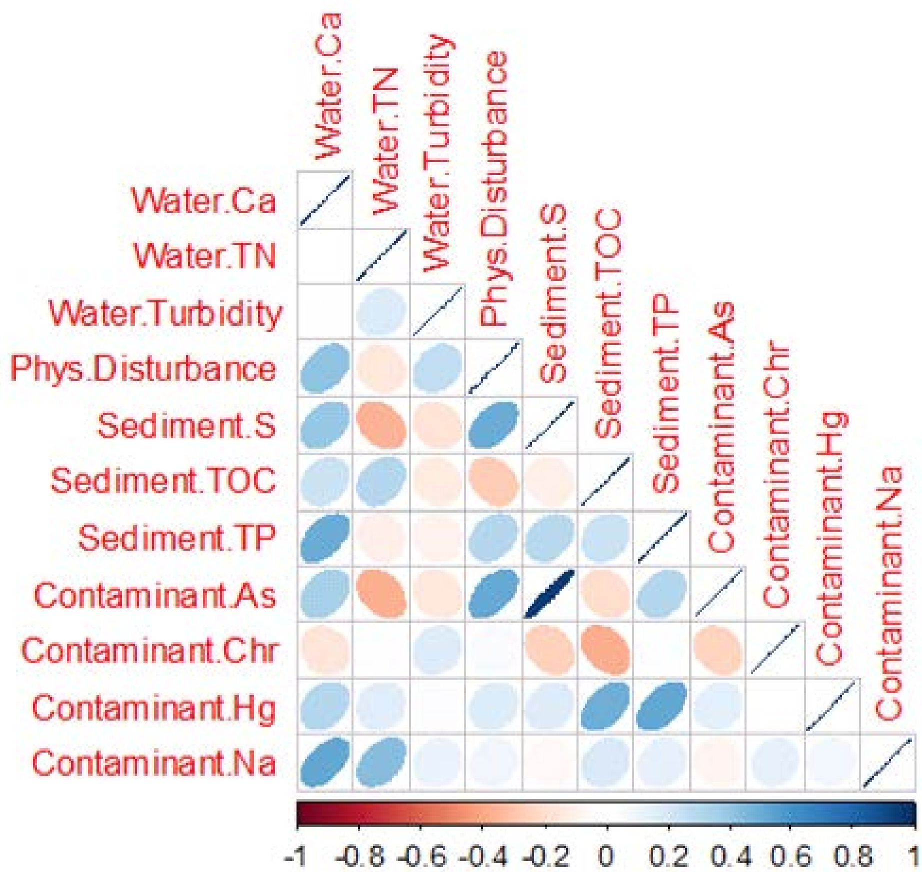

Figure 14. Correlogram of variables used to calculate Stress Index Scores (Spearman rank coefficients).

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Table 1: Spearman rank correlation coefficient matrix for the four categories of variables. Probabilities were adjusted using Holme (1979) for multiple comparisons.

Stress Category	PCA component & representative variables	Correlation Coefficient	Unadjusted Probability	Adjusted Probability multiple comparisons
Water	PC 1	-0.28	0.19	1.00
	Total Nitrogen	-0.21	0.32	1.00
	PC2	**-0.55**	0.01	0.39
	Calcium	**0.74**	0	0
	PC3	0.27	0.20	1.00
	Turbidity	0.16	0.47	1.00
Sediment	PC1	**0.44**	0.03	0.44
	Sulfur	0.34	0.11	1.00
	PC2	**-0.5**	0.01	-0.50
	TOC	-0.31	0.14	1.00
	PC 3	-0.16	0.44	-0.16
	TP	0.29	0.16	1.00
Contaminant	PC1	**-0.71**	0	-0.71
	Arsenic	**0.61**	0	0.13
	PC2	0.26	0.23	0.26
	Chromium	0.13	0.55	1.00
	PC3	-0.06	0.77	1.00
	Mercury	0.25	0.24	1.00
	PC4	0.25	0.24	0.25
	Sodium	0.53	0.01	0.61
Physical (visual estimate)	PC 1	**-0.83**	0	0
	Total Disturbance to margin of wetland (100 m from site)	**0.78**	0	0
	PC3	-0.28	0.18	-0.28
	%Canary Reed Grass	**0.42**	0.04	1.00

Principle Component Scores (PC) and representative variables as dependent variables versus a rapid Human Disturbance Gradient as the independent variable (EPA 2002).

5.4 Weighting and Standardization

There was positive correlation between the six methods of developing the stress scores (Table 2). Stress scores showed high concurrence both between standardization techniques (r>0.94-0.97) and weighting techniques (r>0.95-0.9).

A significant difference between sums of ranks of scores was observed for all Stress Score calculation methods (p<0.008, Table 3). Post-hoc pairwise comparisons with the Kruskall-Wallis Nemenyi-test with tied Chi-squared approximation for independent samples, corrected for ties, demonstrated that all of the scoring methods show significant differences between contaminated sites (High disturbance category, HDG>75) and reference sites including: weighting by variable, principle component variance and category for both percentile binning and z-score standardization methods (Table 4). These same indices were able to distinguish between sites with moderate stress and reference sites. No scoring method was able to discern between High and Moderate effects according to the non-parametric tests.

Table 2: Spearman rank correlation coefficient matrix of PCA data reduction and six methods of calculation of stress scores. Probabilities were significant at <0.001 for all pairs using the adjusted Holme (1979) for multiple comparisons (n=24).

Transformation & Weighting methods	PB Variable	PB PC variance	PB Category	Z-score Variable	Z-score PC variance	Z-score Category
PB by Variable	1	0.96	0.96	0.96	0.95	0.91
PB by PC variance		1	0.94	0.91	0.92	0.89
PB by Category			1	0.92	0.92	0.94
Z-score by Variable				1	0.97	0.96
Z-score by PC variance					1	0.96
Z-score by Category						1

PB=Percentile binning, z-score=z-score transformation, Variable=equal weighting by variable, PC variance = weighting by PC variance and variable, Category = weighting by average stress category.

Table 3: Kruskall-Wallis rank score test of Stress Score calculation method by Disturbance Category (High, Moderate or Low HDG scores), n=24.

Stress Score calculation method	Chi-squared statistic	p-value
PB by Variable	15.0	0.0005*
PB by PC variance	15.9	0.0003*
PB by Category	15.6	0.0004*
Z-score by Variable	15.0	0.0005*
Z-score by PC variance	16.0	0.0003*
Z-score by Category	14.9	0.0005*

PB=Percentile binning, Z-score=z-score transformation, Variable=equal weighting by variable, PC variance = weighting by PC variance and variable, Category = weighting by average stress category. *Significant with the Bonferonni correction p=0.008)

Table 4: Test statistic and inferences of post-hoc pairwise comparisons using Kruskall-Wallis Nemenyi-test with tied Chi-squared approximation for independent samples, corrected for ties, n=24.

Stress Score calculation method	High vs Low	High vs Moderate	Moderate vs Low	Inference
PB by Variable	0.003	0.288	0.022	High=Mod>Low
PB by PC variance	0.002	0.292	0.015	High=Mod>Low
PB by Category	0.002	0.282	0.022	High=Mod>Low
Z-score by Variable	0.003	0.255	0.029	High=Mod>Low
Z-score by PC variance	0.002	0.263	0.025	High=Mod>Low
Z-score by Category	0.002	0.264	0.025	High=Mod>Low

PB=Percentile binning, Z-score=z-score transformation, Variable=equal weighting by variable, PC variance = weighting by PC variance and variable, Category = weighting by average stress category.

Boxplots also confirmed (Figure 15) that all of the scoring methods show good separation between disturbance categories for all calculation methods as evaluated by the lack of overlap between the 25th and 75th percentiles (Table 5). Low sample size as well as unequal sample size likely affected the power of the analysis to detect the trend between high and moderate in making inferences of post-hoc pairwise comparisons using Kruskall-Wallis Nemenyi-test with tied Chi-squared approximation for independent samples, corrected for ties. Particularly, because the high disturbance categories were comprised of only three sites and non-parametric methods have low power to detect differences at low sample sizes.

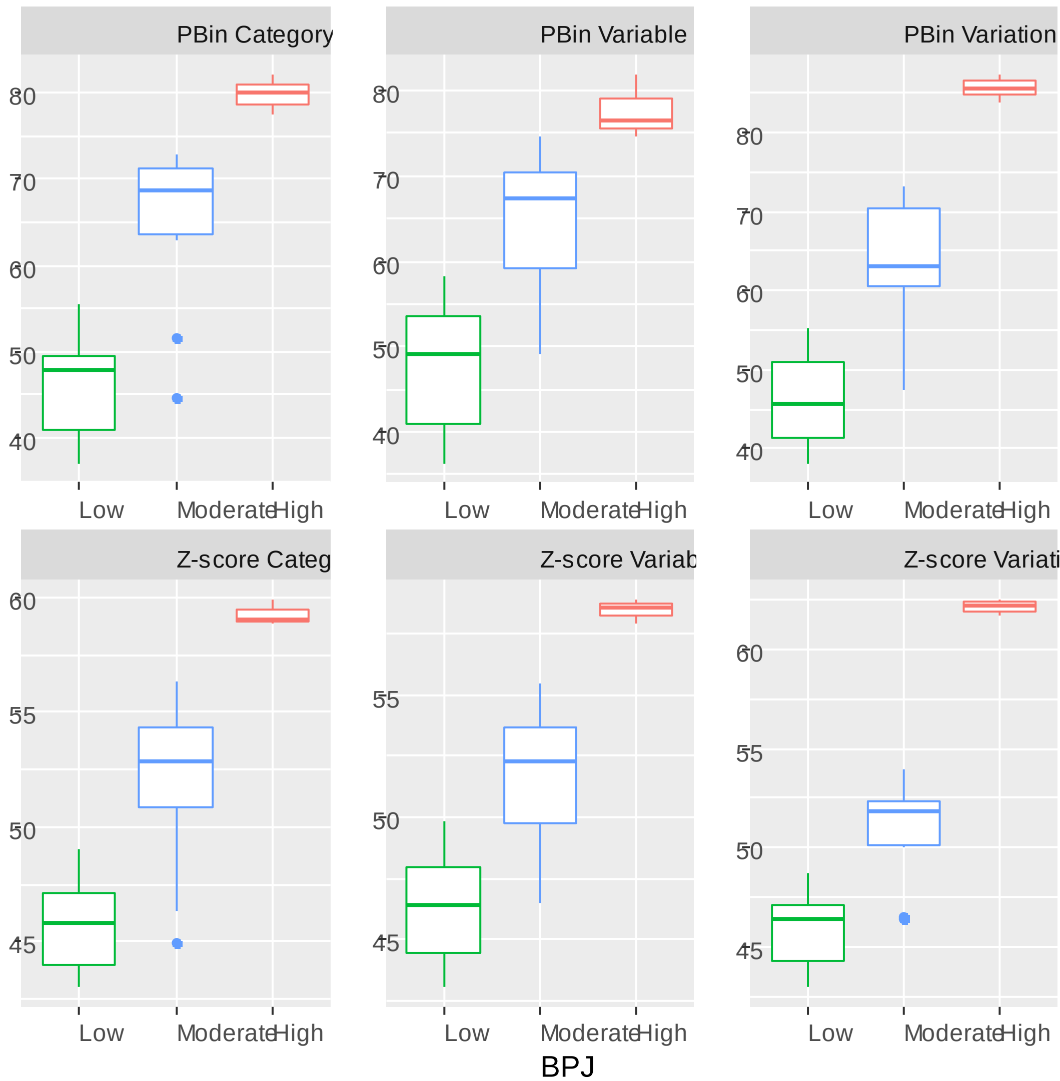

Figure 15. Boxplots of calculated Stress Index Scores by High, Moderate or Low categories of disturbance (EPA 2002) for each of six calculation methods including Percentile binning (PBin), or Z-score transformation, and three weighting schemes (Category = weighting by average stress category, Variable=equal weighting by variable, and Variation = weighting by PC variance). Best Professional Judgement Categories (PBJ) corresponded to rapid Human Disturbance Scores of 0-24 (Low, n=13), 25-74 (Moderate, n=8) and 75-100 (High, n=3). The High category also corresponded to three sites contaminated by legacy mining.

Regression statistics and Akaike information Criteria (Akaike 1974, Figure 16) of the log of metal concentrations (not included in score calculation) were used to evaluate stress scoring methods with respect to discriminate wetland metals levels. This assessment suggested that percentile binning with weighting by principle component scores, z-score transformation methods with weighting by principle component scores or category may be the best models because they had the lowest AIC value (66.82-73.63), highest r^2 (0.433-0.57) and significant p-values (<0.001) to explain stress due to metals (Table 5).

In our examination of macroinvertebrate metric response to wetland stress, we decided to use percentile binning with weighting by principle component scores (see map Figure 17) as a balance between using percentile binning to emphasize moderate impacts to wetlands (Falcone et al. 2010) and weighting by the main indicators of stress identified in principal component analyses which tended to separate sites contaminated by metals. However, all schemes were highly correlated and showed good separation between low and high categories of disturbance scores (Figure 15).

Table 5: Regression statistics of excluded metals ($CTU_{excluded\ metals}$**) versus Stress score calculation method, n=24.**

Stress Score calculation method	Equation	p-value	Adjusted r^2	AIC criteria
PB by Variable	Log(**Excluded metals**)= 0.06*(score)-2.06864	<0.001*	0.37	78.79
PB by PC variance	Log(**Excluded metals**)=-2.3*(score)+ 0.06	<0.001*	0.57	73.04
PB by Category	Log(**Excluded metals**)= 0.06*(score) -1.97964	<0.001*	0.41	76.40
Z-score by Variable	Log(**Excluded metals**)= 0.17*(score) -7.38	<0.001*	0.46	76.24
Z-score by PC variance	Log(**Excluded metals**)=0.18*(score)-7.80	<0.001*	0.43	66.82
Z-score by Category	Log(**Excluded metals**)= 0.16*(score)-6.6	<0.001*	0.48	73.63

PB=Percentile binning, Z-score=z-score transformation, Variable=equal weighting by variable, PC variance = weighting by PC variance and variable, Category = weighting by average stress category. *Significant with the Bonferonni correction p=0.008). Excluded Metals = Cumulative Toxic Units for zinc, lead, copper and cadmium in sediment.

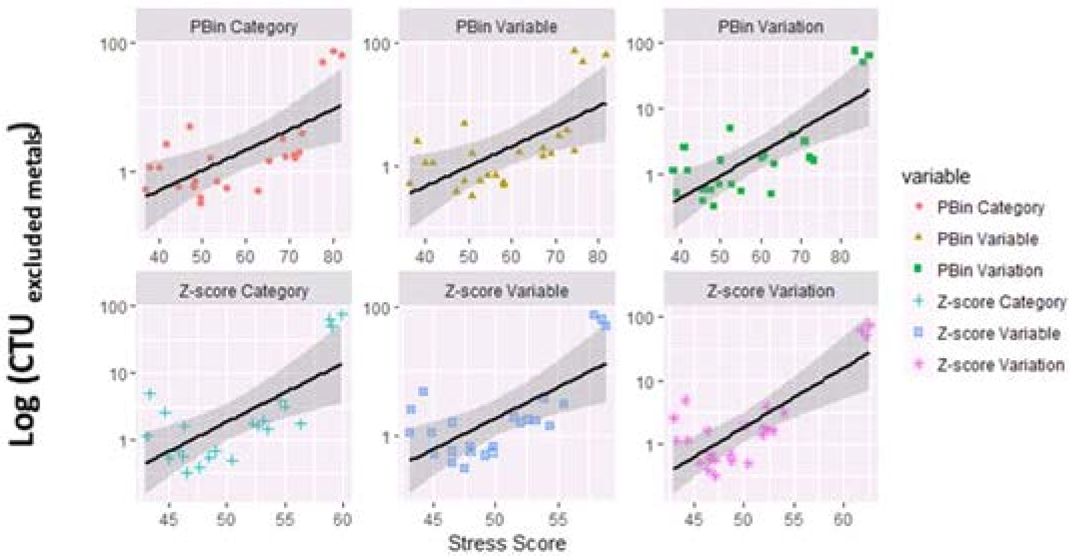

Figure 16. Regression of the Log of cumulative toxic metals (mg/L) excluded from the development of the index versus Stress Index by scoring method including Percentile binning (PBin), or Z-score transformation, and three weighting schemes (Category = weighting by average stress category, Variable=equal weighting by variable, and Variation = weighting by PC variance). CTU $_{\text{excluded metals}}$ was calculated from the sum of the concentration divided by respective criterion for zinc, lead, copper and cadmium in sediment.

6 Macroinvertebrate metric selection

In initial testing of metric selection process, ninety-one metrics were examined for significance in an analysis of covariance that included wetland stress scores for wetland associations with Lacustrine, Palustrine, Riverine and Floodplain habitats, including varying levels pH and total organic carbon from sediment samples (TOC) (raw data and full results in Appendices 11-12). The fourteen metrics that showed a significant result for wetland stress were then assessed for redundancy (Table 6). Six metrics were rejected because they showed a high degree of correlation (Pearson's correlation coefficient of $r \geq 0.65$). The metric in correlated pairs with the poorer fit with wetland stress score (as indicated by r2 value in simple linear regression) was discarded. Eight metrics were retained in this process because they showed low redundancy with other metrics and the strongest relationship to wetland stress (Table 7).

All metrics that were retained had significant scores with wetland stress in analysis of covariance including: Simpson's Diversity Index, percent *Callibaetis sp.*, the number of Clitellata taxa, % Abundance collector-gatherers Number of intolerant taxa, % Diversity of amphipods to (amphipods + bivalves + gastropods). But only three metrics had significant p-values in simple linear regression with wetland stress including: Simpson's Diversity Index, percent *Callibaetis sp.* and the number of Clitellata taxa (Table 8).

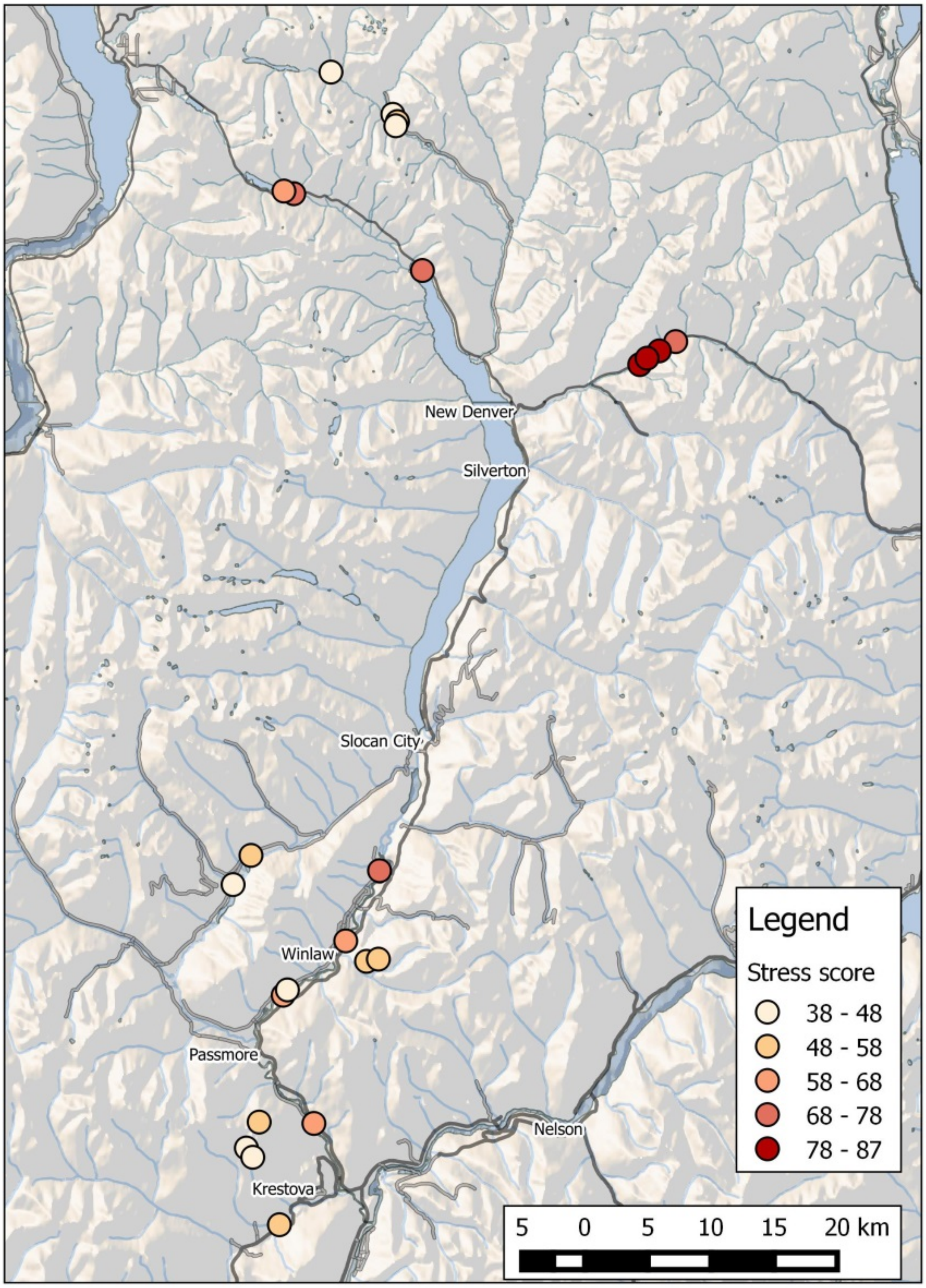

Figure 17. Map of wetland sites coloured by wetland stress score using the percentile binning and weighting by principle component scheme (PBIN variance).

Table 6 Pearson's correlation coefficients among metrics that showed significant response to Wetland Stress ($p<0.05$) in ANCOVA. If pairs of metrics had absolute values rho.≥0.63 then the metric with the highest r^2 value in simple linear regression analyses with wetland stress was retained for use in the IBI.

Metric	Name	DIV_Simpsons	NT_Clitella	PA_1Dom	PA_3Dom	PA_5Dom	PA_Callibaetis	PA_E	PA_ETO	PA_Non_insect	PD_BCG	PA_CG	NT_HBIS	PD_Amph_BCG	PD_CFCG
DIV_Simpsons**	Simpson's Diversity Index	1													
NT_Clitella**	Number of Clitellata taxa	0.353	1												
PA_1Dom	% Dominant taxa	-0.9726	-0.3602	1											
PA_3Dom	% Top 3 dominant taxa	-0.9048	-0.4283	0.8879											
PA_5Dom	% Top 5 dominant taxa	-0.88	-0.4116	0.8666	0.99	1									
PA_Callibaetis**	% Callibaetis	-0.6259	-0.1196	0.5852	0.4365	0.3859	1								
PA_E	% Mayflies	-0.513	-0.0834	0.4688	0.3617	0.297	0.9237	1							
PA_ETO	% Mayflies, caddisflies & dragonflies	-0.4281	-0.1277	0.4058	0.3159	0.2628	0.8421	0.9251	1						
PA_Non_insect	% non-insect	0.435	0.1461	-0.4329	-0.3607	-0.3267	-0.3651	-0.3471	-0.3788	1					
PD_BCG	% Diversity of bivalves, amphipods & gastropods	0.3318	-0.1062	-0.3325	-0.239	-0.2528	-0.4207	-0.3591	-0.2875	0.7257	1				
PA_CG**	% Abundance collector-gatherers	-0.4058	-0.0209	0.353	0.2982	0.2241	0.5627	0.6367	0.5709	-0.3848	-0.0963	1			
NT_HBIS**	Number of intolerant taxa	0.5235	0.4549	-0.5063	-0.5015	-0.5009	-0.1809	-0.0348	-0.0736	0.4567	0.2775	-0.0853	1		
PD_Amph_BCG**	% Diversity of amphipods to (amphipods + bivalves + gastropods)	0.263	0.4589	-0.1745	-0.2123	-0.2201	-0.1661	-0.0426	-0.0659	-0.0071	-0.0149	0.0121	0.3504	1	
PD_CFCG	% Diversity of Collector filterers + Collector Gatherer	-0.5123	-0.0462	0.4762	0.4171	0.4799	0.2823	0.1529	0.1646	-0.2635	-0.3067	0.2041	-0.3239	-0.1093	1

DIV=Diversity index, PA=Percent abundance, NT=No. of Taxa, **Values in green indicate that the metric was retained. Values in red are pairs of metrics that have a correlation coefficient >0.65 were redundant. Percent data was transformed with Anscombe's arcsin square-root and count data was transformed using Ln(x+1).

Table 7: Candidate macroinvertebrate metrics with significant p-values from ANCOVA of metric versus wetland stress score (PBvar), pH, TOC and wetland type (see Appendix 12 for full results).

Metric candidate	Parameter	Level1	Estimate	StdErr	ChiSquare	p-value
DIV_Simpsons	Stress_score		-0.0114	0.0034	9.3523	0.00223
NT_Clitella	Stress_score		-0.027	0.0105	6.7547	0.00935
NT_HBIS	Stress_score		-0.0239	0.012	4.0721	0.0436
PA_Callibaetis	Stress_score		0.0005	0.0001	14.052	0.00018
PA_CG	Stress_score		0.0004	0.0001	6.6555	0.00988
PD_Amph_BCG	Stress_score		-0.0003	0.0002	3.0172	0.08239
PA_CG	pH		-0.0145	0.0043	9.2704	0.00233
PD_Amph_BCG	pH		0.013	0.0047	6.7214	0.00953
NT_Clitella	TOC		-0.0282	0.0161	3.5844	0.05833
PA_CG	TOC		-0.0004	0.0002	5.3554	0.02066
PA_Callibaetis	Type	Floodplain	-0.005	0.0038	8.7531	0.03276
		Lacustrine	-0.0106	0.0033	8.7531	0.03276
		Palustrine	-0.0066	0.0042	8.7531	0.03276
		Riverine	0	0	8.7531	0.03276
PD_Amph_BCG	Type	Floodplain	-0.0037	0.0053	13.7621	0.00325
		Lacustrine	0.0094	0.0046	13.7621	0.00325
		Palustrine	-0.014	0.0058	13.7621	0.00325
		Riverine	0	0	13.7621	0.00325

PA=Percent abundance, NT=No. of Taxa, Percent data was transformed with Anscombe's arcsin square-root, Count data transformed using Ln(x+1).

Table 8: Least-squares regression statistics of macroinvertebrate metric candidates versus wetland Stress score (PBVar).

Metric candidate	Parameter	Estimate	StdErr	ChiSq	p-value	R-Square
DIV_Simpsons	Stress_score	-0.0079	0.0027	7.2529	0.00708	0.260814
PA_Callibaetis	Stress_score	0.0005	0.0001	14.9195	0.00011	0.46294
NT_Clitella	Stress_score	-0.0183	0.0086	4.8348	0.02789	0.147472
PA_CG	Stress_score	0.0003	0.0002	2.3835	0.12263	0.094538
NT_HBIS	Stress_score	-0.0119	0.0094	1.6646	0.19698	0.039942
PA_Amphipod	Stress_score	0.0001	0.0002	0.25	0.6183	0.010290

PA=Percent abundance, NT=No. of Taxa, Percent data was transformed with Anscombe's arcsin square-root, Count data transformed using Ln(x+1).

6.1 Index of Biotic Integrity based on macroinvertebrates

A preliminary version of the macroinvertebrate Index of Biotic integrity (IBI) was calculated based on a continuous scoring that assigned scores as a linear interpolation between the maximum and minimum values (Figure 18). Rooney and Bayley 2010 suggest scoring the IBI relative the reference values makes most theoretical sense although cites that . However, because of low sample size we decided to start with an inspection of potential IBI values using the former method. We also decided to use a continuous method of scoring rather than percentile binning because it has been shown to be potentially more sensitive (Blocksom 2003) or have no effect on IBI values (Rooney and Baily 2010).

The Index of Biotic Integrity for macroinvertebrates showed a significant decline with increasing wetland stress. ($y=0.6228x+16.0164$, $p<0.001$, adjusted $r^2=0.53$, $F=27.01$). Confounding factors such as such as latitude, longitude, elevation, year and type of wetland (Lacustrine, Palustrine, Riverine and Floodplain) were nonsignificant when added as predictors in multiple regression or analysis of covariance. Furthermore, the residuals of the Index of Biotic Integrity were uncorrelated with increasing wetland stress.

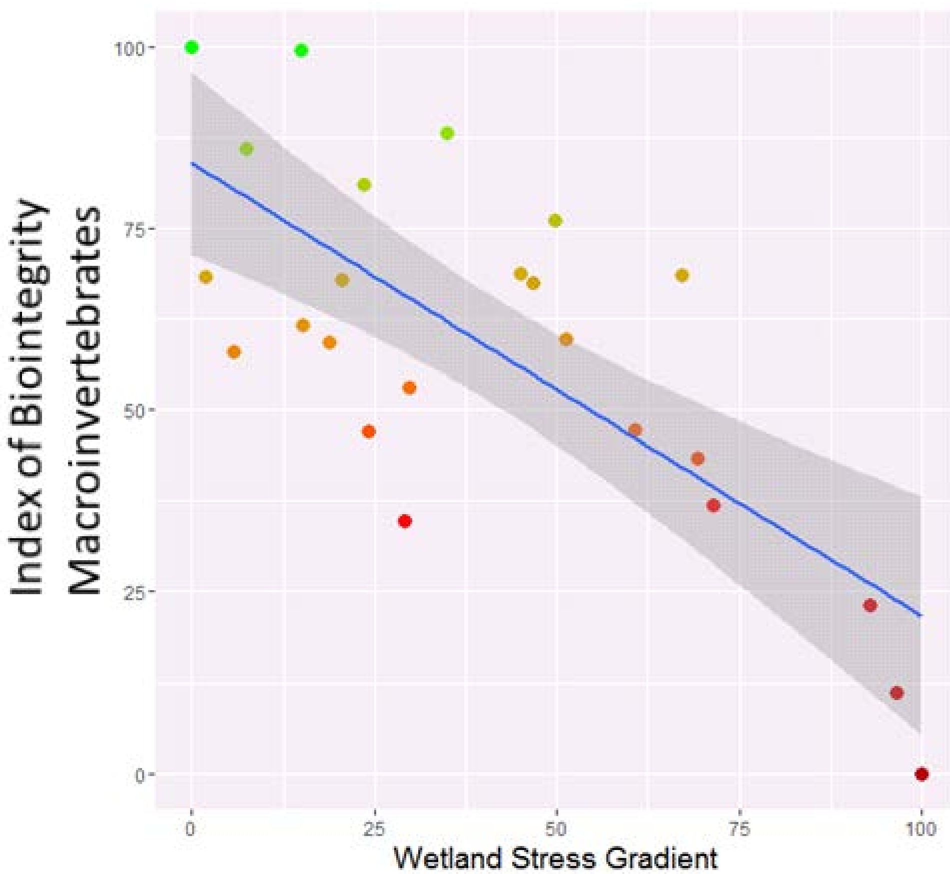

Figure 18. Index of Biotic Integrity (IBI) based on macroinvertebrates versus a quantitative wetland stress gradient (percentile binning and weighting by principal components scheme) $y=0.6228x+16.0164$, $p<0.001$, adjusted $r^2=0.53$, $F=27.01$. The colour of the points is correlated with the y value (IBI).

Potential candidate reference sites were identified if a site was in the lower 25th percentile of scores for wetland stress and if the IBI index was great that one standard deviation above the mean IBI value for sites with wetland stress scores in the lower 25th percentile (Figure 19). Several sites were identified that had high wetland stress and low biological integrity including Riverine, Floodplain and Lacustrine sites.

Riverine associated wetlands had the longest gradient in wetland stress (0-100) and showed the strongest response in IBI values (0-100). Lacustrine wetland habitats had a wetland stress gradient that ranged from 15.3-71.5 and a range of IBI values of 37-99.6. Palustrine sites were under sampled but tended have low to moderate values in wetland stress (5.6-35.8) and IBI (57.9-88.0). In addition, floodplain sites were distributed over a limited gradient in wetland stress (18.8-60.7) with intermediate range of biological health as indicated by the IBI values (47.3-60.9).

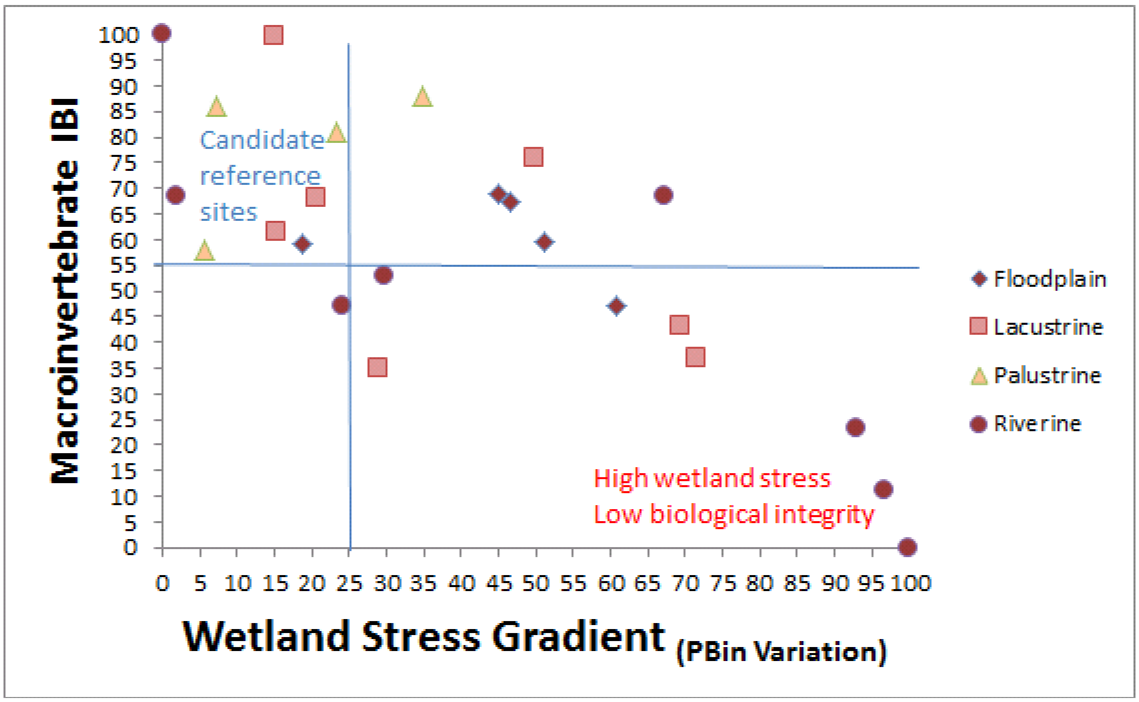

Figure 19. Index of Biotic Integrity (IBI) based on macroinvertebrates versus a quantitative wetland stress gradient (percentile binning and weighting by principal components scheme) by type of wetland type (Floodplain, Lacustrine, Palustrine and Riverine), graph similar to Bayley et al. (2014).

7 Conclusions

We developed quantitative tools to rate wetland stress and biotic integrity that can be used to assess wetlands in the Slocan Watershed to make management decisions about restoration and conservation. We identified an initial list of candidate sites that are low in wetland stress and high in biological integrity that are best-case scenario reference. Establishment of reference conditions for wetland and riparian areas was identified in the Fish and Wildlife Conservation Program

Columbia Basin Riparian Wetland Action Plan as one of the highest priorities for the Slocan Valley for conservation and management planning. Our work addresses this priority in a quantitative and scientifically valid method.

Five macroinvertebrate metrics were selected as indicators of wetland stress across a range of wetland types. An Index of Biotic Integrity for macroinvertebrates calculated from these indicator metrics showed a strong significant response to increasing wetland stress. However, higher sample sizes are required for further testing, and validation.

Stress gradient scores were effective at separating highly (contaminated sites) and moderately stressed sites from reference sites using all scoring methods. Assessment of Stress Scores by calculation method suggested that percentile binning with weighting by principle component scores, and z-score transformation methods with weighting by principle component scores or category may be the best methods for wetlands with gradients in metals levels. We evaluated how scoring methods including transformation and weighting choices influenced the performance of the stress gradient. We minimized best professional judgement and described clearly when and how it was used.

Next steps and future work will include:

- Stress Gradient:
    - Further sampling of sites by habitat types and over longer stress gradients where needed.
    - GIS assessment of land cover within a 500m buffer zone around each wetland site has been completed by Ryan Durand (Appendix 1). Stress gradient performance will be evaluated using this land cover and population-based GIS variables.
    - Further testing of the scoring methods associated with the stress gradient will include an assessment of the independence of residuals of each metric in the stress score and human disturbance.
    - Recommendations on selection of indicators to reduce the cost of water quality sampling.
- Index of Biotic Integrity based on macroinvertebrates.
    - Further testing of scoring methods will be carried out as sample size increases across wetland types and increasing wetland gradient.
    - Potential use of non-linear macroinvertebrate metrics using piecewise quantile regression using methods in Rooney and Bayley (2012).
    - More stringent selection process for reference sites with increased sample size (Bayley et al. 2014, Yates and Bailey 2010a and 2010b).
    - Cross-validation (across wetland type and time) using training and hold-out data sets.
    - Further evaluation of the Index of Biotic Integrity in 2016/17 with an increased number of sites.

- Further work on correlations with quadrat and larger-scale assessments of plant composition collected from SWAMP Phase 3.

- Index of Biotic Integrity-based management actions
  - A list of priority actions for restoration and conservation will continue to be developed (See Appendix 13 for an initial list of IBI-based evaluation of restoration and conservation sites).
  - The SWAMP scientific team, supporters and community members will be surveyed as to priorities for restoration and conservation with regards to the growing information on wetlands in the Slocan Valley.

This document provides an outline of methodologies for the first stages in developing an index of biotic integrity based on wetland invertebrates as part of the SWAMP project. Further development and research will aid in the optimization of this methodology to the SWAMP program.

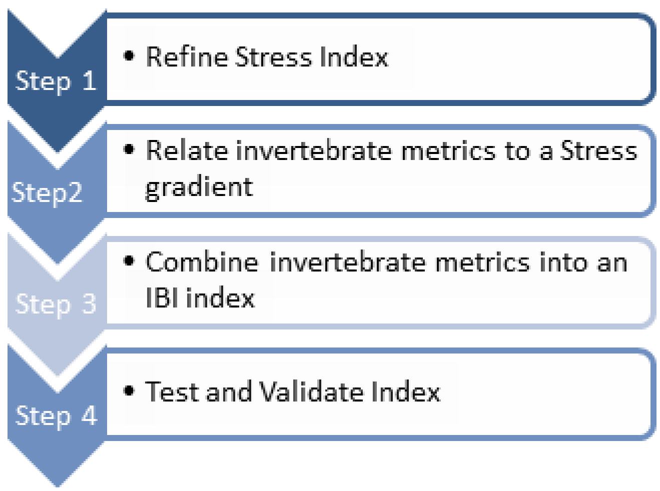

Figure 2. Next steps in developing an Index of Biotic Integrity for Macroinvertebrates for wetlands

7.1 2016 Field season planning

As described above, this project has received technical guidance from Environment Canada, CABIN, funding from the National Wetland Conservation Fund and the Fish and Wildlife Compensation Fund and dovetails with other SWAMP projects (Phases 1-3 and Summit to Bonanza Marsh Corridor). Rebecca Rooney of the University of Waterloo has also agreed to provide technical advice to the project which in turn may lead to further collaboration with the university.

The long-term goal of SWAMP is to sample at least five classes of wetlands and 8-10 sites/class in order to make use of multivariate statistics. Thus, the invertebrate protocols will be developed in a multi-year context funded in an additive approach within the three years. The exact number of sites will be driven by the number of community types and the ability to determine within and between site variability. A recent top-up of funding up to 33% of original funding (Oct, 2015) from the National Wetland Conservation Fund and likely renewal for the 2016 field season demonstrates their support for the project at a Federal level and the potential of our project to raise and leverage funds. The Columbia Basin Trust has approved funding for the 2016 field season. The Winlaw Watershed Committee has also recently expressed interest in providing funding to the project.

For the 2016 field season, wetlands identified by Durand (2015) in the Phase III mapping and field assessments will be evaluated for potential candidate sites for the invertebrate project in 2016. This will be done largely in close collaboration with Ryan Durand and other SWAMP team members. In addition, at least one potential restoration site (Slocan River Streamkeepers Society, Spankie Crooked Horn Farm Project) will be sampled in the 2016 with monitoring pre and post with reference conditions established by other lower valley sites for comparison. Furthermore, our sampling may address community concerns around mosquito issues.

The Royal BC Museum has agreed to house the voucher/reference collection from the project. Taxonomic identifications by Rhithron meet the museum’s specifications for quality control and the reference collection ensures verification, taxonomic consistency, and repeatability. Specimens curated by the Royal British Columbia Museum will be available in perpetuity for further research and to public inquiry that will be facilitated by an expert in collection management. The Royal BC Museum estimates that they will provide $15,000 per year in in-kind maintenance of the collection including curation supplies and staff time.

The development of an Index of biotic integrity for the Slocan Watershed will provide a rating system and a list of priorities for wetland enhancement and conservation. We also plan to work towards establishing performance indicators for restoration work based on a large body of research by Suzanne Bayley (University of Alberta, emeritus) and Rebecca Rooney of the University of Waterloo (Bayley et al. 2014).

Data from our sites will also be leveraged in a variety of other projects and outreach:

- Community engagement and education regarding wetland habitats in the Slocan Watershed.
- Assessment of legacy mining on Seaton Creek wetland and downstream effects.
- Development of CABIN protocols and data sharing on a national level.
- Collaboration with the University of Waterloo.
- Biodiversity of wetland invertebrates in the Slocan Watershed in cooperation with the Royal BC Museum
- Spatial information on water quantity and quality monitoring data within the Columbia basin with respect to climate change in a Columbia Basin Trust project led by Martin Carver.
- Support of other conservation and restoration work under SWAMP.

SWAMP has identified a potential wetland restoration candidate on private land, and grass-roots work by the community has created a dialogue with private landowner. Successful restoration work funded by the Columbia Power Corporation under the Slocan River Riparian Restoration Program at the site has resulted in buy-in by land-owners with regards to restoring their non-functioning wetland. Applications for funding for this restoration site have been submitted to the National Wetland Conservation Fund and an application to the Fish and Wildlife Compensation Program was successful for work in 2016. The Central Kootenay invasive Species Society is willing to contribute to invasive species removal at the restoration site if needed. The Columbia Power Corporation may provide funds for educational signage at the site.

Photo 2. Photo by Ellen Kinsel from Marcy Mahr (2015)

Macroinvertebrates are appealing to community and educational programs. However, the biotic index of integrity is also a rigorous scientific method that once developed can be used by community members, non-profits, and agencies, landowners to assess and implement restoration, preservation and land acquisition projects.

8 Acknowledgements

The Slocan Wetlands Assessment and Mapping Project (SWAMP) is a collaboration of three societies, Slocan Solutions, Slocan River Streamkeepers and Slocan Lake Stewardship, working with the BC Wildlife Federation, the Fish and Wildlife Compensation Program, Columbia Basin Trust, Selkirk College, Regional District of Central Kootenay, Environment Canada's Canadian Aquatic Biomonitoring Network and Canadian Wildlife Service National Wetland Conservation Fund, the Columbia Basin Watershed Network, the Royal BC Museum, Rebecca Rooney of the University of Waterloo and Darcie Quamme of Integrated Ecological Research and Ryan Durand of Durand Ecological Consulting. Since 2013, SWAMP has taken an integrated scientific approach to filling data gaps by identifying, mapping and classifying wetlands throughout the Slocan Valley watershed. This local initiative successfully brings together local professional biologists and citizen scientists to: 1) conduct field surveys; 2) build a comprehensive wetlands database; 3) help refine provincial wetland classification for our region; and 4) identify/ prioritize sensitive wetlands for restoration and protection.

With respect to the present report, Darcie Quamme of Integrated Ecological Research developed the invertebrate protocol design, and conducted field work, statistical analyses and reporting. Rhia MacKenzie carried out grant applications, contract administration for the Slocan River Streamkeepers, field work and reporting. Richard Johnson served as the contract administrator under Slocan Solutions and provided the Stiff diagrams in in-kind hours under his company Opus. John Boulanger of Integrated Ecological Research provided statistical advice and carried out the statistical analyses that were carried out using SAS. Local streamkeepers, Verena Shaw, Mechelle Babic and Jennifer Yeow helped with field work in 2014. Tyson Ehlers and Ryan Durand carried out plant identifications.

The mapping and terrestrial vegetation assessment project of SWAMP led by Ryan Durand, funded by the Columbia Basin Trust, provided mapping products and reconnaissance work that suggested potential sites for the invertebrate component. Local community group members including: Rhia MacKenzie, Gregoire Lamoureux, Richard Johnson and Jennifer Yeow aided site selection by providing input on local knowledge of the area. Kristen Murphy of BC Forests, Lands and Natural Resources reviewed our site selection and protocols in 2015. Jolene Raggett of the Ministry of Environment agreed to be our contact in regards to water quality issues.

Funding, in-kind support or letters of support have been provided by BC Wildlife Federation, the Fish and Wildlife Compensation Program, Columbia Basin Trust, Selkirk College, Regional District of Central Kootenay, Environment Canada's Canadian Aquatic Biomonitoring Network and Canadian Wildlife Service National Wetland Conservation Fund, the Columbia Basin Watershed Network, the Ministry of Environment, the Ministry of Forests, Lands and Natural Resources, the Columbia Power Corporation and the Royal BC Museum.

Members of the SWAMP technical committee have provided valuable feedback and include: Jennifer Yeow, Rhia MacKenzie, Richard Johnson, Irene Manley, Margaret Hartley, Ann Meidinger, Bruce Cottingham, Amy Waterhouse, Doris Hausleitner, Gregoire Lamoureux, Marcy Mahr, Meeri Durand, Neil Fletcher, Terry Anderson, and Martin Carver.

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10 Appendices

10.1 Appendix 1: Site Locations

Sample.id	Disturbances	Year	Elevation (m)	Northing	Easting	%Natural	%Modified	%Disturbed	CABIN	Dominant emergent, 5x5 m
BEAR001	Highway, lake outflow,	2015	1080	5543400	486333	75.1	19.3	5.6	Riverine	Equisetum sylvaticum
BON001	Potential Reference	2015	576	5549023	466568	87.7	1.4	10.9	Lacustrine	Chara,Calliergon sp.,Eleocharis rostellata
BVL001	Potential Reference	2014	867	5561188	464335	77.5	20.1	2.4	Riverine	Equisetum arvense
BVL002	Potential Reference	2015	887	5560619	464692	97.8	0.1	2.1	Riverine	Equisetum fluviatile
BVL003	Potential Reference	2015	891	5560293	464563	95.0	1.8	3.2	Riverine	Carex lasiocarpa
CL001	Potential Reference	2015	1515	5482407	453242	65.5	28.7	5.8	Lacustrine	Carex utriculata
ELD001	Canary Reed Grass, residential	2015	521	5502111	462894	65.3	17.4	17.4	Floodplain	Carex utriculata
FO001	Roads/Rail bed, chloride	2015	519	5496615	460192	41.9	34.3	23.8	Floodplain	Ranunculus aquatilis
FRA001	Cattle	2015	507	5492379	455226	84.1	2.6	13.2	Floodplain	Sparganium angustifolium
GC001	Potential Reference	2015	1571	5480369	452213	98.3	0.0	1.7	Paulstrine	Equisetum sp.
GC002	Potential Reference	2015	1580	5479637	452715	94.8	0.0	5.2	Paulstrine	Sparganium sp.
HAY001	Canary Reed Grass, road, residential	2015	496	5482263	457573	53.4	15.5	31.1	Floodplain	Phalaris arundinacea
LSL001	Potential Reference	2014	611	5503393	452782	71.8	17.7	10.6	Lacustrine	Equisetum fluviatile
LSL002	Potential Reference	2015	653	5501110	451350	94.8	0.0	5.2	Lacustrine	Equisetum fluviatile
LWL001	Potential Reference	2015	906	5564499	459540	91.7	2.8	5.5	Lacustrine	Carex utriculata
PC002	Residential	2014	567	5474295	454778	59.1	5.5	35.3	Riverine	Scirpus microphyllum, Carex sp.
SEAT001	Metals, legacy mining	2015	1035	5542680	485047	96.6	0.0	3.4	Riverine	Calamagrostis canadensis
SEAT002	Metals, legacy mining	2014	962	5541616	483515	86.0	11.6	2.4	Riverine	Calliergon sp.,Hippuris vulgaris,Carex utriculata
SEAT003	Metals, legacy mining	2015	1008	5542111	484088	98.0	0.0	2.0	Riverine	Equisetum fluviatile
SUM001	Highway, rail, lake outflow	2015	702	5555073	456568	77.2	0.0	22.8	Lacustrine	Sparganium angustifolium
SUM002	Lake influence, recreation, residential	2015	765	5555285	455800	86.4	0.4	13.1	Lacustrine	Carex utriculata,Schoenoplectis tabernaemontanii
TY001	Canary Reed Grass, residential	2015	513	5492796	455562	85.6	0.4	13.9	Floodplain	Myriophyllum spicatum
WIN001	Potential Reference	2015	976	5494995	461820	92.2	4.0	3.8	Paulstrine	Scolochloa festucaceae,Mentha arvensis
WIN002	Potential Reference	2015	1028	5495161	462757	79.6	13.7	6.6	Paulstrine	Carex utriculata

% Land cover (Natural/Modified/Disturbed), measured as a GIS variable within 500m buffer zone

10.2 Appendix 2: Field meta-data

Study	SWAMP	SWAMP	SWAMP
Site	GC001 (July 9, 2015)	WIN001 (June 30,2015)	WIN002 (June 30,2015)
Name	Ryan's Fen	Winlaw woodlot	Winlaw woodlot
Basin	Columbia Basin	Columbia Basin	Columbia Basin
Year	2015	2015	2015
SampleNumber	1	1	2
Site_Status	Pot. Ref.	Test	Test
Latitude	49.2826	49.36374	49.36279
Longitude	-117.3934	-117.31707	-117.30562
Altitude	1571	976	1028
Datum	nad83	nad83	nad83
Ecoregion	Columbia Mountains	Columbia Mountains	Columbia Mountains
Basin - pond shape -Circular/Ellipse (Binary)	0	0	0
Basin - pond shape - Highly irregular (Binary)	1	1	1
Basin - pond shape - Linear (Binary)	0	1	1
Basin - pond shape - Complex (Binary)	1	0	0
Disturbance (wetted area)-%none	100	100	100
Disturbance (wetted area)-%filling	0	0	0
Disturbance (wetted area)-%grazing	0	0	0
Disturbance (wetted area)-%road	0	0	0
Disturbance (wetted area)-%urban	0	0	0
Disturbance (wetted area)-%mining	0	0	0
Disturbance (margin)-%none	90	90	100
Disturbance (margin)-%filling	0	0	0
Disturbance (margin)-%grazing	0	0	0
Disturbance (margin)-%road	10	10	0
Disturbance (margin)-%farm yard	0	0	0
Disturbance (margin)-%urban	0	0	0
Disturbance (margin)-%mining	0	0	0
Surrounding Land use - Forest (Binary)	1	1	1
Surrounding Land use - Field/Pasture (Binary)	0	0	0
Surrounding Land use - Agriculture (Binary)	0	0	0
Surrounding Land use - Residential/Urban (Binary)	0	0	0
Surrounding Land use - Logging (Binary)	0	1	1
Surrounding Land use - Mining (Binary)	0	0	0
Surrounding Land use - Comm/Industrial (Binary)	0	0	0
Surrounding Land use 500m - Forest (Binary)	1	1	1
Surrounding Land use 500m - Field/Pasture (Binary)	0	0	0
Surrounding Land use 500m - Agriculture (Binary)	0	0	0
Surrounding Land use 500m - Residential/Urban (Binary)	0	0	0
Surrounding Land use 500m - Logging (Binary)	0	1	1
Surrounding Land use 500m - Mining (Binary)	0	0	0
Surrounding Land use 500m - Comm/Industrial (Binary)	0	0	0
Dominant Surrounding Land use	forest	forest	forest
General -Metered - Conductivity (uS/s)	18	153	69
General -Metered - pH (pH)	7.5	8.1	8.3
Habitats - Marginal (Binary)	1	1	1
Habitats - Emergent (Binary)	1	1	1
Habitats -Submergent (Binary)	1	1	0
Habitats - Open water >2m (Binary)	1	0	1
Marginal zone veg-% Woody riparian	20	80	50
Marginal zone veg-% Typha	0	0	0
Marginal zone veg-% Scirpus	0	0	0
Marginal zone veg-% Grass/sedge	80	20	50
Marginal zone veg- Dominant	grass/sedge	woody.riparian	woody/riparian
Marginal zone veg- 2nd Dominant	woody/riparian	grass/sedge	grass/sedge
Beaver activity - present (Binary)	0	0	0
Beaver activity - absent (Binary)	1	1	1
Maximum Depth - (m) - < 1m (Binary)	0	1	1
Maximum Depth - (m) - 1-2 m (Binary)	1	0	0
Maximum Depth - (m) - >2 m (Binary)	0	0	0
Quadrat - Periphyton (1-5, not slippery to obscured)	1	2.5	1
Quadrat - % Area - Emergent	30	60	80
Quadrat -% Area - Floating plants	15	20	1
Quadrat - % Area - Open water	55	25	20
Quadrat - % Bottom Area - Periphyton	0	1	0
Quadrant - % Area - Submergent plants	30	1	0
Quadrat- %Woody debris	0	1	1
Site -% Area -Emergent vegetation -Visual	25	50	70
Site-% Area -Submergent vegetation- Visual	75	10	0
Site-% Area -Open Water- Visual	0	0	30
Site - Drawdown mudflat (Binary) at site	1	1	1
Site - Average mud flat width (m) at site	1		7.5
Site - Water level - Vestigal (Binary)	0	0	0
Site - Water level - Recessional (Binary)	1	1	1
Site - Water level - Intermedia (Binary)	0	0	0
Site - Water level - Full flooded (Binary)	0	0	0
Site - Water level - Overflowing (Binary)	0	0	0
Site - Hydrological Type - Palustrine (Binary)	1	1	1
Site - Hydrological Type - Lacustrine (Binary)	0	0	0
Site - Hydrological Type - Riverine (Binary)	0	0	0
Site- Wetland type - bog (Binary)	0	0	0
Site- Wetland type - fen (Binary)	1	0	0
Site- Wetland type - marsh (Binary)	0	0	1
Site- Wetland type - swamp (Binary)	0	0	1
Site- Wetland type - shallow-water (Binary)	1	0	0

Study	**SWAMP**	**SWAMP**	**SWAMP**	**SWAMP**
Site	**CL001 (July 9,2015)**	**ELD001 (July 13,2015)**	**FO001 (June 29,2015)**	**FRA001 (July 10, 2015)**
Name	**Cooley Lake**	**Elders' pond**	**Fomi's**	**Franks oxbow**
Basin	Columbia Basin	Columbia Basin	Columbia Basin	Columbia Basin
Year	2015	2015	2015	2015
SampleNumber	1	1	1	1
Site_Status	Test	Test	Test	Test
Latitude	49.2933	49.4013	49.37148	49.34563
Longitude	-117.3844	-117.3051	-117.33041	-117.371
Altitude	1515	521	519	507
Datum	nad83	nad83	nad83	nad83
Ecoregion	Columbia Mountains	Columbia Mountains	Columbia Mountains	Columbia Mountains
Basin - pond shape -Circular/Ellipse (Binary)	1	1	1	0
Basin - pond shape - Highly irregular (Binary)	0	0	0	1
Basin - pond shape - Linear (Binary)	0	0	1	0
Basin - pond shape - Complex (Binary)	0	0	0	0
Disturbance (wetted area)-%none	100	100	50	0
Disturbance (wetted area)-%filling	0	0	0	0
Disturbance (wetted area)-%grazing	0	0	0	100
Disturbance (wetted area)-%road	0	0	50	0
Disturbance (wetted area)-%urban	0	0	0	0
Disturbance (wetted area)-%mining	0	0	0	0
Disturbance (margin)-%none	100	0	50	0
Disturbance (margin)-%filling	0	0	0	0
Disturbance (margin)-%grazing	0	0	0	90
Disturbance (margin)-%road	0	50	50	0
Disturbance (margin)-%farm yard	0	25	0	10
Disturbance (margin)-%urban	0	25	0	0
Disturbance (margin)-%mining	0	0	0	0
Surrounding Land use - Forest (Binary)	1	1	0	1
Surrounding Land use - Field/Pasture (Binary)	0	1	0	1
Surrounding Land use - Agriculture (Binary)	0	1	1	1
Surrounding Land use - Residential/Urban (Binary)	0	1	1	1
Surrounding Land use - Logging (Binary)	0	0	0	1
Surrounding Land use - Mining (Binary)	0	0	0	0
Surrounding Land use - Commercial/Industrial (Binary)	0	0	0	0
Surrounding Land use 500m - Forest (Binary)	1	1	1	1
Surrounding Land use 500m - Field/Pasture (Binary)	0	1	1	1
Surrounding Land use 500m - Agriculture (Binary)	0	1	1	1
Surrounding Land use 500m - Residential/Urban (Binary)	0	1	1	1
Surrounding Land use 500m - Logging (Binary)	0	0	0	1
Surrounding Land use 500m - Mining (Binary)	0	0	0	0
Surrounding Land use 500m - Commercial/Industrial (Binary)	0	0	0	0
Dominant Surrounding Land use	forest	residential/urban	agriculture	agriculture
General -Metered - Conductivity (uS/s)	17	165	510	87
General -Metered - pH (pH)	7	9.4	9	9.7
Habitats - Marginal (Binary)	1	1	1	1
Habitats - Emergent (Binary)	1	1	1	1
Habitats -Submergent (Binary)	1	1	1	1
Habitats - Open water >2m (Binary)	1	1	1	1
Marginal zone veg-% Woody riparian	70	10	30	30
Marginal zone veg-% Typha	0	40	1	0
Marginal zone veg-% Scirpus	0	1	1	0
Marginal zone veg-% Grass/sedge	30	50	70	70
Marginal zone veg- Dominant	woody/riparian	grass/sedge	grass/sedge	grass/sedge
Marginal zone veg- 2nd Dominant	grass/sedge	typha	woody/riparian	woody/riparian
Canopy cover - not shaded (Binary)	0	1	1	1
Canopy cover - partially shaded (Binary)	1	0	0	0
Canopy cover - fully shaded (Binary)	0	0	0	0
Beaver activity - present (Binary)	0	0	1	0
Beaver activity - absent (Binary)	1	1	0	1
Maximum Depth - (m) - < 1m (Binary)	0	1	1	0
Maximum Depth - (m) - 1-2 m (Binary)	1	0	0	0
Maximum Depth - (m) - >2 m (Binary)	0	0	0	1
Quadrat - Periphyton (1-5, not slippery to obscured)	2	4	2.5	2
Quadrat - % Area - Emergent	50	80	40	90
Quadrat -% Area - Floating plants	10	10	30	10
Quadrat - % Area - Open water	40	10	30	1
Quadrat - % Bottom Area - Periphyton	1	90	80	0
Quadrant - % Area - Submergent plants	1	90	80	60
Quadrat- %Woody debris	5	0	50	1
Site -% Area -Emergent vegetation -Visual	20	90	40	85
Site-% Area -Submergent vegetation- Visual	0	85	60	30
Site-% Area -Open Water- Visual	80	0	0	0
Site - Drawdown mudflat (Binary) at site	1	0	1	1
Site - Average mud flat width (m) at site	0.5	0	0.25	1
Site - Water level - Vestigal (Binary)	0	0	0	0
Site - Water level - Recessional (Binary)	1	1	1	1
Site - Water level - Intermedia (Binary)	0	0	0	0
Site - Water level - Full flooded (Binary)	0	0	0	0
Site - Water level - Overflowing (Binary)	0	0	0	0
Site - Hydrological Type - Palustrine (Binary)	0	0	0	0
Site - Hydrological Type - Lacustrine (Binary)	1	0	0	0
Site - Hydrological Type - Riverine (Binary)	0	1	1	1
Site- Wetland type - bog (Binary)	0	0	0	0
Site- Wetland type - fen (Binary)	0	0	0	0

Study	**SWAMP**	**SWAMP**	**SWAMP**	**SWAMP**
Site	**GC002 (July 9, 2015)**	**HAY001 (July 10,2015)**	**LS002 (July 15, 2015)**	**LWL001 (July 20,2015)**
Name	**Flicker pond**	**Hay's wetland**	**Little Slocan South**	**Little Wilson Lake**
Basin	Columbia Basin	Columbia Basin	Columbia Basin	Columbia Basin
Year	2015	2015	2015	2015
SampleNumber	2	1	2	1
Site_Status	Pot. Ref.	Test	Pot. Ref.	Pot. Ref.
Latitude	49.2802	49.29295	49.3938	50.1353
Longitude	-117.3909	-117.359	-117.4027	-117.3402
Altitude	1580	496	653	906
Datum	nad83	nad83	nad83	nad83
Ecoregion	Columbia Mountains	Columbia Mountains	Columbia Mountains	Columbia Mountains
Basin - pond shape -Circular/Ellipse (Binary)	1	1	0	0
Basin - pond shape - Highly irregular (Binary)	0	0	0	0
Basin - pond shape - Linear (Binary)	0	1	0	1
Basin - pond shape - Complex (Binary)	0	0	1	0
Disturbance (wetted area)-%none	100	100	100	100
Disturbance (wetted area)-%filling	0	0	0	0
Disturbance (wetted area)-%grazing	0	0	0	0
Disturbance (wetted area)-%road	0	0	0	0
Disturbance (wetted area)-%urban	0	0	0	0
Disturbance (wetted area)-%mining	0	0	0	0
Disturbance (margin)-%none	50	10	100	50
Disturbance (margin)-%filling	0	0	0	0
Disturbance (margin)-%grazing	0	0	0	0
Disturbance (margin)-%road	50	50	0	50
Disturbance (margin)-%farm yard	0	0	0	0
Disturbance (margin)-%urban	0	40	0	0
Disturbance (margin)-%mining	0	0	0	0
Surrounding Land use - Forest (Binary)	1	1	1	1
Surrounding Land use - Field/Pasture (Binary)	0	0	0	0
Surrounding Land use - Agriculture (Binary)	0	0	0	0
Surrounding Land use - Residential/Urban (Binary)	0	1	0	0
Surrounding Land use - Logging (Binary)	0	0	0	0
Surrounding Land use - Mining (Binary)	0	0	0	0
Surrounding Land use - Comm/Industrial (Binary)	0	0	0	0
Surrounding Land use 500m - Forest (Binary)	1	1	1	1
Surrounding Land use 500m - Field/Pasture (Binary)	0	1	1	0
Surrounding Land use 500m - Agriculture (Binary)	0	0	0	0
Surrounding Land use 500m - Residential/Urban (Binary)	0	1	0	0
Surrounding Land use 500m - Logging (Binary)	0	0	1	1
Surrounding Land use 500m - Mining (Binary)	0	0	0	0
Surrounding Land use 500m - Comm/Industrial (Binary)	0	0	0	0
Dominant Surrounding Land use	forest	residential/urban	forest	forest
General -Metered - Conductivity (uS/s)	9	97	40	55
General -Metered - pH (pH)	8.3	7.3	7.8	6.8
Habitats - Marginal (Binary)	1	1	1	1
Habitats - Emergent (Binary)	1	1	1	1
Habitats -Submergent (Binary)	0	1	1	1
Habitats - Open water >2m (Binary)	1	1	1	0
Marginal zone veg-% Woody riparian	85	50	0	10
Marginal zone veg-% Typha	0	20	0	0
Marginal zone veg-% Scirpus	0	5	10	0
Marginal zone veg-% Grass/sedge	15	25	90	90
Marginal zone veg- Dominant	woody/riparian	woody/riparian	grass/sedge	grass/sedge
Marginal zone veg- 2nd Dominant	grass/sedge	grass/sedge	scirpus	woody/riparian
Canopy cover - not shaded (Binary)	1	0	1	
Canopy cover - partially shaded (Binary)	0	1	0	
Canopy cover - fully shaded (Binary)	0	0	0	
Beaver activity - present (Binary)	0	0	1	
Beaver activity - absent (Binary)	1	1	0	
Maximum Depth - (m) - < 1m (Binary)	0	1	0	0
Maximum Depth - (m) - 1-2 m (Binary)	1	0	0	0
Maximum Depth - (m) - >2 m (Binary)	0	0	1	1
Quadrat - Periphyton (1-5, not slippery to obscured)	2	1	2	2
Quadrat - % Area - Emergent	80	80	80	90
Quadrat -% Area - Floating plants	15	15	1	1
Quadrat - % Area - Open water	5	5	19	0
Quadrat - % Bottom Area - Periphyton	5	1	5	0
Quadrant - % Area - Submergent plants	0	5	5	10
Quadrat- %Woody debris	2	1	0	0
Site -% Area -Emergent vegetation -Visual	40	75	45	60
Site-% Area -Submergent vegetation- Visual	0	5	5	30
Site-% Area -Open Water- Visual	60	20	50	10
Site - Drawdown mudflat (Binary) at site	1	1	1	0
Site - Average mud flat width (m) at site	1.5	2	5	0
Site - Water level - Vestigal (Binary)	0	0	0	0
Site - Water level - Recessional (Binary)	1	1	1	1
Site - Water level - Intermedia (Binary)	0	0	0	0
Site - Water level - Full flooded (Binary)	0	0	0	0
Site - Water level - Overflowing (Binary)	0	0	0	0
Site - Hydrological Type - Palustrine (Binary)	1	0	0	0
Site - Hydrological Type - Lacustrine (Binary)	0	0	1	1
Site - Hydrological Type - Riverine (Binary)	0	1	0	0
Site- Wetland type - bog (Binary)	0	0	0	0
Site- Wetland type - fen (Binary)	0	0	0	0

Study	SWAMP	SWAMP	SWAMP	SWAMP
Site	SEAT003 (August 6,2015)	SUM001 (July 21,2015)	SUM002 (July 21, 2015)	TY001 (July 10, 2015)
Name	Seaton Cr. Complex	Summit Lake Swamp	Summit Lake	Tyson's pond
Basin	Columbia Basin	Columbia Basin	Columbia Basin	Columbia Basin
Year	2015	2015	2015	2015
SampleNumber	4	1	2	1
Site_Status	Test	Test	Test	Pot. Ref.
Latitude	50.01519	50.06466	50.08533	49.35101
Longitude	-117.13198	-117.36283	-117.37071	-117.36535
Altitude	1008	702	765	513
Datum	nad83	nad83	nad83	nad83
Ecoregion	Columbia Mountains	Columbia Mountains	Columbia Mountains	Columbia Mountains
Basin - pond shape -Circular/Ellipse (Binary)	0	0	1	1
Basin - pond shape - Highly irregular (Binary)	1	1	0	0
Basin - pond shape - Linear (Binary)	0	0	0	0
Basin - pond shape - Complex (Binary)	1	1	0	0
Disturbance (wetted area)-%none	50	50	80	100
Disturbance (wetted area)-%filling	0	0	0	0
Disturbance (wetted area)-%grazing	0	0	0	0
Disturbance (wetted area)-%road	50	50	20	0
Disturbance (wetted area)-%urban	0	0	0	0
Disturbance (wetted area)-%mining	0	0	0	0
Disturbance (margin)-%none	20	50	40	100
Disturbance (margin)-%filling	0	0	0	0
Disturbance (margin)-%grazing	0	0	0	0
Disturbance (margin)-%road	50	50	60	0
Disturbance (margin)-%farm yard	0	0	0	0
Disturbance (margin)-%urban	0	0	0	0
Disturbance (margin)-%mining	30	0	0	0
Surrounding Land use - Forest (Binary)	1	1	1	1
Surrounding Land use - Field/Pasture (Binary)	0	0	0	0
Surrounding Land use - Agriculture (Binary)	0	0	0	0
Surrounding Land use - Residential/Urban (Binary)	0	1	1	0
Surrounding Land use - Logging (Binary)	1	1	1	0
Surrounding Land use - Mining (Binary)	1	1	0	0
Surrounding Land use - Comm/Industrial (Binary)	0	0	0	0
Surrounding Land use 500m - Forest (Binary)	1	1	1	1
Surrounding Land use 500m - Field/Pasture (Binary)	0	0	0	0
Surrounding Land use 500m - Agriculture (Binary)	0	0	0	0
Surrounding Land use 500m - Residential/Urban (Binary)	0	1	1	1
Surrounding Land use 500m - Logging (Binary)	1	1	1	0
Surrounding Land use 500m - Mining (Binary)	1	1	1	0
Surrounding Land use 500m - Comm/Industrial (Binary)	0	0	0	0
Dominant Surrounding Land use	forest	forest	forest	forest
Habitats - Marginal (Binary)	1	1	1	1
Habitats - Emergent (Binary)	1	1	1	1
Habitats -Submergent (Binary)	0	1	1	1
Habitats - Open water >2m (Binary)	1	1	1	0
Marginal zone veg-% Woody riparian	10	25	10	10
Marginal zone veg-% Typha	0	5	0	0
Marginal zone veg-% Scirpus	0	1	60	0
Marginal zone veg-% Grass/sedge	90	70	30	90
Marginal zone veg- Dominant	grass/sedge	grass/sedge	scirpus	grass/sedge
Marginal zone veg- 2nd Dominant	woody/riparian	woody/riparian	grass/sedge	woody/riparian
Canopy cover - not shaded (Binary)	1	1	1	0
Canopy cover - partially shaded (Binary)	0	0	0	1
Canopy cover - fully shaded (Binary)	0	0	0	0
Beaver activity - present (Binary)	1	0	0	0
Beaver activity - absent (Binary)	0	1	1	1
Maximum Depth - (m) - < 1m (Binary)	0	0	0	0
Maximum Depth - (m) - 1-2 m (Binary)	1	1	0	1
Maximum Depth - (m) - >2 m (Binary)	0	0	1	0
Quadrat - Periphyton (1-5, not slippery to obscured)	3	2	1	4
Quadrat - % Area - Emergent	85	70	65	50
Quadrat -% Area - Floating plants	0	25	10	0
Quadrat - % Area - Open water	15	5	25	5
Quadrat - % Bottom Area - Periphyton	50	1	0	20
Quadrant - % Area - Submergent plants	0	90	1	75
Quadrat- %Woody debris	0	1	1	0
Site -% Area -Emergent vegetation -Visual	90	1	75	30
Site-% Area -Submergent vegetation- Visual	1	1	1	70
Site-% Area -Open Water- Visual	0	0	0	0
Site - Drawdown mudflat (Binary) at site	1	0	0	1
Site - Average mud flat width (m) at site	1	0	0	0.5
Site - Water level - Vestigal (Binary)	0	0	0	0
Site - Water level - Recessional (Binary)	1	0	0	1
Site - Water level - Intermedia (Binary)	0	1	1	0
Site - Water level - Full flooded (Binary)	0	0	0	0
Site - Water level - Overflowing (Binary)	0	0	0	0
Site - Hydrological Type - Palustrine (Binary)	0	0	0	0
Site - Hydrological Type - Lacustrine (Binary)	0	1	1	0
Site - Hydrological Type - Riverine (Binary)	1	1	0	1
Site- Wetland type - bog (Binary)	0	0	0	0
Site- Wetland type - fen (Binary)	0	0	0	0

Study	SWAMP	SWAMP	SWAMP	SWAMP
Site	PC02 (Aug 25, 2014)	TF01 (Aug 26, 2014)	LSL01 (Aug 27, 2014)	BVL01 (Aug 27, 2014)
Name	Pass Creek Wetland	Seaton Crk. Wetland	Little Slocan Lakes Wetland	Beaver Lakes
Basin	Columbia Basin	Columbia Basin	Columbia Basin	Columbia Basin
Year	2014	2014	2014	2014
SampleNumber	2	1	1	1
Site_Status	Test	Test	Pot. Ref.	Pot. Ref.
Latitude	49.79249954	50.026668	49.681268	50.201836
Longitude	-116.8477783	-117.23015	-117.654757	-117.499701
Altitude	577	950	655	866.9
Datum	nad83	nad83	nad83	nad83
Ecoregion	Columbia Mountains	Columbia Mountains	Columbia Mountains	Columbia Mountains
Basin - pond shape -Circular/Ellipse (Binary)	0	0	0	0
Basin - pond shape - Highly irregular (Binary)	1	1	1	1
Basin - pond shape - Linear (Binary)	1	1	1	1
Basin - pond shape - Complex (Binary)	1	1	1	1
Disturbance (wetted area)-%none	100	60	100	100
Disturbance (wetted area)-%filling	0	0	0	0
Disturbance (wetted area)-%grazing	0	0	0	0
Disturbance (wetted area)-%road	0	40	0	0
Disturbance (wetted area)-%urban	0	0	0	0
Disturbance (wetted area)-%mining	0	0	0	0
Disturbance (margin)-%none	75	20	100	80
Disturbance (margin)-%filling	0	0	0	0
Disturbance (margin)-%grazing	0	0	0	0
Disturbance (margin)-%road	25	40	0	20
Disturbance (margin)-%farm yard	0	0	0	0
Disturbance (margin)-%urban	0	0	0	0
Disturbance (margin)-%mining	0	40	0	0
Dominant Surrounding Land use	residential	mining	forest	forest
General -Metered - Conductivity (uS/s)	82.6	446	37	76
General -Metered - dissolved oxygen (DO mg/L)	9	5	4.375	19.2
General -Metered - pH (pH)	7.2	7.3	6.7	6.9
General-Hach kit - Acidity (mg/L)	2.3	4.6	2.3	4.6
General-Hach kit - Total dissolved solids (mg/L)	55	222	18	38
General-Hach kit - Alkalinity (mg/L)	27.4	147	51.3	68.4
General- Hach kit- Hardness (mg/L)	17.2	154	34.2	34.2
Habitats - Marginal (Binary)	1	1	1	1
Habitats - Emergent (Binary)	1	1	1	1
Habitats -Submergent (Binary)	1	1	1	1
Habitats - Open water >2m (Binary)	0	0	1	0
Marginal zone veg-% Woody riparian	40	75	80	90
Marginal zone veg-% Typha	0	0	0	0
Marginal zone veg-% Scirpus	30	0	0	0
Marginal zone veg-% Grass/sedge	30	25	20	10
Marginal zone veg- Dominant	woody/riparian	woody/riparian	woody/riparian	woody/riparian
Marginal zone veg- 2nd Dominant	grass/sedge	grass/sedge	sedges/grasses	sedges/grasses
Maximum Depth - (m) - < 1m (Binary)	0	1	0	1
Maximum Depth - (m) - 1-2 m (Binary)	1	1	0	0
Maximum Depth - (m) - >2 m (Binary)	0	0	1	0
Quadrat - Periphyton (1-5, not slippery to obscured)	2	3	1	3
Quadrat - % Area - Emergent	50	45	98	50
Quadrat -% Area - Floating plants	25	0	1	0
Quadrat - % Bottom Area - Periphyton	0	55	0	20
Quadrant - % Area - Submergent plants	50	0	1	0
Quadrat- %Woody debris	5	5	0	20
Site -% Area -Emergent vegetation -Visual	20	60	90	80
Site-% Area -Submergent vegetation- Visual	40	40	10	20
Site - Drawdown mudflat (Binary) at site	0	0	0	0
Site - Average mud flat width (m) at site	0	0	0	0
Site - Water level - Vestigal (Binary)	0	0	0	0
Site - Water level - Recessional (Binary)	1	1	1	0
Site - Water level - Intermedia (Binary)	0	0	0	0
Site - Water level - Full flooded (Binary)	0	0	0	0
Site - Water level - Overflowing (Binary)	0	0	0	0
Site - Hydrological Type - Palustrine (Binary)	0	0	0	0
Site - Hydrological Type - Lacustrine (Binary)	0	0	1	1
Site - Hydrological Type - Riverine (Binary)	1	1	0	1
Site- Wetland type - bog (Binary)	0	0	0	0
Site- Wetland type - fen (Binary)	0	0	0	0
Site- Wetland type - marsh (Binary)	1	0	0	0
Site- Wetland type - swamp (Binary)	0	0	0	0
Site- Wetland type - shallow-water (Binary)	1	1	1	1
Temperature - water- Degrees Celcius	20	14.7	22	7

Study	SWAMP	SWAMP	SWAMP
Site	**BEAR001 (July 14,2015)**	**BON001 (July 21, 2015)**	**BVL002 (July 29,2015)**
Name	**Bear Lake**	**Bonanza marsh**	**Beaver Lakes Complex**
Basin	Columbia Basin	Columbia Basin	Columbia Basin
Year	2015	2015	2015
SampleNumber	1	1	2
Site_Status	Test	Test	Test
Latitude	50.02338	50.05331	50.11482
Longitude	-117.11271	-117.28026	-117.29407
Altitude	1080	576	887
Datum	nad83	nad83	nad83
Ecoregion	Columbia Mountains	Columbia Mountains	Columbia Mountains
Basin - pond shape -Circular/Ellipse (Binary)	0	0	0
Basin - pond shape - Highly irregular (Binary)	1	0	1
Basin - pond shape - Linear (Binary)	0	0	0
Basin - pond shape - Complex (Binary)	1	1	1
Disturbance (wetted area)-%none	0	70	100
Disturbance (wetted area)-%filling	0	30	0
Disturbance (wetted area)-%grazing	0	0	0
Disturbance (wetted area)-%road	50	0	0
Disturbance (wetted area)-%urban	0	0	0
Disturbance (wetted area)-%mining	50	0	0
Disturbance (margin)-%none	0	40	0
Disturbance (margin)-%filling	0	20	0
Disturbance (margin)-%grazing	0	0	0
Disturbance (margin)-%road	50	30	100
Disturbance (margin)-%farm yard	0	0	0
Disturbance (margin)-%urban	0	10	0
Disturbance (margin)-%mining	50	0	0
Surrounding Land use - Forest (Binary)	1	1	1
Surrounding Land use - Field/Pasture (Binary)	0	0	0
Surrounding Land use - Agriculture (Binary)	0	0	0
Surrounding Land use - Residential/Urban (Binary)	0	1	0
Surrounding Land use - Logging (Binary)	1	0	0
Surrounding Land use - Mining (Binary)	1	0	0
Surrounding Land use - Commercial/Industrial (Binary)	0	0	0
Surrounding Land use 500m - Forest (Binary)	1	1	1
Surrounding Land use 500m - Field/Pasture (Binary)	0	0	0
Surrounding Land use 500m - Agriculture (Binary)	0	0	0
Surrounding Land use 500m - Residential/Urban (Binary)	0	1	0
Surrounding Land use 500m - Logging (Binary)	1	1	1
Surrounding Land use 500m - Mining (Binary)	1	0	0
Surrounding Land use 500m - Commercial/Industrial (Binary)	0	0	0
Dominant Surrounding Land use	forest	forest	forest
Dissolved organic carbon (mg/L)	1	3.3	5.5
General -Metered - Conductivity (uS/s)	168	558	58
General -Metered - pH (pH)	9.9	6.2	7.5
Habitats - Marginal (Binary)	1	1	1
Habitats - Emergent (Binary)	1	1	1
Habitats -Submergent (Binary)	1	1	0
Habitats - Open water >2m (Binary)	1	1	0
Marginal zone veg-% Woody riparian	20	10	10
Marginal zone veg-% Typha	0	5	0
Marginal zone veg-% Scirpus	0	50	0
Marginal zone veg-% Grass/sedge	80	35	90
Marginal zone veg- Dominant	grass/sedge	scirpus	grass/sedge
Marginal zone veg- 2nd Dominant	woody/riparian	grass/sedge	woody riparian
Beaver activity - present (Binary)	1	0	0
Beaver activity - absent (Binary)	0	1	1
Maximum Depth - (m) - < 1m (Binary)	1	0	0
Maximum Depth - (m) - 1-2 m (Binary)	0	0	1
Maximum Depth - (m) - >2 m (Binary)	0	1	0
Nitrogen - total (mg/L)	0.177	0.273	0.345
Phosphorus - total (mg/L)	0.056	0.014	0.2
Quadrat - Periphyton (1-5, not slippery to obscured)	1	3.5	1
Quadrat - % Area - Emergent	85	70	100
Quadrat -% Area - Floating plants	0	0	1
Quadrat - % Area - Open water	15	30	1
Quadrat - % Bottom Area - Periphyton	0	70	1
Quadrant - % Area - Submergent plants	5	80	0
Quadrat- %Woody debris	5	1	15
Site -% Area -Emergent vegetation -Visual	70	40	90
Site-% Area -Submergent vegetation- Visual	10	80	10
Site-% Area -Open Water- Visual	0	0	0
Site - Drawdown mudflat (Binary) at site	1	0	0
Site - Average mud flat width (m) at site	1.5	0	0
Site - Water level - Vestigal (Binary)	0	0	0
Site - Water level - Recessional (Binary)	1	1	1
Site - Water level - Intermedia (Binary)	0	0	0
Site - Water level - Full flooded (Binary)	0	0	0
Site - Water level - Overflowing (Binary)	0	0	0
Site - Hydrological Type - Palustrine (Binary)	0	0	0
Site - Hydrological Type - Lacustrine (Binary)	1	1	1
Site - Hydrological Type - Riverine (Binary)	0	1	1
Site- Wetland type - bog (Binary)	0	0	0
Site- Wetland type - fen (Binary)	0	0	0
Site- Wetland type - marsh (Binary)	1	1	1
Site- Wetland type - swamp (Binary)	0	0	0

Study	**SWAMP**	**SWAMP**
Site	**SEAT001 - 1 (July 14, 2015)**	**BVL003 (July 29,2015)**
Name	**Seaton Cr. Complex**	**Beaver Lakes Complex**
Basin	Columbia Basin	Columbia Basin
Year	2015	2015
SampleNumber	2	3
Site_Status	Test	Pot. Ref.
Latitude	50.02104	50.1138
Longitude	-117.12317	-117.2947
Altitude	1035	891
Datum	nad83	nad83
Ecoregion	Columbia Mountains	Columbia Mountains
Basin - pond shape -Circular/Ellipse (Binary)	0	0
Basin - pond shape - Highly irregular (Binary)	1	1
Basin - pond shape - Linear (Binary)	0	0
Basin - pond shape - Complex (Binary)	0	1
Disturbance (wetted area)-%none	0	100
Disturbance (wetted area)-%filling	0	0
Disturbance (wetted area)-%grazing	0	0
Disturbance (wetted area)-%road	50	0
Disturbance (wetted area)-%urban	0	0
Disturbance (wetted area)-%mining	50	0
Disturbance (margin)-%none	0	100
Disturbance (margin)-%filling	0	0
Disturbance (margin)-%grazing	0	0
Disturbance (margin)-%road	50	0
Disturbance (margin)-%farm yard	0	0
Disturbance (margin)-%urban	0	0
Disturbance (margin)-%mining	50	0
Surrounding Land use - Forest (Binary)	1	1
Surrounding Land use - Field/Pasture (Binary)	0	0
Surrounding Land use - Agriculture (Binary)	0	0
Surrounding Land use - Residential/Urban (Binary)	0	0
Surrounding Land use - Logging (Binary)	1	0
Surrounding Land use - Mining (Binary)	1	0
Surrounding Land use - Comm/Industrial (Binary)	0	0
Surrounding Land use 500m - Forest (Binary)	1	1
Surrounding Land use 500m - Field/Pasture (Binary)	0	0
Surrounding Land use 500m - Agriculture (Binary)	0	0
Surrounding Land use 500m - Residential/Urban (Binary)	0	0
Surrounding Land use 500m - Logging (Binary)	1	0
Surrounding Land use 500m - Mining (Binary)	1	0
Surrounding Land use 500m - Comm/Industrial (Binary)	0	0
Dominant Surrounding Land use	forest	forest
General -Metered - Conductivity (uS/s)	205	31
General -Metered - pH (pH)	9.4	7.4
Habitats - Marginal (Binary)	1	1
Habitats - Emergent (Binary)	1	1
Habitats -Submergent (Binary)	1	1
Habitats - Open water >2m (Binary)	1	1
Marginal zone veg-% Woody riparian	25	10
Marginal zone veg-% Typha	0	0
Marginal zone veg-% Scirpus	10	0
Marginal zone veg-% Grass/sedge	65	90
Marginal zone veg- Dominant	grass/sedge	grass/sedge
Marginal zone veg- 2nd Dominant	woody/riparian	woody riparian
Beaver activity - present (Binary)	1	0
Beaver activity - absent (Binary)	0	1
Maximum Depth - (m) - < 1m (Binary)	0	0
Maximum Depth - (m) - 1-2 m (Binary)	0	1
Maximum Depth - (m) - >2 m (Binary)	1	0
Quadrat - Periphyton (1-5, not slippery to obscured)	1	3.5
Quadrat - % Area - Emergent	80	60
Quadrat -% Area - Floating plants	0	25
Quadrat - % Area - Open water	20	15
Quadrat - % Bottom Area - Periphyton	0	80
Quadrant - % Area - Submergent plants	1	1
Quadrat- %Woody debris	1	0
Site -% Area -Emergent vegetation -Visual	80	95
Site-% Area -Submergent vegetation- Visual	5	5
Site-% Area -Open Water- Visual	15	0
Site - Drawdown mudflat (Binary) at site	0	
Site - Average mud flat width (m) at site	0	
Site - Water level - Vestigal (Binary)	0	
Site - Water level - Recessional (Binary)	1	1
Site - Water level - Intermedia (Binary)	0	2.5
Site - Water level - Full flooded (Binary)	0	0
Site - Water level - Overflowing (Binary)	0	1
Site - Hydrological Type - Palustrine (Binary)	0	0
Site - Hydrological Type - Lacustrine (Binary)	0	0
Site - Hydrological Type - Riverine (Binary)	1	0
Site- Wetland type - bog (Binary)	0	0
Site- Wetland type - fen (Binary)	0	1

Study	SWAMP	SWAMP	SWAMP
Site	**SEAT001 - 1 (July 14, 2015)**	**SEAT001-2 (August 6, 2015)**	**BVL003 (July 29,2015)**
Name	**Seaton Cr. Complex**	**Seaton Cr. Complex**	**Beaver Lakes Complex**
Basin	Columbia Basin	Columbia Basin	Columbia Basin
Year	2015	2015	2015
SampleNumber	2	3	3
Site_Status	Test	Test	Pot. Ref.
Latitude	50.02104	50.02104	50.1138
Longitude	-117.12317	-117.12317	-117.2947
Altitude	1035	1035	891
Datum	nad83	nad83	nad83
Ecoregion	Columbia Mountains	Columbia Mountains	Columbia Mountains
Basin - pond shape -Circular/Ellipse (Binary)	0	0	0
Basin - pond shape - Highly irregular (Binary)	1	1	1
Basin - pond shape - Linear (Binary)	0	0	0
Basin - pond shape - Complex (Binary)	0	0	1
Disturbance (wetted area)-%none	0	0	100
Disturbance (wetted area)-%filling	0	0	0
Disturbance (wetted area)-%grazing	0	0	0
Disturbance (wetted area)-%road	50	50	0
Disturbance (wetted area)-%urban	0	0	0
Disturbance (wetted area)-%mining	50	50	0
Disturbance (margin)-%none	0	0	100
Disturbance (margin)-%filling	0	0	0
Disturbance (margin)-%grazing	0	0	0
Disturbance (margin)-%road	50	50	0
Disturbance (margin)-%farm yard	0	0	0
Disturbance (margin)-%urban	0	0	0
Disturbance (margin)-%mining	50	50	0
Surrounding Land use - Forest (Binary)	1	1	1
Surrounding Land use - Field/Pasture (Binary)	0	0	0
Surrounding Land use - Agriculture (Binary)	0	0	0
Surrounding Land use - Residential/Urban (Binary)	0	0	0
Surrounding Land use - Logging (Binary)	1	1	0
Surrounding Land use - Mining (Binary)	1	1	0
Surrounding Land use - Comm/Industrial (Binary)	0	0	0
Surrounding Land use 500m - Forest (Binary)	1	1	1
Surrounding Land use 500m - Field/Pasture (Binary)	0	0	0
Surrounding Land use 500m - Agriculture (Binary)	0	0	0
Surrounding Land use 500m - Residential/Urban (Binary)	0	0	0
Surrounding Land use 500m - Logging (Binary)	1	1	0
Surrounding Land use 500m - Mining (Binary)	1	1	0
Surrounding Land use 500m - Comm/Industrial (Binary)	0	0	0
Dominant Surrounding Land use	forest	forest	forest
General -Metered - Conductivity (uS/s)	205	205	31
General -Metered - pH (pH)	9.4	9.4	7.4
Habitats - Marginal (Binary)	1	1	1
Habitats - Emergent (Binary)	1	1	1
Habitats -Submergent (Binary)	1	1	1
Habitats - Open water >2m (Binary)	1	1	1
Marginal zone veg-% Woody riparian	25	25	10
Marginal zone veg-% Typha	0	0	0
Marginal zone veg-% Scirpus	10	10	0
Marginal zone veg-% Grass/sedge	65	65	90
Marginal zone veg- Dominant	grass/sedge	grass/sedge	grass/sedge
Marginal zone veg- 2nd Dominant	woody/riparian	woody/riparian	woody riparian
Beaver activity - present (Binary)	1	1	0
Beaver activity - absent (Binary)	0	0	1
Maximum Depth - (m) - < 1m (Binary)	0	0	0
Maximum Depth - (m) - 1-2 m (Binary)	0	0	1
Maximum Depth - (m) - >2 m (Binary)	1	1	0
Quadrat - Periphyton (1-5, not slippery to obscured)	1	1	3.5
Quadrat - % Area - Emergent	80	80	60
Quadrat -% Area - Floating plants	0	0	25
Quadrat - % Area - Open water	20	20	15
Quadrat - % Bottom Area - Periphyton	0	0	80
Quadrant - % Area - Submergent plants	1	1	1
Quadrat- %Woody debris	1	1	0
Site -% Area -Emergent vegetation -Visual	80	80	95
Site-% Area -Submergent vegetation- Visual	5	5	5
Site-% Area -Open Water- Visual	15	15	0
Site - Drawdown mudflat (Binary) at site	0	0	
Site - Average mud flat width (m) at site	0	0	
Site - Water level - Vestigal (Binary)	0	0	
Site - Water level - Recessional (Binary)	1	1	1
Site - Water level - Intermedia (Binary)	0	0	2.5
Site - Water level - Full flooded (Binary)	0	0	0
Site - Water level - Overflowing (Binary)	0	0	1
Site - Hydrological Type - Palustrine (Binary)	0	0	0
Site - Hydrological Type - Lacustrine (Binary)	0	0	0
Site - Hydrological Type - Riverine (Binary)	1	1	0
Site- Wetland type - bog (Binary)	0	0	0
Site- Wetland type - fen (Binary)	0	0	1

Study	SWAMP	SWAMP	SWAMP
Site	**GC001 (July 9, 2015)**	**WIN001 (June 30,2015)**	**WIN002 (June 30,2015)**
Name	**Ryan's Fen**	**Winlaw woodlot**	**Winlaw woodlot**
Basin	Columbia Basin	Columbia Basin	Columbia Basin
Year	2015	2015	2015
SampleNumber	1	1	2
Site_Status	Pot. Ref.	Pot. Ref.	Pot. Ref
Latitude	49.2826	49.36374	49.36279
Longitude	-117.3934	-117.31707	-117.30562
Altitude	1571	976	1028
Datum	nad83	nad83	nad83
Ecoregion	Columbia Mountains	Columbia Mountains	Columbia Mountains
Basin - pond shape -Circular/Ellipse (Binary)	0	0	0
Basin - pond shape - Highly irregular (Binary)	1	1	1
Basin - pond shape - Linear (Binary)	0	1	1
Basin - pond shape - Complex (Binary)	1	0	0
Disturbance (wetted area)-%none	100	100	100
Disturbance (wetted area)-%filling	0	0	0
Disturbance (wetted area)-%grazing	0	0	0
Disturbance (wetted area)-%road	0	0	0
Disturbance (wetted area)-%urban	0	0	0
Disturbance (wetted area)-%mining	0	0	0
Disturbance (margin)-%none	90	90	100
Disturbance (margin)-%filling	0	0	0
Disturbance (margin)-%grazing	0	0	0
Disturbance (margin)-%road	10	10	0
Disturbance (margin)-%farm yard	0	0	0
Disturbance (margin)-%urban	0	0	0
Disturbance (margin)-%mining	0	0	0
Surrounding Land use - Forest (Binary)	1	1	1
Surrounding Land use - Field/Pasture (Binary)	0	0	0
Surrounding Land use - Agriculture (Binary)	0	0	0
Surrounding Land use - Residential/Urban (Binary)	0	0	0
Surrounding Land use - Logging (Binary)	0	1	1
Surrounding Land use - Mining (Binary)	0	0	0
Surrounding Land use - Comm/Industrial (Binary)	0	0	0
Surrounding Land use 500m - Forest (Binary)	1	1	1
Surrounding Land use 500m - Field/Pasture (Binary)	0	0	0
Surrounding Land use 500m - Agriculture (Binary)	0	0	0
Surrounding Land use 500m - Residential/Urban (Binary)	0	0	0
Surrounding Land use 500m - Logging (Binary)	0	1	1
Surrounding Land use 500m - Mining (Binary)	0	0	0
Surrounding Land use 500m - Comm/Industrial (Binary)	0	0	0
Dominant Surrounding Land use	forest	forest	forest
General -Metered - Conductivity (uS/s)	18	153	69
General -Metered - pH (pH)	7.5	8.1	8.3
Habitats - Marginal (Binary)	1	1	1
Habitats - Emergent (Binary)	1	1	1
Habitats -Submergent (Binary)	1	1	0
Habitats - Open water >2m (Binary)	1	0	1
Marginal zone veg-% Woody riparian	20	80	50
Marginal zone veg-% Typha	0	0	0
Marginal zone veg-% Scirpus	0	0	0
Marginal zone veg-% Grass/sedge	80	20	50
Marginal zone veg- Dominant	grass/sedge	woody.riparian	woody/riparian
Marginal zone veg- 2nd Dominant	woody/riparian	grass/sedge	grass/sedge
Beaver activity - present (Binary)	0	0	0
Beaver activity - absent (Binary)	1	1	1
Maximum Depth - (m) - < 1m (Binary)	0	1	1
Maximum Depth - (m) - 1-2 m (Binary)	1	0	0
Maximum Depth - (m) - >2 m (Binary)	0	0	0
Quadrat - Periphyton (1-5, not slippery to obscured)	1	2.5	1
Quadrat - % Area - Emergent	30	60	80
Quadrat -% Area - Floating plants	15	20	1
Quadrat - % Area - Open water	55	25	20
Quadrat - % Bottom Area - Periphyton	0	1	0
Quadrant - % Area - Submergent plants	30	1	0
Quadrat- %Woody debris	0	1	1
Site -% Area -Emergent vegetation -Visual	25	50	70
Site-% Area -Submergent vegetation- Visual	75	10	0
Site-% Area -Open Water- Visual	0	0	30
Site - Drawdown mudflat (Binary) at site	1	1	1
Site - Average mud flat width (m) at site	1		7.5
Site - Water level - Vestigal (Binary)	0	0	0
Site - Water level - Recessional (Binary)	1	1	1
Site - Water level - Intermedia (Binary)	0	0	0
Site - Water level - Full flooded (Binary)	0	0	0
Site - Water level - Overflowing (Binary)	0	0	0
Site - Hydrological Type - Palustrine (Binary)	1	1	1
Site - Hydrological Type - Lacustrine (Binary)	0	0	0
Site - Hydrological Type - Riverine (Binary)	0	0	0
Site- Wetland type - bog (Binary)	0	0	0
Site- Wetland type - fen (Binary)	1	0	0

10.3 Appendix 3: Laboratory analysed water quality data

Analyte	Units	MRL	F0001	WIN001	WIN002	GC001	GC002	CL001	HAY001
			6-Jul-15	06-Jul-15	6-Jul-15	9-Jul-15	9-Jul-15	9-Jul-15	14-Jul-15
Chloride	mg/L	0.1	76.9	1.28	1.77	<0.10	2.29	<0.10	3.7
Nitrate as N	mg/L	0.01	0.02	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nitrite as N	mg/L	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sulfate	mg/L	1	<1.0	<1.0	<1.0	1	5.2	<1.0	3.7
Carbon, Total Organic	% dry	0.05	23.4	14.8	34.8	22.5	18.8	22.2	12.6
Alkalinity, Total as CaCO3	mg/L		175	87	27	17.1	13.7	13.7	44.5
Carbon, Dissolved Organic	mg/L	0.5	11.8	18.4	35	3.2	6.1	4	9
Ammonia as N, Total	mg/L	0.02	0.066	0.048	0.042	0.034	0.022	<0.020	0.041
Nitrogen, Total Kjeldahl	mg/L	0.05	1.78	1.08	10.5	0.35	0.73	0.38	0.76
Phosphorus, Total as P	mg/L	0.002	0.129	0.037	0.82	0.011	0.047	0.007	0.101
Phosphorus, Total Dissolved	mg/L	0.002	0.021	0.037	0.115	0.008	0.013	0.004	0.027
Solids, Total Suspended	mg/L	2	14	<3	186	<2	18	<2	<2
Turbidity	NTU		4.9	2	47.4	0.65	1.5	0.55	1.8
pH	pH units		7.85	7.58	6.97	6.5	6.5	6.7	6.9
Conductivity (EC)	uS/cm		620	165	61	16.9	8.6	16.4	99.6
Hardness, Total (Total as CaCO3)	mg/L	5	204	86.7	33.8	<5.0	<5.0	<5.0	51.6
Nitrate+Nitrite as N	mg/L	0.01	0.02	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nitrogen, Total	mg/L	0.05	1.8	1.08	10.5	0.35	0.728	0.375	0.755
Nitrogen, Organic	mg/L	0.05	1.71	1.03	10.4	0.316	0.706	0.375	0.714
> 75 µm	% dry	0.1	16.3	11.2	13.5	23.1	17.5	33.4	28
Classification	% dry		Fine	Fine	Fine	Fine	Fine	Fine	Fine
Aluminum, total	mg/L	0.05	<0.05	0.09	1.43	0.11	0.15	0.17	<0.05
Antimony, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, total	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Barium, total	mg/L	0.05	0.13	0.13	0.07	<0.05	<0.05	<0.05	<0.05
Beryllium, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron, total	mg/L	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Cadmium, total	mg/L	0.0001	<0.0001	<0.0001	0.0002	0.0002	0.0001	0.0002	<0.0001
Calcium, total	mg/L	2	55.4	23.5	10.4	<2.0	<2.0	<2.0	15.2
Chromium, total	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt, total	mg/L	0.0005	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Copper, total	mg/L	0.002	<0.002	<0.002	0.008	<0.002	<0.002	<0.002	<0.002
Iron, total	mg/L	0.1	1.25	0.19	1.03	0.21	0.35	<0.10	1.17
Lead, total	mg/L	0.001	<0.001	<0.001	0.004	0.001	0.004	0.001	<0.001
Lithium, total	mg/L	0.001	0.01	<0.001	0.002	<0.001	<0.001	<0.001	0.001
Magnesium, total	mg/L	0.1	15.9	6.8	1.9	0.3	0.1	0.4	3.3
Manganese, total	mg/L	0.002	0.5	0.01	0.037	0.015	0.011	0.011	0.066
Molybdenum, total	mg/L	0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001
Nickel, total	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus, total	mg/L	0.2	0.3	0.2	0.8	<0.2	<0.2	<0.2	<0.2
Potassium, total	mg/L	0.2	5.1	1.5	1.1	0.3	<0.2	0.3	0.2
Selenium, total	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silicon, total	mg/L	5	9	<5	<5	<5	<5	<5	<5
Silver, total	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Sodium, total	mg/L	0.2	46.5	1.9	2.9	0.8	0.7	0.5	2.3
Strontium, total	mg/L	0.01	0.52	0.4	0.38	0.04	0.01	0.02	0.15
Sulfur, total	mg/L	10	<10	<10	<10	<10	15	18	13
Tellurium, total	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Thallium, total	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thorium, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin, total	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium, total	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Uranium, total	mg/L	0.0002	0.0002	0.0004	0.0007	<0.0002	<0.0002	<0.0002	<0.0002
Vanadium, total	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Analysed by CARO Analytical Services

Analyte	Units	MRL	**FRA001** 14-Jul-15	**ELD001** 14-Jul-15	**SEAT001** 15-Jul-15	**BEAR001** 14-Jul-15	**LSL002** 15-Jul-15	**SUM001** 19-Jul-15	**BON001** 21-Jul-15
Chloride	mg/L	0.1	0.42	2.44	0.51	0.34	<0.10	1.08	4.65
Nitrate as N	mg/L	0.01	<0.010	<0.010	0.053	<0.010	0.01	0.018	<0.010
Nitrite as N	mg/L	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sulfate	mg/L	1	4.8	1.6	12.6	11.1	2.6	10.8	79.3
Carbon, Total Organic	% dry	0.05	3.85	5.03	9.59	16.5	5.32	14.9	43.3
Alkalinity, Total as CaCO3	mg/L		47.9	95.8	102.6	88.9	16	61.5	184.7
Carbon, Dissolved Organic	mg/L	0.5	3.5	10.6	0.7	1	1.6	2.6	3.3
Ammonia as N, Total	mg/L	0.02	0.043	0.041	<0.020	0.031	0.031	0.025	0.027
Nitrogen, Total Kjeldahl	mg/L	0.05	0.7	0.77	<0.05	0.18	0.07	0.97	0.27
Phosphorus, Total as P	mg/L	0.002	0.044	0.031	0.007	0.056	0.009	0.035	0.014
Phosphorus, Total Dissolved	mg/L	0.002	0.014	0.012	0.004	0.022	0.004	0.016	0.009
Solids, Total Suspended	mg/L	2	9	4	<2	42	<2	3	8
Turbidity	NTU		13	1.7	1.3	15	1.8	2	0.5
pH	pH units		7.2	7.5	7.8	8.2	7.32	7.3	8
Conductivity (EC)	uS/cm		79.9	173	201	169	38	143	431
Hardness, Total (Total as CaCO3)	mg/L	5	41	92.8	113	95.7	17	78	261
Nitrate+Nitrite as N	mg/L	0.01	<0.010	<0.010	0.053	<0.010	0.01	0.018	<0.010
Nitrogen, Total	mg/L	0.05	0.697	0.766	0.053	0.177	0.078	0.989	0.273
Nitrogen, Organic	mg/L	0.05	0.654	0.725	<0.050	0.146	<0.050	0.946	0.246
> 75 µm	% dry	0.1	44.6	10	49.9	29.6	44.7	40.5	70
Classification	% dry		Fine	Fine	Fine	Fine	Fine	Fine	Coarse
Aluminum, total	mg/L	0.05	0.07	0.09	<0.05	0.41	0.08	0.08	<0.05
Antimony, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Arsenic, total	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Barium, total	mg/L	0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05
Beryllium, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron, total	mg/L	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Cadmium, total	mg/L	0.0001	0.0001	<0.0001	0.0002	0.0002	<0.0001	<0.0001	<0.0001
Calcium, total	mg/L	2	12.9	26.6	33.8	26	6	26.6	68.8
Chromium, total	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt, total	mg/L	0.0005	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.005
Copper, total	mg/L	0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002
Iron, total	mg/L	0.1	5.56	0.38	0.24	0.92	0.2	0.25	<0.10
Lead, total	mg/L	0.001	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.001
Lithium, total	mg/L	0.001	0.003	0.004	0.001	0.001	<0.001	<0.001	0.003
Magnesium, total	mg/L	0.1	2.2	6.4	7	7.5	0.5	2.8	21.7
Manganese, total	mg/L	0.002	0.605	0.053	0.048	0.029	0.008	0.09	0.029
Molybdenum, total	mg/L	0.001	0.002	0.002	0.001	0.002	<0.001	<0.001	<0.001
Nickel, total	mg/L	0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002
Phosphorus, total	mg/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Potassium, total	mg/L	0.2	1.4	2	<0.2	<0.2	0.5	0.8	0.9
Selenium, total	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silicon, total	mg/L	5	<5	<5	<5	<5	<5	<5	7
Silver, total	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Sodium, total	mg/L	0.2	1.7	4.2	1.8	1.4	0.8	2.6	7.2
Strontium, total	mg/L	0.01	0.19	0.39	0.23	0.22	0.02	0.33	0.62
Sulfur, total	mg/L	10	16	13	<10	15	<10	<10	<10
Tellurium, total	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Thallium, total	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thorium, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin, total	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium, total	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Uranium, total	mg/L	0.0002	0.0002	0.0011	0.0003	0.0004	<0.0002	<0.0002	0.0007
Vanadium, total	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Analysed by CARO Analytical Services

Analyte	Units	MRL	LWL001	BVL002	BVL003	SEAT003-1	SEAT003-2	SUM002	TY001
			29-Jul-15	29-Jul-15	29-Jul-15	6-Aug-15	6-Aug-15	21-Jul-15	14-Jul-15
Chloride	mg/L	0.1	2.44	4.97	5.24	0.45	0.44	1.25	1.41
Nitrate as N	mg/L	0.01	0.12	0.105	0.086	0.015	0.021	<0.010	<0.010
Nitrite as N	mg/L	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sulfate	mg/L	1	2.4	<1.0	1	28.8	29	11.2	18.5
Carbon, Total Organic	% dry	0.05	8.3	19	26.8	13	12.1	8.6	2.46
Alkalinity, Total as CaCO3	mg/L		27.36	27.36	20.52	116.28	123.12	68.4	109
Carbon, Dissolved Organic	mg/L	0.5	1.2	5.5	9.6	<0.5	<0.5	3	3.6
Ammonia as N, Total	mg/L	0.02	<0.020	0.031	0.033	0.024	<0.020	<0.020	<0.020
Nitrogen, Total Kjeldahl	mg/L	0.05	<0.05	0.24	0.93	0.06	<0.05	0.34	0.29
Phosphorus, Total as P	mg/L	0.002	0.016	0.02	0.026	0.025	0.02	0.021	0.022
Phosphorus, Total Dissolved	mg/L	0.002	0.006	0.009	0.017	0.003	0.002	0.014	0.011
Solids, Total Suspended	mg/L	2	4	11	4	9	6	2	<2
Turbidity	NTU		0.55	0.4	1.8	1.8	1	0.9	1.1
pH	pH units		7.25	6.9	6.73	7.88	7.9	7.7	8.1
Conductivity (EC)	uS/cm		55.5	54.2	38.9	227.2	235	137	246
Hardness, Total (Total as CaCO3)	mg/L	5	24.4	27.5	18.7	168	155	77	128
Nitrate+Nitrite as N	mg/L	0.01	0.12	0.105	0.086	0.015	0.021	<0.010	<0.010
Nitrogen, Total	mg/L	0.05	0.12	0.345	1.02	0.076	<0.050	0.336	0.294
Nitrogen, Organic	mg/L	0.05	<0.050	0.209	0.901	<0.050	<0.050	0.336	0.294
> 75 µm	% dry	0.1	27.6	27.8	25.3	14	28	82.9	81.9
Classification	% dry		Fine	Fine	Fine	Fine	Fine	Coarse	Coarse
Aluminum, total	mg/L	0.05	<0.05	<0.05	0.11	0.06	<0.05	<0.05	<0.05
Antimony, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, total	mg/L	0.005	<0.005	<0.005	<0.005	0.021	0.01	<0.005	<0.005
Barium, total	mg/L	0.05	<0.05	0.09	0.07	<0.05	<0.05	<0.05	0.06
Beryllium, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron, total	mg/L	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Cadmium, total	mg/L	0.0001	<0.0001	<0.0001	<0.0001	0.0011	0.0004	<0.0001	<0.0001
Calcium, total	mg/L	2	8.2	9.9	6.3	45.3	43.3	26.2	36.6
Chromium, total	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt, total	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Copper, total	mg/L	0.002	<0.002	<0.002	<0.002	0.006	0.002	<0.002	<0.002
Iron, total	mg/L	0.1	0.14	<0.10	0.38	1.56	0.6	0.29	0.14
Lead, total	mg/L	0.001	<0.001	<0.001	<0.001	0.017	0.005	<0.001	<0.001
Lithium, total	mg/L	0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	0.004
Magnesium, total	mg/L	0.1	0.9	0.6	0.7	13.2	11.4	2.8	9
Manganese, total	mg/L	0.002	0.011	0.003	0.05	0.197	0.1	0.073	0.024
Molybdenum, total	mg/L	0.001	<0.001	<0.001	0.001	0.003	0.003	<0.001	0.002
Nickel, total	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus, total	mg/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Potassium, total	mg/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	2.5
Selenium, total	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silicon, total	mg/L	5	<5	<5	<5	<5	<5	<5	7
Silver, total	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Sodium, total	mg/L	0.2	0.9	0.8	0.5	2.2	1.9	2.6	5.2
Strontium, total	mg/L	0.01	0.27	0.74	0.43	0.3	0.26	0.33	0.2
Sulfur, total	mg/L	10	<10	<10	<10	13	<10	<10	13
Tellurium, total	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Thallium, total	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thorium, total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin, total	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium, total	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Uranium, total	mg/L	0.0002	<0.0002	<0.0002	<0.0002	0.001	0.0009	0.0002	0.0007
Vanadium, total	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Analysed by CARO Analytical Services

Site Description	Date Collected	Conductivity @ 25C	Turbidity	Total Acidity	Alkalinity	Hardness	pH
		uS/cm	NTU's	mg/l	mg/l	mg/l CaCO3	
BON001	July 21, 2015	431	0.5	2.3	184.7	156	8
BON001-F	July 21, 2015	1	0.2	4.6	27.4	<10.4	8.1
SUM002	July 21, 2015	137	0.9	4.6	68.4	52	7.7
SUM001	July 21, 2015	143	2	6.8	61.5	52	7.3
FRA001	July 13, 2015	79.9	13	2.3	47.9	31.2	7.2
SEAT001	July 14, 2015	201	1.3	2.3	102.6	62.4	7.8
LS002	July 15, 2015	36.7	2.1	2.3	20.5	10.4	7.5
BEAR001	July 14, 2015	169	15	2.3	88.9	52	8.2
BL002	July 29, 2015	54.2	0.4	4.56	27.36	20.8	6.9
BL003	July 29, 2015	38.9	1.8	6.84	20.52	10.4	6.73
LWL001	July 29, 2015	55.5	0.55	6.84	27.36	20.8	7.25
SEAT003-1	August 6, 2015	227.2	1.8	25.08	116.28	104	7.88
SEAT003-2	August 6, 2015	235	1	25.08	123.12	72.8	7.9
SEAT004-1	August 6, 2015	225.2	0.2	22.8	116.28	83.2	8.06
SEAT004-2	August 6, 2015	232	0.35	22.8	116.28	83.2	8.03
SEAT003-f	August 6, 2015	2.2	0.2	4.56	6.84	<10.4	6.06

Analyzed by Passmore Laboratories Ltd. F denotes a blank, -1 or -2 indicates duplicates

Analyte	Units	MRL	**PASS001**	**SEAT002**	**LSL001**	**BVL001**
			25-Aug-14	26-Aug-14	27-Aug-14	8-Sep-14
Alkalinity, Total as CaCO3	mg/L		27.4	147	51.3	68.4
Carbon, Dissolved Organic	mg/L	0.5	5.12	4.61	5.18	1.93
Ammonia as N, Total	mg/L	0.02				
Nitrogen, Total Kjeldahl	mg/L	0.05	0.351	0.149	0.204	0.199
Phosphorus, Total as P	mg/L	0.002	0.0118	<0.0050	<0.0050	<0.0050
Turbidity	NTU		4.8	0.45	0.85	0.5
pH	pH units		7.2	7.3	6.7	6.9
Conductivity (EC)	uS/cm		94.6	305.3	31.4	68.6
Hardness, Total (Total as CaCO3)	mg/L	5	17.1	154	34.2	34.2
Sulfur, total	mg/L	10	4.29	31.1	1.48	4.45

Analysed by Maxxam Analytics

10.4 Appendix 4: Laboratory analysed sediment quality data

Analyte	Units	MRL	F0001	WIN001	WIN002	GC001	GC002	CL001	HAY001
			6-Jul-15	06-Jul-15	6-Jul-15	9-Jul-15	9-Jul-15	9-Jul-15	14-Jul-15
Aluminum	mg/kg dr	20	10500	16100	7920	18300	14600	11400	10200
Antimony	mg/kg dr	0.1	1.3	0.2	0.9	1	4.4	4.8	1.3
Arsenic	mg/kg dr	0.4	3	2.7	1.4	2.2	4.2	5.9	2.2
Barium	mg/kg dr	1	286	840	183	89	100	69	161
Beryllium	mg/kg dr	0.1	0.6	1.5	0.5	0.7	0.5	0.4	0.4
Bismuth	mg/kg dr	0.1	0.4	0.5	0.2	0.2	0.4	0.5	0.2
Boron	mg/kg dr	2	5	<2	<2	<2	<2	<2	<2
Cadmium	mg/kg dr	0.04	1.77	0.38	0.89	1.83	5.82	7.29	2.12
Calcium	mg/kg dr	100	12900	17100	11200	2220	1040	3740	6510
Chromium	mg/kg dr	1	28.8	14.3	7.5	9.9	5.9	5.1	22.8
Cobalt	mg/kg dr	0.1	4.1	2.1	1.2	2.9	1.2	2.2	3.8
Copper	mg/kg dr	0.2	18.8	61	22.7	9.1	19.6	9.9	14.4
Iron	mg/kg dr	20	11000	10400	3660	5950	3980	2790	11100
Lead	mg/kg dr	0.2	41.9	7.4	20.6	33.8	61.3	204	85.8
Lithium	mg/kg dr	0.1	16	11.2	3.5	6.5	3.4	1.9	12
Magnesium	mg/kg dr	10	4320	1630	807	1870	581	791	3640
Manganese	mg/kg dr	0.4	203	60.4	50.4	60.1	40.8	40.2	166
Mercury	mg/kg dr	0.05	0.08	0.08	0.1	<0.05	0.06	0.11	0.11
Molybdenum	mg/kg dr	0.1	2.7	2.4	1.4	0.7	0.5	0.7	1
Nickel	mg/kg dr	0.4	17	16.1	7.8	7.5	4.2	6.5	14.6
Phosphorus	mg/kg dr	10	824	1090	993	639	486	545	828
Potassium	mg/kg dr	10	836	323	314	278	354	360	1070
Selenium	mg/kg dr	0.5	2.3	1.5	0.9	0.5	<0.5	0.7	0.9
Silicon	mg/kg dr	3000	<3000	<3000	<3000	<3000	<3000	3980	<3000
Silver	mg/kg dr	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sodium	mg/kg dr	40	559	279	141	170	236	127	178
Strontium	mg/kg dr	0.2	182	344	419	34.2	17.6	46.5	92.4
Sulfur	mg/kg dr	1000	3000	2200	3400	1900	<1000	3400	<1000
Tellurium	mg/kg dr	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Thallium	mg/kg dr	0.1	0.1	<0.1	<0.1	0.1	0.2	0.1	0.3
Thorium	mg/kg dr	0.5	3	2.8	<0.5	0.5	<0.5	<0.5	3.4
Tin	mg/kg dr	0.2	0.7	0.5	0.4	0.7	1.3	1.5	1.5
Titanium	mg/kg dr	2	319	138	89	443	521	151	623
Uranium	mg/kg dr	0.1	8.3	33.2	3.3	1.9	1.2	1.4	7.1
Vanadium	mg/kg dr	0.4	22.8	18.5	10.5	17.6	15.6	7.6	24.1
Zinc	mg/kg dr	2	118	15	33	63	48	173	111
Zirconium	mg/kg dr	2	3	11	<2	4	3	<2	<2

Analysed by CARO Analytical Services

Analyte	Units	MRL	FRA001 14-Jul-15	ELD001 14-Jul-15	SEAT001 15-Jul-15	BEAR001 14-Jul-15	LSL002 15-Jul-15	SUM001 19-Jul-15	BON001 21-Jul-15
Aluminum	mg/kg dry	20	8390	14700	585	9710	15300	13200	1070
Antimony	mg/kg dry	0.1	0.3	0.9	2.5	2.8	0.2	1.2	1.1
Arsenic	mg/kg dry	0.4	3.9	4.4	2560	10.4	1.1	5.9	3
Barium	mg/kg dry	1	114	277	17	52	157	197	30
Beryllium	mg/kg dry	0.1	0.5	0.8	<0.1	0.3	0.7	1	<0.1
Bismuth	mg/kg dry	0.1	0.3	0.4	15.6	0.4	0.1	0.1	0.2
Boron	mg/kg dry	2	<2	<2	<2	<2	<2	<2	24
Cadmium	mg/kg dry	0.04	2.46	5.53	92.6	4.44	0.51	2.77	2.36
Calcium	mg/kg dry	100	2700	6380	89100	9300	4530	9890	58700
Chromium	mg/kg dry	1	17.3	38.9	6.2	29.7	38.5	35.7	3.1
Cobalt	mg/kg dry	0.1	5.3	8.2	6.3	11	7.2	6.2	0.8
Copper	mg/kg dry	0.2	10.4	37.3	145	45.9	16.4	34.1	5.7
Iron	mg/kg dry	20	17100	21500	154000	19800	20400	16200	2160
Lead	mg/kg dry	0.2	16.2	48.3	773	71.3	10.4	32.1	71.4
Lithium	mg/kg dry	0.1	20.7	23.9	1.2	10.4	13.1	15.6	1
Magnesium	mg/kg dry	10	4410	7760	34300	5160	6090	5800	3320
Manganese	mg/kg dry	0.4	242	410	7750	187	170	310	153
Mercury	mg/kg dry	0.05	<0.05	0.08	0.08	0.11	<0.05	0.11	0.1
Molybdenum	mg/kg dry	0.1	1.4	1.4	6.8	3.4	1.7	2.4	8.1
Nickel	mg/kg dry	0.4	12.8	29.9	28.8	47.9	22.8	22.9	3.5
Phosphorus	mg/kg dry	10	733	915	711	606	692	751	1110
Potassium	mg/kg dry	10	1240	1730	76	432	3710	567	137
Selenium	mg/kg dry	0.5	0.5	2	8.1	11.3	0.8	13.5	10.5
Silicon	mg/kg dry	3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000
Silver	mg/kg dry	0.2	<0.2	0.5	9.8	1.4	<0.2	0.2	<0.2
Sodium	mg/kg dry	40	103	265	<40	106	442	138	187
Strontium	mg/kg dry	0.2	44	156	183	76.9	26.4	217	239
Sulfur	mg/kg dry	1000	<1000	<1000	110000	2100	<1000	4200	18000
Tellurium	mg/kg dry	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Thallium	mg/kg dry	0.1	0.2	0.3	<0.1	0.1	0.3	0.2	<0.1
Thorium	mg/kg dry	0.5	9.4	11	0.9	3.6	6.1	3	<0.5
Tin	mg/kg dry	0.2	0.8	1.2	38.9	1.4	0.9	0.9	0.8
Titanium	mg/kg dry	2	696	759	14	125	1580	575	30
Uranium	mg/kg dry	0.1	6.6	9	5.3	5.7	9.5	5	2.6
Vanadium	mg/kg dry	0.4	29.3	43.9	9	23	47.9	41.1	3
Zinc	mg/kg dry	2	248	494	12400	275	73	148	41
Zirconium	mg/kg dry	2	<2	<2	<2	3	<2	2	<2

Analysed by CARO Analytical Services

Analyte	Units	MRL	LWL001 29-Jul-15	BVL002 29-Jul-15	BVL003 29-Jul-15	SEAT003-1 6-Aug-15	SEAT003-2 6-Aug-15	SUM002 21-Jul-15	TY001 14-Jul-15
Aluminum	mg/kg dry	20	11600	8430	9530	1840	2280	4600	3670
Antimony	mg/kg dry	0.1	0.3	0.4	1	2	2.3	0.4	<0.1
Arsenic	mg/kg dry	0.4	<0.4	0.6	1.2	1770	1810	1.3	1.5
Barium	mg/kg dry	1	285	351	267	27	32	82	64
Beryllium	mg/kg dry	0.1	0.7	1.9	1.5	0.2	0.2	0.8	0.2
Bismuth	mg/kg dry	0.1	<0.1	<0.1	0.2	12.6	12.7	<0.1	<0.1
Boron	mg/kg dry	2	<2	<2	<2	<2	<2	3	<2
Cadmium	mg/kg dry	0.04	0.15	0.95	1.45	67.8	74.1	0.61	0.42
Calcium	mg/kg dry	100	4400	9510	5230	86800	77700	9990	1450
Chromium	mg/kg dry	1	34.5	29.1	23.5	11.1	11.7	11.7	5.8
Cobalt	mg/kg dry	0.1	4.7	1.3	1.8	4.1	4.5	2.1	2.8
Copper	mg/kg dry	0.2	13.9	11.4	12.7	238	245	12.7	3.7
Iron	mg/kg dry	20	13600	3950	3350	98700	100000	7150	8510
Lead	mg/kg dry	0.2	7	16.5	36.7	983	955	10.4	5.9
Lithium	mg/kg dry	0.1	11.9	7.8	5.1	2.7	3.3	5.7	11.5
Magnesium	mg/kg dry	10	4490	1120	1140	38600	34700	2320	2230
Manganese	mg/kg dry	0.4	183	101	84.4	6540	6030	101	136
Mercury	mg/kg dry	0.05	<0.05	0.11	0.08	0.08	0.09	<0.05	<0.05
Molybdenum	mg/kg dry	0.1	0.2	0.4	0.8	6.1	8.8	1.5	0.7
Nickel	mg/kg dry	0.4	16.6	7.7	9.9	27.2	32.5	10.9	5.9
Phosphorus	mg/kg dry	10	385	1070	493	1190	1190	546	282
Potassium	mg/kg dry	10	1180	533	289	246	305	460	669
Selenium	mg/kg dry	0.5	<0.5	0.9	1	15.3	18.3	5.3	<0.5
Silicon	mg/kg dry	3000	<3000	<3000	<3000	<3000	<3000	<3000	<3000
Silver	mg/kg dry	0.2	<0.2	<0.2	<0.2	8.3	8.4	<0.2	<0.2
Sodium	mg/kg dry	40	95	115	111	51	60	128	51
Strontium	mg/kg dry	0.2	923	965	658	191	174	255	33.9
Sulfur	mg/kg dry	1000	<1000	3100	2800	44000	42000	4700	<1000
Tellurium	mg/kg dry	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Thallium	mg/kg dry	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Thorium	mg/kg dry	0.5	1.4	<0.5	<0.5	1.4	1.3	1.3	4.6
Tin	mg/kg dry	0.2	0.9	0.7	0.6	30.2	30.2	0.8	0.4
Titanium	mg/kg dry	2	899	61	131	29	30	315	340
Uranium	mg/kg dry	0.1	2.4	23.8	10.5	6.3	6.8	3.8	1.2
Vanadium	mg/kg dry	0.4	30.8	9.7	22.3	12.1	12.4	19.9	12.3
Zinc	mg/kg dry	2	63	56	77	9310	10200	45	118
Zirconium	mg/kg dry	2	<2	<2	<2	<2	<2	<2	<2

Analysed by CARO Analytical Services, SEAT003-1 and SEAT003-2 are duplicates.

Analyte	Units	MRL	**PASS001** 25-Aug-14	**SEAT002** 26-Aug-14	**LSL001** 27-Aug-14	**BVL001** 8-Sep-14
Aluminum	mg/kg dry	20	9910	6170	8510	4640
Antimony	mg/kg dry	0.1	3.04	6.86	0.13	0.26
Arsenic	mg/kg dry	0.4	4.33	1400	1.24	1.03
Barium	mg/kg dry	1	119	33.5	108	176
Beryllium	mg/kg dry	0.1	0.44	<0.40	<0.40	2.99
Bismuth	mg/kg dry	0.1	0.24	6.66	<0.10	<0.10
Cadmium	mg/kg dry	0.04	1.73	55.2	0.198	0.82
Calcium	mg/kg dry	100	4420	26000	4020	4870
Chromium	mg/kg dry	1	14.6	22.9	24.8	19.2
Cobalt	mg/kg dry	0.1	2.98	8.34	4.23	1.33
Copper	mg/kg dry	0.2	5.77	103	7.86	6.97
Iron	mg/kg dry	20	9720	98700	10200	3140
Lead	mg/kg dry	0.2	77.4	1080	7.44	12.2
Lithium	mg/kg dry	0.1	24.5	10.3	5.9	<5.0
Magnesium	mg/kg dry	10	2910	17000	4400	742
Manganese	mg/kg dry	0.4	149	2630	101	50.7
Mercury	mg/kg dry	0.05	0.058	0.075	<0.050	0.055
Molybdenum	mg/kg dry	0.1	0.75	15.9	0.62	0.19
Nickel	mg/kg dry	0.4	10.4	50.7	10.3	7.96
Phosphorus	mg/kg dry	10	394	1040	668	408
Potassium	mg/kg dry	10	492	352	1580	227
Selenium	mg/kg dry	0.5	0.54	21.1	<0.50	0.68
Silver	mg/kg dry	0.2	0.109	18.7	<0.050	<0.050
Sodium	mg/kg dry	40	118	<100	140	125
Strontium	mg/kg dry	0.2	41.1	105	30.4	468
Thallium	mg/kg dry	0.1	0.141	0.095	0.171	<0.050
Tin	mg/kg dry	0.2	0.98	16.8	0.64	0.29
Titanium	mg/kg dry	2	609	135	1170	149
Uranium	mg/kg dry	0.1	2.64	5.09	1.6	37.9
Vanadium	mg/kg dry	0.4	20.4	18.8	26.5	19.7
Zinc	mg/kg dry	2	79.2	6910	44.3	34.7
Zirconium	mg/kg dry	2	1.2	1.9	0.75	0.5

Analysed by Maxxam Analytics

10.5 Appendix 5: Water quality guidelines

		Water					
Analyte	**Units**	**BC WQG Max Aq Life**	**BC WQG 30-day**	**BC WQG Wildlife**	**BC Drinking WQG Max**	**WQ CCME Short term**	**WQ CCME Long term**
Chloride	mg/L	600	150	600	250	640	120
Nitrate as N	mg/L	32.8	3	100	10	550	13
Nitrite as N	mg/L	0.06 when $Cl^- \leq 2$, 0.12 when Cl^- 2-4, 0.6 when $Cl^- > 10$	0.02 when $Cl^- \leq 2$, 0.04 when Cl^- 2- 4, 0.2 when $Cl^- > 10$	10	1	60	
Sulfate	mg/L	100 [1]	Sulfate calc[1]		500		
Alkalinity, Total as $CaCO_3$	mg/L		<10 when Ca2+<4, 10-20 when Ca2+ 4-8, >20 when Ca2+ >82				
Ammonia-N	mg/L	3.62 - 23.8 temp & pH			None	3.62-23.8 temp & pH	
pH	pH units	6.5-9.0					
Nitrate+Nitrite	mg/L				10		
Aluminum, total (diss)	mg/L	0.1)		5 (total)	0.2	0.005 if pH <6.5, 0.1 if pH>6.5	
Antimony	mg/L	0.009 (Sb III only)[1]					
Arsenic, total	mg/L		0.005	0.025[2]	0.025	0.005	
Barium, total	mg/L		1				
Beryllium, total	mg/L		0.13				
Boron, total	mg/L		1.2	5	5	29	1.5
Cadmium, total	mg/L	Cd calc[2]	Cd calc[3]			0.001	0.00009
Chromium, total	mg/L		0.009 (III), 0.001 (VI)				
Cobalt, total	mg/L	0.11	0.004				
Copper, total	mg/L	Cu Calc[4]	$\leq 2_{hardness \leq 50}$ Cu Calc[5] if Hardness ≥ 50	300		Cu Calc[6]	
Iron, total	mg/L	1				0.3	

[1]Sulphate 128mg/L if hardness(0-3), 218 if hardness=(31-75), 309 if hardness=(76-180), 49 if hardness=(181-250)

[2]WQG Cd(mg/L) = $e^{[1.03 \times \ln(hardness^{**}) - 5.274]}/1000$, short-term max

[3]WQG Cd(mg/L)= $e^{[0.736 \times \ln(hardness^{*}) - 4.943]}/1000$, long-term average

[4]WQG Cu (mg/L)≤ (0.094 hardness(mg/L) + 2)/1000

[5]WQG Cu (mg/L) ≤ 0.04 (mean hardness)/1000

[6]When the water hardness is 0 to < 82 mg/L, the WQG is 0.002 mg/L, At hardness ≥82 to ≤180 mg/L, WQG (mg/L) =(0.2 * $e^{\{0.8545[\ln(hardness)]-1.465\}}$)/1000, At hardness >180 mg/L, the WQG is 0.004 mg/L

Water quality guidelines (continued)

				Water			
Analyte	**Units**	**BC WQG Max Aq Life**	**BC WQG 30-day**	**BC WQG Wildlife**	**BC Drinking WQG Max**	**WQ CCME Short term**	**WQ CCME Long term**
Lead, total	mg/L	Pb Calc[7]	≤2$_{\text{Hardness} \le 50}$ Pb Calc[8] $_{\text{If Hardness} \ge 50}$				Pb Calc[9]
Manganese, total	mg/L	Mn Calc[10]	Mn Calc[11]				
Molybdenum, total	mg/L	2	<1	0.05		0.73	
Nickel, total	mg/L		0.025 $_{\text{Hardness 0-60mg/L}}$ 0.110 $_{>60 \le 180\text{mg/L}}$ 0.150 $_{>180\text{mg/L}}$				Ni Calc[12]
Phosphorus, total	mg/L		0.005-0.015 for lakes				
Potassium, total	mg/L						
Selenium, total	mg/L	0.001 (alert) 0.002			0.002 (water), 0.006 (bird egg)	0.01	
Silver, total	mg/L	0.0001$_{\text{Hardness} \le 100\text{mg/L}}$ 0.003$_{>100\text{mg/L}}$	0.0015 $_{\text{Hardness} \le 100\text{mg/L}}$ 0.005$_{\text{Hardness} >100\text{mg/L}}$				
Thallium, total	mg/L		0.008 [13]			0.0008	
Uranium, total	mg/L					0.033	0.015
Zinc, total	mg/L	0.0075$_{\text{Hardness} \le 90\text{mg/L}}$ Zncalc$_{>90\text{mg/L}}$[13]	0.033$_{\text{Hardness} \le 90\text{mg/L}}$ Zncalc$_{>90\text{ mg/L}}$[14]				0.03

[7]WQG Pb (mg/L) ≤ $e^{[1.273 \ln(\text{hardness*}) - 1.460]}$/1000

[8]WQG Pb (mg/L) ≤≤ 3.31 + $e^{[1.273 \ln(\text{hardness*}) - 4.704]}$/1000

[9]When hardness is 0 to ≤ 60 mg/L, the WQG is 0.001 mg/L, At hardness >60 to ≤ 180 mg/L WQG (mg/L)= ($e^{\{1.273[\ln(\text{hardness})]-4.705\}}$)/1000, At hardness >180 mg/L, the CWQG is 0.007 mg/L

[10]WQG Mn (mg/L) ≤ 0.01102 hardness+ 0.54/1000

[11]WQG Mn (mg/L)≤ 0.0044 hardness + 0.605/1000

[12]When the water hardness is 0 to ≤ 60 mg/L, the WQG is 0.025 mg/L ,At hardness > 60 to ≤ 180 mg/L WQG Ni (mg/L)=($e^{\{0.76[\ln(\text{hardness})]+1.06\}}$)/1000 At hardness >180 mg/L, the WQG is 0.150 mg/L

[13]30-day average, WQ objective for the lower Columbia River

[14]WQG Zn (mg/L) ≤33 + 0.75(hardness - 90)/1000

[15]WQG Zn (mg/L)≤ 7.5 + 0.75 (hardness - 90))/1000

10.6 Appendix 6: Sediment quality guidelines

		Sediment			
Analyte	Units	BC SQ ISQG	BC SQ PEL	CCME ISQG	CCME PEL
Arsenic	mg/kg dry	5.9	17		
Cadmium	mg/kg dry	0.6	3.5	0.6	3.5
Chromium	mg/kg dry	37.3	90	37.3	90
Cobalt	mg/kg dry				
Copper	mg/kg dry	35.7	197	35.7	197
Iron	mg/kg dry	21,200	43,766		
Lead	mg/kg dry	35	91.3	35	91.3
Magnesium	mg/kg dry				
Manganese	mg/kg dry	460	1100		
Mercury	mg/kg dry	0.17	0.486		
Nickel	mg/kg dry	16	75		
Selenium	mg/kg dry	2			
Silver	mg/kg dry	0.5			
Zinc	mg/kg dry	123	325	123	315

10.7 Appendix 7: Water quality parameters exceeding guidelines

Site	% of parameters exceeding guidelines	Exceedance (source*)
F0001	3.4	Iron (aq. Life CCME and WQG)
WIN001	3.4	Zinc (aq. Life CCME and WQG*)
WIN002	17.24	Aluminum (aq. Life CCME and WQG)
		Iron (aq. Life CCME and WQG)
		Copper (aq. Life CCME)
		Zinc (aq. Life CCME and WQG*)
GC001	6.8	Aluminum (aq. Life CCME and WQG)
		Zinc (aq. Life CCME and WQG*)
GC002	13.79	Aluminum (aq. Life CCME and WQG)
		Iron (aq. Life CCME and WQG)
		Zinc (aq. Life CCME and WQG*)
CL001	6.8	Aluminum (aq. Life CCME and WQG)
		Zinc (aq. Life CCME and WQG*)
HAY001	6.8	Iron (aq. Life CCME and WQG)
		Zinc (aq. Life CCME and WQG*)
TY001	0	none
FRA001	6.8	Iron (aq. Life CCME and WQG)
		Zinc (aq. Life CCME and WQG*)
ELD001	3.4	Iron (aq. Life CCME and WQG*)
BEAR001	3.4	Iron (aq. Life CCME and WQG*)
SEAT001	3.4	Zinc (aq. Life CCME and WQG*)
LSL002	3.4	Zinc (aq. Life CCME and WQG*)
SUM001	3.4	Zinc (aq. Life CCME and WQG*)
BON001	3.4	Cobalt (aq. Life WQG*)
SUM002	3.4	Zinc (aq. Life CCME and WQG*)
LWL001	3.4	Zinc (aq. Life CCME and WQG*)
BVL002	3.4	Zinc (aq. Life CCME and WQG*)
BVL003	10.34	Aluminum (aq. Life CCME and WQG)
		Iron (aq. Life CCME and WQG*)
		Zinc (aq. Life CCME and WQG*)
SEAT003	10.34	Arsenic (aq. Life CCME and WQG*, WQGwild, BCdw)
		Iron (aq. Life CCME and WQG*)
		Zinc (aq. Life CCME and WQG*)
		Lead (aq. Life CCME)
Sources	aq. Life CCME= Canadian Water Quality Guidelines	
	aq. Life CCME*= Canadian Water Quality Guidelines long term	
	aq. Life WQG = BC Water Quality Guidelines	
	aq. Life WQG* = BC Water Quality Guidelines long term	
	WQGwild = BC Water Quality Guidelines for wildlife	
	BCdw = BC Drinking Water Guidelines	

10.8 Appendix 8: Sediment quality parameters exceeding guidelines

Site	% of parameters exceeding guidelines	Exceedance (source*)
PASS001	16.6	Cadmium (aq. Life ISQG CCME)
		Lead (aq. Life ISQG CCME)
SEAT002	83.3	Arsenic (aq. Life ISGQ and PEL CCME)
		Cadmium (aq. Life ISGQ and PEL CCME)
		Copper (aq. Life ISQG CCME)
		Iron (aq. Life ISGQ and PEL CCME)
		Lead (aq. Life ISGQ and PEL CCME)
		Manganese (aq. Life ISGQ and PEL)
		Nickel (aq. Life ISQG)
		Silver (aq. Life ISQG)
		Selenium (aq. Life ISQG)
		Zinc (aq. Life ISGQ and PEL CCME)
LSL001	8.3	Cadmium (aq. Life ISQG CCME)
BVL001	8.3	Cadmium (aq. Life ISQG CCME)
F0001	33	Cadmium (aq. Life ISQG CCME)
		Lead (aq. Life ISQG CCME)
		Nickel (aq. Life ISQG and PEL)
		Selenium (aq. Life ISQG)
WIN001	8.3	Nickel (aq. Life ISQG)
WIN002	8.3	Cadmium (aq. Life ISQG CCME)
GC001	8.3	Cadmium (aq. Life ISQG CCME)
GC002	16.6	Cadmium (aq. Life ISGQ and PEL CCME)
		Lead (aq. Life ISQG CCME)
CL001	25	Cadmium (aq. Life ISGQ and PEL CCME)
		Lead (aq. Life ISQG and PEL CCME)
		Zinc (aq. Life ISGQ CCME)
HAY001	16.6	Cadmium (aq. Life ISQG CCME)
		Lead (aq. Life ISQG CCME)
FRA001	16.6	Cadmium (aq. Life ISQG CCME)
		Zinc (aq. Life ISGQ CCME)
ELD001	66	Cadmium (aq. Life ISGQ and PEL CCME)
		Chromium (aq. Life ISQG CCME)
		Copper (aq. Life ISQG CCME)
		Iron (aq. Life ISQG CCME)
		Lead (aq. Life ISQG CCME)
		Nickel (aq. Life ISQG)
		Silver (aq. Life ISQG)
		Zinc (aq. Life ISGQ and PEL CCME)
LWL001	8.3	Nickel (aq. Life ISQG)
BVL002	8.3	Cadmium (aq. Life ISQG CCME)
Source:	aq. Life (ISQG or PEL) = BC Sediment Quality Guidelines	

Sediment quality parameters exceeding guidelines (continued)

Site	% of parameters exceeding guidelines	Exceedance (source*)
BEAR001	58.3	Cadmium (aq. Life ISGQ and PEL CCME)
		Copper (aq. Life ISQG CCME)
		Lead (aq. Life ISQG CCME)
		Nickel (aq. Life ISQG)
		Silver (aq. Life ISQG)
		Selenium (aq. Life ISQG)
		Zinc (aq. Life ISGQ CCME)
SEAT001	83.3	Arsenic (aq. Life ISGQ and PEL CCME)
		Cadmium (aq. Life ISGQ and PEL CCME)
		Copper (aq. Life ISQG CCME)
		Iron (aq. Life ISGQ and PEL CCME)
		Lead (aq. Life ISGQ and PEL CCME)
		Manganese (aq. Life ISGQ and PEL)
		Nickel (aq. Life ISQG)
		Silver (aq. Life ISQG)
		Selenium (aq. Life ISQG)
		Zinc (aq. Life ISGQ and PEL CCME)
LSL002	16.6	Chromium (aq. Life ISQG CCME)
		Nickel (aq. Life ISQG)
SUM001	41.6	Arsenic (aq. Life ISGQ CCME)
		Cadmium (aq. Life ISQG CCME)
		Nickel (aq. Life ISQG)
		Selenium (aq. Life ISQG)
		Zinc (aq. Life ISGQ CCME)
BON001	25	Cadmium (aq. Life ISQG CCME)
		Lead (aq. Life ISGQ CCME)
		Selenium (aq. Life ISQG)
SUM002	16.6	Cadmium (aq. Life ISQG CCME)
		Selenium (aq. Life ISQG)
BVL003	16.6	Cadmium (aq. Life ISQG CCME)
		Lead (aq. Life ISGQ CCME)
SEAT003	83.3	Arsenic (aq. Life ISGQ and PEL CCME)
		Cadmium (aq. Life ISGQ and PEL CCME)
		Copper (aq. Life ISQG CCME)
		Iron (aq. Life ISGQ and PEL CCME)
		Lead (aq. Life ISGQ and PEL CCME)
		Manganese (aq. Life ISGQ and PEL)
		Nickel (aq. Life ISQG)
		Silver (aq. Life ISQG)
		Selenium (aq. Life ISQG)
		Zinc (aq. Life ISGQ and PEL CCME)
Source:	aq. Life (ISQG or PEL) = BC Sediment Quality Guidelines	

10.9 Appendix 9: Quality control, duplicate values that triggered alerts.

Sample Id	Date	Matrix	Lab	Analyte	Units	MRL	5XMRL	Duplicate	Duplicate	RPD	RPD limit
SEAT003	Aug-6-201	Water	Passmore	Hardness, Total (Total as CaCO3)	mg/L	10.4	52	104	72.8	35.29412	25
SEAT003	Aug-6-15	Water	CARO	*Cadmium, total	mg/L	1E-04	0.0005	0.0011	0.0004	93.33333	25
SEAT003	Aug-6-15	Water	CARO	*Iron, total	mg/L	0.1	0.5	1.56	0.6	88.88889	25
SEAT003	Aug-6-15	Water	CARO	Lead, total	mg/L	0.001	0.005	0.017	0.005	109.0909	25
SEAT003	Aug-6-15	Water	CARO	Manganese, total	mg/L	0.002	0.01	0.197	0.1	65.31987	25
SEAT003	Aug-6-15	Sediment	CARO	*Molybdenum	mg/kg	0.1	0.5	6.1	8.8	36.24161	25

*For Cd, Fe, Mo note the difference between these duplicates is less than 2x the detection limit as one of the values is near or at the detection level. Total Pb is just over this detection criteria

10.10 Appendix 10: Scatterplots of Stress Score calculation methods and Human Disturbance Gradient ratings.

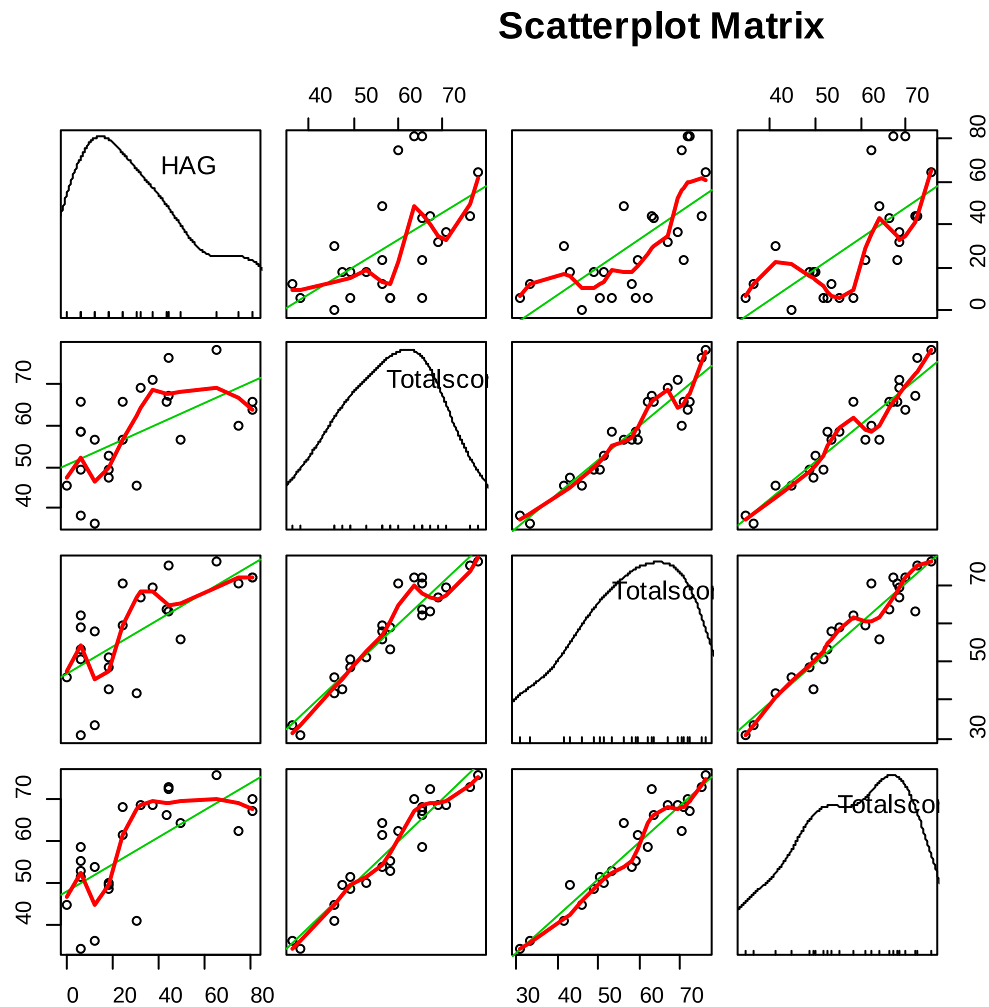

Figure 20. Scatterplot of Human Disturbance Gradient ratings (HDG) and calculated Stress Index Score using percentile binning and three weighting schemes (Totalscore.cat = weighting by average stress category, Totalscore.var=equal weighting by variable, and Totalscore.PC = weighting by PC variance). Smoothed (loess in red) and linear fit lines (in green) are indicted.

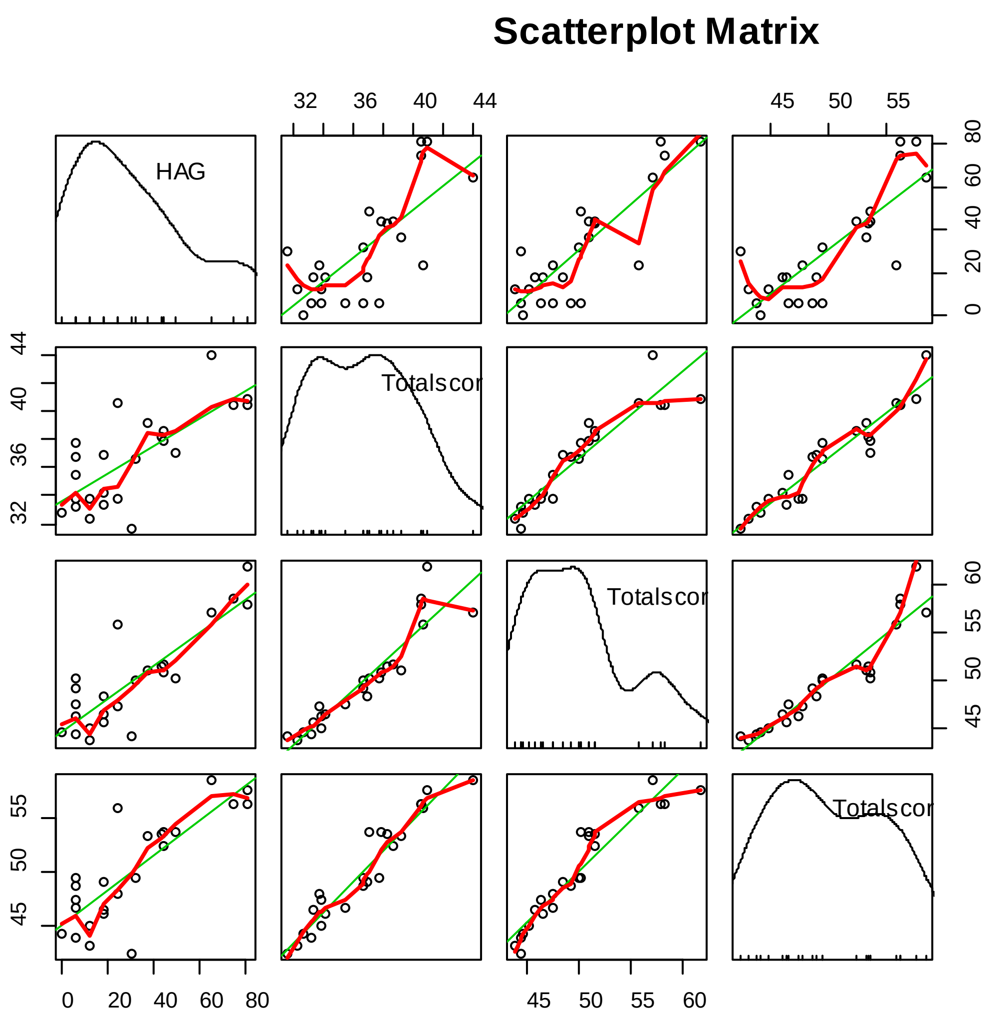

Figure 21. Scatterplot of Human Disturbance Gradient ratings (HDG) and calculated Stress Index Score using z-scoring and three weighting schemes (Totalscore.catz = weighting by average stress category, Totalscore.varz=equal weighting by variable, and Totalscore.PCz = weighting by PC variance). Smoothed (loess in red) and linear fit lines (in green) are indicted.

10.11 Appendix 11: Macroinvertebrate counts

BEAR LAKE (BEAR001), 2015-07-14, CABIN wetland, 73% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae				Aeshnidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Hydroptilidae	Hydroptilinae	Hydroptilini	Agraylea	Agraylea	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus	Arrenurus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Furcatergalia	Caenidae	Caeninae		Caenis	Caenis Diminuta Gr.	2
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	11
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	134
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cryptochironomus	Cryptochironomus	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Dasyheleinae		Dasyhelea	Dasyhelea	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Glossiphoniinae		Glossiphonia	Glossiphonia complanata	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Chilostigmini	Glyphopsyche	Glyphopsyche irrorata	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella	Helobdella	6
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella	Helobdella stagnalis	17
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Heterotrissocladius	Heterotrissocladius	1
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella	Hyalella	15
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Hydrodromidae			Hydrodroma	Hydrodroma	4
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Hydroptilidae	Hydroptilinae	Hydroptilini	Hydroptila	Hydroptila	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium	Pisidium	66
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	13
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Macropelopiini	Radotanypus	Radotanypus	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Sperchontidae			Sperchon	Sperchon	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Tabanidae				Tabanidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini		Thienemannimyia Gr.	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Zavrelimyia	Zavrelimyia	2

BONANZA CR. (BON001), 2015-07-21, CABIN wetland, 11% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	6
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae				Aeshnidae	5
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Furcatergalia	Caenidae	Caeninae		Caenis	Caenis Diminuta Gr.	5
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae				Ceratopogonidae	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	23
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini		Chironomini	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrionidae	58
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Dasyheleinae		Dasyhelea	Dasyhelea	118
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae				Gerridae	2
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella	Hyalella	7
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Libellulidae				Libellulidae	5
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Mesoveliidae			Mesovelia	Mesovelia	2
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Veliidae	Microveliinae		Microvelia	Microvelia	13
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Monopelopia	Monopelopia	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Monopelopia	Monopelopia	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	Paratanytarsus	19
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	Paratanytarsus	2
Mollusca		Gastropoda		Basommatophora		Planorbidae			Planorbella	Planorbella	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	9
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	8
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Pseudochironomini	Pseudochironomus	Pseudochironomus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini		Tanytarsini	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	Tanytarsus	23
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	Tanytarsus	1

BEAVER LAKES COMPLEX (BVL002), 2015-07-29, CABIN wetland, 59% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	34
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	5
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae				Aeshnidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Anisoptera				Anisoptera	31
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae	Anophelinae		Anopheles	Anopheles	4
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	30
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrionidae	18
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Corduliidae				Corduliidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae				Corixidae	12
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura	Corynoneura	15
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura	Corynoneura	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus	Cricotopus (Isocladius)	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae				Culicidae	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae				Culicidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae			Dixella	Dixella	11
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae				Dytiscidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Endochironomus	Endochironomus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae				Gerridae	2
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae				Glossiphoniidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Lestidae			Lestes	Lestes	7
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Belostomatidae	Lethocerinae		Lethocerus	Lethocerus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Libellulidae				Libellulidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Limnophyes	Limnophyes	6
Mollusca		Bivalvia	Heterodonta	Veneroida		Pisidiidae			Musculium	Musculium	7
Arthropoda	Chelicerata	Arachnida	Acari	Sarcoptiformes	Oribatida	Oribatida				Oribatida	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Parachironomus	Parachironomus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	Paratanytarsus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	88
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini		Thienemannimyia Gr.	2

BEAVER LAKES COMPLEX (BVL003), 2015-07-29, CABIN wetland, 76% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	34
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae				Aeshnidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Anisoptera				Anisoptera	14
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus	Arrenurus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	106
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cladopelma	Cladopelma	6
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrionidae	10
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae	Colymbetinae	Colymbetini	Colymbetes	Colymbetes	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cryptochironomus	Cryptochironomus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae				Culicidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae				Culicidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Dasyheleinae		Dasyhelea	Dasyhelea	8
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae				Dytiscidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae				Dytiscidae	1
Annelida		Clitellata	Oligochaeta	Enchytraeida		Enchytraeidae			Enchytraeus	Enchytraeus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Endochironomus	Endochironomus	2
Annelida		Clitellata	Hirudinea	Arhynchobdellida	Erpobdelliformes	Erpobdellidae	Erpobdellinae		Erpobdella	Erpobdella	12
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae	Gerrinae		Gerris	Gerris	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Glossiphoniinae		Glossiphonia	Glossiphonia complanata	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella	Helobdella stagnalis	8
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Larsia	Larsia	3
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Lestidae				Lestidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Libellulidae				Libellulidae	17
Mollusca		Bivalvia	Heterodonta	Veneroida		Pisidiidae			Musculium	Musculium	9
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Nais	Nais	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	Paratanytarsus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Phryganeidae				Phryganeidae	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium	Pisidium	7
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	30
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae				Sphaeriidae	16
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae			Tanypodinae	2

COOLEY LAKE (CL001), 2015-07-9, CABIN wetland, 28% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	4
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae				Aeshnidae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera					Anisoptera	2
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Phryganeidae	Phryganeinae		Banksiola	Banksiola crotchi	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	22
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrionidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Dicrotendipes	Dicrotendipes	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae			Dixella	Dixella	5
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae				Gerridae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Guttipelopia	Guttipelopia	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella	Helobdella stagnalis	2
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella	Hyalella	3
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydraenidae	Hydraeninae	Hydraenini	Hydraena	Hydraena	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae	Hydroporinae	Bidessini	Liodessus	Liodessus	1
Annelida		Clitellata	Oligochaeta	Lumbriculida		Lumbriculidae			Lumbriculus	Lumbriculus	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Microtendipes	Microtendipes Pedellus Gr.	155
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Nilothauma	Nilothauma	11
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Pagastiella	Pagastiella	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Piscicolidae				Piscicolidae	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium	Pisidium	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	12
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	56
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	34
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae				Sphaeriidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Tabanidae				Tabanidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	Tanytarsus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini		Thienemannimyia Gr.	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Zavrelimyia	Zavrelimyia	1

ELDER'S POND (ELD001), 2015-07-13, CABIN wetland, 13% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	SubGenus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia		Ablabesmyia	3
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Anisoptera					Anisoptera	2
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae		Aulodrilus		Aulodrilus	6
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis		Callibaetis	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae					Ceratopogonidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae				Ceratopogoninae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chaoboridae	Chaoborinae		Chaoborus		Chaoborus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cladopelma		Cladopelma	3
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae					Coenagrionidae	24
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae					Corixidae	3
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Crangonyctidae			Crangonyx		Crangonyx	13
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus	Cricotopus	Cricotopus (Cricotopus)	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae					Culicidae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae					Culicidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Dasyheleinae		Dasyhelea		Dasyhelea	4
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae					Dytiscidae	14
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Ephydridae					Ephydridae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae					Gerridae	6
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae	Dytiscinae	Aciliini	Graphoderus		Graphoderus	1
Mollusca		Gastropoda		Basommatophora		Planorbidae			Gyraulus		Gyraulus	5
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Haliplus		Haliplus	1
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella		Hyalella	122
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae	Hydroporinae	Hygrotini	Hygrotus		Hygrotus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Lestidae			Lestes		Lestes	4
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae	Hydroporinae	Bidessini	Liodessus		Liodessus	6
Mollusca		Gastropoda		Basommatophora		Lymnaeidae					Lymnaeidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Micropsectra		Micropsectra	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Microtendipes		Microtendipes Pedellus Gr.	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Veliidae	Microveliinae		Microvelia		Microvelia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Stratiomyidae	Stratiomyinae	Stratiomyini			Odontomyia / Hedriodiscus	1
Mollusca		Gastropoda		Basommatophora		Physidae			Physella		Physella	17
Mollusca		Gastropoda		Basommatophora		Planorbidae					Planorbidae	7
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum		Polypedilum	21
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius		Procladius	11
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius		Psectrocladius	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Nepidae	Ranatrinae		Ranatra		Ranatra	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Sciomyzidae					Sciomyzidae	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae					Sphaeriidae	4
Mollusca		Gastropoda		Basommatophora		Lymnaeidae			Stagnicola		Stagnicola	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae				Tanypodinae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Hydrophilini	Tropisternus		Tropisternus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Hydrophilini	Tropisternus		Tropisternus	1
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae				Tubificinae	1
Mollusca		Gastropoda		Heterostropha		Valvatidae			Valvata		Valvata	10

FOMI'S WETLAND (FO001), 2015-06-29, CABIN wetland, 17% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	SubGenus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia		Ablabesmyia	12
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Acricotopus		Acricotopus	18
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae					Aeshnidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae			Anax		Anax	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Anisoptera					Anisoptera	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae	Anophelinae		Anopheles		Anopheles	8
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus		Arrenurus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Berosini	Berosus		Berosus	8
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis		Callibaetis	85
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae					Ceratopogonidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae				Ceratopogoninae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chaoboridae	Chaoborinae		Chaoborus		Chaoborus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae					Coenagrionidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae					Corixidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura		Corynoneura	6
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Crangonyctidae			Crangonyx		Crangonyx	8
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus	Cricotopus	Cricotopus (Cricotopus)	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae					Culicidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Dasyheleinae		Dasyhelea		Dasyhelea	4
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Dero		Dero	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Dicrotendipes		Dicrotendipes	2
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae					Dytiscidae	15
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Endochironomus		Endochironomus	5
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae					Gerridae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Chilostigmini	Glyphopsyche		Glyphopsyche irrorata	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Guttipelopia		Guttipelopia	1
Mollusca		Gastropoda		Basommatophora		Planorbidae			Gyraulus		Gyraulus	24
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Haliplus		Haliplus	3
Annelida		Clitellata	Hirudinea			Hirudinea					Hirudinea	3
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Hydrachnidae			Hydrachna		Hydrachna	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae					Hydrophilidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Labrundinia		Labrundinia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Lestidae			Lestes		Lestes	6
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Limnesiidae			Limnesia		Limnesia	5
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Veliidae	Microveliinae		Microvelia		Microvelia	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Monopelopia		Monopelopia	2
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae				Naidinae	2
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Nais		Nais	2
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Nepidae					Nepidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Notonectidae	Notonectinae	Notonectini	Notonecta		Notonecta	9
Arthropoda	Chelicerata	Arachnida	Acari	Sarcoptiformes	Oribatida	Oribatida					Oribatida	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Parachironomus		Parachironomus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Anacaenini	Paracymus		Paracymus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus		Paratanytarsus	13
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Peltodytes		Peltodytes	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum		Polypedilum	2
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Pristininae		Pristina		Pristina	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius		Procladius	2
Mollusca		Gastropoda		Basommatophora		Planorbidae			Promenetus		Promenetus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius		Psectrocladius	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Pseudochironomini	Pseudochironomus		Pseudochironomus	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Stratiomyidae					Stratiomyidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae				Tanypodinae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Tipulidae					Tipulidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Hydrophilini	Tropisternus		Tropisternus	1

FRANK Z.'S OXBOW (FRA001), 2015-07-10, CABIN wetland, 12% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	SubGenus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia		Ablabesmyia	6
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Anisoptera					Anisoptera	21
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae	Anophelinae		Anopheles		Anopheles	4
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus		Arrenurus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis		Callibaetis	38
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae					Ceratopogonidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae				Ceratopogoninae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chaoboridae	Chaoborinae		Chaoborus		Chaoborus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Chironomus		Chironomus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Cloeon		Cloeon dipterum	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae					Coenagrionidae	78
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae					Corixidae	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus	Cricotopus	Cricotopus (Cricotopus)	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae					Dytiscidae	9
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Hydrophilini	Enochrus		Enochrus	2
Mollusca		Gastropoda		Basommatophora		Planorbidae			Gyraulus		Gyraulus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Haliplus		Haliplus	1
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella		Hyalella	13
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrochidae			Hydrochus		Hydrochus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Lestidae			Lestes		Lestes	2
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Libellulidae					Libellulidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Limnephilini	Limnephilus		Limnephilus	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Limnesiidae			Limnesia		Limnesia	8
Mollusca		Gastropoda		Basommatophora		Lymnaeidae					Lymnaeidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Micropsectra		Micropsectra	4
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae					Naididae	2
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Unionicolidae			Neumania		Neumania	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Notonectidae	Notonectinae	Notonectini	Notonecta		Notonecta	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Parachironomus		Parachironomus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Anacaenini	Paracymus		Paracymus	1
Mollusca		Gastropoda		Basommatophora		Physidae			Physella		Physella	13
Mollusca		Gastropoda		Basommatophora		Planorbidae					Planorbidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum		Polypedilum	72
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum		Polypedilum	2
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Pristininae		Pristina		Pristina	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius		Psectrocladius	9
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Pseudochironomini	Pseudochironomus		Pseudochironomus	3
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Slavina		Slavina appendiculata	1
Mollusca		Gastropoda		Basommatophora		Lymnaeidae			Stagnicola		Stagnicola	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Thienemanniella		Thienemanniella	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Hydrophilini	Tropisternus		Tropisternus	4
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae				Tubificinae	1

GANDER CR. UPPER FEN (GC001), 2015-07-09, CABIN wetland, 76% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	2
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae				Aeshnidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Anisoptera				Anisoptera	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Phryganeidae	Phryganeinae		Banksiola	Banksiola crotchi	3
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	79
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae				Corixidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Dasyheleinae		Dasyhelea	Dasyhelea	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Dicrotendipes	Dicrotendipes	3
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae				Gerridae	2
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella	Helobdella stagnalis	9
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Hydrachnidae			Hydrachna	Hydrachna	2
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae				Limnephilidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae	Hydroporinae	Bidessini	Liodessus	Liodessus	28
Annelida		Clitellata	Oligochaeta	Lumbriculida		Lumbriculidae			Lumbriculus	Lumbriculus	11
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Microtendipes	Microtendipes Pedellus Gr.	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Notonectidae	Notonectinae	Notonectini	Notonecta	Notonecta	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Pagastiella	Pagastiella	69
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium	Pisidium	60
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	12
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	14
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae				Sphaeriidae	11
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	Tanytarsus	6

GANDER CR. FLICKER POND (GC002), 2015-07-09, CABIN wetland, 13% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	7
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Anisoptera				Anisoptera	8
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae	Gerrinae		Aquarius	Aquarius	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus	Arrenurus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	5
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae				Corixidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura	Corynoneura	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Dicrotendipes	Dicrotendipes	19
Annelida		Clitellata	Hirudinea	Arhynchobdellida	Erpobdelliformes	Erpobdellidae	Erpobdellinae		Erpobdella	Erpobdella	2
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella	Helobdella stagnalis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Lestidae				Lestidae	1
Annelida		Clitellata	Oligochaeta	Lumbriculida		Lumbriculidae				Lumbriculidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Microtendipes	Microtendipes Pedellus Gr.	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Nilothauma	Nilothauma	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Notonectidae	Notonectinae	Notonectini	Notonecta	Notonecta	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Pagastiella	Pagastiella	9
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium	Pisidium	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	23
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	156
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	75
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Tabanidae				Tabanidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	Tanytarsus	10

HAY'S WETLAND (HAY001), 2015-07-10, CABIN wetland, 31% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	11
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae				Aeshnidae	3
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus	Arrenurus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	53
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chaoboridae	Chaoborinae		Chaoborus	Chaoborus	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Chironomus	Chironomus	6
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrionidae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Corduliidae				Corduliidae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae				Corixidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura	Corynoneura	9
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae				Culicidae	15
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae				Culicidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae			Dixella	Dixella	3
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae				Dytiscidae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Ephydridae				Ephydridae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae				Gerridae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrochidae			Hydrochus	Hydrochus	2
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Hydryphantidae				Hydryphantidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Lestidae			Lestes	Lestes	2
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Limnephilini	Limnephilus	Limnephilus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Limnophyes	Limnophyes	1
Annelida		Clitellata	Oligochaeta	Lumbriculida		Lumbriculidae			Lumbriculus	Lumbriculus	2
Mollusca		Gastropoda		Basommatophora		Lymnaeidae				Lymnaeidae	10
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Notonectidae	Notonectinae	Notonectini	Notonecta	Notonecta	5
Arthropoda	Chelicerata	Arachnida	Acari	Sarcoptiformes	Oribatida	Oribatida				Oribatida	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae			Orthocladiinae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Parachironomus	Parachironomus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Furcatergalia	Leptophlebiidae			Paraleptophlebia	Paraleptophlebia	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Phaenopsectra	Phaenopsectra	2
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium	Pisidium	1
Mollusca		Gastropoda		Basommatophora		Planorbidae			Planorbella	Planorbella	3
Mollusca		Gastropoda		Basommatophora		Planorbidae				Planorbidae	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	53
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Sciomyzidae				Sciomyzidae	2
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae				Sphaeriidae	67
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Sphaerium	Sphaerium	2
Mollusca		Gastropoda		Basommatophora		Lymnaeidae			Stagnicola	Stagnicola	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae			Tanypodinae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	Tanytarsus	1

LITTLE SLOCAN LAKES S. (LSL002), 2015-07-15, CABIN wetland, 37% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae	Anophelinae		Anopheles	Anopheles	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus	Arrenurus	1
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae		Aulodrilus	Aulodrilus	9
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	31
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae				Ceratopogonidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini		Chironomini	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrionidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Corduliidae				Corduliidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae				Corixidae	17
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura	Corynoneura	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus	Cricotopus (Isocladius)	8
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cryptochironomus	Cryptochironomus	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cryptotendipes	Cryptotendipes	15
Annelida		Clitellata	Oligochaeta	Enchytraeida		Enchytraeidae			Enchytraeus	Enchytraeus	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella	Helobdella stagnalis	10
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella	Hyalella	6
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Hydroptilidae				Hydroptilidae	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Lebertiidae			Lebertia	Lebertia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Libellulidae				Libellulidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae				Limnephilidae	4
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Limnesiidae			Limnesia	Limnesia	3
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae	Hydroporinae	Bidessini	Liodessus	Liodessus	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Micropsectra	Micropsectra	14
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae				Naididae	7
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Nais	Nais	10
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Unionicolidae			Neumania	Neumania	9
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Orthocladius	Orthocladius annectens	8
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	Paratanytarsus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Paratendipes	Paratendipes	3
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Pionidae			Piona	Piona	10
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Pionidae				Pionidae	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium	Pisidium	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Diamesinae	Diamesini	Potthastia	Potthastia Longimanus Gr.	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	17
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae	Corixinae		Sigara	Sigara	3
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Siphlonuridae			Siphlonurus	Siphlonurus	3
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Slavina	Slavina appendiculata	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Tabanidae				Tabanidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	Tanytarsus	61
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae			Tubificinae	7
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Unionicolidae			Unionicola	Unionicola	1
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Vejdovskyella	Vejdovskyella	1

LITTLE WILSON LAKES (LWL001), 2015-07-29, CABIN wetland, 18% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	SubGenus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae					Aeshnidae	12
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus		Arrenurus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis		Callibaetis	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae					Ceratopogonidae	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae				Ceratopogoninae	7
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini			Chironomini	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Cladotanytarsus		Cladotanytarsus	14
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Conchapelopia		Conchapelopia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae					Corixidae	16
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura		Corynoneura	19
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cryptochironomus		Cryptochironomus	1
Annelida		Clitellata	Hirudinea	Arhynchobdellida	Erpobdelliformes	Erpobdellidae	Erpobdellinae		Erpobdella		Erpobdella	2
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Gammaridae			Gammarus		Gammarus	6
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae					Gerridae	2
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Glossiphoniinae		Glossiphonia		Glossiphonia complanata	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Chilostigmini	Glyphopsyche		Glyphopsyche irrorata	5
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella		Helobdella stagnalis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Heterotrissocladius		Heterotrissocladius	1
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella		Hyalella	9
Cnidaria		Hydrozoa				Hydrozoa					Hydrozoa	2
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Limnephilini	Limnephilus		Limnephilus	6
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae		Limnodrilus		Limnodrilus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Limnophyes		Limnophyes	2
Annelida		Clitellata	Oligochaeta	Lumbriculida		Lumbriculidae					Lumbriculidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Veliidae	Microveliinae		Microvelia		Microvelia	1
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae					Naididae	6
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Nais		Nais	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Orthocladius	Orthocladius	Orthocladius annectens	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Paracladopelma		Paracladopelma	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Phaenopsectra		Phaenopsectra	1
Mollusca		Gastropoda		Basommatophora		Physidae			Physella		Physella	4
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium		Pisidium	92
Mollusca		Gastropoda		Basommatophora		Planorbidae					Planorbidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius		Procladius	7
Arthropoda	Hexapoda	Insecta	Pterygota	Megaloptera		Sialidae			Sialis		Sialis	5
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Siphlonuridae			Siphlonurus		Siphlonurus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Stempellina		Stempellina	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus		Tanytarsus	12
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae				Tubificinae	37

SEATON CR. UPPER (SEAT001), 2015-07-14, CABIN wetland, 36% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	SubGenus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia		Ablabesmyia	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus		Arrenurus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Forcipomyiinae		Atrichopogon		Atrichopogon	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Brillia		Brillia	2
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis		Callibaetis	100
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae					Ceratopogonidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae				Ceratopogoninae	36
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae					Coenagrionidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae					Corixidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura		Corynoneura	70
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura		Corynoneura	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus	Cricotopus	Cricotopus (Cricotopus)	7
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae					Culicidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae			Dixella		Dixella	22
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae					Dytiscidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae					Gerridae	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella		Helobdella stagnalis	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Heterotrissocladius		Heterotrissocladius	1
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella		Hyalella	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Hydroptilidae	Hydroptilinae	Hydroptilini	Hydroptila		Hydroptila	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Hygrobatidae			Hygrobates		Hygrobates	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Laccobiini	Laccobius		Laccobius	4
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Lebertiidae			Lebertia		Lebertia	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Limnesiidae			Limnesia		Limnesia	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Limnophyes		Limnophyes	3
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae					Naididae	1
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Nais		Nais	6
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Notonectidae	Notonectinae	Notonectini	Notonecta		Notonecta	2
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Oxidae			Oxus		Oxus	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Hydryphantidae			Panisus		Panisus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Paracladopelma		Paracladopelma	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Parakiefferiella		Parakiefferiella	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Nudomideopsidae			Paramideopsis		Paramideopsis	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Pionidae			Piona		Piona	2
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Pionidae					Pionidae	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium		Pisidium	7
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius		Procladius	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius		Psectrocladius	3
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Chilostigmini	Psychoglypha		Psychoglypha	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Macropelopiini	Radotanypus		Radotanypus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus		Tanytarsus	5
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae				Tubificinae	6

SEATON CR. MID (SEAT003), 2015-08-06, CABIN wetland, 9% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	SubGenus	Taxon	Sub_Count
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Hydryphantidae			Albertathyas		Albertathyas montana	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Brillia		Brillia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis		Callibaetis	218
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura		Corynoneura	7
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus	Cricotopus (Isocladius)	Cricotopus (Isocladius)	9
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae			Dixella		Dixella	26
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae					Dixidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae					Dytiscidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae					Gerridae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Laccobiini	Laccobius		Laccobius	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Limnophyes		Limnophyes	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Micropsectra		Micropsectra	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Micropsectra		Micropsectra	1
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae					Naididae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Peltodytes		Peltodytes	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium		Pisidium	20
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius		Procladius	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius		Psectrocladius	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Macropelopiini	Radotanypus		Radotanypus	22
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Siphlonuridae			Siphlonurus		Siphlonurus	4
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae				Tubificinae	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Tvetenia		Tvetenia Bavarica Gr.	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Zavrelimyia		Zavrelimyia	3

SUMMIT LAKE LOWER (SUM001), 2015-07-21, CABIN wetland, 11% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	SubGenus	Taxon	Sub_Coun
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Brillia		Brillia	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cladopelma		Cladopelma	7
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae					Coenagrionidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus	Cricotopus	Cricotopus bicinctus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae			Dixella		Dixella	1
Annelida		Clitellata	Oligochaeta	Enchytraeida		Enchytraeidae			Enchytraeus		Enchytraeus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Ephydridae					Ephydridae	50
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Ephydridae					Ephydridae	18
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Chilostigmini	Glyphopsyche		Glyphopsyche irrorata	15
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella		Helobdella stagnalis	8
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella		Hyalella	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Micropsectra		Micropsectra	111
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Micropsectra		Micropsectra	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Microtendipes		Microtendipes Pedellus Gr.	40
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Nanocladius		Nanocladius	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Hydroptilidae	Hydroptilinae	Hydroptilini	Oxyethira		Oxyethira	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus		Paratanytarsus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Paratendipes		Paratendipes	3
Mollusca		Gastropoda		Basommatophora		Physidae			Physella		Physella	2
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium		Pisidium	31
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum		Polypedilum	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius		Procladius	14
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Rheotanytarsus		Rheotanytarsus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Sciomyzidae					Sciomyzidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini			Thienemannimyia Gr.	14
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Zavrelimyia		Zavrelimyia	5

SUMMIT LAKE EDGE (SUM002), 2015-07-21, CABIN wetland, 16% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	SubGenus	Taxon	Sub_Coun
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia		Ablabesmyia	5
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae					Aeshnidae	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae	Anophelinae		Anopheles		Anopheles	7
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Notonectidae	Anisopinae		Buenoa		Buenoa	2
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis		Callibaetis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae					Ceratopogonidae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae				Ceratopogoninae	12
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Chironomus		Chironomus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cladopelma		Cladopelma	5
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae					Coenagrionidae	30
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura		Corynoneura	3
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Dero		Dero	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Dicrotendipes		Dicrotendipes	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae					Dytiscidae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Chilostigmini	Glyphopsyche		Glyphopsyche irrorata	1
Mollusca		Gastropoda		Basommatophora		Planorbidae			Gyraulus		Gyraulus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Haliplus		Haliplus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Haliplus		Haliplus	1
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella		Hyalella	49
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Hydrodromidae			Hydrodroma		Hydrodroma	2
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae	Hydroporinae	Hygrotini	Hygrotus		Hygrotus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Libellulidae					Libellulidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Micropsectra		Micropsectra	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Microtendipes		Microtendipes Pedellus Gr.	5
Mollusca		Bivalvia	Heterodonta	Veneroida		Pisidiidae			Musculium		Musculium	12
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Nais		Nais	2
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Notonectidae					Notonectidae	11
Arthropoda	Chelicerata	Arachnida	Acari	Sarcoptiformes	Oribatida	Oribatida					Oribatida	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Parakiefferiella		Parakiefferiella	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus		Paratanytarsus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Phaenopsectra		Phaenopsectra	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Phryganeidae					Phryganeidae	2
Mollusca		Gastropoda		Basommatophora		Physidae			Physella		Physella	8
Mollusca		Gastropoda		Basommatophora		Planorbidae			Planorbella		Planorbella	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum		Polypedilum	16
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius		Procladius	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius		Psectrocladius	18
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Nepidae	Ranatrinae		Ranatra		Ranatra	1
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Slavina		Slavina appendiculata	2
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Stylaria		Stylaria	43
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Tabanidae					Tabanidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae				Tanypodinae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus		Tanytarsus	9
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Zavrelimyia		Zavrelimyia	6

TYSON E.'S POND (TY001), 2015-07-10, CABIN wetland, 6% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	SubGenus	Taxon	Sub_Coun
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Acricotopus		Acricotopus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae					Aeshnidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Anisoptera					Anisoptera	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae	Anophelinae		Anopheles		Anopheles	4
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus		Arrenurus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis		Callibaetis	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae					Ceratopogonidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae				Ceratopogoninae	11
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae					Coenagrionidae	29
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Corixidae					Corixidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura		Corynoneura	1
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Crangonyctidae			Crangonyx		Crangonyx	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus		Cricotopus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Cricotopus	Cricotopus	Cricotopus (Cricotopus)	37
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae					Culicidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae					Culicidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Dasyheleinae		Dasyhelea		Dasyhelea	10
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae					Dytiscidae	2
Mollusca		Gastropoda		Basommatophora		Planorbidae			Gyraulus		Gyraulus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Haliplus		Haliplus	3
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella		Hyalella	86
Mollusca		Gastropoda		Basommatophora		Lymnaeidae					Lymnaeidae	9
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Veliidae	Microveliinae		Microvelia		Microvelia	3
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Nais		Nais	93
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Peltodytes		Peltodytes	3
Mollusca		Gastropoda		Basommatophora		Physidae			Physella		Physella	5
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium		Pisidium	1
Mollusca		Gastropoda		Basommatophora		Planorbidae					Planorbidae	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum		Polypedilum	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius		Psectrocladius	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Pseudochironomini	Pseudochironomus		Pseudochironomus	8
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Nepidae	Ranatrinae		Ranatra		Ranatra	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae					Sphaeriidae	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Tipulidae	Tipulinae		Tipula		Tipula	2
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae	Hydrophilinae	Hydrophilini	Tropisternus		Tropisternus	1
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Tubificinae				Tubificinae	1
Mollusca		Gastropoda		Heterostropha		Valvatidae			Valvata		Valvata	5

WINLAW WOODLOT LOWER (WIN001), 2015-06-30, CABIN wetland, 100% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	15
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae				Aeshnidae	2
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus	Arrenurus	15
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	11
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Chironomus	Chironomus	6
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Corduliidae				Corduliidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Corynoneura	Corynoneura	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae				Dytiscidae	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Ephydridae				Ephydridae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae				Gerridae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Haliplus	Haliplus	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella	Helobdella stagnalis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Lestidae			Lestes	Lestes	3
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Limnephilini	Limnephilus	Limnephilus	2
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Limnesiidae				Limnesiidae	1
Annelida		Clitellata	Oligochaeta	Lumbriculida		Lumbriculidae				Lumbriculidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Micropsectra	Micropsectra	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Veliidae	Microveliinae		Microvelia	Microvelia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Monopelopia	Monopelopia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	Paratanytarsus	5
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium	Pisidium	33
Mollusca		Gastropoda		Basommatophora		Planorbidae				Planorbidae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Polypedilum	Polypedilum	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	4
Mollusca		Gastropoda		Basommatophora		Planorbidae			Promenetus	Promenetus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Macropelopiini	Psectrotanypus	Psectrotanypus	2
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae				Sphaeriidae	78
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Sphaerium	Sphaerium	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Tabanidae				Tabanidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini		Tanytarsini	1

WINLAW WOODLOT UPPER (WIN002), 2015-06-30, CABIN wetland, 100% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	Ablabesmyia	19
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae			Aeshna	Aeshna	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus	Arrenurus	32
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae				Ceratopogonidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae			Ceratopogoninae	12
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Chironomus	Chironomus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Cladopelma	Cladopelma	5
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Corduliidae				Corduliidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae				Dixidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae				Dytiscidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Ephydridae				Ephydridae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae				Gerridae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Limnephilini	Limnephilus	Limnephilus	3
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Limnesiidae			Limnesia	Limnesia	7
Annelida		Clitellata	Oligochaeta	Lumbriculida		Lumbriculidae				Lumbriculidae	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Pentaneurini	Monopelopia	Monopelopia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Chironomini	Parachironomus	Parachironomus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	Paratanytarsus	2
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Pionidae			Piona	Piona	1
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Pisidium	Pisidium	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Procladiini	Procladius	Procladius	9
Mollusca		Gastropoda		Basommatophora		Planorbidae			Promenetus	Promenetus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Orthocladiinae		Psectrocladius	Psectrocladius	5
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Tanypodinae	Macropelopiini	Psectrotanypus	Psectrotanypus	2
Mollusca		Bivalvia	Heterodonta	Veneroida		Sphaeriidae			Sphaerium	Sphaerium	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Tabanidae				Tabanidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	Tanytarsus	6

BEAVER LAKES (BVL001), 2014-09-08, CABIN wetland, 6% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Forcipomyiinae		Atrichopogon	Atrichopogon	43
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae				Baetidae	6
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Forcipomyiinae		Atrichopogon	Bezzia/Palpomyia	14
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Aturidae			Brachypoda	Brachypoda	2
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	8
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae				Ceratopogonidae	16
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae				Chironomidae	160
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera						Diptera	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae				Dytiscidae	11
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Empididae				Empididae	2
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Gammaridae				Gammaridae	1
Mollusca		Gastropod								Gastropod	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydraenidae	Hydraeninae	Hydraenini	Hydraena	Hydraena	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Lebertiidae			Lebertia	Lebertia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae				Limnephilidae	1
Annelida		Clitellata	Oligochaeta	Lumbriculida		Lumbriculidae				Lumbriculidae	2
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae				Naididae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera					Odonata	1
Annelida		Clitellata	Oligochaeta							Oligochaeta	8
Mollusca		Bivalvia	Heterodonta	Veneroida		Pisidiidae				Pisidiidae	42
Mollusca		Gastropoda		Basommatophora		Planorbidae				Planorbidae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Psychodidae				Psychodidae	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Sperchontidae			Sperchon	Sperchon	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Tabanidae				Tabanidae	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera						Trichoptera	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes						Trombidformes	1
Annelida		Clitellata	Oligochaeta	Tubificida		Tubificidae				Tubificidae	2

LITTLE SLOCAN LAKES (LSL001), 2014-08-27, CABIN wetland, 8% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae				Naididae	3
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Aeshnidae				Aeshnidae	1
Mollusca		Gastropoda		Basommatophora		Ancylidae				Ancylidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae	Anophelinae		Anopheles	Anopheles	2
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae				Baetidae	10
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Forcipomyiinae		Atrichopogon	Bezzia/Palpomyia	4
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae				Ceratopogonidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae				Chironomidae	259
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrionidae	7
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Dero	Dero	31
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae			Dixella	Dixella	2
Annelida		Clitellata	Oligochaeta	Enchytraeida		Enchytraeidae			Enchytraeus	Enchytraeidae	6
Mollusca		Gastropod								Gastropod	1
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae	Gerrinae		Gerris	Gerris	1
Annelida		Clitellata	Hirudinea	Rhynchobdellida		Glossiphoniidae	Haementeriinae		Helobdella	Helobdella	2
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella	Hyalella	5
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophillidae			Hydrochus	Hydrochus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Hydroptilidae				Hydroptilidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Leptoceridae			Ocecetis	Ocectis	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Hydroptilidae	Hydroptilinae	Hydroptilini	Oxyethira	Oxyethira	3
Mollusca		Bivalvia	Heterodonta	Veneroida		Pisidiidae				Pisidiidae	4
Arthropoda	Chelicerata	Arachnida	Acari	Sarcoptiformes						Sarcoptiformes	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes						Trombidformes	2
Annelida		Clitellata	Oligochaeta	Tubificida		Tubificidae				Tubificidae	8

PASS CREEK COMPLEX (PS002), 2014-08-25, CABIN wetland, 5% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae				Naididae	61
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae	Anophelinae		Anopheles	Anopheles	2
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae				Baetidae	130
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Phryganeidae	Phryganeinae		Banksiola	Banksiola	1
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Forcipomyiinae		Atrichopogon	Bezzia/Palpomyia	4
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Furcatergalia	Caenidae				Caenidae	44
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Furcatergalia	Caenidae	Caeninae		Caenis	Caenis	156
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	134
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae				Ceratopogonidae	23
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chaoboridae	Chaoborinae		Chaoborus	Chaoborus	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae				Chironomidae	104
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrion/Enallagma	9
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrionidae	31
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Corduliidae			Cordulia	Cordulia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Anisoptera	Corduliidae				Corduliidae	1
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae	Naidinae		Dero	Dero	80
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae				Dytiscidae	1
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Gammaridae				Gammaridae	8
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Limnephilidae	Limnephilinae	Chilostigmini	Glyphopsyche	Glyphopsyche	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Haliplus	Haliplus	3
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera		Hemiptera				Hemiptera	1
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Hyalellidae			Hyalella	Hyalella	28
Cnidaria		Hydrozoa				Hydrozoa				Hydrozoa	2
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Notonectidae	Notonectinae	Notonectini	Notonecta	Notonecta	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Leptoceridae			Ocecetis	Ocectis	2
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera					Odonata	14
Annelida		Clitellata	Oligochaeta							Oligochaeta	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Hydroptilidae	Hydroptilinae	Hydroptilini	Oxyethira	Oxyethira	2
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Furcatergalia	Leptophlebiidae			Paraleptophlebia	Paraleptophlebia	1
Arthropoda	Hexapoda	Insecta	Pterygota	Trichoptera		Phryganeidae				Phryganeidae	3
Mollusca		Bivalvia	Heterodonta	Veneroida		Pisidiidae				Pisidiidae	8
Mollusca		Gastropoda		Basommatophora		Planorbidae				Planorbidae	8
Arthropoda	Chelicerata	Arachnida	Acari	Sarcoptiformes						Sarcoptiformes	1
Annelida		Clitellata	Oligochaeta	Tubificida		Tubificidae				Tubificidae	14

SEATON CR. LOWER (SEAT001), 2014-09-08, CABIN wetland, 5% sample sorted, Kingdom Animalia

Phylum	SubPhylum	Class	SubClass	Order	SubOrder	Family	SubFamily	Tribe	Genus	Taxon	Sub_Count
Annelida		Clitellata	Oligochaeta	Tubificida		Naididae				Naididae	8
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Dytiscidae			Agabus	Agabus	4
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae	Anophelinae		Anopheles	Anopheles	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes	Prostigmata	Arrenuridae			Arrenurus	Arrenurus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae				Baetidae	146
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Forcipomyiinae		Atrichopogon	Bezzia/Palpomyia	7
Arthropoda	Hexapoda	Insecta	Pterygota	Ephemeroptera	Pisciforma	Baetidae			Callibaetis	Callibaetis	667
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae	Ceratopogoninae		Ceratopogon	Ceratopogon	3
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Ceratopogonidae				Ceratopogonidae	12
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Chironomidae				Chironomidae	231
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera	Coenagrionidae				Coenagrionidae	25
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Culicidae				Culicidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Nematocera	Dixidae			Dixella	Dixella	173
Mollusca		Gastropod								Gastropod	2
Arthropoda	Hexapoda	Insecta	Pterygota	Hemiptera	Heteroptera	Gerridae	Gerrinae		Gerris	Gerris	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Adephaga	Haliplidae			Haliplus	Haliplus	1
Arthropoda	Hexapoda	Insecta	Pterygota	Coleoptera	Polyphaga	Hydrophilidae				Hydrophilidae	2
Arthropoda	Hexapoda	Insecta	Pterygota	Odonata	Zygoptera					Odonata	15
Mollusca		Bivalvia	Heterodonta	Veneroida		Pisidiidae				Pisidiidae	1
Arthropoda	Chelicerata	Arachnida	Acari	Sarcoptiformes						Sarcoptiformes	2
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Brachycera	Tabanidae				Tabanidae	1
Arthropoda	Chelicerata	Arachnida	Acari	Trombidiformes						Trombidformes	3

10.12 Appendix 12: Results of ANCOVA of macroinvertebrate metric versus stress score

.yvar	Parameter	Level1	Estimate	StdErr	ChiSquare	t3chisq	p-value
DIV_Simpsons	Intercept		0.4381	0.6291	0.49	.	.
DIV_Simpsons	Stress_score		-0.0114	0.0034	11.44	9.3523	0.00223
DIV_Simpsons	TOC		0.0008	0.0041	0.04	0.0413	0.83894
DIV_Simpsons	Type	Floodplain	0.052	0.1106	0.22	1.1533	0.76423
DIV_Simpsons	Type	Lacustrine	0.0335	0.0956	0.12	1.1533	0.76423
DIV_Simpsons	Type	Palustrine	-0.0871	0.1226	0.51	1.1533	0.76423
DIV_Simpsons	Type	Riverine	0	0	.	1.1533	0.76423
DIV_Simpsons	pH		0.1256	0.0981	1.64	1.5877	0.20765
NT_Clitella	Intercept		1.733	2.0777	0.7	.	.
NT_Clitella	Stress_score		-0.027	0.0105	6.54	6.7547	0.00935
NT_Clitella	TOC		-0.0282	0.0161	3.05	3.5844	0.05833
NT_Clitella	Type	Floodplain	-0.4391	0.391	1.26	4.7452	0.19144
NT_Clitella	Type	Lacustrine	0.0662	0.308	0.05	4.7452	0.19144
NT_Clitella	Type	Palustrine	-0.5798	0.4252	1.86	4.7452	0.19144
NT_Clitella	Type	Riverine	0	0	.	4.7452	0.19144
NT_Clitella	pH		0.2061	0.3084	0.45	0.4444	0.505
PA_Callibaetis	Intercept		0.0769	0.0216	12.7	.	.
PA_Callibaetis	Stress_score		0.0005	0.0001	19.1	14.052	0.00018
PA_Callibaetis	TOC		-0.0002	0.0001	1.28	1.25	0.26356
PA_Callibaetis	Type	Floodplain	-0.005	0.0038	1.7	8.7531	0.03276
PA_Callibaetis	Type	Lacustrine	-0.0106	0.0033	10.44	8.7531	0.03276
PA_Callibaetis	Type	Palustrine	-0.0066	0.0042	2.46	8.7531	0.03276
PA_Callibaetis	Type	Riverine	0	0	.	8.7531	0.03276
PA_Callibaetis	pH		-0.0041	0.0034	1.51	1.4653	0.22609
PA_CG	Intercept		0.1874	0.0277	45.61	.	.
PA_CG	Scale		0.008	0.0012	_	.	.
PA_CG	Stress_score		0.0004	0.0001	7.67	6.6555	0.00988
PA_CG	TOC		-0.0004	0.0002	6	5.3554	0.02066
PA_CG	Type	Floodplain	-0.0029	0.0049	0.35	5.7064	0.1268
PA_CG	Type	Lacustrine	-0.0033	0.0042	0.6	5.7064	0.1268
PA_CG	Type	Palustrine	-0.0137	0.0054	6.38	5.7064	0.1268
PA_CG	Type	Riverine	0	0	.	5.7064	0.1268
PA_CG	pH		-0.0145	0.0043	11.32	9.2704	0.00233
NT_HBIS	Intercept		-0.8811	2.2046	0.16	.	.
NT_HBIS	Stress_score		-0.0239	0.012	3.97	4.0721	0.0436
NT_HBIS	TOC		-0.0033	0.0148	0.05	0.0509	0.82158
NT_HBIS	Type	Floodplain	-0.0907	0.4041	0.05	0.6602	0.88252
NT_HBIS	Type	Lacustrine	0.0319	0.3338	0.01	0.6602	0.88252
NT_HBIS	Type	Palustrine	-0.2956	0.443	0.45	0.6602	0.88252
NT_HBIS	Type	Riverine	0	0	.	0.6602	0.88252
NT_HBIS	pH		0.4446	0.338	1.73	1.7171	0.19006
PD_Amph_BCG	Intercept		-0.0029	0.0299	0.01	.	.
PD_Amph_BCG	Stress_score		-0.0003	0.0002	3.22	3.0172	0.08239
PD_Amph_BCG	TOC		0.0001	0.0002	0.18	0.1808	0.67068
PD_Amph_BCG	Type	Floodplain	-0.0037	0.0053	0.5	13.7621	0.00325
PD_Amph_BCG	Type	Lacustrine	0.0094	0.0046	4.26	13.7621	0.00325

PD_Amph_BCG	Type	Palustrine	-0.014	0.0058	5.76	13.7621	0.00325
PD_Amph_BCG	Type	Riverine	0	0	.	13.7621	0.00325
PD_Amph_BCG	pH		0.013	0.0047	7.76	6.7214	0.00953

PA=Percent abundance, NT=No. of Taxa, Percent data was transformed with Anscombe's Arcsin(sqrt()), Count data transformed using Ln(x+1).

10.13 Appendix 13: Update on FWCP project condition re: IBI-based evaluation of restoration sites.

Update on possible restoration sites or sites of interest as suggested by community

	Possible restoration site or site of interest	Interest by owner in restoration works	On ground inspection or assessment	Restoration/Conservation potential	Wetland stress score	IBI score
ELI001	Side channels nr. Lemon Creek & Slocan islands	Good	Site visit by invertebrate team in 2015	Restoration, site visit by invertebrate team, possible stream restoration potential	None	None
ELD001	Island Oxbow	Unknown	Sampled for invertebrates	Wetland Restoration	68.0	47.2
BLU001	Wetland complex, side channel	Unknown	Inspection by Slocan Streamkeepers	Wetland Restoration	None	None
FO001	Fominoff's field, large wetland complex	Unknown	Rail to Trail site sampled for invertebrates	Restoration, streamkeepers have carried out riparian planting, Further restoration potential	63.4	59.7
FRA001	Side channel, residual Oxbow	Cattle issues, fencing in place	Inspection by Slocan Streamkeepers, sampled for invertebrates	Restoration	60.2	68.8
SPA001	Temporary wetlands	High	Assessed by Thomas Biebighauser July 4, 2014 (attached).	Wetland restoration funding obtained, restoration works planned, invertebrate sampling planned in 2016 (before and control sites including Schneider's cattail wetland as a nearby control)	2016	2016
SEAT001, SEAT002, SEAT003	Seaton Creek/Threeforks wetlands	Unknown	Sampled for invertebrates in 2014 & 2015 assessed by Durand (2015).	Impacted by legacy mining.	SEAT001 (83.8) SEAT002 (85.7) SEAT003 (87.4)	SEAT001 (23.1) SEAT002 (11.0) SEAT003 (0)
BON001	Bonanza Creek wetland	Unknown	Sampled for invertebrates 2015, further sampling in 2016	Conservation, candidate property for Nature Trust, weed control required, further sampling on west side of wetland)	BON001 (73.3) 2016	BON001 (59.7) 2016
SUM001 SUM002	Wetlands associated with Summit Lake	Unknown	Sampled for invertebrates in 2015 (two sites)	Conservation, candidate property for Nature Trust	SUM001 (72.2) SUM002 (62.6) 2016	SUM001 (43.4) SUM002 (76.1) 2016

'Based on interviews with Gregoire Lamoureux, Jennifer Yeow, Rhia MacKenzie & Richard Johnson and site visits in 2015 by the invertebrate team. Wetland stress scores vary from 0 (no stress) to 100 (maximum stress).. IBI varies from 100 (high biological integrity) to 0 (low biological integrity). Reference condition is indicated by wetland stress of less than 25 and IBI greater than 55. Scores indicated in red fall outside reference condition. These scores may change in future reporting after incorporating further data.

Note: Further IBI-based management recommendations will be developed by the end of April, 2016 for the draft of the National Wetland Conservation Fund report.

11 Technical Reports

11.1 Technical Report, Opus: Analysis of water quality using Stiff diagrams

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Using Stiff Diagrams

to characterize

Surface Water Samples

from Wetlands in the Slocan Watershed

West Kootenay Area, British Columbia

Prepared for:

Slocan River Streamkeepers, Slocan Solutions Society,

Slocan Lake Stewardship Society and BC Wildlife Federation

under the

Slocan Valley Wetlands Assessment and Mapping Project (SWAMP)

Prepared by: Richard Johnson, P.Eng.

February 26, 2016

Table of Contents

Introduction

Opus processed the water analyses from 21 surface water samples taken during the benthic sampling program associated with the SWAMP wetland assessment project in the summer of 2015. The major ions were plotted on Stiff diagrams for visualization and comparison. All Stiff diagrams are included in Appendix A in order of increasing TDS.

A graph plotting the Specific Conductivity against Total Dissolved Solids (TDS) showed good correlation at Specific Conductivities below 250 µS/cm. and is included as Appendix B.

This report discusses our professional interpretation of these diagrams and graph.

Summary

1. The Stiff diagram method of comparing water analyses proved to be a simple system for identifying large abnormal components in the surface water analyses and can be used as a "first pass" indicator of the water quality as it relates to wetland health.
2. We found that all analyses exhibited typical Calcium-Bicarbonate surface water ion assemblages. The TDS can be looked at as a measure of the "age" of the water. Those waters having a simple, surface flow to the wetland are fresher than those having a longer flow path. In the latter case the flow is often underground.
3. The higher TDS samples often indicated human induced influences along the water flow path. In particular higher than expected concentrations of Sodium, Chloride and Iron ions are indicators of these influences.
4. The TDS graded from extremely fresh, TDS of 18 mg/l, to one abnormal sample of 415 mg/l. The latter sample had a high content of Sodium and Chloride ions, probably caused by runoff from the adjacent developments or highway.
5. A sample from the Bonanza marsh had high Calcium and Sulfate concentrations and the second highest TDS of 409 mg/l of the 21 analyses. This could be human induced or a natural assemblage if there is anhydrite in the limestone over and through which the water has flowed.
6. Several samples showed a high Nitrate concentration, which is not plotted on a normal Stiff diagram, but is recorded on the Opus form. The samples from Beaver Lakes and Little Slocan Lakes wetlands showed this variation.
7. As expected, TDS correlates with Conductivity. A graph showing this correlation is included as Appendix B. It shows the best fit straight line and its equation, "TDS = 0.91*Cond +.41". This equation should be valid for most waters in this watershed below a conductivity of 250 µS/cm. Analyses showing TDS higher than 250 µS/cm. should be looked at in more detail to see what is causing the higher TDS.
8. The graph or the equation can be used to obtain an approximate TDS value from future conductivity measurements of wetlands in the Slocan Watershed. This can indicate if significant changes in the major ions have occurred since the previous sampling of water from a wetland. The trace metals are in such low concentrations that changes in these will not be reflected in the conductivity so abnormalities in these ions have to be investigated separately. The conductivity can also be used to indicate when a complete analysis is needed.

Conclusions

1. The waters in the Slocan watershed are all similar because of the bedrock geology and short residence time in the aquifers. Other natural influences are soils and temperature/altitude.
2. All the water samples are Calcium Bicarbonate Type waters. The TDS of this water type is mostly controlled by the partial pressure of Carbon Dioxide. Variations in the trend indicate solution of other salts, often created by human actions.
3. The Stiff diagrams simplify the handling of the major ions in an analysis but do not address the more detailed work that needs to be done because the trace metals have a high impact on benthic invertebrates and other aquatic life.
4. The measurement of conductivity in the field can be used to determine which waters need to have complete analyses and which wetlands have changed since previous sampling. This will save money.
5. Each wetland should be characterized with respect to its hydrogeological setting, relating the vegetation, elevation, hydrology, geomorphology, soils, geology and chemistry to the whole drainage area. Since these parameters can be obtained from existing data banks and satellite images, this characterization can be used as a tool to predict the location of similar wetlands.
6. The analyses need to be looked at in more detail with respect to the metals and the organics. In particular the eH (redox) potentials should be estimated and related to the metal solubilities.

Discussion

Opus transferred the data from a spreadsheet, provided by Integrated Ecological Research (IER), to its plotting program to better compare various parameters and plot the ion assemblage on a “Stiff diagram”. The Stiff diagram is a graphical representation of the ion concentrations (Stiff, H.A., 1951). The original work used a linear scale to represent the ion concentrations. Modern labs present their results using a logarithmic scale to fit oilfield brines onto the diagram and onto a single page. Opus plots the ion concentrations, in milliequivalents, using a logarithmic scale and adds an axis for Potassium.

Although the Opus plotting program does not normally present the Nitrate concentration, we have modified our plotting page for this study to highlight the Nitrate. Darcie Quamme of IER noted the higher Nitrate concentrations in the Beaver Lake samples, BVL002 and BVL003. There is also high Nitrate concentration in the water sample from Little Slocan Lake (LWL001).

The Bicarbonate has been calculated at 1.22 times the Alkalinity. The lab measures alkalinity by acid titration and the result is presented “mg/l as $CaCO_3$”. Since all of the samples have a pH that is lower than 8.4 there is no measurable concentration of Carbonate (CO_3) ions. Although alkalinity can be affected by other ions, the Bicarbonate ion is the dominant control. Opus has converted the Alkalinity to HCO_3 for this presentation.

The shape of the Stiff plot is used by Opus to “fingerprint” waters. We have used the system on thousands of waters to fingerprint most of the subsurface waters in Western Canada by formation name and have published that study under the title of "Formation Waters of Western Canada" (Johnson and Johnson, 1992). The system works well on surface waters and is simpler and more useful to use than Piper diagrams (Piper, 1944) or Durov diagrams (Durov, 1948).

The 21 samples in this study are all typical surface waters which are Calcium-Bicarbonate type waters. The term "Calcium-Bicarbonate" is a descriptor used in the hydrogeology community to describe a water based upon the dominant cation and anion. All of the samples are below the Canadian and US drinking water standard of 500 mg/l. The human palate does not usually notice ion concentrations until the 1500 mg/l range (Personal experience ... taste plain San Pelligrino (940 mg/l) bottled water or Gerolsteiner (2488 mg/l).

The TDS of Calcium Bicarbonate waters can be thought of a measure of the "age" of the water. Precipitation falling upstream from a wetland reaches the wetland in three ways. The simplest is surface run off. The next is travel through the soil. The third way that water reaches a wetland is through aquifer flow below the soil. The latter is the most complex and the slowest and gives the most time and opportunity for increased TDS concentration. A variation of this is probably happening in the Bonanza Marsh where subsurface water is coming to the surface through a fractured limestone bedrock.

Water moving underground is initially affected by the higher concentration of Carbon Dioxide in the soil which is controlled by temperature and depth (CO_2 partial pressure). It also has more opportunity to dissolve salts and other material from the soil and/or aquifer. This is fully explained in Kehew (2001).

In the analyses described in this study we can see that the analyses from the Gander Creek and Cooley Lake are very fresh. These are high elevation sites (over 1500 m. ASL) with small drainage areas, thus short flow paths. Bear Lake and Seaton Creek are the second highest group around 1000 m. ASL. but these have been impacted by mining.

Little Wilson Lake and Beaver Lake are at a similar elevation and show similar waters. Little Slocan Lake is only at 650 m. ASL but is fresher than the Beaver Lake/Little Slocan Lake waters which are in a valley with a larger soil component and longer residence time.

The two samples above Winlaw are at an elevation of about 1000 m. ASL but appear to be affected by human activity rather than drainage basin (small) or elevation. The remaining samples come from complex areas with aquifers and human influences.

A copy of a spreadsheet from Durand Ecological Ltd. is attached, as Appendix C, showing the wetland location and elevation with an added column showing the TDS for the various wetland sites. Detailed work relating various hydrogeomorphic parameters and wetland classifications to the water sample sites can be found in the appendices in Durand (2016).

The Stiff diagrams and the associated data are included in Appendix A, in order of increasing TDS. One can see the area of the enclosed space, inside the Stiff diagram lines, increase while the overall shape develops from a “diamond” into a “kite”. Variations in the samples often indicate contributions from human activity. In particular Sodium, Chloride and Iron are not normal constituents of the waters in the Slocan watershed. The sample F0001 (Fomi’s) shows human created contamination. It is probably Sodium Chloride from surface run-off from the nearby residences, the rail trail or the highway above the site. The analysis, BON001, was a sample taken in Bonanza Marsh. It shows a high Sulfate concentration when compared to the other samples in this study. Bonanza Marsh is fed by springs and streams flowing over a fractured limestone bedrock. Although the Sodium is noticeable, the cation balancing the Sulfate is probably Calcium, indicating a gypsum or anhydrite source. This may from be normal dissolution of these minerals in the limestone, or may be manmade.

The “Ion Balance” is calculated on each Opus page and is printed below the Stiff diagram on the right-hand side of the page. The sum of the milliequivalents of the cations should equal the sum of the milliequivalents of the anions because water has to have the same number of positive charges as negative charges. In saline waters it is usually within 10% but varies so much of fresh waters that we have not found it useful.

All of the samples have a conductivity measurement recorded by the lab. The conductivity shown is called the Specific Conductivity if it is measured at or corrected to 25 degrees Celsius. The conductivity instrument measures the conductivity accurately at the temperature of the sample. If that temperature is not 25 degrees then the internal computer in the instrument corrects it to 25 degrees using an algorithm. The instruments we have worked with use an algorithm based upon Potassium Chloride, so these instruments do not correct accurately for a water sample in which the dominant ions are Calcium and Bicarbonate (Personal measurements with a Hanna meter). That being said, the instrument error is not significant enough to worry about for our purposes in this type of study.

The conductivity of a solution is dependent upon the ionic components in it. Sodium, Potassium and Chloride all produce similar a similar response to an electrical current. Bicarbonate and the di-valent ions are less conductive. This means that a solution carrying large amounts of the latter ions can have a greater TDS yet still measure the same conductivity as a solution of pure Sodium Chloride. This is why we cannot measure the conductivity of a water sample and determine the TDS content directly from that measurement. However, for the waters in this area (Calcium Bicarbonate type), we can estimate TDS fairly closely.

We plotted the Total Dissolved Solids of the samples against the conductivity and have included it as Appendix B. This graph can be used to estimate the TDS for waters, in the Slocan watershed, that are similar to the ones in this sample group that are below a Specific Conductivity of 250 μS/cm. The equation of best fit straight line is “TDS = 0.91 * Conductivity + 0.41”. In Durand (2016) there are numerous field measurements of conductivity which can be used to help evaluate the health of these other wetlands

This graph can be updated with conductivities from future sampling and give more accurate results, however we should note that when a surface water is mixed with Sodium Chloride or Gypsum/Anhydrite, as are two of the samples in this study, they should not be used in defining the correlation for our typical Calcium Bicarbonate surface waters.

It should also be noted that the trace metals in these samples are in such small concentrations that they have an insignificant effect on the conductivity compared to the nine ions plotted on the Stiff diagram. Nitrate and Phosphate ions, being charged, have an effect on the conductivity if their concentration is high enough.

<u>Recommendations for further study</u>

1. There are other samples of waters that have been analyzed in the Slocan watershed. These should be searched out and added to these data. The resulting data bank should be made available to everyone working on waters in this area.

2. Further work should be done to relate the other metals in these analyses to the bedrock and soils through which the water has travelled to reach the sample sites as well as human disturbances upstream.

3. Sampling should continue on these same sites in future years. These data can be used to monitor changes in the wetlands and be integrated into the benthic analyses being done by Integrated Ecological Research.

4. Even if full analyses are not performed on these sites, visitors should take conductivity and pH measurements whenever they are in the area. Changes in these two parameters can alert us to changes in the composition of the water.

5. These data should integrated into water quality monitoring, aquifer mapping, and wetland assessment work being done by the SWAMP collaborative and the SWAMP Multimetric Index of Biotic Integrity work.

<u>References</u>

Durand, R., 2016, “SWAMP Phase 3, Slocan Wetland Monitoring and Assessment Project “, Durand Ecological Ltd.

Durov, S. A., 1948, “Classification of Natural Waters and Graphic Representation of their Composition (in Russian), DokladyAk .Nauk SSR v. 59, no. 1, pp. 87-90.

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Kehew,A.E., 2001, “Applied Chemical Hydrogeology”, Prentice Hall.

Piper, A. M., 1944, ”A graphic procedure in the geochemical interpretation of water analyses”, Transactions American Geophysical Union, 25, 914–928.

Stiff, H. A., Jr., 1951. “The interpretation of chemical water analysis by means of patterns” Journal of Petroleum Technology, v. 3. no.10.

Appendix A

Attached to

Using Stiff Diagrams

to characterize

Surface Water Samples

from Wetlands in the Slocan Watershed

West Kootenay Area, British Columbia

Stiff Diagrams

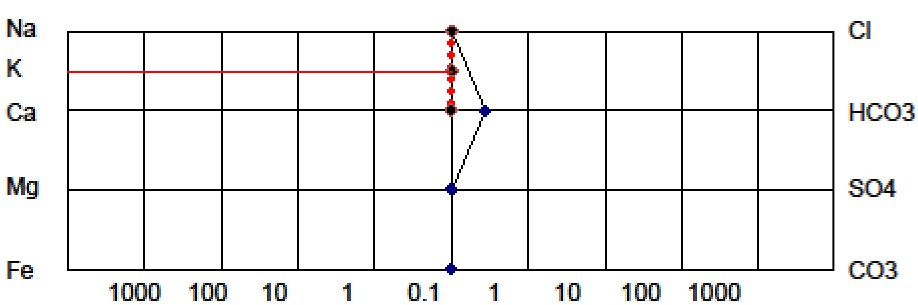
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:		CL 001	Location:	
Date Sampled		09-Jul-15	**Date Received**	10-Jul-15
Lab ID:	5070705-03			
Remarks:	Northing	Easting		
	5482407	453242		

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	0.5	0.0	Cl	<0.10	<0.10
K	0.3	0.0	Br		
Ca	<2.0	0.0	I		
Mg	0.4	0.0	HCO3	16.7	0.3
Ba	<0.05	0.0	SO4	<1.0	<1.0
Sr	0.02	0.0	CO3		
Fe	<0.10	0.0	Nitrate	<0.010	0.0
Total	**1**	**0.1**	**Total**	**17**	**0.3**

TDS calc=	**18**	**Density=**	**25 deg C**	**Conduct:**	16.4	**25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	6.7	**25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**		mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**#VALUE!**	**Ion Balance=**	**0.23**
Flags:	K/Na=	0.4		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Very fresh surface water.***

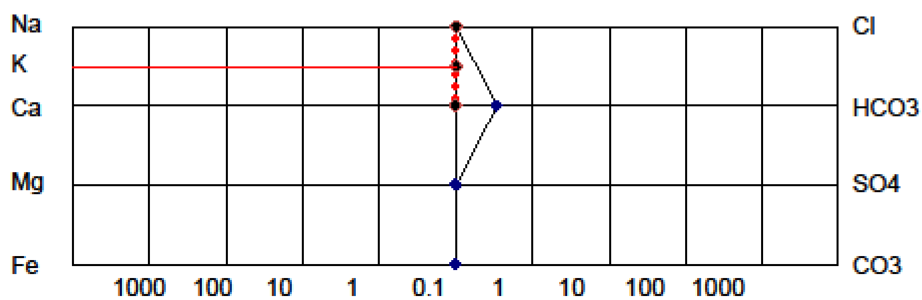
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	GC 001	Location:	
Date Sampled	09-Jul-15	**Date Received**	10-Jul-15
Lab ID:	5070705-01		
Remarks:	Northing	Easting	
	5480369	452213	

Cations		Mg/l	MEQ	Anions		Mg/l	MEQ
Na		0.8	0.0	Cl	<0.10		<0.10
K		0.3	0.0	Br			
Ca	<2.0		0.0	I			
Mg		0.3	0.0	HCO3		20.9	0.3
Ba	<0.05		0.0	SO4		1	0.0
Sr		0.04	0.0	CO3			
Fe		0.21	0.0	Nitrate	<0.010		0.0
Total		**2**	**0.1**	**Total**		**22**	**0.4**

TDS calc=	**24**	**Density=**	**25 deg C**	**Conduct:**	16.9 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	6.5 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**#VALUE!**	**Ion Balance=**	**0.20**
Flags:	K/Na=	0.2		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Very fresh surface water.***

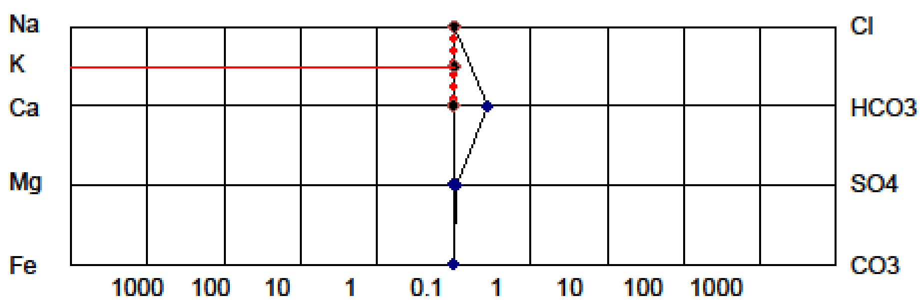
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	GC 002	Location:	
Date Sampled	09-Jul-15	**Date Received**	10-Jul-15
Lab ID:	5070705-02		
Remarks:	Northing	Easting	
	5479637	452715	

Cations	Mg/l	MEQ	Anions	Mg/l	MEQ
Na	0.7	0.0	Cl	2.29	0.1
K	<0.2	0.0	Br		
Ca	<2.0	0.0	I		
Mg	0.1	0.0	HCO3	16.7	0.3
Ba	<0.05	0.0	SO4	5.2	0.1
Sr	0.01	0.0	CO3		
Fe	0.35	0.0	Nitrate	<0.010	0.0
Total	**1**	**0.0**	**Total**	**24**	**0.4**

TDS calc=	**25**	**Density=**	**25 deg C**	**Conduct:**	8.6 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	6.5 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**0.47**	**Ion Balance=**	**0.10**
Flags:	K/Na=	0.0		

Interpretation by: Richard Johnson ***February 19, 2016***

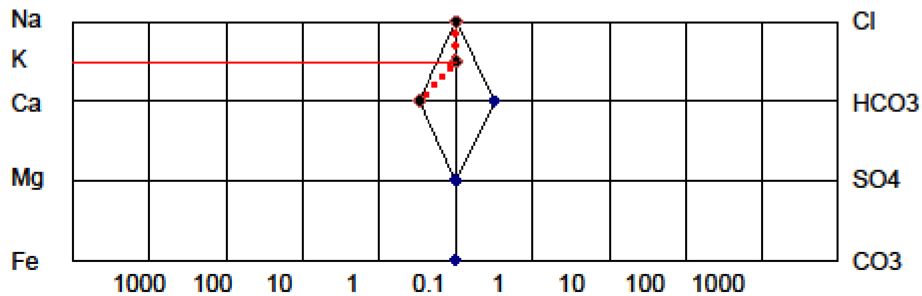
This is: ***Very fresh surface water.***

Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	LSL002	Location:		
Date Sampled	15-Jul-15	**Date Received**	17-Jul-15	
Lab ID:	5071169-01			
Remarks:	Northing	Easting		
	5501110	451350		

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	0.8	0.0	Cl	<0.10	<0.10
K	0.5	0.0	Br		
Ca	6	0.3	I		
Mg	0.5	0.0	HCO3	19.5	0.3
Ba	<0.05	0.0	SO4	2.6	0.1
Sr	0.02	0.0	CO3		
Fe	0.2	0.0	Nitrate	0.01	0.0
Total	**8**	**0.4**	**Total**	**22**	**0.4**

TDS calc=	**30**	**Density=**	**25 deg C**	**Conduct:**	38.0 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.3 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	17.0 mg/l as CaCO3



	Na:Cl=	**#VALUE!**	**Ion Balance=**	**1.05**
Flags:	K/Na=	0.4		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Very fresh surface water.***

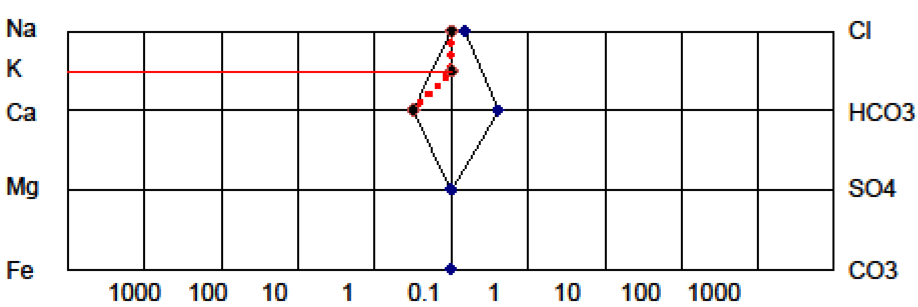
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:		BVL003	Location:	
Date Sampled		29-Jul-15	**Date Received**	31-Jul-15
Lab ID:	5072178-05			
Remarks:	Northing	Easting		
	5560293	464563		

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	0.5	0.0	Cl	5.24	0.1
K	<0.2	0.0	Br		
Ca	6.3	0.3	I		
Mg	0.7	0.1	HCO3	25.0	0.4
Ba	0.07	0.0	SO4	1	0.0
Sr	0.43	0.0	CO3		
Fe	0.38	0.0	Nitrate	0.09	0.0
Total	**8**	**0.4**	**Total**	**31**	**0.6**

TDS calc=	**40**	**Density=**	**25 deg C**	**Conduct:**	38.9 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	6.7 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	18.7 mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**0.15**	**Ion Balance=**	**0.71**
Flags:	K/Na=	0.0		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Very fresh surface water.***

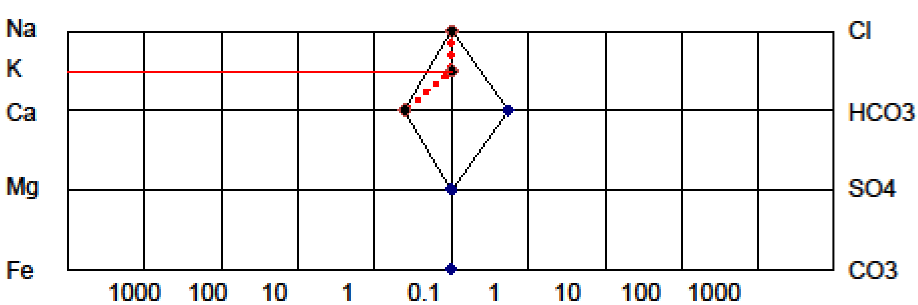
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:		LWL001	Location:	
Date Sampled		29-Jul-15	**Date Received**	31-Jul-15
Lab ID:	5072178-01			
Remarks:	Northing	Easting		
	5564499	459540		

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	0.9	0.0	Cl	2.44	0.1
K	<0.2	0.0	Br		
Ca	8.2	0.4	I		
Mg	0.9	0.1	HCO3	33.4	0.5
Ba	<0.05	0.0	SO4	2.4	0.0
Sr	0.27	0.0	CO3		
Fe	0.14	0.0	Nitrate	0.12	0.0
Total	**10**	**0.5**	**Total**	**38**	**0.7**

TDS calc=	**49**	**Density=**	**25 deg C**	**Conduct:**	**55.5 25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	**7.3 25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	**24.4** mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**0.57**	**Ion Balance=**	**0.80**
Flags:	K/Na=	0.0		

Interpretation by: Richard Johnson ***February 19, 2016***

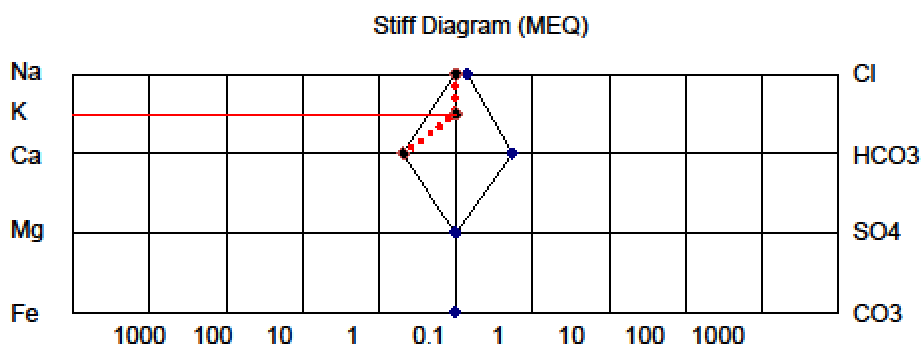
This is: ***Very fresh surface water.***

Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	BVL002	Location:		
Date Sampled	29-Jul-15	**Date Received**	31-Jul-15	
Lab ID:	5072178-03			
Remarks:	Northing	Easting		
	5560619	464692		

Cations	Mg/l	MEQ	Anions	Mg/l	MEQ
Na	0.8	0.0	Cl	4.97	0.1
K	<0.2	0.0	Br		
Ca	9.9	0.5	I		
Mg	0.6	0.0	HCO3	33.4	0.5
Ba	0.09	0.0	SO4	<1.0	<1.0
Sr	0.74	0.0	CO3		
Fe	<0.10	0.0	Nitrate	0.11	0.0
Total	**12**	**0.6**	**Total**	**38**	**0.7**

TDS calc=	**51**	**Density=**	**25 deg C**	**Conduct:**	54.2	**25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	6.9	**25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	27.5	mg/l as CaCO3



	Na:Cl=	**0.25**	**Ion Balance=**	**0.87**
Flags:	K/Na=	0.0		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Very fresh surface water.***

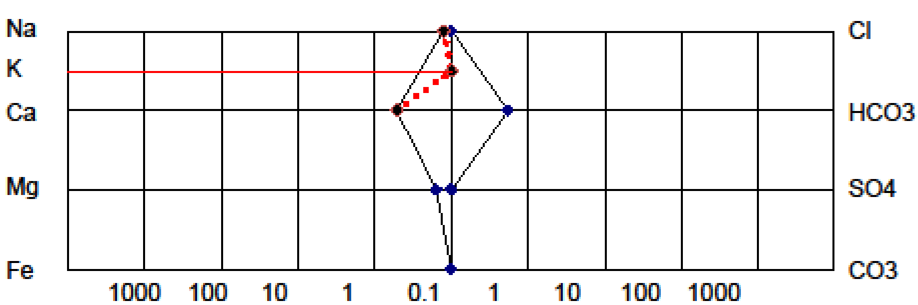
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	WIN 002	Location:		
Date Sampled	06-Jul-15	**Date Received**	07-Jul-15	
Lab ID:	5070338-03			
Remarks:	Northing	Easting		
	5495161	462757		

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	2.9	0.1	Cl	1.77	0.0
K	1.1	0.0	Br		
Ca	10.4	0.5	I		
Mg	1.9	0.2	HCO3	32.9	0.5
Ba	0.07	0.0	SO4	<1.0	<1.0
Sr	0.38	0.0	CO3		
Fe	1.03	0.0	Nitrate	<0.010	0.0
Total	**18**	**0.9**	**Total**	**35**	**0.6**

TDS calc=	**52**	**Density=**	**25 deg C**	**Conduct:**	61.0 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.0 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	33.8 mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**2.53**	**Ion Balance=**	**1.45**
Flags:	K/Na=	0.2		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Very fresh surface water.***

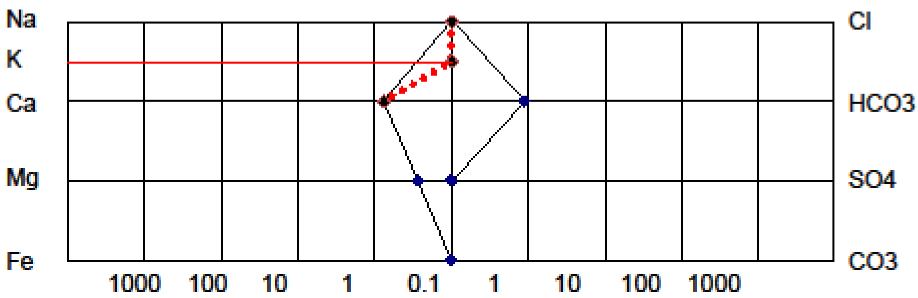
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:		HAY 001	Location:	
Date Sampled		14-Jul-15	**Date Received**	14-Jul-15
Lab ID:	5070941-01			
Remarks:	Northing	Easting		
	5482263	457573		

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	2.3	0.1	Cl	3.7	0.1
K	0.2	0.0	Br		
Ca	15.2	0.8	I		
Mg	3.3	0.3	HCO3	54.3	0.9
Ba	<0.05	0.0	SO4	3.7	0.1
Sr	0.15	0.0	CO3		
Fe	1.17	0.0	Nitrate	<0.010	0.0
Total	**22**	**1.2**	**Total**	**62**	**1.1**

TDS calc=	**84**	**Density=**	**25 deg C**	**Conduct:**	99.6	**25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	6.9	**25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	51.6	mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**0.96**	**Ion Balance=**	**1.08**
Flags:	K/Na=	0.1		

Interpretation by: Richard Johnson ***February 19, 2016***

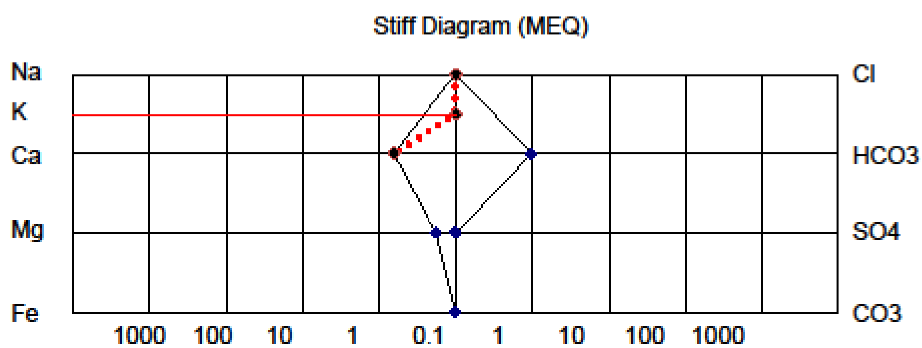
This is: ***Fresh surface water.***

Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	FRA 001	Location:	
Date Sampled	14-Jul-15	**Date Received**	14-Jul-15
Lab ID:	5070941-03		
Remarks:	Northing	Easting	
	5492379	455226	

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	1.7	0.1	Cl	0.42	0.0
K	1.4	0.0	Br		
Ca	12.9	0.6	I		
Mg	2.2	0.2	HCO3	58.4	1.0
Ba	<0.05	0.0	SO4	4.8	0.1
Sr	0.19	0.0	CO3		
Fe	5.56	0.1	Nitrate	<0.010	0.0
Total	**24**	**1.0**	**Total**	**64**	**1.1**

TDS calc=	**88**	**Density=**	**25 deg C**	**Conduct:**	79.9 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.2 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	41.0 mg/l as CaCO3



	Na:Cl=	6.24	**Ion Balance=**	**0.97**
Flags:	K/Na=	0.5		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Fresh surface water.***

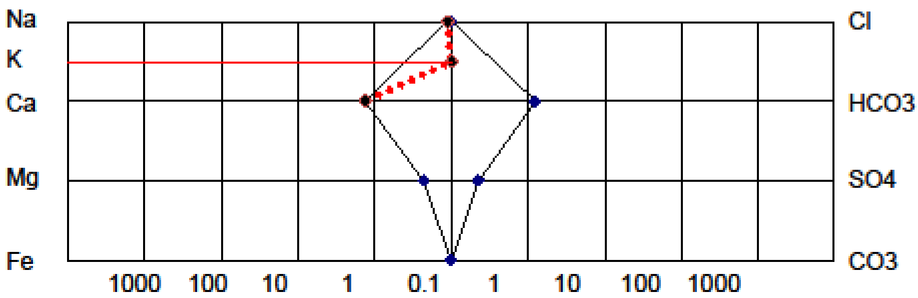
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:		SUM001	Location:	
Date Sampled		19-Jul-15	**Date Received**	22-Jul-15
Lab ID:	5071519-01			
Remarks:	Northing	Easting		
	5555073	456568		

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	2.6	0.1	Cl	1.08	0.0
K	0.8	0.0	Br		
Ca	26.6	1.3	I		
Mg	2.8	0.2	HCO3	75.0	1.2
Ba	<0.05	0.0	SO4	10.8	0.2
Sr	0.33	0.0	CO3		
Fe	0.25	0.0	Nitrate	0.02	0.0
Total	**33**	**1.7**	**Total**	**87**	**1.5**

TDS calc=	**120**	**Density=**	**25 deg C**	**Conduct:**	143.0	**25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.3	**25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	78.0	mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**3.71**	**Ion Balance=**	**1.15**
Flags:	K/Na=	0.2		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Fresh surface water.***

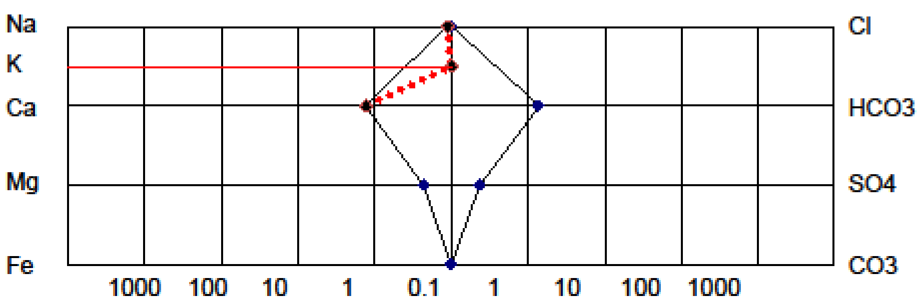
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	SUM002	Location:		
Date Sampled	21-Jul-15	**Date Received**	22-Jul-15	
Lab ID:	5071519-05			
Remarks:	Northing	Easting		
	5555285	455800		

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	2.6	0.1	Cl	1.25	0.0
K	0.4	0.0	Br		
Ca	26.2	1.3	I		
Mg	2.8	0.2	HCO3	83.4	1.4
Ba	<0.05	0.0	SO4	11.2	0.2
Sr	0.33	0.0	CO3		
Fe	0.29	0.0	Nitrate	<0.010	0.0
Total	**33**	**1.7**	**Total**	**96**	**1.6**

TDS calc=	**129**	**Density=**	**25 deg C**	**Conduct:**	137.0 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.7 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	77.0 mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**3.21**	**Ion Balance=**	**1.02**
Flags:	K/Na=	0.1		

Interpretation by: Richard Johnson ***February 19, 2016***

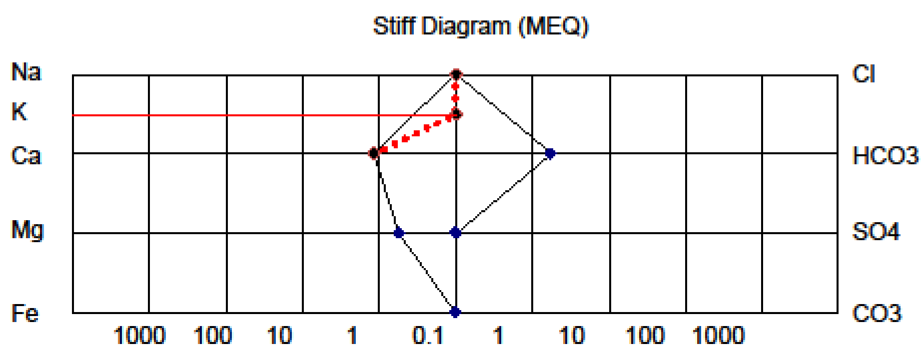
This is: ***Typical surface water.***

Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:		WIN 001	Location:	
Date Sampled		06-Jul-15	**Date Received**	07-Jul-15
Lab ID:	5070338-02			
Remarks:	Northing	Easting		
	5494995	461820		

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	1.9	0.1	Cl	1.28	0.0
K	1.5	0.0	Br		
Ca	23.5	1.2	I		
Mg	6.8	0.6	HCO3	106.1	1.7
Ba	0.13	0.0	SO4	<1.0	<1.0
Sr	0.4	0.0	CO3		
Fe	0.19	0.0	Nitrate	<0.010	0.0
Total	**34**	**1.9**	**Total**	**107**	**1.8**

TDS calc=	**142**	**Density=**	**25 deg C**	**Conduct:**	165.0	**25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.6	**25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	86.7	mg/l as CaCO3



	Na:Cl=	**2.29**	**Ion Balance=**	**1.05**
Flags:	K/Na=	0.5		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Typical surface water.***

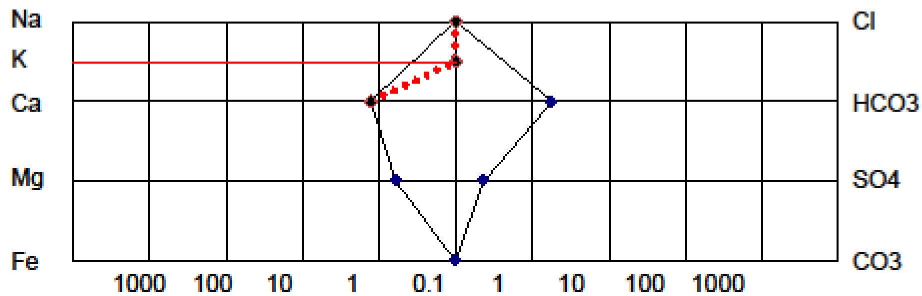
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	BEAR001	Location:		
Date Sampled	14-Jul-15	**Date Received**	15-Jul-15	
Lab ID:	5071060-03			
Remarks:	Northing	Easting		
	5543400	486333		

Cations	Mg/l	MEQ	Anions	Mg/l	MEQ
Na	1.4	0.1	Cl	0.34	0.0
K	<0.2	0.0	Br		
Ca	26	1.3	I		
Mg	7.5	0.6	HCO3	108.5	1.8
Ba	<0.05	0.0	SO4	11.1	0.2
Sr	0.22	0.0	CO3		
Fe	0.92	0.0	Nitrate	<0.010	0.0
Total	**36**	**2.0**	**Total**	**120**	**2.0**

TDS calc=	**156**	**Density=**	**25 deg C**	**Conduct:**	169.0	**25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	8.2	**25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	95.7	mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	6.35	**Ion Balance=**	**0.99**
Flags:	K/Na=	0.0		

Interpretation by: Richard Johnson *February 19, 2016*

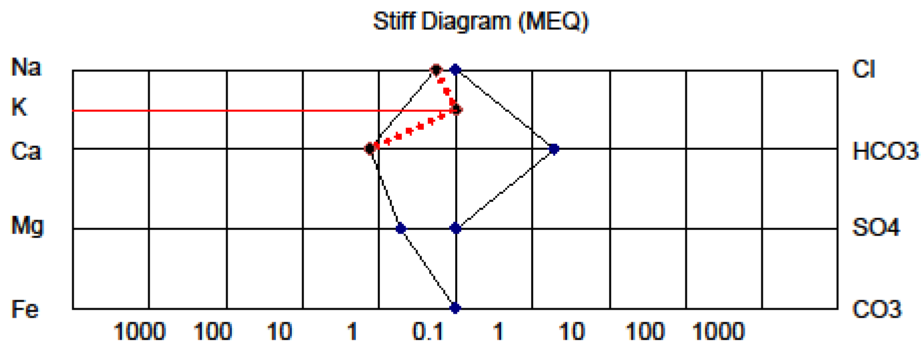
This is: ***Typical surface water.***

Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	ELD 001	Location:	
Date Sampled	14-Jul-15	**Date Received**	14-Jul-15
Lab ID:	5070941-04		
Remarks:	Northing	Easting	
	5502111	462894	

Cations	Mg/l	MEQ	Anions	Mg/l	MEQ
Na	4.2	0.2	Cl	2.44	0.1
K	2	0.1	Br		
Ca	26.6	1.3	I		
Mg	6.4	0.5	HCO3	116.9	1.9
Ba	0.07	0.0	SO4	1.6	0.0
Sr	0.39	0.0	CO3		
Fe	0.38	0.0	Nitrate	<0.010	0.0
Total	**40**	**2.1**	**Total**	**121**	**2.0**

TDS calc=	**161**	**Density=**	**25 deg C**	**Conduct:**	173.0 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.5 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	92.8 mg/l as CaCO3



	Na:Cl=	**2.65**	**Ion Balance=**	**1.04**
Flags:	K/Na=	0.3		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Typical surface water.***

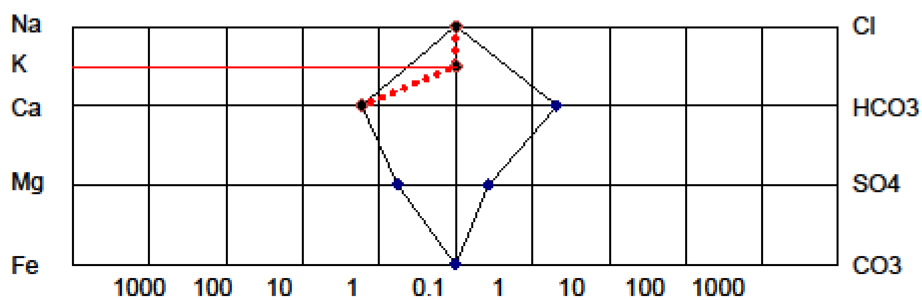
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:		SEAT001	Location:	
Date Sampled		15-Jul-15	**Date Received**	15-Jul-15
Lab ID:	5071060-01			
Remarks:	Northing	Easting		
	5542680	485047		

Cations	Mg/l	MEQ	Anions	Mg/l	MEQ
Na	1.8	0.1	Cl	0.51	0.0
K	<0.2	0.0	Br		
Ca	33.8	1.7	I		
Mg	7	0.6	HCO3	125.2	2.1
Ba	<0.05	0.0	SO4	12.6	0.3
Sr	0.23	0.0	CO3		
Fe	0.24	0.0	Nitrate	0.05	0.0
Total	**43**	**2.4**	**Total**	**138**	**2.3**

TDS calc=	**181**	**Density=**	**25 deg C**	**Conduct:**	201.0	**25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.8	**25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	113.0	mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	5.44	**Ion Balance=**	**1.01**
Flags:	K/Na=	0.0		

Interpretation by: Richard Johnson ***February 19, 2016***

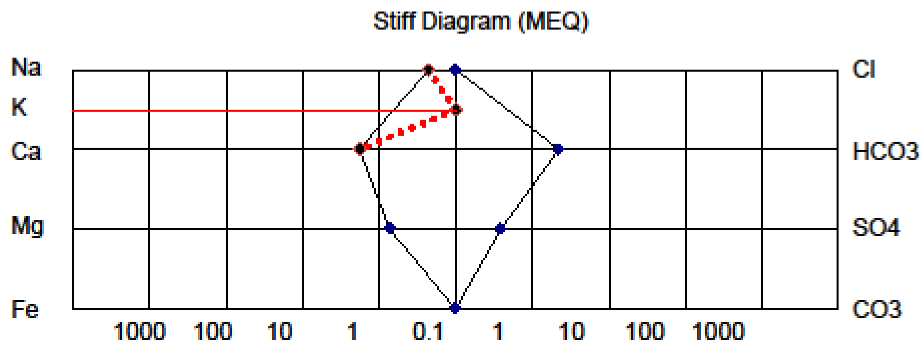
This is: ***Typical surface water.***

Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	TY 001	Location:	
Date Sampled	14-Jul-15	**Date Received**	14-Jul-15
Lab ID:	5070941-02		
Remarks:	Northing	Easting	
	5492796	455562	

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	5.2	0.2	Cl	1.41	0.0
K	2.5	0.1	Br		
Ca	36.6	1.8	I		
Mg	9	0.7	HCO3	133.0	2.2
Ba	0.06	0.0	SO4	18.5	0.4
Sr	0.2	0.0	CO3		
Fe	0.14	0.0	Nitrate	<0.010	0.0
Total	**54**	**2.9**	**Total**	**153**	**2.6**

TDS calc=	**207**	**Density=**	**25 deg C**	**Conduct:**	246.0 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	8.1 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	128.0 mg/l as CaCO3



Na:Cl=	5.69	**Ion Balance=**	**1.10**
Flags: K/Na=	0.3		

Interpretation by: Richard Johnson *February 19, 2016*

This is: *Typical surface water, with increased Na!*

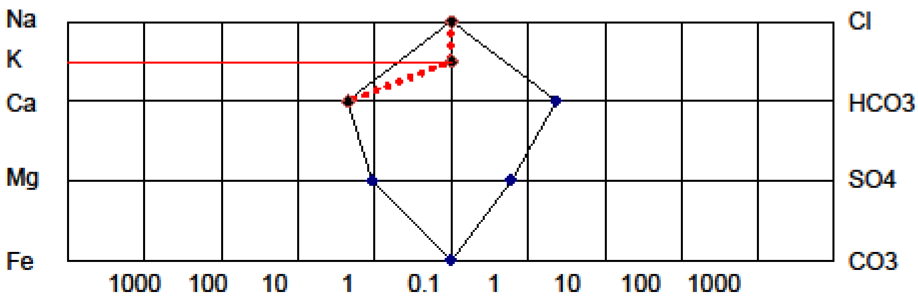
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:		SEAT003-1	Location:		
Date Sampled		06-Aug-15	**Date Received**	07-Aug-15	
Lab ID:	5080461-01				
Remarks:	Northing	Easting			
	5542111	484088			

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	2.2	0.1	Cl	0.45	0.0
K	<0.2	0.0	Br		
Ca	45.3	2.3	I		
Mg	13.2	1.1	HCO3	141.9	2.3
Ba	<0.05	0.0	SO4	28.8	0.6
Sr	0.3	0.0	CO3		
Fe	1.56	0.0	Nitrate	0.02	0.0
Total	**63**	**3.5**	**Total**	**171**	**2.9**

TDS calc=	**234**	**Density=**	**25 deg C**	**Conduct:**	227.2	**25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.9	**25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	168.0	mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	7.54	**Ion Balance=**	1.18
Flags:	K/Na=	0.0		

Interpretation by: Richard Johnson *February 19, 2016*

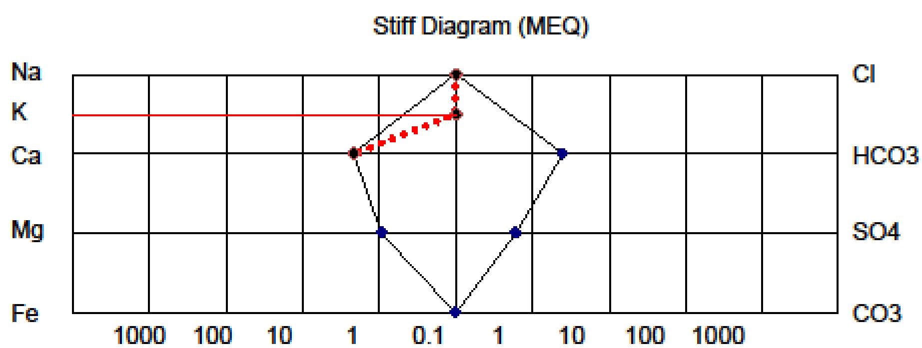
This is: ***Typical surface water with higher Mg and SO4 compared to others in this watershed.***

Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:		SEAT003-2	Location:	
Date Sampled		06-Aug-15	**Date Received**	07-Aug-15
Lab ID:	5080461-02			
Remarks:	Northing	Easting		
	5542111	484088		

Cations		Mg/l	MEQ	Anions	Mg/l	MEQ
Na		1.9	0.1	Cl	0.44	0.0
K	<0.2		0.0	Br		
Ca		43.3	2.2	I		
Mg		11.4	0.9	HCO3	150.2	2.5
Ba	<0.05		0.0	SO4	29	0.6
Sr		0.26	0.0	CO3		
Fe		0.6	0.0	Nitrate	0.02	0.0
Total		**57**	**3.2**	**Total**	**180**	**3.1**

TDS calc=	**237**	**Density=**	**25 deg C**	**Conduct:**	235.0	**25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.9	**25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	155.0	mg/l as CaCO3



	Na:Cl=	6.66	**Ion Balance=**	**1.04**
Flags:	K/Na=	0.0		

Interpretation by: Richard Johnson ***February 19, 2016***

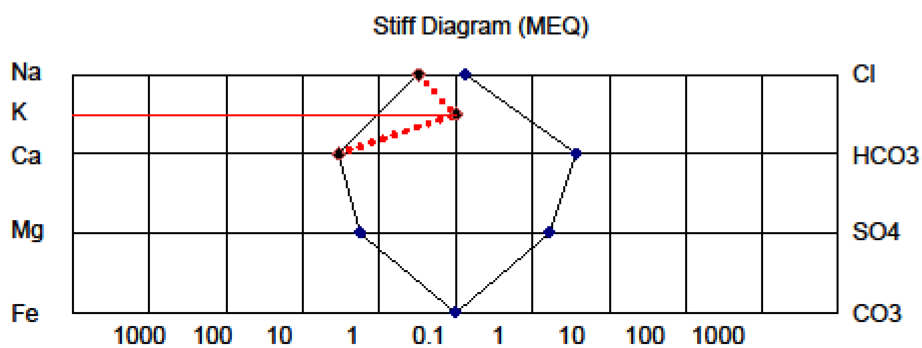
This is: ***Typical surface water with higher Mg and SO4 compared to others in this watershed.***

Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	BON001	Location:	
Date Sampled	21-Jul-15	**Date Received**	22-Jul-15
Lab ID:	5071519-03		
Remarks:	Northing 5549023	Easting 466568	

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	7.2	0.3	Cl	4.65	0.1
K	0.9	0.0	Br		
Ca	68.8	3.4	I		
Mg	21.7	1.8	HCO3	225.3	3.7
Ba	<0.05	0.0	SO4	79.3	1.7
Sr	0.62	0.0	CO3		
Fe	<0.10	0.0	Nitrate	<0.010	0.0
Total	**99**	**5.6**	**Total**	**309**	**5.5**

TDS calc=	**409**	**Density=**	**25 deg C**	**Conduct:**	431.0 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	8.0 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	261.0 mg/l as CaCO3



	Na:Cl=	**2.39**	**Ion Balance=**	**1.02**
Flags:	K/Na=	0.1		

Interpretation by: Richard Johnson ***February 19, 2016***

This is: ***Typical surface water with high Na, Mg and SO4 Anhydrite in source rock? Hot spring? Note Na.***

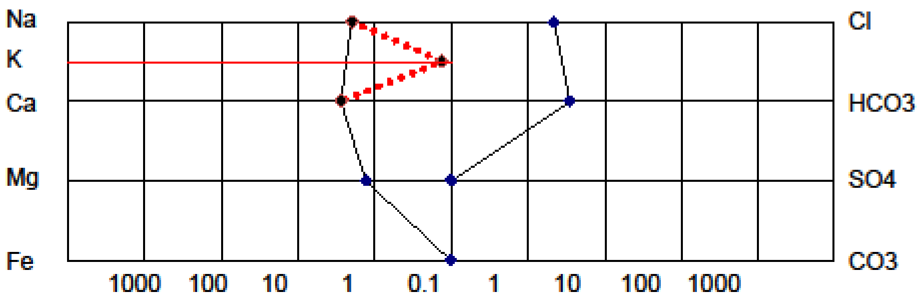
Opus Petroleum Engineering Ltd. (403) 266-6126
Water Analysis Interpretation Form

Sample ID:	FO 001	Location:	
Date Sampled	06-Jul-15	**Date Received**	07-Jul-15
Lab ID:	5070338-01		
Remarks:	Northing	Easting	
	5496615	460192	

Cations	**Mg/l**	**MEQ**	**Anions**	**Mg/l**	**MEQ**
Na	46.5	2.0	Cl	76.9	2.2
K	5.1	0.1	Br		
Ca	55.4	2.8	I		
Mg	15.9	1.3	HCO3	213.5	3.5
Ba	0.13	0.0	SO4	<1.0	<1.0
Sr	0.52	0.0	CO3		
Fe	1.25	0.0	Nitrate	0.02	0.0
Total	**125**	**6.3**	**Total**	**290**	**5.7**

TDS calc=	**415**	**Density=**	**25 deg C**	**Conduct:**	620.0 **25 deg C**
TDS evap=		**Refrac=**	**25 deg C**	**pH**	7.9 **25 deg C**
TDS ign=		**TDS evap @180=**		**Hardness:**	204.0 mg/l as CaCO3

Stiff Diagram (MEQ)



	Na:Cl=	**0.93**	**Ion Balance=**	**1.10**
Flags:	K/Na=	0.1		

Interpretation by: Richard Johnson *February 19, 2016*

This is: ***Surface water with added Na & Cl.***
Contamination from highway, parking lot, ???

Appendix B

Attached to

Using Stiff Diagrams

to characterize

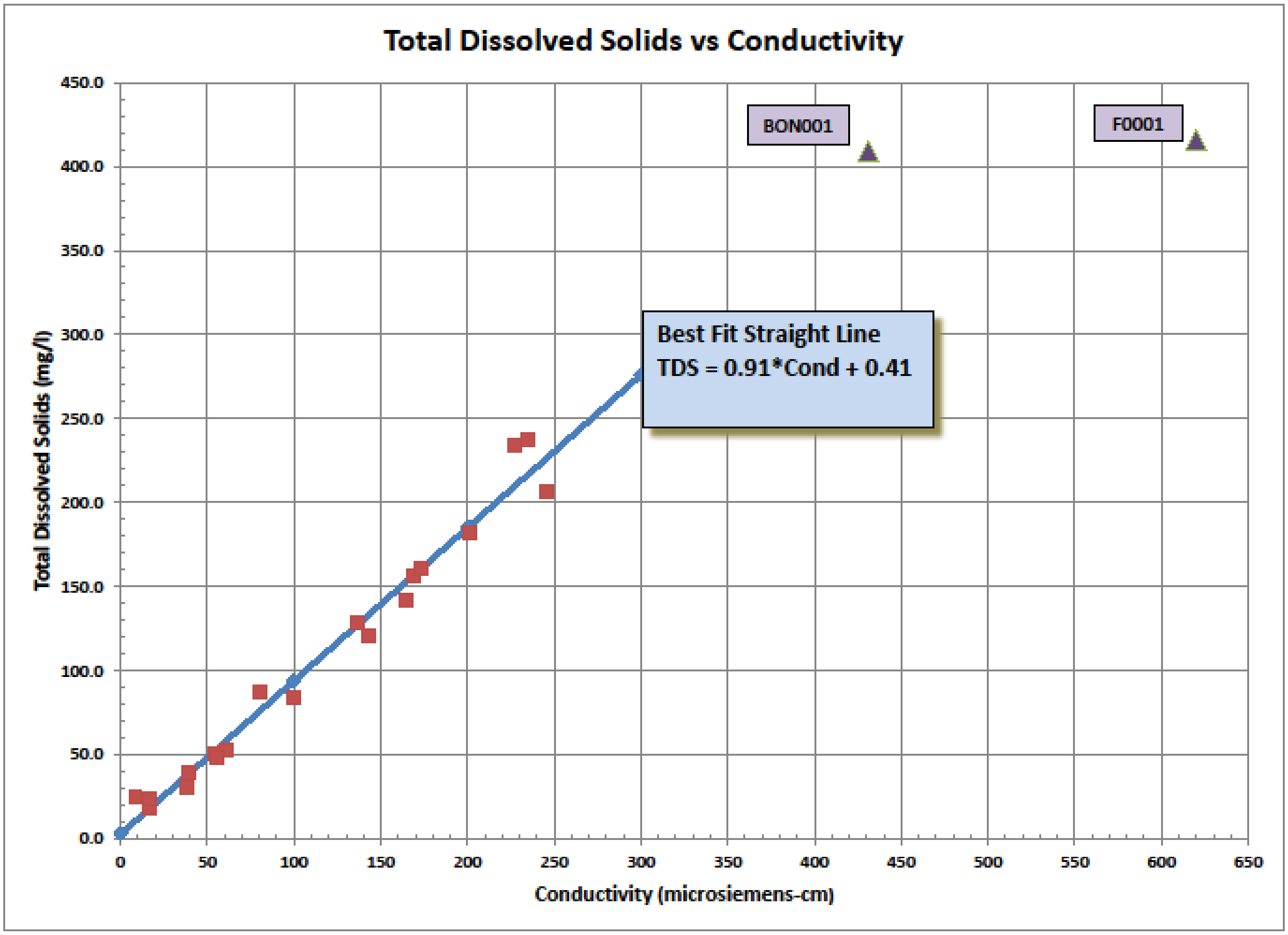
Surface Water Samples

from Wetlands in the Slocan Watershed

West Kootenay Area, British Columbia

Graph of

Total Dissolved Solids vs. Specific Conductivity


Total Dissolved Solids vs Conductivity
Total Dissolved Solids (mg/l)
Conductivity (microsiemens-cm)
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
400.0
450.0
0
50
100
150
200
250
300
350
400
450
500
550
600
650
BON001
F0001
Best Fit Straight Line
TDS = 0.91*Cond + 0.41

Appendix C

Attached to

Using Stiff Diagrams

to characterize

Surface Water Samples

from Wetlands in the Slocan Watershed

West Kootenay Area, British Columbia

Table

Location of Wetlands with Elevation and TDS

info@opuspetroleum.com
www.opuspetroleum.com

Sample.id	Invertsample.d	Site.name	Disturbances	Type	Duration	Elevation	Northing	Easting	TDS
PC002	25/08/2014	Pass Creek Wetland	Residential	Riverine	Permenant	567	5474295	454778	
TF001/SEAT	26/08/2014	Three Forks, renamed Seaton Creek lower	Metals, legacy mining	Riverine	Permenant	962	5541616	483515	
LSL001	27/08/2014	Little Slocan Lakes -north lake, shore	Potential Reference	Lacustrine	Permenant	611	5503393	452782	
BVL001	09/08/2014	Beaver Lake complex, shallow wetland, upper	Potential Reference	Riverine	Permenant	867	5561188	464335	
FO001	29/06/2015	FOMI's wetland	Roads/Rail bed, chloride	Riverine	Temporary	519	5496615	460192	415
WIN001	30/06/2015	Winlaw woodlot wetland lower	Potential Reference	Palustrine	Permenant	976	5494995	461820	142
WIN002	30/06/2015	Winlaw woodlot wetland upper/Moose swamp	Potential Reference	Palustrine	Temporary	1028	5495161	462757	52
GC001	07/09/2015	Gander Crk fen, upper wetland	Potential Reference	Palustrine	Permenant	1571	5480369	452213	24
GC002	07/09/2015	Gander Crk shallow-water wetland, lower Flicker pond	Potential Reference	Palustrine	Permenant	1580	5479637	452715	25
CL001	07/09/2015	Cooley Lake	Potential Reference	Lacustrine	Permenant	1515	5482407	453242	18
HAY001	07/10/2015	Hay's wetland, 2329 Cunningham Road	Canary Reed Grass, road, residential	Riverine	Permenant	496	5482263	457573	84
TY001	07/10/2015	Tyson Ehler's pond	Canary Reed Grass, residential	Riverine	Permenant	513	5492796	455562	207
FRA001	07/10/2015	Frank Zalewski's Oxbow	Cattle	Riverine	Permenant	507	5492379	455226	88
ELD001	13/07/2015	Krispen Elder's pond	Canary Reed Grass, residential	Riverine	Permenant	521	5502111	462894	161
BEAR001	14/07/2015	Bear Lake outflow, south of Hwy 31A	Highway, lake outflow,	Riverine	Permenant	1080	5543400	486333	156
SEAT001	14/07/2015	Seaton Crk upper	Metals, legacy mining	Riverine	Permenant	1035	5542680	485047	181
LSL002	15/07/2015	Little Slocan Lakes -South lake	Potential Reference	Lacustrine	Permenant	653	5501110	451350	30
SUM001	21/07/2015	Summit Lake outflow-lower complex	Highway, rail, lake outflow	Riverine	Permenant	702	5555073	456568	120
SUM002	21/07/2015	Summit Lake outflow-edge of lake	Lake influence, recreation, residential	Lacustrine	Permenant	765	5555285	455800	129
BON001	21/07/2015	Bonanza Crk marsh, east side	Potential Reference	Lacustrine	Permenant	576	5549023	466568	409
LWL001	29/07/2015	Little Wilson Lake	Potential Reference	Lacustrine	Permenant	906	5564499	459540	49
BVL002	29/07/2015	Beaver Lakes complex, Horsetail pond	Potential Reference	Riverine	Permenant	887	5560619	464692	51
BVL003	29/07/2015	Beaver Lakes complex, fen	Potential Reference	Riverine	Permenant	891	5560293	464563	40
SEAT003-01	08/06/2015	Seaton Crk, mid	Metals, legacy mining	Riverine	Permenant	1008	5542111	484088	234
SEAT003-02	08/06/2015	Seaton Crk, mid	Metals, legacy mining	Riverine	Permenant	1008	5542111	484088	237

11.2 Technical Report, Rhithron: Macroinvertebrate quality control

Analysis of biological samples:

Technical summary of methods and quality assurance procedures

Prepared for Integrated Ecological Research

Darcie Quamme, Project Manager

January 13, 2016

by

W. Bollman, Chief Biologist

Rhithron Associates, Inc.

Missoula, Montana

METHODS

Sample processing

Twenty macroinvertebrate samples collected for the Slocan Wetland Assessment & Mapping Project (SWAMP) were delivered to Rhithron's laboratory facility in Missoula, Montana on September 2, 2015. All samples arrived in good condition.

A chain-of-custody document containing sample identification information was provided by the Integrated Ecological Research (IER) Project Manager. Upon arrival, samples were unpacked, examined, and checked against the IER chain-of-custody. An inventory spreadsheet was created which included project code and internal laboratory identification numbers and was uploaded into the Rhithron database prior to sample processing.

Sorting protocols consistent with CABIN standard operating procedures (Environment Canada: CABIN Laboratory Methods: Processing, Taxonomy, and Quality Control of Benthic Macroinvertebrate Samples: May 2014) were applied to achieve representative subsamples of a minimum of 300 organisms. A Marchant Box was used for subsampling and sorting. Subsampling of each sample began with a random selection of 5 Marchant Box cells. All ostracods, copepods and cladoerans were picked from the first selected cell and placed in a separate vial; these organisms were not assigned a count and did not contribute to the 300 organism target. Subsequent sorting did not include these organisms. The initial 5 cells were completely sorted of all organisms. The contents of each grid were examined under stereoscopic microscopes using 10x-30x magnification. All aquatic invertebrates from each selected grid were sorted from the substrate, and placed in 80% ethanol for subsequent identification. Grid selection, examination, and sorting continued until at least 300 organisms were sorted. If more than 50% of the sample was required to obtain the minimum 300 organism count, the entire sample was sorted. All unsorted sample fractions were retained and stored at the Rhithron laboratory.

Organisms were individually examined by certified taxonomists, using 10x – 80x stereoscopic dissecting scopes (Leica S8E) and identified to target taxonomic levels specified by the IER Project Manager, using appropriate published taxonomic references and keys.

Chironomids and oligochaetes were carefully morphotyped using 10x – 80x stereoscopic dissecting microscopes (Leica S8E) and representative specimens were slide mounted and examined at 200x – 1000x magnification using an Olympus BX 51 or Leica DM 1000 compound microscope.

Identification, counts, life stages, and information about the condition of specimens were recorded on electronic bench sheets. Organisms that could not be identified to the taxonomic targets because of immaturity, poor condition, or lack of complete current regionally-applicable published keys were left at appropriate taxonomic levels that were coarser than those specified. Organisms designated as "unique" were those that could be definitively distinguished from other organisms in the sample. Identified organisms were preserved in 80% ethanol in voucher labeled vials (by taxon and life stage), and shipped to the Royal BC Museum in Victoria, British Columbia.

Quality control procedures

Quality control procedures for initial sample processing and subsampling involved checking sorting efficiency. These checks were conducted on 15% of the samples (minimum of 3 samples from the project) by independent observers who microscopically re-examined sorted substrate from each sample. Quality control procedures for each sample proceeded as follows:

The quality control technician poured the sorted substrate from a processed sample out and all substrate was re-examined under 10x – 30x magnification. All organisms that were missed were counted and this number was added to the total number obtained in the original sort. Sorting efficiency was evaluated by applying the following calculation:

$$SE = \frac{n_1}{n_1 + n_2} \times 100$$

where: SE is the sorting efficiency, expressed as a percentage, n_1 is the total number of specimens in the first sort, and n_2 is the total number of specimens in the second sort.

Quality control procedures for taxonomic determinations of invertebrates involved checking accuracy, precision and enumeration. Three samples were randomly selected and all organisms re-identified and counted by an independent taxonomist. Taxa lists and enumerations were compared by calculating a Bray-Curtis similarity statistic (Bray and Curtis 1957), Percent Taxonomic Disagreement (PTD) and Percent Difference in Enumeration (PDE). Routinely, discrepancies between the original identifications and the QC identifications are discussed among the taxonomists, and necessary rectifications to the data are made. Discrepancies that cannot be rectified by discussions are routinely sent out to taxonomic specialists for identification.

Data analysis

Taxa and counts for each sample were entered into Rhithron's customized database software. A taxonomic flat file including site information, taxonomic hierarchy, taxonomic identifications, counts, life stages and other information was formatted in Microsoft Excel.

RESULTS

Quality Control Procedures

Results of internal quality control procedures for subsampling and taxonomy are given in Table 1. Sorting efficiency averaged 99.50%. Taxonomic precision for identification and enumeration averaged 98.17% (Bray-Curtis), 2.20% PTD and 0.49% PDE for the randomly selected taxonomic QC samples, and data entry efficiency averaged 100% for the project. These similarity statistics fall within acceptable industry criteria (Stribling et al. 2003).

Data analysis

An electronic spreadsheet was provided to the IER Project Manager via e-mail. Voucher labeled vials were shipped to the Royal BC Museum.

Table 1. *Results of internal quality control procedures for subsampling and taxonomy.* Slocan Wetland Assessment & Mapping Project (SWAMP), 2015.

Rhithron ID	Station ID	Date Collected	Sorting efficiency	Bray-Curtis similarity for taxonomy and enumeration	Percent Taxonomic Disagreement (PTD)	Percent Difference in Enumeration (PDE)
IER15DQ001	FO001	6/29/2015		96.31%	4.28%	0.62%
IER15DQ002	WIN001	6/30/2015				
IER15DQ003	WIN002	6/30/2015				
IER15DQ004	GC001	7/9/2015	99.40%			
IER15DQ005	GC002	7/9/2015				
IER15DQ006	CL001	7/9/2015				
IER15DQ007	HAY001	7/10/2015				
IER15DQ008	TY001	7/10/2015		99.03%	1.65%	0.69%
IER15DQ009	FRA001	7/10/2015	99.11%			
IER15DQ010	ELD001	7/13/2015				
IER15DQ011	BEAR001	7/14/2015				
IER15DQ012	SEAT001	7/14/2015				
IER15DQ013	LSL002	7/15/2015	100.00%			
IER15DQ014	SUM001	7/21/2015				
IER15DQ015	SUM002	7/21/2015				
IER15DQ016	BON001	7/21/2015				
IER15DQ017	LWL001	7/29/2015				
IER15DQ018	BVL002	7/29/2015		99.18%	0.66%	0.16%
IER15DQ019	BVL003	7/29/2015				
IER15DQ020	SEAT003	8/6/2015				

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