Lemon Creek: 2023 CABIN Monitoring Summary Report

In support of the Columbia Basin Water Monitoring Framework through Living Lakes Canada

Written by Renee Lazor

Table of Contents

Background information

Site

Lemon Creek watershed is located in the west Kootenay region, south of Slocan, British Columbia. The mouth of Lemon Creek drains into the Slocan River. With a drainage area of 202 km^2, the anthropogenic disturbances in the catchment include mineral exploration and low density forestry activities. In 2021 a large wildfire occurred in the region, with areas in the watershed being affected by the burn. In August 2023, precipitation events produced a landslide that deposited silt and mud into the river system and altered flows upstream of the test site. To monitor the impacts of these events using the CABIN protocol, test sites were selected in the lower reach of the tributary above the confluence with the Slocan River.

The goal of using Environment and Climate Change Canada's (ECCC) Canadian Aquatic Biomonitoring Network (CABIN) protocols to monitor lotic systems is to understand the health of streams. CABIN uses standardized protocols to collect benthic macroinvertebrate samples which act as indicators of aquatic ecosystem health (Environment Canada, 2012). Benthic macroinvertebrates (BMI) are bottom dwelling organisms that are found in all freshwater ecosystems. With a lifespan from 1-3 years, these organisms are exposed to and respond differently to pollutants and disturbances in the aquatic environment. The presence and abundance of benthic macroinvertebrate species varies depending on exposure to pollutants and thus, are used to understand the cumulative effects of pollutants on aquatic ecosystem health.

The CABIN protocol uses a reference condition approach (RCA) to compare test sites to a group of reference sites. Descriptor data for land cover, climate, topography and hydrology are extracted for each test site watershed area using GIS tools. During site visits, field data is collected on the physical, biological, chemical and hydrological characteristics of a stream and its channel to characterize the stream reach. This data is input into the CABIN database where analysis is conducted to assess the stream health/condition.

When a reference model has been developed for an area of interest, the RCA approach can be applied. A BEAST analysis uses the derived habitat variables to determine which group of reference sites is most appropriate to compare the test site to, and then categorizes the test site to the most similar group of reference sites. The RIVPACS analysis then assesses a test site's observed benthic macroinvertebrate community compared to the expected BMI community for a group of reference sites. The Brays-Curtis analysis then assesses the degree of similarity between the test site and the median of the predicted reference sites. The deviation of the test site BMI community from the reference group expected BMI community results in the test site being assigned to one of four bands (confidence intervals/ellipses) of stream condition: reference, mildly divergent, divergent, and extremely divergent from reference condition.

Outside of the RCA analysis, ecological metrics for richness, abundance and diversity can be calculated from the BMI sample. These metrics are used to further understand and evaluate the community composition to better understand the condition of the site.

Benthic Macroinvertebrates

In aquatic systems, organisms are continuously exposed to fluctuations in their environment (ECCC, 2012). These fluctuations cause changes in the productivity of the aquatic environment, which influence the spatial and temporal distribution of species in both their composition and abundance (CCME 2008). BMI taxa in aquatic environments experience changes in their community structure, richness, abundance and diversity due to their exposure to water conditions throughout their life stages. Each taxa and Family group, and species, has a sensitivity or tolerance to various environmental conditions (DO%, pH, temperature, etc.). The richness, abundance and diversity of the community, along with taxa sensitivities and tolerances, can be used to understand the cumulative impacts of exposure to the environment on the BMI community. CABIN uses these ecological metrics to further understand impacts of disturbance on the BMI community to assess the stream health.

Taxon identified at the order level as Ephemeroptera, Plecoptera and Trichoptera (EPT) act as indicators of good water quality due to their sensitivity to pollution or degraded aquatic environments. The EPT index examines taxa richness within a sample, comparing the abundance of these 3 taxa to the total number of individuals in a sample. In contrast, the family Chironomidae (non-biting midges), in the order Diptera, are often more tolerant of degraded water quality. Therefore, determining the ratio of Diptera and Chironomidae to EPT species can be a good indicator of water quality. Monitoring the ratio over time can be used to determine whether the community is changing, and these changes may be associated with increased disturbance or climate change in the catchment area upstream of the site.

Metrics

Richness metrics measure the *number of different species* present in the sample. This can be measured as the total number of species at a site or within a taxon(s). Species richness does not take into account the number of individuals of each species present. Rather it gives as much weight to those species represented by very few individuals as to those represented by many individuals. Richness of a stream can decline with degradation of the water quality due to disturbance, with sensitive species replaced by more tolerant taxa.

Unlike richness, ***abundance*** is a measurement of the *sum of all organisms present in a sample at a selected taxonomic level or within a specified group* (ex. # of individuals per Family). The composition of the taxa within the sample population can be expressed numerically or as a percentage of the population also referred to as proportion. Shifts within the population's abundance, with certain species increasing or decreasing, can act as indicators of water quality and stream health. The abundance and compositional measures presented include but are not limited to:

%EPT: ∑EPT individuals / ∑sum of all individuals * 100
Where: the %EPT is expected to decrease with degradation

%Ephemeroptera that are Baetidae: ∑ Baetidae ind. / ∑ Ephemeroptera individuals * 100
Where: Baetidae are more tolerant of degraded conditions and expected to increase with degradation

%Trichoptera that are Hydropsychida: ∑ Hydropsychida ind. / ∑ Trichoptera individuals * 100
Where: Hydrophsychia are more tolerant of degraded conditions and are expected to increase with degradation

% Coleoptera: ∑ Coleoptera ind. / ∑ all individuals * 100
Where: Coleoptera are expected to decrease with disturbance and degraded conditions

% Chironomidae: ∑ Chironomidae ind. / ∑ all individuals * 100
Where: Chironomidae are generally more tolerant of pollution

#EPT individuals/Chironomidae + EPT individuals * 100
Where the ratio is expected to decrease with disturbance

Evenness is a richness metric that measures the *distribution of the relative abundance of various taxa across all taxa* in a community. When all species in a sample have the same abundance of individuals then evenness is highest. If the relative abundances vary between the taxa in a community, evenness gets closer to zero. Evenness can be applied as an indicator of water quality, with evenness decreasing in response to disturbances and decreased water quality. Species evenness can be described using metrics including Pielou's evenness or Simpson's Evenness.

Diversity takes into account the number of different species (richness) in a community, the abundance of the individuals in a species and how evenly the number of individuals is distributed among those species (evenness). Both richness and abundance measures function separately when calculating diversity. Diverse communities are a function of both high richness and high abundance, offering ecological opportunities and resilience within a community. Diverse communities act as indicators of "good" water quality and stream condition, where diversity is expected to decrease in response to disturbances and poor water quality (ECCC, 2024). Simpsons diversity and Shannon-Wiener diversity indices are used to assess diversity through the CABIN analysis.

RIVPACS measures the observed taxa found at the test site divided by the taxa predicted to be at the test site for all groups (p=0.70). The RIVPACS analysis uses only the taxa presence/absence data. A RIVPACS value of 1 indicates the site is in good condition with low values often meaning the site is in poor condition (closer to 0); whereas very high values above 1.0 can mean the site is enriched or a biodiversity hotspot.

The ***Bray-Curtis Index*** compares the degree of dissimilarity of the test site's community to the predicted reference group community. It takes into account the abundance of each taxa observed and compares the test site to the median of the predicted reference community, while not being influenced by the rarity of the species. 0 means there is no difference between the test site and median reference community, whereas a value of 1 means that the test site community is very different from the median of the reference community.

Functional Feeding Groups **(FFG)** are a classification of benthic macroinvertebrates based on the BMI'a primary method of obtaining food, with each group including several different taxa. Comparing FFGs at a site is a way to understand the productivity and inputs to the site in relation to the input of organic matter into the system as well as the productivity of the stream. The presence of FFGs depends on the type of food available such as; Coarse Particulate Organic Matter (CPOM), Fine Particulate Organic Matter (FPOM), algae and vascular plants. These food types vary based on stream characteristics (substrate, flow, depth), photosynthetic active radiation (sunlight) and the inputs from vegetation (organic matter) adjacent to the stream. There are five main FFG (Cummins, 2021):

FFG	**Food Source**
Shredders	Leaf litter, rooted aquatic vascular plants, wood or other coarse particulate organic matter (CPOM; >1 mm)
Scrapers/grazers	Algae and other associated material
Collector/gatherers	Fine particulate organic matter (FPOM; #1 mm) on or in the stream sediments
Filterers	Filter fine particulate organic matter from the water column
Predators	Prey on other consumers

The River Continuum Concept describes how throughout a river system, from lower to higher stream orders, there are changing physical, chemical and biotic conditions that shift biological communities, including BMIs, in response to the change of the stream conditions. Variables such as slope, velocity, channel width, and sunlight exposure influence stream conditions and the availability of food sources within the stream, influencing FFGs along the stream continuum. The proportion of certain groups with respect to other groups has been shown to be related to stream health. In general, specialists such as shredders, are presumed to be more sensitive and therefore associated with healthy streams; whereas generalists (ex. gatherer and filterer species), with their broader diet, are presumed to be more tolerant to disturbance.

The ***Hilsenhoff Biotic Index*** (**HBI**) value estimates organic pollution using the proportion (abundance) of taxa at the genus/species level. Biotic tolerance values are assigned to each taxa based on their response to organic pollution. Index scores range from 0 to 10 (Table 1). Sensitive taxa have low scores while tolerant taxa are assigned high scores. Low HBI values reflect a higher abundance of sensitive groups inferring a lower level of pollution, while an increase in the index value suggests decreased water quality due to organic pollution (Hilsenhoff, 1987). The HBI is advantageous for evaluating the general status of organic pollution in streams to assist in decision making around which streams should be studied further (Hilsenhoff, 1987).

Table 1. Hilsenhoff Biotic Index (HBI) categories.

Biotic Index	Water Quality	Degree of Organic Pollution
0.00–3.50	Excellent	Organic pollution unlikely
3.51–4.50	Very Good	Possible slight organic pollution
4.51–5.50	Good	Some organic pollution probable
5.51–6.50	Fair	Fairly substantial pollution likely
6.51–7.50	Fairly Poor	Substantial pollution likely
7.51–8.50	Poor	Very substantial pollution likely
8.51–10.00	Very Poor	Severe organic pollution likely

For a complete list of metrics and calculations see Appendix A.

Field Site Visit

Annual site visits by LLC to Lemon Creek occurred in 2022 and 2023 at two different sites along the stream. The first site visit to NJLEM03 (49.70612 N, -117.49159 W) occurred October 14, 2022 and a second site visit to NJLEM04 (49.70566 N, -117.49109 W) occurred on September 8, 2023. NJLEM04 is located approximately 30m downstream from NJLEM03. Benthic macroinvertebrate samples were sent to Biologica Consulting for taxonomic analysis. In situ water quality data was collected using an EXO YSI sonde.

Results and Discussion

Test sites on Lemon Creek were established and visited in 2022 and 2023. The stream condition at both test sites was assessed to be mildly divergent from reference conditions in 2022 and 2023.

In 2022 results from the BEAST analysis classified test site NJLEM03 as mildly divergent (for full report see Appendix B). NJLEM03 was categorized into reference group 1 (Model group D), with a group error rate of 53.8%, and probability of group membership at 50.8%. Model performance for group 1 was noted to be cautionary with the classification success rate lower than the recommended minimum standard for CABIN (ECCC, 2020). Due to the precautionary note for test sites classified into group 1, further assessment of the site's condition was examined through biological metrics describing the benthic macroinvertebrate richness, abundance and diversity.

Reference sites included in group 1 of the model were found to have low abundance with a high proportion of Chironomidae. These sites tended to be steeper, narrower channels in smaller stream orders with smaller substrates and watersheds with low sedimentary rock in the bedrock geology (ECCC, 2020). NJLEM03 is a stream order 3 located in an open channel downstream from highway 6 and above the runout into the Slocan River. With the recent landslide and wildfire events, the stability of the channel may be compromised due to sediment deposition and erosional activity resulting in unstable habitat for benthic macroinvertebrate communities.

The dominant substrate type for NJLEM03 was cobble, with fine sand, silt and clay occupying the interstitial space. The proportion of EPT was 87.5%, with the more tolerant Baetidae (77.3%) being most abundant of the Ephemeroptera Order (71.5%). The proportion of EPT in Lemon Creek was within one standard deviation of the mean from the predicted reference group. A low proportion of Chironomidae (9.5%) was also found at the site, with the proportion of Diptera and other non-insects comprising 12.5% of the sample. These metrics are indicative of a system that supports sensitive species and is experiencing good water quality.

The RIVPACS ratio was 1.04, which indicates that the site is in good condition. The Brays-Curtis distance index for Lemon Creek is 0.57, indicating the test site community is moderately different (57% dissimilar) from the median of the reference group community. Simpsons Diversity index was 0.7, indicating moderate diversity at the site.

The Hilsenhoff family Index for NJLEM03 was 3.9, indicating very good water quality at the sampling site with the possibility of slight organic pollution. The dominant functional feeding group was Scrapers

(70.7%). The composition of FFG indicates that algae and similar structured OM were the primary food courses available at the site.

In 2023 a site visit to NJLEM04 (located approximately 30m downstream from NJLEM03) classified the test site as mildly divergent from reference condition. The test site was categorized into reference group 6 with 49.4% probability of group membership. Group 6 is identified as having a low abundance and greater proportion of non-insects relative to other groups (ECCC, 2020).

The RIVPACS ratio for NJLEM04 was 0.81, indicating the condition at the site was degraded. The Brays-Curtis value was 0.71, indicating the test site community is moderately different (71% dissimilar) from the reference group community. Simpsons diversity was 0.7, indicating that the test site has moderately low diversity, with Pielou's evenness (0.6) showing moderate evenness between taxa.

Community diversity and richness metrics show that the proportion of tolerant taxa were higher at NJLEM04 (2023) site versus NJLEM03 (2022). The proportion of EPT was 61.0%, with Baetidae making up 85.1% of the Ephemeroptera Order (53%). The proportion of Diptera and other non-insects (37.8%) was higher than at NJLEM03 (12.5%), with the proportion of Chironomidae (34.1%) increased compared to the NJLEM03 (2022) site visit (9.5%). The total abundance at the 2023 site was 200, which was within 1 standard deviation from the reference group mean. Functional feeding group measures were distributed between filterers (35%), gatherers (33%) and scrapers (41.5).

The Hilsenhoff index was 3.9, the same as the 2022 test site at NJLEM03, indicating very good water quality with a slight possibility of organic pollution.

Overall, stream conditions at NJLEM03 and NJLEM04 were assessed to be good based on the CABIN analysis and ecological metrics for the sites. However, it should be noted that conditions at NJLEM04, situated 30m downstream from NJLEM03, were more degraded with a higher proportion of tolerant taxa. Due to the change in sampling locations, it is difficult to compare site results between the 2022 and 2023 samples due to the variable nature of stream systems. However, the change in community composition between the 2 sites, which are close in proximity, combined with the landslide and forest fire activity upstream from the test sites, may be indicative of a system that has been impacted by these events and which potentially has resulted in degraded conditions in the stream. Continued monitoring at the sites would be beneficial to better understand how changes in land cover and successional recovery of the forest after wildfire are associated with the condition of the benthic community. With annual monitoring there is an opportunity to understand how the stream recovers after wildfire and landslide events, as well as how channel stability influences the benthic communities over time after these climate related events.

Limitations and Recommendations

As noted by the Reference Model for the Columbia Basin document (2020), caution is recommended for any test site that was allocated to group one (Model Group D). This is in part due to the low number of sample sites included in Group D (n=13). Due to the low sample size, it is possible that the reference condition is not adequately described and therefore cannot be well predicted. The ECCC 2020 reference model document for the Columbia Basin suggests that an increased number of reference sites be used to get a more precise description of the natural variation within model group D.

Also, it would be advantageous to compare multiple years of data to further understand the annual variation of the creeks condition. Due to the climate change impacts to the watershed, it is recommended that long term monitoring and planning be considered to understand the relationship between these disturbances and water quality in the Lemon Creek system. Long term monitoring would assist with identifying shifts in species composition, including richness, abundance and diversity, which in turn could be used to assess the stream conditions as successional species repopulate the areas affected by wildfire and landslide events.

Appendix A

Total number of taxa: number present at a selected taxonomic level.

EPT taxa: number present within each group; high numbers of EPTs generally indicate “good” water quality, as they are sensitive to habitat disturbance.

EPT individuals: the sum of all Ephemeroptera, Plecoptera and Trichoptera taxa which respond to most types of anthropogenic disturbance. A decline in abundance or richness of EPT individuals would suggest an environmental disturbance. These are compared to the Chironomidae taxa, expressed as a ratio using abundance or composition values (see Section 3.3.2. below).

RIVPACS: a ratio of the Observed taxa (O):Expected taxa (E) ratio where; O:E =1 are healthy, O:E ratio <1 are impaired, O:E ratio > 1 are biodiversity hotspots/enriched.

Pielou’s Evenness measures between 0-1 with 0 indicating species are unevenly distributed among the community whereas, 1 indicates that the number of individuals within species is evenly distributed between species.

Diversity/evenness measurements: the richness, abundance and distribution among the taxa present (i.e., Simpson’s Diversity/Evenness Index and Shannon-Weiner Index); these measurements provide a summary of the distribution of the taxa. Diverse communities are indicators of “good” water quality.

Simpson's Diversity Index (D): is a weighted arithmetic mean of the proportional abundance of species and gives more weight to dominant or common species.

Simpson's Diversity Index takes into account the number of species present, as well as the relative abundance of each species in each taxa, giving more weight to more abundant species. As the species richness and evenness increase, the diversity increases (ECCC, 2024). 0 represents no diversity whereas, 1 represents infinite diversity.

The formula for Simpson’s Index is:

$D= 1 - \sum_{i=1}^{S} (n_i/N)^2$	where: n = the total number of organisms of a particular species N = the total number of organisms of all species

Site Description

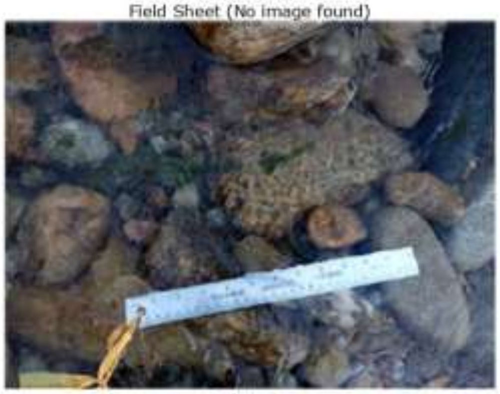
Study Name	BC NGO-Columbia Basin Water Monitoring Framework-LLC
Site	NJLEM03
Sampling Date	Oct 14 2022
Know Your Watershed Basin	Slocan
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera EcoZone Columbia Mountains and Highlands EcoRegion
Coordinates (decimal degrees)	49.70612 N, 117.49159 W
Altitude	544
Local Basin Name	Lemon Creek
	Columbia Basin
Stream Order	

Figure 1. Location Map

Across Reach

Down Stream

Field Sheet (No image found)



Substrate

Up Stream

Cabin Assessment Results

Reference Model Summary	
Model	Columbia Basin 2020
Analysis Date	December 04, 2024
Taxonomic Level	Family

Cabin Assessment Results

Predictive Model Variables	Altitude Drainage-Area Longitude Natl-Grassland Natl-ShrubLow Natl-Water Precip10_Oct Reach-%CanopyCoverage Sedimentary Slope SlopeMax Temp12_DECmin					

Reference Groups	1	2	3	4	5	6
Number of Reference Sites	13	24	28	35	32	15
Group Error Rate	53.8%	55.2%	34.1%	52.2%	23.1%	29.4%
Overall Model Error Rate	39.4%					
Probability of Group Membership	50.8%	6.1%	0.5%	1.9%	0.0%	40.7%
CABIN Assessment of NJLEM03 on Oct 14, 2022	Mildly Divergent					

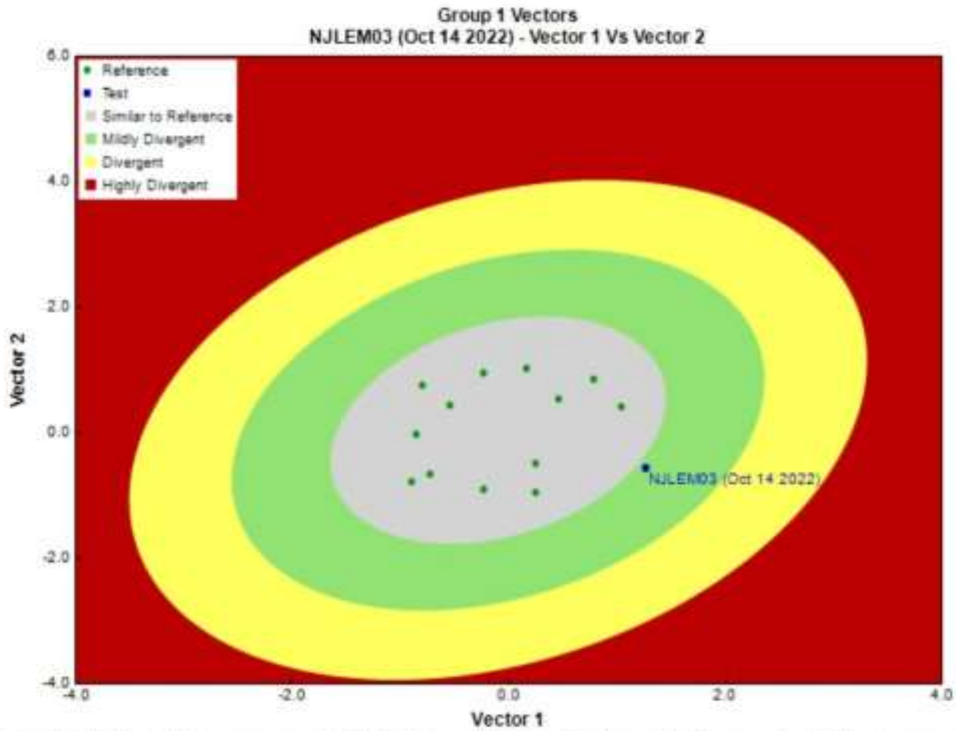


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3

Date: December 6, 2024 1:52 PM

Sample Information

Taxonomist	-
	-
Sub-Sample Proportion	40/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida			1	2.5
		Trombidiformes	Lebertiidae	1	2.5
			Torrenticolidae	2	5.0
	Insecta	Diptera	Chironomidae	28	70.0
			Empididae	3	7.5
			Simuliidae	3	7.5
		Ephemeroptera		8	20.0
			Ameletidae	1	2.5
			Baetidae	163	407.5
			Ephemerellidae	12	30.0
			Heptageniidae	35	87.5
		Plecoptera		3	7.5
			Capniidae	1	2.5
			Chloroperlidae	1	2.5
			Nemouridae	5	12.5
			Perlidae	2	5.0
			Taeniopterygidae	13	32.5
		Trichoptera		7	17.5
			Hydropsychidae	6	15.0
			Hydroptilidae	2	5.0
			Rhyacophilidae	17	42.5
			Total	314	785.0

Metrics

Name	NJLEM03	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.57	0.4 ± 0.1
Biotic Indices		
Hilsenhoff Family index (Mid-Atlantic)	3.9	3.7 ± 1.0
Hilsenhoff Family index (North-West)	3.9	3.8 ± 0.9
Intolerant taxa	--	1.0
Long-lived taxa	2.0	2.9 ± 1.5
Tolerant individuals (%)	--	0.6
Functional Measures		
% Filterers	--	0.6
% Gatherers	22.3	50.0 ± 20.3
% Predatores	19.7	31.9 ± 22.5
% Scrapers	70.7	41.5 ± 22.0
% Shredder	6.1	17.5 ± 12.3
No. Clinger Taxa	19.0	17.0 ± 5.4
Number Of Individuals		
% Chironomidae	9.5	25.7 ± 24.5
% Coleoptera	0.0	1.0 ± 2.0
% Diptera + Non-insects	12.5	29.7 ± 25.4
% Ephemeroptera	71.5	43.3 ± 22.7
% Ephemeroptera that are Baetidae	77.3	43.3 ± 23.0
% EPT Individuals	87.5	68.9 ± 25.5
% Odonata	--	0.0 ± 0.0
% of 2 dominant taxa	67.1	59.1 ± 16.7
% of 5 dominant taxa	86.8	83.4 ± 8.1
% of dominant taxa	55.3	41.7 ± 17.7
% Plecoptera	7.5	20.8 ± 13.1
% Tribe Tanyatarisini	--	
% Trichoptera that are Hydropsychida	24.0	14.7 ± 24.2
% Tricoptera	8.5	4.9 ± 6.8
No. EPT individuals/Chironomids+EPT Individuals	0.9	0.7 ± 0.3

Metrics

Name	NJLEM03	Predicted Group Reference Mean ±SD
Total Abundance	785.0	1823.3 ± 1298.4
Richness		
Chironomidae taxa (genus level only)	1.0	1.0 ± 0.0
Coleoptera taxa	0.0	0.3 ± 0.5
Diptera taxa	3.0	3.1 ± 1.2
Ephemeroptera taxa	4.0	3.8 ± 0.8
EPT Individuals (Sum)	645.0	1328.9 ± 1129.6
EPT taxa (no)	12.0	11.0 ± 2.5
Odonata taxa	--	0.0 ± 0.0
Pielou's Evenness	0.6	0.7 ± 0.1
Plecoptera taxa	5.0	4.7 ± 1.3
Shannon-Wiener Diversity	1.7	1.8 ± 0.5
Simpson's Diversity	0.7	0.7 ± 0.2
Simpson's Evenness	0.2	0.3 ± 0.1
Total No. of Taxa	17.0	16.2 ± 3.8
Trichoptera taxa	3.0	2.5 ± 1.6

Frequency and Probability of Taxa Occurrence

Reference Model Taxa	Frequency of Occurrence in Reference Sites						Probability Of Occurrence at NJLEM03
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	
Baetidae	100%	100%	100%	100%	100%	100%	1.00

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	11.00
RIVPACS : Observed taxa P>0.50	12.00
RIVPACS : O:E (p > 0.5)	1.09
RIVPACS : Expected taxa P>0.70	8.62
RIVPACS : Observed taxa P>0.70	9.00
RIVPACS : O:E (p > 0.7)	1.04

Habitat Description

Variable	NJLEM03	Predicted Group Reference Mean ±SD
Bedrock Geology		
Sedimentary (%)	0.92400	72.45797 ± 36.70120
Channel		
Depth-Avg (cm)	32.0	25.2 ± 17.8
Depth-BankfullMinusWetted (cm)	53.50	57.24 ± 28.97
Depth-Max (cm)	48.0	37.5 ± 24.9
Macrophyte (PercentRange)	0	0 ± 1
Reach-%CanopyCoverage (PercentRange)	0.00	1.00 ± 1.08
Reach-%Logging (PercentRange)	0	0 ± 0
Reach-DomStreamsideVeg (Category(1-4))	4	3 ± 1
Reach-Pools (Binary)	1	1 ± 0
Reach-Rapids (Binary)	0	0 ± 0
Reach-Riffles (Binary)	1	1 ± 0
Reach-StraightRun (Binary)	1	1 ± 1
Slope (m/m)	0.0230000	0.0570046 ± 0.0814795
Veg-Coniferous (Binary)	1	1 ± 0
Veg-Deciduous (Binary)	1	1 ± 0
Veg-GrassesFerns (Binary)	0	1 ± 1
Veg-Shrubs (Binary)	1	1 ± 0
Velocity-Avg (m/s)	0.58	0.55 ± 0.42
Velocity-Max (m/s)	0.89	0.81 ± 0.43
Width-Bankfull (m)	50.0	16.1 ± 14.3
Width-Wetted (m)	9.5	9.6 ± 9.6
XSEC-VelMethod (Category(1-3))	1	2 ± 1
Climate		

Habitat Description

Variable	NJLEM03	Predicted Group Reference Mean ±SD
Precip10_OCT (mm)	84.54000	88.61164 ± 22.09890
Temp12_DECmin (Degrees Celsius)	-10.78000	-11.74201 ± 2.29837
Hydrology		
Drainage-Area (km^2)	202.36100	227.18539 ± 458.61339
Perimeter (Km)	77.88700	79.99141 ± 97.44574
Landcover		
Natl-Grassland (%)	5.20500	3.27800 ± 7.23403
Natl-ShrubLow (%)	0.06900	4.73476 ± 3.22482
Natl-Water (%)	0.07800	0.37895 ± 0.74882
Substrate Data		
%Bedrock (%)	0	0 ± 0
%Boulder (%)	3	7 ± 9
%Cobble (%)	77	49 ± 16
%Gravel (%)	0	7 ± 8
%Pebble (%)	20	37 ± 14
%Sand (%)	0	0 ± 0
%Silt+Clay (%)	0	0 ± 0
D50 (cm)	10.00	7.75 ± 3.16
Dg (cm)	9.5	6.8 ± 3.3
Dominant-1st (Category(0-9))	6	6 ± 2
Dominant-2nd (Category(0-9))	7	6 ± 2
Embeddedness (Category(1-5))	4	4 ± 1
PeriphytonCoverage (Category(1-5))	2	2 ± 1
SurroundingMaterial (Category(0-9))	2	4 ± 2
Topography		
SlopeMax (%)	242.83000	306.43044 ± 136.47512
Water Chemistry		
General-DO (mg/L)	11.4000000	11.3630769 ± 2.0598802
General-pH (pH)	8.1	7.7 ± 0.7
General-SpCond (µS/cm)	198.5000000	119.2000000 ± 132.8872831
General-TempAir (Degrees Celsius)	14.0	9.7 ± 5.1
General-TempWater (Degrees Celsius)	7.8000000	5.9515385 ± 2.8836951
General-Turbidity (NTU)	0.1280000	4.5920000 ± 8.7550283

Site Description

Study Name	BC NGO-Columbia Basin Water Monitoring Framework-LLC
Site	NJLEM04
Sampling Date	Sep 08 2023
Know Your Watershed Basin	Slocan
Province / Territory	British Columbia
Terrestrial Ecological Classification	Montane Cordillera EcoZone Columbia Mountains and Highlands EcoRegion
Coordinates (decimal degrees)	49.70566 N, 117.49109 W
Altitude	545
Local Basin Name	Lemon Creek
	Slocan Lake Basin
Stream Order	3

Figure 1. Location Map

Across Reach

Down Stream
Field Sheet (No image found)

Substrate
Up Stream (No image found)

Cabin Assessment Results

Reference Model Summary						
Model	Columbia Basin 2020					
Analysis Date	December 04, 2024					
Taxonomic Level	Family					
Predictive Model Variables	Altitude Drainage-Area Longitude Natl-Grassland Natl-ShrubLow Natl-Water Precip10_Oct Reach-%CanopyCoverage Sedimentary Slope SlopeMax Temp12_DECmin					
Reference Groups	**1**	**2**	**3**	**4**	**5**	**6**
Number of Reference Sites	13	24	28	35	32	15
Group Error Rate	53.8%	55.2%	34.1%	52.2%	23.1%	29.4%
Overall Model Error Rate	39.4%					
Probability of Group Membership	41.2%	6.2%	0.6%	2.6%	0.0%	49.4%
CABIN Assessment of NJLEM04 on Sep 08, 2023	Mildly Divergent					

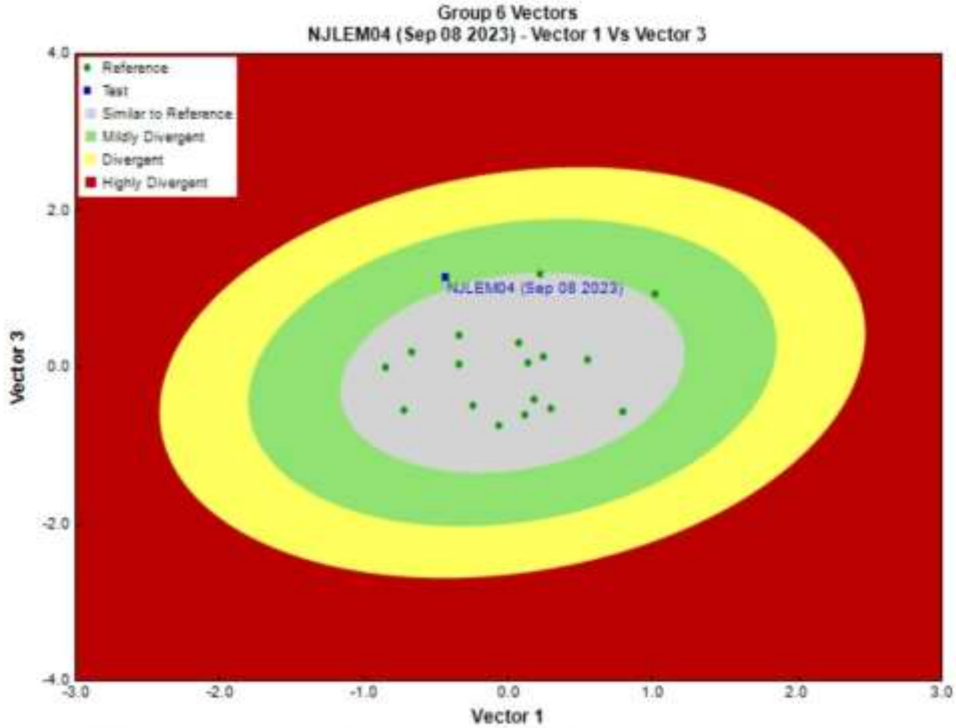


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	-
	-
Sub-Sample Proportion	100/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Sperchontidae	2	2.0
	Insecta	Coleoptera	Elmidae	2	2.0
		Diptera	Ceratopogonidae	1	1.0
			Chironomidae	56	56.0
			Empididae	2	2.0
			Tipulidae	1	1.0
		Ephemeroptera		18	18.0
			Baetidae	74	74.0
			Ephemerellidae	7	7.0
			Heptageniidae	6	6.0
		Plecoptera		3	3.0
			Chloroperlidae	2	2.0
			Leuctridae	1	1.0
			Nemouridae	3	3.0
			Perlidae	1	1.0
		Trichoptera		15	15.0

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
			Brachycentridae	1	1.0
			Glossosomatidae	1	1.0
			Rhyacophilidae	4	4.0
			Total	200	200.0

Metrics

Name	NJLEM04	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.71	0.5 ± 0.2
Biotic Indices		
Hilsenhoff Family index (Mid-Atlantic)	3.9	3.3 ± 0.7
Hilsenhoff Family index (North-West)	3.9	3.0 ± 0.6
Intolerant taxa	--	1.0 ± 0.0
Long-lived taxa	3.0	3.7 ± 2.5
Tolerant individuals (%)	--	
Functional Measures		
% Filterers	--	0.9
% Gatherers	35.0	45.5 ± 16.7
% Predatores	33.0	19.6 ± 9.1
% Scrapers	41.5	47.6 ± 19.0
% Shredder	4.0	33.9 ± 13.8
No. Clinger Taxa	15.0	16.4 ± 6.3
Number Of Individuals		
% Chironomidae	34.1	9.8 ± 10.2
% Coleoptera	1.2	1.8 ± 5.1
% Diptera + Non-insects	37.8	16.2 ± 13.7
% Ephemeroptera	53.0	38.6 ± 16.4
% Ephemeroptera that are Baetidae	85.1	25.0 ± 16.3
% EPT Individuals	61.0	81.5 ± 15.8
% Odonata	--	0.0 ± 0.0
% of 2 dominant taxa	79.3	53.0 ± 11.8
% of 5 dominant taxa	89.6	79.4 ± 9.4
% of dominant taxa	45.1	33.3 ± 9.9
% Plecoptera	4.3	37.6 ± 13.8
% Tribe Tanyatarisini	--	
% Trichoptera that are Hydropsychida	0.0	22.3 ± 35.7
% Tricoptera	3.7	5.3 ± 3.7
No. EPT individuals/Chironomids+EPT Individuals	0.6	0.9 ± 0.1
Total Abundance	200.0	214.3 ± 171.5
Richness		
Chironomidae taxa (genus level only)	1.0	0.9 ± 0.3
Coleoptera taxa	1.0	0.1 ± 0.3
Diptera taxa	4.0	2.8 ± 1.2
Ephemeroptera taxa	3.0	3.7 ± 0.9
EPT Individuals (Sum)	100.0	168.4 ± 119.3
EPT taxa (no)	10.0	11.1 ± 3.2
Odonata taxa	--	0.0 ± 0.0
Pielou's Evenness	0.6	0.8 ± 0.1
Plecoptera taxa	4.0	5.1 ± 1.2
Shannon-Wiener Diversity	1.5	2.1 ± 0.3
Simpson's Diversity	0.7	0.8 ± 0.1
Simpson's Evenness	0.2	0.4 ± 0.1
Total No. of Taxa	16.0	16.4 ± 6.1
Trichoptera taxa	3.0	2.3 ± 1.6

Frequency and Probability of Taxa Occurrence

Reference Model Taxa	Frequency of Occurrence in Reference Sites						Probability Of Occurrence at NJLEM04
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	11.05
RIVPACS : Observed taxa P>0.50	9.00
RIVPACS : O:E (p > 0.5)	0.81
RIVPACS : Expected taxa P>0.70	8.67
RIVPACS : Observed taxa P>0.70	7.00
RIVPACS : O:E (p > 0.7)	0.81

Habitat Description

Variable	NJLEM04	Predicted Group Reference Mean ±SD
Bedrock Geology		
Sedimentary (%)	0.92000	82.88358 ± 30.75953
Channel		
Depth-Avg (cm)	18.3	24.1 ± 15.2
Depth-BankfullMinusWetted (cm)	36.50	47.36 ± 27.19
Depth-Max (cm)	26.5	36.1 ± 20.6
Macrophyte (PercentRange)	0	0 ± 0
Reach-%CanopyCoverage (PercentRange)	0.00	1.12 ± 1.22
Reach-DomStreamsideVeg (Category(1-4))	4	3 ± 1
Reach-Pools (Binary)	0	1 ± 1
Reach-Rapids (Binary)	0	1 ± 0
Reach-Riffles (Binary)	1	1 ± 0
Reach-StraightRun (Binary)	0	1 ± 1
Slope (m/m)	0.0045000	0.0342024 ± 0.0245210
Veg-Coniferous (Binary)	1	1 ± 0
Veg-Deciduous (Binary)	1	1 ± 0
Veg-GrassesFerns (Binary)	1	1 ± 0
Veg-Shrubs (Binary)	1	1 ± 0
Velocity-Avg (m/s)	0.42	0.64 ± 0.25
Velocity-Max (m/s)	0.63	0.94 ± 0.33
Width-Bankfull (m)	23.4	32.9 ± 57.4
Width-Wetted (m)	18.1	13.7 ± 9.2
XSEC-VelMethod (Category(1-3))	1	2 ± 1
Climate		
Precip10_OCT (mm)	84.54000	93.20980 ± 34.74431
Temp12_DECmin (Degrees Celsius)	-10.78000	-13.22157 ± 2.49065
Hydrology		
Drainage-Area (km^2)	202.36000	128.73316 ± 95.34698
Perimeter (Km)	77.89000	70.14529 ± 35.78518
Landcover		
Natl-Grassland (%)	5.20000	6.92953 ± 4.46178
Natl-ShrubLow (%)	0.06900	3.64474 ± 3.23210
Natl-Water (%)	0.07800	0.28041 ± 0.33747
Substrate Data		
%Bedrock (%)	0	0 ± 0
%Boulder (%)	14	7 ± 9
%Cobble (%)	83	56 ± 19
%Gravel (%)	1	4 ± 4
%Pebble (%)	2	33 ± 19
%Sand (%)	0	0 ± 1
%Silt+Clay (%)	0	0 ± 2
D50 (cm)	16.50	10.03 ± 5.73
Dg (cm)	15.1	8.6 ± 4.1
Dominant-1st (Category(0-9))	7	6 ± 1
Dominant-2nd (Category(0-9))	6	6 ± 1
Embeddedness (Category(1-5))	2	4 ± 1
PeriphytonCoverage (Category(1-5))	2	1 ± 0
SurroundingMaterial (Category(0-9))	1	3 ± 1
Topography		
SlopeMax (%)	242.83000	367.17555 ± 135.12349
Water Chemistry		
General-Conductivity (µS/cm)	10.6000000	108.4800000 ± 69.0823952
General-DO (mg/L)	9.0000000	11.0082353 ± 0.9760010

Habitat Description

Variable	NJLEM04	Predicted Group Reference Mean ±SD
General-pH (pH)	8.6	8.1 ± 0.7
General-TempAir (Degrees Celsius)	18.8	8.6 ± 4.0
General-TempWater (Degrees Celsius)	13.4000000	6.0976471 ± 2.0569897

References

Environment Canada. 2012. Canadian Aquatic Biomonitoring Network (CABIN) Field Manual for wadeable streams. 49pp.

Environment Canada. 2014. CABIN Processing, Taxonomy, and Quality Control of Benthic Macroinvertebrate Samples. May 2014.

Environment Canada. 2024. **Benthic macroinvertebrate metric reference guide.** Accessed December 10, 2024 from https://www.canada.ca/en/environment-climate-change/services/canadian-aquatic-biomonitoring-network/resources/benthic-macroinvertebrate-metric-reference-guide.html

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist 20:31-39.

Strachan, S.A., Raggett, J., 2020. Reference Model Supporting Documentation for CABIN Analytical Tools: Columbia Basin, 2020. Retrieved on December 1, 2024, from https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-monitoring/biomonitoring