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Whistler Ecosystems and Species Monitoring Program

2021

Palmer Project #
1602506

Prepared For
Resort Municipality of Whistler

January 31, 2022

470 Granville Street, Suite 630, Vancouver, BC V6C 1V5
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January 31, 2022

Ms. Heather Beresford
Environmental Stewardship Manager
Resort Municipality of Whistler
4325 Blackcomb Way
Whistler, B.C. V0N 1B4

Dear Ms. Beresford,

Re: Whistler Ecosystems and Species Monitoring Program
Project #: 1602506

Enclosed you will find the Whistler Ecosystems and Species Monitoring Program 2021 report. This report covers the aquatic components of the 2021 Program.

We hope our team-based approach will not only fulfil the conservation goals for the Resort Municipality of Whistler (RMOW) but will maintain the connection to residents and produce a report that is scientifically defensible.

Thank you for this opportunity to support you on this interesting project.

Yours truly,
Palmer

Rick Palmer, M.Sc., R.P.Bio
CEO, Fisheries Biologist

Executive Summary

The Resort Municipality of Whistler (RMOW) is located in the southern Coast Mountains of British Columbia, approximately 100 km north of the city of Vancouver. For many years the RMOW has been concerned about describing and conserving biodiversity within the urban development footprint of the RMOW. To help address those concerns, an Ecosystems and Species Monitoring Program (the Program) was initiated by the RMOW in 2013. The objective of the Program was to monitor ecosystems within the RMOW and to find out if there have been changes over time that might indicate a loss, or possible loss, of biodiversity.

Because it is not possible to look at everything in an ecosystem, the Program design was based on the use of indicators to describe and look for changes over time. These indicators have included plants, animals, and specific parts of the environment. In 2021, benthic invertebrate sampling, alongside surface water physical measurements, comprised the aquatic component of the Program.

As in previous years, for the benthic invertebrate samples collected in 2021, the benthic invertebrate community was described and then compared with the Fraser Basin 2014 Reference Model as developed through the Canadian Biomonitoring Network (CABIN) Program within Environment Canada. The CABIN program collects benthic invertebrate samples from many sites within a region and over time develops an understanding of what the benthic invertebrate community should look like in a pristine, reference stream or river. Benthic invertebrate samples from test sites, such as at Whistler, can then be compared with the reference samples. If the benthic invertebrate communities from a test site are comparable with the community from the reference sites, then the test sites are said to be in ‘reference condition’ and in good health. If the test sites are slightly unusual in comparison with reference sites, they are assessed as ‘mildly divergent’, and if the tests sites are highly unusual then they are assessed as ‘divergent’ to ‘highly divergent’.

The 2021 results showed that the benthic invertebrate community was in reference condition for Jordan Creek and River of Golden Dreams (downstream), and mildly divergent from reference condition for Twenty-one Mile Creek, Crabapple Creek, and River of Golden Dreams (upstream). Results from previous years were also variable, with all creeks either in reference or mildly divergent most of the time.

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1. Introduction

1.1 Overview

This report describes monitoring conducted in 2021 by Palmer in aquatic environments in Whistler, British Columbia. The 2021 study was the ninth year of the Ecosystem and Species Monitoring Program[1] (the Program) and the sixth study conducted by this team. The purpose of the Program is to monitor the health of ecosystems over time through ecological indicators (proxies) to help guide the conservation of species and ecosystems and inform sustainable land use planning and development in Whistler. This year, due to budget constraints, two separate reports were produced for the Program: Palmer (2022, this report), and Brett (2022), covering the aquatic (benthic invertebrates) and terrestrial components of the Program respectively.

1.2 Background

The Whistler Biodiversity Project (WBP), funded in significant part by the Resort Municipality of Whistler (RMOW) from 2006 through 2012, began surveys in late 2004. This work led to the first publicly documented record of several important and/or at-risk species, including Coastal Tailed Frog (*Ascaphus truei*), and Red-legged Frog (*Rana aurora*), initiated the first Beaver (*Castor canadensis*) census, and greatly enhanced the inventory of species documented within Whistler. The report (Brett 2007) summarizing early results, recommended further inventory work, and identified and monitored indicator species. This work was the precursor to a report the RMOW commissioned that proposed a framework for the establishment and application of ecological monitoring in Whistler (Askey et al. 2008).

The Ecosystem and Species Monitoring Program was initiated by the RMOW in 2013. The Program design was based on the use of species, habitat, and climate indicators to identify temporal and spatial trends in the overall condition of ecosystems. The initial study design and selection of indicators (Cascade 2014) was based on information from:

- Askey et al. (2008) proposed framework,
- Species data collected through the Whistler Biodiversity Project (Brett 2007 and online lists[2]), and
- Local data held by Cascade Environmental Resource Group Inc (Cascade).

Cascade Environmental Resource Group Ltd. (Cascade) conducted the first three years of the Program, from 2013 through 2015 (Cascade 2014-2016). In 2016, Palmer and Snowline were awarded the contract for the Program. Several changes were made to the study design in 2016 to make it more scientifically robust (e.g., adopting data collection methods which allowed for statistical analysis) while maintaining comparability and consistency with previous years to the greatest extent possible. The changes implemented in 2016 included:

- The addition of benthic invertebrates as an indicator for aquatic ecosystem health
- The use of multiple pass depletion electrofishing methods for fish
- Alterations to previously defined species thresholds

[1] *The name of the Program changed in 2019 to recognize that specific species are useful indicators of ecosystem health. Previous reports refer to the "Ecosystems Monitoring Program."*

[2] *www.whistlerbiodiverisity.ca*

- Changing the methodology for Coastal Tailed Frog surveys from area-constrained to time-constrained and increasing the elevational range of study sites on each creek
- Moving Pileated Woodpecker (*Dryocopus pileatus*) surveys to breeding season and expanding the scope of the cavity tree survey
- Removal/replacement of some study sites and
- A return to a full beaver census throughout Whistler Valley.

The work plan has continued to evolve since 2016 as results are evaluated and priorities re-assessed. Some of the main changes made since 2016 include:

- The installation of two additional temperature loggers at aquatic sampling sites in Crabapple Creek and Twenty-one Mile Creek
- Use of the single-pass electrofishing method with no stop nets for fish sampling
- An increase in the number of Coastal Tailed Frog survey sites, especially on the west side of the valley
- The first mapping to calculate the area affected by beaver flooding and other activities ("beaver-affected wetlands")
- Expanded efforts to census the beaver population, notably on the River of Golden Dreams and in the Miller Creek Wetlands and
- The addition of new species of conservation and monitoring value (Northern Goshawks, Western Toads, and black cottonwoods).

Brett (2018) identified monitoring priorities for species and habitats most important to conserving biodiversity within the RMOW's Development Footprint. Recommendations for the future of the Program will build on past results within that context and propose methods to effectively monitor priority species and habitats in the future.

1.3 Study Area

The RMOW is located in the southern Coast Mountains of British Columbia, approximately 100 km north of Vancouver. The study area, defined by the extent of the RMOW municipal boundaries (Figure 1-1), contains a range of aquatic and terrestrial ecosystems at montane to alpine elevations. Most development (within the municipal "Development Footprint"[3]) is in the valley bottom, from Function Junction to Green Lake.

1.4 Study Design

The Program is based on the use of indicators that reflect the health of a broader range of populations, taxa, and/or ecosystems. In 2021, sampling scope was limited due to the ongoing COVID-19 pandemic; therefore, only benthic invertebrate sampling and stream temperature data collection comprised the aquatic component of the Program. Table 1-1 shows the indicators, field methodologies, and metrics for the 2021 aquatics program.

[3] *Now termed "Urban Development Containment Area" in the latest draft Official Community Plan (https://www.whistler.ca/ocp).*

Table 1-1. 2021 Ecosystems Monitoring Program.

Study Component	Indicator(s)	Methodology/ Equipment	Metrics/Parameters
Aquatic Habitat	Stream temperature *In situ* physical parameters	Temperature loggers set to hourly logging, installed in the study streams *In situ* measurement using handheld water quality meter	• Daily and monthly summary statistics for the open water period • One-time measurement of water quality physical parameters
Aquatic Species	Benthic macroinvertebrate community	CABIN protocol	• Reference condition • Abundance • Taxa richness • EPT taxa richness • Percentage EPT • Diversity indices

490000 495000 500000 505000 510000

5555000

5550000

5545000

CALLAGHAN LAKE PARK

Nineteen Mile Creek

Green River

Wedgemount Creek

Rethel Creek

Twentyone Mile Creek

Green Lake

Wedge Creek

Madeley Creek

Callaghan Creek

River of Golden Dreams

Mt Sproatt

Millar Creek

Lost Lake

Blackcomb Creek

WHISTLER

Alta Lake

Scoria Creek

Sproatt Creek

Horstman Creek

Nita Lake

Jordan Creek

Edna Creek

BLACKCOMB GLACIER PARK

Dority Creek

Millar Creek

Alpha Lake

Alpha Creek

Highway 99

Whistler Creek

Blackcomb Peak

Snow Creek

Harmony Creek

SPEARHEAD RANGE

GARIBALDI PARK

Brandywine Creek

Whistler Mtn

Fitzsimmons Creek

Flute Creek

Oboe Creek

Melody Creek

BRANDYWINE FALLS PARK

FITZSIMMONS RANGE

Petticoat Creek

Helm Creek

Cheakamus River

Russet Creek

Brew Creek

Legend

- RMOW Boundary
- Highway
- Local Road
- Railway
- Elevation Contour (200 m Interval)
- Watercourse
- Lake
- Permanent Snow and Ice
- Developed Land
- Park or Protected Area

Data Sources: Developed land provided by RMOW. Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government Licence – British Columbia. Other base data from Canvec (250k) and licenced under the Open Government Licence - Canada.

0 1 2 3
kilometres

N

DRAWN: B. Elder
CHECKED: I. Tuite
PROJECT: 1602507
DATE: Dec 22, 2021

Scale 1:70000
UTM Zone 10N
NAD 1983

[redacted]

CLIENT: Resort Municipality of Whistler
PROJECT: Annual Monitoring 2021

2021 Ecosystem Monitoring Program Study Area, Whistler, BC

FIGURE 1-1

Document Path: G:\Shared drives\Projects 2016\16025 - Resort Municipality of Whistler\1602507 - 2021 Annual Monitoring\GIS\1_Workspace\Task 2 - Monitoring Figures\1602507_1-1_Study Area.mxd

2. Surface Water

2.1 Stream Water Temperature

2.1.1 Introduction

The objective of continuous temperature data collection is to monitor stream temperature over time and, to the extent possible, understand the influence of stream temperature on aquatic communities. Temperature loggers installed in the RMOW streams record hourly readings, which provides a continuous temperature record.

2.1.2 Methods

Temperature data loggers (Onset HOBO MX2201 Pendant loggers) are currently installed and maintained at five sites (Figure 2-2: Table 2-1), four of which are at or near a benthic invertebrate (aquatic) sampling site. The current loggers were replaced/installed in April 2020 and were downloaded by the Palmer field crew on July 27th and 28th, 2021.

Table 2-1. Temperature Logger Locations

Site	UTM Location (Zone 10)		Location Description	Aquatic Site ID	Access	2021 Download Date
	Easting	Northing				
Jordan Creek	500258	5549255	Near Aquatics Site	JOR-DS-AQ31	Lake Placid Road	27-July-21
Upstream Crabapple Creek	502426	5550589	At Tailed Frog Site #2	-	Sunridge Drive	27-July-21
Downstream Crabapple Creek	502030	5552670	At Aquatics Site	CRB-DS-AQ01	Lorimer Road	28-July-21
River of Golden Dreams	502066	5552829	Near Aquatics Site	RGD-US-AQ11	Lorimer Road	28-July-21
Twenty-one Mile Creek	501910	5552856	At Aquatics Site	21M-DS-AQ21	Lorimer Road	28-July-21

2.1.3 Stream Temperature Record

An overview of the temperature records at the four locations co-located with benthic sampling is shown in Figure **2-1**. The figure shows monthly average temperatures for the period of record at each location. Summary statistics (average, minimum, and maximum monthly stream temperatures) for the 2021 temperature dataset are provided in Appendix A.

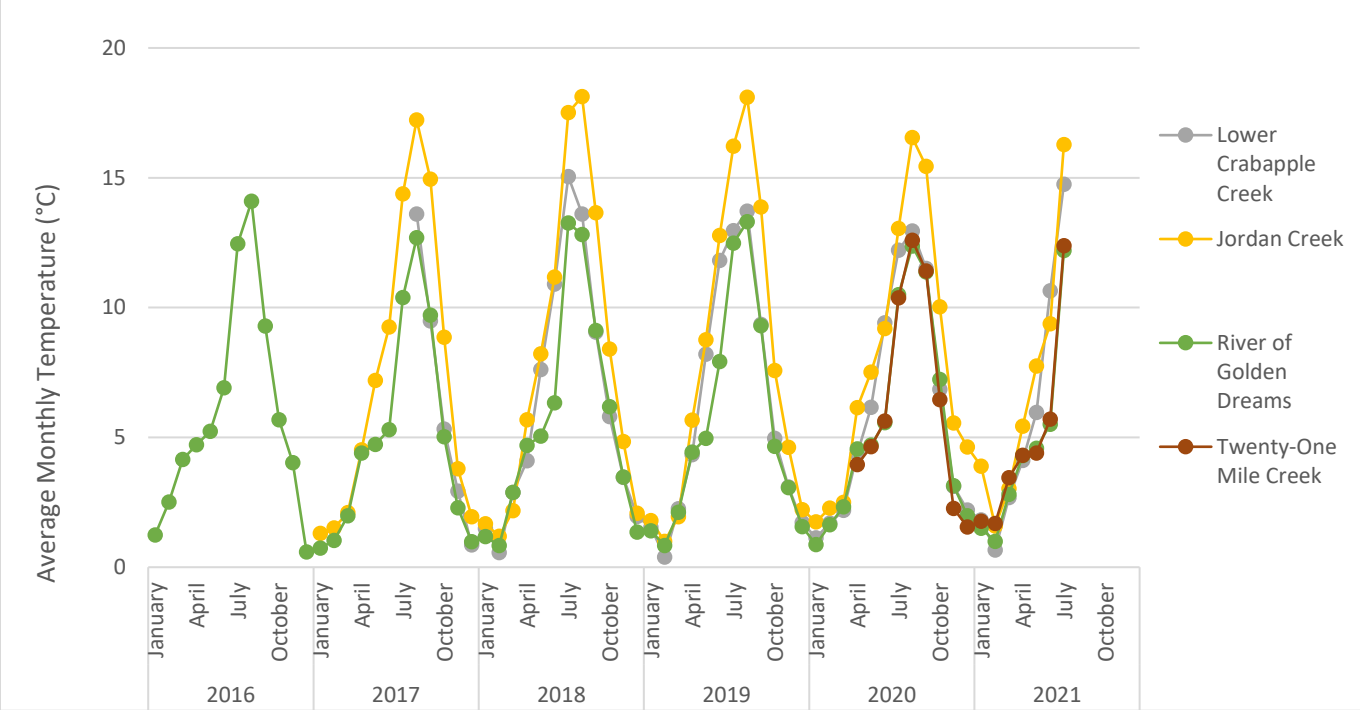

Figure 2-1. Monthly Mean Stream Temperature Record for 2016-2021 for temperature monitoring at locations at or near aquatic sites.

496000 498000 500000 502000 504000

5554000 5552000 5550000 5548000

Twentyone Mile Creek
Green Lake
RGD-DS-AQ12
River of Golden Dreams
21M-DS-AQ21
RGD-US-AQ11
CRB-DS-AQ01
Crabapple Creek
Twentyone Mile Creek
River of Golden Dreams
Crabapple Creek 2
Lost Lake
Blackcomb Creek
Horstman Creek
Alta Lake
Scotia Creek
Sproatt Creek
Crabapple Creek 1
Nita Lake
Jordan Creek
JOR-DS-AQ31
Millar Creek
Alpha Lake
Alpha Creek
Cheakamus River
Whistler Creek

0 50 100
metres

0 25 50
metres

0 500 1,000
metres

N

Legend

- 2021 Aquatics Site
- Temperature Logger
- Watercourse

Notes:
(1) Orthoimagery (2014) provided by RMOW.
(2) Watercourse data from BC Freshwater Atlas (accessed 2017).

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N
0 2 km
Figure Extent
Whistler Village
RMOW Boundary

DRAWN: B. Elder
CHECKED: I. Tuite
PROJECT: 1602507
DATE: Dec 23, 2021

Scale 1:30000
UTM Zone 10N
NAD 1983

[redacted]

CLIENT: Resort Municipality of Whistler
PROJECT: Annual Monitoring 2021

2021 Ecosystem Monitoring Program Aquatic Sampling Sites

FIGURE 2-1

Document Path: G:\Shared drives\Projects 2016\16025 - Resort Municipality of Whistler\1602507 - 2021 Annual Monitoring\GIS\1_Workspace\Task 2 - Monitoring Figures\1602507_2-1_Aquatic Sites.mxd

2.2 Physical Parameters

2.2.1 Introduction

Dissolved oxygen (DO), pH, temperature and conductivity describe fundamental characteristics of a water body. *In situ* water quality measurements of these parameters taken concurrently with aquatic species surveys provide insight into the influence of physical conditions on the biological community.

2.2.2 Methods

Consistent with previous years, *in situ* surface water temperature, dissolved oxygen (DO), pH, and conductivity were measured in 2021 using a hand-held YSI Pro plus meter at each of the five established benthic invertebrate (aquatic) sampling sites (Figure 2-2). Measurements were taken concurrently with benthic invertebrate sampling (Table 3-1).

2.2.3 Surface Water Physical Characterization

Dissolved oxygen varied from 7.5 mg/L to 14.6 mg/L across all sites and years and in 2021 varied from 9.2 mg/L to 11.7 mg/L (Table 2-2). Measured *in situ* dissolved oxygen at all sites in all years was above the BC WQG instantaneous minimum of 5 mg/L (BC MOE, 1997) for all fish life stages. However, a number of measurements were below the BC WQG instantaneous minimum guideline of 9 mg/L (BC MOE, 1997) for buried embryo/alevin life stages.

pH varied from 6.2 to 9.4 across all sites and years and in 2021 varied from 7.5 to 9.4 (Table 2-2). pH was below the BC pH guideline of 6.5 at Twenty-one Mile Creek (21M-DS-AQ21) in 2016 and 2018, and above the BC pH guideline of 9.0 at Twenty-one Mile Creek in 2020: this variation in pH recorded for Twenty-one Mile Creek is unusual and may be an erroneous measurement.

Specific conductance varied from 33 µS/cm to 105 µS/cm across four of the sites. In Crabapple Creek (CRB-DS-AQ01), however, specific conductance was measurably higher, varying from 194 µS/cm to 336 µS/cm through the period of record. The reasons for this difference have not been investigated, although it is noteworthy that Crabapple Creek flows alongside the edge of a golf course and several houses.

Table 2-2. In Situ Surface Water Results, 2016-2021.

Creek	Site ID	Date	Dissolved oxygen (mg/L)	Dissolved oxygen (%)	pH	Specific Conductance (µS/cm)	Water Temperature (°C)
Jordan Creek	JOR-DS-AQ31	03-Aug-16	9.3	94	7.1	64	15.8
		26-Jul-17	8.9*	88	7.1	105	14.9
		01-Aug-18	7.7*	83	7.1	65	18.8
		30-Jul-19	9.4	98	7.7	78	17.4
		05-Aug-20	8.1*	83	7.7	63	16.7
		27-July-2021	**9.2**	**105**	**7.2**	**55**	**18.3**
Crabapple Creek	CRB-DS-AQ01	02-Aug-16	9.4	89	7.6	218	12.7
		25-Jul-17	11.6	108	7.4	336	12.0
		01-Aug-18	7.5*	76	7.5	194	16.0
		30-Jul-19	10.0	97	7.6	235	13.9
		04-Aug-20	9.1	87	9.0	218	13.3
		28-July-2021	**10.8**	**99**	**6.9**	**200**	**18.6**
Twenty-one Mile Creek	21M-DS-AQ21	03-Aug-16	9.4	87	6.3*	40	12.0
		25-Jul-17	11.3	104	7.1	40	11.6
		31-Jul-18	14.6	160[ł]	6.2*	38	19.9
		30-Jul-19	9.8	94	7.0	52	13.3
		04-Aug-20	8.0*	77	9.4*	47	13.9
		28-July-2021	**11.7**	**113**	**7.0**	**55**	**14.2**
River of Golden Dreams (Upper)	RGD-US-AQ11	03-Aug-16	8.3*	76	7.3	64	11.7
		25-Jul-17	11.0	99	7.1	50	10.5
		31-Jul-18	7.5*	75	7.2	36	15.5
		30-Jul-19	9.8	92	6.8	33	12.8
		05-Aug-20	8.2*	79	7.7	42	13.6
		28-July-21	**10.6**	**100**	**7.1**	**46**	**13.1**
River of Golden Dreams (Lower)	RGD-DS-AQ12	05-Aug-16	9.9	99	7.8	69	15.2
		25-Jul-17	9.8	93	7.0	73	13.0
		01-Aug-18	8.2*	86	6.7	48	17.8
		31-Jul-19	9.9	94	7.6	61	13.1
		05-Aug-20	9.1	93	7.5	71	16.3
		28-July-21	**11.5**	**118**	**7.3**	**74**	**16.6**

*Notes: The 2021 results are **bolded**; values that exceeded a guideline are identified with an asterisk (*).*

ł Reading likely erroneous.

3. Benthic Invertebrates

3.1 Introduction

Benthic invertebrates have been of central importance in biomonitoring studies for many years (Barbour et al. 1999). Advantages of using benthic invertebrates include the following;

- Many have limited migration patterns or a sessile life cycle during their aquatic phase, which means they provide a solid integrated understanding of localized, site-specific conditions.
- Many have a terrestrial winged phase in their life cycle, which means that every year to every few years an entire watershed is recolonized.
- Benthic invertebrates have a complex life cycle that lasts approximately one year or longer, which means the community integrates the effects of transient, short-term, and seasonal variations.
- Most are relatively easy to identify to family and many taxa can be readily identified to genus or even species, which provides an in depth understanding of community structure.
- Benthic invertebrate communities are diverse and are composed of species that included a range of trophic levels, feeding strategies, and pollution tolerances: these provide a comprehensive basis for interpreting community status and environmental effects.
- Sampling protocols are established and field tested and have minimal detrimental effects on stream communities.
- Benthic invertebrates are abundant in most streams, which means that adequate numbers of organisms for a robust analysis can be easily collected.

Due to their sedentary nature, relatively long lifecycles, abundance, and high community diversity, benthic invertebrate communities provide insight into the long-term health of aquatic ecosystems within a small spatial area (i.e., a site).

Benthic invertebrates have been monitored annually in the RMOW study area since 2016 (Palmer and Snowline 2017, 2018, 2019, 2020, and 2021) in four streams: Jordan Creek (JOR-DS-AQ31), Crabapple Creek (CRB-DS-AQ01), River of Golden Dreams (RGD-US-AQ11 and RGD-DS-AQ12), and Twenty-one Mile Creek (21M-DS-AQ21).

3.2 Methods

3.2.1 Benthic Invertebrate Sample Collection

Rapid Bioassessment Protocols (RBP) for streams and wadeable rivers were developed decades ago in response to a need for rapid, cost-effective survey techniques that were nevertheless scientifically valid, easily translatable, and environmentally benign (Barbour et al. 1999). Integral components of an RBP include large, composited samples, coordinated habitat characterization, and either multimetric analyses with performance-based evaluation or development of regional reference conditions for benthic invertebrate communities using multivariate ordination (Barbour et al. 1999).

In Canada, Environment and Climate Change Canada has developed a national RBP called the Canadian Aquatic Biomonitoring Network (CABIN) that provides a standardized sampling protocol and a multivariate Reference Condition Approach (RCA) for assessment of benthic invertebrate communities (Barbour et al. 1999, ECCC 2011). As with other RBPs, CABIN includes collection of a composited sample of benthic invertebrates, coordinated habitat characterization, and assessment of the benthic invertebrate community using the RCA.

The CABIN (ECCC 2011) protocol was performed at five test sites in 2021 (Table 3-1) to collect habitat information and benthic invertebrate samples. Field work was undertaken on July 27, 2021 at Jordan Creek and on July 28, 2021, Twenty-one Mile Creek, Crabapple Creek and the upper and lower reaches of the River of Golden Dreams: these five sites were the same as those used in 2016, 2017, 2018, 2019 and 2020. At each site, a CABIN field sheet was completed, and a benthic invertebrate sample was collected using a kick-net. The CABIN method entails kick-net sampling for benthic invertebrates in the erosional zone (riffle, straight run, or rapid) of a representative watercourse reach. A triangular kick-net sampler with 400-micron mesh and detachable collection cup was employed for each kick-net sample. To collect a sample, one collector walked backward in the upstream direction, tracing a zig-zag pattern, and dragging the net along the bottom. The collector kicked the substrate in front of the net while moving upstream for three minutes. All invertebrates were removed from the net, placed in a clean 500 mL sampling jar, preserved using 70-80% ethanol, and submitted to Cordillera Consulting (Summerland, BC) for enumeration and taxonomic identification to the lowest possible level.

Samples from sites RGD-DS-AQ12 and RGD-US-AQ11 were sieved using the bucket swirling method to remove excess debris from the samples (ECCC 2011). A QA/QC was completed in the field for these samples.

Once the kick-sample was collected, habitat characteristics were recorded at each site including canopy coverage, macrophyte coverage, riparian vegetation, periphyton coverage, substrate composition (pebble count), and slope. Velocity was determined using a Marsh-McBirney at six points along a transect of the stream, according to the CABIN protocol (ECCC 2011). At RGD-DS-AQ12 the Marsh-McBirney was not working properly and the floating chip method was used instead.

Table 3-1. The 2021 Surface Benthic Invertebrate Sampling Locations and Dates.

Site	UTM Location (Zone 10)		Aquatic Site ID	Access (Bridge Crossing)	Data Sampled
	Easting	Northing			
Twenty-one Mile Creek	501910	5552856	21M-DS-AQ21	Lorimer Road	28-Jul-2021
Crabapple Creek	502030	5552670	CRB-DS-AQ01	Lorimer Road	28-Jul-2021
Jordan Creek	500242	5549278	JOR-DS-AQ31	Lake Placid Road	27-Jul-2021
River of Golden Dreams (Upper)	502066	5552829	RGD-US-AQ11	Lorimer Road	28-Jul-2021
River of Golden Dreams (Lower)	503035	5554687	RGD-DS-AQ12	Off Nicklaus North Golf Course	28-Jul-2021

3.2.2 Laboratory Analysis

Cordillera Consulting identified and enumerated organisms to the genus-species level, where possible. Enumeration was undertaken using a Marchant box: cells were extracted and enumerated in the order indicated by a random number table. Sorting and counting continued until the 300th organism was identified. If the 300th organism was found part way into sorting a cell, then the balance of the cell was sorted. If the organism count had not reached 300 by the 50th cell then the entire sample was sorted (Appendix B). Organisms were identified to the lowest practical level using Standard Taxonomic Effort lists compiled by the CABIN manual (McDermott et al. 2014, SAFIT 2015, and PNAMP 2015).

The 2021 benthic invertebrate taxonomic richness was reported as number of families, the standard protocol for CABIN reports that accounts for potential misidentification of invertebrates at lower taxonomic levels (e.g., genus or species level). Organisms were grouped as follows: Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), Diptera (true flies) + non-insects, and Other. The grouping of Diptera + non-insects included true flies, bivalves, molluscs, mites, and worms.

3.2.2.1 Quality Assurance/Quality Control

Cordillera Consulting has over ten years' experience in taxonomic analysis of benthic invertebrates from streams, rivers, and lakes of western Canada. The following QA/QC procedures were followed by Cordillera Consulting:

- Complete, blind re-identification and re-enumeration was completed in-house by a second taxonomist (i.e., not the taxonomist who originally processed the samples)
- Samples for taxonomic quality control were randomly selected and quality control procedures were conducted as the samples progressed through the laboratories.
- The second taxonomist calculated and recorded four types of errors:
  - Misidentification error
  - Enumeration error

- Questionable taxonomic resolution error and
- Insufficient taxonomic resolution error.

The percent total identification error rate was calculated as:

$$(Sum\ of\ incorrect\ identifications \div\ total\ organisms\ counted\ in\ audit) \times 100$$

The average identification error rate of audited samples did not exceed 5%. All samples that exceeded a 5% error rate were re-evaluated to determine whether repeated errors or patterns in error contributed (Appendix B).

3.2.3 Data Analysis

3.2.3.1 CABIN Multivariate Reference Condition Approach and Assessment

The 2021 benthic invertebrate sampling results (habitat and taxonomy data) were entered into the online CABIN database. Data from 2016 to 2021 sampling are stored in the database for ease of access, data security, and to allow CABIN analyses to be performed. The benthic invertebrate data were analysed using the RCA adopted from Environment Canada's CABIN protocols (ECCC 2011; Palmer and Snowline 2017, 2018, 2019). The data for all years were compared with the Fraser Basin Reference Model (2014); a long-standing reference model first developed in 1999 (Rosenberg et al. 1999), updated in 2005 (Sylvestre et al. 2005), and updated again in 2014 (Strachan et al. 2014).

The model assigned each site to one of six reference groups based on habitat variables and the type and proportion of taxa present (Sylvestre et al. 2005).

The multivariate ordination (Appendix B) used in the RCA was developed using Bray-Curtis Index (BCI) data calculated for the RCA as a complete data matrix. For the test sites, the BCI was calculated based on the expected relative abundance of the taxa present for that reference group; these BCI data were then used to locate each site on the ordination.

For the BCI, a value of 0 indicates that a site is identical in community structure to the reference condition and a value of 1 indicates a site is entirely different from the reference condition with no species in common. Within that range, between site variability is considered low if BCI values are less than 0.40 moderate if BCI values are between 0.40 and 0.80, and high if BCI values are greater than 0.80. The latter category is also problematic because the correlation between BCI values and ecological 'distance' becomes sharply non-linear above approximately 0.80 (Beals 1984). Site comparisons with BCI values greater than 0.80 should therefore be interpreted with caution. For the reference sites, the mean BCI values ranged from 0.41 to 0.55 and were therefore considered moderately variable on average (Table 3-2).

The CABIN analysis provided an assessment of whether test sites were in reference condition, mildly divergent from reference condition, or divergent from reference condition. The assessment was further developed through comparison of test sites with reference sites using the River Invertebrate Prediction and Classification System (RIVPACS). The RIVPACS compares the observed taxon richness with the taxon richness predicted from the reference model, reported as an Observed:Expected (O:E) ratio. A ratio less than one indicates fewer taxa than expected and a ratio greater than one indicates more taxa than expected.

From an assessment perspective, it is considered that impairment would result in a loss of taxa richness and therefore O:E ratios less than one. For the CABIN assessment, however, divergence would result from either a high or low O:E ratio.

Table 3-2. Characteristics of the Groups within the Fraser River Basin Model (Strachan et al. 2014)

Parameter	Group			
	1	3	4	5
Number of Reference Sites	64	19*	103	13*
Bray-Curtis Index	0.48 ± 0.15 (31%)	0.41 ± 0.17 (42%)	0.53 ± 0.14 (26%)	0.55 ± 0.22 (40%)
Total Abundance	5011 ± 6542 (131%)	3776 ± 2948 (78%)	2647 ± 2773 (105%)	13707 ± 8626 (63%)
EPT Relative Abundance (%)	79.0 ± 14.8 (19%)	78.2 ± 17.8 (23%)	66.1 ± 26.2 (40%)	49.6 ± 26.3 (53%)
Taxon Richness	16.8 ± 4.7 (28%)	14.8 ± 4.3 (29%)	18.0 ± 4.5 (25%)	16.0 ± 4.0 (25%)
EPT Richness	11.0 ± 2.8 (25%)	9.8 ± 2.6 (27%)	10.8 ± 3.5 (32%)	9.3 ±3.6 (39%)
Five Dominant (%)	83.1 ± 9.3 (11%)	86.1 ± 8.2 (10%)	82.2 ± 8.7 (11%)	86.1 ± 8.4 (10%)
Shannon-Wiener Diversity	1.9 ± 0.4 (21%)	1.8 ± 0.4 (22%)	1.9 ± 0.4 (21%)	1.7 ± 0.4 (24%)

(Coefficient of Variation = Standard Deviation/Mean)

**The minimum recommended number of sites (20) for the RCA is not satisfied for Group 3 or Group 5 (Bowman and Somers 2005).*

3.3 Results

3.3.1 Group Assignment

Based on the habitat and the type and proportion of taxa present at each site, the 2021 samples from the five sites were assigned to one of the six reference groups (Table 3-2). Following analysis of the 2021 samples, Twenty-one Mile Creek (21M-DS-AQ21) was assigned to group 3, Crabapple Creek (CRB-DS-AQ01) and River of Golden Dreams (Upper; RGD-US-AQ11) were assigned to group 5, and River of Golden Dreams (Lower; RGD-DS-AQ12) and Jordan Creek (JOR-DS-AQ31) were assigned to group 4.

Overall confidence in the group assignments, however, was low for the following reasons:

- Only the site in Jordan Creek (JOR-DS-AQ31) was consistently classified through all six years of monitoring, with Crabapple Creek (CRB-DS-AQ01) and River of Golden Dreams (Lower; RGD-DS-AQ12) having been assigned to two different groups, and River of Golden Dreams (Upper; RGD-US-AQ11) and Twenty-one Mile Creek (21M-DS-AQ21) having been assigned to three different groups (Table 3-3).
- The probability of group membership was less than 50% for all but 11 sites over all six years (Table 3-3), with the lowest probability estimated at only 27% (RGD-DS-AQ12, 2016).
- Group 3 and Group 5, which were assigned to 17 of the 30 year/site combinations, are currently defined by less than 20 reference sites (Table 3-2). This is less than recommended for development of a robust understanding of reference condition (Bowman and Somers 2005).

Table 3-3. Fraser Basin 2014 Reference Model Group Assignment (% Probability).

Site	Year	Group	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
# Reference Sites			64	57	19	103	13	46
Twenty-one Mile Creek 21M-DS-AQ21	2016	3	6%	4%	***29%***	29%	21%	12%
	2017	3	10%	5%	***33%***	24%	17%	10%
	2018	5	10%	5%	22%	17%	***39%***	6%
	2019	3	10%	5%	***33%***	24%	17%	10%
	2020	4	0%	0%	*0%*	***56%***	33%	11%
	2021	3	10%	5%	***34%***	24%	17%	10%
Crabapple Creek CRB-DS-AQ01	2016	1	***44%***	27%	0%	19%	9%	2%
	2017	1	***44%***	27%	0%	19%	8%	2%
	2018	1	***44%***	27%	0%	19%	8%	2%
	2019	5	0%	0%	0%	16%	***82%***	1%
	2020	5	0%	0%	0%	10%	***90%***	0%
	2021	5	30%	17%	0%	10%	***42%***	1%
Jordan Creek JOR-DS-AQ31	2016	4	14%	8%	0%	***55%***	2%	20%
	2017	4	18%	10%	0%	***51%***	2%	18%
	2018	4	10%	7%	0%	***57%***	7%	18%
	2019	4	8%	6%	0%	***62%***	3%	21%
	2020	4	0%	0%	0%	***99%***	1%	0%
	2021	4	9%	7%	0%	***58%***	8%	19%
River of Golden Dreams (Upper) RGD-US-AQ11	2016	3	9%	5%	***38%***	22%	17%	10%
	2017	3	8%	4%	***41%***	21%	16%	10%
	2018	5	9%	4%	27%	16%	***38%***	7%
	2019	3	9%	5%	***39%***	22%	17%	10%
	2020	4	0%	0%	0%	***61%***	33%	6%
	2021	5	9%	4%	21%	18%	***41%***	7%
River of Golden Dreams (Lower) RGD-DS-AQ12	2016	4	17%	8%	16%	***27%***	23%	9%
	2017	5	16%	7%	10%	17%	***46%***	5%
	2018	5	12%	4%	5%	8%	***68%***	2%
	2019	5	18%	7%	10%	16%	***44%***	5%
	2020	5	18%	7%	10%	16%	***44%***	5%
	2021	4	17%	9%	13%	***29%***	23%	9%

Note – Bold and underlined values represent the highest percent probability of a site's group assignment for a single year of sampling.

3.3.2 Multivariate Site Assessment

The test site BCI values ranged from 0.36 to 0.94 (Table 3-4). The BCI values for most of the test sites were therefore greater than the highest value of 0.55 for the reference sites (Table 3-2). These data indicate that the benthic invertebrate communities at test sites were moderately dissimilar to reference sites.

Based on the reference and test site BCI values, Twenty-one Mile Creek (21M-DS-AQ21), Crabapple Creek (CRB-DS-AQ01), and River of G_olden Dreams (Upper; RGD-US-AQ11) were assessed as being mildly divergent in 2021. Jordan Creek (JOR-DS-AQ31) and River of Golden Dreams (Lower; RGD-DS-AQ12) were assessed as being in reference condition in 2021 (Table 3-4).

The RIVPACS O:E ratios ranged from 0.47 for Jordan Creek (JOR-DS-AQ31) to 1.22 for River of Golden Dreams (Lower; RGD-DS-AQ12;Table 3-4). The only site with an O:E ratio consistently less than 1.0 for all years was Jordan Creek (JOR-DS-AQ31), where the ratio ranged from 0.47 to 0.95 (Table 3-4). The O:E ratio was less than 1.0 for Crabapple Creek (CRB-DS-AQ01) for four years (2016, 2017, 2019 and 2021), Twenty-one Mile Creek (21M-DS-AQ21) in 2017 and River of Golden Dreams (Upper; RGD-US-AQ11). All other sites and years had O:E ratios greater than 1.0 (Table 3-4).

These data indicate that taxon richness at the test sites was on average comparable to what was expected based on the richness of reference sites. The divergence from reference condition identified through the CABIN multivariate assessment therefore was not primarily based on taxon richness.

Table 3-4. Fraser Basin 2014 Reference Model Classification

Site	Year	Test Site Bray-Curtis Index	Reference Bray-Curtis Index (Mean ± SD)	RIVPACS O:E (p>0.7)	Group (Probability)	CABIN Classification
Twenty-one Mile Creek 21M-DS-AQ21	2016	0.74	0.41 ± 0.17	1.17	3 (29%)	Mildly Divergent
	2017	0.78	0.41 ± 0.17	0.93	3 (33%)	Divergent
	2018	0.87	0.55 ± 0.22	1.20	5 (39%)	Mildly Divergent
	2019	0.75	0.41 ± 0.17	1.16	3 (33%)	Mildly Divergent
	2020	0.36	0.53 ± 0.14	1.20	4 (56%)	Reference
	2021	0.85	0.41 ± 0.17	1.16	3 (34%)	Mildly Divergent
Crabapple Creek CRB-DS-AQ01	2016	0.71	0.48 ± 0.15	0.96	1 (44%)	Mildly Divergent
	2017	0.37	0.48 ± 0.15	0.96	1 (44%)	Reference
	2018	0.43	0.48 ± 0.15	1.15	1 (44%)	Reference
	2019	0.72	0.55 ± 0.22	0.56	5 (82%)	Mildly Divergent
	2020	0.74	0.55 ± 0.22	1.11	5 (90%)	Mildly Divergent
	2021	0.88	0.55 ± 0.22	0.90	5 (42%)	Mildly Divergent
Jordan Creek JOR-DS-AQ31	2016	0.78	0.53 ± 0.14	0.82	4 (55%)	Divergent
	2017	0.76	0.53 ± 0.14	0.82	4 (52%)	Mildly Divergent
	2018	0.73	0.53 ± 0.14	0.95	4 (57%)	Mildly Divergent
	2019	0.57	0.53 ± 0.14	0.82	4 (62%)	Reference
	2020	0.74	0.53 ± 0.14	0.47	4 (99%)	Mildly Divergent
	2021	0.83	0.53 ± 0.14	0.95	4 (58%)	Reference
River of Golden Dreams (Upper) RGD-US-AQ11	2016	0.70	0.41 ± 0.17	1.16	3 (38%)	Mildly Divergent
	2017	0.70	0.41 ± 0.17	1.16	3 (41%)	Mildly Divergent
	2018	0.94	0.55 ± 0.22	1.20	5 (38%)	Divergent
	2019	0.71	0.41 ± 0.17	1.16	3 (39%)	Mildly Divergent
	2020	0.48	0.53 ± 0.14	1.19	4 (61%)	Reference
	2021	0.86	0.55 ± 0.22	0.91	5 (41%)	Mildly Divergent
River of Golden Dreams (Lower) RGD-DS-AQ12	2016	0.57	0.53 ± 0.14	1.18	4 (26%)	Reference
	2017	0.72	0.55 ± 0.22	1.22	5 (46%)	Reference
	2018	0.59	0.55 ± 0.22	1.17	5 (68%)	Reference

	2019	0.39	0.55 ± 0.22	1.21	5 (44%)	Reference
	2020	0.58	0.55 ± 0.22	1.21	5 (44%)	Reference
	2021	0.59	0.53 ± 0.14	1.18	4 (29%)	Reference

4. Certification

This report was prepared and reviewed by the undersigned:

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5. References

Askey, Ethan, Bob Brett, and Linda Dupuis. 2008. A proposed framework for the use of ecological data in monitoring and promoting the conservation of biodiversity in Whistler. Golder Associates Ltd., Squamish, BC. Contract report prepared for the Resort Municipality of Whistler. 36 pp. plus appendices.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. Second Edition. EPA 841-B-99-002. 339pp.

Bowman, M.F., and K.M. Somers. 2005. Considerations when Using the Reference Condition Approach for Bioassessment of Freshwater Ecosystems. Water Qual. Res. J. Canada: 40: 347-360.

BC Ministry of Environment (ENV). 1997. UTM: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/dissolvedoxygen-or.pdf. Accessed January 23, 2020.

Brett, Bob. 2007. Whistler Biodiversity Project -- Progress report and provisional checklists. Whistler Biodiversity Project, Whistler, BC. 101 pp.

Brett, Bob. 2018. Species and Habitat Priorities for Biodiversity Conservation in the Resort Municipality of Whistler. Snowline Ecological Research, Whistler BC, and Palmer Environmental Consulting Group, Vancouver, BC. Contract report prepared for the Resort Municipality of Whistler.

Cascade Environmental Resource Group (Cascade). 2014. RMOW Ecosystem Monitoring Program 2013. Contract report for the Resort Municipality of Whistler, Whistler, BC. 78 pp. plus appendices.

Cascade Environmental Resource Group (Cascade). 2015. RMOW Ecosystem Monitoring Program 2014. Contract report for the Resort Municipality of Whistler, Whistler, BC. 75 pp. plus appendices.

Cascade Environmental Resource Group (Cascade). 2016. RMOW Ecosystem Monitoring Program 2015. Contract report for the Resort Municipality of Whistler, Whistler, BC. 65 pp. plus appendices.

Environment and Climate Change Canada (ECCC). 2011. Canadian aquatic biomonitoring network: wadable streams field manual.

McDermott, H., T. Paull, S. Strachan. 2014. Laboratory Methods: Processing, Taxonomy, and Quality Control of Benthic Macrinvertebrate Samples, Environment Canada. ISBN: 978-1-100-25417-3.

Palmer and Snowline. 2017**.** Whistler Ecosystems Monitoring Program 2016. Palmer Environmental Consulting Group, Vancouver, BC, and Snowline Ecological Research, Whistler, BC. Contract report for the Resort Municipality of Whistler.

Palmer and Snowline. 2018**.** Whistler Ecosystems Monitoring Program 2017. Palmer Environmental Consulting Group, Vancouver, BC, and Snowline Ecological Research, Whistler, BC. Contract report for the Resort Municipality of Whistler.

Palmer and Snowline. 2019**.** Whistler Ecosystems Monitoring Program 2018. Palmer Environmental Consulting Group, Vancouver, BC, and Snowline Ecological Research, Whistler, BC. Contract report for the Resort Municipality of Whistler.

Palmer and Snowline. 2020**.** Whistler Ecosystems Monitoring Program 2019. Palmer Environmental Consulting Group, Vancouver, BC, and Snowline Ecological Research, Whistler, BC. Contract report for the Resort Municipality of Whistler.

Palmer and Snowline. 2021**.** Whistler Ecosystems Monitoring Program 2020. Palmer Environmental Consulting Group, Vancouver, BC, and Snowline Ecological Research, Whistler, BC. Contract report for the Resort Municipality of Whistler.

PNAMP. 2015. Pacific Northwest Aquatic Monitoring Partnership. www.pnamp.org

Rosenberg, D.M., T.B. Reynoldson, and V.H. Resh. 1999. Establishing Reference Conditions for Benthic Invertebrate Monitoring in the Fraser River Catchment, British Columbia, Canada. DOE-FRAP-1998-32. 169pp.

SAFIT. Southwest Association of Freshwater Invertebrate Taxonomists. www.safit.org.

Strachan, S., M. Edwards, T. Reynoldson, J. Bailey. 2014. Reference Model Supporting Documentation for CABIN Analytical Tools. Fraser Basin 2014 Model. 14 pp.

Sylvestre, Stephanie, Monique Fluegel and Taina Tuominen. 2005. Benthic invertebrate assessment of streams in the Georgia Basin using the reference condition approach: Expansions of the Fraser River invertebrate monitoring program 1998-2002. Environment Canada, Vancouver BC. EC/GB/o4/81.

Appendix A

Stream Temperature Data

Site	Year	Month	Average Monthly Temperature (°C)	Minimum Average Monthly Temperature (°C)	Maximum Average Monthly Temperature (°C)
Crabapple Creek	2021	Jan	1.8	1.5	2.2
		Feb	0.7	0.4	0.9
		Mar	2.7	2.0	3.5
		Apr	4.1	2.8	5.6
		May	6.0	4.5	7.5
		Jun	10.6	9.3	12.1
		Jul	14.7	13.6	15.8
Jordan Creek	2021	Jan	3.9	3.7	4.1
		Feb	1.6	1.5	1.7
		Mar	3.0	2.9	3.2
		Apr	5.4	5.2	5.8
		May	7.7	7.4	8.2
		Jun	9.4	8.9	10.0
		Jul	16.3	16.0	16.7
River of Golden Dreams	2021	Jan	1.5	1.2	1.8
		Feb	1.0	0.7	1.4
		Mar	2.5	1.9	3.4
		Apr	4.3	3.3	5.7
		May	4.6	3.6	5.9
		Jun	5.5	4.5	7.1
		Jul	12.2	11.0	13.6
Twenty-One Mile Creek	2021	Jan	1.8	1.5	2.1
		Feb	1.7	1.6	1.8
		Mar	3.4	3.0	4.2
		Apr	4.3	3.6	5.8
		May	4.4	3.4	5.6
		Jun	5.7	4.3	7.6
		Jul	12.4	11.1	14.1

Appendix B

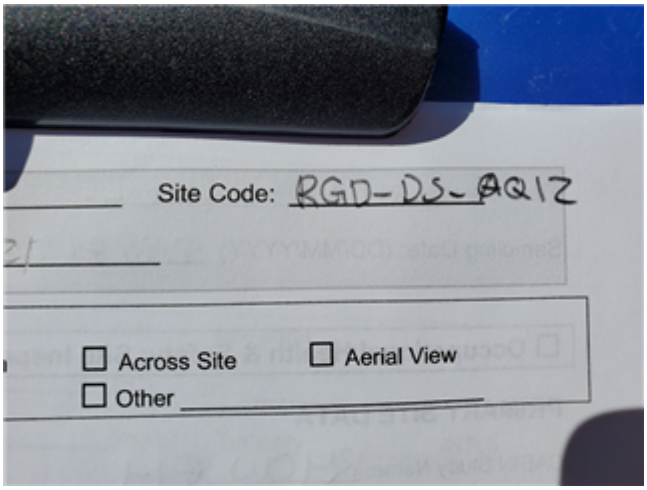
Benthic Invertebrate Taxonomy Results and CABIN Outputs

Site Description

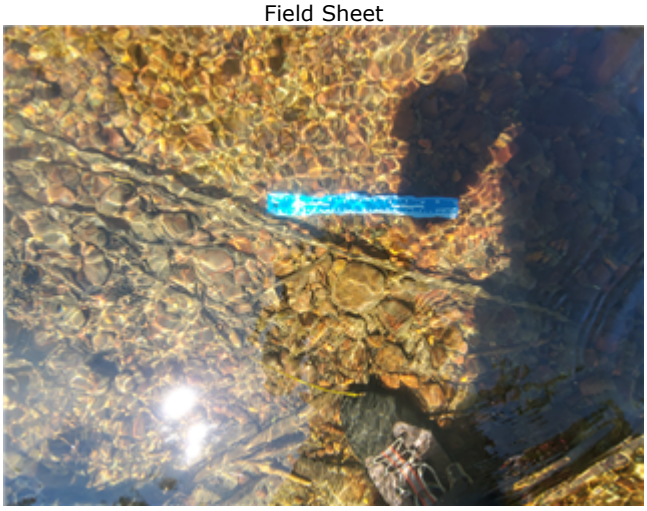
Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	RGD-DS-AQ12
Sampling Date	Jul 28 2021
Know Your Watershed Basin	Harrison
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.14430 N, 122.95760 W
Altitude	632
Local Basin Name	River of Golden Dreams
	River of Golden Dreams
Stream Order	3

Across Reach

Down Stream



Field Sheet



Substrate

Up Stream

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River 2014
Analysis Date	October 23, 2021
Taxonomic Level	Family

Cabin Assessment Results

Predictive Model Variables	Dominant-1st Natl-SnowIce Natl-Water Natl-WetlandHerb Precip02_FEB Reach-Riffles Sedimentary Slope SlopeAvg stream order Temp07_Julmax Width-Bankfull

Reference Groups	**1**	**2**	**3**	**4**	**5**	**6**
Number of Reference Sites	64	57	19	103	13	46
Group Error Rate	46.4%	41.9%	26.3%	44.4%	38.5%	54.9%
Overall Model Error Rate	44.7%					
Probability of Group Membership	16.8%	8.6%	12.5%	29.4%	23.4%	9.2%
CABIN Assessment of RGD-DS-AQ12 on Jul 28, 2021	Similar to Reference					

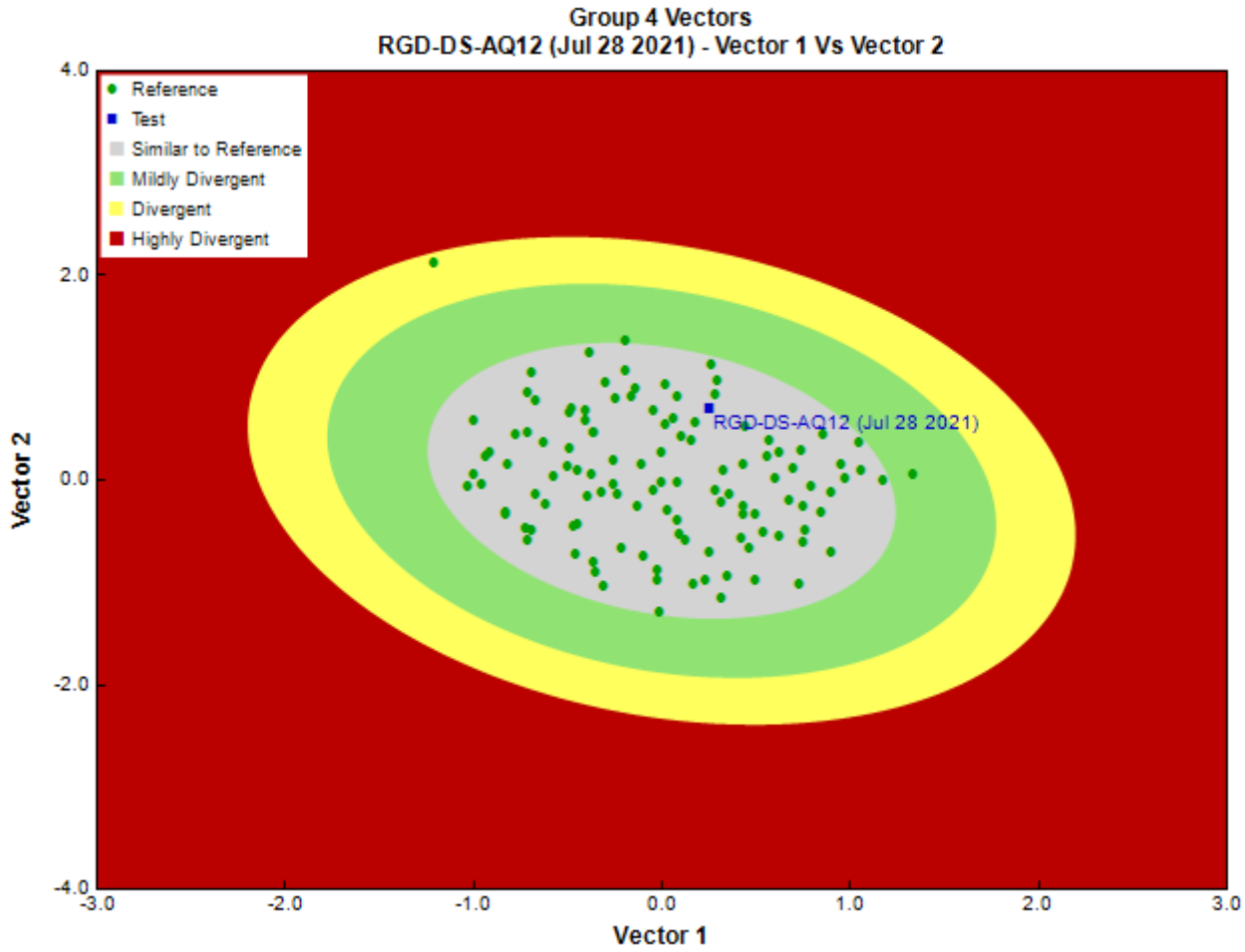


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3

Sample Information

Taxonomist	-
	-
Sub-Sample Proportion	13/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Annelida	Clitellata	Hirudinida	Glossiphoniidae	1	7.7
		Tubificida	Naididae	9	69.2
Arthropoda	Arachnida	Sarcoptiformes	Hydrozetidae	1	7.7
		Trombidiformes	Hygrobatidae	6	46.2
			Lebertiidae	9	69.2
			Sperchontidae	4	30.8
			Torrenticolidae	1	7.7
	Insecta	Coleoptera	Dytiscidae	9	69.2
		Diptera	Chironomidae	113	869.4
			Empididae	2	15.4
			Simuliidae	14	107.7
			Tipulidae	1	7.7
		Ephemeroptera	Ameletidae	9	69.2
			Baetidae	81	623.1
			Ephemerellidae	30	230.8
			Heptageniidae	21	161.5
			Leptophlebiidae	1	7.7
		Plecoptera	Chloroperlidae	16	123.0
			Nemouridae	4	30.8
			Perlidae	3	23.1
			Perlodidae	7	53.8
		Trichoptera	Brachycentridae	1	7.7
			Glossosomatidae	1	7.7
			Limnephilidae	4	30.8
			Rhyacophilidae	2	15.4
Mollusca	Bivalvia	Veneroida	Pisidiidae	1	7.7
	Gastropoda			1	7.7
		Basommatophora	Planorbidae	1	7.7
			Total	353	2,715.6

Metrics

Name	RGD-DS-AQ12	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.59	0.5 ± 0.1
Functional Measures		
% Filterers	--	15.8 ± 40.6
% Gatherers	54.4	57.0 ± 25.0
% Predatores	49.0	29.8 ± 19.3
% Scrapers	34.6	38.5 ± 21.1
% Shredder	2.8	16.3 ± 10.6
No. Clinger Taxa	19.0	16.3 ± 6.3
Number Of Individuals		
% Diptera + Non-insects	46.3	31.3 ± 24.0
% EPT Individuals	51.1	67.4 ± 24.2
% of 5 dominant taxa	74.1	81.5 ± 8.9
No. EPT individuals/Chironomids+EPT Individuals	0.6	0.7 ± 0.2
Total Abundance	2715.4	2836.6 ± 2567.0
Richness		
Chironomidae taxa (genus level only)	1.0	1.0 ± 0.1
Coleoptera taxa	1.0	0.3 ± 0.5
Diptera taxa	4.0	3.4 ± 1.4
Ephemeroptera taxa	5.0	3.6 ± 1.0
EPT Individuals (Sum)	1384.6	1741.0 ± 1398.9
EPT taxa (no)	13.0	11.1 ± 3.4
Odonata taxa	--	0.0 ± 0.0
Pielou's Evenness	0.7	0.7 ± 0.1

Metrics

Name	RGD-DS-AQ12	Predicted Group Reference Mean ±SD
Plecoptera taxa	4.0	4.3 ± 1.7
Shannon-Wiener Diversity	2.3	1.9 ± 0.4
Simpson's Diversity	0.8	0.8 ± 0.1
Simpson's Evenness	0.2	0.3 ± 0.1
Total No. of Taxa	27.0	18.2 ± 4.5
Trichoptera taxa	4.0	3.2 ± 1.6

Frequency and Probability of Taxa Occurrence

Reference Model Taxa	Frequency of Occurrence in Reference Sites						Probability Of Occurrence at RGD-DS-AQ12
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	6.60
RIVPACS : Observed taxa P>0.50	8.00
RIVPACS : O:E (p > 0.5)	1.21
RIVPACS : Expected taxa P>0.70	4.24
RIVPACS : Observed taxa P>0.70	5.00
RIVPACS : O:E (p > 0.7)	1.18

Habitat Description

Variable	RGD-DS-AQ12	Predicted Group Reference Mean ±SD
Bedrock Geology		
Sedimentary (%)	2.17000	28.74839 ± 35.48825
Channel		
Depth-Avg (cm)	51.5	28.2 ± 14.0
Depth-BankfullMinusWetted (cm)	48.00	60.67 ± 44.73
Depth-Max (cm)	67.0	41.6 ± 22.3
Macrophyte (PercentRange)	1	0 ± 0
Reach-%CanopyCoverage (PercentRange)	1.00	0.92 ± 1.11
Reach-DomStreamsideVeg (Category(1-4))	2	3 ± 1
Reach-Pools (Binary)	0	0 ± 0
Reach-Rapids (Binary)	0	0 ± 0
Reach-Riffles (Binary)	1	1 ± 0
Reach-StraightRun (Binary)	1	1 ± 0
Slope (m/m)	0.0100000	0.0249850 ± 0.0294369
Veg-Coniferous (Binary)	0	1 ± 0
Veg-Deciduous (Binary)	1	1 ± 0
Veg-GrassesFerns (Binary)	1	0 ± 1
Veg-Shrubs (Binary)	1	1 ± 0
Velocity-Avg (m/s)	0.23	0.45 ± 0.19
Velocity-Max (m/s)	0.50	0.68 ± 0.25
Width-Bankfull (m)	9.0	36.0 ± 41.7
Width-Wetted (m)	8.7	17.8 ± 20.1
XSEC-VelInstrumentDirect (Category(1-3))	3	1 ± 0
XSEC-VelMethod (Category(1-3))	3	3 ± 0
Climate		
Precip02_FEB (mm)	156.00000	94.95103 ± 61.64910
Temp07_JULmax (Degrees Celsius)	18.66000	17.48320 ± 2.57900
Landcover		
Natl-SnowIce (%)	22.06000	4.62982 ± 9.77010
Natl-Water (%)	2.36000	1.55060 ± 2.36345
Natl-WetlandHerb (%)	0.00000	0.18446 ± 0.50703
Substrate Data		
%Bedrock (%)	0	0 ± 1
%Boulder (%)	0	11 ± 11
%Cobble (%)	7	53 ± 11
%Gravel (%)	5	5 ± 4

Habitat Description

Variable	RGD-DS-AQ12	Predicted Group Reference Mean ±SD
%Pebble (%)	87	30 ± 12
%Sand (%)	0	0 ± 0
%Silt+Clay (%)	1	1 ± 3
D50 (cm)	4.00	8.04 ± 4.60
Dg (cm)	3.3	8.2 ± 3.1
Dominant-1st (Category(0-9))	5	6 ± 1
Dominant-2nd (Category(0-9))	4	6 ± 1
Embeddedness (Category(1-5))	3	4 ± 1
PeriphytonCoverage (Category(1-5))	2	2 ± 1
SurroundingMaterial (Category(0-9))	1	3 ± 1
Topography		
SlopeAvg (%)	36.72000	31.09165 ± 12.51836
Water Chemistry		
General-DO (mg/L)	11.5100000	11.4180702 ± 1.2821697
General-pH (pH)	7.3	7.7 ± 0.7
General-SpCond (µS/cm)	73.8000000	105.8321429 ± 89.5097928
General-TempAir (Degrees Celsius)	31.0	12.1 ± 4.3
General-TempWater (Degrees Celsius)	16.6000000	7.6535897 ± 3.4680513

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	RGD-AQ11
Sampling Date	Jul 28 2021
Know Your Watershed Basin	Harrison
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.12711 N, 122.97198 W
Altitude	651
Local Basin Name	River of Golden Dreams
	River of Golden Dreams
Stream Order	3

Across Reach

Down Stream

Up Stream

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River 2014
Analysis Date	October 23, 2021
Taxonomic Level	Family
Predictive Model Variables	Dominant-1st Natl-SnowIce Natl-Water Natl-WetlandHerb Precip02_FEB Reach-Riffles Sedimentary Slope SlopeAvg stream order Temp07_Julmax Width-Bankfull

Reference Groups	1	2	3	4	5	6
Number of Reference Sites	64	57	19	103	13	46
Group Error Rate	46.4%	41.9%	26.3%	44.4%	38.5%	54.9%
Overall Model Error Rate	44.7%					
Probability of Group Membership	8.7%	4.4%	21.3%	18.1%	40.7%	6.7%
CABIN Assessment of RGD-AQ11 on Jul 28, 2021	Mildly Divergent					

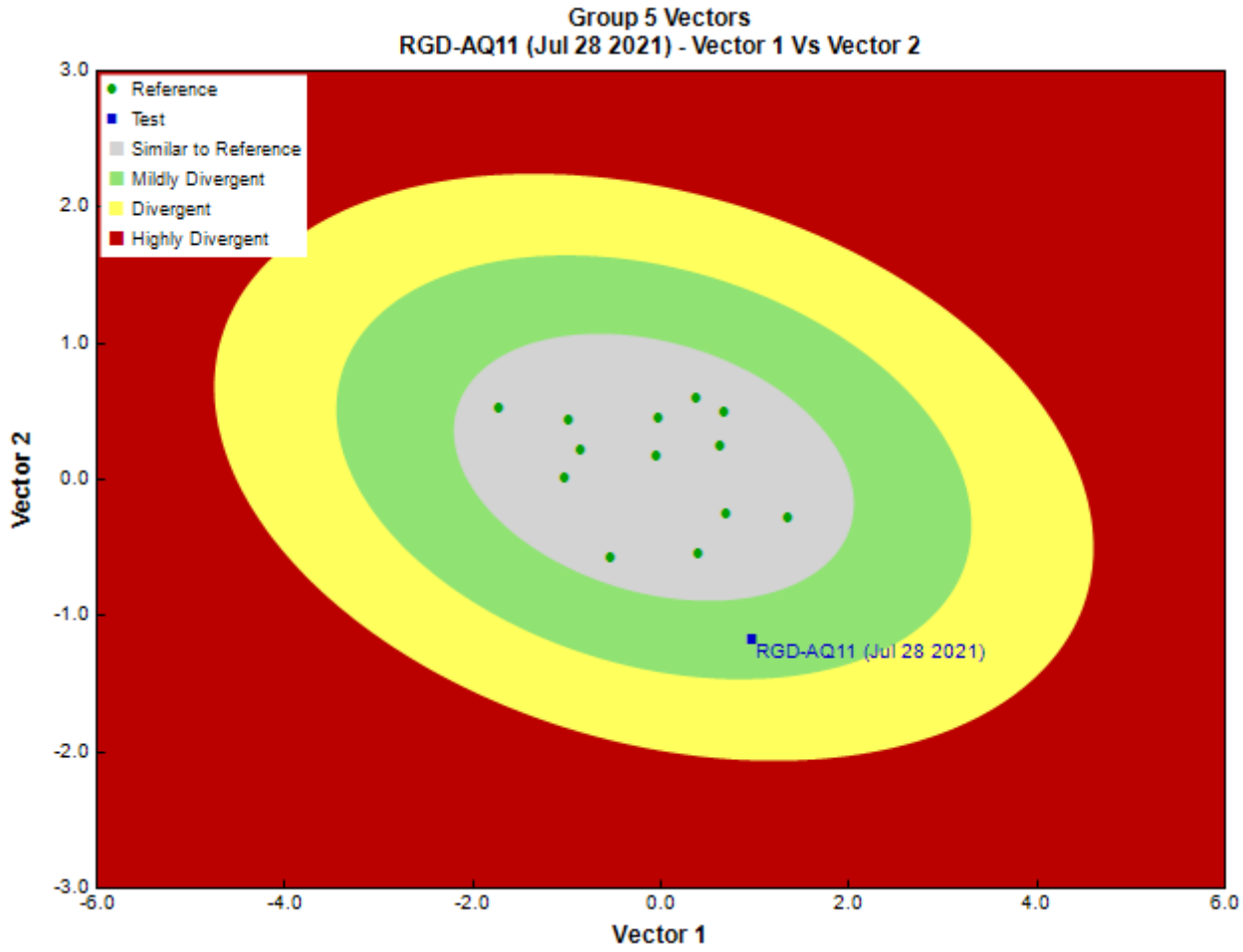


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	-
	-
Sub-Sample Proportion	25/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Annelida	Clitellata	Tubificida	Naididae	4	16.0
Arthropoda	Arachnida	Trombidiformes	Hygrobatidae	8	32.0
			Lebertiidae	5	20.0
			Sperchontidae	16	64.0
	Insecta	Diptera	Chironomidae	34	136.0
			Simuliidae	28	112.0
			Tipulidae	3	12.0
		Ephemeroptera	Ameletidae	45	180.0
			Baetidae	26	104.0
			Heptageniidae	104	416.0
			Leptophlebiidae	10	40.0
		Plecoptera	Capniidae	8	32.0
			Chloroperlidae	24	96.0
			Nemouridae	2	8.0
			Perlidae	11	44.0
			Perlodidae	8	32.0

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
		Trichoptera	Limnephilidae	3	12.0
			Rhyacophilidae	2	8.0
	Malacostraca	Amphipoda		4	16.0
			Crangonyctidae	1	4.0
Mollusca	Bivalvia	Veneroida	Pisidiidae	1	4.0
			Total	347	1,388.0

Metrics

Name	RGD-AQ11	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.86	0.6 ± 0.2
Functional Measures		
% Filterers	--	10.4 ± 10.4
% Gatherers	38.0	60.8 ± 29.3
% Predatores	32.3	35.7 ± 20.2
% Scrapers	46.4	40.3 ± 21.7
% Shredder	4.6	15.6 ± 11.0
No. Clinger Taxa	19.0	14.1 ± 5.8
Number Of Individuals		
% Diptera + Non-insects	29.2	39.6 ± 26.5
% EPT Individuals	70.8	57.4 ± 26.6
% of 5 dominant taxa	69.1	85.5 ± 8.0
No. EPT individuals/Chironomids+EPT Individuals	0.9	0.6 ± 0.3
Total Abundance	1388.0	12156.4 ± 8116.1
Richness		
Chironomidae taxa (genus level only)	1.0	1.0 ± 0.0
Coleoptera taxa	0.0	0.6 ± 0.5
Diptera taxa	3.0	2.9 ± 1.3
Ephemeroptera taxa	4.0	3.5 ± 1.1
EPT Individuals (Sum)	972.0	7124.9 ± 5870.5
EPT taxa (no)	11.0	9.7 ± 3.4
Odonata taxa	--	0.0 ± 0.0
Pielou's Evenness	0.8	0.6 ± 0.1
Plecoptera taxa	5.0	3.6 ± 1.7
Shannon-Wiener Diversity	2.4	1.8 ± 0.4
Simpson's Diversity	0.9	0.7 ± 0.1
Simpson's Evenness	0.4	0.3 ± 0.1
Total No. of Taxa	20.0	16.3 ± 3.9
Trichoptera taxa	2.0	2.7 ± 1.6

Frequency and Probability of Taxa Occurrence

Reference Model Taxa	Frequency of Occurrence in Reference Sites						Probability Of Occurrence at RGD-AQ11
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	5.03
RIVPACS : Observed taxa P>0.50	6.00
RIVPACS : O:E (p > 0.5)	1.19
RIVPACS : Expected taxa P>0.70	3.31
RIVPACS : Observed taxa P>0.70	3.00
RIVPACS : O:E (p > 0.7)	0.91

Habitat Description

Variable	RGD-AQ11	Predicted Group Reference Mean ±SD
Bedrock Geology		
Sedimentary (%)	2.56000	15.90266 ± 33.91726
Channel		

Habitat Description

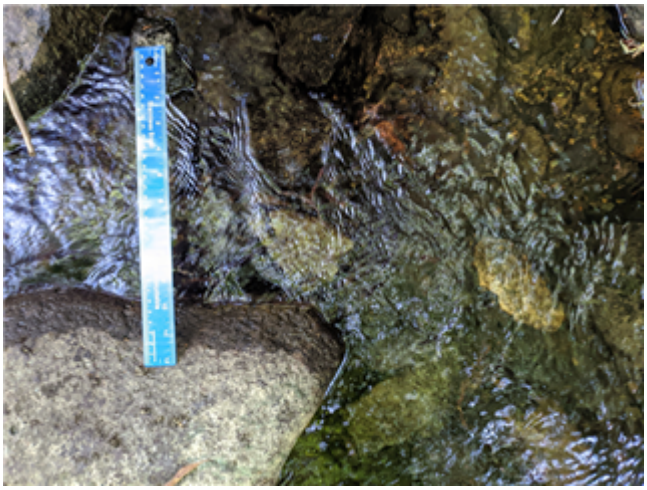
Variable	RGD-AQ11	Predicted Group Reference Mean ±SD
Depth-Avg (cm)	17.2	40.5 ± 22.4
Depth-BankfullMinusWetted (cm)	1.00	188.00
Depth-Max (cm)	35.0	55.5 ± 31.7
Macrophyte (PercentRange)	0	1 ± 2
Reach-%CanopyCoverage (PercentRange)	1.00	0.23 ± 0.44
Reach-DomStreamsideVeg (Category(1-4))	3	2
Reach-Pools (Binary)	1	0 ± 0
Reach-Rapids (Binary)	0	0 ± 0
Reach-Riffles (Binary)	1	0 ± 0
Reach-StraightRun (Binary)	1	1 ± 0
Slope (m/m)	0.0150000	0.0047331 ± 0.0082050
Veg-Coniferous (Binary)	1	0 ± 1
Veg-Deciduous (Binary)	1	0 ± 1
Veg-GrassesFerns (Binary)	1	1 ± 0
Veg-Shrubs (Binary)	1	1 ± 0
Velocity-Avg (m/s)	0.23	0.23 ± 0.24
Velocity-Max (m/s)	0.52	0.31 ± 0.35
Width-Bankfull (m)	11.9	75.1 ± 72.8
Width-Wetted (m)	11.2	50.6 ± 60.4
XSEC-VelInstrumentDirect (Category(1-3))	1	2
XSEC-VelMethod (Category(1-3))	3	3
Climate		
Precip02_FEB (mm)	155.11000	171.50745 ± 107.47690
Temp07_JULmax (Degrees Celsius)	18.25000	20.34230 ± 2.49485
Landcover		
Natl-SnowIce (%)	26.42000	3.62533 ± 10.17162
Natl-Water (%)	2.82000	1.80201 ± 1.29922
Natl-WetlandHerb (%)	0.00000	0.68488 ± 0.92347
Substrate Data		
%Bedrock (%)	0	0
%Boulder (%)	0	0
%Cobble (%)	12	58
%Gravel (%)	7	1
%Pebble (%)	81	41
%Sand (%)	0	0
%Silt+Clay (%)	0	0
D50 (cm)	4.00	3.30
Dg (cm)	3.4	6.6
Dominant-1st (Category(0-9))	4	4 ± 2
Dominant-2nd (Category(0-9))	5	4 ± 2
Embeddedness (Category(1-5))	4	4 ± 1
PeriphytonCoverage (Category(1-5))	1	3
SurroundingMaterial (Category(0-9))	2	2 ± 1
Topography		
SlopeAvg (%)	39.43000	30.12236 ± 18.75100
Water Chemistry		
General-DO (mg/L)	10.5600000	9.3400000 ± 2.0171679
General-pH (pH)	7.1	6.8 ± 1.0
General-SpCond (µS/cm)	45.8000000	176.1000000
General-TempAir (Degrees Celsius)	24.5	0.0 ± 0.0
General-TempWater (Degrees Celsius)	13.1100000	13.2730769 ± 4.7663725

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	JOR-DS-AQ31
Sampling Date	Jul 27 2021
Know Your Watershed Basin	Strait of Georgia - East Shore
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.09550 N, 122.99729 W
Altitude	623
Local Basin Name	Jordan Creek
	Jordan Creek
Stream Order	2

Across Reach

Down Stream



Substrate

Up Stream

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River 2014
Analysis Date	October 23, 2021
Taxonomic Level	Family
Predictive Model Variables	Dominant-1st Natl-SnowIce Natl-Water Natl-WetlandHerb Precip02_FEB Reach-Riffles Sedimentary Slope SlopeAvg stream order Temp07_Julmax Width-Bankfull

Reference Groups	**1**	**2**	**3**	**4**	**5**	**6**
Number of Reference Sites	64	57	19	103	13	46
Group Error Rate	46.4%	41.9%	26.3%	44.4%	38.5%	54.9%
Overall Model Error Rate	44.7%					
Probability of Group Membership	8.8%	7.0%	0.1%	58.0%	7.6%	18.5%
CABIN Assessment of JOR-DS-AQ31 on Jul 27, 2021	Similar to Reference					

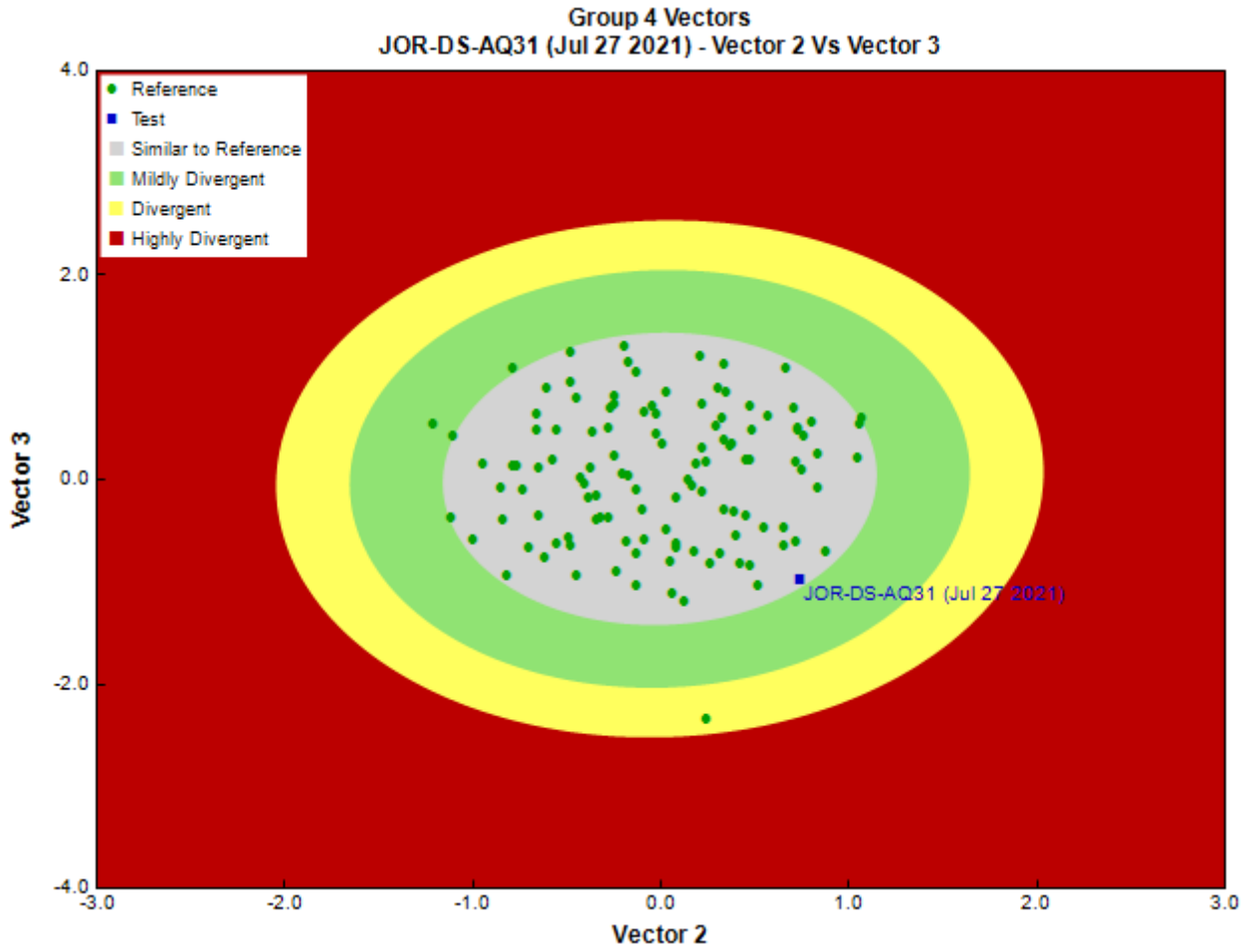


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	-
	-
Sub-Sample Proportion	6/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes		1	16.7
			Sperchontidae	2	33.3
			Torrenticolidae	3	50.0
	Branchiopoda			1	16.7
	Insecta	Diptera	Chironomidae	63	1,050.1
			Empididae	2	33.4
			Simuliidae	56	933.3
		Ephemeroptera	Baetidae	123	2,050.0
			Ephemerellidae	6	100.0
			Leptophlebiidae	43	716.7
		Lepidoptera		1	16.7
		Plecoptera		2	33.3
			Chloroperlidae	5	83.3
			Nemouridae	25	416.7
			Perlidae	3	50.0
		Trichoptera		1	16.7

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
			Hydropsychidae	4	66.7
			Lepidostomatidae	1	16.7
			Rhyacophilidae	1	16.7
Mollusca	Bivalvia	Veneroida	Pisidiidae	8	133.3
			Total	351	5,850.3

Metrics

Name	JOR-DS-AQ31	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.83	0.5 ± 0.1
Functional Measures		
% Filterers	--	15.8 ± 40.6
% Gatherers	58.4	57.0 ± 25.0
% Predatores	38.2	29.8 ± 19.3
% Scrapers	52.1	38.5 ± 21.1
% Shredder	7.4	16.3 ± 10.6
No. Clinger Taxa	13.0	16.3 ± 6.3
Number Of Individuals		
% Diptera + Non-insects	38.8	31.3 ± 24.0
% EPT Individuals	61.2	67.4 ± 24.2
% of 5 dominant taxa	89.9	81.5 ± 8.9
No. EPT individuals/Chironomids+EPT Individuals	0.8	0.7 ± 0.2
Total Abundance	5850.0	2836.6 ± 2567.0
Richness		
Chironomidae taxa (genus level only)	1.0	1.0 ± 0.1
Coleoptera taxa	0.0	0.3 ± 0.5
Diptera taxa	3.0	3.4 ± 1.4
Ephemeroptera taxa	3.0	3.6 ± 1.0
EPT Individuals (Sum)	3516.7	1741.0 ± 1398.9
EPT taxa (no)	9.0	11.1 ± 3.4
Odonata taxa	--	0.0 ± 0.0
Pielou's Evenness	0.7	0.7 ± 0.1
Plecoptera taxa	3.0	4.3 ± 1.7
Shannon-Wiener Diversity	1.9	1.9 ± 0.4
Simpson's Diversity	0.8	0.8 ± 0.1
Simpson's Evenness	0.3	0.3 ± 0.1
Total No. of Taxa	15.0	18.2 ± 4.5
Trichoptera taxa	3.0	3.2 ± 1.6

Frequency and Probability of Taxa Occurrence

Reference Model Taxa	Frequency of Occurrence in Reference Sites						Probability Of Occurrence at JOR-DS-AQ31
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	9.47
RIVPACS : Observed taxa P>0.50	8.00
RIVPACS : O:E (p > 0.5)	0.84
RIVPACS : Expected taxa P>0.70	5.27
RIVPACS : Observed taxa P>0.70	5.00
RIVPACS : O:E (p > 0.7)	0.95

Habitat Description

Variable	JOR-DS-AQ31	Predicted Group Reference Mean ±SD
Bedrock Geology		
Sedimentary (%)	60.51000	28.74839 ± 35.48825
Channel		
Depth-Avg (cm)	22.8	28.2 ± 14.0

Habitat Description

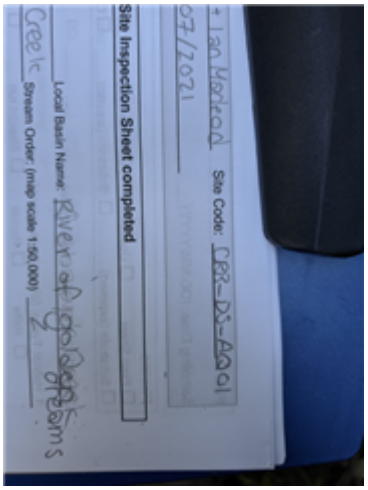
Variable	JOR-DS-AQ31	Predicted Group Reference Mean ±SD
Depth-BankfullMinusWetted (cm)	19.00	60.67 ± 44.73
Depth-Max (cm)	30.0	41.6 ± 22.3
Macrophyte (PercentRange)	0	0 ± 0
Reach-%CanopyCoverage (PercentRange)	4.00	0.92 ± 1.11
Reach-DomStreamsideVeg (Category(1-4))	3	3 ± 1
Reach-Pools (Binary)	1	0 ± 0
Reach-Rapids (Binary)	0	0 ± 0
Reach-Riffles (Binary)	1	1 ± 0
Reach-StraightRun (Binary)	1	1 ± 0
Slope (m/m)	0.0500000	0.0249850 ± 0.0294369
Veg-Coniferous (Binary)	1	1 ± 0
Veg-Deciduous (Binary)	1	1 ± 0
Veg-GrassesFerns (Binary)	1	0 ± 1
Veg-Shrubs (Binary)	1	1 ± 0
Velocity-Avg (m/s)	0.16	0.45 ± 0.19
Velocity-Max (m/s)	0.23	0.68 ± 0.25
Width-Bankfull (m)	5.7	36.0 ± 41.7
Width-Wetted (m)	4.7	17.8 ± 20.1
XSEC-VelInstrumentDirect (Category(1-3))	1	1 ± 0
XSEC-VelMethod (Category(1-3))	3	3 ± 0
Climate		
Precip02_FEB (mm)	163.27000	94.95103 ± 61.64910
Temp07_JULmax (Degrees Celsius)	18.72000	17.48320 ± 2.57900
Landcover		
Natl-SnowIce (%)	3.08000	4.62982 ± 9.77010
Natl-Water (%)	1.45000	1.55060 ± 2.36345
Natl-WetlandHerb (%)	0.00000	0.18446 ± 0.50703
Substrate Data		
%Bedrock (%)	0	0 ± 1
%Boulder (%)	2	11 ± 11
%Cobble (%)	40	53 ± 11
%Gravel (%)	8	5 ± 4
%Pebble (%)	45	30 ± 12
%Sand (%)	0	0 ± 0
%Silt+Clay (%)	4	1 ± 3
D50 (cm)	5.00	8.04 ± 4.60
Dg (cm)	4.3	8.2 ± 3.1
Dominant-1st (Category(0-9))	6	6 ± 1
Dominant-2nd (Category(0-9))	4	6 ± 1
Embeddedness (Category(1-5))	4	4 ± 1
PeriphytonCoverage (Category(1-5))	3	2 ± 1
SurroundingMaterial (Category(0-9))	4	3 ± 1
Topography		
SlopeAvg (%)	40.36000	31.09165 ± 12.51836
Water Chemistry		
General-DO (mg/L)	9.1600000	11.4180702 ± 1.2821697
General-pH (pH)	7.2	7.7 ± 0.7
General-SpCond (µS/cm)	55.2000000	105.8321429 ± 89.5097928
General-TempAir (Degrees Celsius)	28.5	12.1 ± 4.3
General-TempWater (Degrees Celsius)	18.3000000	7.6535897 ± 3.4680513

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	CRB-DS-AQ01
Sampling Date	Jul 28 2021
Know Your Watershed Basin	Harrison
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.12654 N, 122.97168 W
Altitude	639
Local Basin Name	Crabapple Creek
	River of Golden Dreams
Stream Order	2

Across Reach

Down Stream



Field Sheet

Substrate

Up Stream

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River 2014
Analysis Date	October 23, 2021
Taxonomic Level	Family

Cabin Assessment Results

Predictive Model Variables	Dominant-1st Natl-SnowIce Natl-Water Natl-WetlandHerb Precip02_FEB Reach-Riffles Sedimentary Slope SlopeAvg stream order Temp07_Julmax Width-Bankfull

Reference Groups	**1**	**2**	**3**	**4**	**5**	**6**
Number of Reference Sites	64	57	19	103	13	46
Group Error Rate	46.4%	41.9%	26.3%	44.4%	38.5%	54.9%
Overall Model Error Rate	44.7%					
Probability of Group Membership	30.3%	16.9%	0.0%	9.6%	42.3%	0.9%
CABIN Assessment of CRB-DS-AQ01 on Jul 28, 2021	Mildly Divergent					

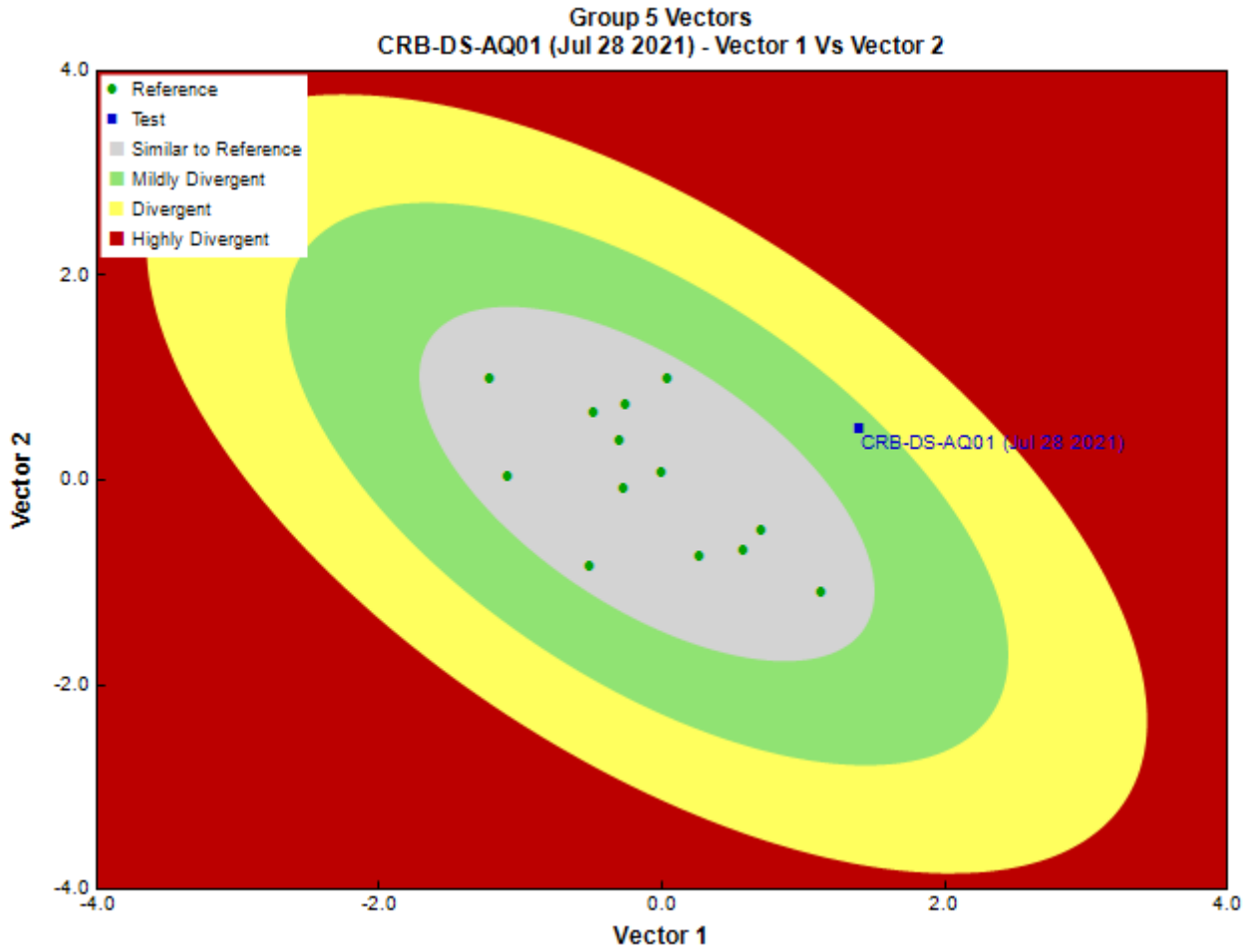


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3

Sample Information

Taxonomist	-
	-
Sub-Sample Proportion	5/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Annelida	Clitellata	Tubificida	Naididae	2	40.0
Arthropoda	Arachnida	Trombidiformes	Aturidae	2	40.0
			Hydryphantidae	2	40.0
			Hygrobatidae	2	40.0
			Lebertiidae	3	60.0
			Sperchontidae	1	20.0
			Torrenticolidae	1	20.0
	Insecta	Diptera	Chironomidae	104	2,080.0
			Empididae	7	140.0
			Simuliidae	14	280.0
			Tipulidae	10	200.0
		Ephemeroptera	Baetidae	143	2,860.0
			Ephemerellidae	1	20.0
			Leptophlebiidae	94	1,880.0
		Plecoptera	Chloroperlidae	17	340.0
			Nemouridae	118	2,360.0
		Trichoptera		1	20.0
			Rhyacophilidae	7	140.0
			Total	529	10,580.0

Metrics

Name	CRB-DS-AQ01	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.88	0.6 ± 0.2
Functional Measures		
% Filterers	--	10.4 ± 10.4
% Gatherers	65.2	60.8 ± 29.3
% Predatores	27.0	35.7 ± 20.2
% Scrapers	29.7	40.3 ± 21.7
% Shredder	24.2	15.6 ± 11.0
No. Clinger Taxa	12.0	14.1 ± 5.8
Number Of Individuals		
% Diptera + Non-insects	28.0	39.6 ± 26.5
% EPT Individuals	72.0	57.4 ± 26.6
% of 5 dominant taxa	90.2	85.5 ± 8.0
No. EPT individuals/Chironomids+EPT Individuals	0.8	0.6 ± 0.3
Total Abundance	10580.0	12156.4 ± 8116.1
Richness		
Chironomidae taxa (genus level only)	1.0	1.0 ± 0.0
Coleoptera taxa	0.0	0.6 ± 0.5
Diptera taxa	4.0	2.9 ± 1.3
Ephemeroptera taxa	3.0	3.5 ± 1.1
EPT Individuals (Sum)	7600.0	7124.9 ± 5870.5
EPT taxa (no)	6.0	9.7 ± 3.4
Odonata taxa	--	0.0 ± 0.0
Pielou's Evenness	0.7	0.6 ± 0.1
Plecoptera taxa	2.0	3.6 ± 1.7
Shannon-Wiener Diversity	1.9	1.8 ± 0.4
Simpson's Diversity	0.8	0.7 ± 0.1
Simpson's Evenness	0.3	0.3 ± 0.1
Total No. of Taxa	17.0	16.3 ± 3.9
Trichoptera taxa	1.0	2.7 ± 1.6

Frequency and Probability of Taxa Occurrence

Reference Model Taxa	Frequency of Occurrence in Reference Sites						Probability Of Occurrence at CRB-DS-AQ01
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	6.62
RIVPACS : Observed taxa P>0.50	7.00
RIVPACS : O:E (p > 0.5)	1.06
RIVPACS : Expected taxa P>0.70	3.34
RIVPACS : Observed taxa P>0.70	3.00
RIVPACS : O:E (p > 0.7)	0.90

Habitat Description

Variable	CRB-DS-AQ01	Predicted Group Reference Mean ±SD
Bedrock Geology		
Sedimentary (%)	0.33000	15.90266 ± 33.91726
Channel		
Depth-Avg (cm)	22.0	40.5 ± 22.4
Depth-BankfullMinusWetted (cm)	13.50	188.00
Depth-Max (cm)	30.0	55.5 ± 31.7
Macrophyte (PercentRange)	0	1 ± 2
Reach-%CanopyCoverage (PercentRange)	3.00	0.23 ± 0.44
Reach-%Logging (PercentRange)	0	0 ± 0
Reach-DomStreamsideVeg (Category(1-4))	3	2
Reach-Pools (Binary)	0	0 ± 0
Reach-Rapids (Binary)	0	0 ± 0
Reach-Riffles (Binary)	1	0 ± 0
Reach-StraightRun (Binary)	1	1 ± 0
Slope (m/m)	0.0200000	0.0047331 ± 0.0082050
Veg-Coniferous (Binary)	0	0 ± 1
Veg-Deciduous (Binary)	1	0 ± 1
Veg-GrassesFerns (Binary)	1	1 ± 0
Veg-Shrubs (Binary)	1	1 ± 0
Velocity-Avg (m/s)	0.07	0.23 ± 0.24
Velocity-Max (m/s)	0.11	0.31 ± 0.35
Width-Bankfull (m)	3.8	75.1 ± 72.8
Width-Wetted (m)	3.3	50.6 ± 60.4
XSEC-VelInstrumentDirect (Category(1-3))	1	2
XSEC-VelMethod (Category(1-3))	3	3
Climate		
Precip02_FEB (mm)	163.00000	171.50745 ± 107.47690
Temp07_JULmax (Degrees Celsius)	20.48000	20.34230 ± 2.49485
Landcover		
Natl-SnowIce (%)	0.00000	3.62533 ± 10.17162
Natl-Water (%)	0.00000	1.80201 ± 1.29922
Natl-WetlandHerb (%)	0.00000	0.68488 ± 0.92347
Substrate Data		
%Bedrock (%)	0	0
%Boulder (%)	0	0
%Cobble (%)	32	58
%Gravel (%)	5	1
%Pebble (%)	40	41
%Sand (%)	0	0
%Silt+Clay (%)	23	0
D50 (cm)	3.00	3.30
Dg (cm)	1.4	6.6
Dominant-1st (Category(0-9))	4	4 ± 2
Dominant-2nd (Category(0-9))	1	4 ± 2
Embeddedness (Category(1-5))	5	4 ± 1
PeriphytonCoverage (Category(1-5))	2	3
SurroundingMaterial (Category(0-9))	3	2 ± 1
Topography		
SlopeAvg (%)	26.12000	30.12236 ± 18.75100

Habitat Description

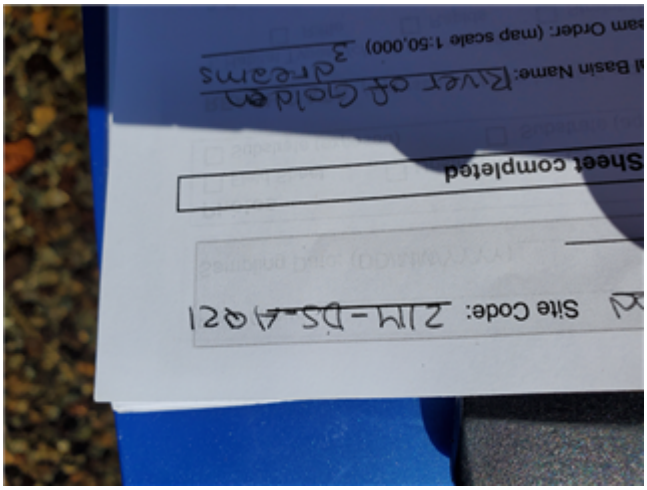
Variable	CRB-DS-AQ01	Predicted Group Reference Mean ±SD
Water Chemistry		
General-DO (mg/L)	10.8000000	9.3400000 ± 2.0171679
General-pH (pH)	6.9	6.8 ± 1.0
General-SpCond (µS/cm)	200.4000000	176.1000000
General-TempAir (Degrees Celsius)	21.5	0.0 ± 0.0
General-TempWater (Degrees Celsius)	13.6000000	13.2730769 ± 4.7663725

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	21M-DS-AQ21
Sampling Date	Jul 28 2021
Know Your Watershed Basin	Harrison
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.12761 N, 122.97293 W
Altitude	640
Local Basin Name	Twenty-One Mile Creek
	River of Golden Dreams
Stream Order	3

Across Reach

Down Stream



Field Sheet

Substrate

Up Stream

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River 2014
Analysis Date	October 23, 2021
Taxonomic Level	Family

Cabin Assessment Results

Predictive Model Variables	Dominant-1st Natl-SnowIce Natl-Water Natl-WetlandHerb Precip02_FEB Reach-Riffles Sedimentary Slope SlopeAvg stream order Temp07_Julmax Width-Bankfull

Reference Groups	**1**	**2**	**3**	**4**	**5**	**6**
Number of Reference Sites	64	57	19	103	13	46
Group Error Rate	46.4%	41.9%	26.3%	44.4%	38.5%	54.9%
Overall Model Error Rate	44.7%					
Probability of Group Membership	10.2%	5.3%	33.5%	24.0%	17.2%	9.9%
CABIN Assessment of 21M-DS-AQ21 on Jul 28, 2021	Mildly Divergent					

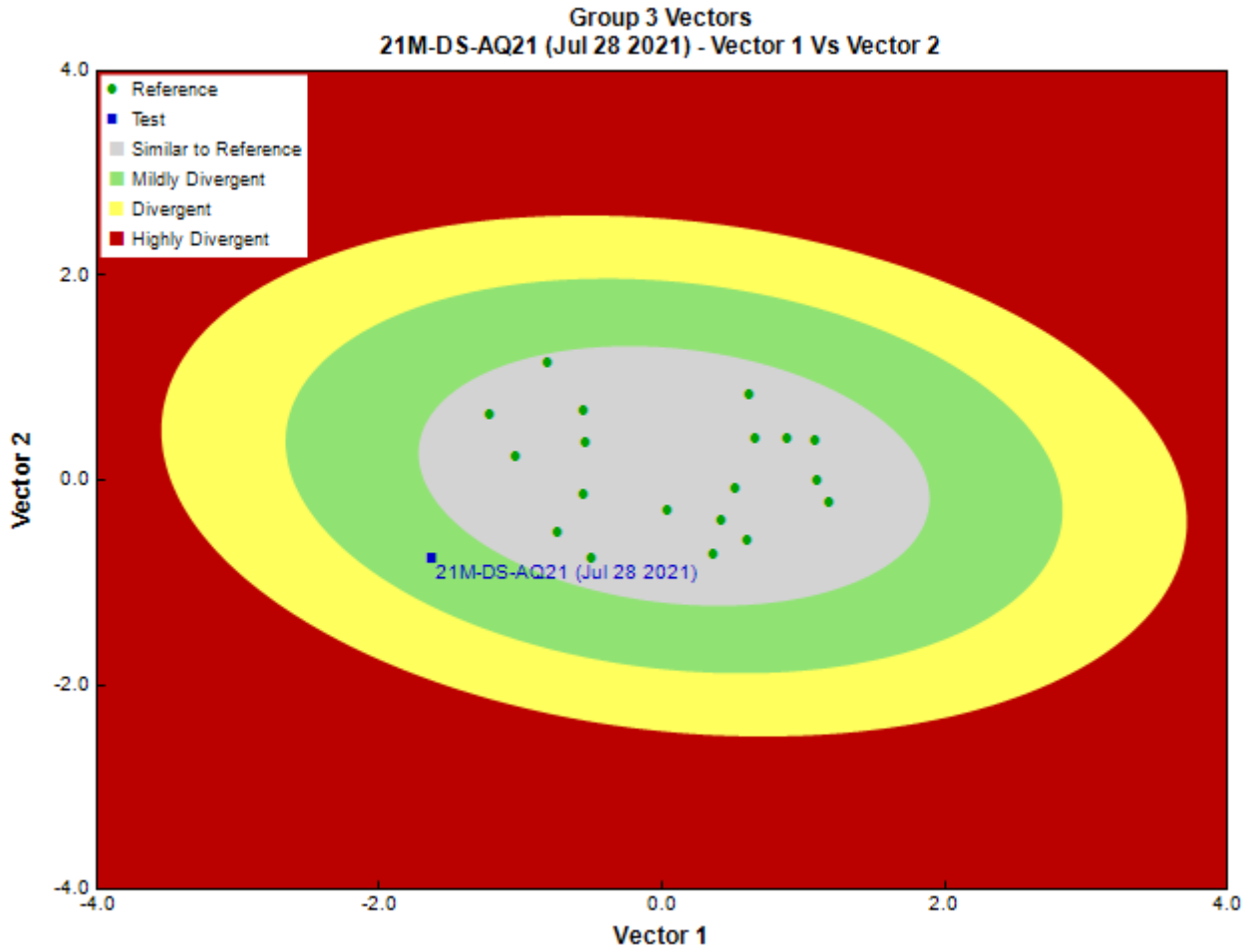


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3

Sample Information

Taxonomist	-
	-
Sub-Sample Proportion	10/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Annelida	Clitellata	Tubificida	Naididae	19	190.0
Arthropoda	Arachnida	Trombidiformes	Hygrobatidae	8	80.0
			Lebertiidae	4	40.0
			Sperchontidae	6	60.0
	Insecta	Coleoptera	Dytiscidae	1	10.0
		Diptera	Ceratopogonidae	7	70.0
			Chironomidae	53	530.0
			Simuliidae	22	220.0
			Tipulidae	2	20.0
		Ephemeroptera	Ameletidae	25	250.0
			Baetidae	29	290.0
			Ephemerellidae	6	60.0
			Heptageniidae	100	1,000.0
			Leptophlebiidae	2	20.0
		Plecoptera	Capniidae	7	70.0
			Chloroperlidae	28	280.0
			Nemouridae	6	60.0
			Perlidae	16	160.0
			Perlodidae	12	120.0
			Pteronarcyidae	1	10.0
		Trichoptera	Limnephilidae	1	10.0
			Rhyacophilidae	1	10.0
			Total	356	3,560.0

Metrics

Name	21M-DS-AQ21	Predicted Group Reference Mean ±SD
Bray-Curtis Distance	0.85	0.4 ± 0.2
Functional Measures		
% Filterers	--	0.8 ± 0.7
% Gatherers	43.3	50.1 ± 18.1
% Predatores	34.6	21.3 ± 14.1
% Scrapers	43.0	52.3 ± 22.4
% Shredder	4.8	27.7 ± 19.9
No. Clinger Taxa	20.0	14.9 ± 5.0
Number Of Individuals		
% Diptera + Non-insects	34.0	19.6 ± 15.4
% EPT Individuals	65.7	79.4 ± 16.0
% of 5 dominant taxa	66.0	84.6 ± 8.6
No. EPT individuals/Chironomids+EPT Individuals	0.8	0.8 ± 0.1
Total Abundance	3560.0	2848.8 ± 2779.3
Richness		
Chironomidae taxa (genus level only)	1.0	1.0 ± 0.2
Coleoptera taxa	1.0	0.2 ± 0.4
Diptera taxa	4.0	3.0 ± 1.3
Ephemeroptera taxa	5.0	3.5 ± 0.9
EPT Individuals (Sum)	2340.0	2242.7 ± 2353.1
EPT taxa (no)	13.0	10.4 ± 2.8
Odonata taxa	--	0.0 ± 0.0
Pielou's Evenness	0.8	0.7 ± 0.1
Plecoptera taxa	6.0	4.3 ± 1.3
Shannon-Wiener Diversity	2.4	1.8 ± 0.4
Simpson's Diversity	0.9	0.7 ± 0.1
Simpson's Evenness	0.3	0.3 ± 0.1
Total No. of Taxa	22.0	15.8 ± 4.7
Trichoptera taxa	2.0	2.7 ± 1.6

Frequency and Probability of Taxa Occurrence

Reference Model Taxa	Frequency of Occurrence in Reference Sites						Probability Of Occurrence at 21M-DS-AQ21
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	7.24
RIVPACS : Observed taxa P>0.50	9.00
RIVPACS : O:E (p > 0.5)	1.24
RIVPACS : Expected taxa P>0.70	4.30
RIVPACS : Observed taxa P>0.70	5.00
RIVPACS : O:E (p > 0.7)	1.16

Habitat Description

Variable	21M-DS-AQ21	Predicted Group Reference Mean ±SD
Bedrock Geology		
Sedimentary (%)	2.56000	18.33344 ± 33.50703
Channel		
Depth-Avg (cm)	22.7	28.3 ± 10.9
Depth-BankfullMinusWetted (cm)	13.00	163.00
Depth-Max (cm)	27.0	43.6 ± 19.2
Macrophyte (PercentRange)	0	0 ± 0
Reach-%CanopyCoverage (PercentRange)	1.00	0.16 ± 0.37
Reach-DomStreamsideVeg (Category(1-4))	2	3 ± 1
Reach-Pools (Binary)	0	0 ± 0
Reach-Rapids (Binary)	0	0 ± 0
Reach-Riffles (Binary)	1	1 ± 0
Reach-StraightRun (Binary)	1	0 ± 1
Slope (m/m)	0.0100000	0.0259896 ± 0.0313728
Veg-Coniferous (Binary)	0	1 ± 0
Veg-Deciduous (Binary)	0	1 ± 1
Veg-GrassesFerns (Binary)	1	0 ± 0
Veg-Shrubs (Binary)	1	1 ± 0
Velocity-Avg (m/s)	0.33	0.49 ± 0.15
Velocity-Max (m/s)	0.50	0.68 ± 0.20
Width-Bankfull (m)	11.9	85.0 ± 66.5
Width-Wetted (m)	8.9	23.1 ± 31.8
XSEC-VelInstrumentDirect (Category(1-3))	3	1 ± 1
XSEC-VelMethod (Category(1-3))	3	3 ± 0
Climate		
Precip02_FEB (mm)	155.11000	127.54903 ± 58.24882
Temp07_JULmax (Degrees Celsius)	18.24000	16.49843 ± 2.42987
Landcover		
Natl-SnowIce (%)	26.43000	30.72486 ± 23.89539
Natl-Water (%)	2.82000	0.99760 ± 0.86372
Natl-WetlandHerb (%)	0.00000	0.02638 ± 0.03974
Substrate Data		
%Bedrock (%)	0	0 ± 0
%Boulder (%)	0	9 ± 8
%Cobble (%)	13	63 ± 4
%Gravel (%)	10	3 ± 4
%Pebble (%)	76	25 ± 7
%Sand (%)	0	0 ± 0
%Silt+Clay (%)	1	0 ± 0
D50 (cm)	4.00	6.67 ± 3.25
Dg (cm)	3.4	8.6 ± 1.6
Dominant-1st (Category(0-9))	5	7 ± 1
Dominant-2nd (Category(0-9))	4	7 ± 1
Embeddedness (Category(1-5))	4	4 ± 1
PeriphytonCoverage (Category(1-5))	2	2 ± 1
SurroundingMaterial (Category(0-9))	3	4 ± 2
Topography		

Habitat Description

Variable	21M-DS-AQ21	Predicted Group Reference Mean ±SD
SlopeAvg (%)	39.45000	41.69956 ± 6.13915
Water Chemistry		
General-DO (mg/L)	11.6900000	12.6052631 ± 1.2122173
General-pH (pH)	7.0	7.4 ± 0.4
General-SpCond (µS/cm)	54.5000000	74.4000000 ± 44.3472660
General-TempAir (Degrees Celsius)	31.0	0.0 ± 0.0
General-TempWater (Degrees Celsius)	14.2000000	5.7731579 ± 1.9704316