Snowline Ecological Research

Palmer Environmental Consulting Group Inc.
470 Granville Street, Suite 630, Vancouver, BC V6C 1V5

Whistler Ecosystems Monitoring Program

2017

PECG Project #
160252

Prepared For
Resort Municipality of Whistler

February 19, 2018

470 Granville Street, Suite 630, Vancouver, BC V6C 1V5

February 19, 2018

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

Dear Ms Beresford,

Re: Whistler Ecosystems Monitoring Program
Project #: 160252

Enclosed you will find the final Whistler Ecosystems Monitoring Program 2017 report. This report has been authored by Palmer Environmental Consulting Group Inc. (PECG) and Snowline Ecological Research (Snowline).

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 local residents, and produce a report that is scientifically defensible.

Thank you for this opportunity to support you on this interesting project. Should you have any questions or require additional information, please feel free to contact May Mason (604) 837-1858 or via email at may@pecg.ca.

Yours truly,
Palmer Environmental Consulting Group Inc.

May Mason, M.Sc., R.P.Bio.
Vice-President and Senior Aquatic Ecologist

Executive Summary

The Resort Municipality of Whistler (RMOW) is located in the southern Coast Mountains of British Columbia (BC), approximately 100 km north of the city of Vancouver. The study area contains a range of aquatic and terrestrial ecosystems interspersed among areas of urban development.

In 2013, the RMOW initiated the Ecosystems Monitoring Program. The program design was based on the use of species, habitat, and climate indicators, to identify temporal and spatial trends in the overall health of ecosystems in the Whistler area. Cascade Environmental Resource Group Ltd (CERG) conducted the first three years of the Ecosystem monitoring program (Cascade 2013 to 2015). In 2016, Palmer Environmental Consulting Group Inc. (PECG), partnered with Snowline Ecological Research, and began the next phase of the program. A few changes were made to the study design in 2016 while maintaining comparability and consistency with previous years to the greatest extent possible (PECG and Snowline, 2017).

At the end of the 2016 program, it was recognized that the suitability of each monitoring component needed to be revisited to establish a long-term monitoring program based on priority species and habitats that could then provide meaningful results on the overall health of ecosystems in the Whistler area. With this separate initiative underway in 2017, the Ecosystems Monitoring Program in 2017 was scaled back considerably to focus on only a few species that were highly likely to remain as future monitoring components. The 2017 Ecosystems Monitoring Program components included benthic invertebrates, fish community, Coastal Tailed Frog (*Ascaphus truei*) and beaver (*Castor canadensis*). Water quality, stream flow, stream temperatures and climate were also included as complementary monitoring components.

A total of five stream sites have been established to monitor the aquatic health of streams in the RMOW. Methods and data collected include: benthic invertebrate sampling, closed-site fish sampling, general water quality parameters, stream flow measurements, stream temperature measurements and reach habitat characteristics. Benthic invertebrate analyses indicated a relatively high proportion of pollution sensitive organisms in the River of Golden Dreams watershed, Crabapple Creek and Twentyone Mile Creek, a sign of healthy benthic invertebrate communities. In contrast, analyses of benthic invertebrate communities in the Jordan Creek indicated reduced community health. These trends were evident in both 2016 and 2017. Three species of fish were identified in the 2017 sampling efforts: Threespine stickleback (*Gasterosteus aculeatus*), undifferentiated trout fry from resident populations of Rainbow (*Oncorhynchus mykiss)* and Cutthroat Trout (*O. clarkii clarkii)* and sculpin. The fish communities in Jordan Creek, Crabapple Creek and Twentyone Mile Creek composed of fish likely 0+ year fry, indicating the importance of the study reaches for trout rearing.

Two riparian species were monitored as part of the program, the Coastal Tailed Frog and Beaver. Stream-dwelling amphibians such as the Coastal Tailed Frog are vulnerable to habitat alteration and degradation and serve a vital role as indicators of stream health. The 2017 survey continued with the 30-minute timed approach from the 2016 program and replaced sampling of Alpha and Scotia creeks with sampling in Horstman and Agnew creeks. Increased tadpole detections in 2017 is likely due higher water temperatures.

Beavers are a keystone species, and the ponds and wetlands created by Whistler's beavers provide important habitat for a wide range of other species groups. A census of beavers in the RMOW was conducted by late-season surveys to confirm active overwintering lodges. Approximately 75 beavers were found overwintering in Whistler during surveys conducted in 2017, which is very close to the nine-year average of 81, and is the same as the 2016 estimate.

Acknowledgements

We greatly appreciate the assistance and expertise provided throughout the project by Tara Schaufele and Hilary Williamson with the RMOW. Karen Needham identified the benthic invertebrates and Kristen Jones provided valuable assistance with the beaver surveys.

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1. Introduction

1.1 Overview

This report describes monitoring studies conducted in 2017 by Palmer Environmental Consulting Group (PECG) and Snowline Ecological Research (Snowline) on aquatic and terrestrial environments in Whistler, British Columbia (BC). The 2017 study was the fifth year of the Ecosystems Monitoring Program. The purpose of the program is to monitor the health of ecosystems over time, through indicator species, such that the results of the program can guide the conservation of species and ecosystems and inform sustainable land use planning and development in Whistler.

1.2 Background

The Whistler Biodiversity Project, funded in significant part by the Resort Municipality of Whistler (RMOW) from 2006 through 2012, began its first surveys in late 2004. This work led to the first publicly documented record of several important and/or at-risk species (e.g., Coastal Tailed Frog (*Ascaphus truei*), and Red-legged Frog (*Rana aurora*)), initiated the first beaver census, and greatly enhanced the knowledge of species inhabiting Whistler. This information was first summarized in 2007 in a report (Brett, 2007), which recommended further inventory work, as well as the identification and monitoring of indicator species. This work was a precursor to a report the RMOW commissioned that proposed a framework for establishing and using ecological monitoring in Whistler (Askey *et al*., 2008).

The RMOW initiated the Ecosystems Monitoring Program 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 health 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; 2015); and
- Local data held by Cascade Environmental Resource Group Inc (Cascade).

Cascade was contracted to conduct the first three years of the Ecosystem Monitoring Program (Cascade 2013 to 2015). In 2016, PECG partnered with Snowline, and the team was awarded the contract for an additional three-year program from 2016 to 2018. In 2016, the team also collaborated with the British Columbia Institute of Technology (BCIT) and students from the Fish, Wildlife and Recreation (FWR), and Ecological Restoration (ER) programs were involved in the first year of field data collection. A few changes were made to the study design in 2016 to make it more scientifically robust (e.g. adopting data collection methods which allow for statistical analysis), while maintaining comparability and consistently with previous years to the greatest extent possible. The changes included:

- Addition of benthic invertebrates as an indicator for aquatic ecosystem health;
- Use of multiple pass depletion electrofishing methods for fish;
- Alterations to previously defined species thresholds;

- Adjusting survey methodology and timing to correspond to best seasonal timing for detection;
- Changing the methodology for Coastal Tailed Frog surveys from area-constrained to time constrained;
- Adding a comprehensive survey for cavity trees excavated by Pileated Woodpeckers (*Dryocopus pileatus*) in place of a survey limited to recent excavations;
- Removal/replacement of some study sites; and
- A return to a full beaver census.

These changes were implemented in 2016, and recommendations for the 2017 monitoring year were made to further increase monitoring success. In 2017, PECG and Snowline conducted the second year of the three-year program. Several changes were made to the study design in 2017, following recommendations established in the 2016 Ecosystems Monitoring Program Report (PECG and Snowline, 2017). These changes included:

- The installation of two additional temperature loggers at aquatic sampling sites in Crabapple Creek (CRB-DS-AQ01) and Twentyone Mile Creek (21M-DS-AQ21);
- Use of the single-pass electrofishing method with no stop nets for fish sampling; and
- Removal of the terrestrial component (Pileated Woodpeckers, beetles, and small mammals).

In the future, the main basis for determining what to monitor and sampling procedures for annual the Ecosystems Monitoring Program will be using prioritized species and habitats most important to conserving biodiversity within the RMOW's development footprint (Brett, 2018). Recommendations for the 2018 work plan will build on the study conducted by Brett (2018) and propose methods to effectively monitor priority species and habitats in 2018 and beyond.

2. Methods

2.1 Study Area

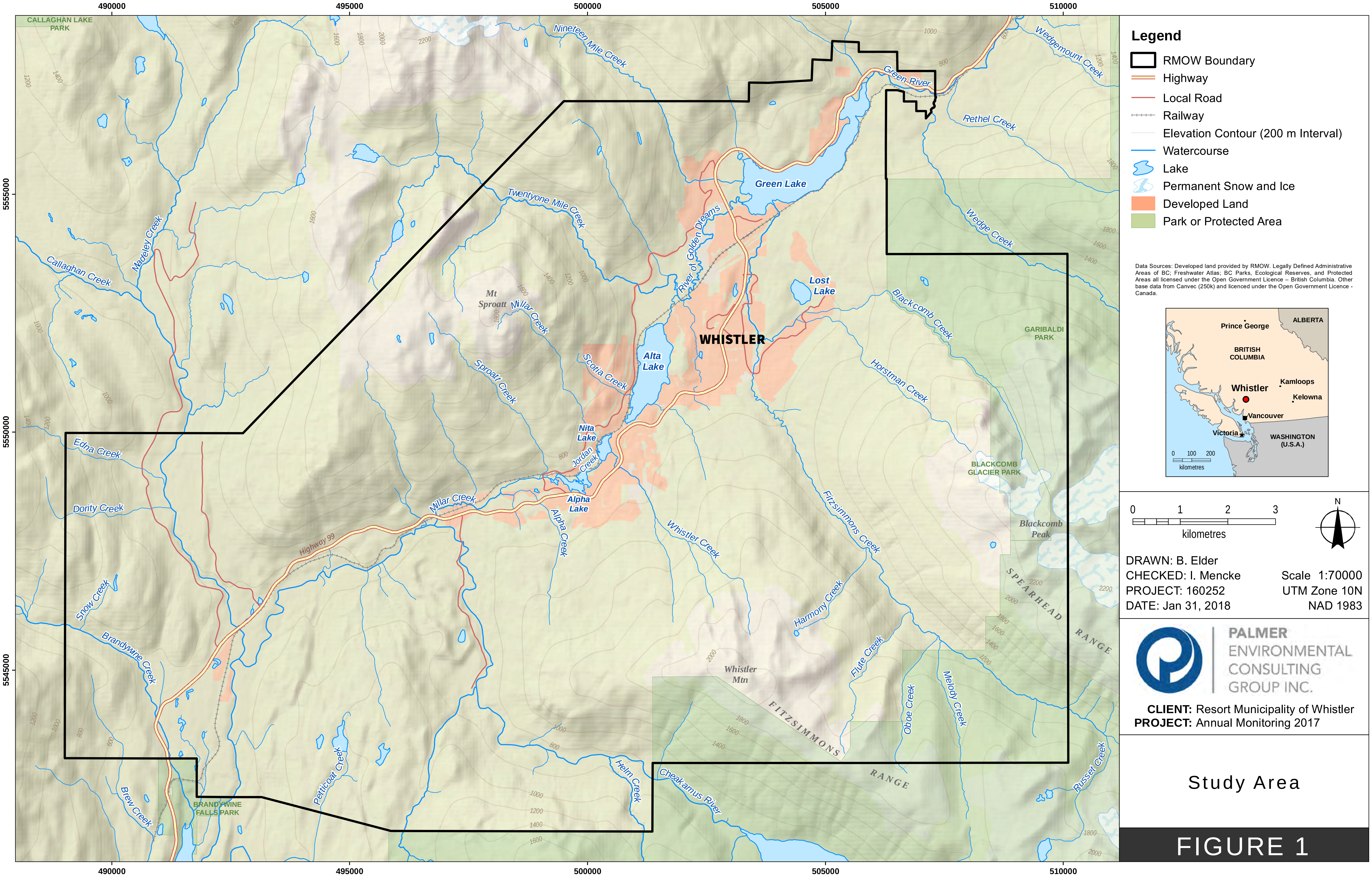
The RMOW located in the southern Coast Mountains of BC, is approximately 100 km north of Vancouver. The area boundaries of the RMOW, which also denotes the study area boundaries, are shown in Figure 1. The study area contains a range of aquatic and terrestrial ecosystems, interspersed amongst urban development areas.

2.2 Study Design

The Ecosystems Monitoring Program is based on the use of indicators, which can reflect the health of a broader range of populations, taxa, and/or overall ecosystem health. Following three years of results from 2013 to 2015 (Cascade), methods for surveying indicator species were modified for 2016 to improve detection rates and more robust analysis (PECG and Snowline, 2017). For 2017, the Terrestrial Habitat and Terrestrial Species components of the monitoring program were temporarily suspended while priorities for the program were re-evaluated. Table 1 shows the indicators, field methodologies, and metrics for each 2017 program component.

Table 1. 2017 Ecosystems Monitoring Program

Study Component	Indicator(s)	Methodology/ Equipment	Metrics/Parameters
Aquatic Species	Benthic macroinvertebrate community	CABIN protocols (3 minute kick-net sample)	• Abundance • Taxa richness • EPT taxa richness • Percentage EPT • Diversity indices
	Fish	One-pass electrofishing	• Species identification • Fish density estimates • Comparison to literature derived reference sites • Fish length to weight relationships
Aquatic Habitat	Water Quality	In Situ measurements using a digital meter	• In Situ parameters: pH, conductivity, dissolved oxygen
	Stream Flow	Transect measurements using a flow meter and wading rod	• Staff gauge readings • depth-velocity profiles
	Stream Temperature	Temperature loggers set to hourly logging, installed at five locations	• Daily and monthly summary statistics for the open water period
Riparian Species	Coastal Tailed Frog (*Ascaphus truei*)	Time constrained surveys (MELP, 2000)	• Tadpole abundance and density • Counts of tadpoles by development stage (i.e. age cohort) • Water temperature and habitat descriptors
	Beaver (*Castor canadensis*)	Field inventories of beaver lodges and activity	• Number and distribution of active lodges • Beaver census
Reassess Priorities; Revise Work Plan	Recommend 2018 work plan (priority species and habitats plus methods) based on assessment of past results and reassessment of EMP priorities.	TBD	N/A



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2.3 Field and Laboratory Methods

2.3.1 Aquatic Sampling

2.3.1.1 Site Selection

Table 2 lists the aquatic sampling sites, as well as their locations, descriptions, and 2017 sampling information. Water quality parameters (pH, specific conductivity, dissolved oxygen, and temperature) were measured *in situ* during each sampling event. In previous years turbidity was measured at all aquatic monitoring sites, however due to logistical issues it was not included in the 2017 monitoring program. Benthic invertebrate sampling was conducted prior to fish sampling, to avoid disturbance of the substrate.

The River of Golden Dreams is the northern outlet to Alta Lake and flows north-northeasterly to Green Lake (Figure 1). The river is 5.4 km long and has an irregular meander pattern. Urban development encroaches on the river, especially within the first kilometer downstream of the Alta Lake and the last 1.5 km before it enters Green Lake. Highway 99 crosses the river 850 m upstream of Green Lake. Twentyone Mile Creek and Crabapple Creek (also known as Archibald Creek) are the major tributaries of the River of Golden Dreams. Twentyone Mile Creek originates at Rainbow Lake and flows for 9.1 km before entering the River of Golden Dreams. Twentyone Mile Creek flows into the River of Golden Dreams approximately 800 m downstream from Alta Lake, and contributes the majority of flow to the river (Thomson, 1996). Crabapple/Archibald Creek drains from its headwaters on Whistler Mountain through the neighborhood of Brio and the Whistler Golf Course, before entering the River of Golden Dreams approximately 50 m downstream of Twentyone Mile Creek. The River of Golden Dreams is popular for recreation, and in summer is subject to heavy traffic from kayaks, canoes, and stand-up paddle boards. The RMOW have identified a need to understand the potential impacts of recreational use, combined with other disturbance (e.g. urban development) on the river.

Fish sampling was previously conducted on the River of Golden Dreams in 2013, 2014, and 2015. The fish sampling site was moved in 2014, to a location with more suitable fish habitat conditions. In 2016, fish sampling was not conducted at this site, as the number and frequency of canoes/paddle boards passing, and the presence of people and dogs, made it unsafe to electrofish. The hazards associated with electrofishing in this river, as well as the limitations of fish data in detecting effects of anthropogenic activities (e.g. high spatial and temporal variability in distribution of fish; need for a large dataset), formed the rationale for removing this fish sampling site. As an alternative, two benthic invertebrate sampling sites were established on the River of Golden Dreams (Figure 2; PECG and Snowline, 2017). The upstream site (RGD-US-AQ11) is located approximately 60 meters (m) upstream of the 2014-2015 fish sampling site, between the Twentyone Mile Creek and Crabapple Creek confluences. The downstream site (RGD-DS-AQ12) is located approximately 3 kilometers (km) downstream from the upstream site, just downstream of the designated canoe/kayak pull out location, and approximately 750 m upstream from Green Lake. Both sites were selected based on having riffle habitat (preferable for CABIN sampling). Monitoring of the benthic invertebrate community provides insight into the aquatic health of the River of Golden Dreams, and comparison between the two sites can provide an indication of how conditions change downstream.

A new fish and benthic invertebrate sampling site (21M-DS-AQ21) was established in 2016 on Twentyone Mile Creek (Figure 2). The site was selected to contain multiple mesohabitats (e.g., pool, riffle, run) representative of the reach being sampled. This site was established as an alternative location to the River of Golden Dreams for fish sampling. Twentyone Mile Creek is relatively undisturbed compared to the River of Golden Dreams and can be considered a potential reference site. Habitat characteristics at the Twentyone Mile Creek site are similar to those at the downstream site on the River of Golden Dreams, and comparison of sampling results, in particular for benthic invertebrates, may provide some insight on the degree of any habitat degradation in the River of Golden Dreams.

Jordan Creek is a short (500 m) connector stream that flows southwest from Nita Lake to Alpha Lake (Figure 1). Fish and benthic invertebrate sampling in 2016 and 2017 was conducted at one of two previously established sites on Jordan Creek (site: Jordan Creek EF #2; Figure 2). Fish sampling was conducted in 2013, 2014, and 2015 at a second site (site: Jordan Creek EF #1) located approximately 100 m upstream from the first site. The upstream site was not sampled in 2016 or 2017, because of its proximity to the downstream site, as either site would be representative of the short (500 m long) creek.

Previous monitoring results from the provincial fisheries database (Fisheries Information Summary System, FISS), and local knowledge, were the key sources of background information on fish presence in the study streams. This information is summarized in Table 3. Kokanee salmon (*Oncorhynchus nerka*) are present in the study streams, with known spawning areas in the River of Golden Dreams. Bull trout (*Salvelinus confluentus),* as well as cutthroat trout (*Oncorhynchus clarki clarki*), are native to the Whistler area, but observations of these species are rare. Both species are blue-listed, indicating that they are considered vulnerable in BC. The lower mainland populations of cutthroat trout are in serious decline (BC MoFLNRO, 2017a). Within the Whistler area, cutthroat trout are believed to have hybridized with rainbow trout (*Oncorhynchus mykiss*). Populations of bull trout are also in decline in BC, and throughout the global range of this species (BC MoFLNRO, 2017b). Bull trout are very similar in shape and coloration to Dolly Varden (*Salvelinus malma*), and genetic analysis is required to definitively differentiate individuals of these species. Rainbow trout are ubiquitous in the study streams and were stocked in Rainbow Lake (the headwater lake of Twentyone Mile Creek) in the late 1970s or early 1980s (Eric Crowe, pers. comms). Coast range sculpin (*Cottus aleuticus*) and stickleback (*Gasterosteidae*) are also common.

Table 2. Aquatic sampling sites (fish and benthic invertebrates), 2017

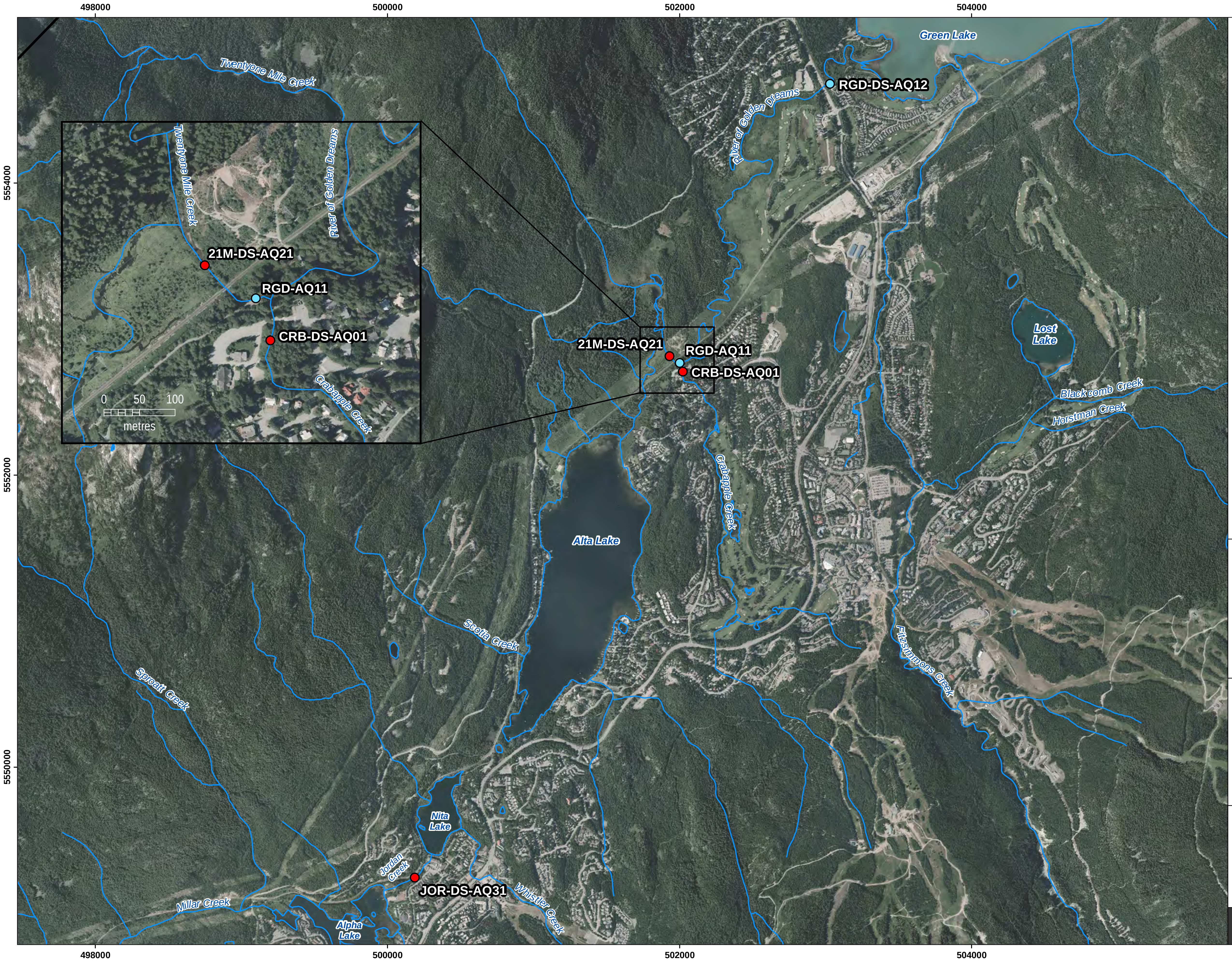
Site Name	UTM Location (Zone 10)		Stream Name and Classification	Historical Information	Description	Date Sampled	
	Easting	Northing				Benthic Invertebrates	Fish
JOR-DS-AQ31	500184	5549252	Jordan Creek (S3)	Jordan Creek electrofishing (i.e. fish sampling) site #2 (downstream site), 2013-2016.	250 m downstream from Nita Lake.	26-July-17	02-Aug-17
CRB-DS-AQ01	502021	5552707	Crabapple Creek (S3)	Crabapple Creek electrofishing (i.e. fish sampling) site, 2014 2016.	100 m upstream from confluence with the River of Golden Dreams.	25-July-17	01-Aug-17
RGD-AQ11	501994	5552793	River of Golden Dreams (S2)	New Site (established in 2016) - Approximately 60 m upstream of ROGD electrofishing (i.e. fish sampling) site, 2014 - 2015.	Site between Crabapple Creek and Twentyone Mile Creek tributaries.	25-July-17	N/A
RGD-DS-AQ12	503029	5554676	River of Golden Dreams (S2)	New site established in 2017.	Downstream of canoe pullout location, 750 m upstream from Green Lake	25-July-17	N/A
21M-DS-AQ21	501935	5552824	Twentyone Mile Creek (S2)	New site established in 2017.	75 m upstream from confluence with the River of Golden Dreams.	25-July-17	01-Aug-17

Table Notes: Fish streams are classified S1–S4. Class S1 streams are >20 m wide; S2 streams are >5 - 20 m wide; S3 streams are 1.5 - 5 m wide; and S4 streams are <1.5 m wide.

Table 3. Fish presence information for the Whistler Study Streams, 2017

Stream Name	Gazetted Name (if different)	Watershed Code	Fish Species Present
Jordan Creek[1]	Millar Creek	900-097600-12900-53800	Sculpin (General) Rainbow Trout Stickleback (General) Cutthroat Trout Threespine Stickleback Kokanee
River of Golden Dreams	Alta Creek	119-467100-98100	Sculpin (General) Rainbow Trout Stickleback (General) Threespine Stickleback Prickly Sculpin Dolly Varden[2] Kokanee Coarse or non-game fish
Crabapple Creek	n/a	119-455209-98009-59490	Rainbow Trout Stickleback (General) Sculpin (General) Cutthroat Trout
Twentyone Mile Creek	n/a	119-467100-98100-53600	Rainbow Trout Dolly Varden[2] Kokanee Sculpin (General)

Table Notes: [1] Jordan Creek is also sometimes referred to as Write-off Creek; [2] All observations (recorded in FISS) are from 1995 or before.



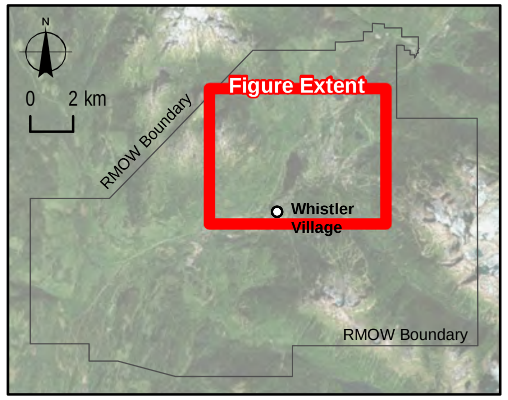
Legend

Watercourse

2017 Aquatics Sites

- Benthic Invertabrates and Fish
- Benthic Invertabrates

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



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PROJECT: Annual Monitoring 2017

Aquatics Sites

FIGURE 2

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2.3.1.2 *Aquatic Habitat*

Habitat Assessment and Water Quality

CABIN benthic invertebrate sampling protocols incorporate habitat data collection, as the benthic community present at a site reflects the habitat conditions. The habitat characteristics recorded at each site were: canopy coverage, macrophyte coverage, riparian vegetation, periphyton coverage, substrate composition (pebble count). Formal fish habitat assessments were not completed in 2017, however CABIN habitat data as well as site descriptions and photographs allow for qualitative descriptions of fish habitat. In situ water quality parameters (pH, temperature, dissolved oxygen, and specific conductance) were measured at each site.

Stream Temperature

Temperature loggers (HOBO Water Temperature Pro v2 Data Logger, model # U22-001) were deployed by Cascade in five creeks (Alpha Creek, Jordan Creek, Scotia Creek, Crabapple Creek, and River of Golden Dreams) in the study area on December 15, 2015 and set to hourly logging. The logger locations are described in Table 4, along with access information. The temperature loggers were installed near bridge crossings of the creeks, for easy access to download and maintain the loggers. These temperature loggers were downloaded in the field in the July 2017 (Table 4) and redeployed following each download. The logger at Crabapple Creek, which failed to download on September 30, 2016, was removed for data extraction and replaced on November 16, 2016 at the same location. Two additional temperature loggers were installed by PECG on August 2, 2017; one at a second location in Crabapple Creek, and the other in Twentyone Mile Creek at the aquatic sampling sites (CRB-DS-AQ01 and 21M-DS-AQ21). Daily and monthly summary statistics (means, maxima, and minima) were calculated during the open water period for each creek between July 2016 and July 2017. The temperature time series were examined to identify periods where data were suspect (e.g. elevated readings, when logger may have been dry), and any suspect data were excluded from the calculations. Mean, minimum and maximum daily stream temperature data are included in Appendix F. Previous stream temperature data can be found in the 2016 Whistler Ecosystems Monitoring Program (PECG and Snowline, 2017).

Table 4. Temperature logger locations, 2017

Site	UTM Location (Zone 10)		Location Description	Access (Bridge Crossing)	Install Date	Download Date
	Easting	Northing				
Alpha Creek	499199	5548227	At Tailed Frog Site #1	Spring Creek Drive	15-Dec-15	25-Jul-17
Jordan Creek	500242	5549278	Near Aquatics Site JOR-DS-AQ31.	Lake Placid Road	15-Dec-15	26-Jul-17
Scotia Creek	500280	5551092	At Tailed Frog Site #2	Stone Bridge Drive	15-Dec-15	26-Jul-17
Crabapple Creek 1	502426	5550589	At Tailed Frog Site #2	Sunridge Drive	15-Dec-15	26-Jul-17
Crabapple Creek 2	502030	5552670	At Aquatics Site CRB-DS-AQ-01	-	02-Aug-17	-
River of Golden Dreams	502066	5552829	Near Aquatics Site RGD-US-AQ11.	Lorimer Road	15-Dec-15	26-Jul-17
Twentyone Mile Creek	501910	5552856	At Aquatics Site 21M-DS-AQ21	-	02-Aug-17	-

2.3.1.3 Benthic Invertebrate Community

Data Collection Methods

Biomonitoring of benthic invertebrates is used to detect potential negative effects from anthropogenic activities which other biomonitoring methods (i.e. other species monitoring, abiotic indices) may not identify. Due to their sedentary nature, relatively long lifecycles, and high community diversity, benthic invertebrate communities provide insight into the long-term health of aquatic ecosystems.

The Canadian Aquatic Biomonitoring Network (CABIN, Environment Canada 2012) protocol was performed at five sites in late-July 2017 (Table 2). The CABIN method entails kick-net sampling for benthic invertebrates in the erosional zone (riffle, straight run, or rapid) of a representative watercourse reach. At each site, a CABIN field sheet was completed, and a single benthic invertebrate sample using the kick-net method was collected.

For benthic invertebrate sampling, a triangular kick-net sampler with 400 micron mesh and detachable collection cup was employed. To collect a sample one field individual (the 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 whilst moving upstream. Sampling was timed for 3 minutes. Each sample was distributed into sampling jars, preserved using 85% ethanol and submitted to a qualified taxonomist at the University of British Columbia for taxonomic analysis. Benthic invertebrates were identified to the lowest possible taxonomic group. The samples from sites RDG-US-AQ11 and 21M-DS-AQ21 were sieved using the “bucket swirling method” to remove excess debris from the samples. A QA/QC sample was collected from the remaining debris at JOR-DS-AQ31, to be processed in the laboratory and ensure that the method was effective in removing the vast majority of benthic invertebrates.

Habitat parameters such as stream substrate, channel dimensions (widths and depths), velocity measurements, and in situ water quality measurements were collected at each site in the vicinity of the benthic invertebrate kick-net area. Velocity measurements were taken with a Marsh McBirney Flow meter. In situ water quality measurements were taken with a YSI Pro Plus digital meter, with a Quatro cable, and sensors for DO (Galvanic sensor), conductivity, temperature, and pH and was calibrated prior to use. Other observations such as macrophyte coverage, streamside vegetation, and slope were evaluated within the entire reach.

Data Analysis

Benthic invertebrate samples were analysed using the Reference Condition Approach (RCA) adopted from Environment Canada's Canadian Aquatic Biomonitoring Network (CABIN) protocols. CABIN field sheets were used to collect all the data required for input into the CABIN database. This includes general site and location data, reach data (i.e. habitat types, canopy coverage, periphyton coverage, etc.), basic water chemistry, slope, widths, depth, velocity, and substrate data. Once uploaded to the CABIN database, data from one sample per site was compared to the Fraser River-Georgia Basin Reference Model (2005) using the predictor variables: Average depth, Dominant-1st, Ecoregion, Embeddedness, pH, Latitude, Slope, Stream order, Veg-Coniferous, Velocity-Max, Width-Wetted.

CABIN analyses include Bray-Curtis, River Invertebrate Prediction and Classification System (RIVPACS) and Benthic Assessment of Sediment (BEAST) Site Assessment Graphs. The Bray-Curtis dissimilarity coefficient is a distance measure that analyses how similar the test sites are to the median of the reference sites; a value of 0 indicates the two sites are identical in community structure and a value of 1 indicates the two sites are entirely different from one another. RIVPACS predicts the probability of a taxon occurring at a test site based on what is expected to occur. Finally, the BEAST analysis is a tool that evaluates whether a test site is in reference condition (unstressed), based on five reference groups differing in type and proportion of taxa, and if not, then how divergent it is from reference condition. Ordination plots are generated in CABIN and provide an overall indicator of whether a site is in reference condition, potentially stressed or stressed.

In addition to the CABIN model outputs described above, the following traditional community descriptors are presented for the 2017 benthic invertebrate data:

- Abundance, calculated as the total number of individuals per kick/net per site;
- Taxa richness, calculated as the total number of species present at each site. Where species could not be discerned, the lowest possible taxonomic level identified was substituted;
- EPT taxa richness, defined as the total number of mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) families per site. These three orders of aquatic insects are typically most sensitive to habitat disturbance;
- Percentage composition, calculated by dividing the density of dominant taxa groups by the total density; and

- Shannon-Wiener diversity index, defined as: $H' = \sum_{i=1}^{R} p_i \,(\ln p_i)$
  Where R is taxa richness, and p_i is the total number of individuals in the i^{th} species divided by the total number of organisms in the sample.

Quality Assurance/Quality Control

The benthic invertebrate taxonomic identification was carried out by Karen Needham, the curator of the Spencer Entomological Museum at the University of British Columbia. Karen specializes in taxonomy, systematics, and biodiversity of aquatic insects, specifically, Hemiptera, Ephemeroptera, Trichoptera, and Plecoptera. Karen was assisted by a CABIN-certified taxonomist, who entered the taxonomic data into the CABIN online database, and recounted/reidentified one sample to family level. All sample errors were within the acceptable limits for CABIN Laboratory methods (less than 5% error) and passed testing according to the CABIN misidentification protocols.

2.3.1.4 Fish Community

Data Collection Methods

Electrofishing was carried out in early August 2017, at three sampling sites (Crabapple Creek, Twentyone Mile Creek, Jordan Creek; Table 2) using a single-pass electrofishing method (no stop nets) to estimate relative abundance of fish and catch per unit effort (CPUE) at the study sites. As recommended in the 2016 Ecosystems Monitoring Report, the one-pass electrofishing method replaced the three-pass method for the 2017 program. The single-pass method was used for 2017 in replacement of the three-pass method due to the difficulties associated with meeting the assumptions for three-pass electrofishing. The level of resolution achieved using the single-pass method is considered adequate to identify any changes in the fish community composition and abundance. At each location, electrofishing crew entered the site at the downstream end and sampled in an upstream direction with an electrofishing pass of approximately 1000s. All fish captured were identified to species, and length and weight were recorded for each individual. Fork length was measured for salmonid fish species, and total length was measured for other species. All captured fish were held during the sampling effort and released into the creeks within close proximity of where they were captured after processing and recovery.

Electrofishing at all sites were completed using a Smith-Root LR-20 Backpack Electrofisher and a two-person crew (one electrofisher and one netter) under Scientific Fish Collection Permit SU17-276081 issued by the BC Ministry of Forests Lands and Natural Resource Operations (MoFLNRO). Site lengths ranged from 40 to 75 m and contained multiple mesohabitats (e.g., pool, riffle, run) representative of the reach being sampled. Electrofishing voltage ranged from 250-400V, and was based on water conductance, water temperature, and expected fish size. Electrofishing effort varied from 833-974s at each site.

Data Analysis

Fish Abundance

Relative fish abundance in each of the study streams was determined using a catch per unit effort (CPUE) index, defined as the number of fish caught per 100 seconds of electrofishing effort. Mean values for the total CPUE (all fish species) and trout CPUE were calculated for each site.

Length, Weight and Condition

Mean length and weight were calculated for each fish species; further analyses were only completed on trout, as this species was proposed as an indicator species in the past and the focus of analysis in the 2016 Whistler Ecosystem Monitoring Report.

Site-specific length-age regressions for trout were calculated as:

$$\log_{10}(W) = a + b \times \log_{10}(L) \qquad (1)$$

where W = weight (g), L = length (mm), a = the intercept of the regression, and b = the slope of the regression.

One sample t-tests were performed on estimated weight-length slope coefficients to determine if slopes significantly differed from the isometric growth value of three. Isometric fish growth occurs when length and weight increase at the same rate as the fish grows, whereas allometric growth occurs when length and weight increase at different rates during fish growth. Isometric and allometric growth are used to understand length-weight relationships in organisms. Slope coefficients of the estimated weight-length slope used in t-tests were estimated using species-specific linear regressions. Isometric growth is a requirement for calculating fish condition using the Fulton condition factor (K), as it assumes that fish shape does not change with increasing length. Trout condition could not be assessed using the Fulton condition factor, due to allometric growth. Instead, the relative condition factor (K_n) was used to characterize fish condition:

$$K_n = \frac{W}{W'} \qquad (2)$$

where W = fish actual weight (g) and W' = predicted length-specific weight using the length-weight regression outlined in Equation 1.

Quality Assurance/Quality Control

All fisheries field data were recorded on waterproof paper field notes and then transferred to electronic spreadsheets in the office. The spreadsheets were compared with the field notes to identify and correct transcription errors. A variety of other measures were taken to further ensure the validity of the data. For example, fish weights were plotted against fish lengths for each species separately to identify outliers that may have been due to errors in recording or transcription. Outliers were then corrected, if possible, or excluded from the analyzed dataset.

2.3.2 Riparian Species

2.3.2.1 Coastal Tailed Frog

Amphibians have long been used as indicators of ecosystem health. Their physiological constraints and sensitivities due to subcutaneous respiration, specialized adaptations, and microhabitat requirements combined with a dual life cycle utilizing aquatic and terrestrial habitats make them susceptible to perturbations in both habitats and suitable as indicator species.

Stream-dwelling amphibians, such as the Coastal Tailed Frog, serve a vital role as an indicator of stream health as they require flowing, clear, cold water throughout their lifecycle (Matsuda *et al*. 2006) and are vulnerable to habitat alteration and degradation such as siltation and algal growth. They are also highly philopatric,[1] long-lived, and maintain relatively stable populations. These attributes make them more trackable and reliable as indicators of potential biotic diversity in stream ecosystems than anadromous fish or macroinvertebrates, and their relative abundance can be a useful indicator of stream condition (Welsh and Ollivier 1998). In the past year, the Coastal Tailed Frog was down-listed in BC from Blue (Special Concern) to Yellow (Not at Risk; CDC 2017). It remains a species of Special Concern under the *Species at Risk Act* (SARA 2017).

Ideal habitats for tailed frogs are smaller, fast-flowing (gradients usually >10%) mountainside streams that are cool (typically 10 to 15ºC in late summer, but at least 5º C for egg development), have a cobble-boulder substrate with rounded to subangular-shaped rocks, and a cascade or step pool morphology (MOE 2015; Wind 2005-2009; Cascade 2014, 2015, 2016; PECG and Snowline, 2017). These characteristics describe many of the streams that drain into the Whistler Valley.

As of 2004, the public documentation of Coastal Tailed Frogs nearest to the RMOW was in Brandywine Creek (Leigh-Spencer 2004), presumably from surveys before the construction of the Independent Power Project (IPP) built on that creek. In late 2004, the Whistler Biodiversity Project began the first valley-wide survey of breeding populations (tadpoles) in 16 creeks in the area (Wind 2005-2009; Brett 2007). Surveys conducted since then as part of the Environmental Monitoring Program (Cascade 2013-2015; PECG and Snowline, 2017) continue to expand our understanding of the distribution and abundance of Coastal Tailed Frogs.

<u>*Data Collection Methods*</u>

The RMOW Ecosystem Monitoring Program began survey for Coastal Tailed Frogs in 2013 (Cascade). Area-constrained searches were conducted on two creeks previously documented as having breeding populations: Alpha Creek, and Scotia Creek (including the Stonebridge site).[2] In 2014, surveys of Coastal Tailed Frogs included two additional creeks: Archibald Creek, and Nineteen Mile Creek. While tailed frogs had already been documented in Archibald Creek,[3] it was unknown whether there was a breeding

[1] Adults typically breed in the stream in which they hatched.

[2] Wind (2006) documented tadpoles in both creeks.

[3] Referred to as Crabapple Creek in Cascade (2013 to 2015), this name is more typically applied to the part of Archibald Creek that flows through the Whistler Golf Course. Archibald Creek (and its subsidiary Scamp Creek) are the names that

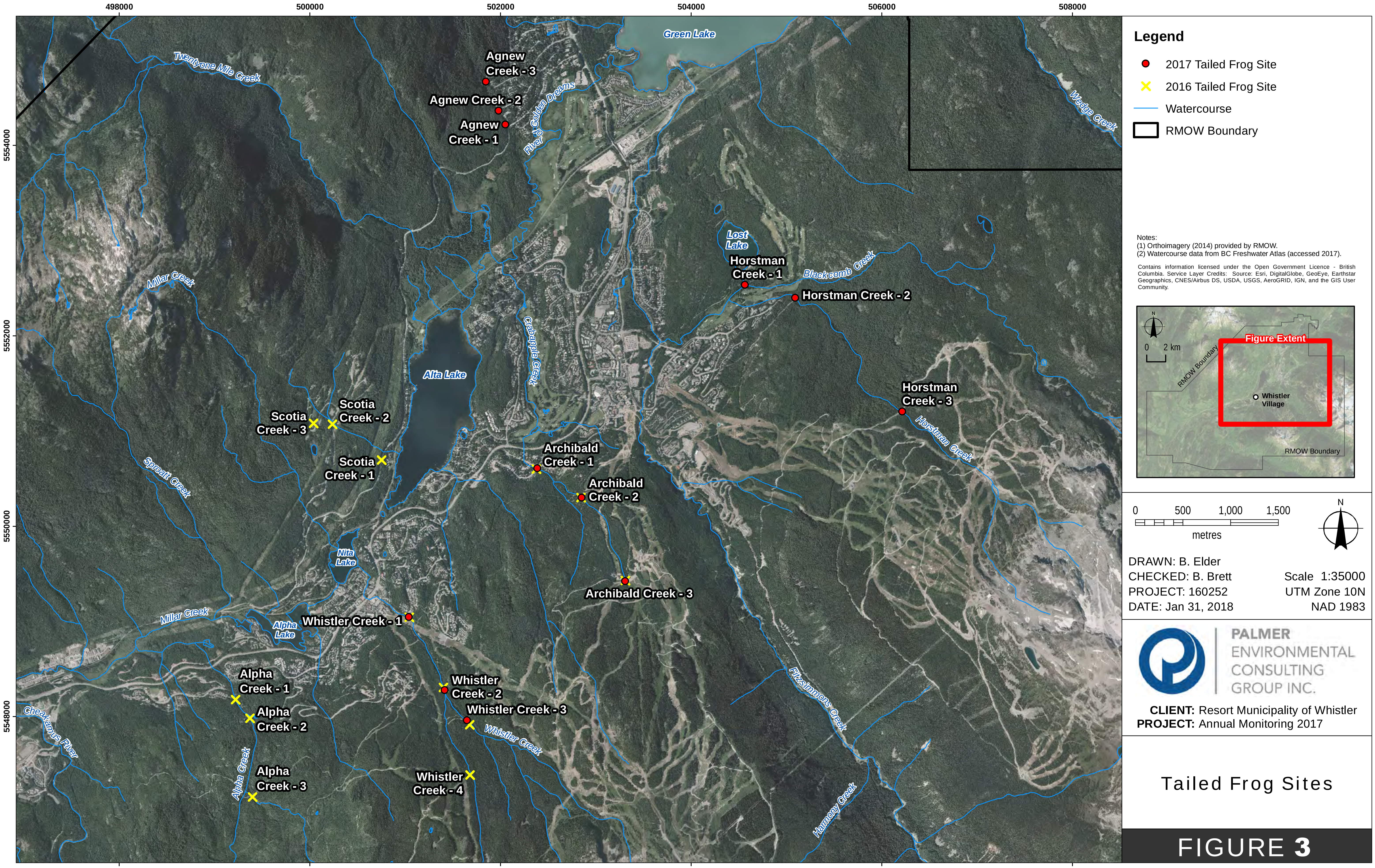
population in Nineteen Mile Creek since no tadpoles had been detected during the only previous survey conducted in this creek in 2006 (Wind, 2006).

The 2016 survey adopted the survey approach conducted in 2013 to 2015 (Cascade), with some changes to site and reach selection. Since no tadpoles were detected during the 2014 and 2015 programs in Nineteen Mile Creek, nor during the survey conducted in 2006 (Wind 2006), the low detectability or absence of a breeding population make this system unsuitable for monitoring. One goal of the monitoring program is to broaden the geographic range of streams surveyed by rotating out streams that appear stable or not under immediate threat. Thus, Whistler Creek replaced the Nineteen Mile Creek sampling site since it is known to have breeding throughout the system (Wind 2006, 2008, 2009; Figure 3).

A second change to the protocol was to survey, where possible, a greater elevational range of reaches within each system to help understand habitat use and monitor tailed frogs in these areas. Surveying at mid-mountain or above is especially important since the effects of development are primarily concentrated at lower elevations, e.g., housing and mountain activities related to mountain biking and snow sports.

The same approach was followed in 2017 to broaden geographic range of surveys: Two new creeks were added (Horstman and Agnew) as replacements for Alpha and Scotia creeks (Figure 3; Table 5). Alpha and Scotia creeks had been surveyed extensively by the WBP and Cascade and detections of tailed frog remained relatively similar. Since there were no obvious threats to Alpha and Scotia creeks (from development or otherwise), they were rotated out of surveys (for at least the next few years). In 2017, Horstman Creek was added to the program as a survey location for tailed frog to increase the spatial distribution of creeks northward, as well as to monitor a creek in a highly used area. In addition, the elevational range of Horstman Creek is the largest (a range of 518m, from 687m to 1206m) of all sampling areas within the Environmental Monitoring Program. Horstman Creek had many detections of tailed frogs in surveys conducted by the WBP in 2006, but otherwise has not been surveyed. In addition to Horstman Creek, Agnew Creek was added to increase the representation of creeks on the west side of Whistler Valley (where there are relatively few creeks suitable for usual sampling methods). Agnew Creek has not previously been sampled for Coastal tailed frog.

appear on Provincial mapping upstream of Highway 99. Tadpoles were first documented in the creek in 2006 (Wind 2006) and their abundance and visibility on rocks make the site upstream of Panorama Drive (Archibald Creek 1) the easiest location in Whistler to see them. Tailed frogs from Archibald Creek have been captured for display at Whistler BioBlitzes from 2007 through 2016 due to the ease of capture.



Tailed Frog Sites

FIGURE 3

Document Path: C:\Egnyte\Shared\Projects\Active\16025 - Resort Municipality of Whistler\160252 - 2017 Annual Monitoing\Mapping\mxd\160252_Figure_TailedFrogs.mxd

Table 5. Tailed frog sampling sites, 2017. Surveyors for all sites were Bob Brett (Snowline), Hillary Williamson (RMOW), and Luke Harrison (RMOW volunteer). Full site data is presented as Appendix G

Site	Date	Area (m^2)	Mapped Easting	Mapped Northing	Mean Elev. (m)	Weather	Air Temp. (°C)	Water Temp. (°C)	Slope (%)
Agnew Creek - 1	2017-08-31	16.8	502054	5554214	666	Cloudy	22	9.5	16
Agnew Creek - 2	2017-08-31	29.5	501982	5554360	680	Cloudy	21	9.4	8
Agnew Creek - 3	2017-08-31	9.9	501848	5554666	735	Cloudy	21	7.6	25
Archibald Creek - 1	2017-09-05	48.2	502387	5550606	695	Haze	19	13.0	17
Archibald Creek - 2	2017-09-05	16.0	502854	5550298	835	Haze	20	12.0	16
Archibald Creek - 3	2017-09-06	24.0	503310	5549422	1026	Haze	19	11.0	11
Horstman Creek - 1	2017-08-31	14.8	504565	5552532	687	Sunny	17	9.8	4
Horstman Creek - 2	2017-08-31	32.9	505094	5552397	736	Cloudy	12	9.0	15
Horstman Creek - 3	2017-09-06	8.5	506216	5551201	1206	Haze	19	9.0	32
Whistler Creek - 1	2017-09-05	6.7	501041	5549045	692	Haze	19	13.0	11
Whistler Creek - 2	2017-09-05	12.5	501417	5548276	879	Haze	18	13.0	4
Whistler Creek - 3	2017-09-05	17.0	501649	5547961	972	Haze	17	13.0	26

Average elevational range increased greatly between 2015 and 2016, and again in 2017 (Table 6). The preferred arrangement of the three reaches on each creek represents three elevational levels, from low to high:

(i) near valley bottom (up to about 700 m);
(ii) montane elevations (from about 700 to 950 m); and
(iii) upper montane/lower subalpine elevations, (from about 1,000 to 1,200 m, the approximate upper limit of tailed frogs in the RMOW).

However, topography and individual stream characteristics can hamper such systematic arrangements of sites; for example, there is difficulty sampling the upper elevations of Agnew Creek, above approximately 750 m).

Table 6. Tailed frog sampling sites by elevation and elevational range. Elevations for 2015 surveys were estimated from locations provided in Cascade (2014)

Creek	Valley side	2015		2016		2017	
		Elev. (m)	Range (m)	Elev. (m)	Range (m)	Elev. (m)	Range (m)
Agnew Creek - 1						666	
Agnew Creek - 2	West					680	69
Agnew Creek - 3						735	
Alpha Creek - 1		676		684			
Alpha Creek - 2	East	720	49	714	179		
Alpha Creek - 3		725		863			
Archibald Creek - 1		685		695		695	
Archibald Creek - 2	East	695	48	835	331	835	331
Archibald Creek - 3		733		1026		1026	
Horstman Creek - 1						687	
Horstman Creek - 2	East					736	519
Horstman Creek - 3						1206	
Scotia Creek - 1		661		661			
Scotia Creek - 2	East	765	153	773	156		
Scotia Creek - 3		814		817			
Whistler Creek - 1				693		693	
Whistler Creek - 2	East			875	437	875	292
Whistler Creek - 3				985		985	
Whistler Creek - 4				1130			
Average, all sites			83		276		303

Table Notes: The Cascade 2015 sites on Nineteen Mile Creek since their locations could not be ascertained. They were likely between approximately 645m and 700m due to the difficulty of accessing the creek, that is, a similar range to the three systems listed above.

Sampling design was changed in 2016 to a 30-minute timed search in which the best habitat within a reach was targeted for sampling (versus the fixed 5m stream lengths used in 2013-2015 surveys). This time-constrained method was also used in Whistler Biodiversity Project surveys (Wind 2006 to 2009). The main goal of this change was to increase detections by allowing surveyors to sample more optimal habitat, and the results generated in 2016 support the use of this change going forward. Total September detections from 12 stream reaches sampled in 2016 more than tripled detections in previous years (from 9 tadpoles to 39 tadpoles, an increase from 3.8 tadpoles/100m^2 to 12.9 tadpoles/100m^2, respectively). Higher detections are necessary to increase the reliability of analysis of population trends, though even the 2016 detections are still lower than ideal (B. Bury, pers. comm.[4]).

One important element of the 2016 approach was to measure the area sampled which permitted direct comparisons with 2013-2015 area-constrained surveys. An unexpected result from the 2016 surveys was

[4] *By email to Brent Matsuda and Bob Brett.*

that the average area surveyed per reach increased only slightly from the 2015 area-constrained surveys (from 19.7 m^2 in 2015 to 23.2 m^2 in 2016). Both approaches therefore measure time and area and the time-constrained approach, though not specifically designed to measure relative abundance, nonetheless provides some equivalence.

Data collection methods were otherwise the same for all tailed frog surveys since 2004. The in-stream surveys consisted of overturning unembedded cover objects such as rocks with dip nets held immediately downstream to catch any dislodged animals (Figure 4). Rocks were also swept by hand to detect any clinging tailed frog larvae before being set back in their original positions, as were large anchored rocks and large woody debris. Data collected at each site included:

- Site characteristics including: location, weather, overhead cover, and stand type;
- Stream characteristics such as morphology, substrate size and shape, slope, and bankfull and wetted widths;
- Water temperature and pH; and
- Total survey area (measured with a cloth tape to the nearest 0.1m).

Figure 4. Luke Harrison (RMOW volunteer) and Hillary Williamson (RMOW) surveying Whistler Creek.

Figure 5. 12 tadpoles captured by one surveyor at Whistler. Creek 1 and kept in a bucket for measurement and classification into cohort and developmental stage.

Data collected for tadpole captures also followed standard methods, including measures of total length for tadpoles (snout to ventral length for later stages), and classification into cohorts based on developmental stage (Figure 5) described by Malt *et al*. (2014) to reflect age (for example, first year (T1), second year (T2), etc.) as follows:

- T1 (tadpole, no visible hind legs);
- T2 (tadpole, recognizable hind legs with knees that do not extend beyond the anal fold);
- T3 (tadpole, conspicuous hind legs with knees that extend out from body); and
- Non-tadpole – metamorph (tail plus front legs), juvenile (no tail, small, no nuptial pads); and adult (larger than juvenile, male has tail and nuptial pads, females larger than males).

This classification scheme was used in the 2013-2015 surveys[5] conducted by Cascade and was also followed in 2016 surveys. During test surveys conducted prior to 2016 surveys, some apparent strong discrepancies between length and developmental stages within and between streams emerged. There was some doubt that developmental stages were reliable proxies for the number of years since hatching, especially between streams within different growing conditions (mainly temperature). This suspicion was later confirmed by Pierre Friele (pers. comm.) who emphasized that the link between developmental stage, length, and age is even more tenuous when applied across large geographic gradients in which climate differs. As a result, the 2016 surveys measured the length of each tadpole and classified to cohort as described by Malt *et al*. (2014), but also noted more detailed developmental stages (i.e., more detailed subsets of Malt *et al*.'s classification) as follows:

1. Hatchling (<15mm);
2. No hind legs;
3. Bulge only, hind legs not defined;
4. Hind legs visible but covered;
5. Hind feet protruding; and
6. Hind knees protruding outside body.

To allow comparisons with past surveys (conducted by both WBP and Cascade), 2016 results were reported according to the Malt *et al*. (2014) classification. Data collection in 2017 followed 2016 with the goal of further analyzing the relationship between developmental stage, length, and age.

To prevent recaptures, all individuals were placed in buckets and released upon completion of the site survey (RIC 2000). Sampling was planned for late-August to early-September when the chance of adult encounters in increased and stream flows increase the detectability of tadpoles. Surveys in 2016 were hampered by inclement weather and field crew schedules and spanned from September 14 to 22. This late finishing date meant that the last surveys occurred after streams had cooled significantly, which was the likely cause of low detections (for example at Archibald Creek 1).[6] Sampling in 2017 was approximately two weeks earlier, from August 31 to September 6 (Table 5).

<u>*Data Analysis*</u>

The total number of tadpoles was compared among 2015, 2016, and 2017 surveys. Results from the 2016 and 2017 surveys were also reported as detections per unit area (per 100 m^2) to permit comparisons between the 2015 area-constrained method and the time-constrained method used during the 2016 and 2017 surveys. Additional parameters for analysis and comparison included: captures by stream system, by elevation, and by age cohort.

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[5] Candace Rose-Taylor, email to Bob Brett.

[6] A mid-August reconnaissance at that site by B. Matsuda and B. Brett yielded approximately 20 tadpoles within 20 minutes, including many individuals clearly visible on top of rocks in the stream flow. The September 21, 2016 survey there only detected one tadpole.

Quality Assurance/Quality Control

For consistency, the same two surveyors searched each reach for 15 minutes while a third recorded site, stream, and capture data. A trial survey was first used to ensure that measurements were consistent between surveyors. Special care was taken to ensure that cohort classes and developmental stages (see above) were recorded consistently. Photos of representative tadpoles in each class were used as guides to improve consistency between surveyors (e.g., Figure 6 and Figure 7).

Figure 6. **Tadpole cohort 2 (T2); developmental transitional to stage 4 (the hind legs are covered and just starting to be defined).**

Figure 7. **Tadpole cohort 3 (T3); developmental stage 6: hind knees protruding outside body.**

2.3.2.2 Beavers

Beavers are a keystone species, second only to humans in their ability to alter the landscape, especially in a flat valley such as Whistler. The ponds and wetlands created by Whistler's beavers provide important habitat for a wide range of other species groups including waterfowl (e.g., ducks and herons), mammals (e.g., otters), and insects such as dragonflies, amphibians, snakes, fish, and aquatic plants. Flooding and other damage caused by beavers can bring them into conflict with humans, which is why there is a long history of removing beavers from urban and other habitats.

From an ecological perspective, it is important to maintain the presence of this keystone species, which is why the Whistler Biodiversity Project initiated Whistler's first beaver census in 2007 (Brett 2007; Mullen 2008) and expanded it to its greatest extent in 2008 (Mullen 2009). With the exception of 2012, beaver surveys have been conducted each year, though with a narrower scope to focus on resurvey of past lodge locations (Pevec 2009; Tayless 2010; E. Tayless and J. Burrows, unpubl. data 2011). The program was adopted by Cascade in 2013 and continued to focus on a subset of lodges over the 2013, 2014 and 2015 field season (Cascade 2014, 2015, 2016). In 2016, the focus of the beaver surveys returned to a full census approach, whereby all possible active beaver locations within Whistler Valley were enumerated. Likewise, the program conducted in 2017, described in this report, continues to represent a full census.

Beavers provide a very unusual situation for field biologists in that it is possible to document all colonies (overwintering lodges) in a valley the size of Whistler. This information, when combined with an estimated multiplier of beavers per colony, provides a population census that can be monitored without statistical analysis as required in population surveys (statistical sampling). The human equivalent is the Canada census compared to election polling: the former includes the whole population while the latter includes a small subset and uses statistical analysis to estimate figures for the whole population.

Another reason why a census for beavers is beneficial is that beavers are colonial animals. They maintain a family lodge which houses the adult parents and generally two years of offspring, both newborns and yearlings (Müller-Scharze and Sun 2003). Two-year-old beavers typically disperse to form new colonies, except when quality habitat is already occupied dispersal is sometimes delayed.

A lodge can remain active indefinitely but more often it is periodically inactive or abandoned permanently (as shown by Whistler data). The dispersal of offspring, death, and migration of adults indicate that the location of active lodges changes each year within the landscape (here defined as lower elevations in Whistler Valley). A full census of beaver activity will, once fully re-established, provide more complete and accurate information about changes to Whistler's beaver population than would a smaller sample.

Data Collection Methods

Late-fall surveys for beaver are ideal as they confidently confirm lodges that are used for overwintering, thereby representing an active colony. Other lodges and bank burrows can be used in summer months which, if counted, would over-estimate the population. Thus, searches for beaver should occur as late in the snow-free fall months as possible.

The census relied on several sources for determining search sites:

- Data from past studies starting in 2007 (Brett 2007);
- Incidental sightings by project staff (K. Jones and B. Brett); and
- Anecdotal reports from residents.

Each search recorded all past and current beaver activity, e.g., freshly cut branches and trees, tracks, food caches submerged in the water, new twigs and branches on dams, new construction on lodges (fresh mud or branches), tunnels through terrestrial vegetation, and exit slides from water edges (Figure 8 and Figure 9). In most cases, it is possible to confidently label a lodge (or area) as "active" based on observations that include:

- Sightings of beavers entering and exiting, or at least in the area;
- New construction or repair, especially in the fall;
- Functioning and freshly-maintained dam(s)
- Fresh food caches submerged at the entrance to a lodge;
- Beaver tracks;
- Well-worn paths (tunnels) through vegetation that links to the lodge's pond; and
- Evidence of extensive clippings and cuttings along those paths.

Figure 8. Late fall beaver activity (left) adjacent to the lodge just offshore of the Alpha Lake dog beach (right)

Figure 9. Signs of beaver activity from the River of Golden Dreams: a lodge (left); tracks (middle); and a runway through adjacent vegetation (right)

Signs of definite inactivity include:

- Absence of any beaver sightings in the area; and
- Absence of a structurally sound lodge; and
- Absence of functioning or freshly-maintained dam(s); and
- Absence of any other fresh signs (i.e., that were obviously from 2016).

Such definitive observations are not always possible which is why all beaver surveys to date include a third classification: “Unknown,” applied to sites for which there isn’t enough evidence to conclude whether they are active or inactive.

Data Analysis

Results from beaver surveys are directly comparable year to year. The surveys update the status of previously documented lodges and add any new lodges identified. Two factors introduce uncertainty into the interpretation of the count of active lodges: (a) lodges for which occupation is unknown; and (b) an incomplete census, that is, an unknown number of lodges that were not assessed. One primary goal of beaver surveys or censuses is to monitor the total population within an area, and this also introduces uncertainty since it requires estimating the number of beavers that occupy each lodge.

The number of beavers per family (overwintering lodge) is based on several factors, especially habitat type and beaver density (Müller-Schwarze and Sun 2003). In 2008, data was averaged from five studies to derive an estimate of the total Whistler beaver population based on 5.8 beavers per lodge (Mullen, 2008). This multiplier has been used each year since to derive an estimated total population. Other studies (Müller-Schwarze and Sun 2003) reported the average number of beavers per family from twelve locations that ranged from 4.1 to 8.2 in which half were 5.1 or below and the average was 5.6 (Table 7). This source suggests the multiplier used in Whistler studies to date is reasonable, though may be slightly high.

Table 7. Number of beavers per family in various locations (Müller-Schwarze and Sun 2003)

Location	Avg. No. per Family	Location	Avg. No. per Family
Alaska	4.1	**Alleghany**	5.4
Montana	4.1	**Ohio**	5.9
Newfoundland	4.2	**Colorado**	6.3
Adirondacks	4.3	**Isle Royale**	6.4
California	4.8	**Massachusetts**	8.1
Michigan	5.1	**Nevada**	8.2

Quality Assurance and Quality Control

In 2017, all possible known sites, both recent and historic, were surveyed and photo-documented. All anecdotal reports were recorded and verified in the field.

3. Results and Discussion

3.1 Aquatic Habitat

3.1.1 Habitat Assessment and Water Quality

In situ water quality data collected during fish and benthic invertebrate sampling in July and August 2017 is provided in Table 8. Measurements were taken on two sampling dates at several sites (sites CRB-DS-AQ01, JOR-DSAQ31, and 21M-DS-AQ12) and results were consistent between sampling dates. Specific conductance was relatively low, except at CRBDS-AQ01 and pH was typically neutral (close to 7.0 pH units). Dissolved oxygen (DO) was relatively consistent across the sites, ranging from 8.23 mg/L to 11.33 mg/L. Overall, the *in situ* water quality results were within acceptable ranges for the parameters measured and do not point to any water quality issue.

Table 8. Results for water quality parameters measured in situ at aquatic sampling sites, 2017

Site	Waterbody	UTM Location (Zone 10)		Date/Sampling Event	Time	Water Temperature °C	pH	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm)
		Easting	Northing						
21M-DS-AQ21	Twentyone Mile Creek	501935	5552824	25-July-17 / Benthic Sampling	13:47	11.6	7.13	11.33	40[1]
				1-Aug-17 / Fish Sampling	14:32	13.5	7.35	8.23	48.7
CRB-DS-AQ01	Crabapple Creek (Archibald Creek)	502021	5552707	25-July-17 / Benthic Sampling	10:02	12.0	7.4	11.6	336.3
				1-Aug-17 / Fish Sampling	13:01	14.2	7.42	10.61	273.9
RGD-US-AQ11	River of Golden Dreams	501994	5552793	25-July-17 / Benthic Sampling	11:40	10.5	7.06	11.02	50.5
RGD-DS-AQ12	River of Golden Dreams	503029	5554676	25-July-17 / Benthic Sampling	15:35	13.0	6.96	9.77	73.3
JOR-DS-AQ31	Jordan Creek	500184	5549252	26-July-17 / Benthic Sampling	8:55	14.9	7.10	8.9	105.1
				2-Aug-17 / Fish Sampling	9:18	16.2	7.26	11.21	109.7

Table Notes: [1] Error message of "under readable range" was present on YSI Water Quality Meter

- *The Canadian Water Quality Guidelines for the Protection of Aquatic Life state the lowest acceptable dissolved oxygen concentration, for a cold water aquatic ecosystem, as 9.5 mg/L for early life stages, and 6.5 mg/L for other life stages.*
- *The Canadian Water Quality Guidelines for the Protection of Aquatic Life, state the guideline range for pH as 6.5 to 9.0.*

3.1.2 Stream Temperature

Mean monthly stream temperatures in the study streams ranged from 0.46°C in February (Crabapple Creek), to 17.7°C (Jordan Creek) in August (Figure 10). The highest temperatures were observed during July and August in all five creeks. Jordan Creek was the warmest creek, with mean monthly temperatures typically 2-3 degrees higher than the other creeks during the spring and summer months. Crabapple and Alpha Creek temperatures tracked closely to one another; however, the River of Golden Dreams, Crabapple, Scotia and Alpha creeks all had similar temperature trends.

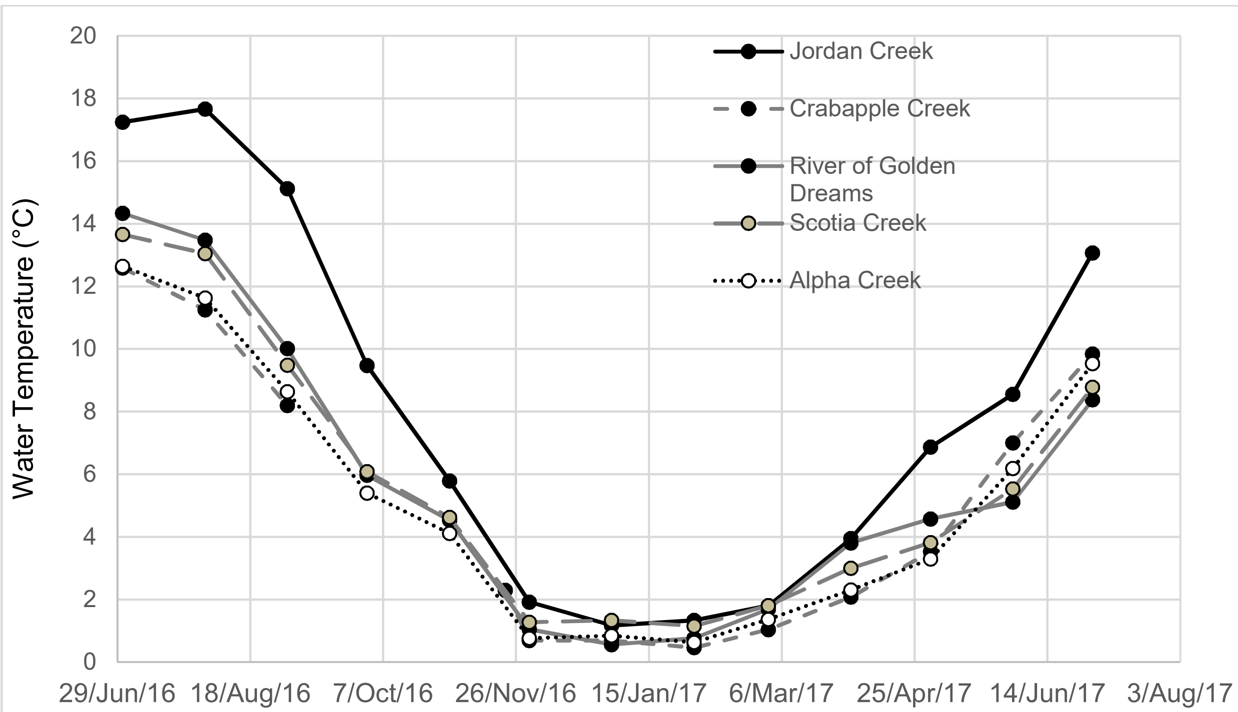


Figure 10. Mean monthly stream temperatures, Whistler, 2017.

3.2 Aquatic Species

3.2.1 Benthic Invertebrate Community

3.2.1.1 Benthic Invertebrate Community Descriptors

Benthic Invertebrate Abundance

Total abundance of benthic invertebrates ranged from 2,575 individuals at the site on Crabapple Creek, to 1,000 individuals at the downstream site on the River of Golden Dream (Figure 11). Overall, Crabapple Creek displayed the highest total abundance (2,575), followed by Jordan Creek (2,571), Twentyone Mile Creek (1,638), upstream site on River of Golden Dreams (1,113), and finally the downstream site on River of Golden Dreams (1,000).

Ephemeroptera, Plecoptera, and Trichoptera (EPT) abundance was highest at Crabapple Creek (2,238 EPT organisms), and lowest at the Jordan Creek site (507 EPT organisms). EPT abundances within the study area demonstrated similar patterns relative to total abundance among sites, with the exception of Jordan Creek, which displayed EPT abundances similar to those at the downstream site on the River of Golden Dreams (Figure 11). A significant relationship was not identified between total and EPT abundance in 2017 (Linear Regression, R^2=0.182, p=0.483). This differed from the relationship observed in 2016, which was significant (Linear Regression, R^2=0.827, p=0.032).

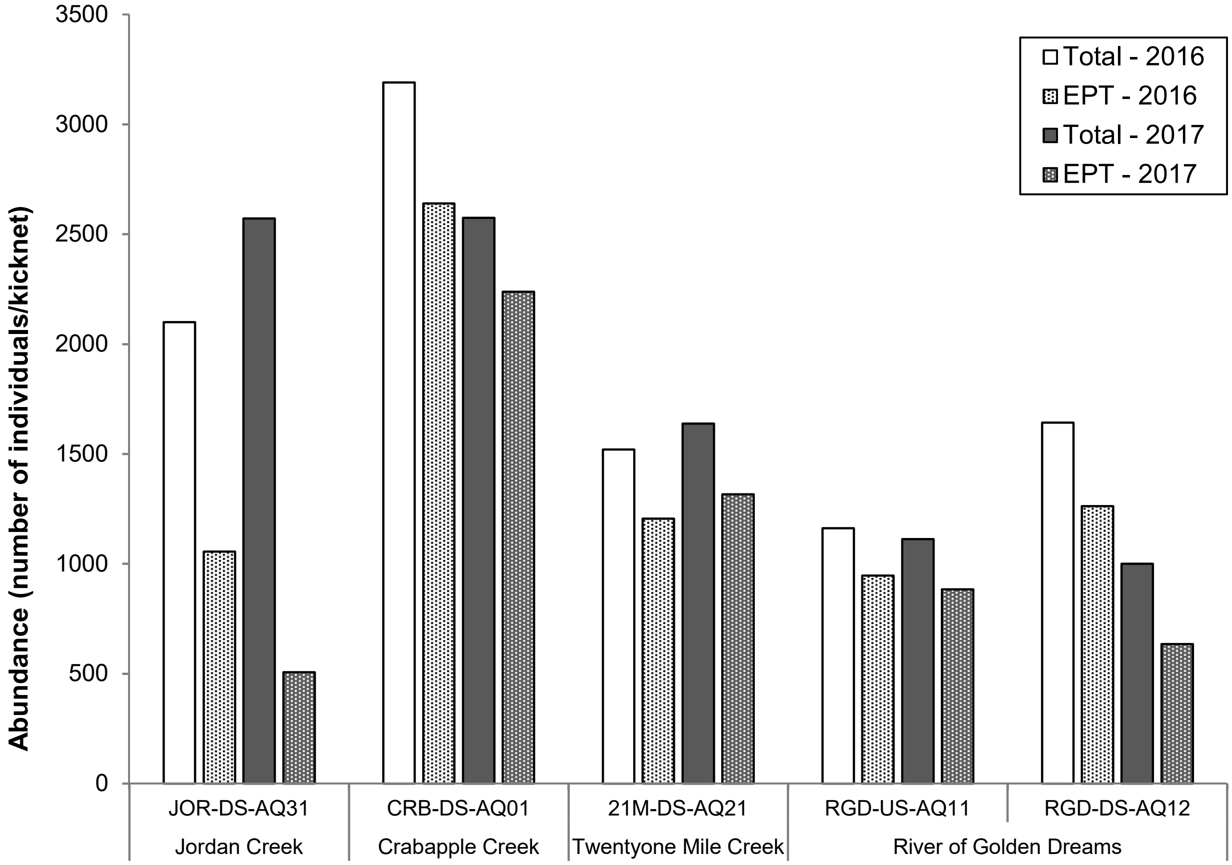


Figure 11. Benthic invertebrate total and Ephemeroptera, Plecoptera and Trichoptera (EPT) abundance by site and year, 2016 and 2017

<u>*Benthic Invertebrate Community Composition*</u>

Figure 12 demonstrates the density of benthic invertebrate communities at each sampling site. Most sampling sites had similar community structure, with the exception of Jordan Creek. Ephemeroptera (mayflies) were the dominant benthic invertebrate group at all sites except Jordan Creek, making up approximately 60-75% of the community composition at each site. Plecoptera (stoneflies) were present at each site, contributing up to 9% to community composition. Diptera (true flies) were dominant at Jordan Creek (80%), and were subdominant at all other sites, making up 12-33% of community composition. Small percentages of (<3%) of Trichoptera were also present at the most sites but were absent at Twentyone Mile Creek. Other taxa groups typically made up less than 3% of the community composition at each site.

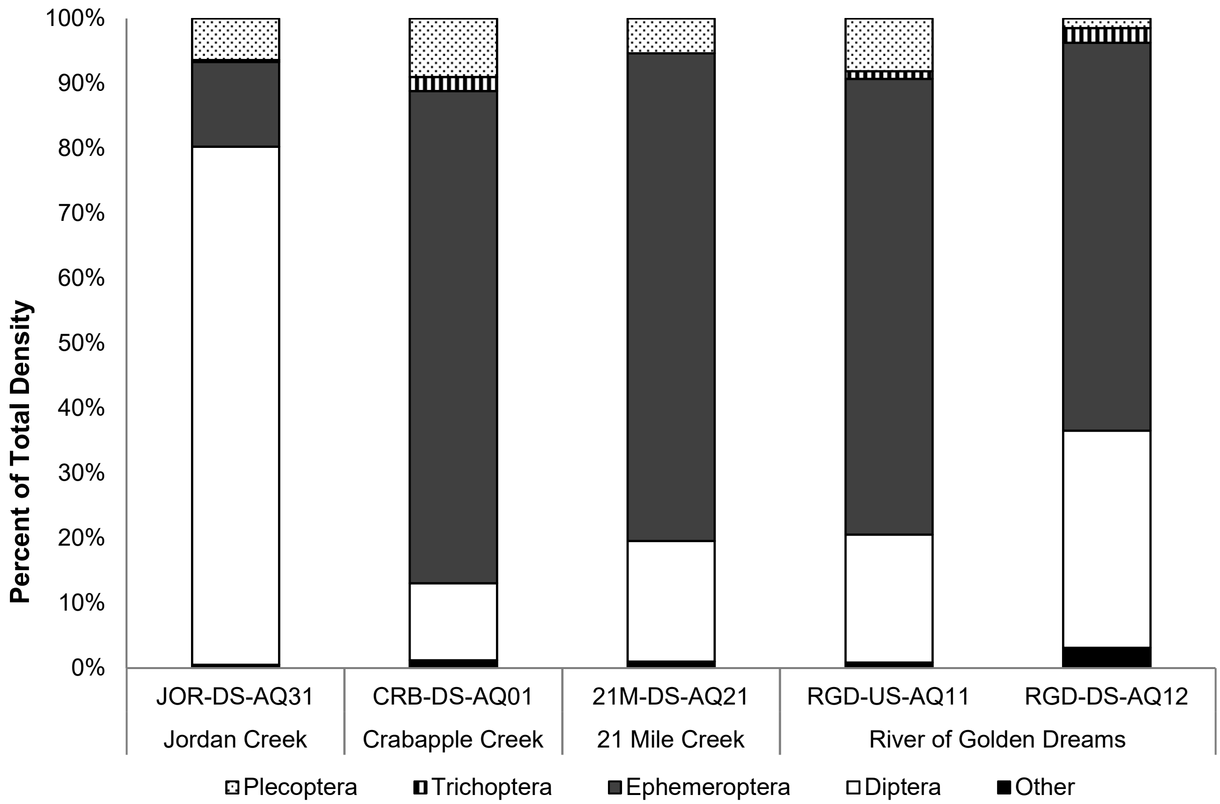


Figure 12. Relative densities of benthic invertebrate communities by site, 2017

Benthic Invertebrate Taxonomic Richness and Diversity

Benthic invertebrate taxonomic richness was highest (14 taxa) at Jordan Creek (JOR-DS-AQ31), and lowest (10 taxa) at Crabapple Creek (CRB-DS-AQ01) (Figure 13). This differed from 2016, where taxonomic richness was highest (21 taxa) at the downstream site on the River of Golden Dreams (RGD-DS-AQ12), and lowest (16 taxa) at Jordan Creek (JOR-DS-AQ31) (Figure 13). Generally, taxonomic richness was lower at all sites in 2017 compared to 2016. EPT taxa richness was highest at Jordan Creek and the upstream site on the River of Golden Dreams (8 taxa) (Figure 14). EPT organisms, which are pollution sensitive and are therefore good indicators of impaired habitat quality, dominated the sites in the River of Golden Dreams watershed, with these taxa forming >60% of organisms at the sites (Figure 15). Jordan Creek had a notably lower proportion of EPT organisms (20%, Figure 15), and was dominated by Diptera, which are generally more tolerant to organic pollution. The Shannon-wiener diversity index characterizes species diversity in a community and accounts for taxa richness as well as the proportion of each species (evenness). The sites on River of Golden Dreams and Twentyone Mile Creek supported the highest diversity values (1.40 to 1.77, Figure 16). Crabapple Creek and Jordan Creek had the lowest diversity values of 1.07 and 1.21, respectively.

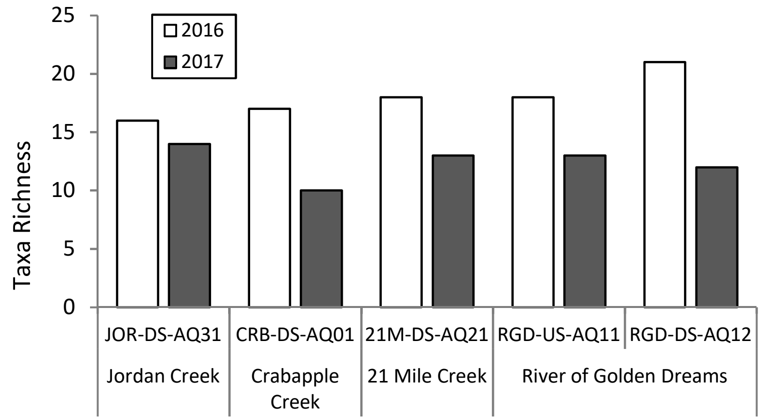


Figure 13. Benthic invertebrate community taxa richness in August 2016 and 2017

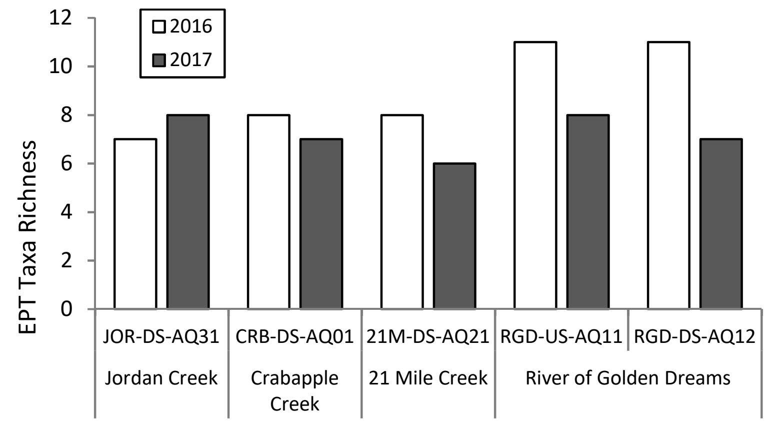


Figure 14. Benthic invertebrate community EPT taxa richness in August 2016 and 2017

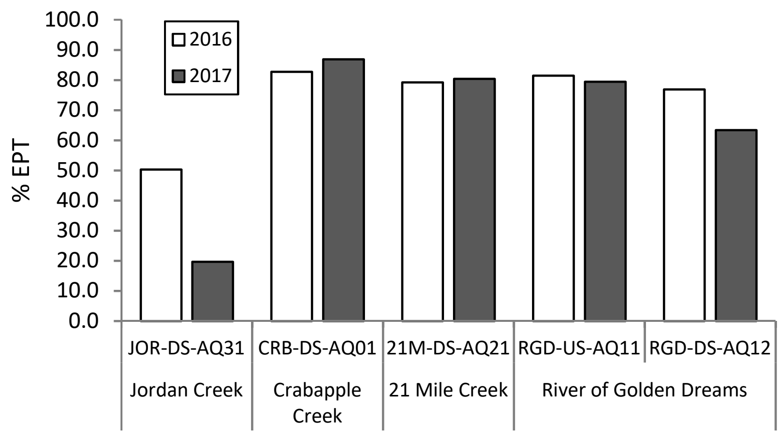


Figure 15. Benthic invertebrate community % EPT in August 2016 and 2017

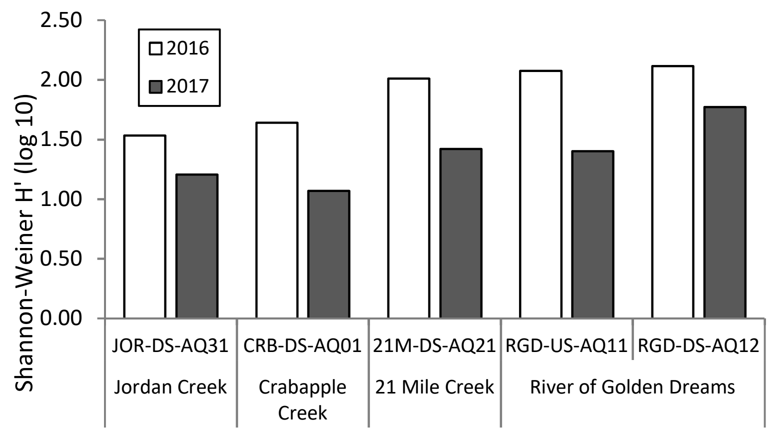


Figure 16. Benthic invertebrate community Shannon-Weiner indices in August 2016 and 2017.

Figure 17. Jordan Creek (JOR-DS-AQ31) benthic sampling area, looking upstream. Date taken: September 26, 2017

Figure 18. Jordan Creek (JOR-DS-AQ31) substrate (14% boulder, 53% cobble, 6% gravel, 27% pebble)

Figure 19. Crabapple Creek (21M-DS-AQ21) benthic sampling area. Date taken: Date taken: July 25, 2017

Figure 20. Crabapple Creek (21M-DS-AQ21) substrate (7% cobble, 30% gravel, 63% pebble). Date taken: Date taken: July 25, 2017.

Figure 21. **Twentyone Mile Creek (21M-DS-AQ21) benthic sampling area. Date taken: Date taken: July 25, 2017.**

Figure 22. **Twentyone Mile Creek (21M-DS-AQ21) substrate (47% cobble, 11% gravel, 39% pebble). Date taken: Date taken: July 25, 2017.**

Figure 23. **River of Golden Dreams Upstream (RGD-US-AQ11) benthic sampling area. Date taken: Date taken: July 25, 2017.**

Figure 24. **River of Golden Dreams Upstream (RGD-US-AQ11) substrate (8% cobble, 12% gravel, 78% pebble).**

Figure 25. River of Golden Dreams Downstream (RGD-DS-AQ12) benthic sampling area. Date taken: Date taken: July 25, 2017.

Figure 26. River of Golden Dreams Downstream (RGD-DS-AQ12) substrate (38% gravel, 62% pebble). Date taken: Date taken: July 25, 2017.

3.2.1.2 CABIN

CABIN analyses are summarized in site assessment reports (Appendix B). Figure 17 to Figure 26 show habitat conditions at the benthic sampling areas, as well as the typical substrate at each site. Substrate composition at each site was calculated based on the pebble count (CABIN protocol) and Table 9 outlines substrate composition (percent of total) at each aquatic sampling site. Twentyone Mile Creek, and the River of Golden Dreams were pebble dominated, while Crabapple Creek and Jordan Creek had coarser substrate (cobble-dominated).

Table 9. Substrate percent composition at each aquatic sampling site, 2017

	Aquatic Sampling Site				
Substrate	**JOR-DS-AQ31**	**CRB-DS-AQ01**	**21M-DS-AQ21**	**RGD-US-AQ11**	**RGD-DS-AQ12**
Pebble	27%	63%	39%	78%	62%
Gravel	6%	30%	11%	12%	38%
Cobble	53%	7%	47%	8%	0%
Boulder	14%	0%	0%	0%	0%

Based on the type and proportion of taxa present at each site, the BEAST prediction results (Table 10) show that, two aquatic sampling sites (JOR-DS-AQ31 and 21M-DS-AQ21) belong to Group 1 (probabilities: 95% and 68.79%), two sites (CRB-DS-AQ01 and RGD-US-AQ11) belong to Group 5 (probabilities: 38.98% and 43.40%) and one site (RGD-DS-AQ12) belongs to Group 4 (probability: 44.36%). Site RGD-US-AQ11 was sorted into Group 5 at a probability of 28.98%, Group 3 at 24.83%, and Group 5 at 38.98%. This indicates that the habitat characteristics of Site RGD-US-AQ11 are similar to all three reference groups.

Table 10. Probabilities of sorting in to each reference model group (based on habitat), for aquatic sampling sites, Whistler, 2016 and 2017

Site	Year	Group	Group 1	Group 2	Group 3	Group 4	Group 5
JOR-DS-AQ31	2016	1	70.98	0.33	21.47	0.26	6.96
	2017	1	**95.05**	0.23	3.80	0.00	0.92
CRB-DS-AQ01	2016	1	50.25	1.03	23.84	0.56	24.31
	2017	5	20.80	0.88	32.88	2.03	**43.40**
21M-DS-AQ21	2016	1	33.33	7.91	28.94	5.43	24.39
	2017	1	**68.79**	14.47	8.04	4.09	4.61
RGD-US-AQ11	2016	1	49.52	1.10	25.61	1.74	22.02
	2017	5	28.98	6.43	24.83	0.77	**38.98**
RGD-DS-AQ12	2016	5	13.02	0.99	28.60	9.03	48.36
	2017	4	25.99	1.91	13.40	**44.36**	14.35

Table Notes: bolded values indicate the maximum percentages calculated for each aquatic sampling site

The Bray-Curtis analysis (Table 11) indicated that of the five sites sampled, site CRB-DS-AQ01 is most similar in community structure to reference condition, and site JOR-DS-AQ31 is the most dissimilar. This differed from 2016 data, where site RGD-US-AQ11 was most similar in community structure to reference condition, and site CRB-DS-AQ01 was the most dissimilar. The RIVPACS tool assesses sites using the ratio of observed to expected (O:E) score, where sites with O:E ratios close to 1 are in good condition. All sites were close to the value of 1, with values ranging from 0. 90 (JOR-DSAQ31) to 1.22 (RGD-DS-AQ12) (Table 12).

Table 11. Bray - Curtis distances for aquatic sampling sites, Whistler, 2016 and 2017

Site	Year	Bray-Curtis Distance	Predicted Group Reference Mean ± SD
JOR-DS-AQ31	2016	0.86	0.55 ± 0.12
	2017	0.87	0.55 ± 0.12
CRB-DS-AQ01	2016	0.88	0.55 ± .012
	2017	0.65	0.47 ± 0.14
21M-DS-AQ21	2016	0.67	0.55 ± 0.12
	2017	0.74	0.55 ± 0.12
RGD-US-AQ11	2016	0.63	0.55 ± 0.12
	2017	0.80	0.47 ± 0.14
RGD-DS-AQ12	2016	0.73	0.47 ± 0.14
	2017	0.80	0.53 ± 0.17

Table 12. RIVPACS Observed /Expected Taxa Ratios for Aquatic Sampling Sites, Whistler 2017

Site	Description	Result
JOR-DS-AQ31 July 26 2017	RIVPACS : Expected taxa P>0.70	5.53
	RIVPACS : Observed taxa P>0.70	5
	RIVPACS : O:E (p > 0.7)	**0.90**
CRB-DS-AQ01 July 25 2017	RIVPACS : Expected taxa P>0.70	5.28
	RIVPACS : Observed taxa P>0.70	5
	RIVPACS : O:E (p > 0.7)	**0.95**
21M-DS-AQ21 July 25 2017	RIVPACS : Expected taxa P>0.70	5.28
	RIVPACS : Observed taxa P>0.70	5
	RIVPACS : O:E (p > 0.7)	**0.95**
RGD-US-AQ11 July 25 2017	RIVPACS : Expected taxa P>0.70	5.28
	RIVPACS : Observed taxa P>0.70	6
	RIVPACS : O:E (p > 0.7)	**1.14**
RGD-DS-AQ12 July 25 2017	RIVPACS : Expected taxa P>0.70	3.28
	RIVPACS : Observed taxa P>0.70	4
	RIVPACS : O:E (p > 0.7)	**1.22**

3.2.1.3 Discussion

The purpose of the benthic invertebrate sampling program was to characterise the benthic communities in the study streams and identify any potentially impaired sites. The 2017 sampling built on the 2016 data to allow for identification of temporal trends.

EPT organisms are sensitive to pollution, and therefore act as an indicator of poor habitat or impaired site health. The high proportion of EPT organisms present in Crabapple Creek, Twentyone Mile Creek, and the River of Golden Dreams sites, identified in both 2016 and 2017 programs, suggests healthy benthic invertebrate communities in the River of Golden Dreams watershed. Unlike these sites, the results for Jordan Creek indicated that the benthic community may be impaired, as this site was dominated by Diptera, which are typically tolerant to organic pollution. The reduced community health compared with the other sites may be due to a point source of organic pollution to Jordan Creek. Jordan Creek and Nita Lake, the headwater lake of Jordan Creek, are both relatively small, such that the degree of mixing and dilution of any pollution inputs would be small. Additionally, Nita Lake Lodge was constructed in approximately 2000 and discharges iron rich water into Jordan Creek upstream of the JOR-DS-AQ31 sample site. Further investigation into the properties of this discharge water (i.e. dissolved metals concentrations) is needed to characterize any potential effects to the benthic invertebrate community. This discharge could potentially be the reason for differences in benthic communities observed in Jordan Creek relative to the other sample sites.

Habitat conditions, such as substrate and temperature, have a direct relationship to the benthic community expected at the site. Crabapple Creek and both sites on the River of Golden Dreams were pebble dominated, while Twentyone Mile Creek and Jordan Creek had coarser substrate (cobble-dominated). Coarse substrate is preferred by many Ephemeroptera, Plecoptera and Trichoptera species, while finer substrate (sand, silt and organics) generally supports more Diptera and Oligochaeta. Jordan Creek had the lowest EPT abundance among the sample sites, despite the dominance of coarse substrate. Water temperatures in Jordan Creek were also warmer than the other study streams, and this may decrease habitat suitability for sensitive EPT taxa. This suggests that the benthic community in Jordan Creek may be impaired rather than benthic community differences due to substrate type.

CABIN analysis provided insight into the similarity of the monitoring sites in the RMOW to reference model sites using habitat variables and benthic invertebrate community composition. For consistency, the Fraser River-Georgia Basin Model 2005 (BEAST) model was chosen, as it was used in the analysis of the 2016 monitoring data. The BEAST model used habitat variables as well as the type and proportion of taxa present to assign each site to a reference Group (Sylvestre *et al*., 2005). Specific information for each Group can be found in the report outlining the Fraser River-Georgia Basin Model used for CABIN analysis (Sylvestre *et al*., 2005). The Bray-Curtis dissimilarity analysis found that the Jordan Creek benthic invertebrate community is the most dissimilar to reference conditions, further suggesting impairment of the Jordan Creek benthic community structure.

3.2.2 Fish Community

3.2.2.1 Species Composition, Relative Abundance, and Population Density

Field identification of juvenile trout can be confounded where Rainbow Trout occur in sympatry with coastal Cutthroat Trout, in part because of common hybridization events between the two species, and because hybrids themselves pose special identification difficulties (Baumsteiger 2005). Visual identification error rates for juvenile trout (sympatric Cutthroat and Rainbow Trout populations) can be quite high without genetic analyses to corroborate genotypes. For example, researchers in northern California found up to 38% of juvenile trout were misidentified to species in sympatric settings (Voight 2008). In the absence of genetic analyses to provide insights concerning the identities of individual fish and given the likelihood that Cutthroat and Rainbow Trout are sympatric and hybridize throughout the study area, we will discuss results in terms of “unknown” trout.

Three species of fish were identified in sampled streams during 2017 sampling efforts (Table 13). Threespine stickleback (*Gasterosteus aculeatus*) represented the overall dominant fish species captured during 2017 sampling efforts and dominated electrofishing captures in Crabapple Creek. This species was also captured in Jordan Creek and Twentyone Mile Creek but did not represent the dominant species. In Jordan Creek, undifferentiated trout fry from resident populations of Rainbow (*Oncorhynchus mykiss*) and Cutthroat Trout (*O. clarkii clarkii*) were the dominant fish species captured. Undifferentiated trout fry were also captured in Crabapple Creek. Trout were not captured in Twentyone Mile creek. Sculpin were also captured in all three sties. Sculpin was the dominant species captured in Twentyone Mile Creek but represented a smaller proportion of fish caught at Jordan and Crabapple Creek. In comparison, in the 2016 sampling program, which occurred approximately the same time of year, undifferentiated trout fry dominated captures in all creeks with Sculpin as the next most abundant species captured at Crabapple Creek and Twentyone Mile Creek, and Threespine Stickleback as the next most abundant species at Jordan Creek (Table 13).

<u>Potential hybridization between O. mykiss and O. clarkia</u>

Rainbow Trout have been stocked in Rainbow Lake (the headwater lake of Twentyone Mile Creek) in the late 1970s or early 1980s, whereas Cutthroat Trout (and Bull Trout [*Salvelinus confluentus*]) are native in the watershed in the lower reaches of Twentyone Mile Creek (with some Bull Trout as far upstream as Rainbow Falls) (Eric Crowe, pers. comm.). The coastal Cutthroat Trout is a blue-listed species, which means coastal Cutthroat Trout populations are considered vulnerable in British Columbia, and populations in the lower mainland are in serious decline (Costello, 2008; BC Conservation Data Centre, 2016; BC Ministry of Environment, 1999). Introgressive hybridization between native and introduced species is a growing conservation concern for native Cutthroat Trout and introduced Rainbow Trout in western North America (Allendorf and Leary 1988; Weigel *et al.* 2003; Bettles *et al*. 2005; McKelvey *et al.* 2016). Rainbow Trout and coastal Cutthroat Trout are known to hybridize throughout the overlap of their respective geographic ranges, and the stocking of non-native Rainbow Trout into areas occupied by naturally allopatric Cutthroat Trout has resulted in extensive introgressive hybridization between trout species (Bettles *et al.* 2005).

No potential hybrid offspring of *O. mykiss* and *O. clarkia* were captured in 2017. During 2017, field sampling efforts returned two salmonids that were greater than 80 mm in Jordan Creek (98 mm) and Crabapple Creek (96 mm); however, these individuals were identified as rainbow trout based on the absence of any cutthroat trout characteristics (Figure 28). During 2016, two juvenile salmonids (greater than 80 mm fork-length) were captured at Twentyone Mile Creek but were not discernible between species. These unidentifiable trout exhibited a combination of phenotypic traits suggesting they may potentially be hybrid offspring: both fish exhibited yellowish cutthroat-like "slash" marks under their jaw yet neither possessed the typically large cutthroat maxillary which extends past the eye (Figure 29). Rainbow Trout have been stocked in Rainbow Lake (the headwater lake of Twentyone Mile Creek) in the late 1970s or early 1980s, whereas Cutthroat Trout (and Bull Trout [*Salvelinus confluentus*]) are native in the watershed in the lower reaches of Twentyone Mile Creek, (with some Bull Trout as far upstream as Rainbow Falls) (Eric Crowe, pers. comm.).

***Table 13*. Fish Community Composition by site, Whistler, 2016 and 2017**

Site	Creek	2016				2017			
		TR	HY	TSB	CC	TR	HY	TSB	CC
JOR-DS-AQ31	Jordan Creek	68%	0%	29%	3%	60%	0%	20%	20%
CRB-DS-AQ01	Crabapple Creek	67%	0%	15%	19%	29%	0%	57%	14%
21M-DS-AQ21	21-Mile Creek	54%	3%	5%	38%	0%	0%	29%	71%
Species Total		61%	1%	13%	25%	30%	0%	35%	35%

Table Notes: TR = trout, HY = suspected hybrid trout, TSB = Threespine Stickleback, CC = Sculpin (General)

Fish Catch per Unit Effort (CPUE) by species is reported for each site (Table 14) and includes undifferentiated trout species. Figure 27 shows a comparison between the CPUE for each species captured during 2016 and 2017 sampling. In 2016, the mean CPUE was calculated at each site and presented for trout, rainbow/cutthroat trout hybrid, threespine stickleback and sculpin as CPUE was based on three passes of electrofishing relative to single pass methods conducted in 2017 (Figure 27).

***Table 14*. Electrofishing Catch per Unit Effort by Site and Species, Whistler, 2017.**

Site	Creek	Date	Effort (s)	Catch Per Unit Effort (#/100s)				
				CC	TR	HY	TSB	Total
JOR-DS-AQ31	Jordan Creek	02-Aug-2017	974	0.21	0.62	0.00	0.21	0.82
CRB-DS-AQ01	Crabapple Creek	01-Aug-2017	952	0.21	0.42	0.00	0.84	1.26
21M-DS-AQ21	21-Mile Creek	01-Aug-2017	833	0.60	0.00	0.00	0.24	0.24

Table Notes: CPUE are number of fish caught per 100s of electrofishing; Total = total CPUE for trout, rainbow/cutthroat trout hybrid, threespine stickleback and scuplin (general).

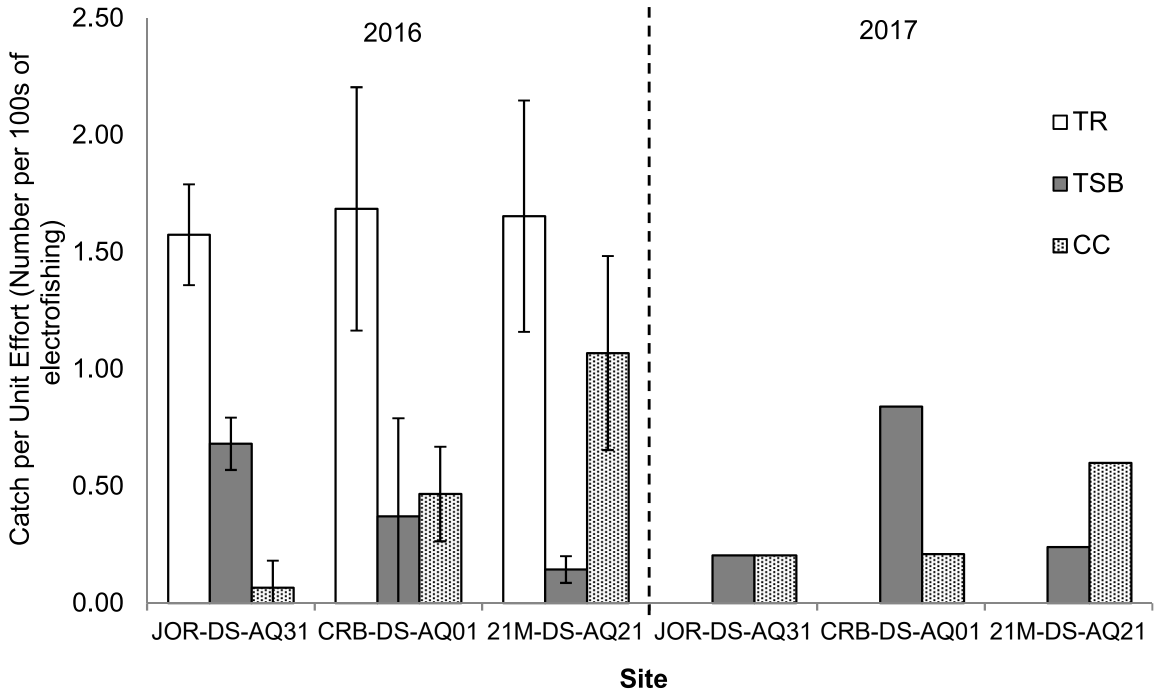


Figure 27. Mean electrofishing catch per unit effort by site, August, 2016 and 2017. TR= unknown trout, TSB = threespine stickleback, CC = sculpin general). Error bars for 2016 denote the standard deviation from the mean (three-pass electrofishing, n=3).

Figure 28. Rainbow trout (fork length 96 mm) captured in Crabapple Creek in 2017 (CRB-DS-AQ01). Date taken: August 1, 2017.

Figure 29. Suspected hybrid trout (fork length 84 mm) captured in Twentyone Mile Creek in 2016 (21M-DS-AQ21). Date taken: August 6, 2016.

3.2.2.2 Lengths, Weights, and Conditions of Sampled Fish

Mean length and weight of each fish species by site is reported in Table 15 and a length frequency analysis for trout sampled in both 2016 and 2017 is presented in Figure 30. Length of trout collected ranged from 27 to 160 mm, with an average length of 67.8 mm. Due to the limited sample size of fish collected in 2017, it is difficult to make accurate comparisons among fish communities; however, trout and sculpin from Jordan Creek had the greatest mean length and weight among the sites. The majority of trout (60%, n= 6) sampled from Jordan and Crabapple Creek in 2017 were less than 60 mm fork-length, which was similar to 2016 (Figure 30). Number of trout sampled during 2017 (20 individuals) was significantly less than 2016 (102 individuals).

Table 15. Mean (± standard deviation) length and weight of fish species collected in 2017

Site	Species	n	Length (mm)				Weight (g)			
			Min	Mean	Max	SD	Min	Mean	Max	SD
21M-DS-AQ21	CC	5	46	59.4	74	10.7	2.1	3.8	6.1	1.7
	TSB	2	47	55.5	64	12.0	1.4	2.4	3.4	1.4
CRB-DS-AQ01	CC	2	62	79	96	24.0	2.8	5.6	8.3	3.9
	TR	4	27	42	57	12.2	0.3	1.4	2.9	1.1
	TSB	8	25	35.6	42	6.1	0.3	1.0	1.7	0.5
JOR-DS-AQ31	CC	2	78	89	100	15.6	9.4	13.4	17.4	5.7
	TR	6	30	73.6	160	55.3	0.3	13.8	54.4	23.3
	TSB	2	51	51.5	52	0.7	1.4	1.5	1.6	0.1
ALL SITES	CC	9	46	68.9	100	17.5	2.1	6.9	17.4	5.1
	TR	10	27	67.8	160	43.3	0.3	9.3	54.4	17.4
	TSB	12	25	41.6	64	10.7	0.3	1.3	3.4	0.8

Table Notes: TR= trout; HY= suspected hybrid trout; TSB = Threespine Stickleback, CC = Sculpin (General), SD = Standard deviation from the mean.

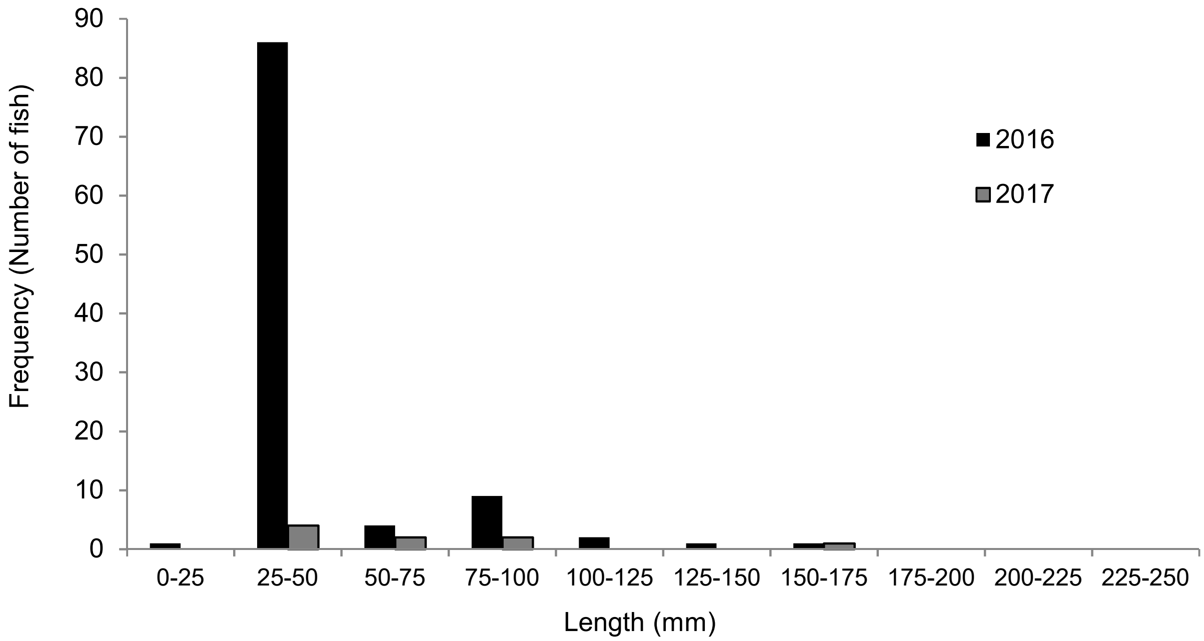


Figure 30. Length-frequency analysis for sampled trout in study streams, August 2016 and 2017

<u>Condition</u>

The length to weight relationship of all the trout sampled in 2016 and 2017 are presented in Figure 31. The length-weight linear regression for juvenile trout collected in 2017 was significant (Linear regression, slope = 2.91, R^2=0.99, df=7, P<0.01). Trout growth was shown to be isometric (t-test, t=0.76, df=7, P=0.47) with fish having relatively similar ratios between length and weight. In comparison, growth in 2016 was shown to be allometric (t-test, t=2.473, df=100, P=0.015) with fish becoming relatively lighter as length increased; however, sample size for trout was much greater in 2016. The low sample size of trout in 2017 (n = 9), means that statistics derived from the data will have limited power, and results should be interpreted with caution. For example Even though the length-weight relationship of 2016 and 2017 trout appear similar (Figure 31), analysis showed trout growth relationships (isometic vs. allometric) were significantly different. Mean relative condition (Kn) for sampled trout in 2017 was 0.835 ± 0.178 (standard deviation).

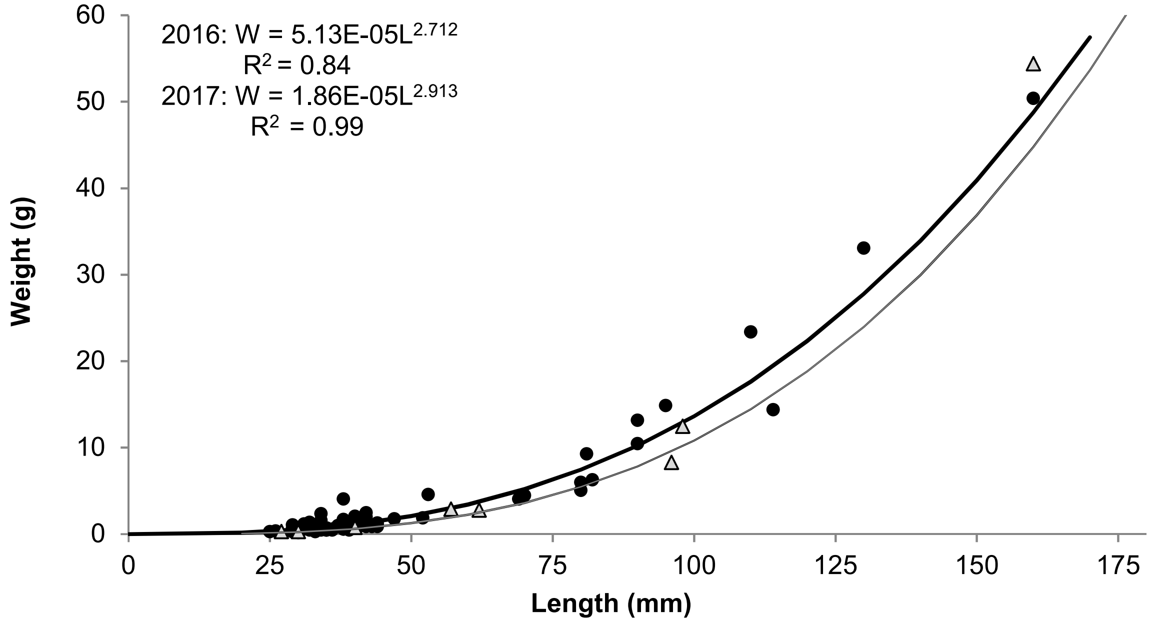


Figure 31. Weight-length relationship for juvenile trout in study streams, August 2016 and 2017

3.2.2.3 Discussion

The purpose of the fish sampling program was to develop a greater understanding of the fish communities in the project streams and to help identify any potential impacts to the sites. The 2017 sampling program built on the work completed in 2016 to allow for the identification of temporal changes to the fish community. Fish community health is a product of the environment in which they live in. As fish occupy a higher trophic level and are longer lived compared to other aquatic organisms (*e.g.* benthic invertebrates), fish community data can provide information on the long-term health of a system.

The fish community in Jordan, Crabapple and Twentyone Mile Creek was composed primarily of fish <60 mm, which were most certainly 0+ year fry, demonstrating the importance of the study reaches as rearing habitat for trout fry. To better understand the age distribution of trout in the study area, and the habitat contribution of the study creeks to the local fish community, future sampling efforts should incorporate the collection and aging of scale samples from all captured trout. Additionally, an increase is sampling effort is recommended in the future, with a minimum number of 8 individuals per species captured, to better understand the fish community and explore differences among areas. Limited sample size inhibits the ability to make spatial and temporal comparisons among the fish communities, and among years. Furthermore, with such a low prevalence of suspected hybrid trout within these systems, increasing sampling effort at each site would increase the probability of their capture.

3.3 Riparian Species

3.3.1 Coastal Tailed Frog

Tadpole detections from targeted surveys conducted between 2015 and 2017 are presented in Table 16 Tadpole detections almost quadrupled, from 9 to 39, from September 2015 to September 2016 (Appendix H). Increased detections were possibly due to different weather conditions or surveyor experience but, more likely due to the switch to a time-constrained method. This conclusion is bolstered by a further significant increase in detections from 39 tadpoles in 2016 to 87 in 2017. The increase in detections in 2016 was a combination of doubled detections in three creeks and, more significantly, high detections in Whistler Creek (the replacement for non-productive surveys at Nineteen Mile Creek (adapted in 2016). The increase in detections in 2017 was mostly attributed to significantly increased detections at both Archibald Creek (from 5 to 33 tadpoles, plus two adult males; Figure 32) and Whistler Creek (from 22 to 48 tadpoles, despite reducing the number of reaches sampled from four in 2016 to three in 2017).

Table 16. Tailed frog captures and water temperature from September 2015 (Cascade), September 2016 (PECG and Snowline, 2017) and September 2017 surveys

Survey Date	Site	No. of Reaches	Total Area (m^2)	Avg. Area (m^2)	Tadpoles	/100m^2	Avg. Water Temp. (°C)
Sept. 17-18, 2015	Alpha Creek	3	69.6	23.2	4	5.7	7.5
	Archibald Creek	3	46.9	15.6	4	8.5	8.7
	Scotia Creek	3	45.8	15.3	1	2.2	8.8
	Nineteen Mile Creek	3	73.6	24.5	0	0.0	7.9
	All Sites	**12**	**235.9**	**19.7**	**9**	**3.8**	**8.2**
Sept. 14-22, 2016	Alpha Creek	3	72.5	24.2	9	12.4	7.0
	Archibald Creek	3	45.2	15.1	5	11.1	6.4
	Scotia Creek	3	86.7	28.9	3	3.5	10.1
	Whistler Creek	4	97.6	24.4	22	22.5	8.8
	All Sites	**13**	**302.0**	**23.2**	**39**	**12.9**	**8.1**
August 31-Sept. 6, 2017	Agnew Creek	3	56.2	18.7	0	0.0	8.8
	Archibald Creek	3	88.2	29.4	33	37.4	12.0
	Horstman Creek	3	56.2	18.7	6	10.7	9.3
	Whistler Creek	3	36.2	12.1	48	132.6	13.0
	All Sites	**12**	**236.8**	**19.7**	**87**	**36.7**	**10.8**

Figure 32 Adult male frog and tadpole from Archibald Creek 3. A total of two adult males were discovered under flat rocks in the creek at this reach

Higher water temperature was the likely reason for increased detections in 2017, likely due to earlier sampling conducted in 2017 relative to previous years (Table 16) and consistently warmer weather in 2017 relative to 2016. There was a significant cooling of water temperatures between the two sampling periods conducted in 2016 (September 14-15 and 21-22). Water temperature in Archibald Creek averaged 6.4°C during the 2016 surveys (which occurred from September 21-22), and 12°C during the 2017 surveys (September 5). Temperatures in Whistler Creek were also significantly higher in 2017 relative to previous years.

Average area surveyed per reach in 2017 (19.7 m^2) was slightly lower than that surveyed in 2016 (23.2 m^2) and, coincidentally identical to time-constrained surveys conducted in 2015 (19.7 m^2; Table 16). This highlights results indicating that total captures and captures per unit area (which is a better indicator of relative abundance) were both approximately 10 times higher in 2017 relative to previous years. In 2017, an average of 36.7 tadpoles per 100 m^2 were detected versus 3.8 tadpoles per 100 m^2 in 2015. Detections by unit area from 2017 were almost three times higher than in 2016.

Detections in 2017 were lowest in Horstman (Figure 33) and Agnew (Figure 34) creeks (the newly added creeks for the 2017 program). Detections in Horstman creek in 2017 were lower than those reported in 2006 (Brett 2007) which is likely because most of the 2006 captures were from a side channel where stream flow was lower (where dip net surveys are more effective). The highest reach in Horstman Creek (Horstman 3) was the most difficult to survey due to large, embedded rocks, steep gradient, and high flow. No detections of Coastal Tailed Frog were recorded in Agnew Creek in 2017 despite reaches having habitat features normally associated with tailed frogs (cool water, reasonable flow, cobbles, etc.). The lack of detections does not mean there are no tailed frogs in this creek. This was the first year Agnew Creek has been surveyed, and future surveys could potentially attempt to survey higher reaches that may yield detections.

Figure 33. Horstman Creek –3, upstream.

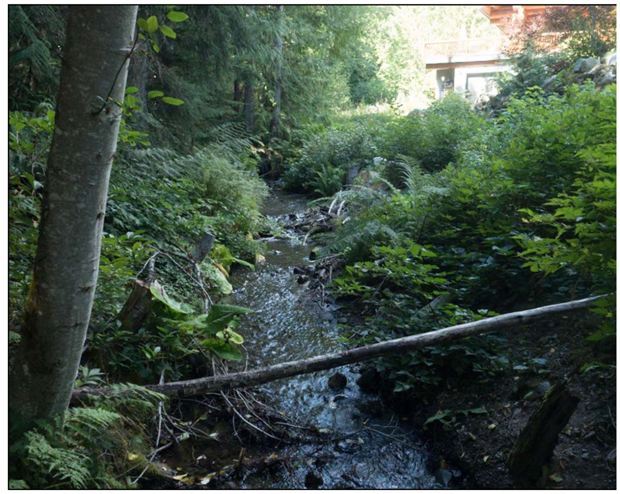


Figure 34. Agnew Creek 2, upstream.

Tailed frog captures by elevation and developmental stage are presented in Table 17. The proportion of tadpoles by cohorts (described by Malt *et al*. in 2014) was similar in 2016 and 2017 (Appendix H). The distribution by cohorts T1 through T3 in 2016 was 63%, 10%, and 23%. In 2017 the distribution in these cohorts was 72%, 13%, and 15%. Even though there were 44% more T3 tadpoles in 2017 (13 versus 9), increases in detections of that cohort were less than those for T1 (152%) and T2 (175%) cohorts. Two reaches, Whistler Creek 1 and Archibald Creek 3, accounted for 60% of T1 (youngest) and 44% of all tadpoles detected during 2017. It would be interesting to test if the proportion of T2 tadpole increases at these reaches in 2018 which would indicate the young tadpoles likely were hatched at the same or nearby (or upstream) site. It is also possible that T1 tadpoles are more detectable (that is, active versus hidden) in warmer weather and that is why a higher proportion of them were captured. The difference between years is likely explained by the lower and unexplained proportion of cohort 3 (T3) tadpoles detected in 2017.

Table 17. Tailed frog captures by elevation and developmental stage, 2016 and 2017

Site	Mean Elev. (m)	2016				2017			
		No. of Tadpoles	T1	T2	T3	No. of Tadpoles	T1	T2	T3
Agnew Creek - 1	666	Not Sampled				0	0	0	0
Agnew Creek - 2	680					0	0	0	0
Agnew Creek - 3	735					0	0	0	0
Alpha Creek - 1	684	3	0	1	2	Not Sampled			
Alpha Creek - 2	714	0	0	0	0				
Alpha Creek - 3	863	6	5	1	0				
Archibald Creek - 1	695	1	0	1	0	11	4	6	1
Archibald Creek - 2	835	1	1	0	0	5	2	1	2
Archibald Creek - 3[7]	1026	3	3	0	0	17	15	0	2
Horstman Creek - 1	687	Not Sampled				1	1	0	0
Horstman Creek - 2	736					5	1	2	2
Horstman Creek - 3	1206					0	0	0	0
Scotia Creek - 1	661	0	0	0	0	Not Sampled			
Scotia Creek - 2	773	0	0	0	0				
Scotia Creek - 3	817	3	1	0	2				
Whistler Creek - 1	693	7	4	2	1	11	9	0	2
Whistler Creek - 2	875	9	7	0	2	26	23	0	3
Whistler Creek - 3	985	2	2	0	0	11	8	2	1
Whistler Creek - 4	1130	4	2	0	2	Not Sampled			
	Total	39	25	4	9	87	63	11	13
	Percent		63%	10%	23%		72%	13%	15%

In 2017, there were no discernable patterns between detections of tailed frog and elevation of reach surveyed (Table 17), similar to results reported in 2016. For example, detections in Archibald Creek were highest at the low and high elevation sites and highest at Horstman and Whistler Creeks in the middle elevation sites. There was also no clear relationship between elevation and developmental stage, possibly with exception of a weak signal at the lowest Archibald Creek (reach 1). At this reach, most of the tadpoles (7 of 11) were in later cohorts (2 and 3). If tadpoles move downstream during their life cycle, it would follow that lower elevations would have a higher proportion of older frogs. An alternate theory is that warmer water speeds development and thus more T3 tadpoles would be found. Higher detections and more sampling sites would increase the power of future statistical analysis of these results. Additionally, for the first time since tailed frog surveys began in 2004, two adults (both male) were found at the same site (Archibald Creek 3). Adults are seldom found in these surveys because they tend to be seen outside the water, on the edge of the creek. Their dark colouration and typical low light conditions in these shaded creeks make them difficult to detect. The only adult male found last year was also under a rock in a stream, during a pre-survey

[7] *Two adult male frogs were also captured (Figure 32). Both were found under flat rocks approximately 15 cm below the water surface.*

trial in late-August. The presence of these males may be related to mating, that is, they may be returning to fall mating locations.

Results from 2017 (Table 18) show overlap between Malt *et al*.'s cohorts, similar to that reported in 2016. In 2016 tadpoles were classified by cohort (Malt *et al*. 2014) and by developmental stage (Malt *et al*. 2014) as well as by anatomical features that were observed in the field to help determine relationships between length, cohort, developmental stage, and age. Previous observations (Pierre Friele (pers. comm.) have demonstrated variability in the relationship between reaches, and especially among creeks that have very different growing conditions (due to elevation, climate, etc). The conclusion of these observations indicated that cohorts based only on developmental stages are not reliable indicators of age.[8] For example, the size range (mm) by cohort is as follows: cohort 1 (25-40), cohort 2 (34-42), and cohort 3 (40-50), which shows overlapping lengths and developmental stages. The most difficult classifications were for tadpoles demonstrating intermediate stages between cohort 1 and 2, and between cohort 2 and cohort 3 classifications as described by Malt *et al*. (2014). In the first case, many tadpoles were transitional between having an undefined "bulge" and defined legs contained within that bulge (Figure 7). In the second case, there were some tadpoles whose rear feet but not knees were free of the skin that covered the bulge. They were transitional to cohort 3 but without the exact characteristics described by Malt *et al*. (2014). This discussion is not meant to persuade anyone from using Malt *et al*.'s cohorts, but rather to suggest that it may not be valid to assume the age (cohort) of tadpoles is consistently related to developmental stage in RMOW streams. For future surveys, it may be useful to explore options while continuing to report results by cohort, to allow comparison with other studies.

[8] *There would presumably be a relationship within the same reach and perhaps system, but this would need to be established on a case-by-case basis.*

Table 18. Tailed frog captures by elevation and life stage. A comparison by cohort (Malt et al. 2014) between 2017 and 2016 is included at the bottom of the main table

		Cohort 0	Cohort 1		Cohort 2	Cohort 3		
Site	Total tadpoles	hatchling (<15mm)	no hind legs	bulge only, hind legs not defined	hind legs visible but covered	hind feet protrudin g	hind knees protrudin g	Adult Male (SVL in cm)
Agnew Creek - 1	0	0	0	0	0	0	0	
Agnew Creek - 2	0	0	0	0	0	0	0	
Agnew Creek - 3	0	0	0	0	0	0	0	
Archibald Creek - 1	11	0	0	4	6	0	1	37, 40
Archibald Creek - 2	5	0	0	2	1	1	1	
Archibald Creek - 3	17	0	5	10	0	2	0	
Horstman Creek - 1	1	0	0	1	0	0	0	
Horstman Creek - 2	5	0	0	1	2	2	0	
Horstman Creek - 3	0	0	0	0	0	0	0	
Whistler Creek - 1	11	0	3	6	0	2	0	
Whistler Creek - 2	26	0	10	13	0	3	0	
Whistler Creek - 3	11	0	0	8	2	1	0	
Total	87		18	45	11	11	2	
		2017	72%		13%	15%		
		2016	63%		10%	23%		
All Sites								
Total Tadpoles		0	18	45	11	11	2	
Mean Length (mm)		n/a	30	33	38	43	44	
Range (mm)		n/a	25 - 33	27- 40	34 - 42	40 -50	43 - 44	
Largest : Smallest		n/a	1:3	1:5	1:2	1:3	1:0	

Stream Disturbance

In 2016, there was significant deposition of sand and small gravel in Archibald Creek below the main part of the Whistler Bike Park (Figure 35 and Figure 36). The deposition was especially deep at the lowest reach, Archibald 1, located uphill of Panorama Drive in Brio. This site was downstream of the data logger that became clogged with sand and gravel in 2016. Two possible interpretations for the low number of tadpoles detected in 2016 were: (i) sedimentation; and (ii) low water temperatures.

Figure 35. Sedimentation in 2016 at Archibald Creek 1 (near Panorama Drive)

Figure 36. Sedimentation in 2016 at Archibald Creek 2 (near Crank It Up in the Whistler Bike Park)

In 2017, Archibald Creek was predominantly clear (i.e., few sediments in the water; Figure 37 and Figure 38) and detections of tadpoles were much higher relative to 2016. While it is difficult to interpret cause and effect due to limitations for determining statistical relationships, water temperature during surveys is a likely explanation for higher detections in 2017. If sedimentation caused significant problems in 2016, there presumably wouldn't have been a preponderance of younger/smaller tadpoles comparable to unaffected reaches. Future monitoring in Archibald Creek is useful for evaluating the effects of sedimentation and other threats on tadpoles.

Figure 37. Clear water and no significant sedimentation at Archibald Creek 1 in 2017

Figure 38. Some sedimentation upstream of Figure 37 in 2017, but much clearer water than in 2016

Reach 1 in Whistler Creek, originally added to the program in 2016, was heavily disturbed since surveyed in 2016 (Figure 39) presumably as part of the bridge improvement at the site. The channel was filled with exotic, large angular rocks that replace much of the cobble that was previously present at the site and provide suboptimal habitat for Coastal Tailed Frog tadpoles. The detections of tadpoles in the 2017 survey were higher than those in 2016 despite the disturbance.

Figure 39. Significant in-stream disturbance occurred at Whistler Creek 1 in 2017

3.3.2 Beavers

Between late-August and late-December, a total of 61 sites were surveyed. These sites included 94 instances of past or present beaver activity including lodges, dams, sightings, clippings, runways, and bank burrows. A total of 44 past and present lodge sites were assessed and classified based on whether they were active (likely or confirmed to have an overwintering colony) or not (Figure 40; Table 19). Of these 44 lodges, 13 were confirmed or likely to be active, similar to results from 2016. Fifteen additional known sties were revisited in 2017 that weren't surveyed in 2016, none of which were active. There was an increase in the total number of inactive and unknown records relative to 2016; a result of surveying additional sites.

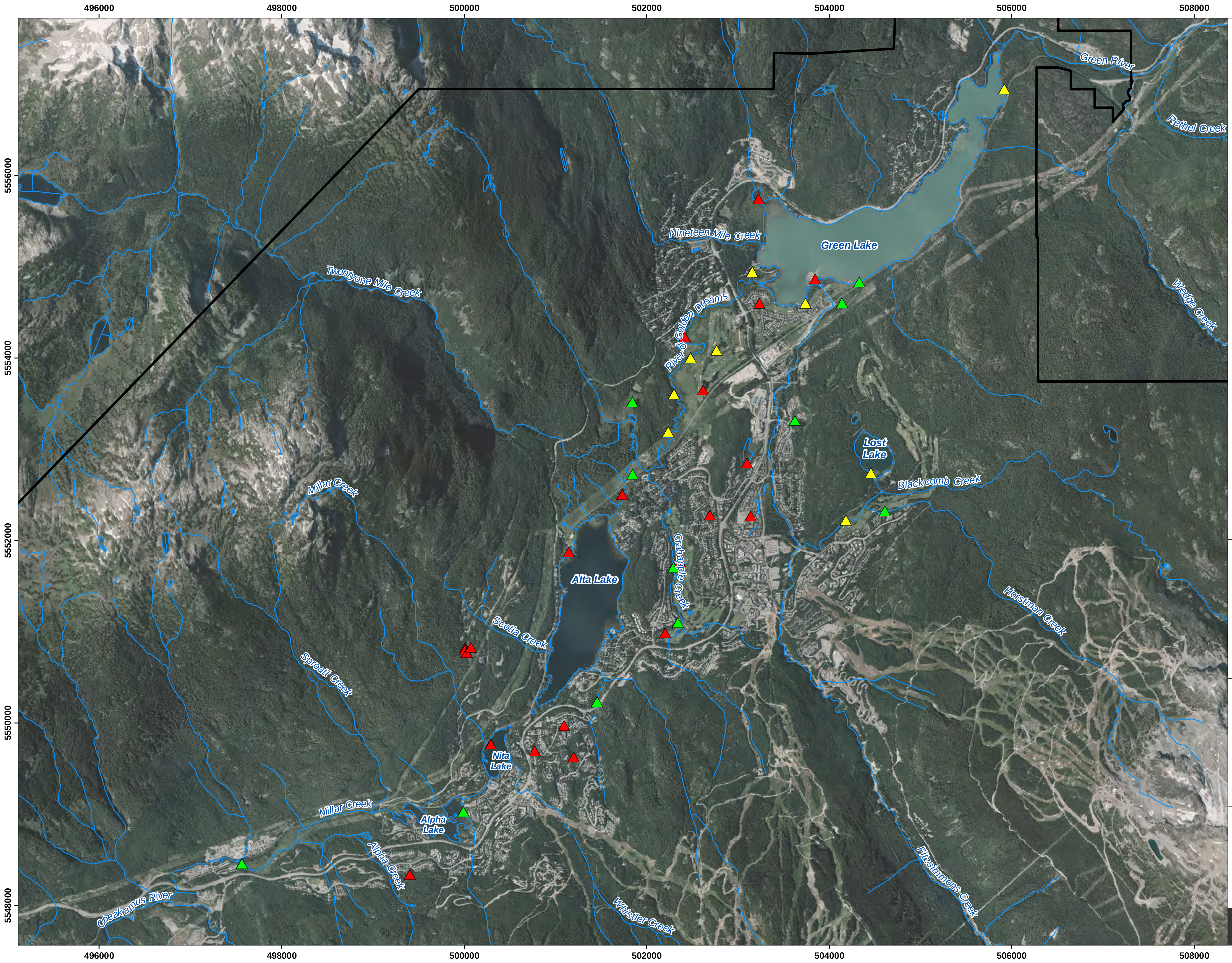
Table 19. Summary table of documented lodges from 2007 through 2016 by activity status. Beaver surveys were not conducted in 2012.

Status	2007	2008	2009	2010	2011	2013	2014	2015	2016	2017
Active	9	27	16	16	17	10	10	7	13	13
Inactive	9	12	13	7	21	5	14	18	11	21
Summer Only?	-	-	-	-	-	-	-	-	2	2
Unknown	1	4	4	4	0	8	1	3	3	8
Total	19	43	33	27	38	23	25	28	29	44

Changes in Lodge Status, 2017

The main changes to lodge status in 2017 (Table 20) were:

- A second lodge became active at Whistler Golf Club located beside the #15 fairway on Crabapple (Archibald) Creek, likely related to the colony that reactivated the lodge beside the #10 tee;
- The lodge on #10 pond at the Nicklaus North Golf Club appears to be inactive. While there are some clippings from this year on top of the lodge, no clippings (food cache) were apparent in late-fall in the water and golf course personnel (Gerrit Woods) didn't see activity since early in the year;
- The lodge at the entrance to the River of Golden Dreams (ROGD) was not found this year (probably due to high water levels) so isn't included in the map of lodges (Figure 40). There were, however, enough signs of activity that there is undoubtedly a colony nearby, and presumably not one already included on the map;
- Signs of activity were also present at the ROGD outflow into Green Lake, the shoreline of Green Lake at the north end of Nicklaus North Golf Club, and the potential lodge originally reported in 2016 by (RMOW; pers. comm.). The amount and spatial distribution of activity is near certain evidence of at least one undetected lodge; and
- Only two active lodges were confirmed on the River of Golden Dreams which is the lowest total since 2007, and one less than was identified in 2016. There are likely more lodges that were not visible due to flooding during late fall surveys (see Table 3 and discussion below).



Legend

RMOW Boundary

Watercourse

2017 Beaver Lodge Status

Actve

Unknown

Inactive

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

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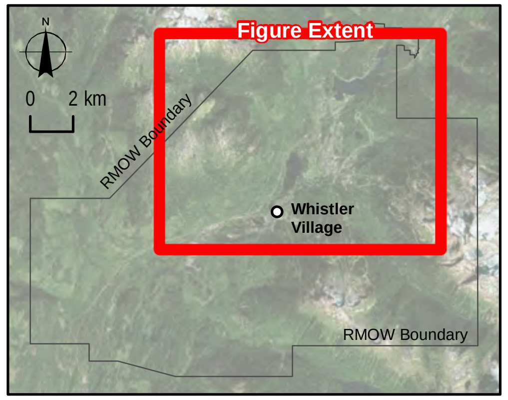

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CLIENT: Resort Municipality of Whistler
PROJECT: Annual Monitoring 2017

Beaver Census

FIGURE **40**

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Table 20. Lodges documented in 2017. Sites where lodge status includes a question mark had enough evidence to suggest they were in the assigned class (e.g., "Active?" lodges were classed as "Active")

Location	No.	Status	Status Change?
Alpha Lake, near dog beach	1	Active	No
Alta Vista Pond	1	Active	No
Chateau GC #2 pond lodge	1	Active	No
Fitzsimmons Creek, back channels near Old Mill Rd.	ND	Active	No
Green Lake - ROGD, Fitz Fan, Parkhurst area	ND	Active	Must be at least 1 undetected lodge based on activity.
Millar Creek wetlands - Function Junction	ND	Active	No
Rainbow Wetlands, NE end near 21-Mile Creek	1	Active	No
ROGD - Alta Lake to 21-Mile Creek junction area	ND	Active	Must be at least 1 undetected lodge based on activity.
ROGD4 - RR bridge to bend nearest Valley Tr.	1	Active	No
Spruce Grove Park, entrance	ND	Active	No
Whistler GC, Crabapple Cr. #10 sand trap	1	Active	No
Whistler GC, Crabapple Cr. #15 fairway	1	Active	New (reactivated) lodge
Wildlife Refuge, middle pond	1	Active	No
Alpine - Buckhorn Place wetland	1	Inactive	No
Beaver Lake #1, west side north	1	Inactive	No
Beaver Lake #2, west side middle	1	Inactive	No
Beaver Lake #3, west side south	1	Inactive	No
Beaver Lake #4; northeast side	1	Inactive	No
Bottomless Pond	1	Inactive	No
Eva Lake	ND	Inactive	No
Fitzsimmons Creek Fan, downstream right end	ND	Inactive	No
Millar's Pond	ND	Inactive	No
Nester's Pond	ND	Inactive	No
Nicklaus North GC, #12 pond	ND	Inactive	No
Nicklaus North GC, #15 pond	ND	Inactive	No

Location	No.	Status	Status Change?
Nita Lake	1	Inactive	No
Rainbow Park, creek near Alta Lake, west side	1	Inactive	No
ROGD1 - Alta Lake entrance to fish weir	ND	Inactive	Activity detected but not Lodge, possibly due to flooding
Snowflake Park	ND	Inactive	Not surveyed in 2016. Historic record, inactive for >10 years.
Tennis Club Amenity Stream	ND	Inactive	No
Wedge Pond	ND	Inactive	No
Whistler GC, #5 tee pond	1	Inactive	No
Whistler GC, Crabapple Cr. #15 fairway	1	Inactive	No
Wolverine Creek	ND	Inactive	No
Chateau GC #18 lower pond	2	Unknown	No
Green Lake Lodge e. of float plane base	1	Unknown	No
Green Lake near Parkhurst	1	Unknown	No
Lost Lake	1	Unknown	No
Nicklaus North GC, #10 pond	1	Unknown	Prob. inactive as of mid-2017. Recent branches but G. Woods (NNGC) didn't see beavers in later year
ROGD4 - RR bridge to bend nearest Valley Tr.	1	Unknown	No
ROGD5 - bend nearest Valley Tr. to Hwy. 99 bridge	ND	Unknown	Active 2016 lodge not relocated. Activity detected but not Lodge, possibly due to flooding
ROGD5 - bend nearest Valley Tr. to Hwy. 99 bridge	ND	Unknown	Inactive 2016 lodge not relocated. Activity detected but not Lodge, possibly due to flooding
ROGD6 - Hwy. 99 bridge to Green Lake	ND	Unknown	Active? 2016 lodge not relocated. Activity detected but not Lodge, possibly due to flooding

Reliability of the 2017 Survey

To increase the accuracy of determining which lodges are used for overwintering, one goal of beaver census was to confirm lodge activity as late in the season as possible. However, like surveys in 2016, weather hampered late season surveys. Continual rain in October and November of 2016 reduced the effectiveness of last year's surveys, especially the second survey of the River of Golden Dreams.[9]. Biological surveys in these conditions are sub-optimal since animals tend to be less active, visibility is lower which reduces detections of both animals and their signs, photo documentation is hampered, and note-making becomes more difficult.

In 2017, snow and subsequent flooding caused the most issues for surveying from late-October onward. Exceptionally deep snow on October 18 and in mid-November was followed by heavy rain and subsequent flooding. This weather impacted beaver surveys by reducing the accessibility of some sites and covering much of the evidence of beaver activity with snow (Figure 41).

The unpredictability of late-fall weather might therefore necessitate a change in approach for future surveys. For example, more of the survey effort could be conducted in September and October, and any unconfirmed sites could be revisited as late in the snow-free season as possible.

Figure 41. Snow obscured signs of beaver activity on many sites in 2017, for example, in the wetland at the entrance to Spruce Grove Park (left and middle). Snow can also be helpful since it can confirm recent activity, for example, the recent gnawing of this alder on top of the Alta Vista Pond lodge (right).

[9] *Only six days in these two months were not rainy.*

Beavers on the River of Golden Dreams (ROGD)

The River of Golden Dreams has been the most consistently active habitat for beavers in Whistler Valley since the first attempt at a full census in 2008 (Table 21), especially in the section between the CN Rail bridge to the outlet at Green Lake. Results of the 2016 survey conducted in late-August, indicated that documentation of three lodges (colonies) was conservative based on the amount of sign and number of sightings. A second, late-season survey was precluded by heavy rains. The only survey conducted in 2017 occurred after the October snow and rains and therefore proved mostly inconclusive (only confirming two lodges). Future surveys should focus on the River of Golden Dreams, with at least two surveys, early- and late-fall, to better understand the number of colonies using that habitat.

Table 21. Active lodges found on the River of Golden Dreams (ROGD, 2007-2012). Beaver surveys were not conducted in 2012

Status and Location	2007	2008	2009	2010	2011	2013	2014	2015	2016	2017
Active lodges - ROGD	1	15	7	7	10	5	5	4	3	2
Active lodges elsewhere	8	12	9	9	7	5	5	3	10	11

The River of Golden Dreams (ROGD) has been the most difficult area to survey since the start of beaver censuses. This difficulty in surveying, coupled with varying search effort, has resulted in large variability in the number of active lodges identified (e.g. one in 2007 to 15 in 2008; Table 21). The low number of lodges identified as active in 2017 is likely due, at least in part, to the lack of conducting a second survey (at least two other locations on the ROGD had possible occupation which can be confirmed in 2018. Results from 2016, where three colonies were deemed active on the River of Golden Dreams, were more consistent with results from 2013 through 2015 (ranging between 2 and 5 lodges), which indicates that either: (a) the ROGD population has decreased since 2008; or (b) some active lodges were used only temporarily so fewer colonies were active relative to the number of lodges. Clarifying which of these possibilities is correct is one goal for the 2018 survey.

After excluding the ROGD lodges, 2017 documented the second highest total of active lodges since 2008. It is likely that more lodges would have been confirmed as active (versus unknown) if snow had not prevented finding lodges and other signs.

Beaver-created Habitat

Seven of the 13 active lodges were located on water bodies that would not differ greatly without the presence of beaver (Table 22). That is, beavers do not significantly alter the habitat because any significant flooding caused by damming would be prevented. These habitats include controlled riparian habitats (especially the River of Golden Dreams and Crabapple Creek), constructed ponds on golf courses, and Alpha Lake.[10] Dams built by beavers in the six active lodges in wetlands contribute to habitat for other species and should be a high conservation priority.

Table 22. Active beaver lodges by habitat type

Habitat	Location	Creates Habitat?
Constructed Pond	Chateau GC #2 pond lodge	No
Lake	Alpha Lake, near dog beach	No
Lake/	Green Lake - ROGD, Fitz Fan, Parkhurst (location ND)	No
Creek	Fitzsimmons Cr. back channels near disc golf course	Some
Creek	ROGD1 - Alta Lake entrance to fish weir	No
Creek	ROGD4 - RR bridge to bend nearest Valley Tr.	No
Creek	Whistler GC, Crabapple Cr. #10 fairway - lodge/dams	No
Creek	Whistler GC, Crabapple Cr. #15 fairway - lodge/dams	No
Wetland	Alta Vista Pond lodge	Yes
Wetland	Millar Creek wetlands - Function Junction	Yes
Wetland	Rainbow Wetlands, NE end near 21-Mile creek, lodge	Yes
Wetland	Spruce Grove Park, entrance	Yes
Wetland	Wildlife Refuge, middle pond - lodge	Yes

Even inactive lodges can play a long-lasting role in creating habitat. For example, the two lodges in #18 pond at the Chateau Golf Course (classed as “summer active?” in 2016 and 2017) have also created significant and long-lasting habitat (Figure 42).

[10] *The level of Alpha Lake has been altered in the past by a dam at the outflow, but the lake level does not appear to have changed for many years (i.e., the beavers no longer affect it, and current development would necessitate removing any dam that caused flooding).*

Figure 42. The beaver-created wetlands at the Chateau Golf Course #18 pond. Two lodges, one of which may be active in the summer, are located at the far left of the photo. No maintenance of the two main dams has been noted in the past two years yet the two resulting ponds persist.

Population Estimates

Estimated numbers of beavers for each year of survey (based on the average number of beavers per lodge from various sources) is presented in Table 23. Applying lower and higher estimates of beaver per lodge (4.2 and 6.4 beavers, respectively; which are the 25th and 75th percentiles in Table 7) gives a range of how many beavers may be in the Whistler Valley. The resulting range in population numbers is between 29 beavers (in 2015) to 173 beavers (in 2008;Table 23). It is likely the total number of beavers is somewhere in the middle of that range. A multiplier of 5.8 (Mullen 2008; Table 7) applied a was applied to estimate the number of beavers in this lodge. Applying low, average and high estimate (4.2, 5.8, and 6.4, respectively) multipliers to all years of beaver surveys helps estimate the possible range of beavers overwintering during that time period (Table 23; Figure 41). The variability in the total number of active lodges is based on two factors: (a) how many are truly active (i.e., how much has the population truly changed), and (b) how many active lodges have been detected (which is mostly based on survey effort). The goal of the beaver survey is to continue efforts to make it a full census so that all colonies are included. Results for 2016 and 2017 suggest the beaver population is currently stable.

Table 23. Estimated number of beavers overwintering in Whistler, 2007-2017. Beaver surveys were not conducted in 2012

Multiplier	2007	2008	2009	2010	2011	2013	2014	2015	2016	2017	Avg.
4.2	38	113	67	67	71	42	42	29	55	55	58
5.8	52	157	93	93	99	58	58	41	75	75	81
6.4	58	173	102	102	109	64	64	45	83	83	89

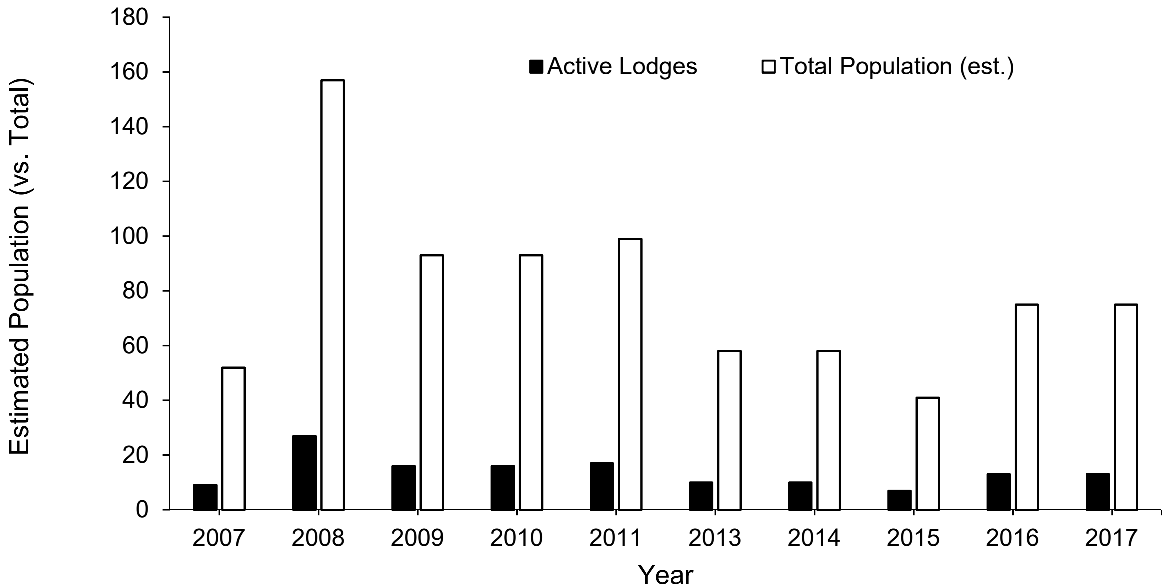

Figure 43. Number of lodges and estimated population, 2007-2017. Note there was an unequal sampling effort in these years

4. Recommendations

In the future, the main basis for determining what to monitor and sampling procedures for annual the Ecosystems Monitoring Program will be using prioritized species and habitats most important to conserving biodiversity within the RMOW's development footprint (Brett, 2018). Recommendations for the 2018 work plan will build on the study conducted by Brett (2018) and propose methods to effectively monitor priority species and habitats in 2018 and beyond.

5. Certification

This report was prepared, reviewed and approved by the undersigned:

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Appendix A

Benthic Invertebrate Taxonomy Results

Benthic Invertebrate Taxonomy Results

Order	Family	Subfamily	*Genus*	*Species*	Lifestage	Crabapple Creek CRB-DS-AQ01	River of Golden Dreams RGD-DS-AQ11	River of Golden Dreams RGD-DS-AQ12	21 Mile Creek ZIM-DS-AQ21	Jordan Creek JOR-DS-AQ31
						25-Jul-17	25-Jul-17	25-Jul-17	25-Jul-17	26-Jul-17
Coleoptera	Dytiscidae		*Hygrotus*		adult			2		
Diptera	Ceratopogonidae				larvae		3		7	
	Chironomidae	Chironominae			larvae		3	12		4
		Orthocladiinae			larvae	31	5	70	8	38
		Tanypodinae	*Ablabesmyia*		larvae	1	7	1		
					pupae	1	3	7	3	7
					adults	1		1		
	Empididae				larvae				1	4
					pupae			2		
	Sciaridae				adults				2	
	Simuliidae				larvae	15	46	23	49	228
					pupae			1	1	5
	Tipulidae				larvae		1		2	1
Ephemeroptera	Ameletidae		*Ameletus*		larvae			2		
	Baetidae		*Baetis*		larvae	302	35	86	86	41
	Ephemerellidae		*Drunella*		larvae		2	4		
			Serratella		larvae	9		24		3
	Heptageniidae		*Cinygmula*		larvae		103	49	80	
			Epeorus		larvae		102	44	129	

	Leptophlebiidae		*Paraleptophlebia*		larvae	1				3
Plecoptera	Chloroperlidae		*Sweltsa*		larvae	12	23	5	15	1
	Leuctridae				larvae					1
	Nemouridae		*Malenka*		larvae	1				1
			Zapada		larvae	24	2		2	19
	Perlidae		*Doroneuria*		larvae		2		3	
			Hesperoperla	*pacifica*	larvae					1
	Perlodidae		*Isoperla*		larvae		1		1	
Trichoptera	Limnephilidae		*Limnephilus*		larvae	1		1		
	Rhyacophilidae		*Rhyacophila*		larvae	8	4	7		1
Acarina	Hydrachnidae				adults	5	3	9	4	1
Collembola					adults					1

	Crabapple Creek	River of Golden Dreams		21 Mile Creek	Jordan Creek
	CRB-DS-AQ01	**RGD-DS-AQ11**	**RGD-DS-AQ12**	**ZIM-DS-AQ21**	**JOR-DS-AQ31**
Subsample	100/16	100/35	100/31	100/24	100/14

Snowline Ecological Research

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B

Benthic Invertebrate (CABIN) Sampling Datasheets and Results Reports

Field Crew: JM, HW, LJH Site Code: 21M-DS-AQ21

Sampling Date: (DD/MM/YYYY) 25/07/2017

☐ **Occupational Health & Safety: Site Inspection Sheet completed**

PRIMARY SITE DATA

CABIN Study Name: Ecosystems Monitoring Local Basin Name: River of Golden Dreams

River/Stream Name: Twenty One Mile Creek Stream Order: (map scale 1:50,000) ?

Select one: ☑ Test Site ☐ Potential Reference Site

Geographical Description/Notes:

Surrounding Land Use: (check those present) Information Source:

☑ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban

☐ Logging ☐ Mining ☐ Commercial/Industrial ☑ Other Electricity pylons BC Hydro cut

Dominant Surrounding Land Use: (check one) Information Source:

☑ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban

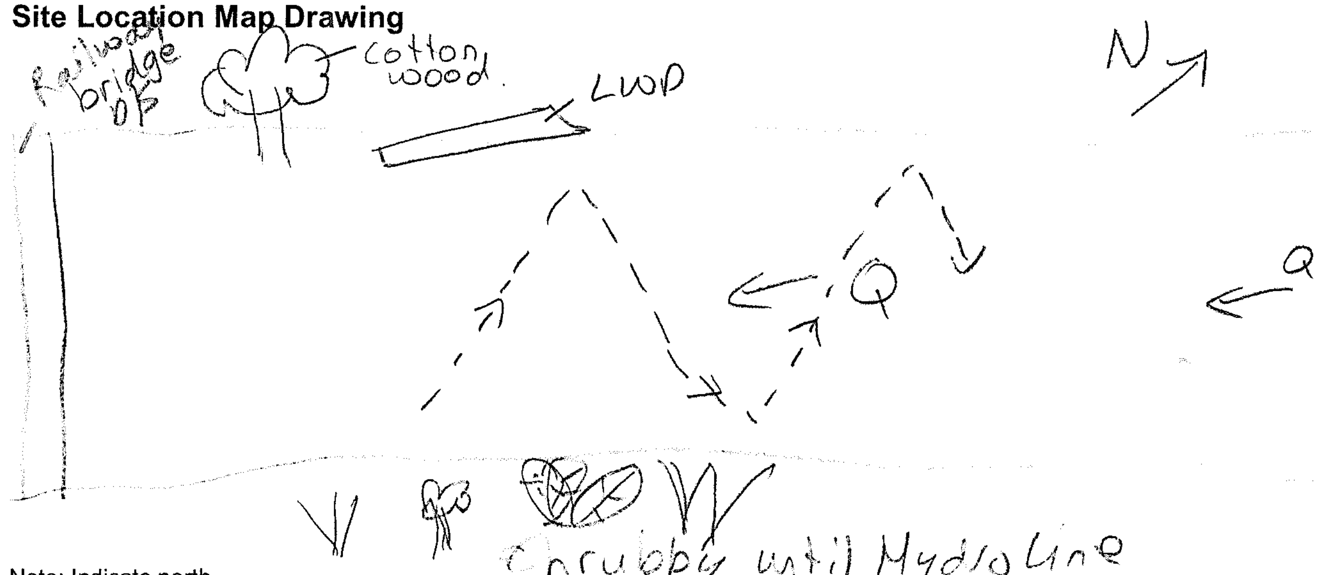
☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other

Location Data (UTM) Zone 10

Latitude: 501935 N Longitude: -552824 W (DMS or DD)

Elevation: 650 (fasl *or* masl) ? GPS Datum: ☑ GRS80 (NAD83/WGS84) ☐ Other:

Site Location Map Drawing



Note: Indicate north

Field Crew: IM, HW, LH Site Code: 21M-DS-AQ21

Sampling Date: (DD/MM/YYYY) 25/07/2017

Photos

☑ Field Sheet 444 ☑ Upstream 440 ☑ Downstream 442 ☑ Across Site 443 ☐ Aerial View

☐ Substrate (exposed) ☑ Substrate (aquatic) 441 ☐ Other ____________

REACH DATA *(represents 6 times bankfull width)*

1. Habitat Types: *(check those present)*

   ☑ Riffle ☐ Rapids ☐ Straight run ☐ Pool/Back Eddy

2. Canopy Coverage: *(stand in middle of stream and look up, check one)*

   ☐ 0 % ☑ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

3. Macrophyte Coverage: *(not algae or moss, check one)*

   ☑ 0 % ☒ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

4. Streamside Vegetation: (*check those present)*

   ☑ ferns/grasses ☑ shrubs ☑ deciduous trees ☑ coniferous trees

5. Dominant Streamside Vegetation: *(check one)*

   ☐ ferns/grasses ☑ shrubs ☐ deciduous trees ☐ coniferous trees

6. Periphyton Coverage on Substrate: *(benthic algae, not moss, check one)*

   ☑ **1** - Rocks are not slippery, no obvious colour (thin layer < 0.5 mm thick)

   ☐ **2** - Rocks are slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)

   ☐ **3** - Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

   ☐ **4** - Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)

   ☐ **5** - Rocks are mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

Note: 1 through 5 represent categories entered into the CABIN database.

BENTHIC MACROINVERTEBRATE DATA

Habitat sampled: (*check one*) ☑ riffle ☐ rapids ☐ straight run

400 μm mesh Kick Net ✓	
Person sampling	HW
Sampling time (i.e. 3 min.)	3 min.
No. of sample jars	1
Typical depth in kick area (cm)	21

Preservative used: Formalin (ethanol 95%)

Sampled sieved on site using "Bucket Swirling Method":

☑ YES ☐ NO

If YES, debris collected for QAQC ☐

Note: Indicate if a sampling method other than the recommended 400 μm mesh kick net is used.

CABIN CANADIAN AQUATIC BIOMONITORING NETWORK

Field Crew: IM, HW, LJH Site Code: 21-M-DS-AQ21

Sampling Date: (DD/MM/YYYY) 25/07/2017

WATER CHEMISTRY DATA **Time:** 13:47 (24 hr clock) **Time zone:** PST

Air Temp: 31 (°C) Water Temp: 11.6 (°C) pH: 7.13

Specific Conductance: 40 (µs/cm) DO: 11.33 (mg/L) Turbidity: — (NTU)

Error message - under measurable range

Check if water samples were collected for the following analyses:

- ☐ TSS (Total Suspended Solids)
- ☐ Nitrogen (i.e. Total, Nitrate, Nitrite, Dissolved, and/or Ammonia)
- ☐ Phosphorus (Total, Ortho, and/or Dissolved)
- ☐ Major Ions (i.e. Alkalinity, Hardness, Chloride, and/or Sulphate) ☐ Other________

Note: Determining alkalinity is recommended, as are other analyses, but not required for CABIN assessments.

CHANNEL DATA

Slope - Indicate how slope was measured: (check one)

☐ **Calculated from map**

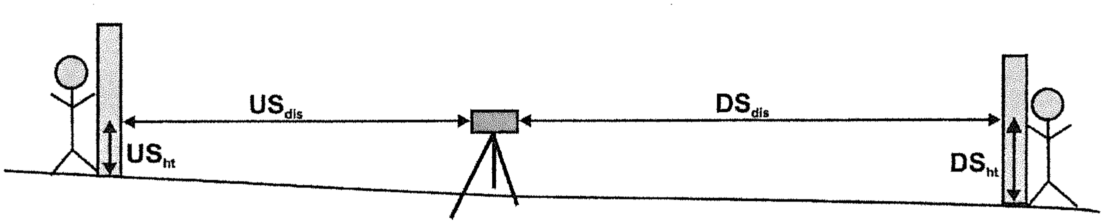
Scale: ________ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) ______ (m),
distance between contour intervals (horizontal distance) ______ (m)
slope = vertical distance/horizontal distance = ______

OR

☐ **Measured in field**

Circle device used and fill out table according to device:
a. Survey Equipment b. Hand Level & Measuring Tape Clino 1 %

Measurements	Upstream (U/S)	Downstream(D/S)	Calculation
[a]Top Hairline (T)			
[a]Mid Hairline (ht) OR [b]Height of rod			
[a]Bottom Hairline (B)			
[b]Distance (dis) OR [a]T-B x 100	$^aUS_{dis}$=T-B	$^aDS_{dis}$=T-B	$US_{dis}+DS_{dis}$=
Change in height (Δht)			$DS_{ht}-US_{ht}$=
Slope (Δht/total dis)			



Field Crew: IM, MW, LJH Site Code: 21M-DS-AQ21

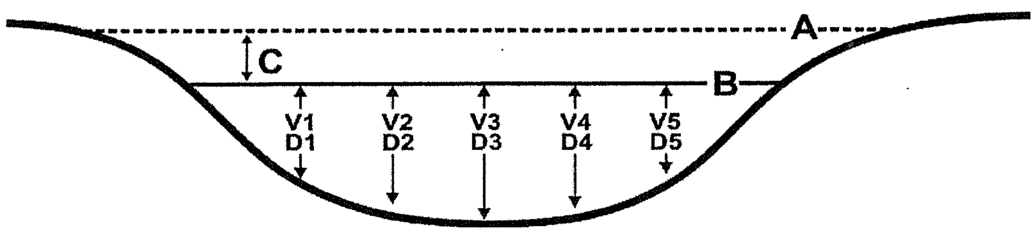
Sampling Date: (DD/MM/YYYY) 25/07/2017

Widths and Depth

Location at site: d/s of kick area (Indicate where in sample reach, ex. d/s of kick area)

A - Bankfull Width: 11.5 (m) B - Wetted Stream Width: 10.4 (m)

C - Bankfull–Wetted Depth (height from water surface to Bankfull): 48 (cm)



Note:
Wetted widths > 5 m, measure a minimum of 5-6 equidistant locations;
Wetted widths < 5 m, measure 3-4 equidistant locations.

Velocity and Depth

Check appropriate velocity measuring device and fill out the appropriate section in chart below. Distance from shore and depth are required regardless of method:

☐ **Velocity Head Rod (or ruler)**: Velocity Equation (m/s) = $\sqrt{[2(\Delta D/100) * 9.81]}$

☐ **Rotary meters**: Gurley/Price/Mini-Price/Propeller (Refer to specific meter conversion chart for calculation)

☑ **Direct velocity measurements**: ☑ Marsh-McBirney ☐ Sontek or ☐ Other________

	1	2	3	4	5	6	AVG
Distance from Shore (m)	~~2.0~~ 1.5	3.0	4.5	6.0	7.5	9.0	
Depth (**D**) (cm)	38	35	25	20	15	18	
Velocity Head Rod (ruler)							
Flowing water Depth (**D_1**) (cm)							
Depth of Stagnation (**D_2**) (cm)							
Change in depth (**$\Delta D = D_2 - D_1$**) (cm)							
Rotary meter							
Revolutions							
Time (minimum 40 seconds)							
Direct Measurement or calculation							
Velocity (**V**) (m/s)	0.73	0.98	1.02	0.80	0.44	-0.01	

CABIN CANADIAN AQUATIC BIOMONITORING NETWORK

Field Crew: IM, MW, LJH Site Code: 21M-DS-AQ21

Sampling Date: (DD/MM/YYYY) 25/07/2017

SUBSTRATE DATA

Surrounding/Interstitial Material

Circle the substrate size category for the surrounding material.

Substrate Size Class	Category
Organic Cover	0
< 0.1 cm (fine sand, silt or clay)	1
0.1-0.2 cm (coarse sand)	2
0.2-1.6 cm (gravel)	3
1.6-3.2 cm (small pebble)	4
3.2-6.4 cm (large pebble)	5
6.4-12.8 cm (small cobble)	6
12.8-25.6 cm (cobble)	7
> 25.6 cm (boulder)	8
Bedrock	9

100 Pebble Count & Substrate Embeddedness

- Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embededness categories (E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

	Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E
1	1		26	6.5		51	2		76	4	
2	3		27	2		52	3		77	3	
3	3.5		28	7		53	0.6		78	4	
4	~~8~~ 0.2		29	1.2		54	5		79	3.5	
5	3		30 x	4	0	55	4.5		80 x	1.5	0
6	6.5		31	0.2		56	0.7		81	2	
7	0.2		32	3.5		57	5.5		82	4	
8	3		33	0.4		58	3		83	3.5	
9	3.5		34	1.5		59	0.3		84	2	
x 10	1.3	0	35	4		60 x	4	0	85	4.5	
11	1.2		36	5		61	4.5		86	4	
12	1.5		37	7		62	4.5		87	3.5	
13	6		38	4.5		63	2.5		88	1	
14	0.6		39	7		64	4		89	1	
15	1.5		40 x	6.6	0	65	3		90 x	4	0
16	0.2		41	1.5		66	4		91	3.5	
17	3.5		42	0.3		67	3		92	2	
18	4.5		43	10		68	2		93	1.5	
19	2		44	4		69	3.5		94	3.5	
x 20	0.4	0	45	5		70 x	2.5	0	95	3	
21	2.5		46	3		71	1.5		96	4	
22	0.7		47	7.5		72	6		97	4	
23	3.5		48	4.3		73	6		98	5.5	
24	5.5		49	1		74	2		99	3.5	
25	0.9		50 x	0.2	0	75	3.5		100 x	1.5	

Note: The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.

CABIN
CANADIAN AQUATIC BIOMONITORING NETWORK

Field Crew: ______________________________ Site Code: ____________

Sampling Date: (DD/MM/YYYY) ____________________

SITE INSPECTION

Site Inspected by: ______________________________

Communication Information

☐ Itinerary left with contact person (include contact numbers)

Contact Person: ________________________ Time checked-in: ______

Form of communication: ☐ radio ☐ cell ☐ satellite ☐ hotel/pay phone ☐ SPOT

Phone number: ( ) __________

Vehicle Safety

☐ Safety equipment (first aid, fire extinguisher, blanket, emergency kit in vehicle)

☐ Equipment and chemicals safely secured for transport

☐ Vehicle parked in safe location; pylons, hazard light, reflective vests if necessary

Notes:

Shore & Wading Safety

☐ Wading Task Hazard Analysis read by all field staff

☐ Wading Safe Work Procedures read by all field staff

☐ Instream hazards identified (i.e. log jams, deep pools, slippery rocks)

☐ PFD worn

☐ Appropriate footwear, waders, wading belt

☐ Belay used

Notes:

Field Crew: IM, MW, LJM

Site Code: RGD - AQ11

Sampling Date: (DD/MM/YYYY) 25/07/2017

☐ **Occupational Health & Safety: Site Inspection Sheet completed**

PRIMARY SITE DATA

CABIN Study Name: Ecosystems Monitoring

Local Basin Name: River of Golden Dreams

River/Stream Name: RoGD.

Stream Order: (map scale 1:50,000) ______

Select one: ☑ Test Site ☐ Potential Reference Site

Geographical Description/Notes:

Surrounding Land Use: (check those present)

Information Source: ______

☑ Forest ☐ Field/Pasture ☐ Agriculture ☑ Residential/Urban

☐ Logging ☐ Mining ☑ Commercial/Industrial → rail ☐ Other ______

Dominant Surrounding Land Use: (check one)

Information Source: ______

☐ Forest ☐ Field/Pasture ☐ Agriculture ☑ Residential/Urban

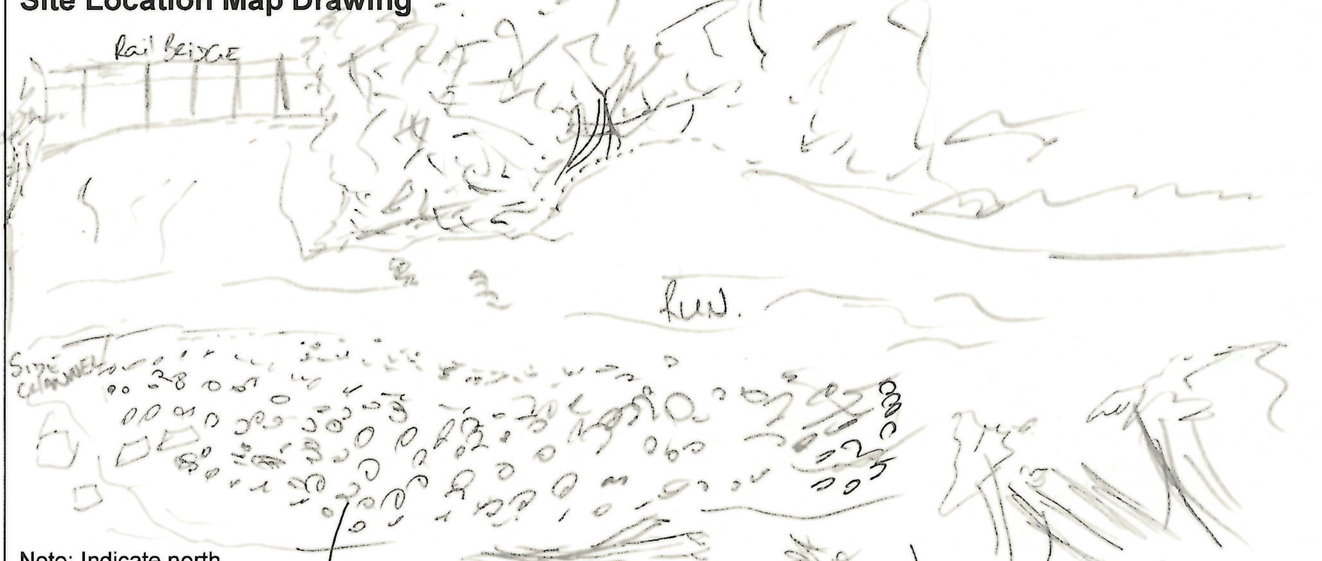
☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other ______

Location Data 10U

Latitude: 501994 N Longitude: - 5552793 W (DMS or DD)

Elevation: 662 (fasl *or* masl) GPS Datum: ☐ GRS80 (NAD83/WGS84) ☐ Other: ______

Site Location Map Drawing



Note: Indicate north

Gravel Bar

Side channel

LWD

CABIN

Field Crew: IM, MW, LJH Site Code: RGD-AQ11

Sampling Date: (DD/MM/YYYY) 25/07/2017

Photos

- ☐ Field Sheet
- ☑ Upstream 103-0436
- ☑ Downstream 103-0434
- ☑ Across Site 103-0435
- ☐ Aerial View
- ☐ Substrate (exposed)
- ☑ Substrate (aquatic) 103-0437
- ☐ Other ______

REACH DATA *(represents 6 times bankfull width)*

1. Habitat Types: *(check those present)*
   ☑ Riffle ☐ Rapids ☑ Straight run ☐ Pool/Back Eddy

2. Canopy Coverage: *(stand in middle of stream and look up, check one)*
   ☐ 0 % ☑ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

3. Macrophyte Coverage: *(not algae or moss, check one)*
   ☑ 0 % ☐ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

4. Streamside Vegetation: (*check those present)*
   ☑ ferns/grasses ☑ shrubs ☑ deciduous trees ☑ coniferous trees

5. Dominant Streamside Vegetation: *(check one)*
   ☐ ferns/grasses ☐ shrubs ☑ deciduous trees ☐ coniferous trees

6. Periphyton Coverage on Substrate: *(benthic algae, not moss, check one*)

   - ☑ **1** - Rocks are not slippery, no obvious colour (thin layer < 0.5 mm thick)
   - ☐ **2** - Rocks are slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)
   - ☐ **3** - Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)
   - ☐ **4** - Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)
   - ☐ **5** - Rocks are mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

   Note: 1 through 5 represent categories entered into the CABIN database.

BENTHIC MACROINVERTEBRATE DATA

Habitat sampled: (*check one*) ☑ riffle ☐ rapids ☑ straight run

400 μm mesh Kick Net ✓	
Person sampling	MW.
Sampling time (i.e. 3 min.)	3 min
No. of sample jars	1
Typical depth in kick area (cm)	35

Preservative used: Formalin-85% Ethanol

Sampled sieved on site using "Bucket Swirling Method":
☑ YES ☐ NO

If YES, debris collected for QAQC ☑

Note: Indicate if a sampling method other than the recommended 400 μm mesh kick net is used.

Field Crew: IM, MW, LJM Site Code: RGD-AQ11

Sampling Date: (DD/MM/YYYY) 25/07/2017

WATER CHEMISTRY DATA **Time:** 11:40 (24 hr clock) **Time zone:** PST

Air Temp: 23 (°C) Water Temp: 10.5 (°C) pH: 7.06

Specific Conductance: 36.9 50.5 (µs/cm) DO: 11.02 (mg/L) Turbidity: – (NTU)

Check if water samples were collected for the following analyses:

- ☐ TSS (Total Suspended Solids)
- ☐ Nitrogen (i.e. Total, Nitrate, Nitrite, Dissolved, and/or Ammonia)
- ☐ Phosphorus (Total, Ortho, and/or Dissolved)
- ☐ Major Ions (i.e. Alkalinity, Hardness, Chloride, and/or Sulphate) ☐ Other –

Note: Determining alkalinity is recommended, as are other analyses, but not required for CABIN assessments.

CHANNEL DATA

Slope - Indicate how slope was measured: (check one)

☐ **Calculated from map**

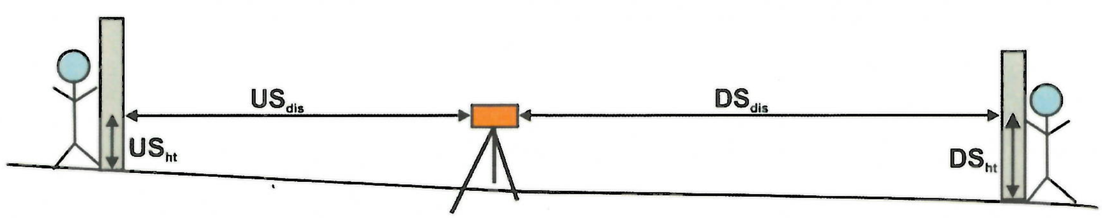
Scale: ________ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) ________ (m),
distance between contour intervals (horizontal distance) ________ (m)
slope = vertical distance/horizontal distance = ________

OR

☑ **Measured in field**

Circle device used and fill out table according to device:
a. Survey Equipment b. Hand Level & Measuring Tape Clino 1%

Measurements	Upstream (U/S)	Downstream(D/S)	Calculation
[a]Top Hairline (T)			
[a]Mid Hairline (ht) OR [b]Height of rod			
[a]Bottom Hairline (B)			
[b]Distance (dis) OR [a]T-B x 100	$^aUS_{dis}$=T-B	$^aDS_{dis}$=T-B	$US_{dis}+DS_{dis}$=
Change in height (Δht)			$DS_{ht}-US_{ht}$=
Slope (Δht/total dis)			



CABIN

Field Crew: IM, MW, LJM Site Code: RGD-AQ11

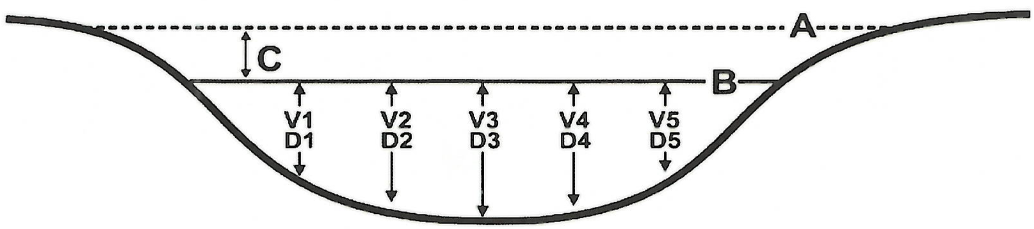
Sampling Date: (DD/MM/YYYY) 25/07/2017

Widths and Depth

Location at site: Centre of kick sample (Indicate where in sample reach, ex. d/s of kick area)

A - Bankfull Width: 19.4 (m) B - Wetted Stream Width: 9.2 (m)

C - Bankfull–Wetted Depth (height from water surface to Bankfull): 40 (cm)



Note:
Wetted widths > 5 m, measure a minimum of 5-6 equidistant locations;
Wetted widths < 5 m, measure 3-4 equidistant locations.

Velocity and Depth

Check appropriate velocity measuring device and fill out the appropriate section in chart below. Distance from shore and depth are required regardless of method:

☐ **Velocity Head Rod (or ruler)**: Velocity Equation (m/s) = √ [2(ΔD/100) * 9.81]

☐ **Rotary meters**: Gurley/Price/Mini-Price/Propeller (Refer to specific meter conversion chart for calculation)

☑ **Direct velocity measurements**: ☑ Marsh-McBirney ☐ Sontek or ☐ Other________

	1	2	3	4	5	6	AVG
Distance from Shore (m)	1.0	2.0	3.0	4.0	5.0		
Depth (**D**) (cm)	0.27	0.46	0.45	0.34	0.24		
Velocity Head Rod (ruler)							
Flowing water Depth (**D_1**) (cm)							
Depth of Stagnation (**D_2**) (cm)							
Change in depth (**$\Delta D = D_2 - D_1$**) (cm)							
Rotary meter							
Revolutions							
Time (minimum 40 seconds)							
Direct Measurement or calculation							
Velocity (**V**) (m/s)	0.62	1.0	1.06	1.05	0.45		

CABIN

Field Crew: IM, MW, LJM Site Code: RGD-AQ11

Sampling Date: (DD/MM/YYYY) 25/07/2017

SUBSTRATE DATA

Surrounding/Interstitial Material

Circle the substrate size category for the surrounding material.

Substrate Size Class	Category
Organic Cover	0
< 0.1 cm (fine sand, silt or clay)	1
0.1-0.2 cm (coarse sand)	2
0.2-1.6 cm (gravel)	3
1.6-3.2 cm (small pebble)	4
3.2-6.4 cm (large pebble)	5
6.4-12.8 cm (small cobble)	6
12.8-25.6 cm (cobble)	7
> 25.6 cm (boulder)	8
Bedrock	9

100 Pebble Count & Substrate Embeddedness

- Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embededness categories (E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

	Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E
1	2.5		26	2.5		51	0.08		76	6	
2	3.0		27	4.5		52	1		77	7	
3	5		28	3.0		53	1		78	3	
4	2.5		29	2.		54	3.5		79	1	
5	7		30 *	2.5	0	55	5		80 *	2.5	0
6	3.		31	5		56	4		81	2	
7	5		32	2		57	3.5		82	7	
8	3.5		33	4.		58	13.		83	5	
9	3.5		34	2		59	6.5		84	8	
10 *	5	1/4	35	4.		60 *	4	0	85	3	
11	4		36	3.5		61	1.8		86	1.5	
12	3		37	5.5		62	2.5		87	2.5	
13	4.5		38	4.0		63	4		88	3	
14	1.5		39	4.5		64	2.5		89	0.5	
15	10		40 *	0.05	0	65	13		90 *	1.5	0
16	3		41	1.5		66	6.		91	2.5	
17	3.5		42	4		67	1.5		92	0.6	
18	6		43	4		68	3		93	3	
19	2.5		44	3.5		69	4		94	7	
20 *	3.	0	45	6		70 *	5	0	95	2	
21	4		46	1.5		71	4		96	5.5	
22	4		47	3.		72	4.5		97	5	
23	5.5		48	2.		73	6		98	3	
24	3		49	2.5		74	4.5		99	3	
25	4		50 *	1.5	0	75	4		100 *	2.5	0

Note: The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.

Field Crew: ______________________________ Site Code: ____________

Sampling Date: (DD/MM/YYYY) ____________________

SITE INSPECTION

Site Inspected by: ______________________________

Communication Information

☐ Itinerary left with contact person (include contact numbers)

Contact Person: ______________________________ Time checked-in: ________

Form of communication: ☐ radio ☐ cell ☐ satellite ☐ hotel/pay phone ☐ SPOT

Phone number: (   ) ____________

Vehicle Safety

☐ Safety equipment (first aid, fire extinguisher, blanket, emergency kit in vehicle)

☐ Equipment and chemicals safely secured for transport

☐ Vehicle parked in safe location; pylons, hazard light, reflective vests if necessary

Notes:

Shore & Wading Safety

☐ Wading Task Hazard Analysis read by all field staff

☐ Wading Safe Work Procedures read by all field staff

☐ Instream hazards identified (i.e. log jams, deep pools, slippery rocks)

☐ PFD worn

☐ Appropriate footwear, waders, wading belt

☐ Belay used

Notes:

Field Crew: IM, MW, LJH Site Code: RGD-DS-AQ12

Sampling Date: (DD/MM/YYYY) 25/07/2017

☐ **Occupational Health & Safety: Site Inspection Sheet completed**

PRIMARY SITE DATA

CABIN Study Name: RMOW Ecosystem Monitoring Local Basin Name: River of Golden Dreams

River/Stream Name: RoGD Stream Order: (map scale 1:50,000) ?

Select one: ☑ Test Site ☐ Potential Reference Site

Geographical Description/Notes:

Surrounding Land Use: (check those present) Information Source: ______

☐ Forest ☐ Field/Pasture ☐ Agriculture ☑ Residential/Urban

☐ Logging ☐ Mining ☑ Commercial/Industrial ? ☐ Other ______

Dominant Surrounding Land Use: (check one) Information Source: ______

☐ Forest ☐ Field/Pasture ☐ Agriculture ☑ Residential/Urban

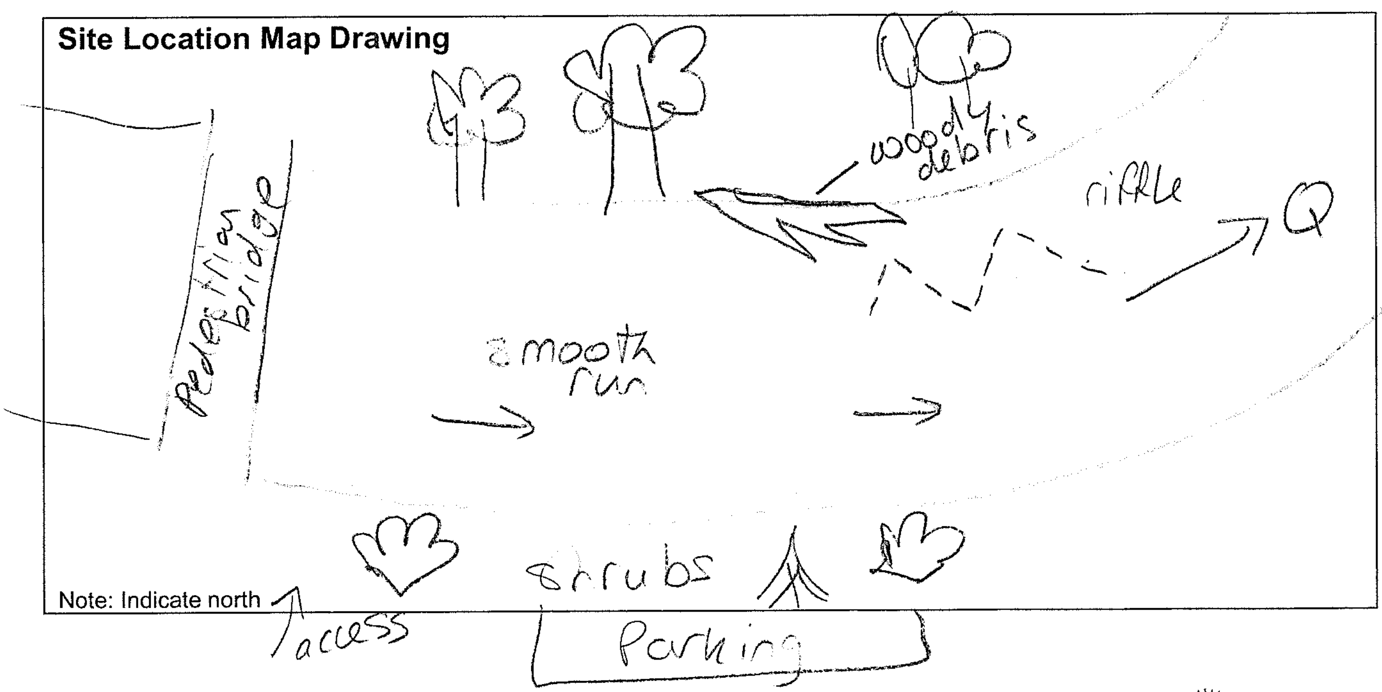
☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other ______

Location Data 10U Zone

Latitude: 503029 N Longitude: - 5554676 W (DMS or DD)

Elevation: 637 (fasl *or* masl) GPS Datum: ☑ GRS80 (NAD83/WGS84) ☐ Other: ______

Site Location Map Drawing



Note: Indicate north

Field Crew: IM, HW, LH Site Code: RGD-DS-AQ12

Sampling Date: (DD/MM/YYYY) 25/07/2017

Photos
- [x] Field Sheet 449
- [x] Upstream 445
- [x] Downstream 446
- [x] Across Site 448
- [ ] Aerial View
- [ ] Substrate (exposed)
- [x] Substrate (aquatic) 447
- [ ] Other ______

REACH DATA *(represents 6 times bankfull width)*

1. Habitat Types: *(check those present)*
   - [x] Riffle
   - [ ] Rapids
   - [x] Straight run
   - [ ] Pool/Back Eddy

2. Canopy Coverage: *(stand in middle of stream and look up, check one)*
   - [ ] 0 %
   - [x] 1-25 %
   - [ ] 26-50 %
   - [ ] 51-75 %
   - [ ] 76-100 %

3. Macrophyte Coverage: *(not algae or moss, check one)*
   - [ ] 0 %
   - [x] 1-25 %
   - [ ] 26-50 %
   - [ ] 51-75 %
   - [ ] 76-100 %

4. Streamside Vegetation: (*check those present)*
   - [x] ferns/grasses
   - [x] shrubs
   - [x] deciduous trees
   - [x] coniferous trees

5. Dominant Streamside Vegetation: *(check one)*
   - [ ] ferns/grasses
   - [ ] shrubs
   - [x] deciduous trees
   - [ ] coniferous trees

6. Periphyton Coverage on Substrate: *(benthic algae, not moss, check one*)
   - [x] **1** - Rocks are not slippery, no obvious colour (thin layer < 0.5 mm thick)
   - [ ] **2** - Rocks are slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)
   - [ ] **3** - Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)
   - [ ] **4** - Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)
   - [ ] **5** - Rocks are mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

Note: 1 through 5 represent categories entered into the CABIN database.

BENTHIC MACROINVERTEBRATE DATA

Habitat sampled: (*check one*) [x] riffle [ ] rapids [x] straight run

400 μm mesh Kick Net ✓	
Person sampling	HW
Sampling time (i.e. 3 min.)	3 min
No. of sample jars	2
Typical depth in kick area (cm)	28

Preservative used: Formalin (Ethanol 86%

Sampled sieved on site using "Bucket Swirling Method":
[ ] YES [x] NO

If YES, debris collected for QAQC [ ]

Note: Indicate if a sampling method other than the recommended 400 μm mesh kick net is used.

Field Crew: IM, HW, LH Site Code: RGD-DS-AQ12

Sampling Date: (DD/MM/YYYY) 25/07/2017

WATER CHEMISTRY DATA **Time:** 15 35 (24 hr clock) **Time zone:** PST

Air Temp: 26. (°C) Water Temp: 13.0 (°C) pH: 6.96

Specific Conductance: 73.3 (µs/cm) DO: 9.77 (mg/L) Turbidity: — (NTU)

Check if water samples were collected for the following analyses:

☐ TSS (Total Suspended Solids)
☐ Nitrogen (i.e. Total, Nitrate, Nitrite, Dissolved, and/or Ammonia)
☐ Phosphorus (Total, Ortho, and/or Dissolved)
☐ Major Ions (i.e. Alkalinity, Hardness, Chloride, and/or Sulphate) ☐ Other________

Note: Determining alkalinity is recommended, as are other analyses, but not required for CABIN assessments.

CHANNEL DATA

Slope - Indicate how slope was measured: (check one)

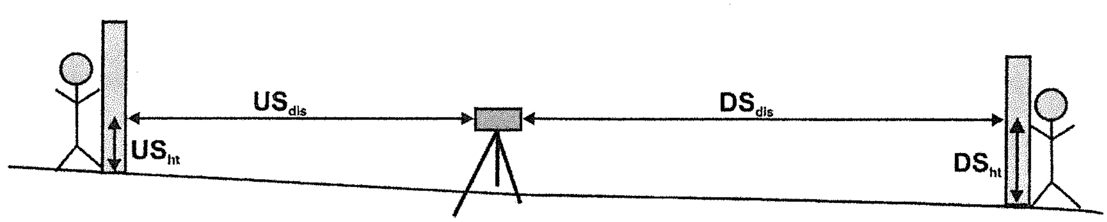
☐ **Calculated from map**
Scale: ____________ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) ________ (m),
distance between contour intervals (horizontal distance) ________ (m)
slope = vertical distance/horizontal distance =____________

OR

☑ **Measured in field**
Circle device used and fill out table according to device:
a. Survey Equipment b. Hand Level & Measuring Tape

CLINO: 0.5%

Measurements	Upstream (U/S)	Downstream(D/S)	Calculation
[a]Top Hairline (T)			
[a]Mid Hairline (ht) OR [b]Height of rod			
[a]Bottom Hairline (B)			
[b]Distance (dis) OR [a]T-B x 100	[a]US_{dis}=T-B	[a]DS_{dis}=T-B	$US_{dis}+DS_{dis}$=
Change in height (Δht)			$DS_{ht}-US_{ht}$=
Slope (Δht/total dis)			



Field Crew: IM, MW, LH Site Code: RGD-DS-AQ12

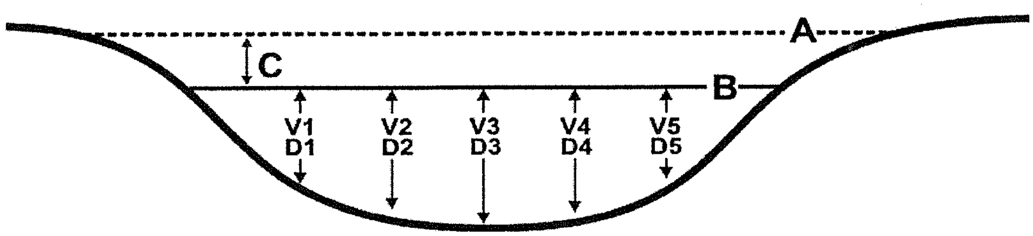
Sampling Date: (DD/MM/YYYY) 25/07/2017

Widths and Depth

Location at site: Upstream end of sample area (Indicate where in sample reach, ex. d/s of kick area)

A - Bankfull Width: 15.4 (m) B - Wetted Stream Width: 15.4 (m)

C - Bankfull–Wetted Depth (height from water surface to Bankfull): 50 cm (cm)



Note:
Wetted widths > 5 m, measure a minimum of 5-6 equidistant locations;
Wetted widths < 5 m, measure 3-4 equidistant locations.

Velocity and Depth

Check appropriate velocity measuring device and fill out the appropriate section in chart below. Distance from shore and depth are required regardless of method:

☐ **Velocity Head Rod (or ruler)**: Velocity Equation (m/s) = $\sqrt{[2(\Delta D/100) * 9.81]}$

☐ **Rotary meters**: Gurley/Price/Mini-Price/Propeller (Refer to specific meter conversion chart for calculation)

☑ **Direct velocity measurements**: ☑ Marsh-McBirney ☐ Sontek or ☐ Other________

	1	2	3	4	5	6	AVG
Distance from Shore (m)	6	7.5	9	10.5	12	13.5	
Depth (**D**) (cm)	39	35	27	30	32	30	
Velocity Head Rod (ruler)							
Flowing water Depth (**D_1**) (cm)							
Depth of Stagnation (**D_2**) (cm)							
Change in depth (**$\Delta D = D_2 - D_1$**) (cm)							
Rotary meter							
Revolutions							
Time (minimum 40 seconds)							
Direct Measurement or calculation							
Velocity (**V**) (m/s)	0.47	0.43	0.36	0.40	0.27	0.07	

*Full width not sampled, only 6m-13.5m from DS right bank was sampled to capture survey area (riffle habitat)

Field Crew: IM, HW, LH Site Code: RGD-OS-A012

Sampling Date: (DD/MM/YYYY) 25/07/2017

SUBSTRATE DATA

Surrounding/Interstitial Material

Circle the substrate size category for the surrounding material.

Substrate Size Class	Category
Organic Cover	0
< 0.1 cm (fine sand, silt or clay)	1
0.1-0.2 cm (coarse sand)	2
0.2-1.6 cm (gravel)	3
1.6-3.2 cm (small pebble)	4
3.2-6.4 cm (large pebble)	5
6.4-12.8 cm (small cobble)	6
12.8-25.6 cm (cobble)	7
> 25.6 cm (boulder)	8
Bedrock	9

100 Pebble Count & Substrate Embeddedness

- Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embededness categories (E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

	Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E
1	3.5		26	2		51	1.5		76	0.8	
2	3		27	1		52	0.7		77	0.5	
3	1.5		28	4.5		53	0.7		78	3	
4	2.5		29	2.5		54	1		79	2	
5	2		30*	3	0	55	2.5		80*	0.5	0
6	2		31	1.5		56	0.5		81	0.6	
7	3.5		32	1		57	1.8		82	1	
8	3.5		33	2.5		58	2.5		83	0.8	
9	2		34	5.5		59	3.0		84	1	
10*	1	1/2	35	1		60*	0.5	0	85	1	
11	3.5		36	2.5		61	4.5		86	2.5	
12	2		37	5		62	0.2		87	0.8	
13	3		38	0.5		63	1.5		88	2.5	
14	2		39	2.5		64	S <0.2cm		89	S <0.2	
15	2.5		40*	1	0	65	3		90*	3	0
16	2		41	1		66	3.3		91	1.8	
17	2.5		42	1.3		67	0.5		92	1	
18	2.5		43	1		68	1		93	3	
19	4		44	2.5		69	4.5		94	3.3	
20*	4	1/4	45	1		70*	2	1/4	95	2.8	
21	2.5		46	2		71	2.5		96	S <0.2cm	
22	3		47	4.5		72	S <0.2		97	4.7	
23	1		48	2.5		73	4		98	2	
24	3		49	3.5		74	2		99	4	
25	2		50*	1.5	1/4	75	2.5		100*	5	1/4

Note: The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.

CABIN CANADIAN AQUATIC BIOMONITORING NETWORK

Field Crew: ______________________ Site Code: __________

Sampling Date: (DD/MM/YYYY) ______________________

SITE INSPECTION

Site Inspected by: ______________________

Communication Information

☐ Itinerary left with contact person (include contact numbers)

Contact Person: ______________________ Time checked-in: __________

Form of communication: ☐ radio ☐ cell ☐ satellite ☐ hotel/pay phone ☐ SPOT

Phone number: ( ) __________

Vehicle Safety

☐ Safety equipment (first aid, fire extinguisher, blanket, emergency kit in vehicle)

☐ Equipment and chemicals safely secured for transport

☐ Vehicle parked in safe location; pylons, hazard light, reflective vests if necessary

Notes:

Shore & Wading Safety

☐ Wading Task Hazard Analysis read by all field staff

☐ Wading Safe Work Procedures read by all field staff

☐ Instream hazards identified (i.e. log jams, deep pools, slippery rocks)

☐ PFD worn

☐ Appropriate footwear, waders, wading belt

☐ Belay used

Notes:

Field Crew: IM, MW, LH Site Code: JOR-DS-A031

Sampling Date: (DD/MM/YYYY) 26/07/2017

☐ **Occupational Health & Safety: Site Inspection Sheet completed**

PRIMARY SITE DATA

CABIN Study Name: RMOW Ecosystems Monitoring Local Basin Name: Jordan Creek → Flows from Nita to Alpha Lake

River/Stream Name: Jordan Creek Stream Order: (map scale 1:50,000) ______

Select one: ☑ Test Site ☐ Potential Reference Site

Geographical Description/Notes:

Surrounding Land Use: (check those present) Information Source: ______

☑ Forest (Just riparian area) ☐ Field/Pasture ☐ Agriculture ☑ Residential/Urban

☐ Logging ☐ Mining ☑ Commercial/Industrial ☑ Other Alpha Lake Park

Dominant Surrounding Land Use: (check one) Information Source: ______

☐ Forest ☐ Field/Pasture ☐ Agriculture ☑ Residential/Urban

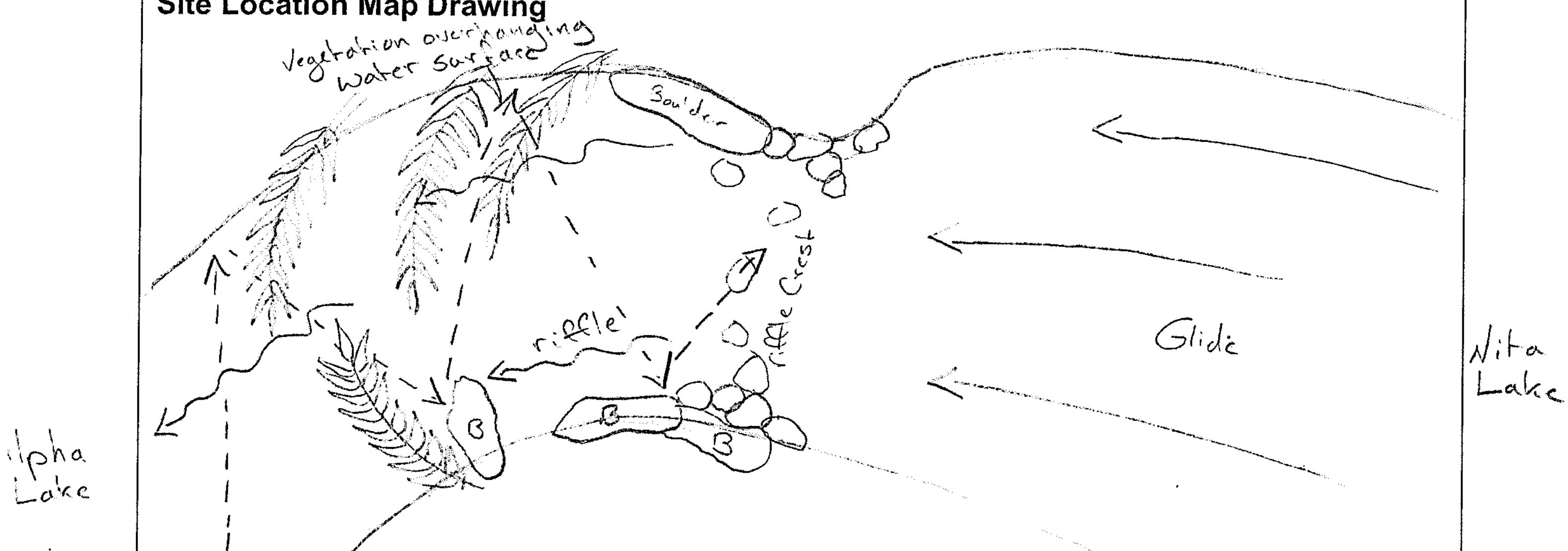
☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other ______

Location Data

Latitude: 500184 N Longitude: - 549252 W (DMS or DD) ~8m accuracy.

Elevation: 602 (fasl *or* masl) GPS Datum: ☑ GRS80 (NAD83/WGS84) ☐ Other: ______

Site Location Map Drawing



Note: Indicate north

Beaver observed swimming upstream towards Nita Lake. Dense vegetation overhanging water surface, most within 1 meter of surface.

CABIN CANADIAN AQUATIC BIOMONITORING NETWORK

Field Crew: IM, HUO, LH Site Code: JOR-DS-AQ31

Sampling Date: (DD/MM/YYYY) 26/07/2017

Photos 103-0454 103-0453 103-0450 103-0452

☑ Field Sheet ☑ Upstream ☑ Downstream ☑ Across Site ☐ Aerial View

☐ Substrate (exposed) ☑ Substrate (aquatic) 103-0451 ☐ Other ____________

REACH DATA *(represents 6 times bankfull width)*

1. Habitat Types: *(check those present)*
   ☑ Riffle ☐ Rapids ☑ Straight run ☐ Pool/Back Eddy

2. Canopy Coverage: *(stand in middle of stream and look up, check one)*
   ☐ 0 % ☐ 1-25 % ☐ 26-50 % ☐ 51-75 % ☑ 76-100 %

3. Macrophyte Coverage: *(not algae or moss, check one)*
   ☑ 0 % ☐ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

4. Streamside Vegetation: (*check those present)*
   ☑ ferns/grasses ☑ shrubs ☑ deciduous trees ☑ coniferous trees

5. Dominant Streamside Vegetation: *(check one)*
   ☐ ferns/grasses ☐ shrubs ☑ deciduous trees ☐ coniferous trees

6. Periphyton Coverage on Substrate: *(benthic algae, not moss, check one*)

   ☐ **1** - Rocks are not slippery, no obvious colour (thin layer < 0.5 mm thick)
   ☑ **2** - Rocks are slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)
   ☐ **3** - Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)
   ☐ **4** - Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)
   ☐ **5** - Rocks are mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

   Note: 1 through 5 represent categories entered into the CABIN database.

BENTHIC MACROINVERTEBRATE DATA

Habitat sampled: (*check one*) ☑ riffle ☐ rapids ☐ straight run

400 µm mesh Kick Net	
Person sampling	IM
Sampling time (i.e. 3 min.)	3 min
No. of sample jars	1
Typical depth in kick area (cm)	24

Preservative used: formalin - 85% ethanol

Sampled sieved on site using "Bucket Swirling Method":
☐ YES ☑ NO

If YES, debris collected for QAQC ☐

Note: Indicate if a sampling method other than the recommended 400 µm mesh kick net is used.

Field Crew: IM, HW, LM Site Code: JOR-OS-AQ31

Sampling Date: (DD/MM/YYYY) 26/07/2017

WATER CHEMISTRY DATA **Time:** 8:55 (24 hr clock) **Time zone:** PST

Air Temp: 16°C (°C) Water Temp: 14.9 (°C) pH: 7.10

Specific Conductance: 105.1 (µs/cm) DO: 8.9 (mg/L) Turbidity: — (NTU)

Check if water samples were collected for the following analyses:

- ☐ TSS (Total Suspended Solids)
- ☐ Nitrogen (i.e. Total, Nitrate, Nitrite, Dissolved, and/or Ammonia)
- ☐ Phosphorus (Total, Ortho, and/or Dissolved)
- ☐ Major Ions (i.e. Alkalinity, Hardness, Chloride, and/or Sulphate) ☐ Other________

Note: Determining alkalinity is recommended, as are other analyses, but not required for CABIN assessments.

CHANNEL DATA

Slope - Indicate how slope was measured: (check one)

☐ **Calculated from map**

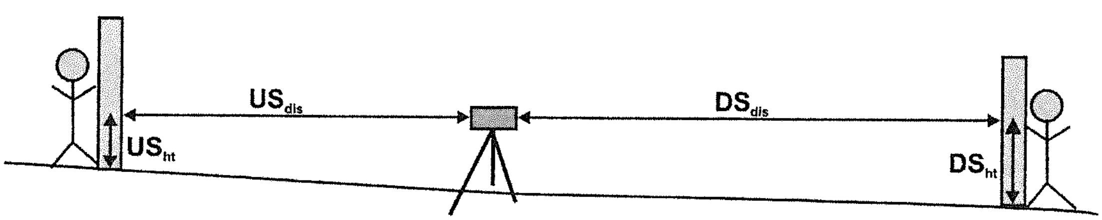
Scale: ________ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) ________ (m),
distance between contour intervals (horizontal distance) ________ (m)
slope = vertical distance/horizontal distance = ________

OR

☑ **Measured in field**

Circle device used and fill out table according to device:
a. Survey Equipment b. Hand Level & Measuring Tape Clinometer 2%

Measurements	Upstream (U/S)	Downstream(D/S)	Calculation
[a]Top Hairline (T)			
[a]Mid Hairline (ht) OR [b]Height of rod			
[a]Bottom Hairline (B)			
[b]Distance (dis) OR [a]T-B x 100	[a]US_{dis}=T-B	[a]DS_{dis}=T-B	$US_{dis}+DS_{dis}$=
Change in height (Δht)			$DS_{ht}-US_{ht}$=
Slope (Δht/total dis)			



Field Crew: IM, HW, LM Site Code: JOR-DS-AQ31

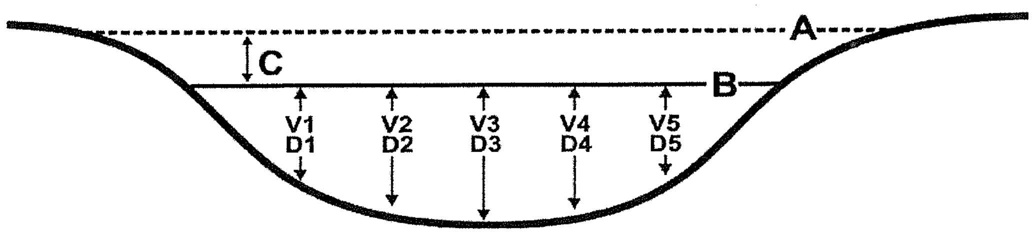
Sampling Date: (DD/MM/YYYY) 26/07/2017

Widths and Depth

Location at site: middle of sample area (Indicate where in sample reach, ex. d/s of kick area)

A - Bankfull Width: 5.7 (m) B - Wetted Stream Width: 3.4 (m)

C - Bankfull–Wetted Depth (height from water surface to Bankfull): 45 (cm)



Note:
Wetted widths > 5 m, measure a minimum of 5-6 equidistant locations;
Wetted widths < 5 m, measure 3-4 equidistant locations.

Velocity and Depth

Check appropriate velocity measuring device and fill out the appropriate section in chart below. Distance from shore and depth are required regardless of method:

☐ **Velocity Head Rod (or ruler)**: Velocity Equation (m/s) = √ [2(ΔD/100) * 9.81]

☐ **Rotary meters**: Gurley/Price/Mini-Price/Propeller (Refer to specific meter conversion chart for calculation)

☑ **Direct velocity measurements**: ☑ Marsh-McBirney ☐ Sontek or ☐ Other________

	1	2	3	4	5	6	AVG
* Distance from Shore (m)	0.5	1	1.5	2	2.5	3	
* Depth (**D**) (cm)	17	19	16	8	8	30	
Velocity Head Rod (ruler)							
Flowing water Depth (**D_1**) (cm)							
Depth of Stagnation (**D_2**) (cm)							
Change in depth (**$\Delta D=D_2-D_1$**) (cm)							
Rotary meter							
Revolutions							
Time (minimum 40 seconds)							
Direct Measurement or calculation							
* Velocity (**V**) (m/s)	0.01	0.72	1.34	1.10	1.69	0.89	

flow meter sitting on top of rock in stream

Field Crew: IM, HW, LM Site Code: JOR-DS-AQ31

Sampling Date: (DD/MM/YYYY) 26/07/2017

Substrate Size Class	Category
Organic Cover	0
< 0.1 cm (fine sand, silt or clay)	1
0.1-0.2 cm (coarse sand)	2
0.2-1.6 cm (gravel)	3
1.6-3.2 cm (small pebble)	4
3.2-6.4 cm (large pebble)	5
6.4-12.8 cm (small cobble)	6
12.8-25.6 cm (cobble)	7
> 25.6 cm (boulder)	8
Bedrock	9

SUBSTRATE DATA

Surrounding/Interstitial Material

Circle the substrate size category for the surrounding material.

100 Pebble Count & Substrate Embeddedness

- Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embededness categories (E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

	Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E
1	5		26	12		51	7		76	2	
2	1.5		27	25		52 *	4	0	77	2.5	
3	11		28	2.3		53	2.5		78	10	
4	12		29	38		54	39		79	35	
5	4		30 *	28		55	16		80	16	
6	2		31	21		56	7		81	13	
7	21		32	5	0	57	4		82 *	6	0
8	11		33	4.5		58	16.5		83	3	
9	9		34	14		59	1		84	13	
* 10	34		35	21		60	15.5		85	1.5	
11	11		36	9		61	13		86	7	
12	19	0	37	32		62 *	15	3/4	87	1	
13	23		38	2		63	19		88	8.5	
14	14		39	16		64	11		89	2	
15	15		40	6		65	13.5		90	4.5	
16	3.5		41	34		66	2.5		91	S <0.2	
17	31		42 *	28	0	67	14		92 *	6.5	1/4
18	19		43	11		68	10		93	18	
19	35		44	16		69	9		94	11	
* 20	22		45	3		70	21		95	3	
21	30		46	18		71	13		96	11	
22	19	0	47	3.5		72 *	8	0	97	3.5	
23	5		48	32		73	2		98	14.5	
24	12		49	33		74	9		99	30	
25	11		50	6		75	6		100 *	1.5	1/4

Note: The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.

CABIN CANADIAN AQUATIC BIOMONITORING NETWORK

Field Crew: ______________________________ Site Code: ____________

Sampling Date: (DD/MM/YYYY) ____________________

SITE INSPECTION

Site Inspected by: ______________________________

Communication Information

☐ Itinerary left with contact person (include contact numbers)

Contact Person: ________________________ Time checked-in: ________

Form of communication: ☐ radio ☐ cell ☐ satellite ☐ hotel/pay phone ☐ SPOT

Phone number: ( ) ____________

Vehicle Safety

☐ Safety equipment (first aid, fire extinguisher, blanket, emergency kit in vehicle)

☐ Equipment and chemicals safely secured for transport

☐ Vehicle parked in safe location; pylons, hazard light, reflective vests if necessary

Notes:

Shore & Wading Safety

☐ Wading Task Hazard Analysis read by all field staff

☐ Wading Safe Work Procedures read by all field staff

☐ Instream hazards identified (i.e. log jams, deep pools, slippery rocks)

☐ PFD worn

☐ Appropriate footwear, waders, wading belt

☐ Belay used

Notes:

Field Crew: IM, MW, LJ Site Code: CRB-DS-AQ01

Sampling Date: (DD/MM/YYYY) 25/07/2017

☐ **Occupational Health & Safety: Site Inspection Sheet completed**

PRIMARY SITE DATA

CABIN Study Name: RMOW Ecosystems Monitoring Local Basin Name: River of Golden Dreams

River/Stream Name: Crabapple Creek Stream Order: (map scale 1:50,000) ______

Select one: ☑ Test Site ☐ Potential Reference Site

Geographical Description/Notes:

Surrounding Land Use: (check those present) Information Source: RMOW

☑ Forest ☐ Field/Pasture ☐ Agriculture ☑ Residential/Urban
☐ Logging ☐ Mining ☐ Commercial/Industrial ☑ Other Golf course

Dominant Surrounding Land Use: (check one) Information Source: ______

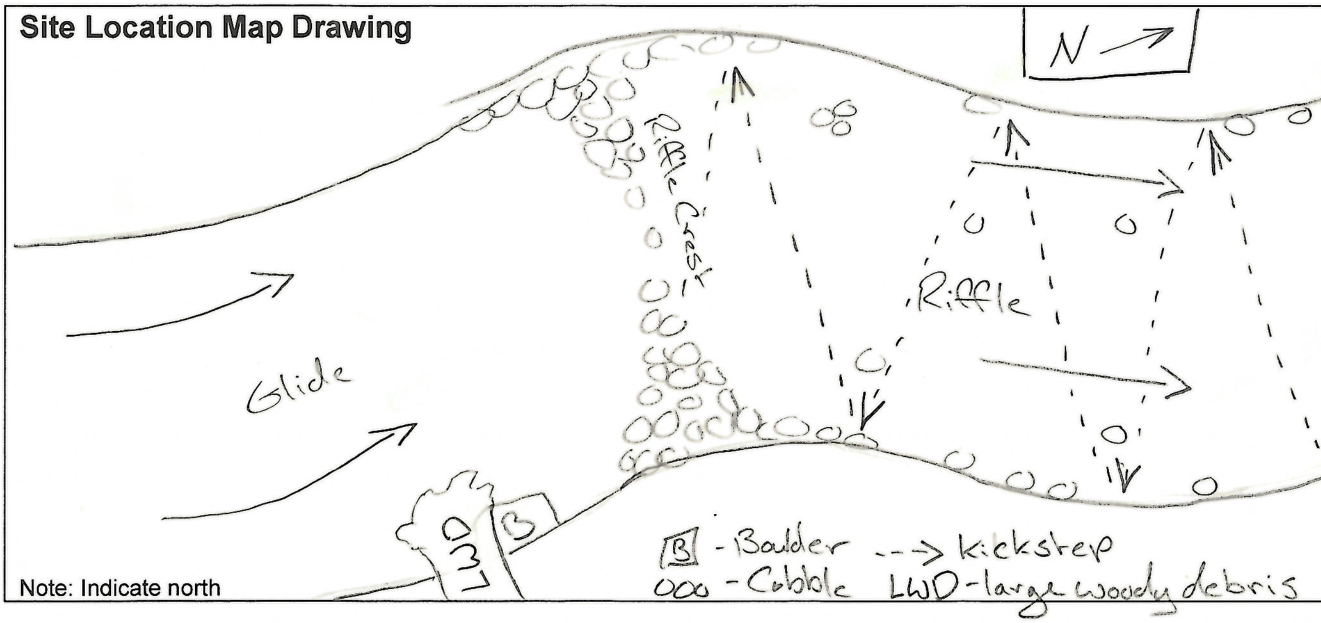
☐ Forest ☐ Field/Pasture ☐ Agriculture ☑ Residential/Urban
☐ Logging ☐ Mining ☐ Commercial/Industrial ☐ Other ______

Location Data

Latitude: 502021 N Longitude: - 5552707 W (DMS or DD)

Elevation: 643 (fasl or masl) GPS Datum: ☑ GRS80 (NAD83/WGS84) ☐ Other: ______

Site Location Map Drawing



Note: Indicate north

Field Crew: IM, HW, LJ Site Code: CRB-DS-AQ01

Sampling Date: (DD/MM/YYYY) 25/07/2017

Photos 432
- [x] Field Sheet
- [x] Upstream 103-0427
- [x] Downstream 103-0428
- [x] Across Site 103-0429
- [ ] Aerial View
- [ ] Substrate (exposed)
- [x] Substrate (aquatic) 103-0430
- [ ] Other ______

REACH DATA *(represents 6 times bankfull width)*

1. Habitat Types: *(check those present)*
   - [x] Riffle
   - [ ] Rapids
   - [x] Straight run
   - [ ] Pool/Back Eddy

2. Canopy Coverage: *(stand in middle of stream and look up, check one)*
   - [ ] 0 %
   - [ ] 1-25 %
   - [ ] 26-50 %
   - [x] 51-75 %
   - [ ] 76-100 %

3. Macrophyte Coverage: *(not algae or moss, check one)*
   - [x] 0 %
   - [ ] 1-25 %
   - [ ] 26-50 %
   - [ ] 51-75 %
   - [ ] 76-100 %

4. Streamside Vegetation: *(check those present)*
   - [x] ferns/grasses
   - [x] shrubs
   - [x] deciduous trees
   - [x] coniferous trees

5. Dominant Streamside Vegetation: *(check one)*
   - [ ] ferns/grasses
   - [ ] shrubs
   - [x] deciduous trees
   - [ ] coniferous trees

6. Periphyton Coverage on Substrate: *(benthic algae, not moss, check one)*
   - [ ] **1** - Rocks are not slippery, no obvious colour (thin layer < 0.5 mm thick)
   - [x] **2** - Rocks are slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)
   - [ ] **3** - Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)
   - [ ] **4** - Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)
   - [ ] **5** - Rocks are mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

Note: 1 through 5 represent categories entered into the CABIN database.

BENTHIC MACROINVERTEBRATE DATA

Habitat sampled: (*check one*) [x] riffle [ ] rapids [ ] straight run

400 μm mesh Kick Net ✓	
Person sampling	IM
Sampling time (i.e. 3 min.)	3 min
No. of sample jars	1
Typical depth in kick area (cm)	15

Preservative used: ~~Formalin~~ (Ethanol) 85.95 %

Sampled sieved on site using "Bucket Swirling Method":
[ ] YES [x] NO

If YES, debris collected for QAQC [ ]

Note: Indicate if a sampling method other than the recommended 400 μm mesh kick net is used.

Field Crew: IM, MW, LJ Site Code: CRB-DS-AQ01

Sampling Date: (DD/MM/YYYY) 25/07/2017

WATER CHEMISTRY DATA **Time:** 10:02 (24 hr clock) **Time zone:** PST

Air Temp: 17.5 (°C) Water Temp: 12 (°C) pH: 7.4

Specific Conductance: 336.3 (µs/cm) DO: 11.6 (mg/L) Turbidity: — (NTU)

Check if water samples were collected for the following analyses:

☐ TSS (Total Suspended Solids)

☐ Nitrogen (i.e. Total, Nitrate, Nitrite, Dissolved, and/or Ammonia)

☐ Phosphorus (Total, Ortho, and/or Dissolved)

☐ Major Ions (i.e. Alkalinity, Hardness, Chloride, and/or Sulphate) ☐ Other__________

Note: Determining alkalinity is recommended, as are other analyses, but not required for CABIN assessments.

CHANNEL DATA

Slope - Indicate how slope was measured: (check one)

☐ **Calculated from map**

Scale: __________ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) ________ (m),
distance between contour intervals (horizontal distance) ________ (m)
slope = vertical distance/horizontal distance =__________

OR

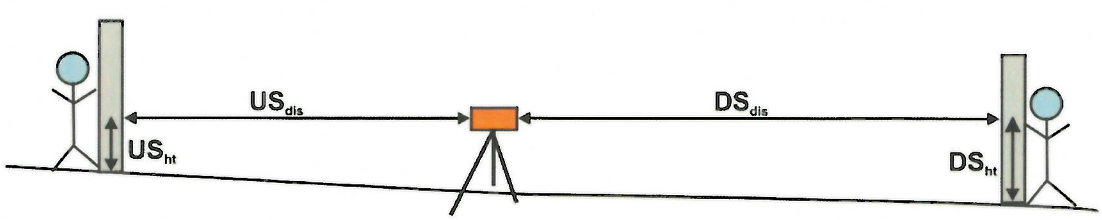
☑ **Measured in field**

Circle device used and fill out table according to device:

linometer- a. Survey Equipment b. Hand Level & Measuring Tape

1%

Measurements	Upstream (U/S)	Downstream(D/S)	Calculation
[a]Top Hairline (T)			
[a]Mid Hairline (ht) OR [b]Height of rod			
[a]Bottom Hairline (B)			
[b]Distance (dis) OR [a]T-B x 100	[a]US_{dis}=T-B	[a]DS_{dis}=T-B	US_{dis}+DS_{dis}=
Change in height (Δht)			DS_{ht}-US_{ht}=
Slope (Δht/total dis)			



CABIN CANADIAN AQUATIC BIOMONITORING NETWORK

Field Crew: IM, MW, LJ Site Code: CRB-DS-AQ01

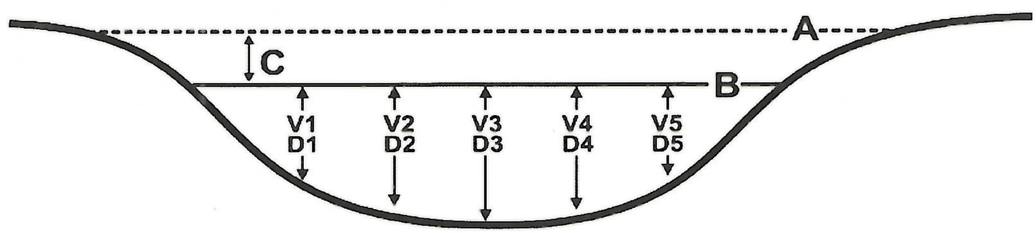
Sampling Date: (DD/MM/YYYY) 25/07/2017

Widths and Depth

Location at site: midway through kick Sample Area (Indicate where in sample reach, ex. d/s of kick area)

A - Bankfull Width: 4.4 (m) B - Wetted Stream Width: 3.32 (m)

C - Bankfull–Wetted Depth (height from water surface to Bankfull): 30 (cm)



Note:
Wetted widths > 5 m, measure a minimum of 5-6 equidistant locations;
Wetted widths < 5 m, measure 3-4 equidistant locations.

Velocity and Depth

Check appropriate velocity measuring device and fill out the appropriate section in chart below. Distance from shore and depth are required regardless of method:

PHOTO 431

☐ **Velocity Head Rod (or ruler)**: Velocity Equation (m/s) = √ [2(ΔD/100) * 9.81]

☐ **Rotary meters**: Gurley/Price/Mini-Price/Propeller (Refer to specific meter conversion chart for calculation)

☑ **Direct velocity measurements**: ☑ Marsh-McBirney ☐ Sontek or ☐ Other

	1	2	3	4	5	6	AVG
Distance from Shore (m)	0.5	1.0	1.5	2.0	2.5	3.0	
Depth (**D**) (cm)	8	5	10	7	8	4	
Velocity Head Rod (ruler)							
Flowing water Depth (**D₁**) (cm)							
Depth of Stagnation (**D₂**) (cm)							
Change in depth (**ΔD=D₂-D₁**) (cm)							
Rotary meter							
Revolutions							
Time (minimum 40 seconds)							
Direct Measurement or calculation							
Velocity (**V**) (m/s)	0.31	0.40	0.39	0.31	0.33	0.06	

Field Crew: IM, HW, LJ   Site Code: CRB-DS-AQ01

Sampling Date: (DD/MM/YYYY) 25/07/2017

SUBSTRATE DATA

Surrounding/Interstitial Material

Circle the substrate size category for the surrounding material.

Substrate Size Class	Category
Organic Cover	0
< 0.1 cm (fine sand, silt or clay)	1
0.1-0.2 cm (coarse sand)	2
0.2-1.6 cm (gravel)	3
1.6-3.2 cm (small pebble)	4
3.2-6.4 cm (large pebble)	5
6.4-12.8 cm (small cobble)	6
12.8-25.6 cm (cobble)	7
> 25.6 cm (boulder)	8
Bedrock	9

100 Pebble Count & Substrate Embeddedness

- Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embededness categories (E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

	Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E
1	11		26	2.5		51	0.5		76	8	
2	2.5		27	10		52	0.04		77	8	
3	5		28	20		53	12		78	14	
4	4		29	12		54	2		79	1	
5	6.5		30*	15	0	55	19		80*	11	0
6	13		31	15		56	5		81	3	
7	2		32	3.5		57	15		82	9	
8	5.5		33	8		58	21		83	2	
9	3.5		34	1.5		59	15		84	6	
10	3.5	0	35	16		60*	2	0	85	4	
11	9		36	0.05		61	6		86	1	
12	9		37	1.5		62	18		87	9	
13	1.5		38	5		63	14		88	14	
14	12		39	8		64	2		89	2.5	
15	6		40*	2.5	0	65	18		90*	11	0
16	7.5		41	12		66	11		91	8	
17	4		42	0.04		67	6.5		92	3	
18	8		43	1.5		68	5		93	6	
19	6.5		44	10		69	2		94	3.5	
20	13	1/4	45	1.5		70*	3	0	95	9	
21	3		46	0.5		71	10		96	2	
22	7		47	4		72	5.5		97	7.5	
23	1.5		48	11		73	7		98	6	
24	13		49	7.5		74	2.5		99	2.5	
25	9		50*	16	0	75	6		100	2	0

Note: The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.

Field Crew: ______________________________ Site Code: ____________

Sampling Date: (DD/MM/YYYY) ____________________

SITE INSPECTION

Site Inspected by: ______________________________

Communication Information

☐ Itinerary left with contact person (include contact numbers)

Contact Person: ______________________________ Time checked-in: ________

Form of communication: ☐ radio ☐ cell ☐ satellite ☐ hotel/pay phone ☐ SPOT

Phone number: (   ) ____________

Vehicle Safety

☐ Safety equipment (first aid, fire extinguisher, blanket, emergency kit in vehicle)

☐ Equipment and chemicals safely secured for transport

☐ Vehicle parked in safe location; pylons, hazard light, reflective vests if necessary

Notes:

Shore & Wading Safety

☐ Wading Task Hazard Analysis read by all field staff

☐ Wading Safe Work Procedures read by all field staff

☐ Instream hazards identified (i.e. log jams, deep pools, slippery rocks)

☐ PFD worn

☐ Appropriate footwear, waders, wading belt

☐ Belay used

Notes:

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	CRB-DS-AQ01
Sampling Date	Jul 25 2017
Know Your Watershed Basin	Harrison
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.12639 N, 122.97167 W
Altitude	2109
Local Basin Name	Crabapple Creek
	River of Golden Dreams
Stream Order	2

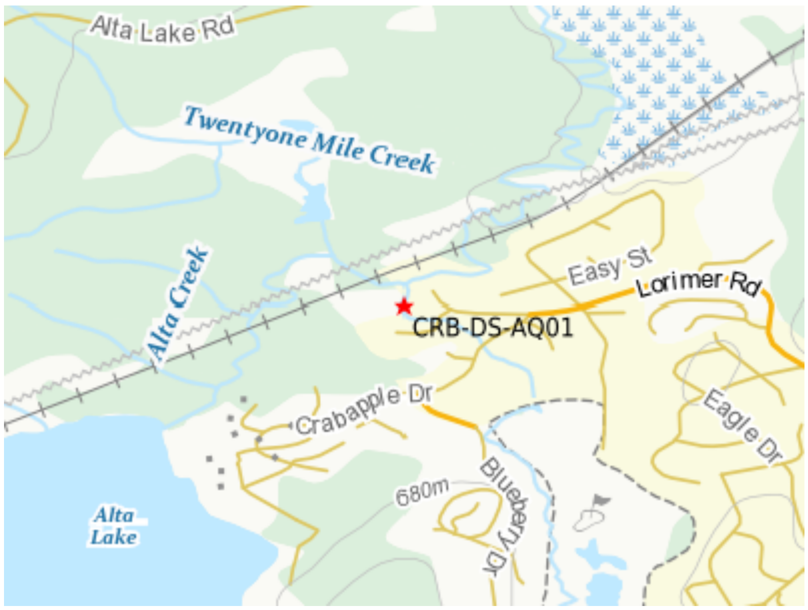


Figure 1. Location Map

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River-Georgia Basin Model 2005
Analysis Date	January 25, 2018
Taxonomic Level	Family
Predictive Model Variables	Depth-Avg Dominant-1st ecoregion Embeddedness General-pH Latitude Slope stream order Veg-Coniferous Velocity-Max Width-Wetted

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	91	16	80	19	68
Group Error Rate	36.3%	56.3%	61.3%	36.8%	44.1%
Overall Model Error Rate			46.7%		
Probability of Group Membership	20.8%	0.9%	32.9%	2.0%	43.4%
CABIN Assessment of CRB-DS-AQ01 on Jul 25, 2017			Divergent		

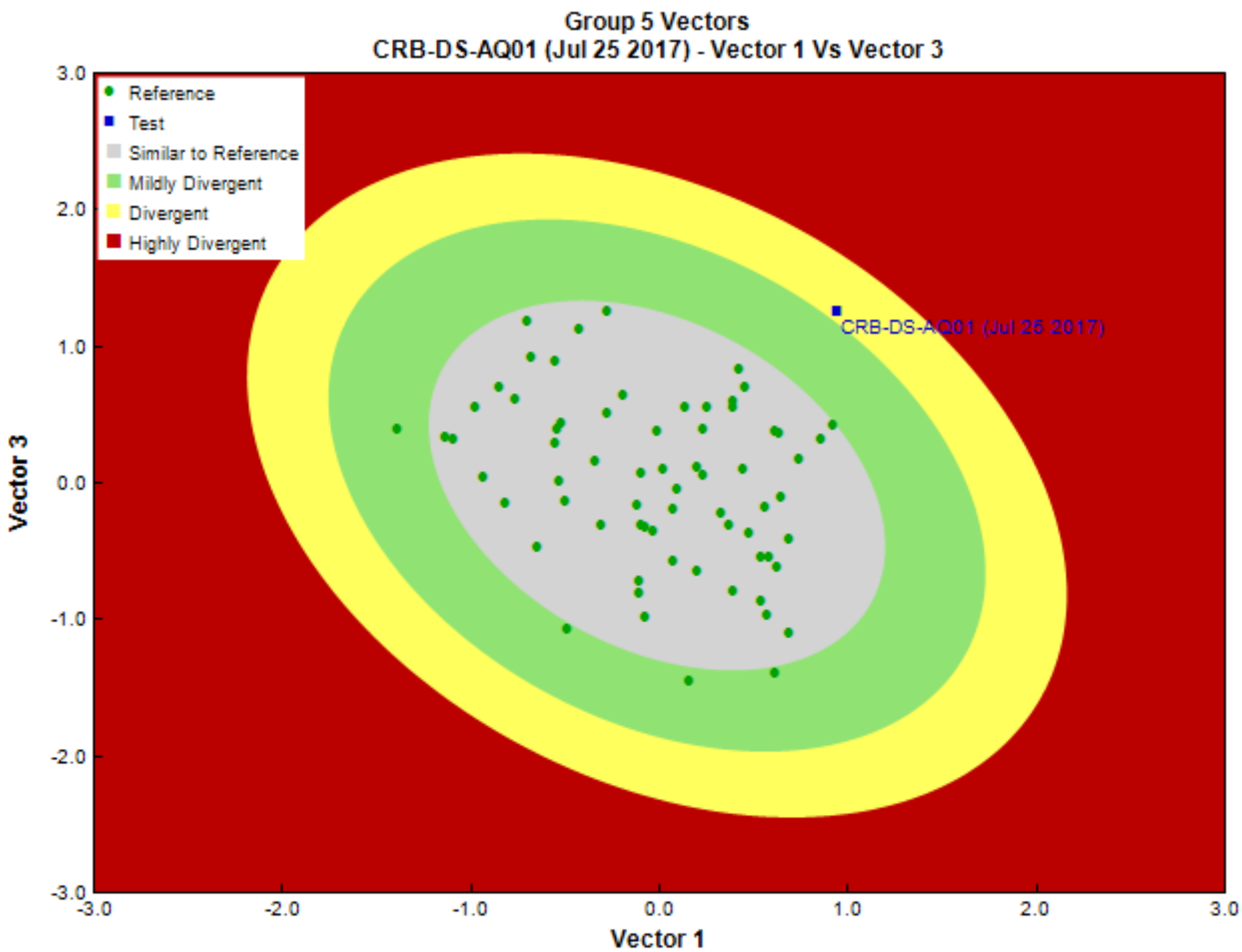


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	November 01, 2017
	Marchant Box
Sub-Sample Proportion	16/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	5	31.3
	Insecta	Diptera	Chironomidae	34	212.5
			Simuliidae	15	93.8
		Ephemeroptera	Baetidae	302	1,887.5
			Ephemerellidae	9	56.3
			Leptophlebiidae	1	6.3
		Plecoptera	Chloroperlidae	12	75.0
			Nemouridae	25	156.3
		Trichoptera	Limnephilidae	1	6.3
			Rhyacophilidae	8	50.0
			Total	412	2,575.3

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	
Baetidae	95%	75%	89%	63%	93%	0.91
Capniidae	63%	75%	60%	47%	69%	0.64
Chironomidae	100%	100%	98%	100%	100%	0.99
Chloroperlidae	89%	81%	84%	37%	71%	0.78
Empididae	52%	69%	55%	26%	53%	0.53
Ephemerellidae	91%	63%	89%	58%	85%	0.87
Heptageniidae	98%	75%	100%	47%	91%	0.94
Nemouridae	81%	63%	78%	21%	79%	0.78
Perlodidae	69%	56%	66%	5%	59%	0.62
Tipulidae	58%	63%	64%	37%	47%	0.55

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	7.62
RIVPACS : Observed taxa P>0.50	5.00
RIVPACS : O:E (p > 0.5)	0.66
RIVPACS : Expected taxa P>0.70	5.28
RIVPACS : Observed taxa P>0.70	5.00
RIVPACS : O:E (p > 0.7)	0.95

Habitat Description

Variable	CRB-DS-AQ01	Predicted Group Reference Mean ±SD
Channel		
Depth-Max (cm)	10.0	31.5 ± 20.2
Slope (m/m)	0.0100000	0.0113537 ± 0.0136699
Velocity-Max (m/s)	0.40	0.52 ± 0.25
Width-Wetted (m)	3.3	10.7 ± 12.2
Substrate Data		
Dominant-1st (Category(0-9))	6	6 ± 1
Embeddedness (Category(1-5))	5	4 ± 1
Water Chemistry		
General-pH (pH)	7.4	7.6 ± 0.7

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	JOR-DS-AQ31
Sampling Date	Jul 26 2017
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)	50.09528 N, 122.99778 W
Altitude	1975
Local Basin Name	Jordan Creek
	Jordan Creek
Stream Order	2

Figure 1. Location Map

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River-Georgia Basin Model 2005
Analysis Date	January 25, 2018
Taxonomic Level	Family
Predictive Model Variables	Depth-Avg Dominant-1st ecoregion Embeddedness General-pH Latitude Slope stream order Veg-Coniferous Velocity-Max Width-Wetted

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	91	16	80	19	68
Group Error Rate	36.3%	56.3%	61.3%	36.8%	44.1%
Overall Model Error Rate	46.7%				
Probability of Group Membership	95.0%	0.2%	3.8%	0.0%	0.9%
CABIN Assessment of JOR-DS-AQ31 on Jul 26, 2017	Mildly Divergent				

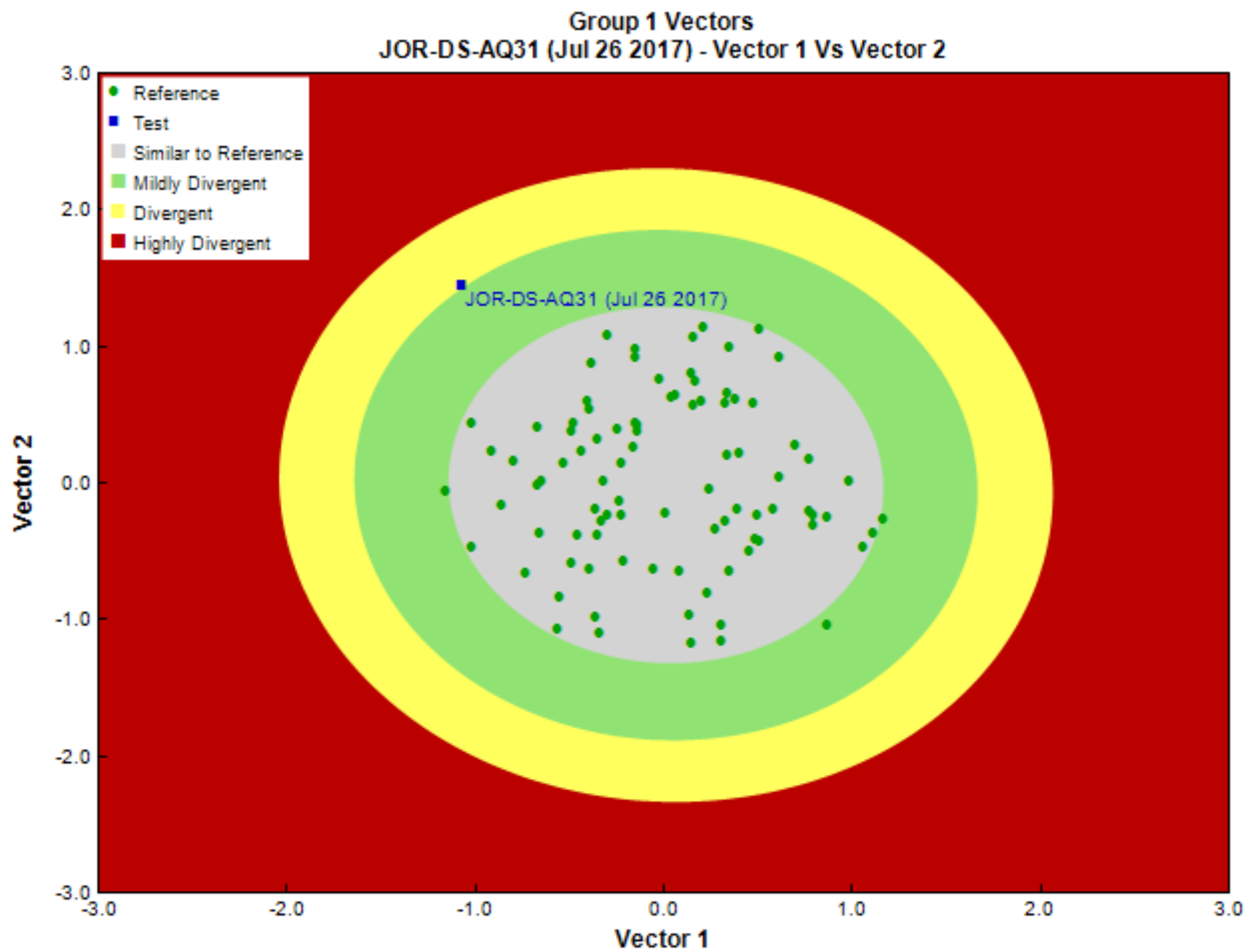


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	November 03, 2017
	Marchant Box
Sub-Sample Proportion	14/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	1	7.1
	Collembola	Collembola		1	7.1
	Insecta	Diptera	Chironomidae	49	350.0
			Empididae	4	28.6
			Simuliidae	233	1,664.3
			Tipulidae	1	7.1
		Ephemeroptera	Baetidae	41	292.9
			Ephemerellidae	3	21.4
			Leptophlebiidae	3	21.4
		Plecoptera	Chloroperlidae	1	7.1
			Leuctridae	1	7.1
			Nemouridae	20	142.9
			Perlidae	1	7.1
		Trichoptera	Rhyacophilidae	1	7.1
			Total	360	2,571.2

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	
Baetidae	95%	75%	89%	63%	93%	0.94
Capniidae	63%	75%	60%	47%	69%	0.63
Chironomidae	100%	100%	98%	100%	100%	1.00
Chloroperlidae	89%	81%	84%	37%	71%	0.89
Empididae	52%	69%	55%	26%	53%	0.52
Ephemerellidae	91%	63%	89%	58%	85%	0.91
Heptageniidae	98%	75%	100%	47%	91%	0.98
Nemouridae	81%	63%	78%	21%	79%	0.81
Perlodidae	69%	56%	66%	5%	59%	0.69
Rhyacophilidae	66%	44%	58%	16%	31%	0.65
Taeniopterygidae	70%	44%	46%	21%	32%	0.69
Tipulidae	58%	63%	64%	37%	47%	0.58

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	9.29
RIVPACS : Observed taxa P>0.50	8.00
RIVPACS : O:E (p > 0.5)	0.86
RIVPACS : Expected taxa P>0.70	5.53
RIVPACS : Observed taxa P>0.70	5.00
RIVPACS : O:E (p > 0.7)	0.90

Habitat Description

Variable	JOR-DS-AQ31	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	16.3	30.4 ± 14.7
Slope (m/m)	0.0200000	0.0248895 ± 0.0256268
Velocity-Max (m/s)	1.69	0.69 ± 0.29
Width-Wetted (m)	3.4	19.8 ± 25.9
Substrate Data		
Dominant-1st (Category(0-9))	7	7 ± 1
Embeddedness (Category(1-5))	5	4 ± 1
Water Chemistry		
General-pH (pH)	7.1	7.5 ± 0.7

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	21M-DS-AQ21
Sampling Date	Jul 25 2017
Know Your Watershed Basin	Harrison
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.12750 N, 122.97278 W
Altitude	2132
Local Basin Name	Twenty-One Mile Creek
	River of Golden Dreams
Stream Order	3

Figure 1. Location Map

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River-Georgia Basin Model 2005
Analysis Date	January 25, 2018
Taxonomic Level	Family
Predictive Model Variables	Depth-Avg Dominant-1st ecoregion Embeddedness General-pH Latitude Slope stream order Veg-Coniferous Velocity-Max Width-Wetted

Reference Groups	1	2	3	4	5
Number of Reference Sites	91	16	80	19	68
Group Error Rate	36.3%	56.3%	61.3%	36.8%	44.1%
Overall Model Error Rate	46.7%				
Probability of Group Membership	68.8%	14.5%	8.0%	4.1%	4.6%
CABIN Assessment of 21M-DS-AQ21 on Jul 25, 2017	Mildly Divergent				

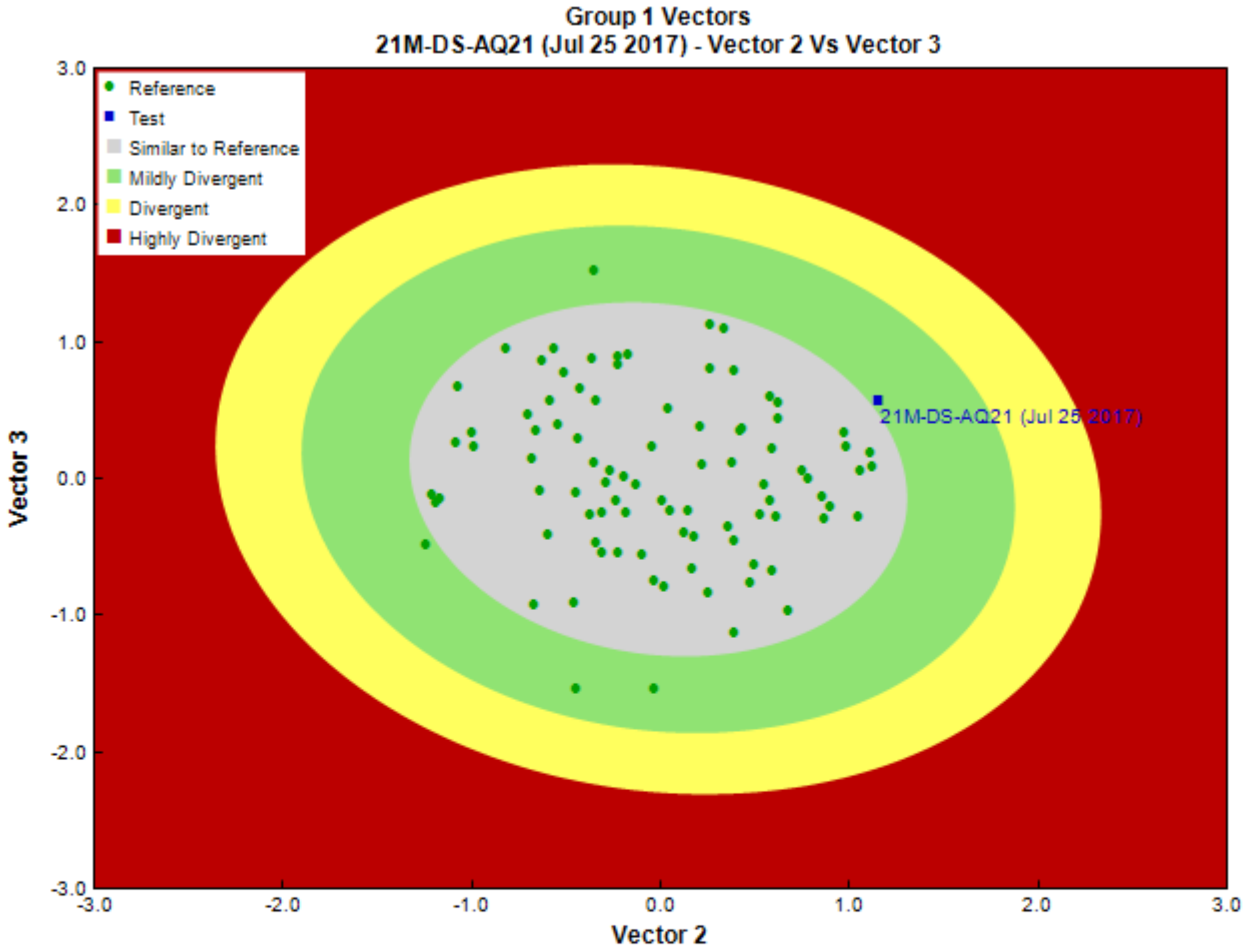


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	November 02, 2017
	Marchant Box
Sub-Sample Proportion	24/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	4	16.7
	Insecta	Diptera	Ceratopogonidae	7	29.2
			Chironomidae	11	45.8
			Empididae	1	4.2
			Simuliidae	50	208.3
			Tipulidae	2	8.3
		Ephemeroptera	Baetidae	86	358.3
			Heptageniidae	209	870.8
		Plecoptera	Chloroperlidae	15	62.5
			Nemouridae	2	8.3
			Perlidae	3	12.5
			Perlodidae	1	4.2
			Total	391	1,629.1

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	
Baetidae	95%	75%	89%	63%	93%	0.90
Chironomidae	100%	100%	98%	100%	100%	1.00
Chloroperlidae	89%	81%	84%	37%	71%	0.84
Empididae	52%	69%	55%	26%	53%	0.53
Heptageniidae	98%	75%	100%	47%	91%	0.92
Nemouridae	81%	63%	78%	21%	79%	0.76
Perlodidae	69%	56%	66%	5%	59%	0.64
Tipulidae	58%	63%	64%	37%	47%	0.58

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	8.86
RIVPACS : Observed taxa P>0.50	8.00
RIVPACS : O:E (p > 0.5)	0.90
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	21M-DS-AQ21	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	25.2	30.4 ± 14.7
Slope (m/m)	0.0100000	0.0248895 ± 0.0256268
Velocity-Max (m/s)	1.02	0.69 ± 0.29
Width-Wetted (m)	48.0	19.8 ± 25.9
Substrate Data		
Dominant-1st (Category(0-9))	5	7 ± 1
Embeddedness (Category(1-5))	5	4 ± 1
Water Chemistry		
General-pH (pH)	7.1	7.5 ± 0.7

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	RGD-DS-AQ12
Sampling Date	Jul 25 2017
Know Your Watershed Basin	Harrison
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.14417 N, 122.95750 W
Altitude	637
Local Basin Name	River of Golden Dreams
	River of Golden Dreams
Stream Order	3

Figure 1. Location Map

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River-Georgia Basin Model 2005
Analysis Date	January 25, 2018
Taxonomic Level	Family
Predictive Model Variables	Depth-Avg Dominant-1st ecoregion Embeddedness General-pH Latitude Slope stream order Veg-Coniferous Velocity-Max Width-Wetted

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	91	16	80	19	68
Group Error Rate	36.3%	56.3%	61.3%	36.8%	44.1%
Overall Model Error Rate			46.7%		
Probability of Group Membership	26.0%	1.9%	13.4%	44.4%	14.4%
CABIN Assessment of RGD-DS-AQ12 on Jul 25, 2017			Mildly Divergent		

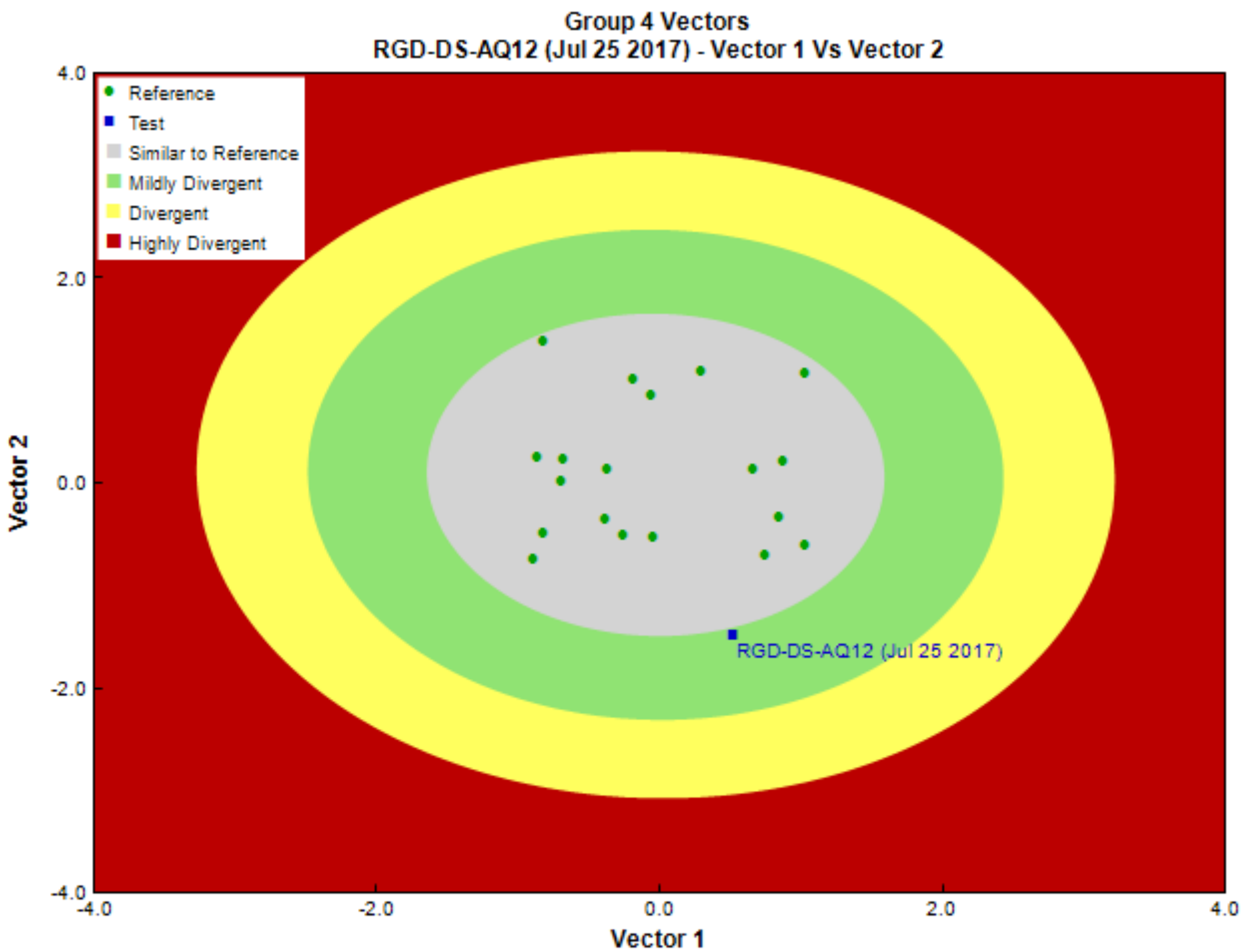


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	November 02, 2017
	Marchant Box
Sub-Sample Proportion	35/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	9	25.7
	Insecta	Coleoptera	Dytiscidae	2	5.7
		Diptera	Chironomidae	91	260.0
			Empididae	2	5.7
			Simuliidae	24	68.6
		Ephemeroptera	Ameletidae	2	5.7
			Baetidae	86	245.7
			Ephemerellidae	28	80.0
			Heptageniidae	93	265.7
		Plecoptera	Chloroperlidae	5	14.3
		Trichoptera	Limnephilidae	1	2.9
			Rhyacophilidae	7	20.0
			Total	350	1,000.0

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	
Baetidae	95%	75%	89%	63%	93%	0.79
Capniidae	63%	75%	60%	47%	69%	0.57
Chironomidae	100%	100%	98%	100%	100%	1.00
Chloroperlidae	89%	81%	84%	37%	71%	0.62
Ephemerellidae	91%	63%	89%	58%	85%	0.75
Heptageniidae	98%	75%	100%	47%	91%	0.74
Naididae	27%	50%	35%	84%	43%	0.56
Nemouridae	81%	63%	78%	21%	79%	0.53

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	5.57
RIVPACS : Observed taxa P>0.50	5.00
RIVPACS : O:E (p > 0.5)	0.90
RIVPACS : Expected taxa P>0.70	3.28
RIVPACS : Observed taxa P>0.70	4.00
RIVPACS : O:E (p > 0.7)	1.22

Habitat Description

Variable	RGD-DS-AQ12	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	32.2	36.5 ± 21.9
Slope (m/m)	0.0050000	0.0056537 ± 0.0112765
Velocity-Max (m/s)	0.47	0.26 ± 0.24
Width-Wetted (m)	15.4	37.1 ± 52.5
Substrate Data		
Dominant-1st (Category(0-9))	4	4 ± 2
Embeddedness (Category(1-5))	4	4 ± 1
Water Chemistry		
General-pH (pH)	7.0	6.9 ± 1.0

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	RGD-AQ11
Sampling Date	Jul 25 2017
Know Your Watershed Basin	Harrison
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.12722 N, 122.97194 W
Altitude	622
Local Basin Name	River of Golden Dreams
	River of Golden Dreams
Stream Order	3

Figure 1. Location Map

Cabin Assessment Results

Reference Model Summary	
Model	Fraser River-Georgia Basin Model 2005
Analysis Date	January 25, 2018
Taxonomic Level	Family
Predictive Model Variables	Depth-Avg Dominant-1st ecoregion Embeddedness General-pH Latitude Slope stream order Veg-Coniferous Velocity-Max Width-Wetted

Reference Groups	**1**	**2**	**3**	**4**	**5**
Number of Reference Sites	91	16	80	19	68
Group Error Rate	36.3%	56.3%	61.3%	36.8%	44.1%
Overall Model Error Rate			46.7%		
Probability of Group Membership	29.0%	6.4%	24.8%	0.8%	39.0%
CABIN Assessment of RGD-AQ11 on Jul 25, 2017			Highly Divergent		

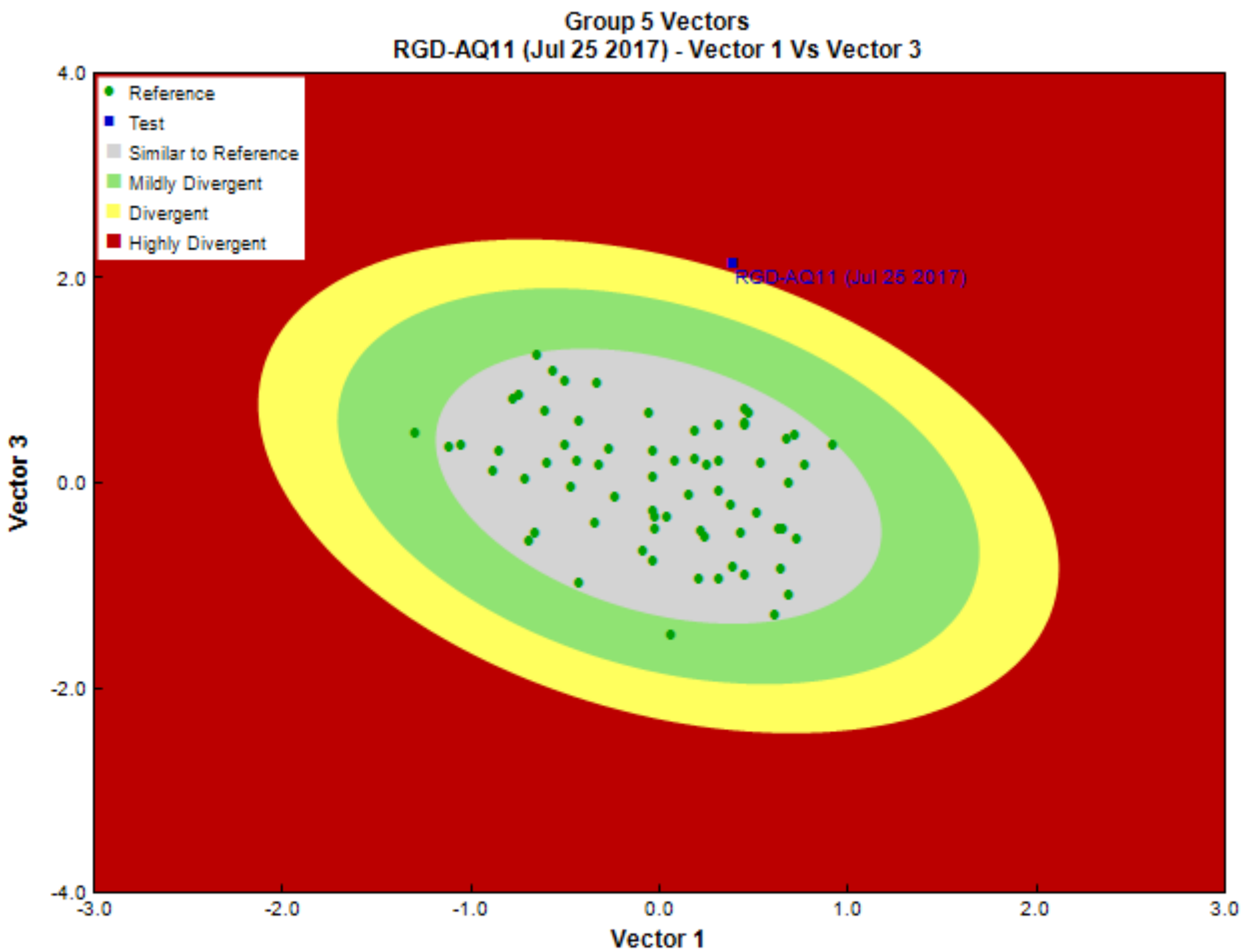


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	November 01, 2017
	Marchant Box
Sub-Sample Proportion	31/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	3	9.7
	Insecta	Diptera	Ceratopogonidae	3	9.7
			Chironomidae	18	58.1
			Simuliidae	46	148.4
			Tipulidae	1	3.2
		Ephemeroptera	Baetidae	35	112.9
			Ephemerellidae	2	6.4
			Heptageniidae	205	661.3
		Plecoptera	Chloroperlidae	23	74.2
			Nemouridae	2	6.4
			Perlidae	2	6.4
			Perlodidae	1	3.2
		Trichoptera	Rhyacophilidae	4	12.9
			Total	345	1,112.8

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	
Baetidae	95%	75%	89%	63%	93%	0.91
Capniidae	63%	75%	60%	47%	69%	0.65
Chironomidae	100%	100%	98%	100%	100%	0.99
Chloroperlidae	89%	81%	84%	37%	71%	0.80
Empididae	52%	69%	55%	26%	53%	0.54
Ephemerellidae	91%	63%	89%	58%	85%	0.86
Heptageniidae	98%	75%	100%	47%	91%	0.94
Nemouridae	81%	63%	78%	21%	79%	0.78
Perlodidae	69%	56%	66%	5%	59%	0.63
Tipulidae	58%	63%	64%	37%	47%	0.55

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	7.65
RIVPACS : Observed taxa P>0.50	8.00
RIVPACS : O:E (p > 0.5)	1.05
RIVPACS : Expected taxa P>0.70	5.28
RIVPACS : Observed taxa P>0.70	6.00
RIVPACS : O:E (p > 0.7)	1.14

Habitat Description

Variable	RGD-AQ11	Predicted Group Reference Mean ±SD
Channel		
Depth-Avg (cm)	0.4	21.2 ± 12.6
Slope (m/m)	0.0100000	0.0113537 ± 0.0136699
Velocity-Max (m/s)	1.06	0.52 ± 0.25
Width-Wetted (m)	9.2	10.7 ± 12.2
Substrate Data		
Dominant-1st (Category(0-9))	5	6 ± 1
Embeddedness (Category(1-5))	5	4 ± 1
Water Chemistry		
General-pH (pH)	7.1	7.6 ± 0.7

Appendix C

Fish Sampling Datasheets

FISH SAMPLING

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Project	RMOW Ecosystems Monitoring	Date	August 1, 2017
Site	CRB-DS-AQ01	Time	13:01
UTM	Zone: Easting (8 digits): Northing (7 digits):	Crew	IM + HW
		Waterbody	Crabapple Creek
Weather	Sun with heavy wildfire Smoke. ~~26°C~~	Mainstem (MS)/Side Channel (SC)	MS
		Tailgate completed and signed:	

Water Quality Data

Temp (°C)		14.2	TDS (ppm)	
pH	~~7.42~~	7.42	DO (mg/L)	10.61
Cond (µS/cm)		273.9	DO (% sat)	103.6
Sp.Cond (µS/cm2)		344.7	Turb. (NTU)	

Sampling Method:		EF (✓) Gee Trap ( ) Other ( )
Effort:		952s
EF Settings:	Voltage:	250 V
	Freq:	50 Hz
	Duty Cycle:	15 %

Site Characteristics			
Length	- get from UTMs	Avg W Width	2.5
Avg. Depth	0.5	Max Pool D	0.85

Site Map

Comments
p 456 - 1km u/s from start loc'n
p. 457 - 1km d/s " end "

FISH SAMPLING

Project	Rmow Ecosystems Monitoring	Date	1-Aug-17
Site	CRB-DS-AQ01	Time	14:05

Extra Col - oops

ID #	Sp.		Fork Length (~~mm~~) cm	Weight (g)	Comments
001	CCG		8.8	9.8	
002	TR		6.2	2.8	
003	TR		9.6	8.3	photo 455
004	CCG		5.7	3.5	
005	TR		5.7	2.9	
006	TSB		4.2	1.0	
007	TSB		4.2	1.4	
008	TSB		3.5	0.5	
009	TSB		4.2	1.7	
010	TSB		3.2	0.9	
011	TSB		3.3	1.3	
012	TR		2.7	0.3	
013	TSB		3.4	1.0	
014	TSB		2.5	0.3	

FISH SAMPLING

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Project	RMOW Ecosystems Monitoring	Date	August 2, 2017
Site	JOR-DS-AQ03	Time	9:18
UTM	Zone: Easting (8 digits): Northing (7 digits):	Crew	IM, HLl
		Waterbody	Jordan Creek
Weather	Sunny with heavy wildfire smoke 20°C	Mainstem (MS)/Side Channel (SC)	MS
		Tailgate completed and signed:	✓

Water Quality Data

Temp (°C)		16.2	TDS (ppm)	—
pH		7.26	DO (mg/L)	11.21
Cond (µS/cm)		91.4	DO (% sat)	113.8
Sp.Cond (µS/cm2)		109.7	Turb. (NTU)	—

Sampling Method:	EF (✓) Gee Trap ( ) Other ( )	
Effort:	974 s	
	Voltage:	300 → changed to 350
EF Settings:	Freq:	50
	Duty Cycle:	15%

Site Characteristics			
Length	-Get from UTMs	Avg W Width	3.0
Avg. Depth	0.60	Max Pool D	0.90

Site Map

Comments

FISH SAMPLING

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Project	RMOW Ecosystems	Date	02 - Aug - 17
Site	JOR-DS-AQ31 Monitoring	Time	10:30

ID #	Sp.	Extra Col.	Length (mm)	Weight (g)	Comments
001	TR	—	—	—	Escaped
002	TR		98	12.5	
003	CCG		100	17.4	
004	CCG		78	9.4	
005	TSB		52	1.4	
006	TSB		51	1.6	
007	TR		40	1.1	
008	TR		40	0.8	
009	TR		30	0.3	Mortality
010	TR	L = 160	~~1601~~	54.4	

FISH SAMPLING

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Project	Ecosystem Monitoring	Date	August 1, 2017
Site	21M-DS-AQ21	Time	14:32
UTM	Zone: Easting (8 digits): Northing (7 digits):	Crew	IM, HW
		Waterbody	21 mile Creek
Weather	Sunny with heavy wildfire smoke	Mainstem (MS)/Side Channel (SC)	MS
		Tailgate completed and signed:	✓

Water Quality Data

Temp (°C)		13.5	TDS (ppm)	—
pH		7.35	DO (mg/L)	8.23
Cond (µS/cm)		38.2	DO (% sat)	78.7
Sp.Cond (µS/cm2)		48.7	Turb. (NTU)	—

Sampling Method:		EF (✓) Gee Trap ( ) Other ( )	
Effort:		833 sec	
		Voltage:	400 (after 370 sec - 350V before)
EF Settings:		Freq:	50 Hz
		Duty Cycle:	15 %

Site Characteristics				
Length			Avg W Width	6 m
Avg. Depth		0.25 m	Max Pool D	0.6m

Site Map

Comments	increased voltage ~~to~~ from 350 to 400 when effort was at 370 sec

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

FISH SAMPLING

Project	RMOW Ecosystem Monitoring	Date	August 1, 2017
Site	21M-DS-AQ21	Time	3:38

ID #	Sp.		Length (mm)	Weight (g)	Comments
001	TSB		6.4	3.4	
002	CCG		7.4	6.1	
003	CCG		5.8	3.1	
004	CCG		6.5	3.8	
005	CCG		5.4	2.1	
006	TSB		4.7	1.4	
007	CCG		4.6	NA	

Appendix D

Fish Biological Characteristics

Fish Biological Characteristics

Site	Watershed	Creek	Sampling date	Electrofishing pass	Fish ID	Species	F. Length (mm)	Weight (g)	Comments
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	Aug-01-2017	First Pass	2	CCG	74	6.1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	Aug-01-2017	First Pass	3	CCG	58	3.1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	Aug-01-2017	First Pass	4	CCG	65	3.8	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	Aug-01-2017	First Pass	5	CCG	54	2.1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	Aug-01-2017	First Pass	7	CCG	46	N/A	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	Aug-01-2017	First Pass	1	TSB	64	3.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	Aug-01-2017	First Pass	6	TSB	47	1.4	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	1	CCG	88	9.8	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	4	CCG	57	3.5	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	2	TR	62	2.8	Photo 455
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	3	TR	96	8.3	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	5	TR	57	2.9	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	12	TR	27	0.3	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	6	TSB	42	1.0	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	7	TSB	42	1.4	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	8	TSB	35	0.5	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	9	TSB	42	1.7	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	10	TSB	32	0.9	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	11	TSB	33	1.3	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	13	TSB	34	1.0	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	Aug-01-2017	First Pass	14	TSB	25	0.3	
JOR-DS-AQ03	Jordan Creek	Jordan Creek	Aug-02-2017	First Pass	3	CCG	100	17.4	
JOR-DS-AQ03	Jordan Creek	Jordan Creek	Aug-02-2017	First Pass	4	CCG	78	9.4	
JOR-DS-AQ03	Jordan Creek	Jordan Creek	Aug-02-2017	First Pass	1	TR	-	-	Escaped
JOR-DS-AQ03	Jordan Creek	Jordan Creek	Aug-02-2017	First Pass	2	TR	98	12.5	
JOR-DS-AQ03	Jordan Creek	Jordan Creek	Aug-02-2017	First Pass	7	TR	40	1.1	
JOR-DS-AQ03	Jordan Creek	Jordan Creek	Aug-02-2017	First Pass	8	TR	40	0.8	
JOR-DS-AQ03	Jordan Creek	Jordan Creek	Aug-02-2017	First Pass	9	TR	30	0.3	Mortality
JOR-DS-AQ03	Jordan Creek	Jordan Creek	Aug-02-2017	First Pass	10	TR	160	54.4	
JOR-DS-AQ03	Jordan Creek	Jordan Creek	Aug-02-2017	First Pass	5	TSB	52	1.4	

Appendix E

Photographs of Aquatic Sampling Sites

Figure 1. ***Twentyone Mile Creek (21M-DS-AQ21) benthic sampling area, looking upstream. Date taken: July 25, 2017.***

Figure 2. ***Twentyone Mile Creek (21M-DS-AQ21) substrate (47% cobble, 11% gravel, 39% pebble Date taken: July 25, 2017.***

Figure 3. ***Twentyone Mile Creek (21M-DS-AQ21) benthic sampling area, looking downstream. Date taken: July 25, 2017.***

Figure 4. ***Twentyone Mile Creek (21M-DS-AQ21) substrate (86% pebble, 8% cobble, 6% gravel). Date taken: July 25, 2017.***

Figure 5. ***Crabapple Creek (CRB-DS-AQ01) benthic sampling area, looking upstream. Date taken: July 25, 2017.***

Figure 6. ***Crabapple Creek (CRB-DS-AQ01) benthic sampling area, looking downstream. Date taken: July 25, 2017.***

Figure 7. ***Crabapple Creek (CRB-DS-AQ01) benthic sampling area. Date taken: July 25, 2017.***

Figure 8. ***Crabapple Creek (CRB-DS-AQ01) substrate (7% cobble, 30%, gravel, 63% pebble). Date taken: July 25, 2017.***

Figure 9. ***Crabapple Creek (CRB-DS-AQ01) benthic sampling area, looking upstream. Date taken: July 25, 2017.***

Figure 10. ***River of Golden Dreams (RGD-DS-AQ12) benthic sampling area, looking upstream. Date taken: July 25, 2017.***

Figure 11. ***River of Golden Dreams (RGD-DS-AQ12) benthic sampling area, looking downstream. Date taken: July 25, 2017.***

Figure 12. ***River of Golden Dreams (RGD-DS-AQ12) substrate (38% gravel, 62% pebble) Date taken: July 25, 2017.***

Figure 13. River of Golden Dreams (RGD-DS-AQ12) benthic sampling area, looking upstream. Date taken: July 25, 2017.

Figure 14. River of Golden Dreams (RGD-US-AQ11) benthic sampling area, looking downstream. Date taken: July 25, 2017.

Figure 15. River of Golden Dreams (RGD-US-AQ11) benthic sampling area. Date taken: July 25, 2017.

Figure 16. River of Golden Dreams (RGD-US-AQ11) benthic sampling area, looking upstream. Date taken: July 25, 2017.

Figure 17. River of Golden Dreams (RGD-US-AQ11) substrate (8% cobble, 12% gravel, 78% pebble).

Figure 18. Jordan Creek (JOR-DS-AQ31) benthic sampling area, looking downstream. Date taken: July 26, 2017.

Figure 19. Jordan Creek (JOR-DS-AQ31) substrate (14% boulder, 53%, cobble, 6% gravel, 27% pebble). Date taken: July 26, 2017.

Figure 20. Jordan Creek (JOR-DS-AQ31) benthic sampling area. Date taken: July 26, 2017.

Figure 21. Jordan Creek (JOR-DS-AQ31) benthic sampling area, looking upstream. Date taken: July 26, 2017.

SNOWLINE Ecological Research

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F

Daily Stream Temperature Data

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
26-Jul-16	11.59	12.44	13.19
27-Jul-16	11.98	12.79	13.59
28-Jul-16	12.41	13.26	14.03
29-Jul-16	12.56	13.36	14.03
30-Jul-16	12.05	12.68	13.45
31-Jul-16	10.59	11.30	11.83
01-Aug-16	10.30	11.16	11.90
02-Aug-16	10.44	10.76	11.49
03-Aug-16	10.57	10.88	11.27
04-Aug-16	10.81	11.32	11.95
05-Aug-16	10.44	10.99	11.54
06-Aug-16	9.36	10.20	10.81
07-Aug-16	10.10	10.54	10.93
08-Aug-16	10.25	10.58	10.86
09-Aug-16	10.64	10.92	11.22
10-Aug-16	10.88	11.24	11.66
11-Aug-16	10.44	11.37	12.36
12-Aug-16	11.52	12.20	12.97
13-Aug-16	12.00	12.71	13.43
14-Aug-16	12.22	12.82	13.31
15-Aug-16	11.73	12.52	13.19
16-Aug-16	12.05	12.76	13.35
17-Aug-16	12.12	12.80	13.38
18-Aug-16	12.29	12.80	13.16
19-Aug-16	11.95	12.58	13.06
20-Aug-16	11.81	12.52	13.09
21-Aug-16	11.66	12.32	12.80
22-Aug-16	10.32	10.86	11.47
23-Aug-16	9.58	10.42	11.13
24-Aug-16	10.17	10.93	11.66
25-Aug-16	10.86	11.51	12.07
26-Aug-16	11.05	11.75	12.44
27-Aug-16	11.90	12.15	12.34
28-Aug-16	11.49	11.71	12.03
29-Aug-16	11.05	11.52	11.98
30-Aug-16	11.47	11.86	12.22
31-Aug-16	11.44	11.62	11.90
01-Sep-16	10.25	10.76	11.37
02-Sep-16	9.19	9.69	10.15
03-Sep-16	9.56	9.84	10.12

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
04-Sep-16	9.44	9.72	10.03
05-Sep-16	9.14	9.42	9.63
06-Sep-16	9.19	9.53	9.90
07-Sep-16	9.61	9.75	9.85
08-Sep-16	9.41	9.63	9.93
09-Sep-16	8.64	9.16	9.63
10-Sep-16	9.51	9.86	10.32
11-Sep-16	8.54	8.94	9.76
12-Sep-16	7.37	7.96	8.42
13-Sep-16	7.47	8.12	8.84
14-Sep-16	8.02	8.70	9.41
15-Sep-16	8.39	9.01	9.53
16-Sep-16	9.29	9.63	9.90
17-Sep-16	9.11	9.55	9.83
18-Sep-16	8.30	8.67	9.02
19-Sep-16	8.00	8.32	8.57
20-Sep-16	7.19	7.68	8.10
21-Sep-16	6.79	7.36	7.77
22-Sep-16	6.54	7.06	7.52
23-Sep-16	7.34	7.51	7.67
24-Sep-16	7.42	7.74	8.05
25-Sep-16	7.80	8.09	8.47
26-Sep-16	7.57	8.11	8.79
27-Sep-16	8.17	8.81	8.94
28-Sep-16	7.24	7.55	8.05
29-Sep-16	6.15	6.62	7.09
30-Sep-16	5.75	6.14	6.64
01-Oct-16	5.67	6.08	6.46
02-Oct-16	6.28	6.53	6.91
03-Oct-16	5.57	6.05	6.51
04-Oct-16	6.33	6.64	6.94
05-Oct-16	6.64	6.91	7.27
06-Oct-16	7.04	7.18	7.32
07-Oct-16	6.26	6.65	7.02
08-Oct-16	4.61	5.48	6.54
09-Oct-16	4.90	5.19	5.67
10-Oct-16	3.62	4.31	4.90
11-Oct-16	2.82	3.22	3.59
12-Oct-16	2.37	2.86	3.46
13-Oct-16	3.54	4.20	5.05

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
14-Oct-16	3.96	4.67	5.10
15-Oct-16	4.45	4.97	5.31
16-Oct-16	5.18	5.44	5.72
17-Oct-16	5.31	5.63	6.00
18-Oct-16	5.54	5.72	5.87
19-Oct-16	5.39	5.76	6.13
20-Oct-16	5.28	5.69	6.26
21-Oct-16	4.77	5.17	5.41
22-Oct-16	4.87	5.22	5.59
23-Oct-16	5.08	5.39	5.80
24-Oct-16	5.46	5.70	5.98
25-Oct-16	4.90	5.58	5.98
26-Oct-16	4.64	4.89	5.13
27-Oct-16	4.95	5.58	5.98
28-Oct-16	5.62	5.83	6.18
29-Oct-16	5.10	5.33	5.57
30-Oct-16	4.25	4.68	5.02
31-Oct-16	4.58	4.86	5.08
01-Nov-16	4.79	4.96	5.15
02-Nov-16	4.84	5.02	5.28
03-Nov-16	5.23	5.40	5.62
04-Nov-16	4.27	5.04	5.80
05-Nov-16	5.57	5.76	5.90
06-Nov-16	5.21	5.48	5.72
07-Nov-16	5.36	5.67	6.05
08-Nov-16	6.10	6.65	6.99
09-Nov-16	6.28	6.60	6.81
10-Nov-16	5.67	6.04	6.26
11-Nov-16	6.18	6.37	6.59
12-Nov-16	5.72	6.15	6.43
13-Nov-16	4.79	5.27	5.62
14-Nov-16	4.43	4.94	5.21
15-Nov-16	4.01	4.28	4.48
16-Nov-16	3.54	3.80	4.12
17-Nov-16	3.54	3.73	3.99
18-Nov-16	3.01	3.26	3.70
19-Nov-16	2.80	3.00	3.22
20-Nov-16	2.80	3.12	3.38
21-Nov-16	3.43	3.80	4.22
22-Nov-16	2.32	2.80	3.33

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
23-Nov-16	2.13	2.32	2.61
24-Nov-16	1.59	1.99	2.66
25-Nov-16	1.13	1.91	2.40
26-Nov-16	1.13	1.72	2.40
27-Nov-16	1.99	2.16	2.26
28-Nov-16	1.86	2.15	2.32
29-Nov-16	1.86	2.09	2.26
30-Nov-16	1.99	2.15	2.32
01-Dec-16	2.21	2.32	2.40
02-Dec-16	2.10	2.20	2.29
03-Dec-16	2.24	2.37	2.42
04-Dec-16	0.41	1.60	2.26
05-Dec-16	0.25	0.31	0.38
06-Dec-16	0.02	0.12	0.25
07-Dec-16	0.05	0.05	0.05
08-Dec-16	0.05	0.05	0.05
09-Dec-16	0.05	0.05	0.08
10-Dec-16	0.08	0.15	0.19
11-Dec-16	0.19	0.26	0.36
12-Dec-16	0.36	0.41	0.47
13-Dec-16	0.30	0.33	0.41
14-Dec-16	0.25	0.28	0.30
15-Dec-16	0.25	0.26	0.30
16-Dec-16	0.25	0.27	0.30
17-Dec-16	0.25	0.26	0.27
18-Dec-16	0.27	0.37	0.50
19-Dec-16	0.33	0.55	0.74
20-Dec-16	0.74	0.81	0.93
21-Dec-16	0.93	1.01	1.10
22-Dec-16	1.10	1.13	1.18
23-Dec-16	1.18	1.20	1.24
24-Dec-16	0.88	1.06	1.18
25-Dec-16	0.55	0.66	0.85
26-Dec-16	0.38	0.53	0.61
27-Dec-16	0.61	0.88	1.10
28-Dec-16	1.07	1.14	1.24
29-Dec-16	0.16	0.81	1.24
30-Dec-16	1.02	1.09	1.13
31-Dec-16	1.02	1.06	1.10
01-Jan-17	0.47	0.64	1.02

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	**Min Temperature (°C)**	**Average Temperature (°C)**	**Max Temperature (°C)**
02-Jan-17	0.25	0.32	0.44
03-Jan-17	0.14	0.18	0.25
04-Jan-17	0.25	0.34	0.41
05-Jan-17	0.30	0.37	0.44
06-Jan-17	0.47	0.60	0.74
07-Jan-17	0.66	0.69	0.74
08-Jan-17	0.58	0.65	0.66
09-Jan-17	0.58	0.65	0.72
10-Jan-17	0.30	0.47	0.63
11-Jan-17	0.25	0.28	0.33
12-Jan-17	0.14	0.17	0.25
13-Jan-17	0.16	0.20	0.25
14-Jan-17	0.25	0.31	0.41
15-Jan-17	0.41	0.55	0.69
16-Jan-17	0.63	0.77	0.85
17-Jan-17	0.36	0.55	0.80
18-Jan-17	0.47	0.75	0.96
19-Jan-17	0.83	1.25	1.45
20-Jan-17	1.45	1.57	1.62
21-Jan-17	1.62	1.68	1.72
22-Jan-17	1.67	1.73	1.78
23-Jan-17	1.43	1.62	1.72
24-Jan-17	0.96	1.12	1.40
25-Jan-17	1.10	1.27	1.48
26-Jan-17	1.34	1.44	1.56
27-Jan-17	1.21	1.38	1.56
28-Jan-17	1.10	1.33	1.53
29-Jan-17	1.53	1.60	1.67
30-Jan-17	0.91	1.41	1.67
31-Jan-17	0.05	0.27	0.80
01-Feb-17	0.02	0.06	0.11
02-Feb-17	0.05	0.05	0.08
03-Feb-17	0.05	0.05	0.05
04-Feb-17	0.05	0.07	0.11
05-Feb-17	0.05	0.09	0.11
06-Feb-17	0.11	0.15	0.19
07-Feb-17	0.14	0.15	0.19
08-Feb-17	0.11	0.13	0.14
09-Feb-17	0.08	0.10	0.14
10-Feb-17	0.14	0.28	0.41

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
11-Feb-17	0.41	0.57	0.72
12-Feb-17	0.72	0.80	0.88
13-Feb-17	0.88	0.94	0.99
14-Feb-17	0.77	0.99	1.07
15-Feb-17	0.11	0.45	0.99
16-Feb-17	0.30	1.07	1.62
17-Feb-17	1.59	1.75	1.89
18-Feb-17	1.56	1.71	1.89
19-Feb-17	1.81	1.86	1.94
20-Feb-17	1.72	1.85	1.94
21-Feb-17	1.45	1.70	1.89
22-Feb-17	0.74	1.06	1.37
23-Feb-17	0.05	0.38	0.74
24-Feb-17	0.44	0.70	0.96
25-Feb-17	0.02	0.18	0.50
26-Feb-17	0.27	0.45	0.52
27-Feb-17	0.02	0.08	0.16
28-Feb-17	0.05	0.07	0.16
01-Mar-17	0.16	0.66	1.04
02-Mar-17	1.04	1.15	1.26
03-Mar-17	0.83	1.11	1.21
04-Mar-17	0.55	0.91	1.15
05-Mar-17	0.19	0.44	0.69
06-Mar-17	0.44	0.66	0.83
07-Mar-17	0.27	0.43	0.58
08-Mar-17	0.19	0.46	0.66
09-Mar-17	0.38	0.53	0.66
10-Mar-17	0.05	0.29	0.80
11-Mar-17	0.85	0.97	1.07
12-Mar-17	1.04	1.19	1.26
13-Mar-17	1.24	1.37	1.48
14-Mar-17	1.45	1.51	1.56
15-Mar-17	1.48	1.73	1.91
16-Mar-17	1.64	1.72	1.75
17-Mar-17	1.67	1.78	1.91
18-Mar-17	0.91	1.39	1.62
19-Mar-17	1.18	1.37	1.59
20-Mar-17	0.80	1.24	1.64
21-Mar-17	1.64	1.76	1.89
22-Mar-17	1.83	1.90	2.02

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
23-Mar-17	1.78	1.93	2.10
24-Mar-17	1.83	1.99	2.16
25-Mar-17	1.86	1.98	2.07
26-Mar-17	1.78	1.92	2.07
27-Mar-17	1.86	2.05	2.24
28-Mar-17	1.75	1.89	2.07
29-Mar-17	1.81	1.90	1.94
30-Mar-17	1.97	2.10	2.32
31-Mar-17	1.99	2.18	2.40
01-Apr-17	1.64	1.99	2.26
02-Apr-17	1.83	2.06	2.29
03-Apr-17	1.43	1.79	2.10
04-Apr-17	1.70	1.96	2.26
05-Apr-17	1.99	2.14	2.29
06-Apr-17	2.10	2.20	2.29
07-Apr-17	2.05	2.23	2.42
08-Apr-17	2.10	2.25	2.42
09-Apr-17	1.99	2.21	2.40
10-Apr-17	1.99	2.17	2.42
11-Apr-17	2.05	2.19	2.42
12-Apr-17	2.07	2.24	2.40
13-Apr-17	1.99	2.27	2.50
14-Apr-17	2.13	2.28	2.50
15-Apr-17	1.99	2.27	2.56
16-Apr-17	1.83	2.21	2.61
17-Apr-17	2.21	2.32	2.48
18-Apr-17	2.18	2.28	2.42
19-Apr-17	2.10	2.33	2.53
20-Apr-17	2.18	2.45	2.85
21-Apr-17	2.18	2.46	2.85
22-Apr-17	2.32	2.48	2.66
23-Apr-17	2.24	2.45	2.69
24-Apr-17	2.29	2.56	3.01
25-Apr-17	2.29	2.55	2.82
26-Apr-17	2.37	2.59	2.93
27-Apr-17	2.40	2.63	3.04
28-Apr-17	2.13	2.59	3.14
29-Apr-17	2.05	2.37	2.64
30-Apr-17	2.32	2.64	3.09
01-May-17	2.13	2.58	3.06

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
02-May-17	2.16	2.76	3.43
03-May-17	2.42	2.66	2.85
04-May-17	2.24	2.67	3.20
05-May-17	2.18	2.47	2.69
06-May-17	2.24	2.57	3.09
07-May-17	1.89	2.59	3.41
08-May-17	2.37	2.85	3.38
09-May-17	2.18	2.88	3.67
10-May-17	2.56	3.04	3.80
11-May-17	2.34	2.66	3.01
12-May-17	2.37	2.70	3.14
13-May-17	2.40	2.90	3.43
14-May-17	2.61	3.04	3.56
15-May-17	2.74	2.99	3.27
16-May-17	2.48	3.17	3.93
17-May-17	2.80	3.44	4.45
18-May-17	2.90	3.45	4.27
19-May-17	2.53	3.31	4.32
20-May-17	2.61	3.61	5.02
21-May-17	2.72	3.52	4.58
22-May-17	2.80	3.63	5.08
23-May-17	2.74	3.57	4.79
24-May-17	2.29	3.26	4.19
25-May-17	2.96	4.05	5.41
26-May-17	3.09	4.22	5.77
27-May-17	3.25	4.38	6.00
28-May-17	3.30	4.43	6.05
29-May-17	3.38	4.56	6.20
30-May-17	3.78	4.03	4.30
31-May-17	3.70	4.33	5.21
01-Jun-17	3.99	4.37	4.82
02-Jun-17	4.04	4.61	5.41
03-Jun-17	3.88	4.55	5.39
04-Jun-17	3.75	4.59	5.59
05-Jun-17	3.35	4.94	6.66
06-Jun-17	4.35	5.67	7.32
07-Jun-17	4.77	5.90	7.49
08-Jun-17	4.77	5.33	5.77
09-Jun-17	4.27	5.04	6.05
10-Jun-17	4.04	5.15	6.23

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
11-Jun-17	4.82	5.77	7.07
12-Jun-17	5.28	6.19	7.39
13-Jun-17	5.36	5.67	6.05
14-Jun-17	4.87	5.31	5.75
15-Jun-17	4.84	5.23	5.54
16-Jun-17	5.28	5.74	6.38
17-Jun-17	4.92	5.71	6.61
18-Jun-17	5.21	5.63	5.98
19-Jun-17	5.57	6.35	7.44
20-Jun-17	6.18	7.00	8.30
21-Jun-17	5.21	6.39	7.54
22-Jun-17	4.95	6.41	7.85
23-Jun-17	5.59	7.04	8.54
24-Jun-17	6.31	7.73	9.34
25-Jun-17	6.76	8.20	9.81
26-Jun-17	7.65	8.40	9.39
27-Jun-17	6.26	7.60	8.87
28-Jun-17	6.41	7.81	9.19
29-Jun-17	6.86	8.38	9.95
30-Jun-17	7.72	8.99	10.22
01-Jul-17	8.07	9.26	10.49
02-Jul-17	8.02	9.27	10.49
03-Jul-17	8.52	9.13	9.76
04-Jul-17	7.27	8.57	9.73
05-Jul-17	7.67	9.02	10.35
06-Jul-17	8.00	9.47	10.91
07-Jul-17	8.69	9.82	10.83
08-Jul-17	8.99	10.07	11.10
09-Jul-17	9.68	10.15	10.61
10-Jul-17	8.64	9.50	10.05
11-Jul-17	9.04	9.70	10.47
12-Jul-17	8.89	9.66	10.30
13-Jul-17	9.21	9.62	10.03
14-Jul-17	7.90	9.19	10.35
15-Jul-17	8.87	9.51	10.05
16-Jul-17	8.49	9.10	9.68
17-Jul-17	7.42	8.67	9.73
18-Jul-17	8.02	9.20	10.30
19-Jul-17	8.64	9.67	10.57
20-Jul-17	9.66	9.88	10.12

Appendix F: Daily Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
21-Jul-17	8.64	9.29	9.66
22-Jul-17	9.06	9.46	9.90
23-Jul-17	9.34	10.09	10.88
24-Jul-17	9.21	10.07	10.91
25-Jul-17	9.51	10.51	11.44
26-Jul-17	10.12	10.53	11.15

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
26-Jul-16	11.61	12.54	13.50
27-Jul-16	11.90	12.81	13.71
28-Jul-16	12.39	13.24	14.10
29-Jul-16	12.51	13.33	14.17
30-Jul-16	11.61	12.56	13.38
31-Jul-16	10.17	11.02	11.71
01-Aug-16	10.03	10.92	11.71
02-Aug-16	10.17	10.46	11.18
03-Aug-16	10.00	10.36	10.74
04-Aug-16	10.10	10.73	11.59
05-Aug-16	10.08	10.64	11.05
06-Aug-16	8.89	9.78	10.47
07-Aug-16	9.56	10.05	10.66
08-Aug-16	9.58	9.94	10.22
09-Aug-16	9.95	10.34	10.74
10-Aug-16	10.22	10.73	11.39
11-Aug-16	10.12	11.10	12.20
12-Aug-16	11.18	11.99	12.85
13-Aug-16	11.81	12.55	13.35
14-Aug-16	12.03	12.63	13.26
15-Aug-16	11.49	12.35	13.16
16-Aug-16	11.90	12.69	13.38
17-Aug-16	11.86	12.60	13.23
18-Aug-16	11.78	12.38	12.85
19-Aug-16	11.42	12.17	12.85
20-Aug-16	11.47	12.24	12.97
21-Aug-16	11.08	12.02	12.61
22-Aug-16	9.71	10.27	10.88
23-Aug-16	9.09	10.01	10.93
24-Aug-16	9.90	10.71	11.59
25-Aug-16	10.66	11.34	12.05
26-Aug-16	10.81	11.53	12.27
27-Aug-16	11.57	11.82	12.03
28-Aug-16	10.79	11.07	11.52
29-Aug-16	10.30	10.89	11.44
30-Aug-16	10.91	11.35	11.78
31-Aug-16	10.69	10.95	11.37
01-Sep-16	9.29	9.95	10.61
02-Sep-16	8.20	8.82	9.24

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
03-Sep-16	8.72	9.01	9.39
04-Sep-16	8.30	8.78	9.24
05-Sep-16	8.57	8.79	9.04
06-Sep-16	8.37	8.81	9.41
07-Sep-16	8.72	8.94	9.09
08-Sep-16	8.52	8.80	9.26
09-Sep-16	7.95	8.53	9.09
10-Sep-16	8.94	9.35	9.85
11-Sep-16	7.95	8.37	9.19
12-Sep-16	7.14	7.74	8.30
13-Sep-16	6.97	7.81	8.77
14-Sep-16	7.95	8.72	9.63
15-Sep-16	8.47	9.18	9.83
16-Sep-16	9.34	9.69	10.00
17-Sep-16	8.64	9.16	9.66
18-Sep-16	8.00	8.30	8.54
19-Sep-16	7.17	7.63	7.95
20-Sep-16	6.41	7.10	7.67
21-Sep-16	6.48	7.08	7.70
22-Sep-16	6.18	6.88	7.47
23-Sep-16	7.09	7.20	7.37
24-Sep-16	6.81	7.16	7.47
25-Sep-16	7.12	7.49	7.95
26-Sep-16	7.39	7.99	8.87
27-Sep-16	7.59	8.53	8.92
28-Sep-16	6.26	6.88	7.44
29-Sep-16	5.57	6.27	6.86
30-Sep-16	5.46	5.79	6.38
01-Oct-16	-	-	-
02-Oct-16	-	-	-
03-Oct-16	-	-	-
04-Oct-16	-	-	-
05-Oct-16	-	-	-
06-Oct-16	-	-	-
07-Oct-16	-	-	-
08-Oct-16	-	-	-
09-Oct-16	-	-	-
10-Oct-16	-	-	-
11-Oct-16	-	-	-

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
12-Oct-16	-	-	-
13-Oct-16	-	-	-
14-Oct-16	-	-	-
15-Oct-16	-	-	-
16-Oct-16	-	-	-
17-Oct-16	-	-	-
18-Oct-16	-	-	-
19-Oct-16	-	-	-
20-Oct-16	-	-	-
21-Oct-16	-	-	-
22-Oct-16	-	-	-
23-Oct-16	-	-	-
24-Oct-16	-	-	-
25-Oct-16	-	-	-
26-Oct-16	-	-	-
27-Oct-16	-	-	-
28-Oct-16	-	-	-
29-Oct-16	-	-	-
30-Oct-16	-	-	-
31-Oct-16	-	-	-
01-Nov-16	-	-	-
02-Nov-16	-	-	-
03-Nov-16	-	-	-
04-Nov-16	-	-	-
05-Nov-16	-	-	-
06-Nov-16	-	-	-
07-Nov-16	-	-	-
08-Nov-16	-	-	-
09-Nov-16	-	-	-
10-Nov-16	-	-	-
11-Nov-16	-	-	-
12-Nov-16	-	-	-
13-Nov-16	-	-	-
14-Nov-16	-	-	-
15-Nov-16	-	-	-
16-Nov-16	3.06	6.51	9.61
17-Nov-16	3.04	3.21	3.49
18-Nov-16	2.40	2.64	3.09
19-Nov-16	2.13	2.42	2.72

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
20-Nov-16	2.21	2.63	3.22
21-Nov-16	3.30	3.69	3.99
22-Nov-16	1.99	2.44	3.09
23-Nov-16	1.91	2.15	2.37
24-Nov-16	1.37	1.72	2.37
25-Nov-16	0.61	1.52	1.94
26-Nov-16	0.36	1.14	1.91
27-Nov-16	1.53	1.67	1.78
28-Nov-16	1.21	1.62	1.86
29-Nov-16	1.15	1.48	1.78
30-Nov-16	1.48	1.62	1.83
01-Dec-16	1.62	1.84	1.91
02-Dec-16	1.56	1.70	1.83
03-Dec-16	1.81	1.98	2.10
04-Dec-16	0.05	0.87	1.75
05-Dec-16	0.00	0.00	0.02
06-Dec-16	0.00	0.00	0.00
07-Dec-16	0.00	0.00	0.00
08-Dec-16	0.00	0.00	0.00
09-Dec-16	0.00	0.00	0.00
10-Dec-16	0.00	0.00	0.02
11-Dec-16	0.02	0.06	0.16
12-Dec-16	0.16	0.30	0.38
13-Dec-16	0.36	0.38	0.44
14-Dec-16	0.44	0.47	0.50
15-Dec-16	0.47	0.50	0.52
16-Dec-16	0.38	0.47	0.50
17-Dec-16	0.41	0.44	0.47
18-Dec-16	0.47	0.58	0.72
19-Dec-16	0.74	0.87	1.02
20-Dec-16	1.02	1.06	1.10
21-Dec-16	1.13	1.16	1.21
22-Dec-16	1.13	1.18	1.24
23-Dec-16	1.10	1.17	1.21
24-Dec-16	0.66	0.90	1.10
25-Dec-16	0.38	0.46	0.66
26-Dec-16	0.38	0.45	0.52
27-Dec-16	0.52	0.86	1.02
28-Dec-16	1.02	1.07	1.15

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
29-Dec-16	0.36	0.86	1.15
30-Dec-16	0.83	0.94	1.04
31-Dec-16	0.88	0.94	0.99
01-Jan-17	0.14	0.55	0.93
02-Jan-17	0.08	0.12	0.25
03-Jan-17	0.02	0.04	0.08
04-Jan-17	0.05	0.11	0.16
05-Jan-17	0.16	0.20	0.30
06-Jan-17	0.30	0.46	0.77
07-Jan-17	0.58	0.67	0.80
08-Jan-17	0.69	0.75	0.80
09-Jan-17	0.74	0.77	0.83
10-Jan-17	0.33	0.52	0.72
11-Jan-17	0.22	0.25	0.30
12-Jan-17	0.11	0.15	0.19
13-Jan-17	0.14	0.17	0.22
14-Jan-17	0.19	0.27	0.44
15-Jan-17	0.47	0.75	0.91
16-Jan-17	0.47	0.88	1.04
17-Jan-17	0.11	0.48	0.80
18-Jan-17	0.00	0.63	1.32
19-Jan-17	1.24	1.50	1.62
20-Jan-17	1.43	1.60	1.67
21-Jan-17	1.48	1.58	1.70
22-Jan-17	1.48	1.61	1.67
23-Jan-17	0.69	1.22	1.59
24-Jan-17	0.05	0.31	0.66
25-Jan-17	0.38	0.62	0.88
26-Jan-17	0.72	0.83	1.04
27-Jan-17	0.63	0.87	1.21
28-Jan-17	0.38	0.94	1.37
29-Jan-17	1.34	1.46	1.59
30-Jan-17	0.27	1.02	1.59
31-Jan-17	0.00	0.00	0.11
01-Feb-17	0.00	0.00	0.00
02-Feb-17	0.00	0.00	0.00
03-Feb-17	0.00	0.00	0.00
04-Feb-17	0.00	0.00	0.02
05-Feb-17	0.00	0.02	0.02

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
06-Feb-17	0.02	0.07	0.11
07-Feb-17	0.11	0.13	0.16
08-Feb-17	0.14	0.15	0.16
09-Feb-17	0.16	0.20	0.25
10-Feb-17	0.22	0.41	0.55
11-Feb-17	0.55	0.64	0.72
12-Feb-17	0.69	0.76	0.83
13-Feb-17	0.80	0.86	0.91
14-Feb-17	0.85	0.93	0.99
15-Feb-17	0.00	0.13	0.80
16-Feb-17	0.02	1.00	1.64
17-Feb-17	1.48	1.71	1.86
18-Feb-17	1.15	1.40	1.67
19-Feb-17	1.45	1.59	1.72
20-Feb-17	1.26	1.49	1.62
21-Feb-17	0.85	1.22	1.56
22-Feb-17	0.05	0.32	0.85
23-Feb-17	0.00	0.00	0.00
24-Feb-17	0.00	0.00	0.02
25-Feb-17	0.00	0.00	0.00
26-Feb-17	0.00	0.00	0.00
27-Feb-17	0.00	0.00	0.00
28-Feb-17	0.00	0.00	0.00
01-Mar-17	0.00	0.02	0.16
02-Mar-17	0.19	0.48	0.69
03-Mar-17	0.52	0.66	0.74
04-Mar-17	0.08	0.43	0.72
05-Mar-17	0.00	0.09	0.19
06-Mar-17	0.11	0.22	0.30
07-Mar-17	0.08	0.16	0.25
08-Mar-17	0.11	0.23	0.38
09-Mar-17	0.19	0.33	0.47
10-Mar-17	0.05	0.26	0.52
11-Mar-17	0.58	0.74	0.83
12-Mar-17	0.80	0.87	0.93
13-Mar-17	0.77	0.87	0.99
14-Mar-17	0.91	1.07	1.18
15-Mar-17	0.93	1.37	1.64
16-Mar-17	1.37	1.46	1.56

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
17-Mar-17	1.40	1.48	1.59
18-Mar-17	0.22	0.92	1.34
19-Mar-17	0.61	0.85	1.15
20-Mar-17	0.11	0.62	1.15
21-Mar-17	1.18	1.36	1.56
22-Mar-17	1.45	1.63	1.83
23-Mar-17	1.43	1.65	1.91
24-Mar-17	1.51	1.74	1.99
25-Mar-17	1.51	1.72	1.83
26-Mar-17	1.40	1.60	1.83
27-Mar-17	1.56	1.82	2.07
28-Mar-17	1.53	1.71	1.91
29-Mar-17	1.51	1.70	1.83
30-Mar-17	1.86	1.99	2.24
31-Mar-17	1.81	2.07	2.40
01-Apr-17	1.34	1.81	2.18
02-Apr-17	1.53	1.84	2.05
03-Apr-17	0.74	1.31	1.83
04-Apr-17	1.18	1.56	2.02
05-Apr-17	1.59	1.88	2.24
06-Apr-17	1.91	2.02	2.21
07-Apr-17	1.81	2.09	2.34
08-Apr-17	1.99	2.09	2.26
09-Apr-17	1.70	1.97	2.18
10-Apr-17	1.67	1.89	2.26
11-Apr-17	1.70	1.87	2.13
12-Apr-17	1.81	1.95	2.18
13-Apr-17	1.64	2.03	2.37
14-Apr-17	1.86	2.05	2.32
15-Apr-17	1.75	2.04	2.40
16-Apr-17	1.37	1.88	2.37
17-Apr-17	1.97	2.10	2.32
18-Apr-17	1.99	2.12	2.29
19-Apr-17	1.97	2.23	2.58
20-Apr-17	1.99	2.29	2.66
21-Apr-17	2.02	2.25	2.58
22-Apr-17	2.07	2.25	2.48
23-Apr-17	2.10	2.37	2.74
24-Apr-17	2.13	2.36	2.74

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
25-Apr-17	2.18	2.46	2.80
26-Apr-17	2.18	2.44	2.72
27-Apr-17	2.16	2.38	2.74
28-Apr-17	1.70	2.32	2.96
29-Apr-17	1.78	2.16	2.50
30-Apr-17	2.13	2.42	2.82
01-May-17	1.97	2.40	2.93
02-May-17	1.81	2.48	3.30
03-May-17	2.37	2.51	2.77
04-May-17	2.34	2.62	3.14
05-May-17	2.32	2.55	2.96
06-May-17	2.05	2.39	2.80
07-May-17	1.48	2.31	3.22
08-May-17	2.24	2.80	3.46
09-May-17	2.18	2.91	3.80
10-May-17	2.56	3.00	3.72
11-May-17	2.40	2.79	3.20
12-May-17	2.32	2.66	3.14
13-May-17	2.32	2.87	3.46
14-May-17	2.66	3.08	3.64
15-May-17	2.72	3.02	3.38
16-May-17	2.42	3.17	4.12
17-May-17	2.82	3.59	4.71
18-May-17	3.04	3.67	4.64
19-May-17	2.77	3.51	4.40
20-May-17	2.93	3.83	5.21
21-May-17	3.09	3.87	4.95
22-May-17	3.22	4.05	5.33
23-May-17	3.30	4.10	5.49
24-May-17	2.42	3.52	4.71
25-May-17	3.54	4.51	5.75
26-May-17	3.72	4.78	6.20
27-May-17	3.99	5.04	6.59
28-May-17	4.19	5.20	6.76
29-May-17	4.40	5.46	6.97
30-May-17	4.82	5.20	5.62
31-May-17	4.74	5.45	6.48
01-Jun-17	5.08	5.48	5.98
02-Jun-17	5.00	5.49	6.20

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
03-Jun-17	4.66	5.50	6.41
04-Jun-17	4.58	5.31	6.10
05-Jun-17	4.09	5.49	7.04
06-Jun-17	5.15	6.27	7.70
07-Jun-17	5.72	6.78	8.27
08-Jun-17	5.59	6.52	7.04
09-Jun-17	4.82	5.56	6.41
10-Jun-17	4.74	5.75	6.81
11-Jun-17	5.41	6.41	7.67
12-Jun-17	6.10	6.75	7.80
13-Jun-17	6.05	6.34	6.79
14-Jun-17	5.39	5.74	6.10
15-Jun-17	5.31	5.72	6.28
16-Jun-17	5.85	6.34	6.94
17-Jun-17	5.51	6.26	6.97
18-Jun-17	5.72	6.20	6.69
19-Jun-17	6.36	7.11	8.22
20-Jun-17	7.17	7.78	8.74
21-Jun-17	6.10	6.96	7.85
22-Jun-17	5.64	6.92	8.20
23-Jun-17	6.46	7.71	9.09
24-Jun-17	7.37	8.68	10.15
25-Jun-17	8.25	9.60	11.08
26-Jun-17	9.49	9.99	10.52
27-Jun-17	7.57	8.80	9.81
28-Jun-17	7.72	8.93	10.12
29-Jun-17	8.22	9.54	10.98
30-Jun-17	9.14	10.21	11.20
01-Jul-17	9.49	10.51	11.57
02-Jul-17	9.34	10.40	11.39
03-Jul-17	9.63	10.04	10.61
04-Jul-17	8.17	9.26	10.30
05-Jul-17	8.49	9.61	10.79
06-Jul-17	8.72	9.97	11.35
07-Jul-17	9.41	10.50	11.66
08-Jul-17	9.66	10.61	11.47
09-Jul-17	10.25	10.72	11.20
10-Jul-17	9.21	9.99	10.57
11-Jul-17	9.21	9.85	10.64

Appendix F: Daily Stream Temperature Data

Crabapple Creek			
Date	**Min Temperature (°C)**	**Average Temperature (°C)**	**Max Temperature (°C)**
12-Jul-17	9.21	9.92	10.52
13-Jul-17	9.51	9.90	10.37
14-Jul-17	8.30	9.40	10.54
15-Jul-17	9.02	9.63	10.10
16-Jul-17	8.42	8.96	9.51
17-Jul-17	7.47	8.64	9.68
18-Jul-17	8.25	9.28	10.49
19-Jul-17	8.82	9.70	10.59
20-Jul-17	9.41	9.66	10.00
21-Jul-17	8.52	9.18	9.58
22-Jul-17	8.82	9.31	9.90
23-Jul-17	9.29	10.02	10.98
24-Jul-17	9.11	10.05	11.08
25-Jul-17	9.58	10.56	11.69
26-Jul-17	10.25	10.62	11.22

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
26-Jul-16	15.46	16.22	16.87
27-Jul-16	16.51	17.37	18.37
28-Jul-16	17.18	17.90	18.63
29-Jul-16	16.73	17.79	18.65
30-Jul-16	16.37	17.23	17.94
31-Jul-16	16.30	16.93	17.53
01-Aug-16	16.51	16.94	17.70
02-Aug-16	16.01	16.36	16.99
03-Aug-16	15.80	15.97	16.25
04-Aug-16	15.89	16.37	17.20
05-Aug-16	16.23	16.49	16.73
06-Aug-16	15.84	16.39	17.23
07-Aug-16	16.06	16.32	16.73
08-Aug-16	16.13	16.34	16.75
09-Aug-16	15.99	16.09	16.18
10-Aug-16	15.92	16.18	16.56
11-Aug-16	15.99	16.90	17.92
12-Aug-16	16.96	17.82	19.06
13-Aug-16	17.56	18.18	18.99
14-Aug-16	17.84	18.30	19.22
15-Aug-16	17.82	18.39	18.96
16-Aug-16	18.18	18.58	19.06
17-Aug-16	18.25	19.28	20.67
18-Aug-16	18.60	19.31	19.87
19-Aug-16	18.37	19.16	20.20
20-Aug-16	18.46	19.21	20.22
21-Aug-16	18.11	18.57	19.08
22-Aug-16	17.53	17.81	18.06
23-Aug-16	17.15	17.93	19.03
24-Aug-16	17.34	18.17	19.03
25-Aug-16	17.65	18.55	19.53
26-Aug-16	17.96	18.51	18.91
27-Aug-16	18.08	18.40	18.70
28-Aug-16	17.65	17.84	18.22
29-Aug-16	17.42	17.80	18.25
30-Aug-16	17.42	17.83	18.30
31-Aug-16	17.39	17.52	17.68
01-Sep-16	16.92	17.19	17.37
02-Sep-16	16.70	16.86	17.20

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
03-Sep-16	16.49	16.66	16.96
04-Sep-16	16.20	16.60	17.08
05-Sep-16	15.92	16.15	16.30
06-Sep-16	15.80	16.15	16.75
07-Sep-16	15.61	15.85	16.03
08-Sep-16	15.51	15.84	16.34
09-Sep-16	15.41	15.67	15.92
10-Sep-16	15.39	15.81	16.39
11-Sep-16	15.13	15.62	16.15
12-Sep-16	14.94	15.58	16.27
13-Sep-16	14.86	15.51	16.20
14-Sep-16	14.91	15.57	16.46
15-Sep-16	14.94	15.55	16.37
16-Sep-16	15.34	15.62	16.01
17-Sep-16	15.01	15.25	15.51
18-Sep-16	14.86	15.04	15.20
19-Sep-16	14.48	14.69	14.86
20-Sep-16	14.22	14.45	14.70
21-Sep-16	13.95	14.41	14.91
22-Sep-16	13.76	14.24	14.84
23-Sep-16	13.79	13.88	14.05
24-Sep-16	13.62	13.78	14.03
25-Sep-16	13.55	13.75	14.10
26-Sep-16	13.47	13.75	13.95
27-Sep-16	13.59	13.93	14.34
28-Sep-16	13.16	13.58	13.95
29-Sep-16	12.92	13.35	13.95
30-Sep-16	12.85	13.14	13.74
01-Oct-16	12.75	12.92	13.11
02-Oct-16	12.68	12.99	13.50
03-Oct-16	12.49	12.72	12.99
04-Oct-16	12.49	12.77	13.09
05-Oct-16	12.46	12.80	13.33
06-Oct-16	12.34	12.65	12.80
07-Oct-16	12.12	12.22	12.32
08-Oct-16	11.47	11.77	12.12
09-Oct-16	11.27	11.42	11.57
10-Oct-16	10.74	10.99	11.22
11-Oct-16	10.32	10.54	10.74

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
12-Oct-16	9.98	10.34	10.71
13-Oct-16	10.00	10.29	10.49
14-Oct-16	9.19	9.71	10.17
15-Oct-16	8.79	9.05	9.16
16-Oct-16	8.10	8.24	8.69
17-Oct-16	7.80	8.03	8.22
18-Oct-16	7.77	7.87	8.00
19-Oct-16	7.70	7.76	7.87
20-Oct-16	7.57	7.72	7.80
21-Oct-16	7.47	7.63	7.77
22-Oct-16	7.44	7.69	8.00
23-Oct-16	7.62	7.76	7.90
24-Oct-16	7.47	7.63	7.75
25-Oct-16	7.24	7.39	7.49
26-Oct-16	7.17	7.24	7.32
27-Oct-16	7.07	7.12	7.22
28-Oct-16	7.12	7.34	7.54
29-Oct-16	6.97	7.15	7.42
30-Oct-16	6.86	6.99	7.09
31-Oct-16	6.84	6.93	6.99
01-Nov-16	6.74	6.81	6.86
02-Nov-16	6.61	6.70	6.74
03-Nov-16	6.43	6.48	6.59
04-Nov-16	6.43	6.51	6.59
05-Nov-16	6.26	6.35	6.48
06-Nov-16	6.28	6.30	6.33
07-Nov-16	6.28	6.42	6.56
08-Nov-16	6.38	6.46	6.59
09-Nov-16	6.51	6.63	6.97
10-Nov-16	6.66	6.79	6.86
11-Nov-16	6.74	6.84	6.97
12-Nov-16	6.38	6.64	6.84
13-Nov-16	6.28	6.42	6.51
14-Nov-16	6.23	6.34	6.46
15-Nov-16	6.08	6.17	6.28
16-Nov-16	6.03	6.06	6.13
17-Nov-16	5.87	5.97	6.08
18-Nov-16	5.69	5.78	5.87
19-Nov-16	5.57	5.61	5.67

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
20-Nov-16	5.51	5.56	5.62
21-Nov-16	5.39	5.49	5.54
22-Nov-16	5.23	5.30	5.39
23-Nov-16	5.10	5.17	5.23
24-Nov-16	4.82	5.00	5.10
25-Nov-16	4.71	4.82	4.92
26-Nov-16	4.25	4.41	4.77
27-Nov-16	4.22	4.38	4.45
28-Nov-16	4.12	4.20	4.30
29-Nov-16	3.96	4.04	4.12
30-Nov-16	3.88	4.02	4.12
01-Dec-16	4.09	4.21	4.35
02-Dec-16	4.01	4.14	4.22
03-Dec-16	3.93	4.07	4.14
04-Dec-16	3.62	3.84	3.99
05-Dec-16	2.98	3.22	3.43
06-Dec-16	2.37	2.73	3.27
07-Dec-16	2.26	2.50	2.77
08-Dec-16	2.29	2.45	2.64
09-Dec-16	2.21	2.31	2.45
10-Dec-16	1.94	2.08	2.24
11-Dec-16	1.81	1.91	2.07
12-Dec-16	1.51	1.70	1.86
13-Dec-16	1.26	1.42	1.51
14-Dec-16	1.15	1.25	1.40
15-Dec-16	1.10	1.14	1.26
16-Dec-16	1.02	1.14	1.24
17-Dec-16	1.15	1.25	1.32
18-Dec-16	1.21	1.27	1.34
19-Dec-16	1.04	1.28	1.40
20-Dec-16	1.07	1.31	1.37
21-Dec-16	1.32	1.40	1.48
22-Dec-16	1.34	1.39	1.43
23-Dec-16	1.32	1.39	1.45
24-Dec-16	1.10	1.26	1.37
25-Dec-16	0.99	1.09	1.18
26-Dec-16	0.99	1.10	1.21
27-Dec-16	1.10	1.24	1.32
28-Dec-16	1.29	1.33	1.37

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	**Min Temperature (°C)**	**Average Temperature (°C)**	**Max Temperature (°C)**
29-Dec-16	1.07	1.25	1.37
30-Dec-16	1.26	1.30	1.34
31-Dec-16	1.24	1.31	1.37
01-Jan-17	0.96	1.05	1.21
02-Jan-17	0.50	0.97	1.04
03-Jan-17	0.88	0.97	1.07
04-Jan-17	0.96	1.01	1.10
05-Jan-17	0.91	1.00	1.13
06-Jan-17	1.04	1.09	1.15
07-Jan-17	0.96	1.02	1.10
08-Jan-17	0.83	0.98	1.04
09-Jan-17	0.77	0.94	1.04
10-Jan-17	0.74	0.88	0.93
11-Jan-17	0.74	0.81	0.88
12-Jan-17	0.69	0.77	0.88
13-Jan-17	0.69	0.77	0.93
14-Jan-17	0.66	0.79	0.96
15-Jan-17	0.85	0.95	1.10
16-Jan-17	1.02	1.11	1.24
17-Jan-17	0.80	0.91	1.07
18-Jan-17	0.85	0.91	0.99
19-Jan-17	1.02	1.12	1.21
20-Jan-17	1.21	1.27	1.32
21-Jan-17	1.32	1.38	1.43
22-Jan-17	1.43	1.47	1.53
23-Jan-17	1.48	1.54	1.62
24-Jan-17	1.45	1.53	1.62
25-Jan-17	1.48	1.55	1.59
26-Jan-17	1.51	1.57	1.67
27-Jan-17	1.51	1.59	1.70
28-Jan-17	1.53	1.60	1.72
29-Jan-17	1.62	1.67	1.72
30-Jan-17	1.56	1.65	1.75
31-Jan-17	1.40	1.47	1.59
01-Feb-17	1.29	1.40	1.51
02-Feb-17	1.18	1.28	1.43
03-Feb-17	1.07	1.17	1.26
04-Feb-17	0.93	1.12	1.26
05-Feb-17	1.07	1.12	1.18

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
06-Feb-17	0.99	1.07	1.13
07-Feb-17	0.83	0.98	1.15
08-Feb-17	0.74	0.94	1.07
09-Feb-17	0.66	0.84	0.99
10-Feb-17	1.02	1.10	1.18
11-Feb-17	1.04	1.09	1.18
12-Feb-17	0.91	1.15	1.34
13-Feb-17	1.07	1.22	1.43
14-Feb-17	1.13	1.26	1.40
15-Feb-17	1.21	1.29	1.40
16-Feb-17	1.24	1.28	1.34
17-Feb-17	1.37	1.45	1.51
18-Feb-17	1.51	1.60	1.64
19-Feb-17	1.64	1.69	1.75
20-Feb-17	1.67	1.75	1.83
21-Feb-17	1.75	1.81	1.91
22-Feb-17	1.72	1.79	1.89
23-Feb-17	1.62	1.70	1.81
24-Feb-17	1.48	1.60	1.72
25-Feb-17	1.40	1.49	1.62
26-Feb-17	1.34	1.45	1.59
27-Feb-17	1.26	1.35	1.51
28-Feb-17	1.26	1.42	1.53
01-Mar-17	1.37	1.42	1.53
02-Mar-17	1.34	1.44	1.56
03-Mar-17	1.40	1.47	1.62
04-Mar-17	1.29	1.43	1.59
05-Mar-17	1.18	1.32	1.51
06-Mar-17	1.24	1.33	1.45
07-Mar-17	1.15	1.25	1.34
08-Mar-17	1.13	1.25	1.43
09-Mar-17	1.07	1.20	1.34
10-Mar-17	1.02	1.21	1.37
11-Mar-17	1.21	1.29	1.40
12-Mar-17	1.37	1.48	1.64
13-Mar-17	1.37	1.42	1.48
14-Mar-17	1.43	1.52	1.64
15-Mar-17	1.56	1.69	1.81
16-Mar-17	1.72	1.83	1.91

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
17-Mar-17	1.89	1.94	1.99
18-Mar-17	1.89	1.98	2.10
19-Mar-17	1.89	1.99	2.18
20-Mar-17	1.86	1.98	2.18
21-Mar-17	1.89	2.00	2.13
22-Mar-17	1.99	2.09	2.34
23-Mar-17	2.05	2.09	2.16
24-Mar-17	2.10	2.18	2.26
25-Mar-17	2.21	2.28	2.37
26-Mar-17	2.26	2.31	2.37
27-Mar-17	2.32	2.41	2.53
28-Mar-17	2.42	2.47	2.53
29-Mar-17	2.40	2.47	2.53
30-Mar-17	2.48	2.58	2.69
31-Mar-17	2.64	2.70	2.80
01-Apr-17	2.72	2.80	2.90
02-Apr-17	2.82	2.88	2.98
03-Apr-17	2.88	2.98	3.14
04-Apr-17	2.98	3.06	3.14
05-Apr-17	2.98	3.06	3.12
06-Apr-17	2.96	3.01	3.09
07-Apr-17	2.98	3.05	3.12
08-Apr-17	3.04	3.10	3.14
09-Apr-17	3.12	3.19	3.30
10-Apr-17	3.22	3.27	3.35
11-Apr-17	3.27	3.39	3.62
12-Apr-17	3.33	3.39	3.49
13-Apr-17	3.35	3.45	3.59
14-Apr-17	3.33	3.48	3.59
15-Apr-17	3.49	3.61	3.78
16-Apr-17	3.56	3.80	4.04
17-Apr-17	3.75	3.82	3.85
18-Apr-17	3.75	3.83	3.91
19-Apr-17	3.70	3.73	3.78
20-Apr-17	3.70	3.89	4.12
21-Apr-17	3.99	4.45	4.92
22-Apr-17	4.01	4.45	4.66
23-Apr-17	3.85	4.23	4.74
24-Apr-17	3.93	5.12	6.54

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	**Min Temperature (°C)**	**Average Temperature (°C)**	**Max Temperature (°C)**
25-Apr-17	4.58	4.97	5.39
26-Apr-17	5.02	5.15	5.33
27-Apr-17	5.13	5.45	5.95
28-Apr-17	5.80	6.08	6.43
29-Apr-17	5.36	6.02	6.38
30-Apr-17	5.54	5.86	6.20
01-May-17	5.95	6.06	6.33
02-May-17	6.10	6.78	7.77
03-May-17	6.86	7.32	7.80
04-May-17	6.64	7.25	8.00
05-May-17	5.33	5.87	6.74
06-May-17	5.15	5.53	6.00
07-May-17	5.39	5.72	6.33
08-May-17	5.62	6.01	6.18
09-May-17	5.98	6.51	7.19
10-May-17	6.41	7.12	7.97
11-May-17	5.67	6.58	7.37
12-May-17	5.26	5.55	5.77
13-May-17	5.49	5.80	6.36
14-May-17	5.69	6.02	6.54
15-May-17	5.92	6.16	6.41
16-May-17	6.00	6.40	7.04
17-May-17	6.59	7.03	7.47
18-May-17	7.27	7.81	8.72
19-May-17	7.39	8.03	8.54
20-May-17	7.85	8.45	9.44
21-May-17	7.75	8.29	8.94
22-May-17	7.39	7.89	8.74
23-May-17	5.87	6.73	7.65
24-May-17	6.26	6.67	7.37
25-May-17	6.66	8.27	10.17
26-May-17	7.09	7.81	9.16
27-May-17	7.12	7.80	8.42
28-May-17	6.91	7.55	8.30
29-May-17	6.74	7.48	8.52
30-May-17	5.98	6.60	7.09
31-May-17	5.77	5.93	6.31
01-Jun-17	5.82	6.04	6.41
02-Jun-17	5.77	6.30	7.37

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
03-Jun-17	6.00	6.69	7.62
04-Jun-17	6.33	6.90	7.47
05-Jun-17	7.02	7.67	8.59
06-Jun-17	7.72	8.72	9.78
07-Jun-17	7.95	8.69	9.98
08-Jun-17	6.71	7.35	8.54
09-Jun-17	6.43	7.19	8.82
10-Jun-17	7.37	7.72	8.44
11-Jun-17	7.62	8.10	8.67
12-Jun-17	8.07	8.55	9.61
13-Jun-17	7.75	8.23	9.21
14-Jun-17	7.70	8.10	8.52
15-Jun-17	7.52	8.36	9.04
16-Jun-17	7.34	7.75	8.20
17-Jun-17	7.52	8.14	8.59
18-Jun-17	7.70	8.11	8.79
19-Jun-17	8.00	8.78	9.53
20-Jun-17	7.54	8.12	9.44
21-Jun-17	7.85	8.68	9.88
22-Jun-17	8.69	9.39	10.57
23-Jun-17	9.39	10.04	10.93
24-Jun-17	10.10	10.62	11.52
25-Jun-17	9.41	10.14	11.08
26-Jun-17	9.06	9.86	11.54
27-Jun-17	8.97	9.98	11.49
28-Jun-17	9.41	10.23	11.83
29-Jun-17	10.05	10.96	12.58
30-Jun-17	10.42	11.10	12.05
01-Jul-17	10.12	11.11	12.10
02-Jul-17	10.47	11.47	12.73
03-Jul-17	10.61	11.33	12.51
04-Jul-17	11.03	11.83	12.92
05-Jul-17	11.47	12.21	13.31
06-Jul-17	11.95	12.74	13.93
07-Jul-17	11.47	12.58	13.67
08-Jul-17	12.07	12.76	13.62
09-Jul-17	11.98	12.69	13.71
10-Jul-17	11.90	12.65	13.35
11-Jul-17	12.00	12.72	14.22

Appendix F: Daily Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
12-Jul-17	12.61	13.00	13.83
13-Jul-17	12.20	12.74	13.04
14-Jul-17	12.51	12.97	13.79
15-Jul-17	12.53	13.16	13.47
16-Jul-17	12.73	13.36	14.27
17-Jul-17	13.06	13.69	14.65
18-Jul-17	13.45	14.06	14.72
19-Jul-17	13.57	14.16	14.94
20-Jul-17	13.50	13.99	14.51
21-Jul-17	13.28	13.59	13.98
22-Jul-17	13.04	13.31	13.76
23-Jul-17	12.99	13.80	14.96
24-Jul-17	14.05	14.63	15.32
25-Jul-17	14.39	15.02	15.96
26-Jul-17	14.82	15.18	15.75

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
26-Jul-16	12.61	14.23	15.94
27-Jul-16	13.02	14.54	16.23
28-Jul-16	13.35	14.80	16.37
29-Jul-16	13.38	14.90	16.49
30-Jul-16	13.14	14.38	15.68
31-Jul-16	12.03	13.15	14.15
01-Aug-16	11.86	13.09	14.27
02-Aug-16	11.81	12.19	13.19
03-Aug-16	11.59	12.05	12.56
04-Aug-16	11.61	12.69	14.05
05-Aug-16	11.59	12.60	13.62
06-Aug-16	10.69	12.06	13.35
07-Aug-16	11.49	12.31	13.14
08-Aug-16	11.25	11.80	12.22
09-Aug-16	11.57	12.08	12.61
10-Aug-16	11.83	12.70	13.86
11-Aug-16	11.57	12.86	14.29
12-Aug-16	12.24	13.50	14.86
13-Aug-16	12.87	14.07	15.39
14-Aug-16	13.19	14.32	15.53
15-Aug-16	12.78	14.07	15.27
16-Aug-16	13.19	14.36	15.51
17-Aug-16	13.21	14.37	15.51
18-Aug-16	13.04	14.14	15.20
19-Aug-16	12.68	14.13	16.49
20-Aug-16	12.05	14.77	17.11
21-Aug-16	12.46	14.13	16.25
22-Aug-16	11.76	13.20	15.34
23-Aug-16	9.90	13.11	16.34
24-Aug-16	10.08	13.97	18.11
25-Aug-16	11.15	14.55	18.77
26-Aug-16	11.37	14.70	19.18
27-Aug-16	13.62	15.07	19.48
28-Aug-16	12.92	13.37	13.76
29-Aug-16	12.27	13.90	17.63
30-Aug-16	12.27	14.48	18.63
31-Aug-16	12.61	13.06	13.57
01-Sep-16	11.25	11.68	12.53
02-Sep-16	10.37	11.17	11.83

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
03-Sep-16	10.79	11.47	12.29
04-Sep-16	10.54	11.37	12.17
05-Sep-16	10.52	11.04	11.54
06-Sep-16	10.47	11.30	12.24
07-Sep-16	10.71	11.20	11.52
08-Sep-16	10.20	10.83	11.57
09-Sep-16	9.83	10.67	11.49
10-Sep-16	10.81	11.72	12.61
11-Sep-16	9.31	10.87	12.24
12-Sep-16	7.59	9.89	12.00
13-Sep-16	7.17	10.01	12.27
14-Sep-16	7.97	10.71	13.14
15-Sep-16	8.52	11.08	13.09
16-Sep-16	10.30	11.32	12.41
17-Sep-16	9.39	10.37	11.01
18-Sep-16	9.19	9.70	10.39
19-Sep-16	8.74	9.18	9.68
20-Sep-16	7.95	8.69	9.44
21-Sep-16	7.87	8.72	9.58
22-Sep-16	7.59	8.59	9.61
23-Sep-16	8.54	8.73	8.92
24-Sep-16	8.15	8.71	9.21
25-Sep-16	8.82	9.23	9.81
26-Sep-16	8.64	9.19	9.66
27-Sep-16	8.92	9.68	10.37
28-Sep-16	7.09	8.29	9.58
29-Sep-16	5.95	7.60	9.29
30-Sep-16	5.82	7.38	9.09
01-Oct-16	6.18	7.37	8.27
02-Oct-16	6.59	7.83	9.29
03-Oct-16	5.64	7.04	8.20
04-Oct-16	7.34	7.82	8.22
05-Oct-16	7.09	8.09	8.89
06-Oct-16	7.62	8.07	8.42
07-Oct-16	6.41	6.93	7.54
08-Oct-16	4.90	5.85	6.74
09-Oct-16	4.92	5.47	6.23
10-Oct-16	4.58	5.06	5.51
11-Oct-16	3.54	4.07	4.64

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
12-Oct-16	3.01	3.76	4.48
13-Oct-16	4.06	4.74	5.41
14-Oct-16	3.78	4.59	5.26
15-Oct-16	4.30	4.98	5.51
16-Oct-16	4.79	5.20	5.69
17-Oct-16	5.41	6.00	6.59
18-Oct-16	6.08	6.32	6.66
19-Oct-16	6.13	6.52	7.04
20-Oct-16	5.57	5.93	6.31
21-Oct-16	5.39	5.76	6.08
22-Oct-16	5.69	6.11	6.66
23-Oct-16	6.05	6.38	6.84
24-Oct-16	5.92	6.41	6.79
25-Oct-16	5.57	5.87	6.38
26-Oct-16	5.18	5.43	5.67
27-Oct-16	5.00	5.35	5.62
28-Oct-16	5.46	5.82	6.31
29-Oct-16	5.36	5.58	5.82
30-Oct-16	5.00	5.39	5.69
31-Oct-16	5.28	5.40	5.51
01-Nov-16	5.28	5.48	5.77
02-Nov-16	4.61	4.88	5.31
03-Nov-16	4.51	4.79	5.00
04-Nov-16	4.53	5.16	5.87
05-Nov-16	4.51	4.79	5.64
06-Nov-16	4.58	5.19	5.64
07-Nov-16	5.36	5.48	5.67
08-Nov-16	4.74	5.34	5.62
09-Nov-16	4.58	5.19	5.82
10-Nov-16	5.26	5.75	6.23
11-Nov-16	5.80	6.03	6.15
12-Nov-16	5.08	5.42	5.80
13-Nov-16	4.71	5.04	5.31
14-Nov-16	4.71	5.16	5.59
15-Nov-16	4.74	4.99	5.18
16-Nov-16	4.51	4.77	5.02
17-Nov-16	4.64	4.88	5.21
18-Nov-16	4.40	4.59	4.90
19-Nov-16	4.09	4.37	4.53

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
20-Nov-16	4.06	4.24	4.48
21-Nov-16	4.06	4.31	4.58
22-Nov-16	3.06	3.61	4.01
23-Nov-16	3.04	3.36	3.67
24-Nov-16	3.20	3.39	3.70
25-Nov-16	2.58	3.25	3.62
26-Nov-16	2.32	2.85	3.59
27-Nov-16	3.09	3.26	3.46
28-Nov-16	3.27	3.49	3.78
29-Nov-16	3.17	3.46	3.62
30-Nov-16	3.25	3.45	3.72
01-Dec-16	3.33	3.51	3.72
02-Dec-16	3.06	3.29	3.46
03-Dec-16	3.01	3.21	3.38
04-Dec-16	2.24	2.67	2.93
05-Dec-16	1.81	2.04	2.34
06-Dec-16	1.29	1.58	1.83
07-Dec-16	0.96	1.12	1.26
08-Dec-16	0.83	0.89	1.07
09-Dec-16	0.80	0.85	0.88
10-Dec-16	0.72	0.83	0.99
11-Dec-16	0.74	0.79	0.85
12-Dec-16	0.41	0.65	0.80
13-Dec-16	0.25	0.37	0.50
14-Dec-16	0.16	0.23	0.33
15-Dec-16	0.16	0.22	0.36
16-Dec-16	0.19	0.27	0.41
17-Dec-16	0.22	0.31	0.38
18-Dec-16	0.30	0.35	0.41
19-Dec-16	0.11	0.39	0.55
20-Dec-16	0.47	0.62	0.72
21-Dec-16	0.63	0.81	0.96
22-Dec-16	0.85	0.98	1.10
23-Dec-16	0.96	1.09	1.21
24-Dec-16	0.41	0.77	0.96
25-Dec-16	0.22	0.37	0.55
26-Dec-16	0.19	0.36	0.47
27-Dec-16	0.33	0.53	0.69
28-Dec-16	0.63	0.84	1.10

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
29-Dec-16	0.38	0.78	1.02
30-Dec-16	0.69	0.89	1.02
31-Dec-16	0.80	0.88	0.99
01-Jan-17	0.27	0.51	0.80
02-Jan-17	0.19	0.24	0.30
03-Jan-17	0.16	0.22	0.30
04-Jan-17	0.19	0.27	0.38
05-Jan-17	0.16	0.26	0.36
06-Jan-17	0.30	0.39	0.47
07-Jan-17	0.27	0.42	0.52
08-Jan-17	0.25	0.41	0.50
09-Jan-17	0.22	0.35	0.47
10-Jan-17	0.16	0.25	0.33
11-Jan-17	0.14	0.16	0.22
12-Jan-17	0.02	0.06	0.14
13-Jan-17	-0.06	0.01	0.08
14-Jan-17	-0.17	-0.01	0.11
15-Jan-17	0.08	0.15	0.25
16-Jan-17	0.25	0.43	0.58
17-Jan-17	0.08	0.19	0.52
18-Jan-17	0.08	0.11	0.22
19-Jan-17	0.19	0.78	1.07
20-Jan-17	0.96	1.04	1.24
21-Jan-17	0.91	1.03	1.21
22-Jan-17	0.93	1.07	1.24
23-Jan-17	0.80	1.05	1.29
24-Jan-17	0.44	0.69	0.96
25-Jan-17	0.74	0.94	1.24
26-Jan-17	0.85	1.14	1.53
27-Jan-17	0.83	1.10	1.51
28-Jan-17	0.74	1.05	1.51
29-Jan-17	1.13	1.30	1.53
30-Jan-17	0.88	1.24	1.59
31-Jan-17	0.36	0.59	0.93
01-Feb-17	0.22	0.42	0.80
02-Feb-17	0.22	0.42	0.80
03-Feb-17	0.16	0.30	0.44
04-Feb-17	0.08	0.38	0.61
05-Feb-17	0.19	0.38	0.66

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
06-Feb-17	0.30	0.44	0.69
07-Feb-17	0.05	0.34	0.63
08-Feb-17	0.05	0.23	0.47
09-Feb-17	0.00	0.06	0.16
10-Feb-17	0.19	0.42	0.61
11-Feb-17	0.52	0.66	0.85
12-Feb-17	0.66	0.92	1.37
13-Feb-17	0.69	1.02	1.62
14-Feb-17	0.72	1.12	1.62
15-Feb-17	0.27	0.61	1.18
16-Feb-17	0.22	0.71	1.18
17-Feb-17	1.10	1.33	1.75
18-Feb-17	0.96	1.26	1.70
19-Feb-17	1.32	1.50	1.86
20-Feb-17	1.29	1.55	2.10
21-Feb-17	1.13	1.49	1.99
22-Feb-17	0.72	1.11	1.72
23-Feb-17	0.33	0.80	1.40
24-Feb-17	0.74	1.04	1.67
25-Feb-17	0.33	0.75	1.18
26-Feb-17	0.58	0.96	1.67
27-Feb-17	0.36	0.66	1.13
28-Feb-17	0.25	0.63	1.18
01-Mar-17	0.69	1.20	1.91
02-Mar-17	1.10	1.42	1.91
03-Mar-17	1.18	1.38	1.62
04-Mar-17	0.91	1.32	2.13
05-Mar-17	0.74	1.11	1.83
06-Mar-17	0.77	1.10	1.67
07-Mar-17	0.63	0.94	1.29
08-Mar-17	0.52	1.07	1.91
09-Mar-17	0.74	1.12	1.67
10-Mar-17	0.33	1.04	1.97
11-Mar-17	1.13	1.20	1.34
12-Mar-17	1.29	1.74	2.34
13-Mar-17	1.18	1.58	1.94
14-Mar-17	1.43	1.66	2.05
15-Mar-17	1.15	1.71	2.50
16-Mar-17	1.34	1.62	1.83

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
17-Mar-17	1.43	1.71	2.18
18-Mar-17	0.80	1.41	1.97
19-Mar-17	1.15	1.77	2.90
20-Mar-17	0.93	1.63	2.53
21-Mar-17	1.64	1.98	2.61
22-Mar-17	1.78	2.06	2.42
23-Mar-17	1.64	2.07	2.74
24-Mar-17	1.78	2.24	2.85
25-Mar-17	1.91	2.21	2.80
26-Mar-17	1.75	2.15	2.72
27-Mar-17	1.94	2.38	3.09
28-Mar-17	1.89	2.28	2.77
29-Mar-17	1.70	2.04	2.29
30-Mar-17	1.89	2.60	3.80
31-Mar-17	2.05	2.61	3.33
01-Apr-17	1.70	2.48	3.49
02-Apr-17	1.94	2.55	3.27
03-Apr-17	1.72	2.67	4.01
04-Apr-17	2.13	2.63	3.22
05-Apr-17	2.32	2.67	3.17
06-Apr-17	2.48	2.72	3.04
07-Apr-17	2.34	2.85	3.49
08-Apr-17	2.56	3.04	3.62
09-Apr-17	2.53	3.27	4.40
10-Apr-17	2.64	3.19	4.04
11-Apr-17	2.69	3.80	5.31
12-Apr-17	3.04	3.38	3.78
13-Apr-17	2.90	3.38	4.09
14-Apr-17	2.85	3.71	4.84
15-Apr-17	3.33	4.12	5.39
16-Apr-17	2.96	4.15	5.49
17-Apr-17	3.85	4.09	4.32
18-Apr-17	3.51	3.84	4.38
19-Apr-17	3.27	3.85	4.56
20-Apr-17	3.49	4.44	5.77
21-Apr-17	3.67	4.88	6.64
22-Apr-17	3.64	4.06	4.38
23-Apr-17	3.35	4.22	5.33
24-Apr-17	3.96	4.90	6.20

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	**Min Temperature (°C)**	**Average Temperature (°C)**	**Max Temperature (°C)**
25-Apr-17	4.06	4.87	6.03
26-Apr-17	4.01	4.90	6.18
27-Apr-17	4.06	5.02	6.36
28-Apr-17	3.88	5.29	7.09
29-Apr-17	4.19	4.54	5.05
30-Apr-17	3.91	4.84	5.85
01-May-17	4.17	5.20	6.64
02-May-17	4.48	5.91	7.57
03-May-17	3.30	4.53	5.92
04-May-17	2.56	3.28	4.22
05-May-17	2.48	2.87	3.22
06-May-17	2.90	3.58	4.38
07-May-17	2.98	4.28	5.82
08-May-17	3.96	4.77	5.67
09-May-17	3.83	5.03	6.48
10-May-17	4.09	4.85	6.08
11-May-17	3.17	3.75	4.09
12-May-17	3.17	3.91	4.79
13-May-17	3.72	4.72	5.75
14-May-17	4.35	5.24	6.46
15-May-17	4.66	5.14	5.85
16-May-17	4.27	5.31	6.59
17-May-17	4.51	5.55	7.57
18-May-17	4.17	4.94	6.31
19-May-17	3.62	4.65	5.92
20-May-17	3.70	4.84	6.99
21-May-17	3.46	4.36	5.75
22-May-17	3.38	4.36	6.28
23-May-17	3.20	4.12	6.05
24-May-17	3.01	4.13	5.36
25-May-17	4.14	5.08	6.99
26-May-17	3.78	4.80	6.84
27-May-17	3.75	4.64	6.59
28-May-17	3.67	4.56	6.43
29-May-17	3.75	4.63	6.43
30-May-17	3.80	4.12	4.53
31-May-17	3.85	4.55	5.62
01-Jun-17	4.04	4.37	4.95
02-Jun-17	3.83	4.43	5.33

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
03-Jun-17	3.78	4.69	6.08
04-Jun-17	3.99	4.78	5.82
05-Jun-17	3.88	5.26	7.34
06-Jun-17	4.30	5.33	7.37
07-Jun-17	4.12	4.93	6.84
08-Jun-17	3.70	4.22	4.77
09-Jun-17	3.54	4.53	6.15
10-Jun-17	4.01	4.94	6.10
11-Jun-17	4.35	5.47	7.54
12-Jun-17	4.51	5.33	7.17
13-Jun-17	4.25	4.80	5.69
14-Jun-17	4.17	4.79	5.72
15-Jun-17	4.22	4.62	5.13
16-Jun-17	3.49	4.16	4.92
17-Jun-17	3.78	4.77	6.13
18-Jun-17	4.22	4.80	5.44
19-Jun-17	4.48	5.00	5.80
20-Jun-17	4.04	5.06	6.89
21-Jun-17	3.75	5.03	6.79
22-Jun-17	3.99	5.42	7.57
23-Jun-17	4.27	5.64	8.00
24-Jun-17	4.40	5.67	7.95
25-Jun-17	4.53	5.69	7.95
26-Jun-17	4.48	5.62	7.44
27-Jun-17	4.32	5.69	7.95
28-Jun-17	4.64	6.05	8.44
29-Jun-17	4.79	6.23	8.82
30-Jun-17	5.00	6.24	8.39
01-Jul-17	5.21	6.40	8.67
02-Jul-17	5.18	6.48	8.82
03-Jul-17	5.36	6.36	8.25
04-Jul-17	5.05	6.58	8.92
05-Jul-17	5.41	6.95	9.44
06-Jul-17	5.72	7.18	9.68
07-Jul-17	5.85	7.32	9.88
08-Jul-17	5.98	7.37	9.51
09-Jul-17	6.46	7.39	9.09
10-Jul-17	6.00	7.19	8.69
11-Jul-17	6.15	7.72	9.83

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix F: Daily Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
12-Jul-17	6.79	7.91	9.49
13-Jul-17	6.94	7.89	9.34
14-Jul-17	6.36	8.19	10.59
15-Jul-17	7.24	8.61	10.54
16-Jul-17	7.52	8.58	10.08
17-Jul-17	7.07	8.80	10.49
18-Jul-17	8.00	9.72	11.76
19-Jul-17	8.47	10.15	11.93
20-Jul-17	9.46	10.06	10.76
21-Jul-17	8.69	9.57	10.25
22-Jul-17	8.94	9.60	10.49
23-Jul-17	8.64	10.20	12.10
24-Jul-17	8.84	10.50	12.24
25-Jul-17	9.73	11.43	13.31
26-Jul-17	10.39	10.99	11.83

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
26-Jul-16	12.51	13.37	14.17
27-Jul-16	12.97	13.78	14.53
28-Jul-16	13.45	14.26	15.01
29-Jul-16	13.62	14.39	15.18
30-Jul-16	13.02	13.77	14.34
31-Jul-16	11.76	12.38	12.85
01-Aug-16	11.44	12.27	13.04
02-Aug-16	11.52	11.73	12.27
03-Aug-16	11.25	11.60	11.95
04-Aug-16	11.49	12.03	12.73
05-Aug-16	11.35	11.96	12.68
06-Aug-16	10.22	11.29	12.27
07-Aug-16	10.79	11.39	12.10
08-Aug-16	10.74	11.07	11.32
09-Aug-16	11.10	11.52	12.00
10-Aug-16	11.47	11.98	12.78
11-Aug-16	11.25	12.56	14.05
12-Aug-16	12.36	13.59	15.03
13-Aug-16	12.99	14.22	15.63
14-Aug-16	13.19	14.37	15.70
15-Aug-16	12.75	14.21	15.63
16-Aug-16	13.16	14.52	16.03
17-Aug-16	13.19	14.56	16.06
18-Aug-16	13.47	14.89	16.34
19-Aug-16	13.28	14.79	16.56
20-Aug-16	13.21	14.95	16.82
21-Aug-16	12.12	13.87	15.46
22-Aug-16	10.79	12.11	13.71
23-Aug-16	9.95	11.97	13.83
24-Aug-16	11.35	13.13	15.10
25-Aug-16	12.34	13.87	15.58
26-Aug-16	12.56	14.18	15.99
27-Aug-16	13.64	14.72	16.03
28-Aug-16	12.10	12.76	13.47
29-Aug-16	11.30	12.77	13.98
30-Aug-16	12.27	13.47	14.98
31-Aug-16	11.71	12.27	12.82
01-Sep-16	10.47	11.20	11.73
02-Sep-16	9.73	10.16	10.54

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
03-Sep-16	9.83	10.26	10.91
04-Sep-16	9.51	10.14	10.81
05-Sep-16	9.61	10.02	10.61
06-Sep-16	9.39	10.28	11.52
07-Sep-16	9.53	10.13	10.57
08-Sep-16	9.56	10.26	11.39
09-Sep-16	8.77	9.94	10.88
10-Sep-16	10.08	10.97	12.27
11-Sep-16	8.69	9.82	11.10
12-Sep-16	7.65	9.33	10.86
13-Sep-16	7.59	9.71	11.71
14-Sep-16	9.04	10.76	12.68
15-Sep-16	9.14	11.00	12.85
16-Sep-16	10.49	11.16	12.53
17-Sep-16	9.26	10.00	10.37
18-Sep-16	9.14	9.38	9.73
19-Sep-16	8.20	8.79	9.16
20-Sep-16	7.72	8.23	8.72
21-Sep-16	7.65	8.33	9.04
22-Sep-16	7.27	8.25	9.09
23-Sep-16	8.17	8.35	8.59
24-Sep-16	7.87	8.27	8.67
25-Sep-16	8.07	8.52	9.02
26-Sep-16	8.30	8.95	9.68
27-Sep-16	8.17	9.38	9.90
28-Sep-16	7.42	8.15	9.04
29-Sep-16	6.48	7.62	8.74
30-Sep-16	6.18	7.19	8.27
01-Oct-16	6.26	7.09	7.67
02-Oct-16	6.51	7.39	8.32
03-Oct-16	5.80	6.89	7.59
04-Oct-16	6.76	7.34	7.82
05-Oct-16	7.12	7.75	8.37
06-Oct-16	7.47	7.75	8.00
07-Oct-16	6.86	7.08	7.44
08-Oct-16	5.41	6.05	6.84
09-Oct-16	5.41	5.62	6.03
10-Oct-16	4.35	4.99	5.41
11-Oct-16	3.67	4.03	4.38

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
12-Oct-16	3.25	3.98	4.71
13-Oct-16	4.51	4.99	5.49
14-Oct-16	5.13	5.51	6.00
15-Oct-16	5.98	6.19	6.36
16-Oct-16	6.03	6.24	6.46
17-Oct-16	6.10	6.34	6.69
18-Oct-16	6.23	6.32	6.48
19-Oct-16	6.03	6.28	6.61
20-Oct-16	5.77	6.16	6.66
21-Oct-16	5.67	5.95	6.10
22-Oct-16	5.77	6.00	6.26
23-Oct-16	5.82	6.07	6.38
24-Oct-16	6.10	6.26	6.43
25-Oct-16	5.80	6.14	6.43
26-Oct-16	5.44	5.54	5.67
27-Oct-16	5.41	5.84	6.15
28-Oct-16	5.92	6.12	6.38
29-Oct-16	5.67	5.92	6.15
30-Oct-16	5.15	5.40	5.62
31-Oct-16	5.15	5.32	5.44
01-Nov-16	5.26	5.40	5.59
02-Nov-16	5.31	5.44	5.72
03-Nov-16	5.72	5.88	6.03
04-Nov-16	5.15	5.74	6.31
05-Nov-16	5.62	5.96	6.33
06-Nov-16	5.49	5.73	6.03
07-Nov-16	5.75	5.95	6.23
08-Nov-16	6.10	6.55	6.74
09-Nov-16	5.75	6.17	6.66
10-Nov-16	6.05	6.35	6.74
11-Nov-16	6.43	6.66	6.74
12-Nov-16	5.72	6.14	6.43
13-Nov-16	5.08	5.42	5.64
14-Nov-16	5.10	5.44	5.75
15-Nov-16	4.69	4.87	5.13
16-Nov-16	4.22	4.44	4.84
17-Nov-16	4.06	4.26	4.48
18-Nov-16	3.62	3.88	4.22
19-Nov-16	3.41	3.58	3.70

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
20-Nov-16	3.35	3.62	3.91
21-Nov-16	3.93	4.33	4.61
22-Nov-16	2.90	3.49	3.93
23-Nov-16	2.72	3.00	3.30
24-Nov-16	3.12	3.31	3.64
25-Nov-16	2.74	3.26	3.51
26-Nov-16	1.67	2.46	3.49
27-Nov-16	2.66	2.81	2.90
28-Nov-16	2.69	2.90	3.06
29-Nov-16	2.69	2.84	2.98
30-Nov-16	2.56	2.78	2.90
01-Dec-16	2.80	2.93	3.01
02-Dec-16	1.99	2.52	2.80
03-Dec-16	2.77	3.05	3.20
04-Dec-16	1.94	2.57	2.88
05-Dec-16	1.64	1.76	1.89
06-Dec-16	0.96	1.28	1.59
07-Dec-16	0.61	0.71	0.91
08-Dec-16	0.52	0.60	0.69
09-Dec-16	0.63	0.71	0.80
10-Dec-16	0.77	0.92	1.02
11-Dec-16	1.02	1.04	1.07
12-Dec-16	0.91	1.03	1.10
13-Dec-16	0.72	0.79	0.91
14-Dec-16	0.66	0.71	0.74
15-Dec-16	0.61	0.64	0.69
16-Dec-16	0.55	0.60	0.66
17-Dec-16	0.47	0.56	0.63
18-Dec-16	0.63	0.81	0.96
19-Dec-16	0.44	0.94	1.26
20-Dec-16	1.13	1.29	1.40
21-Dec-16	1.43	1.50	1.53
22-Dec-16	1.34	1.50	1.56
23-Dec-16	0.69	1.51	1.59
24-Dec-16	1.18	1.41	1.53
25-Dec-16	0.93	1.01	1.15
26-Dec-16	0.11	0.76	0.96
27-Dec-16	0.44	0.97	1.34
28-Dec-16	1.32	1.41	1.51

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
29-Dec-16	0.52	1.11	1.53
30-Dec-16	1.26	1.40	1.48
31-Dec-16	1.29	1.41	1.48
01-Jan-17	0.91	1.12	1.40
02-Jan-17	0.22	0.70	0.91
03-Jan-17	0.52	0.58	0.66
04-Jan-17	0.69	0.79	0.88
05-Jan-17	0.74	0.85	0.99
06-Jan-17	0.99	1.07	1.18
07-Jan-17	1.10	1.12	1.18
08-Jan-17	0.91	1.03	1.07
09-Jan-17	0.85	0.96	1.02
10-Jan-17	0.61	0.75	0.91
11-Jan-17	0.19	0.59	0.66
12-Jan-17	0.44	0.53	0.61
13-Jan-17	0.52	0.59	0.69
14-Jan-17	0.58	0.71	0.91
15-Jan-17	0.91	1.07	1.21
16-Jan-17	0.91	1.25	1.37
17-Jan-17	0.36	0.52	0.77
18-Jan-17	0.41	1.21	1.83
19-Jan-17	1.75	1.95	2.10
20-Jan-17	2.13	2.23	2.32
21-Jan-17	2.26	2.34	2.42
22-Jan-17	2.32	2.38	2.42
23-Jan-17	1.78	2.28	2.40
24-Jan-17	1.72	1.90	2.07
25-Jan-17	1.70	1.88	1.99
26-Jan-17	1.83	1.98	2.13
27-Jan-17	1.78	1.94	2.16
28-Jan-17	1.81	1.99	2.16
29-Jan-17	2.07	2.18	2.26
30-Jan-17	1.43	1.94	2.24
31-Jan-17	0.85	1.03	1.34
01-Feb-17	0.63	0.78	0.91
02-Feb-17	0.55	0.63	0.72
03-Feb-17	0.36	0.49	0.58
04-Feb-17	0.33	0.55	0.66
05-Feb-17	0.22	0.53	0.66

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
06-Feb-17	0.52	0.65	0.74
07-Feb-17	0.52	0.58	0.66
08-Feb-17	0.08	0.42	0.52
09-Feb-17	0.14	0.25	0.36
10-Feb-17	0.41	0.78	1.07
11-Feb-17	1.10	1.25	1.37
12-Feb-17	1.34	1.43	1.51
13-Feb-17	1.26	1.48	1.56
14-Feb-17	0.58	1.33	1.48
15-Feb-17	0.47	0.72	1.34
16-Feb-17	0.41	1.36	1.97
17-Feb-17	1.99	2.11	2.24
18-Feb-17	1.99	2.10	2.26
19-Feb-17	2.18	2.26	2.37
20-Feb-17	2.18	2.30	2.45
21-Feb-17	1.99	2.21	2.34
22-Feb-17	1.51	1.73	1.94
23-Feb-17	1.02	1.30	1.48
24-Feb-17	1.15	1.36	1.56
25-Feb-17	0.74	1.05	1.29
26-Feb-17	0.88	1.12	1.21
27-Feb-17	0.63	0.78	0.99
28-Feb-17	0.47	0.71	0.93
01-Mar-17	0.96	1.24	1.43
02-Mar-17	1.37	1.47	1.56
03-Mar-17	1.40	1.50	1.62
04-Mar-17	1.10	1.37	1.51
05-Mar-17	0.85	1.03	1.21
06-Mar-17	0.96	1.09	1.24
07-Mar-17	0.74	0.92	1.04
08-Mar-17	0.80	0.99	1.18
09-Mar-17	0.93	1.11	1.26
10-Mar-17	0.41	0.73	1.15
11-Mar-17	1.18	1.25	1.32
12-Mar-17	0.19	1.28	1.53
13-Mar-17	1.34	1.51	1.64
14-Mar-17	1.53	1.67	1.78
15-Mar-17	1.59	1.93	2.18
16-Mar-17	1.97	2.11	2.21

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
17-Mar-17	2.18	2.26	2.37
18-Mar-17	1.56	1.90	2.16
19-Mar-17	1.81	2.02	2.29
20-Mar-17	1.51	1.86	2.16
21-Mar-17	2.10	2.21	2.32
22-Mar-17	2.10	2.33	2.48
23-Mar-17	2.16	2.32	2.50
24-Mar-17	2.26	2.43	2.64
25-Mar-17	2.32	2.43	2.56
26-Mar-17	2.26	2.39	2.58
27-Mar-17	2.37	2.55	2.77
28-Mar-17	2.26	2.43	2.56
29-Mar-17	2.21	2.36	2.45
30-Mar-17	2.42	2.65	3.01
31-Mar-17	2.53	2.75	3.04
01-Apr-17	2.18	2.51	2.82
02-Apr-17	2.42	2.64	2.93
03-Apr-17	2.16	2.53	2.96
04-Apr-17	2.34	2.60	2.90
05-Apr-17	2.48	2.66	2.85
06-Apr-17	2.69	2.74	2.85
07-Apr-17	2.53	2.78	3.01
08-Apr-17	2.69	2.84	3.04
09-Apr-17	2.58	2.83	3.17
10-Apr-17	2.56	2.79	3.14
11-Apr-17	2.56	2.94	3.35
12-Apr-17	2.74	2.88	3.04
13-Apr-17	2.64	2.90	3.14
14-Apr-17	2.69	2.94	3.30
15-Apr-17	2.69	3.00	3.49
16-Apr-17	2.50	2.98	3.51
17-Apr-17	2.90	2.99	3.12
18-Apr-17	2.80	2.92	3.12
19-Apr-17	2.80	3.02	3.30
20-Apr-17	2.82	3.25	3.91
21-Apr-17	2.90	3.30	3.93
22-Apr-17	3.01	3.16	3.35
23-Apr-17	2.93	3.23	3.67
24-Apr-17	2.96	3.37	3.93

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
25-Apr-17	3.06	3.36	3.80
26-Apr-17	2.98	3.38	3.91
27-Apr-17	3.01	3.44	4.06
28-Apr-17	2.82	3.49	4.25
29-Apr-17	2.90	3.13	3.33
30-Apr-17	3.06	3.44	3.93
01-May-17	3.01	3.55	4.14
02-May-17	3.09	3.87	4.71
03-May-17	3.17	3.50	3.78
04-May-17	2.90	3.30	3.93
05-May-17	2.85	3.06	3.27
06-May-17	2.58	3.07	3.46
07-May-17	2.50	3.36	4.27
08-May-17	3.12	3.68	4.40
09-May-17	2.98	3.72	4.53
10-May-17	3.17	3.67	4.56
11-May-17	2.82	3.22	3.49
12-May-17	2.74	3.19	3.72
13-May-17	2.90	3.51	4.06
14-May-17	3.25	3.80	4.45
15-May-17	3.41	3.72	4.06
16-May-17	3.12	3.81	4.56
17-May-17	3.51	4.11	5.21
18-May-17	3.43	4.03	4.90
19-May-17	3.20	3.91	4.90
20-May-17	3.14	3.98	5.49
21-May-17	3.17	3.84	4.90
22-May-17	3.22	3.95	5.41
23-May-17	2.80	3.85	5.49
24-May-17	2.42	3.33	4.19
25-May-17	3.33	4.33	5.90
26-May-17	3.43	4.44	6.23
27-May-17	3.62	4.55	6.33
28-May-17	3.64	4.52	6.26
29-May-17	3.75	4.63	6.31
30-May-17	3.91	4.23	4.58
31-May-17	3.88	4.62	5.82
01-Jun-17	4.12	4.48	5.05
02-Jun-17	3.96	4.54	5.46

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
03-Jun-17	3.78	4.54	5.41
04-Jun-17	3.88	4.53	5.21
05-Jun-17	3.54	4.85	6.43
06-Jun-17	4.22	5.28	6.91
07-Jun-17	4.40	5.41	7.14
08-Jun-17	3.96	4.77	5.39
09-Jun-17	3.54	4.40	5.49
10-Jun-17	3.99	4.84	5.77
11-Jun-17	4.61	5.52	6.89
12-Jun-17	4.82	5.61	6.71
13-Jun-17	4.84	5.24	5.87
14-Jun-17	4.27	4.67	5.10
15-Jun-17	4.32	4.73	5.18
16-Jun-17	4.61	5.03	5.33
17-Jun-17	4.40	5.13	6.00
18-Jun-17	4.48	5.03	5.64
19-Jun-17	5.15	5.78	6.59
20-Jun-17	5.02	6.22	7.87
21-Jun-17	4.69	5.54	6.61
22-Jun-17	4.56	5.75	7.07
23-Jun-17	5.05	6.21	7.80
24-Jun-17	5.46	6.57	8.22
25-Jun-17	5.72	6.89	8.77
26-Jun-17	5.57	6.75	8.07
27-Jun-17	5.21	6.37	7.92
28-Jun-17	5.54	6.77	8.49
29-Jun-17	5.85	7.17	9.11
30-Jun-17	6.48	7.42	8.84
01-Jul-17	6.66	7.65	9.34
02-Jul-17	6.43	7.61	9.36
03-Jul-17	6.48	7.33	8.32
04-Jul-17	5.87	7.07	8.52
05-Jul-17	6.48	7.65	9.02
06-Jul-17	6.94	8.13	9.66
07-Jul-17	7.34	8.54	10.10
08-Jul-17	7.44	8.60	9.93
09-Jul-17	8.07	8.63	9.41
10-Jul-17	7.49	8.33	9.19
11-Jul-17	7.49	8.45	9.49

Appendix F: Daily Stream Temperature Data

Scotia Creek			
Date	**Min Temperature (°C)**	**Average Temperature (°C)**	**Max Temperature (°C)**
12-Jul-17	8.05	8.78	9.46
13-Jul-17	8.22	8.68	9.16
14-Jul-17	7.57	8.69	9.78
15-Jul-17	8.30	8.99	9.56
16-Jul-17	8.00	8.50	8.84
17-Jul-17	7.29	8.38	9.29
18-Jul-17	8.20	9.20	10.10
19-Jul-17	8.87	9.78	10.49
20-Jul-17	9.36	9.63	9.95
21-Jul-17	8.59	9.12	9.41
22-Jul-17	8.74	9.24	9.83
23-Jul-17	9.29	10.12	10.93
24-Jul-17	9.51	10.28	10.93
25-Jul-17	10.03	10.95	11.71
26-Jul-17	10.79	11.12	11.59

SNOWLINE Ecological Research

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Appendix G

Site Data for Coastal Tailed Frog Surveys

SNOWLINE Ecological Research

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Appendix G: Site Data for Coastal Tailed Frog Surveys

Site	Date	End Time	Surveyors	Mapped Easting	Mapped Northing	Mean Elev. (m)	Weather	Air Temp. (°C)	Slope (%)	Water Temp. (°C)	pH	EC (µS)	TDS (ppm)	Notes
Agnew Creek - 1	2017-08-31	14:17	B.Brett, H.Williamson, L..Harrison	502054	5554214	666	Cloudy	22	16	9.5	NR	NR	NR	Fine sediment under rocks (leaves., gravel)
Agnew Creek - 2	2017-08-31	13:30	B.Brett, H.Williamson, L..Harrison	501982	5554360	680	Cloudy	21	8	9.4	8.0	154	108	Good riffle habitat
Agnew Creek - 3	2017-08-31	12:25	B.Brett, H.Williamson, L..Harrison	501848	5554666	735	Cloudy	21	25	7.6	8.1	158	111	At entrance to Mandatory Suicide; looks like good habitat
Archibald Creek - 1	2017-09-05	14:05	B.Brett, H.Williamson, L..Harrison	502387	5550606	695	Smoke Haze	19	17	13.0	NR	NR	NR	No sediment (vs. 2016); 2 sample areas=13m2; bedrock=35m2
Archibald Creek - 2	2017-09-05	14:58	B.Brett, H.Williamson, L..Harrison	502854	5550298	835	Smoke Haze	20	16	12.0	NR	NR	NR	Less sediment than 2017, higher downstream
Archibald Creek - 3	2017-09-06	10:35	B.Brett, H.Williamson, L..Harrison	503310	5549422	1026	Smoke Haze	19	11	11.0	NR	NR	NR	Low sediment above Bike Park; Med-High below
Horstman Creek - 1	2017-08-31	11:20	B.Brett, H.Williamson, L..Harrison	504565	5552532	687	Sunny	17	4	9.8	7.12	52	36	
Horstman Creek - 2	2017-08-31	10:21	B.Brett, H.Williamson, L..Harrison	505094	5552397	736	Cloudy	12	15	9.0	7.0	51	36	
Horstman Creek - 3	2017-09-06	13:55	B.Brett, H.Williamson, L..Harrison	506216	5551201	1206	Haze	19	32	9.0	NR	NR	NR	Heavy flow - diff. to survey due to pools and embedded rocks; lots of diving beetles
Whistler Creek - 1	2017-09-05	09:40	B.Brett, H.Williamson, L..Harrison	501041	5549045	692	Haze	19	11	13.0	NR	NR	NR	Recent construction with introduced angular rocks
Whistler Creek - 2	2017-09-05	10:20	B.Brett, H.Williamson, L..Harrison	501417	5548276	879	Haze	18	4	13.0	NR	NR	NR	
Whistler Creek - 3	2017-09-05	11:30	B.Brett, H.Williamson, L..Harrison	501649	5547961	972	Haze	17	26	13.0	NR	NR	NR	

Appendix G: Site Data for Coastal Tailed Frog Surveys

Site	Date	End Time	Surveyors	Channel Width (m)	Wetted Width (m)	Survey Area (m2)	Disch-arge	Mean Depth (cm)	Crown Closur e	Tree Comp.	Struct. Stage	Stream Disturb -ance	Stream Morph.	Rock Size	Rock Shape
Agnew Creek - 1	2017-08-31	14:17	B.Brett, H.Williamson, L..Harrison	3.0	2.5	16.8	Med	20	60	Conif.	YF	Low	Step Pool	Cobble (Boulder)	Rounded
Agnew Creek - 2	2017-08-31	13:30	B.Brett, H.Williamson, L..Harrison	3.6	2.5	29.5	Med	8	45	Conif.	YF	Med.	Riffle (Cascade)	Cobble (Gravel)	Rounded
Agnew Creek - 3	2017-08-31	12:25	B.Brett, H.Williamson, L..Harrison	3.3	2.1	9.9	Med	11	65	Mixed	YF	Med.	Riffle (Step Pool)	Cobble (Gravel)	Rounded
Archibald Creek - 1	2017-09-05	14:05	B.Brett, H.Williamson, L..Harrison	5.6	3.1	48.2	Med	23	0 to 100	Decid.	Pole/Sapl.	Low	Cascade (Step Pool)	Bedrock (Boulder)	Subangular
Archibald Creek - 2	2017-09-05	14:58	B.Brett, H.Williamson, L..Harrison	2.4	1.8	16.0	Low	13	100	Mixed	Shrub/YF	Med.	Cascade	Cobble	Angular/BR
Archibald Creek - 3	2017-09-06	10:35	B.Brett, H.Williamson, L..Harrison	3.2	2.2	24.0	Med	13	75	Mixed	YF/Shrub	Med.	Cascade (Step Pool)	Cobble (Boulder)	Subangular
Horstman Creek - 1	2017-08-31	11:20	B.Brett, H.Williamson, L..Harrison	4.7	3.3	14.8	Low	15	85	Decid.	Shrub/PS	Low	Riffle	Cobble (Boulder)	Subrounde d
Horstman Creek - 2	2017-08-31	10:21	B.Brett, H.Williamson, L..Harrison	10.3	6.7	32.9	Low	17	5	Mixed	MF	Low	Riffle (Cascade)	Cobble (Boulder)	Subrounde d
Horstman Creek - 3	2017-09-06	13:55	B.Brett, H.Williamson, L..Harrison	10.0	6.0	8.5	Med	40	10	Conif.	MF	High	Cascade (Step Pool)	Cobble (Boulder)	Subangular
Whistler Creek - 1	2017-09-05	09:40	B.Brett, H.Williamson, L..Harrison	NR	7.4	6.7	Med	24	5	Mixed	Shrub/YF	Low	Step Pool (Cascade)	Cobble (Boulder)	Angular
Whistler Creek - 2	2017-09-05	10:20	B.Brett, H.Williamson, L..Harrison	9.0	5.7	12.5	Low	13	20	Conif.	OF	Low	Step Pool (Cascade)	Cobble (Boulder)	Ang./Rounded
Whistler Creek - 3	2017-09-05	11:30	B.Brett, H.Williamson, L..Harrison	6.6	5.0	17.0	Med	12	30	Conif.	OF	Low	Cascade	Boulder	Subangular

Appendix H

Capture Data for Coastal Tailed Frog Surveys

Appendix H: Capture Data for Coastal Tailed Frog Surveys

Site	Total tadpoles	hatchling (<15mm)	no hind legs	bulge only, hind legs not defined	hind legs visible but covered	hind feet protruding	hind knees protruding	Adult Male (SVL cm)
Agnew Creek – 3 sites								
Archibald Creek - 1	11			37	40		44	
				34	38			
				35	37			
				33	36			
					40			
					35			
Archibald Creek - 2	5			28	34	40	43	
				32				
Archibald Creek - 3	17		33	30		44		37
			25	34		40		40
			27	28				
			28	30				
			30	31				
				30				
				29				
				36				
				37				
				31				
Horstman Creek - 1	1			40				
Horstman Creek - 2	5			34	42	47		
					40	50		
Horstman Creek - 3	0							
Whistler Creek - 1	11		33	38		45		
			33	34		43		
			33	40				
				40				
				32				
				33				
Whistler Creek - 2	26		31	32		40		
			30	34		42		
			30	33		42		
			32	32				
			30	40				
			30	27				
			30	27				
			28	32				
			30	34				
			27	28				
				28				
				33				
				30				
Whistler Creek - 3	11			33	37	45		
				35	36			
				32				
				35				
				36				
				34				
				31				
				34				
Total	87	0	18	45	11	11	2	2