



PALMER
ENVIRONMENTAL
CONSULTING
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470 Granville Street, Suite 630, Vancouver, BC V6C 1V5

Whistler Ecosystems Monitoring Program

2016

PECG Project #
160251

Prepared For
Resort Municipality of Whistler

March 31, 2017



PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

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

March 31, 2017

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 #: 160251

Enclosed you will find the final Whistler Ecosystems Monitoring Program 2016 report. This report has been authored by Palmer Environmental Consulting Group Inc. (PECG) and Snowline Ecological Research.

Our overall study design and field program was carried out with support from specialists and student volunteers from the Whistler community, British Columbia Institute of Technology (BCIT) and the University of British Columbia (UBC).

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, invest in the future of young biologists 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 Rick Palmer at (604) 787-8013 or via email at rick@pecg.ca.

Yours truly,
Palmer Environmental Consulting Group Inc.

Rick Palmer, M.Sc., R.P.Bio.
President and Senior Fisheries Biologist

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, 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. This report describes the fourth year of the Ecosystems Monitoring program, conducted in 2016.

The Ecosystems monitoring program included various components of a natural ecosystem, including aquatic species, aquatic habitat, riparian species, terrestrial habitat, terrestrial species, and climate.

A total of five stream sites have been established to monitor the aquatic health of streams in the RMOW. Methods and data collected include closed-site fish sampling, benthic invertebrate sampling, general water quality parameters, and reach habitat characteristics. Undifferentiated trout fry from resident populations of Rainbow (*Oncorhynchus mykiss*) and Cutthroat Trout (*O. clarkii clarkii*) were the most abundant species captured at all creeks, with the vast majority of sampled trout being age 0+ fry, indicating the importance of the study reaches for trout rearing. Benthic invertebrate analyses indicated a relatively high proportion of pollution sensitive organisms in the River of Golden Dreams watershed, a sign of healthy benthic invertebrate communities. Analyses of benthic invertebrate communities in the Jordan Creek indicated less healthy communities in 2016.

Two riparian species have been monitored as part of the program, the Coastal Tailed Frog (*Ascaphus truei*) and the Beaver (*Castor canadensis*). 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 2016 survey adopted much of the previous approach with some changes to site and reach selection, including increased elevational range, and moving from area-constrained sampling to time-constrained sampling. Results showed that the 2016 timed approach resulted in higher detections and was more likely to detect the presence of tadpoles.

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. Surveys in 2016 showed approximately 75 beavers overwintering in Whistler, which is very close to the nine-year average of 81, and almost twice the 2015 estimate.

Terrestrial species were monitored to assess potential changes in habitat in response to various types of anthropogenic activities. Pitfall trapping of Carabid beetles, inventory of cavity trees and cavities created by Pileated Woodpeckers (*Dryocopus pileatus*), call playback surveys for Pileated Woodpeckers, winter tracking, and small mammal trapping were conducted as part of terrestrial surveys. Key results included similar Carabid beetle results compared to previous years; Western redcedar, Western hemlock, and Douglas fir represented the majority (90%) of the cavity trees; Pileated Woodpecker was detected through callback surveys in areas with the most suitable intact habitat (i.e., at 3 of 7 sites); small mammal captures were highest at Millar's Pond and a River Runs Through It, which is unsurprising given the relatively less disturbed and higher quality habitats in these locations; and a new addition to the Program design, a single winter tracking session, yielded a higher diversity and nearly half as many total animals than the multiple small mammal trapping sessions.

An unexpected outcome of monitoring by field crews in 2016 was the first confirmed breeding of a Northern Goshawk (*Accipiter gentilis*) in Whistler, a significant and exciting find, as Northern Goshawks are Red-listed and protected under the British Columbia *Wildlife Act*.

Continued monitoring of the key aquatic and terrestrial ecosystem components are recommended to help establish a baseline of ecosystem health in the RMOW study area. Recommendations also include discontinuing the small mammal and Carabid beetle programs, given the results over the past four years only indicate these programs would provide more meaningful results only if sampling efforts were to greatly intensify to a level beyond what would be reasonably expected from a monitoring program of this scope.

Acknowledgements

There are many people who contributed to various aspects of this project, most in a volunteer capacity due to their devotion and passion to conservation initiatives and the desire to apply sound science to natural resources management. For the terrestrial components of this project we greatly extend thanks to Dr. Doug Ransome of BCIT and Dr. Suzie Lavallee of UBC for sharing their expertise of sampling methodology. Damian Power generously shared his expertise of animal tracking during the winter tracking survey. Chris Ratzlaff of the Beatty Biodiversity Museum identified the Carabid beetles and Karen Needham identified the benthic invertebrates and provided additional advice on sampling and field collection procedures. Kristen Jones helped greatly with the beaver surveys, and also assisted with mammal and beetle surveys. We also appreciate assistance from Julie Burrows and Kristina Swerhun for all field surveys.

There were several volunteers who assisted with the field surveys, many from BCIT's Ecological Restoration and Fish, Wildlife, and Recreation Programs. Field assistants for the Pileated Woodpecker surveys, Carabid beetle sampling and small mammal trapping included: Bianca Dureault, Carly Walters, Connor McGillion, Davina Dube, Georgia Taipalus, Katherine Loewen, Lauren Crosby, Mike Paleologou, Olivia Peruzzo, Sasha Lavigne and Sunita Brazil.

We also greatly appreciate the assistance and expertise provided throughout the project by Tara Schaufele and Kate Brandon with the RMOW.

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1. Introduction

1.1 Overview

This report describes monitoring studies conducted in 2016 by Palmer Environmental Consulting Group (PECG) and Snowline Ecological Research on aquatic and terrestrial environments in Whistler, British Columbia (BC). The 2016 study was the fourth year of the Ecosystems Monitoring program. The purpose of the program is to monitor the health of ecosystems over time, through the use of indicators, 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 RMOW from 2006 through 2012, began its first surveys in late 2004. This work led to the first publicly documented records of a number of important and/or at-risk species, e.g., Coastal Tailed Frogs (*Ascaphus truei*), and Red-legged Frogs (*Rana aurora*), initiated the first beaver census, and greatly enhanced the knowledge of which species inhabit Whistler. This information was first summarized in 2007 (Brett) in a report which also 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 the 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 2013) was based on information from:

- Askey et al. (2008) proposed framework.
- Species data collected through the Whistler Biodiversity Project (Brett 2007; 2012); and
- Local data held by Cascade Environmental Resource Group Inc (Cascade).

Cascade conducted the first three years of the Ecosystem Monitoring Program (Cascade 2013 to 2015). In 2016, PECG partnered with Snowline Ecological Research, and the team were awarded the contract for the first year of a three-year program for 2016 to 2018. 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 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 were:

- 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 in (*Dryocopus pileatus*) place of a survey limited to recent excavations;
- Removal/replacement of some study sites; and
- A return to a full beaver census.

2. Methods

2.1 Study Area

The Resort Municipality of Whistler (RMOW) is located in the southern Coast Mountains of BC, 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.

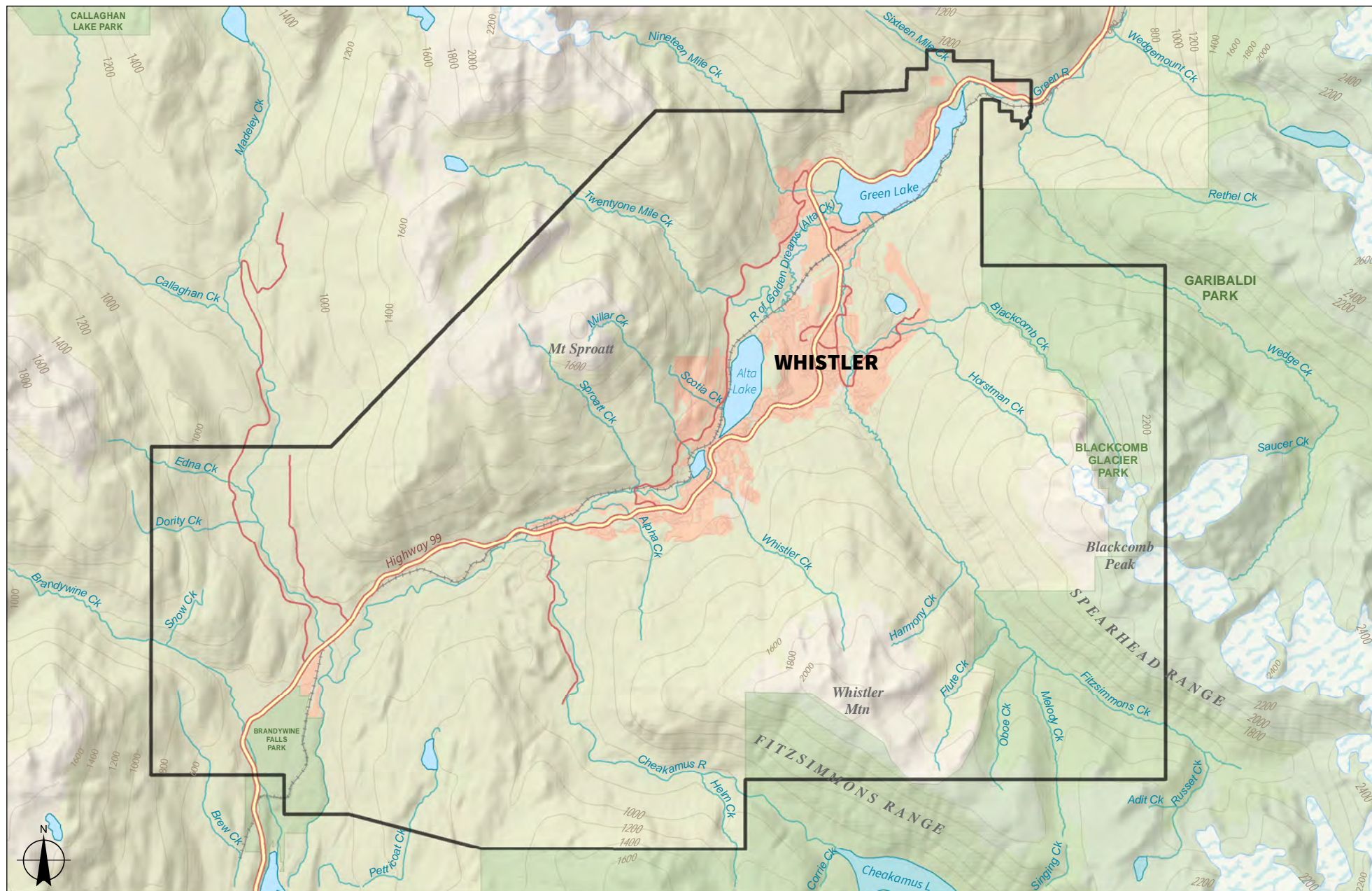


FIGURE 1. Ecosystems Monitoring Project Study Area, 2016

Project: Annual Monitoring	Client: Resort Municipality of Whistler
Scale: 1:110,000	
NAD 83 UTM 10 N	

LEGEND

RMOW Boundary

	Roads
	Highway
	Local Road
	Railroad

	Developed Land
	Permanent Snow and Ice
	Protected Area

NOTES

1. Elevation contours displayed in metres (above sea level) at 200m intervals
2. Data Sources: Developed land provided by RMOW. Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government License - British Columbia, 2016. Other base data from Canvec (250k) and licensed under the Open Government Licence - Canada, 2016.

DRAWN: B. Elder	Project: 160251
CHECKED: I. Mencke	23/02/2017



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. The indicator species for the program were re-evaluated in 2016, and the metrics for those indicators were defined. Table 1 shows the indicators, and field methodologies and metrics for each program component.

Table 1. 2016 Ecosystems Monitoring Program

Study Component	Indicator(s)	Methodology/ Equipment	Metrics/Parameters
Aquatic Species	Benthic macroinvertebrate community	CABIN protocols (3 minute kick-net sample)	<ul style="list-style-type: none"> Abundance Taxa richness EPT taxa richness Percentage EPT diversity indices
	Fish: <ul style="list-style-type: none"> Kokanee salmon (<i>Oncorhynchus nerka</i>) Bull Trout (<i>Salvelinus confluentus</i>) Rainbow Trout (<i>Oncorhynchus mykiss</i>) Cutthroat Trout (<i>Oncorhynchus clarkii</i>) 	Three-pass depletion (closed site) electrofishing	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> In Situ parameters: pH, conductivity, dissolved oxygen, turbidity
	Stream Flow	Transect measurements using a flow meter and wading rod	<ul style="list-style-type: none"> Staff gauge readings depth-velocity profiles
	Stream Temperature	Temperature loggers set to hourly logging, installed at five locations	<ul style="list-style-type: none"> Daily and monthly summary statistics for the open water period
Riparian Species	Coastal Tailed Frog (<i>Ascaphus truei</i>)	Time constrained surveys (MELP, 2000)	<ul style="list-style-type: none"> Tadpole abundance and density Counts of tadpoles by cohort (i.e. age) In situ water quality
	Beaver (<i>Castor canadensis</i>)	Field inventories of beaver lodges and activity	<ul style="list-style-type: none"> Number and distribution of active lodges Beaver census
Terrestrial Habitat	Carabid beetles (Family Carabidae)	Pitfall trapping	<ul style="list-style-type: none"> Diversity indices
	Cavity trees	Survey of cavity trees on Pileated Woodpecker surveys	<ul style="list-style-type: none"> Number and size class of cavities Size, decay class, and species of trees with cavities
Terrestrial Species	Pileated Woodpecker (<i>Dryocopus pileatus</i>)	Call-playback surveys (MOELP, 1999)	<ul style="list-style-type: none"> Relative abundance based on call-playback surveys
	Small mammals	Live trapping	<ul style="list-style-type: none"> Body mass Gender Breeding condition
Climate	Alta Lake freeze-up and thaw dates	Desktop research	<ul style="list-style-type: none"> Alta Lake thaw

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 2016 sampling information. Water quality parameters (pH, conductivity, dissolved oxygen, temperature, and turbidity) were measured *in situ* during each sampling event. Benthic invertebrate sampling was conducted prior to fish sampling, to avoid disturbance of the substrate prior to sampling.

The River of Golden Dreams is the northern outlet to Alta Lake and flows north-northeasterly to Green Lake. The river is 5.4 km long, and has an irregular meander pattern. Urban development encroaches on the river, in particular for the first kilometer (approximately) 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.

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 for sampling. 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. 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). 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. Monitoring of the benthic invertebrate community will provide insight into the aquatic health of the river, and comparison between the two sites will provide an indication of how conditions change downstream.

A new fish/benthic invertebrate sampling site (21M-DS-AQ21) was established in 2016 on Twentyone Mile Creek. 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 fish sampling location to the River of

Golden Dreams. Twentyone Mile Creek is relatively undisturbed compared to the River of Golden Dreams, and is therefore also considered a potential reference site. Habitat characteristics at the Twentyone Mile Creek site are similar to the River of Golden Dreams site downstream, 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. Fish and benthic invertebrate sampling was conducted at one of two previously established sites on Jordan Creek. Fish sampling was conducted at this site (called "Jordan Creek EF #2"), and at a second site approximately 100 m upstream (called "Jordan Creek EF #1"), in 2013, 2014, and 2015. The upstream site was not sampled in 2016, because of its proximity to the downstream site, which means that either site would be representative of the short (500 m long) creek.

The provincial fisheries database (Fisheries Information Summary System, FISS), previous monitoring results, 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, meaning 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 from 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), 2016

Site Name	UTM Location (Zone 10)		Stream Name and Classification *	Historical Information	Description	Date Sampled - Benthic Invertebrates	Date Sampled - Fish
	Easting	Northing					
JOR-DS-AQ31	500190	5549243	Jordan Creek (S3)	Jordan Creek electrofishing (i.e. fish sampling) site #2 (downstream site), 2013-2015.	250 m downstream from Nita Lake.	3-Aug-16	4-Aug-16
CRB-DS-AQ01	502023	5552707	Crabapple Creek (S3)	Crabapple Creek electrofishing (i.e. fish sampling) site, 2014 - 2015.	100 m upstream from confluence with the River of Golden Dreams.	2-Aug-16	5-Aug-16
21M-DS-AQ21	501938	5552817	Twentyone Mile Creek (S2)	n/a - New site established in 2016.	75 m upstream from confluence with the River of Golden Dreams.	3-Aug-16	6-Aug-16
RGD-US-AQ11	502000	5552755	River of Golden Dreams (S2)	New Site - Approximately 60 m upstream of ROGD electrofishing (i.e. fish sampling) site, 2014 - 2015.	Site between Crabapple Creek and Twentyone Mile Creek tributaries.	3-Aug-16	n/a
RGD-DS-AQ12	503031	5554678	River of Golden Dreams (S2)	n/a - New site established in 2016.	Downstream of canoe pull- out location, 750 m upstream from Green Lake	5-Aug-16	n/a

*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, 2016

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)

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



FIGURE 2. Aquatic Sites 2016

Project: Annual Monitoring

Client: Resort Municipality of Whistler

0 250 500 750 1,000
METRES

Scale: 1:40,000

NAD 83 UTM 10 N

LEGEND

Samples Taken

- Benthic Invertebrates and Fish
- Benthic Invertebrates

Basemap Features

- Highway
- Arterial Road
- Local Road
- Trail
- Railroad
- Developed Land
- Protected Area

NOTES

1. Elevation contours displayed in metres (above sea level) at 40 m (200 m index) intervals
2. Data Sources: Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government License - British Columbia, 2016. Other base data provided by RMOW.

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2017-04-14



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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). A fish habitat assessment was conducted at the site on Jordan Creek (JOR-DS-AQ31). Time restraints prohibited fish habitat assessment at the two remaining fish sampling sites, however the CABIN habitat data collected at these sites, as well as habitat field notes and photographs, will allow for qualitative descriptions of the fish habitat. *In situ* water quality parameters (pH, temperature, dissolved oxygen, specific conductance, and turbidity) were measured during all sampling events.

Stream Temperature

Temperature loggers (HOBO Water Temperature Pro v2 Data Logger, model # U22-001) were deployed by Cascade in five creeks in the study area on December 15, 2015, and set to hourly logging. The logger locations are shown in Table 4, along with location descriptions and access information. All of the loggers were installed near a bridge crossing of the creek, for easy access to download and maintain the loggers. The temperature loggers were downloaded in the field in the spring and/or fall of 2016 (Table 4) and redeployed following each download. The logger at Crabapple Creek, which failed to download on September 30, 2016 had to be removed on that date and was sent for data retrieval to the manufacturer. Daily and monthly summary statistics (means, maxima, and minima) were calculated during the open water period for each creek where a logger was deployed. 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.

Table 4. Temperature logger locations, 2016

Site	UTM Location (Zone 10)		Location Description	Access (Bridge Crossing)	Install Date	Download Date(s)	
	Easting	Northing					
Alpha Creek	499199	5548227	At Tailed Frog Site #1	Spring Creek Drive	15-Dec-15	5-May-16	16-Nov-16
Jordan Creek	500242	5549278	Near Aquatics Site JOR-DS-AQ31.	Lake Placid Road	15-Dec-15	5-May-16	30-Sep-16
Scotia Creek	500280	5551092	At Tailed Frog Site #2	Stone Bridge Drive	15-Dec-15	-	16-Nov-16
Crabapple Creek	502426	5550589	At Tailed Frog Site #2	Sunridge Drive	15-Dec-15	See note*	
River of Golden Dreams	502066	5552829	Near Aquatics Site RGD-US-AQ11.	Lorimer Road	15-Dec-15	5-May-16	30-Sep-16

*Note: The housing of the temperature logger from Crabapple Creek was filled with gravel and sand on May 5, 2016, and could not be downloaded. On September 30, 2016, the logger was removed and sent to Hoskins Scientific for data retrieval because the logger download failed. Data for the period December 15, 2015 to September 30, 2016, was retrieved from the logger. A replacement logger (HOBO TidbiT v2 Water Temperature Data Logger, model # UTBI-001) was installed at the site on November 16, 2016.

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 may not identify. Due to their sedentary nature, relatively long life-cycles, 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 the five sites in early August, 2016 (Table 2). At each site, a CABIN field sheet was completed, and a single benthic invertebrate sample was collected. The CABIN method entails kick-net sampling for benthic invertebrates in the erosional zone (riffle, straight run, or rapid) of a representative watercourse reach.

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. Turbidity was measured using a La Motte 2020we turbidity meter. Both meters were calibrated prior to use. Other observations such as macrophyte coverage, streamside vegetation, and slope were evaluated within the entire reach (Environment Canada 2012).

For benthic invertebrate sampling, a triangular kick-net sampler with 400 micron mesh and detachable collection cup was employed. To collect a sample 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 21M-DS-AQ21, to be processed in the laboratory and ensure that the method was effective in removing the vast majority of benthic invertebrates.

Data Analysis

Benthic invertebrate samples were analysed using the Reference Condition Approach (RCA) as 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 1 indicates the two sites are entirely different from one another and a value of 0 indicates the two sites are identical in community structure. 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 or not a test site is in reference condition, and if not, then how divergent it is from reference condition. Ordination plots are generated in CABIN and provides an overall indicator of whether a site is in reference condition (unstressed), potentially stressed or stressed.

In addition to the CABIN model outputs described above, the following traditional community descriptors are presented for the 2016 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 H' , 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 (QA/QC)

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, in particular Hemiptera, Ephemeroptera, Trichoptera, and Plecoptera. Karen was assisted by a CABIN-certified taxonomist, who entered the taxonomic data into the CABIN online database, and also recounted/reidentified one sample to family level. Karen recounted/reidentified two other samples in their entirety. 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

Three-pass closed site electrofishing was carried out in early August, 2016, at all three fish sampling sites (Table 2). Prior to electrofishing, stop nets were positioned at the upstream and downstream ends of the site to isolate the area and prohibit fish migration during sampling. The electrofishing crew entered the site at the downstream end and sampled downstream to upstream. Each pass completed had similar effort (in seconds), and a minimum of 30 minutes was allowed to elapse between passes to allow recovery of uncaptured fish. All fish captured were identified to species, and length and weight was recorded for each. Fork length was measured for salmonid fish species, and total length was measured for other species. Fish were released into areas outside of the site boundaries after processing and recovery.

Electrofishing at all sites was completed using a Smith-Root LR-20 Backpack Electrofisher and a two-person crew (one electrofisher and one netter) under Scientific Fish Collection Permit SU16-235510 issued by the BC Ministry of Forests Lands and Natural Resource Operations (MoFLNRO). Site lengths ranged from 25 to 38 m and contained multiple mesohabitats (e.g., pool, riffle, run) representative of the reach being sampled. Electrofishing voltage ranged from 250-350V, and was based on water conductance, water temperature, and expected fish size. Electrofishing effort varied from 450-961 seconds per electrofishing pass, with an average effort of 705 seconds/pass.

Data Analysis

Fish Abundance

Relative fish abundance in 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 and trout CPUE was calculated for each site, by considering each electrofishing pass as a sample. Standard deviation of the mean CPUE (total and trout) was calculated based on the three samples. The rationale for this approach was that depletion (decreasing catch with increasing pass number) did not occur, meaning the equal probability of capture assumption was violated, and therefore each pass could be treated as an independent sample. Violation of the equal probability of capture assumption meant that the data could not be used to calculate standardized fish density estimates.

Length, Weight, and Condition

Mean length and weight were calculated for each fish species; further analyses were only completed on trout, as they dominated the catch at all sites, with sufficient sample sizes available for analyses.

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

$$\ln_{-1}(W) = a + b \times \ln_{-1}(L) \quad (1)$$

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. Slope coefficients 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:

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

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

QA/QC

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

The general goal of monitoring indicator species is to select representative species that will reflect the health of a broader range of populations, taxa, and/or ecosystem health. As riparian habitat is a vital component of wetlands and streams, species dependent on riparian habitat reflect the overall functioning of a broader ecosystem encompassing the interfaces between upland, riparian, and stream/wetland habitats. Monitoring riparian species indicators will allow assessment of the relative health of local riparian habitats.

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 monitoring indicator species.

Stream-dwelling amphibians such as the Coastal Tailed Frog (*Ascaphus truei*) serves a vital role as an indicator of stream health as they require flowing, clear, cold water throughout their lifecycle (Matsuda et al. 2006) making them 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). The Coastal Tailed Frog is provincially blue-listed, and is a species of Special Concern under the Species at Risk Act (SARA; Brett 2016).

Ideal habitats for tailed frogs are smaller, fast-flowing (gradients usually >10%) mountainside streams that are cool (typically 10 to 15°C in late summer, and at least 5°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). These characteristics describe many of the streams that drain into the Whistler Valley.

In 2004, the closest public documentation of Coastal Tailed Frogs was in Brandywine Creek (Leigh-Spencer 2004), presumably from surveys before the construction of the Independent Power Project (IPP) built on that creek. Beginning in late 2004, the Whistler Biodiversity Project documented breeding populations (tadpoles) in 16 creeks either within the RMOW, or subsidiary creeks that drained into to larger creeks in the RMOW (Wind 2005-2009; Brett 2007).

Data Collection Methods

The RMOW Ecosystem Monitoring Program began a survey for Coastal Tailed Frogs in 2013 (Cascade). They conducted area-constrained searches on two creeks previously documented as having breeding populations: Alpha Creek, Scotia Creek (including the Stonebridge site).² Surveys in 2014 added two 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 population in Nineteen Mile Creek since no tadpoles had been detected in the only previous survey (Wind 2006).

A total of four streams were sampled in 2016 (Figure 3; Table 5; Appendix G). Whistler Creek was added as a replacement for Nineteen Mile Creek in which no tadpoles were detected in the previous two years of sampling, nor previously in 2006 (Wind 2006). Another change was that reaches were chosen where possible so that a greater range of elevations was sampled, though there was no change for Scotia Creek since the morphology of that creek precluded useful sampling at higher elevations (Table 6). Mid-mountain sampling sites were established for the first time on Alpha and Archibald sites, and the greatest elevational range of the four 2016 sites was established on Whistler Creek.

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 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.



FIGURE 3. Tailed Frog Sampling Sites, 2016

LEGEND

● 2016 Tailed Frog Site

NOTES

1. Elevation contours displayed in metres (above sea level) at 40 m (200 m index) intervals.
2. Data Sources: Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government License - British Columbia, 2016. Other base data provided by RMOW.

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31/12/2016



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Project: Annual Monitoring		Client: RMOW	
Scale: 1:25,000		NAD 83 UTM 10 N	

Table 5. Tailed frog sampling sites in 2016.

<u>Creek</u>	<u>Date</u>	<u>Survey Area (m²)</u>	<u>Lower Easting</u>	<u>Lower Northing</u>	<u>Upper Easting</u>	<u>Upper Northing</u>	<u>Mean Elev. (m)</u>
Alpha Creek - 1	2016-09-15	30	499200	5548225	499242	5548134	684
Alpha Creek - 2	2016-09-15	27	499869	5547994	499376	5547973	714
Alpha Creek - 3	2016-09-21	15	499408	5547152	499389	5547161	863
Archibald Creek - 1	2016-09-21	12	502417	5550594	502335	5550607	695
Archibald Creek - 2	2016-09-21	26	502841	5550302	502849	5550300	835
Archibald Creek - 3	2016-09-22	7	503311	5549446	503310	5549414	1026
Scotia Creek - 1	2016-09-14	30	500746	5550684	500758	5550703	661
Scotia Creek - 2	2016-09-14	25	500210	5551083	500265	5551061	773
Scotia Creek - 3	2016-09-14	32	500010	5551100	500069	5551060	817
Whistler Creek - 1	2016-09-14	25	501036	5549055	501052	5549036	693
Whistler Creek - 2	2016-09-15	35	501391	5548329	501414	5548282	875
Whistler Creek - 3	2016-09-15	31	501644	5547952	501710	5547880	985
Whistler Creek - 4	2016-09-21	8	501681	5547378	501676	5547396	1130

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

	<u>2015</u>		<u>2016</u>		
<u>Creek</u>	<u>Elevation (m)</u>	<u>Range (m)</u>	<u>Elevation (m)</u>	<u>Range (m)</u>	<u>Change (m)</u>
Alpha Creek - 1	676	49	684	179	+130
Alpha Creek - 2	720		714		
Alpha Creek - 3	725		863		
Archibald Creek - 1	685	48	695	331	+283
Archibald Creek - 2	695		835		
Archibald Creek - 3	733		1026		
Scotia Creek - 1	661	153	661	156	+3
Scotia Creek - 2	765		773		
Scotia Creek - 3	814		817		
Whistler Creek - 1			693	437	new
Whistler Creek - 2			875		
Whistler Creek - 3			985		
Whistler Creek - 4			1130		

The elevational range of reaches surveyed for the three 2015 creeks resurveyed in 2016 (Alpha, Archibald, and Scotia Creeks) was 661m to 814m (Table 6), a range of 153m. The elevation of 2016 ranged from 661m to 1130m, a range of 561m that included mid-mountain sites on all but Scotia Creek systems.

The 2016 survey adopted much of the previous approach with some changes to site and reach selection. Since no tadpoles were detected in two years by the previous monitoring program in Nineteen Mile Creek nor in a previous survey (Wind 2006), the low detectability or absence of a breeding population made that system unsuitable as part of a monitoring program. Whistler Creek was its replacement since it is known to have breeding throughout the system (Wind 2006, 2008, 2009).

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

Another change was to sampling design. The previous monitoring program used an area-constrained search of three reaches within each stream system, each 5m long. This is the approach originally recommended by the BC Government (RIC 2000) but, the great deal of information compiled since that report has suggested new sampling approaches may provide better information (E. Wind and P. Friele, pers. comm.). Detections in 2015 were very low, with only nine tadpoles captured in 12 stream reaches (i.e., 0.75 tadpoles/reach). Such low densities prevent a reliable measure of relative abundance, especially with only three reaches per stream (B. Bury, pers. comm.⁴).

The 2016 survey took the approach that confirming presence in stream systems in the RMOW (for the first time, or as ongoing monitoring) is more important than attempting to measure relative abundance, especially given the budget constraints of the program. In addition, there is a large overlap between time- and area-constrained approaches. The area-constrained methodology described in the original BC protocol (RIC 2000) prescribes a survey distance of 5m, regardless of stream width (specifically, wetted width). While it doesn't prescribe a time limit, a survey must necessarily employ one or surveys cannot be compared as equivalent, for example, the 2013 to 2015 surveys used 30 minutes for their surveys. Time-constrained searches, meanwhile, typically also measure the area surveyed (Wind 2006 to 2009). Both approaches therefore measure time and area and the time-constrained approach, though not specifically designed to measure relative abundance, nonetheless provides somewhat standardized data about relative abundance.

The main change from the 2013 to 2015 surveys was to employ a 30-minute timed search in which the best habitat within a reach was targeted for sampling (versus a fixed 5m stretch). This was the method also used in Whistler Biodiversity Project surveys (Wind 2006 to 2009). Data collection methods were otherwise the same for all tailed frog surveys since 2004. The surveys consisted of overturning unembedded cover objects such as rocks within the stream flow with dip nets held immediately downstream to catch any dislodged animals. 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.

⁴ Bruce Bury (pers. comm.) recommended that a robust survey (one that would provide adequate statistical power) would detect at least one tadpole per square metre. Data from virtually all surveys to date in Whistler are well below that density.

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 and early September when the chances of adult encounters are increased and stream flows increase the detectability of tadpoles. Due to weather and personnel availability, the surveys were conducted later than planned and finished on September 22.

- Data collected at each height was mostly the same as previous surveys, i.e.: location, weather, overhead cover, and stand type;
- Stream characteristics such as morphology, substrate size and shape, slope, and bankful and wetted width;
- Water temperature and pH; and
- Total survey area (measured with a cloth tape to the nearest 0.1m).

All captured frogs were classed by cohort into T1 (tadpole, no legs); T2 (tadpole, legs not exposed); T3 (tadpole, feet or knees exposed), metamorph, juvenile, and adult (Malt 2006).

Data Analysis

The total number of tadpoles was compared between the four 2016 sites, and results for 2016 were also compared with those from 2015. One purpose of the 2016 survey was to evaluate results from time-constrained and area-constrained searches, so data was compared for total captures as well as captures per 100m². Additional parameters for analysis and comparison included: captures by stream system, by elevation, and by age cohort.

QA/QC

For most sites, two surveyors each searched for 15 minutes while a third recorded site, stream, and capture data. In the other sites, two surveyors completed their searches then recorded these parameters. A trial survey was first used to ensure that measurements were consistent between surveyors. Special care was taken to ensure that cohort classes (T1, T2, and T3 especially) were recorded consistently. Photos were taken of representative tadpoles in each class as documentation (Figure 4 and Figure 5).



Figure 4. Tadpole life stage 2 (T2)



Figure 5. Tadpole life stage 3 (T3)

2.3.2.2 Beaver

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), insects such as dragonflies, amphibians, snakes, 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 them 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 in which the focus has been to resurvey past lodge locations (Pevec 2009; Tayless 2010; E. Tayless and J. Burrows, unpubl. data 2011). The program was adopted by Cascade (2014, 2015, 2016) who continued Tayless and Burrows's focus on a subset of lodges. This report describes results from 2016 which began the return to the original goal of a full census, that is, in which all possible active beaver locations within Whistler Valley are enumerated.

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 for a census 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-olds typically disperse to form new colonies, though when quality habitat is already occupied dispersal is sometimes delayed.

A lodge can remain active indefinitely but more often is periodically inactive or abandoned permanently (as shown by Whistler data). The dispersal of offspring, death, and migration of adults mean 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.

Searches should occur as late in the snow-free fall months as possible. Such late surveys can more confidently confirm which lodges are used for overwintering and therefore represent an active colony. Other lodges and bank burrows can be used in summer months which, if counted, would over-estimate the population.

The census relied on a number of sources for determining search sites:

- Data from past studies starting in 2007.
- Incidental sightings by project staff (B. Brett, K. Jones, J. Burrows, and K. Swerhun).
- Anecdotal reports from 17 residents and key contacts including Dan Nash, Stu Carmichael, and Gerrit Woods at the three local golf courses (Appendix H).

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. It was possible to confidently label a lodge (or area) "active" or "inactive" in many cases. Observations that can confirm a lodge is active 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.

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. 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 a number of factors, especially habitat type and beaver density (Müller-Schwarze and Sun 2003). Mullen (2008) averaged data from five studies to derive an estimate of the total Whistler beaver population based on 5.8 beavers per lodge. This multiplier has been used each year since then to derive an estimated total population. Müller-Schwarze and Sun 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

QA/QC

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

2.3.3 Terrestrial Habitat Indicators

Indicator species are those that have such narrow ecological tolerance that the size and health of their populations is a good indication of environmental conditions (Hunter and Gibbs 2006). Their presence, absence or abundance may reflect a specific environmental condition which can signal a change in the biological condition of an ecosystem, and thus may be used as a proxy to diagnose the health of the ecosystem (McDonough et al. 2012). The role of indicator species is to serve as a subset of attributes to assess biodiversity and monitor the success or failure of management practices to sustain biodiversity (Lindenmayer et al. 2000). For this study, terrestrial species were monitored to assess potential changes in habitat in response to various types of anthropogenic activities.

Previous monitoring studies conducted in the Whistler Valley selected various terrestrial species to use as indicators of ecosystem change (Cascade 2013, 2014, 2015). For comparative purposes, we retained many of the species for our first year of monitoring but expanded sampling methodology and/or timing to align with the appropriate survey season and current scientific literature. For terrestrial species this included Carabid beetles (Family Carabidae), Pileated Woodpecker, and small mammals in place of the Red-backed Vole (*Myodes gapperi*) with reasoning explained in each section discussing the relevant survey below.

2.3.3.1 Carabid Beetles

As a follow-up to the previous terrestrial monitoring program, sampling for ground beetles in the family Carabidae was continued to provide comparative data to the previous studies (Cascade 2014, 2015, 2016). Terrestrial invertebrates, particularly insects, are good indicators of ecosystem health due to their short life cycle and low resilience making them sensitive to small changes in ecosystem parameters. They represent an efficient and easily-observed early warning system for subtle changes in the ecosystem or its stability (Brown 1997).

Carabid beetles are sensitive to human-altered abiotic conditions (Koivula 2011) and can potentially serve as keystone indicators of changing ecosystem conditions. They have a wide range of habitat requirements (Villa-Castillo and Wagner 2002), are diverse, taxonomically and ecologically well-known, and since they reflect biotic and abiotic conditions, they are relevant at multiple spatial scales (Koivula 2011). They are also relatively easy to monitor because data collection is simple and cost-effective (Cascade 2014).

Prior to initiating the field study, an assessment of the previous field design and analyses was conducted to identify areas for improvement. Sampling effort for Carabids was enhanced by extending the sampling period during their active season, conducting multiple trapping sessions, and increasing sampling effort at each site. Three sites were selected for sampling: Millar's Pond, Bob's Rebob, and River Runs Through It. Explanations for selecting these three sites is provided below.

Data Collection Methods

In 2013, two sites established for terrestrial monitoring included the south end of Blueberry Hill and Rainbow Trail in the vicinity of Bob's Rebob trail beside and east of 21-Mile creek uphill of Alta Lake Road (Cascade 2014). Both of these sites were in coniferous forests that were had at least some human-caused disturbance. There has been highgrading in the Bob's Rebob (named "Rainbow" by Cascade), as indicated by many springboard-notched stumps throughout the forest, although the overstorey is comprised of old trees. The previous biomonitoring study added a third site for 2013 and 2014 at Function Junction, approximately 150 m south of the RMOW Sewage Treatment Plan between Highway 99 and the Cheakamus River (Cascade 2015). The oldest tree found in this coniferous forest was only 43 years old in 2014 (Cascade 2015). The 2015 sites therefore did not include undisturbed old forests with large conifers (true old-growth), nor high-value riparian habitat with large deciduous trees, particularly black cottonwood (*Populus trichocarpa*). As such, we selected two sites for 2016 as replacements for the 2015 Blueberry and Function Junction sites (Figure 6): Millar's Pond (Figure 7) and the River Runs Through It trail (Figure 8). The previous Rainbow site (Figure 9), renamed Bob's Rebob (due to the trail located there) was retained to allow comparisons to past years. The Millar's Pond site is located in the southern portion of our study

area near Bayshores south of Alpha Lake whereas Bob's Rebob and River Runs Through It are located across the road from each other at the north end of Alta Lake alongside Twentyone Mile Creek.

The Millar's Pond site is on RMOW land uphill of Millar's Pond and the subdivision it is named after. This forest is a classic old-growth stand with large Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) trees. Its vertical structure is more complex than previous sites and is a rare remnant of a forest type that would have been more common before logging began in the Whistler Valley. The River Runs Through It site is named after the mountain bike trail located south of Twentyone Mile Creek in a mixed riparian forest with many large cottonwoods and conifers. Beetle and mammal stations were chosen as much as possible in areas where cottonwood was the dominant species.

Application of effective statistical analysis in field ecology is difficult due to the inherent uniqueness of site conditions that make replication challenging. At a minimum, effective statistical analysis requires at least three replicates of the same type of site (which was not the case in previous sampling years). Since it is rare to find sites similar to the two habitat types added in 2016 in the Whistler Valley, sampling for this year was meant to test as wide a range of habitats as possible to help direct future work.

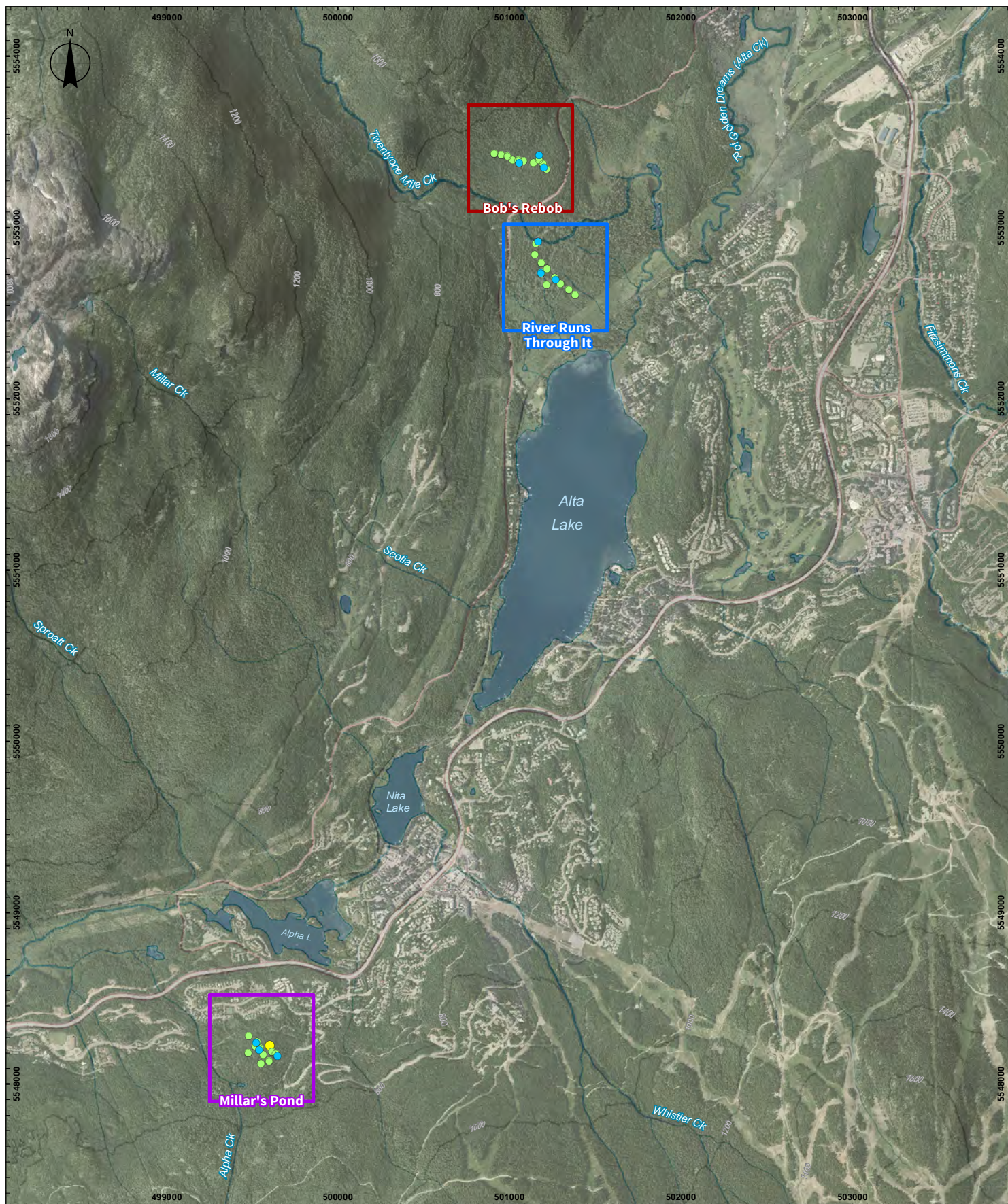


FIGURE 6. Small mammals, Carabid beetles and Northern Goshawk Sampling Sites, Overview

Project: Annual Monitoring	Client: RMOW
Scale: 1:30,000	
NAD 83 UTM 10 N	

LEGEND

2016 SURVEY STATIONS

- Small Mammals
- Carabid Beetles
- Northern Goshawk Nest

NOTES

- Elevation contours displayed in metres (above sea level) at 40 m (200 m index) intervals.
- Data Sources: Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government License - British Columbia, 2016. Other base data provided by RMOW.

DRAWN: B. Elder

Project: 160251

CHECKED: B. Matsuda

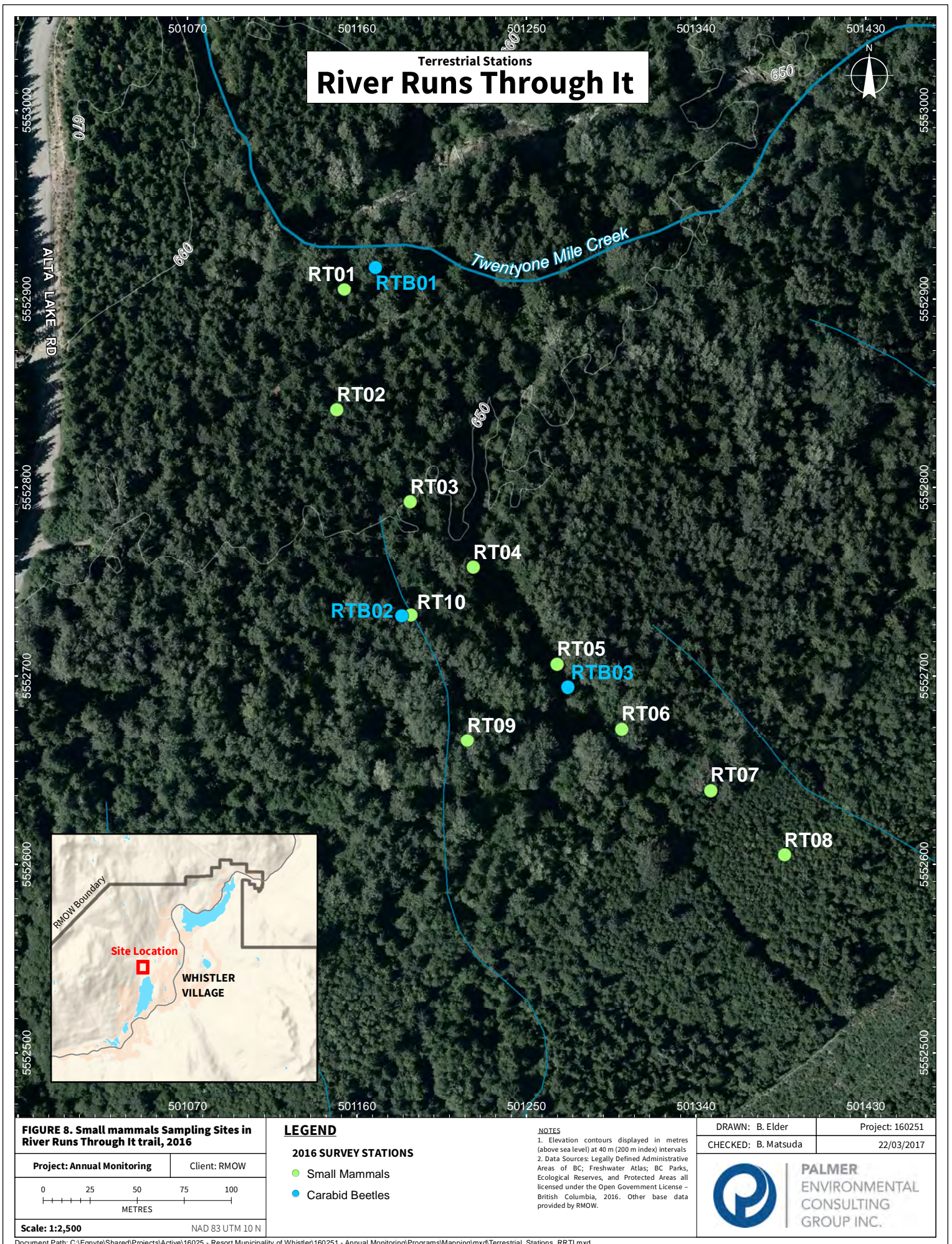
30/12/2016



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FIGURE 7. Small mammals, Carabid beetles and Northern Goshawk Sampling Sites in Millar's Pond, 2016		LEGEND 2016 SURVEY STATIONS <ul style="list-style-type: none"> ● Small Mammals ● Carabid Beetles ● Northern Goshawk 	NOTES 1. Elevation contours displayed in metres (above sea level) at 10 m intervals 2. Data Sources: Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government License - British Columbia, 2016. Other base data provided by RMOW.	
Project: Annual Monitoring	Client: RMOW		DRAWN: B. Elder	Project: 160251
			CHECKED: B. Matsuda	30/12/2016
Scale: 1:2,500 NAD 83 UTM 10 N				



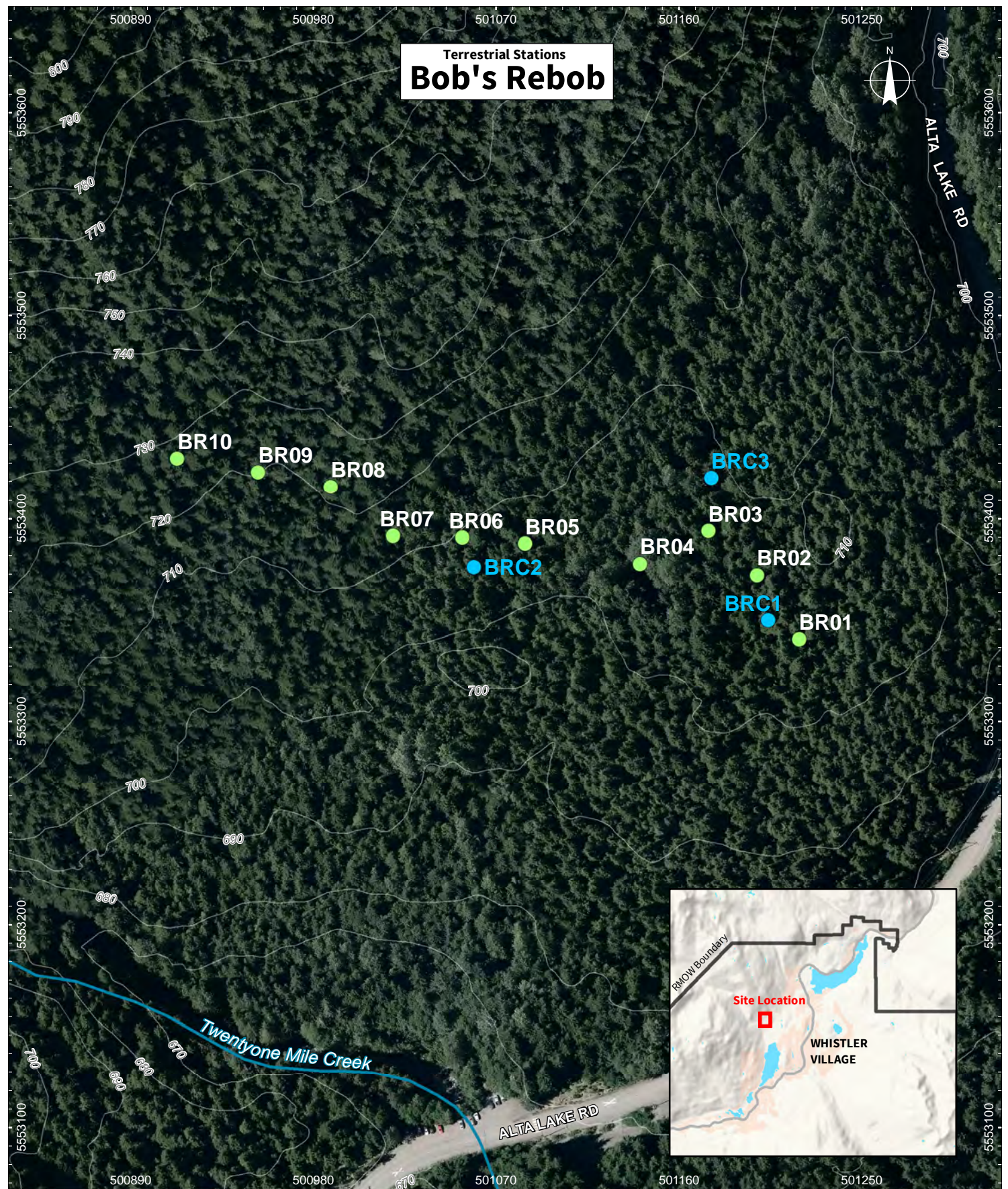


FIGURE 9. Small mammals, Carabid beetles and Northern Goshawk Sampling Sites in Bob's Rebob, 2016

Project: Annual Monitoring	Client: RMOW
Scale: 1:2,500 NAD 83 UTM 10 N	

LEGEND

2016 SURVEY STATIONS

- Small Mammals
- Carabid Beetles

NOTES

1. Elevation contours displayed in metres (above sea level) at 10 m intervals
2. Data Sources: Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government License - British Columbia, 2016. Other base data provided by RMOW.

DRAWN: B. Elder

Project: 160251

CHECKED: B. Matsuda

23/02/2017



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Pitfall trapping was conducted using plastic cups (10 cm diameter and 13 cm deep) installed flush with the ground. Each trap was filled with a 70% dilution of propylene glycol. A cover was elevated approximately three cm directly over the trap to protect it from the rain using a plastic food plate and nails (Figure 10). A triangle formation of three traps was placed along the 300 m small mammal transect line with a minimum of five meters spaced between each trap. As carabid beetles can move relatively long distances (e.g., 75 m per night; S. Lavallee, UBC, personal communication), three triangles were established at each of the sites, spaced 50-100 m apart. Specimens from each triangle were combined to serve as a single sample. All invertebrates caught in the traps were collected and preserved in 70% ethanol. Beetles were later separated from the samples and any carabids identified to species following Lindroth (1961).



Figure 10. Close-up of pitfall trap used to sample for Carabid beetles.

Data Analysis

Depending on numbers caught, comparisons of relative abundance and diversity can be analysed to assess any patterns of habitat use and evaluate population parameters over time. If sample size warrant, biodiversity indices can be calculated such as the Simpson's Index or Shannon-Wiener Index. A diversity index is a quantitative measure that reflects how many different types (e.g., species) there are in a dataset, and simultaneously takes into account how evenly the basic entities (such as individuals) are distributed among those types. The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of type, the value of a diversity index is maximized when all types are equally abundant. The use of such calculations will depend on whether the sample size is sufficient for use in such calculations. In this case, assessment would be warranted if sufficient numbers are caught to conduct the analyses.

QA/QC

Taxonomic identification of Carabid beetles was conducted by Chris Ratzlaff of the Spencer Entomological Museum at the University of British Columbia. Chris is part of the entomology team that specializes in the taxonomy, systematics, and biodiversity of insects, including the order Coleoptera (beetles).

2.3.3.2 Cavity Trees

Two measures related to Pileated Woodpeckers (*Dryocopus pileatus*) were surveyed in 2016: cavities in trees created by these birds (this section) and call/playback surveys for active birds (Section 2.3.4). This section describes the size and abundance of woodpecker-excavated cavities, as well as attributes of the trees chosen for excavation. Additional information about Pileated Woodpeckers is included in Section 2.3.4.

Pileated Woodpeckers are the largest woodpecker that is resident (breeds) in the RMOW (Table 8). Pileated Woodpeckers are the most important of the 11 resident birds in Whistler that are primary cavity excavators (Table 9). They play a keystone role in Whistler's forested ecosystems by excavating large cavities that provide important habitat for a large range of secondary cavity nesters (Table 10) as well as feeding opportunities for insects and other animals. All primary excavators also create habitat, but only the "Strong" excavators can create holes in non-decayed wood (Table 9).

Table 8. Resident (breeding) woodpeckers in the RMOW (Ricker et al. 2014), including length (Sibley 2003) and comparison of cavity sizes and shapes (Moskowitz 2010).

Common Name	Scientific Name	Length (cm)	Cavity Size/Shape (compared to Pileated Woodpeckers)
Pileated Woodpecker	<i>Dryocopus Pileatus</i>	42	Foraging cavities 7.5 cm or much larger; usually rectangular (see below re oval nest entrances)
Northern Red-shafted Flicker	<i>Colaptes auratus</i>	32	Usually smaller, oval and tapered to bottom
Hairy Woodpecker	<i>Picoides villosus</i>	23	Usually smaller, oval and tapered to bottom
Downy Woodpecker	<i>Picoides pubescens</i>	17	Smaller, oval and only in soft, rotten wood
Am. Three-toed Woodpecker	<i>Picoides dorsalis</i>	22	Bark beetle specialists so focusses on inner bark (cambium and phloem) so holes are not deep
Red-naped Sapsucker	<i>Sphyrapicus nuchalis</i>	22	Linear rows of drill-hole "wells;" also can excavate small oval cavities
Red-breasted Sapsucker	<i>Sphyrapicus ruber</i>	22	

Table 9. Primary cavity excavators in the RMOW according to their ability to excavate cavities in live wood ("Strong" excavators) or reliance on decayed, soft wood for their excavations ("Weak" excavators; Fenger et al. 2006). Flickers excavate in decayed trees, though they may be capable of excavating sound wood.

Common Name	Scientific Name	Strong/ Weak
Pileated Woodpecker	<i>Dryocopus pileatus</i>	Strong
Northern Red-shafted Flicker	<i>Colaptes auratus</i>	Weak?
Hairy Woodpecker	<i>Picoides villosus</i>	Strong
Downy Woodpecker	<i>Picoides pubescens</i>	Weak
Am. Three-toed Woodpecker	<i>Picoides dorsalis</i>	Strong
Red-naped Sapsucker	<i>Sphyrapicus nuchalis</i>	Weak
Red-breasted Sapsucker	<i>Sphyrapicus ruber</i>	Weak

Common Name	Scientific Name	Strong/ Weak
Black-capped Chickadee	<i>Poecile atricapillus</i>	Weak
Mountain Chickadee	<i>Poecile gambeli</i>	Weak
Chestnut-backed Chickadee	<i>Poecile rufescens</i>	Weak
Red-breasted Nuthatch	<i>Sitta canadensis</i>	Weak

Table 10. Secondary cavity nesters (Fenger et al. 2006) that are resident (breeding) in the RMOW (Ricker et al. 2014; Brett 2016b). The last two records of Fishers were from 1956 (reported in Brett 2007); and possibly still occur in the RMOW (Brett 2016a). Other species also use these cavities, e.g., Pacific Wren.

Group	Common Name	Scientific Name	CDC List
Birds	Wood Duck	<i>Aix sponsa</i>	
	Bufflehead	<i>Bucephala albeola</i>	
	Barrow's Goldeneye	<i>Bucephala islandica</i>	
	Common Goldeneye	<i>Bucephala clangula</i>	
	Common Merganser	<i>Mergus merganser</i>	
	Hooded Merganser	<i>Lophodytes cucullatus</i>	
	American Kestrel	<i>Falco sparverius</i>	
	Barred Owl	<i>Strix varia</i>	
	Northern Pygmy-Owl	<i>Glaucidium gnoma</i>	
	Vaux's Swift	<i>Chaetura vauxi</i>	
	Tree Swallow	<i>Tachycineta bicolor</i>	
	Brown Creeper	<i>Certhia americana</i>	
	Bats		
	Big Brown Bat	<i>Eptesicus fuscus</i>	
	California Myotis	<i>Myotis californicus</i>	
	Hoary Bat	<i>Lasiurus cinereus</i>	
	Keen's Long-eared Myotis	<i>Myotis keenii</i>	Blue
	Little Brown Myotis	<i>Myotis lucifugus</i>	
	Long-legged Myotis	<i>Myotis volans</i>	
	Silver-haired Bat	<i>Lasionycteris noctivagans</i>	
	Yuma Myotis	<i>Myotis yumanensis</i>	
Rodents	Bushy-tailed Woodrat	<i>Neotoma cinerea</i>	
	Keen's Mouse	<i>Peromyscus keeni</i>	
	Northern Flying Squirrel	<i>Glaucomys sabrinus</i>	
Large Mammals	Black Bear	<i>Ursus americanus</i>	
	Fisher	<i>Pekania pennanti</i>	Blue

Pileated Woodpeckers and the other six local woodpeckers create different sizes and shapes of foraging and nesting cavities (Table 8 and Table 11). Any cavity larger than approximately 7.5cm is almost certainly created by a Pileated Woodpecker. It is the only local species that excavates such large cavities (sometimes in excess of 35cm tall) or that create rectangular cavities in their search for carpenter ants in dead and

decaying trees (Campbell et al. 1990; Moskowitz 2010; Table 8). Their rounded nest cavities are also notably larger than other species, usually >8cm in at least one dimension (Table 11; Figure 11 and Figure 12).

Table 11. Nest cavities and preferred nest trees (Campbell et al. 1990)

Common Name	Nest entrance hole dia. (cm)	Preferred nest trees
Pileated Woodpecker	8 to 15	Living (66%); deciduous (70%) esp. aspen and cottonwood; nest cavity is typically oval versus rectangular (as when foraging)
Red-shafted flicker	5 to 13	Variety of trees plus wooden structures
Hairy Woodpecker	4 to 5	Living (53%) or dead; (47%) deciduous (69%)
Downy Woodpecker	2.5 to 2.9	Dead (57%); deciduous (81%)
Am. Three-toed Woodpecker	4	Living and dead; coniferous (67%)
Red-naped Sapsucker	3 to 5	Living (73%); deciduous (91%)
Red-breasted Sapsucker	5 to 10	Dead (55%); deciduous (65%)

* Only two records in Campbell et al (1990).



Figure 11. Pileated Woodpecker nesting or roosting cavity (round-shaped) on Shit Happens trail.



Figure 12. Pileated Woodpecker foraging cavity (rectangular-shaped) on Bob's Rebob trail.

Nesting cavities of all these species clearly play an important role in Whistler's forests. Pileated Woodpeckers, mainly the male, excavate at least one nesting cavity and one roosting cavity per year – nests are not re-used. This activity means that at least 2 large cavities per breeding territory are created each year which, given the fact that many conifers in Whistler are long-lived, results in a large supply of

cavities for secondary nesters. Other woodpeckers similarly create smaller cavities that benefit other animals.

While it is indisputable that nest excavations create important habitat in local forests, it is less clear how much secondary habitat is created by foraging cavities, particularly the large, rectangular cavities created by Pileated Woodpeckers. Nest excavations commonly penetrate to the middle of a (usually hollow) tree to create shelter for the original and subsequent inhabitants (Figure 11). Foraging cavities meanwhile tend to be in the outer parts of a tree (Figure 12). As trees with foraging cavities decay, they provide access to the hollow interior and provide habitat for secondary cavity nesters who are able to make a defensible, temperate space in which to shelter. The cavities that are common in larger, hollow western redcedars in Whistler are also likely important. Future studies can help confirm how much of a role these foraging cavities play.

Woodpeckers are selective in their choice of trees for foraging and nesting (Table 11). Large deciduous trees (which are almost exclusively black cottonwoods in the Whistler area) are particularly important nesting habitats for the majority of local woodpeckers. Conifers almost certainly play a much larger role in Whistler than shown by data compiled for BC as a whole (Campbell et al. 1990) since there are few stands with a large component of deciduous trees.

Data Collection Methods

The Ecosystem Monitoring Program first started documenting cavity trees in 2014 when approximately 27 such trees were documented on four transects.⁵ The stated goal was to record only recent cavities but most that were recorded were older (Table 45, Cascade 2015). No tree cavities were recorded in 2015.

The goal for 2016 was to enumerate all trees with cavities, whether the cavities were recent or old, and regardless of size. Cavity tree data was recorded for the Comfortably Numb transect (also surveyed in 2014) and Shit Happens transect (added in 2016).

All cavity trees within approximately 20m of the transect were included. The following data were recorded: location (UTM), tree species, tree diameter, decay class (Fenger et al. 2006) number and sizes of cavities, and lowest and highest height of multiple cavities above the base of the tree. Cavity sizes were estimated from the base of the tree (using binoculars where necessary) into the following estimated size classes:

- Small (<7.5cm)
- Medium (7.5 to 12cm);
- Large and Very Large (>12cm)

Holes that did not penetrate the bark to the wood inside were not included, including the galleries of holes drilled by sapsuckers.

These classes are based on the approximate differentiation between Pileated and other woodpeckers (Table 8 and Table 11). Shape was not recorded consistently until it became apparent that it would be

⁵ The data for Transects 1 and 2 is mapped but not described in tables. The data for Transects 3 and 4 are in tables but not mapped.

helpful to differentiate breeding and foraging cavities. Future surveys should record this important information if time allows.

Data Analysis

The main goals in data analysis were to describe: (a) the species, size, and decay class characteristics of cavity trees; and (b) the number and size of the cavities. These were compared in simple tables and charts.

QA/QC

Data was recorded on waterproof paper and transferred to Excel files. Photos were taken for trees and cavities that were particularly representative or unique.

2.3.4 Terrestrial Species

Although there are several terrestrial species that could serve as bioindicators of ecosystem change in the Whistler valley, we chose to monitor the same species groups used in previous years to compare findings but with more scientific rigour. This consisted of the Pileated Woodpecker, winter tracking surveys, and small mammals. Methods are explained in more detail below.

2.3.4.1 Winter Tracking

Winter track count transects have been commonly used to assess the relative abundance of ungulates and carnivores, either in population assessment or, more commonly, as a tool to assess effects of habitat alteration due to forestry or mining practices. Snow tracking has recently been used in B.C. to identify preferred winter ranges and habitat use of large mammals such as ungulates, although there are currently no RISC guidelines on methodology for smaller mammals and predators.

Winter track counts conducted along transects can be used to monitor populations regularly using an area or territory and also document a multitude of other species, including weasels, marten, snowshoe hare, and ungulate species. Monitoring wildlife populations use and movements through an area will help evaluate changes over time. While many species are flexible in their habitat requirements or undergo cyclic changes in abundance (i.e., small mammals), the abundance of many predators and ungulates do not dramatically change over a short time period, and may provide a reliable index of habitat change. Some species like mustelids (i.e., weasels), may avoid urbanization which may indicate changes in fragmentation and isolation of forest habitats. Detection of urban-adapted species (e.g., coyote) may also signal the transformation of land use from “wild” to rural or urban. Winter tracking methodology has not been used in Whistler despite its practical utility as an assessment tool to monitor mammal populations and habitat use of an area.

Data Collection Methods

For winter tracking to assess general mammal presence, a simplified version of that described for ungulates in RIC (2006) and D'Eon (2001) was conducted on February 8, 2017 at the three terrestrial sampling sites (i.e., same sites as the small mammal sampling). Two surveyors (Brent Matsuda, Damian Power) traveling on snowshoes followed the same transect lines used to establish the small mammal trap stations and documented all animal tracks that crossed the 300 m transect line at each site. All mammal tracks that

crossed the transect centerline were recorded as '1' observation. Track aggregates (trails) were to be recorded as '5' observations if discerning individual tracks was not possible (e.g., for species that occur in groups such as deer, wolves, etc.). Each track/trail encountered on a transect was georeferenced (UTM location). Standardization of track counts to account for animal activity between snowfalls is normally achieved by dividing the observed number of tracks by the number of days since last significant snowfall. However, since only one tracking day has been conducted at this point, standardization was not necessary.

The tracking survey was conducted during a period of no snow accumulation to provide sufficient time for tracks to accumulate while timing to avoid fresh snowfall so tracks would not be covered. Given the difficulty in timing tracking relative to snowfall occurrences, only one snow-tracking survey was completed during the winter period as budget constraints also deemed that this work could only be conducted voluntarily.

Data Analysis

With repeated surveying, depending on the number of tracks observed, relative distribution or abundance by habitat type can be estimated, as well as biodiversity indices to assess species diversity between habitats. With only one sampling session, data analyzes would be limited to presence/not detected at this point.

QA/QC

Track identification was assessed by Damian Power, a professional biologist who has conducted numerous winter tracking surveys in the Canadian Arctic. While small mammal tracks can be readily identified visually, predator tracks can be more challenging due to the weight of the animal and leg movement which can be obscured in loose snow. For suspected predator tracks, Power would measure the animal's trail width, sinking depth, distance between steps, and snow depth (Figure 13). He also took into account movement pattern, foot drag, size and shape of footprint, and would feel the toe pad imprint in the snow. Photos were also taken of the tracks for future reference.



Figure 13. Damian Power measuring trail width of Bobcat tracks

2.3.4.2 *Pileated Woodpecker*

Woodpeckers (family Picidae) have been found to be reliable indicators of avian diversity in forests because their populations can be readily monitored, and their foraging and nesting activities can positively influence the abundance and richness of other forest birds (Drever et al. 2008). Consequently, woodpecker field surveys have been increasingly conducted over the past two decades in response to habitat alteration caused by widespread forest fragmentation and loss, simplification of forest structure through even-aged stand management, and reduction in important forest structural features (RIC 1999) such as snags and their corresponding cavities which serve as wildlife trees and eventually contribute to downed woody debris volume and nutrient cycling.

As the largest woodpecker in the Pacific Northwest, the Pileated Woodpecker is a keystone habitat modifier as its foraging activities create large cavities in hard snags and decadent live trees that are used by a wide array of species (Aubry and Raley 2002). In addition, this species provides foraging opportunities for other species, accelerates decay processes and nutrient cycling, and mediates insect outbreaks. Due to their keystone role as an indicator species in forests, Pileated Woodpeckers warrant special attention with regard to their habitat needs in forest management plans and monitoring activities (Aubry and Raley 2002).

Data Collection Methods

The previous biomonitoring study surveyed transects along the Comfortably Numb trail east of Green Lake and a forested area uphill of Alta Lake Road on either side of Twentyone Mile Creek where the northern area included the Bob's Rebob/Rainbow site (Cascade 2014). In 2014, they added two additional sites: (1) the Creekside site that spanned higher elevations on either side of the Peak to Creek ski run near Kadenwood; and (2) the Stonebridge site that was mainly above the Stonebridge subdivision west of Alta Lake (Cascade 2015). These four sites were surveyed again in 2015 (Cascade 2016). We retained the Comfortably Numb site for 2016 surveying. The 2016 Emerald Forest transect included some of the 2015 Rainbow transect but started in Emerald Forest and continued westerly uphill of Bob's Rebob trail. An additional transect was added near the Shit Happens trail. This transect started above Emerald Estates then continued south through the Shit Happens trail then west above the Rainbow housing subdivision. Most of the transect passed through old, dry (CWHms1/03) stands dominated by Douglas-fir. The western portion included a mix of young and young-mature forests with some old veteran trees. The purpose of the different transects was: (a) to sample new habitats and extend what's known about the distribution of woodpeckers in Whistler; and (b) possibly increase detections since the previous study detected none in 2015 (Cascade 2016).

In total, seven areas were surveyed for Pileated Woodpecker (Figure 14). However, the number of stations surveyed on each transect varied from 1-10 depending on the size of suitable habitat and its corresponding transect length. Dates and number of stations at each transect are presented in Table 12.

Table 12. *Pileated Woodpecker survey transects*

Transect	Date Surveyed	Number of survey stations at transect	Transect UTM Start/End
Comfortably Numb	May 18, 2016	10	• Station CN01: 10U 507201 5556149

Transect	Date Surveyed	Number of survey stations at transect	Transect UTM Start/End
			<ul style="list-style-type: none"> • Station CN10: 10U 506031 5554229
Emerald Forest	May 17, 2016	10	<ul style="list-style-type: none"> • Station EF01: 10U 501962 5553062 • Station EF10: 10U 500471 5553228
Shit Happens	May 26, 2016	10	<ul style="list-style-type: none"> • Station SH01: 10U 504680 5556678 • Station SH10: 10U 503319 5556435
Nicholas North	May 27, 2016	3	<ul style="list-style-type: none"> • Station NN01: 10U 502957 5554829 • Station NN03: 10U 503071 5555366
Centennial Trail	May 27, 2016	2	<ul style="list-style-type: none"> • Station CT01: 10U 503723 5553625 • Station CT02: 10U 503814 5553926
Blueberry North	May 27, 2016	3	<ul style="list-style-type: none"> • Station BB01: 10U 501897 5551930 • Station BB03: 10U 501768 5551335
Nesters Hill	May 27, 2016	1	<ul style="list-style-type: none"> • Station NH01: 10U 502882 5552925

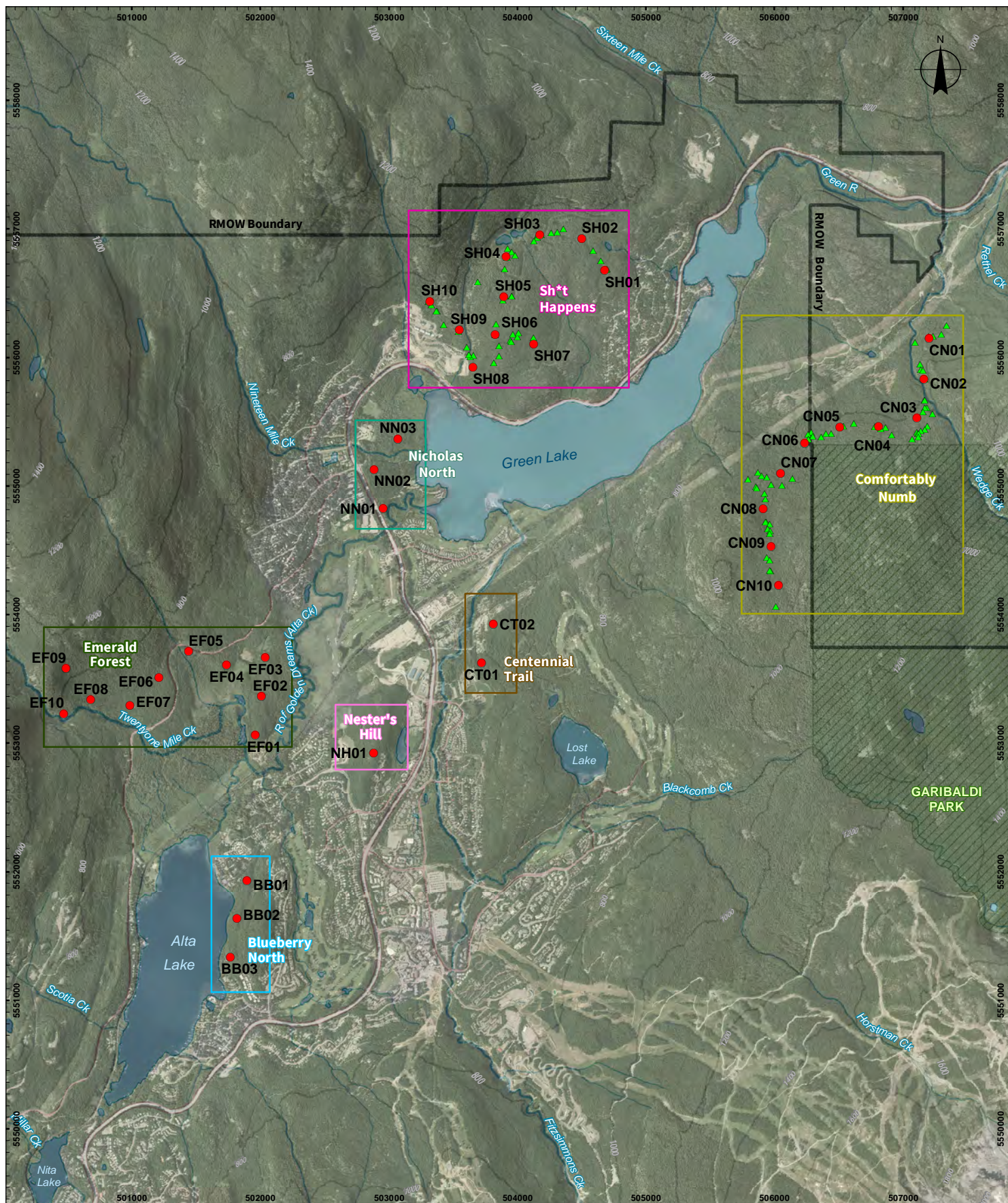


FIGURE 14. Pileated Woodpecker Sampling Sites, 2016

Project: Annual Monitoring

Client: RMOW



Scale: 1:40,000

NAD 83 UTM 10 N

LEGEND

- 2016 Pileated Woodpecker Survey Station
- ▲ 2016 Cavity Tree

NOTES

1. Elevation contours displayed in metres (above sea level) at 40 m (200 m index) intervals
2. Data Sources: Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government License - British Columbia, 2016. Other base data provided by RMOW.

DRAWN: B. Elder

Project: 160251

CHECKED: B. Matsuda

22/03/2017



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Survey transects were established in seven locations selected for surveys based on local knowledge of old forest habitat potentially suitable for Pileated Woodpeckers. Call playback surveys were conducted at stations spaced 300 m apart along each transect (RIC 1999) using a Foxpro wildlife call amplifier to broadcast a combination of calls and drumming. The number of stations along each transect varied from 1-10 depending on the size of suitable habitat and its corresponding transect length.

Call playback methodology followed that of RIC (1999). Whenever possible, surveys began in the morning from at least one half hour after sunrise or shortly thereafter, and ended at 12 noon. An exception was made for the Comfortably Numb Trail; due to its length and access, surveys were continued past noon until suitable habitat diminished to the point where surveys became unwarranted.

Upon arriving at a survey station, surveyors would listen for one minute for birds, before broadcasting a call. Habitat data and weather conditions were recorded during this time. If no birds were heard, a call was broadcasted for 20 seconds followed by a 30 second break to watch and listen for responses. If there were no responses, call direction was shifted 120° and the procedure was repeated, then again for a total of three calls. If there was no response to calls, a drumming sequence was broadcast to supplement the call playbacks, following the same procedures for broadcasting direction. However, playback of drumming sequence lasted approximately 5 seconds, followed by a 10 second pause and repeated three times as above (e.g., 5/10, 5/10, 5/10).

If a Pileated Woodpecker responded, either auditory or visual or both, initial direction of detection was recorded, as well as distance to initial detection, activity response to call or drumming, sex, and age class. Photos were taken whenever possible.

To better understand how to improve our knowledge of this keystone species and its habitat use in Whistler, structural data was also recorded during the surveys by assessing the abundance of tree cavities excavated by Pileated Woodpecker and other woodpeckers. This information is presented in Section 2.3.3.2.

Data Analysis

The main goal in data collection and analysis was to assess Pileated Woodpecker presence and habitat use during the territory establishment period which would indicate breeding. As a keystone habitat modifier species, breeding would suggest that habitat is suitable for populations to persist despite anthropogenic disturbance.

QA/QC

Data was recorded on waterproof paper and transferred to Excel files. Photos were taken of birds that responded during call playback for further verification. Both the lead terrestrial biologists conducted the surveys and confirmed the observations of any Pileated Woodpeckers responding during the surveys.

2.3.4.3 Small Mammals

Small mammals are often used as indicator species of ecosystem health due to their responses to changes in habitat (Avenant and Cavallini 2007, Chase et al. 2000, Orrock et al. 2000). They play a key role in nutrient cycling, habitat modification, plant consumption, and seed dispersal while serving a valuable functional link between primary producers and secondary consumers (e.g., prey base for medium-sized predators and aerial predators). Changes in small mammal habitats are associated with changes in diversity and community structure, and ecological disturbance of these habitats affecting the presence or absence of indicator species is typically reflected in changes to small mammal species richness. Small mammals are also relatively easy to trap, handle and mark and it is simple to monitor their movements (Avenant and Cavallini 2007).

Previous monitoring activities in Whistler have targeted the Red-backed Vole as an indicator of ecosystem change. However, Red-backed Voles are not reliable bioindicators as they are a ubiquitous species whose populations greatly fluctuate (D. Ransome, BCIT, personal communication). Hence the thresholds derived from their captures are difficult to interpret with respect to using them as indicators of environmental health. Rather than focusing strictly on voles, expanding the scope of the study to assess overall small mammal diversity and community abundance provides a more reliable assessment of ecosystem health as an indicator of terrestrial vertebrate prey populations. Using traps that are known to be more effective at capturing small mammals than the Sherman traps (Jung 2016) used in previous studies would also provide a more reliable means of data collection. Ideally a comparative approach encompassing more than one trap type would allow a means of assessing trap efficacy.

Data Collection Methods

The same three sites used for Carabid sampling were also used to establish small mammal traps (Figure 6 and Figure 7 and Figure 8 and Figure 9). For details on the history and reasoning for selecting these sites (Millar's Pond, Bob's Rebob, River Runs Through It), refer to section 2.3.3.1.1 of this report.

To monitor small mammals, Sherman, Tomahawk, and Longworth (aka. Little Critter) live traps were established in the same three sites used for the Carabid beetle sampling. Tomahawk live-traps (Model 201, Tomahawk Live Trap Co., Tomahawk, WI) were loaded with a nest box (1 litre plastic jar with coarse brown cotton) and a plastic sheet covering to provide protection from wind and rain on three sides, then baited with sunflower seeds. Tomahawk traps were used to primarily target squirrels. Ten stations were placed at 30-m intervals along a transect with 3 traps at each station within 5 m of each other. Multiple traps were used as dominant species like Deer Mice (*Peromyscus maniculatus*) can easily swamp live traps, reducing the capture of other species. It also provided us the opportunity to compare captures between trap types. Traps were prebaited for two weeks prior to sampling with whole oats and carrots. Similarly, traps were baited with whole oats and carrot during trapping, and supplied with coarse brown cotton for warmth. There were five trap sessions conducted between May and September (snow-free period). Traps were set 1 h before dark on day 1 and checked in the morning of day 2, and then locked open until the next trap session. For each animal captured, species, ear-tag number (if previously caught), location, body mass (± 5 g on a Pesola spring balance), gender, and breeding condition was recorded, then released at their point of capture. All captured small mammals were marked with individually numbered ear tags. Females were categorized as "non-breeding" (small mammarys) or "breeding" (large mammarys). Breeding condition of

males was evaluated by palpating the testes and categorized as non-breeding (testes abdominal) or breeding (testes scrotal; McCravy and Rose 1992).

Since 70 to 80 percent of animals are captured in the first night of trapping, a second night was deemed unnecessary, given the objectives of the monitoring and the added impact on animals (D. Ransome, BCIT, pers. comm.). If sufficient numbers are caught, then extra traps would be added, rather than extra trap nights. This minimizes the repeat captures of the same individuals that technically do not provide additional information for the study (all pertinent information is collected at the first capture, not subsequent captures). Mark-recapture will help assess the frequency of return captures (i.e., if trap happiness will be an issue). As the main objective is a relative abundance survey (among sites and years), then as long as the methods are kept consistent across monitoring sites, a one-day trap session is sufficient for the objectives of the study since we are not assessing absolute abundance.

Data Analysis

Due to the difficulty in distinguishing between the Deer Mouse (*Peromyscus maniculatus*) and Keen's Mouse (*Peromyscus keeni*) in this region, any *Peromyscus* species was simply recorded as *Peromyscus* sp. The two species overlap in the Whistler valley and vary genetically, but are very difficult to differentiate based on morphological features (Nagorsen 2005). Similarly, with the exception of the water shrews, it is extremely difficult to morphologically distinguish between the four species of shrews possibly occurring in the area (Nagorsen 1996), so species were recorded simply as *Sorex* sp. unless they could be later identified based on diagnostic features in the case of a mortality.

Depending on numbers caught, similar to data analysis for Carabid beetles, comparisons of relative abundance, diversity, and trap efficacy can be analysed to assess any patterns of habitat use and evaluate population parameters over time. If sample size warrant, biodiversity indices can also be calculated. Such analysis will depend on whether sufficient numbers are caught to conduct the analyses.

QA/QC

The lead terrestrial biologist was on hand during each trap checking session to handle and measure all captures. Photos were taken of any questionable identifications, injured animals, or any other reason. Mortalities, particularly for any shrews, were collected for later identification by Dr. Doug Ransome.

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 August 2016 is provided in Table 13. Where measurements were taken on two sampling dates (sites CRB-DS-AQ01, JOR-DS-AQ31, and 21M-DS-AQ12), results were consistent. Specific conductance was relatively low, except CRB-DS-AQ01. Turbidity was also low at all the sites, and pH was typically neutral (close to 7.0 pH

units). Dissolved oxygen (DO) was relatively consistent across the sites, ranging from 8.27 mg/L at RGD-US-AQ11 to 9.89 mg/L at RGD-DS-AQ12. Overall, the *in situ* water quality results were within acceptable ranges for the parameters measured and do not point to any water quality issues.

Table 13. Results for water quality parameters measured in situ at aquatic sampling sites, 2016

Site	Waterbody	UTM Location (Zone 10)		Date / Sampling Event	Time	Water Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm)	Turbidity (NTU)
		Easting	Northing							
CRB-DS-AQ01	Crabapple Creek (Archibald Creek)	502023	5552707	2-Aug-16 / Benthic Sampling	15:42	12.7	7.60	9.35	217.8	1.55
				5-Aug-16 / Fish Sampling	9:00	12.9	7.84	9.72	210.9	2.30
RGD-US-AQ11	River of Golden Dreams	502000	5552755	3-Aug-16 / Benthic Sampling	9:20	11.7	7.35	8.27	64.0	1.34
JOR-DS-AQ31	Jordan Creek	500190	5549243	3-Aug-16 / Benthic Sampling	14:30	15.8	7.12	9.32	63.6	0.63
				4-Aug-16 / Fish Sampling	12:00	15.9	7.50	8.63	63.9	
21M-DS-AQ21	Twentyone Mile Creek	501938	5552817	3-Aug-16 / Benthic Sampling	11:56	12.0	6.27	9.39	40.5	2.63
				6-Aug-16 / Fish Sampling	10:00	11.3	7.55	9.83	39.5	
RGD-DS-AQ12	River of Golden Dreams	503031	5554678	5-Aug-16 / Benthic Sampling	15:00	15.2	7.76	9.89	69.0	1.30

Table Notes:

- 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°C in December (Alpha and Scotia Creeks), to 18°C (Jordan Creek) in August (Figure 15). The highest temperatures were observed during August in all five creeks. Jordan Creek was observed to be the warmest creek, with mean monthly temperatures typically 3 degrees higher than the other creeks, in the spring and summer months. Scotia and Alpha Creek temperatures tracked closely. The River of Golden Dreams and Crabapple Creek also had matching temperature trends, which would be expected.

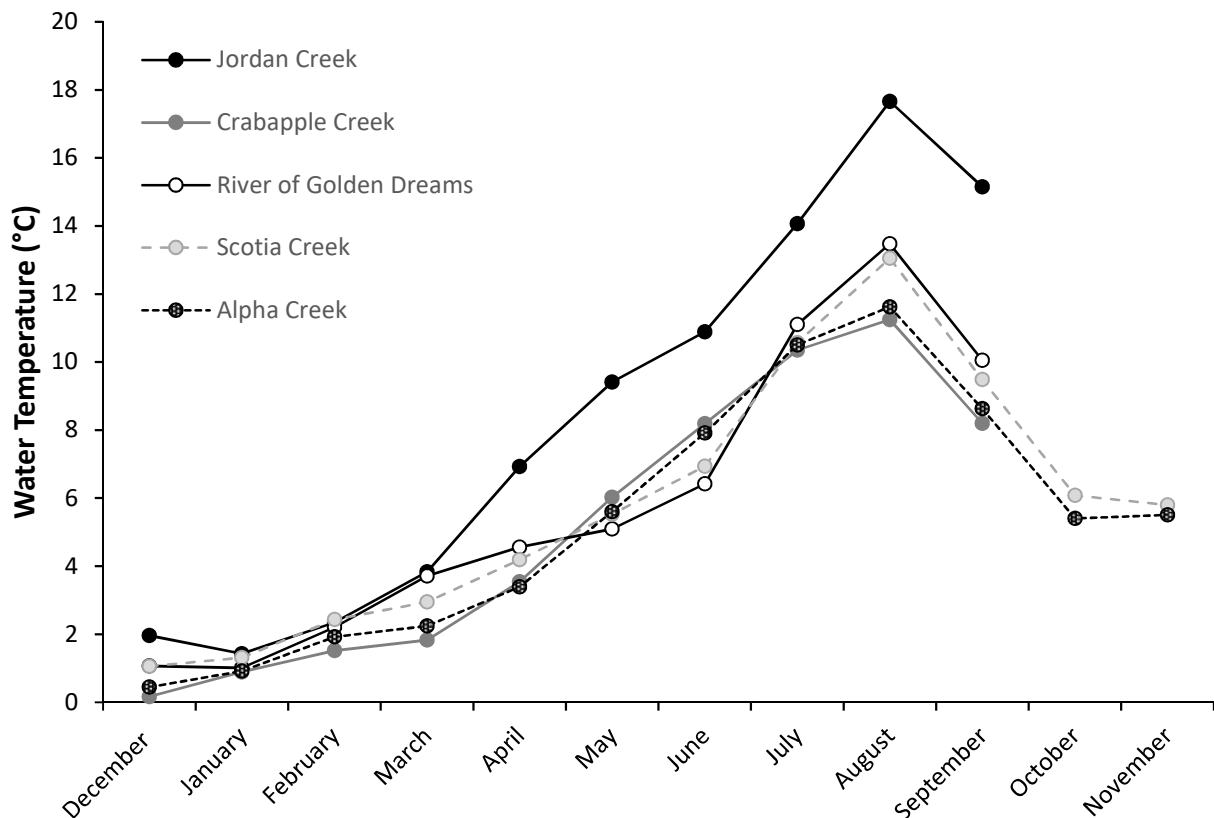


Figure 15. Mean monthly stream temperatures, 2016

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 3190 individuals at the Crabapple Creek site, to 1162 individuals at the River of Golden Dream upstream site (Figure 16). Overall, Crabapple Creek displayed the highest total abundance (3190), followed by Jordan Creek (2100), River of Golden Dreams downstream site (1642), Twentyone Mile Creek (1520), and then the River of Golden Dreams upstream site (1162).

Ephemeroptera, Plecoptera, and Trichoptera (EPT) abundances within the study area demonstrated similar patterns to overall abundance, with a significant relationship observed between the two indices (Linear regression, $R^2=0.83$, $P<0.03$). EPT abundance was highest at Crabapple (2640 EPT organisms), and lowest at the River of Golden Dreams upstream site (946 EPT organisms).

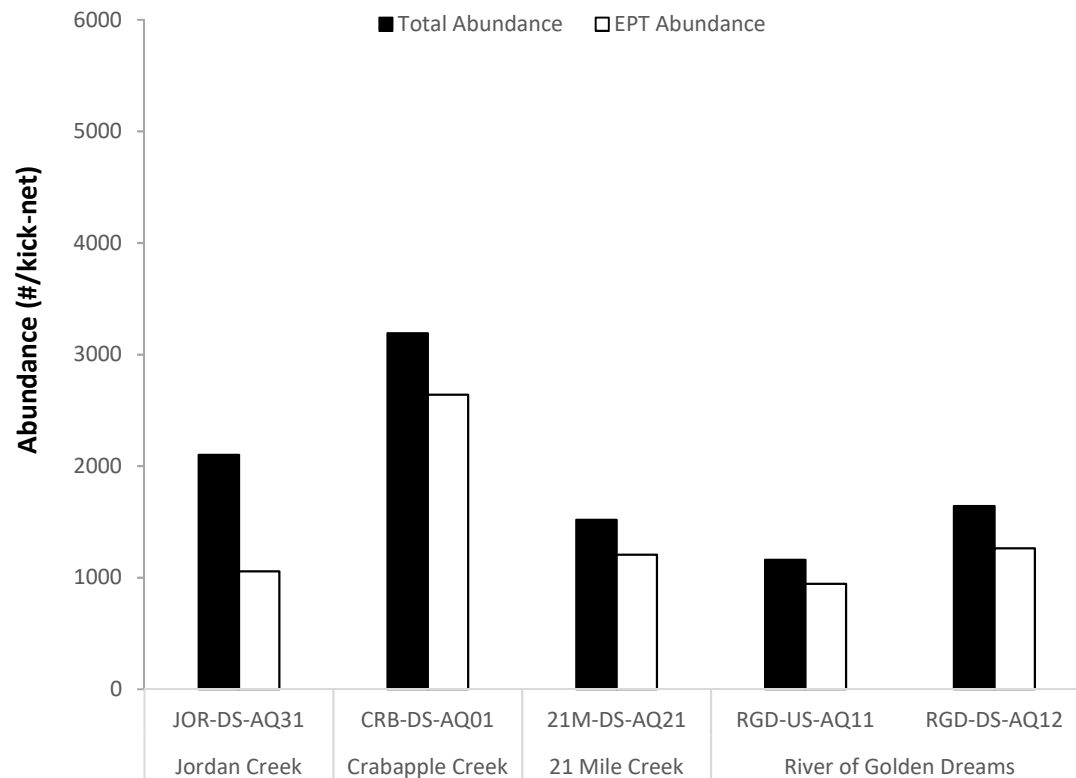


Figure 16. Benthic invertebrate total and Ephemeroptera, Plecoptera and Trichoptera (EPT) abundance by site, 2016.

Benthic Invertebrate Community Composition

As shown in Figure 17, Ephemeroptera (mayflies) were the dominant benthic invertebrate group in the River of Golden Dreams and Twentyone Mile Creek, making up approximately 50% of the community composition at each site. Plecoptera (stoneflies) were subdominant, contributing 20-25% to the community composition. Smaller percentages Diptera (true flies, 17 - 18%) were also present at those sites. Crabapple Creek was dominated by Plecoptera (68%), and had approximately equal proportions of Ephemeroptera and Diptera (~ 14%). Jordan Creek was dominated by Diptera (48%), but also had a high percentage of Plecoptera (45%). Small percentages of (<3%) of Trichoptera were also present at the sites, and other taxa groups typically made up less than 5% of the community composition.

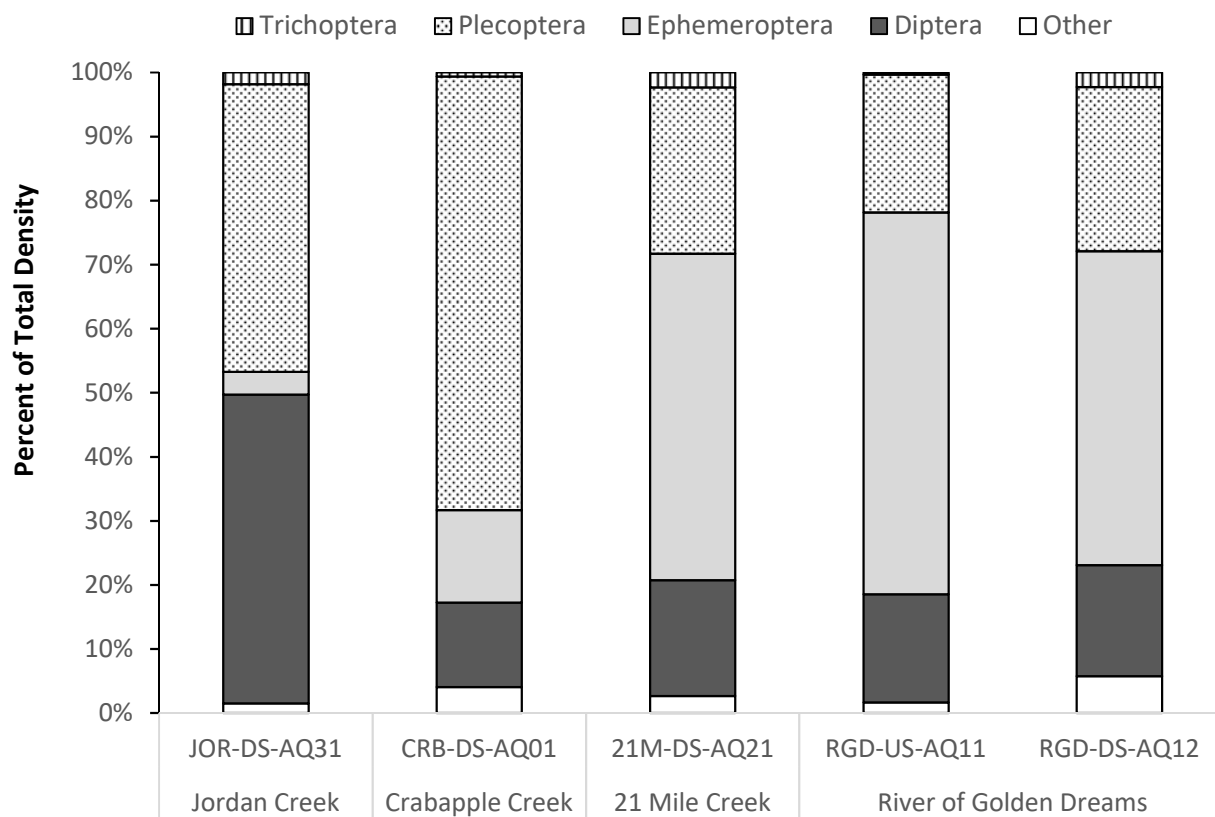


Figure 17. Relative densities of benthic invertebrate communities by site, 2016.

Benthic Invertebrate Taxonomic Richness and Biodiversity

Benthic invertebrate taxonomic richness was highest at the River of Golden Dreams downstream site (RGD-DS-AQ12, 21 taxa), and lowest at Jordan Creek (JOR-DS-AQ31, 16 taxa) (Figure 18). This trend was also observed for EPT taxonomic richness (Figure 19). Pollution sensitive EPT organisms dominated the sites in the River of Golden Dreams watershed, with these taxa forming >75% of organisms at the sites (Figure 20). Jordan Creek had a notably lower proportion of EPT organisms (50%, Figure 20), 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 takes into account 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 (2.01 to 2.12, Figure 21). Crabapple Creek and Jordan Creek had the lowest diversity values of 1.64 and 1.53, respectively.

Discussion

The purpose of benthic invertebrate sampling program was to characterise the benthic communities in the study streams, and identify any potentially impaired sites. Future sampling will build on the 2016 data to allow identification of temporal trends. The high proportion of pollution sensitive EPT organisms present the Crabapple, Twentyone Mile Creek, and the River of Golden Dreams sites, points to healthy benthic invertebrate communities in the River of Golden Dreams watershed. The benthic communities in the River of Golden Dreams and Twentyone Mile Creek also have more diverse communities. This may be due, in part, to their larger size (S2 streams) compared to Crabapple and Jordan Creeks (S3 streams).

Figure 22 to Figure 31 show habitat conditions at the benthic sampling areas, as well as the typical substrate at each site. Habitat conditions have a direct relationship to the type of community expected at the site, in particular temperature, flow, substrate, and food resources. Substrate composition at each site was calculated based on the pebble count (part of CABIN protocol). Twentyone Mile Creek, and the River of Golden Dreams were pebble dominated, while Crabapple 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.

The results for Jordan Creek indicated that the benthic community may be impaired, as this site demonstrated the lowest diversity, and 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. Nita Lake, the headwater lake of Jordan Creek, and Jordan Creek, are both relatively small, such that the degree of mixing and dilution of any pollution inputs would be lower. Temperatures in Jordan Creek also tend to be warmer than the other study streams.

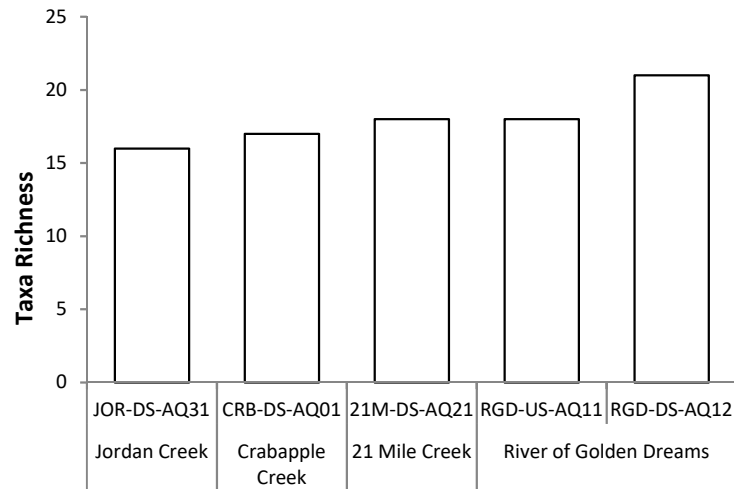


Figure 18. Benthic invertebrate community taxonomic richness

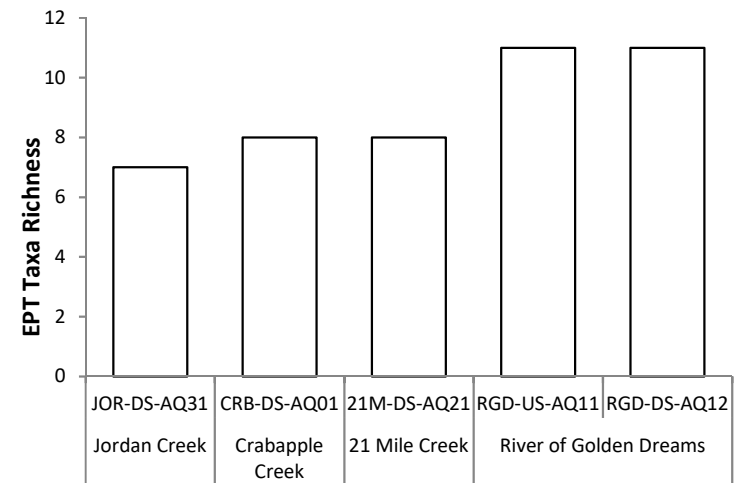


Figure 19. Benthic invertebrate community EPT taxonomic richness

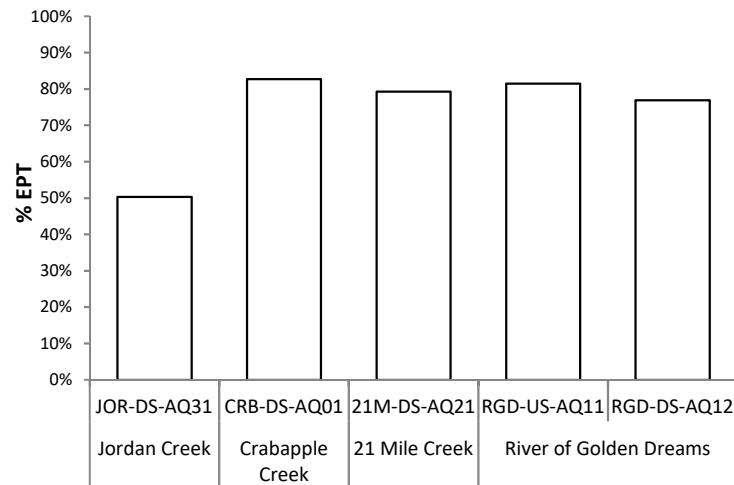


Figure 20. Benthic invertebrate community % EPT

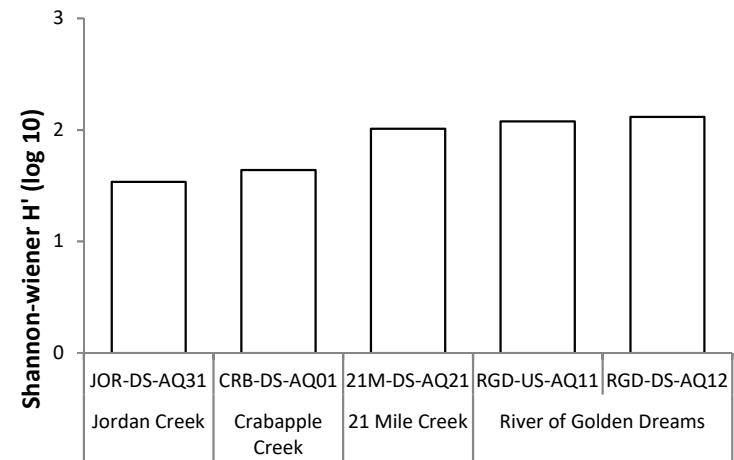


Figure 21. Benthic invertebrate community Shannon-wiener indices



Figure 22. Jordan Creek (JOR-DS-AQ31) benthic sampling area, looking upstream. Date taken: August 3, 2016.



Figure 23. Jordan Creek (JOR-DS-AQ31) substrate (52% cobble, 25% pebble, 15% boulder). Date taken: August 3, 2016.



Figure 24. Crabapple Creek (CRB-DS-AQ01) benthic sampling area, looking across from river right to river left. Date taken: August 2, 2016.



Figure 25. Crabapple Creek (CRB-DS-AQ01) substrate (68% cobble, 25% pebble, 6% gravel). Date taken: August 2, 2016.



Figure 26. Twentyone Mile Creek (21M-DS-AQ21) benthic sampling area, looking upstream. Date taken: August 3, 2016.



Figure 27. Twentyone Mile Creek (21M-DS-AQ21) substrate (79% pebble, 18% cobble, 3% gravel). Date taken: August 3, 2016.



Figure 28. River of Golden Dreams (RGD-US-AQ11) benthic sampling area, looking upstream. Date taken: August 3, 2016.



Figure 29. River of Golden Dreams (RGD-US-AQ11) substrate (86% pebble, 8% cobble, 6% gravel). Date taken: August 3, 2016.



Figure 30. River of Golden Dreams (RGD-DS-AQ12) benthic sampling area, looking upstream. Date taken: August 5, 2016.



Figure 31. River of Golden Dreams (RGD-DS-AQ12) substrate (75% pebble, 23% gravel, 2% cobble). Date taken: August 5, 2016.

3.2.1.2 CABIN

CABIN analyses are summarized in site assessment reports (Appendix B). The BEAST prediction results (Table 14) show that based on the benthic invertebrate communities, the majority of aquatic sampling sites belong to Group 1 (probabilities: 33 – 71%) with the exception of site RGD-DS-AQ12 which belongs to Group 5 (probability: 48%). Site 21M-DS-AQ21 was sorted into Group 1 at a probability of 33.3%, Group 3 at 28.9%, and Group 5 at 24.4%. This indicates that the habitat characteristics of 21M-DS-AQ21 are similar to all three reference groups.

Table 14. Probabilities of sorting into each reference model group (based on habitat), for aquatic sampling sites, Whistler, 2016

Site	Group	Group 1	Group 2	Group 3	Group 4	Group 5
JOR-DS-AQ31	1	71.0%	0.3%	21.5%	0.3%	7.0%
CRB-DS-AQ01	1	50.3%	1.0%	23.8%	0.6%	24.3%
21M-DS-AQ21	1	33.3%	7.9%	28.9%	5.4%	24.4%
RGD-US-AQ11	1	49.5%	1.1%	25.6%	1.7%	22.0%
RGD-DS-AQ12	5	13.0%	1.0%	28.6%	9.0%	48.4%

The Bray-Curtis analysis (Table 15) indicated that of the five sites, Site RGD-US-AQ11 is most similar in community structure to reference condition and Site CRB-DS-AQ01 is the most dissimilar. The RIVPACS tools 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 0.91 (JOR-DS-AQ31) to 1.18 (RGD-DS-AQ12) (Table 16).

Table 15. Bray-Curtis distances for aquatic sampling sites, Whistler, 2016

Site	Bray-Curtis Distance*	Predicted Group Reference Mean \pm SD
JOR-DS-AQ31	0.86	0.55 \pm 0.12
CRB-DS-AQ01	0.88	0.55 \pm 0.12
21M-DS-AQ21	0.67	0.55 \pm 0.12
RGD-US-AQ11	0.63	0.55 \pm 0.12
RGD-DS-AQ12	0.73	0.47 \pm 0.14

* A number close to 1 represents a site benthic invertebrate community that is far away from the median reference community.

Table 16. RIVPACS Observed/Expected Taxa Ratios for aquatic sampling sites, Whistler, 2016

Site	Description	Result
JOR-DS-AQ31 (Aug 03 2016)	RIVPACS : Expected taxa $P > 0.70$	5.47
	RIVPACS : Observed taxa $P > 0.70$	5.00
	RIVPACS : O:E (p > 0.7)	0.91
CRB-DS-AQ01 (Aug 02 2016)	RIVPACS : Expected taxa $P > 0.70$	5.39
	RIVPACS : Observed taxa $P > 0.70$	5.00
	RIVPACS : O:E (p > 0.7)	0.93
21M-DS-AQ21 (Aug 03 2016)	RIVPACS : Expected taxa $P > 0.70$	5.20
	RIVPACS : Observed taxa $P > 0.70$	6.00
	RIVPACS : O:E (p > 0.7)	1.15
RGD-US-AQ11 (Aug 03 2016)	RIVPACS : Expected taxa $P > 0.70$	5.37
	RIVPACS : Observed taxa $P > 0.70$	6.00
	RIVPACS : O:E (p > 0.7)	1.12
RGD-DS-AQ12 (Aug 05 2016)	RIVPACS : Expected taxa $P > 0.70$	5.11
	RIVPACS : Observed taxa $P > 0.70$	6.00
	RIVPACS : O:E (p > 0.7)	1.18

The BEAST site assessment graphs (Appendix B) display each test site in relation to the reference sites of the Fraser River-Georgia Basin Model 2005 reference model. The degree of deviation from reference condition can indicate the severity of impairment. The different levels of deviation range in order from (1) reference condition, (2) mildly divergent, (3) divergent, and (4) highly divergent. Of the five sites tested, most sites 21M-DS-AQ21 and RGD-US-AQ11 were in the similar to reference category, which indicates little to no anthropogenic stress. Site CRB-DS-AQ01 was in the mildly divergent category which is one band further from the reference condition. Sites JOR-DS-AQ31 and RGD-DS-AQ12 were in the divergent category, which indicates potential anthropogenic stress.

3.2.2 Fish Community

3.2.2.1 Species Composition, Relative Abundance, and Population Density

Undifferentiated trout fry from resident populations of Rainbow (*Oncorhynchus mykiss*) and Cutthroat Trout (*O. clarkii clarkii*) dominated electrofishing captures in all creeks. Coastrange Sculpin (*Cottus aleuticus*) was the next most abundant species captured at Crabapple Creek and Twentyone Mile Creek (Table 17). At Jordan Creek, Threespine Stickleback (*Gasterosteus aculeatus*) were the next most abundance species after trout (Table 17).

“Unknown” Trout

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.

Potential hybridization between *O. mykiss* and *O. clarkii*

Two juvenile salmonids greater than 80 mm fork-length were captured at Twentyone Mile Creek, but could not be positively identified. Each unidentified trout exhibited a combination of phenotypic traits suggesting these individuals were potentially hybrid offspring of *O. mykiss* and *O. clarkii*: 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 33 to Figure 36). 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).

Table 17. Fish Community Composition by site, Whistler, 2016

Site	Creek	TR	HY	TSB	CAL
JOR-DS-AQ31	Jordan Creek	68%	0%	29%	3%
CRB-DS-AQ01	Crabapple Creek	67%	0%	15%	19%
21M-DS-AQ21	Twentyone Mile Creek	54%	3%	5%	38%
Species Total		61%	1%	13%	25%

Table Notes: TR=unknown trout, HY = suspected hybrid trout, TSB = Threespine Stickleback, CAL = Coastrange Sculpin

Three-pass depletion removal methods were employed to estimate fish species population densities. However, due to poor depletion ratios in all three surveys, fish abundance is instead reported for each site using a CPUE abundance index. In removal studies, one assumes that the probability of capture for every fish is equal and that it does not change between removal passes (Zippin 1956); when more fish are captured on a subsequent pass this assumption has not been met. Potential reasons for this include:

- It was not possible to effectively electrofish the entire area of the Jordan Creek site, as the site includes a deep pool where the crew could not safely wade, or reach with the electrofisher anode

and dip net. Fish could have moved into/out of deep pool during sampling, and thereby violated the equal probability of capture between passes assumption.

- At Crabapple and Jordan creeks, the crew members alternated dip-netting and electro-shocking roles each pass, and, as the crew members had different levels of experience conducting electrofishing surveys, this led to inconsistent sampling effectiveness.

The mean CPUE was calculated across the three passes, at each site, for all species (Table 18) and for undifferentiated trout (Table 19). Figure 32 shows the CPUE for each species captured.

Table 18. Electrofishing CPUE by Site and Electrofishing Pass, Whistler, August 2016

Site	Creek	Date	CPUE (all fish species)				
			Pass 1	Pass 2	Pass 3	Mean	SD
JOR-DS-AQ31	Jordan Creek	04-Aug-2016	1.93	2.60	2.44	2.32	0.35
CRB-DS-AQ01	Crabapple Creek	05-Aug-2016	1.74	3.71	2.12	2.52	1.05
21M-DS-AQ21	21-Mile Creek	06-Aug-2016	2.86	3.02	2.73	2.87	0.15

Table Notes: CPUE are number of fish caught per 100s of electrofishing; Mean = average CPUE across the three passes; SD = Standard deviation of the mean.

Table 19. Electrofishing CPUE for trout, by Site and Electrofishing Pass, August 2016

Site	Creek	Date	CPUE (Unknown Trout)				
			Pass 1	Pass 2	Pass 3	Mean	SD
JOR-DS-AQ31	Jordan Creek	04-Aug-2016	1.35	1.60	1.78	1.58	0.22
CRB-DS-AQ01	Crabapple Creek	05-Aug-2016	1.16	2.20	1.69	1.69	0.52
21M-DS-AQ21	21-Mile Creek	06-Aug-2016	2.14*	1.66	1.15	1.65	0.49

Table Notes: CPUE are number of fish caught per 100s of electrofishing; Mean = average CPUE across the three passes; SD = Standard deviation of the mean.

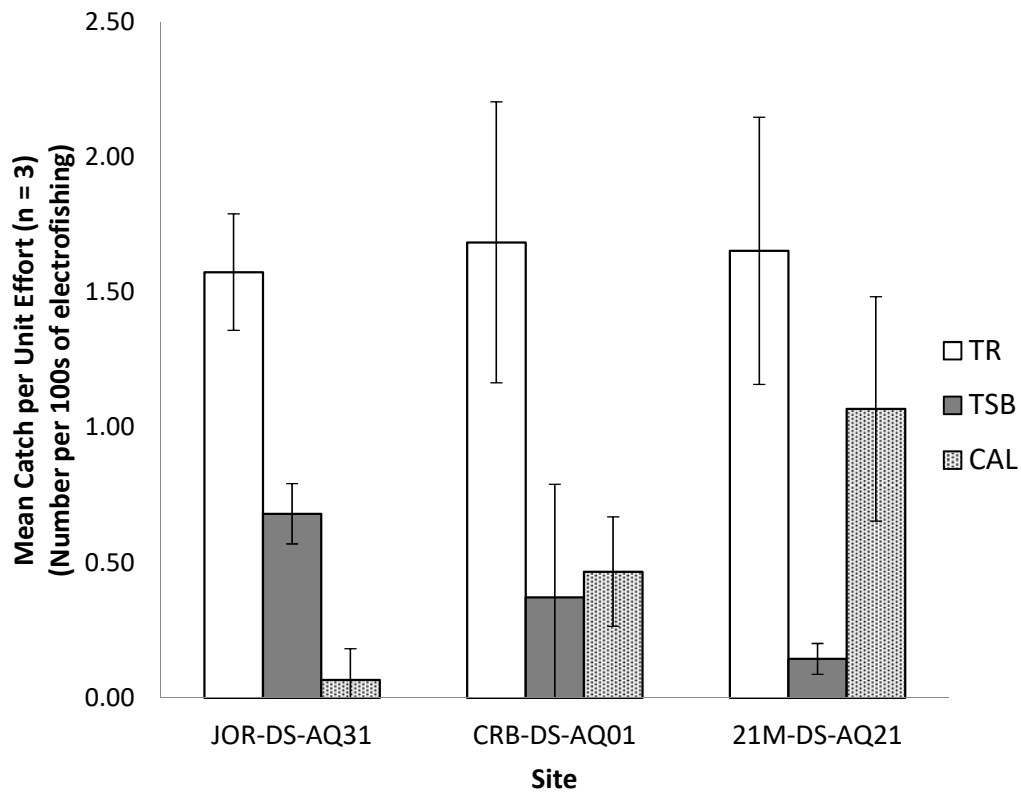


Figure 32 Mean Electrofishing Catch Per Unit Effort by Site, August, 2016. TR= unknown trout, TSB = Threespine Stickleback, CAL = Coastrange Sculpin). Error bars denote the standard deviation from the mean.



Figure 33. Suspected hybrid trout (fork length 84 mm) captured in Twentyone Mile Creek (21M-DS-AQ21). Date taken: August 6, 2016. Photo 1 of 2.



Figure 34. Suspected hybrid trout (fork length 84 mm) captured in Twentyone Mile Creek (21M-DS-AQ21). Date taken: August 6, 2016. Photo 2 of 2.



Figure 35. Suspected hybrid trout (fork length 80 mm) captured in Twentyone Mile Creek (21M-DS-AQ21). Date taken: August 6, 2016. Photo 1 of 2.



Figure 36. Suspected hybrid trout (fork length 80 mm) captured in Twentyone Mile Creek (21M-DS-AQ21). Date taken: August 6, 2016. Photo 2 of 2.

3.2.2.2 Lengths, Weights, and Conditions of Sampled Fish

Mean length and weight of each fish species is reported in Table 20 and a length frequency analysis for sampled trout is presented in Figure 37.

Table 20. Mean Length and Weight of Fish Species, August 2016

Site	Species	n	Length (mm)				Weight (g)			
			Min	Mean	Max	SD	Min	Mean	Max	SD
21M-DS-AQ21	CAL	30	40	51	85	12	0.8	2.1	9.6	2.2
	TR	43	25	39	114	13	0.2	1.1	14.4	2.2
	HY	2	80	82	84	3	5.4	6.7	7.9	1.8
	TSB	4	50	54	60	5	1.3	1.7	2.5	0.6
CRB-DS-AQ01	CAL	10	39	58	78	15	0.9	3.3	7.9	2.2
	TR	36	26	45	160	28	0.3	3.7	50.4	9.0
	TSB	8	21	41	61	17	0.2	1.5	3.6	1.3
JOR-DS-AQ31	CAL	1	90	90	90	-	13.0	13.0	13.0	-
	TR	23	30	51	130	26	0.5	4.6	33.1	7.4
	TSB	10	35	43	57	6	1.3	1.9	2.5	0.4
ALL SITES	CAL	41	39	54	90	14	0.8	2.7	13.0	2.7
	TR	102	25	44	160	23	0.2	2.8	50.4	6.6
	HY	2	80	82	84	3	5.4	6.7	7.9	1.8
	TSB	22	21	44	61	12	0.2	1.7	3.6	0.8

Table Notes: TR= unknown trout; HY= suspected hybrid trout; TSB = Threespine Stickleback, CAL = Coastrange Sculpin. SD = Standard deviation from the mean.

Sampled trout lengths ranged from 25 to 160 mm, with an average length of 44 mm (Table 20, Figure 37). The vast majority of sampled trout (83%, n= 167) from all three sites were less than 60 mm fork-length, and are almost certainly all age 0+ fry, demonstrating the importance of the study reaches for rearing trout fry. In order to better understand the age distribution of trout in the study area, future year's efforts should incorporate the collecting and aging of scale samples from all captured trout.

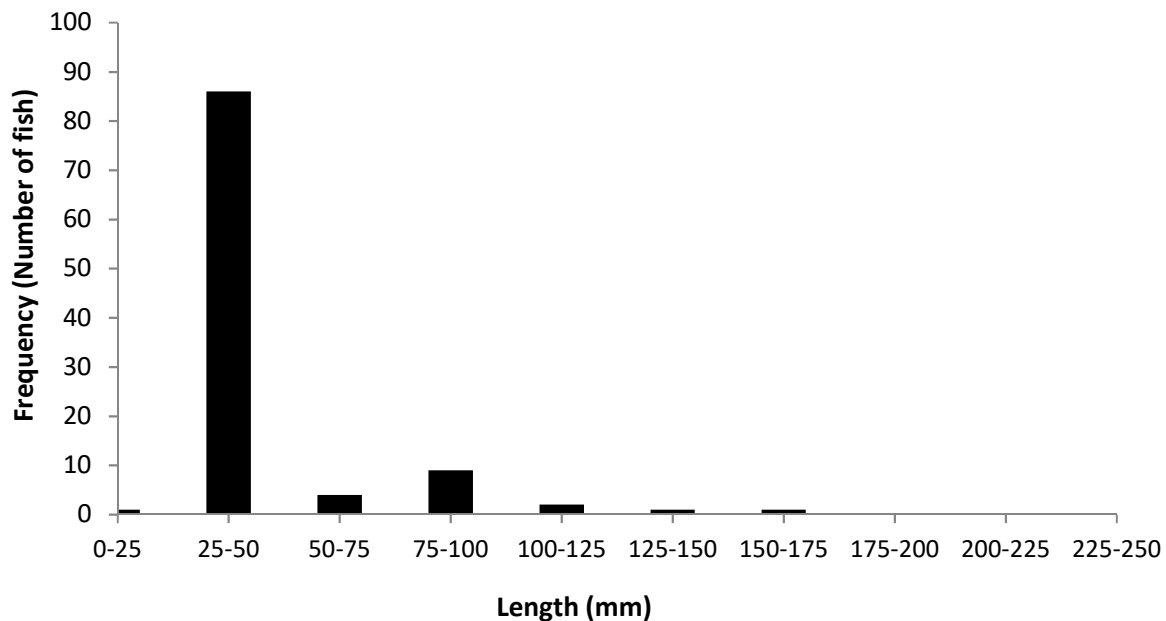


Figure 37. Length-frequency analysis for sampled trout in study streams, August 2016

Condition

The length-weight regression for sampled juvenile trout was significant (Figure 38, Linear regression, $R^2=0.84$, $df=100$, $P<0.01$). However growth was shown to be allometric (t-test, $t=2.473$, $df=100$, $P=0.015$), with fish becoming relatively lighter as length increased. Mean relative condition (K_n) was 1.10 ± 0.56 (standard deviation).

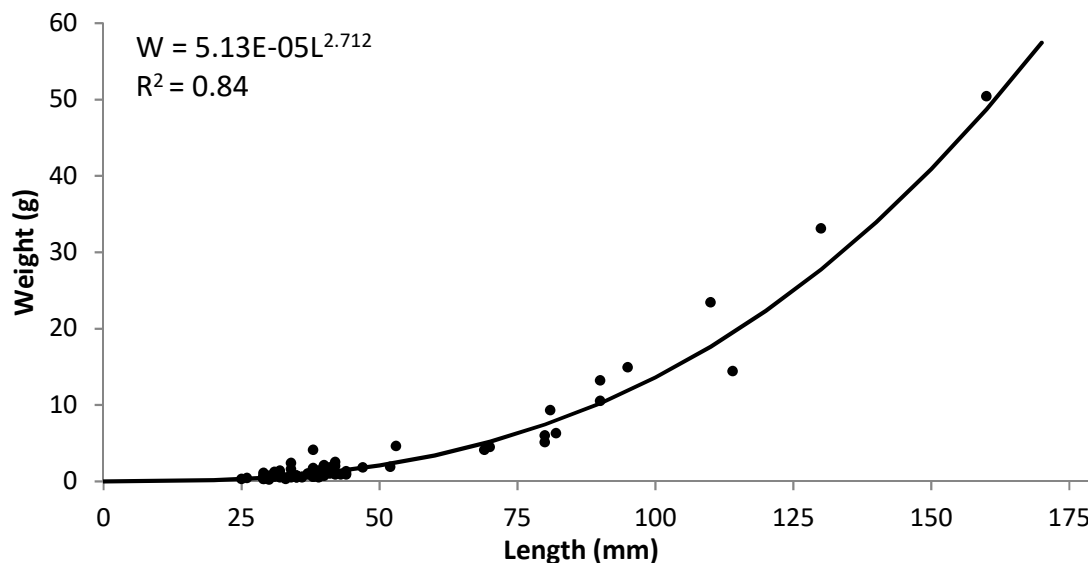


Figure 38. Weight-Length Relationship for juvenile trout in study streams, August 2016

3.3 Riparian Species

3.3.1 Coastal Tailed Frog

The previous three years of surveys (2013-15) included sampling in three months: July, August, and September (Table 21). Total tadpoles captured for the four sites decreased from a high of 21 in July to only nine in September. The average area surveyed was 19.7 m², and captures decreased from 8.9/100m² in July to 3.8/100m² in September. Average capture rates are decreased due to no detections in Nineteen Mile Creek. Average detections per unit area (m² or 100 m²) are also likely higher than reported in later months, at least September, when wetted widths would have been less (due to lower flow rates later in the year) than the fixed numbers reported.

Table 21. Tailed frog locations sampled in 2015.

<u>Location</u>	<u>No. of Reaches</u>	<u>Total ReachArea (m²)</u>	<u>Avg. Reach Area (m²)</u>	<u>July 2015</u>		<u>Aug. 2015</u>		<u>Sept. 2015</u>	
				<u>No. Tad-pole Captures</u>	<u>No. Captured per 100m²</u>	<u>No. Tad-pole Captures</u>	<u>Location</u>	<u>No. of Reaches</u>	<u>Total ReachArea (m²)</u>
Alpha Creek	3	69.6	23.2	9	12.9	7	Alpha Creek	3	69.6
Archibald Cr.	3	46.9	15.6	11	23.5	6	Archibald Cr.	3	46.9
Scotia Creek	3	45.8	15.3	1	2.2	5	Scotia Creek	3	45.8
Nineteen Mile Cr.	3	73.6	24.5	0	0.0	0	Nineteen Mile Cr.	3	73.6
Totals for All Sites	12	235.9	19.7	21	8.9	18	Totals for All Sites	12	235.9

Table 22. Tailed frog sampling sites, September 9 to 22, 2016

<u>Location</u>	<u>No. of Reaches</u>	<u>Total ReachArea (m²)</u>	<u>Avg. Reach Area (m²)</u>	<u>No. Tad-pole Captures</u>	<u>No. Captured per 100m²</u>
Alpha Creek	3	72.5	24.2	9	12.4
Archibald Creek	3	45.2	15.1	5	11.1
Scotia Creek	3	86.7	28.9	3	3.5
Whistler Creek	4	97.6	24.4	22	22.5
All Sites	13	302.0	23.2	39	12.9

Almost twice as many tadpoles were captured in September 2016 (Table 22) than in any survey month in 2015, and four times as many as in September 2015 (39 in 2016; nine in 2015). The capture density in September 2015 (12.9 per 100m²) was also higher than any month in 2015. This result shows that the 2016

approach was more likely to detect the presence of tadpoles, and also provide data on relative abundance. One juvenile tailed frog was captured at reach 2 on Scotia Creek (Figure 39). Otherwise no metamorphosed frogs were detected.



Figure 39. Juvenile Coastal Tailed Frog captured at the Scotia Creek 2 site.

Almost two-thirds of all tadpoles captured were in the youngest (T1) cohort (Table 23). No elevational pattern of cohorts and elevation was detected. There was also no relationship evident in number of captures by elevation.

Table 23. Tailed frog captures by elevation and life stage.

Site	Mean Elev. (m)	#Tad-poles	T1	T2	T3
Alpha Creek - 1	684	3		1	2
Alpha Creek - 2	714	0			
Alpha Creek - 3	863	6	5	1	
Archibald Creek - 1	695	1		1	
Archibald Creek - 2	835	1	1		
Archibald Creek - 3	1026	3	3		
Scotia Creek - 1	661	0			
Scotia Creek - 2	773	0			
Scotia Creek - 3	817	3	1		2
Whistler Creek - 1	693	7	4	2	1
Whistler Creek - 2	875	9	7		2
Whistler Creek - 3	985	2	2		
Whistler Creek - 4	1130	4	2		2
	Total	40	25	4	9
			63%	10%	23%

Comparison of Captures by Stream in 2015 and 2016

Three creeks were surveyed in both 2015 and 2016: Alpha, Archibald (Crabapple), and Scotia. Captures were higher in 2016, with the most tadpoles captured at Alpha Creek. These overall data obscure the variability between reaches. No tadpoles were detected on the middle reach of Alpha Creek, nor the lower and middle reaches on Scotia Creek. Based on previous surveys (Wind 2006 to 2009; Cascade 2013 to 2015), it is likely some of the reaches with no or low detections in 2016 actually had higher populations of tailed frogs, notably Alpha Creek 2 and Archibald 1. This latter site was visited on August 27, 2016 and 23 tadpoles were visible on rounded rocks and bedrock, so this reach definitely still has a strong population. The weather cooled significantly in the second week of sampling (September 21-22) which likely reduced detections in Crabapple Creek as tadpoles retreated to deeper substrates.

Stream Disturbance

There was significant deposition of sand and small gravel in Archibald Creek below mid-station which is the uphill limit of the Whistler Bike Park (Figure 40 and Figure 41). The deposition was especially deep at the lowest reach, Archibald 1, which is located just uphill of Panorama Drive in Brio. This site was just downstream of the data logger that became clogged with sand and gravel (Section 2.3.1.2). This deposition does not appear to have affected the abundance of tailed frogs but should continue to be monitored.

Other Records

- One adult frog captured during site reconnaissance on August 13th in an unnamed creek adjacent to the Sea to Sky trail, uphill of the Cheakamus River bridge (UTM 494450E 5546726N).
- One tailed frog was captured during electrofishing for this project on Twentyone Mile Creek (UTM 5011923E 5552833 N). The frog was captured near the wetted edge on river right just downstream of the upstream electrofishing net, on a pebble substrate.



Figure 40. Sedimentation at Archibald Creek, site 1 (near Panorama Drive).



Figure 41. Sedimentation at Archibald Creek, site 2 (near Crank It Up).

Observations

Results from 2016 lead to the following conclusions:

- The time-constrained searches allowed surveyors to “high-grade” the best habitat and reveal two to four times the number of tadpoles in 30 minute searches versus area-constrained searches.

- Density of tadpoles (per 100m²) was also higher for time-constrained searches.
- There was no clear elevational pattern for life stage (cohort).
- There was also no clear elevational signal for abundance, that is, elevation was not a predictor for the number of captures.
- Elevational effects may be detected in the future, and a greater elevational range of reaches may help.
- Weather and time of year greatly affect captures. Where possible, surveys should occur on warm, clear days in late August or early September to maximize chances for detection.
- Detectability is also related to stream type. The dipnet method is appropriate for small streams but not for large streams. For example, dipnet sampling in Fitzsimmons Creek and Twentyone Mile Creek (Wind 2006) did not detect tailed frogs. They were first detected in Fitzsimmons Creek as bycatch during electrofishing. Similarly, the first documentation in Twentyone Mile was this year, and did not use dipnets. If future surveys include larger creeks, alternate methods need to be investigated.

3.3.2 Beaver

Although searches were intended to occur during October and early November (to better confirm which lodges were used for overwintering), inclement weather hampered this goal – only six days in October and November had no rain.⁶ Biological surveys in such 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. Due to these reasons, searches were delayed and instead conducted opportunistically mainly in late October, late November, and early December. The last search occurred on December 21st. Snow was present on the ground for searches from November 25th which, at some sites, limited the ability to confidently determine activity. Conversely, the late date and snow actually helped confirm activity on other sites for which lodge repairs only became visible in December.

Between late August and late December, 62 sites were surveyed from Logger's Lake in the south to Wedge Pond in the north. A lodge further north near Parkhurst on Green Lake, reported by Tara Schaufele (RMOW; pers. comm.) was not assessed due to inclement weather. A total of 78 signs of activity were recorded (Figure 42) which included lodges and other signs of beaver activity including dams, sightings, and clippings and cuttings. In all, 29 lodges were located, of which 13 were Active, 11 were Inactive,⁷ the status of three was Unknown, and two⁸ were likely active in the summer only (Table 24 and Table 25).

Changes in lodge status

Three or possibly four lodges active in 2015 became inactive in 2016: Green Lake east of the float plane base,⁹ Nita Lake, Rainbow Park across from the dog beach, and possibly one lodge on the River of Golden Dreams (the ROGD survey had unclear results). These sites will be assessed again in 2017.

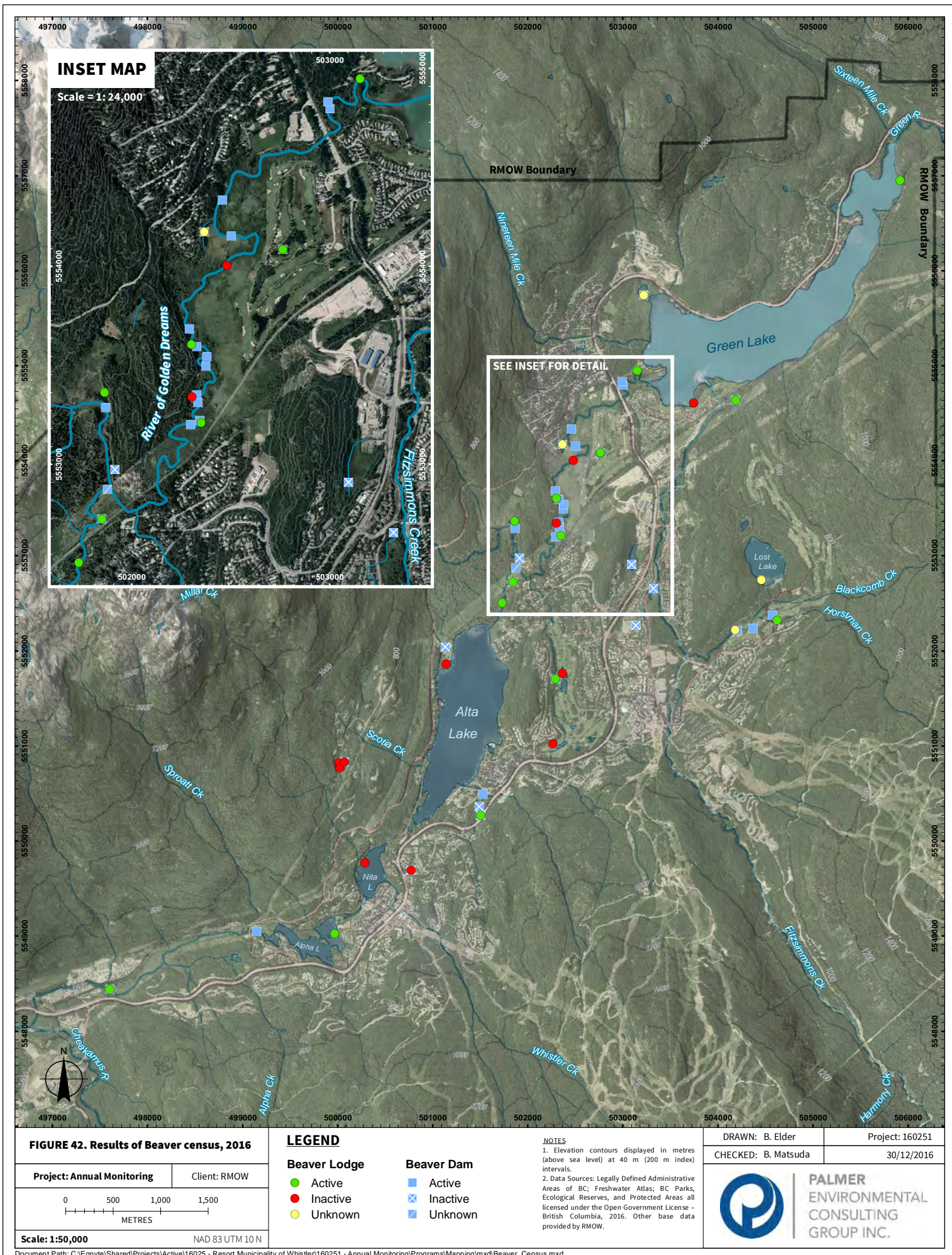
⁶ <http://climate.weather.gc.ca/>

⁷ While it was not possible to confirm the status of two sites labelled "Active" and five labelled "Inactive", there was enough evidence to include them with "Active" and "Inactive" lodges, respectively.

⁸ Fairmont Chateau Golf Course pond #18. Dan Nash (pers.Comm.) reported likely occupation of at least one lodge.

⁹ This lodge was classed as "unknown" in 2015, but active for many years before.

Three areas not surveyed before 2016 were confirmed as supporting active colonies: the Wildlife Refuge, the northeast part of Rainbow Wetlands near the CN Rail line, and the Millar Creek wetlands (which had extensive beaver activity though the lodge was not located due to snow).



Other old lodges were recolonized in 2016, that is, though inactive for a number of years they now house beavers. The Alta Vista Pond lodge is occupied for the first time since 2008. The lodge on Crabapple Creek beside the 10th fairway does not appear in previous data (which may just be an error in UTM), but is almost certainly an old lodge reactivated since September. The roofs of both these lodges were being repaired with mud in December 2016 (Figure 43 and Figure 44).



Figure 43. Fresh roof repair at the lodge in Alta Vista Pond;



Figure 44. A freshly cut red alder on Crabapple Creek beside the 10th fairway on Whistler Golf Course. The recolonized lodge is about 10 metres downstream on the left side. This activity only became evident in late fall.

The status of three lodges is unknown, mainly because snow prevented confirming whether there was an active lodge. The lodge at Wedge Pond has been active for many years but snow prevented confirmation of its current status. Many signs were present, however, especially of tunnels and canals created by beavers, so it is possible the lodge remains active. There is also a great deal of activity at the wetland connecting with the River of Golden Dreams that is downhill from Buckhorn Place. A lodge could not be located so this may just be a feeding site for beavers.¹⁰ A third lodge on Green Lake near Parkhurst was reported by Tara Schaufele (RMOW, pers. comm.) but could not be assessed due to inclement weather.

Table 24. *Lodges documented in 2016. 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	Date	Surveyor(s)	Easting	Northing	Method	Lodge Status
Alpha Lake, near dog beach	2016-11-28	B. Brett, K. Jones	499970	5549027	Survey	Active
Alpine -Buckhorn Place wetland	2016-12-04	K. Jones	502367	5554175	Survey	Unknown
Alta Vista Pond lodge	2016-11-28	B. Brett, K. Jones	501508	5550273	Survey	Active
Beaver Lake #1, northwest	2016-11-04	B. Brett	500012	5550828	Survey	Inactive
Beaver Lake #2, west middle	2016-11-04	B. Brett	500012	5550802	Survey	Inactive

¹⁰ An unnamed resident reported watching two beavers feeding (diving and emerging with vegetation) in this pond earlier in the year.

Location	Date	Surveyor(s)	Easting	Northing	Method	Lodge Status
Beaver Lake #3, southwest	2016-11-04	B. Brett	500027	5550773	Survey	Inactive
Beaver Lake #4; northeast side	2016-11-04	B. Brett	500072	5550831	Survey	Inactive
Bottomless Pond	2016-11-28	B. Brett	500774	5549695	Survey	Inactive
Chateau GC #18 pond	2016-10-28	B. Brett	504184	5552221	Survey	Summer Only?
Chateau GC #2 pond lodge	2016-10-28	B. Brett	504625	5552326	Survey	Active
Fitz. Cr.back channels nr. disc golf	2016-12-11	K. Jones	504189	5554641	Survey	Active
Green Lk. lodge e. of float plane base	2016-11-25	B. Brett	503746	5554612	Survey	Inactive?
Green Lake near Parkhurst	2016-08-26	T. Schaufele	505917	5556951	Anecd.	Unknown
Lost Lake Park, Lost Lake Lodge	2016-10-30	K. Jones	504460	5552746	Survey	Unknown
Millar Creek wetlands - Function Junction	2016-12-04	K. Jones, B. Brett	497603	5548441	Survey	Active
Nicklaus North GC, #10 pond	2016-11-25	B. Brett	502764	5554086	Survey	Active
Nita Lake Lodge	2016-11-04	B. Brett	500290	5549772	Survey	Inactive?
Rainbow Park, creek near Alta Lake, west side	2016-11-04	B. Brett, K. Jones	501142	5551862	Survey	Inactive?
Rainbow Wetlands, NE end near 21-Mile creek, lodge	2016-11-21	K. Jones	501848	5552727	Survey	Active
ROGD1 - Alta Lake entrance to fish weir	2016-08-25	B. Brett, K. Brandon	501732	5552505	Survey	Active
ROGD4 - RR bridge to bend nearest Valley Tr.	2016-08-25	B. Brett, K. Brandon	502350	5553212	Survey	Active
ROGD4 - RR bridge to bend nearest Valley Tr.	2016-08-25	B. Brett, K. Brandon	502303	5553343	Survey	Inactive?
ROGD5 - bend nearest Valley Tr. to Hwy. 99 bridge	2016-08-25	B. Brett, K. Brandon	502302	5553607	Survey	Active?
ROGD5 - bend nearest Valley Tr. to Hwy. 99 bridge	2016-08-25	B. Brett, K. Brandon	502480	5554005	Survey	Inactive?
ROGD6 - Hwy. 99 bridge to Green Lake	2016-11-25	B. Brett	503153	5554949	Survey	Active?
Spruce Grove Park, entrance	2016-11-28	B. Brett	502764	5554086	Survey	Active
Wedge Pond Lodge and dam	2016-11-22	K. Jones	503224	5555745	Survey	Unknown
Whistler GC, #7T pond	2016-11-28	B. Brett	502367	5551766	Survey	Inactive
Whistler GC, Crabapple Cr. #10 fairway - lodge/dams	2016-11-28	B. Brett	502293	5551708	Survey	Active
Whistler GC, Crabapple Cr. #15 fairway - lodge/dams	2016-12-09	K. Jones	502266	5551020	Survey	Inactive
Wildlife Refuge, middle pond - lodge	2016-11-21	K. Jones	501863	5553365	Survey	Active

Table 25. Summary table of documented lodges from 2007 through 2016 by activity status.

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

Note: No data is available for beaver surveys in 2012.

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 26), especially in the section between the CN Rail bridge to the outlet at Green Lake. There is no doubt there are at least three and maybe more colonies active in 2016, partly based on repeated sightings¹¹ and also the 2016 survey of structures and signs conducted on August 25th. This was the only site intended for a second survey as late in the year as possible. The second survey would have helped confirmed which lodges were used for overwintering since some of the structures (lodges and bank burrows) may be for summer use only.

Table 26. Active lodges found on the River of Golden Dreams (ROGD)

Active Lodges	2007	2008	2009	2010	2011	2013	2014	2015	2016
Active lodges found on ROGD	1	15	7	7	10	5	5	4	3
Active lodges elsewhere	8	12	9	9	7	5	5	3	10

Note: No data is available for beaver surveys in 2012.

There has been a large range in lodges classified as active since 2008 (Table 26; Figure 45 and Figure 46), from a high of 12 in 2008 to a low of three this year. This year's low number is likely due at least in part to not having conducted a second survey (at least two other locations on the ROGD had possible occupation which can be confirmed in 2017). The three colonies deemed active in 2016 on the River of Golden Dreams is more similar to results from 2013 through 2015, 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 actually active than number of lodges. Clarifying which of these possibilities is correct is one goal for the 2017 survey.

After removing the ROGD lodges, 2016 documented the second highest total of active lodges since 2008. It is almost certain more would have been confirmed as active (versus unknown) if snow had not prevented finding lodges and other signs.

¹¹ Anecdotal reports confirm at least three and up to seven lodges active on the ROGD (Appendix H)



Figure 45. A dam on the River of Golden Dreams. Note the fresh (green) branches that confirm recent activity.



Figure 46. One of the active lodges on the River of Golden Dreams.

Habitat

Eight of the 14 active lodges (including the summer active lodge in Chateau #18 pond) are located on water bodies that would not differ greatly without the beavers' presence (Table 27). These habitats include controlled riparian habitats (especially the River of Golden Dreams and Crabapple Creek), constructed ponds on golf courses, and Alpha Lake.¹² That is, beavers do not significantly alter the habitat because any significant flooding caused by damming would be prevented. Dams built by beavers in the other six active lodges (all classed as wetland habitat) contribute to habitat for other species and should be a high conservation priority.

Table 27. Active beaver lodges by habitat type.

Habitat	Location	Creates Habitat?
Constructed Pond	Chateau GC #2 pond lodge	No
Constructed Pond	Nicklaus North GC, #10 pond	No
Lake	Alpha Lake, near dog beach	No
Riparian	Fitzsimmons Cr. back channels near disc golf course	No
Riparian	ROGD1 - Alta Lake entrance to fish weir	No
Riparian	ROGD4 - RR bridge to bend nearest Valley Tr.	No
Riparian	ROGD5 - bend nearest Valley Tr. to Hwy. 99 bridge	No
Riparian	ROGD6 - Hwy. 99 bridge to Green Lake	No
Riparian	Whistler GC, Crabapple Cr. #10 fairway - lodge/dams	No
Wetland	Alta Vista Pond lodge	Yes

¹² 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).

Habitat	Location	Creates Habitat?
Wetland	Chateau GC #18 pond (summer only)	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

Population Estimates

Based on an estimated average of 5.8 beavers per lodge (Mullen 2008), there are approximately 75 beavers overwintering in Whistler this year (Table 28; Figure 47). This is very close to the nine-year average of 81, and almost twice the 2015 estimate. 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). Extending the intent of 2016 searches back to the original concept of a full census allowed new areas to be documented for the first time in the nine-year project (e.g., Wildlife Refuge, northeast part of Rainbow Wetlands near the CN Rail line, and Millar Creek wetlands).

Table 28. Estimated number of beavers overwintering in Whistler

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

Applying lower and higher estimates (4.2 and 6.4 beavers per lodge, respectively; the 25th and 75th percentiles in Table 28) gives a range of how many beavers may be in the Whistler Valley. The resulting population range is from 29 (2015) to 173 beavers (2008). It is likely the total number of beavers is close to 100, and future enumeration of additional areas will help clarify that number.

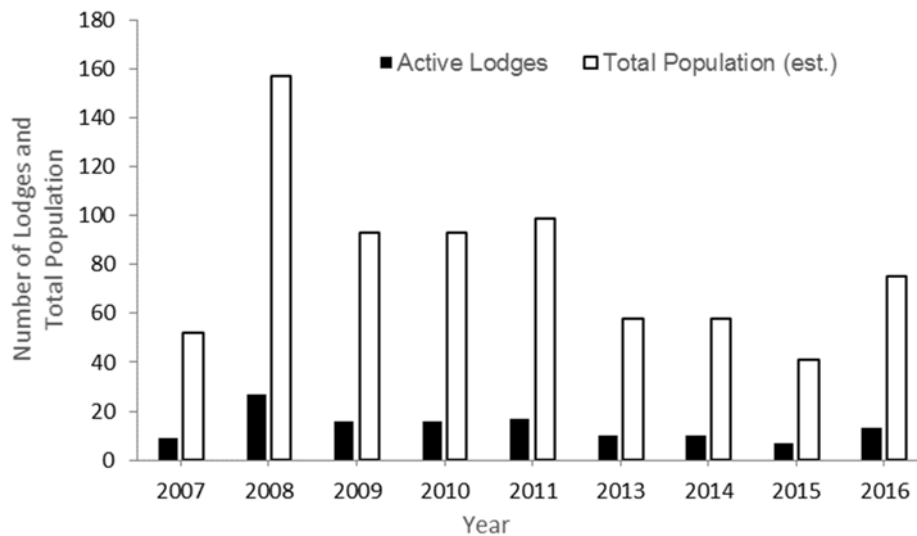


Figure 47. Number of lodges and estimated population by year

Thresholds:

Cascade (2015) introduced the concept of thresholds for beaver density in the RMOW but did not include a rationale of the threshold of 0.132 colonies per km². They based their threshold on data summarized from 50 studies (Jarema in Cascade 2015) in which the lowest reported density was 0.1 colonies per km². No information is presented for habitat type or human pressures, especially trapping, both of which would affect densities. For example, Müller-Schwarze and Sun (2003) report a New Brunswick study that found a density of 0.33 colonies km² in trapped habitats and 1.06 colonies per km² in untrapped habitats.

In place of specific threshold values, another option would be an annual report of the area of beaver-affected wetlands, that is, habitat that has been significantly altered by beaver activity. The total area affected by the six active lodges in wetlands (Table 27) would be a starting point. Preparing this geospatial data would be a useful goal in 2017, especially when a full census in better weather conditions can confirm activity in wetland habitats. Total population is also an important metric since, as dispersing, colonial animals, beavers have source and sink populations. The beavers in the Rainbow Wetlands and Wildlife Refuge, for example, may have been colonized by juveniles dispersing from colonies in the River of Golden Dreams. The 2016 results provide a good start to a complete census of lodges in the Whistler Valley, and additional work in 2017 should complete that census to provide much more accurate population numbers that can be compared year to year.

3.4 Terrestrial Habitat

3.4.1 Carabid Beetle

Among the three sites there were monitored for Carabids, there were 168 specimens of the order Coleoptera (beetles) collected of which seven families were represented. Within the Carabid family there were five species identified among 76 Carabid specimens (Table 29). For a complete list of all beetle

species identified from all families, see Appendix I. As Carabids were the focal species, some non-Carabid species that were difficult to identify were only keyed to morpho-species and are indicated in the Appendix I.

Table 29. Relative abundance and species diversity of Carabid beetles found in the three study sites by date.

Site	Date	<i>P. adstrictus</i>	<i>P. amethystinus</i>	<i>P. herculaneus</i>	<i>P. neobrunneus</i>	<i>S. angusticollis</i>	Total
Bob's Rebob	5/27/2016			6	1	1	8
	6/18/2016		1	10	4	1	16
	8/22/2016			3	2	1	6
	<i>Subtotal</i>	<i>0</i>	<i>1</i>	<i>19</i>	<i>7</i>	<i>3</i>	<i>30</i>
Millar's Pond	5/27/2016			7	11		18
	6/18/2016			6	3		9
	7/19/2016			2	1	1	4
	8/22/2016				4		4
	9/20/2016					1	1
	<i>Subtotal</i>	<i>0</i>	<i>0</i>	<i>15</i>	<i>19</i>	<i>2</i>	<i>36</i>
River Runs Through It	6/18/2016	1		1			2
	7/19/2016			2			2
	8/22/2016		1	1		3	5
	9/20/2016					1	1
	<i>Subtotal</i>	<i>1</i>	<i>1</i>	<i>4</i>	<i>0</i>	<i>4</i>	<i>10</i>
Total		1	3	72	52	14	76

Preliminary assessment of the Carabids collected indicates little variation in terms of diversity between the three sites with Bob's Rebob and River Runs Through It yielding four species each, although Millar's Pond had the highest number of specimens collected in terms of relative abundance (Table 29).

The previous monitoring study conducted in Whistler recorded seven species of Carabids over the three years of assessment (Cascade 2015, 2016). Those studies included two species (*Leistus ferruginosus* and *Notophilus sylvaticus*) that were not found this year. Similarly, the 2016 program recorded two species that were not detected previously (*Pterostichus adstrictus*, *P. amethystinus*; Table 29). However, there has been at least 23 species of Carabidae recorded in the Whistler valley through the Whistler Biodiversity Project (Brett 2016b). The two *Pterostichus* species have not been previously identified in Whistler, which contributes to the database of new species for the area.

Overall these findings yield little new information on habitat. Although two new species of Carabids can be added to the Whistler's species list, they are not Species at Risk. Thresholds cannot be assessed given the sample sizes and even if numbers were higher, no conclusions could be drawn with regard to ecosystem fluctuations based on Carabid captures. Over the long term, larger sample sizes may yield useful

information which can possibly be extrapolated to ecosystem responses. However, this would require more intensive sampling covering a larger area in each habitat type and over longer periods of time.

3.4.2 Tree Cavities

A total of 58 cavity trees were recorded on the Comfortably Numb (Figure 48) transect and another 42 on the Shit Happens transect (Figure 49), (Table 30; Appendix J). Western redcedar and western hemlock were equally represented and accounted for two-thirds of all cavity trees on these sites. Most of the remainder (24%) were Douglas-firs.

Table 30. Tree species in which woodpecker cavities were detected.

Species	Comfortably Numb		Shit Happens		Total	
	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>
Amabilis fir			2	5%	2	2%
Black cottonwood	1	2%			1	1%
Western redcedar	23	40%	11	26%	34	34%
Douglas-fir	11	19%	13	31%	24	24%
Lodgepole pine			4	10%	4	4%
Western hemlock	20	34%	12	29%	32	32%
Unknown	3	5%			3	3%
All species	58		42		100	

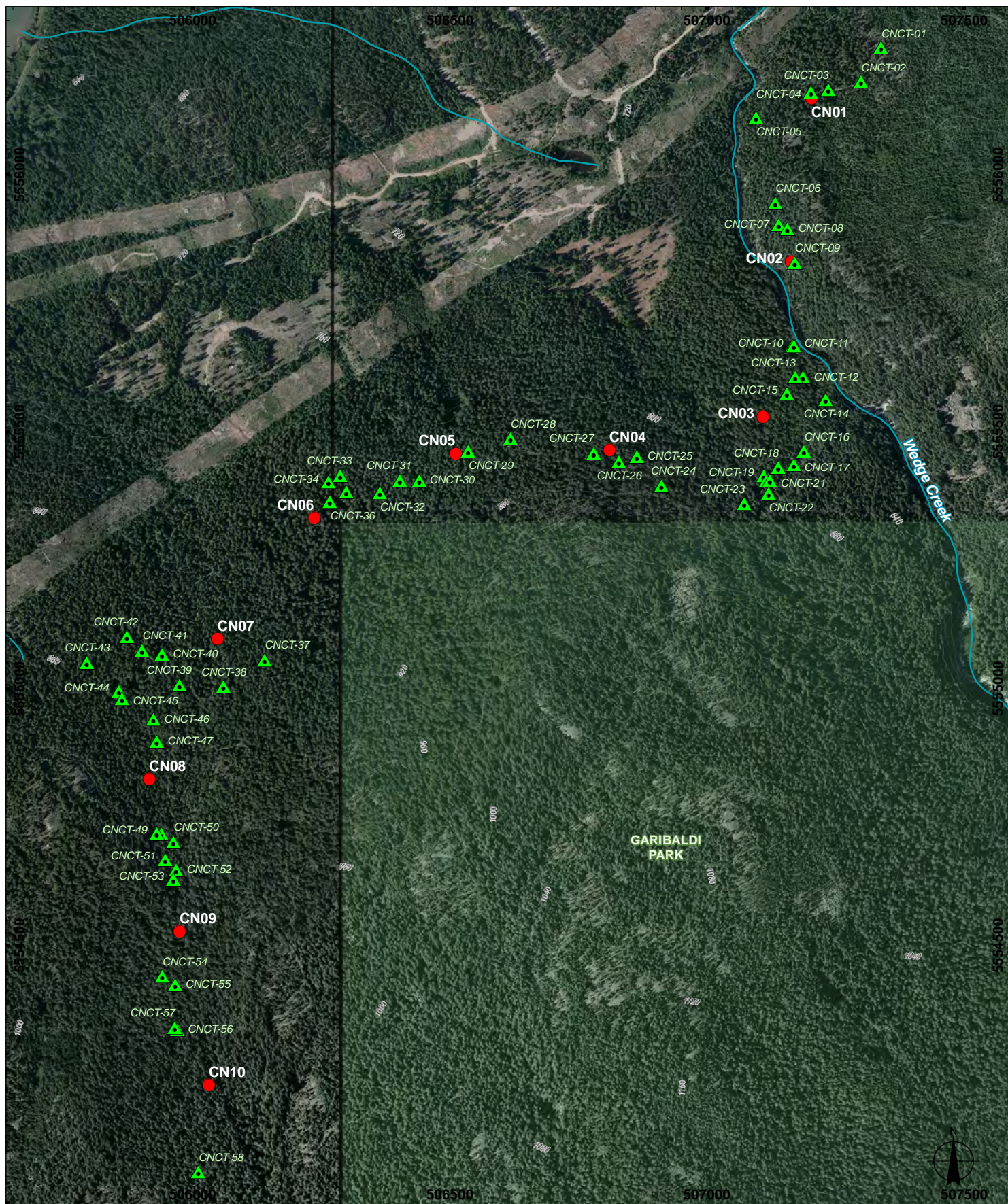


FIGURE 48. Distribution of Pileated Woodpeckers and cavity trees, Comfortably Numb, 2016

Project: Annual Monitoring	Client: RMOW
<div> <div>0 50 100 150 200 250</div> <div>+++++</div> <div>METRES</div> </div>	
Scale: 1:8,500	NAD 83 UTM 10 N

LEGEND

- Pileated Woodpecker Survey Station 2016
- ▲ Cavity Tree 2016

NOTES

1. Elevation contours displayed in metres (above sea level) at 10 m (40 m index) intervals
2. Data Sources: Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government License - British Columbia, 2016. Other base data provided by RMOW.

DRAWN: B. Elder

Project: 160251

CHECKED: B. Matsuda

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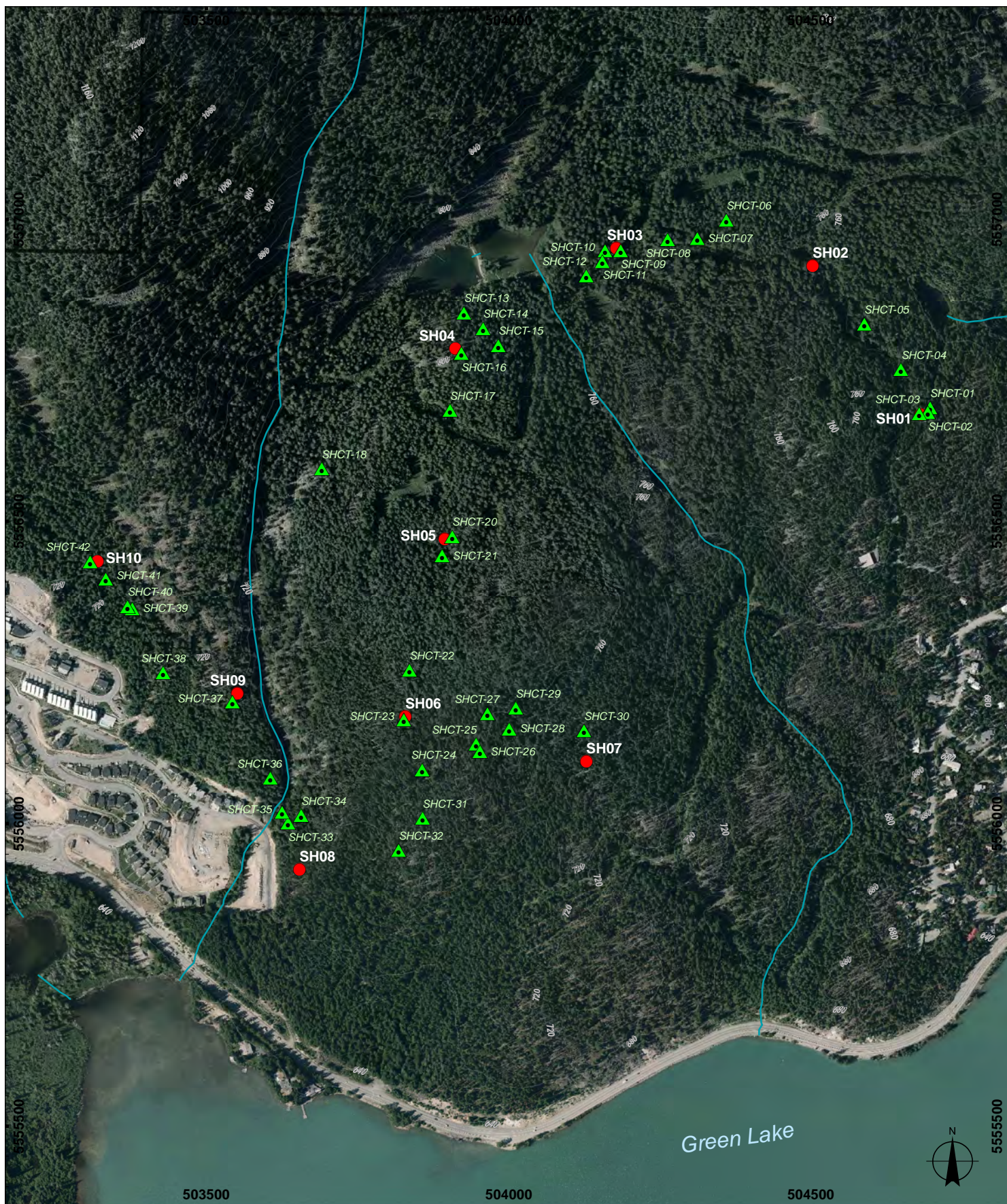


FIGURE 49. Distribution of Pileated Woodpeckers and cavity trees, Shit Happens, 2016

Project: Annual Monitoring	Client: RMOW
Scale: 1:8,500 NAD 83 UTM 10 N	

LEGEND

- Pileated Woodpecker Survey Station 2016
- ▲ Cavity Tree 2016

NOTES

1. Elevation contours displayed in metres (above sea level) at 10 m (40 m index) intervals
2. Data Sources: Legally Defined Administrative Areas of BC; Freshwater Atlas; BC Parks, Ecological Reserves, and Protected Areas all licensed under the Open Government License - British Columbia, 2016. Other base data provided by RMOW.

DRAWN: B. Elder

Project: 160251

CHECKED: B. Matsuda

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The distribution of cavity trees by diameter shows that almost half (47%) of the cavity trees on the Comfortably Numb transect were 60 cm or larger, and two-thirds (68%) were 50 cm or larger (Table 31). The size of all trees on the Shit Happens transect were smaller which reflects drier growing conditions. As a result, far fewer (45% vs. 68%) of the cavity trees had diameters 60cm or larger. The smallest cavity tree, on Shit Happens, was 25cm. Only five other trees less than 35cm were recorded: two on Comfortably Numb and one on Shit Happens.



Figure 50. A male Pileated Woodpecker on Shit Happens trail



Figure 51. A partially excavated cavity, likely for nesting or roosting.

Table 31. Diameter of cavity trees by transect.

Diameter	Comfortably Numb		Shit Happens	
	No.	%	No.	%
<40 cm	8	14%	11	26%
40-59 cm	11	19%	12	29%
50-59 cm	12	21%	10	24%
60+ cm	27	47%	9	21%
<i>Total</i>	58		42	

The proportion of cavity trees by decay class was consistent between the two sites. Over half of all cavity trees were live (Table 32). Though not consistently noted in the field, virtually all (if not all) western redcedar were hollow. This finding is consistent with previous tree ring studies in the RMOW.¹³ A surprisingly high percentage of western redcedar cavity trees (94%) were live, and these account for over half of all live canopy trees recorded.

Table 32. Cavity trees by species and decay class (Fenger et al. 2006). Three trees have not been included since extensive decay prevented confirmation of species.

	Live (class 1,2)		Snag (class 3,4,5)		Stub (class 6,7,8)		
Species	No.	%	No.	%	No.	%	Total
Black cottonwood			1	100%			1
Amabilis fir			1	50%	1	50%	2
Western redcedar	32	94%	2	6%			34
Douglas-fir	7	29%	4	17%	13	54%	24
Western hemlock	15	47%	9	28%	8	25%	32
Lodgepole Pine	2	50%	1	25%	1	25%	4
All Species	56	58%	18	19%	23	24%	97

More than three-quarters (77%) of all cavity trees had a least one cavity with a vertical opening (height) of at least 7.5cm (Table 33), a size above which only Pileated Woodpeckers are the likely excavator. That is, at least that proportion of trees had cavities excavated by Pileated Woodpeckers, and the number is actually higher since some of the holes classed as small were rectangular and were likely also excavated by this species. This proportion remained mostly consistent regardless of the size (diameter) of the canopy tree.

Table 33. Number of cavities with a vertical opening (height) of at least 7.5cm, a size above only Pileated Woodpeckers are the likely excavator, by diameter of cavity tree.

		At Least One >7.5 cm		5 or more >7.5cm	
Tree Diameter		No.	%	No.	%
<40 cm	Yes	15	79%	9	47%
	No	4	21%	10	53%
40-59 cm	Yes	19	83%	11	48%
	No	4	17%	12	52%
50-59 cm	Yes	14	64%	12	55%
	No	8	36%	10	45%
60+ cm	Yes	29	81%	16	44%
	No	7	19%	20	56%
All sizes	Yes	77	77%	48	48%
	No	23	23%	52	52%

¹³ B. Brett, unpubl. data.

Snags were most likely (95%) to have at least one cavity probably excavated by a Pileated Woodpecker (Table 34). Far more snags than live trees (79% vs. 38%) had more than five cavities, which is expected because: (a) excavations would be easier in decayed wood; (b) there would be more wood-decaying insect prey such as carpenter ants; and (c) the tree would likely either be older or be standing decayed for longer.

Table 34. Number of cavities with a vertical opening (height) of at least 7.5cm, a size above only Pileated Woodpeckers are the likely excavator, by decay class.

Decay Class		At Least One		5 or more	
		No.	%	No.	%
Live (class 1 & 2)	Yes	42	75%	21	38%
	No	14	25%	35	63%
Snag (class 3 to 5)	Yes	18	95%	15	79%
	No	1	5%	4	21%
Stub (class 6 to 8)	Yes	17	68%	12	48%
	No	8	32%	13	52%
All sizes	Yes	77	77%	48	48%
	No	23	23%	52	52%

One observation regarding cavities is that not all appear to have been caused by woodpeckers, for example, one small (ca. 4.5cm diameter) hole that was apparently caused by the decay of a branch stub. This hole was 1.5m above the ground in a 75cm diameter Douglas-fir. During the survey, a small bird (probably a Pacific Wren, but it was not a clear view) flew out.

Density of Cavity Trees

Each transect included an area of approximately 10.8 hectares (10 stations at 300m spacing x 20m x 2 sides). There were therefore approximately 5.4 cavity trees per hectare on the Comfortably Numb transect and 3.9 cavity trees per hectare on the Shit Happens transect. These are the first such numbers for the Whistler area so their significance is unknown, for example, how these numbers compare to younger forests and different stand compositions. It is however likely that stands that don't include live and dead trees larger than 50cm, or older trees (giving more time for cavities to be excavated) will have fewer cavity trees.

3.5 Terrestrial Species

3.5.1 Winter Tracking

Overall there were five mammal species detected during the winter tracking survey among the three sites (Table 35). Old Grouse tracks (species unknown; Figure 52) were also observed at Bob's Rebob but are not included as the emphasis was focused on mammals. The River Runs Through It site yielded the most animals and highest diversity, with five species detected whereas Millar's Pond only indicated the presence of Douglas Squirrel (*Tamiasciurus douglasii*). The Douglas Squirrel was the most common species in all three sites (Figure 53). For predators, a single Bobcat (*Lynx rufus*; Figure 54) was detected

in Bob's Rebob and River Runs Through It, with four sets of Coyote (*Canis latrans*; Figure 55) tracks observed in River Runs Through It. However, it is possible that one or more of the Coyote tracks may have been from the same animal. Coyote tracks can usually be distinguished from domestic dog tracks based on movement pattern. Dog tracks are usually erratic with no apparent pattern or rhythm reflective of their playful tendency in snow conditions whereas wild canine tracks are usually more purposeful and consistent in direction. Several domestic dog tracks were also observed during the surveys (and dogs were also visually seen) but were not counted as part of the survey. Voles tracks (Figure 56) could only be identified as vole, most likely Red-backed Vole based on the summer trapping at these sites. These tracks are distinguishable from mice as tail trails would appear in mouse tracks. Snowshoe Hare (*Lepus americanus*) tracks (Figure 57) are usually the most distinctive tracks given the typical appearance of three snow imprints due to their hopping movement. These were observed in Bob's Rebob and River Runs Through It.

Table 35. Mammal species detected at each site during the winter tracking surveys.

Species	Millars Pond	Bob's Rebob	River Runs Through It	Total
Douglas Squirrel	4	3	10	17
Vole Species		2	1	3
Snowshoe Hare		2	3	5
Bobcat		1	1	2
Coyote			4	4
Site Total	4	8	19	31



Figure 52. Old grouse tracks at Bob's Rebob.



Figure 53. *Douglas Squirrel tracks leading to hole in snow at River Runs Through It*



Figure 54. *Bobcat tracks showing distinctive paw prints at River Runs Through It.*



Figure 56. Coyote tracks in River Runs Through It



Figure 55. Vole tracks in Bob's Rebob



Figure 57. Snowshoe Hare tracks in River Runs Through It

Despite conducting only one winter tracking session, our observations yielded a higher diversity and nearly half as many total animals than multiple small mammal trapping sessions. Given more winter tracking sessions, it is highly likely that more predator species would have been detected, such as mustelids (D. Power, personal communication). Similar to the small mammal trapping sessions, the River Runs Through It site had the highest diversity of species detected although Millar's Pond yielded the most individuals, almost exclusively Red-backed Voles which interestingly were not detected there during the winter tracking sessions. This may possibly reflect a different species of vole detected during the winter tracking sessions, or site conditions influencing behavioral differences between the sites, or may simply be a reflection of only having conducted one winter tracking session with the likelihood that voles would have been detected in the Millar's Pond site given more sampling sessions there.

The higher diversity in the River Runs Through It site is likely a reflection of habitat conditions there or the surrounding habitat which is highly variable. It is the only site which has a riparian zone relatively close by with the river flowing within 50 m near the first two stations and two stations amidst a moist forest which is likely flooded during the rainy season. As such, the variable habitats will cater to a broader range of species using the area, particularly those associated or dependent on riparian zones.

Regardless it can be seen that winter tracking is a worthwhile, efficient, and hence cost-effective means of surveying for mammals while also being less intrusive and stressful on the animals. Results described above demonstrate the effectiveness of this technique for detecting elusive and rarely seen mammals with significantly less sampling effort and time than small mammal trapping.

3.5.2 Pileated Woodpecker

Of the seven sites surveyed, Pileated Woodpeckers were detected at the three locations which were the largest forested tracts with suitable habitat for the species: Comfortably Numb, Emerald Forest and Shit Happens (Table 36). All detections were confirmed by visual observation as males flew in and began drumming in response to call playback (Figure 58). The other four call transects varied in size from 1-3 stations along the transect and were located in more disturbed habitat with roads or housing in close proximity. As such, habitat was much more fragmented, as indicated by the low number of stations located on these transects. However, given the number of large old trees and adjacent old growth patches, we felt it prudent to survey the area to flush out any Pileated Woodpeckers potentially occurring in the vicinity.

Table 36. 2016 Pileated Woodpecker survey detections.

Transect	Date Surveyed	Survey Station Detections (UTM Locations)	Comments
Comfortably Numb	May 18, 2016	<ul style="list-style-type: none"> Station CN03: 10U 507108 5555529 	<ul style="list-style-type: none"> Flew in and began drumming; could hear another PIWO drumming in the distance
Emerald Forest	May 17, 2016	<ul style="list-style-type: none"> Station EF09: 10U 500488 5553581 	<ul style="list-style-type: none"> Flew in after drumming call played.
Shit Happens	May 26, 2016	<ul style="list-style-type: none"> Station SH01: 10U 504680 5556678 Station SH02: 10U 504502 5556923 	<ul style="list-style-type: none"> Flew in and began drumming Likely same male as last station

		<ul style="list-style-type: none"> • Station SH03: 10U 504977 5556593 • Station SH04: 10U 503911 5556796 • Station SH05: 10U 503893 5556472 	<ul style="list-style-type: none"> • Likely same male following us • Different bird; drumming heard in distance • Heard call, visual sighting, then drumming
--	--	--	---



Figure 58. Male Pileated Woodpecker drumming on tree in response to call playback on the Comfortably Numb trail

The detections came as little surprise given the habitat conditions for woodpeckers (e.g., number of snags and availability of large, old trees). There were also several trees with Pileated Woodpecker excavations along the transect indicating Pileated Woodpecker activity (Figure 59 and Figure 60). Details regarding these cavity trees were recorded and are discussed in more detail in Section 3.4.2.



Figure 59. Bob Brett examining a Pileated Woodpecker cavity excavation in a Western Redcedar tree on the Emerald Forest Trail



Figure 60. Close-up of Pileated Woodpecker cavity excavation on the Emerald Forest Trail.

Prior to starting the surveys this year, we had anecdotal reports from local residents about Pileated Woodpecker seen or heard in various locations throughout Whistler village further indicating that the species is common throughout the valley. The lack of Pileated Woodpecker detections in 2015 (Cascade 2016) is likely a consequence of the surveys being conducted in September rather than during the spring breeding season when males are establishing territories and seeking out mates. There were other anecdotal reports of woodpecker activity during 2016, some of which are included below (Table 37).

Table 37. Some anecdotal sightings of Pileated Woodpeckers or signs of activity in 2016.

Date	Location	Easting	Northing	Observer	Notes
April 18	Celebration Plaza	503245	5551918	Bob Brett	Visual. NE edge of paved area on topped Cw snag
Unknown	Celebration Plaza	503245	5551918	Heather Beresford	Visual. Likely same PIWO as above; and same tree
May 11	Panorama Ridge, west of thinning site, in forest	502095	5550593	Bob Brett	Heard PIWO uphill of houses in forest
Early May	Nesters Road	503062	5552694	Kimberley Eisenberg	Male (likely); territorial packing on metal roof
Early May	North end of Blueberry Trail, near Barnfield	501969	5552255	Tara Schaufele	Visual?

Date	Location	Easting	Northing	Observer	Notes
Mid-April	Near Central Scrutinizer trail, Lost Lake	504145	5554140	Kristina Swerhun	Visual? Approximate UTM
Mid-May	Drifter Way and Alpine Dr.	502154	5554754	Julius	"Lots of activity;" approximate UTM
May 17	Yummy Mummy @ Comfortably Numb	505618	5554268	Bob Brett	Many PIWO cavities

3.5.3 Small Mammals

Small mammal trapping yielded a total of 63 specimens over the six trapping sessions amongst the three sites (Table 38). The Red-backed Vole (Figure 61 and Figure 62) was the most common species caught followed by *Peromyscus* sp. (field mice). The Millar's Pond site had the greatest number of overall captures followed by River Runs Through It. This is not surprising given that the Millar's Pond site was the oldest and least disturbed of all the trapping sites. Populations have been able to proceed undisturbed in this habitat allowing a dynamic equilibrium to establish over time with regard to ecosystem processes and species interactions. The River Runs Through It site has a large riparian component so it would also be expected to sustain a diversity of species particularly those with some form of riparian dependency. The Red-backed Vole was the most common and abundant mammal caught, predominantly at Millar's Pond. This is unsurprising as the species is typically a forest-dependent species, particularly older forest, so they would be expected to be caught there. However, without a monitoring program designed to be long-term, their presence and abundance provides no insight beyond the fact that they prefer forested habitats over more open areas in contrast to other vole species which occur in more open areas.

Table 38. Small mammal captures among the three monitoring sites.

Species	Millar's Pond	River Runs Through It	Bob's Rebob	Total
Red-backed Vole	27	4	5	36
<i>Peromyscus</i> sp.	0	16	5	21
Shrew (<i>Sorex</i> sp.)	2	3	1	6
<i>Total</i>	29	23	11	63



Figure 61. Measuring a captured Southern Red-backed Vole at the Millar's Pond site.



Figure 62. A captured Southern Red-backed Vole at the Millar's Pond site.

Comparing trap efficacy, the Longworth/Little Critter traps significantly out-performed the other two traps similar to the findings by Jung (2016) (Table 39). There were no captures in the tomahawk traps so they are not indicated in the Table 39. The tomahawk traps were used mainly to target Flying Squirrels in which activity tends to increase over the winter months, so it is possible that the squirrels still had sufficient food in the upper canopy and did not venture down to ground level for foraging which occurs during periods of limited food availability usually during the winter (D. Ransome, BCIT, pers. comm.). Since trapping was shut down at the end of September due to lack of student resources to proceed with trapping over the most active period for flying squirrels, this task could not be conducted.

Table 39. Small mammal capture numbers by trap type within each study site.

Date	Site	Species ¹⁴	Longworth	Sherman	Total
May 28, 2106	Millar's Pond	Red-backed Vole	4		4
June 18, 2016	Millar's Pond	Red-backed Vole	3	1	4
	River Runs Through It	<i>Peromyscus</i> sp.	3		3
July 19, 2016	Millar's Pond	Red-backed Vole	3		3
	River Runs Through It	<i>Peromyscus</i> sp.	4	2	6
	Bob's Rebob	<i>Peromyscus</i> sp.	1		1
August 13, 2016	Millar's Pond	Red-backed Vole	5		5
		Shrew (<i>Sorex</i> sp.)	1		1
	River Runs Through It	<i>Peromyscus</i> sp.	1	1	2

¹⁴ Since the Keen's Mouse (*Peromyscus keenii*) and Deer Mouse (*Peromyscus maniculatus*) cannot be morphologically distinguished (Nagorsen 2005), they are identified to genus only. Shrew identification is equally difficult, and four mortality samples are awaiting identification confirmation by Dr. Doug Ransome.

Date	Site	Species ¹⁴	Longworth	Sherman	Total
	Bob's Rebob	Shrew (<i>Sorex</i> sp.)	1		1
		Red-backed Vole	2		2
		<i>Peromyscus</i> sp.	2		2
		Shrew (<i>Sorex</i> sp.)		1	1
August 27, 2016	Millar's Pond	Red-backed Vole	6	1	7
	River Runs Through It	Red-backed Vole	1		1
		<i>Peromyscus</i> sp.	1	3	4
		Shrew (<i>Sorex</i> sp.)	1		1
	Bob's Rebob	Red-backed Vole	2		2
		<i>Peromyscus</i> sp.	1		1
September 11, 2016	Millar's Pond	Red-backed Vole	3	1	4
		Shrew (<i>Sorex</i> sp.)	1		1
	Bob's Rebob	Red-backed Vole		1	1
		<i>Peromyscus</i> sp.	1		1
	River Runs Through It	Red-backed Vole	3		3
		<i>Peromyscus</i> sp.	1		1
		Shrew (<i>Sorex</i> sp.)	1		1
		Total Captures	52	11	63

Overall, the small mammal data offered no surprises in terms of captures. Apart from the sampling conducted during the previous monitoring studies (Cascade 2014, 2015, 2016), there has been substantial small mammal trapping conducted during the 10 years of Whistler BioBlitzes (e.g., Matsuda 2011) so small mammal diversity is well-documented in the Whistler valley.

There have been 24 species of rodents, 6 species of insectivores (i.e., non-bat species such as shrews and moles) recorded in Whistler (Brett 2016). At this point, further small mammal trapping would be redundant unless intensified for specific purposes (e.g., evaluation of response to a specific activity or locale) or consistently conducted over the long-term to monitor population fluctuations over time. For the purposes of this work, three years is insufficient in terms of monitoring small mammals unless intensified and replicated, which budget constraints do not allow.

3.6 Species at Risk

There are 68 confirmed species at risk in the RMOW, another 9 are likely and 23 are possible or uncertain (Table 40; Brett 2016a). Of the known (confirmed) species, 16 are vertebrates, two are butterflies, 22 are vascular plants, mosses, and liverworts, and 19 are lichens. The only species at risk dealt with directly by the Ecosystem Monitoring Program since 2013 are Bull Trout and Coastal Tailed Frog, both of which are Blue-listed in BC.

Table 40. Species at risk by group and confirmed or likelihood of being resident in the RMOW (Brett 2016a, Table 3.4).

Group 1	Group 2	Resident in Whistler			Total
		Yes	Likely	Poss./Unc.	
Vertebrates	Amphibians	3	0	0	3
	Birds	9	0	0	9
	Fishes	1	0	0	1
	Mammals	5	0	3	8
Invertebrates	Butterflies	2	0	1	3
	Snails & Clams	0	1	3	4
Plants	Vascular	7	0	6	13
	Mosses	15	3	7	25
	Liverworts	8	2	1	11
Lichens	Lichens	19	3	2	24
	<i>Total</i>	69	9	23	

Once the RMOW establishes priorities for Species at Risk, these priorities (new detections, monitoring populations, and/or monitoring habitats) could be included in the Environmental Monitoring Program.

Northern Goshawk (*Accipiter gentilis ssp. laingii*)

A Northern Goshawk nest was found uphill of Millar's Pond during mammal trapping on May 20, 2016, and was monitored throughout the season as two chicks eventually fledged (Figure 63 and Figure 64). This nest is a significant find. It is the first confirmed breeding of Northern Goshawk in Whistler and one of few nest sites documented in the South Coast Region¹⁵ (Frank Doyle, Wildlife Dynamics Consulting, pers. comm.). Northern Goshawks are Red-listed and identified Wildlife in BC, and listed as Threatened by the Species At Risk Act (SARA). They typically nest in old forests that are much larger than the small remnant patch at Millar's Pond. The nest was in the crotch of a southeast facing branch, approximately 14m above the base of a 73cm (diameter at breast height) Douglas-fir (UTM 499597E 5548212N).

¹⁵ Although the Whistler bird list (Ricker et al. 2014) lists Northern Goshawk as a confirmed breeding bird, the one Breeding Atlas record upon which that designation was based is actually in the Upper Squamish Valley (Marcia Danielson, pers. comm.).



Figure 63. Northern Goshawk at Millar's Pond, June 9, 2016.



Figure 64. Northern Goshawk on nest at Millar's Pond, June 12, 2016.

3.7 Climate

The climate indicator chosen for the first three years of the Ecosystem Monitoring Program was the date of spring thaw for Alta Lake. Data was compiled from various sources, most recently by the Alta Lake Ice Break Up Raffle, a fundraiser for The Point Artist-Run Centre. Historic records span from 1942 to 1973 and The Point's newer records started in 2005. Cascade (2016; Appendix H) lists dates through to 2014. Stephen Vogler (pers. comm.) from The Point provided the last two dates for spring thaw on Alta Lake: The last two dates for spring thaw on Alta Lake were:

- March 7, 2015, 8:30 pm.
- March 16, 2016, 3:25 pm.

A number of observations can be made from these data (1942-1973; 2005-2016):

- The earliest melt between 1942 and 1973 was April 6, 1970.
- Approximately two-thirds (22 of 31) in that period of thaw dates were April 20th or later, of which eight occurred in May. The latest melt was May 21, 1952.
- In contrast, the latest thaw between 2005 and 2014 was April 28, 2008 and the earliest was February 20, 2014.
- Based on the cold winter so far in 2016/17, it is likely that ice melt will be later than in the past two years and more in line with historic dates.
- These data are suggestive but not conclusive that winters are shorter now than in the middle of the last century. A summary of temperature data for that period would help corroborate if there is a long-term warming trend.

4. Recommendations

4.1 Aquatics

Key recommendations:

- Continue with benthic invertebrate sampling program on an annual basis (same sites and sampling method). Rationale: The CABIN sampling ensured a standardized and repeatable approach, and continued monitoring of benthic invertebrate communities is expected to identify any changes in aquatic ecosystem health.
- Add water temperature loggers to Crabapple (EF site) and Twentyone Mile Creeks
- Continue conducting single pass fish sampling for one additional year to confirm whether three pass sampling is required and if so, at what frequency (i.e. every three years). This level of resolution is considered adequate to identify changes in the fish community composition and abundance.
- Use single pass electrofishing method (no stop nets) for fish sampling to estimate relative abundance and CPUE at study sites (Crabapple Creek, 21 Mile Creek, Jordan Creek). Rationale: Multiple pass depletion (closed site) method to calculate fish densities and population estimates requires meeting the assumptions of equal effort, equal probability of capture, and consistency of effort (between passes, sites, and years). Meeting these assumptions may be difficult if different crew members are employed, and at some sites (e.g. Twentyone Mile Creek) stop-net setup is difficult (wide channel, fast/deep water). Single pass electrofishing covering a larger area within each study creek will provide information on fish species presence/absence, fish community composition, relative abundance, and fish condition.

4.2 Beavers

- The 2016 surveys were a strong start towards completing a full census of beavers in the Whistler Valley in 2017.
- The River of Golden Dreams in particular needs to be surveyed more thoroughly, ideally more than once.
- Wetland habitats should be targeted for thorough searches due to the role of beaver activity in maintaining or creating habitat.
- An additional measure of beavers and their impact on the landscape would be a GIS-based map showing all wetlands that have been created and maintained by beavers.
- Expand opportunities for local residents to report before activity by restarting the “Have You Seen a Beaver” campaign.
- More direct observations of beaver activity should be a goal for 2017.

4.3 Coastal Tailed Frogs

- Continue to survey four stream systems each year, but institute a rotating schedule that includes systems monitored in the past four years (2013 to 2016) and adds new systems, e.g., (i) streams

previously confirmed as having tadpoles (Wind 2006 to 2009), (ii) those in which none were detected, and (iii) sites that have not yet been surveyed. The long-term goal is to establish monitoring at the landscape level that also captures changes in abundance within individual streams. Stream systems that have had relatively stable results over the past four years such as Alpha and Scotia Creeks could be replaced in 2017 by other streams and moved to rotation of surveys every two to five years.

- Where changes have been noticed, surveys each year should be continued. For example, the deposition of sand and small gravel on Archibald Creek caused by mountain bike trails and noted in 2016 is a potential concern for aquatic habitat. Tailed Frog surveys should continue on this system for at least the next two years to monitor population trends. The mountain bike park extended to the Whistler Creek drainage in 2015. Although no deposition was noted in the creek in 2016, this system should also be monitored annually for at least two more years, then on rotation if no changes are noted.
- If possible, add streams on the west side of Whistler Valley, e.g., on Sproatt and Rainbow Mountains. Side drainages of Twentyone and Nineteen Mile Creeks (in which dip nets will be appropriate) should be priorities as well as any other streams with enough flow in late August to allow detections of tailed frogs.
- Adopt the timed search approach with the goal of maximizing detections. All data should continue to be reported as both total captures per reach as well as captures per unit area (m²). As more data accumulates, a better idea of possible source and sink populations may be possible, at which time the overall approach could be modified.

4.4 Terrestrial Habitat – Cavity Trees

- Rough estimates of size classes are adequate but should include more detail on shape. Medium to large round holes (for nesting and foraging) are of particular interest but were only noted sporadically in the 2016 survey.
- Data from other old, mature, and young forests should be collected and compared with the goal of determining the availability of cavities across stand types.
- The role of foraging cavities in providing secondary habitat is unclear. Future work should include an expanded literature and consultation with additional experts to confirm what is known.
- The role of cavities created by other primary excavators (especially “strong” excavators) should be explored.

4.5 Terrestrial Habitat – Carabid Beetles

As previously mentioned, the Carabids found during this sampling did not yield any information, apart from two new species being detected, that can be used to draw any inferences of ecosystem responses. As such, we recommend that Carabid sampling be discontinued or replaced with species more indicative of ecosystem responses (e.g., dragonflies, butterflies).

4.6 Pileated Woodpeckers

Although we detected Pileated Woodpeckers during our surveys, the detections came as no surprise as we expected to find them where we did. The lack of detections from previous studies (Cascade 2016) simply reflects surveys being conducted at an inappropriate time of year. Pileated Woodpecker excavations are common throughout the forested areas of Whistler, and our detections confirmed their presence, which can be assessed based on cavity surveys alone.

4.7 Small Mammals

Given that the small mammal trapping results did not yield any further useful information that we did not already know or would expect to see given our knowledge of the habitats and life history of the small mammals known to occur in the area, we recommend that the small mammal trapping be replaced with targeting species that provide more useful information about the ecosystem processes and health.

One possible species is the live trapping of the Northern Flying Squirrel (*Glaucomys sabrinus*). Flying squirrels are an important link between below-ground soil processes, tree health, and aerial predators. Abundance of Northern Flying Squirrels appears to be strongly linked to abundance of food (Ransome and Sullivan 2004). Their primary diet are the fruiting bodies of hypogeous fungi (McKeever 1960; Maser et al., 1978a,b, 1985, 1986). All commercially-important tree species require a healthy mycorrhizal relationship with hypogeous fungi (Maser et al., 1978a,b, 1985, 1986). Thus, a healthy abundance of Northern Flying Squirrels may be positively-related to the health of forests. In addition, given their nocturnal nature, they comprise a strong component of the diet of nocturnal predators, like owls. For example, Northern Flying Squirrels are the primary diet of Northern Spotted Owls (*Strix occidentalis caurina*; Carey et al., 1992; Forsman et al., 1984).

The single winter tracking session provided more information on habitat use by mammals than multiple small trapping sessions which did not yield anything new with regard to small mammal habitat use. Given the number of small mammal studies that have been conducted in the Whistler area (e.g., Whistler BioBlitzes, Matsuda 2011), these populations tend to be well-known, including habitat types and species diversity. Winter tracking provides a more useful, cost-effective and less intrusive means of detecting both large and small mammals, particularly predators which are rarely seen under the best of conditions. It would be recommended that winter tracking surveys be intensified with more sampling sessions possibly combined with winter squirrel trapping if staffing resources allow, as both can be conducted simultaneously at the same sites and provide insight on mammal habitat use that has not been thoroughly assessed in Whistler Valley.



5. Certification

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

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Appendix A

Benthic Invertebrate Taxonomy Results

Appendix A: Benthic Invertebrate Taxonomy

	Lifestage	Site				
		Jordan Creek	Crabapple Creek	21 Mile Creek	River of Golden Dreams	
		JOR-DS-AQ31	CRB-DS-AQ01	21M-DS-AQ21	RGD-US-AQ11	RGD-DS-AQ12
		03-Aug-16	02-Aug-16	03-Aug-16	03-Aug-16	05-Aug-16
Order: Acarina		0	0	0	0	0
Family: Hydrachnidae	adult	25	100	40	19	84
		0	0	0	0	0
Order: Araneae	adult	0	10	0	0	0
		0	0	0	0	0
Order: Collembola	adult	0	10	0	0	0
		0	0	0	0	0
Order: Psocoptera	adult	6	0	0	0	0
		0	0	0	0	0
Order: Coleoptera		0	0	0	0	0
Family: Dytiscidae		0	0	0	0	0
<u>Hygrotus</u>	adult	0	0	0	0	11
		0	0	0	0	0
Order: Diptera		0	0	0	0	0
Family: Ceratopogonidae	larvae	6	0	10	31	11
Family: Chironomidae		0	0	0	0	0
Subfamily: Chironominae		0	0	0	0	0
Tribe: Tanytarsini	larvae	31	10	5	0	11
Subfamily: Orthoclaadiinae	larvae	181	170	90	19	105
Subfamily: Tanypodinae		0	0	0	0	0
Tribe: Pentaneurini		0	0	0	0	0
<u>Ablabesmyia</u>	larvae	56	0	5	12	89
<u>Ablabesmyia</u>		0	0	10	0	32
Family: Empididae	larvae	13	50	5	19	16
Family: Empididae	pupae	0	0	0	0	5
Family: Simuliidae	larvae	700	170	140	112	16
Family: Simuliidae	pupae	25	0	5	4	0
Family: Tipulidae	larvae	0	20	5	0	0
		0	0	0	0	0
Order: Ephemeroptera		0	0	0	0	0
Family: Baetidae		0	0	0	0	0
<u>Baetis</u>	larvae	56	410	515	392	421
Family: Ephemerellidae		0	0	0	0	0
<u>Drunella spinifera</u>	larvae	0	0	0	4	0
<u>Drunella</u>	larvae	0	0	20	15	237
<u>Serratella</u>	larvae	19	50	0	8	137
Family: Heptageniidae		0	0	0	0	0
<u>Cinygmula</u>	larvae	0	0	130	127	11
<u>Epeorus</u>	larvae	0	0	110	119	0
<u>Rhithrogena</u>	larvae	0	0	0	27	0
		0	0	0	0	0
Order: Neuroptera		0	0	0	0	0
Family: Sialidae		0	0	0	0	0
<u>Sialis</u>	larvae	0	10	0	0	0
		0	0	0	0	0
Order: Plecoptera		0	0	0	0	0
Family: Chloroperlidae		0	0	0	0	0
<u>Sweltsa</u>	larvae	6	550	60	131	5
Family: Leuctridae	larvae	0	10	0	0	26
Family: Nemouridae		0	0	0	0	0
<u>Zapada</u>	larvae	906	1590	325	100	384
Family: Perlidae		0	0	0	0	0
<u>Hesperoperla pacifica</u>	larvae	31	0	0	0	0
Family: Perlodidae		0	0	0	0	0
<u>Megarcys</u>	larvae	0	10	10	19	5
		0	0	0	0	0

Appendix A: Benthic Invertebrate Taxonomy

	Lifestage	Site				
		<i>Jordan Creek</i>	<i>Crabapple Creek</i>	<i>21 Mile Creek</i>	<i>River of Golden Dreams</i>	
		JOR-DS-AQ31	CRB-DS-AQ01	21M-DS-AQ21	RGD-US-AQ11	RGD-DS-AQ12
		03-Aug-16	02-Aug-16	03-Aug-16	03-Aug-16	05-Aug-16
Order: Trichoptera		0	0	0	0	0
Family: Hydropsychidae		0	0	0	0	0
<i>Hydropsyche</i>	larvae	31	0	0	0	26
Family: Limnephilidae		0	0	0	0	0
<i>Onocosmoecus unicolor</i>	larvae + case	0	10	0	0	0
<i>Psychoglypha subborealis</i>	larvae + case	0	0	0	0	5
Family: Rhyacophilidae		0	0	0	0	0
<i>Rhyacophila</i>	larvae	6	10	35	4	5
	Totals:	2100	3190	1520	1162	1642



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GROUP INC.

Appendix **B**

Benthic Invertebrate (CABIN) Sampling Datasheets and Results Reports

Field Crew: IM, TSSite Code: CRB-DS-AQ01Sampling Date: (DD/MM/YYYY) 02/08/2016
~14:30Lower Crabapple
near Lorimer Rd☐ Occupational Health & Safety: Site Inspection Sheet completed**PRIMARY SITE DATA**CABIN Study Name: RMOW Ecosystems Monitoring Local Basin Name: CrabappleRiver/Stream Name: Crabapple Creek Stream Order: (map scale 1:50,000) (2nd ?)Select one: ☒ Test Site ☐ Potential Reference Site**Geographical Description/Notes:** Lower Crabapple Electrofish/benthic site @ Lorimer Rd + south of Crabapple drive upstream of church, ~250m ups of ROAD

Surrounding Land Use: (check those present)

☐ Forest ☐ Field/Pasture ☐ Agriculture
☐ Logging ☐ Mining ☐ Commercial/IndustrialInformation Source: TS, RMOW☒ Residential/Urban Valley trail
☒ Other Recreational

Dominant Surrounding Land Use: (check one)

☐ Forest ☐ Field/Pasture ☐ Agriculture
☐ Logging ☐ Mining ☐ Commercial/IndustrialInformation Source: TS, RMOW☒ Residential/Urban
☐ Other _____**Location Data**Latitude: 50°07.596' N Longitude: -122°58.302' W (DMS or DD)Elevation: 660m (fast or masl) GPS Datum: ☒ GRS80 (NAD83/WGS84) ☐ Other: _____**Site Location Map Drawing**

Field Crew:

IM, TS

Site Code:

CRB-DS-A001

Sampling Date: (DD/MM/YYYY)

02/08/2016

Photos

- ☒ Field Sheet ⁰¹⁰³⁻⁰¹⁰⁸
☒ Upstream ⁰¹⁰⁴
☒ Downstream ⁰¹⁰⁵
☒ Across Site ⁰¹⁰⁶
☐ Aerial View
- ☒ Substrate (exposed) ⁰¹⁰⁷
☒ Substrate (aquatic)
- ☐ 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 %
 ~26%

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 DATAHabitat sampled: (check one) ☒ riffle ☐ rapids ☐ straight run

400 µm mesh Kick Net	<input checked="" type="checkbox"/>
Person sampling	TS
Sampling time (i.e. 3 min.)	3 min
No. of sample jars	2
Typical depth in kick area (cm)	8

Preservative used:

Formalin (Ethyl Alcohol)

Sampled sieved on site using "Bucket Swirling Method":

☐ YES ☒ NOIf 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, TSSite Code: CRB-DS-A001Sampling Date: (DD/MM/YYYY) 02/08/2016**WATER CHEMISTRY DATA** Time: 15:42 (24 hr clock) Time zone: PSTAir Temp: 12.2 (°C) Water Temp: 12.7 (°C) pH: 7.6Specific Conductance: 217.8 (µs/cm) DO: 9.35 (mg/L) Turbidity: 1.55 (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 _____↳ use RMOW
turb. meter

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)1% → Estimate☐ **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 = _____

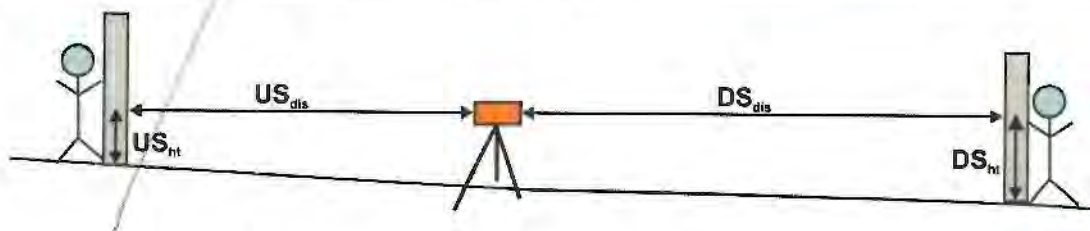
OR

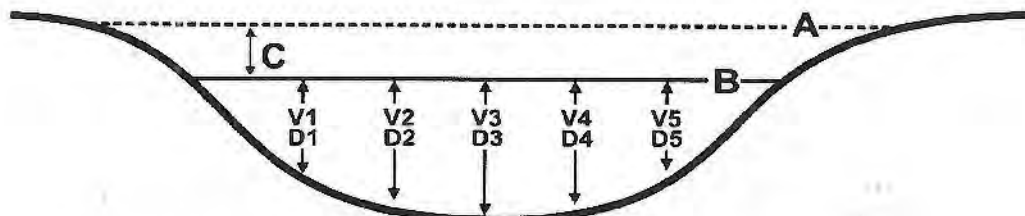
☐ **Measured in field**

Circle device used and fill out table according to device:

a. Survey Equipment b. Hand Level & Measuring Tape

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			$US_{dis} + DS_{dis} =$
^a T-B x 100	$^{a}US_{dis} = T - B$	$^{a}DS_{dis} = T - B$	
Change in height (Δht)			$DS_{ht} - US_{ht} =$
Slope ($\Delta ht / \text{total dis}$)			



Field Crew: IM, TSSite Code: CRB-DS-AQ01Sampling Date: (DD/MM/YYYY) 62/08/2016**Widths and Depth**Location at site: center of sample area (Indicate where in sample reach, ex. d/s of kick area)A - Bankfull Width: 5.2 (m)B - Wetted Stream Width: 3.0 (m)C - Bankfull-Wetted Depth (height from water surface to Bankfull): 58 (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 ☐ OtherDistance from PIN: 1.80 2.2 2.6 3.0 3.4 3.8

	1	2	3	4	5	6	AVG
Distance from Shore (m) (<u>River right</u>)	0.40	0.80	1.20	1.60	2.00	2.40	
Depth (D) (cm)	5	11	12	12.5	6.0	5.0	8.6
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)	0.29	0.46	0.62	0.51	0.05	0.05	0.33

Field Crew:

IM, TS

Site Code:

AQ01

Sampling Date: (DD/MM/YYYY)

02/08/2016

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.
- Embeddedness 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	4.0	26	4.0	51	12.0	76	1.0
2	2.0	27	13.5	52	10.0	77	4.0
3	4.5	28	5.0	53	15.0	78	9.0
4	8.0	29	30.0	54	6.0	79	2.5
5	11.0	30	7.0	55	11.0	80	7.0
6	11.0	31	7.0	56	7.0	81	12.0
7	3.5	32	7.0	57	7.0	82	10.0
8	9.0	33	8.0	58	3.0	83	9.0
9	7.0	34	6.5	59	3.0	84	8.0
10	2.0	35	21.0	60	8.0	85	9.0
11	13.0	36	6.5	61	1.0	86	11.0
12	16.0	37	10.0	62	3.0	87	9.0
13	9.0	38	5.0	63	11.0	88	16.0
14	7.0	39	2.0	64	8.0	89	8.0
15	11.0	40	15.0	65	13.0	90	6.0
16	14.0	41	7.0	66	20.0	91	5.0
17	5.0	42	6.0	67	12.0	92	8.0
18	9.0	43	0.5	68	12.0	93	8.5
19	5.0	44	9.0	69	18.0	94	8.0
20	8.0	45	10.0	70	14.0	95	11.0
21	0.5	46	10.0	71	13.0	96	10.0
22	11.0	47	9.0	72	13.0	97	1.0
23	1.0	48	18.0	73	13.0	98	10.0
24	3.5	49	10.0	74	2.0	99	7.0
25	2.0	50	4.5	75	2.0	100	7.5

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.

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, KB (RP + Lion) Site Code: RGD-ACQ11
 Sampling Date: (DD/MM/YYYY) 03/08/2016 (am)

☐ 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: River of Golden Dreams Stream Order: (map scale 1:50,000) □ ?

Select one: ☒ Test Site ☐ Potential Reference Site

Geographical Description/Notes: SG reading (u/s) = 0.048 m (photo on RP's camera)
River of Golden Dreams, upstream of Crabapple Ch,
Downstream of 21 mile Creek & End of Lorimer Rd*

Surrounding Land Use: (check those present)

☐ Forest

☐ Field/Pasture

☐ Agriculture

☒ Residential/Urban

☐ Logging

☐ Mining

☐ Commercial/Industrial

☒ Other Path + Park (recreation)

Dominant Surrounding Land Use: (check one)

☐ Forest

☐ Field/Pasture

☐ Agriculture

☐ Residential/Urban

☐ Logging

☐ Mining

☐ Commercial/Industrial

☒ Other Path + Park (recreation)

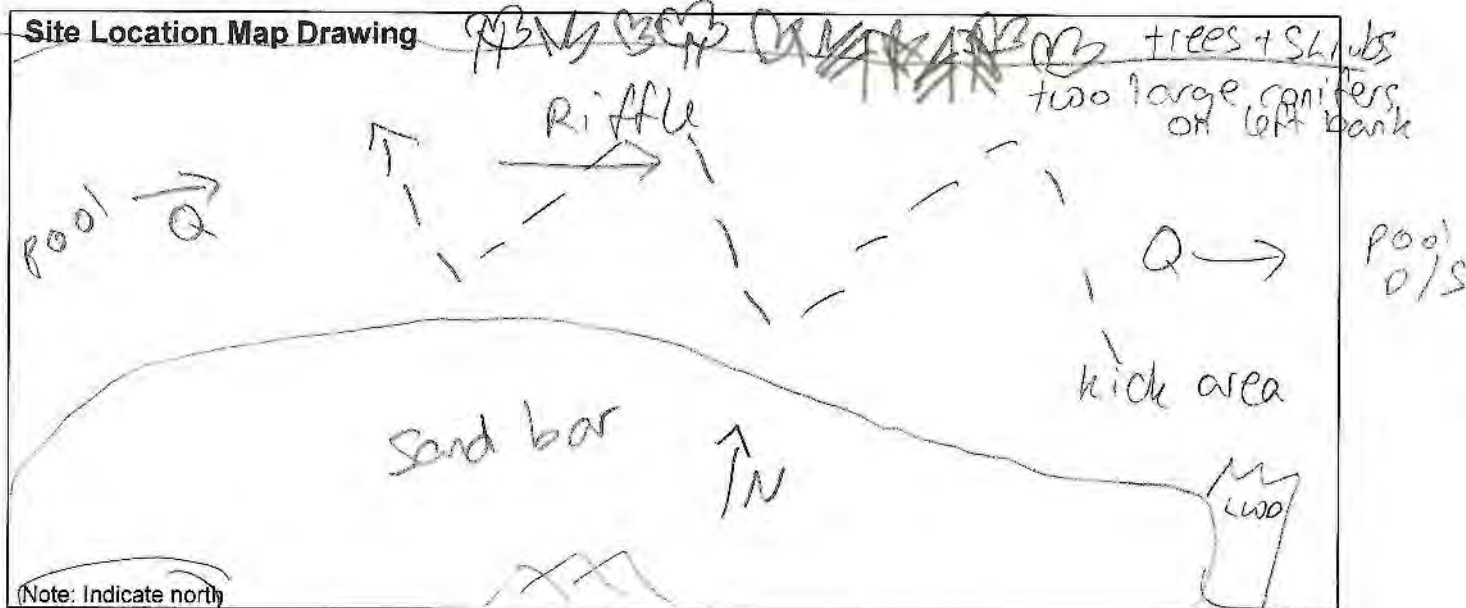
Location Data

Latitude: 50°07.622' N Longitude: -122°58.321' W (DMS or DD)

Elevation: 642 (ft or masl)

GPS Datum: ☒ GRS80 (NAD83/WGS84) ☐ Other: _____

Site Location Map Drawing



Field Crew: IM, RB Site Code: RGD-A011
 Sampling Date: (DD/MM/YYYY) 03/08/2016

Photos			
<input checked="" type="checkbox"/> Field Sheet ¹⁰³⁻⁰¹¹⁶	<input checked="" type="checkbox"/> Upstream ¹¹⁰	<input checked="" type="checkbox"/> Downstream ¹¹¹	<input checked="" type="checkbox"/> Across Site ¹¹²
<input type="checkbox"/> Substrate (exposed)	<input checked="" type="checkbox"/> Substrate (aquatic) ^{113 → 115, and 117}	<input checked="" type="checkbox"/> Other <u>109 - Staff Gauge</u>	

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	<input checked="" type="checkbox"/>
Person sampling	<u>KB</u>
Sampling time (i.e. 3 min.)	<u>3 min</u>
No. of sample jars	<u>1</u>
Typical depth in kick area (cm)	<u>15</u>

Preservative used: Ethyl Alcohol (Formalin)

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: JM, KB Site Code: RGD-AQ 11
 Sampling Date: (DD/MM/YYYY) 03/08/2016

WATER CHEMISTRY DATA Time: 9:20 (24 hr clock) Time zone: PST

Air Temp: 14.8 (°C) Water Temp: 11.7 (°C) pH: 7.35

Specific Conductance: 64 (µs/cm) DO: 8.27 (mg/L) Turbidity: 1.34 (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)

1% → Theodolite App on iPad

☐ **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 =

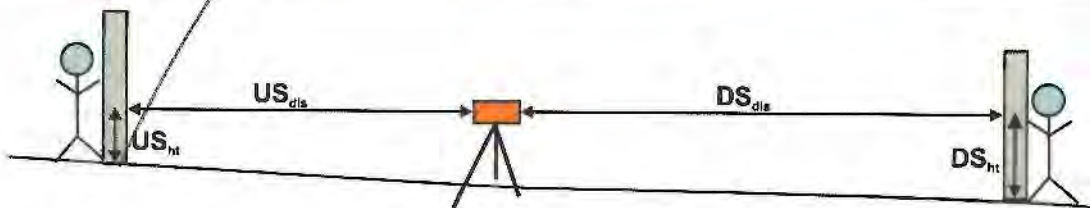
OR

☐ **Measured in field**

Circle device used and fill out table according to device:

a. Survey Equipment b. Hand Level & Measuring Tape

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			US _{dis} +DS _{dis} =
^a T-B x 100	^a US _{dis} =T-B	^a DS _{dis} =T-B	
Change in height (Δht)			DS _{ht} -US _{ht} =
Slope (Δht/total dis)			



Field Crew: IM, KB Site Code: RUD-AQ11
 Sampling Date: (DD/MM/YYYY) 08/08/2016

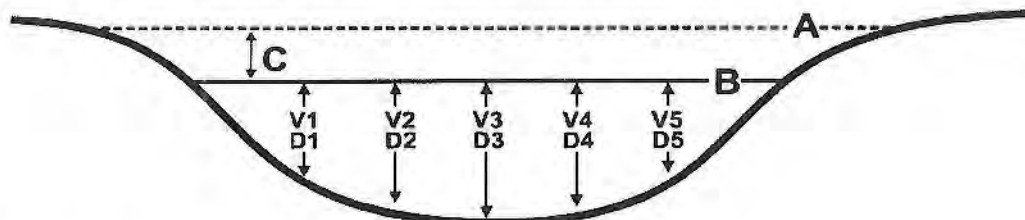
Widths and Depth

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

A - Bankfull Width: 16.8 (m)

B - Wetted Stream Width: 6.8 (m)

C - Bankfull-Wetted Depth (height from water surface to Bankfull): 37 (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

12.5m = RWE

13.5 14.5 15.5 16.5 17.5 18.5

	1	2	3	4	5	6	AVG
Distance from Shore (m)	1.0	2.0	3.0	4.0	5.0	6.0	
Depth (D) (cm)	11	23	28	19	16	15	
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)	0.26	0.60	0.89	0.79	0.53	0.25	

Field Crew: IM, RBSite Code: RCD-AQ11Sampling Date: (DD/MM/YYYY) 03/08/2016**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.
- Embeddedness 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	5.0	26	3	51	1	76	2.5
2	3.5	27	2	52	1	77	5
3	5.0	28	1.5	53	6	78	3
4	2.0	29	3.5	54	2	79	4
5	4.5	30	4.5	55	5.5	80	3.5
6	4.0	31	7	56	0.5	81	5
7	4.0	32	3	57	6.5	82	3.5
8	2.5	33	3.5	58	4	83	10.5
9	4.0	34	5	59	4	84	4.5
10	3.5	35	1.7	60	4	85	3
11	3	36	3.5	61	4.5	86	7
12	1	37	5.5	62	4.5	87	5
13	3	38	8	63	3	88	2.5
14	3	39	2.5	64	4	89	3
15	3.5	40	3.5	65	2.5	90	3
16	3	41	4	66	5.5	91	3
17	2.5	42	3	67	2	92	2
18	2	43	5	68	4	93	7
19	3	44	2.5	69	4	94	5.5
20	2.5	45	4.5	70	3	95	2.5
21	4	46	4	71	6	96	3.5
22	3	47	3	72	2	97	2.5
23	6	48	4	73	2	98	4
24	3.5	49	3.5	74	1.5	99	9
25	12	50	5	75	4.5	100	2

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, KB, RP + Liam Site Code: JOR-DS-AQ31
 Sampling Date: (DD/MM/YYYY) 03/08/2016 (pm) (EF#1)

☐ Occupational Health & Safety: Site Inspection Sheet completed

PRIMARY SITE DATA

CABIN Study Name: Ecosystem Monitoring Local Basin Name: Jordan Creek
 River/Stream Name: Jordan Creek Stream Order: (map scale 1:50,000) 1?
 Select one: ☒ Test Site ☐ Potential Reference Site

Geographical Description/Notes:

Commercial/Industrial consists of CN station, Restaurants and pubs. Turn down @ the husky, then left

Surrounding Land Use: (check those present)

☐ Forest ☐ Field/Pasture ☐ Agriculture ☒ Residential/Urban
☐ Logging ☐ Mining ☒ Commercial/Industrial ☐ Other _____

Information Source: _____

Dominant Surrounding Land Use: (check one)

☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban
☐ Logging ☐ Mining ☒ Commercial/Industrial ☐ Other _____

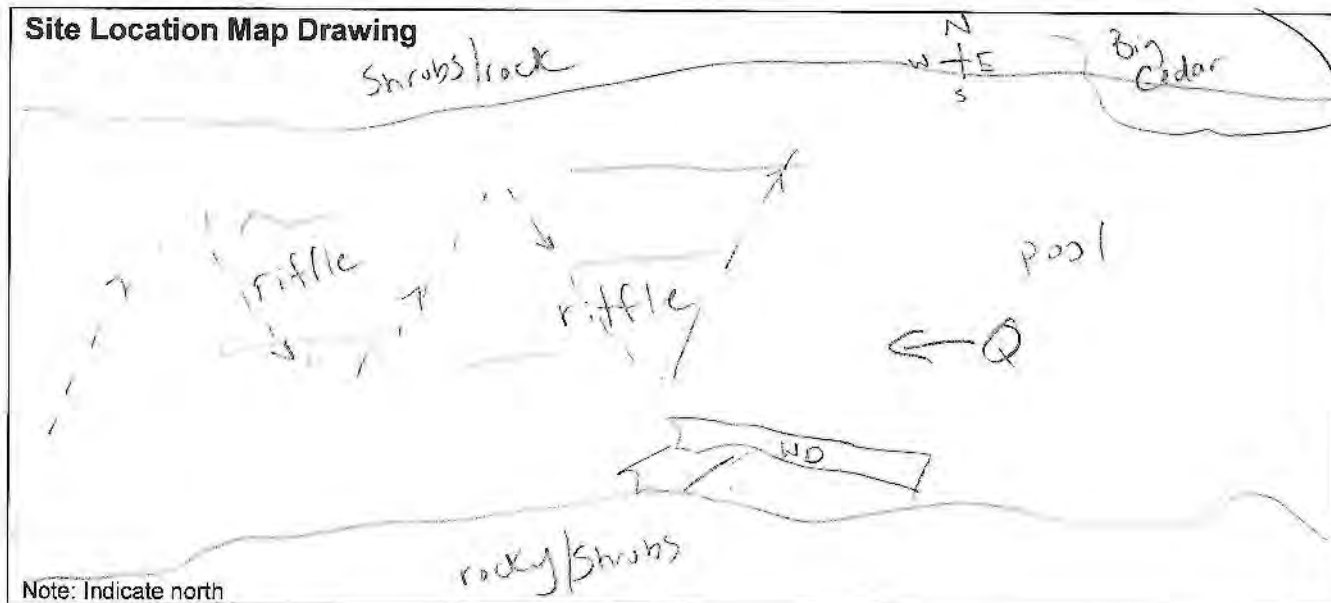
Information Source: _____

Location Data

Latitude: 50°05'12.9" N Longitude: - 122°59'41" W (DMS or DD)

Elevation: 623 (ft or masl) GPS Datum: ☒ GRS80 (NAD83/WGS84) ☐ Other: _____

Site Location Map Drawing



Note: Indicate north

Field Crew: IM, KB, RP Site Code: JOK-DS-A031
 Sampling Date: (DD/MM/YYYY) 03/08/2016

Photos

☐ Field Sheet ☒ ¹⁰³⁻⁰¹²⁸ Upstream ☒ ¹⁰³⁻⁰¹²⁷ Downstream ☒ ¹⁰³⁻⁰¹³² Across Site ☐ Aerial View
☒ ¹⁰³⁻⁰¹²⁹⁻⁰¹³¹ Substrate (exposed) ☐ Substrate (aquatic) ☐ 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 μ m mesh Kick Net	
Person sampling	<u>IM</u>
Sampling time (i.e. 3 min.)	<u>3 min</u>
No. of sample jars	<u>1</u>
Typical depth in kick area (cm)	<u>20</u>

Preservative used: Ethyl Alcohol 10% Formalin

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 μ m mesh kick net is used.

Field Crew: IM, KB, RP + LiamSite Code: JOR-DS-AQ31Sampling Date: (DD/MM/YYYY) 03/08/2016**WATER CHEMISTRY DATA** Time: 14:30 (24 hr clock) Time zone: PSTAir Temp: 17.4 (°C) Water Temp: 15.8 (°C) pH: 7.12Specific Conductance: 63.6 (µs/cm) DO: 9.32 (mg/L) Turbidity: 0.63 (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 = _____

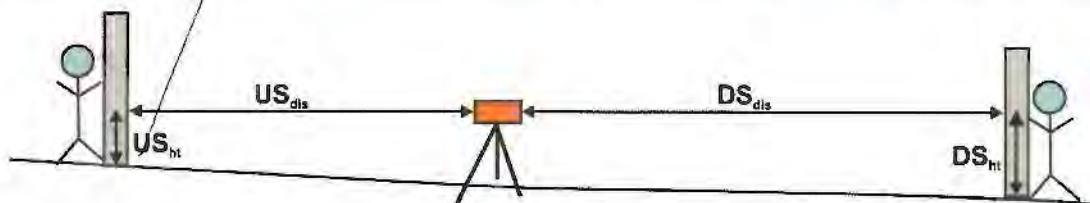
OR

☐ **Measured in field**

Circle device used and fill out table according to device:

a. Survey Equipment b. Hand Level & Measuring Tape

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			US _{dis} + DS _{dis} =
^a T-B x 100	^a US _{dis} = T-B	^a DS _{dis} = T-B	
Change in height (Δht)			DS _{ht} - US _{ht} =
Slope (Δht/total dis)			



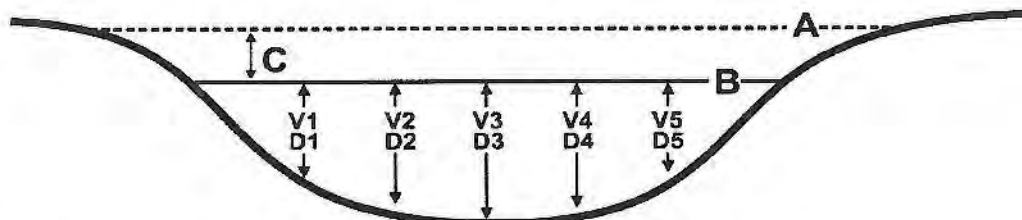
Field Crew: IM, KP, RP + Liam Site Code: JOR-DS-AQ31
 Sampling Date: (DD/MM/YYYY) 03/03/2016

Widths and Depth

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

A - Bankfull Width: 7.1 (m) B - Wetted Stream Width: 4.2 (m)

C - Bankfull-Wetted Depth (height from water surface to Bankfull): 74 (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 _____

RWE = 1.8

2.5 3.2 3.9 4.6 5.6 6.0

	1	2	3	4	5	6	AVG
Distance from Shore (m)	0.7	1.4	2.1	2.8	3.5	4.2	
Depth (D) (cm)	24	19	20	19	16	13	
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)	0.02	0.32	0.77	0.74	0.53	0.03	

Field Crew: IM, RB, RP + LiamSite Code: JOR-05-AQ31Sampling Date: (DD/MM/YYYY) 03/08/2016**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.
- Embeddedness 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	20	51	14	76	31
2	27	27	15	52	23	77	18
3	0.5	28	12	53	21	78	15
4	13	29	12	54	5	79	4.5
5	15	30	10	55	25	80	13
6	0.8	31	3	56	18	81	26
7	5	32	3.5	57	6.5	82	5
8	17	33	31	58	18	83	9
9	4	34	1	59	7	84	11
10	38	35	4	60	42	85	29
11	4.5	36	1.5	61	15	86	23
12	5	37	8.5	62	20	87	13
13	36	38	4	63	14	88	24
14	10	39	8	64	35	89	23
15	25	40	21	65	12	90	5
16	20	41	11	66	33	91	11
17	10	42	4.5	67	22	92	31
18	13	43	9.5	68	15	93	12
19	12	44	9	69	7	94	35
20	23	45	8	70	39	95	5
21	1	46	2.5	71	0.5	96	2.5
22	1.3	47	19	72	36	97	2
23	2	48	5.5	73	22	98	20
24	2	49	12	74	26	99	1.5
25	3.5	50	36	75	2	100	3

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: JOR-DS-AQ31

Sampling Date: (DD/MM/YYYY) 03/03/2016

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, KB RP + Liam Site Code: 21M-DS-AQ21
 Sampling Date: (DD/MM/YYYY) 03/08/2016 (pm)

☐ Occupational Health & Safety: Site Inspection Sheet completed

PRIMARY SITE DATA

CABIN Study Name: R.M.O.W. Ecosys. Mon. Local Basin Name: 21-Mile Creek

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

Select one: ☐ Test Site ☒ Potential Reference Site

→ Not pristine but further from anthropogenic influences, with no development along banks.

Geographical Description/Notes:

Twenty-one Mile Creek, upstream (~50m) of confluence with R.O.G.D. Site not used by paddlers, composite upstream
 * Small inflow on RB beside birch tree

Surrounding Land Use: (check those present)

☒ Forest

☐ Field/Pasture

☐ Agriculture

☒ Residential/Urban → downstream

☐ Logging

☐ Mining

☒ Commercial/Industrial

☒ Other Elec. pole/rail line

Dominant Surrounding Land Use: (check one)

☐ Forest

☐ Field/Pasture

☐ Agriculture

☐ Residential/Urban

☐ Logging

☐ Mining

☐ Commercial/Industrial

☒ Other Under elec. lines/near rail line

Location Data

Latitude: 50°07.655'N Longitude: - 122°58.373'W (DMS or DD)

Elevation: 632 (ft or msl)

GPS Datum: ☒ GRS80 (NAD83/WGS84) ☐ Other: _____

Site Location Map Drawing



Field Crew: IM, KB, RPSite Code: 21M-DS-AQ21Sampling Date: (DD/MM/YYYY) 03/08/2016**Photos**

103-0125 0119 0126 0121
☒ Field Sheet ☒ Upstream ☒ Downstream ☒ Across Site ☐ Aerial View
☐ Substrate (exposed) ☒ Substrate (aquatic) ☐ Other _____

→ 122 → 123

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

} very mixed veg.

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 DATAHabitat sampled: (check one) ☒ riffle ☐ rapids ☒ straight run

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

Preservative used: Ethyl Alcohol 10% Formalin

Sampled sieved on site using "Bucket Swirling Method":

☒ YES ☐ NOIf YES, debris collected for QA/QC ☒ yes

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

Field Crew: IM, KB, RP Site Code: 21M-DS-A021
 Sampling Date: (DD/MM/YYYY) 03/08/2016

WATER CHEMISTRY DATA Time: 11:56 (24 hr clock) Time zone: PST

Air Temp: 16.3 (°C) Water Temp: 12.0 (°C) pH: 6.27

Specific Conductance: 40.5 (µs/cm) DO: 9.39 (mg/L) Turbidity: 2.63 (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 14 ppm (RP's Manna Re)

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

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			US _{dis} +DS _{dis} =
^a T-B x 100	^a US _{dis} =T-B	^a DS _{dis} =T-B	
Change in height (Δht)			DS _{ht} -US _{ht} =
Slope (Δht/total dis)			



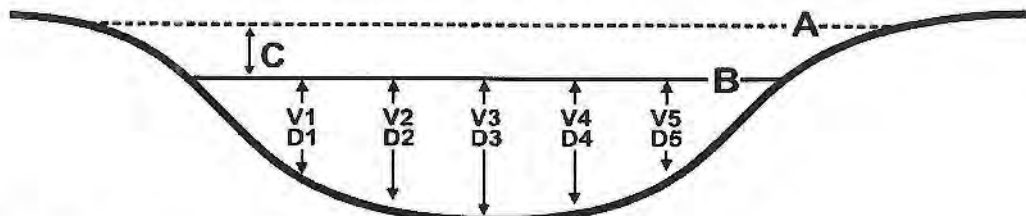
Field Crew: IM, KB, RP Site Code: 21M-DS-AQ21
 Sampling Date: (DD/MM/YYYY) 03/08/2016

Widths and Depth

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

A - Bankfull Width: 11.2 (m) B - Wetted Stream Width: 9.6 (m)

C - Bankfull-Wetted Depth (height from water surface to Bankfull): 100 (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

LWE = 1.3

2.6 4.1 5.6 7.1 8.6 10.1

	1	2	3	4	5	6	AVG
Distance from Shore (m)	1.5	3.0	4.5	6.0	7.5	9.0	
Depth (D) (cm)	0.29	0.13	0.06	0.06	0.04	0.06	
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)	0.93	0.83	0.65	0.59	0.16	0.29	

B23

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: JM, KB Site Code: RGD-DS-AQ12
 Sampling Date: (DD/MM/YYYY) 05/08/2016 (pm)

☐ Occupational Health & Safety: Site Inspection Sheet completed

PRIMARY SITE DATA

CABIN Study Name: ^{RMOW} Ecosystems Monit Local Basin Name: RGD
 River/Stream Name: River of Golden Dreams Stream Order: (map scale 1:50,000) (?)

Select one: ☒ Test Site ☐ Potential Reference Site

Geographical Description/Notes: Downstream on RGD, below the new and old locations of pullout for boats/kayaks

Surrounding Land Use: (check those present)

☒ Forest ☐ Field/Pasture ☐ Agriculture
☐ Logging ☐ Mining ☒ Commercial/Industrial

Information Source: Kate/Tara

☒ Residential/Urban

☒ Other Urban green belt
→ Park + dog area upstream
→ Highway

Dominant Surrounding Land Use: (check one)

☐ Forest ☐ Field/Pasture ☐ Agriculture
☐ Logging ☐ Mining ☐ Commercial/Industrial

Information Source: → Highway

☐ Residential/Urban

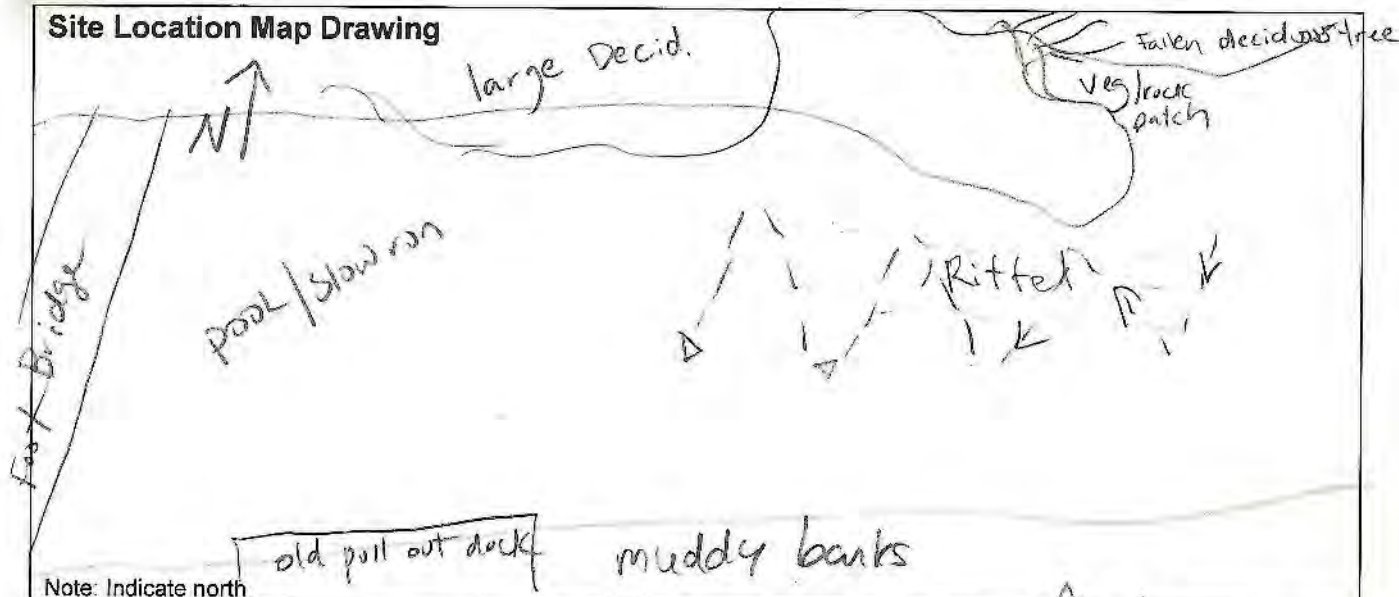
☒ Other Urban green belt

Location Data ±3m

Latitude: 50.14432N Longitude: -122.95758W (DMS or DD)

Elevation: 631 (fast or masl) GPS Datum: ☒ GRS80 (NAD83/WGS84) ☐ Other: _____

Site Location Map Drawing



Note: Osprey sited @ site, flying over river. @ 4pm

Field Crew: IM, KB Site Code: RGD-DS-AQ12
 Sampling Date: (DD/MM/YYYY) 05/08/2016

Photos

☐ Field Sheet ☒ ¹⁶⁸ Upstream ☒ ¹⁶⁴⁻¹⁶⁵ Downstream ☒ ¹⁶⁷ Across Site ☐ Aerial View
☐ Substrate (exposed) ☒ Substrate (aquatic) ☒ Other 166 → representative area of sample zone

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 → small amount of riffle
 Preservative used: Formalin (10% E. Alco)

400 µm mesh Kick Net	<input checked="" type="checkbox"/>
Person sampling	<u>IM</u>
Sampling time (i.e. 3 min.)	<u>3 min</u>
No. of sample jars	<u>1</u>
Typical depth in kick area (cm)	<u>12</u>

Sampled sieved on site using "Bucket Swirling Method":

☐ YES ☒ NO

If YES, debris collected for QAQC ☒ n/a

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

Field Crew: IM, KB Site Code: R6D-DS-AQ12
 Sampling Date: (DD/MM/YYYY) 05/08/2016

WATER CHEMISTRY DATA Time: 15:00 (24 hr clock) Time zone: PST
 Air Temp: 22 (Whistler) (°C) Water Temp: 15.2 (°C) pH: 7.76
 Specific Conductance: 69 (µs/cm) DO: 9.89 (mg/L) Turbidity: 1.30 (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)

0.5% (Estimate)

☐ **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 =

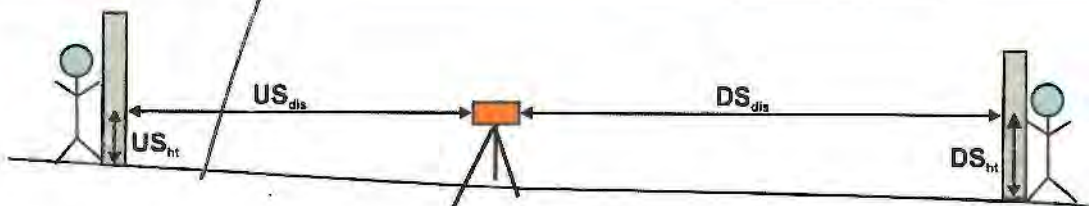
OR

☐ **Measured in field**

Circle device used and fill out table according to device:

a. Survey Equipment b. Hand Level & Measuring Tape

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			$US_{dis} + DS_{dis} =$
^a T-B x 100	$^{a}US_{dis} = T - B$	$^{a}DS_{dis} = T - B$	
Change in height (Δht)			$DS_{ht} - US_{ht} =$
Slope ($\Delta ht / \text{total dis}$)			



Field Crew: IM, KB Site Code: R0D-DS-AQ12
 Sampling Date: (DD/MM/YYYY) 05/08/2016

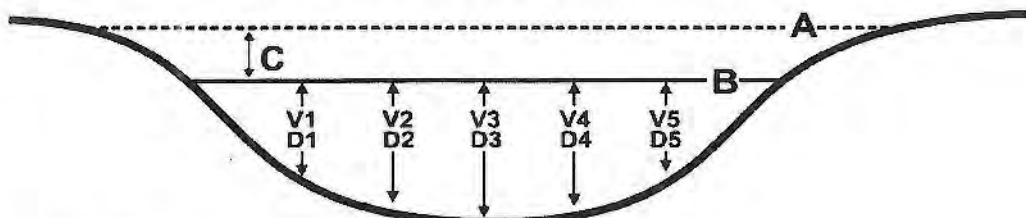
Widths and Depth

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

A - Bankfull Width: 14.8 (m)

B - Wetted Stream Width: 13.3 (m)

C - Bankfull-Wetted Depth (height from water surface to Bankfull): 62 (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

LWE = 0.8 m

4.0 5.0 6.0 7.0 8.0 9.0

taken
through
1st ~ 9m
on LB,
where sample
was taken

	1	2	3	4	5	6	AVG
Distance from Shore (m)	3.2	4.2	5.2	6.2	7.2	8.2	
Depth (D) (cm)	12	9	8	10	14	16	
Velocity Head Rod (ruler)							
Flowing water Depth (D ₁) (cm)							
Depth of Stagnation (D ₂) (cm)							
Change in depth (ΔD=D ₂ -D ₁) (cm)							
Rotary meter							
Revolutions							
Time (minimum 40 seconds)							
Direct Measurement or calculation							
Velocity (V) (m/s)	0.31	0.29	0.29	0.20	0.30	0.22	

Field Crew: IN + KB Site Code: RGD-DS-A012
 Sampling Date: (DD/MM/YYYY) 05/08/2016

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.
- Embeddedness 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	1.5	51	2.5	76	3
2	3.0	27	5.0	52	4.5	77	0.5
3	3.0	28	3.0	53	4	78	1.5
4	4.5	29	3.0	54	2	79	3.5
5	2.0	30	1.0	55	3.5	80	4
6	4.5	31	2.0	56	0.8	81	0.5
7	2.5	32	3.5	57	0.3	82	3
8	3.0	33	4.0	58	2.5	83	5
9	1.5	34	6.0	59	3	84	3.5
10	3.5	35	3.5	60	0.4	85	4
11	1.0	36	2.0	61	1.7	86	3
12	1.5	37	3.5	62	0.7	87	3
13	3.5	38	3.5	63	1.5	88	4
14	3.0	39	3.5	64	1.5	89	2
15	0.5	40	5.0	65	1.5	90	2.5
16	2.0	41	7.0	66	0.2	91	5
17	3.0	42	6.0	67	3	92	2
18	4.5	43	6.0	68	3.5	93	2
19	3.0	44	1.2	69	3	94	4
20	3.0	45	7.0	70	3.5	95	1
21	2.5	46	5.0	71	1.5	96	1
22	3.0	47	5.0	72	2	97	2
23	4.5	48	4.0	73	2.5	98	4
24	4.0	49	4.0	74	1	99	1.5
25	1.0	50	3.0	75	3.5	100	4.5

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.

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	21M-DS-AQ21
Sampling Date	Aug 03 2016
Know Your Watershed Basin	
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.12758 N, 122.97288 W
Altitude	2073
Local Basin Name	Twenty-One Mile Creek
	River of Golden Dreams
Stream Order	3

Cabin Assessment Results

Reference Model Summary					
Model	Fraser River-Georgia Basin Model 2005				
Analysis Date	February 17, 2017				
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	33.3%	7.9%	28.9%	5.4%	24.4%
CABIN Assessment of 21M-DS-AQ21 on Aug 03, 2016	Similar to Reference				

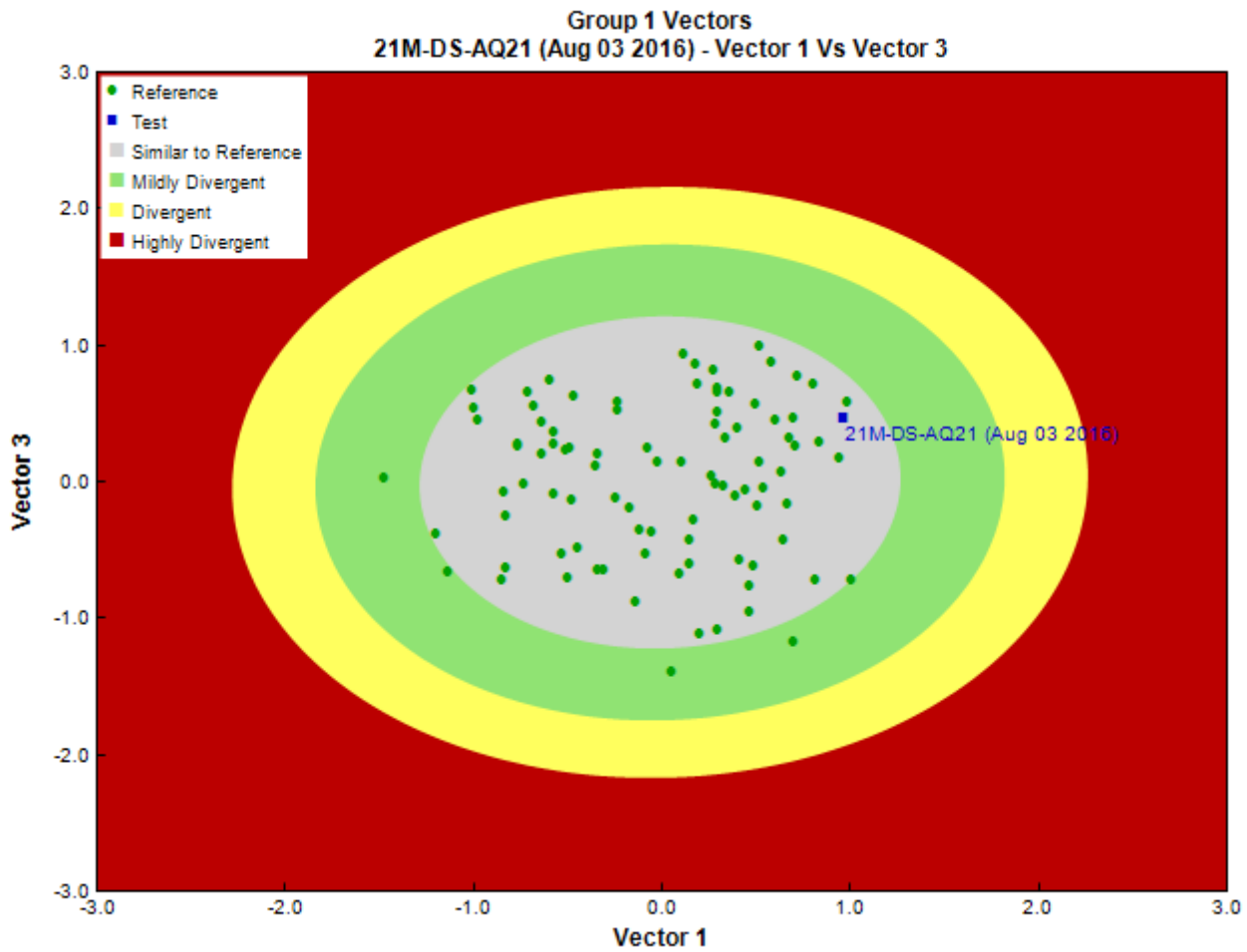


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	October 11, 2016
	Marchant Box
Sub-Sample Proportion	20/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	8	40.0
	Insecta	Diptera	Ceratopogonidae	2	10.0
			Chironomidae	22	110.0
			Empididae	1	5.0
			Simuliidae	29	145.0
			Tipulidae	1	5.0
		Ephemeroptera	Baetidae	103	515.0
			Ephemerellidae	4	20.0
			Heptageniidae	48	240.0
		Plecoptera	Chloroperlidae	12	60.0
			Nemouridae	65	325.0
			Perlodidae	2	10.0
		Trichoptera	Rhyacophilidae	7	35.0
			Total	304	1,520.0

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%	0.89
Capniidae	63%	75%	60%	47%	69%	0.64
Chironomidae	100%	100%	98%	100%	100%	0.99
Chloroperlidae	89%	81%	84%	37%	71%	0.80
Empididae	52%	69%	55%	26%	53%	0.53
Ephemerellidae	91%	63%	89%	58%	85%	0.85
Heptageniidae	98%	75%	100%	47%	91%	0.92
Nemouridae	81%	63%	78%	21%	79%	0.75
Perlodidae	69%	56%	66%	5%	59%	0.61
Rhyacophilidae	66%	44%	58%	16%	31%	0.50
Tipulidae	58%	63%	64%	37%	47%	0.56

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	8.05
RIVPACS : Observed taxa P>0.50	10.00
RIVPACS : O:E (p > 0.5)	1.24
RIVPACS : Expected taxa P>0.70	5.20
RIVPACS : Observed taxa P>0.70	6.00
RIVPACS : O:E (p > 0.7)	1.15

Habitat Description

Variable	21M-DS-AQ21	Predicted Group Reference Mean \pm SD
Channel		
Depth-Avg (cm)	10.7	30.4 \pm 14.7
Slope (m/m)	0.0300000	0.0248895 \pm 0.0256268
Velocity-Max (m/s)	0.93	0.69 \pm 0.29
Width-Wetted (m)	9.6	19.8 \pm 25.9
Substrate Data		
Dominant-1st (Category(0-9))	5	7 \pm 1
Embeddedness (Category(1-5))	5	4 \pm 1
Water Chemistry		
General-pH (pH)	6.3	7.5 \pm 0.7

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	CRB-DS-AQ01
Sampling Date	Aug 02 2016
Know Your Watershed Basin	
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.12660 N, 122.97170 W
Altitude	2165
Local Basin Name	Crabapple Creek
	River of Golden Dreams
Stream Order	2

Cabin Assessment Results

Reference Model Summary					
Model	Fraser River-Georgia Basin Model 2005				
Analysis Date	February 17, 2017				
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	50.3%	1.0%	23.8%	0.6%	24.3%
CABIN Assessment of CRB-DS-AQ01 on Aug 02, 2016	Mildly Divergent				

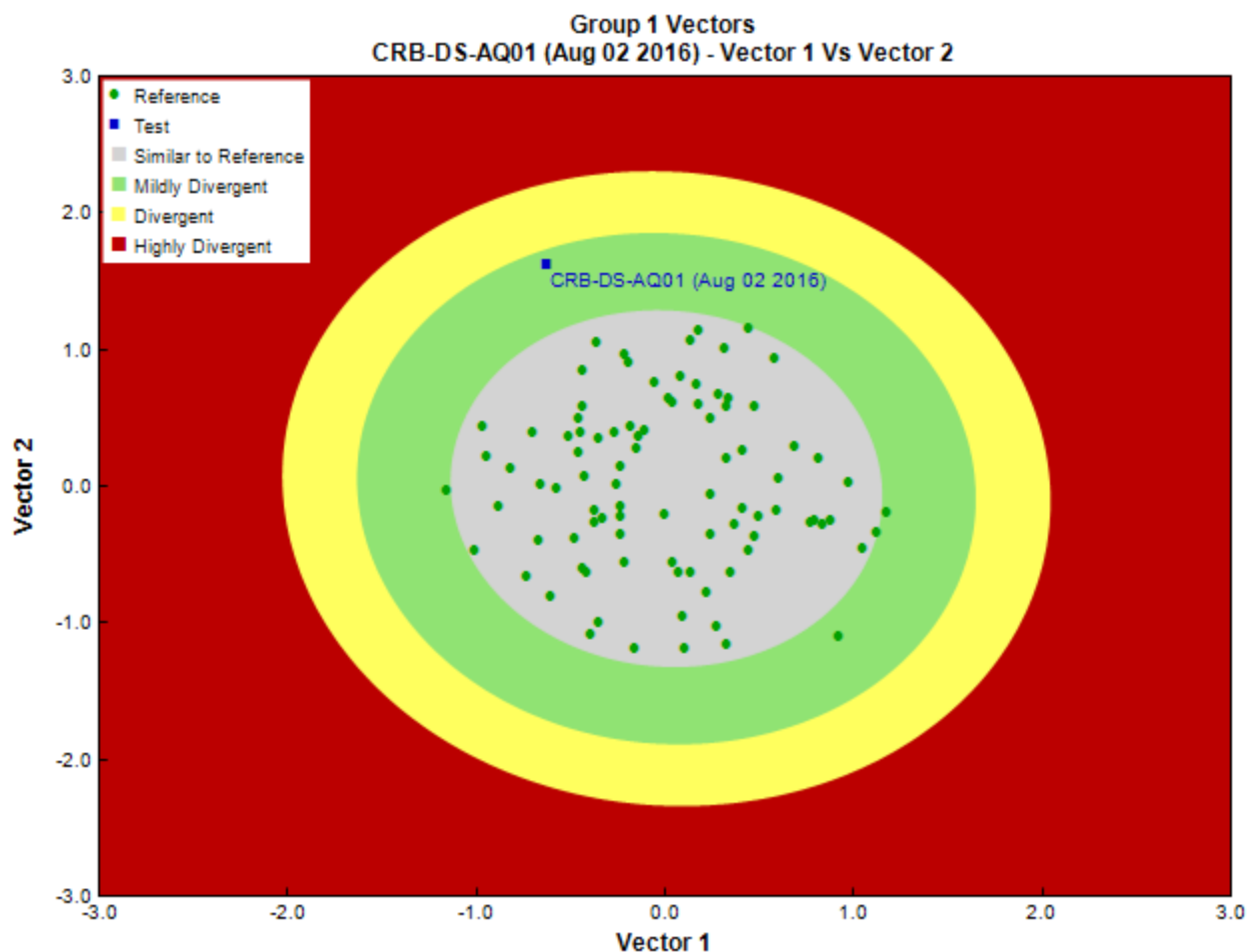


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	September 27, 2016
	Marchant Box
Sub-Sample Proportion	10/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	10	100.0
	Collembola	Collembola		1	10.0
	Insecta	Diptera	Chironomidae	18	180.0
			Empididae	5	50.0
			Simuliidae	17	170.0
			Tipulidae	2	20.0
		Ephemeroptera	Baetidae	41	410.0
			Ephemerellidae	5	50.0
		Megaloptera	Sialidae	1	10.0
		Plecoptera	Chloroperlidae	55	550.0
			Leuctridae	1	10.0
			Nemouridae	159	1,590.0
			Perlodidae	1	10.0
		Trichoptera	Limnephilidae	1	10.0
			Rhyacophilidae	1	10.0

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
			Total	318	3,180.0

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%	0.92
Capniidae	63%	75%	60%	47%	69%	0.64
Chironomidae	100%	100%	98%	100%	100%	0.99
Chloroperlidae	89%	81%	84%	37%	71%	0.83
Empididae	52%	69%	55%	26%	53%	0.53
Ephemerellidae	91%	63%	89%	58%	85%	0.89
Heptageniidae	98%	75%	100%	47%	91%	0.96
Nemouridae	81%	63%	78%	21%	79%	0.79
Perlodidae	69%	56%	66%	5%	59%	0.65
Rhyacophilidae	66%	44%	58%	16%	31%	0.55
Taeniopterygidae	70%	44%	46%	21%	32%	0.55
Tipulidae	58%	63%	64%	37%	47%	0.57

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	8.87
RIVPACS : Observed taxa P>0.50	9.00
RIVPACS : O:E (p > 0.5)	1.01
RIVPACS : Expected taxa P>0.70	5.39
RIVPACS : Observed taxa P>0.70	5.00
RIVPACS : O:E (p > 0.7)	0.93

Habitat Description

Variable	CRB-DS-AQ01	Predicted Group Reference Mean \pm SD
Channel		
Depth-Avg (cm)	8.6	30.4 \pm 14.7
Slope (m/m)	0.0100000	0.0248895 \pm 0.0256268
Velocity-Max (m/s)	0.62	0.69 \pm 0.29
Width-Wetted (m)	3.0	19.8 \pm 25.9
Substrate Data		
Dominant-1st (Category(0-9))	6	7 \pm 1
Embeddedness (Category(1-5))	4	4 \pm 1
Water Chemistry		
General-pH (pH)	7.6	7.5 \pm 0.7

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	JOR-DS-AQ31
Sampling Date	Aug 03 2016
Know Your Watershed Basin	
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.09545 N, 122.99735 W
Altitude	2044
Local Basin Name	Jordan Creek
	Jordan Creek
Stream Order	2

Cabin Assessment Results

Reference Model Summary					
Model	Fraser River-Georgia Basin Model 2005				
Analysis Date	February 17, 2017				
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	71.0%	0.3%	21.5%	0.3%	7.0%
CABIN Assessment of JOR-DS-AQ31 on Aug 03, 2016	Divergent				

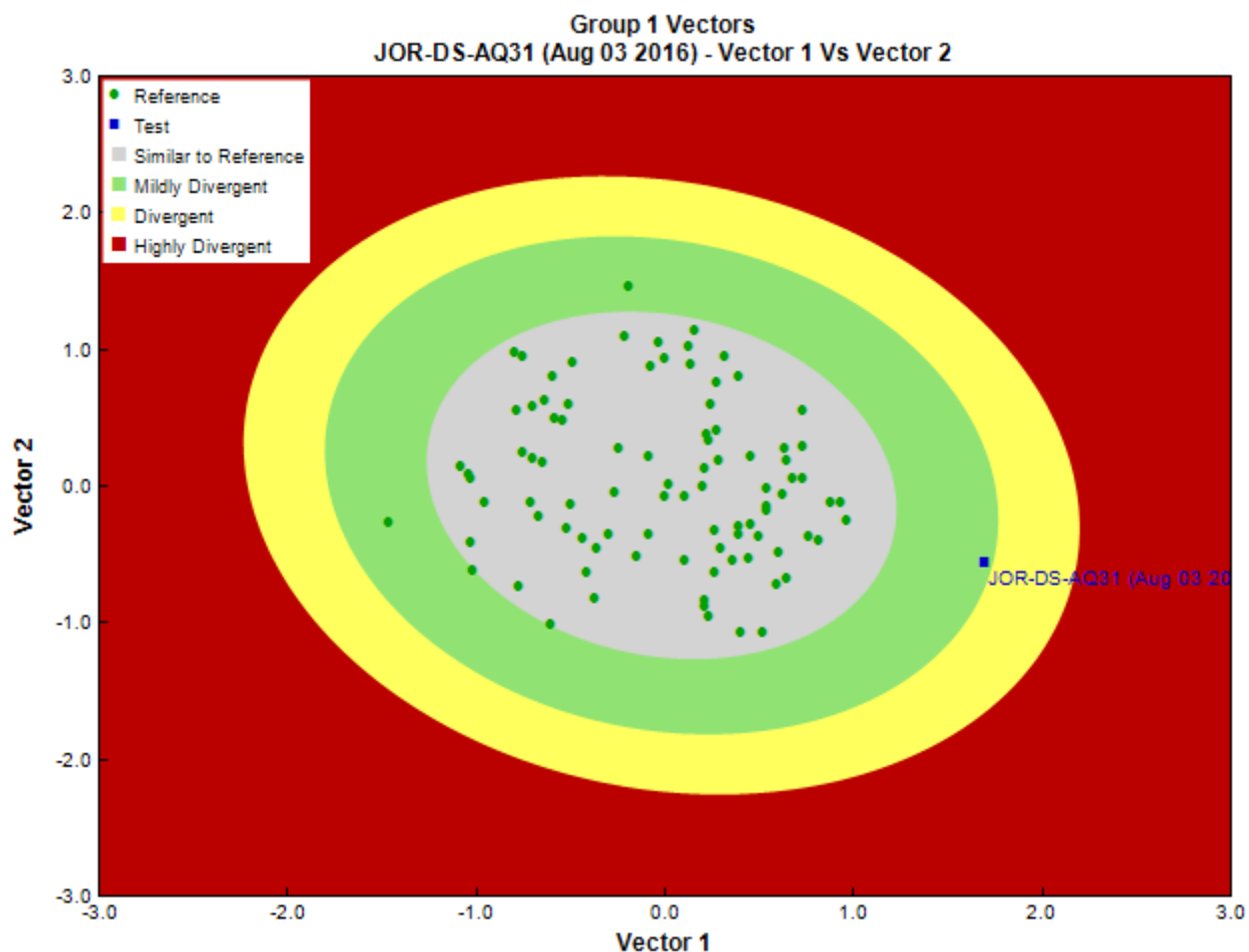


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	October 03, 2016
	Marchant Box
Sub-Sample Proportion	16/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	4	25.0
			Ceratopogonidae	1	6.3
	Insecta	Diptera	Chironomidae	43	268.8
			Empididae	2	12.5
			Simuliidae	116	725.0
		Ephemeroptera	Baetidae	9	56.3
			Ephemerellidae	3	18.8
		Plecoptera	Chloroperlidae	1	6.3
			Nemouridae	145	906.3
			Perlidae	5	31.3
		Trichoptera	Hydropsychidae	5	31.3
			Rhyacophilidae	1	6.3
			Total	335	2,094.2

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%	0.93
Capniidae	63%	75%	60%	47%	69%	0.63
Chironomidae	100%	100%	98%	100%	100%	0.99
Chloroperlidae	89%	81%	84%	37%	71%	0.86
Empididae	52%	69%	55%	26%	53%	0.52
Ephemerellidae	91%	63%	89%	58%	85%	0.90
Heptageniidae	98%	75%	100%	47%	91%	0.98
Nemouridae	81%	63%	78%	21%	79%	0.80
Perlodidae	69%	56%	66%	5%	59%	0.68
Rhyacophilidae	66%	44%	58%	16%	31%	0.61
Taeniopterygidae	70%	44%	46%	21%	32%	0.62
Tipulidae	58%	63%	64%	37%	47%	0.59

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	9.12
RIVPACS : Observed taxa P>0.50	7.00
RIVPACS : O:E (p > 0.5)	0.77
RIVPACS : Expected taxa P>0.70	5.47
RIVPACS : Observed taxa P>0.70	5.00
RIVPACS : O:E (p > 0.7)	0.91

Habitat Description

Variable	JOR-DS-AQ31	Predicted Group Reference Mean \pm SD
Channel		
Depth-Avg (cm)	18.5	30.4 \pm 14.7
Slope (m/m)	0.0300000	0.0248895 \pm 0.0256268
Velocity-Max (m/s)	0.77	0.69 \pm 0.29
Width-Wetted (m)	4.2	19.8 \pm 25.9
Substrate Data		
Dominant-1st (Category(0-9))	7	7 \pm 1
Embeddedness (Category(1-5))	5	4 \pm 1
Water Chemistry		
General-pH (pH)	7.1	7.5 \pm 0.7

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	RGD-AQ11
Sampling Date	Aug 03 2016
Know Your Watershed Basin	
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.12703 N, 122.97202 W
Altitude	2106
Local Basin Name	River of Golden Dreams
	River of Golden Dreams
Stream Order	3

Cabin Assessment Results

Reference Model Summary					
Model	Fraser River-Georgia Basin Model 2005				
Analysis Date	February 17, 2017				
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	49.5%	1.1%	25.6%	1.7%	22.0%
CABIN Assessment of RGD-AQ11 on Aug 03, 2016	Similar to Reference				

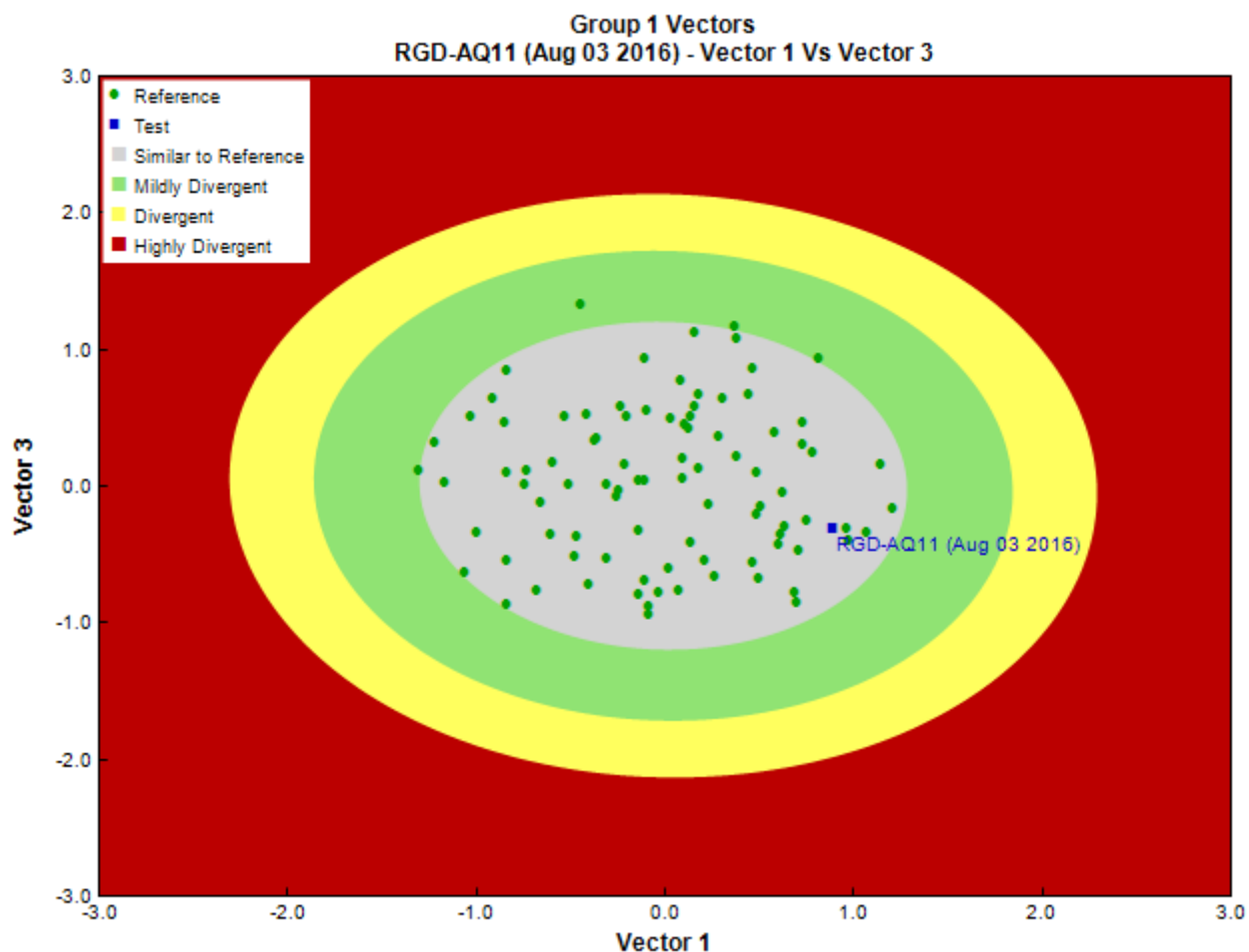


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	September 29, 2016
	Marchant Box
Sub-Sample Proportion	26/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	5	19.2
			Ceratopogonidae	8	30.8
	Insecta	Diptera	Chironomidae	8	30.8
			Empididae	5	19.2
			Simuliidae	30	115.4
		Ephemeroptera	Baetidae	102	392.3
			Ephemerellidae	7	26.9
			Heptageniidae	71	273.1
		Plecoptera	Chloroperlidae	34	130.8
			Nemouridae	26	100.0
			Perlodidae	5	19.2
		Trichoptera	Rhyacophilidae	1	3.8
			Total	302	1,161.5

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%	0.92
Capniidae	63%	75%	60%	47%	69%	0.63
Chironomidae	100%	100%	98%	100%	100%	0.99
Chloroperlidae	89%	81%	84%	37%	71%	0.83
Empididae	52%	69%	55%	26%	53%	0.53
Ephemerellidae	91%	63%	89%	58%	85%	0.88
Heptageniidae	98%	75%	100%	47%	91%	0.96
Nemouridae	81%	63%	78%	21%	79%	0.79
Perlodidae	69%	56%	66%	5%	59%	0.65
Rhyacophilidae	66%	44%	58%	16%	31%	0.55
Taeniopterygidae	70%	44%	46%	21%	32%	0.55
Tipulidae	58%	63%	64%	37%	47%	0.57

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	8.84
RIVPACS : Observed taxa P>0.50	9.00
RIVPACS : O:E (p > 0.5)	1.02
RIVPACS : Expected taxa P>0.70	5.37
RIVPACS : Observed taxa P>0.70	6.00
RIVPACS : O:E (p > 0.7)	1.12

Habitat Description

Variable	RGD-AQ11	Predicted Group Reference Mean \pm SD
Channel		
Depth-Avg (cm)	18.7	30.4 \pm 14.7
Slope (m/m)	0.0100000	0.0248895 \pm 0.0256268
Velocity-Max (m/s)	0.89	0.69 \pm 0.29
Width-Wetted (m)	6.8	19.8 \pm 25.9
Substrate Data		
Dominant-1st (Category(0-9))	5	7 \pm 1
Embeddedness (Category(1-5))	5	4 \pm 1
Water Chemistry		
General-pH (pH)	7.4	7.5 \pm 0.7

Site Description

Study Name	BC-Resort Municipality of Whistler-Ecosystem Monitoring
Site	RGD-DS-AQ12
Sampling Date	Aug 05 2016
Know Your Watershed Basin	
Province / Territory	British Columbia
Terrestrial Ecological Classification	Pacific Maritime EcoZone Pacific Ranges EcoRegion
Coordinates (decimal degrees)	50.14432 N, 122.95758 W
Altitude	2070
Local Basin Name	River of Golden Dreams
	River of Golden Dreams
Stream Order	3

Cabin Assessment Results

Reference Model Summary					
Model	Fraser River-Georgia Basin Model 2005				
Analysis Date	February 17, 2017				
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	13.0%	1.0%	28.6%	9.0%	48.4%
CABIN Assessment of RGD-DS-AQ12 on Aug 05, 2016	Divergent				

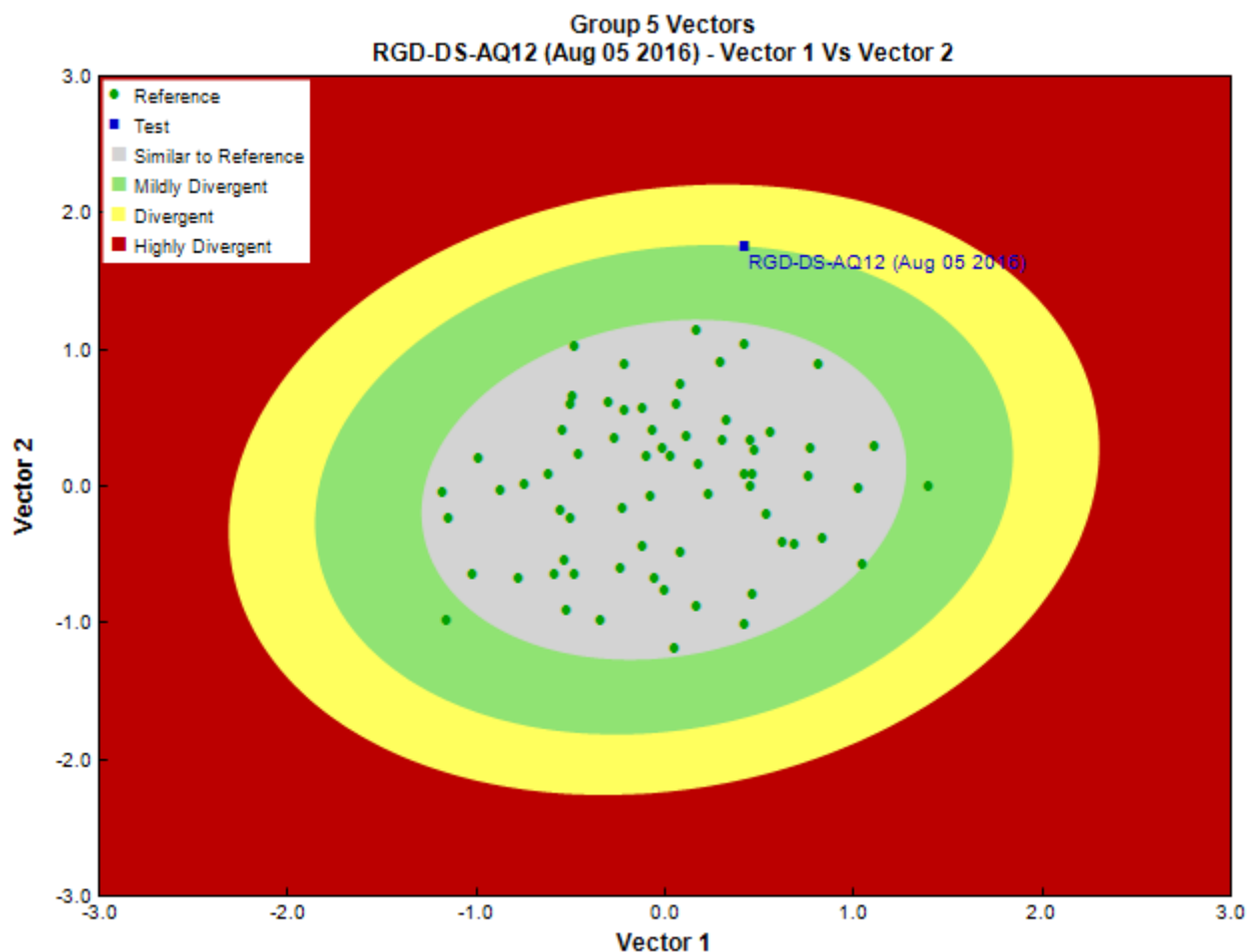


Figure 3. CABIN ordination assessment of the test site with the predicted group of reference sites. Each axis represents the relative abundance of the entire benthic invertebrate community with different organisms weighted differently on each axis.

Sample Information

Sampling Device	Kick Net
Mesh Size	400
Sampling Time	3
Taxonomist	Karen Needham, Spencer Entomological Collecti
Date Taxonomy Completed	October 20, 2016
	Marchant Box
Sub-Sample Proportion	19/100

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
Arthropoda	Arachnida	Trombidiformes	Hydrachnidae	16	84.2
			Dytiscidae	2	10.5
	Insecta	Diptera	Ceratopogonidae	2	10.5
			Chironomidae	45	236.8
			Empididae	4	21.0
			Simuliidae	3	15.8
		Ephemeroptera	Baetidae	80	421.0
			Ephemerellidae	71	373.7
			Heptageniidae	2	10.5
		Plecoptera	Chloroperlidae	1	5.3
			Leuctridae	5	26.3
			Nemouridae	73	384.2
		Trichoptera	Perlodidae	1	5.3
			Hydropsychidae	5	26.3
			Limnephilidae	1	5.3

Community Structure

Phylum	Class	Order	Family	Raw Count	Total Count
			Rhyacophilidae	1	5.3
			Total	312	1,642.0

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%	0.89
Capniidae	63%	75%	60%	47%	69%	0.64
Chironomidae	100%	100%	98%	100%	100%	0.99
Chloroperlidae	89%	81%	84%	37%	71%	0.74
Empididae	52%	69%	55%	26%	53%	0.51
Ephemerellidae	91%	63%	89%	58%	85%	0.84
Heptageniidae	98%	75%	100%	47%	91%	0.90
Nemouridae	81%	63%	78%	21%	79%	0.74
Perlodidae	69%	56%	66%	5%	59%	0.57
Tipulidae	58%	63%	64%	37%	47%	0.53

RIVPACS Ratios

RIVPACS : Expected taxa P>0.50	7.35
RIVPACS : Observed taxa P>0.50	8.00
RIVPACS : O:E (p > 0.5)	1.09
RIVPACS : Expected taxa P>0.70	5.11
RIVPACS : Observed taxa P>0.70	6.00
RIVPACS : O:E (p > 0.7)	1.18

Habitat Description

Variable	RGD-DS-AQ12	Predicted Group Reference Mean \pm SD
Channel		
Depth-Avg (cm)	11.5	21.2 \pm 12.6
Slope (m/m)	0.0050000	0.0113537 \pm 0.0136699
Velocity-Max (m/s)	0.31	0.52 \pm 0.25
Width-Wetted (m)	13.3	10.7 \pm 12.2
Substrate Data		
Dominant-1st (Category(0-9))	5	6 \pm 1
Embeddedness (Category(1-5))	5	4 \pm 1
Water Chemistry		
General-pH (pH)	7.8	7.6 \pm 0.7



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Appendix C

Fish Sampling (Electrofishing) Results

Appendix C. Electrofishing Effort and Catch

Date	Site	Pass #	Site Length (m)	Site Avg Wetted Width (m)	Voltage (V)	Effort (s)	Catch				
							TR	HY	TSB	CAL	Total
04-Aug-2016	JOR-DS-AQ31	1	25	7.1	350	519	7	-	3	-	10
04-Aug-2016	JOR-DS-AQ31	2	25	7.1	350	500	8	-	4	1	13
04-Aug-2016	JOR-DS-AQ31	3	25	7.1	350	450	8	-	3	-	11
05-Aug-2016	CRB-DS-AQ01	1	30	4.0	250	689	8	-	2	2	12
05-Aug-2016	CRB-DS-AQ01	2	30	4.0	250	727	16	-	6	5	27
05-Aug-2016	CRB-DS-AQ01	3	30	4.0	250	708	12	-	-	3	15
06-Aug-2016	21M-DS-AQ21	1	38	9.5	250/350	840	16	2	1	5	24
06-Aug-2016	21M-DS-AQ21	2	38	9.5	350	961	16	-	1	12	29
06-Aug-2016	21M-DS-AQ21	3	38	9.5	350	953	11	-	2	13	26

Notes:

TR= unknown trout; HY= suspected hybrid trout, TSB=three spine stickleback, CAL=coast range sculpin



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Appendix **D**

Fish Biological Characteristics

Appendix D. Fish Biological Characteristics

Site	Watershed	Creek	Sampling date	Electrofishing pass	Fish ID	Species	Length (mm)	Weight (g)	Comments
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	1	RB	40	1.7	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	2	RB	32	0.9	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	3	TSB	45	1.6	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	4	TSB	41	2.4	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	5	RB	40	2.1	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	6	TSB	46	2.1	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	7	RB	47	1.8	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	8	RB	30	0.5	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	9	RB	130	33.1	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	1	10	RB	35	0.7	Mortality
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	11	RB	31	0.6	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	12	TSB	57	2.1	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	13	TSB	37	1.6	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	14	TSB	42	1.6	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	15	CAL	90	13	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	16	RB	53	4.6	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	17	TSB	40	2.2	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	18	RB	41	1.8	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	19	RB	34	2.4	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	20	RB	52	1.9	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	21	RB	38	1.7	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	22	RB	35	0.7	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	2	23	RB	42	1	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	24	TSB	40	1.3	Mortality
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	25	RB	90	10.5	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	26	RB	95	14.9	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	27	RB	90	13.2	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	28	TSB	35	2.5	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	29	RB	42	2	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	30	TSB	46	2	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	31	RB	40	2	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	32	RB	42	2.5	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	33	RB	30	0.7	
JOR-DS-AQ31	Jordan Creek	Jordan Creek	04-Aug-2016	3	34	RB	70	4.5	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	1	RB	38	4.1	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	2	CAL	74	5.7	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	3	TSB	59	2.5	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	4	RB	31	1.2	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	5	RB	38	1.6	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	6	TSB	61	3.6	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	7	RB	38	1.2	

Appendix D. Fish Biological Characteristics

Site	Watershed	Creek	Sampling date	Electrofishing pass	Fish ID	Species	Length (mm)	Weight (g)	Comments
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	8	RB	34	1.6	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	9	RB	29	1.1	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	10	RB	32	1.4	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	11	CAL	72	4	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	1	12	RB	160	50.4	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	13	RB	32	0.8	Mortality
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	14	RB	81	9.3	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	15	RB	40	1.7	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	16	TSB	58	2.7	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	17	CAL	78	7.9	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	18	RB	29	0.4	Mortality
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	19	CAL	70	4.1	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	20	RB	29	0.3	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	21	RB	110	23.4	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	22	RB	32	0.8	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	23	RB	34	0.9	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	24	RB	41	1	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	25	RB	37	1	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	26	TSB	28	1	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	27	RB	38	0.9	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	28	RB	29	0.5	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	29	TSB	23	0.3	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	30	RB	32	0.5	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	31	TSB	29	0.4	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	32	TSB	45	1.2	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	33	CAL	39	0.9	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	34	RB	29	0.4	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	35	CAL	48	1.7	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	36	TSB	21	0.2	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	37	RB	29	0.3	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	38	RB	26	0.4	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	2	39	CAL	61	3.5	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	40	RB	39	1.1	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	41	RB	80	5.1	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	42	RB	40	0.9	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	43	RB	82	6.3	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	44	RB	41	1.1	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	45	RB	80	6	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	46	RB	32	0.7	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	47	RB	40	1.8	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	48	CAL	54	1.9	

Appendix D. Fish Biological Characteristics

Site	Watershed	Creek	Sampling date	Electrofishing pass	Fish ID	Species	Length (mm)	Weight (g)	Comments
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	49	CAL	47	1.2	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	50	RB	35	0.6	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	51	RB	40	1.6	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	52	RB	29	0.7	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	53	RB	32	0.8	
CRB-DS-AQ01	River of Golden Dreams	Crabapple Creek	05-Aug-2016	3	54	CAL	40	1.8	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	101	RB	33	0.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	102	CAL	82	8.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	103	RB	40	0.7	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	104	TSB	60	2.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	105	RB	38	0.8	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	106	RB	29	0.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	107	RB	31	0.7	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	108	RB	35	0.7	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	109	CAL	44	1.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	110	RB	30	0.2	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	111	RB	37	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	112	RB	42	1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	113	RB	35	0.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	114	RB	39	0.6	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	115	RB	35	0.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	116	CAL	45	1.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	117	RB	38	0.6	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	118	RB	38	0.6	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	119	RB	43	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	120	CAL	45	1.1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	121	RB	40	1.2	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	122	CAL	46	1.3	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	123	HY	84	7.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	1	124	HY	80	5.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	125	CAL	85	9.6	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	126	RB	41	1.2	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	127	CAL	45	1.2	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	128	CAL	41	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	129	CAL	46	1.2	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	130	RB	69	4.1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	140	CAL	47	1.6	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	141	RB	39	1.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	142	CAL	47	1.8	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	143	RB	114	14.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	144	RB	39	1.1	

Appendix D. Fish Biological Characteristics

Site	Watershed	Creek	Sampling date	Electrofishing pass	Fish ID	Species	Length (mm)	Weight (g)	Comments
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	145	RB	38	0.8	Mortality
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	146	CAL	44	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	147	RB	31	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	148	RB	42	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	149	TSB	54	1.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	150	CAL	41	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	151	CAL	51	2.3	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	152	RB	36	0.6	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	153	CAL	47	0.8	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	154	RB	32	0.6	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	155	RB	38	1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	156	CAL	43	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	157	RB	38	0.7	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	158	RB	36	0.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	159	RB	34	0.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	160	CAL	45	1.2	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	161	RB	39	0.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	2	162	RB	33	0.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	163	RB	44	1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	164	CAL	64	1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	165	CAL	63	3.9	Mortality
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	166	RB	44	1.3	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	167	RB	25	0.3	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	168	TSB	50	1.3	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	169	CAL	70	5.3	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	170	TSB	50	1.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	171	RB	34	0.7	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	172	CAL	74	4.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	173	CAL	47	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	174	CAL	52	1.5	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	175	CAL	47	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	176	RB	38	0.8	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	177	RB	33	0.3	Mortality
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	178	RB	29	0.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	179	CAL	44	1.8	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	180	RB	40	1	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	181	CAL	40	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	182	CAL	46	2.3	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	183	RB	30	0.4	Mortality
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	184	CAL	43	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	185	CAL	46	1.9	

Appendix D. Fish Biological Characteristics

Site	Watershed	Creek	Sampling date	Electrofishing pass	Fish ID	Species	Length (mm)	Weight (g)	Comments
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	186	RB	33	0.4	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	187	RB	44	0.9	
21M-DS-AQ21	River of Golden Dreams	21-Mile Creek	06-Aug-2016	3	187	CAL	49	1.1	

Notes:

TR= unknown trout; HY= suspected hybrid trout, TSB=three spine stickleback, CAL=coast range sculpin.

Length = fork length for TR/HY.

Length = total length for TSB and CAL.



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Appendix **E**

Photographs of Aquatic Sampling Sites



Photograph 1. Looking upstream from CABIN sampling area at CRB-DS-AQ01. 02-Aug-2016.



Photograph 2. Looking downstream at CABIN sampling area at CRB-DS-AQ01. 02-Aug-2016.



Photograph 3. Looking across CABIN sampling area at CRB-DS-AQ01. 02-Aug-2016.



Photograph 4. Example of substrate in CABIN sampling area at CRB-DS-AQ01. 02-Aug-2016.



Photograph 5. Looking upstream at CABIN sampling area at RGD-US-AQ11. 03-Aug-2016.



Photograph 6. Looking downstream at CABIN sampling area at RGD-US-AQ11. 03-Aug-2016.



Photograph 7. Looking across CABIN sampling area at RGD-US-AQ11. 03-Aug-2016.



Photograph 8. Example of substrate in CABIN sampling area at RGD-US-AQ11. 03-Aug-2016.



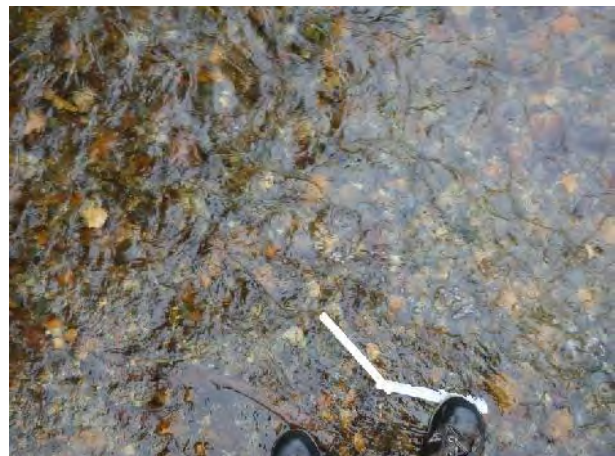
Photograph 9. Looking upstream at CABIN sampling area at 21M-DS-AQ21. 03-Aug-2016.



Photograph 10. Looking downstream at CABIN sampling area at 21M-DS-AQ21. 03-Aug-2016.



Photograph 11. Looking across CABIN sampling area at 21M-DS-AQ21. 03-Aug-2016.



Photograph 12. Example of substrate in CABIN sampling area at 21M-DS-AQ21. 03-Aug-2016.



Photograph 13. Looking upstream at CABIN sampling area at JOR-DS-AQ31. 03-Aug-2016.



Photograph 14. Looking downstream at CABIN sampling area at JOR-DS-AQ31. 03-Aug-2016.



Photograph 15. Looking across CABIN sampling area at JOR-DS-AQ31. 03-Aug-2016.



Photograph 16. Example of substrate in CABIN sampling area at JOR-DS-AQ31. 03-Aug-2016.



Photograph 17. Looking upstream at CABIN sampling area at RGD-DS-AQ12. 05-Aug-2016.



Photograph 18. Looking downstream at CABIN sampling area at RGD-DS-AQ12. 05-Aug-2016.



Photograph 19. Looking across at CABIN sampling area at



Photograph 20. Example of substrate in CABIN sampling area at RGD-DS-AQ12. 05-Aug-2016.



Photograph 21. Looking upstream at upstream electrofishing stop net, JOR-DS-AQ31. 04-Aug-2016.



Photograph 22. Looking downstream at downstream electrofishing stop net, JOR-DS-AQ31. 04-Aug-2016.



Photograph 23. Looking upstream at upstream electrofishing stop net, CRB-DS-AQ01. 05-Aug-2016.



Photograph 24. Looking downstream at downstream electrofishing stop net, CRB-DS-AQ01. 05-Aug-2016.



Photograph 25. Looking upstream at downstream electrofishing stop net, 21M-DS-AQ21. 06-Aug-2016.



Photograph 26. Looking upstream at upstream electrofishing stop net, 21M-DS-AQ21. 06-Aug-2016.

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Appendix **F**

Daily Stream Temperature Data

- F1. Alpha Creek
- F2. Crabapple Creek
- F3. Jordan Creek
- F4. River of Golden Dreams
- F5. Scotia Creek

Appendix F1. Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2015-12-15	1.29	1.39	1.45
2015-12-16	0.14	0.45	1.29
2015-12-17	0.11	0.14	0.16
2015-12-18	0.05	0.27	0.80
2015-12-19	0.88	1.10	1.26
2015-12-20	0.36	1.04	1.48
2015-12-21	0.52	1.19	1.45
2015-12-22	0.47	0.67	0.91
2015-12-23	0.52	0.63	0.74
2015-12-24	0.41	0.52	0.63
2015-12-25	0.02	0.15	0.38
2015-12-26	0.05	0.05	0.05
2015-12-27	0.05	0.16	0.38
2015-12-28	0.14	0.23	0.36
2015-12-29	0.05	0.06	0.14
2015-12-30	0.05	0.05	0.05
2015-12-31	0.05	0.06	0.08
2016-01-01	0.08	0.08	0.08
2016-01-02	0.08	0.09	0.11
2016-01-03	0.08	0.10	0.11
2016-01-04	0.11	0.12	0.16
2016-01-05	0.16	0.20	0.27
2016-01-06	0.27	0.36	0.47
2016-01-07	0.47	0.59	0.72
2016-01-08	0.72	0.80	0.85
2016-01-09	0.66	0.78	0.85
2016-01-10	0.41	0.49	0.66
2016-01-11	0.36	0.41	0.52
2016-01-12	0.55	0.71	0.80
2016-01-13	0.38	0.59	0.80
2016-01-14	0.77	0.94	1.04
2016-01-15	0.88	0.93	1.04
2016-01-16	0.69	0.88	1.04
2016-01-17	1.04	1.12	1.18
2016-01-18	0.96	1.08	1.13
2016-01-19	0.91	1.12	1.21
2016-01-20	1.10	1.19	1.26
2016-01-21	0.19	0.60	1.21

Appendix F1. Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-01-22	0.14	0.21	0.50
2016-01-23	0.63	1.38	1.64
2016-01-24	1.62	1.70	1.81
2016-01-25	1.29	1.54	1.78
2016-01-26	1.78	1.84	1.91
2016-01-27	1.10	1.92	2.05
2016-01-28	0.41	1.17	1.89
2016-01-29	1.86	1.97	2.05
2016-01-30	1.72	1.82	1.94
2016-01-31	1.48	1.78	1.86
2016-02-01	1.37	1.59	1.75
2016-02-02	0.52	0.80	1.29
2016-02-03	0.47	0.69	1.04
2016-02-04	1.02	1.44	1.70
2016-02-05	0.96	1.57	1.83
2016-02-06	1.13	1.52	1.67
2016-02-07	1.48	1.68	1.91
2016-02-08	1.86	1.94	2.02
2016-02-09	1.94	2.03	2.10
2016-02-10	1.91	2.14	2.32
2016-02-11	2.13	2.31	2.48
2016-02-12	2.16	2.24	2.32
2016-02-13	2.02	2.27	2.45
2016-02-14	2.18	2.35	2.53
2016-02-15	1.72	2.39	2.69
2016-02-16	1.99	2.27	2.50
2016-02-17	2.07	2.21	2.32
2016-02-18	2.07	2.34	2.58
2016-02-19	2.34	2.48	2.74
2016-02-20	2.10	2.25	2.48
2016-02-21	1.51	1.81	2.05
2016-02-22	1.48	1.85	1.99
2016-02-23	0.69	1.18	1.56
2016-02-24	1.40	1.75	2.21
2016-02-25	1.45	1.80	2.13
2016-02-26	1.62	2.04	2.42
2016-02-27	2.29	2.42	2.66
2016-02-28	1.89	2.20	2.29

Appendix F1. Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-02-29	2.10	2.24	2.45
2016-03-01	1.24	1.66	2.10
2016-03-02	1.67	1.92	2.13
2016-03-03	1.89	2.25	2.56
2016-03-04	2.32	2.40	2.56
2016-03-05	2.16	2.48	2.82
2016-03-06	2.26	2.48	2.77
2016-03-07	2.34	2.50	2.69
2016-03-08	2.18	2.38	2.58
2016-03-09	1.72	2.27	2.69
2016-03-10	1.37	1.92	2.34
2016-03-11	2.21	2.39	2.64
2016-03-12	1.72	1.96	2.29
2016-03-13	1.89	1.96	2.07
2016-03-14	1.86	1.94	2.13
2016-03-15	1.94	2.10	2.34
2016-03-16	1.67	2.01	2.34
2016-03-17	0.83	1.31	1.72
2016-03-18	0.93	1.44	1.94
2016-03-19	1.59	2.06	2.56
2016-03-20	2.21	2.39	2.64
2016-03-21	2.21	2.48	2.85
2016-03-22	2.26	2.60	2.96
2016-03-23	2.32	2.57	2.80
2016-03-24	2.10	2.43	2.66
2016-03-25	2.26	2.51	2.88
2016-03-26	2.02	2.44	2.96
2016-03-27	2.16	2.48	3.01
2016-03-28	1.89	2.26	2.74
2016-03-29	1.59	2.27	3.12
2016-03-30	2.32	2.74	3.46
2016-03-31	2.37	2.81	3.49
2016-04-01	2.29	2.81	3.54
2016-04-02	2.45	2.90	3.54
2016-04-03	2.40	2.95	3.59
2016-04-04	2.42	2.75	3.04
2016-04-05	2.61	2.78	2.96
2016-04-06	2.74	3.07	3.49

Appendix F1. Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-04-07	2.80	3.22	3.99
2016-04-08	2.58	3.16	4.12
2016-04-09	2.53	3.08	3.85
2016-04-10	2.56	3.21	4.06
2016-04-11	3.01	3.31	3.72
2016-04-12	2.53	3.04	3.41
2016-04-13	2.42	2.87	3.43
2016-04-14	2.40	3.05	3.85
2016-04-15	2.72	3.25	3.83
2016-04-16	2.69	3.26	3.80
2016-04-17	3.04	3.69	4.79
2016-04-18	2.96	3.71	4.95
2016-04-19	2.90	3.66	4.87
2016-04-20	2.93	3.68	4.90
2016-04-21	3.06	3.66	4.43
2016-04-22	3.33	3.62	4.17
2016-04-23	3.27	3.63	4.25
2016-04-24	3.35	3.67	4.30
2016-04-25	3.01	3.59	4.51
2016-04-26	2.50	3.51	4.61
2016-04-27	3.04	3.94	4.95
2016-04-28	3.41	4.10	4.95
2016-04-29	3.67	4.30	5.15
2016-04-30	2.93	4.23	5.62
2016-05-01	3.35	4.59	6.08
2016-05-02	3.54	4.84	6.48
2016-05-03	4.25	5.06	6.26
2016-05-04	4.19	4.62	5.15
2016-05-05	3.96	4.86	6.13
2016-05-06	3.38	4.88	6.51
2016-05-07	3.80	5.28	6.94
2016-05-08	4.09	5.07	6.28
2016-05-09	3.22	4.53	5.80
2016-05-10	3.46	4.98	6.51
2016-05-11	4.58	5.38	6.26
2016-05-12	4.30	5.48	6.74
2016-05-13	4.71	5.93	7.37
2016-05-14	5.26	6.35	7.54

Appendix F1. Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-05-15	5.10	6.40	7.87
2016-05-16	5.75	6.43	7.47
2016-05-17	5.67	6.59	7.77
2016-05-18	5.75	6.30	6.84
2016-05-19	5.15	5.39	5.69
2016-05-20	4.90	5.63	6.56
2016-05-21	4.77	5.85	6.99
2016-05-22	5.57	6.00	6.43
2016-05-23	5.59	6.08	6.79
2016-05-24	5.80	6.25	6.79
2016-05-25	6.03	6.85	7.85
2016-05-26	5.85	6.58	7.14
2016-05-27	5.28	5.73	6.23
2016-05-28	3.67	4.40	5.46
2016-05-29	3.75	4.98	6.20
2016-05-30	3.99	5.57	7.09
2016-05-31	5.13	6.62	8.10
2016-06-01	6.56	7.26	7.92
2016-06-02	6.79	7.27	7.97
2016-06-03	6.41	7.04	7.75
2016-06-04	6.79	8.21	9.88
2016-06-05	7.52	9.00	10.59
2016-06-06	8.20	9.36	10.52
2016-06-07	7.95	9.10	10.30
2016-06-08	7.80	8.32	8.82
2016-06-09	6.79	7.37	8.02
2016-06-10	6.23	6.77	7.24
2016-06-11	5.95	6.37	6.91
2016-06-12	6.13	6.82	7.39
2016-06-13	6.15	6.76	7.09
2016-06-14	5.36	5.85	6.43
2016-06-15	5.13	5.79	6.64
2016-06-16	4.32	5.60	6.64
2016-06-17	5.77	6.55	7.39
2016-06-18	5.92	6.57	7.14
2016-06-19	6.13	6.92	7.87
2016-06-20	6.56	7.89	9.26
2016-06-21	7.65	8.48	9.16

Appendix F1. Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-06-22	8.05	8.46	8.82
2016-06-23	7.80	8.15	8.52
2016-06-24	7.67	8.05	8.47
2016-06-25	7.92	8.66	9.51
2016-06-26	7.52	8.92	10.27
2016-06-27	8.74	9.79	10.81
2016-06-28	8.99	10.27	11.59
2016-06-29	9.71	10.87	11.90
2016-06-30	10.27	10.97	11.66
2016-07-01	10.05	10.32	10.81
2016-07-02	9.56	10.12	10.59
2016-07-03	9.21	9.76	10.22
2016-07-04	8.69	9.06	9.41
2016-07-05	8.77	9.16	9.63
2016-07-06	8.92	9.36	9.90
2016-07-07	8.62	9.10	9.41
2016-07-08	9.09	9.40	9.71
2016-07-09	8.84	9.13	9.46
2016-07-10	7.59	8.84	9.83
2016-07-11	9.24	9.61	10.03
2016-07-12	9.26	9.58	9.88
2016-07-13	8.87	9.58	10.22
2016-07-14	9.19	9.68	10.10
2016-07-15	8.54	9.39	10.17
2016-07-16	9.78	10.39	11.05
2016-07-17	10.30	10.84	11.49
2016-07-18	10.05	10.80	11.57
2016-07-19	10.54	10.80	11.15
2016-07-20	10.20	10.45	10.71
2016-07-21	9.02	10.13	11.13
2016-07-22	9.71	10.61	11.37
2016-07-23	10.47	10.82	11.15
2016-07-24	9.46	10.68	11.95
2016-07-25	11.10	11.98	12.94
2016-07-26	11.59	12.44	13.19
2016-07-27	11.98	12.79	13.59
2016-07-28	12.41	13.26	14.03
2016-07-29	12.56	13.36	14.03

Appendix F1. Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-07-30	12.05	12.68	13.45
2016-07-31	10.59	11.30	11.83
2016-08-01	10.30	11.16	11.90
2016-08-02	10.44	10.76	11.49
2016-08-03	10.57	10.88	11.27
2016-08-04	10.81	11.32	11.95
2016-08-05	10.44	10.99	11.54
2016-08-06	9.36	10.20	10.81
2016-08-07	10.10	10.54	10.93
2016-08-08	10.25	10.58	10.86
2016-08-09	10.64	10.92	11.22
2016-08-10	10.88	11.24	11.66
2016-08-11	10.44	11.37	12.36
2016-08-12	11.52	12.20	12.97
2016-08-13	12.00	12.71	13.43
2016-08-14	12.22	12.82	13.31
2016-08-15	11.73	12.52	13.19
2016-08-16	12.05	12.76	13.35
2016-08-17	12.12	12.80	13.38
2016-08-18	12.29	12.80	13.16
2016-08-19	11.95	12.58	13.06
2016-08-20	11.81	12.52	13.09
2016-08-21	11.66	12.32	12.80
2016-08-22	10.32	10.86	11.47
2016-08-23	9.58	10.42	11.13
2016-08-24	10.17	10.93	11.66
2016-08-25	10.86	11.51	12.07
2016-08-26	11.05	11.75	12.44
2016-08-27	11.90	12.15	12.34
2016-08-28	11.49	11.71	12.03
2016-08-29	11.05	11.52	11.98
2016-08-30	11.47	11.86	12.22
2016-08-31	11.44	11.62	11.90
2016-09-01	10.25	10.76	11.37
2016-09-02	9.19	9.69	10.15
2016-09-03	9.56	9.84	10.12
2016-09-04	9.44	9.72	10.03
2016-09-05	9.14	9.42	9.63

Appendix F1. Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-09-06	9.19	9.53	9.90
2016-09-07	9.61	9.75	9.85
2016-09-08	9.41	9.63	9.93
2016-09-09	8.64	9.16	9.63
2016-09-10	9.51	9.86	10.32
2016-09-11	8.54	8.94	9.76
2016-09-12	7.37	7.96	8.42
2016-09-13	7.47	8.12	8.84
2016-09-14	8.02	8.70	9.41
2016-09-15	8.39	9.01	9.53
2016-09-16	9.29	9.63	9.90
2016-09-17	9.11	9.55	9.83
2016-09-18	8.30	8.67	9.02
2016-09-19	8.00	8.32	8.57
2016-09-20	7.19	7.68	8.10
2016-09-21	6.79	7.36	7.77
2016-09-22	6.54	7.06	7.52
2016-09-23	7.34	7.51	7.67
2016-09-24	7.42	7.74	8.05
2016-09-25	7.80	8.09	8.47
2016-09-26	7.57	8.11	8.79
2016-09-27	8.17	8.81	8.94
2016-09-28	7.24	7.55	8.05
2016-09-29	6.15	6.62	7.09
2016-09-30	5.75	6.14	6.64
2016-10-01	5.67	6.08	6.46
2016-10-02	6.28	6.53	6.91
2016-10-03	5.57	6.05	6.51
2016-10-04	6.33	6.64	6.94
2016-10-05	6.64	6.91	7.27
2016-10-06	7.04	7.18	7.32
2016-10-07	6.26	6.65	7.02
2016-10-08	4.61	5.48	6.54
2016-10-09	4.90	5.19	5.67
2016-10-10	3.62	4.31	4.90
2016-10-11	2.82	3.22	3.59
2016-10-12	2.37	2.86	3.46
2016-10-13	3.54	4.20	5.05

Appendix F1. Stream Temperature Data

Alpha Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-10-14	3.96	4.67	5.10
2016-10-15	4.45	4.97	5.31
2016-10-16	5.18	5.44	5.72
2016-10-17	5.31	5.63	6.00
2016-10-18	5.54	5.72	5.87
2016-10-19	5.39	5.76	6.13
2016-10-20	5.28	5.69	6.26
2016-10-21	4.77	5.17	5.41
2016-10-22	4.87	5.22	5.59
2016-10-23	5.08	5.39	5.80
2016-10-24	5.46	5.70	5.98
2016-10-25	4.90	5.58	5.98
2016-10-26	4.64	4.89	5.13
2016-10-27	4.95	5.58	5.98
2016-10-28	5.62	5.83	6.18
2016-10-29	5.10	5.33	5.57
2016-10-30	4.25	4.68	5.02
2016-10-31	4.58	4.86	5.08
2016-11-01	4.79	4.96	5.15
2016-11-02	4.84	5.02	5.28
2016-11-03	5.23	5.40	5.62
2016-11-04	4.27	5.04	5.80
2016-11-05	5.57	5.76	5.90
2016-11-06	5.21	5.48	5.72
2016-11-07	5.36	5.67	6.05
2016-11-08	6.10	6.65	6.99
2016-11-09	6.28	6.60	6.81
2016-11-10	5.67	6.04	6.26
2016-11-11	6.18	6.37	6.59
2016-11-12	5.72	6.15	6.43
2016-11-13	4.79	5.27	5.62
2016-11-14	4.43	4.94	5.21
2016-11-15	4.01	4.28	4.48
2016-11-16	3.54	3.76	4.12

Appendix F2. Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2015-12-15	0.66	0.83	0.96
2015-12-16	-0.06	0.05	0.66
2015-12-17	-0.06	-0.04	-0.03
2015-12-18	-0.03	0.00	0.14
2015-12-19	0.16	0.37	0.69
2015-12-20	0.11	0.71	0.99
2015-12-21	0.08	0.67	0.96
2015-12-22	0.08	0.25	0.47
2015-12-23	0.11	0.24	0.38
2015-12-24	0.02	0.18	0.30
2015-12-25	-0.06	-0.04	0.00
2015-12-26	-0.06	-0.04	-0.03
2015-12-27	-0.03	0.00	0.08
2015-12-28	0.02	0.06	0.11
2015-12-29	-0.03	-0.03	0.00
2015-12-30	-0.03	-0.03	-0.03
2015-12-31	-0.03	-0.01	0.00
2016-01-01	0.00	0.03	0.11
2016-01-02	0.11	0.20	0.30
2016-01-03	0.25	0.28	0.30
2016-01-04	0.30	0.40	0.52
2016-01-05	0.52	0.57	0.66
2016-01-06	0.66	0.74	0.80
2016-01-07	0.69	0.82	0.93
2016-01-08	0.88	0.97	0.99
2016-01-09	0.61	0.80	0.96
2016-01-10	0.52	0.57	0.61
2016-01-11	0.63	0.70	0.88
2016-01-12	0.83	0.96	1.07
2016-01-13	0.38	0.73	0.93
2016-01-14	0.88	0.99	1.04
2016-01-15	0.55	0.69	0.93
2016-01-16	0.63	0.77	1.02
2016-01-17	1.04	1.08	1.13
2016-01-18	0.88	1.01	1.07
2016-01-19	0.99	1.06	1.13
2016-01-20	0.85	1.02	1.13
2016-01-21	0.25	0.58	1.04

Appendix F2. Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-01-22	0.00	0.39	0.96
2016-01-23	1.02	1.32	1.45
2016-01-24	1.34	1.43	1.48
2016-01-25	0.83	1.13	1.40
2016-01-26	1.34	1.47	1.62
2016-01-27	0.08	1.43	1.94
2016-01-28	0.02	1.28	1.83
2016-01-29	1.43	1.68	1.81
2016-01-30	1.13	1.25	1.43
2016-01-31	0.96	1.16	1.26
2016-02-01	0.63	0.82	1.02
2016-02-02	-0.03	0.09	0.55
2016-02-03	-0.06	0.01	0.11
2016-02-04	0.11	0.73	1.13
2016-02-05	0.77	1.19	1.40
2016-02-06	0.85	1.14	1.32
2016-02-07	0.93	1.18	1.48
2016-02-08	1.37	1.47	1.53
2016-02-09	1.56	1.69	1.78
2016-02-10	1.72	2.03	2.32
2016-02-11	1.91	2.07	2.21
2016-02-12	1.89	2.09	2.32
2016-02-13	1.72	2.05	2.21
2016-02-14	1.86	2.01	2.29
2016-02-15	1.59	2.15	2.37
2016-02-16	1.72	2.02	2.21
2016-02-17	1.72	1.86	1.94
2016-02-18	1.67	2.05	2.34
2016-02-19	2.05	2.20	2.37
2016-02-20	1.64	1.84	2.07
2016-02-21	0.85	1.24	1.53
2016-02-22	0.83	1.26	1.45
2016-02-23	0.08	0.45	0.85
2016-02-24	0.66	1.13	1.56
2016-02-25	1.07	1.40	1.64
2016-02-26	1.45	1.85	2.29
2016-02-27	2.05	2.19	2.42
2016-02-28	1.70	1.94	2.10

Appendix F2. Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-02-29	1.75	1.90	2.13
2016-03-01	0.74	1.30	1.78
2016-03-02	1.21	1.61	1.83
2016-03-03	1.53	1.99	2.26
2016-03-04	2.05	2.15	2.32
2016-03-05	1.83	2.17	2.48
2016-03-06	1.97	2.17	2.37
2016-03-07	1.97	2.16	2.40
2016-03-08	1.75	1.97	2.18
2016-03-09	1.13	1.78	2.16
2016-03-10	0.63	1.41	1.91
2016-03-11	1.75	1.97	2.18
2016-03-12	1.24	1.49	1.78
2016-03-13	1.37	1.47	1.59
2016-03-14	1.29	1.38	1.51
2016-03-15	1.32	1.44	1.64
2016-03-16	1.02	1.34	1.51
2016-03-17	0.16	0.63	1.04
2016-03-18	0.30	0.78	1.24
2016-03-19	1.04	1.46	1.86
2016-03-20	1.64	1.88	2.18
2016-03-21	1.86	2.14	2.58
2016-03-22	2.02	2.32	2.72
2016-03-23	2.02	2.26	2.42
2016-03-24	1.86	2.10	2.32
2016-03-25	1.94	2.11	2.40
2016-03-26	1.64	2.04	2.50
2016-03-27	1.81	2.19	2.74
2016-03-28	1.37	1.82	2.26
2016-03-29	1.32	1.93	2.64
2016-03-30	2.18	2.49	2.98
2016-03-31	2.26	2.58	3.06
2016-04-01	2.32	2.71	3.33
2016-04-02	2.48	2.87	3.54
2016-04-03	2.40	2.86	3.43
2016-04-04	2.48	2.78	3.01
2016-04-05	2.45	2.62	2.80
2016-04-06	2.64	3.03	3.59

Appendix F2. Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-04-07	2.61	3.04	3.64
2016-04-08	2.74	3.21	4.09
2016-04-09	2.58	3.07	3.67
2016-04-10	2.61	3.30	4.22
2016-04-11	3.20	3.47	3.88
2016-04-12	2.34	3.04	3.35
2016-04-13	2.10	2.62	3.20
2016-04-14	2.05	2.86	3.80
2016-04-15	2.74	3.23	3.75
2016-04-16	2.69	3.32	3.88
2016-04-17	3.12	3.81	4.79
2016-04-18	3.30	3.93	4.97
2016-04-19	3.38	3.98	5.02
2016-04-20	3.35	4.00	4.97
2016-04-21	3.62	4.26	5.08
2016-04-22	3.93	4.24	4.79
2016-04-23	3.88	4.25	4.82
2016-04-24	3.54	3.91	4.32
2016-04-25	3.12	3.76	4.61
2016-04-26	2.58	3.62	4.66
2016-04-27	3.27	4.19	5.08
2016-04-28	3.96	4.65	5.49
2016-04-29	4.27	4.83	5.59
2016-04-30	3.51	4.62	5.75
2016-05-01	3.99	5.07	6.41
2016-05-02	4.40	5.50	6.89
2016-05-03	5.10	5.84	6.84
2016-05-04	4.82	5.21	5.67
2016-05-05	4.64	5.35	6.36
2016-05-06	4.14	5.42	6.91
2016-05-07	4.79	6.01	7.39
2016-05-08	4.35	5.62	6.38
2016-05-09	3.54	4.78	5.98
2016-05-10	4.06	5.32	6.56
2016-05-11	5.21	5.86	6.71
2016-05-12	4.71	5.77	6.79
2016-05-13	5.26	6.27	7.44
2016-05-14	5.98	6.93	8.05

Appendix F2. Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-05-15	6.00	7.06	8.34
2016-05-16	6.48	7.07	8.02
2016-05-17	6.23	7.07	8.22
2016-05-18	6.33	6.97	7.49
2016-05-19	5.51	5.78	6.08
2016-05-20	5.15	5.79	6.69
2016-05-21	5.13	6.01	6.89
2016-05-22	5.92	6.38	6.89
2016-05-23	6.00	6.51	7.14
2016-05-24	6.31	6.80	7.37
2016-05-25	6.56	7.24	8.10
2016-05-26	5.85	6.85	7.32
2016-05-27	5.26	5.66	6.15
2016-05-28	3.72	4.45	5.44
2016-05-29	4.09	5.27	6.46
2016-05-30	4.53	5.89	7.17
2016-05-31	5.72	6.99	8.27
2016-06-01	7.12	7.70	8.30
2016-06-02	7.19	7.59	8.10
2016-06-03	6.76	7.46	8.27
2016-06-04	7.49	8.82	10.39
2016-06-05	8.54	9.93	11.37
2016-06-06	9.58	10.55	11.52
2016-06-07	9.21	10.10	10.98
2016-06-08	8.44	9.15	9.83
2016-06-09	7.29	7.66	8.25
2016-06-10	6.36	6.85	7.34
2016-06-11	6.00	6.39	6.89
2016-06-12	6.23	6.92	7.52
2016-06-13	6.13	6.89	7.24
2016-06-14	5.23	5.64	6.10
2016-06-15	4.84	5.53	6.33
2016-06-16	4.32	5.51	6.46
2016-06-17	5.75	6.56	7.44
2016-06-18	6.13	6.69	7.29
2016-06-19	6.13	6.99	8.07
2016-06-20	7.02	8.12	9.31
2016-06-21	7.97	8.65	9.31

Appendix F2. Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-06-22	8.05	8.47	8.79
2016-06-23	7.75	8.19	8.54
2016-06-24	7.70	8.14	8.57
2016-06-25	7.95	8.73	9.63
2016-06-26	7.90	9.14	10.44
2016-06-27	9.16	10.05	10.96
2016-06-28	9.44	10.68	11.98
2016-06-29	10.15	11.27	12.36
2016-06-30	10.57	11.21	11.81
2016-07-01	10.08	10.43	10.93
2016-07-02	9.51	10.09	10.57
2016-07-03	9.04	9.57	10.17
2016-07-04	8.64	8.90	9.16
2016-07-05	8.47	8.86	9.29
2016-07-06	8.54	9.07	9.76
2016-07-07	8.62	8.97	9.24
2016-07-08	8.82	9.20	9.56
2016-07-09	8.64	8.92	9.29
2016-07-10	7.54	8.73	9.88
2016-07-11	9.04	9.37	9.73
2016-07-12	8.92	9.20	9.46
2016-07-13	8.64	9.42	10.27
2016-07-14	9.06	9.42	9.73
2016-07-15	8.30	9.18	10.17
2016-07-16	9.51	10.24	11.08
2016-07-17	10.08	10.63	11.32
2016-07-18	9.93	10.71	11.52
2016-07-19	10.22	10.53	10.98
2016-07-20	9.88	10.12	10.35
2016-07-21	8.97	9.99	11.01
2016-07-22	9.63	10.53	11.42
2016-07-23	10.12	10.56	11.10
2016-07-24	9.49	10.68	11.90
2016-07-25	11.08	12.01	13.16
2016-07-26	11.61	12.54	13.50
2016-07-27	11.90	12.81	13.71
2016-07-28	12.39	13.24	14.10
2016-07-29	12.51	13.33	14.17

Appendix F2. Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-07-30	11.61	12.56	13.38
2016-07-31	10.17	11.02	11.71
2016-08-01	10.03	10.92	11.71
2016-08-02	10.17	10.46	11.18
2016-08-03	10.00	10.36	10.74
2016-08-04	10.10	10.73	11.59
2016-08-05	10.08	10.64	11.05
2016-08-06	8.89	9.78	10.47
2016-08-07	9.56	10.05	10.66
2016-08-08	9.58	9.94	10.22
2016-08-09	9.95	10.34	10.74
2016-08-10	10.22	10.73	11.39
2016-08-11	10.12	11.10	12.20
2016-08-12	11.18	11.99	12.85
2016-08-13	11.81	12.55	13.35
2016-08-14	12.03	12.63	13.26
2016-08-15	11.49	12.35	13.16
2016-08-16	11.90	12.69	13.38
2016-08-17	11.86	12.60	13.23
2016-08-18	11.78	12.38	12.85
2016-08-19	11.42	12.17	12.85
2016-08-20	11.47	12.24	12.97
2016-08-21	11.08	12.02	12.61
2016-08-22	9.71	10.27	10.88
2016-08-23	9.09	10.01	10.93
2016-08-24	9.90	10.71	11.59
2016-08-25	10.66	11.34	12.05
2016-08-26	10.81	11.53	12.27
2016-08-27	11.57	11.82	12.03
2016-08-28	10.79	11.07	11.52
2016-08-29	10.30	10.89	11.44
2016-08-30	10.91	11.35	11.78
2016-08-31	10.69	10.95	11.37
2016-09-01	9.29	9.95	10.61
2016-09-02	8.20	8.82	9.24
2016-09-03	8.72	9.01	9.39
2016-09-04	8.30	8.78	9.24
2016-09-05	8.57	8.79	9.04

Appendix F2. Stream Temperature Data

Crabapple Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-09-06	8.37	8.81	9.41
2016-09-07	8.72	8.94	9.09
2016-09-08	8.52	8.80	9.26
2016-09-09	7.95	8.53	9.09
2016-09-10	8.94	9.35	9.85
2016-09-11	7.95	8.37	9.19
2016-09-12	7.14	7.74	8.30
2016-09-13	6.97	7.81	8.77
2016-09-14	7.95	8.72	9.63
2016-09-15	8.47	9.18	9.83
2016-09-16	9.34	9.69	10.00
2016-09-17	8.64	9.16	9.66
2016-09-18	8.00	8.30	8.54
2016-09-19	7.17	7.63	7.95
2016-09-20	6.41	7.10	7.67
2016-09-21	6.48	7.08	7.70
2016-09-22	6.18	6.88	7.47
2016-09-23	7.09	7.20	7.37
2016-09-24	6.81	7.16	7.47
2016-09-25	7.12	7.49	7.95
2016-09-26	7.39	7.99	8.87
2016-09-27	7.59	8.53	8.92
2016-09-28	6.26	6.88	7.44
2016-09-29	5.57	6.27	6.86
2016-09-30	5.46	5.79	6.38

Appendix F3. Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2015-12-15	2.80	2.81	2.82
2015-12-16	2.56	2.65	2.77
2015-12-17	2.40	2.47	2.53
2015-12-18	2.21	2.36	2.42
2015-12-19	2.32	2.37	2.48
2015-12-20	2.21	2.29	2.34
2015-12-21	2.13	2.25	2.32
2015-12-22	2.13	2.18	2.21
2015-12-23	1.94	2.07	2.13
2015-12-24	1.91	1.96	2.02
2015-12-25	1.67	1.84	1.94
2015-12-26	1.64	1.67	1.72
2015-12-27	1.53	1.61	1.64
2015-12-28	1.40	1.48	1.56
2015-12-29	1.29	1.34	1.43
2015-12-30	1.21	1.26	1.29
2015-12-31	1.02	1.20	1.26
2016-01-01	1.13	1.18	1.24
2016-01-02	1.13	1.17	1.24
2016-01-03	1.07	1.11	1.18
2016-01-04	1.07	1.15	1.24
2016-01-05	1.10	1.15	1.21
2016-01-06	1.18	1.22	1.32
2016-01-07	1.13	1.22	1.37
2016-01-08	1.13	1.22	1.29
2016-01-09	1.10	1.15	1.21
2016-01-10	1.04	1.11	1.21
2016-01-11	0.96	1.06	1.21
2016-01-12	1.07	1.15	1.24
2016-01-13	0.88	1.14	1.26
2016-01-14	1.21	1.28	1.40
2016-01-15	1.15	1.22	1.29
2016-01-16	0.96	1.17	1.26
2016-01-17	1.21	1.28	1.34
2016-01-18	1.26	1.37	1.45
2016-01-19	1.34	1.39	1.48
2016-01-20	1.32	1.36	1.45
2016-01-21	0.99	1.20	1.34

Appendix F3. Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-01-22	1.29	1.45	1.59
2016-01-23	1.45	1.49	1.53
2016-01-24	1.53	1.58	1.64
2016-01-25	1.67	1.70	1.75
2016-01-26	1.70	1.74	1.81
2016-01-27	1.78	1.85	1.94
2016-01-28	1.97	2.35	2.85
2016-01-29	2.29	2.35	2.37
2016-01-30	2.21	2.26	2.32
2016-01-31	2.16	2.19	2.24
2016-02-01	2.07	2.13	2.18
2016-02-02	1.89	1.98	2.10
2016-02-03	1.75	1.84	1.89
2016-02-04	1.78	1.82	1.86
2016-02-05	1.81	1.85	1.89
2016-02-06	1.78	1.83	1.89
2016-02-07	1.86	1.92	1.97
2016-02-08	1.94	1.96	2.02
2016-02-09	1.94	2.00	2.05
2016-02-10	1.99	2.03	2.07
2016-02-11	2.05	2.10	2.16
2016-02-12	2.16	2.23	2.32
2016-02-13	2.32	2.35	2.40
2016-02-14	2.40	2.44	2.48
2016-02-15	2.45	2.48	2.53
2016-02-16	2.50	2.51	2.53
2016-02-17	2.53	2.55	2.58
2016-02-18	2.50	2.54	2.58
2016-02-19	2.53	2.59	2.64
2016-02-20	2.61	2.64	2.69
2016-02-21	2.58	2.63	2.69
2016-02-22	2.53	2.58	2.66
2016-02-23	2.48	2.56	2.64
2016-02-24	2.50	2.59	2.72
2016-02-25	2.50	2.61	2.74
2016-02-26	2.58	2.69	2.80
2016-02-27	2.72	2.81	2.96
2016-02-28	2.80	2.84	2.90

Appendix F3. Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-02-29	2.69	2.83	2.96
2016-03-01	2.85	2.88	2.93
2016-03-02	2.69	2.76	2.82
2016-03-03	2.72	2.79	2.85
2016-03-04	2.82	2.89	2.96
2016-03-05	2.88	2.94	3.01
2016-03-06	2.98	3.02	3.06
2016-03-07	3.01	3.07	3.14
2016-03-08	3.04	3.12	3.22
2016-03-09	3.01	3.13	3.25
2016-03-10	3.09	3.14	3.20
2016-03-11	3.01	3.11	3.17
2016-03-12	3.12	3.16	3.25
2016-03-13	3.01	3.11	3.20
2016-03-14	3.12	3.23	3.35
2016-03-15	3.22	3.33	3.49
2016-03-16	3.01	3.39	3.72
2016-03-17	2.80	3.19	3.62
2016-03-18	2.90	3.29	3.78
2016-03-19	3.06	3.52	3.88
2016-03-20	3.64	3.86	4.09
2016-03-21	3.85	4.01	4.53
2016-03-22	3.85	4.02	4.38
2016-03-23	3.96	4.07	4.25
2016-03-24	4.04	4.14	4.25
2016-03-25	4.12	4.44	4.97
2016-03-26	4.64	4.96	5.51
2016-03-27	4.74	4.93	5.23
2016-03-28	4.77	5.51	6.36
2016-03-29	5.39	6.21	7.14
2016-03-30	6.13	6.86	8.12
2016-03-31	6.23	6.80	7.77
2016-04-01	5.98	6.36	6.86
2016-04-02	5.64	6.32	6.71
2016-04-03	6.20	6.60	7.49
2016-04-04	5.67	5.92	6.20
2016-04-05	5.36	5.60	6.10
2016-04-06	5.36	5.68	6.43

Appendix F3. Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-04-07	6.18	6.64	7.37
2016-04-08	5.82	6.50	7.04
2016-04-09	6.28	6.80	7.57
2016-04-10	5.90	6.47	6.89
2016-04-11	6.10	6.38	6.74
2016-04-12	5.95	6.21	6.56
2016-04-13	6.00	6.19	6.56
2016-04-14	6.08	6.79	7.92
2016-04-15	5.98	6.43	6.84
2016-04-16	6.48	6.95	7.32
2016-04-17	7.07	7.80	8.87
2016-04-18	7.39	8.03	8.67
2016-04-19	7.59	7.99	8.79
2016-04-20	7.17	7.97	9.11
2016-04-21	6.61	7.02	7.80
2016-04-22	6.03	7.13	7.95
2016-04-23	6.05	6.23	6.54
2016-04-24	5.95	6.31	7.07
2016-04-25	6.33	6.88	8.10
2016-04-26	7.04	7.34	7.65
2016-04-27	7.39	8.14	9.39
2016-04-28	7.37	7.99	8.57
2016-04-29	7.44	8.24	9.11
2016-04-30	8.17	8.84	9.44
2016-05-01	8.69	9.50	11.05
2016-05-02	8.49	9.37	10.37
2016-05-03	8.25	8.81	9.44
2016-05-04	7.65	8.13	8.82
2016-05-05	8.25	9.16	10.44
2016-05-06	8.15	9.07	10.66
2016-05-07	8.30	8.79	9.51
2016-05-08	7.65	8.67	10.05
2016-05-09	8.64	9.57	10.54
2016-05-10	8.77	9.52	10.64
2016-05-11	8.32	9.27	10.57
2016-05-12	9.21	10.08	11.64
2016-05-13	9.34	10.19	11.57
2016-05-14	8.99	10.15	11.81

Appendix F3. Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-05-15	8.82	9.52	10.03
2016-05-16	8.74	9.25	9.76
2016-05-17	9.11	9.59	10.91
2016-05-18	8.84	9.35	10.57
2016-05-19	8.44	8.90	10.08
2016-05-20	8.94	9.99	10.98
2016-05-21	8.59	9.48	10.20
2016-05-22	8.54	9.01	9.95
2016-05-23	8.62	8.98	9.68
2016-05-24	8.64	9.03	9.73
2016-05-25	8.92	9.84	11.42
2016-05-26	9.06	9.73	11.35
2016-05-27	9.19	9.50	10.37
2016-05-28	8.69	9.05	9.73
2016-05-29	8.69	9.27	10.35
2016-05-30	9.29	10.04	11.27
2016-05-31	10.05	10.77	11.54
2016-06-01	9.71	10.45	11.20
2016-06-02	9.29	9.87	10.61
2016-06-03	9.34	10.07	11.71
2016-06-04	10.61	11.25	12.27
2016-06-05	10.49	10.96	11.52
2016-06-06	9.56	10.46	11.66
2016-06-07	9.81	10.44	11.13
2016-06-08	9.49	10.22	11.22
2016-06-09	8.89	9.61	10.59
2016-06-10	9.19	9.69	10.30
2016-06-11	8.89	9.10	9.68
2016-06-12	8.99	9.44	10.00
2016-06-13	9.19	9.66	10.25
2016-06-14	8.97	9.49	10.10
2016-06-15	9.21	9.83	10.71
2016-06-16	9.85	10.41	11.01
2016-06-17	10.37	11.52	13.06
2016-06-18	10.08	10.84	12.29
2016-06-19	10.15	10.65	12.07
2016-06-20	11.35	12.23	13.02
2016-06-21	10.91	11.83	12.75

Appendix F3. Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-06-22	10.96	11.51	12.10
2016-06-23	10.66	11.10	11.90
2016-06-24	10.27	10.74	11.44
2016-06-25	10.61	11.13	11.98
2016-06-26	11.66	12.58	13.79
2016-06-27	12.51	13.11	14.05
2016-06-28	11.88	12.65	13.88
2016-06-29	11.90	12.86	14.12
2016-06-30	12.05	12.79	13.83
2016-07-01	12.15	12.89	13.83
2016-07-02	12.36	12.94	13.71
2016-07-03	12.07	12.55	13.19
2016-07-04	11.88	12.09	12.49
2016-07-05	11.76	12.36	13.21
2016-07-06	12.36	12.89	13.62
2016-07-07	11.95	12.51	13.14
2016-07-08	11.83	12.31	12.56
2016-07-09	11.59	12.11	12.56
2016-07-10	11.98	12.48	13.64
2016-07-11	12.10	12.69	13.45
2016-07-12	12.29	12.79	13.23
2016-07-13	12.32	12.88	13.43
2016-07-14	12.56	13.20	13.91
2016-07-15	12.61	13.03	13.43
2016-07-16	12.82	13.61	14.36
2016-07-17	13.69	14.79	15.96
2016-07-18	13.67	14.04	14.39
2016-07-19	13.28	13.76	14.27
2016-07-20	13.09	13.50	14.05
2016-07-21	13.33	14.09	15.15
2016-07-22	13.45	14.47	15.51
2016-07-23	13.79	14.21	14.63
2016-07-24	14.24	14.74	15.70
2016-07-25	14.63	15.61	16.82
2016-07-26	15.46	16.22	16.87
2016-07-27	16.51	17.37	18.37
2016-07-28	17.18	17.90	18.63
2016-07-29	16.73	17.79	18.65

Appendix F3. Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-07-30	16.37	17.23	17.94
2016-07-31	16.30	16.93	17.53
2016-08-01	16.51	16.94	17.70
2016-08-02	16.01	16.36	16.99
2016-08-03	15.80	15.97	16.25
2016-08-04	15.89	16.37	17.20
2016-08-05	16.23	16.49	16.73
2016-08-06	15.84	16.39	17.23
2016-08-07	16.06	16.32	16.73
2016-08-08	16.13	16.34	16.75
2016-08-09	15.99	16.09	16.18
2016-08-10	15.92	16.18	16.56
2016-08-11	15.99	16.90	17.92
2016-08-12	16.96	17.82	19.06
2016-08-13	17.56	18.18	18.99
2016-08-14	17.84	18.30	19.22
2016-08-15	17.82	18.39	18.96
2016-08-16	18.18	18.58	19.06
2016-08-17	18.25	19.28	20.67
2016-08-18	18.60	19.31	19.87
2016-08-19	18.37	19.16	20.20
2016-08-20	18.46	19.21	20.22
2016-08-21	18.11	18.57	19.08
2016-08-22	17.53	17.81	18.06
2016-08-23	17.15	17.93	19.03
2016-08-24	17.34	18.17	19.03
2016-08-25	17.65	18.55	19.53
2016-08-26	17.96	18.51	18.91
2016-08-27	18.08	18.40	18.70
2016-08-28	17.65	17.84	18.22
2016-08-29	17.42	17.80	18.25
2016-08-30	17.42	17.83	18.30
2016-08-31	17.39	17.52	17.68
2016-09-01	16.92	17.19	17.37
2016-09-02	16.70	16.86	17.20
2016-09-03	16.49	16.66	16.96
2016-09-04	16.20	16.60	17.08
2016-09-05	15.92	16.15	16.30

Appendix F3. Stream Temperature Data

Jordan Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-09-06	15.80	16.15	16.75
2016-09-07	15.61	15.85	16.03
2016-09-08	15.51	15.84	16.34
2016-09-09	15.41	15.67	15.92
2016-09-10	15.39	15.81	16.39
2016-09-11	15.13	15.62	16.15
2016-09-12	14.94	15.58	16.27
2016-09-13	14.86	15.51	16.20
2016-09-14	14.91	15.57	16.46
2016-09-15	14.94	15.55	16.37
2016-09-16	15.34	15.62	16.01
2016-09-17	15.01	15.25	15.51
2016-09-18	14.86	15.04	15.20
2016-09-19	14.48	14.69	14.86
2016-09-20	14.22	14.45	14.70
2016-09-21	13.95	14.41	14.91
2016-09-22	13.76	14.24	14.84
2016-09-23	13.79	13.88	14.05
2016-09-24	13.62	13.78	14.03
2016-09-25	13.55	13.75	14.10
2016-09-26	13.47	13.75	13.95
2016-09-27	13.59	13.93	14.34
2016-09-28	13.16	13.58	13.95
2016-09-29	12.92	13.35	13.95
2016-09-30	12.85	12.97	13.38

Appendix F4 Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2015-12-15	1.64	1.83	1.89
2015-12-16	1.18	1.39	1.78
2015-12-17	1.07	1.15	1.21
2015-12-18	0.52	1.02	1.34
2015-12-19	1.40	1.53	1.67
2015-12-20	1.34	1.55	1.67
2015-12-21	1.24	1.58	1.83
2015-12-22	1.18	1.35	1.62
2015-12-23	1.13	1.31	1.53
2015-12-24	0.96	1.20	1.48
2015-12-25	0.66	0.99	1.13
2015-12-26	0.58	0.70	0.88
2015-12-27	0.72	0.86	1.07
2015-12-28	0.52	0.73	1.02
2015-12-29	0.38	0.51	0.69
2015-12-30	0.33	0.43	0.58
2015-12-31	0.30	0.41	0.55
2016-01-01	0.33	0.44	0.61
2016-01-02	0.33	0.45	0.61
2016-01-03	0.30	0.41	0.52
2016-01-04	0.38	0.51	0.69
2016-01-05	0.41	0.54	0.63
2016-01-06	0.61	0.72	0.91
2016-01-07	0.52	0.76	1.02
2016-01-08	0.80	1.03	1.21
2016-01-09	0.72	0.93	1.18
2016-01-10	0.38	0.58	0.77
2016-01-11	0.33	0.53	0.74
2016-01-12	0.66	0.84	1.02
2016-01-13	0.50	0.87	1.15
2016-01-14	1.15	1.33	1.62
2016-01-15	0.99	1.22	1.40
2016-01-16	0.80	1.08	1.26
2016-01-17	1.10	1.27	1.34
2016-01-18	1.18	1.42	1.64
2016-01-19	1.34	1.54	1.72
2016-01-20	1.34	1.54	1.78
2016-01-21	0.27	0.81	1.56

Appendix F4 Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-01-22	0.05	0.29	0.52
2016-01-23	0.38	0.77	1.21
2016-01-24	1.07	1.38	1.67
2016-01-25	1.07	1.37	1.64
2016-01-26	1.40	1.54	1.67
2016-01-27	0.38	1.40	1.83
2016-01-28	0.33	0.94	1.56
2016-01-29	1.53	1.62	1.72
2016-01-30	1.43	1.53	1.72
2016-01-31	1.48	1.67	1.91
2016-02-01	1.34	1.58	1.91
2016-02-02	1.04	1.29	1.51
2016-02-03	0.91	1.17	1.53
2016-02-04	0.99	1.54	1.99
2016-02-05	1.53	1.75	1.91
2016-02-06	1.32	1.71	2.24
2016-02-07	1.56	1.81	2.16
2016-02-08	1.78	2.01	2.53
2016-02-09	1.67	1.97	2.53
2016-02-10	1.81	2.03	2.34
2016-02-11	1.86	2.15	2.48
2016-02-12	2.13	2.20	2.34
2016-02-13	1.86	2.17	2.42
2016-02-14	1.97	2.23	2.53
2016-02-15	1.78	2.40	2.74
2016-02-16	2.02	2.34	2.85
2016-02-17	2.07	2.28	2.40
2016-02-18	2.13	2.44	2.85
2016-02-19	2.42	2.70	3.20
2016-02-20	2.24	2.53	2.93
2016-02-21	1.86	2.16	2.42
2016-02-22	2.07	2.47	3.20
2016-02-23	1.59	2.10	2.66
2016-02-24	1.94	2.49	3.25
2016-02-25	1.94	2.58	3.41
2016-02-26	2.10	2.82	3.54
2016-02-27	2.85	3.27	3.96
2016-02-28	2.72	2.90	3.17

Appendix F4 Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-02-29	2.42	2.86	3.38
2016-03-01	1.94	2.38	2.90
2016-03-02	2.07	2.55	3.04
2016-03-03	2.53	2.87	3.35
2016-03-04	2.69	2.84	2.98
2016-03-05	2.48	3.06	3.85
2016-03-06	2.96	3.15	3.41
2016-03-07	2.85	3.22	3.75
2016-03-08	2.85	3.30	3.85
2016-03-09	3.01	3.45	4.09
2016-03-10	2.58	2.86	3.25
2016-03-11	2.77	3.29	3.88
2016-03-12	2.80	3.09	3.64
2016-03-13	2.82	3.25	3.67
2016-03-14	2.77	3.32	4.04
2016-03-15	2.88	3.48	4.27
2016-03-16	2.72	3.52	4.53
2016-03-17	2.42	3.40	4.58
2016-03-18	2.45	3.48	4.69
2016-03-19	3.09	3.88	4.87
2016-03-20	3.67	4.01	4.43
2016-03-21	3.30	3.97	4.71
2016-03-22	3.51	4.41	5.62
2016-03-23	3.85	4.27	4.71
2016-03-24	3.43	3.99	4.66
2016-03-25	3.54	4.56	5.98
2016-03-26	3.85	4.95	6.20
2016-03-27	4.48	5.12	6.05
2016-03-28	3.96	5.00	6.43
2016-03-29	3.41	4.83	6.61
2016-03-30	3.80	5.01	6.89
2016-03-31	3.56	4.44	6.13
2016-04-01	3.20	4.18	5.98
2016-04-02	3.35	4.24	5.75
2016-04-03	3.38	4.21	5.31
2016-04-04	3.46	3.92	4.38
2016-04-05	3.64	4.01	4.51
2016-04-06	3.96	4.78	6.03

Appendix F4 Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-04-07	3.80	4.76	6.36
2016-04-08	3.41	4.29	5.95
2016-04-09	3.14	4.08	5.59
2016-04-10	3.41	4.45	6.10
2016-04-11	4.06	4.62	5.92
2016-04-12	3.64	4.11	4.53
2016-04-13	3.41	4.23	5.18
2016-04-14	3.59	4.81	6.28
2016-04-15	4.25	5.01	5.92
2016-04-16	4.43	5.10	5.82
2016-04-17	4.40	5.45	7.24
2016-04-18	3.62	4.60	6.66
2016-04-19	3.41	4.14	5.82
2016-04-20	3.27	4.10	5.85
2016-04-21	3.38	4.11	5.13
2016-04-22	3.70	4.02	4.53
2016-04-23	3.70	4.22	5.44
2016-04-24	3.72	4.39	5.62
2016-04-25	3.78	4.85	6.33
2016-04-26	3.93	5.13	6.56
2016-04-27	4.38	5.36	6.64
2016-04-28	4.48	5.41	6.91
2016-04-29	4.35	5.06	6.43
2016-04-30	3.64	4.95	6.89
2016-05-01	3.85	5.02	7.22
2016-05-02	3.75	4.86	6.94
2016-05-03	4.06	4.76	6.26
2016-05-04	3.80	4.29	5.10
2016-05-05	3.80	4.83	6.74
2016-05-06	3.56	4.87	7.07
2016-05-07	3.83	5.02	7.14
2016-05-08	3.88	4.77	6.51
2016-05-09	3.49	4.71	6.13
2016-05-10	3.80	5.24	7.39
2016-05-11	4.38	5.03	6.38
2016-05-12	3.78	5.06	6.89
2016-05-13	4.12	5.27	7.42
2016-05-14	4.19	5.18	7.34

Appendix F4 Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-05-15	4.06	5.18	7.17
2016-05-16	4.30	5.02	6.48
2016-05-17	4.19	5.24	7.09
2016-05-18	4.32	4.91	5.54
2016-05-19	3.99	4.65	5.51
2016-05-20	4.19	5.30	7.19
2016-05-21	4.12	5.24	6.74
2016-05-22	4.69	5.37	6.48
2016-05-23	4.56	5.05	5.77
2016-05-24	4.51	5.22	6.31
2016-05-25	4.45	5.61	7.59
2016-05-26	4.35	5.09	6.08
2016-05-27	4.09	5.04	6.46
2016-05-28	3.91	4.29	4.71
2016-05-29	4.17	5.41	7.14
2016-05-30	4.38	6.08	8.27
2016-05-31	4.82	6.30	8.37
2016-06-01	4.74	5.86	7.57
2016-06-02	4.43	4.90	5.85
2016-06-03	4.35	5.08	6.00
2016-06-04	4.64	5.96	8.52
2016-06-05	4.71	5.95	8.22
2016-06-06	4.97	6.02	8.12
2016-06-07	4.95	6.16	8.54
2016-06-08	5.05	5.68	6.46
2016-06-09	4.77	5.73	7.17
2016-06-10	5.00	5.55	6.18
2016-06-11	5.02	5.48	6.10
2016-06-12	5.10	5.89	6.81
2016-06-13	5.02	5.72	6.48
2016-06-14	4.53	5.69	7.32
2016-06-15	4.87	6.04	7.70
2016-06-16	4.51	5.99	7.52
2016-06-17	5.49	6.58	8.25
2016-06-18	5.36	6.17	7.29
2016-06-19	5.23	6.26	7.72
2016-06-20	5.33	6.97	9.31
2016-06-21	5.57	6.93	8.92

Appendix F4 Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-06-22	5.72	6.50	7.22
2016-06-23	5.51	6.30	7.24
2016-06-24	5.62	6.57	7.92
2016-06-25	6.03	7.07	8.94
2016-06-26	5.64	7.53	10.27
2016-06-27	6.48	7.76	9.95
2016-06-28	6.54	8.30	10.88
2016-06-29	7.32	8.91	11.35
2016-06-30	7.62	9.10	11.30
2016-07-01	8.05	8.82	10.12
2016-07-02	7.97	9.03	10.15
2016-07-03	7.75	8.47	9.16
2016-07-04	7.44	8.24	9.11
2016-07-05	7.72	8.58	9.71
2016-07-06	8.05	9.07	10.47
2016-07-07	8.34	8.93	9.41
2016-07-08	8.27	8.78	9.49
2016-07-09	7.85	8.59	9.63
2016-07-10	7.37	9.27	11.39
2016-07-11	9.26	9.89	10.61
2016-07-12	9.21	9.73	10.25
2016-07-13	8.99	10.18	11.44
2016-07-14	9.31	10.26	11.25
2016-07-15	8.99	10.35	11.90
2016-07-16	10.42	11.74	13.43
2016-07-17	10.79	11.74	12.82
2016-07-18	10.37	11.99	13.62
2016-07-19	11.20	11.71	12.44
2016-07-20	10.61	11.03	11.44
2016-07-21	9.66	11.41	13.35
2016-07-22	10.64	12.24	14.03
2016-07-23	11.27	11.96	12.58
2016-07-24	10.44	12.37	14.43
2016-07-25	12.27	13.73	15.25
2016-07-26	12.61	14.23	15.94
2016-07-27	13.02	14.54	16.23
2016-07-28	13.35	14.80	16.37
2016-07-29	13.38	14.90	16.49

Appendix F4 Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-07-30	13.14	14.38	15.68
2016-07-31	12.03	13.15	14.15
2016-08-01	11.86	13.09	14.27
2016-08-02	11.81	12.19	13.19
2016-08-03	11.59	12.05	12.56
2016-08-04	11.61	12.69	14.05
2016-08-05	11.59	12.60	13.62
2016-08-06	10.69	12.06	13.35
2016-08-07	11.49	12.31	13.14
2016-08-08	11.25	11.80	12.22
2016-08-09	11.57	12.08	12.61
2016-08-10	11.83	12.70	13.86
2016-08-11	11.57	12.86	14.29
2016-08-12	12.24	13.50	14.86
2016-08-13	12.87	14.07	15.39
2016-08-14	13.19	14.32	15.53
2016-08-15	12.78	14.07	15.27
2016-08-16	13.19	14.36	15.51
2016-08-17	13.21	14.37	15.51
2016-08-18	13.04	14.14	15.20
2016-08-19	12.68	14.13	16.49
2016-08-20	12.05	14.77	17.11
2016-08-21	12.46	14.13	16.25
2016-08-22	11.76	13.20	15.34
2016-08-23	9.90	13.11	16.34
2016-08-24	10.08	13.97	18.11
2016-08-25	11.15	14.55	18.77
2016-08-26	11.37	14.70	19.18
2016-08-27	13.62	15.07	19.48
2016-08-28	12.92	13.37	13.76
2016-08-29	12.27	13.90	17.63
2016-08-30	12.27	14.48	18.63
2016-08-31	12.61	13.06	13.57
2016-09-01	11.25	11.68	12.53
2016-09-02	10.37	11.17	11.83
2016-09-03	10.79	11.47	12.29
2016-09-04	10.54	11.37	12.17
2016-09-05	10.52	11.04	11.54

Appendix F4 Stream Temperature Data

River of Golden Dreams			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-09-06	10.47	11.30	12.24
2016-09-07	10.71	11.20	11.52
2016-09-08	10.20	10.83	11.57
2016-09-09	9.83	10.67	11.49
2016-09-10	10.81	11.72	12.61
2016-09-11	9.31	10.87	12.24
2016-09-12	7.59	9.89	12.00
2016-09-13	7.17	10.01	12.27
2016-09-14	7.97	10.71	13.14
2016-09-15	8.52	11.08	13.09
2016-09-16	10.30	11.32	12.41
2016-09-17	9.39	10.37	11.01
2016-09-18	9.19	9.70	10.39
2016-09-19	8.74	9.18	9.68
2016-09-20	7.95	8.69	9.44
2016-09-21	7.87	8.72	9.58
2016-09-22	7.59	8.59	9.61
2016-09-23	8.54	8.73	8.92
2016-09-24	8.15	8.71	9.21
2016-09-25	8.82	9.23	9.81
2016-09-26	8.64	9.19	9.66
2016-09-27	8.92	9.68	10.37
2016-09-28	7.09	8.29	9.58
2016-09-29	5.95	7.60	9.29
2016-09-30	5.82	6.66	7.62

Appendix F5. Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2015-12-15	1.70	1.99	2.07
2015-12-16	1.24	1.47	1.97
2015-12-17	1.02	1.11	1.21
2015-12-18	0.66	1.06	1.40
2015-12-19	1.32	1.42	1.51
2015-12-20	0.99	1.34	1.62
2015-12-21	1.18	1.56	1.67
2015-12-22	1.15	1.28	1.43
2015-12-23	1.04	1.20	1.32
2015-12-24	0.96	1.07	1.18
2015-12-25	0.63	0.89	1.02
2015-12-26	0.55	0.66	0.77
2015-12-27	0.74	0.85	0.96
2015-12-28	0.69	0.85	0.91
2015-12-29	0.63	0.75	0.88
2015-12-30	0.50	0.54	0.63
2015-12-31	0.41	0.48	0.52
2016-01-01	0.44	0.52	0.61
2016-01-02	0.58	0.63	0.72
2016-01-03	0.47	0.50	0.58
2016-01-04	0.47	0.57	0.66
2016-01-05	0.63	0.69	0.83
2016-01-06	0.85	0.97	1.07
2016-01-07	1.02	1.15	1.29
2016-01-08	1.26	1.32	1.37
2016-01-09	1.04	1.18	1.29
2016-01-10	0.80	0.91	1.02
2016-01-11	0.77	0.85	0.96
2016-01-12	0.96	1.13	1.24
2016-01-13	0.77	0.95	1.15
2016-01-14	1.13	1.25	1.32
2016-01-15	1.21	1.27	1.32
2016-01-16	0.99	1.17	1.29
2016-01-17	1.24	1.33	1.40
2016-01-18	1.18	1.26	1.34
2016-01-19	1.34	1.40	1.48
2016-01-20	1.40	1.46	1.51
2016-01-21	0.41	0.89	1.45

Appendix F5. Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-01-22	0.38	0.57	1.15
2016-01-23	1.34	1.87	2.10
2016-01-24	2.02	2.12	2.21
2016-01-25	0.19	1.83	2.24
2016-01-26	2.13	2.23	2.32
2016-01-27	0.88	2.14	2.53
2016-01-28	0.99	1.77	2.37
2016-01-29	2.21	2.36	2.42
2016-01-30	2.10	2.19	2.32
2016-01-31	1.94	2.07	2.16
2016-02-01	1.75	1.89	2.05
2016-02-02	1.18	1.35	1.72
2016-02-03	0.96	1.17	1.37
2016-02-04	1.18	1.56	1.78
2016-02-05	1.67	1.97	2.18
2016-02-06	1.99	2.25	2.45
2016-02-07	2.21	2.36	2.56
2016-02-08	2.32	2.42	2.50
2016-02-09	2.37	2.48	2.64
2016-02-10	2.40	2.62	2.82
2016-02-11	2.64	2.76	2.90
2016-02-12	2.69	2.82	2.98
2016-02-13	2.53	2.79	2.90
2016-02-14	2.64	2.78	2.98
2016-02-15	2.29	2.80	3.01
2016-02-16	2.48	2.83	3.09
2016-02-17	2.53	2.64	2.74
2016-02-18	2.50	2.79	3.04
2016-02-19	2.77	2.92	3.14
2016-02-20	2.56	2.71	2.88
2016-02-21	2.21	2.36	2.48
2016-02-22	2.21	2.46	2.74
2016-02-23	1.59	1.93	2.16
2016-02-24	1.97	2.26	2.61
2016-02-25	2.10	2.42	2.72
2016-02-26	2.34	2.68	3.01
2016-02-27	2.74	2.95	3.25
2016-02-28	2.53	2.73	2.90

Appendix F5. Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-02-29	2.64	2.81	3.06
2016-03-01	1.62	2.20	2.74
2016-03-02	1.97	2.34	2.61
2016-03-03	2.42	2.75	3.01
2016-03-04	2.80	2.88	2.96
2016-03-05	2.74	3.06	3.41
2016-03-06	2.93	3.09	3.25
2016-03-07	2.90	3.07	3.33
2016-03-08	2.72	2.92	3.20
2016-03-09	2.48	2.84	3.17
2016-03-10	1.83	2.48	2.90
2016-03-11	2.69	2.91	3.17
2016-03-12	2.45	2.64	3.01
2016-03-13	2.45	2.60	2.74
2016-03-14	2.40	2.56	2.85
2016-03-15	2.45	2.66	2.93
2016-03-16	2.45	2.72	3.14
2016-03-17	1.78	2.25	2.61
2016-03-18	1.83	2.28	2.69
2016-03-19	2.40	2.73	3.12
2016-03-20	2.88	3.02	3.22
2016-03-21	2.80	3.14	3.56
2016-03-22	2.85	3.31	3.85
2016-03-23	3.09	3.26	3.43
2016-03-24	2.96	3.17	3.46
2016-03-25	2.93	3.36	3.93
2016-03-26	2.88	3.40	3.96
2016-03-27	3.01	3.39	3.93
2016-03-28	2.74	3.28	3.80
2016-03-29	2.72	3.46	4.19
2016-03-30	3.33	3.80	4.53
2016-03-31	3.22	3.73	4.53
2016-04-01	3.17	3.76	4.69
2016-04-02	3.30	3.82	4.66
2016-04-03	3.20	3.77	4.48
2016-04-04	3.33	3.60	3.88
2016-04-05	3.20	3.38	3.56
2016-04-06	3.54	4.03	4.71

Appendix F5. Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-04-07	3.67	4.24	5.15
2016-04-08	3.54	4.16	5.36
2016-04-09	3.27	3.92	4.84
2016-04-10	3.38	4.17	5.21
2016-04-11	3.72	4.11	4.69
2016-04-12	3.06	3.58	3.88
2016-04-13	2.74	3.33	3.91
2016-04-14	2.85	3.69	4.56
2016-04-15	3.51	3.93	4.40
2016-04-16	3.51	4.03	4.45
2016-04-17	4.04	4.84	5.98
2016-04-18	4.06	4.88	6.41
2016-04-19	3.91	4.61	6.10
2016-04-20	3.83	4.54	6.05
2016-04-21	3.91	4.64	5.64
2016-04-22	4.30	4.56	5.00
2016-04-23	3.91	4.47	5.31
2016-04-24	3.62	4.06	4.92
2016-04-25	3.22	4.01	4.92
2016-04-26	3.14	4.09	5.00
2016-04-27	3.70	4.51	5.36
2016-04-28	4.27	4.97	5.82
2016-04-29	4.58	4.94	5.46
2016-04-30	3.91	4.91	6.05
2016-05-01	4.17	5.18	6.59
2016-05-02	4.32	5.38	6.99
2016-05-03	4.79	5.47	6.71
2016-05-04	4.38	4.85	5.46
2016-05-05	4.35	5.07	6.31
2016-05-06	3.96	5.11	6.56
2016-05-07	4.40	5.57	7.24
2016-05-08	3.88	5.17	6.31
2016-05-09	3.30	4.43	5.41
2016-05-10	3.96	5.13	6.36
2016-05-11	4.97	5.51	6.38
2016-05-12	4.58	5.49	6.61
2016-05-13	4.79	5.79	7.04
2016-05-14	5.36	6.23	7.59

Appendix F5. Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-05-15	5.08	6.12	7.57
2016-05-16	5.49	6.03	7.02
2016-05-17	5.18	6.08	7.32
2016-05-18	5.26	6.05	6.51
2016-05-19	4.71	4.98	5.33
2016-05-20	4.53	5.25	6.18
2016-05-21	4.61	5.42	6.26
2016-05-22	5.39	5.83	6.31
2016-05-23	5.41	5.81	6.33
2016-05-24	5.49	6.09	6.79
2016-05-25	5.67	6.49	7.32
2016-05-26	5.18	6.10	6.56
2016-05-27	4.64	5.16	5.82
2016-05-28	3.51	4.09	4.84
2016-05-29	3.83	4.89	5.92
2016-05-30	4.53	5.73	6.79
2016-05-31	5.51	6.65	7.75
2016-06-01	6.36	6.89	7.54
2016-06-02	5.54	6.10	6.66
2016-06-03	5.23	6.01	6.91
2016-06-04	6.18	7.26	8.84
2016-06-05	6.61	7.63	9.09
2016-06-06	6.99	7.80	9.26
2016-06-07	6.54	7.48	9.09
2016-06-08	6.33	6.82	7.24
2016-06-09	5.67	6.11	6.69
2016-06-10	5.51	5.74	5.92
2016-06-11	5.21	5.55	5.98
2016-06-12	5.57	6.10	6.61
2016-06-13	5.39	6.00	6.38
2016-06-14	4.69	5.19	5.80
2016-06-15	4.38	5.13	5.92
2016-06-16	4.30	5.28	5.98
2016-06-17	5.36	6.11	6.89
2016-06-18	5.75	6.22	6.79
2016-06-19	5.62	6.28	6.99
2016-06-20	6.38	7.51	8.72
2016-06-21	7.04	7.77	8.62

Appendix F5. Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-06-22	6.84	7.30	7.67
2016-06-23	6.54	6.94	7.34
2016-06-24	6.41	6.94	7.54
2016-06-25	6.89	7.52	8.32
2016-06-26	6.76	8.04	9.29
2016-06-27	6.08	8.20	10.17
2016-06-28	6.79	8.50	10.47
2016-06-29	8.54	9.78	11.30
2016-06-30	8.89	9.86	10.93
2016-07-01	8.84	9.25	9.68
2016-07-02	8.39	9.25	9.90
2016-07-03	8.20	8.80	9.34
2016-07-04	7.95	8.22	8.54
2016-07-05	7.72	8.25	8.82
2016-07-06	7.90	8.43	9.04
2016-07-07	8.30	8.59	8.84
2016-07-08	8.47	8.77	9.14
2016-07-09	8.12	8.47	8.87
2016-07-10	7.44	8.60	9.63
2016-07-11	8.87	9.25	9.73
2016-07-12	8.82	9.08	9.31
2016-07-13	8.69	9.38	10.10
2016-07-14	9.09	9.58	10.25
2016-07-15	8.62	9.42	10.20
2016-07-16	9.73	10.49	11.27
2016-07-17	10.49	11.00	11.59
2016-07-18	10.49	11.29	12.05
2016-07-19	10.91	11.24	11.52
2016-07-20	10.57	10.78	11.01
2016-07-21	9.73	10.72	11.57
2016-07-22	10.37	11.29	12.20
2016-07-23	10.86	11.21	11.54
2016-07-24	10.27	11.46	12.56
2016-07-25	11.86	12.71	13.57
2016-07-26	12.51	13.37	14.17
2016-07-27	12.97	13.78	14.53
2016-07-28	13.45	14.26	15.01
2016-07-29	13.62	14.39	15.18

Appendix F5. Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-07-30	13.02	13.77	14.34
2016-07-31	11.76	12.38	12.85
2016-08-01	11.44	12.27	13.04
2016-08-02	11.52	11.73	12.27
2016-08-03	11.25	11.60	11.95
2016-08-04	11.49	12.03	12.73
2016-08-05	11.35	11.96	12.68
2016-08-06	10.22	11.29	12.27
2016-08-07	10.79	11.39	12.10
2016-08-08	10.74	11.07	11.32
2016-08-09	11.10	11.52	12.00
2016-08-10	11.47	11.98	12.78
2016-08-11	11.25	12.56	14.05
2016-08-12	12.36	13.59	15.03
2016-08-13	12.99	14.22	15.63
2016-08-14	13.19	14.37	15.70
2016-08-15	12.75	14.21	15.63
2016-08-16	13.16	14.52	16.03
2016-08-17	13.19	14.56	16.06
2016-08-18	13.47	14.89	16.34
2016-08-19	13.28	14.79	16.56
2016-08-20	13.21	14.95	16.82
2016-08-21	12.12	13.87	15.46
2016-08-22	10.79	12.11	13.71
2016-08-23	9.95	11.97	13.83
2016-08-24	11.35	13.13	15.10
2016-08-25	12.34	13.87	15.58
2016-08-26	12.56	14.18	15.99
2016-08-27	13.64	14.72	16.03
2016-08-28	12.10	12.76	13.47
2016-08-29	11.30	12.77	13.98
2016-08-30	12.27	13.47	14.98
2016-08-31	11.71	12.27	12.82
2016-09-01	10.47	11.20	11.73
2016-09-02	9.73	10.16	10.54
2016-09-03	9.83	10.26	10.91
2016-09-04	9.51	10.14	10.81
2016-09-05	9.61	10.02	10.61

Appendix F5. Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-09-06	9.39	10.28	11.52
2016-09-07	9.53	10.13	10.57
2016-09-08	9.56	10.26	11.39
2016-09-09	8.77	9.94	10.88
2016-09-10	10.08	10.97	12.27
2016-09-11	8.69	9.82	11.10
2016-09-12	7.65	9.33	10.86
2016-09-13	7.59	9.71	11.71
2016-09-14	9.04	10.76	12.68
2016-09-15	9.14	11.00	12.85
2016-09-16	10.49	11.16	12.53
2016-09-17	9.26	10.00	10.37
2016-09-18	9.14	9.38	9.73
2016-09-19	8.20	8.79	9.16
2016-09-20	7.72	8.23	8.72
2016-09-21	7.65	8.33	9.04
2016-09-22	7.27	8.25	9.09
2016-09-23	8.17	8.35	8.59
2016-09-24	7.87	8.27	8.67
2016-09-25	8.07	8.52	9.02
2016-09-26	8.30	8.95	9.68
2016-09-27	8.17	9.38	9.90
2016-09-28	7.42	8.15	9.04
2016-09-29	6.48	7.62	8.74
2016-09-30	6.18	7.19	8.27
2016-10-01	6.26	7.09	7.67
2016-10-02	6.51	7.39	8.32
2016-10-03	5.80	6.89	7.59
2016-10-04	6.76	7.34	7.82
2016-10-05	7.12	7.75	8.37
2016-10-06	7.47	7.75	8.00
2016-10-07	6.86	7.08	7.44
2016-10-08	5.41	6.05	6.84
2016-10-09	5.41	5.62	6.03
2016-10-10	4.35	4.99	5.41
2016-10-11	3.67	4.03	4.38
2016-10-12	3.25	3.98	4.71
2016-10-13	4.51	4.99	5.49

Appendix F5. Stream Temperature Data

Scotia Creek			
Date	Min Temperature (°C)	Average Temperature (°C)	Max Temperature (°C)
2016-10-14	5.13	5.51	6.00
2016-10-15	5.98	6.19	6.36
2016-10-16	6.03	6.24	6.46
2016-10-17	6.10	6.34	6.69
2016-10-18	6.23	6.32	6.48
2016-10-19	6.03	6.28	6.61
2016-10-20	5.77	6.16	6.66
2016-10-21	5.67	5.95	6.10
2016-10-22	5.77	6.00	6.26
2016-10-23	5.82	6.07	6.38
2016-10-24	6.10	6.26	6.43
2016-10-25	5.80	6.14	6.43
2016-10-26	5.44	5.54	5.67
2016-10-27	5.41	5.84	6.15
2016-10-28	5.92	6.12	6.38
2016-10-29	5.67	5.92	6.15
2016-10-30	5.15	5.40	5.62
2016-10-31	5.15	5.32	5.44
2016-11-01	5.26	5.40	5.59
2016-11-02	5.31	5.44	5.72
2016-11-03	5.72	5.88	6.03
2016-11-04	5.15	5.74	6.31
2016-11-05	5.62	5.96	6.33
2016-11-06	5.49	5.73	6.03
2016-11-07	5.75	5.95	6.23
2016-11-08	6.10	6.55	6.74
2016-11-09	5.75	6.17	6.66
2016-11-10	6.05	6.35	6.74
2016-11-11	6.43	6.66	6.74
2016-11-12	5.72	6.14	6.43
2016-11-13	5.08	5.42	5.64
2016-11-14	5.10	5.44	5.75
2016-11-15	4.69	4.87	5.13
2016-11-16	4.32	4.48	4.84



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Appendix G

Site Data for Coastal
Tailed Frog Surveys

Appendix G: Site Data for Coastal Tailed Frog Surveys

Site	Date	End Time	Surveyors	Survey Area (m ²)	Lower Easting	Lower Northing	Upper Easting	Upper Northing	Mean Elev. (m)	Weather	Air Temp. (°C)	Cloud (%)	Slope (%)	Water Temp. (°C)	pH	EC (µS)	TDS (ppm)
Alpha Creek 1	2016-09-15	10:00	B. Brett, K.Brandon, T.Schaufele	30	499200	5548225	499242	5548134	684	Sunny	10	0	12	8.0	4.1	110	64
Alpha Creek 2	2016-09-15	11:30	B. Brett, K.Brandon, T.Schaufele	27	499869	5547994	499376	5547973	714	Sunny	15	0	8	7.6	5.0	114	57
Alpha Creek 3	2016-09-21	11:55	B. Brett, K.Brandon	15	499408	5547152	499389	5547161	863	Sunny	5	0	17	5.5	6.3	116	59
Archibald Creek 1	2016-09-21	12:30	B. Brett, K.Brandon	12	502417	5550594	502335	5550607	695	Sunny	9	0	17	7.1	6.6	161	158
Archibald Creek 2	2016-09-21	14:05	B. Brett, K.Brandon	26	502841	5550302	502849	5550300	835	Sunny	10	0	18	6.5	7.5	161	81
Archibald Creek 3	2016-09-22	15:30	B. Brett, K.Brandon	7	503311	5549446	503310	5549414	1026	Sunny	8	0	16	5.6	7.1	163	91
Scotia Creek 1	2016-09-14	11:30	B. Brett, K.Brandon, T.Schaufele	30	500746	5550684	500758	5550703	661	Sunny	11	0	6	9.3	5.9	77	38
Scotia Creek 2	2016-09-14	12:30	B. Brett, K.Brandon, T.Schaufele	25	500210	5551083	500265	5551061	773	Sunny	19	0	13	9.8	6.2	73	38
Scotia Creek 3	2016-09-14	13:15	B. Brett, K.Brandon, T.Schaufele	32	500010	5551100	500069	5551060	817	Sunny	24	0	15	11.1	5.6	36	18
Whistler Creek 1	2016-09-14	16:15	B. Brett, K.Brandon, T.Schaufele	25	501036	5549055	501052	5549036	693	Sunny	24	0	13	11.0	5.6	68	34
Whistler Creek 2	2016-09-15	15:00	B. Brett, K.Brandon, T.Schaufele	35	501391	5548329	501414	5548282	875	Sunny	23	0	12	10.0	6.0	55	29
Whistler Creek 3	2016-09-15	13:30	B. Brett, K.Brandon, T.Schaufele	31	501644	5547952	501710	5547880	985	Sunny	22	0	18	10.0	5.9	59	29
Whistler Creek 4	2016-09-21	11:45	B. Brett, K.Brandon	8	501681	5547378	501676	5547396	1130	Sunny	5	0	18	4.3	7.0	43	24

Appendix G: Site Data for Coastal Tailed Frog Surveys

Site	Date	End Time	Surveyors	Channel Width (m)	Wetted Width (m)	Discharge	Mean Depth (cm)	Crown Closure	Tree Comp.	Struct. Stage	Stream Disturbance	Stream Morph.	Rock Size	Rock Shape	Notes
Alpha Creek 1	2016-09-15	10:00	B. Brett, K.Brandon, T.Schaufele	3.8	2.1	Low	35	50	Mixed	YF/MF	Low	Riffle (Cascade)	Cobble (Bedrock)	Subangular	
Alpha Creek 2	2016-09-15	11:30	B. Brett, K.Brandon, T.Schaufele	3.9	3.1	Low	10	80	Conif.	YF/MF	Med.	Riffle (Cascade)	Cobble (Boulder)	Subangular	
Alpha Creek 3	2016-09-21	11:55	B. Brett, K.Brandon	4.2	1.1	Low	10	90	Mixed	Shrub/YF	Med.	Cascade (Step Pool)	Cobble (Boulder)	Angular	
Archibald Creek 1	2016-09-21	12:30	B. Brett, K.Brandon	6.3	3.0	Low	10	10	Decid.	Shrub	High	Cascade (Riffle)	Bedrock (Boulder)	Subangular	Extensive deposition of sand and small gravel
Archibald Creek 2	2016-09-21	14:05	B. Brett, K.Brandon	3.0	3.0	Low	9	85	Mixed	YF	Med.	Riffle (Cascade)	Cobble (Boulder)	Angular	Deposition of sand and small gravel
Archibald Creek 3	2016-09-22	15:30	B. Brett, K.Brandon	3.5	1.0	Low	10	90	Mixed	YF	Med.	Cascade (Step Pool)	Cobble (Boulder)	Subangular	No significant deposition
Scotia Creek 1	2016-09-14	11:30	B. Brett, K.Brandon, T.Schaufele	5.0	1.2	Low	10	85	Conif.	YF	Med.	Cascade (Riffle)	Cascade (Riffle)	Subangular	Very embedded; difficult to find habitat
Scotia Creek 2	2016-09-14	12:30	B. Brett, K.Brandon, T.Schaufele	4.0	1.2	Low	38	65	Mixed	YF	High	Riffle	Cobble (Bedrock)	Subangular	Lots of logging debris in creek; lots of bedrock
Scotia Creek 3	2016-09-14	13:15	B. Brett, K.Brandon, T.Schaufele	5.0	1.0	Low	5	55	Mixed	YF	High	Riffle (Cascade)	Cobble (Bedrock)	Subangular	Very embedded; difficult to find habitat
Whistler Creek 1	2016-09-14	16:15	B. Brett, K.Brandon, T.Schaufele	NR	1.7	Low	10	75	Decid.	Pole/YF	Low	Riffle (Cascade)	Cobble (Boulder)	Subangular	Just above constructed stream (low disturb.)
Whistler Creek 2	2016-09-15	15:00	B. Brett, K.Brandon, T.Schaufele	6.2	3.6	Low	28	10	Conif.	OF	Low	Riffle (Step Pool)	Cobble (Boulder)	Subangular	Open area (bridge) has shrubs within old forest
Whistler Creek 3	2016-09-15	13:30	B. Brett, K.Brandon, T.Schaufele	6.4	4.4	Low	26	30	Conif.	OF	Med.	Riffle (Cascade)	Boulder (Bedrock)	Subangular	check water temps i remeasured
Whistler Creek 4	2016-09-21	11:45	B. Brett, K.Brandon	5.2	1.0	Low	7	15	Conif.	OF	Low	Riffle (Cascade)	Cobble (Boulder)	Subangular	

Appendix H

Local Contacts for Beaver Activity

Appendix H: Local Contacts for Beaver Activity

Personal communications with contacts reporting beaver activity

Angie Gunton Fulton, Nov. 30, 2016

-) "This summer between July and October: One Mile Lake, Shadow Lake, Green Lake, River of Golden Dreams and fits creek at the campground."

Bob (Rocket) and Kelly Richards, Nesters Pond, Dec 21, 2016

-) Only otters and kingfishers this year

Bruce Barker, Whistler Air, 604-932-3299, Sept. 4, 2016

-) Family of otters lived under floatplane base (Green Lake) last winter.
-) Three herons in area (I have photo)
-) Two chicks in the Osprey nest
-) Saw two beavers last year swimming together from the vicinity of the lodge near Nick North
-) Saw only one beaver this year, earlier in the spring [could be from ROGD lodge]

Daren Romano, Sept 25, 2016

-) Saw a beaver (how many times) on Alpha Lake

Francois Hebert (Whistler Sailing), several times summer and fall

-) No sightings from Whistler Hostel and vicinity (sailboats cover much of the lake)

Karl Ricker:

-) Reported activity at Shadow Lake, ROGD near Valley Trail bridge at base of Lorimer Rd.; and Wildlife Refuge

Kate Brandon and Tara Schaufele

-) Received a report of a dead beaver in the ROGD at the beginning of August. [It wasn't retrieved]

Kathryn Shephard, Nov 25, 2016

-) Reports sightings at Spruce Grove, south side of trail near greenhouses
-) Plus beside entrance to parking lot

Liz Barrett, (November 30, 2016)

-) Reported 7 dens on ROGD, and 3 dens on Green Lake Nick North section [downstream of Hwy 99?].

Mark Beaven, Oct 27, 2016

-) Hasn't seen any beavers on Alta Lake
-) Saw submerged branches near Alpha Lake lodge @ dog beach this week. He feels he would've seen them before if they'd been there last year, therefore probably from this year

Paul Cain, Nov. 30, 2016

Appendix H: Local Contacts for Beaver Activity

-) "Below the frisby golf course near NIC North there is a super active one there currently at war with the trees. **Sara (Backroads)**
-) Saw many beavers during twilight tours and thinks there are 3 to 4 active lodges

Steve and Aidan Legge (Nov. 25, 2016)

-) Steve saw 2 or 3 this summer near floatplane base
-) Aiden saw 2 or 3 near Fitz Cr. delta ("sandbar")

Tara Schaufele, RMOW

-) Reported a lodge near Parkhurst on Green Lake

Unnamed resident walking on Whistler Rd. near RimRock 2, Sept. 9, 2016

-) He hasn't seen any beavers in the area since there was activity in Bottomless Lake (many years prior)

Beaver sightings on the River of River of Golden Dreams

-) Many sightings of beavers on ROGD, mainly between the east end of Tapley's Farm to Rainbow Park (e.g., Teresa Oswald, Kristina Swerhun, Ian Brett, other others)

Golf Courses

Dan Nash, Fairmont Chateau GC, Oct. 28, 2016

-) Beavers have been very active since September. Signs of dragging branches across frost on fairways
-) Lodge on #2 has fresh cuttings
-) Dam on Horstman Creek, ~1m high, just upstream of golf cart bridge on #1 fairway
-) At least one active lodge in #18 pond, possibly 2-3 lodges
-) Dan thinks there may be movement between lodges, incl. using one as summer lodge and one for winter
-) Not worried since fairways are elevated enough to avoid flooding. Just needs maintenance on Horstman Creek dams – they remove them once in a while and rebuilding normally takes a few weeks
-) One 8" tree felled by beaver near #1 green recently

Gerrit Woods, Nicklaus North GC, Oct. 27, 16

-) Hasn't seen activity at #10 pond lodge = inactive?
-) He's seen one beaver moving between #10 and marsh (aka, ROGD to the west). Never sees more than one at a time and thinks it might be same beaver
-) Some minor weir damage that they've repaired. They don't remove beavers unless the damage is too much
-) Also seen a beaver moving between #5 pond and marsh
-) No evidence of beavers at float plane base. They were aggressive [i.e. with tree cutting] 3 to 4 years ago. Trees are now wired for protection.

Stu Carmichael Whistler GC, late September, 2016

-) Reported first activity of year near #10 fairway [i.e., a new beaver(s)]

Appendix I

Coleoptera (beetle) samples

Appendix I: Coleoptera (beetle) Samples

Site	Family	Genus	Species
Bob's Rebob	Cantharidae	<i>Podabrus</i>	<i>sp.</i>
	Carabidae	<i>Pterostichus</i>	<i>amethystinus</i>
	Carabidae	<i>Pterostichus</i>	<i>herculaneus</i>
	Carabidae	<i>Pterostichus</i>	<i>neobrunneus</i>
	Carabidae	<i>Scaphinotus</i>	<i>angusticollis</i>
	Chrysomelidae	<i>Syneta</i>	<i>simplex</i>
	Curculionidae	<i>Pissodes</i>	<i>sp.</i>
	Staphylinidae	<i>Staphylinus</i>	<i>sp. 1</i>
	Staphylinidae	<i>Tachinus</i>	<i>sp. 1</i>
	Staphylinidae		<i>sp. 1</i>
	Staphylinidae		<i>sp. 2</i>
Millar's Pond	Carabidae	<i>Pterostichus</i>	<i>herculaneus</i>
	Carabidae	<i>Pterostichus</i>	<i>neobrunneus</i>
	Carabidae	<i>Scaphinotus</i>	<i>angusticollis</i>
	Curculionidae	<i>Sthereus</i>	<i>horridus</i>
	Latridiidae	<i>Enicmus</i>	<i>sp.</i>
	Staphylinidae	<i>Staphylinus</i>	<i>sp. 1</i>
	Staphylinidae	<i>Tachinus</i>	<i>sp. 1</i>
	Staphylinidae	<i>Tachinus</i>	<i>sp. 2</i>
	Staphylinidae		<i>sp. 1</i>
	Staphylinidae		<i>sp. 2</i>
	Staphylinidae		<i>sp. 3</i>
	Staphylinidae		<i>sp. 4</i>
	Zopheridae	<i>Phellopsis</i>	<i>obcordata</i>
River Runs Through It	Carabidae	<i>Pterostichus</i>	<i>adstrictus</i>
	Carabidae	<i>Pterostichus</i>	<i>amethystinus</i>
	Carabidae	<i>Pterostichus</i>	<i>herculaneus</i>
	Carabidae	<i>Scaphinotus</i>	<i>angusticollis</i>
	Curculionidae	<i>Sthereus</i>	<i>horridus</i>
	Staphylinidae	<i>Staphylinus</i>	<i>sp. 1</i>
	Staphylinidae		<i>sp. 2</i>
	Staphylinidae		<i>sp. 3</i>
	Zopheridae	<i>Phellopsis</i>	<i>obcordata</i>

Appendix J

Detailed Description of Tree Cavities

Appendix J: Detailed Description of Tree Cavities

Transect	Easting	Northing	Cavity Tree	Species	DBH (cm)	Size Class	Decay Class	Decay Group	Small	Med.	Large/V. Large
Comfortably Numb	507339	5556248	CNCT-01	Fd	50	50-59	Live	Live	3		
Comfortably Numb	507300	5556182	CNCT-02	Fd	35	<40	7	Stub	mult.		mult.
Comfortably Numb	507236	5556166	CNCT-03	Hw	70	60+	Live	Live	2		2
Comfortably Numb	507202	5556162	CNCT-04	Cw	60	60+	Live	Live	mult.	mult.	
Comfortably Numb	507096	5556112	CNCT-05	Fd	50	50-59	4	Snag			1
Comfortably Numb	507133	5555946	CNCT-06	Hw	35	<40	7	Stub			mult.
Comfortably Numb	507140	5555904	CNCT-07	Cw	35	<40	Live	Live		1	
Comfortably Numb	507157	5555896	CNCT-08	Cw	45	40-59	Live	Live	2		
Comfortably Numb	507171	5555830	CNCT-09	Unk.	60	60+	7	Stub	mult.		
Comfortably Numb	507167	5555667	CNCT-10	Hw	50	50-59	7	Stub	1		
Comfortably Numb	507169	5555667	CNCT-11	Cw	50	50-59	Live	Live	mult.	mult.	
Comfortably Numb	507187	5555607	CNCT-12	Cw	70	60+	Live	Live		mult.	
Comfortably Numb	507172	5555607	CNCT-13	Hw	50	50-59	4	Snag		mult.	mult.
Comfortably Numb	507231	5555563	CNCT-14	Hw	30	<40	7	Stub			1
Comfortably Numb	507156	5555575	CNCT-15	Cw	45	40-59	Live	Live		1	1
Comfortably Numb	507189	5555463	CNCT-16	Fd	40	40-59	7	Stub	mult.	mult.	
Comfortably Numb	507169	5555437	CNCT-17	Hw	40	40-59	Live	Live		1	1
Comfortably Numb	507139	5555431	CNCT-18	Hw	50	50-59	5	Snag	mult.		
Comfortably Numb	507111	5555415	CNCT-19	Hw	60	60+	6	Stub		2	2
Comfortably Numb	507116	5555407	CNCT-20	Hw	50	50-59	7/8	Stub	mult.		
Comfortably Numb	507123	5555406	CNCT-21	Cw	45	40-59	Live	Live	mult.	mult.	
Comfortably Numb	507120	5555381	CNCT-22	Cw	75	60+	Live	Live		mult.	mult.
Comfortably Numb	507073	5555361	CNCT-23	Fd	70	60+	Live	Live	1		
Comfortably Numb	506912	5555396	CNCT-24	Cw	35	<40	Live	Live			1
Comfortably Numb	506864	5555453	CNCT-25	Cw	50	50-59	Live	Live	4		
Comfortably Numb	506829	5555443	CNCT-26	Hw	75	60+	Live	Live			1
Comfortably Numb	506780	5555459	CNCT-27	Cw	45	40-59	Live	Live	mult.	mult.	
Comfortably Numb	506618	5555488	CNCT-28	Fd	45	40-59	8	Stub		mult.	
Comfortably Numb	506536	5555463	CNCT-29	Cw	55	50-59	Live	Live	mult.	mult.	
Comfortably Numb	506441	5555407	CNCT-30	Hw	75	60+	Live	Live		mult.	
Comfortably Numb	506403	5555407	CNCT-31	Fd	75	60+	7	Stub	mult.		

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Transect	Easting	Northing	Cavity Tree	Species	DBH (cm)	Size Class	Decay Class	Decay Group	Small	Med.	Large/V. Large
Comfortably Numb	506364	5555382	CNCT-32	Fd	75	60+	7	Stub	mult.		
Comfortably Numb	506287	5555416	CNCT-33	Hw	75	60+	4	Snag	mult.	1	
Comfortably Numb	506264	5555403	CNCT-34	Unk.	45	40-59	4	Snag	mult.	mult.	
Comfortably Numb	506299	5555385	CNCT-35	Hw	65	60+	Live	Live		1	1
Comfortably Numb	506267	5555365	CNCT-36	Cw	100	60+	Live	Live	1		
Comfortably Numb	506140	5555057	CNCT-37	Fd	55	50-59	6	Stub	mult.	mult.	
Comfortably Numb	506060	5555006	CNCT-38	Cw	100	60+	4	Snag	mult.	mult.	mult.
Comfortably Numb	505975	5555009	CNCT-39	Cw	45	40-59	Live	Live		2	
Comfortably Numb	505941	5555068	CNCT-40	Hw	55	50-59	3	Snag		50+	
Comfortably Numb	505902	5555076	CNCT-41	Hw	70	60+	Live	Live		1	
Comfortably Numb	505872	5555103	CNCT-42	Fd	60	60+	7	Stub		1	
Comfortably Numb	505794	5555053	CNCT-43	Cw	80	60+	Live	Live		1	
Comfortably Numb	505857	5554997	CNCT-44	Cw	60	60+	Live	Live		2	
Comfortably Numb	505863	5554982	CNCT-45	Fd	45	40-59	7	Stub	2		
Comfortably Numb	505924	5554942	CNCT-46	Unk.	50	50-59	7	Stub		2	
Comfortably Numb	505931	5554899	CNCT-47	Hw	80	60+	4	Snag		2	
Comfortably Numb	505939	5554719	CNCT-48	Cw	90	60+	Live	Live		3	
Comfortably Numb	505931	5554720	CNCT-49	Cw	70	60+	Live	Live	mult.	mult.	mult.
Comfortably Numb	505963	5554703	CNCT-50	Act	90	60+	4	Snag			5
Comfortably Numb	505947	5554669	CNCT-51	Hw	35	<40	6	Stub			1
Comfortably Numb	505968	5554649	CNCT-52	Hw	80	60+	4	Snag		~40	
Comfortably Numb	505963	5554630	CNCT-53	Cw	90	60+	Live	Live		6	
Comfortably Numb	505941	5554442	CNCT-54	Hw	35	<40	7	Stub		1	
Comfortably Numb	505966	5554425	CNCT-55	Cw	40	40-59	Live	Live		1	
Comfortably Numb	505970	5554338	CNCT-56	Hw	60	60+	Live	Live		10	
Comfortably Numb	505965	5554342	CNCT-57	Cw	30	<40	Live	Live		2	2
Comfortably Numb	506011	5554061	CNCT-58	Cw	60	60+	Live	Live		2	
Shit Happens	504697	5556689	SHCT-01	Hw	55	50-59	3	Snag		mult.	mult.
Shit Happens	504693	5556681	SHCT-02	Hw	50	50-59	Live	Live	1		
Shit Happens	504679	5556679	SHCT-03	Hw	40	40-59	Live	Live	mult.	mult.	1
Shit Happens	504649	5556752	SHCT-04	Hw	35	<40	Live	Live	mult.		
Shit Happens	504588	5556827	SHCT-05	Cw	70	60+	Live	Live	1	1	
Shit Happens	504360	5556999	SHCT-06	Fd	50	50-59	7	Stub		1	
Shit Happens	504312	5556969	SHCT-07	Fd	50	50-59	7	Stub			1
Shit Happens	504263	5556967	SHCT-08	Cw	90	60+	Live	Live		1	

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Transect	Easting	Northing	Cavity Tree	Species	DBH (cm)	Size Class	Decay Class	Decay Group	Small	Med.	Large/V. Large
Shit Happens	504185	5556949	SHCT-09	Hw	65	60+	4	Snag		10+	
Shit Happens	504159	5556949	SHCT-10	Hw	50	50-59	6	Stub	mult.		
Shit Happens	504155	5556931	SHCT-11	Hw	45	40-59	Live	Live		3	
Shit Happens	504128	5556907	SHCT-12	Hw	40	40-59	Live	Live	3		
Shit Happens	503926	5556846	SHCT-13	Cw	35	<40	5	Snag		2	
Shit Happens	503958	5556820	SHCT-14	Hw	65	60+	Live	Live	2		
Shit Happens	503983	5556792	SHCT-15	Cw	60	60+	Live	Live	mult.	mult.	2
Shit Happens	503922	5556779	SHCT-16	PI	40	40-59	Live	Live		2	1
Shit Happens	503903	5556685	SHCT-17	Cw	30	<40	Live	Live	5		
Shit Happens	503691	5556588	SHCT-18	Cw	35	<40	Live	Live	1		
Shit Happens	503955	5559586	SHCT-19	Hw	50	50-59	4	Snag		5	
Shit Happens	503907	5556476	SHCT-20	Fd	55	50-59	Live	Live	1		
Shit Happens	503890	5556444	SHCT-21	Fd	45	40-59	Live	Live		mult.	
Shit Happens	503836	5556255	SHCT-22	PI	30	<40	Live	Live		5	
Shit Happens	503827	5556173	SHCT-23	Fd	60	60+	6	Stub			3
Shit Happens	503857	5556090	SHCT-24	Fd	60	60+	Live	Live		mult.	2
Shit Happens	503946	5556133	SHCT-25	PI	35	<40	3	Snag	1	3	
Shit Happens	503953	5556120	SHCT-26	Fd	35	<40	6	Stub	mult.	2	
Shit Happens	503965	5556183	SHCT-27	Fd	35	<40	6	Stub		1	1
Shit Happens	504001	5556158	SHCT-28	Fd	40	40-59	4	Snag	25+	25+	1
Shit Happens	504012	5556192	SHCT-29	PI	25	<40	7	Stub	3	5	
Shit Happens	504125	5556155	SHCT-30	Fd	50	50-59	3	Snag	mult.	mult.	
Shit Happens	503858	5556010	SHCT-31	Fd	40	40-59	4	Snag	mult.	3	
Shit Happens	503818	5555957	SHCT-32	Fd	40	40-59	Live	Live	mult.	3	
Shit Happens	503635	5556002	SHCT-33	Cw	35	<40	Live	Live	mult.		
Shit Happens	503657	5556015	SHCT-34	Cw	45	40-59	Live	Live	mult.	mult.	
Shit Happens	503625	5556020	SHCT-35	Cw	50	50-59	Live	Live			1
Shit Happens	503606	5556077	SHCT-36	Cw	45	40-59	Live	Live	2	1	
Shit Happens	503543	5556203	SHCT-37	Hw	50	50-59	Live	Live	mult.	1	
Shit Happens	503429	5556251	SHCT-38	Fd	70	60+	Live	Live	3		
Shit Happens	503378	5556357	SHCT-39	Ba	30	<40	4	Snag	mult.	mult.	
Shit Happens	503370	5556361	SHCT-40	Ba?	40	40-59	6	Stub			1
Shit Happens	503334	5556406	SHCT-41	Hw	70	60+	Live	Live		1	
Shit Happens	503308	5556435	SHCT-42	Cw	45	40-59	Live	Live	4		