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RMOW Ecosystems Monitoring Report 2015

Whistler, BC

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Executive Summary

This report documents ecosystem monitoring efforts for 2015 in the Resort Municipality of Whistler (RMOW). This report documents the third year of this monitoring program and compares results from 2013 and 2014 (Cascade, 2013 and Cascade, 2014). Monitoring took place in the spring, summer and fall of 2015, after areas of interest had been established based on key indicator species and habitats identified in 2013. Areas of interest were determined based on Ecological Hotspot candidates, priority habitats and priority species. Monitoring mainly consisted of vegetation, wildlife, fish and amphibian capture and/or abundance surveys, as well as habitat assessments using Terrestrial Ecosystem Mapping (TEM) based on Biogeoclimatic Ecological Classification (BEC). Each species monitored provide information on the health of specific habitat (i.e. aquatic, riparian and terrestrial habitat). In addition, abundance thresholds were established based on literature search.

Aquatic Indicators

Physical attributes of the aquatic habitat were monitored through water quality sampling of Alpha Creek, Scotia Creek, Fitzsimmons Creek, Jordan Creek, River of Golden Dreams, Nineteen Mile Creek and Crabapple Creek. In addition, temperature loggers were installed on Alpha Creek, Scotia Creek, River of Golden Dreams, Jordan Creek and Crabapple Creek. The temperature loggers will provide a continuous temperature profile of some of the creeks targeted in the ecosystem monitoring study and will better facilitate the detection of any changes in temperature over time. In order to assess the health of representative creeks around whistler, bull trout (*Salvelinus confluentus*), cutthroat trout (*Oncorhynchus clarkii*), kokanee (*Oncorhynchus nerka*), rainbow trout (*Oncorhynchus mykiss*) were monitored by way of electrofishing and foot surveying. The presence of these species indicates that the creeks are in good health. Fish species composition and population were determined in Crabapple Creek, Jordan Creek, the River of Golden Dreams and Fitzsimmons. Bull trout were captured in 2015 in Fitzsimmons Creek but no cutthroat trout were observed while cutthroat were observed in low numbers in Jordan Creek in 2013 and Crabapple Creek in 2014. Data suggest that the abundance of rainbow trout have been increasing since 2013 for Jordan Creek (Ranging from 456% to 502%) and an increase between 2014 and 2015 (Ranging from 72% to 460%) for the other creeks except Fitzsimmons creek where a slight decline was observed (-33%).

The RMOW Environmental Stewardship staff and Whistler Fisheries Stewardship Group volunteers carried out spawning surveys for rainbow trout and kokanee in 2015. A total of 168 rainbow trout were observed in, Jordan Creek, Crabapple Creek, Blackcomb Creek, Scotia Creek and Lakeside Creek which represent a decrease in the number of spawners compared to 2014 (-28%). During the 2015 kokanee spawning surveys, a total of 540 kokanee were observed which represents an increase compared to the previous year (181%). No kokanee were observed in 2014, whereas 192 individuals were observed in 2013.

Riparian Species Indicators

Coastal tailed frogs (*Ascaphus truei*) and beavers (*Castor canadensis*) were selected as riparian species indicators. Coastal tailed frogs are recognized as useful indicator species of ecosystem health. They are considered to be sensitive to perturbations due to their late maturation, small habitat range and low fecundity. They have indicator species value in both terrestrial and aquatic environments because of their dual life histories. The beaver can be used as a valuable indicator species of the health of an ecosystem since a variety of species rely on the habitat it creates.

Surveys for coastal tailed frog were conducted along Scotia Creek, Alpha Creek, Nineteen Mile Creek and Crabapple Creek. In total, 20 tadpoles were found in Alpha Creek, seven tadpoles in Scotia Creek, none in Nineteen Mile Creek and 21 in Crabapple Creek. The abundance of coastal tailed frogs caught in Alpha Creek Scotia Creek and Crabapple has increased from 2013 to 2015 (ranging from 5% to 133% per site).

The beaver survey sites were selected by using previously identified lodge sites and two previously known beaver locations were added this year. Alpha Lake, Wedge Pond, Green Lake, Fitzsimmons Creek Fan, Nita Lake, the River of Golden Dreams and waterways along Nicklaus North, Chateau, beaver lake, bottom less pond and Whistler Golf Courses were resurveyed for activity and previously undocumented lodges were found. A total of 34 lodges were surveyed in 2015 with 7 of them being active while 10 active lodges were documented in 2013 and 2014. The population appears to be in decline compare to the previous year of the survey with a 30% decrease from 2013 and 2014. However, the population is still active as lodges are abandoned and old lodges are re-colonised.

Terrestrial Species Indicators

Carabid beetles (Carabidae) are a good indicator of ecosystem health because they are sensitive to different environmental factors and have wide range of habitat requirements. The carabid beetle abundance was assessed at the Blueberry site, the Rainbow site and the Function site. The data show an increase in the carabid abundance at Blueberry Hill (12%) and Rainbow (50%) and a decrease in Function (-38%) from 2014 to 2015.

As a keystone species, pileated woodpecker is good indicator of forest health. The monitoring program was conducted by foot by the Comfortably Numb trail, the Rainbow/Madely trail, Whistler Mountain and Stonebridge. Woodpeckers were surveyed using the call-playback method to determine relative abundance. No pileated woodpeckers were observed in 2015 while 0.007 and 0.011 animal/ha were observed in 2013 and 2014 respectively.

Red-backed voles play a key role in nutrient cycling, habitat modification, plant consumption, seed dispersal, but also constitute the primary link between primary producers and secondary consumers. They were monitored by way of live trapping using Sherman traps at Blueberry Hill, Rainbow and Function sites during the spring and the summer. In the spring, relative abundance increase of 50% from 2014 to 2015 at Blueberry site and decreased in the summer by 33% from 2013 to 2015. At the Rainbow site the relative abundance increase in the spring (from 0 in 2014 to 0.02 animal/trap night in 2015) but the abundance decrease from 2013 to 2015 by 33% for the summer sampling. Overall no apparent trend is observed.

Climate Indicators

Alta Lake freeze-up and thaw was selected as an indicator for monitoring the effects of climate change. Existing records from 1942 to 2015 are reported, showing the number of days Alta Lake remained frozen each year and the dates of freeze and thaw each year. At 54 days, it is the shortest period of ice cover yet recorded and was roughly half the duration ice coverage of typical previous years. However, this is a long term indicator and as yet no trends of either warming or cooling are readily apparent in the duration or seasonality of the ice on the lake.

Conclusions

The 2015 ecosystem monitoring provides a third year of data collection and represents an essential step towards a sustainable future for Whistler as it establishes a baseline of quantifiable ecosystem health indicators. In subsequent years the program can be refined and expanded to increase the volume of data generated and to analyze trends in the populations of the target species and indicators. The resulting data pool should be kept orderly to ensure that it is usable by the ecosystem monitoring program.

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1 Introduction

Cascade Environmental Resource Group (Cascade) respectfully submits this report on the RMOW Ecosystems Monitoring Program for 2015. Cascade has operated in Whistler for 25 years, and has extensive experience with the local environment and its conditions. Cascade used its expertise in freshwater ecology, fish, wildlife, avian and vegetation surveys, habitat assessment and environmental monitoring and management in the preparation of this report. Cascade drew upon the knowledge of other experts in the vegetation and wildlife fields to ensure that methodologies, indicators and reporting mechanisms were properly identified, defined and documented. To meet the identified goals and objectives of the ecosystem monitoring program, Cascade conducted vegetation, wildlife, fish and amphibian capture and abundance surveys, as well as habitat assessments using Terrestrial Ecosystem Mapping (TEM) based on Biogeoclimatic Ecological Classification (BEC).

This report provides measurable and quantified data for the biodiversity and ecosystems health indicators selected in the RMOW ecosystem monitoring report of 2013. Over time, the records should reveals trends that can be used to interpret ecosystem health.

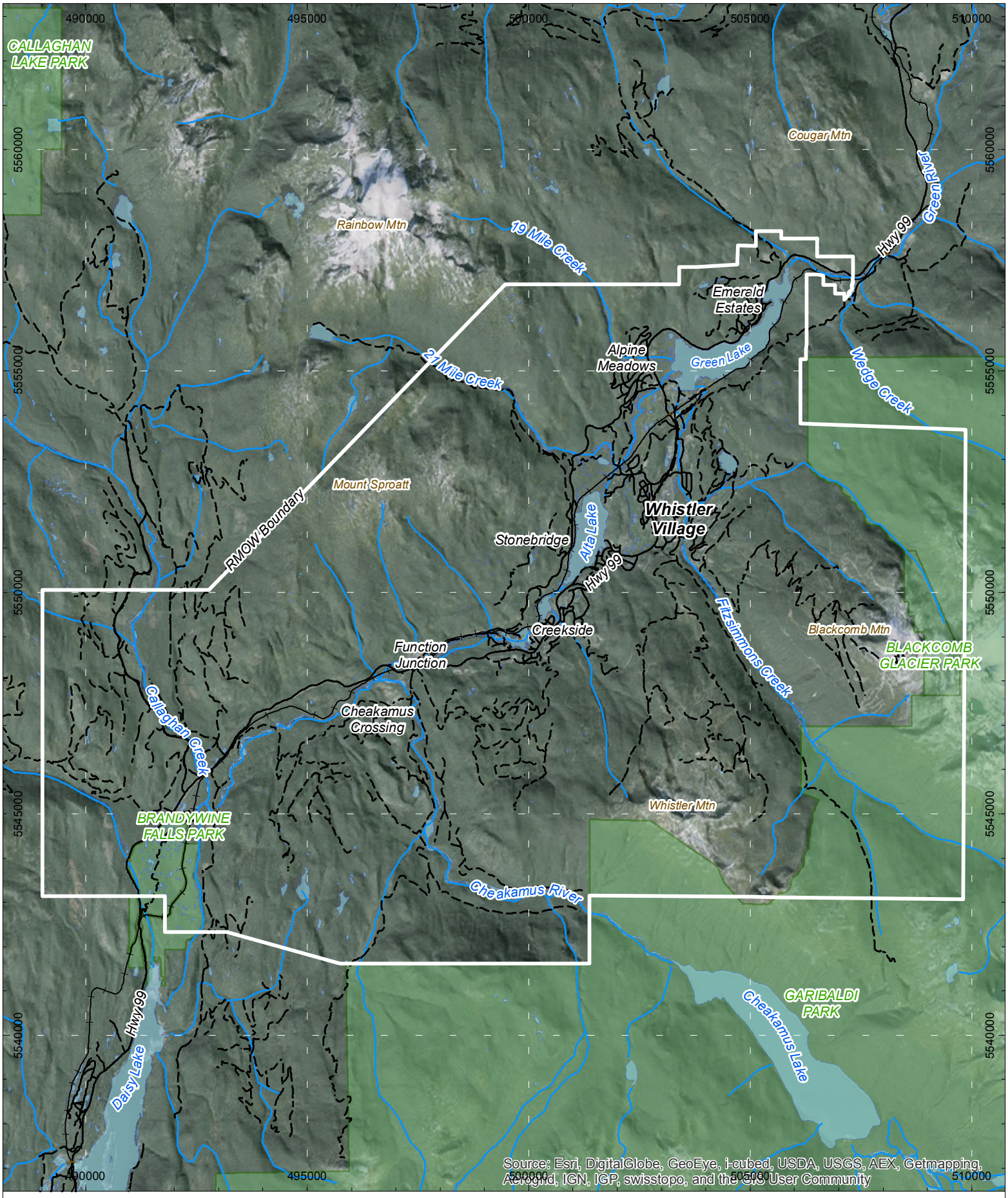
This study represents the third year of data collection of an ongoing program with the capacity to evolve and expand over time, creating a baseline record of abundance. Most of the results should be considered as preliminary and as the program is still in its early stages the findings are generally insufficient for identification of definite trends, or risk to ecosystem health. As the program develops over subsequent years, and as the standardized, replicable inventory generates more depth to the database, it is the authors' belief that trends and conclusions should become evident.

In addition, this report presents abundance thresholds for the selected indicators. These thresholds were established using data available in the literature. These thresholds represent identification of quantitative values of the level of abundance below which the population could be at risk and reflects a potential change in the ecosystem health. The thresholds in conjunction with the baseline abundances, should help the RMOW to protect the natural resource of Whistler, as well as to help with decision making for future development within the municipality.

1.1 Terms of Reference and Project Scope

1.1.1 Purpose and Background

In 2008, Golder and Associates with contribution from Snowline Ecological Research prepared *A Proposed Framework for the use of Ecological Data in Monitoring and Promoting the Conservation of Biodiversity in Whistler* which laid out seven priority action items for monitoring and reporting on indicators of biodiversity in the Whistler area. Herein that report is referred to as Phase 1 of the ecosystem monitoring program. In 2013 Phase 2 was initiated, it identified priority species indicators, developed and executed a monitoring program. In 2014 and 2015 the same indicators were monitored and this report delivers the program's findings.



GIS Cartographer: Todd Hellinga
Date: February 4, 2014
CERG File#: 013-48-01
Projection: UTM 10N NAD83
Orthophoto: ESRI

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Map 1 - Location

RMOW Biodiversity Monitoring Project
Whistler, British Columbia

The RMOW is interested in monitoring ecosystem health recognizing that biodiversity is important. The following rationale in support of biodiversity provided by Failing and Gregory (2003) supports the RMOW's interest:

1. Preserve ecological services (such as carbon sequestration or hydrology regulation) associated with the composition, structure, and function of ecosystems, as well as the resilience to provide these services into the future;
2. Prevent losses to a targeted species or forest attribute (often a vulnerable or keystone species);
3. Prevent aesthetic losses (associated with what have been termed 'charismatic megafauna' or other losses of recreational quality);
4. Uphold ethical principles of ecosystem-based forest management (associated with a belief in the intrinsic value and rights of all species);
5. Protect and enhance social and economic value, both current and future, derived from industrial, medical, and agricultural uses of species and genes.

Biodiversity is characterised by the European Academies Science Advisory Council (2005) according to the following attributes:

1. Variety, the number of different types
   This aspect is well covered by the inventory gathered through the Biodiversity Project.
2. Quantity, the number or total biomass of any type
   This is an objective for this phase of study and is based on indicators and abundance.
3. Distribution, the extent and nature of geographic spread of different types
   Partially completed through existing inventories, development of the geodatabase will provide distribution and geographic context.

For the purpose of this phase of the ecosystem monitoring program the following definition will be used for guidance:

Biodiversity is the number, variety and variability of living organisms (species) for a standard area (ha).

The biodiversity of whistler is monitored through key indicator species. For each species the relative or absolute abundance was measured. Relative abundance data provide indices of population sizes which are usually based on some measure of effort such as a unit of time, distance travelled or number of traps. Typical relative abundance measures include, for example:

- number of animals or their sign seen per unit of time (e.g., deer/hour, also termed time-restraint)
- number of animals or their sign seen per linear distance (e.g., raptors seen per kilometre of powerline)
- number of animals trapped per 24 hours (e.g., mice)
- number of animal calls heard per hour (e.g., frogs)

Absolute abundance provides a population estimate expressed as number of individuals per unit area (MFLNRO, 1998)

Each species studied in this report provides information on the ecosystem health at various trophic levels in terrestrial, aquatic and riparian habitats. Over the years, abundance data collected on the indicator species will show trends that should correlate to environmental condition, and will help the RMOW to manage natural resources in Whistler

1.1.2 Work Objectives

1. Monitor select indicators of biodiversity
2. Establish abundance thresholds for the selected indicator species

Cascade has met the following objectives developed from the Proposed Framework's recommendations:

1. Identify priority species for monitoring in order to manage for preservation of biodiversity
2. Monitor species indicators for the third year using methodologies determined in the RMOW ecosystem monitoring report of 2013.
3. Submit a final report with accompanying shape files relating to the program.

A number of people contributed to this study including analysis of the data, development of the monitoring program and execution of the sampling program. The core study team for the project included:

Dave Williamson, B.E.S., ASc.T, QEP
Todd Hellinga, B.Sc., G.I.S.
Candace Rose-Taylor, M.Sc., EP. P.Biol.
Mike Nelson, B.Sc., R.P.Bio, QEP
Ruth Begg, M.E.M., EP
Adrien Baudouin, M.Sc. R.P.Bio.
Brian Xhignesse, M.Sc. (RMOW)
Tara Schaufele, M.A. (RMOW)

Additionally, a number of associates and external professionals were consulted during the data gathering and program development stages of the study. Their contributions are greatly appreciated:

Heather Beresford, M.A. (Environmental Stewardship Manager, RMOW)
Tina Symko M.R.M. (Environmental Coordinator, RMOW)

2 Work Plan and Methodology

2.1 Identified Priority Habitats and Species for Monitoring

In 2013 Cascade reviewed "A Proposed Framework for the Use of Ecological Monitoring and Promoting the Conservation of Biodiversity in Whistler" (Golder, 2008) and in-house ecological inventory information, as well as species data previously collected through the Whistler Biodiversity Project. The purpose of the review was to identify and select indicators of biodiversity. Biodiversity indicators, and their accompanying metrics, can provide feedback to land mangers and other user groups. Indicators can be used to interpret the effects of change over time, if monitored in a consistent and quantifiable manner. The survey methods for indicators should be repeatable, focusing on providing the sought after information.

Biodiversity indicators can be divided into species indicators, habitat indicators, or landscape, with links between all three. To use species indicators there must be a sufficient baseline inventory, and the inventory methodology must be repeatable. To use a habitat indicator, the link between the applicable species and the habitat unit must be understood, and to use a landscape indicator the relationship between species and habitat patch size and fragmentation should be known. Indicators, therefore, need a sufficient knowledge set to be effective. To be useful and cost efficient, indicators should by definition be able to represent trends affecting a larger group of species.

With reference to the previous report and in consultation with the RMOW, along with the GIS information, a prioritized list of appropriate species, habitat and landscape biodiversity indicators was developed. The list considered inventory information already gathered, regional and local values or priorities, as well as the availability of a cost-effective, standardized and replicable inventory methodology. The list was vetted and refined through a series of meetings with the RMOW. The refined list of indicator species and habitats going forward is as follows:

Aquatic Habitat Indicators

- Water Quality Sampling
    - Full spectrum

Aquatic Species Indicators

- Kokanee salmon (*Oncorhynchus nerka*)
- Bull trout (*Salvelinus confluentus*)
- Rainbow trout (*Oncorhynchus mykiss*)
- Cutthroat trout (*Oncorhynchus clarki clarki*)

Riparian Species Indicators

- Amphibians
    - Tailed frog (*Ascaphus truei*)
- Mammals
    - Beaver (*Castor canadensis*)

Terrestrial Habitat Indicators

- Terrestrial ecosystem unit
- Invertebrates
    - Carabid beetle (Carabidae)

Terrestrial Species Indicators

- Avifauna
    - Pileated woodpecker (*Hylatomus pileatus*)
- Small mammals
    - Red-backed vole (*Myodes gapperi*)

Climate Indicators

- Alta Lake freeze-up and thaw dates

2.2 Establish abundance threshold for the selected indicator species

In order to establish preliminary thresholds, an extensive literature search was conducted for each indicator species. The search focused on articles with comparable units of abundance, habitat and location as closely related to the habitats found in the RMOW as possible. Only data from undisturbed ecosystem were used in order to provide thresholds for healthy ecosystems.

These thresholds represent identification of quantitative values of the level of abundance below which the population could be at risk and reflects a potential change in the ecosystem health. The thresholds in conjunction with the baseline abundances should help the RMOW to protect the natural resource of Whistler as well as help with decision making for future development within the municipality.

3 Monitoring Program

With the selection of indicators species completed and based on the 2013 monitoring program developed in the initial stage of this project, Cascade monitored the identified species, habitat or landscape feature identified in the previous section.

3.1 Aquatic Habitat Indicators

3.1.1 Water Quality

Whistler contains a number of streams, rivers, lakes and wetlands that provide habitat for many species that depend on the aquatic environment during their life cycles. Impacts such as human activity, climate change or natural disasters may affect the quality of the water flowing in these watercourses, negatively impacting aquatic species and species that depend on aquatic animals as a food source. One of the objectives of the Ecosystem Monitoring Program is to collect and collate water quality information on watercourses in Whistler in order to provide a baseline of water quality data that future impacts may be measured against, and to aid in the development of water quality objectives.

Information on water quality within the Whistler region has been collected on a project by project basis and is therefore decentralized. In 2013 the Resort Municipality of Whistler began compiling this data, but by its nature will take some time to assemble and sort. The RMOW, in collaboration with the Ministry of the Environment (MOE), has been collecting water quality data for all Whistler lakes and developing water quality objectives for the lakes. This data once compiled will be used as a baseline for future years (Burrows and Tayless pers. comm.).

Five HOBO Water Temperature Pro v2 Data Loggers were installed on December 15, 2015 in the River of Golden Dreams, Crabapple Creek, Alpha Creek, Scotia Creek and Jordan Creek. Details of each location are presented in Table 1. Each logger was set to continuously record hourly water temperature.

Table 1: Location of the temperature loggers

Creek	Location
River of Golden Dreams	Electrofishing site, downstream of pedestrian bridge
Crabapple Creek	Tailed frog site #2
Alpha Creek	Tailed frog site #1
Scotia Creek	Tailed frog site #2, downstream of the Stonebridge drive bridge
Jordan Creek	Electrofishing site, upstream of pedestrian wood bridge

Water quality data was collected during the fish and amphibian surveys. Basic water quality information, including temperature, pH and conductivity, turbidity and dissolved oxygen was collected at each coastal tailed frog tadpole survey site (Appendix B: Table 25 to Table 27).

Prior to electrofishing on Jordan Creek, the River of Golden Dreams, Crabapple Creek and Fitzsimmons Creek, basic water quality measurements were taken. These include temperature, pH, conductivity, turbidity and dissolved oxygen (Appendix B: Table 28).

The RMOW Fish Stewardship Group volunteers recorded basic water quality parameters in 19 Mile Creek, Blackcomb Creek, Crabapple Creek, Jordan Creek, Lakeside Creek, the River of Golden Dreams, Scotia Creek, Whistler Creek, and Write-off Creek during the expected 2015 kokanee and rainbow spawning season (Appendix B: Table 29).

3.1.1.1 Trend analysis

Data collected during the tailed frog survey, the electrofishing survey and the spawning survey were used to calculate the monthly average of temperature, pH and conductivity in 2014 and 2015 for the creeks where enough data was collected. Data from 2013 were not used because the data collected were too patchy and not consistent and therefore would not provide any valuable information to the trend analysis

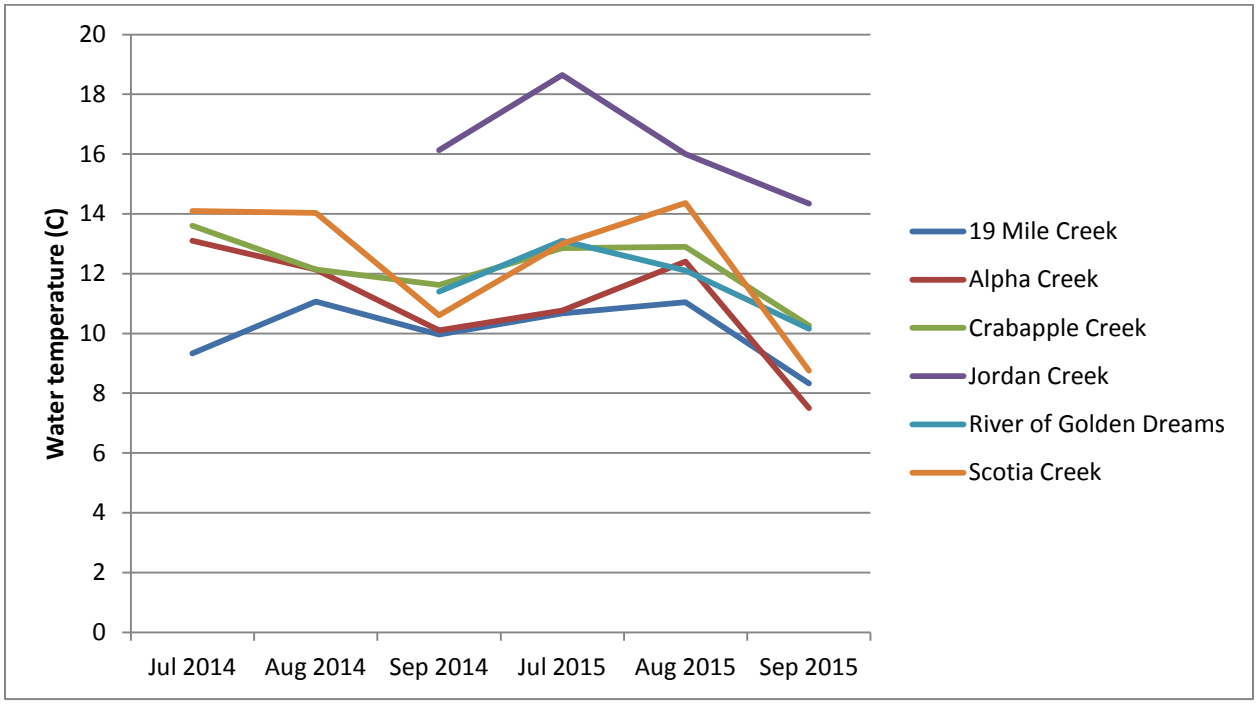


Figure 1: Average temperature for July, August and September in 2014 and 2015 in 19 Mile Creek, Alpha Creek, Crabapple Creek, Jordan Creek, River of Golden Dreams and Scotia Creek

Figure 1 presents the monthly average temperatures for 19 Mile Creek, Alpha Creek, Crabapple Creek, Jordan Creek, River of Golden Dreams and Scotia Creek. Water temperatures are similar in 2014 and 2015 in all creeks. However a slight decline in temperature is observed in all creeks in September 2015 compared to September 2014. This could be explained by lower average temperature over September 2015 compared to September 2014. Based on the data from the environment Canada, the average air temperature in September 2014 was 14.62 while in September 2015 it was 11.28.

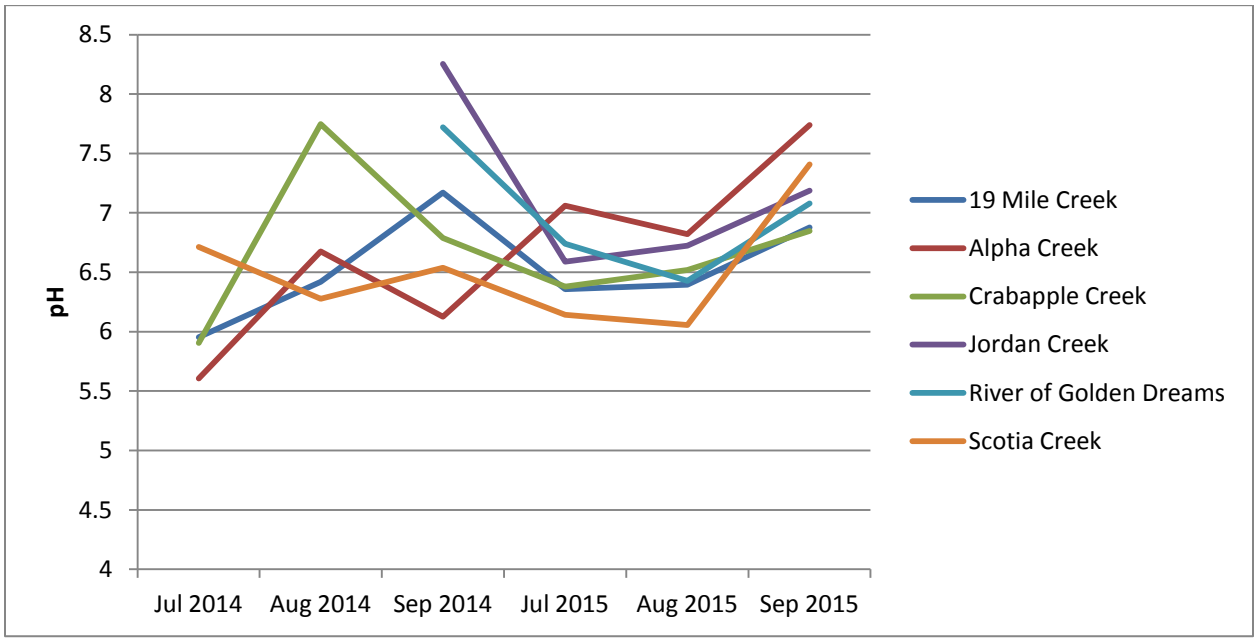


Figure 2: Average pH for July, August and September in 2014 and 2015 in 19 Mile Creek, Alpha Creek, Crabapple Creek, Jordan Creek, River of Golden Dreams and Scotia Creek

Figure 2 presents the monthly average pH for 19 Mile Creek, Alpha Creek, Crabapple Creek, Jordan Creek, River of Golden Dreams and Scotia Creek. No trend is apparent; the pH fluctuates between 5.6 and 8.3 with a median of 6.7. The Canadian Council of Ministers of the Environment (CCME) water quality guidelines indicate normal pH ranges from 6.5 to 9 (CCME, 2007), the pH observed remains within the guidelines

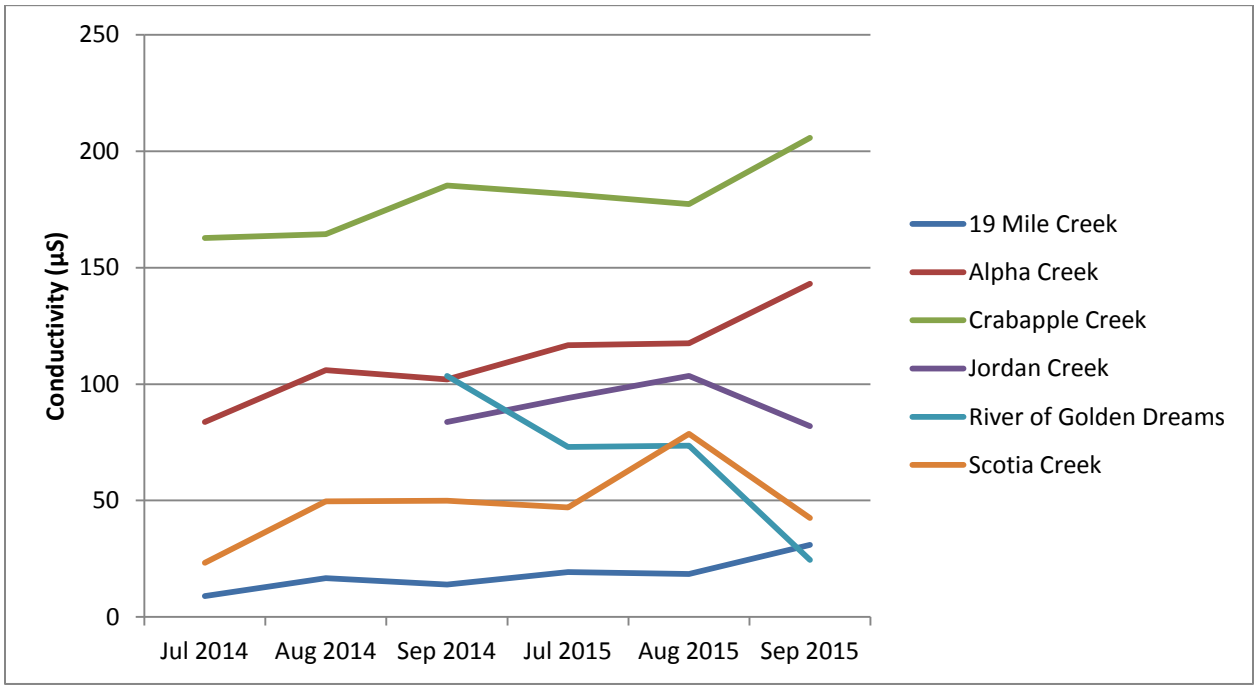


Figure 3: Average conductivity for July, August and September in 2014 and 2015 in 19 Mile Creek, Alpha Creek, Crabapple Creek, Jordan Creek, River of Golden Dreams and Scotia Creek

Figure 3 presents the monthly average conductivity for 19 Mile Creek, Alpha Creek, Crabapple Creek, Jordan Creek, River of Golden Dreams and Scotia Creek. The conductivity in 19 Mile Creek remains stable from 2014 to 2015 while a slight increase can be observed in Alpha Creek and Crabapple Creek. A decrease of 75µs can be observed between September 2014 and September 2015 in the River of Golden Dreams. For example, a sewage leak into a creek would raise the conductivity, whereas an oil leak or other organic compound would lower the conductivity. Data and trends are still preliminary, therefore it is still too early to confirm an actual increase or decrease of the conductivity.

3.1.1.2 Discussion and Recommendations

Water quality during the summer of 2015 remained within guidelines which confirm the good health of the creeks monitored in Whistler. The only concern is the decrease in conductivity in the River of Golden dreams. Data were only collected over two years; it is therefore too early to confirm the trend observed. Continuation of the current monitoring program will help better determine the early trend observed so far. Cascade also recommends tracking leaks from the utility department. In addition, installation of the temperature loggers will allow accurately track water quality and detect changes in creeks being monitored in this study

3.2 Aquatic Species Indicators

Resident fish spend their entire life cycle in local rivers and lakes, and their condition and population size are important indicators of ecosystem health (Raymond et. al 1999). The BC Ministry of Environment's Fisheries Information Summary System (FISS) database indicates that several species of salmonids have been observed in the water bodies that flow through the Resort Municipality of Whistler. Within the RMOW boundaries historic records include kokanee, bull trout, Dolly Varden, rainbow trout and cutthroat trout. The Daisy Lake Dam and Nairn Falls provide barriers to fish passage preventing other fish species such as coho salmon, chum salmon, pink salmon, chinook salmon, steelhead, sockeye salmon and brook trout, which are known to occur in Cheakamus River and Green River, from entering the municipal boundaries. It should also be noted that the FISS records are occurrence only and do not provide population estimates or changes in distribution or time. InStream Research Inc. recently conducted an evaluation of the Green Lake bull trout population (Instream

2012). Other than this detailed population study, very little work has been done to estimate salmonid populations within the region. To better understand the resident fish population in Whistler, Cascade began conducting abundance surveys in 2013. Fish survey data was also opportunistically gathered during fish salvage for gravel extraction/flood management operations carried out for the RMOW in Fitzsimmons Creek. In 2014 and 2015 surveys were carried out on Jordan Creek, the River of Golden Dream and Crabapple Creek. Gravel extraction works were performed on Fitzsimmons Creek in 2013 and 2015 and fish data were collected for this creek. Information gathered from these surveys may build on the information gathered by the RMOW Environmental Stewardship department over the past 20 years.

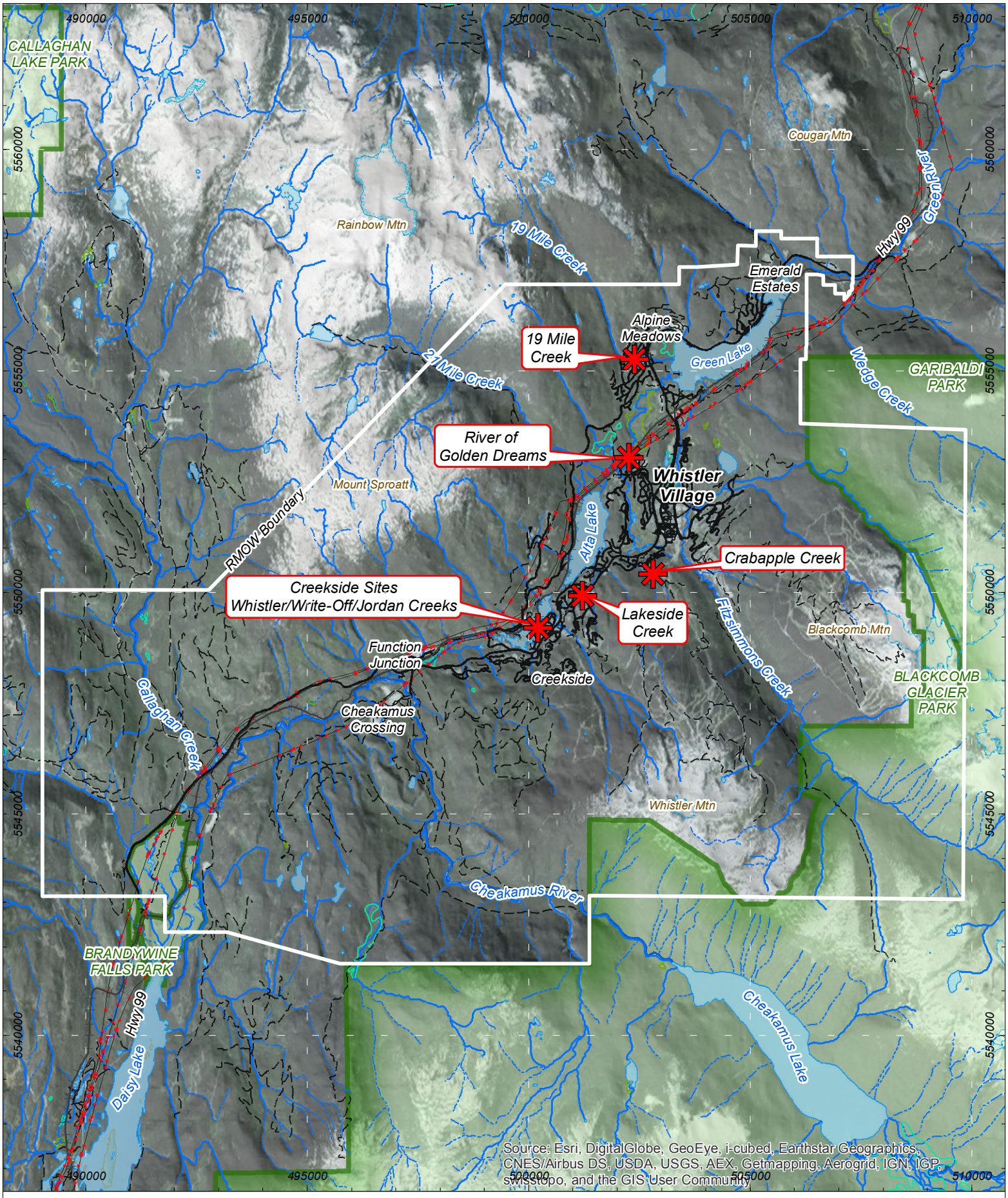
3.2.1 Site Selection

Three representative creeks were examined to assess the fish species composition and population in Whistler: Jordan Creek, the River of Golden Dreams and Crabapple Creek. Jordan Creek is a small, < 500 m connector stream that flows from Nita Lake to Alpha Lake. It is surrounded by Nita Lake Lodge, houses, roads, the paved valley trail, rail road tracks and municipal park land. The River of Golden Dreams (ROGD), also known as Alta Creek, flows from Alta Lake to Green Lake. It is hemmed by houses, roads and the valley trail. The ROGD is also popular for recreational paddlers and is used extensively by individual canoeists, kayakers, stand-up paddle (SUP) boards as well as commercial tour operators. Crabapple Creek, also known as Archibald Creek, drains from its headwaters on Whistler Mountain through the neighborhood of Brio and the Whistler Golf Course before connecting with the River of Golden Dreams (Map 2).

3.2.2 Fish Species

In B.C. fish are protected under the provincial *Wildlife Act*, the provincial *Fish Protection Act* and the federal *Fisheries Act.* The Ministry of Environment assigns species and ecological communities to the Red, Blue or Yellow list depending on their provincial Conservation Status Rank. The Red List includes species that are designated as Endangered or Threatened under the *Wildlife Act*, or are extirpated or are candidates for these designations. Blue Listed species are not immediately threatened but are of concern due to factors that make them sensitive to human activities or other environmental change. The Yellow List includes all species not on the Red or Blue Lists. Most fish species that occur within the RMOW boundaries are Yellow Listed, except for bull trout and cutthroat trout, which are Blue Listed.

In 2013 Cascade captured rainbow trout, bull trout, cutthroat trout, sticklebacks and sculpin. During the 2014 surveys Cascade captured rainbow trout, and cutthroat trout as well as stickleback and sculpin. In 2015, rainbow trout, bull trout, sticklebacks and sculpin were captured. The RMOW Environmental Stewardship department also conducted surveys of spawning rainbow trout and Kokanee in the River of Golden Dreams. Rainbow trout, bull trout, cutthroat trout and Kokanee live in clean streams and are good indicators of the stream health while stickleback and sculpin are more tolerant species. Stickleback and sculpin are considered by-catch but the data was included in the report



GIS Cartographer: Todd Hellinga
Date: January 13, 2015
CERG File#: 013-48-02
Projection: UTM 10N NAD83
Orthophoto: ESRI

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Fish Survey - Location

Biodiversity Monitoring Project
Resort Municipality Of Whistler
British Columbia

3.2.3 Electrofishing Surveys Results

Jordan Creek

Two areas were sampled on Jordan Creek on July 23, 2015. Basic water chemistry at both sites was similar (Table 2). Site #1 was a 108 m^2 glide. Site #2 was a 108 m^2 riffle (Photo 1). Total numbers of fish caught are listed in Table 3 below, and absolute abundances of fish caught are described in Table 4.

Photo 1: View of a rainbow trout captured in Jordan Creek. July 23, 2015

River of Golden Dreams

On July 31, 2015 a 100 m^2 pool area was electrofished on the River of Golden Dreams, approximately 25 m upstream of the Lorimer Road pedestrian bridge (Photo 2). Water chemistry at the time of sampling is described in Table 2. Total numbers and absolute abundances of fish caught are detailed in Table 3 and Table 4 respectively.

Photo 2: View of the isolated area at the River of Golden Dreams electrofishing site, July 31, 2015.

Fitzsimmons Creek

On August 18, 2015, a 560 m^2 area was isolated on Fitzsimmons Creek immediately upstream of the Spruce Grove wood bridge. The sampled area consisted of a glide. Water chemistry at the time of sampling is described in Table 2**.** Ttotal numbers and absolute abundances of fish caught are outlined in Table 3 and Table 4 respectively.

Crabapple Creek

On July 31, 2015 a 99 m^2 area was electrofished on Crabapple Creek, approximately 30 m upstream of the River of Golden Dream confluence. The sampled area consisted of a glide at the upstream end, and transitioned to a riffle at the downstream end. Water chemistry at the time of sampling is described in Table 2. Total numbers and absolute abundances of fish caught are outlined in Table 3 and Table 4 respectively.

Details regarding individual fish data at each of these water bodies can be obtained from the Department of Oceans and Fisheries (DFO) forms in Appendix C

Table 2: Electrofishing sites and shocker settings

Site	Date	Area (m^2)	Basic Water Chemistry				Electrofisher Settings			
			Water Temp. (^oC)	pH	DO (mg/L)	Turb. (NTU)	Cond. (µS)	Voltage (V)	Freq.(Hz)	Duty Cycle (%)
Jordan Creek #1	2015.07.23	108	19.1	6.47	7.76	1.15	60	295	50	12
Jordan Creek #2	2015.07.23	108	18.2	6.47	9.16	1.15	68	300	50	12
ROGD	2015.07.31	100	13.1	6.74	9.1	1.24	73	350	50	12
Crabapple Creek	2015.07.31	99	15.6	6.42	9.73	1.17	228	295	50	12
Fitzsimmons Creek	2015.08.18	560	6.7	7.33	n/a	n/a	61	350	30	12

Table 3: Number of fish caught at each site

Site	Date	Bull trout	Rainbow trout	Stickleback	Sculpin	Total
Jordan Creek #1	2015.07.23	0	24	23	12	59
Jordan Creek #2	2015.07.23		13	15	11	39
ROGD	2015.07.31		28	3	57	88
Crabapple Creek	2015.07.31		36	31	10	77
Fitzsimmons Creek	2015.08.18	1	10		20	31

Table 4: Absolute abundance of fish captured

Site	Area (m^2)	Abundance (#fish/m^2)			
		Bull trout	Rainbow trout	Stickleback	Sculpin
Jordan Creek #1	108	0	0.22	0.21	0.11
Jordan Creek #2	108	0	0.12	0.14	0.10
ROGD	100	0	0.28	0.03	0.57
Crabapple Creek	99	0	0.36	0.31	0.10
Fitzsimmons Creek	560	0.002	0.02	0	0.04

Rainbow Trout Spawning

Rainbow trout spawning surveys were conducted from April 29 to June 3, 2015 on Write-off Creek, Jordan Creek, Whistler Creek, Crabapple Creek, River of Golden Dreams, Lakeside Creek, Blackcomb Creek, and Scotia Creek, by a team of volunteers and the RMOW Environmental Stewardship department. A total of 168 rainbow trout were observed in, Jordan Creek, Crabapple Creek, Blackcomb Creek, Scotia Creek and Lakeside Creek (Table 5).

Table 5: 2015 Rainbow Trout Spawning Observations

	Write-off Creek	Jordan Creek	Whistler Creek	Crabapple Creek	River of Golden Dreams	Blackcomb Creek	Scotia Creek	Lakeside Creek	Totals
Total Rainbow trout observed	**0**	**65**	**0**	**61**	**0**	3	8	31	168
Number of observation days	**8**	**19**	**6**	**9**	**1**	4	10	12	69
Total Quantity paired up	0	15	0	6	0	0	0	9	
Total redds	0	12	0	0	0	0	0	11	
Peak count day	0	21	0	20	0	2	5	8	
first observed system	11/05/15	11/05/15	1/05/15	30/04/15	30/04/15	29/04/15	01/05/15	30/04/15	
last observed in system	30/05/15	30/05/15	3/06/15	23/05/15	30/04/15	19/05/15	31/05/15	31/05/15	
Annual Duration	19	19	33	23	0	20	30	32	

Kokanee Spawning Surveys

Kokanee spawning surveys were conducted from August 22 to September 25, 2015 on Write-off Creek, Crabapple Creek, Jordan Creek, Whistler Creek, 19 Mile Creek, The River of Golden Dreams, Blackcomb Creek and Scotia Creek by a team of volunteers and the RMOW Environmental Stewardship department. A total of 540 Kokanee were observed in the surveyed creeks in 2015 (Table 6).

Table 6: 2015 Spawning kokanee observations

	Write-off Creek	Jordan Creek	Whistler Creek	19 Mile Creek	Crabapple Creek	River of Golden Dreams	Blackcomb Creek	Scotia Creek	Totals
Total Kokanee observed	0	0	84	0	456	0	0	0	540
Number of observation days	9	10	14	3	11	14	4	2	67
Peak count day			21		263				
first observed system			31/08/15		31/08/15				
last observed in system			15/09/15		14/09/15				
Annual Duration			15		14				

3.2.3.1 Trend analysis

Fish abundance

Data gathered from 2013 to 2015 in Jordan Creek (site #1 and #2), the River of Golden Dreams, Crabapple Creek and Fitzsimmons Creek were used to determine early trends for the rainbow trout abundance. Cutthroat trout were only observed once and the number a bull trout captured in 2013 and 2015 is too low to provide any meaningful trends while sculpin and stickleback are considered by-catch. Therefore, these four species were omitted from the trend analysis.

Figure 4 presents the trends for the creek surveyed during the Ecosystem Monitoring Program. Jordan Creek have been monitored from 2013 to 2015 and show an increase in abundance at Site #1 and #2. This trend is

also observed in Crabapple Creek and Scotia Creek based on results from 2014 and 2015. In Fitzsimmons Creek, the rainbow trout abundance has decreased from 0.03 fish/m^2 to 0.02 fish/m^2 from 2013 to 2015 which represents a 33% decrease.

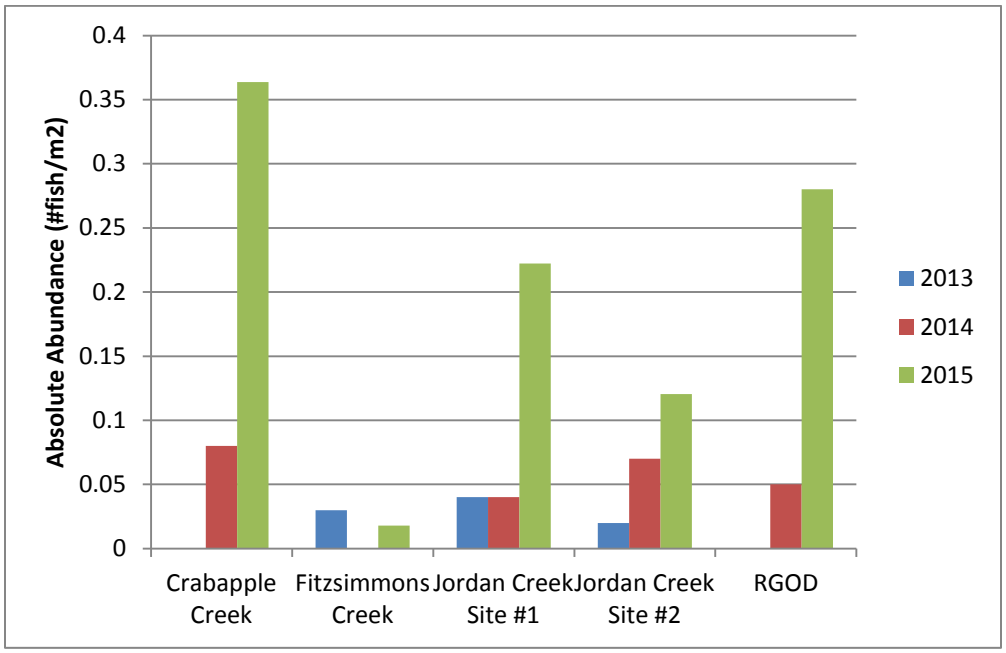


Figure 4: Rainbow trout abundance (#fish/ m^2) in Crabapple Creek, Fitzsimmons Creek, Jordan Creek (Site #1 and Site #2) and the River of Golden Dreams from 2013 to 2015

Rainbow Trout Spawning Surveys

The RMOW organised volunteers to conduct a rainbow trout spawning observation survey in 2014 and 2015 (No rainbow trout spawning survey was conducted in 2013). In 2014, no rainbow trout were observed spawning in Write-off Creek, Jordan Creek, Whistler Creek, Blackcomb Creek or Scotia Creek. 6 rainbow trout were observed spawning in Millar Creek, and in Lakeside Creek there were 228 observations of rainbow trout spawning (Table 7). In 2015, 65 rainbow trout were observed spawning in Jordan Creek, 61 in Crabapple Creek, 3 in Blackcomb Creek, 8 in Scotia Creek and 31 in Lakeside Creek (Table 7). Spawning rainbow trout were observed in more creeks during 2015; however the total count all creeks included was lower in 2015.

Table 7: Results of the rainbow trout spawning survey in various creeks in 2014 and 2015. Results are expressed as the number as the total number of individuals observed throughout the survey.

Year	Write-off Creek	Jordan Creek	Whistler Creek	Crabapple Creek	River of Golden Dreams	Blackcomb Creek	Scotia Creek	Miller Creek	Lakeside Creek	Totals
2014	0	0	0	n/a	n/a	0	0	6	228	**234**
2015	0	65	0	61	0	3	8	n/a	31	**168**

Kokanee Spawning Surveys

Table 8 summarised the results of the kokanee spawning survey from 2013 to 2015. During the 2013 spawning season, over 186 individuals were observed on the River of Golden Dreams and 6 in Whistler Creek. During the 2014 spawning surveys, no kokanee were observed in any of the creeks surveyed. In 2015, 84 kokanee were observed in Whistler Creek and 456 individuals were observed in Crabapple Creek. The results indicate an increase in the number of kokanee spawning from 2013 to 2015 with a total of 192 and 540 respectively.

Table 8: Results of the Kokanee spawning survey in various creeks from 2013 to 2015. Results are expressed as the number as the total number of individuals observed throughout the survey.

Year	Write-off Creek	Jordan Creek	Whistler Creek	19 Mile Creek	Crabapple Creek	River of Golden Dreams	Blackcomb Creek	Scotia Creek	Totals
2013	0	0	6	0	0	186	0	0	**192**
2014	0	0	0	0	0	0	0	0	**0**
2015	0	0	84	0	456	0	0	0	**540**

3.2.4 Discussion and Recommendations

This report presents findings of the abundance of fish in the Whistler area creeks and the results of kokanee and rainbow trout spawning surveys in Whistler for the 2015 season, and compares these findings with the 2013 and 2014 season where applicable.

Results suggest an increase in rainbow trout abundance at all sites with the exception of Fitzsimmons Creek. The site on Fitzsimmons Creek is located in side channel next to a gravel bar that is part of the gravel extraction program. Therefore the physical attributes of the side channel such as water depth and velocity are likely to change after each gravel extraction and this could explain why the rainbow trout abundance has decrease from 2013 to 2015 while the abundance at the other sites have increased. However the rainbow trout spawning survey suggest a decrease in the number of individual spawning. Abundance results for bull trout are still too low to attempt to analyse any abundance trend. Overall, the data should still be considered preliminary as they are only based on two to three years of data. Continuation of the current monitoring program should provide meaningful trend over time.

Cascade recommends that the same creek should be monitored year after year during the spawning survey. This would allow to obtain more consistent and robust data which would allow to better identify trend over time.

3.3 Riparian Species Indicators

3.3.1 Coastal Tailed Frog

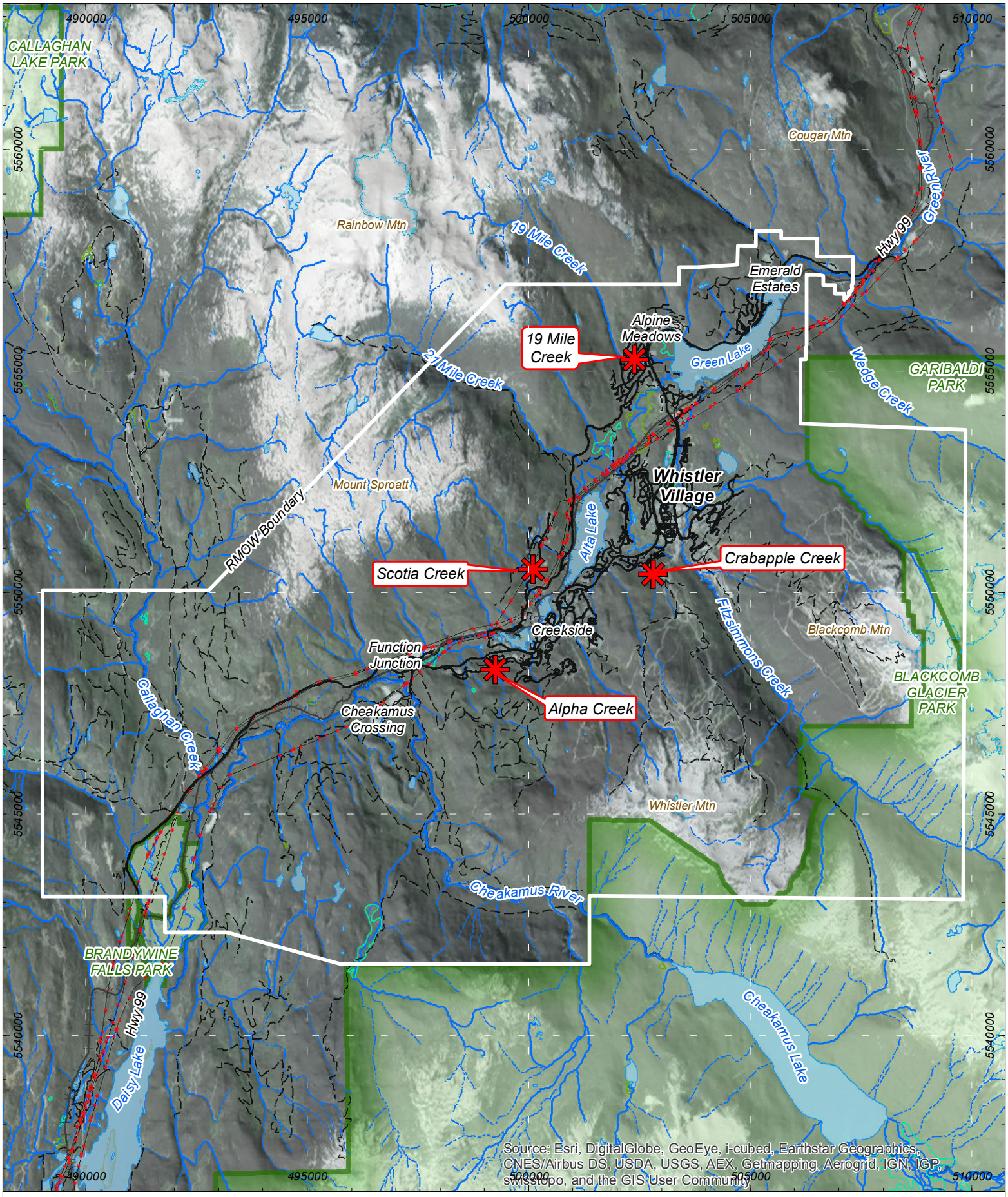
Amphibians have been widely recognized as useful indicator species of ecosystem health (Sheridan and Olson, 2003). They are considered to be sensitive to perturbations in both terrestrial and aquatic environments because of their dual life histories, highly specialized physiological adaptations, and specific microhabitat requirements (Welsh & Olliver, 1998). Coastal tailed frogs (*Ascaphus truei*) are unique among anurans due to their habitat requirement. Tadpoles are present in streams characterized by fast current over coarse gravel, pebble, cobble or boulder substrates with a high water velocity and cold water temperatures (Welsh & Olliver, 1998).

The coastal tailed frog (*Ascaphus truei*) is provincially Blue listed, and is regarded federally as a species of special concern (BC MOE, 2012; COSEWIC, 2011). This species is a known inhabitant of mountain streams in undisturbed forests and requires cold, clear, unsilted waters (Green & Campbell, 1992). The coastal tailed frog has a very unique life cycle as it remains a tadpole for up to four years prior to metamorphosis and takes up to 7

years to reach sexual maturity; with periods of highest activity from June to September (Dupuis & Steventon, 1999). The coastal tailed frog tadpole requires a continuous flow of clean, cold water throughout its lifecycle making this frog species vulnerable to habitat alteration and its degradation. The coastal tailed frog is sensitive to stream disturbance such as siltation and algal growth (Stevens, 1995).

Sample Site Selection

The 2015 Coastal Tailed Frog survey was conducted on the same four creeks from the 2014 survey: Alpha Creek, Scotia Creeks 19 Mile Creek and Crabapple Creek (Map 3). Sampling was conducted at three stations on each creek, upstream, mid stream and downstream locations. Sites were located in portions of the creek that were accessible by the surveyors and were characterized by a depth between 0.1 and 0.6 m, and a slow to moderate flow. Dominant substrate type consisted of cobbles and gravels or bedrock as the sub-dominant substrate



GIS Cartographer: Todd Hellinga
Date: January 13, 2015
CERG File#: 013-48-02
Projection: UTM 10N NAD83
Orthophoto: ESRI

CASCADE ENVIRONMENTAL RESOURCE GROUP LTD

N
W E
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0 1 2 3 4 5
Kilometers

Tailed Frog Survey - Location

Biodiversity Monitoring Project
Resort Municipality Of Whistler
British Columbia

3.3.1.1 Results

Four creeks were surveyed for Coastal Tailed Frogs in 2015, 19 Mile Creek, Alpha Creek, Crabapple Creek and Scotia Creek. A downstream (1), mid stream (2) and upstream (3) location was sampled on each creek (Table 9). A total of 20 coastal tailed frog tadpoles were observed in Alpha Cree, 7 in Scotia Creek and 21 in Crabapple Creek (Table 9).

Table 9: Results of tailed frog tadpoles surveys in four creeks in Whistler, BC

Location	Upstream Reachbreak UTM	Length (m)	Gradient (%)	Average Wetted Width (m)	Stream Morphology	Dominant Substrate	Tailed tadpoles observed
Alpha Creek	0499201 5548219	15.88	2	4.37	Riffle	LC	20
Scotia Creek	0500759 5550711	12.58	4	3.07	Riffle	SC	7
19 Mile Creek	502137 E 5555240 N	15.25	4	4.77	Riffle-Pool	LC	0
Crabapple Creek	502556 E 5550510 N	15.32	4	3.06	Riffle	SC	21

SC=small cobble
LC=large cobble

3.3.1.1.1 Relative Abundance Survey

Abundance estimates were calculated for each sample location of the four creeks (Table 10 to Table 12). Relative abundance of tailed frogs was calculated as the number of individuals encountered/area (wetted width x survey length).

Coastal tailed frog tadpoles in life stage 1 and 2 were observed in Site 2 and 3 of Alpha Creek, in Site 2 of Scotia Creek and at Site 3 of Crabapple Creek during an area-constrained search on July 14 and 15, 2014 (Table 10). One Adult was captured in Site 2 of Scotia Creek.

Table 10: Relative Abundance Results (July 14-15, 2015)

Location	Site #	Total Area Surveyed (m^2)	Total Number of Tadpoles Found	Length (mm)	Weight (g)	Life Stage	Average Abundance of Tadpoles (Tadpoles/m^2)
Alpha Creek	1	18.4	Not detected	n/a	n/a	n/a	n/a
	2	15.4	4	37 38 39 41	0.5 0.4 0.7 0.6	2 2 2 2	0.26
	3	35.8	5(3 escaped)	35 37	0.5 0.2	1 2	0.14

Location	Site #	Total Area Surveyed (m^2)	Total Number of Tadpoles Found	Length (mm)	Weight (g)	Life Stage	Average Abundance of Tadpoles (Tadpoles/m^2)
Scotia Creek	1	21.4	Not detected	n/a	n/a	n/a	n/a
	2	17.2	1	38	0.6	2	0.058
	3	7.20	Not detected	n/a	n/a	n/a	n/a
19 Mile Creek	1	41.34	Not detected	n/a	n/a	n/a	n/a
	2	24.75	Not detected	n/a	n/a	n/a	n/a
	3	7.5	Not detected	n/a	n/a	n/a	n/a
Crabapple Creek	1	14.71	Not detected	n/a	n/a	n/a	n/a
	2	16.35	Not detected	n/a	n/a	n/a	n/a
	3	15.85	11	32 29 33 28 31 29 32 31 31 30 33	0.3 0.3 0.6 0.5 0.4 0.4 0.5 0.6 0.5 0.3 0.4	1 1 1 1 1 1 1 1 1 1 1	0.69

Total area surveyed = (wetted width of sample area) x (total length of sample area)
Average abundance = Total number found / Total area surveyed

Two coastal tailed frog tadpoles were observed in Site 2 of Alpha Creek, one was in a life stage 3 and the life stage of the other one is unknown as it escaped. Four tadpoles were observed in Site 2 in the life stage 2 of Alpha Creek and one tadpole escaped in Site 3. In Scotia Creek, 5 tadpoles of life stage 2 and 3 were recorded in Site 2. One tadpole of life stage 1 was caught on Crabapple Creek in Site 2 and five tadpole of life stage 1 and 2 were observed in Site 3. No tadpoles were caught in 19 Mile Creek (Table 11). One adult was caught in Alpha Creek in Site 3, another one in Scotia in Site 2 and a last one in Crabapple Creek in Site 3

Table 11: Relative Abundance Results (August 13-14, 2015)

Location	Site #	Total Area Surveyed (m^2)	Total Number of Tadpoles Found	Length (mm)	Weight (g)	Life Stage	Average Abundance of Tadpoles (Tadpoles/m^2)
Alpha Creek	1	18.4	2 (1escape)	44	1	3	0.054
	2	15.4	4(1 escape)	37 44 39	0.6 0.9 0.7	2 2 2	0.26
	3	35.8	1 escape	Unknown	Unknown	unknown	0.028
Scotia Creek	1	21.4	Not detected	n/a	n/a	n/a	n/a
	2	17.2	5(2 escapes)	40 41 45	0.5 0.5 0.5	2 2 3	0.29
	3	7.20	Not detected	n/a	n/a	n/a	n/a
19 Mile Creek	1	41.34	Not detected	n/a	n/a	n/a	n/a
	2	24.75	Not detected	n/a	n/a	n/a	n/a
	3	7.5	Not detected	n/a	n/a	n/a	n/a
Crabapple Creek	1	14.71	Not detected	n/a	n/a	n/a	n/a
	2	16.35	1	43	0.8	1	0.061
	3	15.85	5	40 34 32 35 35	0.6 0.4 0.3 0.5 0.6	2 1 1 1 1	0.19

Total area surveyed = (wetted width of sample area) x (total length of sample area)
Average abundance = Total number found / Total area surveyed

Coastal tailed frog tadpoles in life stage 1 and 3 were observed in Site 2 and 3 of Alpha Creek. In Scotia Creek one coastal tailed frog tadpole in life stage 3 was observed in Site 2 while one stage 3 tadpole was observed in Site 2 in Crabapple Creek and three tadpoles of life stage 2 were observed in Site 3 (Table 12). One adult was observed in Scotia Creek in Site 2.

Table 12: Relative Abundance Results (September 17-18, 2015)

Location	Site #	Total Area Surveyed (m^2)	Total Number of Tadpoles Found	Length (mm)	Weight (g)	Life Stage	Average Abundance of Tadpoles (Tadpoles/m^2)
Alpha Creek	1	18.4	Not detected	n/a	n/a	n/a	n/a
	2	15.4	1	47	0.7	3	0.065
	3	35.8	3 (1 escape)	39 43	0.5 0.6	1 3	0.084
Scotia Creek	1	21.4	Not detected	n/a	n/a	n/a	n/a
	2	17.2	1	41	0.5	3	0.058
	3	7.20	Not detected	n/a	n/a	n/a	n/a
19 Mile Creek	1	41.34	Not detected	n/a	n/a	n/a	n/a
	2	24.75	Not detected	n/a	n/a	n/a	n/a
	3	7.5	Not detected	n/a	n/a	n/a	n/a
Crabapple Creek	1	14.71	Not detected	n/a	n/a	n/a	n/a
	2	16.35	1	45	0.8	3	0.061
	3	15.85	3	40 30 39	0.6 0.3 0.5	2 2 2	0.19

Total area surveyed = (wetted width of sample area) x (total length of sample area)
Average abundance = Total number found / Total area surveyed

Photo 3: tailed frog processing. July 14, 2015

Photo 4: tailed frog processing. July 14, 2015

Photo 5: Adult tailed frog in holding bucket. July 14, 2015

Photo 6: Adult tailed frog in processing bag. July 14, 2015

3.3.1.1.2 Comparison of the 2013, 2014 and 2015 results

In 2013 two creeks were surveyed for Coastal tailed frogs, Alpha Creek and Scotia Creek. Surveys of each creek were done once in 2013. Since coastal tailed frogs were found in low numbers in 2013 and because non detection does not equate to absence, the surveys conducted in 2014 were expanded to include three repeat survey periods and the same survey was repeated in 2015. Table 13 shows the relative abundance of coastal tailed frogs in Alpha Creek, Scotia Creek and Crabapple Creek at the three survey sites in 2013, and average of the three replicates excluding the null results for 2014 and 2015. The abundance of tailed frogs in Alpha Creek increase in Site 1 decreased from 2013 to 2014 but increase in 2015 while the trend from 2013 to 2015 is an increase in Site 2 and 3. In Scotia Creek, tadpole were only observed in Site 2 where an increase in abundance was observed in Crabapple Creek, the abundance has decreased in Site 2 and increased in Site 3. No tadpoles were observed in 19 mile Creek.

Table 13: Abundance of tailed frog tadpole (number of tadpole/ m^2) in Alpha Creek, Scotia Creek and Crabapple Creek at all sites in 2013, 2014 and 2015

Location	Site #	2013	2014	2015
Alpha Creek	1	0	0.054	0.109
	2	0.13	0.087	0.195
	3	0.08	0.028	0.084
Scotia Creek	1	0	0.000	0.000
	2	0	0.058	0.136
	3	0	0.000	0.000
Crabapple Creek	1	n/a	0.000	0.000
	2	n/a	0.102	0.041
	3	n/a	0.252	0.400

Figure 5 provides a visual representation of the tailed frog tadpole abundance. The overall trend appears to be an increase in abundance in all creeks from 2013 to 2014. Tailed frog tadpole abundance during the three year of the survey has always been the highest in Crabapple Creek and the lowest in Scotia Creek (or Alpha Creek in 2013).

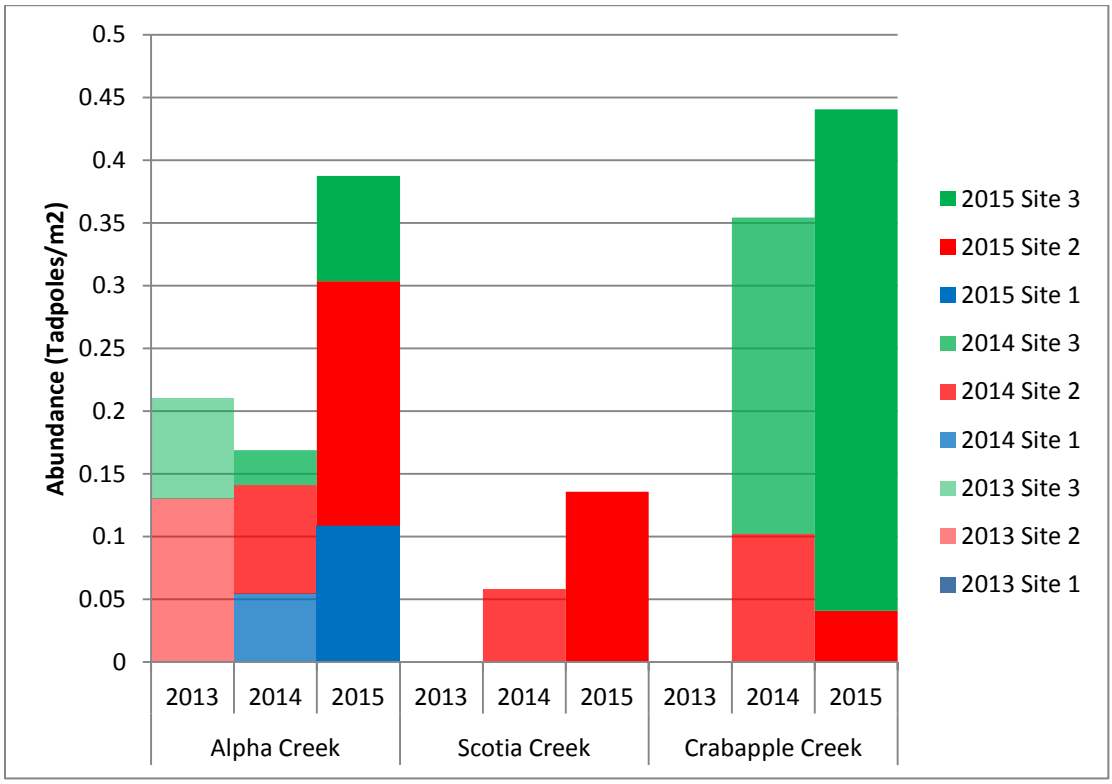


Figure 5: Tailed frog tadpole abundance in Alpha Creek, Scotia Creek and Crabapple in all three sites during 2013, 2014 and 2015.

3.3.1.2 Discussion and Recommendations

After three years of survey, some early trends are appearing. Over the years it appears that the tailed frog tadpole abundance has increased overall from 2013 to 2015 with a slight decrease from 2013 to 2014 in Alpha Creek. No tadpoles have been observed in 19 Mile Creek from 2013 to 2015. These results are supported by the capability analysis conducted in 2014. The results of the analysis suggest that Alpha Creek, Scotia Creek and Crabapple Creek have high capability of supporting coast tailed frogs while Nineteen Mile Creek has a very low capability to support coastal tailed frogs.

The 2015 summer being warmer and drier than average could have positively influenced the tailed frog population. With the help of the temperature loggers that were installed in 2015, the potential correlation between tadpole abundance and water temperature will be further investigated in the coming years. The abundance in Scotia Creek is still low compared to the 23 individuals captured over three sites in 2006 (Biodiversity Project, 2006). The population in Scotia Creek seems to be recovering as abundance is increasing. Stone bridge being an area with a lot of development, this could have affected the tailed frog population. Further monitoring will help to determine population trends and better identify hotspots where populations may be threatened.

Tailed frog tadpoles were documented in 19 Mile Creek during the Biodiversity project of 2006. However after three years of survey during the ecosystem monitoring program, no tadpole has been detected. If after four years of survey no tadpole is observed, Cascade recommends that another creek should be surveyed.

3.3.2 Beaver

The North American Beaver (*Castor canadensis*) is considered a keystone species in North America and has an influential impact on the structure of an ecosystem. Beavers are archetypal ecosystem engineers in their

construction of dams, lodges and wetland habitat that is capable of supporting herbaceous plant species not found elsewhere in the riparian zone (Wright *et al*., 2002). As such, the beaver can be used as a valuable indicator species of the health of an ecosystem since a variety of species rely on the habitat created by the beaver (Stevens *et al.*, 2007). A beaver's lodge will provide the beaver with a stretch of calm water, where it can build its lodge. A typical lodge is built from felled trees, collected sticks, and mud. An indicator of an active lodge is the presence of fresh mud on the outside surface of the lodge and freshly cut/gnawed trees and branches (Baker & Hill, 2003). During the fall, northern beaver colonies will construct an underwater food cache of branches and logs close to the lodge to be consumed through the winter months. Locating an underwater food cache with fresh cuttings is also an indicator of active beaver presence (Jenkins & Busher, 1979).

3.3.2.1 Site Selection

Lodges and study area previously surveyed in Cascade (2013) were re-surveyed for signs of activity (Map 4) and undocumented lodges were recorded. The survey sites included the following:

- Alpha Lake
- Wedge Pond
- Green Lake
- Fitzsimmons Creek Fan
- Unnamed waterways (Nicklaus North Golf Course)
- Crystal Creek (Chateau Golf Course)
- Crabapple Creek (Whistler Golf Course)
- Nita Lake
- River of Golden Dreams(ROGD)
- Beaver Lake
- Bottomless Pond

RMOW Boundary
Road - Paved
Road - Gravel
Railway - Single Track
Transmission Line
Bridge
Whistler/Blackcomb Lifts
Singletrack Trail
Valley Trail
RMOW - Watercourse
RMOW - Wetlands
RMOW - Parks

Beaver Lodge Status 2015

active
inactive
not found
unknown

Rainbow
Emerald Estates
Green Lake
Alpine Meadows
Spruce Grove
Tapley's Farm
Whistler Village
Benchlands
Blueberry
Alta Lake
Alta Vista
Brio
Hwy 99
Nordic Estates
Nita Lake
Alpha Lake

GIS Cartographer: Todd Hellinga
Date: January 6, 2016
CERG File#: 013-48-03
Projection: UTM 10N NAD83
Orthophoto/Data: BC Gov/RMOW

CASCADE ENVIRONMENTAL RESOURCE GROUP LTD

0 200 400 600 800 1,000
Meters

Beaver Lodges Location

RMOW Biodiversity Monitoring Project
Whistler, British Columbia

3.3.2.2 Beaver Population Abundance

The 2015 beaver population census surveyed 34 beaver lodges including 1 lodge that was not documented before. 7 (31%) of which were *active*, 19 (44%) were *inactive*, 3 (3%) were *unknown* and 5 (22%) lodges surveyed in Cascade (2013) were not found. A status of each lodge and photo documentation of the lodges surveyed, with the exception of the lodges on the ROGD, are present in Appendix D

The mean colony size of 5.8 individuals, which was established by Mullen (2008), was applied to the 7 known active lodges in the 2015 survey. Based on this extrapolation, an estimate of the beaver population in the Resort Municipality of Whistler is 41 beavers. Compared to the results of the previous year, it appears that the population is on decline since 2008 (Figure 6). It should be stressed that lodges do not equate to colonies, and that the number of lodges is likely greater than the number of colonies due the potential for one colony to maintain up to three different lodges.

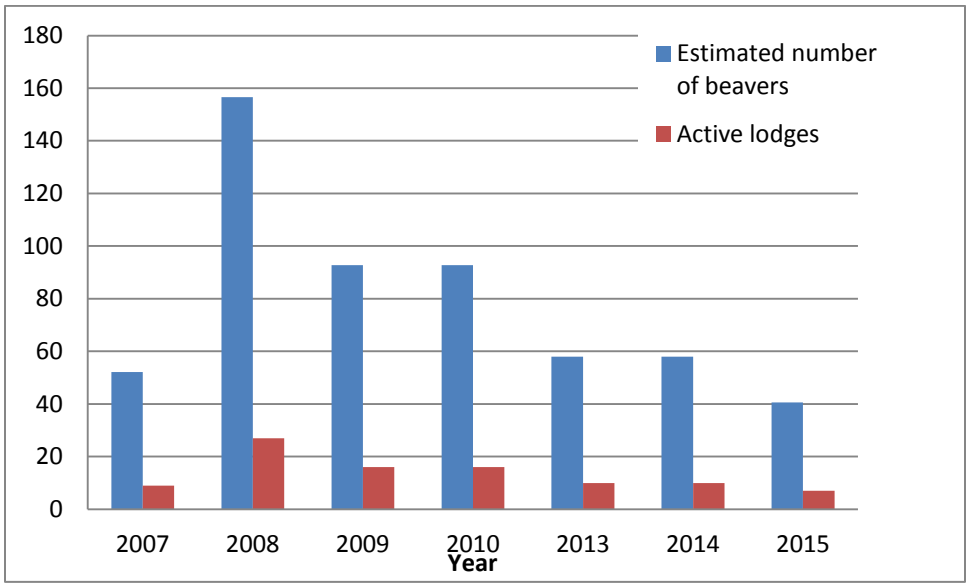


Figure 6: Total annual population of beavers over the six year study period and the corresponding active lodges.

Table 14 details the number of beaver lodges found in Whistler with their activity status over the past five years. 26 lodges have been consistently monitored over the last three year, two of those have been considered *active* during that three years period. Between the 2014 and the 2015 survey 4 *active* lodges became *inactive* and two *inactive* lodges became *active*.

Table 14: Summary of beaver lodge status in surveys from 2007-2013, Whistler, BC

	2007	2008	2009	2010	2013	2014	2015
Active	9	27	16	16	10	10	7
Inactive	9	12	13	17	5	14	19
Unknown	1	4	4	4	8	1	3
Not found	-	-	-	7	5	7	5
Not surveyed	-	-	10	1	-		
TOTAL SITES	**19**	**43**	**33**	**46**	**28**	**32**	**34**

3.3.2.3 Population Distribution

The Whistler area provides ideal habitat for beaver populations. Beaver inhabit a variety of aquatic habitats in Whistler; including natural streams, rivers, ponds and lakes, as well as constructed ponds (golf course ponds for example) and drainage waterways.

The number of active lodges observed in 2015 is lower than in 2014. The trend now indicates a decline in the population. However, confirming the observation form the previous surveys, resident beaver lodges tend to be more active along larger waterways as opposed to small streams, ponds or lakes. 57% of the active lodges were along a river, 43% were along a pond and no active lodge were along a small stream or a lake. Comparing 2015 survey data to 2014 survey data; there has been a decrease in the number of active lodges located in lake, stream and river habitats, and an increase in the number of active lodge found in pond habitat (Table 15).

Table 15. Beaver lodge classification by habitat type, 2015 in Whistler, BC

Habitat	Number of Active Lodges
Pond <2m deep	3(43%)
Lake >2m deep	0
Stream <5m wide	0
River >5m wide	4 (57%)

3.3.2.4 Discussion and Recommendations

The population appears to be in decline compare to the previous years of the survey (2007 to 2014). However, the population is still active as lodges are abandoned and old lodges are re-colonised. This cycle of abandoning and re-colonising old lodge or building new one might explain why the number of active lodge is down this year. New beaver lodge might have been built outside of the survey area. This shows the importance of surveying as much as possible of the valley in Whistler in order to get an accurate and representative estimation of the beaver population.

The survey area was extended this year, Bottomless Pond and Beaver Lake were surveyed. Inactive lodges were previously documented in these two locations but no new or active lodges were observed during this year's survey. Cascade recommends that a new area or an area surveyed prior to 2010 should be surveyed every year. If inactive lodges are observed, they should be surveyed every 4 years for potential re-colonization. This would lead to an eventual inventory the entire valley bottom for beaver lodges.

Continued monitoring of the dynamic of the beaver population can provide useful information on the habitat available and the ecosystem health in Whistler.

3.4 Terrestrial Habitat Indicators

3.4.1 Terrestrial Ecosystem Unit

Terrestrial ecosystem unit in Mature/old forest hotspots were selected as the target ecosystem in 2013(Cascade, 2014). During the 2014 survey, a young alluvial forest site was selected as the target ecosystem.

Using BEC and TEM inventory from the GIS, specific ecosystem units were identified and targeted for study. A Terrestrial ecosystem plot was established to record ecosystem data associated with terrestrial wildlife surveys. One plot was established at each of the locations of the red-backed vole and ground beetle survey sites.

Terrestrial ecosystem plot assessments was not conducted this year but should be repeated in future monitoring years. This will allow for a between-year analysis of the data that may correlate to the results of terrestrial

wildlife surveys. The ecosystem is not expected to undergo important natural changes from one year to another. Therefore, each plot should be re-assessed approximately every 5 years.

3.4.2 Carabid Beetle

Carabid beetles (Carabidae) are a good indicator of ecosystem health because they are sensitive to different environmental factors and have wide range of habitat requirements (Villa-Castillo and Wagner, 2002). Carabids appear to be useful model organisms and indicators because they are diverse, they are taxonomically and ecologically well-known, they efficiently reflect biotic and abiotic conditions, and they are relevant at multiple spatial scales (Koivula, 2011). Carabids are frequently used to indicate habitat alteration. They have been used in grasslands and boreal forests where species number and/or abundances have been noted to change along a habitat disturbance gradient (Rainio and Niemela, 2002). They are also a good species to monitor because data collection is simple and cost-effective.

3.4.2.1 Site Selection

Trapping was conducted at the same three sites as the 2014 and 2013 surveys. Two sites were located in old growth/mature forest and one site was located in a young alluvial forest.

Site 1 is located on Blueberry Hill, approximately 50 m uphill from the trail. Site 2 is located west side of Alta Lake Road in Whistler, near the Rainbow Lake Trail parking lot. Both sites are characterized by a mature forest composed mainly of western hemlock (*Tsuga heterophylla*). Site 3 is located in Function Junction between the cheakamus river and the sewage treatment plant. The dominant tree species at this site is amabilis fir (*Abies amabilis*)

3.4.2.2 Results

A total of 200 ground beetle specimens, representing 6 species were collected from the 27 days of trapping. The relative abundance ranges from 0.012 to 1.143 ground beetle per trap night (Table 16). The highest abundance was observed at Function(Site 3) during the 2nd sampling period and the lowest abundance was observed at Rainbow (Site 2) and at Function during the 1st sampling period with an abundance of 1.143 and 0.012 animals per trap night respectively (Figure 7). All species included, Function had the highest abundance during both sampling period while the lowest abundance during the 1st sampling period was observed at Rainbow and at Blueberry during the 2nd sampling period.

The most abundant species was *S.angusticollis* which accounted for 67.5% of all the ground beetle collected. Species richness was the highest at Site 3 with 6 different species while Site 1 had the lowest species richness with 2 species (Figure 8). *S.angusticollis* and *P. Herculaneus* were present at all Sites while two species were only found at Site 3 and one species was only found at Site 2

Table 16: relative abundance (nbr of beetles per trap night) of carabid species collected from blueberry hill, rainbow and function between June 13 and September 22, 2015

Species	Site 1: Blueberry		Site 2: Rainbow		Site 3: Function	
	1st sampling	2nd sampling	1st sampling	2nd sampling	1st sampling	2nd sampling
Notiophilus sylvaticus					0.131	0.013
Pterostichus castaneus				0.064		0.013
Pterostichus herculaneus	0.202	0.141	0.024	0.103	0.012	0.064
Pterostichus neobrunneus			0.012			
Scaphinotus angusticollis	0.083		0.048		1.143	0.372
Trechus obtusus						0.013
Totals	**0.285**	**0.141**	**0.084**	**0.167**	**1.286**	**0.475**

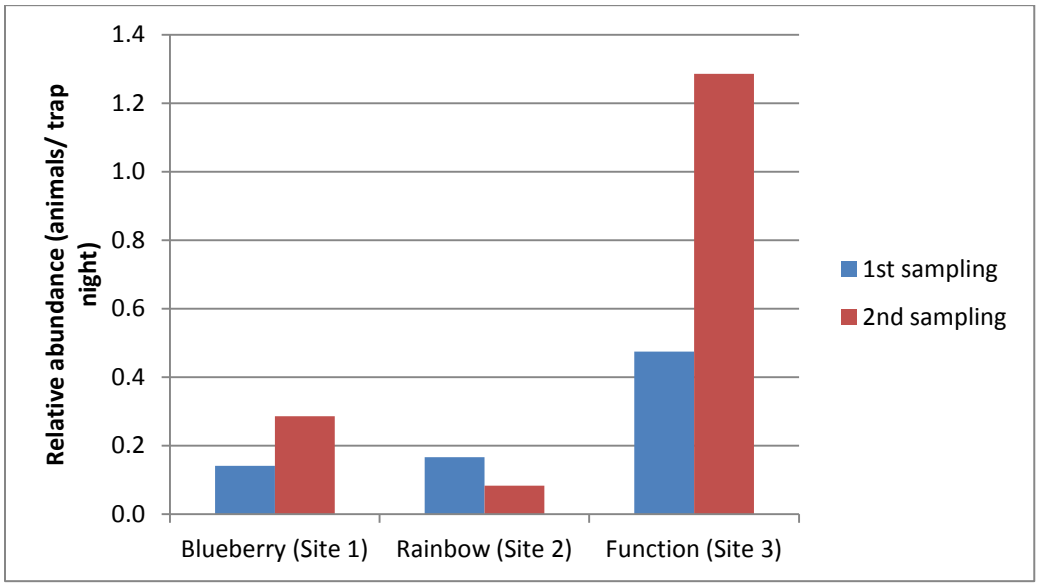


Figure 7: Relative abundance (animals / trap night) during both sampling periods at the Blueberry, Rainbow and Function site

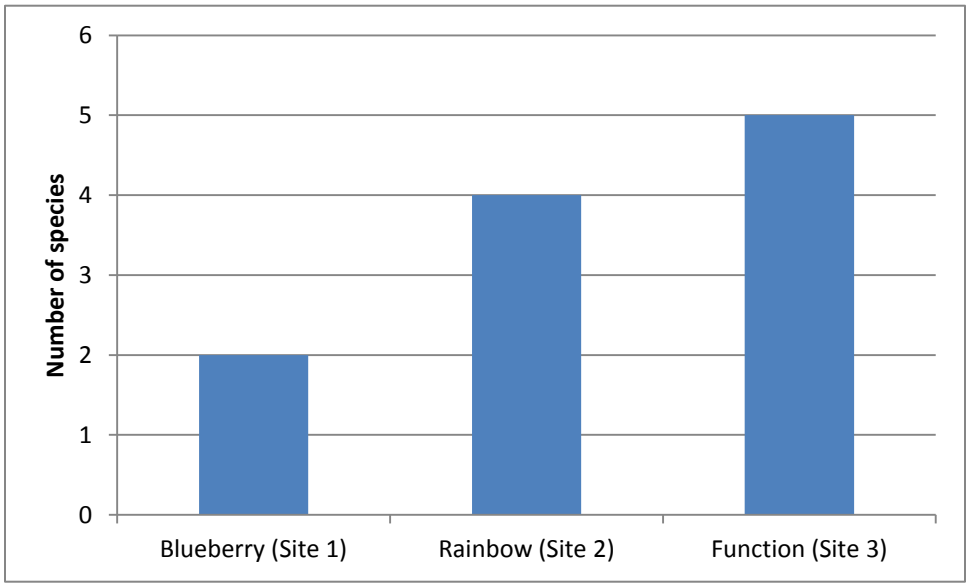


Figure 8: Species richness at the Blueberry, Rainbow and Function site

Photo 7: ***Trechus obtusus***

Photo 8: ***Pterostichus herculaneus***

Photo 9: ***Notiophilus sylvaticus***

3.4.2.2.1 Comparison of the 2013, 2014 and 2015 results

The abundance of the carabid beetle all species included over the entire sampling season shows a slight increase for the Blueberry and the Rainbow site while a decline in abundance is observed at the Function site (Figure 9). The species richness remained the same in 2014 and 2015 with 6 species. Only two species were observed in 2013 but sampling was only conducted during the late summer at Blueberry and Rainbow. During the three years of the survey, a total of 7 different species have been observed with the two most abundant species being *S. angusticollis* and *P. herculaneus.*

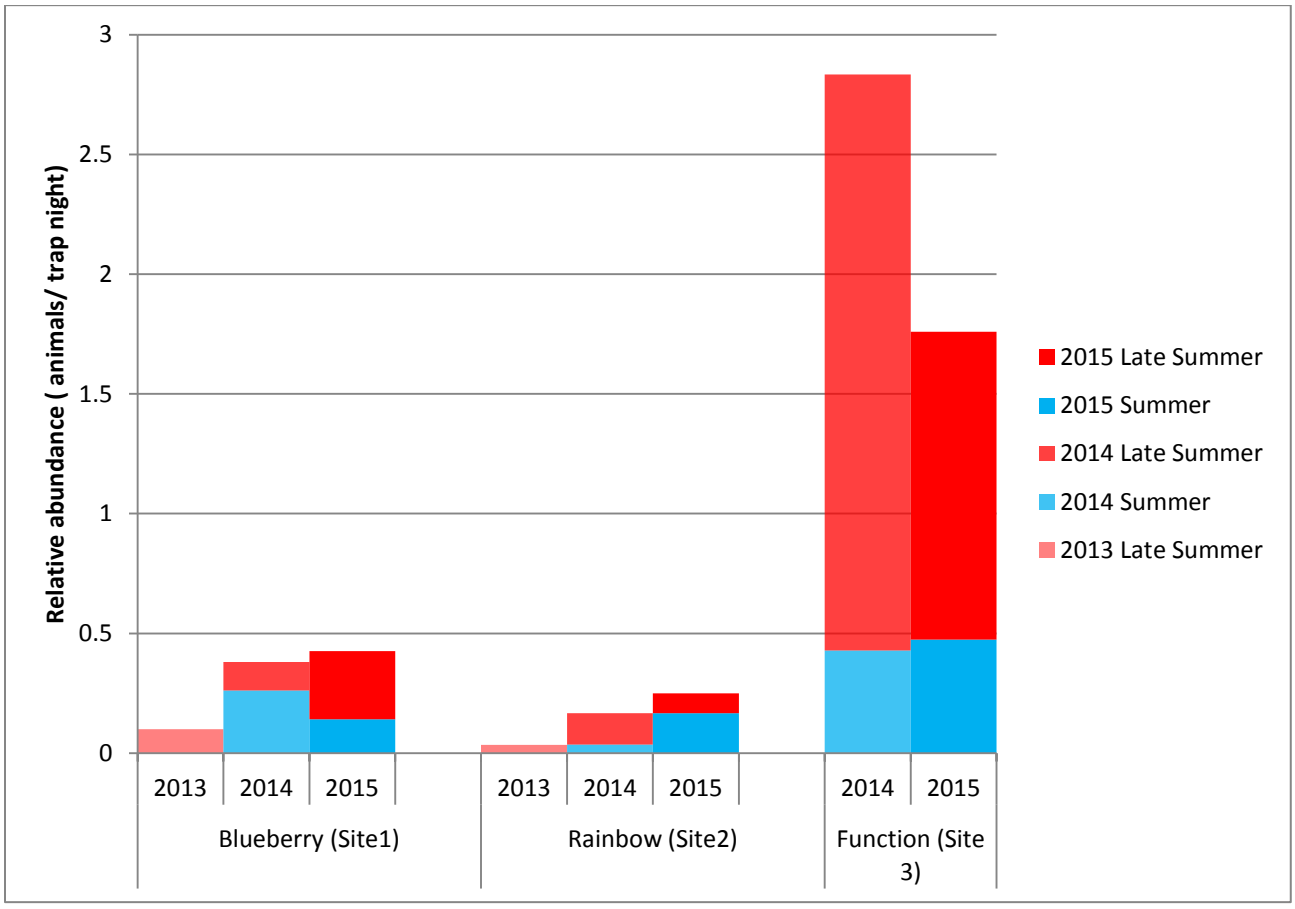


Figure 9: comparison of the carabid abundance between 2013, 2014 and 2015 at the Blueberry, Rainbow and Function sites.

3.4.2.3 Discussion and Recommendations

Early trends can be observed with an increase in carabid abundance at the Blueberry and the Rainbow site and a decrease in abundance at the Function site. The trends are based only on two years of data as the 2013 data at the Blueberry and the Rainbow sites were only collected in the late summer. The monitoring program still being in its early stage, it is not possible to explain the trends observed. Continuation of this monitoring program should show more evident trends over time.

The carabid abundance is higher at the Function site. This can be explained by the site characteristics. The Function site is located in a young alluvial forest unlike the other two sites which are located in a mature/old growth forest. These results are supported by previous studies which reported higher carabid abundance in intermediate aged forest classes (Spence et al. 1996; Riley and Browne, 2011). Following a severe disturbance of mature forests (as occurs with clear-cutting) there is an influx of rapidly colonizing, open habitat carabid species in combination with the temporary presence of the carabid generalists more typical of mature forests (Riley and Browne, 2011). While the Blueberry and Rainbow sites are similar ecologically and can be compared, the results from Function should not be compared with the others,

A fourth site should be developed next year, located in young alluvial forest. This will provide a comparative for the Function site.

3.5 Terrestrial Species Indicators

3.5.1 Pileated Woodpecker

Woodpeckers (family *Picidae*) are considered good indicators of avian diversity in forests because their populations can be reliably monitored, and their foraging and nesting activities can positively influence the abundance and richness of other forest birds (Drever *et al.*, 2008). The pileated woodpecker (*Hylatomus pileatus*) is a keystone habitat modifier. It forages primarily by excavating and is the only species capable of creating large cavities in hard snags and decadent live trees. A wide array of species use old pileated nest and roost cavities. In addition, pileated woodpeckers provide foraging opportunities for other species, accelerate decay processes and nutrient cycling, and mediate insect outbreaks. Because of the indicator and keystone role of pileated woodpeckers in forests, it is appropriate to give special attention to their habitat needs in forest management plans and monitoring activities (Aubry and Raley, 2002).

3.5.1.1 Site Selection

Four transects were surveyed. The two transects from last year's survey were revisited and two new transects were established using the same selection criteria. Transect 1 is located along the Comfortably Numb trail, Transect 2 is located west of Alta Lake Road in the area of the Rainbow/Madely Trail, Transect 3 is located on Whistler mountain above Creekside and Transect 4 is located near Stonebridge. Each transect consists of 10 survey stations located approximately 300 m apart. The transect locations were selected to be within mature to old forests in suitable site series of the CWHmm biogeoclimatic subzone, including Site Series 01 (TEM Code: AM - HwBa – Step moss), Site Series 04 (TEM Code: AO – BaCw – Oak fern), and Site Series 03 (TEM Code: DF – FdHw - Falsebox) and below 1,200 m in elevation.

3.5.1.2 Results

No pileated woodpeckers were observed or recorded during the survey. Further details regarding survey data collected at all transects are provided in Appendix E.

3.5.1.3 Comparison of the 2013, 2014 and 2015 results

In 2013 only two transects were surveyed giving an overall abundance of 0.007 pileated woodpecker per hectare. In 2014, four transects were surveyed giving a more accurate abundance estimation of 0.011 pileated woodpecker. In 2015, all four transects were surveyed but no pileated woodpecker was detected (Table 17, Figure 10). With the data collected so far, it is not possible to identify any early trend.

Table 17: Comparison of pileated woodpecker abundance in 2013, 2014 and 2015.

Transect	Abundance (number of animal/ha)		
	2013	2014	2015
#1- Comfortably Numb	0.014	0.014	Not detected
#2- Rainbow	Not detected	Not detected	Not detected
#3- Creekside	n/a	0.014	Not detected
#4- Stone Bridge	n/a	0.014	Not detected
Total	**0.007**	**0.011**	Not detected

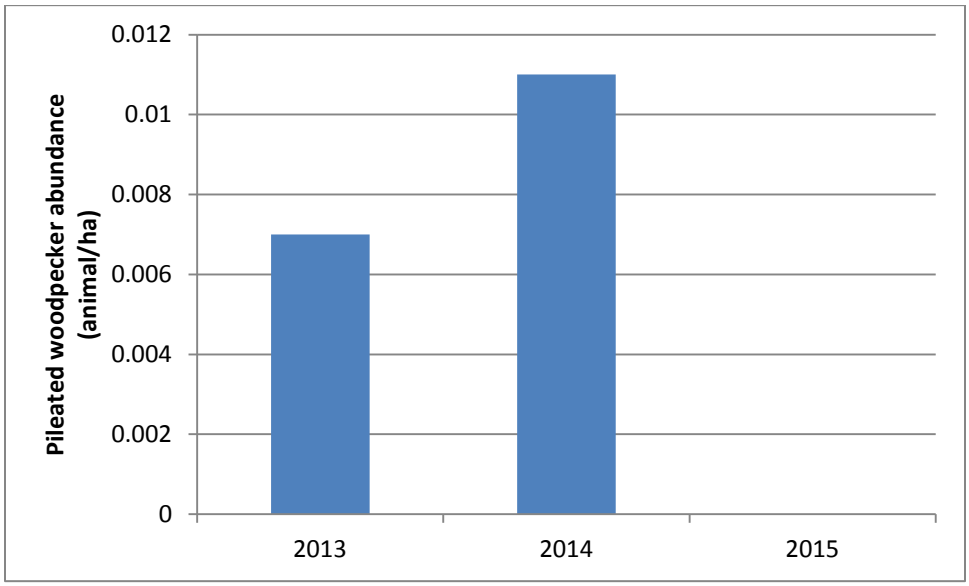


Figure 10: Comparison of the pileated woodpecker abundance in 2013, 2014 and 2015.

Pileated Woodpecker Survey Points

- Cavity Tree
- Bird Sighting
- Call Station
- Call Area
- Transect
- Potential Woodpecker Habitat - SS 6/7, SC AM/AO/DF
- Road - Gravel
- Railway - Single Track
- Transmission Line
- Bridge
- Whistler/Blackcomb Lifts
- Road - Paved
- Singletrack Trail
- Valley Trail
- Doubletrack, Access
- RMOW - Wetlands
- RMOW - Parks

RMOW - Cadastre (Ownership)

- CROWN MUNICIPAL
- CROWN PROVINCIAL; CROWN FEDERAL
- PRIVATE
- UNKNOWN

505000 506000 5556000 5555000 5554000 5553000

Parkhurst Parkhurst Parkhurst Jeff's Trail Sea to Sky Trail Tommy Moore Tommy Moore Forest Trail Poler's Road Old Mill Road Yummy Numby Reservoir Climb Valley Trail Valley Trail Valley Trail Valley Trail

GARIBALDI PARK

GIS Cartographer: Todd Hellinga
Date: January 7, 2016
CERG File#: 013-48-03
Projection: UTM 10N NAD83
Orthophoto/Data: RMOW/BC Gov

CASCADE ENVIRONMENTAL RESOURCE GROUP LTD

N W E S

0 100 200 300 400 500
Meters

Pileated Woodpecker Survey - Transect 1: Comfortably Numb

RMOW Biodiversity Monitoring Project
Whistler, British Columbia

Pileated Woodpecker Survey Points

- Cavity Tree
- Bird Sighting
- Call Station
- Call Area
- Transect
- Potential Woodpecker Habitat - SS 6/7, SC AM/AO/DF
- Road - Gravel
- Railway - Single Track
- Transmission Line
- Bridge
- Whistler/Blackcomb Lifts
- Road - Paved
- Singletrack Trail
- Valley Trail
- Doubletrack, Access
- RMOW - Wetlands
- RMOW - Parks

RMOW - Cadastre (Ownership)

- CROWN MUNICIPAL
- CROWN PROVINCIAL; CROWN FEDERAL
- PRIVATE
- UNKNOWN

499000 500000 555000 5550000 5549000

Scotia Creek
Stonebridge Dr
Cheap Thrills
Rainbow-Sproatt Flank
Legalize It
Bush Doctor
Gebhart Creek
Dirty Deeds
High Society
Pura Vida
A La Mode
Lower Sproatt
Danimal
Danimal South
Moose Knuckles
THC
Piece of Cake
AC/DC
Valley Trail

GIS Cartographer: Todd Hellinga
Date: January 7, 2016
CERG File#: 013-48-03
Projection: UTM 10N NAD83
Orthophoto/Data: RMOW/BC Gov

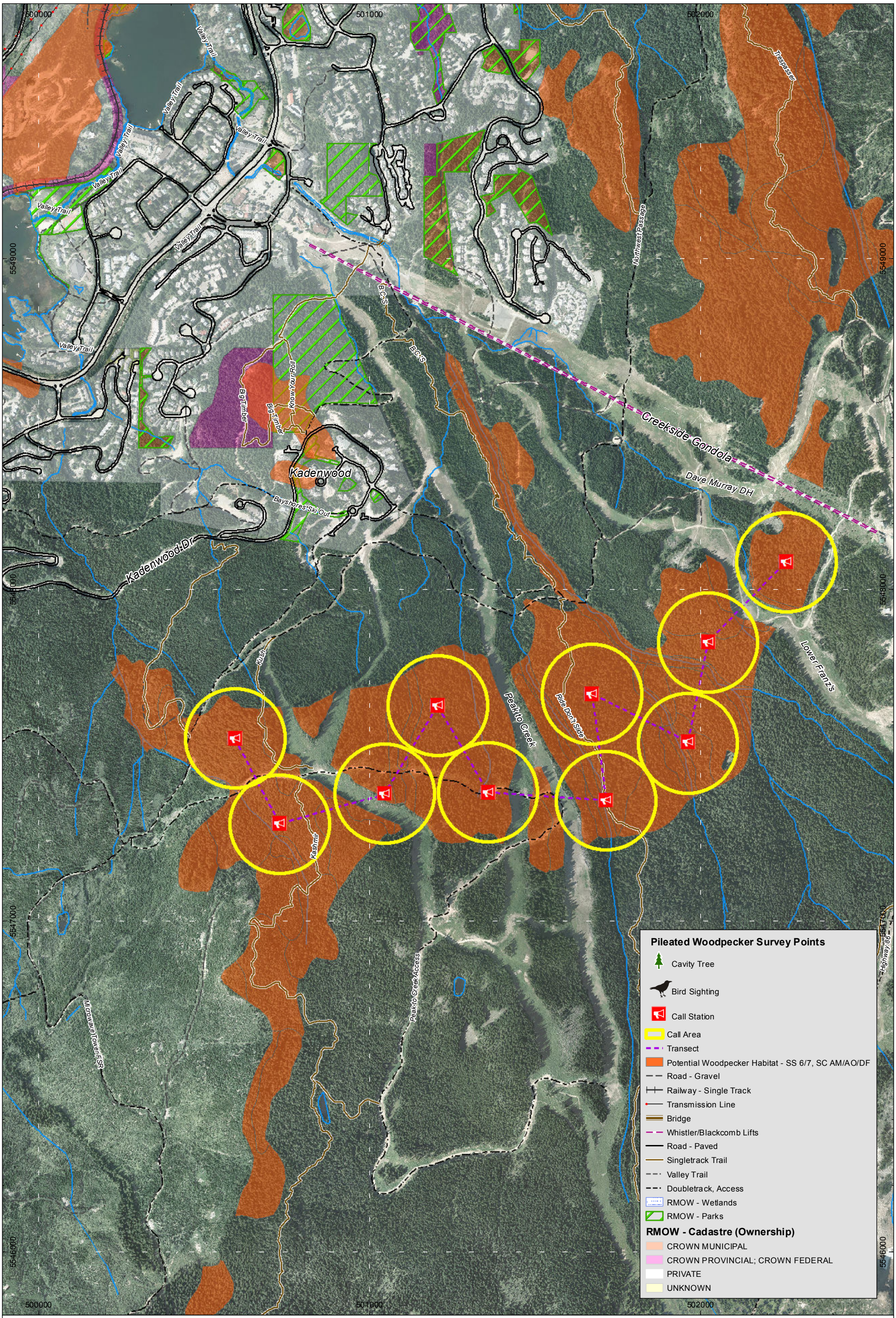
CASCADE ENVIRONMENTAL RESOURCE GROUP LTD

N W E S

0 100 200 300 400 500
Meters

Pileated Woodpecker Survey - Transect 2: Stonebridge

RMOW Biodiversity Monitoring Project
Whistler, British Columbia



GIS Cartographer: Todd Hellinga
Date: January 7, 2016
CERG File#: 013-48-03
Projection: UTM 10N NAD83
Orthophoto/Data: RMOW/BC Gov

CASCADE ENVIRONMENTAL RESOURCE GROUP LTD

N W E S

0 100 200 300 400 500

Meters

Pileated Woodpecker Survey - Transect 3: Creekside

RMOW Biodiversity Monitoring Project
Whistler, British Columbia

Pileated Woodpecker Survey Points

- Cavity Tree
- Bird Sighting
- Call Station
- Call Area
- Transect
- Potential Woodpecker Habitat - SS 6/7, SC AM/AO/DF
- Road - Gravel
- Railway - Single Track
- Transmission Line
- Bridge
- Whistler/Blackcomb Lifts
- Road - Paved
- Singletrack Trail
- Valley Trail
- Doubletrack, Access
- RMOW - Wetlands
- RMOW - Parks

RMOW - Cadastre (Ownership)

- CROWN MUNICIPAL
- CROWN PROVINCIAL; CROWN FEDERAL
- PRIVATE
- UNKNOWN

499000 500000 5551000 5550000 5549000

Rainbow-Sproatt Flank
Cheap Thrills
Stonebridge Dr
Scotia Creek
Legalize It
Bush Doctor
Gebhart Creek
Dirty Deeds
High Society
Pura Vida
A La Mode
Lower Sproatt
Danimal
Danimal South
Moose Knuckles
THC
Piece of Cake
AC/DC
Valley Trail

GIS Cartographer: Todd Hellinga
Date: January 13, 2015
CERG File#: 013-48-02
Projection: UTM 10N NAD83
Orthophoto/Data: BC Gov/RMOW

CASCADE ENVIRONMENTAL RESOURCE GROUP LTD

N W E S

0 100 200 300 400 500
Meters

Pileated Woodpecker Survey - Transect 4 Stonebridge

RMOW Biodiversity Monitoring Project
Whistler, British Columbia

3.5.1.5 Discussion and Recommendations

No pileated woodpeckers were observed this year compared to 0.007 and 0.011 pileated woodpecker/ha in 2013 and 2014 respectively. The non -responsiveness for the woodpecker does not mean they were not present in the survey areas. Though the survey was conducted during a week where forest fire smoke was considerable and this may have adversely affected call response, since considerable bird activity was observed during the survey. A pair of hairy woodpecker (*Picoides villosus*) a sooty grouse (*Dendragapus fuliginosus*) and numerous northern flickers (*Colaptes auratus*) were observed throughout the survey transects. In addition, a pileated woodpecker was heard at the Rainbow site during the small mammal survey in September. All this would indicate that the pileated woodpecker were likely present in the study area at the time of the survey but did not respond to the broadcasted calls, whether this non-responsiveness was due to the smoke or not is unknown. In order to account for the potential lack of detectability, additional sampling effort is needed. The survey should be conducted twice a year at each sites, on survey in June and continue the current survey timing.

3.5.2 Red-backed Vole

Small mammals have been used as indicator species in numerous studies (Avenant and Cavallini, 2007; Orrock *et al.*, 2000 and Chase *et al.*, 2000). They play a key role in nutrient cycling, habitat modification, plant consumption, seed dispersal, but also constitute the primary link between primary producers and secondary consumers. These predator-prey relationships are widely recognized and researched. For example the boom and bust population relationship between the snowshoe hare (*Lepus americanus*) and Canadian lynx (*Lynx canadensis*) is well documented and correlated (Sheriff, et al, 2009). Anecdotally, reports of sightings of lynx, bobcats (*Lynx rufus*), cougars (*Puma concolor*) and coyotes (*Canis latrans*) are increasing within Whistler and may affect future survey results if the predator populations are, in fact, on the rise. Changes in small mammal habitats are associated with changes in diversity and community structure, and ecological disturbance of these habitats is associated with the presence or absence of indicator species and decreases in small mammal species richness. As such, they have been identified as valuable indicators of habitat. In addition, small mammals are relatively easy to trap, handle and mark and it is simple to monitor their movements (Avenant and Cavallini, 2007). Red backed voles are a good indicator species as they are dependent on old, moist forest sites with woody debris and are potentially sensitive to timber management practices that may alter understory conditions. They also have large population fluctuations, are polygynous and short-lived (Venier *et al.*, 2007).

3.5.2.1 Site Selection

The small mammal sampling sites were located on the terrestrial ecosystem sampling plots in an effort to build a more complete inventory of the ecological condition. The Blueberry site and the Rainbow site from last year's monitoring report were re-surveyed and a third site was added.

The Blueberry site is located near the Blueberry subdivision in Whistler, BC approximately 50 m off Blueberry Trail. The Rainbow site is located on the west side of Alta Lake Road in Whistler, near the Rainbow Lake Trail parking lot. Both sites are located in mature to old forests. The third site (Function site) is located a young alluvial forest in Function Junction between the Cheakamus River and the sewage treatment plant. All sites were selected to be far from manmade trails as possible to minimize human disturbance and trap tampering.

3.5.2.2 Results

A total of 101 small mammals were captured and released at the three sites over two trapping sessions of two nights. 6 species were captured including 63 deer mice (*Peromyscus* sp.) (Photo 10), 20 southern red-backed voles (*Clethrionomys gapperi*), 14 shrews (*Sorex* sp.) 2 yellow-pine chipmunks (*Neotamias amoenus*), 1 long-tailed voles (*Microtus longicaudus*) and 1 short-tailed weasel (*Mustela erminea*).

Overall abundance was the highest at the Function site during the late summer (0.57 animal/ trap night) and the lowest at the Blueberry site during the spring (0.16 animal/ trap night). The most abundant species at Blueberry

was the shrew (0.08 animal/ trap night) during the spring and the Red-back vole (0.29 animal/trap night) during the late summer. Deer mouse was the most abundant species at Rainbow both during the spring and the summer with a relative abundance of 0.18 and 0.16 animal/ trap night respectively. The dominant species in Function during both seasons was the Deer mouse with an abundance of 0.48 animal/ trap night and 0.55 animal/ trap night for the spring and the summer respectively (Table 18).

Table 19 shows the number of voles in each age class per sex at both sites. At the Blueberry site, 33 %(5 voles) of the red-back vole captured were females and 67% (10) were males. All the females captured were adults while juvenile and adult were the two main age class for male with 33% and 27% respectively. At the Rainbow site 53 %(9) of the deer mice were female and 47 %(8) were male. Among the female, the juvenile was the dominant age class with 29% and adults were dominant amongst male with 24%. All female red-backed voles were adults while half of the male were adults and the other half sub-adults. At the Function site, 56% of the deer mice were male and 44% were female. The dominant age class for the male was the juvenile and adult was the dominant age class for female.

No animals were recaptured at either of the sites and trap availability remained superior at 20% at all site during both trapping periods.

Details regarding individual trap data can be obtained in Appendix F.

Photo 10: View of a juvenile deer mouse being handled. June 25, 2015

Table 18: Relative abundance of small mammal species at Blueberry, Rainbow and Function Sites expressed as the number of individual captured per trap night.

	Blueberry		Rainbow		Function	
	Spring	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**
Deer mouse	0	0.00	0.18	0.16	0.48	0.55
Long-tailed vole	0	0.00	0	0	0.00	0.02
Red-backed vole	0.06	0.29	0.02	0.04	0.00	0
Shrew	0.08	0.10	0.02	0.04	0.04	0
Short-tailed weasel	0	0.00	0	0	0.02	0
Yellow-pine chipmunk	0.02	0.00	0	0.02	0.00	0.00
Total	**0.16**	**0.40**	**0.22**	**0.26**	**0.54**	**0.57**

Table 19: Total number of animal caught (with percentage in brackets) at each site for each sex and age class for each species

Site	Species	Female			Male			Total
		Adult	Sub-adult	Juvenile	Adult	Sub-adult	Juvenile	
Blueberry	Red-backed vole	5 (33)			4 (27)	5 (33)	1 (7)	15
Rainbow	Deer mouse	3(18)	1 (6)	5 (29)	4 (24)	3 (18)	1 (6)	17
	Red-backed vole	1(33)			1 (33)	1 (33)		3
Function	Deer mouse	10(28)	3 (8)	3 (8)	4 (11)	6 (17)	10 (28)	36
	Long-tailed vole				1 (100)			1

3.5.2.3 Results comparison between 2013, 2014 and 2015

Abundance of red-backed vole in Blueberry ranged from 0.04 animal per trap night in the spring of 2014 and 0.44 in the summer of 2013. In Rainbow, the abundance ranged from 0 in the spring of 2014 and0.06 in the summer of 2013. The deer mouse abundance in Rainbow ranged from 0 in the summer of 2013 and 0.18 in the spring of 2015. In Function, the abundance range from 0.48 in the spring of 2015 and 0.56 in the summer of 2014. During the three years of the survey no red-backed voles were captured at the Function site and no deer mice were captured at the Blueberry site (Table 20).

Table 20: Comparison of the re-backed vole an deer mouse abundance (animal/trap night) at Blueberry, Rainbow and Function between 2013 and 2015

		Red-backed vole		Deer mouse	
		Blueberry	Rainbow	Rainbow	Function
2013	Spring	N/A	N/A	N/A	N/A
	Summer	0.44	0.06	0	N/A
2014	Spring	0.04	0	0.1	N/A
	Summer	0.08	0.2	0.04	0.56
2015	Spring	0.06	0.02	0.18	0.48
	Summer	0.29	0.04	0.16	0.55

Figure 11 to Figure 14 provide a visual representation of the fluctuation of the abundance for red backed vole and deer mouse at the three sites from 2013 to 2015. No apparent trends can be observed for the red backed vole at the Blueberry site and the Rainbow site (Figure 11 and Figure 12). The deer mouse abundance at the Rainbow site appears to have increased from 2013 to 2015 (Figure 13) while the deer mouse abundance at the Function site remained similar from 2014 to 2015 (Figure 14).

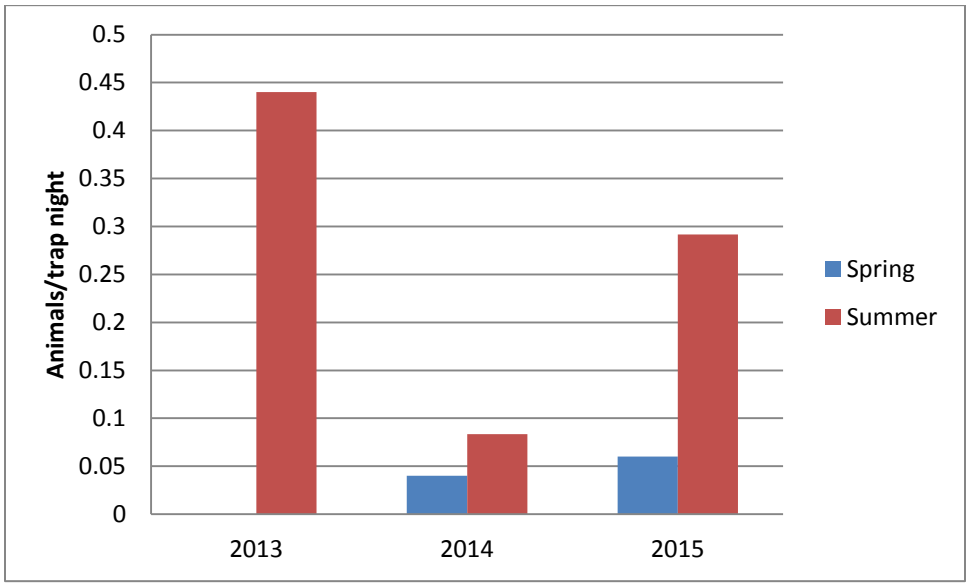


Figure 11: Red-backed vole abundance (animal/ trap night) at the Blueberry site from 2013 to 2015

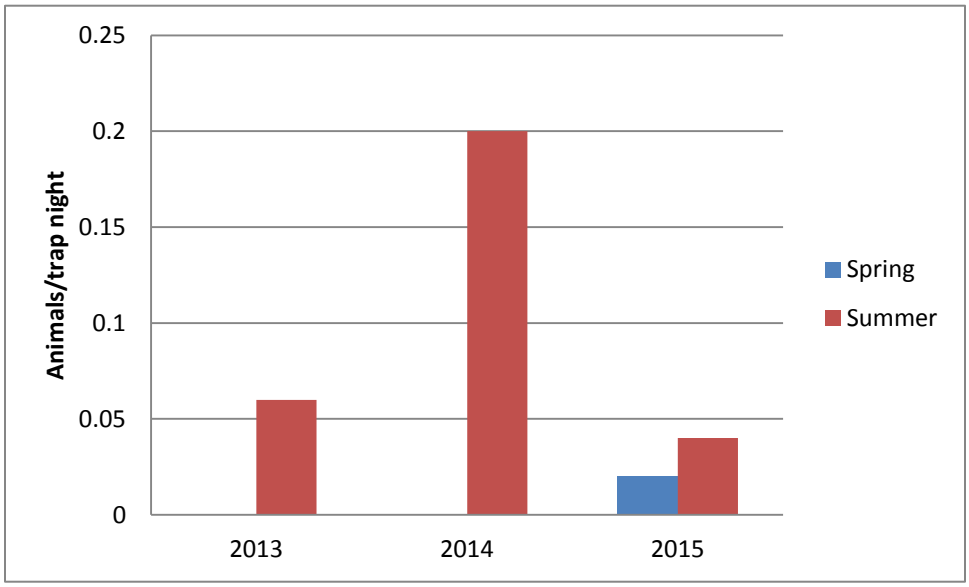


Figure 12: Red-backed vole abundance (animal/ trap night) at the Rainbow site from 2013 to 2015

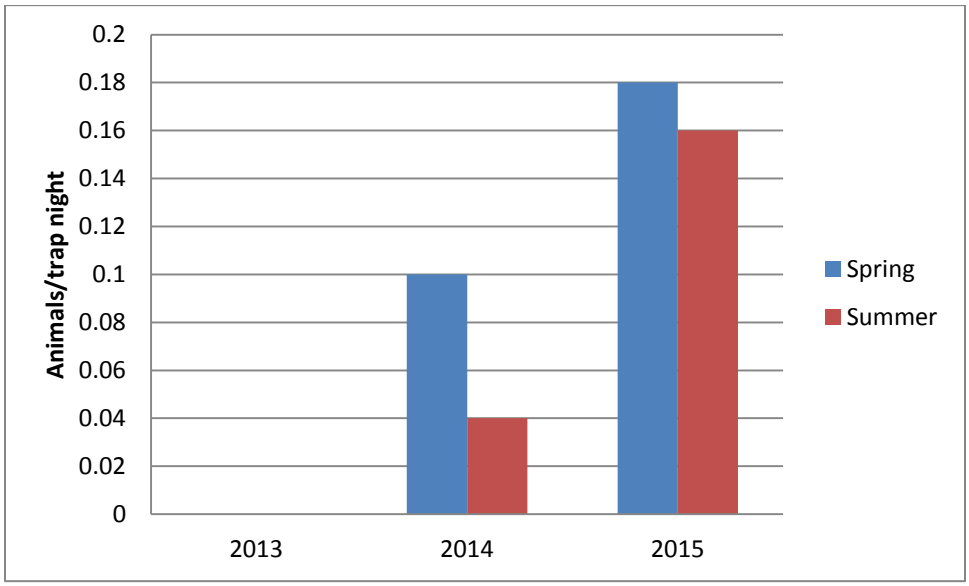


Figure 13: Deer mouse abundance (animal/ trap night) at the Rainbow site from 2013 to 2015

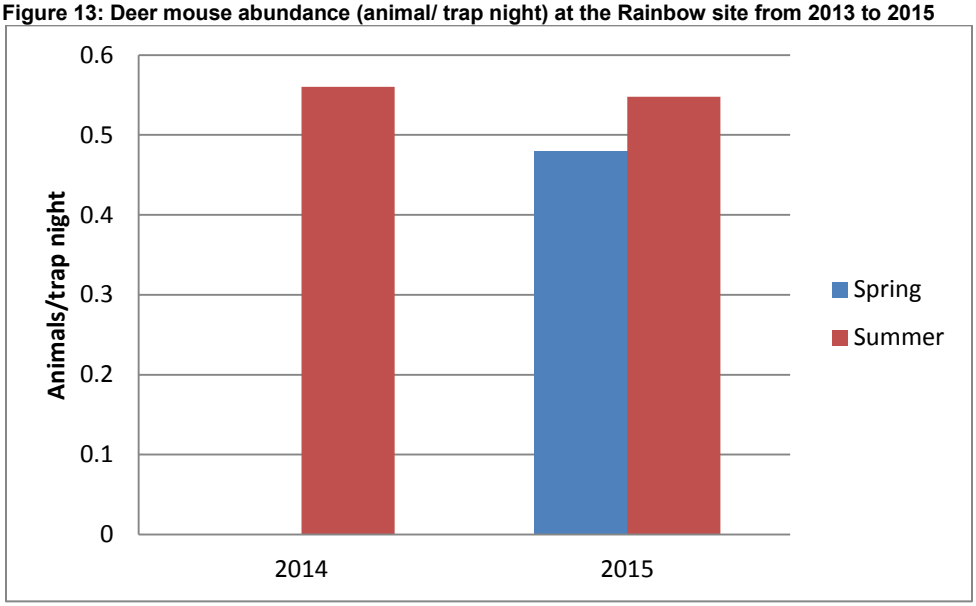


Figure 14: Deer mouse abundance (animal/ trap night) at the Function site from 2013 to 2015

3.5.2.4 Discussion and Recommendations

This report provides the third year of data collection for the small mammal survey. Small mammal community was similar between 2014 and 2015 with the dominant species being the red backed vole at the Blueberry site and the deer mouse at the Rainbow and Function site.

Early signs of trend can be observed with an increase of the deer mouse abundance at the Rainbow site while the deer mouse abundance remained stable at the Function. Red backed vole abundance at the Blueberry and the Rainbow site appears to fluctuate each year with no evident trend. Continuation of this monitoring program should, over time, illuminate trends.

The Function site is located in a young alluvial forest; unlike the other two sites which are located in a mature/old growth forest. The Function site is characterised by an abundance of deer mice two to three times higher than the other stations. In addition, red-backed voles are not present at this site. The species of vole observed instead at the Function site is the long tailed vole.

At all stations, no marked animal was recaptured; which indicates that the abundance calculated is likely an underestimation of the true population. Additional trap nights would provide a more accurate measurement of the population.

Continuation of small mammal monitoring in future years would provide valuable information regarding biodiversity trends in Whistler, The effects of habitat loss or gain, changes in biodiversity and ecosystem structure are indicated by the small mammal community population and abundance.

3.6 Ecosystems Monitoring Thresholds

An extensive literature search was conducted for each indicator species. The search focused on articles with comparable units of abundance, habitat and location as closely related to the habitats found in the RMOW as possible. Only data from undisturbed ecosystems were used in order to derive thresholds for healthy ecosystems.

Once the abundance data was compiled for each species, the 5th percentile was calculated and used as the threshold number. The 5th percentile was used in order to provide a cut-off similar to the significance level of 5% (Alpha) used for normal distribution. However, the data gathered from the literature were not normal, so the 5th percentile was used instead.

For some species, the abundance unit used in the ecosystem monitoring reports was slightly modified in order to match the unit used in the literature. For example, the abundance of the pileated woodpecker is expressed as the response rate (number of response per call station) instead of the number of woodpecker per surface area, and the abundance of the red-backed vole is expressed as the number of capture per 100 trap nights instead of the number of capture per trap night. In the case of carabid beetles' abundance data was only considered for only the two most common and abundant species to established the thresholds

3.6.1 Thresholds

Thresholds for the selected indicator species are presented in Table 21. In order to assess the suitability of the method, the thresholds were compared to the range of abundance observed during the ecosystem monitoring program so far (Table 21).

Most species present an abundance higher than the thresholds with the exception of the pileated woodpecker, bull trout, rainbow trout and tailed frog.

For the bull trout very little literature was available (Appendix G). This makes it difficult to establish a proper threshold. The rainbow trout abundance observed is also lower than the calculated threshold. This could be explained by the fact the literature available was from research conducted on different type of habitat (i.e. larger, more productive systems versus small, less productive systems). The threshold established for tailed frog is in the middle of the range observed during the biomonitoring program which could indicate that this method of establishing thresholds is not suitable for tailed frog tadpoles. Regardless, using a precautionary approach, these species should be flagged for concern as being close to the minimum threshold and additional effort should be devoted to continued monitoring.

Data used to establish the thresholds for each species is presented in the appendices.

Table 21: Thresholds and the range of abundance observed during the ecosystem monitoring program (2013-2014) for the selected indicator species

Species		Thresholds	Range of abundances observed during ecosystem monitoring (2013-2014)	Range of abundance observed in 2015	Units
Common name	Latin name				
Beaver	***Castor canadensis***	0.132	0.33	0.19	Colonies/km^2
Beaver	***Castor canadensis***	0.126	1	0.8	Colonies/km of river
Bull trout	***Salvelinus confluentus***	0.018	0.01	0.002	Fish/m^2
Carabid beetle	***Pterostichus herculaneus***	0.006	0.012 to 0.214	0.024 to 0.202	Beetles/ trap night
Carabid beetle	***Scaphinotus angusticollis***	0.007	0.048 to 2.345	0.048 to 1.143	Beetles/ trap night
Pileated woodpecker	***Hylatomus pileatus***	0.047	0.05 to 0.075	0	Response rate
Rainbow trout	***Oncorhynchus mykiss***	3.44	0.02 to 0.08	0.02 to 0.22	Fish/m^2
Southern red-backed vole	***Myodes gapperi***	0.52	2 to 8	2 to 29	Voles/100 trap night
Coastal tailed frog	***Ascaphus truei***	0.18	0.028 to 0.252	0.028 to 0.69	Tadpoles/m^2

3.6.2 Conclusion and Recommendation

The thresholds provided in this report appears to be suitable for most species and provided a starting point in the establishment of long term monitoring thresholds. The thresholds for bull trout, rainbow trout and tailed frog appear to be less suitable given the range of abundance observed. More research would be required to better calculate a suitable threshold for these species.

Thresholds were established using data compiled from the available literature and therefore should be considered as preliminary. The thresholds are based on data from a variety of locations and habitat; therefore it is important to note that species abundance can vary greatly from one type of habitat to another. In order to establish more accurate thresholds for each species, the data for the Ecosystem Monitoring program should be collected for a minimum of 7 years and used in conjunction with the data collected in the literature.

Abundance tends to fluctuate strongly due to natural causes and therefore could go under the threshold level without the population being at risk. Therefore, a response should only trigger if the observed abundance is below the threshold for a period of 5 years. By allowing a 5-year period, we make sure that the population is not in a "natural" low abundance phase before a response is triggered. In addition, the level of detection of some species might fluctuate as well and this 5-year period allows to account for the potential lack of detection of some species during certain years. The 5-year period is be long enough that no unnecessary action will be taken if the population is in a "natural" low abundance phase but short enough that if the population is in danger the necessary measures will be taken. However, if a species previously documented at one site is not observed for a period of two years, a response should be triggered and further instigation would be needed.

3.7 Climate Indicators

Climate change is an over-arching, macro-scale modifier of ecosystems and ecosystem response to climate change can be mis-interpreted as being the response to meso or micro-scale effects. While the rate of change and natural periodicity of climate fluctuations is subject to debate, climate change is universally accepted, and anthropogenic climate change is a generally accepted phenomenon. In consultation with the RMOW, use of Alta Lake freeze-up and thaw was selected as an indicator of climate change that is easily monitored with the potential to reveal emerging trends and cycles with the local climate. Historic records were gathered by the RMOW and combined with records provided by Stephen Vogler for the Spring Thaw Fundraiser (Figure 15 and Figure 16). The ice-on date is recorded when the lake is frozen solid on the entire surface and the ice-off date is recorded when the barrels goes through the ice. The records are provided in Appendix H.

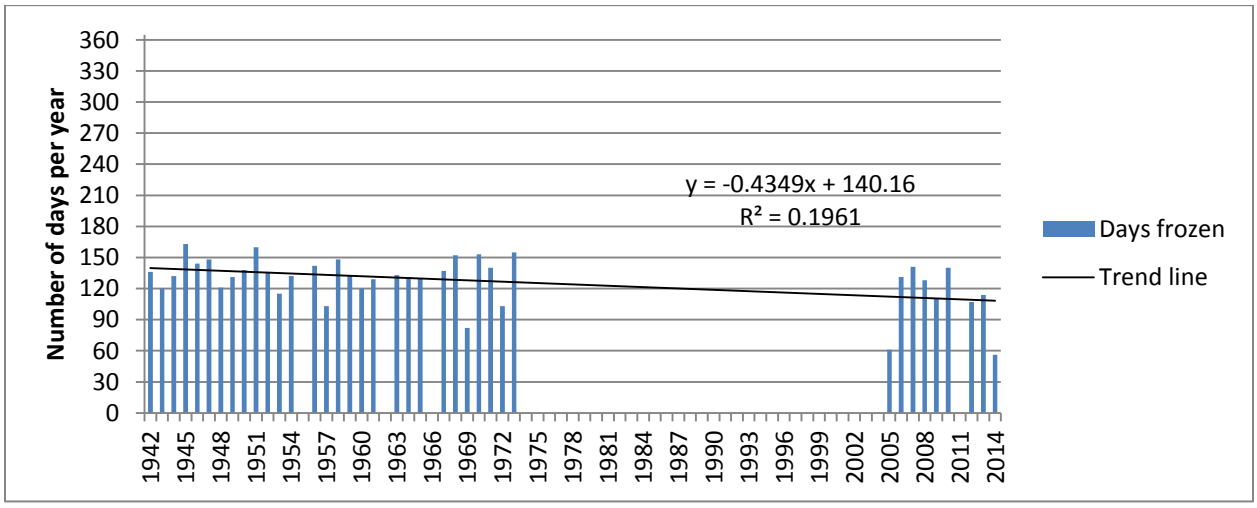


Figure 15: Number of ice days on Alta Lake – 1942 to 2014.

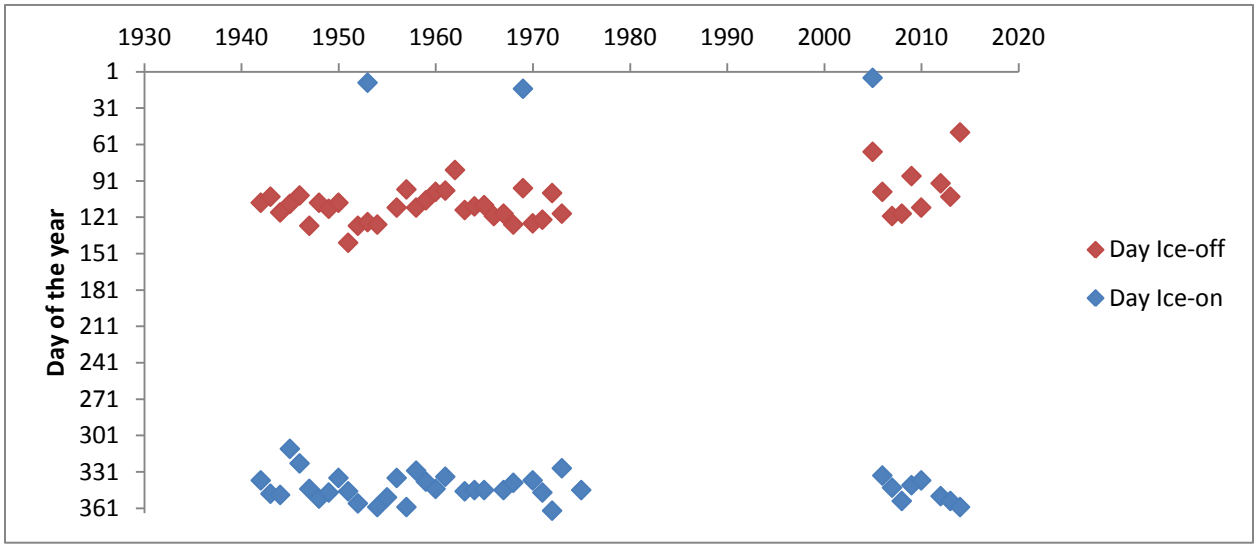


Figure 16: Dates of freeze up and thaw on Alta Lake – 1942 to 2014.

3.7.1 Discussion and Recommendations

With a discontinuous record extending back for over 70 years, the records indicate a widely fluctuating pattern of short and long ice coverage seasons. While 2015 is the shortest freeze up recoded (56 days) at Alta Lake, two other years, 1969 and 2005 (82 and 61 days respectively), were also short freeze-up seasons. While the trend appears to be towards warmer weather, there is little change in the overall pattern or duration of freeze up for Alta Lake. These results may indicate a relatively consistent climatic pattern for the area and may appear to call into question any theories of rapid and observable climate change. However, two potentially significant factors may be influencing these results. At the meso-scale, Alta Lake is a relatively warm lake and coupled with the recent volcanism in the area, the effects of climate change may be buffered. Similarly at the macro-scale, the buffering effects from the proximity of the Pacific Ocean on coastal mountain climate are long understood (Wall and McBoyle, 1991).

While it is recommended that this indicator should continue to be monitored, other indicators should also be investigated next year. Whistler is fortunate to have a long established weather station and the data merits review with an aim to identifying other indicators such as temperature and precipitation.

4 Recommendations

4.1 General Recommendations

This report provides the third year of data collection of the ongoing ecosystem monitoring project in the RMOW. Survey protocols were designed and tested in 2013 with a few changes implemented in 2014. While the protocols and the plans continued to evolve in 2015, the program has become solidified. These protocols will allow obtaining continuous and standardised data over the coming years. Being in the early stage of the project, trends are still preliminary and should be treated with caution and in many instances the trends are not yet evident. Therefore, it is important to continue the monitoring process in order to observe any changes in the ecosystem health.

4.1.1 Recommendations

1. Continue monitoring the indicator species using the current methodologies and continue to refine as needed.
2. Pay special attention to the flagged indicators to see if the trends persist. If over time a negative trend become more apparent, then start investigating causation.
3. Track changes in land use around current monitoring sites in order to observed potential correlation with species abundance
4. Summarize data collected by the RMOW such as the data collected during the E.coli and the western toad monitoring.
5. Survey additional species at risk

4.2 Survey Specific Recommendations

4.2.1 Fish Surveys

- Future studies should include surveys in a variety of habitats within the fish bearing reaches of Fitzsimmons Creek to achieve a more accurate representation of the available fish habitat.
- Futures studies should include surveys at different points throughout the length of the River of Golden Dreams to better determine fish population. Notify outfitters of the sampling date to minimize boat traffic.
- Flag the absence of the rainbow trout spawning in Write-off Creek and Whistler Creek and the absence of kokanee spawning in the River of Golden Dreams as a potential indicator concern.
- For spawning surveys, the same creeks should be surveyed year after year in order to provide consistent data.

4.2.2 Water Quality Sampling

- Expand the number of temperature loggers if budget allows. Ideally, a temperature logger should be present in each fish bearing creeks being monitored by the Whistler Fisheries Stewardship Group and the ecosystem monitoring program.
- Track leaks from the RMOW utility department.

4.2.3 Coastal Tailed Frog Surveys

- The abundance of tailed frog tadpoles and adults should continue to be monitored in coming years to identify population trends and areas where populations may be threatened.
- The abundance surveys should be expanded to include additional streams with known occurrence.
- The occurrence surveys should continue to confirm presence in unsampled streams within the RMOW.
- Select an alternative site for the upper sampling area in Scotia Creek.

- If after four years of survey, no tadpole is detected in 19 Mile Creek, an alternate creek should be selected and 19 Mile Creek should be revisited every two years.
- The observed presence of an adult in the River of Golden Dreams and observed tadpoles in the lower reaches of Crabapple Creek, Whistler Creek and Fitzsimmons Creek is unexpected. The type of habitat where the adult and the tadpoles were found is not the typical habitat where coastal tailed frogs are found. Therefore, the viability of potential valley bottom populations merits further investigation.

4.2.4 Beaver Surveys

- The study area should be expanded to cover the entire valley bottom. This would help to fully understand the population dynamic of the beavers in Whistler.
- Cascade recommends that new areas or area surveyed prior to 2010 should be surveyed every year. If inactive lodges are observed, they should be surveyed every 3 years for potential re-colonization
- Monitoring of beaver populations should be continued in future years as an indicator of healthy ecosystems and of land management decisions in Whistler's urban environment.

4.2.5 Pileated Woodpecker Surveys

- In order to account for the potential lack of detectability, additional sampling effort would be required. The survey should be conducted twice a year at each sites, on survey in June and continue the current survey timing
- Investigate habitat uses in forest other than old growth/mature.
- More transects should be surveyed. This could be achieved with the help of citizen science.

4.2.6 Red-backed Vole Surveys

- Traps should be set out for an increased number of nights in order to achieve a better recapture estimate.
- Vole abundance monitoring should be continued in future years to provide valuable information regarding biodiversity trends in Whistler.

4.2.7 Carabid Beetle Surveys

- Increasing the length of the sampling period or increasing the number of sampling periods would likely increase the number of species captured.
- A fourth site should be developed next year, located in young alluvial forest. This will provide a comparative for the Function site.

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APPENDICES

APPENDIX A: METHODS

Fish Sampling Methodology

Cascade physically sampled fish using active (electrofishing) methods. The RMOW collected data on spawning rainbow trout and kokanee through visual observations (foot survey).

Fish species description

Bull Trout

Bull trout (*Salvelinus confluentus*) are not true trout, but are in fact char. They are often confused with Dolly Varden (*Salvelinus malma*) which have similar markings, skull morphology and distribution (Hammond, 2004). Through genetic studies, the separation between the two species was recognized by the American Fisheries Society in 1980 (Hammond, 2004). Bull trout are characterized as having a large head and jaw relative to their long, slender body. When compared to Dolly Varden, bull trout have a larger, broader and flatter head and more ventrally flattened body (Hammond, 2004). Their colour ranges from green to greyish blue. Some lake residents have silver sides. The dorsal and peduncle regions are spotted with pale yellowish-orange spots. Bull trout are distinguished from other char and trout species native to western Canada by the absence of black spots on the dorsal fin (Hammond, 2004).

Bull trout are endemic to western Canada and the U.S. Pacific Northwest. In B.C. they are found in all major drainage basins on the mainland. However they are on the provincial Blue List. Bull trout populations are declining in abundance in Canada and the U.S. (Hammond, 2004). In B.C. the main threat to bull trout populations is habitat fragmentation due to disruption of the migration patterns by obstructions such as perched culverts, water velocity through culverts and degraded habitats (Hammond, 2004).

Cutthroat Trout

Adult Coastal cutthroat trout (*Oncorhynchus clarki clarki*) are distinguished by a red or orange streak under their jaw while young cutthroat (45-100 mm) usually have red or yellow marks under the chin (McPhail and Carveth, 1993). In comparison to other trout, cutthroats have many spots all over the head and sides of the body and occasionally on the belly and fins (MOE BC Fish Fact Sheet- Cutthroat).

Coastal cutthroats range from southern Alaska to the Eel River in California. Their range does not extend very far inland from the coast—usually less than 150 km (MOE BC Fish Fact Sheet- Cutthroat). In B.C. the coastal cutthroat is considered vulnerable and is therefore on the provincial Blue List.

Their numbers are most notably in decline on the East coast of Vancouver Island and the Lower Mainland. Coastal cutthroat rely on small streams for spawning, however it is these streams that are easily altered or destroyed or simply overlooked during planning for residential, agricultural and industrial development or forest harvesting (MOE BC Fish Fact Sheet- Cutthroat). While there is some debate locally regarding the historic presence of cutthroat in the Whistler area, sterilized cutthroats were introduced to Alta Lake in an effort to control the stickleback population.

Kokanee

Kokanee (*Oncorhynchus nerka*) are morphologically similar to sockeye salmon, however kokanee are non-anadromous and spend their entire lives in freshwater. Non-breeding kokanee have bright silver sides, dark grey dorsal regions and may have dark markings on the dorsal fin (MOE BC Fish Fact Sheet- Kokanee). Spawning kokanee change colour, becoming bright crimson in the body with a green or black head. The colour change is most notable on the males who also develop long jaws, hooked snouts, large teeth and a slight hump behind the head. The female colour change is not as pronounced and their overall shape does not change (MOE BC Fish Fact Sheet- Kokanee).

Natural resident populations of kokanee range from California to Alaska and northeast Asia. In North America the natural populations of kokanee are most abundant in B.C. (MOE BC Fish Fact Sheet - Kokanee). Kokanee live in mid depths of open lakes but more commonly are found around lake shores or tributaries to spawn (MOE BC Fish Fact Sheet - Kokanee). In BC, kokanee are on the provincial *Yellow List*, which means they are not at risk but their populations can be influenced by industrial, agricultural and urban development. Forestry practices

can increase sedimentation and water temperature which can also put kokanee populations at risk (MOE BC Fish Fact Sheet- Kokanee).

Rainbow Trout

Rainbow trout (*Oncorhynchus mykiss*) are generally silvery in colour with an iridescent pink to reddish band along the lateral line (MOE BC Fish Fact Sheet- Rainbow Trout). In B.C. native populations of rainbow trout are descended from two lines and can be divided into two types: the coastal rainbow trout and the interior red-band rainbow trout (MOE BC Fish Fact Sheet- Rainbow Trout). Coastal rainbow trout are heavily spotted with irregularly-shaped spots above and below the lateral line with rounded parr marks. At all stages of the life cycle the lateral line appears rose red in colour (MOE BC Fish Fact Sheet- Rainbow Trout). Red-band rainbow trout have larger spots, they may be yellow or orange tinted through the body and they may have a slight cutthroat mark and faint streak under the lower jaw (MOE BC Fish Fact Sheet- Rainbow Trout).

Native rainbow trout populations range from west of the Rocky Mountains, and from northwest Mexico to the Kuskokwim River in Alaska. In B.C. the native coastal rainbow trout are found throughout the coastal drainage system while the red-band species is found in the interior within the Fraser and the Columbia basins (MOE BC Fish Fact Sheet- Rainbow Trout). Rainbow trout have been widely introduced outside their natural range and are now found across Canada. In B.C. most rainbow trout that are reared in hatcheries and used for stocking are red-band rainbow trout originating from Pennask Lake (MOE BC Fish Fact Sheet- Rainbow Trout).

In B.C. rainbow trout are on the provincial *Yellow List*, therefore they are not considered at risk. However several populations have declined as a result of habitat damage or over-fishing (MOE BC Fish Fact Sheet- Rainbow Trout).

Sculpin

Coast range sculpin (*Cottus aleuticus*) are mottled brown to light blue-grey with dark dorsal and white ventral regions. The head of the coast range sculpin is large and the body tapers from the head to the tail (MOE BC Fish Fact Sheet- Coastrange Sculpin).

Coast range sculpins range from southern California to Bristol Bay, Alaska. In B.C. they occur in streams, rivers, estuaries and lakes along the entire coast as well as Vancouver Island and Haida Gwaii (MOE BC Fish Fact Sheet- Coastrange Sculpin). Coast range sculpins are widely distributed and not considered at risk in B.C.

Stickleback

Threespine stickleback (*Gasteroteus aculeatus*) are small fish that do not tend to grow larger than 7 cm and are named for the three spines that project upward from their back (Hatfield, 1999). Threespine stickleback are commonly found in estuaries, the lower reaches of streams and in lowland lakes throughout the central coast (McPhail and Carveth, 1993). Threespine sticklebacks are on the provincial *Yellow List* and are not at risk.

Electrofishing

Electrofishing involves passing electricity through the water to attract or immobilize fish for capture. It is a very efficient method of fish collection when used in contained areas of rivers and streams that are difficult to sample using nets or traps (MELP 1997). Electrofishing is performed on foot using a backpack unit. The fish respond to the electrical current in one of three ways: forced swimming (taxis), muscle contraction (tenanus) or muscle relaxation (narcosis). Alternating current (AC) is damaging to fish and cause high mortality therefore only direct current (DC) electrofishers are approved for use in BC. DC is less harmful and causes forced swimming (galvanotaxis) towards the anode. The closer the fish get to the anode they go into narcosis and can be easily captured. The efficiency of electrofishing is affected by fish behaviour, which varies between species. Benthic fish, such as sculpins, swim in short bursts and tend to sink when stunned and can become lost in the substrate. Nectonic fish such as salmonids can be forced to swim longer therefore can be brought into open water where they are easier to catch. Territorial fish are also easier to catch because they tend to stand their ground where as schooling fish have a fright response that causes them to swim away and avoid capture.

Sampling with a portable backpack electrofisher was conducted with a minimum of two individuals, one person to operate the machine and the other to catch the fish with a dip net and hold the bucket containing the fish. The

crew worked from downstream to upstream and vice versa with stop nets/fish fences in place to prevent fish from escaping the sample area (Photo 11).

Fish Handling Procedure

Fish are coated with a mucilaginous layer, referred to as 'slime', which acts to protect them against infection, parasitic invasion and the effects of water (MELP, 1997). Handling fish removes their 'slime' layer; making the fish susceptible to infection and disease. When the animal is returned to the water after being handled it will experience "waterburn" since its protective mucilaginous layer has been removed. Hence, it is important that the fish be handled as little as possible and processed as quickly as possible to avoid stress.

While waiting to be processed, fish were kept in holding buckets filled with water from the creek they were captured from (Photo 12). Since fish viscera is not adequately supported by mesenteries and muscle (MELP, 1997), fish were kept in horizontal positions and processed as quickly as possible to minimize the amount of time the fish spent out of the water.

Photo 11. Upstream stop net upstream on the River of Golden Dreams July 31, 2014.

Photo 12: Fish processing and holding buckets, July 31, 2014

Electrofishing Sample Sites

Cascade carried out electrofishing surveys on Jordan Creek, the River of Golden Dreams (ROGD) and Crabapple Creek (Map 2**Error! Reference source not found.**). Fish surveys on Jordan Creek were carried out t the same sites that were established in 2013. The survey on the ROGD was carried out approximately 200 m downstream of the site established in 2013. The substrate at the 2013 ROGD site was predominantly organic matter that produced an anoxic scent when disturbed. The 2014 ROGD site was downstream of the confluences of the Twentyone Mile Creek and Crabapple Creek where the substrate was primarily gravel and water temperatures were cooler. The Crabapple Creek survey was new in 2014. All fish captured were measured, weighed and the developmental stage was identified.

Length

Length is the most important measurement when collecting information on the size of fish in a population, and it can be used to determine the age of the fish as well as its growth rate. Length measurements are either taken as whole body measurements, or particular body part measurements. Body part measurements are generally taken for a specialized study, whereas whole body measurements are more common for fisheries studies (MELP, 1997). The most common whole body measurements are fork length, total length and standard length (Anderson and Gutreuter, 1983).

Fork length is measured from the extreme anterior part of the head to the median of the caudal fin rays (fork of tail). Measuring the fork length is the most common method used in Canada, but can only be used for fork tailed fish such as salmon, trout and char (Anderson and Gutreuter, 1983). Total length is the distance from the extreme anterior part of the head to the end of the longest caudal fin ray, when the fin lobes are held together. Scientists in B.C. use the total length measurement technique on fish without forked tails, such as sculpins and bulbot (MELP, 1997). Standard length is the measured distance from the extreme anterior part of the upper jaw to the posterior end of the hypural bone of the fish. Since there are a variety of different ways to measure this standard length, this measurement technique is confusing and inconvenient to use. For this study fork length was measured for all salmonid species captured while total length was used to measure all sculpins and stickleback that were captured.

Weight

The whole wet weight of a recently captured fish is usually recorded in grams (g) after the excess water has been drained or blotted off with a paper towel before measurement. There are a variety of scales that can be used to weigh fish in the field; including toploading electronic balances, beam balances and spring scales. It should be noted that one should endeavour to match the accuracy of the scale with the size of fish to be sampled—fry or juvenile fish should not be weighed on a spring scale that is designed to weigh adult fish (MELP, 1997). For this study, fish were weighed to the nearest 1 g using a Cuisinart Perfect Weight kitchen scale.

Foot Survey (Spawning fish)

When sampling takes place during the spawning season a foot survey (set interval method) can be used to estimate the spawning population. Spawning grounds should be surveyed several times during the spawning season, which depends on the residency time of the spawners (DFO 1995). The residency time is the turnover time between one spawning group and the next. This varies between 5 and 28 days and is influenced by location, species, season and stream conditions. Counts of live and dead fish are combined to estimate the total number for the season.

Variations on the set interval method may be required depending on stream size, access, size of spawning area, amount of data needed and number of surveyors available. The adapted methods include:

1. Single Count Survey: a count of live fish during spawning done before any fish die, or a count of live and dead fish at or just after the peak of spawning activity
2. Adjusted Frequent Survey: intensive survey of the spawning area to count live and dead fish during the peak of the spawning season
3. Factor Five Method: survey shallow riffle spawning areas to count live fish then apply a formula to estimate population from counts, turnover rate and number of survey days
4. Strip Surveys: spawners are counted along one meter wide transects in the spawning area
5. Carcass Count: remove and count all dead fish within reach of the shore, every three days or less

Rainbow Trout Spawning

Counts of spawning rainbow trout were carried out by volunteers for the RMOW Environmental Stewardship department. Surveyor experience was low therefore the survey data is an account of presence rather than abundance. Volunteers surveyed the Write-off Creek, Jordan Creek, Lakeside Creek, Blackcomb Creek, Scotia Creek, and Millar Creek between May 11 and June 7, 2014 (Map 2).

Kokanee Spawning Survey Sites

Counts of spawning kokanee were carried out by volunteers for the RMOW Environmental Stewardship department. Surveyor experience was low therefore the survey data is an account of presence rather than abundance. Volunteers surveyed the Jordan Creek, Crabapple Creek, the River of Golden Dreams and Nineteen Mile Creek between August 29 and September 18, 2014 (Map 2).

Costal Tailed Frog survey methodology

Indicator Stream Selection

Coastal tailed frogs are known to be generally ubiquitous across the landscape of mountain streams in Whistler. The Biodiversity Project has been actively inventorying streams in the Whistler area for occurrence of tailed frogs and Cascade has records of occurrences throughout the valley as well. However, in order to use coastal tailed frogs as an indicator of ecosystem health, trends in relative abundance should be monitored. The GIS was used to examine the geographic distribution of occurrence records from all available sources. In 2013, two streams known to contain tailed frogs were selected as representative of the range of tailed frog habitat (aquatic biophysical) conditions in Whistler; Scotia Creek and Alpha Creek (Map 3). These two creeks were intended as pilot sites to test the monitoring protocol with an aim of expanding to additional streams in subsequent years. In 2014 two additional creeks, Nineteen Mile Creek and Crabapple Creek were surveyed. To assist with future pre-screening for coastal tailed frog streams, a Habitat Capability Analysis model developed for the province by Friele and Dupuis is presented in this report (2007)

Costal Tailed Frog Habitat Capability Analysis

To elucidate the distribution of coastal tailed frog, Friele and Dupuis (2007) have developed a “watershed level habitat model for British Columbia” seen in Table 22. The model is based on habitat requirements of coastal tailed frog in their lotic stage and includes the following parameters:

- Ecosection (from known range),
- Watershed Area (streams within area ,10 km^2 viewed “core”, basins with areas of 10-50 km^2 are considered potential occurrence but with low abundance, with larger streams considered important for dispersal but not breeding),
- Aspect of drainage (south facing aspects are ranked higher – more insulation, warmer water),
- Ratio of watershed’s relief above the treeline divided by the total watershed relief (Back-end rule), (tailed frogs are more common in streams near the front-end of a watershed, or in streams draining the faces between watersheds, and occurrence is often more spotty in the headwaters),
- Biogeoclimatic zone (reflection of mesoscale climate and a proxy of stream temperature)
- Presence of lakes (insolation may lead to warmer water temperatures, and may lead to higher abundance of tailed frog).

Table 22: Watershed level coastal tailed frog habitat capability model (adapted from Friele & Dupuis, 2007)

Variable	Variable State	Model Points	Alpha Creek	Scotia Creek	Nineteen Mile Creek	Crabapple Creek
Ecoregions	Eastern Pacific Ranges Ecosection	100	100	100	100	100
Basin Area	0-10 km2 10-50 km2 >50 km2	100 50 1	100	100	50	100
Aspect	13-225° 45-135°, 225-315° 315-360°, 1-45°3	4 3 2	3	3	3	3
Ratio of watershed's relief above the treeline	0-25% 25-50% 50-75% 75-100%	4 3 2 1	4	4	3	4
Biogeoclimatic Zone	CWH MH AT	4 3 1	4	4	4	4
Lake	Present Not present	10 0	0	0	10	0
Ranking Total			**211**	**211**	**170**	**211**

*In lower reaches
Ranking Classification: <125 Out of Range; 150-175 Very Low; 200-206 Low; 207-210 Moderate; 211-225 High

Initial analysis focused on identifying sub-basins of < 10 km^2 and high capability ranking. Over time a more comprehensive occurrence inventory may be deemed appropriate by the RMOW. Once a candidate stream is identified as high capability, the RMOW and Biodiversity Project databases should be consulted for occurrences. In the absence of existing occurrence a survey is required to confirm presence. The four creeks surveyed in this study had been identified as creeks where coastal tailed frogs have been observed (Biodiversity Project, 2006).

Habitat Characterization

For each creek sampled; the water temperature, wetted width, bankful width, and substrate composition was measured and recorded. This data is summarized the Water Quality section of this report (see section 3.1.1).

Tadpole Handling Procedure

In order to minimize stress and overheating, captured tadpoles were kept in a shaded bucket, immersed in the stream. All surveyors wore non-powdered latex gloves while handling amphibians and gloves were changed between animal captures. Captured individuals were placed in a water filled Ziploc Bag during observation. Upon completion of the survey tadpoles were released at the upstream end of the altered reach so that they could drift to new desired locations. Tadpoles were measured, weighed and the developmental stage was identified (Photo 13).

Photo 13: Coastal Tadpole in Ziploc bag with creek water ready for measuring and weighing, July 17, 2014.

Survey Methods

Coastal tailed frog surveys in Whistler were conducted by Cascade in July, August and September 2014 on Nineteen Mile Creek, Alpha Creek, Crabapple Creek and Scotia Creek. Three repeat surveys were carried out at three representative sites along each creek.

Hand and time constrained search methodology (MELP, 2000) was used for the coastal tailed frog survey. An area-constrained search (ACS) method was used for acquiring data on relative abundance (number of individuals/m^2) of tadpoles. Three 5 m sections per site were searched by hand for tadpoles. The stream survey was initiated downstream and carried out in one meter increments. The survey included an initial scan of the surface of the stream and the stream bank for active animals, followed by an in-depth search of the creek substrate. Unembedded cover objects such as rocks and coarse woody debris were overturned minimizing disturbance to the stream bank. Each object was carefully scanned for clinging tailed frog tadpoles before it was set back in its original position. Large anchored rocks and large woody debris were swept by hand. Dip nets were held immediately downstream of searchers to catch dislodged animals. The position (i.e. surface, under rock) and location information (depth and microhabitat) of each tadpole captured was recorded. In order to prevent recaptures, all captured individuals were placed in shaded buckets and released upon completion of the site survey (MELP, 2000).

Sampling was conducted during the dry summer months (June to September) when the chances of adult encounters are increased and when stream temperatures of 8^{o}C or higher are more tolerable for hand collection. Sampling was restricted to rainless periods since tadpoles tend to seek refuge during heavy rainfall periods (MFLNRO, 2000).

Beaver Survey Methodology

Existing lodge inventories developed by the RMOW Fish and Wildlife Technicians were used to estimate the active beaver population in the Whistler area. Beaver lodges that were identified as *active* in previous surveys were revisited and new sites were established if they presented themselves (Tayless, 2010). The location of each lodge was determined by using a personal GPS unit (Garmin GPSmap 60C) which was downloaded into the GIS for distributional analysis. The status of each lodge was assessed; features including fresh mudding, addition of fresh trees, branches or shrubs and maintenance of entrances was used to determine the status of each lodge (Appendix D). Lodges were deemed *active* if signs of maintenance and construction were found—fresh mudding, addition of fresh trees, branches or shrubs, maintenance of entrances and the presence of an underwater food cache. Lodges were deemed *inactive* if there were no signs of maintenance, continued construction or signs of activity surrounding the lodge (Tayless, 2010). Lodges were deemed *unknown* if there

were signs of activity around the lodge (fresh cuttings) but the lodge itself showed no signs of maintenance or construction (fresh branches and mud). The survey was conducted on October 26 and October 27, 2015.

At each lodge, the waterway was classified as one of the following categories:

- Pond (<2m deep)
- Lake (>2m deep)
- Stream (<5m wide)
- River (>5m wide)

Carabid beetle sampling methodology

Insect Trapping

The same method used during the 2013 ecosystem monitoring survey was used. Pitfall traps made out of plastic cups (10 cm diameter and 13 cm deep) were installed flush with the ground. A cover was placed about 3 cm above the ground directly over the trap to protect it from the rain using a plastic plate and nails. Six traps were placed along a transect line with a minimum of five meters between them. Traps were filled with formalin 10% up to the ¾ mark. Sampling lasted for two periods of two weeks (Table 23) and traps were emptied weekly in order to prevent complete evaporation of the formalin . Insects collected were stored in ethanol and identified to species level using Lindroth (1961). Abundance will be expressed as the number of individuals per pitfall trap per night (trap night) (MELP, 1998).

Table 23: Carabid beetle sampling dates for each site.

Sites	Date of the 1st sampling	Date of the 2nd sampling
#1 : Blueberry	13/07/2014 to 27/07/2014	09/09/2014 to 22/09/2014
#2 : Rainbow	13/07/2014 to 27/07/2014	09/09/2014 to 22/09/2014
#3: Function	13/07/2014 to 27/07/2014	09/09/2014 to 22/09/2014

Woodpecker Survey methodology

Survey Method

The call-playback survey method was used to determine the relative abundance of pileated woodpeckers. At each survey station, pileated woodpecker calls and drums were broadcasted using a megaphone. Surveys were conducted between July 7 and July 10, 2015. Upon arrival at each station, the surveyors listened for one minute for calling birds. If no birds were heard, three 20 s calls were broadcasted, each followed by 30 seconds of listening and watching. Each call was broadcasted at 120° directional rotation (360°) from the previous one. If there was no response to the calls, a drumming sequence was then broadcasted three times. Each drumming sequence was broadcast for 5 seconds followed by a 10 second listening period. In the event that a pileated woodpecker did respond, all broadcasts were stopped and the location of the woodpecker was recorded. Abundance will be reported in terms of number of woodpeckers detected per hectare, based on an acoustic range of 300 m from each survey station.

Red-backed Vole survey methodology

Animal Trapping

The same method used during the 2013 and 2014 ecosystem monitoring survey was used. Sherman traps were placed following an index line. 20 capture stations followed the transect line with a minimum of 15 m between each capture station. One trap was placed at each station, with every fourth station having two traps, making a

total of 25 traps at each of the two sites. Relative abundance was measured in terms of number of individuals captured per trap per night (trap night). (MELP, 1998)

A pre-baiting period of 1 week preceded sampling. Each trap was baited with slices of carrots and whole oats and cotton bedding material was provided. The traps were covered with debris or vegetation for camouflage. Once the pre-baiting period was complete, the traps were set around 4pm and checked the following morning around 8am. Species, sex class, length, weight and age class of individuals were determined. The animals were separated into juveniles (with remains of juvenile pelage and smaller size), subadults (adult fur and size but not reproductively active), adults (reproductively active). Each animal was marked with a black permanent marker in order to identify recapture. The index traplines remained active for 2 nights (MELP, 1998). Trapping occurred during two trapping sessions. Due to a limited number of traps, all sites were not surveyed at the same time. Table 24 summarizes the date at which each site was surveyed.

Table 24: Dates of the spring and summer trapping at the Blueberry, Rainbow and Function sites.

	Blueberry site	**Rainbow site**	**Function site**
Spring trapping date	Jun 11 and 12 2015	Jun 11 and 12 2015	June 25 and 26 2015
Summer trapping date	September 10 and 11 2015	September 10 and 11 2015	September 24 and 25, 2015

APPENDIX B: WATER QUALITY DATA

Table 25: Basic water quality at each coastal tailed frog tadpole survey site (July 14-15, 2015)

Site	Date	Area (m^2)	Basic Water Chemistry				
			Water Temp. (^oC)	pH	Cond. (µS)	Turbidity	DO (mg/L)
Alpha Creek #1	2015.07.14	18	10.9	7.66	114	0.33	11.5
Alpha Creek #2	2015.07.14	15	10.7	6.76	118	0.23	11.18
Alpha Creek #3	2015.07.14	36	10.7	6.76	118	0.23	11.18
Scotia Creek #1	2015.07.14	21	13.4	6.14	30	0.96	10.38
Scotia Creek #2	2015.07.14	13	12.5	6.19	52	0.67	10.29
Scotia Creek #3	2015.07.14	17	13.1	6.1	59	0.63	10.58
19 Mile Creek #1	2015.07.15	41	10.8	6.15	18	0.9	11.45
19 Mile Creek #2	2015.07.15	25	10.6	6.46	20	0.93	11.58
19 Mile Creek #3	2015.07.15	8	10.6	6.46	20	0.93	11.58
Crabapple Creek #1	2015.07.15	15	14	6.53	202	1.69	9.92
Crabapple Creek #2	2015.07.15	16	11	6.3	150	1.02	10.55
Crabapple Creek #3	2015.07.15	16	10.8	6.27	146	0.92	11.16

Table 26: Basic water quality at each coastal tailed frog tadpole survey site (August 13-14, 2015)

Site	Date	Area (m^2)	Basic Water Chemistry			
			Water Temp. (^oC)	*pH*	*Cond. (µS)*	*DO (mg/L)*
Alpha Creek #1	2015.08.13	18	12.6	7.3	121	10.25
Alpha Creek #2	2015.08.13	15	12.2	6.34	114	9.83
Alpha Creek #3	2015.08.13	36	n/a	n/a	n/a	n/a
Scotia Creek #1	2015.08.13	21	15.2	6.06	52	9.38
Scotia Creek #2	2015.08.13	13	13.1	6.02	97	9.21
Scotia Creek #3	2015.08.13	17	14.8	6.09	87	8.77
19 Mile Creek #1	2015.08.14	41	13	6.28	18	10.48
19 Mile Creek #2	2015.08.14	25	12.7	6.3	18	10.32
19 Mile Creek #3	2015.08.14	8	n/a	n/a	n/a	n/a
Crabapple Creek #1	2015.08.14	15	15.2	6.6	194	9.02

Site	Date	Area (m^2)	Basic Water Chemistry			
			Water Temp. (^oC)	*pH*	*Cond. (µS)*	*DO (mg/L)*
Crabapple Creek #2	2015.08.14	16	12.5	6.11	145	10.24
Crabapple Creek #3	2015.08.14	16	12.3	6.11	145	10.23

Table 27: Basic water quality at each coastal tailed frog tadpole survey site (September 17-18, 2015)

Site	Date	Area (m^2)	Basic Water Chemistry			
			Water Temp. (^oC)	*pH*	*Cond. (µS)*	*DO (mg/L)*
Alpha Creek #1	2015.09.17	18	7.6	8.14	143	12.16
Alpha Creek #2	2015.09.17	15	7.4	7.34		12.0
Alpha Creek #3	2015.09.17	36				
Scotia Creek #1	2015.09.17	21	9	7.66		10.38
Scotia Creek #2	2015.09.17	13	8.88	7.26		11.34
Scotia Creek #3	2015.09.17	17	8.5	7.28		11.58
19 Mile Creek #1	2015.09.18	41	8.1	6	32	
19 Mile Creek #2	2015.09.18	25	7.7	7.51	39	
19 Mile Creek #3	2015.09.18	8	7.9	6.7	33	
Crabapple Creek #1	2015.09.18	15	10.2	6.2	298	10.63
Crabapple Creek #2	2015.09.18	16	8.1	6.32	190	11.6
Crabapple Creek #3	2015.09.18	16	7.8	5.95	174	11.76

Table 28: Basic water quality at electrofishing sites

Site	Date	Area (m^2)	Basic Water Chemistry				
			Water Temp. (^oC)	pH	Cond. (µS)	Turbidity. (NTU)	Dissolved oxygen (mg/l)
Jordan Creek #1	2015.07.23	108	19.1	6.47	120	1.15	7.76
Jordan Creek #2	2015.07.23	108	18.2	6.71	68	1.15	9.16
River of Golden Dreams	2015.07.31	100	13.1	6.74	73	1.24	9.1
Crabapple Creek	2015.07.31	99	15.6	6.42	228	1.17	9.13
Fitzsimmons Creek	2015.08.18	880	6.7	7.33	61	n/a	61

Table 29: RMOW kokanee spawning survey water quality

Site	Date	Time	Water Temperature (°C)	Conductivity (µS/s)	pH	TSS (ppm)
19 Mile Creek	2015-08-26	8:20	9.8	27	6.7	13
19 Mile Creek	2015-08-31	8:45	8.7	11	6.3	5
19 Mile Creek	2015-09-09	8:45	9.6	20	7.3	10
Blackcomb Creek	2015-08-25	12:20	10.1	44	7.34	22
Blackcomb Creek	2015-09-01	14:00	8.9	32	6.9	15
Blackcomb Creek	2015-09-15	11:20	7.9	44	7.33	22
Blackcomb Creek	2015-09-23	9:20	6.3	52	7.8	26
Blackcomb Creek	2015-04-29	16:00	5.3	71	6.2	37
Blackcomb Creek	2015-05-06	15:50	5.7	70	6.7	34
Blackcomb Creek	2015-05-13	16:00	7.5	n/a	6.91	22
Blackcomb Creek	2015-05-19	19:00	7.9	38	7.66	18
Crabapple Creek	2015-08-31	8:45	11.6	225	7.26	114
Crabapple Creek	2015-09-01	15:00	10.8	164	7.15	82
Crabapple Creek	2015-09-02	16:00	11.9	247	7.07	123
Crabapple Creek	2015-09-03	8:30	9.5	181	7.2	95
Crabapple Creek	2015-09-05	10:00	11	256	6.23	130
Crabapple Creek	2015-09-09	10:20	11.9	190	7.5	95
Crabapple Creek	2015-09-14	9:40	10.7	198	7.45	99
Crabapple Creek	2015-09-21	15:00	10.7	159	7.4	75
Crabapple Creek	2015-05-03	20:00	7	210	6.96	5
Crabapple Creek	2015-05-12	10:30	8	211	6.98	3
Crabapple Creek	2015-05-14	10:00	7.5	210	6.96	5
Jordan Creek	2015-08-22	8:10	16.6	120	6.4	51
Jordan Creek	2015-08-26	7:30	15.4	87	7.05	42
Jordan Creek	2015-09-02	7:40	15.5	100	6.37	45
Jordan Creek	2015-09-03	9:30	15.3	52	7.6	26

Site	Date	Time	Water Temperature (°C)	Conductivity (µS/s)	pH	TSS (ppm)
Jordan Creek	2015-09-06	8:20	14.4	93	7.1	51
Jordan Creek	2015-09-09	8:20	14.8	82	7.3	39
Jordan Creek	2015-09-14	7:45	14.2	89	7.3	46
Jordan Creek	2015-09-17	7:45	13.6	86	7.19	42
Jordan Creek	2015-09-20	8:30	13.9	76	7.38	38
Jordan Creek	2015-09-23	7:20	13	78	7.26	40
Jordan Creek	2015-04-30	8:30	7.6	64	6.59	64
Jordan Creek	2015-05-06	8:15	9	65	6.42	32
Jordan Creek	2015-05-10	8:15	11.5	58	6.81	29
Jordan Creek	2015-05-10	8:58	11.8	60	6.56	31
Jordan Creek	2015-05-13	7:57	11.3	53	6.62	26
Jordan Creek	2015-05-13	8:30	11.5	55	6.4	27
Jordan Creek	2015-05-15	7:08	11.4	53	6.94	26
Jordan Creek	2015-05-15	7:31	11.5	53	6.92	26
Jordan Creek	2015-05-17	14:36	n/a	n/a	n/a	n/a
Jordan Creek	2015-05-20	7:27	11.2	46	7.17	22
Jordan Creek	2015-05-20	7:52	11.3	46	7.13	23
Jordan Creek	2015-05-23	7:25	10.9	42	6.84	21
Jordan Creek	2015-05-23	7:49	10.7	42	7.2	21
Jordan Creek	2015-05-25	7:39	11.5	43	7.05	21
Jordan Creek	2015-05-25	8:04	11.5	43	7.1	21
Jordan Creek	2015-05-29	7:41	11.9	41	6.93	20
Jordan Creek	2015-05-29	8:03	11.7	40	7.07	20
Jordan Creek	2015-06-03	7:40	10.6	42	7.18	21
Jordan Creek	2015-06-03	8:02	10.6	40	7.34	21
Lakeside Creek	2015-04-30	10:02	8.4	151	6.9	74
Lakeside Creek	2015-05-04	15:57	11.4	147	7.9	74

Site	Date	Time	Water Temperature (°C)	Conductivity (µS/s)	pH	TSS (ppm)
Lakeside Creek	2015-05-24	20:15	18.9	187	7.88	93
River of Golden dreams	2015-08-24	10:00	12.6	86	7.3	42
River of Golden dreams	2015-08-25	11:10	14	123	6.9	63
River of Golden dreams	2015-08-25	10:30	12.5	93	6.12	47
River of Golden dreams	2015-08-27	8:10	12.1	67	6.8	34
River of Golden dreams	2015-08-27	10:00	12.5	102	5.61	51
River of Golden dreams	2015-08-31	8:00	10.1	22	5.9	12
River of Golden dreams	2015-08-31	8:30	10.9	22	6.36	11
River of Golden dreams	2015-09-01	14:30	10.9	13	6.9	6
River of Golden dreams	2015-09-02	15:30	11	27	6.04	13
River of Golden dreams	2015-09-03	8:00	8.9	14	7.4	7
River of Golden dreams	2015-09-09	10:00	11.6	20	7.38	10
River of Golden dreams	2015-09-14	10:30	10.6	37	7.46	18
River of Golden dreams	2015-09-21	15:45	9.9	12	7.6	6
River of Golden dreams	2015-09-22	8:00	8.2	49	6.78	24
River of Golden dreams	2015-04-30	9:14	5.8	203	6.55	101
Scotia Creek	2015-09-03	10:45	9.3	46	7.49	23
Scotia Creek	2015-09-25	10:15	8.1	39	7.35	19
Whistler Creek	2015-08-24	8:55	11.9	90	7.33	48
Whistler Creek	2015-08-28	19:00	12.4	94	7.57	51
Whistler Creek	2015-08-31	20:00	10.7	75	7.3	37
Whistler Creek	2015-09-01	8:00	9.8	61	6.6	30
Whistler Creek	2015-09-02	19:00	12	187	7.04	91
Whistler Creek	2015-09-03	10:00	9	63	7.5	32
Whistler Creek	2015-09-07	16:30	10.6	97	7.42	49
Whistler Creek	2015-09-10	12:40	11.9	65	7.8	32
Whistler Creek	2015-09-12	15:30	12.7	99	7.2	50

Site	Date	Time	Water Temperature (°C)	Conductivity (µS/s)	pH	TSS (ppm)
Whistler Creek	2015-09-15	10:30	9.9	70	7.45	35
Whistler Creek	2015-09-15	19:00	9.6	116	7.15	52
Whistler Creek	2015-09-21	10:00	9	95	7.2	48
Whistler Creek	2015-09-21	n/a	9.2	105	6.94	55
Whistler Creek	2015-05-10	9:17	6.4	50	6.6	24
Whistler Creek	2015-05-13	8:50	6	44	6.94	22
Whistler Creek	2015-05-20	8:10	5.2	35	7.25	17
Whistler Creek	2015-05-29	8:20	6.9	37	7.1	18
Whistler Creek	2015-06-03	8:30	6.5	41	7.7	20
Write-off Creek	2015-08-22	7:50	10.1	242	6.5	125
Write-off Creek	2015-08-26	7:10	10	238	6.96	117
Write-off Creek	2015-09-02	8:12	10.2	244	6.72	115
Write-off Creek	2015-09-06	8:00	9.6	250	6.84	139
Write-off Creek	2015-09-09	8:00	10.3	241	6.79	119
Write-off Creek	2015-09-14	7:30	9.5	250	7.2	126
Write-off Creek	2015-09-17	7:30	9.3	252	6.78	123
Write-off Creek	2015-09-20	8:20	10.7	188	6.88	89
Write-off Creek	2015-09-23	7:00	8.5	216	6.76	108
Write-off Creek	2015-05-10	7:53	6.8	141	6.69	71
Write-off Creek	2015-05-13	7:33	7.2	141	6.91	71
Write-off Creek	2015-05-15	6:48	7.4	143	6.84	72
Write-off Creek	2015-05-20	7:05	8.1	149	6.77	74
Write-off Creek	2015-05-23	7:05	9	155	6.72	78
Write-off Creek	2015-05-25	7:18	8.8	148	6.62	74
Write-off Creek	2015-05-29	7:24	9.1	163	6.94	81
Write-off Creek	2015-06-03	7:25	8.6	164	6.8	82

APPENDIX C: INDIVIDUAL FISH DATA

Table 30: Fish captured during the first pass in Jordan Creek at Site#1on July 23, 2015.

Daily Fish Log				
MOE licence number: SU15-166877		DFO licence number:		
Project number: 013-48-03		Site number (Reach):1 u/s		
Contractor: RMOW		Field team:CRT BX		
Date: 15-07-23		Waterbody name: Jordan Creek		
Weather: Sunny		Waterbody location: Whistler Creekside		
Fish Collection Summary Information				
Turbidity: 1.15	Visibilit y Clear:	GPS co-ordinates(D/S end- U/S end): 500241.19 5549285.55 Accuracy:		
Water temperature (ºC): 19.1		Conductivity (µS/cm): 120		
pH: 6.47		D.O: 7.76 mg/L 80.0		
Block nets: U/S D/S Partial None		Start time:	End time:	
Electrofishing specifications		**Minnow trap specifications**		
Pass number: 1	Seconds:559	Trap number:		
Voltage:295	Frequency:50	Trap depth:		
EF Length(m): 20	EF Width(m):5	Soak time (hrs):		
Individual Fish Data				
Species	**Length (mm)**	**Weight (gr)**	**Stage**	**Total caught**
RB	39 29 50 45 45 45 20 53 40 43 45 42 40	1 0.1 <1 <1 <1 <1 2 2 <1 <1 <1 <1 <1		

SB	50	<1		
	48	<1		
	44	<1		
	52	<1		
	43	<1		
	45	<1		
	42	<1		
	48	<1		
	47	<1		
	47	<1		
	52	<1		
	49	<1		
	46	<1		
	43	<1		
	41	<1		
	39	<1		
	46	<1		
	43	<1		
	42	<1		
	43	<1		
SC	112	19		
	114	21		
	98	13		
	95	12		
	95	14		
		<		
Total number of fish collected: P1= 38 P2=17 total= 55				
Comments (additional species caught):				

Table 31: Fish captured during the second pass in Jordan Creek at Site#1on July 23, 2015.

Daily Fish Log	
MOE licence number: SU15-166877	DFO licence number:
Project number:	Site number (Reach):1 u/s

013-48-03			
Contractor: RMOW		Field team:CRT BX	
Date: 15-07-23		Waterbody name: Jordan Creek	
Weather: Sunny		Waterbody location: Whistler Creekside	
Fish Collection Summary Information			
Turbidity: 1.15	Visibilit y Clear:	GPS co-ordinates(D/S end- U/S end): 500241.19 5549285.55 Accuracy:	
Water temperature (ºC): 19.1		Conductivity (µS/cm): 120	
pH: 6.47		D.O: 7.76 mg/L 80.0	
Block nets: U/S D/S Partial None		Start time:	End time:
Electrofishing specifications		**Minnow trap specifications**	
Pass number: 2	Seconds:597	Trap number:	
Voltage:295	Frequency:50	Trap depth:	
EF Length(m): 20	EF Width(m):5	Soak time (hrs):	

Individual Fish Data

Species	Length (mm)	Weight (gr)	Stage	Total caught
RB	34	4		
	29	0.3		
	43	0.9		
	51	0.9		
	43	0.9		
	50	0.9		
	44	<1		
	33	<1		
	100	9		
	145	27		
	47	<1		
SB	50	<1		
	47	<1		
	46	<1		
SC	89	12		
	86	10		
	81	8		

Total number of fish collected: P1= 38 P2=17 total= 55

Comments (additional species caught):

Table 32: Fish captured during the first pass in Jordan Creek at Site#2on July 23, 2015.

Daily Fish Log	
MOE licence number: SU15-166877	DFO licence number:

Project number: 013-48-03		Site number (Reach):2 d/s	
Contractor: RMOW		Field team:CRT BX	
Date: 15-07-23		Waterbody name: Jordan Creek	
Weather: Sunny		Waterbody location: Whistler Creekside	
Fish Collection Summary Information			
Turbidity: 1.15	Visibilit y Clear:	GPS co-ordinates(D/S end- U/S end): 500117.53 5549209.37 Accuracy:	
Water temperature (ºC): 18.2		Conductivity (µS/cm): 68	
pH: 6.47		D.O: 9.16 mg/L 97.1	
Block nets: U/S D/S Partial None		Start time: 9:30	End time:11:15
Electrofishing specifications		**Minnow trap specifications**	
Pass number: 1	Seconds:536	Trap number:	
Voltage:300	Frequency:50	Trap depth:	
EF Length(m): 20	EF Width(m):5	Soak time (hrs):	

Individual Fish Data

Species	Length (mm)	Weight (gr)	Stage	Total caught
RB	32	0.5		
	24	0.3		
	27	0.1		
	125	18		
SC	90	9		
SB	61	3		
	57	3		
	52	3		
	60	2		
	61	4		
	46	5		
	51	<1		
	52	<1		

Total number of fish collected: P1= 13 P2=15 P=10 total= 38

Comments (additional species caught):

Table 33: Fish captured during the second pass in Jordan Creek at Site#2on July 23, 2015

Daily Fish Log	
MOE licence number: SU15-166877	DFO licence number:
Project number: 013-48-03	Site number (Reach):2 d/s
Contractor: RMOW	Field team:CRT BX
Date: 15-07-23	Waterbody name: Jordan Creek

Weather: Sunny		Waterbody location: Whistler Creekside	
Fish Collection Summary Information			
Turbidity: 1.15	Visibilit y Clear:	GPS co-ordinates(D/S end- U/S end): 500117.53 5549209.37 Accuracy:	
Water temperature (ºC): 18.2		Conductivity (µS/cm): 68	
pH: 6.47		D.O: 9.16 mg/L 97.1	
Block nets: U/S D/S Partial None		Start time: 9:30	End time:11:15
Electrofishing specifications		**Minnow trap specifications**	
Pass number: 2	Seconds:639	Trap number:	
Voltage:30	Frequency:50	Trap depth:	
EF Length(m): 20	EF Width(m):5	Soak time (hrs):	

Individual Fish Data

Species	Length (mm)	Weight (gr)	Stage	Total caught
RB	29	0.4		
	34	0.3		
	35	0.3		
	33	0.5		
	50	0.9		
	80	5		
	43	<1		
SC	123	27		
SB	22	0.1		
	44	<1		
	43	<1		
	42	<1		
	51	<1		
	52	<1		
	62	2		

Total number of fish collected: P1= 13 P2=15 P=10 total= 38

Comments (additional species caught):

Table 34: Fish captured during the third pass in Jordan Creek at Site#2on July 23, 2015

Daily Fish Log	
MOE licence number: SU15-166877	DFO licence number:
Project number:	Site number (Reach):2 d/s

013-48-03			
Contractor: RMOW		Field team:CRT BX	
Date: 15-07-23		Waterbody name: Jordan Creek	
Weather: Sunny		Waterbody location: Whistler Creekside	
Fish Collection Summary Information			
Turbidity: 1.15	Visibilit y Clear:	GPS co-ordinates(D/S end- U/S end): 500117.53 5549209.37 Accuracy:	
Water temperature (ºC): 18.2		Conductivity (µS/cm): 68	
pH: 6.47		D.O: 9.16 mg/L 97.1	
Block nets: U/S D/S Partial None		Start time: 9:30	End time:11:15
Electrofishing specifications		**Minnow trap specifications**	
Pass number: 3	Seconds:410	Trap number:	
Voltage:30	Frequency:50	Trap depth:	
EF Length(m): 20	EF Width(m):5	Soak time (hrs):	

Individual Fish Data				
Species	**Length (mm)**	**Weight (gr)**	**Stage**	**Total caught**
RB SC	92 90 95 55 48 48 53 39 56 49	7 7 13 <1 <1 2 <1 <1 2 <1		
Total number of fish collected: P1= 13 P2=15 P=10 total= 38				
Comments (additional species caught):				

Table 35: Fish captured during the first pass in Crabapple Creek on July 31, 2015

Daily Fish Log	
MOE licence number: SU15-166877	DFO licence number:
Project number: 013-48-03	Site number (Reach): 1
Contractor: RMOW	Field team: CRT, BX
Date: 15/07/31	Waterbody name: Crabapple Creek
Weather: Sunny	Waterbody location: Lorimer Bridge
Fish Collection Summary Information	

Turbidity: 1.17	Visibility: clear	GPS co-ordinates(D/S end- U/S end): 502026.5 5552680.62 Accuracy:	
Water temperature (ºC): 15.6		Conductivity (µS/cm): 228	
pH:6.42		D.O:99.0% 9.73 mg/L	
Block nets: U/S D/S Partial None		Start time: 13:40	End time:15:10
Electrofishing specifications		**Minnow trap specifications**	
Pass number: 1	Seconds:703	Trap number:	
Voltage:295	Frequency: 50	Trap depth:	
EF Length(m): 33	EF Width(m): 3	Soak time (hrs):	

Individual Fish Data

Species	Length (mm)	Weight (gr)	Stage	Total caught
RB	37	<1		Mortality
	35	<1		Mortality
	40	<1		
	33	<1		
	4541	<1		
	69	3		
	115	15		
	101	11		
	34	<1		
	45	<1		
	50	<1		
	39	<1		
RB	35	<1		
	36	<1		
	41	<1		
	39	<1		
	31	<1		
	38	<1		
	35	<1		
	36	<1		
	39	<1		
	33	<1		
	32	<1		
	45	<1		
	42	<1		
	36	<1		
	45	<1		
SB	52	<1		
	35	<1		
	48	<1		
	48	<1		
	47	<1		
	49	<1		
	56	2		
	56	2		
	56	<1		
	50	<1		
	54	<1		
	36	<1		

SC	44 45 39 40 53 50 51 74 64 67 56 78 45	<1 <1 <1 <1 2 <1 <1 7 4 4 3 5 <1		
Total number of fish collected: P1= 52				
Comments (additional species caught):				

Table 36: Fish captured during the secondt pass in Crabapple Creek on July 31, 2015

Daily Fish Log				
MOE licence number: SU15-166877		DFO licence number:		
Project number: 013-48-03		Site number (Reach): 1		
Contractor: RMOW		Field team: CRT, BX		
Date: 15/07/31		Waterbody name: Crabapple Creek		
Weather: Sunny		Waterbody location: Lorimer Bridge		
Fish Collection Summary Information				
Turbidity: 1.17	Visibility: clear	GPS co-ordinates(D/S end- U/S end): 502026.5 5552680.62 Accuracy:		
Water temperature (ºC): 15.6		Conductivity (µS/cm): 228		
pH:6.42		D.O:99.0% 9.73 mg/L		
Block nets: U/S D/S Partial None		Start time: 13:40	End time:15:10	
Electrofishing specifications		**Minnow trap specifications**		
Pass number: 2	Seconds:617	Trap number:		
Voltage:295	Frequency: 50	Trap depth:		
EF Length(m): 33	EF Width(m): 3	Soak time (hrs):		
Individual Fish Data				
Species	**Length (mm)**	**Weight (gr)**	**Stage**	**Total caught**

RB	43 41 44 43 41 38 42 26 44	<1 <1 <1 <1 <1 <1 <1 <1 <1		Mortality Mortality
SB	45 45 51 54 41 44 43 44 33 46 45 36 43	<1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1		
SC	74 63 45	5 3 <1		
Total number of fish collected: P2= 25 Total= 77				
Comments (additional species caught):				

Table 37: Fish captured during the first pass in the River of Golden Dreams on July 15, 2015

Daily Fish Log			
MOE licence number: SU15-166877		DFO licence number:	
Project number: 013-48-03		Site number (Reach): 1	
Contractor: RMOW		Field team: CRT, BX	
Date: 15/07/15		Waterbody name: ROGD	
Weather: Sunny		Waterbody location: Lorimer Road	
Fish Collection Summary Information			
Turbidity: 1.24	Visibility: Clear	GPS co-ordinates(D/S end- U/S end): 502043.26 5552815.19 Accuracy:	
Water temperature (ºC): 13.1		Conductivity (µS/cm): 73	
pH:6.74		D.O:91.8 % 9.1 mg/L	
Block nets: U/S D/S Partial None		Start time: 10:10	End time:12:15

Electrofishing specifications		Minnow trap specifications
Pass number: 1	Seconds: 619	Trap number:
Voltage: 350	Frequency: 50	Trap depth:
EF Length(m): 11.5	EF Width(m): 9	Soak time (hrs):

Individual Fish Data				
Species	**Length (mm)**	**Weight (gr)**	**Stage**	**Total caught**
RB	30 48 48 45 38 28 42 39 41 34 36 40	<1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1		Mortality
SB SC	51 81 48 52 50 57 65 64 59 63 71 63 66 72 59 52 51 56 55 54	<1 6 <1 2 <1 3 4 3 3 3 4 3 4 5 3 2 2 3 3 2		
Total number of fish collected: P1= 32				
Comments (additional species caught): Adult male tailed frog caught				

Table 38: Fish captured during thesecond pass in the River of Golden Dreams on July 15, 2015

Daily Fish Log	
MOE licence number: SU15-166877	DFO licence number:
Project number: 013-48-03	Site number (Reach): 1
Contractor: RMOW	Field team: CRT, BX
Date:	Waterbody name: ROGD

15/07/15			
Weather: Sunny		Waterbody location: Lorimer Road	
Fish Collection Summary Information			
Turbidity: 1.24	Visibility: Clear	GPS co-ordinates(D/S end- U/S end): 502043.26 5552815.19 Accuracy:	
Water temperature (ºC): 13.1		Conductivity (µS/cm): 73	
pH:6.74		D.O:91.8 % 9.1 mg/L	
Block nets: U/S D/S Partial None		Start time: 10:10	End time:12:15
Electrofishing specifications		**Minnow trap specifications**	
Pass number: 2	Seconds: 700	Trap number:	
Voltage: 350	Frequency: 50	Trap depth:	
EF Length(m): 11.5	EF Width(m): 9	Soak time (hrs):	

Individual Fish Data

Species	Length (mm)	Weight (gr)	Stage	Total caught
SB	14	<1		Mortality
RB	22	<1		
	39	<1		
	41	<1		
	34	<1		
	33	<1		
	34	<1		
	34	<1		
	39	<1		
	39	<1		
	37	<1		
	37	<1		
RB	28	<1		
	39	<1		
	38	<1		
SB	40	<1		
RB	27	<1		
	28	<1		
SC	61	2		
	71	4		
	85	7		
	62	2		
	61	2		
	58	2		
	69	3		
	61	2		
	66	3		
	68	4		
	71	4		
	49	<1		
	81	6		
	77	5		
	49	<1		
	66	3		
	65	3		

	79 59 59 61 64 70 65 41 56 61 46 55 49 46 41 49 42 44 46 45 40	5 3 3 3 3 4 3 <1 2 2 <1 2 <1 <1 <1 <1 <1 <1 <1 <1 <1		
Total number of fish collected: P2= 66 Total= 98				

Table 39: Fish captured during the first pass in Fitzsimmons Creek at the Spruce Grove pedestrian bridge on August 18, 2015

Daily Fish Collection		
Date:08/18/15	Project Number:013-09-10-02	
Time:8:00	Field Crew: MB, SF, VL	
Location: Whistler	Weather: Clear	
Waterbody Name: Fitz Creek	Waterbody Type: Creek	
Location on Water body: Spruce Grove Pedestrian Bridge	UTM Coordinates:	
MOE licence number: SU15-166877	DFO licence number:	
Water Quality Data		
Turbidity (NTU):	Visibility: □ Clear □ Lightly Turbid ⊗Moderately Turbid □ Turbid	
Water Temperature (ºC):6.7	Conductivity (µS/cm):61	
pH:7.33	D.O. (mg/L):	
Fish Collection Data		
Method(s) Used: ⊗ EF □ MT □ NS	Project Type: □ Inventory ⊗ Salvage	
Electrofishing (EF)		
Block Nets: □ U/S □ D/S □ Partial □ None	Start Time:	End Time:
	Area Length (m):	Area Width (m):

Pass #	Voltage	Frequency	Duty Cycle (%)	Seconds
1	**350**	**30**	**12**	**1178**

Minnow Trapping (MT)		
Number of Traps:	Traps Set at: □ Surface □ Midwater □ Bottom	Trap Depth (m):
Time Set:	Time Retrieved:	Soak Time (hrs):

Night Snorkel (NS)			
Team #	**Start Time(s)**	**End Time(s)**	**Effort (person minutes)**
1			
2			

Individual Fish Data				
Species	**Length (mm)**	**Weight (g)**	**Stage**	**Total Caught**
RB	30			1
BT	115			1
SC	70			1
RB	125			1
RB	110			1
RB	25			1
SC	45			2
SC	75			2
SC	60			1
SC	50			3
SC	80			1
RB	95			1
Total number of fish collected: 16				
Comments (additional species caught):				

Table 40: Fish captured during the second pass in Fitzsimmons Creek at the Spruce Grove pedestrian bridge on August 18, 2015

Daily Fish Collection	
Date:08/18/15	Project Number:013-09-10-02
Time:8:00	Field Crew: MB, SF, VL
Location: Whistler	Weather: Clear
Waterbody Name: Fitz Creek	Waterbody Type: Creek

Location on Water body: Spruce Grove Pedestrian Bridge	UTM Coordinates:
MOE licence number: SU15-166877	DFO licence number:

Water Quality Data

Turbidity (NTU):	Visibility: □ Clear □ Lightly Turbid ⊗Moderately Turbid □ Turbid
Water Temperature (ºC):6.7	Conductivity (µS/cm):61
pH:7.33	D.O. (mg/L):

Fish Collection Data

Method(s) Used: ⊗ EF □ MT □ NS	Project Type: □ Inventory ⊗ Salvage

Electrofishing (EF)

Block Nets: □ U/S □ D/S □ Partial □ None	Start Time:	End Time:
	Area Length (m):	Area Width (m):

Pass #	Voltage	Frequency	Duty Cycle (%)	Seconds
2	**350**	**30**	**12**	**2011**

Minnow Trapping (MT)

Number of Traps:	Traps Set at: □ Surface □ Midwater □ Bottom	Trap Depth (m):
Time Set:	Time Retrieved:	Soak Time (hrs):

Night Snorkel (NS)

Team #	Start Time(s)	End Time(s)	Effort (person minutes)
1			
2			

Individual Fish Data

Species	Length (mm)	Weight (g)	Stage	Total Caught
RB	25			3
SC	70			5
SC	90			2
SC	80			3
SC	60			6

SC	65			3
SC	75			2
SC	55			3
SC	50			4
RB	35			1
Total number of fish collected: 30				
Comments (additional species caught):				

Table 41: Fish captured during the third pass in Fitzsimmons Creek at the Spruce Grove pedestrian bridge on August 18, 2015

Daily Fish Collection		
Date:08/18/15	Project Number:013-09-10-02	
Time:8:00	Field Crew: MB, SF, VL	
Location: Whistler	Weather: Clear	
Waterbody Name: Fitz Creek	Waterbody Type: Creek	
Location on Water body: Spruce Grove Pedestrian Bridge	UTM Coordinates:	
MOE licence number: SU15-166877	DFO licence number:	
Water Quality Data		
Turbidity (NTU):	Visibility: □ Clear □ Lightly Turbid ⊗Moderately Turbid □ Turbid	
Water Temperature (ºC):6.7	Conductivity (µS/cm):61	
pH:7.33	D.O. (mg/L):	
Fish Collection Data		
Method(s) Used: ⊗ EF □ MT □ NS	Project Type: □ Inventory ⊗ Salvage	
Electrofishing (EF)		
Block Nets: □ U/S □ D/S □ Partial □ None	Start Time:	End Time:
	Area Length (m):	Area Width (m):

Pass #	Voltage	Frequency	Duty Cycle (%)	Seconds
3	**350**	**30**	**16**	**872**

Minnow Trapping (MT)		
Number of Traps:	Traps Set at: □ Surface □ Midwater □ Bottom	Trap Depth (m):
Time Set:	Time Retrieved:	Soak Time (hrs):

Night Snorkel (NS)			
Team #	**Start Time(s)**	**End Time(s)**	**Effort (person minutes)**
1			
2			

Individual Fish Data				
Species	**Length (mm)**	**Weight (g)**	**Stage**	**Total Caught**
RB	25			2
SC	75			2
SC	65			1
SC	55			1
Total number of fish collected: 6				
Comments (additional species caught):				

Table 42: Fish captured during the fourth pass in Fitzsimmons Creek at the Spruce Grove pedestrian bridge on August 18, 2015

Daily Fish Collection	
Date:08/18/15	Project Number:013-09-10-02
Time:8:00	Field Crew: MB, SF, VL
Location: Whistler	Weather: Clear
Waterbody Name: Fitz Creek	Waterbody Type: Creek

Location on Water body: Spruce Grove Pedestrian Bridge	UTM Coordinates:
MOE licence number: SU15-166877	DFO licence number:

Water Quality Data

Turbidity (NTU):	Visibility: □ Clear □ Lightly Turbid ⊗Moderately Turbid □ Turbid
Water Temperature (ºC):6.7	Conductivity (µS/cm):61
pH:7.33	D.O. (mg/L):

Fish Collection Data

Method(s) Used: ⊗ EF □ MT □ NS	Project Type: □ Inventory ⊗ Salvage

Electrofishing (EF)

Block Nets: □ U/S □ D/S □ Partial □ None	Start Time:	End Time:
	Area Length (m):	Area Width (m):

Pass #	Voltage	Frequency	Duty Cycle (%)	Seconds
4	**350**	**30**	**16**	**619**

Minnow Trapping (MT)

Number of Traps:	Traps Set at: □ Surface □ Midwater □ Bottom	Trap Depth (m):
Time Set:	Time Retrieved:	Soak Time (hrs):

Night Snorkel (NS)

Team #	Start Time(s)	End Time(s)	Effort (person minutes)
1			
2			

Individual Fish Data

Species	Length (mm)	Weight (g)	Stage	Total Caught
SC	55			1
SC	75			1

Total number of fish collected:
2

Comments (additional species caught):

Table 43: Fish captured during the fifth pass in Fitzsimmons Creek at the Spruce Grove pedestrian bridge on August 18, 2015

Daily Fish Collection				
Date:08/18/15			Project Number:013-09-10-02	
Time:8:00			Field Crew: MB, SF, VL	
Location: Whistler			Weather: Clear	
Waterbody Name: Fitz Creek			Waterbody Type: Creek	
Location on Water body: Spruce Grove Pedestrian Bridge			UTM Coordinates:	
MOE licence number: SU15-166877			DFO licence number:	
Water Quality Data				
Turbidity (NTU):			Visibility: □ Clear □ Lightly Turbid ⊗Moderately Turbid □ Turbid	
Water Temperature (ºC):6.7			Conductivity (µS/cm):61	
pH:7.33			D.O. (mg/L):	
Fish Collection Data				
Method(s) Used: ⊗ EF □ MT □ NS			Project Type: □ Inventory ⊗ Salvage	
Electrofishing (EF)				
Block Nets: □ U/S □ D/S □ Partial □ None	Start Time:		End Time:	
	Area Length (m):		Area Width (m):	
Pass #	**Voltage**	**Frequency**	**Duty Cycle (%)**	**Seconds**
5	**350**	**30**	**12**	**1011**
Minnow Trapping (MT)				
Number of Traps:	Traps Set at: □ Surface □ Midwater □ Bottom		Trap Depth (m):	
Time Set:	Time Retrieved:		Soak Time (hrs):	
Night Snorkel (NS)				
Team #	**Start Time(s)**	**End Time(s)**	**Effort (person minutes)**	
1				

2			

Individual Fish Data				
Species	**Length (mm)**	**Weight (g)**	**Stage**	**Total Caught**
RB	105			1
SC	75			1
RB	95			1
Total number of fish collected: 3				
Comments (additional species caught):				

APPENDIX D: BEAVER LODGE DATA

Table 44: Location and level of activity observed for each beaver lodge visited in Whistler, BC for 2010, 2013, 2014 and 2015. The status of each lodge was assessed; features including fresh mudding, addition of fresh trees, branches or shrubs were observed and used to make an activity level status for each lodge

Location	Easting	Northing	2010	2013	2014	2015	observations
Wedge Pond Lodge	503224	5555745	active	active	active	active	Worn trail, food cache, fresh mud, fresh cuttings
Green Lake Lodge	503746	5554612	active	active	active	*Unknown*	Fresh nible around the lodge
Fitz Fan Lodge	503847	5554866	active	*unknown*	*unknown*	*Unknown*	Fresh nible around the lodge
Nicklaus North Tee 12	502659	5553663	active	active	inactive	active	fresh cuts, fresh mud, food cache
Spruce grove #1	503653	5553302		inactive	inactive	inactive	
Spruce grove #2	503551	5553348		inactive	inactive	inactive	
Spruce grove #3	503546	5553377			inactive	inactive	
Spruce grove #4	503537	5553411			inactive	inactive	
Spruce grove #5	503518	5553500			active	inactive	
Chateau Irrigation Pond Lodge	504625	5552337	active	active	active	active	fresh cuts, fresh mud, food cache
Chateau Golf Course	504184	5552221	active	*unknown*	inactive	inactive	
Whistler Golf Course #2	502367	5551790	active	active	inactive	inactive	
Beaver Lake	500012	5550802				inactive	two lodges bot inactive
Nita Lake Lodge	500290	5549772	active	*unknown*	active	inactive	
Alpha Lake Lodge	499203	5548997	active	inactive	inactive	inactive	
ROGD Lodge #0	501742	5552506				active	Food cache, mud, fresh cuts
ROGD Lodge #1	502130	5552997	inactive	not found	active	inactive	
ROGD Lodge #2	502297	5553210	*unknown*	not found	not found	*unknown*	Fresh wood, no mud
ROGD Lodge #3	502348	5553202	active	*unknown*	inactive	inactive	2 lodges
ROGD Lodge #4	502421	5553438	*unknown*	active	active	active	Food cache, fresh print around but didnt find the lodge
ROGD Lodge #5	502309	5553844	active	active	not found	not found	
ROGD Lodge #6	502364	5553932	inactive	not found	not found	active	Food cache, fresh print around but didnt find the lodge
ROGD Lodge #7	502521	5554056	inactive	not found	not found	not found	
ROGD Lodge #8	502635	5554124	*unknown*	not found	not found	not found	
ROGD Lodge #9	502440	5554221	active	active	inactive	not found	
ROGD Lodge #10	502645	5554445	active	active	active	inactive	
ROGD Lodge #11	502660	5554457	inactive	inactive	not found	inactive	
ROGD Lodge #11b	503030	5554733			active	inactive	
ROGD Lodge #12	502994	5554838	*unknown*	inactive	active	not found	
ROGD Lodge #13	503142	5554830	inactive	inactive	not found	inactive	

Location	Easting	Northing	2010	2013	2014	2015	observations
ROGD Lodge #14	503203	5554929	active	*unknown*	inactive	inactive	
ROGD Lodge #15	503188	5554839	active	*unknown*	inactive	inactive	
ROGD Lodge #16	503196	5554835	*unknown*	active	inactive	inactive	
ROGD Lodge #17	503203	5554833	*unknown*	*unknown*	inactive	active	

Table 45: Photo documentation of some of the lodges surveyed

Photo 14: Alpha lake lodge. October 26, 2015

Photo 15: Nita lake lodge. October 26, 2015

Photo 16: View of one of the lodge on Beaver lake. October 26, 2015

Photo 17: Whistler golf course lodge. October 26, 2015

Photo 18: Chateau golf course, irrigation pond lodge covered with fresh mud and branches. October26, 2015

Photo 19: Chateau golf course lodge. October 26, 2015

Photo 20: Spruce grove lodge. October 26, 2015

Photo 21: Fresh mud on the lodge near the tee 12 at the Nicklaus north golf course. October 26, 2015

Photo 22: Lodge near hole 15 at the Nicklaus north golf course. Octovber26, 2015

Photo 23: Green lake lodge. October 26, 2015

Photo 24: Wedge pond lodge. October 26, 2015

Photo 25: Food cache near the lodge at Wedge pond. October 26, 2015

Photo 26: lodge #0 on the River of Golden Dreams. October 27, 2015

APPENDIX E: PILEATED WOODPECKER SURVEY DATA

Table 46: Survey effort at call playback stations along Transects 1, 2, 3 and 4

Station	Start Time	End Time	Species Detected	Comments
***Rainbow Transect*- July 7, 2015**				
1	8:29	8:33	Varied Thrush	
2	8:49	8:54	-	
3	9:44	9:48	-	Heard Pecking
4	10:19	10:23	-	
5	10:32	10:36	Varied Thrush	
6	10:56	11:00	Varied Thrush	
7	11:14	11:18	-	
8	11:45	11:49	-	
9	12:00	12:04	-	
10	12:15	12:19	-	
***Comfortably Numb Transect*- July 8, 2015**				
1	8:43	8:51		
2	9:11	9:15		
3	9:24	9:29	Red-breasted nuthatch	
4	9:58	9:42	Varied Thrush	
5	9:59	10:03	Varied Thrush, robin	
6	10:13	10:17	Varied Thrush	
7	10:28	10:32	Northern flicker	Heard prior to start, flew away (no answer)
8	10:49	10:53	Unidentified song bird	
9	11:13	11:17		
10	11:27	11:32	Red-breasted nuthatch, potential grey catbiard	Two hairy woodpecker and a grouse were observed after the survey was completed
***Creekside Transect*- July 9, 2015**				
1	8:46	8:50		
2	9:05	9:09		

Station	Start Time	End Time	Species Detected	Comments
3	9:27	9:31	Northern flicker	
4	9:59	10:03		Drumming heard on the way to the station
5	10:19	10:23	Varied thrush	
6	10:38	10:42		
7	10:54	10:58		
8	11:16	11:20		
9	11:43	11:46	Varied Thrush	
10	12:06	12:10		
***Stone Bridge Transect*- July 10, 2015**				
1	9:03	9:07	Robin, potential P.woodpecker or N. flicker	But no answer to the call
2	9:32	9:36		
3	9:47	9:51		
4	10:11	10:15		
5	10:30	10:34		
6	10:48	10:52		
7	11:11	11:15		
8	11:36	11:40	Songbird	Pura vida trail
9	11:57	12:01		Near a la mode, lower sproatt
10	12:10	12:15	Junco, songbird, red-breasted nuthatch	

APPENDIX F: SMALL MAMMAL TRAP DATA

Table 47: Small mammal trap counts in 2015 at the Blueberry, Rainbow and Function site during the spring and the summer. DM=deer mouse, RBV = southern red-backed vole, S = shrew, YPC= yellow pine chipmunk

Site	Season	date	trap night	Trap Number	Species	Sex (M/F)	Age Class	Body length (cm)	Weight (g)	Comments
Blueberry	Spring	11/06/2015	1	1a	Empty					
Blueberry	Spring	11/06/2015	1	1b	RBV	M	Adult	80	20	
Blueberry	Spring	11/06/2015	1	2	Empty					
Blueberry	Spring	11/06/2015	1	3	Empty					
Blueberry	Spring	11/06/2015	1	4	Empty					
Blueberry	Spring	11/06/2015	1	5a	Empty					
Blueberry	Spring	11/06/2015	1	5b	Empty					
Blueberry	Spring	11/06/2015	1	6	Empty					
Blueberry	Spring	11/06/2015	1	7	Empty					
Blueberry	Spring	11/06/2015	1	8	Empty					
Blueberry	Spring	11/06/2015	1	9	Empty					
Blueberry	Spring	11/06/2015	1	10a	Empty					
Blueberry	Spring	11/06/2015	1	10b	Empty					
Blueberry	Spring	11/06/2015	1	11	Empty					
Blueberry	Spring	11/06/2015	1	12	Empty					
Blueberry	Spring	11/06/2015	1	13	Empty					
Blueberry	Spring	11/06/2015	1	14	Empty					
Blueberry	Spring	11/06/2015	1	15a	Empty					
Blueberry	Spring	11/06/2015	1	15b	Empty					
Blueberry	Spring	11/06/2015	1	16	Empty					
Blueberry	Spring	11/06/2015	1	17	Empty					
Blueberry	Spring	11/06/2015	1	18	Empty					
Blueberry	Spring	11/06/2015	1	19	RBV	F	Adult	75	24	
Blueberry	Spring	11/06/2015	1	20a	Empty					
Blueberry	Spring	11/06/2015	1	20b	Empty					
Blueberry	Spring	12/06/2015	2	1a	S					mortality
Blueberry	Spring	12/06/2015	2	1b	RBV					
Blueberry	Spring	12/06/2015	2	2	Empty					
Blueberry	Spring	12/06/2015	2	3	YPC					
Blueberry	Spring	12/06/2015	2	4	Empty					
Blueberry	Spring	12/06/2015	2	5a	Empty					
Blueberry	Spring	12/06/2015	2	5b	Empty					
Blueberry	Spring	12/06/2015	2	6	Empty					
Blueberry	Spring	12/06/2015	2	7	Empty					
Blueberry	Spring	12/06/2015	2	8	S					mortality

Site	Season	date	trap night	Trap Number	Species	Sex (M/F)	Age Class	Body length (cm)	Weight (g)	Comments
Blueberry	Spring	12/06/2015	2	9	S					mortality
Blueberry	Spring	12/06/2015	2	10a	Empty					
Blueberry	Spring	12/06/2015	2	10b	Empty					
Blueberry	Spring	12/06/2015	2	11	Empty					
Blueberry	Spring	12/06/2015	2	12	Empty					
Blueberry	Spring	12/06/2015	2	13	Empty					
Blueberry	Spring	12/06/2015	2	14	Empty					
Blueberry	Spring	12/06/2015	2	15a	Empty					
Blueberry	Spring	12/06/2015	2	15b	Empty					
Blueberry	Spring	12/06/2015	2	16	S					mortality
Blueberry	Spring	12/06/2015	2	17	Empty					
Blueberry	Spring	12/06/2015	2	18	Empty					
Blueberry	Spring	12/06/2015	2	19	Empty					
Blueberry	Spring	12/06/2015	2	20a	Empty					
Blueberry	Spring	12/06/2015	2	20b	Empty					
Rainbow	Spring	11/06/2015	1	1a	Empty					
Rainbow	Spring	11/06/2015	1	1b	Empty					
Rainbow	Spring	11/06/2015	1	2	Empty					
Rainbow	Spring	11/06/2015	1	3	Empty					
Rainbow	Spring	11/06/2015	1	4	Empty					
Rainbow	Spring	11/06/2015	1	5a	Empty					
Rainbow	Spring	11/06/2015	1	5b	Empty					
Rainbow	Spring	11/06/2015	1	6	Empty					
Rainbow	Spring	11/06/2015	1	7	Empty					
Rainbow	Spring	11/06/2015	1	8	Empty					
Rainbow	Spring	11/06/2015	1	9	Empty					
Rainbow	Spring	11/06/2015	1	10a	Empty					
Rainbow	Spring	11/06/2015	1	10b	Empty					
Rainbow	Spring	11/06/2015	1	11	Empty					
Rainbow	Spring	11/06/2015	1	12	Empty					
Rainbow	Spring	11/06/2015	1	13	Empty					
Rainbow	Spring	11/06/2015	1	14	DM	M	Adult	80	25	
Rainbow	Spring	11/06/2015	1	15a	Empty					
Rainbow	Spring	11/06/2015	1	15b	Empty					
Rainbow	Spring	11/06/2015	1	16	Empty					
Rainbow	Spring	11/06/2015	1	17	S					
Rainbow	Spring	11/06/2015	1	18	DM	M	Adult	85	32	

Site	Season	date	trap night	Trap Number	Species	Sex (M/F)	Age Class	Body length (cm)	Weight (g)	Comments
Rainbow	Spring	11/06/2015	1	19	DM	M	Sub-adult	70	25	
Rainbow	Spring	11/06/2015	1	20a	Empty					
Rainbow	Spring	11/06/2015	1	20b	DM	M	Adult	85	28	
Rainbow	Spring	12/06/2015	2	1a	Empty					
Rainbow	Spring	12/06/2015	2	1b	Empty					
Rainbow	Spring	12/06/2015	2	2	Empty					
Rainbow	Spring	12/06/2015	2	3	Empty					
Rainbow	Spring	12/06/2015	2	4	Empty					
Rainbow	Spring	12/06/2015	2	5a	Empty					
Rainbow	Spring	12/06/2015	2	5b	Empty					
Rainbow	Spring	12/06/2015	2	6	Empty					
Rainbow	Spring	12/06/2015	2	7	Empty					
Rainbow	Spring	12/06/2015	2	8	Empty					
Rainbow	Spring	12/06/2015	2	9	Empty					
Rainbow	Spring	12/06/2015	2	10a	Empty					
Rainbow	Spring	12/06/2015	2	10b	Empty					
Rainbow	Spring	12/06/2015	2	11	Empty					
Rainbow	Spring	12/06/2015	2	12	Empty					
Rainbow	Spring	12/06/2015	2	13	DM	F	Adult	80	26	
Rainbow	Spring	12/06/2015	2	14	Empty					
Rainbow	Spring	12/06/2015	2	15a	Empty					
Rainbow	Spring	12/06/2015	2	15b	DM	F	Adult	75	26	
Rainbow	Spring	12/06/2015	2	16	DM	F	Juvenile	75	17	
Rainbow	Spring	12/06/2015	2	17	DM	F	Adult	85	34	
Rainbow	Spring	12/06/2015	2	18	Empty					
Rainbow	Spring	12/06/2015	2	19	Empty					
Rainbow	Spring	12/06/2015	2	20a	DM	M	Sub-adult	75	23	
Rainbow	Spring	12/06/2015	2	20b	RBV	M	Adult	80	24	
Function	Spring	25/06/2015	1	1a	Empty					
Function	Spring	25/06/2015	1	1b	DM	F	Adult	75	26	
Function	Spring	25/06/2015	1	2	Empty					
Function	Spring	25/06/2015	1	3	Empty					
Function	Spring	25/06/2015	1	4	Empty					
Function	Spring	25/06/2015	1	5a	Empty					trap not set
Function	Spring	25/06/2015	1	5b	DM	M	Juvenile	70	23	
Function	Spring	25/06/2015	1	6	DM					escaped

Site	Season	date	trap night	Trap Number	Species	Sex (M/F)	Age Class	Body length (cm)	Weight (g)	Comments
Function	Spring	25/06/2015	1	7	DM	M	Juvenile	60	13	grey fur
Function	Spring	25/06/2015	1	8	DM	M	Juvenile	55	12	grey fur
Function	Spring	25/06/2015	1	9	Empty					
Function	Spring	25/06/2015	1	10a	Empty					
Function	Spring	25/06/2015	1	10b	Empty					
Function	Spring	25/06/2015	1	11	DM	M	Sub-adult	70	18	grey fur
Function	Spring	25/06/2015	1	12	Empty					
Function	Spring	25/06/2015	1	13	DM	F	Adult	75	28	
Function	Spring	25/06/2015	1	14	Empty					
Function	Spring	25/06/2015	1	15a	Empty					
Function	Spring	25/06/2015	1	15b	DM		Adult			escape
Function	Spring	25/06/2015	1	16	Empty					
Function	Spring	25/06/2015	1	17	Empty					
Function	Spring	25/06/2015	1	18	Short-tailed weasel					Likely ate the mouse that got caught in the trap
Function	Spring	25/06/2015	1	19	DM	F	Adult	80	32	
Function	Spring	25/06/2015	1	20a	Empty					
Function	Spring	25/06/2015	1	20b	DM	M	Adult	70	25	
Function	Spring	26/06/2015	2	1a	Empty					
Function	Spring	26/06/2015	2	1b	Empty					
Function	Spring	26/06/2015	2	2	S					Mortality
Function	Spring	26/06/2015	2	2	DM	F	Adult	75	26	
Function	Spring	26/06/2015	2	3	Empty					
Function	Spring	26/06/2015	2	4	DM	M	Adult	70	24	
Function	Spring	26/06/2015	2	5a	Empty					
Function	Spring	26/06/2015	2	5b	Empty					
Function	Spring	26/06/2015	2	6	DM	M	Juvenile	65	18	
Function	Spring	26/06/2015	2	7	S					Mortality
Function	Spring	26/06/2015	2	8	Empty					
Function	Spring	26/06/2015	2	9	DM	M	Juvenile	55	11	
Function	Spring	26/06/2015	2	10a	DM	F	Juvenile	55	13	
Function	Spring	26/06/2015	2	10b	DM	F	Adult	85	28	
Function	Spring	26/06/2015	2	11	DM		Juvenile			escaped
Function	Spring	26/06/2015	2	12	DM	F	Adult	80	33	
Function	Spring	26/06/2015	2	13	DM	F	Adult	75	26	
Function	Spring	26/06/2015	2	14	DM		Adult			escaped
Function	Spring	26/06/2015	2	15a	Empty					

Site	Season	date	trap night	Trap Number	Species	Sex (M/F)	Age Class	Body length (cm)	Weight (g)	Comments
Function	Spring	26/06/2015	2	15b	Empty					
Function	Spring	26/06/2015	2	16	DM	F	Adult	85	30	
Function	Spring	26/06/2015	2	17	DM					escaped
Function	Spring	26/06/2015	2	18	Empty					
Function	Spring	26/06/2015	2	19	Empty					
Function	Spring	26/06/2015	2	20a	Empty					
Function	Spring	26/06/2015	2	20b	DM		Adult			escaped
Blueberry	Summer	10/09/2015	1	1a	RBV	F	Adult	80	25	
Blueberry	Summer	10/09/2015	1	1b	Empty					
Blueberry	Summer	10/09/2015	1	2	Empty					Broken trap not set
Blueberry	Summer	10/09/2015	1	3	RBV	M	Sub-adult	70	21	
Blueberry	Summer	10/09/2015	1	4	Empty					
Blueberry	Summer	10/09/2015	1	5a	Empty					
Blueberry	Summer	10/09/2015	1	5b	Empty					
Blueberry	Summer	10/09/2015	1	6	RBV	M	Sub-adult	80	24	
Blueberry	Summer	10/09/2015	1	7	Empty					
Blueberry	Summer	10/09/2015	1	8	Empty					
Blueberry	Summer	10/09/2015	1	9	Empty					
Blueberry	Summer	10/09/2015	1	10a	S					No measurement
Blueberry	Summer	10/09/2015	1	10b	RBV	M	Sub-adult	70	24	
Blueberry	Summer	10/09/2015	1	11	Empty					
Blueberry	Summer	10/09/2015	1	12	Empty					
Blueberry	Summer	10/09/2015	1	13	Empty					
Blueberry	Summer	10/09/2015	1	14	Empty					
Blueberry	Summer	10/09/2015	1	15a	Empty					
Blueberry	Summer	10/09/2015	1	15b	Empty					
Blueberry	Summer	10/09/2015	1	16	Empty					
Blueberry	Summer	10/09/2015	1	17	Empty					
Blueberry	Summer	10/09/2015	1	18	Empty					
Blueberry	Summer	10/09/2015	1	19	RBV	F	Adult	80	19	
Blueberry	Summer	10/09/2015	1	20a	Empty					
Blueberry	Summer	10/09/2015	1	20b	S					No measurement
Blueberry	Summer	11/09/2015	2	1a	RBV	F	Adult	90	25	
Blueberry	Summer	11/09/2015	2	1b	Empty					
Blueberry	Summer	11/09/2015	2	2	Empty					Broken not set
Blueberry	Summer	11/09/2015	2	3	RBV	M	Sub-adult	75	21	

Site	Season	date	trap night	Trap Number	Species	Sex (M/F)	Age Class	Body length (cm)	Weight (g)	Comments
Blueberry	Summer	11/09/2015	2	4	Empty					
Blueberry	Summer	11/09/2015	2	5a	Empty					
Blueberry	Summer	11/09/2015	2	5b	RBV	M	Sub-adult	75	21	
Blueberry	Summer	11/09/2015	2	6	RBV	M	Adult	80	21	
Blueberry	Summer	11/09/2015	2	7	Empty					
Blueberry	Summer	11/09/2015	2	8	RBV	M	Juvenile	75	16	
Blueberry	Summer	11/09/2015	2	9	Empty					
Blueberry	Summer	11/09/2015	2	10a	Empty					
Blueberry	Summer	11/09/2015	2	10b	S					Mortality
Blueberry	Summer	11/09/2015	2	11	Empty					
Blueberry	Summer	11/09/2015	2	12	S					Mortality
Blueberry	Summer	11/09/2015	2	13	Empty					
Blueberry	Summer	11/09/2015	2	14	RBV		Juvenile	65	14	Escaped
Blueberry	Summer	11/09/2015	2	15a	Empty					
Blueberry	Summer	11/09/2015	2	15b	Empty					
Blueberry	Summer	11/09/2015	2	16	RBV	M	Adult	90	22	
Blueberry	Summer	11/09/2015	2	17	Empty					
Blueberry	Summer	11/09/2015	2	18	RBV	M	Adult	80	19	
Blueberry	Summer	11/09/2015	2	19	RBV	F	Adult	80	20	
Blueberry	Summer	11/09/2015	2	20a	S					Mortality
Blueberry	Summer	11/09/2015	2	20b	Empty					
Rainbow	Summer	10/09/2015	1	1a	Empty					
Rainbow	Summer	10/09/2015	1	1b	Empty					
Rainbow	Summer	10/09/2015	1	2	Empty					
Rainbow	Summer	10/09/2015	1	3	Empty					
Rainbow	Summer	10/09/2015	1	4	DM	F	Juvenile	65	15	
Rainbow	Summer	10/09/2015	1	5a	Empty					
Rainbow	Summer	10/09/2015	1	5b	Empty					
Rainbow	Summer	10/09/2015	1	6	Empty					
Rainbow	Summer	10/09/2015	1	7	Empty					
Rainbow	Summer	10/09/2015	1	8	Empty					
Rainbow	Summer	10/09/2015	1	9	S					Mortality
Rainbow	Summer	10/09/2015	1	10a	Empty					
Rainbow	Summer	10/09/2015	1	10b	DM	F	Sub-adult	70	29	
Rainbow	Summer	10/09/2015	1	11	Empty					
Rainbow	Summer	10/09/2015	1	12	Empty					
Rainbow	Summer	10/09/2015	1	13	DM	F	Juvenile	65	16	

Site	Season	date	trap night	Trap Number	Species	Sex (M/F)	Age Class	Body length (cm)	Weight (g)	Comments
Rainbow	Summer	10/09/2015	1	14	DM	M	Sub-adult	70	17	
Rainbow	Summer	10/09/2015	1	15a	Empty					
Rainbow	Summer	10/09/2015	1	15b	Empty					
Rainbow	Summer	10/09/2015	1	16	Empty					
Rainbow	Summer	10/09/2015	1	17	Empty					
Rainbow	Summer	10/09/2015	1	18	Empty					
Rainbow	Summer	10/09/2015	1	19	Empty					
Rainbow	Summer	10/09/2015	1	20a	Empty					
Rainbow	Summer	10/09/2015	1	20b	RBV	M	Sub-adult	80	20	
Rainbow	Summer	11/09/2015	2	1a	Empty					
Rainbow	Summer	11/09/2015	2	1b	Empty					
Rainbow	Summer	11/09/2015	2	2	S					Mortality
Rainbow	Summer	11/09/2015	2	3	Empty					
Rainbow	Summer	11/09/2015	2	4	Empty					
Rainbow	Summer	11/09/2015	2	5a	Empty					
Rainbow	Summer	11/09/2015	2	5b	Empty					
Rainbow	Summer	11/09/2015	2	6	Empty					
Rainbow	Summer	11/09/2015	2	7	Empty					
Rainbow	Summer	11/09/2015	2	8	Empty					
Rainbow	Summer	11/09/2015	2	9	Empty					
Rainbow	Summer	11/09/2015	2	10a	Empty					
Rainbow	Summer	11/09/2015	2	10b	DM	M	Adult	75	30	
Rainbow	Summer	11/09/2015	2	11	DM	M	Juvenile	70	17	
Rainbow	Summer	11/09/2015	2	12	Empty					
Rainbow	Summer	11/09/2015	2	13	RBV	F	Adult	80	23	
Rainbow	Summer	11/09/2015	2	14	Empty					
Rainbow	Summer	11/09/2015	2	15a	Empty					
Rainbow	Summer	11/09/2015	2	15b	Empty					
Rainbow	Summer	11/09/2015	2	16	DM	F	Juvenile	65	15	
Rainbow	Summer	11/09/2015	2	17	Empty					
Rainbow	Summer	11/09/2015	2	18	Empty					
Rainbow	Summer	11/09/2015	2	19	Empty					
Rainbow	Summer	11/09/2015	2	20a	DM	F	Juvenile	70	16	
Rainbow	Summer	11/09/2015	2	20b	YPC					No measurement
Function	Summer	24/09/2015	1	1a	DM	M	Adult	80	19	
Function	Summer	24/09/2015	1	1b	DM					Escaped

Site	Season	date	trap night	Trap Number	Species	Sex (M/F)	Age Class	Body length (cm)	Weight (g)	Comments
Function	Summer	24/09/2015	1	2	Empty					
Function	Summer	24/09/2015	1	3	Empty					
Function	Summer	24/09/2015	1	4	DM	M	Sub-adult	75	25	
Function	Summer	24/09/2015	1	5a	DM	F	Sub-adult	65	19	
Function	Summer	24/09/2015	1	5b	DM	F	Adult	85	30	
Function	Summer	24/09/2015	1	6	DM					Escaped
Function	Summer	24/09/2015	1	7	DM	M	Juvenile	70	14	
Function	Summer	24/09/2015	1	8	DM	M	Juvenile	65		no weight, bag wet and too heavy for scale
Function	Summer	24/09/2015	1	9	Empty					
Function	Summer	24/09/2015	1	10a	Empty					No trap (visited by a bear during pre-baiting)
Function	Summer	24/09/2015	1	10b	Empty					No trap (visited by a bear during pre-baiting)
Function	Summer	24/09/2015	1	11	Empty					No trap (visited by a bear during pre-baiting)
Function	Summer	24/09/2015	1	12	Empty					
Function	Summer	24/09/2015	1	13	Empty					No trap (visited by a bear during pre-baiting)
Function	Summer	24/09/2015	1	14	Empty					
Function	Summer	24/09/2015	1	15a	Empty					
Function	Summer	24/09/2015	1	15b	Empty					
Function	Summer	24/09/2015	1	16	DM	M	Juvenile	65		
Function	Summer	24/09/2015	1	17	DM					Escaped
Function	Summer	24/09/2015	1		DM	M	Juvenile	70		Two mice in one trap
Function	Summer	24/09/2015	1	18	LTV	M	Adult	95		
Function	Summer	24/09/2015	1	19	Empty					
Function	Summer	24/09/2015	1	20a	Empty					
Function	Summer	24/09/2015	1	20b	Empty					
Function	Summer	25/09/2015	2	1a	Empty					
Function	Summer	25/09/2015	2	1b	Empty					
Function	Summer	25/09/2015	2	2	Empty					
Function	Summer	25/09/2015	2	3	DM	M	Sub-adult	75	20	
Function	Summer	25/09/2015	2	4	Empty					
Function	Summer	25/09/2015	2	5a	DM	F	Adult	75		no weight bag too wet and heavy
Function	Summer	25/09/2015	2	5b	DM	M	Sub-adult	75	22	
Function	Summer	25/09/2015	2	6	DM					Escaped

Site	Season	date	trap night	Trap Number	Species	Sex (M/F)	Age Class	Body length (cm)	Weight (g)	Comments
Function	Summer	25/09/2015	2	7	DM	M	Sub-adult	75		
Function	Summer	25/09/2015	2	8	DM	M	Sub-adult	75		
Function	Summer	25/09/2015	2	9	Empty					
Function	Summer	25/09/2015	2	10a	Empty					No trap (visited by a bear during pre-baiting)
Function	Summer	25/09/2015	2	10b	Empty					No trap (visited by a bear during pre-baiting)
Function	Summer	25/09/2015	2	11	Empty					No trap (visited by a bear during pre-baiting)
Function	Summer	25/09/2015	2	12	DM	F	Juvenile	70		
Function	Summer	25/09/2015	2	13	Empty					No trap (visited by a bear during pre-baiting)
Function	Summer	25/09/2015	2	14	DM	M	Adult	80		
Function	Summer	25/09/2015	2	15a	DM	F	Sub-adult	75		
Function	Summer	25/09/2015	2	15b	DM	M	Juvenile	70		
Function	Summer	25/09/2015	2	16	DM	F	Juvenile	70		
Function	Summer	25/09/2015	2	17	Empty					
Function	Summer	25/09/2015	2	18	Empty					
Function	Summer	25/09/2015	2	19	Empty					
Function	Summer	25/09/2015	2	20a	DM	F	Sub-adult	70		
Function	Summer	25/09/2015	2	20b	Empty					

APPENDIX G: ECOSYSTEM MONITORING THRESHOLDS

Table 48: Density estimates for North American beavers *(Castor canadensis)* in Canada expressed as the average number of beaver colonies/km^2 or number of beaver colonies/ km of river.

Abundance	Unit	Site	Location	Year	Reference
0.85	Colonies/km^2	Blackfoot and Ministik	Alberta	1975	Larson and Gunson 1983*
3.51	Colonies/km^2	Minburn Grazing reserve	Alberta	1968	Larson and Gunson 1983*
0.93	Colonies/km^2	Elk Island National Park	Alberta	1973	Larson and Gunson 1983*
0.9	Colonies/km^2	Mackay River	Alberta	1981	Larson and Gunson 1983*
0.4	Colonies/km^2	Wood Buffalo National Park	Alberta	1983	Larson and Gunson 1983*
0.12	Colonies/km^2	Liard North	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
0.25	Colonies/km^2	TroutWest	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
1	Colonies/km^2	Kakisa	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
0.17	Colonies/km^2	Trout East	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
0.17	Colonies/km^2	Simpson West	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
0.16	Colonies/km^2	Mink Lake	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
0.58	Colonies/km^2	Martin River	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
0.46	Colonies/km^2	Dettah Eas	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
0.37	Colonies/km^2	Yellowknife West	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
0.27	Colonies/km^2	Ft. Rae East	Northwest Territories/Yukon	N/A	Poole and Croft 1990*
0.53	Colonies/km^2	WiliowLake	Northwest Territories/Yukon	1989-2001	Popko et al. 2002*
0.5	Colonies/km^2	8rackett Lak	Northwest Territories/Yukon	1989	Poole and Croft 1990*
0.22	Colonies/km^2	Oscar Lake	Northwest Territories/Yukon	1989-2001	Popko et al. 2002*
0.75	Colonies/km^2	Ramparts River	Northwest Territories/Yukon	1989-2001	Popko et al. 2002*

Abundance	Unit	Site	Location	Year	Reference
0.17	Colonies/km^2	Richardson Mountains	Northwest Territories/Yukon	1973	Dennington and Johnson 1974*
0.3	Colonies/km^2	Mackenzie Delta	Northwest Territories/Yukon	1962-65/65-67	Larson and Gunson 1983, Aleksiuk 1969*
0.13	Colonies/km^2	Mackenzie River Valley	Northwest Territories/Yukon	1973	Larson and Gunson 1984*
0.13	Colonies/km of river	Fort Smith	Northwest Territories/Yukon	1951-49	Fuller 1953*
0.3	Colonies/km of river	Fort Laird	Northwest Territories/Yukon	1956	Novakowski 1965*
0.4	Colonies/km of river	Wood Buffalo National Park	Northwest Territories/Yukon	1958	Novakowski 1965*
0.27	Colonies/km of river	Liard North/Muskeg River	Northwest Territories/Yukon	1989	Poole and Croft 1990*
0.5	Colonies/km of river	Hay River- Fort Providence	Northwest Territories/Yukon	1955	Novakowski 1965*
0.45	Colonies/km of river	Kakisa River	Northwest Territories/Yukon	1989	Poole and Croft 1990*
0.16	Colonies/km of river	Fort Providence	Northwest Territories/Yukon	1951	Fuller 1953*
0.67	Colonies/km of river	Birch River	Northwest Territories/Yukon	1989	Poole and Croft 1990*
0.2	Colonies/km of river	Fort Simpson	Northwest Territories/Yukon	1956	Novakowski 1965*
0.31	Colonies/km of river	Laferte River	Northwest Territories/Yukon	1989	Poole and Croft 1990*
0.45	Colonies/km of river	Mink Lake Horn River	Northwest Territories/Yukon	1989	Poole and Croft 1990*
0.45	Colonies/km of river	Martin River	Northwest Territories/Yukon	1989	Poole and Croft 1990*
0.1	Colonies/km of river	Wrigley	Northwest Territories/Yukon	1956	Novakowski 1965*
0.4	Colonies/km of river	Fort Norman	Northwest Territories/Yukon	1955	Novakowski 1965*
0.3	Colonies/km of river	Fort Franklin-Déline-Great Bear lake	Northwest Territories/Yukon	1955	Novakowski 1965*
0.4	Colonies/km of river	Fort Good Hope	Northwest Territories/Yukon	1955	Novakowski 1965*

Abundance	Unit	Site	Location	Year	Reference
0.2	Colonies/km of river	Fort McPherson	Northwest Territories/Yukon	1957	Novakowski 1965*
0.2	Colonies/km of river	Arctic Red River	Northwest Territories/Yukon	1957	Novakowski 1965*

*: Jarema, 2006.

Table 49: Density estimates of bull trout (*Salvelinus confluentus*) expressed as the number of fish per m^2

Abundance	Unit	Life stage	Site	Location	Year	Reference
0.6	fish/m^2	Juvenile	Upper Coldwater	Kelowna, BC	2006	Decker, 2007
1	fish/m^2	Juvenile	Juliet	Kelowna, BC	2006	Decker, 2007
0.9	fish/m^2	Juvenile	Upper spius	Kelowna, BC	2006	Decker, 2007
0.05	fish/m^2	Juvenile	Lower Coldwater	Kelowna, BC	2001-2006	Decker, 2007
0.01	fish/m^2	Juvenile	Lower Spius	Kelowna, BC	2001-2006	Decker, 2007

Table 50: Abundance of two species of carabid beetle expressed as the number of beetle per trap night

Abundance	Species	Unit	Habitat	Site	Location	Year	Reference
0.066	*Pterostichus herculaneus*	Beetles/ trap night	Mature forest	Aquarium	Stanley park, Vancouver, BC	2007	McLean and Li, 2009
0.005	*Scaphinotus angusticollis*	Beetles/ trap night	Mature forest	Aquarium	Stanley park, Vancouver, BC	2007	McLean and Li, 2009
0.093	*Pterostichus herculaneus*	Beetles/ trap night	Mature forest	Hollow tree	Stanley park, Vancouver, BC	2007	McLean and Li, 2009
0.033	*Scaphinotus angusticollis*	Beetles/ trap night	Mature forest	Hollow tree	Stanley park, Vancouver, BC	2007	McLean and Li, 2009
0.058	*Pterostichus herculaneus*	Beetles/ trap night	Mature forest	South creek trail	Stanley park, Vancouver, BC	2007	McLean and Li, 2009
0.043	*Scaphinotus angusticollis*	Beetles/ trap night	Mature forest	South creek trail	Stanley park, Vancouver, BC	2007	McLean and Li, 2009
0.065	*Pterostichus herculaneus*	Beetles/ trap night	Mature forest	Merilees trail	Stanley park, Vancouver, BC	2007	McLean and Li, 2009
0.008	*Scaphinotus angusticollis*	Beetles/ trap night	Mature forest	Merilees trail	Stanley park, Vancouver, BC	2007	McLean and Li, 2009
0.3	*Scaphinotus angusticollis*	Beetles/ trap night	Hemlock forest	Malcolm Knapp Research Forest	Maple ridge, BC	2000	Lavalle and Richardson, 2010

Abundance	Species	Unit	Habitat	Site	Location	Year	Reference
0.6	*Scaphinotus angusticollis*	Beetles/ trap night	Hemlock forest	Malcolm Knapp Research Forest	Maple ridge, BC	2000	Lavalle and Richardson, 2010
0.01	*Scaphinotus angusticollis*	Beetles/ trap night	Hemlock forest	Malcolm Knapp Research Forest	Maple ridge, BC	2001	Lavalle and Richardson, 2010
0.018	*Scaphinotus angusticollis*	Beetles/ trap night	Hemlock forest	Malcolm Knapp Research Forest	Maple ridge, BC	2001	Lavalle and Richardson, 2010
0.06	*Scaphinotus angusticollis*	Beetles/ trap night	Hemlock forest	Malcolm Knapp Research Forest	Maple ridge, BC	2002	Lavalle and Richardson, 2010
0.04	*Scaphinotus angusticollis*	Beetles/ trap night	Hemlock forest	Malcolm Knapp Research Forest	Maple ridge, BC	2002	Lavalle and Richardson, 2010
0.21	*Scaphinotus angusticollis*	Beetles/ trap night	Hemlock forest	Malcolm Knapp Research Forest	Maple ridge, BC	2002	Lavalle and Richardson, 2010
0.0170	*Pterostichus herculaneus*	Beetles/ trap night	Mature forest	Victoria water shed	South east vancouver island	1992-1993	Craig, 1987
0.0358	*Scaphinotus angusticollis*	Beetles/ trap night	Mature forest	Victoria water shed	South east vancouver island	1992-1993	Craig, 1987
0.0169	*Pterostichus herculaneus*	Beetles/ trap night	Mature forest	Koksilah	South east vancouver island	1992-1993	Craig, 1987
0.0466	*Scaphinotus angusticollis*	Beetles/ trap night	Mature forest	Koksilah	South east vancouver island	1992-1993	Craig, 1987
0.0004	*Pterostichus herculaneus*	Beetles/ trap night	Engelmann Spruce-subapline fir	N/A	East barriere lake, BC	1991-1996	McDowell, 1998
0.0282	*Pterostichus herculaneus*	Beetles/ trap night	interior cedar-hemlock	N/A	East barriere lake, BC	1991-1996	McDowell, 1998

Table 51: abundance of Pileated woodpecker (*Hylatomus pileatus*) expressed as the response rate

Abundance	Unit	Site	Location	Habitat	Year	Reference
0.273	Response rate	Sooke study site	south-eastem Vancouver Island	mature CWHxm forest	1996	Hartwig, 1999
0.25	Response rate	Goldstream park	south-eastem Vancouver Island	mature CWHxm forest	1996	Hartwig, 1999
0.095	Response rate	East sooke park	south-eastem Vancouver Island	mature CWHxm forest	1996	Hartwig, 1999
0.063	Response rate	Cowichan river park	south-eastem Vancouver Island	mature CWHxm forest	1996	Hartwig, 1999
0.333	Response rate	Francis king park	south-eastem Vancouver Island	mature CWHxm forest	1996	Hartwig, 1999

Abundance	Unit	Site	Location	Habitat	Year	Reference
0.067	Response rate	thetis lake park	south-eastem Vancouver Island	mature CWHxm forest	1996	Hartwig, 1999
0	Response rate	bugaboo creek	south-eastem Vancouver Island	mature CWHxm forest	1996	Hartwig, 1999
0	Response rate	lizard lake	south-eastem Vancouver Island	mature CWHxm forest	1996	Hartwig, 1999
0.051	Response rate	Niagara	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.075	Response rate	Sooke study site	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0	Response rate	Hillridge	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0	Response rate	Hillridge	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.048	Response rate	Niagara	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.119	Response rate	Niagara	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.175	Response rate	Sooke	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.116	Response rate	Sooke	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.116	Response rate	Rithet	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.14	Response rate	Rithet	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.027	Response rate	Hillridge	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.122	Response rate	Niagara	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.163	Response rate	Niagara	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.119	Response rate	Sooke	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.178	Response rate	Sooke	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999
0.049	Response rate	Rithet	south-eastem Vancouver Island	mature CWHxm forest	1997	Hartwig, 1999

Table 52: Density of rainbow trout (*Oncorhynchus mykiss*) expressed as the number of fish per square meter

Abundance	Unit	Site	Location	Habitat	Life stage	Year	Reference
3.84	fish/m^2	site 1	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
7.5	fish/m^2	site 1	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
11.54	fish/m^2	site 1	Cheakamus river	Stream	Juvenile	2009	Golder, 2013
12.85	fish/m^2	site 1	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
11.3	fish/m^2	site 1	Cheakamus river	Stream	Juvenile	2011	Golder, 2013
13.6	fish/m^2	site 2	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
15.77	fish/m^2	site 2	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
26.73	fish/m^2	site 2	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
18.18	fish/m^2	site 2	Cheakamus river	Stream	Juvenile	2011	Golder, 2013
9.5	fish/m^2	site 2	Cheakamus river	Stream	Juvenile	2012	Golder, 2013
3.57	fish/m^2	site 3	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
24.05	fish/m^2	site 3	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
49.38	fish/m^2	site 3	Cheakamus river	Stream	Juvenile	2009	Golder, 2013
10.52	fish/m^2	site 3	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
3.31	fish/m^2	site 3	Cheakamus river	Stream	Juvenile	2011	Golder, 2013
6.34	fish/m^2	site 4	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
19.05	fish/m^2	site 4	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
62.43	fish/m^2	site 4	Cheakamus river	Stream	Juvenile	2009	Golder, 2013
13.33	fish/m^2	site 4	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
4.85	fish/m^2	site 4	Cheakamus river	Stream	Juvenile	2011	Golder, 2013
8.5	fish/m^2	site 5	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
40.66	fish/m^2	site 5	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
38.1	fish/m^2	site 5	Cheakamus river	Stream	Juvenile	2009	Golder, 2013
24.69	fish/m^2	site 5	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
17.1	fish/m^2	site 5	Cheakamus river	Stream	Juvenile	2011	Golder, 2013

Abundance	Unit	Site	Location	Habitat	Life stage	Year	Reference
11.84	fish/m^2	site 6	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
29.93	fish/m^2	site 6	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
53.77	fish/m^2	site 6	Cheakamus river	Stream	Juvenile	2009	Golder, 2013
17.69	fish/m^2	site 6	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
15.03	fish/m^2	site 6	Cheakamus river	Stream	Juvenile	2011	Golder, 2013
11.23	fish/m^2	site 7	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
9.2	fish/m^2	site 7	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
29.69	fish/m^2	site 7	Cheakamus river	Stream	Juvenile	2009	Golder, 2013
7.5	fish/m^2	site 7	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
11.74	fish/m^2	site 7	Cheakamus river	Stream	Juvenile	2011	Golder, 2013
16.2	fish/m^2	site 8	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
50.44	fish/m^2	site 8	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
68.82	fish/m^2	site 8	Cheakamus river	Stream	Juvenile	2009	Golder, 2013
11.48	fish/m^2	site 8	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
26.33	fish/m^2	site 8	Cheakamus river	Stream	Juvenile	2011	Golder, 2013
11.55	fish/m^2	site 9	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
8.97	fish/m^2	site 9	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
15.37	fish/m^2	site 9	Cheakamus river	Stream	Juvenile	2009	Golder, 2013
11.33	fish/m^2	site 9	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
2	fish/m^2	site 9	Cheakamus river	Stream	Juvenile	2011	Golder, 2013
2	fish/m^2	site 10	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
17.64	fish/m^2	site 10	Cheakamus river	Stream	Juvenile	2007	Golder, 2013
12.98	fish/m^2	site 10	Cheakamus river	Stream	Juvenile	2008	Golder, 2013
40.21	fish/m^2	site 10	Cheakamus river	Stream	Juvenile	2009	Golder, 2013
19.5	fish/m^2	site 10	Cheakamus river	Stream	Juvenile	2010	Golder, 2013
9.42	fish/m^2	site 10	Cheakamus river	Stream	Juvenile	2011	Golder, 2013

Table 53: Abundance of southern red-backed vole (*Myodes gapperi*) expressed as the number of vole per 100 trap nights

Abundance	Unit	Site	Location	Habitat	Year	Reference
177	Voles/100 trap night	N/A	Saskatchewan	Southern boreal mixedwood forest	1994-1996	Bayne and Hobson 1998
236	Voles/100 trap night	N/A	Saskatchewan	Southern boreal mixedwood forest	1994-1996	Bayne and Hobson 1998
273	Voles/100 trap night	N/A	Saskatchewan	southern boreal mixedwood forest	1994-1996	Bayne and Hobson 1998
6	Voles/100 trap night	Site MB1	southeastern Wyoming	Subalpine conifer forest	N/A	Keinath and Hayward, 2003
3.4	Voles/100 trap night	Site MB2	southeastern Wyoming	Subalpine conifer forest	N/A	Keinath and Hayward, 2003
6.5	Voles/100 trap night	Site MB3	southeastern Wyoming	Subalpine conifer forest	N/A	Keinath and Hayward, 2003
0.5	Voles/100 trap night	N/A	Maple ridge BC	Mature growth forest	1999	Cockle and Richardson, 2003
0.4	Voles/100 trap night	N/A	Maple ridge BC	Mature growth forest	2000	Cockle and Richardson, 2003
2.1	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1995	Hannon et al., 2002
13.7	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1995	Hannon et al., 2002
1.6	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1996	Hannon et al., 2002
15.3	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1996	Hannon et al., 2002
4.2	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1997	Hannon et al., 2002
25.3	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1997	Hannon et al., 2002
13.7	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1998	Hannon et al., 2002
1.6	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1995	Hannon et al., 2002
16.8	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1995	Hannon et al., 2002
0.5	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1996	Hannon et al., 2002

Abundance	Unit	Site	Location	Habitat	Year	Reference
11.6	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1996	Hannon et al., 2002
2.1	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1997	Hannon et al., 2002
24.2	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1997	Hannon et al., 2002
13.7	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1998	Hannon et al., 2002
5.3	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1995	Hannon et al., 2002
9.5	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1995	Hannon et al., 2002
0.5	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1996	Hannon et al., 2002
4.2	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1996	Hannon et al., 2002
1.1	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1997	Hannon et al., 2002
13.7	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1997	Hannon et al., 2002
7.9	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1998	Hannon et al., 2002
4.2	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1995	Hannon et al., 2002
5.3	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1995	Hannon et al., 2002
2.6	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1996	Hannon et al., 2002
4.2	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1996	Hannon et al., 2002
0.5	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1997	Hannon et al., 2002
8.9	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1997	Hannon et al., 2002
6.8	Voles/100 trap night	N/A	Alberta	Boreal mixedwood forest	1998	Hannon et al., 2002

Table 54: Densities of coastal tailed frog (*Ascaphus truei*) tadpole expressed as the number of tadpole per square meter

Abundance	Unit	Site	Location	Habitat	Year	Reference
4.3	Tadpoles/m^2	Shannon	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
4.6	Tadpoles/m^2	Shannon	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
0.5	Tadpoles/m^2	Shannon	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
2.2	Tadpoles/m^2	Shannon	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
2.7	Tadpoles/m^2	Shannon	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
3.4	Tadpoles/m^2	Carpenter	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
2.6	Tadpoles/m^2	Carpenter	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
2	Tadpoles/m^2	Carpenter	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
0.8	Tadpoles/m^2	Carpenter	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
9.7	Tadpoles/m^2	Carpenter	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
1.3	Tadpoles/m^2	Carpenter	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
0.3	Tadpoles/m^2	Kleanza	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
0.1	Tadpoles/m^2	Kleanza	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
0.6	Tadpoles/m^2	Kleanza	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
2.5	Tadpoles/m^2	Kleanza	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
5.8	Tadpoles/m^2	Kleanza	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
0.2	Tadpoles/m^2	Kleanza	Terrace, BC	Clear-cut	1994	Dupuis and Steventon, 1999
3.1	Tadpoles/m^2	Kleanza	Terrace, BC	Clear-cut	1994	Dupuis and Steventon, 1999
1.5	Tadpoles/m^2	Copper	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
1.3	Tadpoles/m^2	Copper	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
4.4	Tadpoles/m^2	Copper	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
5.6	Tadpoles/m^2	Copper	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
0.4	Tadpoles/m^2	Copper	Terrace, BC	clear-cut	1994	Dupuis and Steventon, 1999
1.1	Tadpoles/m^2	Trap	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
2.3	Tadpoles/m^2	Trap	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999

Abundance	Unit	Site	Location	Habitat	Year	Reference
0.1	Tadpoles/m^2	Trap	Terrace, BC	Clear-cut	1994	Dupuis and Steventon, 1999
0.7	Tadpoles/m^2	Trap	Terrace, BC	Clear-cut	1994	Dupuis and Steventon, 1999
9.2	Tadpoles/m^2	Clore	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
2.3	Tadpoles/m^2	Clore	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
0.9	Tadpoles/m^2	Clore	Terrace, BC	Old growth	1994	Dupuis and Steventon, 1999
0.9	Tadpoles/m^2	Clore	Terrace, BC	Buffered clear-cut	1994	Dupuis and Steventon, 1999
0.2	Tadpoles/m^2	Clore	Terrace, BC	Clear-cut	1994	Dupuis and Steventon, 1999
1	Tadpoles/m^2	Clore	Terrace, BC	Clear-cut	1994	Dupuis and Steventon, 1999
1.8	Tadpoles/m^2	N/A	Terrace, BC	CWHws	1996	Steventon et al., 1996
2.3	Tadpoles/m^2	N/A	Terrace, BC	CWHws	1996	Steventon et al., 1996
0.3	Tadpoles/m^2	N/A	Terrace, BC	CWHws	1996	Steventon et al., 1996
1.9	Tadpoles/m^2	N/A	BC	N/A	1994-1995	https://www.registrelep-sararegistry.gc.ca/default.asp?lang=En&n=7736032F-1#_Toc316374113

APPENDIX H: CLIMATE CHANGE INDICATORS

Table 55: Alta Lake Ice Records

Year	Ice-On	Ice-Off	Barrel	Day Ice-on	Day Ice-off	Year	Year	Days frozen
1942	04-Dec-42	19-Apr-43		338	100	1942	1942	136.00
1943	15-Dec-43	13-Apr-44		349	109	1943	1943	120.00
1944	15-Dec-44	27-Apr-45		350	104	1944	1944	132.00
1945	08-Nov-45	20-Apr-46		312	117	1945	1945	163.00
1946	20-Nov-46	13-Apr-47		324	110	1946	1946	144.00
1947	11-Dec-47	07-May-48		345	103	1947	1947	148.00
1948	18-Dec-48	19-Apr-49		353	128	1948	1948	121.00
1949	14-Dec-49	24-Apr-50		348	109	1949	1949	131.00
1950	02-Dec-50	19-Apr-51		336	114	1950	1950	138.00
1951	13-Dec-51	21-May-52		347	109	1951	1951	160.00
1952	22-Dec-52	08-May-53		357	142	1952	1952	136.00
1953	10-Jan-54	05-May-54		10	128	1953	1953	115.00
1954	26-Dec-54	07-May-55		360	125	1954	1954	132.00
1955	18-Dec-55			352	127	1955	1955	
1956	01-Dec-56	23-Apr-57		336		1956	1956	142.00
1957	26-Dec-57	08-Apr-58		360	113	1957	1957	103.00
1958	26-Nov-58	23-Apr-59		330	98	1958	1958	148.00
1959	05-Dec-59	16-Apr-60		339	113	1959	1959	133.00
1960	10-Dec-60	10-Apr-61		345	107	1960	1960	120.00
1961	01-Dec-61	09-Apr-62		335	100	1961	1961	129.00
1962		23-Mar-63	21-Apr-62		99	1962	1962	
1963	13-Dec-63	24-Apr-64		347	82	1963	1963	133.00
1964	11-Dec-64	22-Apr-65		346	115	1964	1964	131.00
1965	12-Dec-65	21-Apr-66		346	112	1965	1965	130.00
1966		30-Apr-67			111	1966	1966	
1967	12-Dec-67	27-Apr-68		346	120	1967	1967	137.00
1968	05-Dec-68	07-May-69		340	118	1968	1968	152.00
1969	15-Jan-70	06-Apr-70		15	127	1969	1969	82.00
1970	04-Dec-70	06-May-71		338	97	1970	1970	153.00
1971	14-Dec-71	02-May-72		348	126	1971	1971	140.00
1972	28-Dec-72	11-Apr-73		363	123	1972	1972	103.00
1973	24-Nov-73	28-Apr-74		328	101	1973	1973	155.00
1974					118	1974	1974	
1975	12-Dec-75			346		1975	1975	
1976						1976	1976	
1977						1977	1977	
1978						1978	1978	

Year	Ice-On	Ice-Off	Barrel	Day Ice-on	Day Ice-off	Year	Year	Days frozen
1979						1979	1979	
1980						1980	1980	
1981						1981	1981	
1982						1982	1982	
1983						1983	1983	
1984						1984	1984	
1985						1985	1985	
1986						1986	1986	
1987						1987	1987	
1988						1988	1988	
1989						1989	1989	
1990						1990	1990	
1991						1991	1991	
1992						1992	1992	
1993						1993	1993	
1994						1994	1994	
1995						1995	1995	
1996						1996	1996	
1997						1997	1997	
1998						1998	1998	
1999						1999	1999	
2000						2000	2000	
2001						2001	2001	
2002			14-Apr-02			2002	2002	
2003			17-Mar-03			2003	2003	
2004			25-Mar-04			2004	2004	
2005	6-Jan-06	8-Mar-06		6		2005	2005	61.00
2006	30-Nov-06	10-Apr-07		334	67	2006	2006	131.00
2007	10-Dec-07	29-Apr-08	29-Apr-08	344	100	2007	2007	141.00
2008	20-Dec-08	28-Apr-09	29-Apr-09	355	120	2008	2008	128.00
2009	08-Dec-09	28-Mar-10	28-Mar-11	342	118	2009	2009	110.00
2010	04-Dec-10	23-Apr-11	23-Apr-11	338	87	2010	2010	140.00
2011			23-Apr-12		113	2011	2011	
2012	16-Dec-12	03-Apr-23	02-Apr-13	351		2012	2012	107.00
2013	21-Dec-13	14-Apr-14		355	93	2013	2013	114.00
2014	26-Dec-14	20-Feb-15		360	104	2014	2014	56.00
2015	24–Dec-15							