CASCADE ENVIRONMENTAL
RESOURCE GROUP LTD

# RMOW Ecosystems Monitoring Report 2014

## Whistler, BC

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# Executive Summary

This report documents ecosystem monitoring efforts for 2014 in the Resort Municipality of Whistler (RMOW). In 2013, in an effort to incorporate existing work commissioned by the RMOW, Cascade built on the previous study, *A Proposed Framework for the use of Ecological Data in Monitoring and Promoting the Conservation of Biodiversity in Whistler* (Golder 2008).This report documents the second year of this monitoring program and compares results from 2013 (Cascade, 2013). Monitoring took place in the spring, summer and fall of 2014, 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).

**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. After collecting basic water quality data from the creeks Cascade determined that all water quality measures were within acceptable BC water quality parameters. 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. Fish species composition and population were determined in Crabapple Creek, Jordan Creek and the River of Golden Dreams. No bull trout were captured in 2014. In Jordan creek there was a slight increase in rainbow trout abundance at one of the site surveyed. In 2014 the sample site on the River of Golden Dream, was changed in 2014 and rainbow trout were observed with absolute abundance (number of fish per square metre) of 0.05 fish/$m^2$.The fish abundance was measured for the first time in Crabapple Creek in 2014 giving an absolute abundance of 0.08 fish/$m^2$ for rainbow trout and 0.05 fish/$m^2$ for cutthroat trout

The RMOW Environmental Stewardship staff and Whistler Fisheries Stewardship Group volunteers carried out spawning surveys for rainbow trout and kokanee in 2014. Six rainbow trout were observed spawning in Millar Creek, and in Lakeside Creek there were 228 observations of rainbow trout spawning. During the 2014 kokanee spawning surveys, no kokanee were observed in any of the creeks surveyed 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 in both terrestrial and aquatic environments because of their dual life histories. While 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 Cree. In total seven tadpoles were found in Alpha Creek, one tadpole in Scotia Creek, none in Nineteen Mile Creek and twelve in Crabapple Creek. The abundance (measured in number of tadpoles per square metre) ranged from 0.028 to 0.442 tadpoles per $m^2$. The abundance of coastal tailed frogs caught in Alpha Creek and Scotia Creek has increased from 2013 to 2014 but this might reflect the increased and more refined survey effort, i.e. three replicate surveys in 2014 versus one survey in 2013.

The beaver survey sites were selected by using previously identified lodge sites. Alpha Lake, Wedge Pond, Green Lake, Fitzsimmons Creek Fan, Nita Lake, the River of Golden Dreams and waterways along Nicklaus North, Chateau and Whistler Golf Courses were re-surveyed for activity and previously undocumented lodges were found. A total of 32 lodges were surveyed in 2014 with 10 of them being active. The population appears

stable compared to the 2013 results but the number of active lodges has decreased compared to the surveys conducted between 2008 and 2010.

**Terrestrial Species Indicators**

An additional ecosystem plot located in a young alluvial forest in function junction was established in 2014. This site, in addition to the two plots established in 2013, was used for carabid beetle and red-backed vole surveys. Pileated woodpeckers (*Hylatomus pileatus*) were also used as a terrestrial indicator species with each species providing information at a different trophic level.

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. Results of the first sampling showed a relative abundance to be 0.262 for Blueberry Hill, 0.036 for Rainbow and 0.429 for Function. The second sampling period had a higher relative abundance for Rainbow (0.131) and Function (2.405) but a lower abundance at Blueberry Hill (0.119).the abundance was similar in 2013 and 2014 at the Blueberry site but the abundance was higher in Rainbow in 2014 compared to 2013

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. Three pileated woodpeckers were observed on three different transects (Comfortably Numb, Whistler Mountain and Stonebridge) making the overall relative abundance 0.011 pileated woodpeckers per hectare which gives a more representative estimate of pileated woodpecker abundance than the abundance observed in 2013 where one pileated woodpecker was recorded giving an relative abundance of.0.007 pileated woodpecker per hectare.

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. Relative abundance of red-backed vole (measured in number of individuals captured per trap night) for the Blueberry site was 0.4 in the spring and 0.08 in the summer, the Rainbow site was 0 in the spring and 0.02 in the summer and for the Function site no data was collected in the spring and the abundance was 0.08 in the summer. Relative abundance was higher in 2013 which could be explained by a slight change in the survey period.

**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 2014 are reported, showing the number of days Alta Lake remained frozen each year and the dates of freeze and thaw each year. No trends of either warming or cooling are readily apparent in the duration or seasonality of the ice on the lake.

**Conlcusions**

The 2014 ecosystem monitoring provides a second 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. To further the project, permanent monitoring stations should be installed and regularly monitored to provide year-round data where they are appropriate and not already installed.

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# 1 Introduction

Cascade Environmental Resource Group (Cascade) respectfully submits this report on the RMOW Ecosystems Monitoring Program for 2014. Cascade has operated in Whistler for over 20 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).

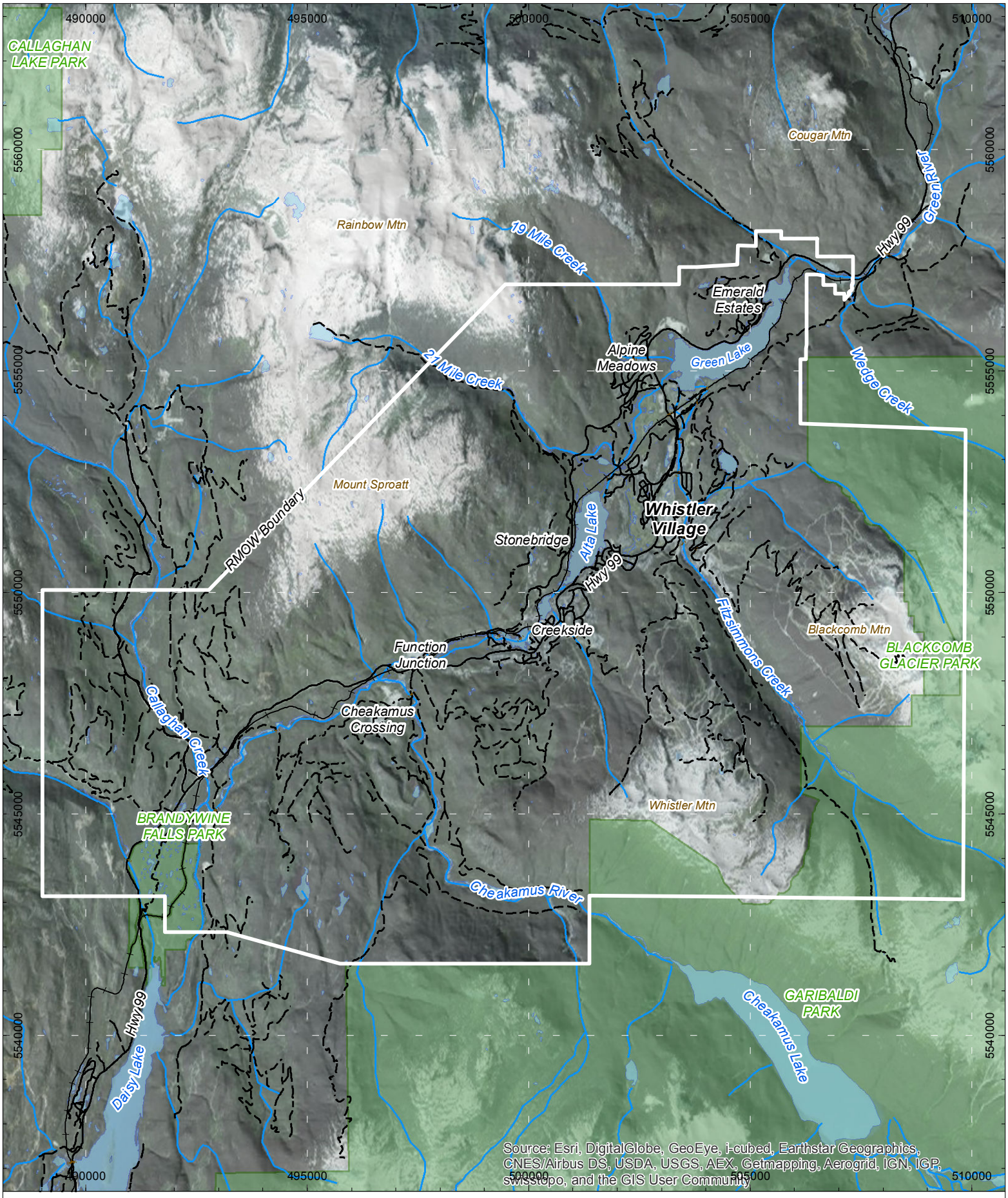
This report provides measurable and quantified data for the biodiversity and ecosystems health indicators selected in the RMOW ecosystem monitoring report of 2013. So that over time, the records can reveals trends that can be used to interpret ecosystem health.

This study represents the second year of data collection of an ongoing program with the capacity to evolve and expand over time, but that will create a baseline record of abundance. Most of the results should be considered as preliminary and as the program is in its early stages the findings are generally insufficient for identification of trends, or risk to ecosystem health. As the program develops and is refined 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.

## 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 the same indicators were monitored and this report delivers the program's findings.




GIS Cartographer: Todd Hellinga
Date: March 11, 2015
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. Identify and monitor select indicators of biodiversity
2. Identify ecological “hotspots”
3. Incorporate inventory data into municipal database/GIS

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 second year using methodologies and at intervals 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.
Charlotte Whitney, 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)
Clare Greenberg, B.Sc. (Executive Director, SSISC)

# 2 Work Plan and Methodology

## 2.1 Identify Ecological Hotspots

One of the objectives of this phase of the program is identification of biodiversity hotspots at the local scale. Although the following definition is aimed at the more typical regional scale, it was agreed upon as a starting point for identification of hotspot indicator sites:

*A biodiversity hotspot is a region with exceptional levels of* endemic *species AND by serious levels of habitat loss.* http://www.conservation.org/where/priority_areas/hotspots/Pages/hotspots_defined.aspx

The RMOW OCP (2013) has identified sensitive ecosystems that should provide candidates for hotspots. Identification of ecological hotspots will be an ongoing process and other than the initial hotspots, should be results-based and directed by the trends revealed by the indicator species monitoring. Building on the theme of scarcity, the RMOW has completed an inventory of terrestrial ecosystem mapping and have identified the rare and special ecosystems of interest. In order to classify specific ecosystems as hotspots, these candidate sites should be at risk of impact by external factors, such as land development, industrial development, infrastructural development, tourism development or recreational activity. Lands that present a potential risk due to development include private lands, provincial and municipal parks, recreation sites and tenured intensive use on Crown land.

Initial identification of hotspots focused on the following conditions:

1. Mature/old forest ecosystems
   Renewable, old forests are becoming rare in the RMOW valley bottom due to development pressure and scarcity combined with high biodiversity constitutes qualifying criterion. Mature and old forests are established ecosystems with naturally high levels of species biodiversity due to their age and the lack of

disturbance. While not necessarily under threat, they may be considered hotspots meriting protection due to the presence of a wide range of endemic species.

2. Forested floodplain ecosystems
   Valley bottom, forested ecosystems occurring on floodplains are identified s are rare in the RMOW valley bottom due to development pressure from the "boom" period of 1980 to 2000. This scarcity combined with high biodiversity values associated with floodplains and riparian vegetation constitutes qualifying criterion.

3. Early succession ecosystems
   With the exception of a few isolated sites, the entire valley bottom was harvested for timber. The period of extensive harvesting began shortly after the start of the last century, with the introduction of the Pacific Great Eastern Railway and carried on well into the 1980's. As a result, early succession ecosystem are widespread and abundant. However, the high level of biodiversity represented by these successional ecosystems constitutes qualifying criterion.

4. Wetland ecosystems
   Wetlands in the Whistler valley have been subjected to encroachment for mining, agriculture, real estate and recreation development. Wetlands are known to be important for protection of biodiversity because species occupation and utilization may be specific and not represented in other ecosystems. As a result, the remaining wetlands are widely recognized as a valued ecosystem component of the community and qualify as hotspots.

5. Other sensitive ecosystems of concern identified by the RMOW include high mountain ecosystems and avalanche tracks. At this time, these identified ecosystems are not included in the hotspots list because the threats are not readily articulated at this time. These may be added to the list in subsequent monitoring studies.

## 2.2 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 meeting with the RMOW. In 2014, the wetland and the invasive species plant survey were not conducted. However a summary of the works conducted by the Sea to Sky Invasive Species Council (SSIC) is presented in this report In addition the number of site surveyed was extended for some species. 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***

- Invertebrates
    - Carabid beetle (Carabidae)
- Invasive Plants (Summary of SSISC monitoring and eradication program )

***Terrestrial Species Indicators***

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

***Climate Indicators***

- Alta Lake freeze-up and thaw dates

# 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.).

During the summer of 2014, Cascade partnered with Dr. Ian Spooner from Acadia University under an NSERC ENGAGE grant to host and support a masters student, Dewey Dunnington, who used paleolimnological techniques to study the impact of human development on Alta Lake. Mr. Dunnington's thesis provides a detailed record of water quality and change over time of Alta Lake.

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 (Table 1 to Table 3).

**Table 1: Basic water quality at each coastal tailed frog tadpole survey site (July 17-18, 2014)**

| Site | Date | Time | Area ($m^2$) | Basic Water Chemistry | | | |
|---|---|---|---|---|---|---|---|
| | | | | *Water Temp. ($^oC$)* | *pH* | *Cond. (µS)* | *Turbidity* |
| Alpha Creek #1 | 2014.07.17 | 12:15 | 18 | 13.1 | 5.60 | 81 | 0.29 |
| Alpha Creek #2 | 2014.07.17 | 12:50 | 15 | 13.0 | 5.57 | 85 | 0.31 |
| Alpha Creek #3 | 2014.07.17 | 13:20 | 36 | 13.2 | 5.65 | 85 | |
| Scotia Creek #1 | 2014.07.17 | 10:10 | 21 | 14.3 | 8.07 | 34 | 0.51 |
| Scotia Creek #2 | 2014.07.17 | 10:35 | 13 | 13.7 | 6.14 | 23 | 0.32 |
| Scotia Creek #3 | 2014.07.17 | 11:05 | 17 | 14.3 | 5.93 | 13 | 0.52 |
| Nineteen Mile Creek #1 | 2014.07.18 | 12:35 | 41 | 9.2 | 5.48 | 9 | 1.87 |
| Nineteen Mile Creek #2 | 2014.07.18 | 11:50 | 25 | 9.7 | 5.56 | 9 | 1.78 |
| Nineteen Mile Creek #3 | 2014.07.18 | 11:10 | 8 | 9.1 | 6.82 | 9 | 1.16 |

| Site | Date | Time | Area ($m^2$) | Basic Water Chemistry | | | |
|---|---|---|---|---|---|---|---|
| | | | | *Water Temp. ($^oC$)* | *pH* | *Cond. (µS)* | *Turbidity* |
| Crabapple Creek #1 | 2014.07.18 | 15:40 | 15 | 15.0 | 5.86 | 179 | 2.02 |
| Crabapple Creek #2 | 2014.07.18 | 14:40 | 16 | 12.2 | 5.95 | 136 | 0.66 |
| Crabapple Creek #3 | 2014.07.18 | 14:15 | 16 | 11.8 | 5.66 | 133 | 0.85 |

**Table 2: Basic water quality at each coastal tailed frog tadpole survey site (August 14-15, 2014)**

| Site | Date | Time | Area ($m^2$) | Basic Water Chemistry | | | |
|---|---|---|---|---|---|---|---|
| | | | | *Water Temp. ($^oC$)* | *pH* | *Cond. (µS)* | *DO (mg/L)* |
| Alpha Creek #1 | 2014.08.14 | 09:35 | 18 | 12.2 | 6.35 | 108 | 9.5 |
| Alpha Creek #2 | 2014.08.14 | 10:20 | 15 | 12.1 | 6.84 | 105 | 9.6 |
| Alpha Creek #3 | 2014.08.14 | 10:47 | 36 | 12.1 | 6.84 | 105 | 9.6 |
| Scotia Creek #1 | 2014.08.14 | 11:41 | 21 | 14.1 | 6.30 | 59 | 8.7 |
| Scotia Creek #2 | 2014.08.14 | 12:19 | 13 | 13.2 | 5.98 | 57 | 9.1 |
| Scotia Creek #3 | 2014.08.14 | 12:54 | 17 | 14.8 | 6.55 | 33 | 9.1 |
| Nineteen Mile Creek #1 | 2014.08.15 | 10:28 | 41 | 10.8 | 6.40 | 17 | 10.6 |
| Nineteen Mile Creek #2 | 2014.08.15 | 10:22 | 25 | 10.9 | 6.30 | 15 | 10.5 |
| Nineteen Mile Creek #3 | 2014.08.15 | 09:54 | 8 | 11.5 | 6.56 | 18 | 10.6 |
| Crabapple Creek #1 | 2014.08.15 | 14:34 | 15 | 11.3 | 8.14 | 193 | 9.2 |
| Crabapple Creek #2 | 2014.08.15 | 14:01 | 16 | 12.8 | 7.75 | 150 | 10.2 |
| Crabapple Creek #3 | 2014.08.15 | 12:58 | 16 | 12.3 | 7.35 | 150 | 10.4 |

**Table 3: Basic water quality at each coastal tailed frog tadpole survey site (September18-19, 2014)**

| Site | Date | Time | Area ($m^2$) | Basic Water Chemistry | | | |
|---|---|---|---|---|---|---|---|
| | | | | *Water Temp. ($^oC$)* | *pH* | *Cond. (µS)* | *DO (mg/L)* |
| Alpha Creek #1 | 2014.09.18 | 12:25 | 18 | 10.3 | 6.36 | 104 | 11.93 |
| Alpha Creek #2 | 2014.09.18 | 13:11 | 15 | 10.0 | 6.01 | 101 | 11.69 |
| Alpha Creek #3 | 2014.09.18 | 13:40 | 36 | 10.0 | 6.01 | 101 | 11.69 |
| Scotia Creek #1 | 2014.09.18 | 10:10 | 21 | 11.7 | 6.49 | 92 | 10.58 |
| Scotia Creek #2 | 2014.09.18 | 10:52 | 13 | 10.8 | 6.80 | 107 | 11.10 |

| Site | Date | Time | Area ($m^2$) | Basic Water Chemistry | | | |
|---|---|---|---|---|---|---|---|
| | | | | *Water Temp. ($^oC$)* | *pH* | *Cond. (µS)* | *DO (mg/L)* |
| Scotia Creek #3 | 2014.09.18 | 11:25 | 17 | 11.6 | 6.45 | 100 | 10.78 |
| Nineteen Mile Creek #1 | 2014.09.19 | 09:50 | 41 | 10.0 | 7.87 | 17 | 11.7 |
| Nineteen Mile Creek #2 | 2014.09.19 | 10:25 | 25 | 10.0 | 6.95 | 14 | 12.14 |
| Nineteen Mile Creek #3 | 2014.09.19 | 10:55 | 8 | 9.9 | 6.69 | 11 | 11.82 |
| Crabapple Creek #1 | 2014.09.19 | 11:45 | 15 | 12.2 | 5.66 | 170 | 10.90 |
| Crabapple Creek #2 | 2014.09.19 | 12:25 | 16 | 10.5 | 5.96 | 137 | 11.2 |
| Crabapple Creek #3 | 2014.09.19 | 13:05 | 16 | 10.2 | 5.86 | 131 | 12.1 |

Prior to electrofishing on Jordan Creek, the River of Golden Dreams and Crabapple Creek, basic water quality measurements were taken. These include temperature, pH, conductivity, turbidity and dissolved oxygen (Table 4).

**Table 4: 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 | 2014.07.25 | 108 | 15.3 | 6.86 | 60 | 1.19 | 9.4 |
| Jordan Creek #2 | 2014.07.25 | 108 | 15.0 | 6.65 | 60 | 1.25 | 9.3 |
| River of Golden Dreams | 2014.07.31 | 100 | 13.5 | 7.45 | 64 | 0.86 | 9.15 |
| Crabapple Creek | 2014.07.31 | 99 | 15.4 | 6.15 | 203 | 2.10 | 10.2 |

The RMOW Environmental Stewardship staff recorded basic water quality parameters in Jordan Creek, Whistler Creek, Crabapple Creek, the River of Golden Dreams and Nineteen Mile Creek during the expected 2014 kokanee spawning season (Table 5).

**Table 5: RMOW kokanee spawning survey water quality**

| Site | Date | Time | Weather | Water Temperature ($^oC$) | Conductivity (µS/s) | pH | TSS (ppm) |
|---|---|---|---|---|---|---|---|
| Jordan Creek | 2014.09.09 | 14:50 | Sunny | 17.4 | 79 | 8.18 | 41 |
| | 2014.09.11 | 11:30 | Sunny | 15.5 | 87 | 8.37 | 39 |
| | 2014.09.18 | 11:20 | Cloudy | 15.5 | 85 | 8.21 | 40 |
| Whistler Creek | 2014.09.09 | 14:30 | Sunny | 13.3 | 95 | 8.76 | 46 |
| | 2014.09.11 | 11:20 | Sunny | 10.8 | 92 | 8.72 | 49 |
| | 2014.09.18 | 11:00 | Cloudy | 12.5 | 91 | ? | 47 |

| Site | Date | Time | Weather | Water Temperature (°C) | Conductivity (µS/s) | pH | TSS (ppm) |
|---|---|---|---|---|---|---|---|
| Crabapple Creek | 2014.09.08 | 08:07 | Partly Cloudy | 12.6 | 244 | 8.23 | 116 |
| River of Golden Dreams | 2014.09.04 | 09:11 | Sunny | 11.3 | 105 | 7.39 | 58 |
| | 2014.09.08 | 08:20 | Partly Cloudy | 11.5 | 102 | 8.05 | 44 |
| Scotia Creek | 2014.09.09 | 19:45 | Clear | 10.0 | 20 | 6.31 | 10 |
| | 2014.09.11 | 19:30 | Clear | 10.3 | 26 | 6.72 | 11 |
| | 2014.09.15 | 22:20 | Clear | 10.4 | 29 | 6.52 | 13 |

#### 3.1.1.1 Discussion and Recommendations

**Temperature**

The temperature data recorded for 2014 indicates decreasing creek temperature from July to September for the majority of creeks monitored. The average daily air temperature in Whistler was 18.4 °C in July, 19.0 °C in August and 14.4°C in September (Environment Canada, 2015). Average maximum daily air temperature was 26.0 °C in July, 25.9 °C in August and 21.2°C in September (Environment Canada, 2015). Decreasing creek temperature from July to September may be due to increasing amounts of meltwater entering the creeks, and may also be influenced by decreases in average daily maximum temperatures.

Nineteen Mile Creek shows significantly lower temperatures than all other creeks monitored in July, and maintains a more consistent temperature throughout the monitoring period than any other creek measured. This may be due to the size, source, or fast-flowing nature of Nineteen Mile Creek.

Jordan Creek shows higher temperatures than other creeks measured in both the July and September monitoring events. This may reflect the fact that the source of Jordan Creek is Nita Lake, so it is not itself glacially fed. Jordan Creek is also shorter than other creeks measured (<500 m), and flow tends to be slower.

**pH**

The Canadian Council of Ministers of the Environment (CCME) water quality guidelines indicate normal pH ranges from 6.5 to 9 (CCME, 2007). Water samples collected from the Whistler watercourses in 2014 generally indicate pH ranges at the low end of the normal range, with many values in the 5.5 to 6.6 pH range. This is fairly indicative of creek systems with limited buffering capacity (due to local rock geochemisty) that receive inputs from melt water and precipitation.

**Conductivity**

Conductivity levels are affected by the presence of inorganic dissolved solids, and vary considerably for the creeks monitored in 2014. Variation between creeks may be due to differences in the geology of the stream catchment area. For example, streams that run through areas with granite bedrock tend to have a lower conductivity, whereas streams that run through areas with clay soils tend to have higher conductivity (EPA, 2015). Discharges into creeks can also affect conductivity levels. A sewage leak into a creek would raise the conductivity, whereas an oil leak would lower the conductivity. Neither the CCME or the BC water quality guidelines provide ranges of acceptable conductivity levels.

**Dissolved Oxygen (DO)**

Dissolved oxygen levels for the creeks monitored range from 8.7 mg/l to 12.14 mg/l. Turbulent flows with long stretches of cascading whitewater and cold creek temperatures contribute to higher DO levels. Dissolved oxygen is essential for aquatic organisms that utilize aerobic respiration. The BC Ministry of Environment recommends minimum dissolved oxygen levels of 5-8 mg/l for the protection of aquatic life (MOE, 2015).

**Turbidity**

Turbidity is a measure of water clarity, and isaffected by suspended matter such as clay, silt, organic matter, plankton and other microscopic organisms that interfere with the passage of light through the water. Turbidity is closely related to total suspended solids (TSS), but also includes plankton and other organisms (Murphy, 2005). High turbidity increases water temperatures and reduces photosynthesis and the concentration of dissolved oxygen. Suspended materials can also clog fish gills, reducing growth rates and development (EPA, 2015). Sources of turbidity include erosion, waste discharges, urban runoff, excessive algal growth, and activities that stir up bottom sediments. Turbidity often increases sharply during a rainfall event.

The creeks monitored in 2014 show low levels of turbidity, with values ranging from 0.29 NTU to 2.10 NTU. Low levels of turbidity indicate high water clarity in the creeks studied. The BC Ministry of Environment recommends that the NTU of a creek should not be changed from background levels by more than 8 NTU for a duration of 24 hours, or by more than 2 NTU for a duration of 30 days, but does not offer guidelines for background turbidity levels (MOE, 2015).

**Discussion and Recommendations**

To better track water quality and detect changes in creeks being monitored in this study it is recommended that a budget be set aside for water samples to be collected on a quarterly basis for laboratory analysis as well as for the purchase and installation of thermisters and level logger and barrologgers.

As part of the NSERC grant agreement, Dr Spooner will continue to partner with Cascade, and the paleolimnological technique used to study Alta Lake has been shared with Cascade. To that end, should funds become available, Cascade has the capacity to perform a paleolimnological assessment of all lakes within the boundaries of the RMOW and provide a detailed assessment of the water quality of each lake and describe the change over time relative to development that has already occurred. This data would provide greater context to the data that is currently being collected by MOE and the RMOW. The paleolimological assessment would provide a baseline data of the lakes which would allow a better detection of changes in water quality in the future.

## 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 surveys were carried out on Jordan Creek, the River of Golden Dream and Crabapple Creek. Gravel extraction works were not performed on Fitzsimmons Creek in 2014 and as a result no 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

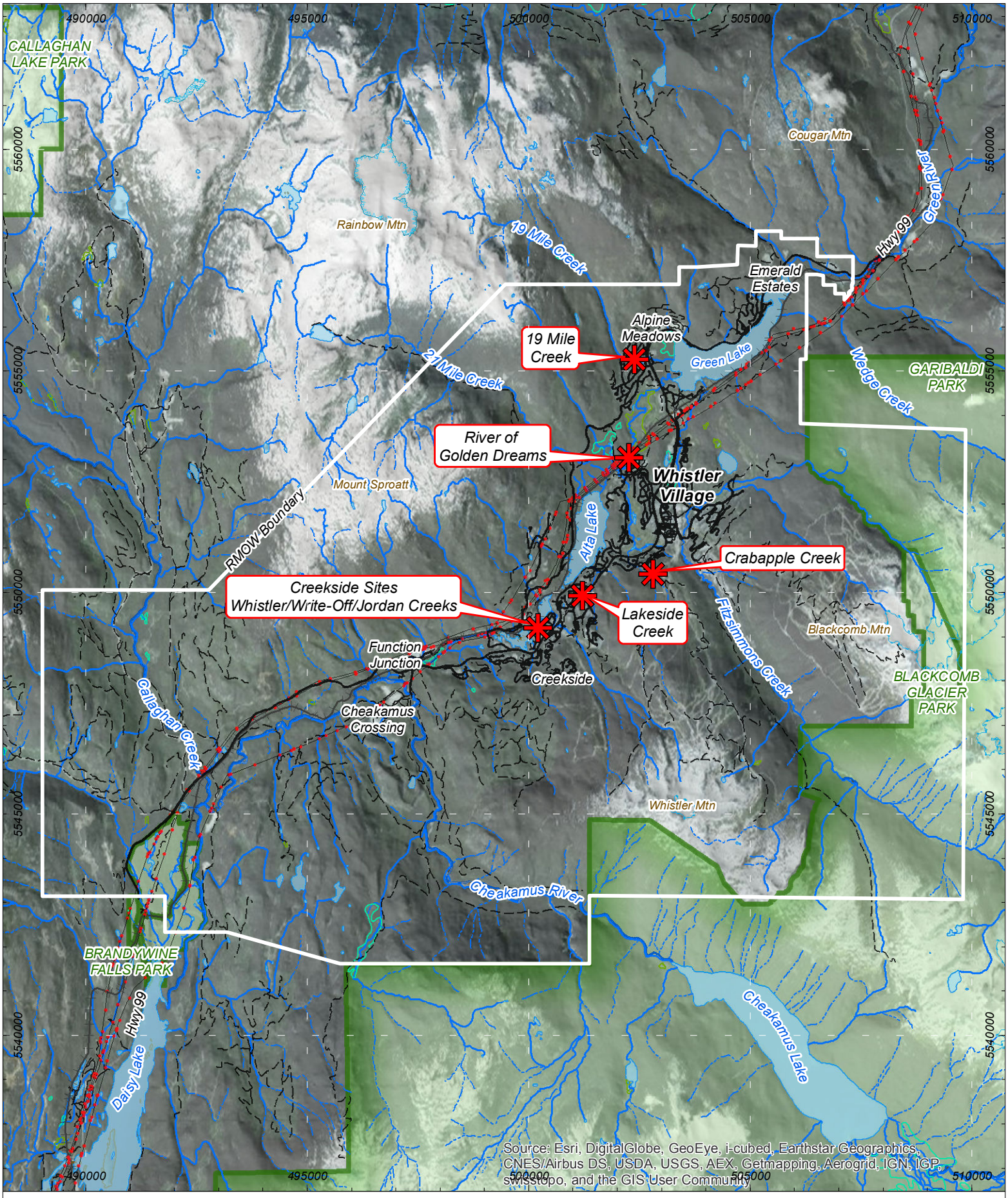
Three representative creeks were examined to assess the fish species composition and population in Whistler: Jordan Creek, the River of Golden Dreams and Crabapple Creek. Jordan Creek is a small, < 500 m connector stream that flows from Nita Lake to Alpha Lake. It is surrounded by Nita Lake Lodge, houses, 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. 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 adn are good indicators of the stream health while stickleback and sculpin are more tolerant species. Stickelnack and sculpin are considered by-cacth 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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**Map 2 - Fish Survey Location**

Biodiversity Monitoring Project
Resort Municipality Of Whistler
British Columbia


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

CASCADE ENVIRONMENTAL
RESOURCE GROUP LTD

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0 50 100 150
Meters

**Map 3 - Fish Survey Site Crabapple Creek**

RMOW Biodiversity Monitoring Project
Whistler, British Columbia

### 3.2.3 Electrofishing Surveys Results

**Jordan Creek**

Two areas were sampled on Jordan Creek on July 25, 2014. Basic water chemistry at both sites was similar (Table 6). Site #1 was a 108 $m^2$ glide (Photo 1 and Photo 3). Site #2 was a 108 $m^2$ riffle (Photo 2 and Photo 4). Total numbers of fish caught are listed in Table 7 below, and absolute abundances of fish caught are described in Table 8.

**Photo 1. Jordan Creek site #1 – glide, September 4, 2013.**

**Photo 2. Jordan Creek Site #2 – riffle, July 25, 2014.**

**Photo 3. Rainbow trout caught at site #1, July 25, 2014.**

**Photo 4. Rainbow trout, stickleback and sculpin caught at site #2, July 25, 2014.**

**River of Golden Dreams**

On July 31, 2014 a 100 $m^2$ pool area was electrofished on the River of Golden Dreams, approximately 25 m upstream of the Lorimer Road pedestrian bridge (Map 3) (Photo 5). Water chemistry at the time of sampling is described in Table 6, total numbers and absolute abundances of fish caught are detailed in Table 7 and Table 8 respectively.

**Photo 5. Downstream stop net at the River of Golden Dreams electrofishing site, July 31, 2014.**

### Crabapple Creek

On July 31, 2014 a 99 $m^2$ area was electrofished on Crabapple Creek, approximately 30 m upstream of the River of Golden Dream confluence (Map 3). The sampled area consisted of a glide at the upstream end, and transitioned to a riffle at the downstream end (Photo 8 and Photo 9). Water chemistry at the time of sampling is described inTable 6, total numbers and absolute abundances of fish caught are outlined in Table 7 and Table 8 respectively. Fish caught at this site included five cutthroat trout, which were distinguished from the rainbow trout by the yellow marks under the lower jaw (Photo 6 and Photo 7). Photo 10 and Photo 11 show the fish captured

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 B

**Photo 6: Cutthroat trout with yellow slashes under the jaw, July 31, 2014.**

**Photo 7: Cutthraot trout with yellow mark under the chin, July 31, 2014.**

**Photo 8. Crabapple Creek upstream glide, July 31, 2014..**

**Photo 9. Crabapple Creek downstream riffle, July 31, 2014..**

**Photo 10. Rainbow trout, stickleback and sculpin caught in Crabapple Creek, July 31, 2014..**

**Photo 11. Rainbow trout caught in Crabapple Creek, July 31, 2014..**

**Table 6: Electrofishing sites and shocker settings**

| Site | Date | Area ($m^2$) | Basic Water Chemistry | | | | Electrofisher Settings | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Temp. (°C) | pH | DO (mg/L) | Turb. (NTU) | Cond. (µS) | Voltage (V) | Freq.(Hz) | Duty Cycle (%) |
| Jordan Creek #1 | 2014.07.25 | 108 | 15.3 | 6.86 | 9.7 | 1.19 | 60 | 360 | 50 | 12 |
| Jordan Creek #2 | 2014.07.25 | 108 | 15.0 | 6.65 | 9.3 | 1.25 | 60 | 395 | 50 | 12 |
| ROGD | 2014.07.31 | 100 | 13.5 | 7.45 | 9.15 | 0.86 | 64 | 340 | 50 | 12 |
| Crabapple Creek | 2014.07.31 | 99 | 15.4 | 6.15 | 10.2 | 2.10 | 203 | 235 | 50 | 12 |

**Table 7: Number of fish caught at each site**

| Site | Date | Bull trout | Rainbow trout | Cutthroat trout | Stickleback | Sculpin | Total |
|---|---|---|---|---|---|---|---|
| Jordan Creek #1 | 2014.07.25 | 0 | 4 | 0 | 2 | 4 | 10 |
| Jordan Creek #2 | 2014.07.25 | 0 | 7 | 0 | 2 | 2 | 11 |
| ROGD | 2014.07.31 | 0 | 5 | 0 | 1 | 6 | 12 |
| Crabapple Creek | 2014.07.31 | 0 | 8 | 5 | 29 | 18 | 60 |

**Table 8: Absolute abundance of fish captured**

| Site | Area ($m^2$) | Abundance (#fish/$m^2$) | | | | |
|---|---|---|---|---|---|---|
| | | Bull trout | Rainbow trout | Cutthroat trout | Stickleback | Sculpin |
| Jordan Creek #1 | 108 | 0 | 0.04 | 0 | 0.02 | 0.04 |
| Jordan Creek #2 | 108 | 0 | 0.07 | 0 | 0.02 | 0.02 |
| ROGD | 100 | 0 | 0.05 | 0 | 0.01 | 0.06 |
| Crabapple Creek | 99 | 0 | 0.08 | 0.05 | 0.29 | 0.18 |

### Rainbow Trout Spawning

Rainbow trout spawning surveys were conducted from May 11 to June 7, 2014 on Write-off Creek, Jordan Creek, Whistler Creek, Lakeside Creek, Blackcomb Creek, Scotia Creek, and Millar Creek by a team of volunteers. No rainbow trout were observed in Write-off Creek, Jordan Creek, Whistler Creek, Blackcomb Creek or Scotia Creek despite daily observations, however rainbow trout were observed in Lakeside Creek and Millar Creek (Map 2) (Table 9).

**Table 9: 2014 Rainbow Trout Spawning Observations**

| Site | Date | Time | #RB |
|---|---|---|---|
| Write-off Creek | 11-May | 20:00 | 0 |
| | 11-May | 20:10 | 0 |
| | 13-May | 19:15 | 0 |
| | 13-May | 19:30 | 0 |
| | 25-May | 15:15 | 0 |
| | 25-May | 15:30 | 0 |

| Site | Date | Time | #RB |
|---|---|---|---|
| | 30-May | 19:25 | 0 |
| | 30-May | 19:40 | 0 |
| Jordan Creek | 11-May | 19:30 | 0 |
| | 11-May | 19:40 | 0 |
| | 13-May | 19:30 | 0 |
| | 13-May | 19:37 | 0 |
| | 25-May | 15:50 | 0 |
| | 25-May | 16:00 | 0 |
| | 30-May | 19:10 | 0 |
| | 30-May | 19:20 | 0 |
| Whistler Creek | 11-May | 20:00 | 0 |
| | 11-May | 20:10 | 0 |
| | 13-May | 19:15 | 0 |
| | 13-May | 19:30 | 0 |
| | 25-May | 15:15 | 0 |
| | 25-May | 15:30 | 0 |
| | 30-May | 19:25 | 0 |
| | 30-May | 19:40 | 0 |
| Lakeside Creek | 19-May | 10:00 | 1 |
| | 20-May | 10:15 | 25 |
| | 21-May | 10:00 | 46 |
| | 22-May | 10:15 | ? |
| | 23-May | 10:00 | ? |
| | 24-May | 10:00 | ? |
| | 25-May | 9:50 | 15 |
| | 26-May | 13:30 | 21 |
| | 28-May | 15:30 | 21 |
| | 29-May | 13:30 | 27 |
| | 30-May | 10:00 | 15 |
| | 31-May | 10:45 | 16 |
| | 1-Jun | 9:30 | 13 |
| | 2-Jun | 9:45 | 10 |
| | 3-Jun | 10:00 | 12 |
| | 4-Jun | 9:15 | 4 |
| | 5-Jun | 12:00 | 2 |
| | 6-Jun | 9:30 | 0 |
| | 7-Jun | 9:30 | 0 |
| Blackcomb Creek | 26-May | 14:33 | 0 |
| | 26-May | 14:47 | 0 |

| Site | Date | Time | #RB |
|---|---|---|---|
| Scotia Creek | 26-May | 9:10 | 0 |
| Millar Creek | 26-May | 10:06 | 6 |
| | 26-May | 10:32 | 0 |

### Kokanee Spawning Surveys

Kokanee spawning surveys were conducted from August 29 to September 18, 2014 on Crabapple Creek, Jordan Creek, The River of Golden Dreams, Whistler Creek and Nineteen Mile Creek by a team of volunteers. No kokanee were observed in any of the surveyed creeks in 2014 despite daily observations. (Map 2) (Table 10).

**Table 10. 2014 Spawning kokanee observations**

| Site | Date | Time | #KO |
|---|---|---|---|
| Jordan Creek | 9-Sep | 14:50 | 0 |
| | 11-Sep | 11:30 | 0 |
| | 18-Sep | 11:20 | 0 |
| | 8-Sep | 14:52 | 0 |
| Whistler Creek | 9-Sep | 14:30 | 0 |
| | 11-Sep | 11:20 | 0 |
| | 18-Sep | 11:00 | 0 |
| | 8-Sep | 14:39 | 0 |
| Crabapple Creek | 8-Sep | 8:07 | 0 |
| | 29-Aug | 14:00 | 0 |
| | 3-Sep | 7:40 | 0 |
| | 4-Sep | 8:03 | 0 |
| River of Golden Dreams | 2-Sep | 8:30 | 0 |
| | 4-Sep | 9:11 | 0 |
| | 8-Sep | 8:20 | 0 |
| Nineteen Mile Creek | 6-Sep | 10:00 | 0 |
| | 9-Sep | 19:45 | 0 |
| | 11-Sep | 19:30 | 0 |
| | 15-Sep | 22:20 | 0 |

### 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 2014 season, and compares these findings with the 2013 season where applicable

**Jordan Creek**

Historical records from the FISS database show that mountain whitefish, rainbow trout, kokanee and stickleback have been observed in Jordan Creek. The results of the electrofishing surveys conducted on September 4, 2013 (Cascade, 2013) and July 25, 2014 (Table 7) suggest that the observation of sculpin and cutthroat trout are new or recent occurrences in Jordan Creek. No kokanee were captured during the electrofishing surveys of 2013 (Cascade, 2013) or 2014 (Table 7), and no spawning kokanee were observed in Jordan Creek during the 2013 (Cascade 2013) or 2014 spawning surveys (Table 10).

The exact survey areas established on Jordan Creek in 2013 were again surveyed in 2014. A total of 26 fish were captured in the 2013 electrofishing surveys (6 rainbow trout, 1 cutthroat trout, 15 stickleback and 4 sculpin) (Cascade, 2013) compared to a total of 21 fish captured in the 2014 electrofishing surveys (11 rainbow trout, 4 stickleback and 6 sculpin) (Table 7). These results indicate an increase in abundance of rainbow trout and a decrease in abundance of stickleback from 2013 to 2014 (Table 11 and Table 12), but the sample size is too small and repeated too infrequently to allow a definitive comparison. The absence of cutthroat trout in the 2014 survey may be reflective of the low abundance shown in the 2013 survey. Future surveys should be conducted to allow for more accurate analysis of the data.

**Table 11: Absolute abundance of fish at Site 1 on Jordan Creek between 2013 and 2014**

| Year | Absolute Abundance (#fish/$m^2$) | | | | |
|---|---|---|---|---|---|
| | BT | RB | CT | SB | SC |
| 2013 | 0 | 0.04 | 0 | 0.09 | 0.03 |
| 2014 | 0 | 0.04 | 0 | 0.02 | 0.04 |

**Table 12: Absolute abundance of fish at Site 2 on Jordan Creek between 2013 and 2014**

| Year | Absolute Abundance (#fish/$m^2$) | | | | |
|---|---|---|---|---|---|
| | BT | RB | CT | SB | SC |
| 2013 | 0 | 0.02 | 0.01 | 0.05 | 0.01 |
| 2014 | 0 | 0.07 | 0 | 0.02 | 0.02 |

**River of Golden Dreams**

Records for the FISS database indicate sculpin, Dolly Varden, kokanee, rainbow trout and stickleback are known to occur in the River of Golden Dreams. One stickleback was captured during the 2013 electrofishing survey of the ROGD (Cascade, 2013), whereas a total of 12 fish were captured in the 2014 survey (5 rainbow trout, 1 stickleback and 6 sculpin) (Table 7). Although similar sized areas were fished in 2013 (100 $m^2$) and 2014 (99 $m^2$), the low number of fish caught in the 2013 survey may be due to the survey site location; the area of the creek chosen for the 2013 survey had a substrate of organic matter and debris, and was likely anoxic and unsuitable habitat for fish. For this reason, the survey site was re-located downstream to a site with gravel substrate for the 2014 survey (Map 3). The resulting increase in fish caught in 2014 may reflect this change of survey site location. The abundance of rainbow trout increased from zero in 2013 to 0.05 fish/$m^2$ in 2014. The abundance of stickle back remained at 0.01 fish/$m^2$, and sculpin increased from zero to 0.06 fish/$m^2$ (Cascade, 2013).

**Table 13: Absolute abundance of fish in the River of Golden Dreams between 2013 and 2014**

| Year | Absolute Abundance (#fish/m$^2$) | | | | |
|---|---|---|---|---|---|
| | BT | RB | CT | SB | SC |
| 2013 (Site 1) | 0 | 0 | 0 | 0.01 | 0 |
| 2014 (Site 2) | 0 | 0.05 | 0 | 0.01 | 0.06 |

### Crabapple Creek

Crabapple Creek was not surveyed in 2013, however, 60 fish were caught in Crabapple Creek in the 2014 electrofishing survey (Table 7). Almost half of the fish caught were stickleback with an absolute abundance of 0.29 fish/m$^2$, and nearly a third were sculpin with an absolute abundance of 0.18 (Table 14). Thirteen salmonids were captured, of which 8 were rainbow trout and 5 were cutthroat trout with an absolute abundance of 0.08 and 0.05 respectively (Table 14).

**Table 14: Absolute abundance of fish in Crabapple Creek between 2013 and 2014**

| Year | Absolute Abundance (#fish/m$^2$) | | | | |
|---|---|---|---|---|---|
| | BT | RB | CT | SB | SC |
| 2013 | n/a | n/a | n/a | n/a | n/a |
| 2014 | 0 | 0.08 | 0.05 | 0.29 | 0.18 |

### Rainbow Trout Spawning Surveys

The RMOW organised volunteers to conduct a rainbow trout spawning observation survey in 2014 (Table 9). No rainbow trout were observed spawning in Write-off Creek, Jordan Creek, Whistler Creek, Blackcomb Creek or Scotia Creek in the 2014 surveys. 6 rainbow trout were observed spawning in Millar Creek, and in Lakeside Creek there were 228 observations of rainbow trout spawning.

### Kokanee Spawning Surveys

The RMOW Environmental Stewardship division has conducted kokanee spawning survey within Whistler since 2001. The data that has been gathered is a valuable historic record of the health and condition of the kokanee population in Whistler. 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. Surveys are conducted by volunteers without scientific training. It is therefore recommended that volunteers undergo training in the foot survey method or shadow someone who is trained in this method so that the data collected can be used more effectively for population estimates as opposed to presence/absence indications.

## 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 2014 Coastal Tailed Frog survey was conducted on four creeks within the RMOW: Alpha Creek, and Scotia Creeks, which were both surveyed in 2013 along with Nineteen Mile Creek and Crabapple Creek (Map 4). 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 (Photo 12 to Photo 15).

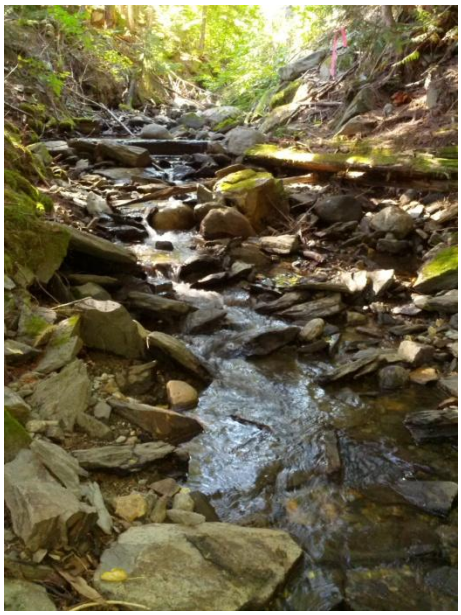
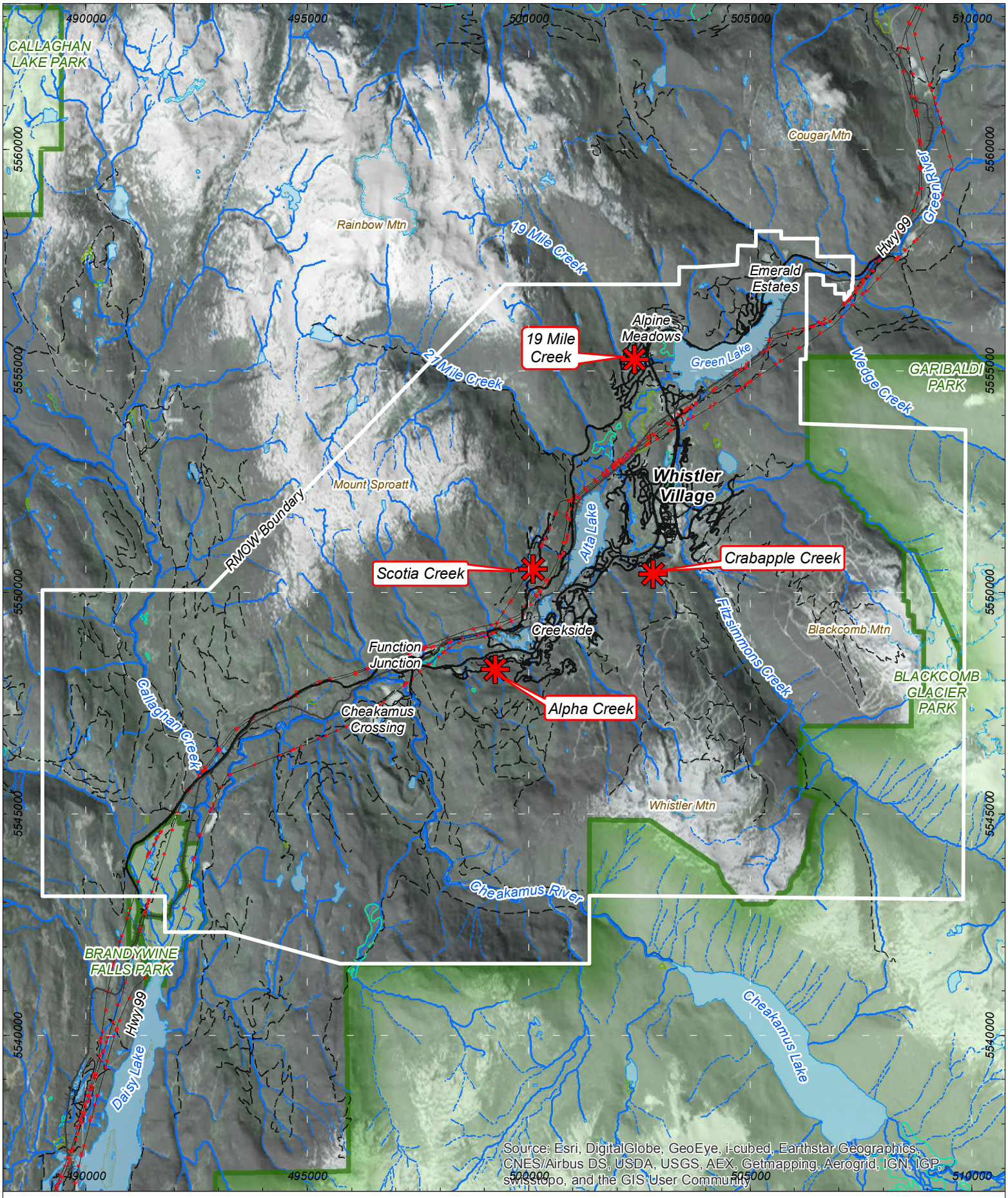


**Photo 12: Scotia Creek Station #3, September 11, 2014**

**Photo 13: Alpha Creek Stn #2, July 17, 2014**

**Photo 14: Nineteen Mile Creek Station #1, July 18, 2014**

**Photo 15: Crabapple Creek Station #2, July 18, 2014**

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**Map 4 - Tailed Frog Survey Location**

Biodiversity Monitoring Project
Resort Municipality Of Whistler
British Columbia

### 3.3.1.1 Results

Four creeks were surveyed for Costal Tailed Frogs in 2014: 19 Mile Cree, Alpha Creek, Crabapple Creek and Scotia Creek. A downstream (1), mid stream (2) and upstream (3) location was sampled on each creek (Table 15). A total of seven coastal tailed frog tadpoles were observed in Alpha Creek, one in Scotia Creek, none in Nineteen Mile Creek, and 12 in Crabapple Creek (Table 15).

**Table 15: 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<br>5548219 | 15.88 | 2 | 4.37 | Riffle | LC | 7 |
| Scotia Creek | 0500759<br>5550711 | 12.58 | 4 | 3.07 | Riffle | SC | 1 |
| Nineteen Mile Creek | 502137 E<br>5555240 N | 15.25 | 4 | 4.77 | Riffle-Pool | LC | 0 |
| Crabapple Creek | 502556 E<br>5550510 N | 15.32 | 4 | 3.06 | Riffle | SC | 12 |

SC=small cobble
LC=large cobble

### 3.3.1.2 Relative Abundance Survey

Abundance estimates were calculated for each sample location of the four creeks (Table 16 to Table 18). 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, 3 and 4 were observed in Site 2 and 3 of Alpha Creek and at Site 2 of Crabapple Creek, with none observed in Nineteen Mile Creek or Scotia Creek during an area-constrained search on July 17 and 18, 2014 (Table 16).

**Table 16: Relative Abundance Results (July 17-18, 2014)**

| 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 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 15.4 | 1 | 50 | 1.4 | 4 | 0.065 |
| | 3 | 35.8 | 1 | 30 | 1.1 | 1 | 0.028 |
| Scotia Creek | 1 | 21.4 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 17.2 | Non detected | n/a | n/a | n/a | n/a |
| | 3 | 7.20 | Non detected | n/a | n/a | n/a | n/a |
| Nineteen Mile Creek | 1 | 41.34 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 24.75 | Non detected | n/a | n/a | n/a | n/a |
| | 3 | 7.5 | Non detected | n/a | n/a | n/a | n/a |
| Crabapple | 1 | 14.71 | Non detected | n/a | n/a | n/a | n/a |

| Location | Site # | Total Area Surveyed ($m^2$) | Total Number of Tadpoles Found | Length (mm) | Weight (g) | Life Stage | Average Abundance of Tadpoles (Tadpoles/$m^2$) |
|---|---|---|---|---|---|---|---|
| Creek | 2 | 16.35 | 2 | 30<br>45 | 0.1<br>0.8 | 1<br>3 | 0.122 |
| | 3 | 15.85 | Non detected | n/a | n/a | n/a | n/a |

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

One coastal tailed frog tadpole in life stage 1 was observed in Site 2 of Alpha Creek. One tadpole was observed in Site 3 of Alpha Creek and one in Site 2 of Scotia Creek but both escaped capture. In Crabapple Creek one coastal tailed frog tadpole in life stage 2 was observed in Site 2 while seven stage 1 tadpoles were observed in Site 3 on August 14 and 15, 2014 (Table 17).

**Table 17: Relative Abundance Results (August 14-15, 2014)**

| 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 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 15.4 | 1 | 35 | 0.4 | 1 | 0.065 |
| | 3 | 35.8 | 1 escape | unknown | unknown | unknown | 0.028 |
| Scotia Creek | 1 | 21.4 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 17.2 | 1 escape | unknown | unknown | unknown | 0.058 |
| | 3 | 7.20 | Non detected | n/a | n/a | n/a | n/a |
| Nineteen Mile Creek | 1 | 41.34 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 24.75 | Non detected | n/a | n/a | n/a | n/a |
| | 3 | 7.5 | Non detected | n/a | n/a | n/a | n/a |
| Crabapple Creek | 1 | 14.71 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 16.35 | 1 | 38 | 0.9 | 2 | 0.061 |
| | 3 | 15.85 | 7 | 32<br>35<br>26<br>32<br>35<br>32<br>35 | 0.7<br>1<br>0.3<br>0.5<br>0.5<br>0.5<br>09 | 1<br>1<br>1<br>1<br>1<br>1<br>1 | 0.442 |

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 2 and 3 were observed in Site 1 and 2 of Alpha Creek on September 18, 2014. In Crabapple Creek one coastal tailed frog tadpole in life stage 1 and 2 were observed in Site 2 while one stage 1 tadpole was observed in Site 3 on September 19, 2014 (Table 18).

**Table 18: Relative Abundance Results (September 18-19, 2014)**

| 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 | 1 | 41 | 1 | 3 | 0.054 |
| | 2 | 15.4 | 2 | 39<br>47 | 0.5<br>0.9 | 2<br>3 | 0.130 |
| | 3 | 35.8 | Non detected | n/a | n/a | n/a | n/a |
| Scotia Creek | 1 | 21.4 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 17.2 | Non detected | n/a | n/a | n/a | n/a |
| | 3 | 7.20 | Non detected | n/a | n/a | n/a | n/a |
| Nineteen Mile Creek | 1 | 41.34 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 24.75 | Non detected | n/a | n/a | n/a | n/a |
| | 3 | 7.5 | Non detected | n/a | n/a | n/a | n/a |
| Crabapple Creek | 1 | 14.71 | Non detected | n/a | n/a | n/a | n/a |
| | 2 | 16.35 | 2 | 36<br>29 | 0.4<br>0.6 | 2<br>1 | 0.122 |
| | 3 | 15.85 | 1 | 47 | 1.1 | 3 | 0.06 |

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

### 3.3.1.3 Discussion and Recommendations

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. Table 19 shows the relative abundance of coastal tailed frogs in Alpha Creek at the three survey sites in 2013 and average of the three 2014 replicates. The abundance of tailed frogs at Site 1 and 3 has increased but decreased at Site 2.

**Table 19: Relative abundance of Coastal Tailed Frogs in Alpha Creek between 2013 and 2014**

| Alpha Creek | 2013 | 2014 |
|---|---|---|
| 1 | 0.000 | 0.054 |
| 2 | 0.130 | 0.087 |
| 3 | 0.080 | 0.280 |

Table 20 shows the relative abundance of coastal tailed frogs in Scotia Creek at the three survey sites in 2013 and average of the three 2014 replicates. The abundance of tailed frogs at Site 2 has increased due to the single observed escapee.

**Table 20: Relative abundance of Coastal Tailed Frogs in Scotia Creek between 2013 and 2014**

| Scotia Creek | 2013 | 2014 |
|---|---|---|
| 1 | 0.000 | 0.000 |
| 2 | 0.000 | 0.058 |
| 3 | 0.000 | 0.000 |

In addition to Alpha Creek and Scotia Creek coastal tailed frog surveys in 2014 were also conducted on Nineteen Mile Creek and Crabapple Creek. No coastal tailed frogs were observed in Nineteen Mile creek in 2014.

The capability analysis was performed for all four creeks. The results of the analysis suggests 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 small number of tadpole observations to date would indicate a low abundance of coastal tailed frogs in Alpha Creek and Crabapple Creek. But for the one escaped tadpole observed in 2014, the near absence of coastal tailed frogs captured in Scotia Creek is concerning since their presence was previously confirmed with 23 individuals captured over three sites (Biodiversity Project, 2006). There are two probable explanations for the low result. Firstly, the area constrained search methodology may need to be expanded to cover a wider area if the densities are too low for detection. Secondly, it is generally accepted that tailed frogs are sensitive to habitat destruction and degradation and that the population is decreasing. It is recommended that abundance of tailed frog tadpoles continues to be monitored in coming years to determine population trends and better identify hotspots where populations may be threatened.

### 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).

### 3.3.3 Site Selection

Lodges and study area previously surveyed in Cascade (2013) were re-surveyed for signs of activity (Map 5) and lodges never documented before were recorded. The survey sites will include 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)

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 2014**

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 20, 2015
CERG File#: 013-48-02
Projection: UTM 10N NAD83
Orthophoto/Data: BC Gov/RMOW

CASCADE ENVIRONMENTAL RESOURCE GROUP LTD

0 200 400 600 800 1,000
Meters

**Map 5 - Beaver Lodges Location**

RMOW Biodiversity Monitoring Project
Whistler, British Columbia

**Photo 16. Active beaver lodge in Spruce Grove. Fresh mud and wood present on lodge. October 29, 2014.**

**Photo 17. Tracks observed on muddy shore at Green lake lodge . October 29, 2014.**

**Photo 18. Inactive lodge at Alpha lake. October 29, 2014.**

### 3.3.3.1 Beaver Population Abundance

The 2014 beaver population census surveyed 32 beaver lodges including 4 lodges that were not documented before. 10 (31%) of which were *active*, 14 (44%) were *inactive*, 1 (3%) were *unknown* and 7 (22%) lodges surveyed by Cascade in 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 presented in Appendix C

The mean colony size of 5.8 individuals, which was established by Mullen (2008) was applied to the 10 known active lodges in the 2014 survey. Based on this extrapolation, an estimate of the beaver population in the Resort Municipality of Whistler is 58 beavers. Compared to the previous year's results it appears that after a small decline after 2008, the population is now stable as the population estimate is equal to the results in 2013. 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.

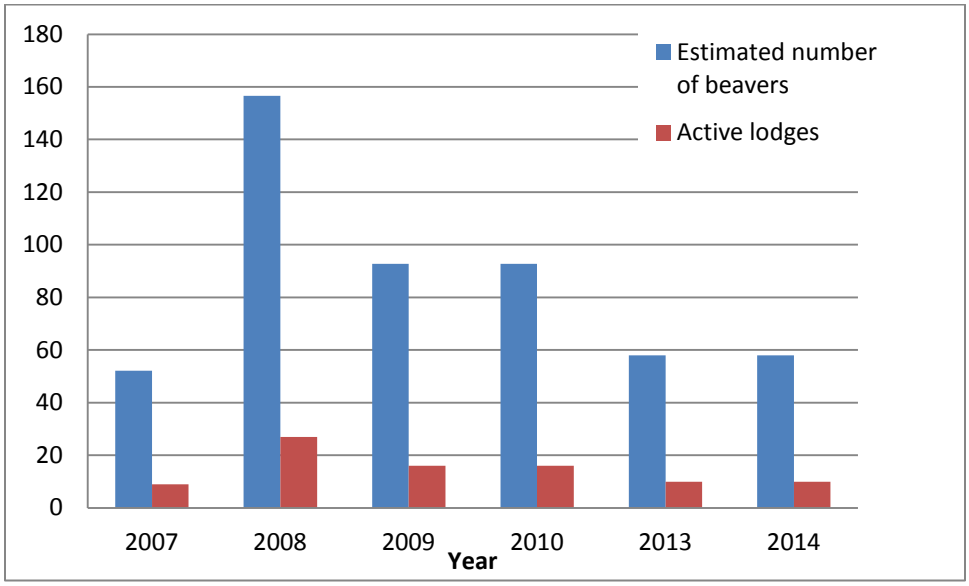



**Figure 1: Total annual population of beavers over the six year study period and the corresponding active lodges.**

Figure 1 and Table 21 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 years, four of those have been considered *active* during that three years period. Between the 2013 and the 2014 survey 3 *active* lodges became *inactive* and one *inactive* lodge became *active*. 5 *unknown* lodges are now considered *inactive* and one *unknown* lodge is now considered *active*.

**Table 21. Summary of beaver lodge status in surveys from 2007-2013, Whistler, BC**

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

### 3.3.3.2 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 local beaver population appears to be stable since the same number of active lodges were observed. Confirming the observation from last year's survey, resident beaver lodges tend to be more active along larger waterways as opposed to small streams, ponds or lakes. Among the active lodge which accounted for a total of 40%, 20% were along a river, 16% were along a pond or a lake and 4% were along a small stream. Comparing 2014 survey data to 2013 survey data; there has been a 10 percent decrease in the number of active lodges

located in pond habitats, and a 3 percent decrease in number of inactive lodges located in a river habitat (Table 22).

**Table 22. Beaver lodge classification by habitat type, 2014 Whistler, BC Beaver Census**

| Habitat | Active | Inactive | Unknown |
|---|---|---|---|
| Pond <2m deep | 2(8%) | 4 (16%) | 0 |
| Lake >2m deep | 2 (8%) | 1 (4%) | 0 |
| Stream <5m wide | 1 (4%) | 3 (12%) | 0 |
| River >5m wide | 5 (20%) | 6 (24%) | 1 (4%) |

#### 3.3.3.3 Discussion and Recommendations

The 2014 survey was conducted later in the year which allowed a more accurate determination of the lodge status. Signs of lodge maintenance were more evident as the beaver had more time to add mud or branches on the lodge. Therefore, the number of *unknown* lodges was greatly reduced.

When food supplies become depleted beavers abandon their lodge and colonise new habitat. Habitat being limited they tend to recolonize old lodges when food becomes sufficiently available and the cycle begins again (Martell, 2004). This cycle is currently not being observed among the lodges studied. One explanation is that beaver are able to find unexploited habitat rather than recolonizing old lodges. Expanding the survey to cover as much as possible of the valley bottom would provide a better picture of the population dynamic.

The ROGD appears to have reached its maximum beaver lodge density for the area surveyed. The section of the ROGD where beaver lodges are present is approximately four km long and contains four active beaver lodges. According to Halter and Beal (2003), average population density rarely exceeds one active colony per km of shoreline in optimal habitats.

The population appears stable as the lodge count was identical in 2013 and 2014. However, some lodges were abandoned and new lodges were discovered. Continued monitoring of the dynamic of the beaver population can provide useful information on the habitat available and the ecosystem health in Whistler. It is recommended that the survey area be expanded to include all potential habitat within the RMOW.

## 3.4 Terrestrial Habitat Indicators

### 3.4.1 Terrestrial Ecosystem Units

One of the objectives of the Phase 2 study was identification of area" of high biodiversity. Based on the evaluative criteria used to identify potential biodiverse areas and presented earlier in the 2013 report, Cascade reviewed the Wetland, Riparian and Other Sensitive Ecosystems identified in Schedules I, J, and K of the Official Community Plan (RMOW, 2013) to select trial plots. In 2013, Mature/old forest hotspots were selected as the target ecosystem (Cascade, 2014). During the 2014 survey, a young alluvial forest site was selected as the target ecosystem. Additional hotspots may be added in subsequent years.

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 the locations of the red-backed vole and ground beetle survey sites.

### 3.4.2 Results

Collected data has been recorded using VENUS 5.1, a database made available by the BC Ministry of Forests and Range (MOFR) and the BC Ministry of Environment (MOE). The data will be delivered as Microsoft Excel spreadsheets, but are best viewed by importing into VENUS 5.1. This data will be stored and remain available for between-year comparisons and future analysis in relation to terrestrial wildlife surveys.

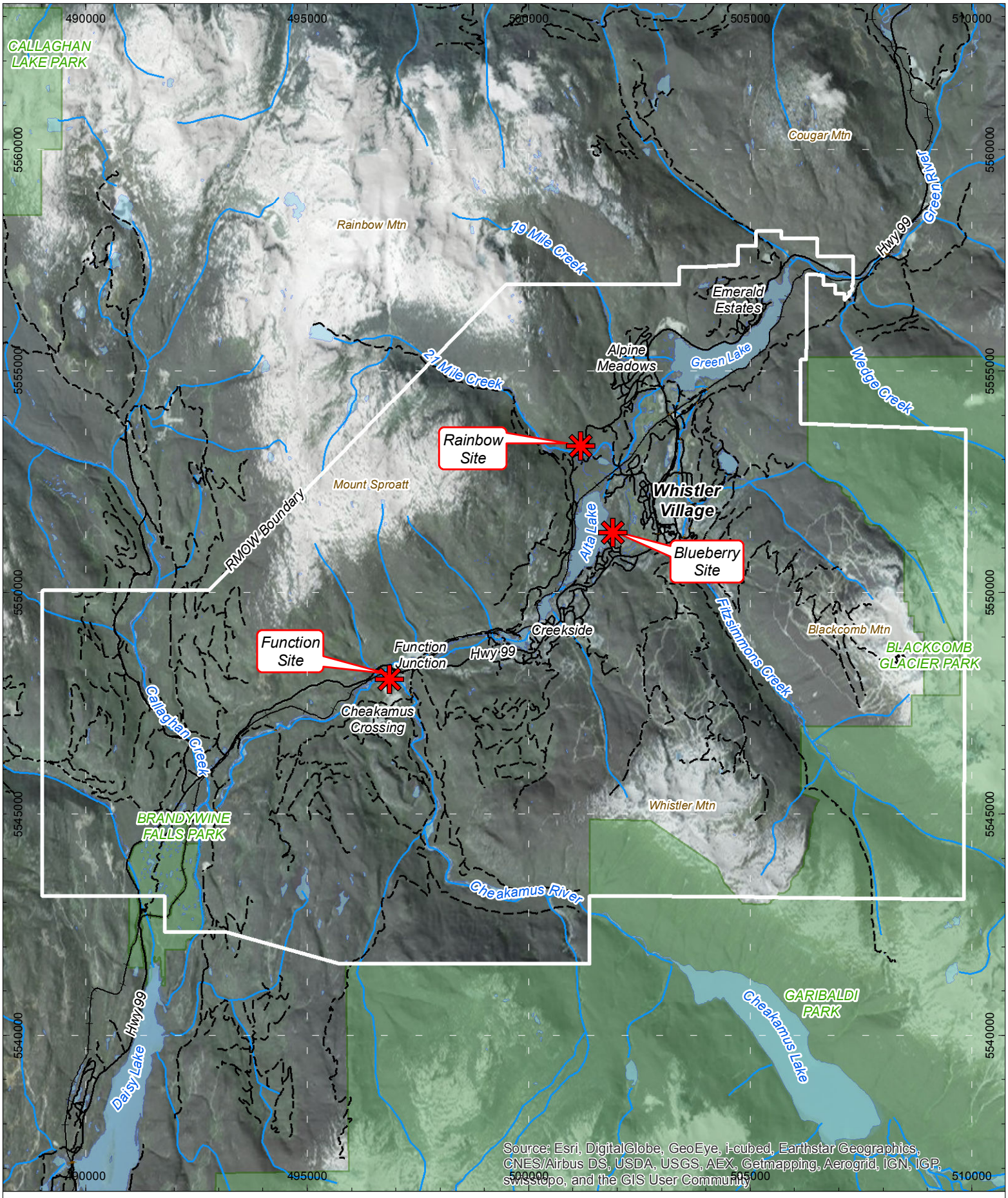
#### 3.4.2.1 **Site Classification**

The valley bottom within the RMOW falls within Coastal Western Hemlock southern moist submaritime variant (CWHms1) (Map 6). The CWHms1 variant occurs at elevations of 650 to 1200 m and has a transitional climate between coastal and interior. The climate is typically cool year-round with moist winters including heavy snowfall and relatively dry summers (Green and Klinka, 1994).

Plot 3 represents zonal, or typical, conditions of the CWHms1 variant (Site Series 07 – Salmonberry).

#### 3.4.2.2 **Soils**

Plot 3 is located along the Cheakamus River (Map 7) with the surface profile nearly horizontal with a slight slope of 4%. The terrain texture consists of sand and organic material originating from fluvial and glaciofluvial material. The bedrock in the areas of the study plots consists of granite and the dominant soil type is Brunosol. The soil consists of silty clay and the humus form is vermimull. The soil is somewhat dry (i.e. submesic) and nutrient rich. Soil sample shows that organic soil horizons consists of an Fa horizon of a depth of 1 cm made out of weakly aggregated and non-compacted material with a low abundance of medium sized roots. The mineral horizon consists of a Bt horizon of a depth of at least 20cm. The coarse fragments are made of subrounded cobbles and represent 20% of the mineral horizon. Roots in this horizon are abundant with a size ranging from 3 to 5 mm (Photo 19). The root restricting layer was assumed to be approximately 22 cm deep. The study plot is well drained; the water source is precipitation and occasional flooding is likely to occur.




GIS Cartographer: Todd Hellinga
Date: January 13, 2015
CERG File#: 013-48-01
Projection: UTM 10N NAD83
Orthophoto: ESRI

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RESOURCE GROUP LTD

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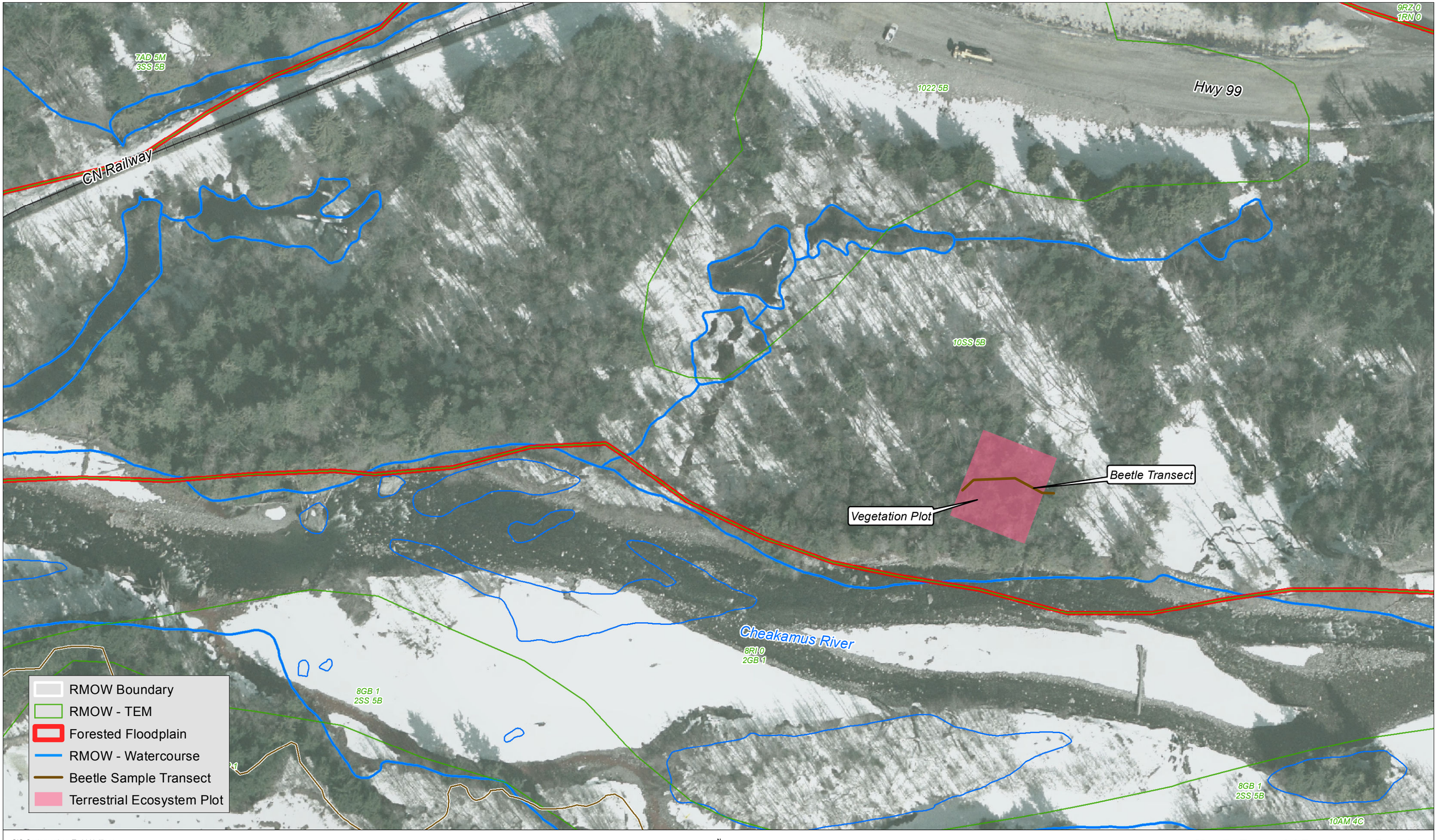
**Map 6 - Terrestrial Ecosystem Plots Location**

Biodiversity Monitoring Project
Resort Municipality Of Whistler
British Columbia




GIS Cartographer: Todd Hellinga
Date: January 22, 2015
CERG File#: 013-48-02
Projection: UTM 10N NAD83
Orthophoto: BC GOv

CASCADE ENVIRONMENTAL
RESOURCE GROUP LTD

**Map 7 - Terrestrial Ecosystems Function**

Biodiversity Monitoring Project 2014
Resort Municipality Of Whistler
British Columbia

**Photo 19. Soil profile at Terrestrial Ecosystem Plot 3. August 18, 2014. Function Junction.**

#### 3.4.2.3 **Vegetation**

The successional stage of Plot 3 is multi-storey young forest (Photo 20). The dominant tree species (A1 layer) are amabilis fir (*Abies amabilis*) and Douglas-fir (*Pseudotsuga menziesii*). The largest tree in Plot 3 is a Douglas-fir with a DBH of 70 cm and is 43 years old. The largest amabilis fir on the site is 40 cm in DBH and 37 years of age. The A2 layer is composed of western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*).

The shrub layer is open and consists of young western redcedar, rose twisted-stalk (*Streptopus lanceolatus*), salmonberry (*Rubus spectabilis*), thimbleberry (*Rubus parviflorus*) and black gooseberry (*Ribes divaricatum*). Two species were identified in the herb layer, bracken fern (*Pteridium aquilinum)* and sword fern (*Polystichum munitum*). The moss layer step moss and cat-tail moss (*Isothecium myosuriodes*) present in equal quantities. Unidentified lichens were also present in the study plot.

**Photo 20: looking south at the Terrestrial Ecosystem Plot 3 from the photo point. October 9, 2014**

#### 3.4.2.4 Wildlife Habitat

Plot 3 provides valuable habitat for birds, small mammals and black bears. Bird species, including woodpeckers, may use larger trees at the site for perching and feeding. Coarse Woody Debris (CWD) were present in small quantity, mainly in the advanced or extensive decay stage with DBH ranging from 10 to 33 cm. Cavities formed under the CWD and trees provide denning habitat for small mammals including voles, mice, squirrels and chipmunks.

#### 3.4.2.5 Discussion and Recommendations

This terrestrial ecosystem assessment allows an in-depth description of the study site. This description is important to understand the habitat in which small mammals and ground beetles are studied, and to monitor for change over time.

Terrestrial ecosystem plot assessments 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. Additional plots in different ecosystems should be established in subsequent years.

### 3.4.3 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.

#### 3.4.3.1 Site Selection

Trapping was conducted in three sites. Two sites from the 2013 survey located in old growth/mature forest were revisited and one site located in a young alluvial forest was added.

Site 1 is located on blueberry hill, approximately 50m uphill from the trail. Site 2 is located west side of Alta Lake Road in Whistler, near the Rainbow Lake Trail parking lot (Map XX). Both sites are characterized by a mature forest composed mainly of western hemlock. 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

#### 3.4.3.2 Results

A total of 284 ground beetle specimens, representing six species were collected from the 28 days of trapping. The relative abundance ranges from 0.012 to 2.345 ground beetles per trap night (Table 23). The highest abundance was observed at Site 3 during the second sampling period and the lowest abundance was observed at Site 2 during the first sampling period with an abundance of 2.4 and 0.036 animals per trap night respectively (Figure 2). Site 3 had the highest abundance during both sampling period while the lowest abundance during the first sampling period was observed at Site 2 and at Site 1 during the second sampling period.

The most abundant species was *Scaphinotusangusticollis* which accounted for 86.6% of all the ground beetles collected. Species richness was the highest at Station 3 with six different species while Station 1 and 2 had two species (Figure 3). *S.angusticollis* and *Pterostichus Herculaneus* were present at all Stations while four species were only found at Station 3.

**Table 23: Relative abundance (number of beetles per trap night) of carabid species collected from Blueberry hill Rainbow and Function between June 14 and September 22, 2014**

| Species | Site 1: Blueberry | | Site 2: Rainbow | | Site 3: Function | |
|---|---|---|---|---|---|---|
| | 1st sampling | 2nd sampling | 1st sampling | 2nd sampling | 1st sampling | 2nd sampling |
| *Leistus ferruginosus* | | | | | 0.012 | |
| *Notophilius sylvaticus* | | | | | 0.048 | 0.012 |
| *Pterostichus castaneus* | | | | | 0.012 | 0.012 |
| *Pterostichus herculaneus* | 0.214 | 0.048 | 0.036 | 0.024 | | 0.012 |
| *Pterostichus neobrunneus* | | | | | | 0.024 |
| *Scaphinotus angusticollis* | 0.048 | 0.071 | | 0.107 | 0.357 | 2.345 |
| **Total** | **0.262** | **0.119** | **0.036** | **0.131** | **0.429** | **2.405** |

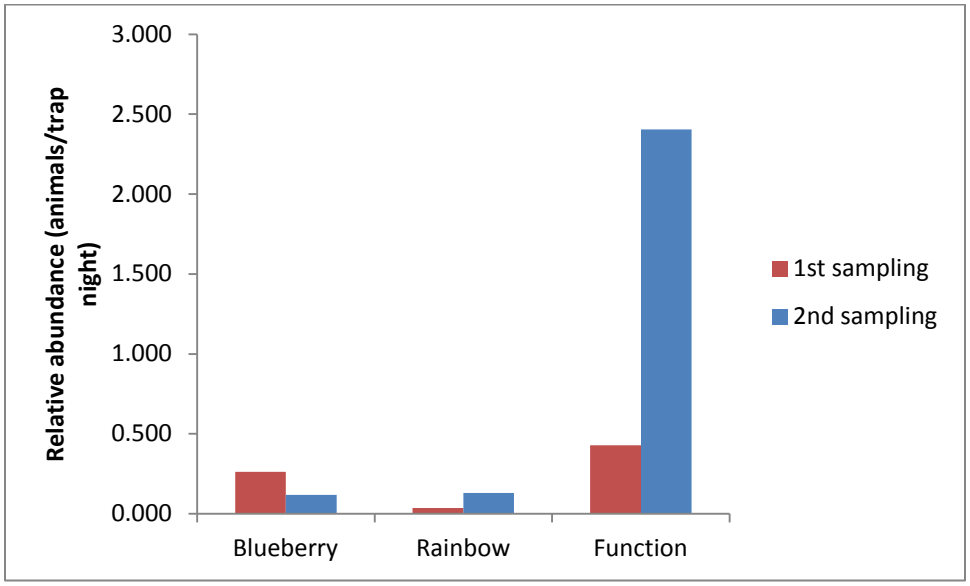



**Figure 2: Relative abundance (animals/ trap night) during both sampling periods at the Blueberry, Rainbow and Function station.**

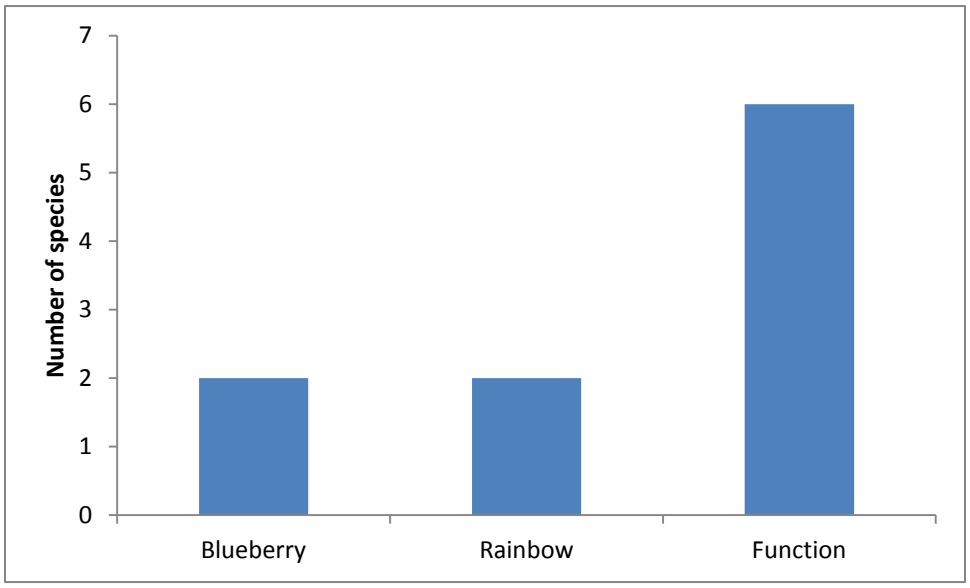



**Figure 3: Species richness at the Blueberry, Rainbow and Function station.**

### 3.4.3.3 Discussion and Recommendations

Species richness was identical to the one observed during last year's survey at Station 1 and 2 (Cascade, 2013). Species richness was higher in Station 3 where six species were collected. Species richness appears low at all stations in comparison to Spence *et al.* (1997) where they found 10 to 17 species from each stand age class. Species richness tends to increase as the stand age decreases (Spence *et al.*, 1997 and Niemela *et al.*, 1993), this could explain why more species were observed at Station 3 which is a younger forest.

The abundance of *S. angusticollis* and *P. herculaneus* were higher this year compared to 2013 results with the exception of Station 1 where *S. Angusticollis* was more abundant last year. Overall the abundance is similar at the Blueberry site in 2013 and 2014 with 0.11 and 0.119 animal per trap night respectively but at the Rainbow site the abundance was higher in 2014 with 0.131 animal per trap night compare to 0.026 in 2013 (Table 24). Comparison can only be made between the second period of sampling as only a two weeks sampling period

was conducted in 2013 and no comparison could be made at the Function site as it was not surveyed in 2013. This year's survey was conducted during mid-June and mid-September while in 2013 the survey was conducted at the end of September/beginning of October which could explain the difference in abundance observed. Indeed, Honek (1997) showed that the temperature can have an important impact on the activity and therefore the trappability of carabids. Honek showed that the catch size increases an average of 6.3 percent per 1ºC increase of average temperature. The data collected after a few years will provide a baseline for future monitoring program. A change in species assemblage or abundance would indicate a disturbance of the ecosystem.

Future monitoring efforts should aim to conduct the survey at the same time each year in order to have comparable results. Average daily temperature should also be monitored during each sampling period which in some cases could explain abnormally low number of carabids captured. In addition, increasing the length of the sampling period or increasing the number of sampling periods would like increase the number of species captured.

**Table 24: Comparison of the abundance of Carabid species between 2013 and 2014**

| Species | Site 1: Blueberry | | | Site 2: Rainbow | | | Site 3: Function | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | | 2013 | 2014 | | 2014 | |
| | 2nd Period | 1st Period | 2nd Period | 2nd Period | 1st Period | 2nd Period | 1st Period | 2nd Period |
| *Leistus ferruginosus* | | | | | | | 0.012 | |
| *Notophilius sylvaticus* | | | | | | | 0.048 | 0.012 |
| *Pterostichus castaneus* | | | | | | | 0.012 | 0.012 |
| *Pterostichus herculaneus* | 0.02 | 0.214 | 0.048 | | 0.036 | 0.024 | | 0.012 |
| *Pterostichus neobrunneus* | | | | | | | | 0.024 |
| *Pterostichus sp.* | | | | 0.01 | | | | |
| *Scaphinotus angusticollis* | 0.09 | 0.048 | 0.071 | 0.025 | | 0.107 | 0.357 | 2.345 |
| **Total** | **0.11** | **0.262** | **0.119** | **0.026** | **0.036** | **0.131** | **0.429** | **2.405** |

## 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, pileateds 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**

Three pileated woodpeckers were observed on three different transects (1, 3 and 4) during the survey. The total abundance of pileated woodpeckers is therefore 0.011 animal per hectare for the area surveyed (Table 25)

**Table 25: number of pileated woodpecker observed at each transect and the respective abundance.**

| Transect | Number of pileated woodpecker detected | Area surveyed (ha) | Abundance (number of animal/ha) |
|---|---|---|---|
| #1- Comfortably Numb | 1 | 70.6858 ha | 0.014 |
| #2- Rainbow | 0 | 70.6858 ha | 0 |
| #3- Creekside | 1 | 70.6858 ha | 0.014 |
| #4- Stone Bridge | 1 | 70.6858 ha | 0.014 |
| **Total** | **3** | **282.7432 ha** | **0.011** |

Further details regarding survey data collected at all transects are provided in Appendix D.

##### 3.5.1.2.1 Transect 1

One pileated woodpecker was detected along this transect (Map 8). Relative abundance of pileated woodpeckers along this transect is therefore 0.014 per hectare for this transect. In addition to the pileated, red-breasted nuthatch (*Sitta canadensis*) and Varied Thrush (*Ixoreus naevius*) were observed.

Habitat and cavity trees description can be found in Cascade (2014)

##### 3.5.1.2.2 Transect 2

No pileated woodpeckers were located during the survey of this transect (Map 9).

Habitat and cavity trees description can be found in Cascade (2014)

##### 3.5.1.2.3 Transect 3

One pileated woodpecker was detected along this transect (Map 10). Relative abundance of pileated woodpeckers along this transect is therefore 0.014 per hectare for this transect. Additional species observed include Varied Thrush (*Ixoreus naevius*), American robin (*Turdus migratorius*) and black bear (*Ursus americanus*).

The forest along this transect consists of mature coniferous forest with mostly dense understorey and an abundance of fallen trees (Photo 21). The canopy cover is dominated by western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*) and amabilis fir (*Abies amabilis*). The understory was composed of various shrubs species, vaccinium species, ferns and Devil's club (*Oplopanax horridus*) near the creeks. Two cavity trees were identified. Both trees presented multiple old cavities resulting from Pileated woodpecker activity (Photo 22).

##### 3.5.1.2.4 Transect 4

One pileated woodpecker was detected along this transect (Photo 23,Map 11). Relative abundance of pileated woodpeckers along this transect is therefore 0.014 per hectare for this transect

The forest along this transect consists of mature coniferous forest with an open understorey (Photo 24) and numerous rocky slopes. Dead trees were abundant along this transect. The canopy cover is dominated by Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*) and amabilis fir (*Abies amabilis*). Twelve cavity trees were identified. Most of those trees contain ten cavities or more (Photo 25) and five trees presented recent activity (Photo 26). All trees but one had cavities made by Pileated woodpeckers.

**Photo 21: Mature forest with dense understory and fallen logs typical of Transect 3. July 9, 2014.**

**Photo 22: Western redcedar presenting cavities resulting from a pileated woodpecker along Transect 3. July 9, 2014**

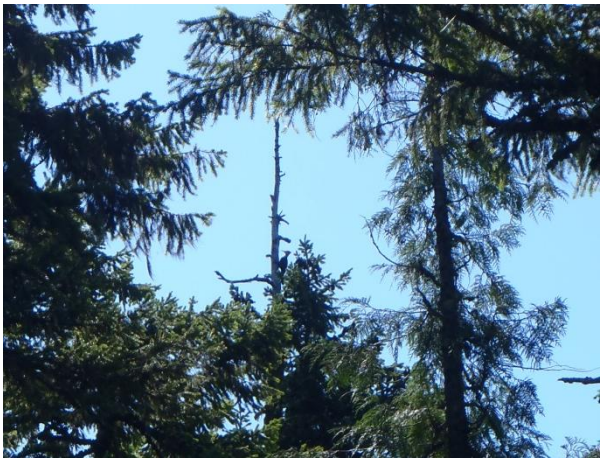


**Photo 23: Pileated woodpecker observed at Station 5 along Transect 4. July 10, 2014.**

**Photo 24: Mature forest with open understory characteristic of Transect 4. July 10, 2014.**

**Photo 25: Cavity tree containing many holes resulting from pileated woodpeckers along Transect 4. July 10, 2014.**

**Photo 26: Large cavity showing signs of recent use. July 10, 2014.**

**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 507000

5556000 5555000 5554000 5553000

Parkhurst Parkhurst

Jeffs Trail

Green Lake Loop

Sea to Sky Trail

Foreplay

Yummy Numby

Reservoir Climb

Valley Trail Valley Trail

GARIBALDI PARK

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

**Map 8 -Pileated Woodpecker Survey Transect 1 Comfortably Numb**

RMOW Biodiversity Monitoring Project
Whistler, British Columbia

500000
501000
5554000
5553000
Stn 3
Stn 4
Tree 2
Stn 5
Stn 6
Stn 7
Stn 2
Tree 1
Stn 1
Stn 8
Stn 9
Stn 10
Rainbow Trail Trailhead
Alta Lake Rd
Rainbow Park

**Pileated Woodpecker Survey Points**

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

GIS Cartographer: Todd Hellinga
Date: November 8, 2013
CERG File#: 013-48-01
Projection: UTM 10N NAD83
Orthophoto/Data: Bing Maps, RMOW

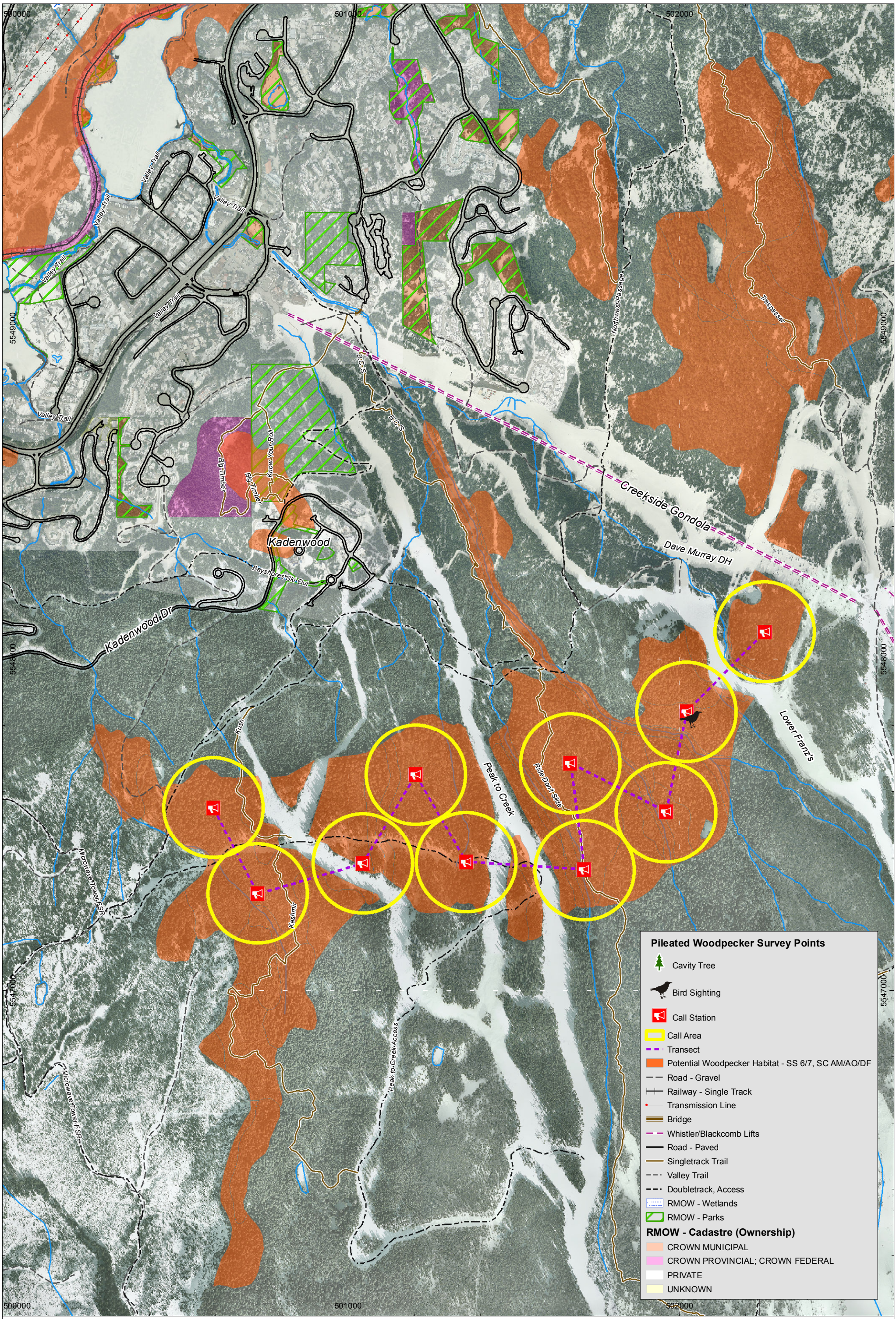
CASCADE ENVIRONMENTAL RESOURCE GROUP LTD

N W E S

0 100 200 300 400 500
Meters

**Map 9 - Pileated Woodpecker Survey Transect 2 Westside Road**

RMOW Biodiversity Monitoring Project
Whistler, British Columbia




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
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0 100 200 300 400 500
Meters

**Map 10 - 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

Scotia Creek
Cheap Thrills
Stonebridge Dr
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 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

**Map 11 - Pileated Woodpecker Survey Transect 4 Stonebridge**

RMOW Biodiversity Monitoring Project
Whistler, British Columbia

#### 3.5.1.3 Discussion and Recommendations

Three woodpeckers in total were detected, along three out of four transects which confirms the efficiency of the site selection process and the study method. However no pileated woodpecker was detected along Transect 2, even though the survey was conducted at the optimal time of the year; which suggests that the site selection process could be refined by focusing only on older forest. Suitable habitat was determined by identifying Vegetation Resource Inventory forest of age class 7, 8, and 9 using the GIS. Habitat selection could be refined by focusing on forest of age class 8 and 9. In addition, the habitat suitability index model created by Tirpak *et al.* (2009) could be use. The model combines six variables (landform, land cover, successional age class, large snag (> 30 cm d.b.h.) density, forest patch size, and percentage of forest in a 1-km radius) to score the habitat.

Based on the results of the 2014 survey, with three specimens encountered for 283 ha surveyed, the density is 0.011 per hectare. The 2014 results provide a more complete estimation than the 2013 results which estimated the density at 0.007 animals per hectare (Table 26). Extrapolating the density measured this year to the suitable habitat below 1200 m asl. Suitable habitat was determined by identifying Vegetation Resource Inventory forest of age class 7, 8, and 9 using the GIS. This would yield an estimated population of 61 individuals based on a suitable habitat base of 5,509 ha. This number is higher than the estimation calculated in 2013 which was 39. Extending the survey area and increasing the number of transect at each site will provide a better estimation of the actual population present in Whistler. It is difficult to identify population trends after only two years of survey. Continuing the study should provide baseline data and will allow identifying changes in ecosystem health.

Future monitoring effort could estimate the use of other type of forest in order to have a more accurate estimation of the actual population.

**Table 26: Comparison of pileated woodpecker abundance between 2013 and 2014**

| Transect | Abundance (number of animal/ha) | |
|---|---|---|
| | 2013 | 2014 |
| #1- Comfortably Numb | 0.014 | 0.014 |
| #2- Rainbow | 0 | 0 |
| #3- Creekside | n/a | 0.014 |
| #4- Stone Bridge | n/a | 0.014 |
| **Total** | **0.007** | **0.011** |

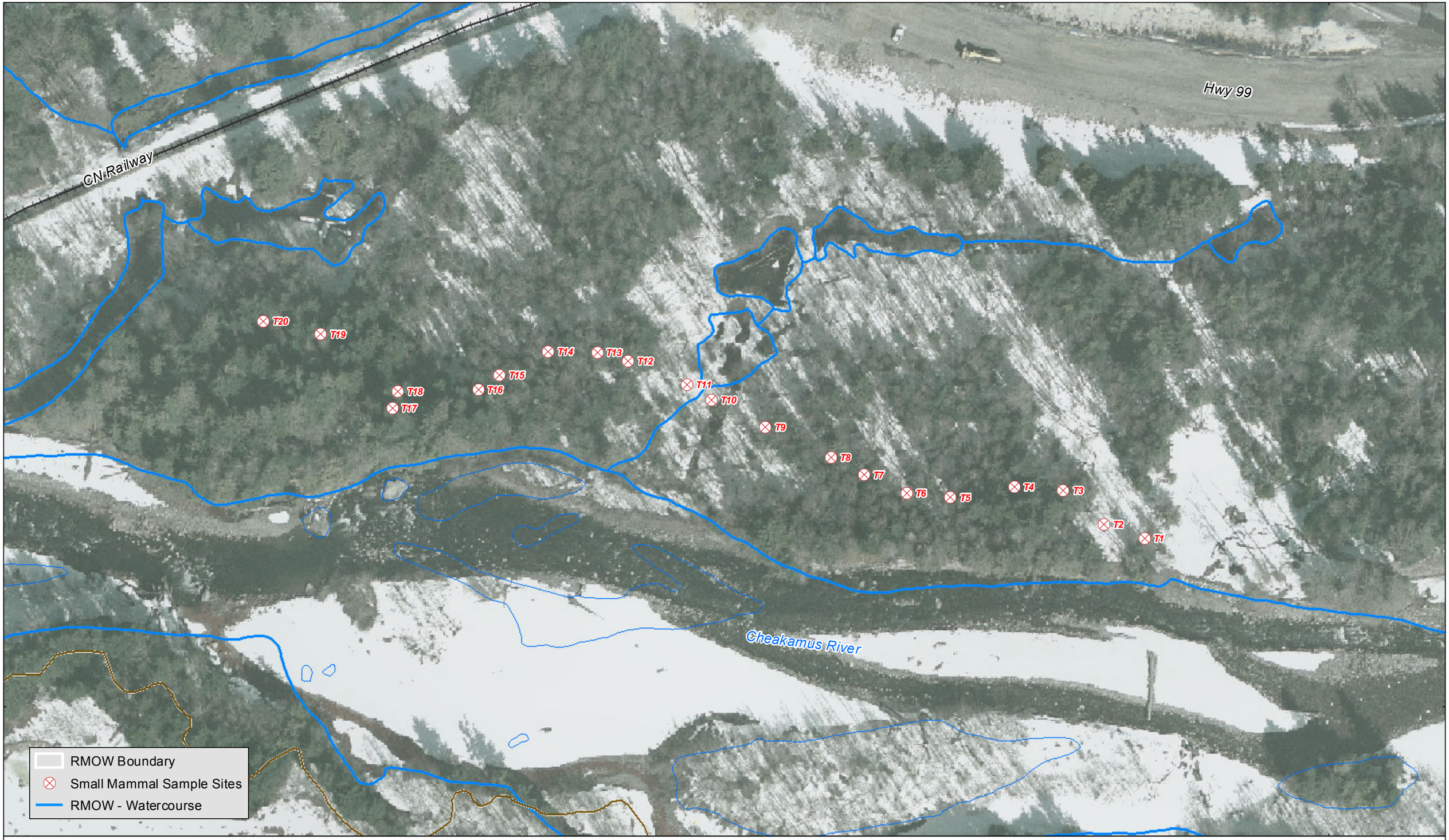
### 3.5.2 Red-backed Vole

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). In general, 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 in Function Junction was added (Map 12).

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 in 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.




GIS Cartographer: Todd Hellinga
Date: January 22, 2015
CERG File#: 013-48-02
Projection: UTM 10N NAD83
Orthophoto: BC GOv

CASCADE ENVIRONMENTAL

N
W E
S

0 20 40 60 80 100

Meters

**Small Mammal Sampling - Function**

Biodiversity Monitoring Project 2014
Resort Municipality Of Whistler
British Columbia

#### 3.5.2.2 **Results**

A total of 51 small mammals were captured and released at the three sites over two trapping sessions of two nights. 6 species were captured including 29 deer mice (*Peromyscus* sp.) (**Error! Reference source not ound.**), 10 southern red-backed voles (*Myodes gapperi*) (**Error! Reference source not found.**), four yellow-pine chipmunks (*Neotamias amoenus*), 3 shrews (*Sorex* sp.), three Douglas squirrels (*Tamiasciurus douglasii*) and two long-tailed voles (*Microtus longicaudus*).

Overall abundance was the highest at the function site during the late summer (0.68 animal/ trap night) and the lowest at the Rainbow site during the spring (0.12 animal/ trap night). The most abundant species at Blueberry was the Douglas squirrel (0.06 animal/ trap night) during the spring and the Red-back vole (0.08 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 0.1 and 0.08 animal/ trap night respectively. Small mammal abundance was only measured over one trap night during the summer at the Function site due to a bear interfering with the traps. The dominant species in Function was the Deer mouse with an abundance of 0.56 animal/ trap night (

Table 27).

Table 28 shows the number of voles in each age class per sex at both sites. At the Blueberry site, 33% (2 voles) of the red-back vole captured were females and 66% (4 voles) were males. All the females captured were adults while adult and subadult accounted each for 25 % of the male caught and the remaining 50% were juveniles. At the Rainbow site 50%(5 voles) of the deer mice were female and 50%(5 voles) were male. 60% of the female were adult and 40% were subadult. Among the male 40% were adult while 60% were subadult. All red-back vole were male of which 66% were adult and 33% were subadult. At the Function site all the deer mice captured were subadult with 69%(9 voles) of female and 31%(4 voles) of male. All captured long tailed vole were adult males (2 voles).

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 E.

**Photo 27 Southern red backed vole in holding bucket May 20, 2014**

**Photo 28: Deer mouse in holding bucket. September 9, 2014**

**Table 27: Relative abundance of small mammal species at Blueberry, Rainbow and Function Sites expressed as the number of individuals captured per trap night.**

| | Blueberry | | Rainbow | | Function | |
|---|---|---|---|---|---|---|
| | Spring | Summer | Spring | Summer | Spring | Summer |
| Deer mouse | 0 | 0 | 0.1 | 0.08 | Traps damaged by a bear | 0.56 |
| Douglas squirrel | 0.06 | 0 | 0 | 0 | | |
| Red-back vole | 0.04 | 0.08 | 0 | 0.02 | | |
| Long-tailed vole | 0 | 0.00 | 0 | 0 | | 0.08 |
| Shrew | 0.02 | 0.00 | 0.02 | 0 | | 0.04 |
| Yellow-pine chipmunk | 0.04 | 0.04 | 0 | 0 | | |
| **Total** | **0.16** | **0.125** | **0.12** | **0.28** | **0** | **0.68** |

**Table 28: Total number of animals caught at each site for each sex and age class for each species**

| Site | Species | Female | | | Male | | |
|---|---|---|---|---|---|---|---|
| | | Adult | Subadult | Juvenile | Adult | Subadult | Juvenile |
| Blueberry | Red-back vole | 2 | 0 | 0 | 1 | 1 | 2 |
| | Shrew | 1 | 0 | 0 | 0 | 0 | 0 |
| Rainbow | Deer mouse | 3 | 2 | 0 | 2 | 3 | 0 |
| | Red-back vole | 0 | 0 | 0 | 2 | 1 | 0 |
| | Shrew | 1 | 0 | 0 | 0 | 0 | 0 |
| Function | Deer mouse | 0 | 9 | 0 | 0 | 4 | 0 |
| | Long-tailed vole | 0 | 0 | 0 | 2 | 0 | 0 |

### 3.5.2.3 Discussion and Recommendations

The sex class, length, weight and age class were determined only for red-backed vole, deer mice, long-tailed vole and shrew as other species were considered by-catch and could not be handled safely.

The small mammal community was different this year compared to the 2013's survey. In 2013, mainly red-backed voles were captured with the incidental capture of a few shrews and a weasel. This year four species were observed at Blueberry versus two last year. Red-backed vole abundance was lower in 2014 at the Blueberry with 0.08 animal per trap night compared to 0.44 in 2013 and 0.02 in 2014 compared to 0.06 in 2013 at the Rainbow site (Table 29). That difference in abundance and species richness could be explained by slightly different survey timing. This year survey was conducted over two trapping periods in order to have a broader understanding of the small mammal population. The second trapping period was conducted slightly earlier than last year in order to avoid colder weather. This highlights the importance of using the same trapping window every year in order to have comparable results.

The Function site was added to the survey this year and presents a different small mammal community than the Blueberry and the Rainbow sites. The overall abundance at the Function site was approximately three to four times higher than the other sites. The most abundant species was the deer mice, and the red-backed voles were not found due to the type of habitat, long-tailed voles were caught instead. Those differences are likely due the difference type of habitat, the Function site being a young alluvial forest versus the other sites being mature/old growth forest.

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

For future monitoring programs, capture sessions should continue to occur at least twice during the active season (May to October) as recommended by MELP (1998). The spring trapping was conducted late May/ early June but in order to reduce bear conflicts this session should be conducted late June early July.

Continuation of small mammal monitoring in future years would provide valuable information regarding biodiversity trends in Whistler. By monitoring the number small mammal species and their abundance it would be possible to indicate the effects of habitat loss or gain, changes in biodiversity and ecosystem structure.

**Table 29: comparison of small mammal abundance between 2013 and 2014**

| | Blueberry | | | Rainbow | | | Function | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | | 2013 | 2014 | | 2014 | |
| | Summer | Spring | Summer | Summer | Spring | Summer | Spring | Summer |
| **Deer mouse** | 0 | 0 | 0 | 0 | 0.1 | 0.08 | Traps damaged by a bear | 0.56 |
| **Douglas squirrel** | 0 | 0.06 | 0 | 0 | 0 | 0 | | 0 |
| **Red-back vole** | 0.44 | 0.04 | 0.08 | 0.06 | 0 | 0.02 | | 0 |
| **Long-tailed vole** | 0 | 0 | 0 | 0 | 0 | 0 | | 0.08 |
| **Shrew** | 0.02 | 0.02 | 0 | 0.04 | 0.02 | 0 | | 0.04 |
| **Yellow-pine chipmunk** | 0 | 0.04 | 0.04 | 0 | 0 | 0 | | 0 |
| **Total** | **0.46** | **0.16** | **0.125** | **0.1** | **0.12** | **0.28** | **0** | **0.68** |

## 3.6 Invasive Alien Plant Monitoring

In 2013, invasive hotspots were identified by GIS analysis. Most of the hotspots were located along roadsides or in disturbed areas and two plots were surveyed. After discussion with the RMOW and the SSISC, there was concern regarding the redundancy of the data collected during the invasive alien plant monitoring program. Therefore it was recommended that SSISC would carry out inventory, control and monitoring work at sites throughout the municipality. The work conducted by the SSISC in 2014 can be found in the "2014 SSISC CEP Grant Report and Financial Statement" document. A summary of the number of site treated and the number of site discovered for each species is presented in Table 30

**Table 30: Summary of the number of sites treated and the number of new site for each species.**

| Species | New sites | Sites treated |
|---|---|---|
| **Yellow flag iris** | 2 | 8 |
| **Scotch broom** | 13 | 66 |
| **Spanish broom** | | 5 |
| **Japanese knotweed** | 0 | 3 |
| **Himalayan blackberry** | 2 | 3 |
| **Purple loosestrife** | 0 | 0 |
| **Canadian horseweed** | 0 | 1 |

## 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 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 4 and Figure 5). The records are provided in Appendix F.

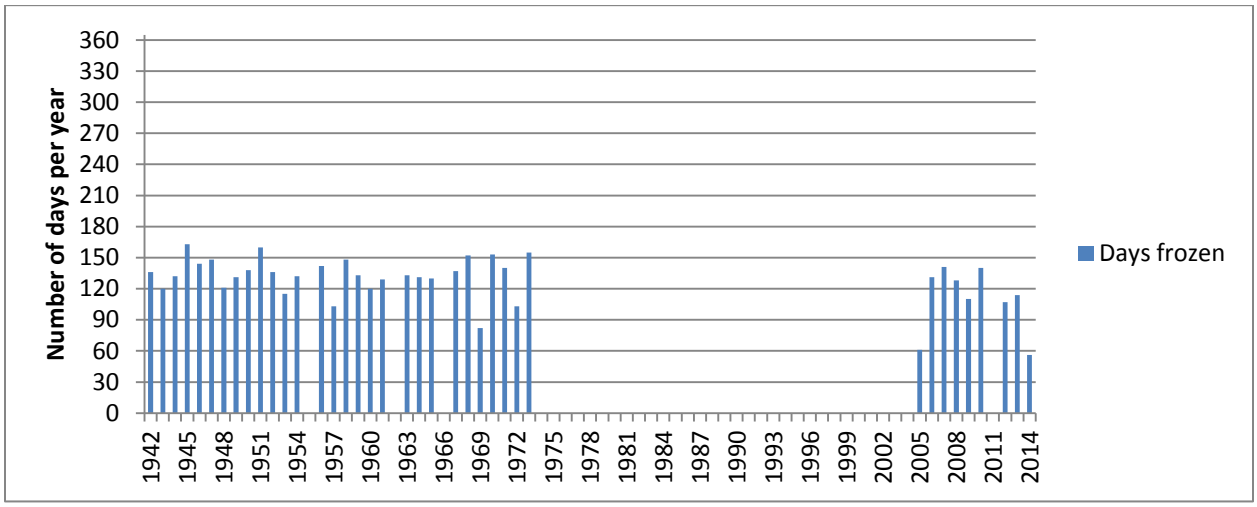



**Figure 4: Number of ice days on Alta Lake – 1942 to 2014.**

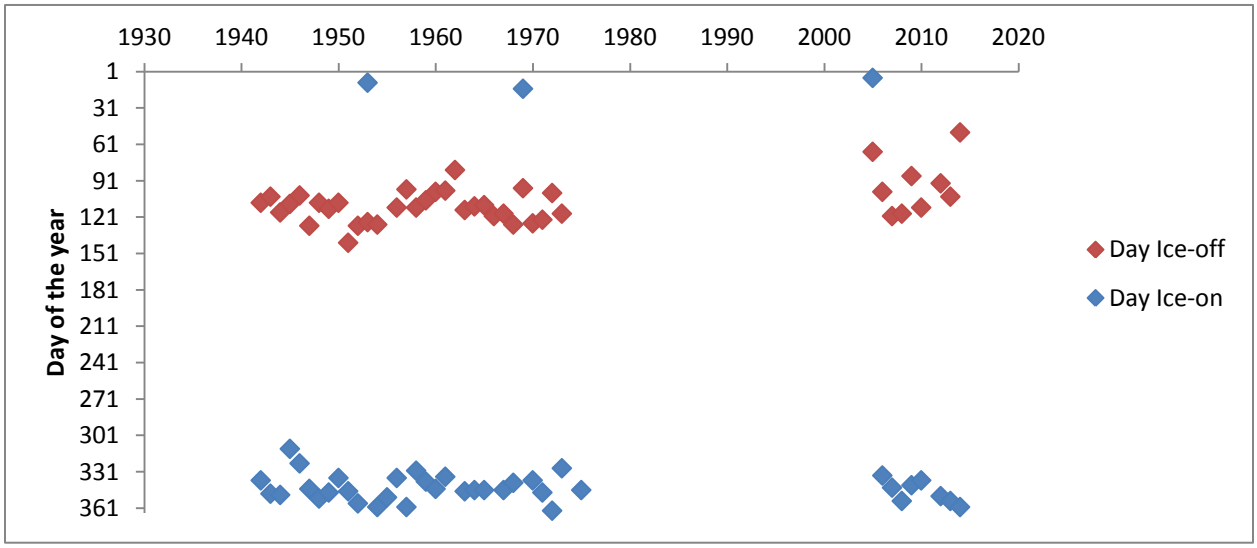



**Figure 5: Dates of freeze up and thaw on Alta Lake – 1942 to 2014.**

### 3.7.1 Discussion and Recommendations

With a discontinuous record extending back for over 70 years, the records indicate little change in the 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 second year of data collection of the ongoing ecosystem monitoring project in the RMOW. Survey protocols were designed and tested in 2013 with few changes implemented in 2014. These protocols will allow obtaining continuous and standardised data over the coming years. Being in the early stage of the project, trends might not yet be evident. Therefore, it is important to continue the monitoring process in order to observe any changes in the ecosystem health. In addition, expanding the number of survey sites would provide a better understanding of the status of the fauna and the flora in the RMOW.

### 4.1.1 Recommendations

1. Continue monitoring the indicator species using the current methodologies and refine if needed
2. Add survey sites representing the other identified sensitive terrestrial ecosystems of interest.
3. Track changes in land use around current monitoring sites in order to observed potential correlation with species abundance

## 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.
- Investigate the absence of the rainbow trout spawning in Write-off Creek, Jordan Creek and Whistler Creek,
- For spawning surveys, volunteers should undergo training in the foot survey method or shadow someone who is trained so that the data collected can be used more effectively for population estimates as opposed to presence/absence indications.

### 4.2.2 Water Quality Sampling

- Permanent monitoring sites and regular monitoring should be established on key Whistler creeks which will allow the RMOW to identify changes that could impact the health and productivity of aquatic and riparian flora and fauna within Whistler.
- Paleolimnology studies of Whistler lakes will add context to lake water quality monitoring currently being conducted by the RMOW and MOE

### 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.
- A more detailed or expanded study of Scotia Creek should be conducted to determine if a coastal tailed frog population still exists in that creek
- If abundance surveys of Nineteen Mile Creek produce null results next year, the occurrence survey method should be used to confirm presence.
- 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.

### 4.2.4 Beaver Surveys

- A larger area should be covered in future beaver surveys in order to identify new beaver lodges.
- 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

- The survey area should be expanded to include additional transects in future years.
- Refine habitat selection
- Investigate habitat uses in forest other than old growth/mature
- Use model to score habitat

### 4.2.6 Red-backed Vole Surveys

- For future monitoring program, the spring trapping session should be conducted late June- early July in order to reduce risk of bear conflict
- 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

- Average daily temperature should also be monitored during each sampling period which in some case could explain abnormally low number of carabids captured
- Increasing the length of the sampling period or increasing the number of sampling periods would likely increase the number of species captured.

### 4.2.8 Terrestrial Ecosystem Plots

- Portions of the terrestrial ecosystem plot assessments should be repeated in future years to allow for a between-year analysis of data that may correlate to the results of terrestrial wildlife surveys.
- Only data that is expected to change over time should be re-assessed which includes taking photos at photo points, updating successional status and structural stage, repeating vegetation, tree mensuration, tree attributes for wildlife, wildlife habitat assessment and coarse woody debris assessments.

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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 29).

### 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 30). 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 29. Upstream stop net upstream on the River of Golden Dreams July 31, 2014.**

**Photo 30: Fish processing and holding buckets, July 31, 2014**

### Electrofishing Sample Sites

In 2014 Cascade carried out electrofishing surveys on Jordan Creek, the River of Golden Dreams (ROGD) and Crabapple Creek (Map 3). Fish surveys on Jordan Creek were carried out at 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 4). 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 31. 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 31: 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<br>10-50 km2<br>>50 km2 | 100<br>50<br>1 | 100 | 100 | 50 | 100 |
| Aspect | 13-225°<br>45-135°, 225-315°<br>315-360°, 1-45°3 | 4<br>3<br>2 | 3 | 3 | 3 | 3 |
| Ratio of watershed's relief above the treeline | 0-25%<br>25-50%<br>50-75%<br>75-100% | 4<br>3<br>2<br>1 | 4 | 4 | 3 | 4 |
| Biogeoclimatic Zone | CWH<br>MH<br>AT | 4<br>3<br>1 | 4 | 4 | 4 | 4 |
| Lake | Present<br>Not present | 10<br>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 31).

**Photo 31: 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 C). 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 (Photo 16 and Photo 17). Lodges were deemed *inactive* if there were no signs of maintenance, continued construction or signs of activity surrounding the lodge (Photo 18) (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 29 and October 30, 2014.

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)

## Terrestrial Ecosystem Site Assessment

In order to select potential plot locations, GIS analysis focused on identification of candidate sites based on the following criteria:

1. Site Located in a young alluvial forest;
2. Located on RMOW natural park land or Crown land with an unlikelihood of future development;
3. Zonal or representative of the general ecological condition of the area;
4. Little human contact (distance from roads and trails); and
5. Reasonably flat ground.

Based on these criteria one plot was selected. Plot 3 is located in Function Junction between the Cheakamus River and Highway 99, south of the sewage treatment plan (Map 14). The terrestrial ecosystem plots consisted of 20 m by 20 m quadrats demarcated on the ground and a photo point.

Assessment of the terrestrial ecosystem plots consisted of filling out field forms developed by the BC Ministry of Forests and Range (MOFR) and the BC Ministry of Environment (MOE), including the Ecosystem Field Form, which describes the site, soil, vegetation and tree mensuration, as well as the Wildlife Habitat Assessment, Tree Attributes for Wildlife, and Coarse Woody Debris field forms. The forms were filled out in accordance with the *Field Manual for Describing Terrestrial Ecosystems 2nd Edition* (MOFR and MOE, 2010). These were filled out to the best of the ability of the surveyors given that there were time and budget constraints. A photo of the plot was also taken from a permanently established photo point.

## 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 32) 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 32: Carabid beetle sampling dates for each site.**

| Sites | Date of the 1st sampling | Date of the 2nd sampling |
|---|---|---|
| #1 : Blueberry | 14/07/2014 to 28/07/2014 | 08/09/2014 to 22/09/2014 |
| #2 : Rainbow | 14/07/2014 to 28/07/2014 | 08/09/2014 to 22/09/2014 |
| #3: Function | 14/07/2014 to 28/07/2014 | 08/09/2014 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, 2014 during favourable weather conditions consisting of clear skies, warm temperatures and no wind to a light breeze. 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.

### Habitat Data Collection

Habitat attributes were also collected for transects 3 and 4 including species composition, stand age (i.e. structural stage), stand density, and the number and quality of dead or dying trees. Where potential pileated woodpecker cavities were observed, associated data was recorded including the tree species, height and decay class and cavity height, size and shape. Cavities were considered recent if the colour of the wood appeared fresh or if wood chips were present on the ground. Each cavity tree was recorded in the GPS and photo documented. Only recent cavities were documented along transect 1 and 2

## Red-backed Vole survey methodology

### Animal Trapping

The same method used during the 2013 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. **Error! Reference source not found.** summarizes the date at which each site was surveyed.

**Table 33: Dates of the spring and summer trapping at the Blueberry, Rainbow and Function sites.**

| | Blueberry site | Rainbow site | Function site |
|---|---|---|---|
| **Spring trapping date** | May 21 and 22 2014 | May 21 and 22 2014 | June 3 2014 |
| **Summer trapping date** | September 10 and 11 2014 | September 10 and 11 2014 | September 24 and 25, 2014 |

# APPENDIX B: INDIVIDUAL FISH DATA

**Table 34: Fish captured during the first pass at site 1 of Jordan Creek on July 25, 2014**

| **Daily Fish Log** | | | |
|---|---|---|---|
| MOE licence number:<br>**SU14-94101** | | DFO licence number: | |
| Project number:<br>013-48-02 | | Site number (Reach):<br>1 | |
| Contractor:<br>RMOW | | Field team:<br>CRT, CW (RMOW) | |
| Date:<br>2014-07-25 | | Waterbody name:<br>Jordan's Creek | |
| Partly Cloudy | | Waterbody location:<br>Creekside, Whistler. | |
| **Fish Collection Summary Information** | | | |
| Turbidity:<br>1.19 NTU | Visibility: clear | GPS co-ordinates(D/S end- U/S end):<br>Accuracy: 10U 0500206E 5549251N | |
| Water temperature (ºC):<br>15.3 | | Conductivity (µS/cm): 60 | |
| pH:<br>6.86 | | D.O:<br>9.7 mg/L | |
| Block nets: **U/S D/S** Partial None<br>U/S and D/S | | Start time:<br>12:50 | End time:<br>13:11 |
| **Electrofishing specifications** | | **Minnow trap specifications** | |
| Pass number:1 | Seconds:511 | Trap number: | |
| Voltage:360 | Frequency:50 | Trap depth: | |
| EF Length(m): 18 | EF Width(m):6 | Soak time (hrs): | |

**Individual Fish Data**

| **Species** | **Length (mm)** | **Weight (gr)** | **Stage** | **Total caught** |
|---|---|---|---|---|
| SC<br>SC<br>SC<br>SB<br>RB<br>RB | 80<br>90<br>100<br>55<br>35<br>30 | 10<br>11<br>14<br>2<br><1<br><1 | <br><br><br><br>Emergent<br>Emergent | 1<br>1<br>1<br>1<br>1 (mort)<br>1 |

**Total number of fish collected: 6**

**Comments (additional species caught):**
Duty cycle: 12%

**Table 35: Fish captured during the second pass at site 1 of Jordan Creek on July 25, 2014**

| **Daily Fish Log** | | | |
|---|---|---|---|
| MOE licence number:<br>**SU14-94101** | | DFO licence number: | |
| Project number:<br>013-48-02 | | Site number (Reach):<br>1 | |
| Contractor:<br>RMOW | | Field team:<br>CRT, CW (RMOW) | |
| Date:<br>2014-07-25 | | Waterbody name:<br>Jordan's Creek | |
| Partly Cloudy | | Waterbody location:<br>Creekside, Whistler. | |
| **Fish Collection Summary Information** | | | |
| Turbidity:<br>1.19 NTU | Visibility: clear | GPS co-ordinates(D/S end- U/S end):<br>Accuracy: 10U 0500206E 5549251N | |
| Water temperature (ºC):<br>15.3 | | Conductivity (µS/cm): 60 | |
| pH:<br>6.86 | | D.O:<br>9.7 mg/L | |
| Block nets: **U/S D/S** Partial None<br>U/S and D/S | | Start time:<br>13:20 | End time:<br>13:44 |
| **Electrofishing specifications** | | **Minnow trap specifications** | |
| Pass number:1 | Seconds:540 | Trap number: | |
| Voltage:360 | Frequency:50 | Trap depth: | |
| EF Length(m): 18 | EF Width(m):6 | Soak time (hrs): | |

**Individual Fish Data**

| **Species** | **Length (mm)** | **Weight (gr)** | **Stage** | **Total caught** |
|---|---|---|---|---|
| SC<br>SB<br>RB<br>RB | 75<br>45<br>30<br>100 | 7<br><1<br><1<br>10 | Emergent<br>Parr | 1<br>1<br>1<br>1 |

**Total number of fish collected: 4**

**Comments (additional species caught):**
Duty cycle: 12%

**Table 36: Fish captured during the first pass at site 2 of Jordan Creek on July 25, 2014**

| **Daily Fish Log** | | | |
|---|---|---|---|
| MOE licence number:<br>**SU14-94101** | | DFO licence number: | |
| Project number:<br>013-48-02 | | Site number (Reach):<br>2 | |
| Contractor:<br>RMOW | | Field team:<br>CRT, CW (RMOW) | |
| Date:<br>2014-07-25 | | Waterbody name:<br>Jordan's Creek | |
| Overcast | | Waterbody location:<br>Creekside, Whistler. | |
| **Fish Collection Summary Information** | | | |
| Turbidity:<br>1.25 NTU | Visibility: clear | GPS co-ordinates(D/S end- U/S end):<br>Accuracy: 10U 0500206E 5549251N | |
| Water temperature (ºC):<br>15.0 | | Conductivity (µS/cm): 60 | |
| pH:<br>6.86 | | D.O:<br>9.3 mg/L | |
| Block nets: **U/S D/S** Partial None<br>U/S and D/S | | Start time:<br>10:30 | End time:<br>10:57 |
| **Electrofishing specifications** | | **Minnow trap specifications** | |
| Pass number:1 | Seconds: 590 | Trap number: | |
| Voltage:395 | Frequency:50 | Trap depth: | |
| EF Length(m): 18 | EF Width(m):6 | Soak time (hrs): | |

**Individual Fish Data**

| **Species** | **Length (mm)** | **Weight (gr)** | **Stage** | **Total caught** |
|---|---|---|---|---|
| SC<br>SC<br>SB<br>SB<br>RB<br>RB | 100<br>90<br>50<br>45<br>20<br>65 | 14<br>12<br>5<br>2<br><1<br>3 | Emergent<br>Parr | 1<br>1<br>1<br>1<br>1<br>1 |

**Total number of fish collected: 4**

**Comments (additional species caught):**
Duty cycle: 12%

**Table 37: Fish captured during the second pass at site 2 of Jordan Creek on July 25, 2014**

| **Daily Fish Log** | | | |
|---|---|---|---|
| MOE licence number:<br>**SU14-94101** | | DFO licence number: | |
| Project number:<br>013-48-02 | | Site number (Reach):<br>2 | |
| Contractor:<br>RMOW | | Field team:<br>CRT, CW (RMOW) | |
| Date:<br>2014-07-25 | | Waterbody name:<br>Jordan's Creek | |
| Overcast | | Waterbody location:<br>Creekside, Whistler. | |
| **Fish Collection Summary Information** | | | |
| Turbidity:<br>1.25 NTU | Visibility: clear | GPS co-ordinates(D/S end- U/S end):<br>Accuracy: 10U 0500206E 5549251N | |
| Water temperature (ºC):<br>15.0 | | Conductivity (µS/cm): 60 | |
| pH:<br>6.86 | | D.O:<br>9.3 mg/L | |
| Block nets: **U/S D/S** Partial None<br>U/S and D/S | | Start time:<br>11:10 | End time:<br>11:58 |
| **Electrofishing specifications** | | **Minnow trap specifications** | |
| Pass number:1 | Seconds: 479 | Trap number: | |
| Voltage:395 | Frequency:50 | Trap depth: | |
| EF Length(m): 18 | EF Width(m):6 | Soak time (hrs): | |

**Individual Fish Data**

| **Species** | **Length (mm)** | **Weight (gr)** | **Stage** | **Total caught** |
|---|---|---|---|---|
| RB<br>RB<br>RB | 20<br>25<br>110 | <1<br><1<br>16 | Emergent<br>Emergent<br>Parr | 2<br>1<br>1 |

**Total number of fish collected: 4**

**Comments (additional species caught):**
Duty cycle: 15%

**Table 38: Fish captured during the first pass of Crabapple Creek on July 31, 2014**

| **Daily Fish Log** | | | |
|---|---|---|---|
| MOE licence number: **SU14-94101** | | DFO licence number: | |
| Project number: 013-48-02 | | Site number (Reach): 1 | |
| Contractor: RMOW | | Field team: CRT, CW (RMOW) | |
| Date: 2014-07-31 | | Waterbody name: Crabapple Creek | |
| Sunny | | Waterbody location: Whistler. | |
| **Fish Collection Summary Information** | | | |
| Turbidity:<br>2.10 NTU | Visibility: clear | GPS co-ordinates(D/S end- U/S end):<br>Accuracy: 10U 502022E 5552000N | |
| Water temperature (ºC):<br>15.4 | | Conductivity (µS/cm):<br>203 | |
| pH:<br>6.15 | | D.O:<br>10.2 mg/L | |
| Block nets: **U/S D/S** Partial None<br>U/S and D/S | | Start time:<br>12:00 | End time:<br>12:25 |
| **Electrofishing specifications** | | **Minnow trap specifications** | |
| Pass number:<br>1 | Seconds:<br>647 | Trap number: | |
| Voltage:<br>235 | Frequency:<br>50 | Trap depth: | |
| EF Length(m):<br>33 | EF Width(m):<br>3 | Soak time (hrs): | |

**Individual Fish Data**

| **Species** | **Length (mm)** | **Weight (gr)** | **Stage** | **Total caught** |
|---|---|---|---|---|
| SB | 40 | <1 | | 1 |
| SB | 50 | <1 | | 1 |
| SB | 55 | <1 | | 1 |
| SB | 40 | <1 | | 1 |
| SC | 50 | <1 | | 1 |
| SC | 55 | <1 | | 1 |
| SB | 45 | <1 | | 1 |
| SC | 55 | <1 | | 1 |
| SB | 50 | <1 | | 1 |
| SC | 50 | <1 | | 1 |
| SC | 50 | 2 | | 1 |
| SB | 40 | <1 | | 1 |
| SC | 60 | 2 | | 1 |
| SB | 35 | <1 | | 1 |
| RB | 35 | <1 | Fry | 1 |
| RB | 35 | <1 | Fry | 1 |
| RB | 145 | 37 | Parr | 1 |

**Total number of fish collected: 17**

**Comments (additional species caught):**
Duty cycle: 12%

**Table 39: Fish captured during the second pass of Crabapple Creek on July 31, 2014**

| **Daily Fish Log** | | | |
|---|---|---|---|
| MOE licence number: **SU14-94101** | | DFO licence number: | |
| Project number: 013-48-02 | | Site number (Reach): 1 | |
| Contractor: RMOW | | Field team: CRT, CW (RMOW) | |
| Date: 2014-07-31 | | Waterbody name: Crabapple Creek | |
| Sunny | | Waterbody location: Whistler. | |
| **Fish Collection Summary Information** | | | |
| Turbidity:<br>2.10 NTU | Visibility: clear | GPS co-ordinates(D/S end- U/S end):<br>Accuracy: 10U 502022E 5552000N | |
| Water temperature (ºC):<br>15.4 | | Conductivity (µS/cm):<br>203 | |
| pH:<br>6.15 | | D.O:<br>10.2 mg/L | |
| Block nets: **U/S D/S** Partial None<br>U/S and D/S | | Start time:<br>12:45 | End time:<br>13:07 |
| **Electrofishing specifications** | | **Minnow trap specifications** | |
| Pass number:<br>2 | Seconds:<br>740 | Trap number: | |
| Voltage:<br>235 | Frequency:<br>50 | Trap depth: | |
| EF Length(m):<br>33 | EF Width(m):<br>3 | Soak time (hrs): | |

**Individual Fish Data**

| Species | Length (mm) | Weight (gr) | Stage | Total caught |
|---|---|---|---|---|
| SB | 50 | 2 | | 1 |
| SB | 60 | 2 | | 1 |
| SB | 50 | <1 | | 1 |
| SB | 45 | <1 | | 1 |
| SC | 65 | 3 | | 1 |
| SB | 40 | <1 | | 1 |
| RB | 175 | 57 | Juvenile | 1 |
| RB | 25 | <1 | Parr | 1 |
| SB | 4 | <1 | | 1 |
| SB | 45 | <1 | | 1 |
| SB | 40 | <1 | | 1 |
| SB | 40 | <1 | | 1 |
| SB | 40 | <1 | | 1 |
| SC | 50 | <1 | | 1 |
| *RB | 90 | 7 | Parr | 1 |
| *RB | 75 | 4 | Parr | 1 |
| *RB | 90 | 7 | Parr | 1 |
| SC | 55 | 2 | | 1 |
| SC | 60 | 4 | | 1 |
| SB | 30 | <1 | | 1 |
| SC | 55 | 3 | | 1 |
| SC | 45 | 2 | | 1 |
| SB | 40 | <1 | | 1 |
| SB | 40 | <1 | | 1 |
| SB | 40 | <1 | | 1 |
| *RB | 90 | 10 | Parr | 1 |
| SC | 65 | 3 | | 1 |
| RB | 30 | <1 | Fry | 1 |
| SC | 55 | 3 | | 1 |
| SB | 45 | <1 | | 1 |

**Total number of fish collected: 30**

**Comments (additional species caught):**
Duty cycle: 12%
*RB with yellow tinged jaw. Potential cutthroat hybrid

**Table 40: Fish captured during the third pass of Crabapple Creek on July 31, 2014**

CASCADE ENVIRONMENTAL
RESOURCE GROUP LTD

**Daily Fish Log**

| | |
|---|---|
| MOE licence number: **SU14-94101** | DFO licence number: |
| Project number: 013-48-02 | Site number (Reach): 1 |
| Contractor: RMOW | Field team: CRT, CW (RMOW) |
| Date: 2014-07-31 | Waterbody name: Crabapple Creek |
| Sunny | Waterbody location: Whistler. |

**Fish Collection Summary Information**

| | | |
|---|---|---|
| Turbidity:<br>2.10 NTU | Visibility: clear | GPS co-ordinates(D/S end- U/S end):<br>Accuracy: 10U 502022E 5552000N |
| Water temperature (ºC):<br>15.4 | | Conductivity (µS/cm):<br>203 |
| pH:<br>6.15 | | D.O:<br>10.2 mg/L |
| Block nets: **U/S D/S** Partial None<br>U/S and D/S | | Start time:<br>13:30 / End time:<br>13:51 |

| | | |
|---|---|---|
| **Electrofishing specifications** | | **Minnow trap specifications** |
| Pass number:<br>3 | Seconds:<br>563 | Trap number: |
| Voltage:<br>235 | Frequency:<br>50 | Trap depth: |
| EF Length(m):<br>33 | EF Width(m):<br>3 | Soak time (hrs): |

**Individual Fish Data**

| Species | Length (mm) | Weight (gr) | Stage | Total caught |
|---|---|---|---|---|
| SC | 70 | 4 | | 1 |
| SC | 55 | 2 | | 1 |
| SC | 75 | 7 | | 1 |
| SB | 40 | <1 | | 1 |
| SB | 40 | <1 | | 1 |
| SB | 55 | 3 | | 1 |
| SB | 40 | <1 | | 1 |
| SB | 45 | <1 | | 1 |
| SB | 35 | <1 | | 1 |
| SC | 40 | 2 | | 1 |
| RB | 75 | 6 | Parr | 1 |
| RB | 215 | 100 | Adult | 1 |
| RB | 130 | 26 | Juvenile | 1 |

**Total number of fish collected: 13**

**Comments (additional species caught):**
Duty cycle: 12%
*RB with yellow tinged jaw. Potential cutthroat hybrid

**Table 41: Fish captured during the first pass of River of Golden Dreams on July 31, 2014**

| **Daily Fish Log** | | | |
|---|---|---|---|
| MOE licence number:<br>**SU14-94101** | | DFO licence number: | |
| Project number:<br>013-48-02 | | Site number (Reach):<br>2 | |
| Contractor:<br>RMOW | | Field team:<br>CRT, CW (RMOW) | |
| Date:<br>2014-07-31 | | Waterbody name:<br>River of Golden Dreams | |
| Sunny | | Waterbody location:<br>Whistler. | |
| **Fish Collection Summary Information** | | | |
| Turbidity:<br>0.86 NTU | Visibility: clear | GPS co-ordinates(D/S end- U/S end):<br>Accuracy: 10U 502032E 5552777N | |
| Water temperature (ºC):<br>15.3 | | Conductivity (µS/cm):<br>64 | |
| pH:<br>6.86 | | D.O:<br>9.15 mg/L | |
| Block nets: **U/S D/S** Partial None<br>U/S and D/S | | Start time:<br>10:15 | End time:<br>11:30 |
| **Electrofishing specifications** | | **Minnow trap specifications** | |
| Pass number:<br>1 | Seconds:<br>368 | Trap number: | |
| Voltage:<br>340 | Frequency:<br>50 | Trap depth: | |
| EF Length(m):<br>8 | EF Width(m):<br>12.5 | Soak time (hrs): | |

**Individual Fish Data**

| **Species** | **Length (mm)** | **Weight (gr)** | **Stage** | **Total caught** |
|---|---|---|---|---|
| SC<br>RB<br>RB | 60<br>25<br>30 | 2<br><1<br><1 | <br>Emergent Fry<br>Emergent Fry | 1<br>4<br>1 |

**Total number of fish collected: 6**

**Comments (additional species caught):**
Duty cycle: 12%

**Table 42: Fish captured during the second pass of River of Golden Dreams on July 31, 2014**

| **Daily Fish Log** | | | |
|---|---|---|---|
| MOE licence number:<br>**SU14-94101** | | DFO licence number: | |
| Project number:<br>013-48-02 | | Site number (Reach):<br>2 | |
| Contractor:<br>RMOW | | Field team:<br>CRT, CW (RMOW) | |
| Date:<br>2014-07-31 | | Waterbody name:<br>River of Golden Dreams | |
| Sunny | | Waterbody location:<br>Whistler. | |
| **Fish Collection Summary Information** | | | |
| Turbidity:<br>0.86 NTU | Visibility: clear | GPS co-ordinates(D/S end- U/S end):<br>Accuracy: 10U 502032E 5552777N | |
| Water temperature (ºC):<br>15.3 | | Conductivity (µS/cm):<br>64 | |
| pH:<br>6.86 | | D.O:<br>9.15 mg/L | |
| Block nets: **U/S D/S** Partial None<br>U/S and D/S | | Start time:<br>10:15 | End time:<br>11:30 |
| **Electrofishing specifications** | | **Minnow trap specifications** | |
| Pass number:<br>1 | Seconds:<br>250 | Trap number: | |
| Voltage:<br>340 | Frequency:<br>50 | Trap depth: | |
| EF Length(m):<br>8 | EF Width(m):<br>12.5 | Soak time (hrs): | |

**Individual Fish Data**

| **Species** | **Length (mm)** | **Weight (gr)** | **Stage** | **Total caught** |
|---|---|---|---|---|
| SB | 50 | 2 | | 1 |
| SC | 50 | 2 | | 1 |
| SC | 75 | 5 | | 1 |
| SC | 65 | 3 | | 1 |
| SC | 65 | 2 | | 1 |
| SC | 45 | <1 | | 1 |

**Total number of fish collected: 6**

**Comments (additional species caught):**
Duty cycle: 12%

# APPENDIX C: BEAVER LODGE DATA

**Table 43: Location and level of activity observed for each beaver lodge visited in Whistler, BC for 2010, 2013 and 2014. 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 | observations |
|---|---|---|---|---|---|---|
| Wedge Pond Lodge | 503224 | 5555745 | active | active | active | Fresh wood and fresh mud |
| Green Lake Lodge | 503746 | 5554612 | active | active | active | fresh mud and prints |
| Fitz Fan Lodge | 503847 | 5554866 | active | *unknown* | *unknown* | found branches with teeth mark around |
| Nicklaus North Tee 12 | 502659 | 5553663 | active | active | inactive | big hole near the lodge might have collapsed |
| Spruce grove #1 | 503653 | 5553302 | | inactive | inactive | by the pond |
| Spruce grove #2 | 503551 | 5553348 | | inactive | inactive | south end of the parking in the channel |
| Spruce grove #3 | 503546 | 5553377 | | | inactive | channel by the parking |
| Spruce grove #4 | 503537 | 5553411 | | | inactive | channel by the parking |
| Spruce grove #5 | 503518 | 5553500 | | | active | north of parking in the channel, fresh mud and branches lots of cuttings |
| Chateau Irrigation Pond Lodge | 504625 | 5552337 | active | active | active | fresh mud and fresh branches |
| Chateau Golf Course | 504184 | 5552221 | active | *unknown* | inactive | 2 lodges |
| Whistler Golf Course #2 | 502367 | 5551790 | active | active | inactive | Old mud, path not cleaned, no fresh twigs |
| Nita Lake Lodge | 500290 | 5549772 | active | *unknown* | active | few fresh cuttings and fresh wood on lodge |
| Alpha Lake Lodge | 499203 | 5548997 | active | inactive | inactive | |
| ROGD Lodge #1 | 502130 | 5552997 | inactive | not found | active | pile of chewed branches, worn mud path |
| ROGD Lodge #2 | 502297 | 5553210 | *unknown* | not found | not found | |
| ROGD Lodge #3 | 502348 | 5553202 | active | *unknown* | inactive | |
| ROGD Lodge #4 | 502421 | 5553438 | *unknown* | active | active | lots of fresh cuts |
| ROGD Lodge #5 | 502309 | 5553844 | active | active | not found | fresh cuts on lodge |
| ROGD Lodge #6 | 502364 | 5553932 | inactive | not found | not found | no longer a lodge |
| ROGD Lodge #7 | 502521 | 5554056 | inactive | not found | not found | |
| ROGD Lodge #8 | 502635 | 5554124 | *unknown* | not found | not found | |
| ROGD Lodge #9 | 502440 | 5554221 | active | active | inactive | |
| ROGD Lodge #10 | 502645 | 5554445 | active | active | active | Food cache, no leaves on path, fresh debarjed branches |
| ROGD Lodge #11 | 502660 | 5554457 | inactive | inactive | not found | |
| ROGD Lodge #11b | 503030 | 5554733 | | | active | worn mud path, fresh branch and mud on lodge |
| ROGD Lodge #12 | 502994 | 5554838 | *unknown* | inactive | active | food cache+ fresh wood on lodge |
| ROGD Lodge #13 | 503142 | 5554830 | inactive | inactive | not found | |
| ROGD Lodge #14 | 503203 | 5554929 | active | *unknown* | inactive | collapsed at the middle |
| ROGD Lodge #15 | 503188 | 5554839 | active | *unknown* | inactive | |

| Location | Easting | Northing | 2010 | 2013 | 2014 | observations |
|---|---|---|---|---|---|---|
| ROGD Lodge #16 | 503196 | 5554835 | *unknown* | active | inactive | |
| ROGD Lodge #17 | 503203 | 5554833 | *unknown* | *unknown* | inactive | |

**Table 44: Photo documentation of the lodges surveyed with the exception of the lodges on the ROGD**

**Photo 32: View of the lodge at Alpha lake. October 29, 2014**

**Photo 33: Close up view of the lodge at Alpha lake. October 29, 2014**

**Photo 34: View of the beaver path on the lodge at Alpha lake. October 29, 2014**

**Photo 35: View of the lodge at Nita lake. October 29, 2014**

**Photo 36: View of the lodge at Nita lake. October 29, 2014**

**Photo 37: View of fresh debarked branches on the lodge at Nita Lake. October 29, 2014**

**Photo 38: View of the Lodge at Whistler golf course pond. October 29, 2014**

**Photo 39: View of the beaver path on the lodge at the Whistler golf course pond. October 29, 2014**

**Photo 40: View of the Lodge at Whistler golf course pond. October 29, 2014**

**Photo 41: View of the Lodge at Chateau golf course pond. October 29, 2014.**

**Photo 42: View of the Lodge at Chateau golf course pond. October 29, 2014.**

**Photo 43: View of the dam Lodge at Chateau golf course pond. October 29, 2014.**

**Photo 44: View of the fresh mud on the lodge at the Chateau irrigation pond. October 29, 2014**

**Photo 45: View of the fresh wood on the lodge at the Chateau irrigation pond. October 29, 2014**

**Photo 46: View of the lodge at the Chateau irrigation pond. October 29, 2014**

**Photo 47: View of the active lodge at Spruce grove. October 29, 2014**

**Photo 48: View of the inactive lodge at Spruce grove. October 29, 2014**

**Photo 49: Sign of activity around the lodge at Spruce grove. October 29, 2014**

**Photo 50: View of the Lodge at the Nicklaus north golf course. October 29, 2014**

**Photo 51: View of the Lodge at the Nicklaus north golf course. October 29, 2014**

**Photo 52: View of a hole on top of the Lodge at the Nicklaus north golf course. October 29, 2014**

**Photo 53: View of the lodge at the Fitzsimmons fan. October 29, 2014**

**Photo 54: Freshly debarked twig observed near the lodge at the Fitzsimmons fan. October 29, 2014**

**Photo 55: View of the lodge at Green lake. October 29, 2014**

**Photo 56: Beaver print in the mud observed near the lodge on Green lake. October 29, 2014**

**Photo 57: View of the Lodge at Wedge pond. October 29, 2014**

**Photo 58: View of the Lodge at Wedge pond. October 29, 2014**

# APPENDIX D: PILEATED WOODPECKER SURVEY DATA

**Table 45: Summary of cavity trees and attributes identified along Transects 3 and 4**

| Tree # | Tree Information | | | | Cavity Information | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Species | Height (m) | DBH (cm) | Decay Class* | Number of Cavities | Shape | Size (cm) | Height (m) | Signs of Recent Use | Result of Pileated Woodpecker? |
| ***Creekside Transect 3*** | | | | | | | | | | |
| 1 | Western redcedar | 30 | 49 | 2 | 6 | Oval | 5-23 | 1.5-5 | Appear old | Yes |
| 2 | Amabilis fir | 35 | 63 | 5 | >20 | Oval | 5-24 | 0-2 | Appear old | Yes |
| ***Stone Bridge Transect 4*** | | | | | | | | | | |
| 1 | Douglas-fir | 30 | 87.5 | 5 | 14 | Oval | 5-32 | 0.1 - 3 | Appear recent from colour of wood | Yes |
| 2 | Western redcedar | 30 | 55 | 3 | >20 | Oval | 9-19 | 0.5 – 10 | Old | Yes |
| 3 | Western redcedar | 25 | 58 | 3 | >20 | Oval | 5-25 | All over | Recent | Yes |
| 4 | Western redcedar | 20 | 31 | 2 | 9 | Oval | 6-19 | 1.5-3 | Old | Yes |
| 5 | Western redcedar | 20 | 34 | 2 | 10 | Oval and round | 3-20 | 1.5-3 | Recent | Yes |
| 6 | Amabilis fir | 10 | 41.5 | 6 | >20 | Oval and round | 3-30 | 0-8 | Recent and old | Yes |
| 7 | Western redcedar | 25 | 43.5 | 2 | 6 | Oval | 2-10 | 2-8 | Old | Yes |
| 8 | Western redcedar | 25 | 48 | 2 | 10 | Oval | 5-21 | 1.5-8 | Recent and old | Yes |
| 9 | Western redcedar | 25 | 46 | 2 | 16 | Oval | 4-31 | 0.8-4 | Old | Yes |
| 10 | Western redcedar | 35 | 71.5 | 2 | >20 | Oval | 2-30 | 0.5-10 | Old | Yes |
| 11 | Western redcedar | 10 | 32 | 8 | 3 | Oval | 9 | 0.5-1.5 | Old | Yes |
| 12 | Douglas-fir | 35 | 119 | 5 | >20 | Round | 1-9 | 0-2 | Old | No |

*Decay classes from MOFR and MOE, 2010.

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

| Station | Start Time | End Time | Species Detected | Comments |
|---|---|---|---|---|
| ***Comfortably Numb Transect 1*** | | | | |
| 1 | 7:38 | 7:41 | Red breasted nuthatch (x2) | |
| 2 | 8:00 | 8:04 | - | |
| 3 | 8:12 | 8:16 | Varied thrush | |
| 4 | 8:23 | 8:28 | | Pecking heard briefly |
| 5 | 8:47 | 8:51 | Varied thrush, red breasted nuthatch | |
| 6 | 9:02 | 9:05 | Plieated woodpecker | visual |
| 7 | 9:15 | 9:19 | Plieated woodpecker | Drumming heard, most likely the same than from call station 6 |
| 8 | 9:28 | 9:33 | Plieated woodpecker | Visual, most likely the same than than from call station 6 |
| 9 | 9:50 | 9:56 | Varied thrush | |
| 10 | 10:04 | 10:08 | - | |
| ***Rainbow Transect 2*** | | | | |
| 1 | 7:45 | 7:52 | - | |
| 2 | 8:01 | 8:07 | - | |
| 3 | 8:32 | 8:35 | - | |
| 4 | 8:43 | 8:46 | - | |
| 5 | 9:07 | 9:10 | - | |
| 6 | 9:45 | 9:48 | - | |
| 7 | 10:00 | 10:04 | - | |
| 8 | 10:24 | 10:27 | - | |
| 9 | 10:40 | 10:44 | - | |
| 10 | 10:56 | 11:00 | - | |
| ***CreeksideTransect 3*** | | | | |
| 1 | 8:15 | 8:18 | - | |
| 2 | 8:48 | 8:52 | Pileated woodpecker | Drumming heard in response of broadcasted call |
| 3 | 9:15 | 9:18 | - | |
| 4 | 9:36 | 9:41 | Varied thrush | |
| 5 | 9:59 | 10:02 | - | |
| 6 | 10:16 | 10:24 | - | |
| 7 | 10:41 | 10:48 | - | |
| 8 | 11:07 | 11:12 | - | |
| 9 | 11:39 | 11:45 | - | |
| 10 | 12:25 | 12:29 | - | |
| ***Stone Bridge Transect 4*** | | | | |
| 1 | 8:18 | 8:22 | - | |
| 2 | 9:21 | 9:26 | - | |
| 3 | 9:43 | 9:48 | - | |
| 4 | 10:10 | 10:14 | - | |
| 5 | 10:29 | 10:33 | Pileated woodpecker | Visual and drumming |
| 6 | 11:03 | 11:07 | - | |
| 7 | 11:24 | 11:28 | - | |
| 8 | 12:00 | 12:04 | - | |
| 9 | 12:33 | 12:36 | - | |
| 10 | 12:48 | 12:53 | - | |

# APPENDIX E: SMALL MAMMAL TRAP DATA

**Table 47: Small mammal trap counts on Night 1 at Site 1 near Blueberry subdivision in Whistler, BC. Traps were set in the late afternoon on May 20, 2014 and checked the morning of May 21, 2014. DS= Douglas squirrel, RBV = southern red-backed vole, S = shrew**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | Empty | - | - | - | - | Trap triggered and moved |
| 1b | Empty | - | - | - | - | Trap triggered and moved |
| 2 | Empty | - | - | - | - | - |
| 3 | Empty | - | - | - | - | Trap triggered and moved |
| 4 | Empty | - | - | - | - | Trap triggered |
| 5a | Empty | - | - | - | - | Trap triggered |
| 5b | Empty | - | - | - | - | Trap triggered |
| 6 | Empty | - | - | - | - | Trap triggered |
| 7 | DS | - | - | - | - | - |
| 8 | Empty | - | - | - | - | Trap triggered |
| 9a | Empty | - | - | - | - | Trap triggered |
| 9b | Empty | - | - | - | - | Trap triggered |
| 10 | Empty | - | - | - | - | Trap triggered |
| 11 | RBV | M | Juvenile | 85 | 26 | - |
| 12 | Empty | - | - | - | - | - |
| 13a | S | F | Adult | 60 | 6 | Mortality |
| 13b | Empty | - | - | - | - | - |
| 14 | Empty | - | - | - | - | Trap triggered |
| 15 | Empty | - | - | - | - | Trap triggered |
| 16 | RBV | M | Juvenile | 90 | 22 | |
| 17a | Empty | - | - | - | - | Trap triggered |
| 17b | Empty | - | - | - | - | Trap triggered |
| 18 | Empty | - | - | - | - | Trap triggered |
| 19 | Empty | - | - | - | - | Trap triggered |
| 20 | Empty | - | - | - | - | Trap triggered |
| **Total Small Mammals** | | **4** | | | | |

**Table 48: Small mammal trap counts on Night 2 at Site 1 near Blueberry subdivision in Whistler, BC. Traps were set in the late afternoon on May 21, 2014 and checked the morning of May 22, 2014. DS= Douglas squirrel, YPC= yellow-pine chipmunk**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | YPC | - | - | - | - | - |
| 1b | YPC | - | - | - | - | - |
| 2 | DS | - | - | - | - | Mortality |
| 3 | Empty | - | - | - | - | - |
| 4 | DS | - | - | - | - | - |

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 5a | Empty | - | - | - | - | - |
| 5b | Empty | - | - | - | - | Trap triggered |
| 6 | Empty | - | - | - | - | - |
| 7 | Empty | - | - | - | - | - |
| 8 | Empty | - | - | - | - | - |
| 9a | Empty | - | - | - | - | Trap triggered |
| 9b | Empty | - | - | - | - | Trap triggered |
| 10 | Empty | - | - | - | - | - |
| 11 | Empty | - | - | - | - | - |
| 12 | Empty | - | - | - | - | - |
| 13a | Empty | - | - | - | - | Trap triggered |
| 13b | Empty | - | - | - | - | Trap triggered |
| 14 | Empty | - | - | - | - | - |
| 15 | Empty | - | - | - | - | Trap triggered |
| 16 | Empty | - | - | - | - | Trap triggered |
| 17a | Empty | - | - | - | - | Trap triggered |
| 17b | Empty | - | - | - | - | Trap triggered |
| 18 | Empty | - | - | - | - | Trap triggered |
| 19 | Empty | - | - | - | - | - |
| 20 | Empty | - | - | - | - | - |
| **Total Small Mammals** | | **4** | | | | |

**Table 49: Small mammal trap counts on Night 1 at Site 2 near Rainbow Lake Trail parking lot in Whistler, BC.**
**Traps were set in the late afternoon on May 20, 2014 and checked the morning of May 21, 2014. S = shrew, DM = deer mouse**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | Empty | - | - | - | - | - |
| 1b | Empty | - | - | - | - | - |
| 2 | Empty | - | - | - | - | - |
| 3 | Empty | - | - | - | - | - |
| 4 | Empty | - | - | - | - | - |
| 5a | Empty | - | - | - | - | - |
| 5b | Empty | - | - | - | - | - |
| 6 | Empty | - | - | - | - | - |
| 7 | Empty | - | - | - | - | - |
| 8 | Empty | - | - | - | - | - |
| 9a | Empty | - | - | - | - | - |
| 9b | Empty | - | - | - | - | - |
| 10 | S | F | Adult | 55 | 6 | Mortality |
| 11 | Empty | - | - | - | - | - |

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 12 | Empty | - | - | - | - | - |
| 13a | Empty | - | - | - | - | - |
| 13b | Empty | - | - | - | - | - |
| 14 | DM | - | - | - | - | Escaped bucket |
| 15 | Empty | - | - | - | - | Trap triggered |
| 16 | Empty | - | - | - | - | - |
| 17a | DM | F | Adult | 80 | 8 | Worn tits |
| 17b | Empty | - | - | - | - | - |
| 18 | Empty | - | - | - | - | - |
| 19 | Empty | - | - | - | - | - |
| 20 | DM | M | - | 80 | - | Escaped |
| **Total Small Mammals** | | **4** | | | | |

**Table 50: Small mammal trap counts on Night 2 at Site 2 near Rainbow Lake Trail parking lot in Whistler, BC.**
**Traps were set in the late afternoon on May 21, 2014 and checked the morning of May 22, 2014. DM = deer mouse**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | Empty | - | - | - | - | Trap triggered |
| 1b | Empty | - | - | - | - | - |
| 2 | Empty | - | - | - | - | - |
| 3 | Empty | - | - | - | - | - |
| 4 | Empty | - | - | - | - | - |
| 5a | Empty | - | - | - | - | - |
| 5b | Empty | - | - | - | - | - |
| 6 | Empty | - | - | - | - | - |
| 7 | DM | F | Adult | 70 | 22 | - |
| 8 | Empty | - | - | - | - | - |
| 9a | Empty | - | - | - | - | - |
| 9b | Empty | - | - | - | - | - |
| 10 | Empty | - | - | - | - | - |
| 11 | Empty | - | - | - | - | Trap triggered |
| 12 | Empty | - | - | - | - | - |
| 13a | Empty | - | - | - | - | - |
| 13b | Empty | - | - | - | - | Trap moved |
| 14 | Empty | - | - | - | - | Trap triggered |
| 15 | Empty | - | - | - | - | - |
| 16 | DM | - | - | - | - | Escaped |
| 17a | Empty | - | - | - | - | - |
| 17b | Empty | - | - | - | - | - |

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 18 | Empty | - | - | - | - | - |
| 19 | Empty | - | - | - | - | - |
| 20 | Empty | - | - | - | - | - |
| **Total Small Mammals** | | **2** | | | | |

**Table 51: Small mammal trap counts on Night 1 at Site 3 near Function Junction in Whistler, BC. Traps were set in the late afternoon on June 2, 2014 and checked the morning of June 3, 2014.**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | Empty | - | - | - | - | Trap triggered |
| 1b | Empty | - | - | - | - | Trap triggered |
| 2 | Empty | - | - | - | - | Trap triggered |
| 3 | Traps damaged by a bear | | | | | |
| 4 | | | | | | |
| 5a | | | | | | |
| 5b | | | | | | |
| 6 | | | | | | |
| 7 | | | | | | |
| 8 | | | | | | |
| 9a | | | | | | |
| 9b | | | | | | |
| 10 | | | | | | |
| 11 | | | | | | |
| 12 | | | | | | |
| 13a | | | | | | |
| 13b | | | | | | |
| 14 | | | | | | |
| 15 | | | | | | |
| 16 | | | | | | |
| 17a | | | | | | |
| 17b | | | | | | |
| 18 | | | | | | |
| 19 | | | | | | |
| 20 | | | | | | |
| **Total Small Mammals** | | **-** | | | | |

**Table 52: Small mammal trap counts on Night 1 at Site 1 near Blueberry subdivision in Whistler, BC. Traps were set in the late afternoon on September 09, 2014 and checked the morning of September 10, 2014. RBV = southern red-backed Vole, YPC= yellow-pine chipmunk**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | Empty | - | - | - | - | Trap triggered |

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1b | RBV | F | Adult | 85 | 26 | |
| 2 | Empty | - | - | - | - | Not set |
| 3 | Empty | - | - | - | - | Trap triggered |
| 4 | Empty | - | - | - | - | Trap triggered |
| 5 | Empty | - | - | - | - | Trap triggered |
| 6a | Empty | - | - | - | - | Trap triggered |
| 6b | Empty | - | - | - | - | - |
| 7 | Empty | - | - | - | - | Trap triggered |
| 8 | Empty | - | - | - | - | Trap triggered |
| 9a | Empty | - | - | - | - | Trap triggered |
| 9b | Empty | - | - | - | - | Trap triggered |
| 10 | Empty | - | - | - | - | - |
| 11 | Empty | - | - | - | - | - |
| 12 | Empty | - | - | - | - | Trap triggered |
| 13a | Empty | - | - | - | - | Trap triggered |
| 13b | YPC | - | - | - | - | - |
| 14 | Empty | - | - | - | - | Trap triggered |
| 15 | Empty | - | - | - | - | Trap triggered |
| 16 | Empty | - | - | - | - | Trap triggered |
| 17a | Empty | - | - | - | - | Trap triggered |
| 17b | Empty | - | - | - | - | Trap triggered |
| 18 | Empty | - | - | - | - | Trap triggered |
| 19 | Empty | - | - | - | - | Trap triggered |
| 20 | Empty | - | - | - | - | Trap triggered |
| **Total Small Mammals** | | **2** | | | | |

**Table 53: Small mammal trap counts on Night 2 at Site 1 near Blueberry subdivision in Whistler, BC. Traps were set in the late afternoon on September 10, 2014 and checked the morning of September 11, 2014. RBV = southern red-backed vole, YPC= yellow-pine chipmunk**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | Empty | - | - | - | - | Trap triggered |
| 1b | YPC | - | - | - | - | - |
| 2 | Empty | - | - | - | - | Not set |
| 3 | Empty | - | - | - | - | Trap triggered |
| 4 | Empty | - | - | - | - | Trap triggered |
| 5 | RBV | F | Adult | 75 | 27 | - |
| 6a | Empty | - | - | - | - | Trap triggered |
| 6b | Empty | - | - | - | - | Trap triggered |
| 7 | Empty | - | - | - | - | Trap triggered |
| 8 | Empty | - | - | - | - | Trap triggered |

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 9a | Empty | - | - | - | - | Trap triggered |
| 9b | Empty | - | - | - | - | Trap triggered |
| 10 | Empty | - | - | - | - | Trap triggered |
| 11 | Empty | - | - | - | - | Trap triggered |
| 12 | Empty | - | - | - | - | Trap triggered |
| 13a | Empty | - | - | - | - | - |
| 13b | Empty | - | - | - | - | - |
| 14 | RBV | M | Adult | 70 | 18 | - |
| 15 | Empty | - | - | - | - | Trap triggered |
| 16 | Empty | - | - | - | - | Trap triggered |
| 17a | Empty | - | - | - | - | - |
| 17b | Empty | - | - | - | - | Trap triggered |
| 18 | Empty | - | - | - | - | Trap triggered |
| 19 | RBV | M | Sub adult | 75 | 16 | - |
| 20 | Empty | - | - | - | - | Trap triggered |
| **Total Small Mammals** | | **4** | | | | |

**Table 54 : Small mammal trap counts on Night 1 at Site 2 near Rainbow Lake Trail parking lot in Whistler, BC.**
**Traps were set in the late afternoon on September 09, 2014 and checked the morning of September 10, 2014. DM = deer mouse, RBV = southern red-backed vole**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | Empty | - | - | - | - | - |
| 1b | Empty | - | - | - | - | - |
| 2 | Empty | - | - | - | - | - |
| 3 | DM | F | Subadult | 75 | 17 | |
| 4 | Empty | - | - | - | - | - |
| 5a | Empty | - | - | - | - | - |
| 5b | Empty | - | - | - | - | Trap triggered |
| 6 | DM | M | Adult | 70 | 21 | Trap triggered |
| 7 | Empty | - | - | - | - | Trap triggered |
| 8 | Empty | - | - | - | - | Trap triggered |
| 9a | Empty | - | - | - | - | - |
| 9b | Empty | - | - | - | - | - |
| 10 | Empty | - | - | - | - | Trap triggered |
| 11 | DM | M | Subadult | 70 | 18 | Trap triggered |
| 12 | Empty | - | - | - | - | - |
| 13a | DM | M | Adult | 75 | 18 | - |
| 13b | DM | - | - | - | - | Escaped |
| 14 | Empty | - | - | - | - | - |
| 15 | Empty | - | - | - | - | - |

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 16 | Empty | - | - | - | - | - |
| 17a | Empty | - | - | - | - | Trap triggered |
| 17b | Empty | - | - | - | - | Trap triggered |
| 18 | RBV | M | Adult | 85 | 19 | |
| 19 | Empty | - | - | - | - | Trap triggered |
| 20 | RBV | M | Adult | 85 | 19 | |
| **Total Small Mammals** | | **7** | | | | |

**Table 55: Small mammal trap counts on Night 2 at Site 2 near Rainbow Lake Trail parking lot in Whistler, BC.**
**Traps were set in the late afternoon on September 10, 2014 and checked the morning of September 11, 2014. DM = deer mouse, RBV = southern red-backed vole**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | Empty | - | - | - | - | - |
| 1b | Empty | - | - | - | - | - |
| 2 | Empty | - | - | - | - | - |
| 3 | Empty | - | - | - | - | - |
| 4 | Empty | - | - | - | - | - |
| 5a | Empty | - | - | - | - | - |
| 5b | Empty | - | - | - | - | - |
| 6 | Empty | - | - | - | - | - |
| 7 | DM | M | Subadult | 65 | 18 | |
| 8 | Empty | - | - | - | - | - |
| 9a | Empty | - | - | - | - | - |
| 9b | Empty | - | - | - | - | - |
| 10 | DM | F | Subadult | 70 | 18 | |
| 11 | DM | M | Subadult | 65 | 17 | |
| 12 | Empty | - | - | - | - | Trap triggered |
| 13a | Empty | - | - | - | - | - |
| 13b | DM | - | - | - | - | Lethargic, no measurements |
| 14 | Empty | - | - | - | - | - |
| 15 | Empty | - | - | - | - | Trap triggered |
| 16 | Empty | - | - | - | - | - |
| 17a | RBV | - | - | - | - | Mortality |
| 17b | RBV | M | Juvenile | 70 | 12 | Trap triggered |
| 18 | DM | F | Adult | 80 | 20 | |
| 19 | Empty | - | - | - | - | Trap triggered |
| 20 | Empty | - | - | - | - | Trap triggered |
| **Total Small Mammals** | | **7** | | | | |

**Table 56: Small mammal trap counts on Night 1 at Site 3 near Function Junction in Whistler, BC.**
**Traps were set in the late afternoon on September 23, 2014 and checked the morning of September 24, 2014. DM = deer mouse, LTV= long-tailed vole,S = shrew**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | DM | F | Subadult | 70 | 19 | |
| 1b | LTV | M | Adult | 85 | 32 | |
| 2 | S | | | 45 | 7 | Mortality |
| 3 | DM | F | Subadult | 70 | 15 | |
| 4 | DM | F | Subadult | 70 | 17 | |
| 5a | DM | M | Subadult | 75 | 20 | |

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 5b | DM | M | Subadult | 70 | 19 | |
| 6 | Empty | - | - | - | - | Trap triggered |
| 7 | DM | F | Subadult | 75 | - | |
| 8 | DM | F | Subadult | 65 | 17 | Trap triggered |
| 9a | DM | F | Subadult | 65 | 17 | - |
| 9b | LTV | M | Adult | 95 | 31 | - |
| 10 | Empty | - | - | - | - | Trap triggered |
| 11 | Empty | - | - | - | - | - |
| 12 | DM | F | Subadult | 75 | 20 | |
| 13a | Empty | - | - | - | - | Trap triggered |
| 13b | DM | F | Subadult | 75 | 21 | |
| 14 | DM | - | - | - | - | Lethargic no measurements |
| 15 | Empty | - | - | - | - | - |
| 16 | DM | F | Subadult | 85 | 22 | - |
| 17a | Empty | - | - | - | - | Trap triggered |
| 17b | Empty | - | - | - | - | Trap triggered |
| 18 | Empty | - | - | - | - | Trap triggered |
| 19 | DM | M | Subadult | 70 | 20 | |
| 20 | DM | M | Subadult | 70 | 19 | |
| **Total Small Mammals** | | **17** | | | | |

**Table 57: Small mammal trap counts on Night 2 at Site 4 near Function Junction in Whistler, BC. Traps were set in the late afternoon on September 24, 2014 and checked the morning of September 25, 2014.**

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 1a | Traps damaged by a bear | | | | | |
| 1b | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5a | | | | | | |
| 5b | | | | | | |
| 6 | | | | | | |
| 7 | | | | | | |
| 8 | | | | | | |
| 9a | | | | | | |
| 9b | | | | | | |
| 10 | | | | | | |
| 11 | | | | | | |
| 12 | | | | | | |

| Trap Number | Species | Sex (M/F) | Age Class | Body length (cm) | Weight (g) | Notes |
|---|---|---|---|---|---|---|
| 13a | | | | | | |
| 13b | | | | | | |
| 14 | | | | | | |
| 15 | | | | | | |
| 16 | | | | | | |
| 17a | | | | | | |
| 17b | | | | | | |
| 18 | | | | | | |
| 19 | | | | | | |
| 20 | | | | | | |
| **Total Small Mammals** | | - | | | | |

# APPENDIX F: CLIMATE CHANGE INDICATORS

**Table 58: 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 | Tropical Punch? | 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 |
| 2014 | 26-Dec-14 | 20-Feb-15 | | 360 | 104 | 2014 | 2014 | 56 |