


Whistler Ecosystems and Species Monitoring Program

2021 Terrestrial and Riparian Components

Prepared for:

Resort Municipality of Whistler

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Acknowledgements

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Executive Summary

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

Since it impossible to monitor everything in an ecosystem, the Program design was based on the use of indicators to describe and look for changes. These indicators have included plants, animals, and specific parts of the environment. Due to financial challenges caused by the Covid-19 pandemic, the budget and therefore scope of work for this program was reduced for 2021. Snowline's 2021 fieldwork for terrestrial and riparian components of the program (presented in this report) nonetheless continued most of the work plan of those past years, including for: Coastal Tailed Frogs, Beavers, and Northern Goshawks. Snowline's project partner, Palmer, describes results from the aquatic components of the program in a separate report.

General Observations;

- Based on the indicators presented in this report, there is no confirmed evidence that habitat quantity or quality has been reduced in the RMOW in mountain streams (Coastal Tailed Frogs), riparian and wetland areas (Beavers), or old-growth forests (Northern Goshawks).
- There were two encouraging results from the 2021 work:
    - The number of beaver lodges detected in 2021 is the highest yet and is a very close approximation of a full census of Whistler's Beaver population.
    - Two active breeding sites for Northern Goshawks were found in 2021 near Whistler's Development Footprint. This rare species is dependent on old forest habitat for successful breeding and these records are an indication that Whistler provides at least some of the necessary habitat.
- Slight caveats to the first statement above are presented with Coastal Tailed Frogs and Beavers under their respective sections below.

Coastal Tailed Frogs:

1. Mostly the same program as in 2020, with mostly similar results.
2. Previous disturbances to creek beds by in-stream construction (Whistler Creek) and floods (west-side creeks) are mostly undetectable four years after those events. The impacts of logging debris at mid-elevation creeks on the west side of Whistler Valley meanwhile persists with a likely negative impact on stream habitat.
3. As in past years, the most tadpoles were detected on Whistler and Archibald Creeks.
4. There is still some indication that sedimentation and possibly other effects from the Whistler Bike Park are decreasing detections.
5. Although the number of tadpoles detected in Whistler Creek were high, they included only the T1 (youngest stage) cohort. Whether this truly reflects low survivorship and negative changes to habitat or an anomaly needs to be tested in subsequent studies.

Beavers:

1. The number of active beaver lodges and bank burrows detected in 2021 (46) is the highest yet and is a very close approximation of a full census of Whistler's beaver population, now estimated at +/-267 individuals.
2. In addition to moving ever-closer each year to a complete census of existing colonies, there is strong evidence of growth in Whistler's beaver population in 2021.
3. An expanded search effort discovered for the first time seven lodges in the Rainbow Wetlands and Wildlife Refuge complex. These lodges were likely active for many years prior to detection and showed the importance of this beaver habitat.
4. New lodge construction on Alta Lake south of the Scotia Creek outlet appears to be indicative of more beavers (as mentioned above) rather than migration of colonies from other lodges nearby.
5. As o 2021, almost 75% of active colonies are located in one of two wetland complexes: the Millar Wetlands and the ROGD-Rainbow-Wildlife Refuge complex. Such strong, long-established populations no doubt provide the largest source of out-migration that keeps beavers active in less-ideal habitats.
6. Flooding in September and November hampered surveys and, more importantly, may have damaged overwintering structures enough to increase mortality and/or reduce reproduction success. The effect of this flooding will not be observable until next year.

Beaver-affected Wetlands:

1. From an ecological and habitat perspective, wetlands are not only very important but rarer than before human development. In Whistler, at least 72% of original wetland have been lost since development began.
2. Beavers play an irreplaceable role in the creation and maintenance of wetlands, which is why monitoring the area of these "beaver-affected wetlands" is a useful proxy for how well the RMOW is protecting habitat.
3. Two changes occurred to the total area of beaver-affected wetlands in 2021:
    i. Field truthing added another 0.4 ha to the Rainbow Wetlands. This was pre-existing wetland hidden by tree cover and not a true gain.
    ii. There was some loss of wetland habitat due to the new Valley Trail in Function Junction. Estimated as a loss of approximately 0.1 ha, it is as yet unclear if there has or will be any significant, negative effect on beavers and their habitat.
4. With these updated numbers, approximately two-thirds (100.7 of 150.7 ha) of the RMOW's remaining wetlands in the Development Footprint have been created and/or maintained by beavers.

Northern Goshawks:

1. At least two nests active in 2021 successfully produced fledglings in Whistler Valley.
2. One nest beside the one at Comfortably Numb was very close to detections in the only other survey years (conducted by other studies) in 2014, 2015, and 2019. Whether this represents the same breeding pair is not known, but it demonstrates the continued importance of this old forest habitat to Whistler's goshawk population.
3. The second active area near the Danimal Mid trail above Alpha Lake was likely also active last year (when surveys were not successful in locating a nest). A nest tree was not found, but records nearby are strong evidence of one: an adult sighting in July and photographs of two juveniles in September
4. Given the documented success of fledged juveniles since 2014, there is a strong possibility there are other, undocumented breeding pairs in Whistler Valley.
5. The relationship between old forests and Northern Goshawk habitat is well-established elsewhere. Their choice of nesting locations in Whistler follows this pattern.
6. The 2021 survey was remarkably successful given that two nests were detected (one confirmed and one probable). The presence of at least two successful breeding pairs very close to Whistler's Development Footprint is an encouraging sign and indicates that there is enough old forest habitat to support them. There is a good chance that future surveys will detect additional nests, especially as past fledglings reach breeding age.

Notable (Local) Range Extensions:

1. Incidental observations extended the known distribution of Coastal Tail Frogs (higher by ca. 250 m in elevation), Red-legged Frog (the northernmost sighting yet, at the Cal-Cheak campground), and Northern Alligator Lizard (higher elevation than known, and possibly at a birthing site).

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1. Introduction

Covid-19 Effects on 2021 Work Plan

Due to financial challenges caused by the Covid-19 pandemic, the budget and therefore scope of work for this program was reduced for 2021. The 2021 fieldwork for terrestrial and riparian components of the program (presented in this report) nonetheless continued most of the work plan of those past years even if some analytical sections could not be included. Palmer described results from the aquatic components of the program in a separate report.

1.1 Overview

This report describes terrestrial and riparian monitoring components of 2021 monitoring studies conducted by Snowline Ecological Research in the Resort Municipality of Whistler (RMOW). The purpose of the RMOW's Ecosystems and Species Monitoring Program is to monitor the health of ecosystems and species over time through ecological indicators (proxies) that guide the conservation and inform sustainable land use planning and development in Whistler. The 2021 study was the ninth year of the program and the sixth study conducted by a partnership between Palmer and Snowline. Aquatic components of the 2021 program conducted by Palmer are presented in a separate report submitted with this one. As noted above, the work plan for the 2021 was reduced due to budget cuts related to the Covid-19 pandemic. For full reports from the past five years of this team's reports see Palmer and Snowline (2017-2021).

1.2 Background

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

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

- Askey *et al*. (2008) proposed framework,
- Species data collected through the WBP (Brett 2007 and online lists);[1] and
- Local data held by Cascade Environmental Resource Group Inc (Cascade).

[1] *www.whistlerbiodiverisity.ca*

Cascade was contracted to conduct the first three years of the program, from 2013 through 2015 (Cascade 2014-2016). In 2016 and again in 2019, Palmer and Snowline were contracted to conduct the three-year program. Major changes were made to the study design in 2016 to make it more scientifically robust (e.g., adopting data collection methods which allowed for statistical analysis) while maintaining comparability and consistency with previous years to the greatest extent possible. The work plan has continued to evolve since 2016 as results are evaluated and priorities re-assessed in consultation with RMOW staff, including some redirection in survey effort that resulted from an analysis of conservation priorities (Brett 2018). These changes are described in each annual report (Palmer and Snowline 2017-2021).

1.3 Study Area

The RMOW is located in the southern Coast Mountains of British Columbia, approximately 100 km north of Vancouver. The study area, defined by the extent of the RMOW municipal boundaries, contains a range of aquatic and terrestrial ecosystems at montane to alpine elevations. Most development (within the municipal "Development Footprint"2) is located in the valley bottom, from Function Junction to Green Lake. The Development Footprint is the main focus of the program.

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

2. Coastal Tailed Frogs

Lead Biologist and Author: Bob Brett
Additional Surveyors: Hillary Williamson and Jagoda Kozikowska

Key Takeaways:

1. Mostly the same program as in 2020, with mostly similar results.
2. Previous disturbances to creek beds by in-stream construction (Whistler Creek) and floods (west-side creeks) are mostly undetectable four years after those events. The impacts of logging debris at mid-elevation creeks on the west side of Whistler Valley meanwhile persists with a likely negative impact on stream habitat.
3. As in past years, the most tadpoles were detected on Whistler and Archibald Creeks.
4. There is still some indication that sedimentation and possibly other effects from the Whistler Bike Park are decreasing detections.
5. Although the number of tadpoles detected in Whistler Creek were high, they included only the T1 (youngest stage) cohort. Whether this truly reflects low survivorship and negative changes to habitat or an anomaly needs to be tested in subsequent studies.

2.1 Introduction

Amphibians have long been used as indicators of ecosystem health. They have physiological constraints and sensitivities due to subcutaneous respiration, specialized adaptations and microhabitat requirements, as well as a dual life cycle that includes aquatic and terrestrial habitats. These characteristics make them susceptible to perturbations in both habitat types and suitable as indicator species of ecosystem health.

Stream-dwelling amphibians such as Coastal Tailed Frog (*Ascaphus truei*) serve a vital role as indicators of stream health as they require flowing, clear, cold water throughout their lifecycle (Matsuda et al. 2006) and are vulnerable to habitat alteration and degradation such as siltation and algal growth. They are also highly philopatric,[3] long-lived, and maintain relatively stable populations. These attributes make them more trackable and reliable as indicators of potential biotic diversity in stream ecosystems than anadromous fish, and their relative abundance can be a useful indicator of stream condition (Welsh and Ollivier 1998).

Ideal habitats for tailed frogs are small, fast-flowing (usually >10% grade), mountainside streams that are cool (typically 10 to 15ºC in late summer, but at least 5º C for egg development), have a cobble-boulder substrate with rounded to subangular-shaped rocks, and a cascade or step pool morphology (Matsuda et al. 2006; BC MOE 2015). These characteristics describe many of the streams that drain into the Whistler Valley and, as a result, tadpoles have been detected in most Whistler streams surveyed to date (Wind 2005-2009; Cascade 2014-2016; Palmer and Snowline 2017-2021).

Prior to 2004, the only documentation of Coastal Tailed Frogs near the RMOW was in Brandywine Creek (Leigh-Spencer 2004), presumably from surveys before the construction of the Independent Power Project built on that

3 Adults typically breed in the stream in which they hatched.

creek. In late 2004, the Whistler Biodiversity Project began the first valley-wide survey Since then, tadpoles have been found in over 40 local creeks (Wind 2005-2009; Brett 2007; Cascade 2013-2015; Palmer and Snowline 2017-2021).

In 2017, Coastal Tailed Frogs were down-listed in BC from Blue (Special Concern) to Yellow ("least risk of being lost"; CDC 2021). It remains a species of Special Concern under the Species at Risk Act (Government of Canada 2021).

2.2 Methods

2.2.1 Site Selection

The selection of tailed frog survey sites has been modified each year to maximize the ability to detect changes across years and between east and west sides of the valley. Since 2013, a total of 11 creeks have been surveyed, most in more than three of the survey years (Table 2-1). More sites have been surveyed on the east than west side of the valley for two main reasons:

- the creeks on the east side of the valley tend to be easier to survey due to higher and more predictable flows; and
- they are generally in areas with more development and therefore more potential impacts.

As a result, more sites in the past nine years have been surveyed on the east (64) than west (50) sides of the valley.

Table 2-1. Coastal Tailed Frog sampling sites, 2013 to 2015 (Cascade) and 2016 to 2021 (Palmer and Snowline).

Creek	Valley Side	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total	Survey Years
Agnew Creek	West					3	3				6	2
Alpha Creek	East	3	3	3	3						12	4
Archibald Creek	East		3	3	3	3	3	3	3	3	24	8
Blackcomb Creek	East							1	3	2	6	3
FJ West Creek	West						2	3	2		7	3
Horstman Creek	East					3					3	1
Nineteen Mile Cr.	West		2	2							4	2
Scotia Creek	West	3	3	3	3		1				13	5
Sproatt Creek	West						1	3	3	3	10	4
Van West Creek	West						2	2	3	3	10	4
Whistler Creek	East				4	3	3	3	3	3	19	6
Total East		**3**	**6**	**6**	**10**	**9**	**6**	**7**	**9**	**8**	**64**	**9**
Total West		**3**	**5**	**5**	**3**	**3**	**9**	**8**	**8**	**6**	**50**	**9**
Grand Total		**6**	**11**	**11**	**13**	**12**	**15**	**15**	**17**	**14**	**114**	**9**

The main change to site selection since 2016 has been the establishment of three reaches on each creek, each of which is meant to represent the following elevations:

1. the toe slope just above the valley bottom;
2. mid-elevations at ca. 800 m; and
3. ca. 1000m.

This elevational range is meant to include one site within the development footprint, one at its upper end, and a third above the development footprint (as a control site), respectively.

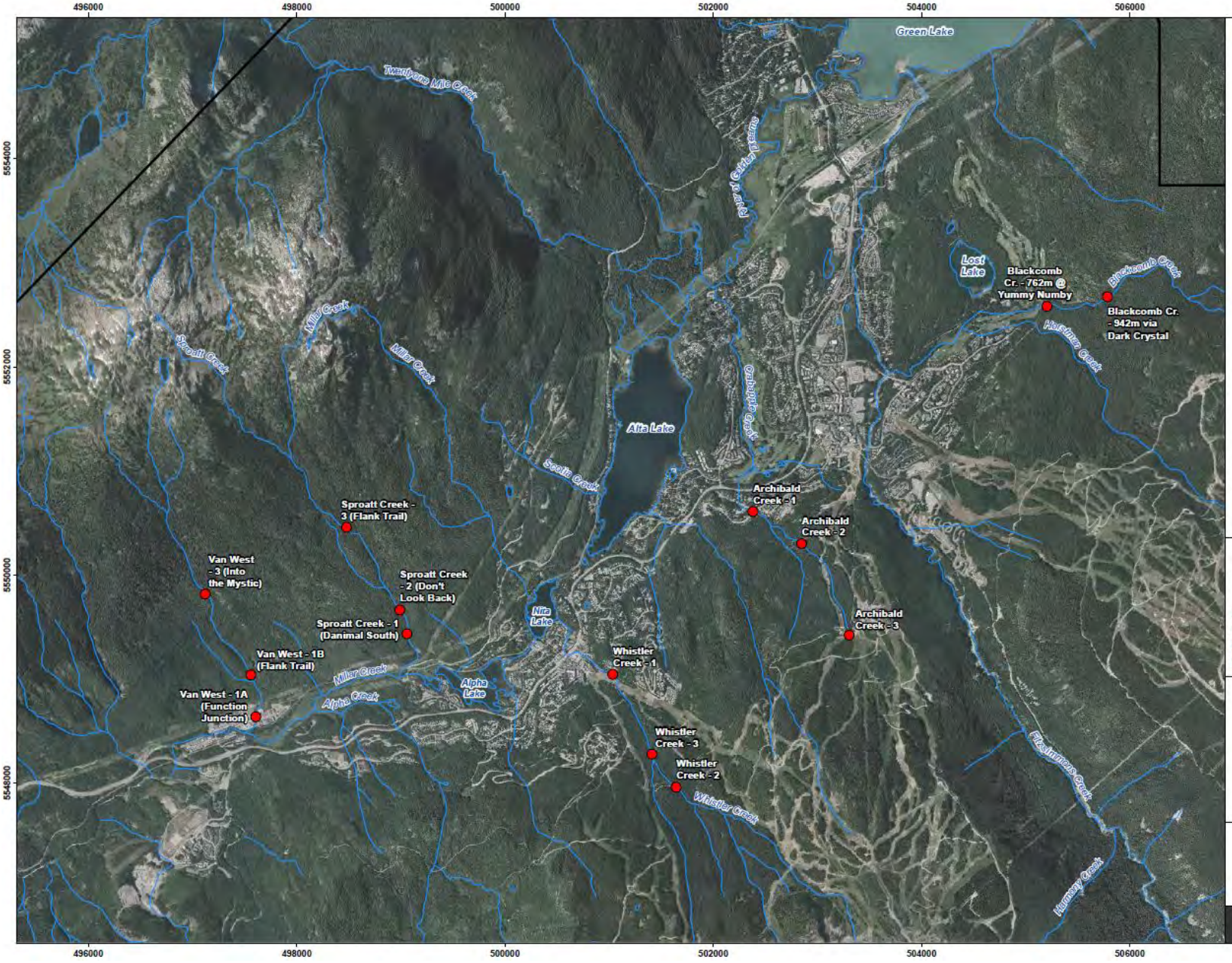
The inclusion of similar number of east- and west-side creeks increases the geographic range of sampling. At least as importantly, the inclusion of sites on both sides of the valley means creeks with different hydrological regimes are represented since most east-side creeks are glacier-fed while most west-side creeks are not. Creeks with a glacial source typically have higher and more sustained flows than those relying solely on snowmelt and rainwater. They are also more sensitive to climate change since glacier melt reduces the volume and timing of water flows.

Four creeks were sampled in the first three years of the program (Cascade 2014 to 2016; Table 2-1). Five years of sampling from 2016 to 2019 included 10 creeks, seven of which were new to the program (Palmer and Snowline 2017 to 2020). The decision to replace some creeks was based on the site selection criteria above, in particular, the goal of expanding geographic representation.

Only one creek, Archibald, has been included in all years of the program to date (Table 2-1). Whistler Creek, added in 2016, is the next most frequently sampled creek. These two watersheds are both within the Whistler-Blackcomb ski area and contain the Whistler Bike Park. Sampling in consecutive years has been intended to increase the likelihood of detecting effects from both winter and summer activities.

No tadpoles have yet been detected in three of 11 creeks surveyed in this program: Agnew and Nineteen Mile Creeks (on the west side of the valley), and Blackcomb Creek (on the east side). Topography has limited the ability to survey at higher elevations on the first two creeks. As a result, they may support a tailed frog population that has not yet been detected. While also challenging to survey due to steep chasms, the absence of detections on Blackcomb Creek may be related more to low temperatures resulting from its reliance on meltwater from the Blackcomb Glacier (though this hypothesis is challenged somewhat by 2020 results; Section 2.3).

The work plan for 2021 remained essentially unchanged from 2020, in spite of the reduced scope of the program (Table 2-1; Figure 2-1). All 2020 sites were resurveyed with the exception of one on Blackcomb Creek (at Lost Lake Park) and two on FJ West Creek (from outside the Development Footprint).


496000
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5548000
Green Lake
Twentyone Mile Creek
Sproatt Creek
Mile Creek
Miller Creek
Alta Lake
Scotia Creek
Rainbow Creek
Lost Lake
Blackcomb Creek
Fitzsimmons Creek
Blackcomb Cr. - 762m @ Yummy Numby
Blackcomb Cr. - 942m via Dark Crystal
Archibald Creek - 1
Archibald Creek - 2
Archibald Creek - 3
Sproatt Creek - 3 (Flank Trail)
Van West - 3 (Into the Mystic)
Sproatt Creek - 2 (Don't Look Back)
Sproatt Creek - 1 (Danimal South)
Nita Lake
Van West - 1B (Flank Trail)
Van West - 1A (Function Junction)
Alpha Creek
Alpha Lake
Whistler Creek - 1
Whistler Creek - 3
Whistler Creek - 2
Whistler Creek
Fitzsimmons Creek
Hummingbird Creek
Legend
2021 Tailed Frog Site
Watercourse
RMOW Boundary
Notes:
(1) Orthoimagery (2014) provided by RMOW.
(2) Watercourse data from BC Freshwater Atlas (accessed 2017).
Contains information licensed under the Open Government Licence – British Columbia. Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0
2 km
Figure Extent
Whistler Village
RMOW Boundary
0
500
1,000
1,500
metres
N
DRAWN: B. Elder
CHECKED: B. Brett
PROJECT: 1602506
DATE: Dec 16, 2021
Scale 1:35000
UTM Zone 10N
NAD 1983
SNOWLINE
Ecological Research
Palmer
CLIENT: Resort Municipality of Whistler
PROJECT: Annual Monitoring 2021
Coastal Tailed Frog Sampling Sites, 2021
FIGURE 2-1

2.2.2 Sampling Design

Almost all previous surveys for tailed frog tadpoles in the RMOW study area by the WBP (Wind 2005-2009; Brett 2007) and this program (Cascade 2014-2016; Palmer and Snowline 2017-2021) have used the same methods. The only one exception occurred in surveys from 2013 to 2015 which used area-constrained rather than time-constrained surveys.

The BC Resource Inventory Committee (BC MELP 2000) recommended that area-constrained approach for measuring relative abundance. Based on this guidance, surveys from 2013 to 2015 sampled in fixed 5 m stream lengths for a total of 30 minutes (Cascade 2014-2016). Far fewer tadpoles were detected using this method compared to previous WBP surveys (Wind 2005-2009).4 Surveys since 2016 therefore returned to the time-constrained approach of 30 minutes total sampling time, regardless of area, which greatly increased detections (Palmer and Snowline 2017-2021) and therefore statistical power (Malt et al. 2014a, 2014b).

In spite of the change back from area- to time-constrained surveys, it has still been possible to make comparisons between these years since both methods sampled for the same amount of time (30 minutes per site). It is also noteworthy that the total area surveyed at each site since 2016 using the time-constrained approach remained remarkably similar to that surveyed using the area-constrained approach (Palmer and Snowline 2017 to 2021).

Data collection methods were otherwise the same for all tailed frog surveys since 2004 and followed recommendations of the BC Resource Inventory Committee (BC MELP 2000). The in-stream surveys consisted of overturning rocks and other unembedded cover objects with dipnets held immediately downstream to catch any dislodged animals (Photos 2-1 and 2-2). Rocks were also swept by hand to detect any clinging tailed frog tadpoles before being set back in their original positions, as were large anchored rocks and large woody debris. Data collected at each site included:

- Site characteristics including location, weather, overhead cover and stand type;
- Stream characteristics including morphology, substrate size and shape, slope, and bankfull and wetted widths;
- Overhead canopy cover, forest type (coniferous, deciduous, or mixed) and forest successional stage;
- Water and air temperature (measured at the sampling site); and
- Total survey area (measured with a cloth tape to the nearest 0.1 m).

4 Bruce Bury (in a 2016 email to Brent Matsuda and Bob Brett) recommends that detections should be >2 tadpoles/m^2 to ensure statistical power. Virtually all sites sampled to date in Whistler have revealed densities far lower.

***Photo 2-1**. Hillary Williamson from the RMOW Environmental Stewardship Department dipnetting for tadpoles in Whistler Creek (2019 photo).*

***Photo 2-2.** Captured tadpoles are transferred to a bucket until they are measured, classified to cohort and development stage, then released upstream.*

Data collected for tadpole captures also followed standard methods, including a measurement of total length for tadpoles and snout to ventral length for later stages. From 2013 to 20155 and again in 2016, tadpoles were classed into cohorts defined by Malt et al (2014a, b) which served as proxies for age classes (e.g., first year - T1; second year - T2, etc.) as follows:

- T0 (hatchling <15 mm);6
- T1 (tadpole, no visible hind legs);
- T2 (tadpole, recognizable hind legs with knees that do not extend beyond the anal fold (Photo 2-3);
- T3 (tadpole, conspicuous hind legs with knees that extend out from body (Photo 2-4); and
- Non-tadpole – metamorph (tail plus front legs), juvenile (no tail, small, no nuptial pads); and adult (larger than juvenile, male has tail and nuptial pads, females larger than males).

Doubts about this classification scheme emerged in 2016 regarding how accurately these classes acted as reliable proxies for age cohorts, especially across different streams. The relationship between length and cohorts (as defined above) was weaker than expected, for example, many longer tadpoles were placed into early cohorts based on morphology, and vice-versa, Pre-survey tests in 2017 again showed overlaps between length and developmental stages within and between streams. These observations intensified questions about whether “cohorts” were reliable proxies for the number of years since hatching, especially between streams that have different growing conditions. This doubt was later strengthened by Pierre Friele7 who emphasized that the link between developmental stage, length and age is even more tenuous when applied across large geographic gradients in which climate and water temperature regimes differ. As a result, surveys since 2017 measured the length of each tadpole and classified them by more detailed developmental stages as follows:

5 Candace Rose-Taylor, 2016 email to Bob Brett.
6 No hatchlings have been reported to date in Whistler surveys conducted in late August and September.
7 Pierre Friele email to B. Brett and follow-up phone conversation, December 2017.

Table 2-2. Tadpole Developmental Stages and Classifications

Developmental Stage	Cohort (Malt 2014a,b)
DS0 – Hatchling <15 mm	T0
DS1 - No visible hind legs	T1
DS2 - Bulge only, hind legs not defined	
DS3 - Hind legs visible but covered	T2
DS4 - Hind feet protruding	
DS5 -Hind knees protruding outside body	T3

Note: No hatchlings (DS0, T0) have been observed in September surveys in Whistler.

Photo 2-3: *Tadpole Cohort 2 (T2). This individual's developmental stage is transitional between developmental stages DS1 and DS2 2 and 3 (hind legs covered but just starting to be defined).*

Photo 2-4: *This tadpole's hind knees protrude outside its body and its legs are clearly free from previously enclosing skin. It is in Cohort T3 and its equivalent developmental stage DS5.*

For consistency with past reports, the classes above were grouped according to Malt et al.'s (2014a, b) cohorts during data analysis. That is, Developmental Stages 1 and 2 (DS1 and DS2) were grouped into Malt's T1 cohort, and Developmental Stages 3 and 4 (DS3 and DS4) were grouped into Malts' T2 cohort. Future analyses may be able to use these detailed classifications to calibrate a reliable relationship between age and developmental stage in Whistler-area creeks. For the purposes of this report, most of the analysis and discussion is based on Malt et al.'s cohorts.

To prevent recaptures, all tadpoles were placed in buckets and released after measurements were complete (Photo 2-2; BC MELP 2000). Non-tadpoles, or post metamorphosis individuals, were classed as metamorphs (non-resorbed tail), juveniles (no tail, smaller than adults, no nuptial pads on males) or adults (larger than juveniles, males have a cloacal "tail," nuptial pads, and are smaller than females; Corkran and Thoms 1996; Jones et al. 2005). Surveys were scheduled for early September when low streamflows would increase the detectability of tadpoles.

2.2.3 Data Analysis

The total number of tadpoles per site (reach) detected in 2021 was compared to surveys since 2015 (the last year of the time-constrained approach). Results were also reported as detections per unit area (per 100 m^2) to permit comparisons between the 2015 area-constrained method and the time-constrained method used for the past five surveys.

2.2.4 Quality Assurance/Quality Control

Although the ideal way to ensure consistency between sites and years would be to use the same surveyor(s), that is seldom achievable due to changes in available personnel. To maximize consistency, surveys since 2017 have included at least two surveyors from the previous year. A trial survey was conducted beforehand to ensure consistency between surveyors. Special care was taken to ensure that cohort classes and developmental stages (see above) were recorded consistently. Photos of representative tadpoles in each class were used as guides to improve consistency between surveyors (e.g., Photos 2-3 and 2-4).

2.3 Results and Discussion

2.3.1 Study Sites

Fourteen sites were surveyed from September 7 to 13, 2021 (Table 2-3). On average, water and air temperatures were lower at the eight east-side sites than at the six west-side sites, a result that is consistent with less direct sun and a greater influence of glacial water on that side of the valley. As in 2020, water was much warmer at the Van West-site than other sites; this is the closest site to the valleybottom and also has the least canopy cover (Appendix A).

Table 2-3. Coastal Tailed Frog sampling sites, 2021.

Valley Side	Site	Date	Surv-eyors	Easting	Northing	Elev. (m)	Weath-er	Water Temp.	Air Temp.
East	Archibald Cr.-1	2021-09-10	BB; JK	502387	5550606	695	Sun	11.0	16.0
	Archibald Cr.-2	2021-09-10	BB; JK	502854	5550298	835	Sun	10.0	13.0
	Archibald Cr.-3	2021-09-10	BB; JK	503310	5549422	1026	Cloud	9.0	15.0
	Blackcomb Cr.-762m @ Yummy Numby	2021-09-13	BB; HW	505211	5552576	762	Cloud	7.0	9.0
	Blackcomb Cr.-942m via Dark Crystal	2021-09-13	BB	505792	5552668	942	Cloud	6.5	11.0
	Whistler Cr.-1	2021-09-10	BB; JK	501041	5549045	692	Sun	11.0	16.0
	Whistler Cr.-2	2021-09-10	BB; JK	501649	5547961	879	Cloud	10.0	13.0
	Whistler Cr.-3	2021-09-10	BB; JK	501417	5548276	972	Cloud	10.0	12.0
West	Sproatt Cr.-1 (Danimal South)	2021-09-07	BB; HW	499063	5549434	692	Sun	11.0	16.0
	Sproatt Cr.-2 (Don't Look Back)	2021-09-07	BB; HW	498996	5549662	790	Sun	10.0	16.0
	Sproatt Cr.-3 (Flank Trail)	2021-09-07	BB; HW	498483	5550455	996	Sun	11.0	15.5
	Van West-1A (Function	2021-09-07	BB; HW	497611	5548635	604	Sun	13.0	21.0
	Van West-1B (Flank Trail)	2021-09-07	BB; HW	497563	5549038	706	Sun	9.0	11.0
	Van West-3 (Into the Mystic)	2021-09-07	BB; HW	497125	5549816	1036	Sun	9.2	13.0
							East-side Average (8 sites)	**9.3**	**13.1**
							West-side Average (6 sites)	**10.5**	**15.4**
							Average (All Sites)	**9.8**	**14.1**

2.3.2 Tadpole Detections

A total of 63 tadpoles and one metamorphosed (sub-adult) frog were detected in 2021 (Table 2-4, Appendix B). This total represents a rebound from the 2020 low of 3.0 tadpoles detected per site back to 4.5 tadpoles per site, and is approximately in the middle of the range since 2016 (Figure 2-2). As in 2020, that per-site average was reduced due to no detections in Blackcomb Creek (where no tadpoles have been detected in four survey years since 2006).

Table 2-4. Tadpoles detected in 2021 by creek and cohort.

Valley Side	Site	Elev. (m)	Cohort T1	Cohort T2	Cohort T3	Total Tadpoles	Meta-morphs/ Adults
East	Archibald Creek - 1	695	3	0	5	8	0
East	Archibald Creek - 2	835	1	0	1	2	0
East	Archibald Creek - 3	1026	6	0	0	6	0
East	Blackcomb Cr. - 762m @ Yummy Numby	762	0	0	0	0	0
East	Blackcomb Cr. - 942m via Dark Crystal	942	0	0	0	0	0
West	Sproatt Creek - 1 (Danimal South)	692	0	0	0	0	0
West	Sproatt Creek - 2 (Don't Look Back)	790	1	1	1	3	0
West	Sproatt Creek - 3 (Flank Trail)	996	2	7	1	10	1
West	Van West - 1A (Function Junction)	604	0	0	0	0	0
West	Van West - 1B (Flank Trail)	706	0	0	0	0	0
West	Van West - 3 (Into the Mystic)	1036	3	7	3	13	0
East	Whistler Creek - 1	692	11	0	0	11	0
East	Whistler Creek - 2	879	5	0	0	5	0
East	Whistler Creek - 3	972	5	0	0	5	0
All Sites			**37**	**15**	**11**	**63**	**1**

The average survey area per site decreased markedly in 2021 (Figure 2-2), but that is more likely a result of a narrower definition of the actual area surveyed (which is of necessity an estimation by the surveyors) rather than an increased tadpole density.

Previous results showed a weak, positive relationship between warmer water and higher detection rates of tadpoles, a relationship that Palmer and Snowline (2019) attributed more to tadpole behaviour than to higher densities in warm water. At lower temperatures, tadpoles are typically more difficult to find since they are less likely to be feeding on surveyable rocks.[8] This year's results nonetheless showed higher detections than in 2020 (63 compared to 51, respectively) even with slightly lower average temperatures (9.8 compared to 10.1° C., respectively (Figure 2-2). Note nonetheless that such comparisons of annual totals provide incomplete information and that comparisons between sites from year to year are preferable (e.g., Section 2.3.5).

All 14 sites surveyed in 2021 were also surveyed in 2020, and six sites (on Archibald and Whistler Creeks) have been surveyed all six years since 2016 (Table 2-5).[9] Results have been mostly consistent over these six years of sampling with the same time-limited method, with two exceptions:

1. Very high detections on Archibald Creek from 2017 to 2019 have not been replicated since. If low detections in the past two years continue, it is an indication that tadpole density and therefore habitat quality has decreased. Further years of low detections would strengthen this conclusion.
2. In contrast, the very high number of tadpoles detected in Whistler Creek in 2017 appears to be an outlier since detections in the other five survey years are very consistent.

Both of these exceptions will be discussed further in Section 2.3.5, below.

[8] *That is, they are more likely to be in the substrate where detection is difficult.*
[9] *Archibald Creek was also surveyed between 2013 and 2016 by Cascade, but with slightly different methods.*

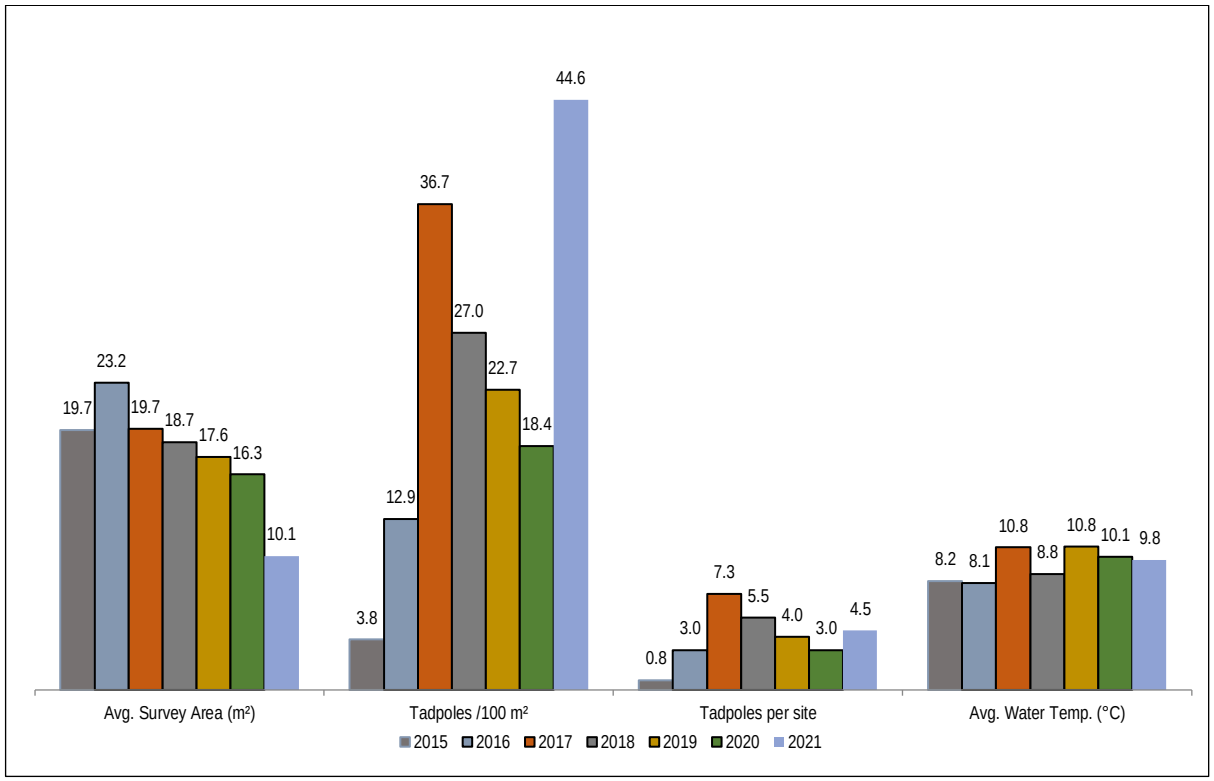


Figure 2-2. Average area, tadpoles per 100 m2, tadpoles per site, and average water temperature of Coastal Tailed Frog Surveys, 2015 to 2021.

Table 2-5. Tadpole detections by creek and site, 2015-2021.

Creek	Site	Elev (m)	2016	2017	2018	2019	2020	2021	Aver-age	Survey Years
Archibald	Site 1	695	1	11	19	19	4	8	10.3	6
	Site 2	835	1	5	5	5	1	2	3.2	6
	Site 3	1026	3	17	6	6	0	6	6.3	6
	Total Tadpoles		**5**	**33**	**30**	**30**	**5**	**16**	**19.8**	**6**
Blackcomb	At Yummy Numby	762	Not Surveyed				0	0	0.0	2
	At 942m via Dark Crystal	942					0	0	0.0	2
	Total Tadpoles						**0**	**0**	0.0	2
Sproatt	Site 1 (Danimal South)	692	Not Surveyed			1	1	0	0.7	3
	Site 2 (Don't Look Back)	790				1	5	3	3.0	3
	Site 3 (Flank Trail)	996			11	11	8	10	10.0	4
	Total Tadpoles				**11**	**11**	**14**	**13**	**12.3**	**4**
Van West	Site 1A (Function Junction)	604	Not Surveyed				0	0	0.0	2
	Site 1B (Flank Trail)	706			1	1	0	0	0.5	4
	Site 3 (Into the Mystic)	1036			16	16	8	13	13.3	4
	Total Tadpoles				**17**	**17**	**8**	**13**	**13.8**	**4**
Whistler	Site 1	693	7	11	7	7	6	11	8.2	6
	Site 2	875	9	26	5	5	10	5	10.0	6
	Site 3	985	2	11	9	9	4	5	6.7	6
	Total Tadpoles		**18**	**48**	**21**	**21**	**20**	**21**	**24.8**	**6**

2.3.3 Detections by Cohort

Survivorship curves for all animal populations lead to the expectation that there will be fewer individuals at later ages/stages, and this has generally been the case for tailed frog surveys (Table 2-6; Figure 2-3). In particular, more T1 tadpoles (the earliest/youngest stage) have been detected in all years. However, only detections in 2020 and 2021 completely followed the expected trend, in which number of detections by stage (cohort) decreased from T1 through T3. Although any interpretations of these results must be tempered by the fact that detectability is not constant (that is, that weather and other contingencies are involved), it is reassuring that: (a) younger stage tadpoles continue to enter the population; and (b) latest-stage tadpoles in Cohort T3 consistently represent a significant minority of all detections.

Table 2-6. Tadpole detections by year, site, elevation and cohort, 2016-2021.

	No. of Tadpoles by Cohort			Tadpoles by Cohort (%)		
Year	**T1**	**T2**	**T3**	**T1**	**T2**	**T3**
2016	25	5	9	64%	13%	23%
2017	63	11	13	72%	13%	15%
2018	64	2	16	78%	2%	20%
2019	26	14	20	43%	23%	33%
2020	22	20	9	43%	39%	18%
2021	37	15	11	59%	24%	17%
Total	237	67	78	60%	19%	21%

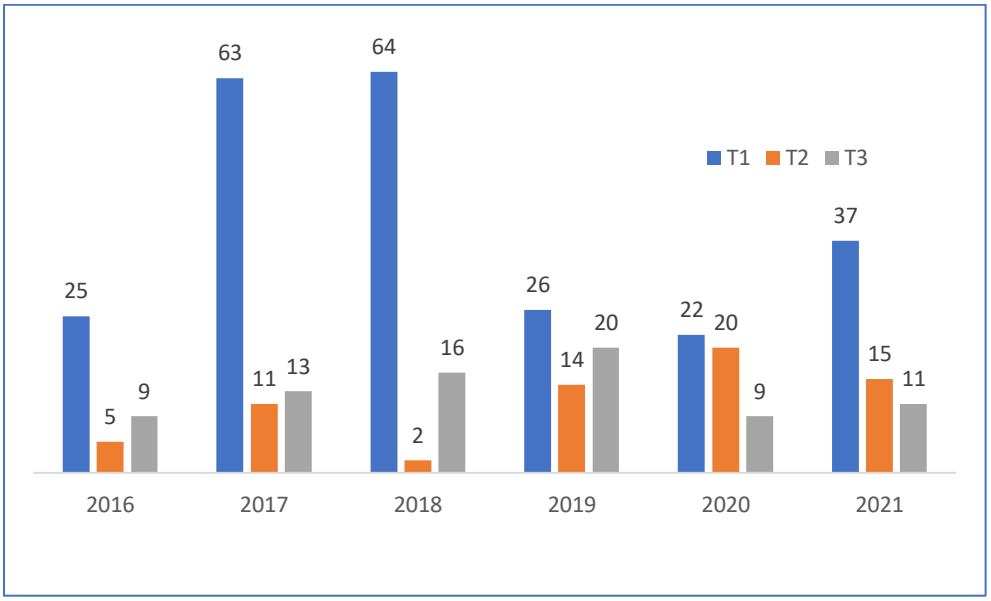


Figure 2-3. Tadpole detections by cohort and year.

2.3.4 Detections by Valley Side (East and West)

Since 2016, more than twice as many tadpoles have been detected per site on the east-side than on the west-side of Whistler Valley (Table 2-7). As discussed above (Section 2.2.1), glacier-fed creeks are predominantly on the east side of Whistler Valley where glacial run-off increases overall volume and provides more mid-summer flow than in creeks reliant solely on rainwater. Creeks on the east side of the valley are therefore more likely to be larger and, as found in these surveys, apparently have better habitat characteristics such as more cobbles, less embeddedness, and more riffles. These are preliminary conclusions that need to be further tested, especially since the predominance of detections from two creeks (Whistler and Archibald) affect the totals so much. Consistent with the influence of more glacial meltwater, east-side creeks have been colder than west-side creeks, a fact reinforced by temperature loggers (e.g., Palmer and Snowline 2017-2021).

Table 2-7. Tadpoles detected in east-side versus west-side creeks, 2016 to 2021.

Valley Side	No. Sites	Tadpoles /Site	Water Temp. (°C)
East	49	6.2	9.4
West	37	2.8	10.2
East to West Ratio	1.3	2.2	n/a

The conclusions regarding cohorts above (Section 2.3.3) are based on data from sites on both sides of the Whistler Valley, but breaking the data further into east- and west-side sites reveals a potentially different conclusion (Table 2.8). As in past years, more tadpoles were detected in east-side creeks in 2021, but the difference to west-side creeks was:

(a) less pronounced, at 1.4 versus 2.6 times the number of tadpoles; and
(b) even more heavily skewed to earlier stage (T1 cohort) tadpoles.

Table 2-8. Tadpoles detected in east-side versus west-side creeks 2016-2021, by cohort.

Year(s)	Valley Side	T1/Site	T2/Site	T3/Site	Total/Site	T1 (%)
2021	East	3.9	0.0	0.75	4.6	84%
	West	1.0	2.5	0.83	4.3	23%
	East to West Ratio	3.9	0.0	0.90	1.1	3.6
2016 to 2020	East	4.0	1.3	1.3	6.5	61%
	West	1.6	0.5	0.5	2.5	62%
	East to West Ratio	2.5	2.8	2.5	2.6	1.0

Between 2016 and 2020, detections of all three cohorts in east-side creeks was between 2.5 and 2.8 times higher than in west-side creeks, and the proportion of T1 detections was almost the same (61% to 62%, respectively). Results in 2021 were much different: T1 tadpoles represented 84% of all detections in east-side creeks, and no T2 tadpoles were detected. The encouraging news from 2021 is that there does not seem to be a problem with tadpole breeding (i.e., there were more young-stage tadpoles detected than in 2020). Less encouraging is the suggestion that survivorship was lower, unless lower detections of later stage/older tadpoles did not accurately represent populations in those streams due to sampling variability. Single year results such as these need to be re-evaluated in future years to determine if there is a significant and real trend towards lower survivorship.

2.3.5 Notes on Streams Surveyed in 2021

Archibald Creek

Archibald Creek and Whistler Creek are the only two systems surveyed in all six years since 2016. For Archibald Creek, last year's detections were the lowest since 2016 (Tables 2-4 and 2-5; Figure 2.4) when low detections were attributed to poor weather and possibly sedimentation from the Whistler Bike Park that had accumulated at Sites 1 and 2 (Palmer and Snowline 2017). Archibald Creek had the highest detections by far in 2018 and 2019, and were second only to exceptionally high detections in Whistler Creek in 2017 (Table 2-5). Detections rebounded in 2021, especially at the highest elevation site (Site 3), just above the Whistler Bike Park mid-station. A total of 16 tadpoles were detected versus only five in 2020. These results nonetheless do not show a return to high detection rates between 2017 and 2019 and thus warrant further investigation in future years to ensure no lasting affects on habitat quality due to sedimentation or other negative effects from the Whistler Bike Park.

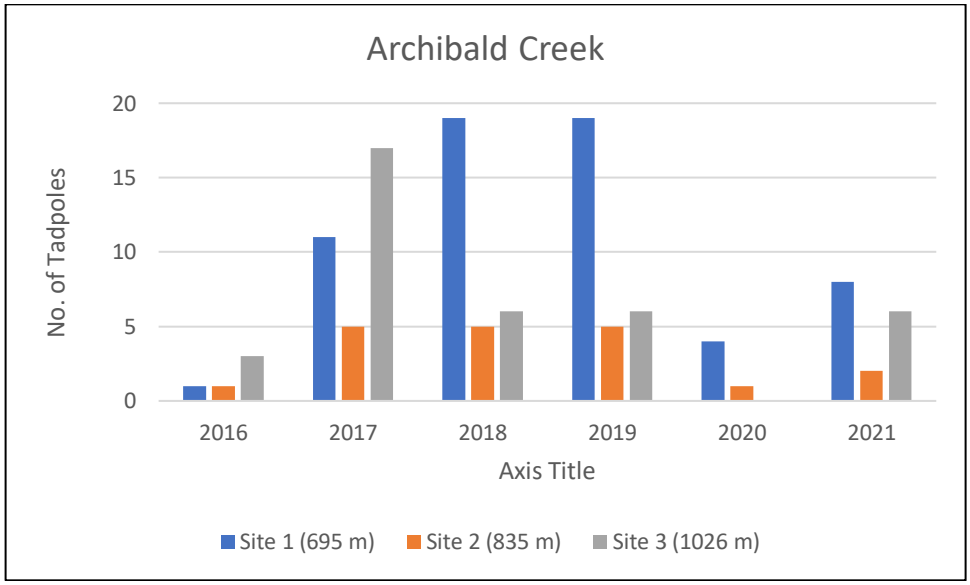


Figure 2-4. Tadpole detections in Archibald Creek by site, 2016-2021.

Detections have been most variable over the past six years at Site 1 (Photo 2-5), the lowest on Archibald Creek (where it passes under a bridge in Brio subdivision, just upstream of Panorama Drive). This is a unique site in Whistler since it has been mostly unshaded since the bridge was built, and has smooth, exposed bedrock where many tadpoles can often be seen foraging, especially on warm days. This stream structure has also made it difficult to ensure consistent surveys since the detectability is heavily impacted by the weather. Surprisingly low detections in 2016 coincided with significant sedimentation that almost washed downstream from Whistler Bike Park trails. Higher detections between 2017 and 2019 led to the conclusion that sedimentation from the Bike Park did not cause lasting harm to the habitat (Palmer and Snowline 2018-2020), then low detections in 2020 again raised the question of potential negative impacts on habitat quality, likely due to Bike Park activities.

With higher detections again in 2021, worries about frog habitat in this system and, in particular, this site may be lessened for now. Future surveys could include further analysis of the benthic invertebrate community that, as of 2020 (Palmer and Snowline 2021, Section 3.1.8) showed a five-year decline in pollution-intolerant invertebrates (the EPT taxa -- mayflies, stoneflies, and caddisflies) at the Crabapple

Creek site downstream.[10] As noted in last year's report, the distance between Site 1 tailed frog surveys and benthic invertebrate sampling on this creek weakens any potential conclusions, especially since the downstream Crabapple Creek site includes much more potential sources of runoff from the golf course, the highway, and urban developments.

***Photo 2-5**. Sedimentation in 2016 at Archibald Creek-1 adjacent to Panorama Drive.*

***Photo 2-6**. The streambed at Archibald Creek-3, uphill of the culvert at Olympic mid-station, changed significantly between 2019 and 2021 surveys*

Site 3 was chosen as the highest surveyable location on Archibald Creek that could act as a kind of control compared to the lower two sites (Section 2.2.1). That is, it has the least potential for sedimentation and other deleterious effects of bike park and/or other mountain activities. Excepting the lack of tadpoles found in 2020 as an outlier, detections at Site 3 have been relatively constant since 2016. The site is, however, comprised of two sections, one uphill of the main road linking to the chairlift (Photo 2-6) and one much more disturbed section below. Almost all detections at this site since 2016 have been from the uphill side of the site. The difference in stream conditions within this one site is not ideal, but the best compromise that matches with the elevation of other sites (that is, above the Development Footprint at ca. 1000 m). It is therefore not possible to conclude that habitat disturbance (especially from the Bike Park) is responsible for lower or no detections (as in the past two years) downhill of the road at Site 3; however, that possibility could be explored in future years.

Blackcomb Creek

The first tailed frog survey on Blackcomb Creek in 2006 yielded no tadpole detections at sites at four elevations, from valleybottom (near Lost Lake) to 1377 m (Wind 2006), and no tadpoles have been detected in three survey years since (including 2021). Very cold water at these sites provided the most obvious explanation for the lack of detections. The surveys took place on August 25, 2006 when the water was 6.3°C at 859 m (at the RMOW water intake) and only 4.0°C at 1377 m. This creek is therefore the coldest yet recorded during Whistler tailed frog surveys. Since water colder than 5.0°C is inhospitable for egg development (Section 2.1), it was reasonable at that time to assume Blackcomb Creek might be too cold

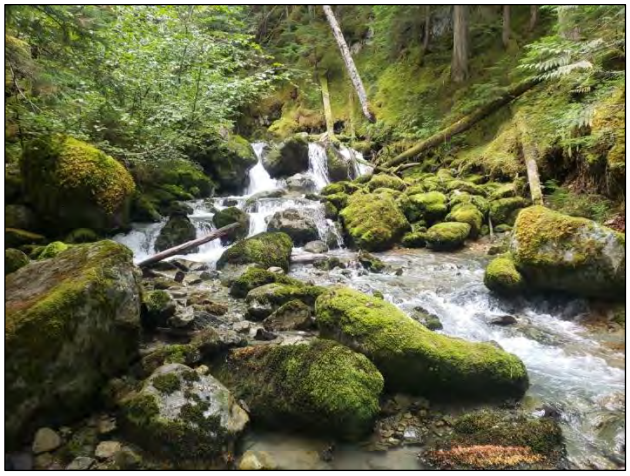
[10] *Two names are used for this same creek. The section upstream of Highway 99 and the Whistler Golf Course it is named Archibald Creek. Its name changes to Crabapple Creek downstream of Highway 99 as it passes through Whistler Golf Course towards its junction with the River of Golden Dreams.*

to support tailed frogs, at least until run-off from the melting Blackcomb Glacier (due to climate change) diminished enough to reduce its cooling effect.

In 2019, one Blackcomb Creek site next to the Yummy Numby bike trail was surveyed as the first test of this hypothesis (Palmer and Snowline 2020). In 2020, the Yummy Numby site and two additional ones were surveyed, one downstream at Lost Lake, and another upstream at 942 m that was accessed via Dark Crystal Trail. Stream temperatures measured during these surveys were surprisingly warm, from 8.0° C to 10.0°.C, and in a range similar to other creeks that supported tailed frogs. Nonetheless, no tailed frogs were detected.

In 2021, temperatures returned to values significantly lower than at other sites: 7.0° C at the Yummy Numby site, and 6.5° C at the Dark Crystal site (Table 2-3; Photos 2-7 and 2-8). Glacier-fed creeks in Whistler had higher flows than usual throughout the 2021 summer, likely due to exceptionally high air temperatures that caused more glacial melt. This melting is the likely cause for the lower stream temperatures measured in Blackcomb Creek.

As of 2021, the habitat suitability for Coastal Tailed Frogs in Blackcomb Creek appears to be increasing, at least from the standpoint of in-stream temperatures for egg development. Even if the lack of tadpole detections to date is accurate, there is therefore no reason why tailed frogs will not eventually colonize this warming stream system, especially as the influence of the Blackcomb Glacier upstream continues to diminish with melting caused by climate change. As noted in last year's report (Palmer and Snowline 2021) however, the water intake between the Yummy Numby and Dark Crystal sites reduce the habitat available to tailed frogs by hampering connectivity between upstream and downstream portions of Blackcomb Creek (cf. Dale et al. 2020).



***Photos 2-7**. Blackcomb Creek at the Yummy Numby bridge at 762 m. Water here measured 9.0°C in early September 2020 but only 7.0°C on a similar date in 2021.*

***Photo 2-8**. Blackcomb Creek at 942 m, accessed via Dark Crystal Trail. Water here measured 10.0°C in early September 2020 but only 6.5°C on a similar date in 2021.*

Sproatt Creek

Based on streambed characteristics alone, Sproatt Creek may have some of the best potential habitat for tailed frogs on the west side of Whistler Valley. As with all creeks on the west side of Whistler Valley, evidence of past logging is present up to and sometimes above the Mid-Flank Trail. In addition, a large rain event in fall 2017 significantly impacted Sproatt Creek, among others (Palmer and Snowline 2019, 2020). For example, it moved logging debris and altered the streambed on the mid-elevation site (Sproatt Creek-2; Figure 2-1; Photo 2-9) and severely scoured the streambed on the upper site at Sproatt Creek (Sproatt Creek-3; Photo 2-10).

In spite of these impacts, the tailed frog population in this creek appears to be strong, especially at the highest site where sampling detected between eight and 11 tadpoles between 2018 and 2020, and a similar number of 11 in 2021. Two sites added in 2019 have had lower detections in spite of habitat that appears suitable. At the lowest site (Sproatt Creek-1), only one tadpole was found in 2019 and 2020 and none in 2021. Detections at the mid-elevation site (Sproatt Creek 2; Photo 5-12); increased from one tadpole in 2019, to five in 2020, then back to three in 2021. As noted in last year's report, the streambed has recovered from the 2017 flood even though outside the surrounding area shows clear evidence of major disturbance. More detections at Sproatt Creek 2 may be partly a result of more non-embedded cobbles, because that increased detectability and/or the quantity and quality of habitat.

***Photos 2-9**: The 2017 flood moved logging debris in and around Sproatt Creek-2 and disrupted the streambed. By 2020, the streambed had regained the characteristics of undisturbed creeks, even though the effects of the flooding were still evident on the banks (2021 photo).*

***Photo 2-10**: The fall 2017 flood severely scoured the streambed at the Sproatt Creek-3 site, at the Flank Trail bridge next to the Lord of the Squirrels bike trail exit. Boulders and cobbles were clearly pushed away from the bedrock substrate (2019 photo).*

For the second consecutive year, Sproatt Creek-3 was the only site in which a metamorphosed frog was found (Table 2-4; Photo 2-11). Detections of metamorphosed frogs, both sub-adults and adults, are relatively rare so finding one two years in a row at this site may not be a coincidence. That is, metamorphosed frogs and therefore potential breeders (once sexually mature) may be more common in this area during breeding season (September to October). This hypothesis is very preliminary given limited data points, but something that could be investigated in future studies, if locating breeding is the focus.

***Photo 2.11**. This subadult frog was found at the highest site on Sproatt Creek (Site 3). It is the second year in a row that this site was the only one where metamorphosed frog was found.*

Van West Creek

Van West is the third west-side creek added along with FJ West and Sproatt Creek in 2018. It shares some similarities with those creeks, including a steep midsection and abrupt toe slope just above the valley bottom. Debris from past logging is abundant at lower elevations (Photo 2-12) but, unlike the two other creeks, impacts from the flood in fall 2017 are not obvious. The topography of this stream has precluded establishing three sites analogous to other systems in the program, other than at the upper site Van West 3 (Photo 2-13). This upper site is unimpacted by logging or other disturbances and has excellent habitat characteristics for tailed frogs; the other two sites at Van West 1a and 1b do not. Van West 1a is located just above Millar Creek in Function Junction, is low gradient, the warmest and lowest site in the program, and supports fish, as first discovered in 2020 (Photos 2-14 and 2-15).

***Photo 2-12**. Van West Creek-1b is on both sides of the Mid- Flank Trail bridge that crosses it (2020 photo)*

***Photo 2-13**. Van West Creek-3 is below the Into the Mystic bridge.*

As expected from the habitat characteristics of these three sites, the upper site (Van West 3) is by far the most productive for tailed frogs: 53 of 55 tadpoles detected in this system so far have been recorded there, including 13 in 2021. The lowest site (Van West 1a) was first surveyed in 2020 when the only detection was of a Rainbow Trout fry (Photo 5-18). This result was repeated in 2021 when four trout between 35 and 75mm were detected. These small fish were found under cobbles, in exactly the same habitat a tailed frog would be expected. Fish presence is not totally unexpected given that the junction with Millar Creek is only 175 m downstream, and it decreases the likelihood that this part of the creek supports tailed frogs (due to fish predation). As of 2021, only two tadpoles have been detected at the heavily-disturbed middle-elevation site, Van West 1b (including none in 2021; Photo 2-12).

Van West Creek is perhaps the most obvious example of a disturbed stream system in the program and, as such, it is not surprising therefore that only the upper, undisturbed site has a significant population of tailed frogs. This conclusion is tempered somewhat by the absence (due to difficult topography and access) of a true mid-elevation site, ideally one with less disturbance from logging.

***Photo 2-14**. The Van West Creek-1 site in Function Junction is ca. 175 m upstream from Millar Creek.*

***Photo 2-15**. Salmonids have been found under rocks in 2020 and 2021 at Van West Creek-2 (2020 photo).*

Whistler Creek

Since being added to the program in 2016, more tadpoles have been detected on Whistler Creek than any other creek (Tables 2-4 and 2-5; Figure 2-5). Habitat on this creek and its tributaries is mostly unaltered and the watershed probably supports a higher tailed frog population than any other sampled in the greater Whistler area.[11] One of the main reasons to resurvey Whistler Creek in 2016 was to measure possible impacts of the Whistler Bike Park which started expanding into the watershed at that time. Prior to 2021, no evidence of effects from the Bike Park or other mountain operations was detected. In 2021, the absence of later-stage tadpole detections (T2 and T3) raises the possibility of some impact.

Detections have been mostly consistent other than exceptionally high totals in 2017, especially at the middle site (Site 2; Figure 2-5). A partial explanation for higher detections in 2017 was the addition a very experienced surveyor (Palmer and Snowline 2018), but the same surveyor has participated in surveys since without duplicating what now appears to be an unrepresentative number of detections.

11 This statement is based on results from this program since 2013 as well as studies previously, especially Wind (2006 to 2010). Those surveys included additional tributaries of Whistler Creek, all of which had tailed frogs.

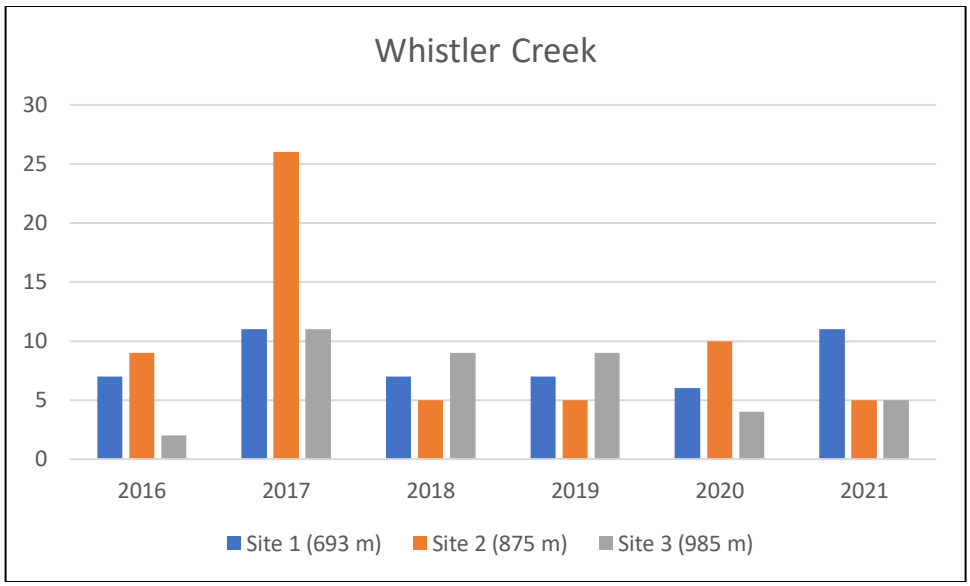


Figure 2-5. Tadpole detections in Whistler Creek by site, 2016-2021.

The most surprising result from 2021 sampling in Whistler Creek as that all 21 tadpoles detected were in the earliest-stage cohort (T1; Table 2-4). It is unclear if there is any significance to this observation, that is, whether it indicates lower survivorship and therefore possible habitat degradation. What is certain is that it is a change from previous years, for example, in 2020 when half of the 20 tadpoles detected were in later cohorts (five each of tadpoles in T2 and T3 cohorts; Palmer and Snowline 2021). Future surveys are required to test if survivorship is truly a problem.

A more encouraging result from Whistler Creek is that five years after in-stream works at the lowest site (Whistler Creek 1; Photos 2-16 and 2-17), there is no evidence of disturbance or habitat impacts. Consistent with these observations, for the first time more tadpoles were detected at this site in 2021 than the other two on Whistler Creek.

***Photo 2-16**. Significant in-stream disturbance occurred at the Whistler Creek-1 site before the 2017 surveys.*

***Photo 2-17**. By 2019, the streambed appeared undisturbed. This photo is from 2021.*

3. Beavers

Lead Biologist and Author: Bob Brett
Co-surveyor: Kristen Jones

Key Takeaways:

1. The number of active beaver lodges and bank burrows detected in 2021 (46) is the highest yet and is a very close approximation of a full census of Whistler's beaver population, now estimated at +/-267 individuals.
2. In addition to moving ever-closer each year to a complete census of existing colonies, there is strong evidence of growth in Whistler's beaver population in 2021.
3. An expanded search effort discovered for the first time seven lodges in the Rainbow Wetlands and Wildlife Refuge complex. These lodges were likely active for many years prior to detection and showed the importance of this beaver habitat.
4. New lodge construction on Alta Lake south of the Scotia Creek outlet appears to be indicative of more beavers (as mentioned above) rather than migration of colonies from other lodges nearby.
5. As o 2021, almost 75% of active colonies are located in one of two wetland complexes: the Millar Wetlands and the ROGD-Rainbow-Wildlife Refuge complex. Such strong, long-established populations no doubt provide the largest source of out-migration that keeps beavers active in less-ideal habitats.
6. Flooding in September and November hampered surveys and, more importantly, may have damaged overwintering structures enough to increase mortality and/or reduce reproduction success. The effect of this flooding will not be observable until next year.

3.1 Introduction

Beavers are a keystone species that literally shaped North America's landscapes, especially before European settlers drastically reduced their numbers (Goldfarb 2018). They are commonly referred to as ecosystem and wetlands engineers (e.g., Müller-Schwarze and Sun 2003) in recognition of their immense impact on landscapes that is second only to that of humans. The life history of beavers is predicated on altering landscapes to provide shelter, food, and security which thereby creates the dams, ponds, wetlands, channels, and wetland vegetation that provides critical habitat for countless other species (Morgan 1986; Müller-Schwarze and Sun 2003; Runtz 2015; Goldfarb 2018; Romansic et al. 2020).

Beavers no doubt exerted a vast impact on the Whistler area before the railway opened in 1913. The Whistler Valley contains five lakes in in a flat pass that, even now, are connected by creeks and wetlands impacted by beavers. Before European settlement, that habitat would have been much larger and would have stretched north in a mostly continuous swath from what is now Function Junction through Meadow Park and the Nicklaus North Golf Course beside Green Lake. The first, and significant reduction of Whistler's beaver population was caused by so much trapping that Racey and McTaggart-Cowan (1935) noted that beavers had already been "completely trapped out in the district for over twenty years" (p. 24), even though their dams and meadows persisted.

Though the area covered by wetlands is approximately 72 percent smaller than before Whistler was developed (McBlane 2007), beavers still inhabit such notable wetlands as the Millar Creek Wetlands, the Rainbow Wetlands, the Wildlife Refuge, and the River of Golden Dreams wetland complex. And although other former beaver habitats have been replaced by housing developments, golf courses and other developments, beavers continue to maintain their presence throughout the valley bottom.

Due to their critical role in creating and maintaining wetland habitats, beavers have the most positive impact on the quantity and quality of those habitats of any species in Whistler. They also play an important role in flood management, erosion control, and water quantity and quality. Their dams raise the water table to keep areas inundated even through dry summer months, and reduce erosion by slowing streamflow (Goldfarb 2018). From an ecological perspective, it would be difficult to have too many beavers on the landscape.

Many land managers, however, view beavers as pests to be trapped, killed, or otherwise dissuaded from their normal activities. In Whistler, the conflict between humans and beavers has been concentrated in the valley bottom. Much of the valley bottom habitat that once housed beavers has been transformed into low-lying developments where beavers are not welcome due to their propensity to cut valuable trees, raise water levels, and generally cause trouble for property owners. The ongoing challenge for the RMOW (among other land managers) is to balance the enormous ecological benefit of beavers on the landscape with other priorities such as protecting property and infrastructure.

Beavers are colonial animals. They maintain a family lodge which typically houses the adult parents, two yearlings, and two young-of-the-year (Müller-Schwarze and Sun 2003). Two-year-old beavers generally disperse to form new colonies, except when dispersal is delayed by the lack of suitable habitat and they remain with the family lodge. Some lodges can remain active indefinitely, especially in prime habitats, while others are periodically inactive or abandoned permanently. As a result, the exact location of Whistler's lodges changes somewhat each year.

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

The Whistler Biodiversity Project initiated Whistler's first beaver census in 2007 (Brett 2007; Mullen 2008). Surveys continued through 2011, the last two of which were in conjunction with RMOW staff (Mullen 2009; Pevec 2009; Tayless 2010; Tayless and Burrows 2011). The survey was reinitiated in 2013 as part of this program but focussed only on a subset of lodges (Cascade 2014-2016). The 2016 surveys returned to a full census approach where as many active lodges as possible were enumerated (Palmer and Snowline 2017). The greater survey effort and geographic range that began in 2016 year increased the number of documented colonies from nine in 2015 to 33 in 2020, and greatly expanded the geographic range of known colonies. Each year, these surveys have come closer to a full census of all beaver colonies in Whistler.

3.2 Methods

3.2.1 Survey Design

Fieldwork began in 2016 towards (re-) building a full census of Whistler's beavers, with the recognition that this goal could only be achieved with intensive and cumulative effort. It started with lodges still documented as of 2015 and resurveyed other areas where the Whistler Biodiversity Project had earlier documented them. Surveys were also directed into areas that had anecdotal reports of beaver activity, as well as suitable habitats that were not known yet known to house beavers. This general approach has continued since, and each year benefits from knowledge accumulated in previous years.

This beaver census is based on tallying the number of active lodges which then act as a proxy for the actual number of beavers (based on a multiplier per colony; Section 3.2.2). Annual fieldwork therefore includes every lodge that was active in recent years, plus any new lodge or associated activity observed or reported by others. Physical structures (lodges, dams, bank burrows) are mapped, and their activity status is recorded (that is, active or inactive). In most cases, it is possible to confidently identify where a lodge, burrow, or dam is active based on observations that include:

- Sightings of beavers, especially if entering and exiting structures (Photo 3-1;
- New construction or repair of lodges, especially in the fall when it shows a colony will overwinter in that lodge (Photos 3-1 and 3-2a);
- Functioning and freshly-maintained dam(s);
- Fresh food caches submerged at the entrance to a lodge;
- Beaver tracks (Photo 3-2b);
- Well-worn paths (tunnels and slides) through vegetation that links to the lodge's pond (Photo 3-2c) and/or
- Evidence of extensive clippings and cuttings along those paths.

Signs of inactivity include the absence of:

- any beaver sightings in the area;
- a structurally sound lodge;
- a functioning or freshly-maintained dam(s); and/or
- any other fresh signs (*i.e.*, that were obviously not from the survey year).

Until 2019, lodges for which activity status was unclear were recorded as having "Unknown" status. Starting in 2019, this uncertainty has instead been recognized by question marks beside a record, that is, "Active?" or "Inactive?" This change forced surveyors to choose which of the two classifications was most probable and was meant to allow easier interpretation of population trends. While those designations have typically been correct, any errors are generally corrected in the subsequent year. For example, a lodge recorded as "Active?" will typically be confirmed active in the subsequent year or, less often confirmed as inactive.

***Photo 3-1**. Two beavers were observed in the water near this new lodge (left side of photo) at the north end of Lost Lake on November 21, 2021. The combination of fresh mud, abundant evidence of feeding nearby, and fresh branches on the top of the lodge were each enough to assume that a colony was overwintering in this lodge. Observing the associated beavers was additional proof, and very rare since Whistler's beavers are seldom seen during the day.*

***Photo 3-2** Other evidence of recent beaver activity: (a) a lodge freshly mudded before winter 2021; (b; beaver tracks; and (c) a runway through adjacent vegetation.*

3.2.2 Data Analysis

Three factors introduce uncertainty into the reliability of estimates of Whistler's beaver population. Firstly, and as discussed above, it is not always possible to conclude whether a lodge will be occupied overwinter, that is, houses a colony. Secondly, not all occupied lodges are detected each year, though the number of undetected lodges decreases each year due to accumulated knowledge. Thirdly, and because reliably censusing individual beavers is impossible within the scope of this program, it is necessary to use a proxy, in this case the number of active lodges. The population is therefore estimated by multiplying the number of active lodges by a multiplier based on the number of beavers per colony documented in other studies.

The number of beavers per colony (overwintering lodge or bank burrow) is based on several factors, especially habitat type and beaver density, which is why that number can vary widely. The 2008 beaver survey (Mullen 2008) applied a multiplier of 5.8 beavers per lodge from five studies elsewhere and this is the multiplier that has been used in beaver surveys since to estimate Whistler's total beaver population. That multiplier continues to be a reasonable estimate because of two reasons:

1. It is consistent with the studies cited by Mullen, and also within the middle of the range of averages from studies in 12 locations reported in Müller-Schwarze and Sun (2003; Table 3-1); and,
2. It is consistent with a typical colony that contains two adults, two yearlings, and two young-of- the-year (Section 3.1).

Regardless of the multiplier chosen, it is still necessary to realize that this proxy only provides an approximation of the true population. For that reason, surveys since 2016 have included a range of multipliers that includes the middle half of the reported averages in Müller-Schwarze and Sun (2003; Table 6-1): a low estimate of 4.2 beavers per colony; a middle estimate of 5.8 beavers per colony; and a high estimate of 6.4 beavers per colony.

Table 3-1. Number of beavers per family in various locations (Müller-Schwarze and Sun 2003).

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

3.2.3 Quality Assurance and Quality Control

Results from beaver surveys are comparable year to year, with the caveats that: (a) survey effort has only been constant for the past 6 years; and (b) each subsequent year documents previously unknown lodges, that is, the census gets more accurate and comprehensive with each year of sustained effort.

3.3 Results and Discussion

3.3.1 2021 Surveys

For the sixth consecutive year, beaver surveys detected more active lodges than the previous year. The 46 colonies recorded in 2021 (45 lodges and one burrow) is by far the highest total to date (Tables 3-2 and 3-3; Figure 3-1; Appendix G). The total number of lodges and burrows surveyed in 2021 (95) is also a significant increase from past years and another indication of the increased extent of search effort since 2015.

Table 3-2. Lodges and Burrows by activity status, 2007 to 2021.

Status	2007	2008	2009	2010	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021
Lodge - Active(?)	9	27	16	16	17	10	10	7	13	13	16	27	33	45
Burrow - Active(?)	0	0	0	0	0	0	0	0	0	0	2?	0	0	1
Total Active	**9**	**27**	**16**	**16**	**17**	**10**	**10**	**7**	**13**	**13**	**16**	**27**	**33**	**46**
Lodge - Inactive(?)	9	12	13	7	21	5	14	18	11	21	32	36	45	49
Summer Only	0	0	0	0	0	0	0	0	2	2	2	0	0	0
Unknown	1	4	4	4	0	8	1	3	3	8	9	NR	NR	NR
Total Surveyed	**19**	**43**	**33**	**27**	**38**	**23**	**25**	**28**	**29**	**44**	**59**	**65**	**78**	**95**

Notes: NR = not recorded. Starting in 2019, surveyors classified lodges with an uncertain status as either "Active?" or "Inactive?" based on available evidence. These lodges have been included with "Active" and "Inactive" lodges, respectively. No survey was conducted in 2012. See notes in Section 3.2.2 that explain why the 2008 tally of active lodges was almost certainly an error.

It becomes clearer with each subsequent survey that lodges can remain active for many years, presumably with the same mating pair and maybe even their descendants. While the most recent data (Table 3-3) shows that only four lodges were active continuously since 2017, the true number is certainly higher since many of well-established lodges now listed as active were first detected in the intervening years.

Table 3-3. Lodges and burrows documented in 2021.

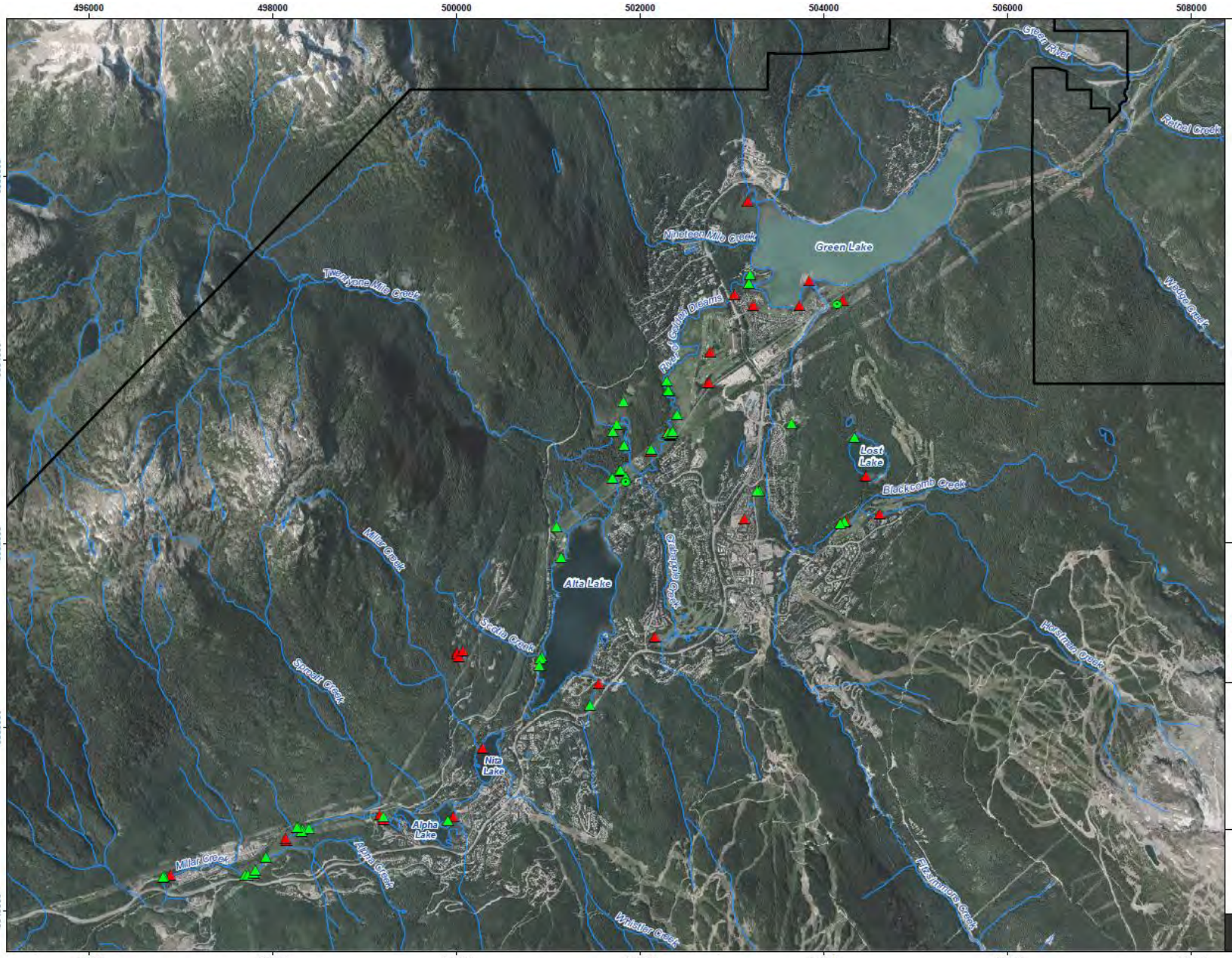
Location	Record	2021	2020	2019	2018	2017	Easting	Northing
Fitzsimmons Creek, back channels	Burrow	Active	Active	NR	NR	NR	504142	5554607
Chateau GC #18 main pond	Lodge	Active	Active	NR	NR	NR	504228	5552240
Millar Creek, west of FJ, south bend in river	Lodge	Active	Active	NR	NR	NR	496821	5548379
Millar Wetlands, 1st lodge, west end	Lodge	Active	Active	Active	Active	NR	497706	5548388
Millar Wetlands, 2nd lodge, west end	Lodge	Active	Active	NR	NR	NR	497737	5548390
Millar Wetlands, n end, near Valley Trail	Lodge	Active	Active	Active	Inactive?	NR	498284	5548908
Millar Wetlands, n end, ESE of closest lodge	Lodge	Active	Active	Active	NR	NR	498328	5548894
Millar Wetlands, n end, east of closest lodge	Lodge	Active	Active	Active	NR	NR	498398	5548903
Rainbow Wetlands, NE near 21-Mile Creek	Lodge	Active	Active	NR	NR	NR	501777	5552792
ROGD4 - RR bridge to bend near Valley Tr.	Lodge	Active	Active	Active	NR	NR	502312	5553214
ROGD4 - RR bridge to bend near Valley Tr.	Lodge	Active	Active	Active	Active	NR	502327	5553188
ROGD4 - RR bridge to bend near Valley Tr.	Lodge	Active	Active	Active	Active?	NR	502349	5553202
ROGD4 - RR bridge to bend near Valley Tr.	Lodge	Active	Active	Active	NR	NR	502406	5553403
ROGD5 - bend near Valley Tr. to Hwy. 99	Lodge	Active	Active	NR	NR	NR	502294	5553771
ROGD5 - bend near Valley Tr. to Hwy. 99	Lodge	Active	Active	Inactive?	Inactive	NR	502308	5553673
ROGD5 - bend near Valley Tr. to Hwy. 99	Lodge	Active	Active	Inactive	Inactive	NR	502311	5553661
ROGD6 - Hwy. 99 bridge to Green Lake	Lodge	Active	Active	Active	Inactive?	NR	503187	5554830
Wildlife Refuge, north end	Lodge	Active	Active	Active	Active	Active	501825	5553543
Wildlife Refuge, west side of middle pond	Lodge	Active	Active	NR	NR	NR	501750	5553298
Millar Creek, west of FJ, south bend in river	Lodge	Active	Active?	NR	NR	NR	496812	5548373
Rainbow Park, west side US of Alta Lk.	Lodge	Active	Active?	Inactive	Inactive	Inactive	501145	5551850
Rainbow Wetlands, NE end near 21-Mile Cr.	Lodge	Active	Active?	Active	Active	Active	501848	5552727
ROGD4 - RR bridge to bend near Valley Tr.	Lodge	Active	Active?	Active	NR	NR	502126	5553026
Fitz Creek Pond	Lodge	Active	Inactive	Inactive	NR	NR	503300	5552575
Fitz Creek Pond	Lodge	Active	Inactive?	Active	Active	NR	503275	5552571
Alta Lake, ~55m south of Scotia Creek outlet	Lodge	Active	NR	NR	NR	NR	500934	5550767
Alta Lake, ~80m south of Scotia Creek outlet	Lodge	Active	NR	NR	NR	NR	500919	5550750
Lost Lake, active lodge closest to north inlet	Lodge	Active	NR	NR	NR	NR	504337	5553160
Rainbow Wetlands – across from fish weir	Lodge	Active	NR	NR	NR	NR	501694	5552718
Rainbow Wetlands - across from fish weir	Lodge	Active	NR	NR	NR	NR	501702	5552711
Rainbow Wetlands, NE end near 21-Mile Cr.	Lodge	Active	NR	NR	NR	NR	501790	5552801
Rainbow Wetlands, NE end near 21-Mile Cr.	Lodge	Active	NR	NR	NR	NR	501848	5552721
Wildlife Refuge, SW side of middle pond	Lodge	Active	NR	NR	NR	NR	501709	5553226
Wildlife Refuge, w. side of pond nr main dam	Lodge	Active	NR	NR	NR	NR	501830	5553068
Millar Wetlands -FJ (Valley Trail access)	Lodge	Active	NR	NR	NR	NR	498270	5548912
Alta Vista Pond, main lodge	Lodge	Active?	Active	Active	Active	Active	501458	5550235
Millar Wetlands, 3rd lodge from west	Lodge	Active?	Active	Active	Active	NR	497796	5548408
Millar Wetlands, middle	Lodge	Active?	Active	Inactive	NR	NR	497931	5548588
Millar Wetlands, n end, farthest from VT	Lodge	Active?	Active	Active	NR	NR	498321	5548863
Spruce Grove Park, entrance	Lodge	Active?	Active	Active	Active	Active	503652	5553307
ROGD6 - Hwy. 99 bridge to Green Lake	Lodge	Active?	Active?	Inactive?	Unknown	NR	503202	5554930
Chateau GC #18 lower pond	Lodge	Active?	Inactive	Inactive	Summer?	Summer?	504181	5552219
ROGD4 - RR bridge to bend near Valley Tr.	Lodge	Active?	Inactive?	Inactive	Inactive	NR	502358	5553224
Alpha Lake, islet near dog beach	Lodge	Active?	NR	NR	NR	NR	499913	5548986
Alta Lake, 5m n. of Chaplinville docks	Lodge	Active?	NR	NR	NR	NR	500906	5550670
Rainbow Wetlands, westmost main pond	Lodge	Active?	NR	NR	NR	NR	501096	5552182
Millar Wetlands, visible from pump track?	Lodge	Possible	Inactive	Active	Inactive	NR	497818	5548447
ROGD2 - downstream left from fish weir	Burrow	Possible	NR	NR	NR	NR	501840	5552670

Note: Lodges and burrows recorded for the first time are highlighted in blue.

Of the 45 active lodges recorded in 2021, 13 were recorded for the first time (Table 3-4). More than half of these newly lodges were recorded due to the first detailed search in the southwest portion of the Rainbow Wetlands (five new lodges) and west side of the Wildlife Refuge (two new lodges). Although dense shrubs and open water in both of these areas have delayed confirmation of activity until 2021 (due to difficulties in access), there is no doubt beavers have been present in them as long as other parts of the Rainbow-Wildlife Refuge-ROGD Wetland Complex that had already been surveyed. These additional lodges reinforce the importance of this wetland complex that was discussed in previous reports (especially Palmer and Snowline 2019-2021).

Table 3-4. Changes in the status of active lodges between 2020 and 2021.

2021 Change	**Lodge Location**	**2021**	**2020**	**Change**
New Active(?)	Alpha Lake, islet near dog beach	Active?		
	Alta Lake, ~55m south of Scotia Creek outlet	Active		
	Alta Lake, ~80m south of Scotia Creek outlet	Active		
	Alta Lake, 5m n. of Chaplinville docks	Active?		
	Lost Lake, active lodge closest to north inlet	Active		
	Millar Wetlands -FJ (Valley Trail access)	Active		
	Rainbow Wetlands - across from fish weir	Active	Not	+13
	Rainbow Wetlands – across from fish weir	Active	Recorded	
	Rainbow Wetlands, NE end near 21-Mile Cr.	Active		
	Rainbow Wetlands, NE end near 21-Mile Cr.	Active		
	Rainbow Wetlands, westmost main pond	Active?		
	Wildlife Refuge, SW side of middle pond	Active		
	Wildlife Refuge, w. side of pond nr main dam	Active		
Reactivated(?)	Chateau GC #18 lower pond	Active?	Inactive	
	Fitz Creek Pond	Active	Inactive?	+4
	Fitz Creek Pond	Active	Inactive	
	ROGD4 - RR bridge to bend near Valley Tr.	Active?	Inactive?	
Newly Deactivated(?)	Alpha Lake, beside dam, ~8m inland on north side	Inactive	Active	-4
	Alpha Lake, near dog beach	Inactive?	Active	
	Lost Lake south end of nature trail, near lake outlet	Inactive?	Active	
	Millar Wetlands, n. of FJ, water access?	Inactive?	Active?	
			Total Net Change	+13



Legend

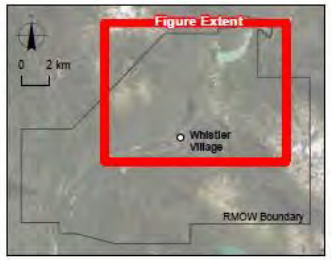
2021 Beaver Lodge Status

- Active Burrow
- Active Lodge
- Inactive Lodge

RMOW Boundary

Watercourse

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



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metres

N

DRAWN: B. Elder
CHECKED: B. Brett
PROJECT: 1602506
DATE: Dec 17, 2021

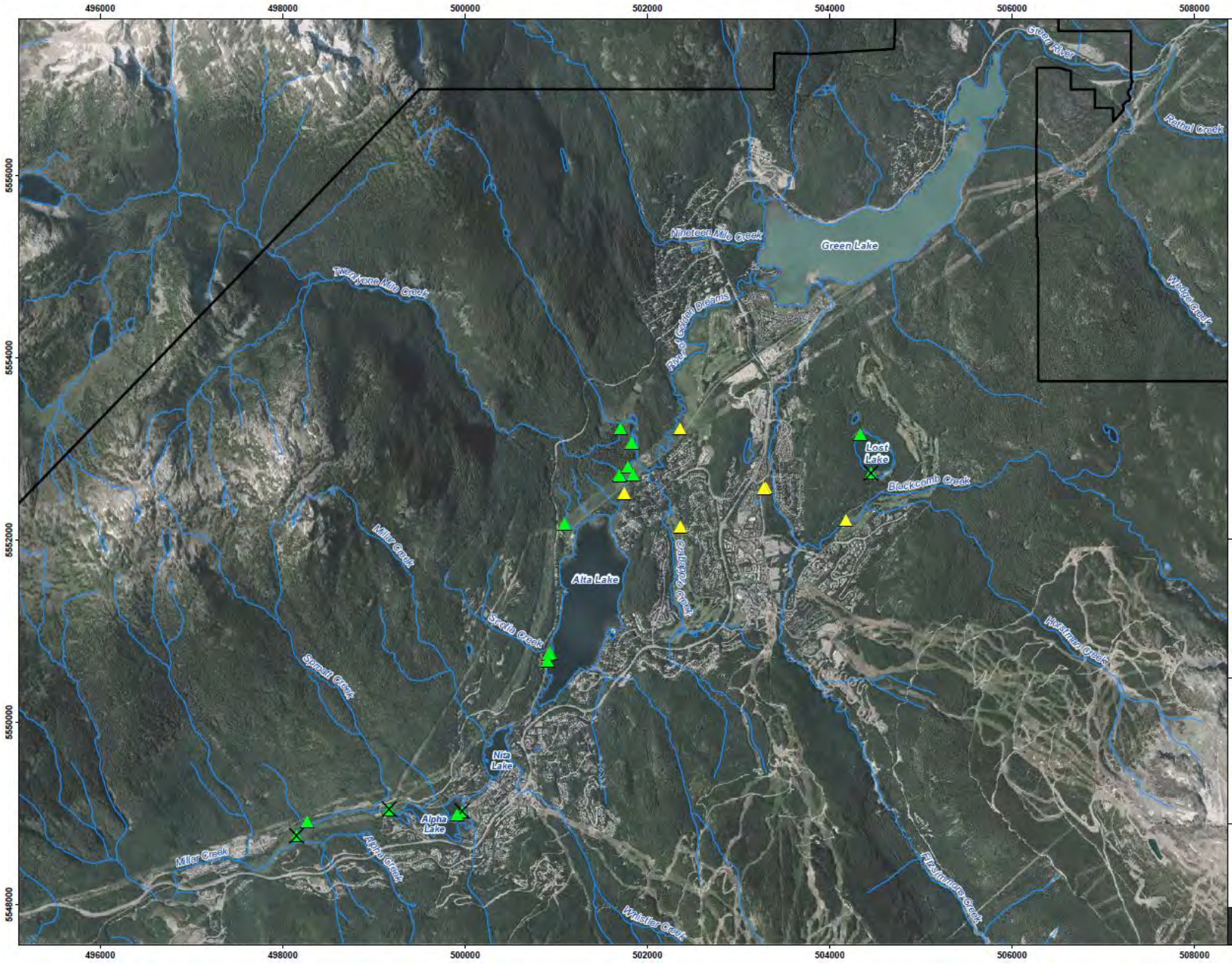
Scale 1:40000
UTM Zone 10N
NAD 1983

SNOWLINE Ecological Research
Palmer™

CLIENT: Resort Municipality of Whistler
PROJECT: Annual Monitoring 2021

Results of 2021 Census of Beaver Lodges in Whistler

FIGURE 3-1



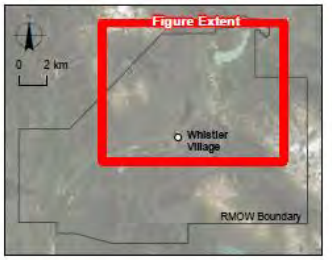
Legend

Changes in Lodge Status in 2021

- Reactivated in 2021
- Active - 1st Record in 2021
- Deactivated since 2020

- RMOW Boundary
- Watercourse

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



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metres

N

DRAWN: B. Elder
CHECKED: B. Brett
PROJECT: 1602506
DATE: Dec 16, 2021

Scale 1:40000
UTM Zone 10N
NAD 1983

SNOWLINE Ecological Research
Palmer™

CLIENT: Resort Municipality of Whistler
PROJECT: Annual Monitoring 2021

New, Reactivated, and Newly Deactivated Lodges

FIGURE 3-2

3.3.2 Population Estimates

The 46 colonies documented in 2021 represent the most comprehensive survey to date and therefore is the closest approximation yet to a full census of Whistler's beaver population. The middle population estimate, based on 5.8 beavers per colony (Section 3.3.2), has risen from a low of 41 in 2015 to 267, an increase which is more a reflection of greater knowledge about local beavers rather than an increased population (Table 3-5; Figure 3-2). The 2021 survey confirms that the beaver population in Whistler remains relatively large in spite of the loss of almost 75% of their habitat since development began (Section 3.4).

Table 3-5. Estimated number of beavers in Whistler, 2007-2021.

	2007	2008	2009	2010	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021
Active colonies	9	27	16	16	17	10	10	7	13	13	16	27	33	46
@ 4.2 beavers	38	113	67	67	71	42	42	29	55	55	67	113	139	193
@ 5.8 beavers	52	157	93	93	99	58	58	41	75	75	93	157	191	267
@ 6.4 beavers	58	173	102	102	109	64	64	45	83	83	102	173	211	294

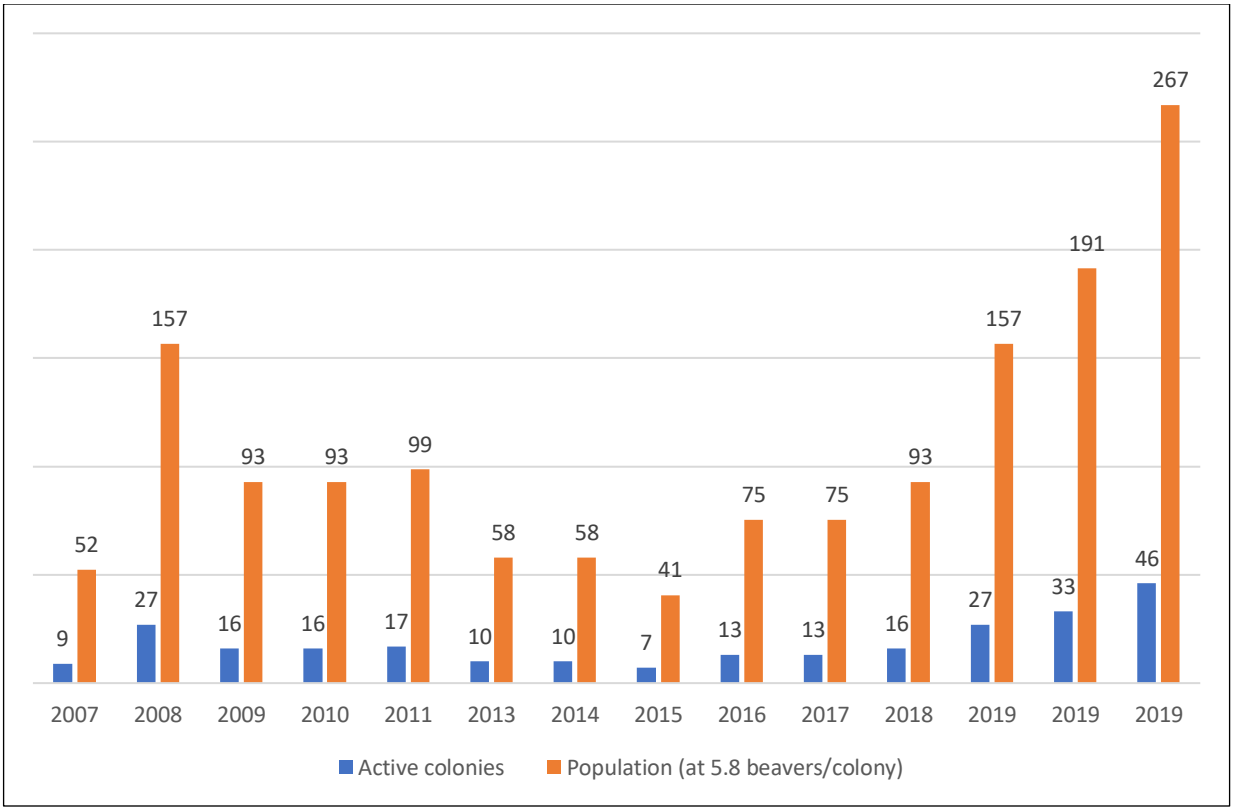


Figure 3-2. Estimated beaver population from 2007-2021 based on 5.8 beavers per colony (lodge). Surveys were not conducted in 2012.

The main benefit of this increased confidence in the comprehensiveness of this survey is that it coincides with a greater ability to detect true population trends, an ability that will also increase with future surveys conducted with similar effort. For example, the addition at least two new lodges/colonies on Alta Lake at Scotia Creek (the status of an adjacent third lodge was unclear; Section 3.3.4) shows the beaver population in that area has expanded (cf., Figure 3-3).

3.3.3 Importance of (a) ROGD-Rainbow-Wildlife Refuge Complex and (b) Millar Wetlands

The impact and presence of beavers in Whistler was well-known long before annual surveys began (e.g., Racey and McTaggart-Cowan 1935). Before these surveys, perhaps the most obvious habitat was on the River of Golden Dreams (ROGD) where paddlers had to navigate multiple beaver dams. It was therefore not surprising when the first decade of beaver surveys confirmed that at least half of known lodges in Whistler were on the ROGD. While the ROGD has remained important beaver habitat, expanded surveys since 2019 have discovered that other areas provide a similar amount of beaver habitat, notably the Millar Wetlands, the Rainbow Wetlands, and wetlands in the Wildlife Refuge.

Ambitious surveys in 2019 expanded the survey area to the entire Millar Wetland area, including parts that were very difficult to access. That effort was rewarded with the discovery of seven previously unknown lodges and brought the total for that area to nine active lodges. The goal for the 2021 survey was to apply a similar effort to the Rainbow Wetlands and Wildlife Refuge that had not been included due to difficult access, and again that additional effort was rewarded with the discovery of previously unknown lodges.

In 2021, surveys discovered previously unknown lodges in the Rainbow Wetlands (five) and Wildlife Refuge (two), and confirmed that they together provide a similar amount of beaver habitat to the ROGD and Millar Wetlands (Table 3-6; Figure 3-3). Between them, the Millar Wetlands and "ROGD-Rainbow-Wildlife Refuge Wetland Complex" represent approximately three-quarters of all active lodges in Whistler.

Table 3-6: Active lodges by main activity zones, 2020 and 2021.

		1. ROGD/Rainbow/WR Complex				2. Millar Wetlands & Creek	3. Other Areas	Total (1 + 2)	Total All Areas (1+2+3)
		1A. ROGD	1B. Rainbow Wetlands	1C. Wildlife Refuge	Total (1A+1B+1C)				
2020	No.	10	2	2	14	11	8	25	33
	%	30%	6%	6%	42%	33%	24%	76%	100%
2021	No.	11	7	4	22	11	13	33	46
	%	24%	15%	9%	48%	24%	28%	72%	100%
Change (%)		-6%	9%	3%	5%	-9%	4%	-4%	0%

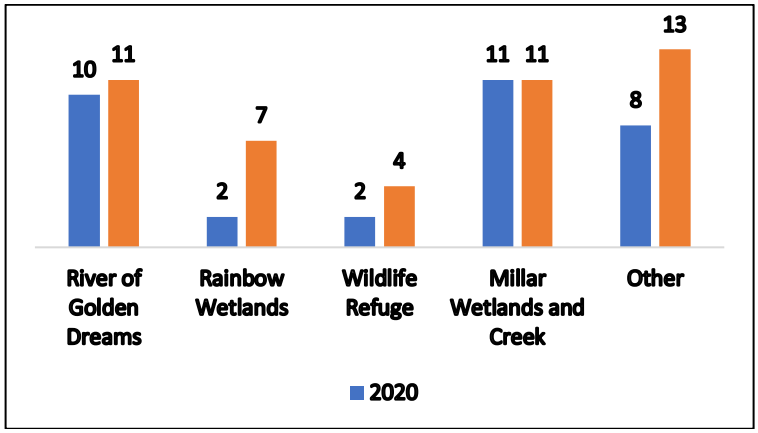


Figure 3-3. Colonies by major activity area, 2020 and 2021.

3.3.4 Notable Activity in 2021 (Alphabetical)

Alta Lake at Scotia Creek and Rainbow Park

The discovery of major new beaver activity in 2021 on the shore of Alta Lake just south of the outlet of Scotia Creek was second in importance only to the discovery of all the new lodges in the Rainbow Wetlands and Wildlife Refuge. While inactive lodges and other old signs show that beavers have inhabited this area before, it has clearly not been recent. The three lodges recorded in mid-November 2021 therefore represent a significant recolonization. Two of those lodges had abundant fresh evidence including recently mudding (which is a common pre-winter behaviour) and therefore house overwintering colonies (Photo 3-9). The third had branches and other evidence that was from 2021, but it was not possible to confirm overwintering status (that is, it may have been used in summer only).

Photo 3-9. *This lodge, among the largest recorded in 2021, was newly constructed on the shore of Alta Lake south of the Scotia Creek outlet.*

Alta Vista Pond

The RMOW lowered water levels in Alta Vista Pond in 2018 due to concerns about the roadbed on the north side of the pond. The main lodge at the south end of the pond (Photo 3-10) is still intact and likely still houses a colony, though no recent evidence was detected. Since the RMOW did not conduct any control efforts since, it is reasonable to assume future visits will confirm an active colony in the lodge. One sign of the lowered water level is that an entrance burrow for a still intact, but now inactive lodge is well above the current water level (Photo 3-11).

Photo 3-10. *The main lodge on Alta Vista Pond (left side of photo) is probably still active in spite of no evidence of recent activity.*

Photo 3-11. *This second lodge on Alta Vista Pond is structurally sound but currently inactive. The entrance on the far right is well above the current water level.*

Fitz Creek Pond

Beaver activity in the remnant wetland between the north end of Blackcomb Way and Fitzsimmons Creek is probably the only reason there is open water in this area. That is, the dams at the outlet to Fitzsimmons Creek maintain a water level high enough that the cattails and other emergent vegetation haven't completely overgrown the area. In 2020, surveys could not detect enough beaver activity to conclude the presence of an active colony but this proved to be incorrect. In early 2021, both lodges were clearly active and in late 2021 (November) fresh mudding reconfirmed overwintering in both (Photos 3-12 and 3-13).

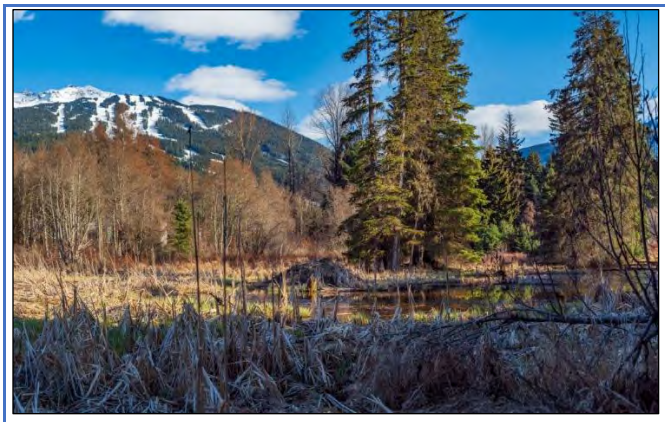


***Photo 3-13**. The largest lodge in the Fitzsimmons Creek wetland was incorrectly labelled inactive in 2020.*

***Photo 3-14**. In November 2021 the second lodge in the same wetland showed recent mudding.*

Fitzsimmons Back Channels

In past surveys, abundant evidence of past bank burrows and lodges have been detected near the overflow flooding channels at the northmost bend of Fitzsimmons Creek (where it flows west to Green Lake, and near the new Muffin Man bike trail; Figure 3-1). In 2020, however, no overwintering colonies could be detected. In 2021, a small presence was detected including the only bank burrow in the survey for which overwintering was likely (Photo 3-15).[12]

***Photo 3-15**. This bank burrow in the overflow channels between Fitzsimmons Creek and Green Lake became active in 2021, as shown by the fresh food cache.*

***Photo 3-16**. A small dam in the channel is associated with the bank burrow.*

[12] *See below for comments about burrows on the River of Golden Dreams.*

Golf Courses

Much of the area on which in the two valleybottom golf courses (Whistler and Nicklaus North) were built was previously beaver habitat, and at least some wetlands (at the south end) were replaced by the otherwise upland Chateau Golf Course. Beavers continually migrate into these areas to establish lodges, as documented by past beaver surveys, but lodge activity has been less in recent years, especially on the Whistler Golf Course. Only the Chateau Golf Course has had overwintering colonies in 2020 and 2021.

Overall, beaver activity on the three courses in 2020 and 2021 are among the lowest of any years surveyed since 2007. As much as can be determined, especially since information is difficult to obtain, the decreased activity on Whistler and Nicklaus North courses, especially since 2020 were not due to beaver trapping or other control measures. In fact, the three golf courses have expressed a desire to allow as much beaver activity as possible within their overarching priority of protecting infrastructure on their courses.[13]

Chateau Golf Course

There have been lodges for many years in the two valleybottom ponds on the Chateau Golf Course, the #2 pond and the #18 pond. Horstman Creek passes through both of them as it flows to meet Blackcomb Creek downstream of the #18 pond. Although the previously long-active lodge on the #2 pond has been vacant for three years (Appendix C), beaver activity restarted in the #18 pond in late 2020. That active lodge was enlarged in 2021 (Photo 3-17), additional maintenance on the main dam has raised the water level of the pond, and a second lodge was almost certainly active just below it. It may not be a coincidence that this area is directly connected to Lost Lake and the wetland between Fitzsimmons Creek and Blackcomb Way. That is, it is reasonable to assume out- and in-migration occurs between these areas.

Photo 3-17. *This lodge on the pond between the Chateau GC #18 fairway and Blackcomb Creek became active in 2020 and has since been enlarged.*

[13] *Based on many communications during 2021 and prior years between Bob Brett and Stu Carmichael and Geoff Barnett (Whistler Golf Course), Gerrit Woods and Aaron Mansbridge (Nicklaus North), and Dan Nash (Chateau Golf Course).*

Whistler Golf Course:

Prior to 2020, there were more beavers on the Whistler Golf Course than the other two courses, often with two or more active lodges (Appendix C). The 2021 survey was the first in which no beaver activity at all was detected. The 2020 survey (Palmer and Snowline 2021) found late fall tree cutting by beavers in the pond beside the #4 green and speculated it might indicate an undetected colony overwintering nearby; however, no evidence of that colony was found in 2021.

Nicklaus North Golf Course

Virtually no beaver activity has been detected on the Nicklaus North Golf Course since a lodge on the #10 pond was vacated sometime in 2016 (Appendix C). The proximity of this course to the active beaver habitat on the River of Golden Dreams would suggest dispersing beavers would try to re-colonize the area, but this has not happened in recent years. In late November, feeding was seen in the #15 pond, likely by beavers from the colony at the mouth of the River of Golden Dreams.

Lost Lake and Old Mill Pond

Beavers in Whistler are often hard to see since they tend to be mostly nocturnal, no doubt to avoid humans. It might therefore surprise many people to learn that beavers commonly have one or more active lodges on Lost Lake. The lodge near the outlet to Blackcomb Creek that was active in 2020 was no longer active at the end of 2021. Meanwhile, a new lodge was built at the north end of the lake (Photo 3-18). This was a rare record that provided multiple confirmations of overwintering: fresh mudding, abundant feeding, and the presence of two beavers swimming nearby. The outlet dam on the adjacent Old Mill Pond was freshly maintained, apparently by the Lost Lake colony since only inactive lodges were detected above the dam (Appendix C).

Photo 3-18. *This new lodge at the north end of Lost Lake has fresh mudding in late November 2021. Two beavers are swimming near the shore in this photo (not visible at this scale).*

Millar Creek Downstream of Function Junction

Beaver activity was first documented in 2019 on Millar Creek downstream from the Millar Wetlands at the west end of Function Junction. Given the large number of beavers in the adjacent Millar Wetlands, it would be reasonable to expect that out-migration by dispersing juveniles or displaced adults would occur in suitable habitat nearby such as this. A long history of beaver presence on this part of Millar Creek is therefor almost certain.

Two lodges were again active in 2021, and the extensive tree cutting in late fall is a further indication of habitation in the area (Photos 3-19 and 3-20). By November 2021, almost all cottonwoods near the lodges cut by beavers which raised the question of whether there will be enough food for such active colonies in future years. A related observation from that area is that there are still many standing alders which: (a) demonstrates the higher desirability of cottonwoods as beaver food; and (b) might become the main source of food for these colonies in 2022, or at least until the cottonwoods regrow in sufficient numbers.

***Photo 3-19**. This is one of two very active lodges at the west end Millar Creek, where the creek bends south towards the highway (photo taken from the top of the second lodge just downstream). The piling of sticks and branches on top of the two lodges is unique among Whistler lodges and may be a secondary cache for winter food (in addition to the branches cached in the water in front of the lodge).*

***Photo 3-20**. Most of the cottonwoods smaller than this one pictured near the two Millar Creek lodges were cut down by mid-November 2021. Notice that the alders behind the cottonwood were mostly left untouched which indicates their lower attractiveness as food for beavers.*

Millar Wetlands

In hindsight, it is remarkable that the full importance of the Millar Wetlands to Whistler's beaver population remained unknown (or at least underreported) until 2019 (Section 3-3). In the two surveys since then, a pattern of relative stability has emerged. That is, the many colonies occupying the large lodges in the Millar Wetlands (stable at nine since 2019) likely represent a continuation from many centuries or more. It should be noted that results from the 2021 survey many not be as reliable as in past years since, due to flooding, several of the lodges could only be viewed through binoculars. The late November flooding was so significant, that some of the lodges were at least partially submerged (Photo 3-21).

Construction for the Fortis gas line and RMOW Valley Trail began in 2018. The low grade of gas line and the right-of-way led to conflicts with beavers that attempted to raise water levels nearby. That conflict led to the installation of beaver deceivers beside the right-of-way but no other apparent disturbance of the beaver population in the area. In 2021, preparation for the opening of the Valley Trail included extensive cutting of shrubs and small trees at the north end (trail side) of the wetland. As a result, at least two lodges are now in full view of the trail (Photo 3-22). Whether this change causes problems for those lodges, for example by increased danger from dogs, is not yet known.

***Photo 3-21**. A major flood in late November 2021 hampered beaver surveys including in the Millar Wetlands shown here. Note the lodge in the middle back of the photo that surrounded by water.*

***Photo 3-22.** This lodge is one of the largest found since Whistler surveys began in 2007. Before the new Valley Trail opened in 2021, it was not visible from the trail but is now easily seen.*

Rainbow Park

A long-active lodge beside Rainbow Park was vacated in approximately 2015, then reactivated last year. The 2020 report suggested that change was precipitated by the abandonment of another well-established lodge upstream of the ROGD fish weir (and visible upstream of the nearby Valley Trail bridge). The Rainbow Park lodge remained active in 2021 (Photo 3-23) and, with at least two new colonies south of it at the Scotia Creek outlet (see above), it represents more beavers on Alta Lake than in recent memory.

Photo 3-23. *The lodge beside Rainbow Park is large but obscured by trees and shrubs. It is more obvious between fall and spring when there are no leaves.*

Rainbow Wetlands

As mentioned above (Section 3.3.3), the 2021 survey successfully surveyed the entire Rainbow Wetlands for the first time, and found five previously undetected lodges (Photo 3-24). Even then, it is quite possible more lodges remain undetected due to the difficulty in finding them in such dense vegetation. Some lodges are only visible when standing directly beside them (Photo 3-25).

***Photo 3-24**. One of the largest lodges in the Rainbow Wetlands was in the middle and only visible when within several metres of it.*

***Photo 3-25**. A lodge near the eastern edge of the Rainbow Wetlands showing the vegetation that makes detection difficult.*

Many of the lodges recorded by these surveys have clearly been present for many years or decades, as shown by the dense vegetation growing on them, their large size, and/or other obvious signs of a long presence in the area. One example of this is from the westmost channel of the Rainbow Wetlands (next to the lower parking lot for Rainbow Park; Photo 3-26). In spite of efforts to find a lodge associated with what appeared to be a beaver pond, past surveys were unsuccessful. In 2021, more sustained efforts finally discovered that lodge which may be the most cryptic lodge found to date (Photo 3-27).

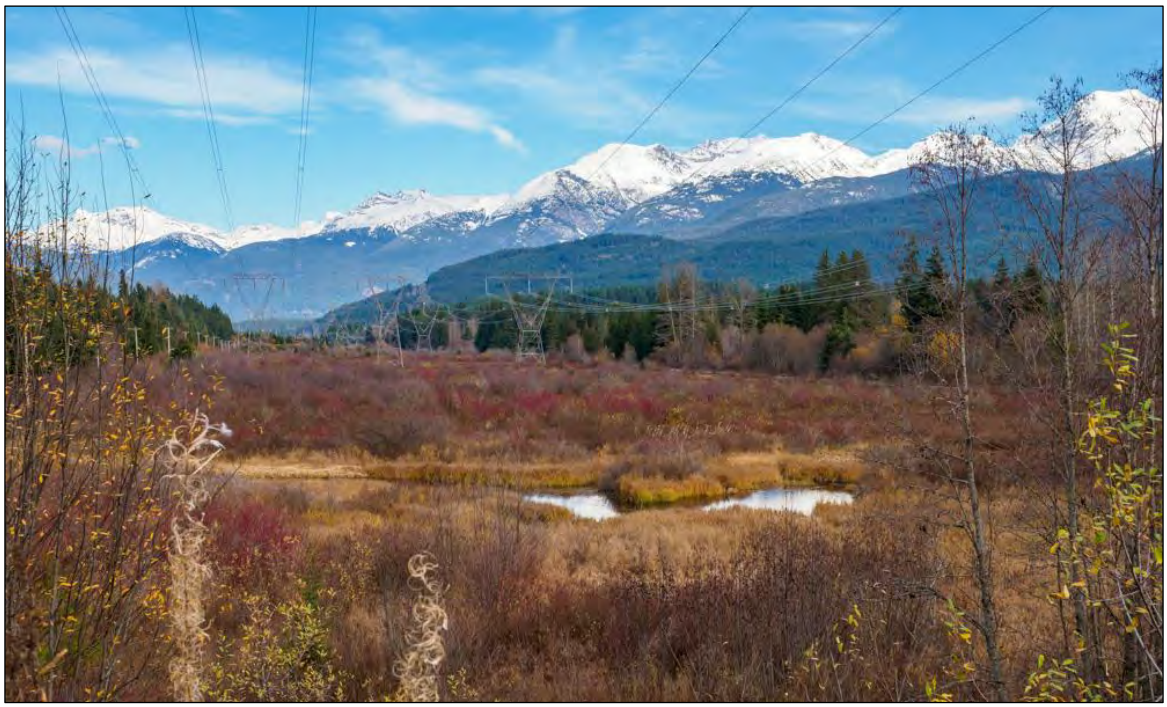


***Photo 3-26.** The pond in the westmost channel of the Rainbow Wetlands. The dam in Photo 3-27 is on the right edge of the pond. The newly discovered lodge is in the middle of the far side of the pond.*

Photo 3-27. *The dam at the outlet of the pond shown in Photo 3-26. The lodge is hidden under the reddish dogwood shrubs on the back left side of this photo, to the right of the power pole.*

River of Golden Dream (ROGD)

The 2021 beaver survey on the River of Golden Dreams (ROGD) added one lodge to the 10 active lodges recorded in 2020 and thus brought the total known colonies to at least 11. The ROGD is therefore the single most populous area for beavers in Whistler, especially when considered in conjunction with the related Rainbow Wetlands and Wildlife Refuge (Table 3-6).

Lodge surveys on the ROGD are always difficult since lodges can be remarkably cryptic due to vegetation that obscures them, and the fact that many are set back enough from the creek that they are often unnoticeable without walking on land (Photo 3-28). In 2021, the difficulty of confirming bank burrows on the ROGD also became evident.

Based on past surveys, the use of bank burrows appears to be limited to the ROGD and, to a lesser degree, the Fitzsimmons Back Channels (above). Burrows are difficult to confirm, however, since they don't have an obvious structure such as a lodge. Clear evidence of a bank burrow was nonetheless found in May 2021 during the dam survey, including a very fresh and obvious food cache (Section 3.3.5). High water levels in several subsequent visits in fall 2021 prevented any confirmation of the continued occupation of the burrow or whether it would be occupied overwinter. It was therefore recorded as "Possible," a new category that reflected its unknown status and may also mean the total number of colonies on the ROGD was undercounted.

***Photo 3-28**. The lodge at the bottom left of the photo is at least two metres from the water's edge and not visible without land-based searching.*

***Photo 3-29**. This bank burrow was found in May 2021 downstream of the fish weir on the ROGD. Fresh branches were proof of occupation then, but high water prevented an accurate resurvey to confirm continued presence in late fall.*

A second possible location where colonies were undercounted was between Meadow Park and the first section of the ROGD downstream of Highway 99. Each year, extensive beaver activity has been observed in this section but a lodge or bank burrow has never been found (excepting a brief occupation of the artificial pond beside the Sports Centre). In 2021, Liz Barrett may have found at least one source of that activity in 2021 when she saw beavers at the first bend downstream of the highway bridge that she thought to be associated with one or more bank burrows nearby.14 None were seen during the canoe-based annual survey on October 3, 2021, but that may have been related to high water hiding the entrance(s). And despite numerous subsequent efforts, continued flooding meant confirmation of burrows in that area had to be delayed until 2022 (Photo 3-30).

***Photo 3-30**. Flooding on November 15, 2021 inundated much of the area surrounding the River of Golden Dreams downstream of the Highway 99 bridge. It was therefore not possible to confirm whether there were active bank burrows on this bend of the ROGD.*

Wildlife Refuge

As detailed above (Section 3.3.3), the Wildlife Refuge is part of a wetland complex that includes the Rainbow Wetlands and River of Golden Dreams and provides habitat for almost half of Whistler's beavers (Table 3-6). It was also the subject of an intensive search that included the entire wetted area, notably the western portion that is most inaccessible (Photo 3-31). Abundant evidence of beaver activity is present through the whole area, so it was not surprising to discover an additional two lodges, including the one associated with the main dam (Photo 3-32), which brought the known total to four.

14 *Personal communication with Bob Brett several times in Fall 2021.*

Photo 3-31. *Although no beavers are currently present in the western portion of the Wildlife Refuge (shown here), there is abundant evidence of past occupation, including the small dam that impounds this pond.*

Photo 3-32. *The lodge associated with the dam that impounds the main pond in the Wildlife Refuge remained undiscovered until this year. The survey occurred after major flooding in November which broke the dam enough to lower water levels below one of the entrances to this lodge. It is therefore curious why the dam was not immediately repaired even though the colony in this very large lodge (only partially visible in this photo) was apparently active.*

Wedge Pond

Old channels, lodges, and beaver sign are abundant from Wedge Pond east to the shore of Green Lake (Photo 3-33). There has been an active lodge on the pond itself in the past three years, but it became inactive this year. It is very possible, even likely, that another active lodge was present but not detected in less accessible parts of this area.

***Photo 3-33**. The snowy hummock in the left foreground is one of many that indicate the long presence of beavers near Wedge Pond.*

High water during the survey highlighted the fact that a low but very long dam on the east side of the pond is responsible for forming Wedge Pond (Photo 3-34). Another new observation in 2021 was the presence of numerous inactive lodges and hummocks west of the pond that were almost certainly once beaver lodges. This beaver-created meadow is an example of ones described by Racey and McTaggart-Cowan (1935; Section 3.1).

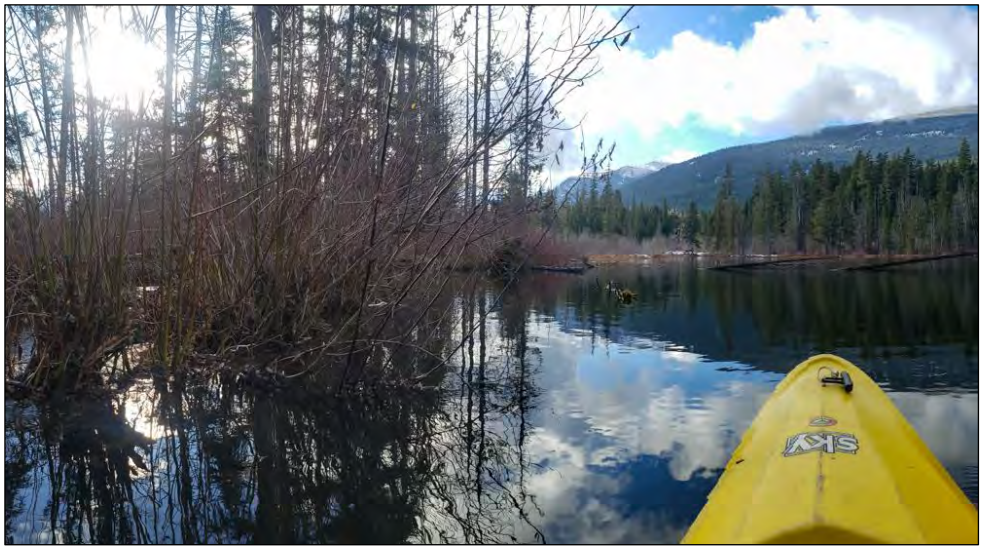


***Photo 3-34**. The long, low beaver dam barely visible on the left of this photo is responsible for maintaining the water level in Wedge Pond.*

3.3.5 Beaver Dam Surveys on the River of Golden Dreams (ROGD)

Reasons for a Survey of Beaver Dams

At the request of the RMOW in 2020, the first dam survey on the ROGD was conducted to determine their location, the potential impact of recreation on them (and vice-versa), and changes over time (Palmer and Snowline 2021). The ROGD is heavily used for summer commercial and non-commercial recreation and paddlers in and on various watercraft (canoes, kayaks, inflatable boats, and paddleboards) therefore need to negotiate the many beaver dams they encounter. Dams are frequently breached by paddlers as well as by RMOW staff concerned about the potential for flooding and/or the passage of spawning fish. The goal of the 2020 survey was to establish a baseline for future monitoring.

Not everyone sees beaver dams as impediments to be breached or removed. Wildlife ecologists and some land managers welcome beaver dams since they create habitat, reduce impacts of flooding, reverse erosion through the aggradation of sediments, and retain water through dry seasons (Runtz 2015; Goldfarb 2018). One less-known benefit of beaver dams is that they not only slow and impound the open water upstream of the dam; they also distribute and store water in the surrounding (wet)lands (Goldfarb 2018). This impact is almost certainly large and therefore important for flood and wildlife concerns within the ROGD wetlands and other areas in Whistler. It can also be very long-lasting since beaver dams can impound water for decades or potentially longer (Photo 3-35)

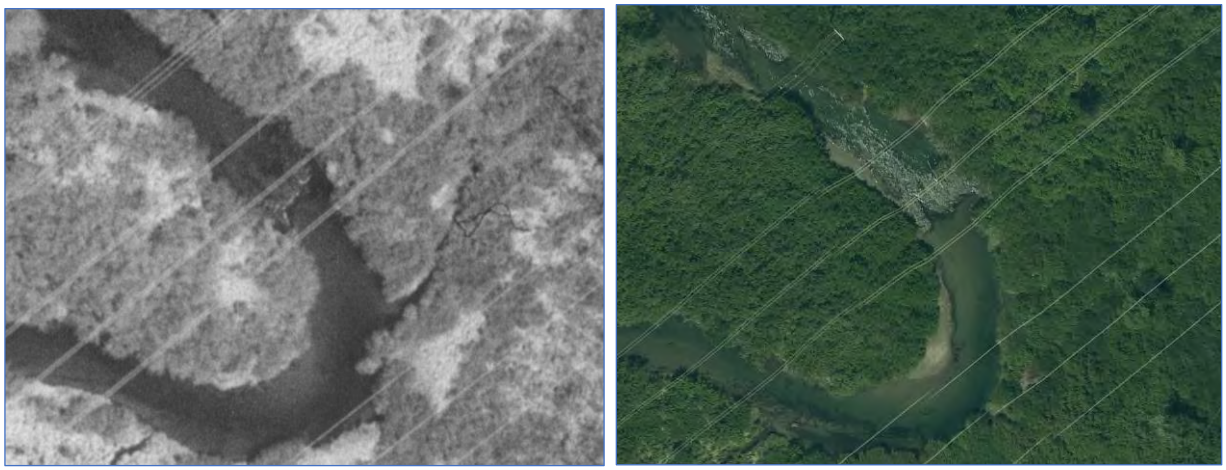


***Photo 3-35**. RMOW imagery of dam ROGD4-1 in 1995 (left) and 2018 (right).[15] The dam is near the middle of the photo, under the middle power line.*

Summary of 2020 Survey

Last year's survey was done by canoe on September 11, 2020 when a total of 12 dams were documented between Alta Lake and Green Lake (Table 3-7; Palmer and Snowline 2021). Most of the dams were in the middle sections (Sections 4 and 5;[16] Photo 3-36), especially the largest and most active ones, and were associated with the largest concentration of active lodges on the river (Figure 3-1).

[15] *https://webmap.whistler.ca/HTML5Viewer/Index.html?viewer=ExternalGIS. Accessed February 21, 2021*

[16] *Section 4 extends from the CN railway bridge to the meander that is closest to the Valley Trail. Section 5 extends from that point to the upstream side of the bridge over Highway 99.*

Table 3-7. Dams on the River of Golden Dreams, September 11, 2020 (Palmer and Snowline 2021)

Dam No.	Status	Impoundment Height (cm)			Dam Width (m)	Breach Width (m)
		Actual	**Without Breach**	**Maximum (Flood)**		
ROGD1-1	Active	15	15	25	8	1
ROGD4-1	Active	25	30	50	8	1
ROGD4-2	Active	25	30	35	9	1
ROGD4-3	Active	40	40	40+	7	none
ROGD4-4	Active	40	50	75	8	1
ROGD5-1	Active	40	50	60	8	2
ROGD5-2	Active	10	15	30	9	4
ROGD5-3	Active?	5	15	15	10	3
ROGD5-4	Inactive?	0	10	15	9	3
ROGD5-5	Active	30	40	60	11	2
ROGD6-1	Active	20	20	20	13	1
ROGD6-2	Inactive	0	0	0	10	5

2021 Survey Attempts

Two dam surveys were attempted in 2021 but, due to flooding, neither succeeded in documenting any functional dams. The first survey, on May 13th, 2021, was conducted to meet the RMOW's request for an early season baseline survey, that is, before the paddling season began. All 2020 dams in Table 3-7 were found, but none of them impounded any water (Photo 3-37). This was the result predicted by Keenan Moses who has operated canoe and kayak tours on the ROGD for many years.17 In his observations, beavers wait to rebuild dams until after the spring freshet since otherwise they get washed away. It also makes sense that beavers do not need dams when water levels are already high but rather only to maintain water levels later in the summer and early fall when flows in the ROGD are low.

A second dam survey was conducted on October 2nd as part of the lodge survey and it too did not find any significant impounding of water by beaver dams. The fall survey was delayed for several weeks due to unseasonal flooding which apparently washed away dam structures. Another even more severe flood occurred on November 15th when water levels submerged at least some of the smaller lodges (e.g., Photo 3-30). It will not be possible to determine until 2022 whether or how the 2021 flooding affected beavers on the ROGD, for example by direct displacement and/or lower winter survival.

17 Personal communication with Bob Brett.

Photo 3-36. (a) *Dam ROGD4-1 was impounding ca. 25 cm of water in September 2020 (Table3-7).* ***(b)*** *In early October, the dam was essentially non-existent at the same location. It was not impounding any water and there were only remnants of the branches that made up the former dam. This dam has been present at this location for at least 35 years, and probably much longer (Photo 3-35).*

4. Beaver-affected Wetlands

Lead Biologist and Author: Bob Brett

Key Takeaways:

1. From an ecological and habitat perspective, wetlands are not only very important but rarer than before human development. In Whistler, at least 72% of original wetland have been lost since development began.
2. Beavers play an irreplaceable role in the creation and maintenance of wetlands, which is why monitoring the area of these "beaver-affected wetlands" is a useful proxy for how well the RMOW is protecting habitat.
3. Two changes occurred to the total area of beaver-affected wetlands in 2021:
   iii. Field truthing added another 0.4 ha to the Rainbow Wetlands. This was pre-existing wetland hidden by tree cover and not a true gain.
   iv. There was some loss of wetland habitat due to the new Valley Trail in Function Junction. Estimated as a loss of approximately 0.1 ha, it is as yet unclear if there has or will be any significant, negative effect on beavers and their habitat.
4. With these updated numbers, approximately two-thirds (100.7 of 150.7 ha) of the RMOW's remaining wetlands in the Development Footprint have been created and/or maintained by beavers.

4.1 Updated Calculation of Total Area

As mentioned above (Section 3.1), a beaver's life is inextricably involved in creating its own habitat. Their incredible ability to alter and saturate landscapes is recognized in their description as "wetlands engineers." By creating and maintaining wetlands, beavers provide habitat for countless plants and animals, reduce erosion, and mitigate floods (Müller-Schwarze and Sun 2003; Goldfarb 2018). The first attempt to quantify this effect of beavers on Whistler's landscape was included in the first mapping of "beaver-affected wetlands" (Palmer and Snowline 2019), that is, the area of wetlands that have been created and/or directly affected by beavers within Whistler Valley.

The goal of the 2018 maps was to create a baseline calculation of how much area beavers have created in Whistler Valley, and to monitor that area over time. The 2018 report included a discussion of the challenges in producing accurate maps of beaver-affected wetlands, since the only way to confirm that area would be to remove beavers until their dams no longer impounded water. Nonetheless, it produced maps that yielded areal totals that could be monitored over time.

Since first calculated in 2018, there has been no major loss or gain of beaver-affected wetland. Two minor changes occurred in 2021:

1. The addition in 2021 of 0.5 ha of wetted areas that were found to extend into the forest adjacent to the Rainbow Wetlands. This addition has been added to calculations and maps.
2. The loss of approximately 0.1 ha (565m length x 2m width) due to construction of the Valley Trail beside the Millar Wetlands. This habitat loss has been added as an estimate to Table 4-1 but not to Figures 4-1 and 4-2.

With these changes, the area of beaver-affected wetlands is still just over 100 ha (Table 4-1; Figures 4-1 and 4-2). The River of Golden Dreams (ROGD) continues to account for almost half of all beaver-affected wetlands in Whistler (Table 4-2). The middle section of the ROGD (section 4 and 5, from the railway bridge to the bridge under Highway 99) accounts for the largest area and is also where most of the active beaver lodges on the ROGD have been found.

Table 4-1. Location and area of beaver-affected wetlands in Whistler, 2021.

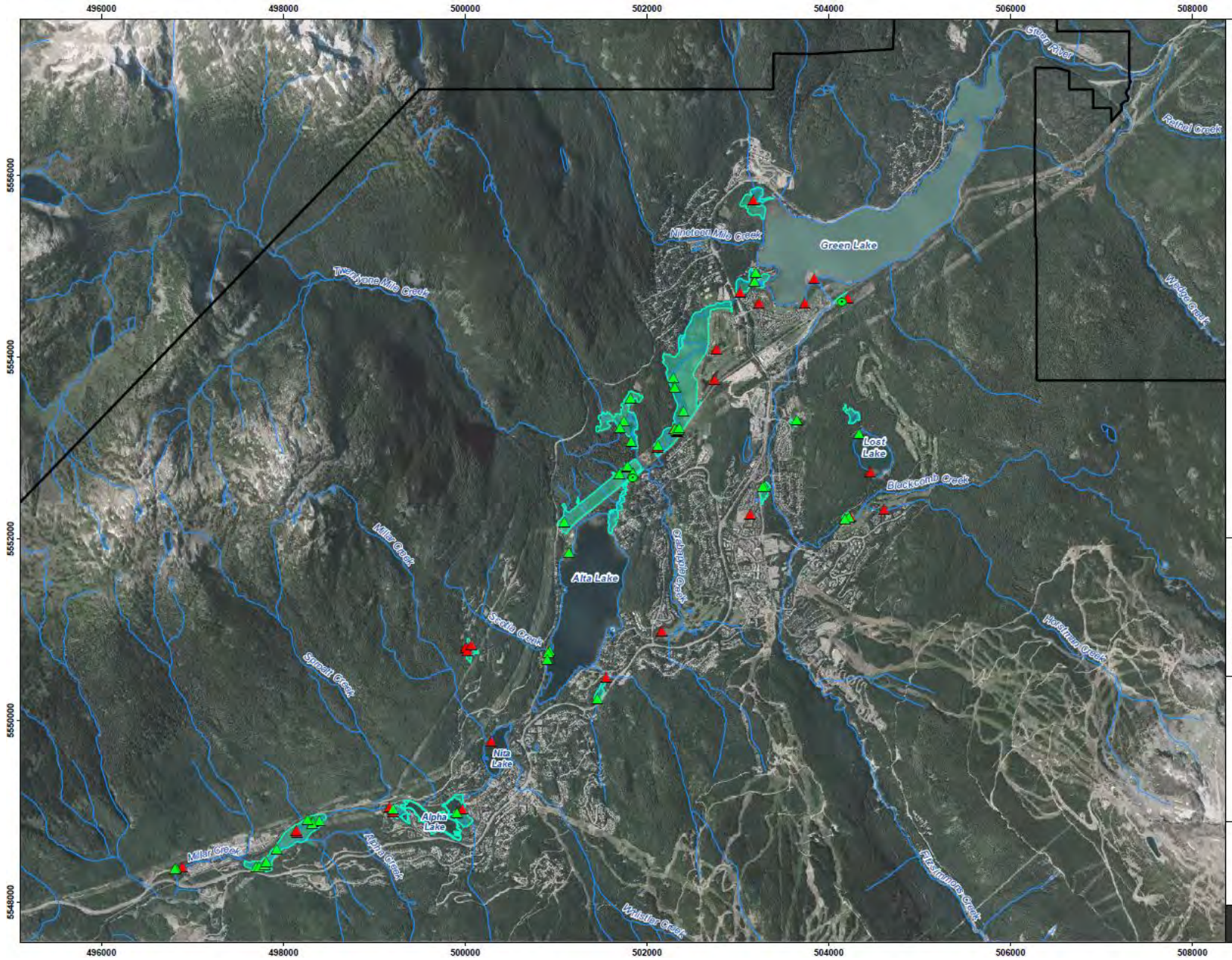
Wetland (South to North)	2020 Area (ha)	2021 Area (ha)	Change	2021 Area (%)	Notes (from text above)
Millar Creek Wetlands	13.3	13.2	0.1	13%	1
Beaver Lake	1.8	1.8		2%	
Alta Vista Pond	1.3	1.3		1%	
Rainbow Wetlands	14.7	15.2	0.5	15%	2
Fitzsimmons Wetlands	1.4	1.4		1%	
Chateau GC #18 Pond	0.7	0.7		1%	
Wildlife Refuge	10.4	10.4		10%	
Spruce Grove Wetland	0.3	0.3		0%	
Lost Lake - Sawmill Wetland	1.6	1.6		2%	
Buckhorn Pond	0.5	0.5		0%	
River of Golden Dreams	47.9	47.9		47%	
Fitzsimmons Creek Back Channels	0.9	0.9		1%	
Wedge Pond	5.5	5.5		5%	
Total beaver-affected wetlands	**100.3**	**100.7**	**0.6**	**100%**	
Alpha Lake (flood effect of dam)	7.1	7.1			3
Total beaver effect	**107.4**	**107.4**			

Table 4-2. Area of beaver-affected wetlands on the River of Golden Dreams (ROGD).

ROGD Survey Area	Area (ha)	Area (%)
ROGD-1 (Alta Lake to fish weir)	3.0	6%
ROGD-2 (fish weir to 21-Mile Creek)	0.1	0.2%
ROGD-4/5 (railway bridge to Hwy. 99)	40.4	84%
ROGD-6 (Hwy. 99 to Green Lake)	4.4	9%
Total	**47.9**	**100%**

Note: ROGD-3 is located between the junction with 21 Mile Creek and railway bridge; this section is not included because no beaver activities have yet been detected there.

Two of the next largest beaver-affected wetlands are the Rainbow Wetlands and the Wildlife Refuge (Table 3-9). Before the railway and subsequent developments, the ROGD wetland would have been directly connected to the Wildlife Refuge and Rainbow Wetlands in a complex spanning from Alta Lake to Green Lake, and which would have included what are now the Whistler and Nicklaus North Golf Courses (McBlane 2007). In addition, connections would have extended south through Alpha Lake to the Millar Creek Wetlands and no doubt provided much more beaver habitat than now. Descriptions of these and the other wetlands in Table 3-8 are included in the next section.



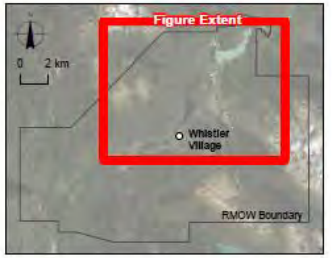
Legend

2021 Beaver Lodge Status

- Active Burrow
- Active Lodge
- Inactive Lodge

- Beaver Affected Wetland
- RMOW Boundary
- Watercourse

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



0 500 1,000 1,500
metres

N

DRAWN: B. Elder
CHECKED: B. Brett
PROJECT: 1602506
DATE: Dec 17, 2021

Scale 1:40000
UTM Zone 10N
NAD 1983

SNOWLINE Ecological Research
Palmer™

CLIENT: Resort Municipality of Whistler
PROJECT: Annual Monitoring 2021

Results of 2021 Census of Beaver Lodges and Beaver Affected Wetlands in Whistler

FIGURE 4-1

4.2 Historic Context

Among other impacts, there were four main changes that that significantly impacted beavers since the railway was built in 1913:

1. The railbed raised water flows in some areas and lowered them elsewhere.
2. The railway facilitated the development of Whistler which brought more people.
3. Beavers were mostly extirpated from the valley within a few years after the railway opened, presumably due to trapping for pelts (Racey and McTaggart-Cowan 1935); and,
4. The expanded development that began with the opening of Whistler Mountain in 1966 and significant loss of beaver habitat since (e.g., McBlane 2007).

The railway bisected the large wetland complex mentioned above[18] which changed the hydrology and reduced the connectivity of that area. As Whistler's population started to grow in the 1960s and 1970s, wetlands were increasingly replaced by subdivisions, golf courses and other urban developments. By 2003, at least 72% of the original area covered by wetlands was lost to development (McBlane 2007; Table 4-3; Figure 4-2). The loss of wetlands has definitely slowed since McBlane's (2007) calculations, though it is not possible with current data to provide exact figures. The RMOW's most recent mapping in 2014 showed that approximately 25% of the wetland area remained below 800 metres and within the Development Footprint[19] (Table 3-10).

Table 4-3. Wetland area in the RMOW by year and scope.

Year	Wetland Scope	Area (ha)	Compared to 1946	Source
1946	All RMOW	604.4	100%	McBlane 2007
2003	All RMOW	169.9	28%	McBlane 2007
2014	All RMOW	193.4	32%	Palmer and Snowline (unpublished data)
2014	All RMOW <800 m	169.7	28%	Palmer and Snowline (unpublished data)
2014	<800 m, study area only	150.7	25%	Palmer and Snowline (unpublished data)
2018	Beaver-affected, study area only	94.7	16%	Palmer and Snowline 2019
Current	Beaver-affected, study area only	100.7	17%	Palmer and Snowline 2021

Notes: The current study area is equivalent to the RMOW Development Footprint, from Function Junction to the north end of Green Lake. McBlane (2007) compared air photos taken in 1946 and 2003 within a similar but not exact scope. The 2014 data is based on the RMOW's most recent mapping of wetlands.

Based on map calculations of remaining wetlands (Table 4-1), beavers have created and/or maintain approximately two-thirds of all wetlands (100.7 of 150.7 ha) in Whistler's Development Footprint: as of 2021.

[18] *Rainbow Wetlands, Wildlife Refuge, and River of Golden Dreams, and Whistler Golf Course.*
[19] *Roughly from Function Junction north to Emerald Estates and mostly below 800 metres.*

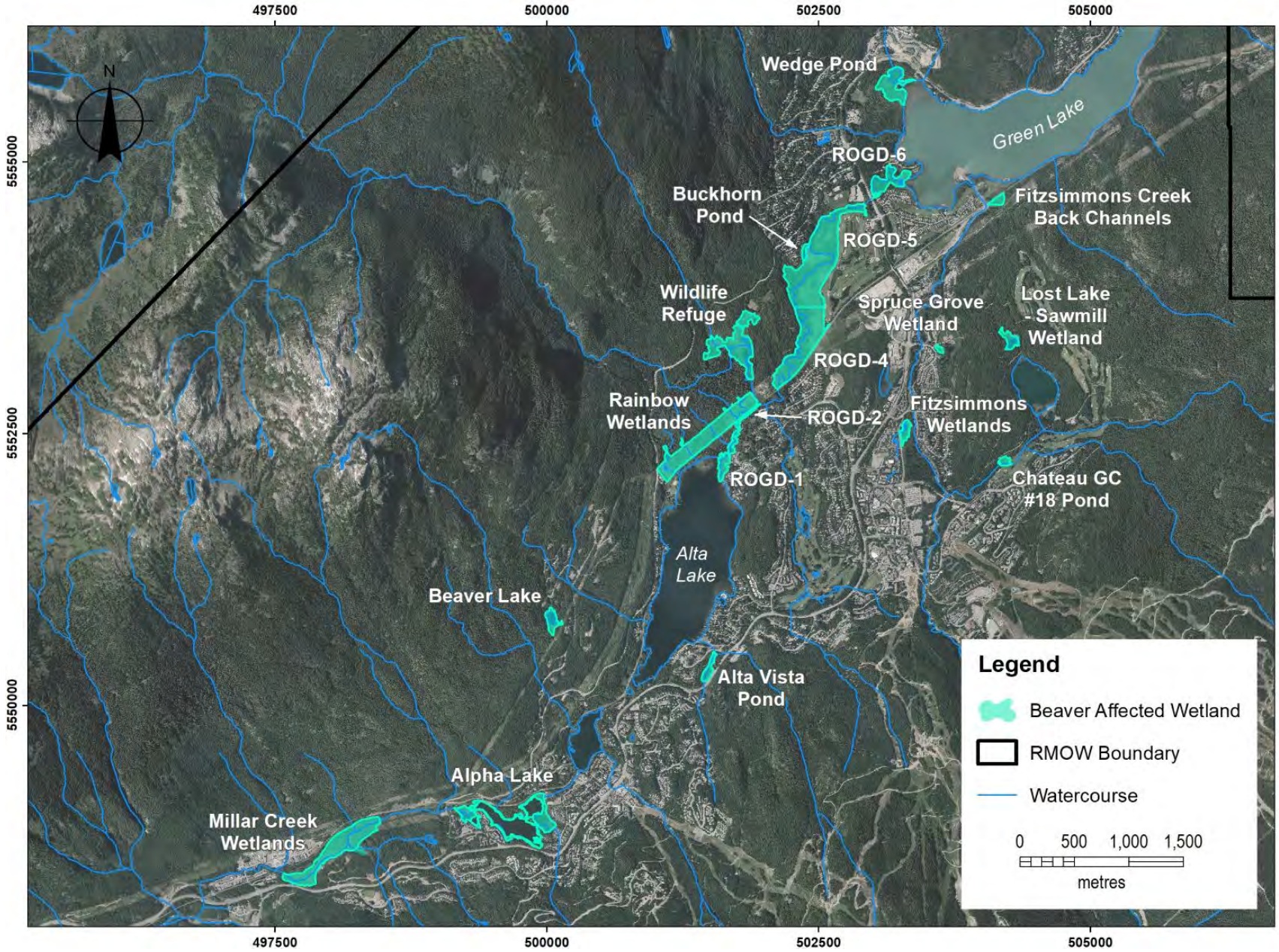


Figure 4-2. Wetlands in the Whistler development footprint (including ones not created by beaver activity).

5. Northern Goshawks

Lead Biologist and Author: Bob Brett

Key Takeaways:

1. At least two nests active in 2021 successfully produced fledglings in Whistler Valley.
2. One nest beside the one at Comfortably Numb was very close to detections in the only other survey years (conducted by other studies) in 2014, 2015, and 2019. Whether this represents the same breeding pair is not known, but it demonstrates the continued importance of this old forest habitat to Whistler's goshawk population.
3. The second active area near the Danimal Mid trail above Alpha Lake was likely also active last year (when surveys were not successful in locating a nest). A nest tree was not found, but records nearby are strong evidence of one: an adult sighting in July and photographs of two juveniles in September
4. Given the documented success of fledged juveniles since 2014, there is a strong possibility there are other, undocumented breeding pairs in Whistler Valley.
5. The relationship between old forests and Northern Goshawk habitat is well-established elsewhere. Their choice of nesting locations in Whistler follows this pattern.
6. The 2021 survey was remarkably successful given that two nests were detected (one confirmed and one probable). The presence of at least two successful breeding pairs very close to Whistler's Development Footprint is an encouraging sign and indicates that there is enough old forest habitat to support them. There is a good chance that future surveys will detect additional nests, especially as past fledglings reach breeding age.

5.1 Introduction

The population of BC's Northern Goshawks (*Accipiter gentilis*) has declined precipitously in recent years, at least partly due to the loss of old forest habitat (BC MFLNRO 2018). Two subspecies occur in British Columbia. Queen Charlotte Goshawk occurs in the Whistler area (*A. gentilis laingi*; MFLNRO and Madrone 2014, 2015; CDC 2021).[20] The other subspecies, *A. gentilis atricapillus*, occurs throughout the rest of BC and other parts of North America. Both subspecies of the Northern Goshawk are listed as species at risk. The *A.* laingi subspecies is Red-listed in BC (CDC 2021) and Threatened under the Canadian Species At Risk Act (Government of Canada 2020). The other subspecies of Northern Goshawk that occurs in BC, ssp. *atricapillus*, is Blue-listed in BC but considered Not At Risk by the Canadian Government (CDC 2021; Government of Canada 2021).

Surveys over the past decade have established that Whistler includes some of the most active breeding habitat for goshawks on BC's South Coast, presumably due to the availability of old forest habitat in this area (Brett 2020). Due to their rarity and affiliation with old forests, Northern Goshawks were therefore selected by the Working Group (Brett 2018) for inclusion within this program. Reports since have compiled and updated records available since 2001 (Palmer and Snowline 2019-2021).

[20] *See Brett (2020) for an update and discussion of the taxonomic and conservation status of Northern Goshawk.*

The first nest documented in the area (at least from available data) occurred in 2011 when a survey for the BC Government reported an active nest uphill and west of the current Whistler RV Park.[21] Surveys in advance of construction of an Independent Power Project (IPP) on Wedge Creek found active nests near Comfortably Numb Trail in 2014 and 2015 (MFLNRO and Madrone). Another active nest was recorded in 2016 and 2017 in a patch of old forest above Millar's Pond by this program (Palmer and Snowline 2017, 2018). In 2019, after several years without surveys in the area, evidence of an active nest was again found near the Comfortably Numb Trail (Brett 2020).

5.2 Methods

Call-playback is an established survey method that is meant to evoke a response from nearby birds. For surveys in the early nesting season, responses are elicited best with the playback of an adult alarm call. Goshawks nesting or planning to nest in that area will have a territorial response to that recording and ideally be detected by sound and/or sight. Detections are meanwhile maximized in the later nesting season by broadcasting juvenile begging calls meant to elicit a response from hungry juveniles begging for food (T. Willmott, pers. comm.).

Recordings of both adult alarm and juvenile begging calls via Erica McLaren were supplied by Brent Matsuda. Formal surveys generally followed established protocols (e.g., MFLNRO and Madrone 2014, 2015; Erica McClaren, undated), though were spaced more closely and to take advantage of terrain in contrast to the 400 m spacing applicable to areas in which goshawks are not already known to nest. The call was repeated six times at each station in all directions, and separated by 30 seconds. Signs including whitewash, plucking posts, and feathers were recorded. Stand conditions and notes about any wildlife were recorded at each station using a data form originally supplied by Trystan Willmott and modified for a 2019 project (Brett 2020). The key stand characteristics of interest were those related to habitat elements required for goshawk breeding and foraging and included the availability of nesting platforms, presence of flyways, and access to the forest floor (for hunting).

The timing of surveys was based on results from Brett (2020) which suggested dates earlier in July might elicit stronger and more reliable responses. This intention was confounded somewhat by abnormally warm temperatures which delayed surveys (since birds are unlikely to as responsive in extreme weather conditions). Opinions and results vary for which call, adult or juvenile, to play in late June and early July in more coastal locations. In general, juvenile calls were played though at some sites the adult call was also played due to lack of response.

The goal of the 2021 work plan was to survey the two most probable areas for nesting, based on recent activity. The Comfortably Numb area was the first priority that nests had been found in each of the three years it was surveyed since 2014. The second priority was an area near Lower Sproatt Trail, Danimal Mid Trail and 3 Birds Trail where local resident Bruce Worden report goshawk calls throughout the summer of 2020. Additional areas included: Millar Pond old growth (the site of the 2016-17 nest) and the Taluswood area (where goshawks have been seen fairly regularly over the past few years by Liz Barrett and other local birders).

[21] *BC Conservation Data Centre (CDC) Species Occurrence Report Shape ID 106601. This area was recorded as Brew Creek.*

5.3 Results and Discussion

5.3.1 Survey Sites

A total of 37 stations at six sites were surveyed in 2021 between July 4th and 25th (Figure 4-1; Appendix C):

- Comfortably Numb trail north from Jeff's Trail.
- Bring on the Weekend Trail to Comfortably Numb Trail.
- 3 Birds Trail area.
- Millar's Pond old-growth forest.
- Yo Mama Trail up to the Northwest Passage Trail near Taluswood.

5.3.2 Survey Results and Other Sightings

Active Nest near Comfortably Numb Trail

One active nest area was documented beside Comfortably Numb trail. near the 2019 record of a juvenile and a nest which was last active in 2014 (Brett 2020). One adult male (based on size) responded to a juvenile begging call and perched on a branch within 15m of the trail (Photo 5-1; Appendix D). One or possibly two unseen juveniles called repeatedly from the other side of the trail during the ca. 10 minutes the adult perched on this branch. In spite of these obvious signs, the exact nest location could not be located; however, the nest tree was almost certainly within 30m of the adult sighting on the downhill (west) side of the trail (Photo 5-2). This record is confirmation of a nest in an adjacent tree, even though the nest itself was not located. Biologist Trystan Willmott, who also worked on the 2019 goshawk survey (Brett 2020) visited the site the next week and also recorded goshawks without determining the exact nest tree.

Photo 5-1. *This adult goshawk responded to a juvenile begging call beside the Comfortably Numb trail.*

Photo 5-2. *The adult goshawk above was perched on the uphill side of Comfortably Numb Trail, just outside the right-hand edge of this photo and approximately 20 metres from the location of juvenile calls on the left side of the trail. The nest tree could not be confirmed but is almost certainly included in the trees on the left (west) side of the trail in this photo.*

Probable Nest near 3 Birds/Lower Danimal Trails

Additional activity was documented above Alpha Lake in the vicinity of Lower Sproatt, Danimal Mid, and 3 Birds trails, an area in which Bruce Worden regularly heard goshawk calls in 2020;(Appendix D). The broadcast of mostly juvenile begging calls on July 24, 2021 elicited a response from one adult that flew overhead.[22] In spite of additional calls and search effort, no nest was located despite a follow-up survey the next day.

While not part of the survey itself, the strongest evidence that there was a successful nest (that is, with fledged juveniles) in that area was the presence of two juveniles downhill of the survey sites on September 27, 2021 (Photo 5-3). The two birds likely fledged nearby since juveniles typically remain close to their natal nest for weeks or months after fledging (Wiens et al. 2006; COSEWIC 2013).

[22] *The bird was backlit by the sun when flying above the treetops fairly far away. While this is not a certain identification, it is consistent with all other evidence.*

***Photo 5-3**. This is one of two juvenile goshawks photographed and videoed by Bruce Worden on September 27, 2021 downhill of the Danimal Mid Trail (Bruce Worden photo).*

No Detections at Other Survey Sites

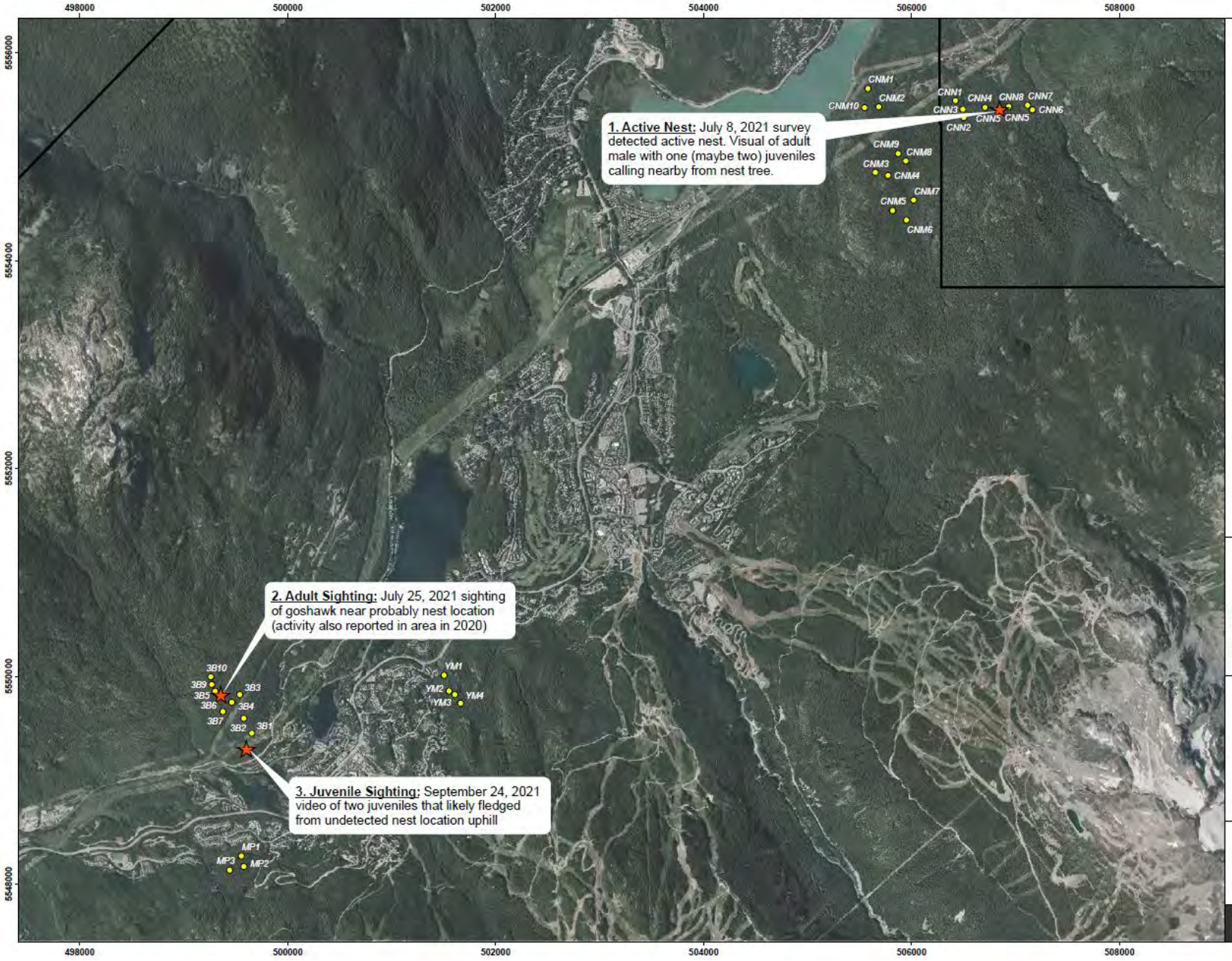
No other goshawks or signs were detected at Millar's Pond, Yo Mama Trail/Taluswood, or in the Bring on the Weekend/Comfortably Numb areas (Appendix D). It is important to note that lack of detections is not proof of lack of the presence of an active nest. That is, the timing of surveys or other contingencies may have prevented detection.

These nest records show that goshawks have maintained a presence in Whistler and typically have at least one active nest in the area each year. In addition, and even though additional nest records have not been found, there have been enough additional visual and auditory records ("sightings") in recent years to suggest more than one breeding pair may be active in at least some years. Records from 2021 again showed that goshawks were active in the area, though no breeding was found.

Other Sightings and Discussion

Goshawk records since 2001 now total 74, including the two 2021 nest sites described above and four sightings recorded in 2021 by Liz Barrett and/or contributions to eBird.org (Appendix E). The Taluswood area (centering on the Powderwood condo development) remains an area of intense interest given the relatively frequent sightings of goshawks in that area. Sightings since 2001 in the Callaghan Valley have also been fairly regular and may indicate nesting in that area, or foraging by goshawks nesting elsewhere.

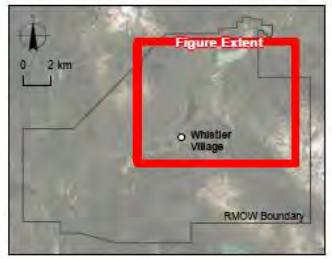
The 2021 survey was remarkably successful given that two nests were detected (one confirmed one probable). The presence of at least two successful breeding pairs very close to Whistler's Development Footprint is an encouraging sign and indicates that there is enough old forest habitat to support them. There is a good chance that future surveys will detect additional nests, especially as past fledglings reach breeding age.



Legend

- 2021 Detection
- 2021 Survey
- RMOW Boundary

Notes:
(1) Nest and sighting location source - www.eBird.org; MFLNRO and Madrone 2014, 2015, and B. Brett, unpubl. data
(2) Orthoimagery (2014) provided by RMOW.



0 0.5 1 1.5
kilometers

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DRAWN: B. Elder
CHECKED: B. Brett
PROJECT: 1602506
DATE: Dec 16, 2021

Scale 1:35000
UTM Zone 10N
NAD 1983

SNOWLINE Ecological Research
Palmer™

CLIENT: Resort Municipality of Whistler
PROJECT: Annual Monitoring 2021

Northern Goshawk Survey 2021

FIGURE 5-1

6. Notable (Local) Range Extensions

Lead Biologist and Author: Bob Brett

6.1 Introduction

During 2021, three incidental observations of note were recorded. Although not part of formal surveys, each expands our understanding of the habitat distribution of the three species included below and expands the known range of each.

6.2 Coastal Tailed Frog

Prior to 2020, the highest elevation any Coastal Tailed Frog (*Ascaphus truei*) tadpoles were found was in 20016, at 1180m on Horstman Creek where the water temperature was 7° C.[23] Based on that data, it was reasonable to conclude that this site was near the upper elevation limit for frogs since colder water with increasing elevation limited the development of their eggs (Section 3.1). This hypothesis was disproved when Christopher Stinson[24] by chance discovered a tailed frog tadpole during the 2020 Whistler BioBlitz in the stream running through Brandywine Creek (Photo 6-1).

Photo 6-1. *Brandywine Meadows is a hanging valley at approximately 1435 m elevation. There are numerous small creeks that flow down the east (warm aspect) slopes on the right of this photo. The 2020 tadpole was found in the main stem of the creek. The 2021 tadpole was found in one of the side creeks to the right (east).*

[23] *Whistler Biodiversity Project data submitted to the RMOW on July 17, 2011.*
[24] *Lead Curatorial Assistant of Mammals, Reptiles, and Amphibians and Cross Collections at the UBC Beaty Museum.*

The habitat in the cold, slow moving stream that drains the valley is unusual for tailed frogs (Section 3-1), so it was reasonable to assume the 2020 tadpole had washed downstream from one of the many small creeks that flow into the valley, especially from the east side where most of those creeks are located. The 2021 BioBlitz confirmed this expectation when Zeke Gilmore found a tadpole at the toe slope in one of those creeks. These two records mean that: (a) the elevational limit of Whistler's tailed frogs is higher than previously known; and (b) that either some subalpine creeks are warmer than expected, or that the temperature limit for egg development may not be as low as previously thought. Both are testable hypotheses, but probably outside the scope of this program.

6.3 Northern Red-legged Frog

The Whistler Biodiversity Project published the first documented record of Northern Red-legged Frogs (*Rana aurora*) in Whistler, from a 2005 observation near the north end of what is now Brandywine Falls Park. Subsequent research discovered that the BC Government had commissioned earlier amphibian surveys in that area as part of a compensation project related to the expansion of Highway 99 that led to the expansion of the park. These surveys also documented the presence of Red-legged Frogs, though that information was not published.

Those records represented a range extension for the species north from known locations near Black Tusk Village. As of 2005, it remained unknown if Red-legged Frogs occurred any further north, especially north of a potential barrier at the Callaghan River and at higher elevations towards Whistler Village. In 2007, Jory Mullen's Whistler Biodiversity Project[25] survey recorded the first Red-legged Frog north of the Callaghan River, at Hippy Lake (south of the Whistler Bungy Zone). Since then, a number of informal surveys (by Leslie Anthony, Liz Barrett, Bob Brett, Denis Knopp, Mike Toochin and other Whistler BioBlitz scientists) have established the that this species also occurs in the lower Callaghan Valley the north side of the highway, near the Whistler Transfer Station.[26] Confounding the situation is that Columbia Spotted Frog (Rana luteiventris) has also been confirmed in the Callaghan Valley and there is a unconfirmed possibility these two related species hybridize.

On April 26 2021, Liz Barrett confirmed the northernmost occurrence yet of Northern Red-legged Frog, at the south end of the Cal-Cheak campground (Photo 6-2). This record is not proof of breeding north of the Callaghan River, but additional evidence (with the Hippy Lake record) that it is likely. Future pond surveys will be needed in this area to confirm whether breeding does occur.

[25] *www.whistlerbiodiverstiy.ca*
[26] *www.whistlerbiodiverstiy.ca*

Photo 6-2. *This Red-legged Frog was found by Liz Barrett beside a very small creek just uphill of the confluence of the Cheakamus and Callaghan Rivers, and at the east end of the Cal-Cheak campground.*

6.4 Northern Alligator Lizard

Northern Alligator Lizards (*Elgaria coerulea*) are native to Whistler and typically found in the warmest valleybottom sites including railway tracks and rock outcrops.[27] While they are not rare in Whistler, they are relatively uncommon, presumably due to the lack of warm, open areas since they are much more common in Pemberton and similar habitats.

Before 2021, there were no records of alligator lizards far from the valley floor. It was therefore surprising to find one at 742 m on the Danimal South trail during tailed frog surveys on Sproatt Creek (Photo 6-3). That location was well uphill of the valleybottom and under a relatively forest cool forest canopy, albeit on a warm aspect slope. Little is known about local alligator lizards, especially the timing and location of breeding and birthing (this species bear live young). Based on available evidence, it is nonetheless possible to assume this was a female near where it birthed its young given: (a) its length[28] (b); timing within the known birthing window (St. John 2002; Matsuda et al. 2006); and (c) that it did not appear to be gravid.

[27] *www.whistlerbiodiverstiy.ca*

[28] *Based on photo estimates, it was ca. 24 cm long and had a snout-to-ventral length of ca. 12 cm, both at the high end of this species size range.*

Photo 6-3. *This Northern Alligator Lizard was found under the forest canopy on Lower Danimal Trail at 742m on September 7, 2021.*

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Appendix A: Tailed Frog Site and Capture Data

Valley Side	Site	Date	Easting	Northing	Elev. (m)	Slope (%)	Channel Width (m)	Wetted Width (m)	Flow (rel.)	Stream Disturb-ance	Mean Depth (cm)	Embedd-edness	Survey-ability	Subj. Habitat Rating
East	Archibald Creek - 1	2021-09-10	502387	5550606	695	17	4.0	4.2	Med	Med	10	High	Low	3
East	Archibald Creek - 2	2021-09-10	502854	5550298	835	18	2.7	1.5	High	Med	8	Med	Med	3
East	Archibald Creek - 3	2021-09-10	503310	5549422	1026	12	2.2	1.3	Med	Med	7	Low	High	3
East	Blackcomb Cr. @ Yummy Numby	2021-09-13	505211	5552576	762	15	8.4	4.2	Med	Low	12	Med	Med	5
East	Blackcomb Cr. - 942m via Dark Crystal	2021-09-13	505792	5552668	942	25	10.0	4.0	High	Low	15	Med	Med	4
West	Sproatt Creek - 1 (Danimal South)	2021-09-07	499063	5549434	692	25	6.6	4.1	Med	med	7	Low	High	5
West	Sproatt Creek - 2 (Don't Look Back)	2021-09-07	498996	5549662	790	32	7.8	2.4	Med	Med	9	Low	High	5
West	Sproatt Creek - 3 (Flank Trail)	2021-09-07	498483	5550455	996	24	5.0	1.7	Med	Med	11	Med	High	4
West	Van West - 1A (Function Junction)	2021-09-07	497611	5548635	604	4	7.0	1.4	Med	Med	5	Med	Med	2
West	Van West - 1B (Flank Trail)	2021-09-07	497563	5549038	706	18	5.1	1.2	Med	High	10	High	Low	2
West	Van West - 3 (Into the Mystic)	2021-09-07	497125	5549816	1036	25	4.2	1.0	Med	Low	9	Low	High	5
East	Whistler Creek - 1	2021-09-10	501041	5549045	692	14	6.2	5.2	Med	Low	8	Med	Med	4
East	Whistler Creek - 2	2021-09-10	501649	5547961	879	14	5.1	3.1	Med	Low	10	Low	High	5
East	Whistler Creek - 3	2021-09-10	501417	5548276	972	25	4.1	5.0	Med	Low	9	Low	Med	5

Valley Side	Site	Date	Survey-ors	Easting	Northing	Elev. (m)	Weather	Water Temp. (°C)	Air Temp. (°C)	T1	T2	T3	Total	Tad-poles /100m2	Meta+ Adults	Survey Area (m2)
East	Archibald Creek - 1	2021-09-10	BB; JK	502387	5550606	695	Sun	11.0	16.0	3	0	5	8	66.7	0	12.0
East	Archibald Creek - 2	2021-09-10	BB; JK	502854	5550298	835	Sun	10.0	13.0	1	0	1	2	13.8	0	14.5
East	Archibald Creek - 3	2021-09-10	BB; JK	503310	5549422	1026	Cloud	9.0	15.0	6	0	0	6	73.2	0	8.2
East	Blackcomb Cr. @ Yummy Numby	2021-09-13	BB; HW	505211	5552576	762	Cloud	7.0	9.0	0	0	0	0	0.0	0	10.8
East	Blackcomb Cr. - 942m via Dark Crystal	2021-09-13	BB	505792	5552668	942	Cloud	6.5	11.0	0	0	0	0	0.0	0	10.2
West	Sproatt Creek - 1 (Danimal South)	2021-09-07	BB; HW	499063	5549434	692	Sun	11.0	16.0	0	0	0	0	0.0	0	8.2
West	Sproatt Creek - 2 (Don't Look Back)	2021-09-07	BB; HW	498996	5549662	790	Sun	10.0	16.0	1	1	1	3	29.4	0	10.2
West	Sproatt Creek - 3 (Flank Trail)	2021-09-07	BB; HW	498483	5550455	996	Sun	11.0	15.5	2	7	1	10	122.0	1	8.2
West	Van West - 1A (Function Junction)	2021-09-07	BB; HW	497611	5548635	604	Sun	13.0	21.0	0	0	0	0	0.0	0	10.2
West	Van West - 1B (Flank Trail)	2021-09-07	BB; HW	497563	5549038	706	Sun	9.0	11.0	0	0	0	0	0.0	0	6.2
West	Van West - 3 (Into the Mystic)	2021-09-07	BB; HW	497125	5549816	1036	Sun	9.2	13.0	3	7	3	13	139.8	0	9.3
East	Whistler Creek - 1	2021-09-10	BB; JK	501041	5549045	692	Sun	11.0	16.0	11	0	0	11	98.2	0	11.2
East	Whistler Creek - 2	2021-09-10	BB; JK	501649	5547961	879	Cloud	10.0	13.0	5	0	0	5	46.3	0	10.8
East	Whistler Creek - 3	2021-09-10	BB; JK	501417	5548276	972	Cloud	10.0	12.0	5	0	0	5	44.6	0	11.2

Surveyors: BB (Bob Brett); HW (Hillary Williamson); JK (Jagoda Kozikowska)

Appendix B: Beaver Surveys, 2017 to 2021

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Location	Record	Easting	Northing	Date	Survey-or(s)	2021 Status	2020 Status	2019 Status	2018 Status
Alpha Lake, ~60m upstream of dam, south side bank	Lodge	499208	5548997	2021-11-21	BB	ND	Inactive	Inactive	Inactive
Alpha Lake, ~70m upstream of dam, south side bank	Lodge	499214	5548991	2021-11-21	BB	Inactive	Inactive	Inactive	Inactive
Alpha Lake, beside dam, ~8m inland on north side	Lodge	499172	5549048	2021-11-21	BB	Inactive	Active	Active	Active
Alpha Lake, islet bet. Woods Island and dog beach	Lodge	499913	5548986	2021-11-21	BB	Active?	NR	NR	NR
Alpha Lake, near dog beach	Lodge	499970	5549027	2021-11-21	BB	Inactive?	Active	Active	Active
Alpha Lake, northwest side of resident owned island	Lodge	499861	5548981	2021-11-21	BB	ND	Inactive	Inactive	Inactive
Alta Lake, ~55m south of Scotia Creek outlet	Lodge	500934	5550767	2021-11-16	BB	Active	NR	NR	NR
Alta Lake, ~80m south of Scotia Creek outlet	Lodge	500919	5550750	2021-11-13	BB	Active	NR	NR	NR
Alta Lake, 5m n. of northmost Chaplinville dock	Lodge	500906	5550670	2021-11-13	BB	Active?	NR	NR	NR
Alta Lake, inactive lodge ~25m south of Scotia Creek	Lodge	500954	5550790	2021-11-16	BB	Inactive?	NR	NR	NR
Alta Vista Pond, below middle dam east side	Lodge	501544	5550444	2021-11-23	BB	Inactive?	Inactive	NR	NR
Alta Vista Pond, main lodge	Lodge	501458	5550235	2021-11-23	BB	Active?	Active	Active	Active
Alta Vista Pond, near northeast end	Lodge	501552	5550477	2021-11-23	BB	Inactive	Inactive	NR	NR
Beaver Lake #1, westside north	Lodge	500012	5550828	2021-11-13	BB	Inactive	Inactive	Inactive	Inactive
Beaver Lake #2, westside middle	Lodge	500012	5550802	2021-11-13	BB	Inactive	Inactive	Inactive	Inactive
Beaver Lake #3, westside south	Lodge	500027	5550773	2021-11-13	BB	Inactive	Inactive	Inactive	Inactive
Beaver Lake #4; northeast side	Lodge	500072	5550831	2021-11-13	BB	Inactive	Inactive	Inactive	Inactive
Chateau GC #18 lower pond, slightly inland and east	Lodge	504184	5552221	2021-11-01	BB	Inactive	Inactive	Inactive	Inactive
Chateau GC #18 lower pond, westerly nearest water	Lodge	504181	5552219	2021-11-01	BB	Active?	Inactive	Inactive	Summer?
Chateau GC #18 main pond	Lodge	504228	5552240	2021-11-01	BB	Active	Active	NR	NR
Chateau GC #18 main pond	Lodge	504245	5552249	2021-11-01	BB	Inactive	Inactive	Inactive?	NR
Chateau GC #2 pond lodge	Lodge	504612	5552324	2021-10-30	BB	Inactive	Inactive	Inactive?	Inactive?
Fitz Creek Pond - Blackcomb Way/Nancy Greene Dr.	Lodge	503275	5552571	2021-10-03	KJ; BB	Active	Inactive?	Active	Active
Fitz Creek Pond - Blackcomb Way/Nancy Greene Dr.	Lodge	503300	5552575	2021-10-03	KJ; BB	Active	Inactive	Inactive	NR
Fitzsimmons Creek Fan, downstream right end	Lodge	503847	5554866	2021-10-03	KJ; BB	Inactive	Inactive	Inactive	Inactive
Fitzsimmons Creek, back channels near Old Mill Rd.	Burrow	504142?	5554607	2021-10-03	KJ; BB	Active	Active	NR	NR
Fitzsimmons Creek, back channels near Old Mill Rd.	Lodge	504212	5554643	2021-10-03	KJ; BB	Inactive	Inactive	Inactive?	Active
Green Lake Lodge e. of float plane base	Lodge	503740	5554600	2021-10-03	KJ; BB	Inactive	Inactive	Inactive	Inactive
Lost Lake - Old Mill Pond north end of pond	Lodge	504223	5553409	2021-11-21	BB	Inactive	NR	NR	NR
Lost Lake - Old Mill Pond north end of pond	Lodge	504232	5553421	2021-11-21	BB	Inactive	NR	NR	NR
Lost Lake south end of nature trail, near lake outlet	Lodge	504458	5552740	2021-11-21	BB	Inactive?	Active	Active	Active
Lost Lake, active lodge closest to north inlet	Lodge	504337	5553160	2021-11-21	BB	Active	NR	NR	NR
Lost Lake, inactive~ lodge ~5m SW of active lodge	Lodge	504333	5553154	2021-11-21	BB	Inactive?	NR	NR	NR

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Location	Record	Easting	Northing	Date	Survey-or(s)	2021 Status	2020 Status	2019 Status	2018 Status
Millar Creek, behind pkg area, upstream of dams	Lodge	496888	5548391	2021-11-23	BB	Inactive	Inactive	NR	NR
Millar Creek, west of FJ, south bend in river, large	Lodge	496821	5548379	2021-11-23	BB	Active	Active	NR	NR
Millar Creek, west of FJ, south bend in river, small	Lodge	496812	5548373	2021-11-23	BB	Active	Active?	NR	NR
Millar Wetlands -FJ (Valley Trail access)	Lodge	498270	5548912	2021-11-28	KJ	Active	NR	NR	NR
Millar Wetlands, 1st lodge from west seen from Hwy.	Lodge	497706	5548388	2021-11-23	BB	Active	Active	Active	Active
Millar Wetlands, 2nd lodge from lwest seen from Hwy.	Lodge	497737	5548390	2021-11-23	BB	Active	Active	NR	NR
Millar Wetlands, 3rd lodge from west, hidden from Hwy?	Lodge	497796	5548408	2021-11-28	KJ	Active?	Active	Active	Active
Millar Wetlands, middle, east of Bartle & Gibson bldg.	Lodge	497931	5548588	2021-11-28	KJ	Active?	Active	Inactive	NR
Millar Wetlands, n end, closest to Valley Trail	Lodge	498284	5548908	2021-11-28	KJ	Active	Active	Active	Inactive?
Millar Wetlands, n end, ESE of closest lodge	Lodge	498328	5548894	2021-11-28	KJ	Active	Active	Active	NR
Millar Wetlands, n end, farther east of closest lodge	Lodge	498398	5548903	2021-11-28	KJ	Active	Active	Active	NR
Millar Wetlands, n end, farthest from VT, s. hydro lines	Lodge	498321	5548863	2021-07-16	KJ	Active?	Active	Active	NR
Millar Wetlands, n end, farthest from VT, s. hydro lines	Lodge	498321	5548863	2021-11-28	KJ	Active?	Active	Active	NR
Millar Wetlands, n. of FJ, water access?	Lodge	498146	5548795	2021-11-28	KJ	Inactive	Inactive	Inactive	NR
Millar Wetlands, n. of FJ, water access?	Lodge	498156	5548764	2021-11-28	KJ	Inactive?	Active?	Active?	NR
Millar Wetlands, visible from pump track?	Lodge	497818	5548447	no survey	n/a	ND	Inactive	Active	Inactive
Nicklaus North GC, #10 pond	Lodge	502764	5554086	2021-10-31	BB	Inactive	Inactive	Inactive	Inactive
Nicklaus North GC, #12 pond	Lodge	502746	5553748	2021-10-31	BB	Inactive	Inactive	Inactive	Inactive
Nicklaus North GC, #15 pond	Lodge	503235	5554601	2021-10-31	BB	Inactive	Inactive	Inactive	Inactive
Nita Lake	Lodge	500290	5549772	2021-11-23	BB	Inactive	Inactive	Inactive	Inactive
Rainbow Park, west side upstream of Alta Lake	Lodge	501145	5551850	2021-10-31	BB	Active	Active?	Inactive	Inactive
Rainbow Wetlands - 2nd channel east of Rainbow Park	Lodge	501278	5552385	2021-10-23	KJ; BB	Inactive?	NR	NR	NR
Rainbow Wetlands - channel leading to fish weir pond	Lodge	501694	5552718	2021-10-23	KJ; BB	Active	NR	NR	NR
Rainbow Wetlands - channel leading to fish weir pond	Lodge	501702	5552711	2021-10-23	KJ; BB	Active	NR	NR	NR
Rainbow Wetlands, NE end near 21-Mile Creek	Lodge	501777	5552792	2021-10-23	KJ; BB	Active	Active	NR	NR
Rainbow Wetlands, NE end near 21-Mile Creek	Lodge	501790	5552801	2021-10-23	KJ; BB	Active	NR	NR	NR
Rainbow Wetlands, NE end near 21-Mile Creek	Lodge	501848	5552727	2021-10-23	KJ; BB	Active	Active?	Active	Active
Rainbow Wetlands, NE end near 21-Mile Creek	Lodge	501848	5552721	2021-10-23	KJ; BB	Active	NR	NR	NR
Rainbow Wetlands, westmost channel main pond	Lodge	501096	5552182	2021-11-01	BB	Active?	NR	NR	NR
ROGD1 - Alta Lake entrance to fish weir	Lodge	501744	5552517	2021-10-03	KJ; BB	Inactive	Inactive?	Active	Active
ROGD2 - downstream left from fish weir	Burrow	501840	5552670	2021-05-13	BB	Active	NR	NR	NR
ROGD2 - downstream left from fish weir	Burrow	501840	5552670	2021-05-16	KJ	Active	NR	NR	NR
ROGD2 - downstream left from fish weir	Burrow	501840	5552670	2021-10-03	KJ; BB	Possible	NR	NR	NR

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Location	Record	Easting	Northing	Date	Survey-or(s)	2021 Status	2020 Status	2019 Status	2018 Status
ROGD4 - RR bridge to bend nearest Valley Tr.	Lodge	502120	5553004	2021-10-03	KJ; BB	Inactive	Inactive	Inactive	Inactive
ROGD4 - RR bridge to bend nearest Valley Tr.	Lodge	502126	5553026	2021-10-03	KJ; BB	Active	Active?	Active	NR
ROGD4 - RR bridge to bend nearest Valley Tr.	Lodge	502302	5553215	2021-10-03	KJ; BB	Inactive	Inactive	Inactive	Inactive
ROGD4 - RR bridge to bend nearest Valley Tr.	Lodge	502312	5553214	2021-10-03	KJ; BB	Active	Active	Active	NR
ROGD4 - RR bridge to bend nearest Valley Tr.	Lodge	502327	5553188	2021-10-03	KJ; BB	Active	Active	Active	Active
ROGD4 - RR bridge to bend nearest Valley Tr.	Lodge	502334	5553183	2021-10-03	KJ; BB	Inactive	Inactive	Inactive	Inactive
ROGD4 - RR bridge to bend nearest Valley Tr.	Lodge	502349	5553202	2021-10-03	KJ; BB	Active	Active	Active	Active?
ROGD4 - RR bridge to bend nearest Valley Tr.	Lodge	502358	5553224	2021-10-03	KJ; BB	Active?	Inactive?	Inactive	Inactive
ROGD4 - RR bridge to bend nearest Valley Tr.	Lodge	502406	5553403	2021-10-03	KJ; BB	Active	Active	Active	NR
ROGD5 - bend nearest Valley Tr. to Hwy. 99 bridge	Lodge	502294	5553771	2021-10-03	KJ; BB	Active	Active	NR	NR
ROGD5 - bend nearest Valley Tr. to Hwy. 99 bridge	Lodge	502304	5553839	2021-10-03	KJ; BB	Inactive?	Inactive?	Inactive?	Inactive
ROGD5 - bend nearest Valley Tr. to Hwy. 99 bridge	Lodge	502308	5553673	2021-10-03	KJ; BB	Active	Active	Inactive?	Inactive
ROGD5 - bend nearest Valley Tr. to Hwy. 99 bridge	Lodge	502311	5553661	2021-10-03	KJ; BB	Active	Active	Inactive	Inactive
ROGD6 - Hwy. 99 bridge to Green Lake	Lodge	503029	5554719	2021-10-03	KJ; BB	Inactive	Inactive	NR	NR
ROGD6 - Hwy. 99 bridge to Green Lake	Lodge	503050	5554860	2021-10-03	KJ; BB	Inactive?	Inactive	Inactive	Inactive
ROGD6 - Hwy. 99 bridge to Green Lake	Lodge	503185	5554836	2021-10-03	KJ; BB	Inactive	Inactive	Inactive	Inactive
ROGD6 - Hwy. 99 bridge to Green Lake	Lodge	503187	5554830	2021-10-03	KJ; BB	Active	Active	Active	Inactive?
ROGD6 - Hwy. 99 bridge to Green Lake	Lodge	503202	5554930	2021-10-03	KJ; BB	Active?	Active?	Inactive?	Unknown
Spruce Grove Park, entrance	Lodge	503652	5553307	2021-10-03	KJ; BB	Active?	Active	Active	Active
Tennis Club Amenity Stream	Lodge	503139	5552271	2021-11-28	KJ	Inactive	Inactive	Inactive	Inactive
Wedge Pond, northwest edge of pond	Lodge	503166	5555813	2021-11-16	BB	Inactive	NR	NR	NR
Wedge Pond, west edge near small channel	Lodge	503176	5555733	2021-11-16	BB	inactive	Active	Active	Active
Wedge Pond, west of pond in hardhack meadow	Lodge	503121	5555719	2021-11-16	BB	inactive	NR	NR	NR
Whistler GC, #15 fairway, n. or green.	Lodge	502167	5550989	2021-10-30	BB	Inactive	Inactive	Inactive?	Inactive
Whistler GC, #15 fairway, s. of #16 outflow	Lodge	502346	5551092	2021-10-30	BB	Inactive	Inactive	Inactive	Inactive
Whistler GC, #15 fairway, s. of #16 outflow	Lodge	502356	5551107	2021-10-30	BB	Inactive	Inactive	Active?	Active
Whistler GC, #5 tee pond	Lodge	502367	5551766	2021-10-30	BB	Inactive	Inactive	Inactive	Inactive
Whistler GC, #7 pond	Lodge	502361	5552148	2021-10-30	BB	Inactive	Inactive?	Active	NR
Whistler GC, Crabapple Cr. #10 sand trap	Lodge	502293	5551708	2021-10-30	BB	Inactive	Inactive	Active?	Active
Whistler GC, Crabapple Cr. s. of #10 green	Lodge	502290	5551566	2021-10-30	BB	Inactive	Inactive	Inactive?	Active
Wildlife Refuge, main pond in west section of wetland	Lodge	501693	5553232	2021-10-23	KJ; BB	Inactive	NR	NR	NR
Wildlife Refuge, north end [note change in description]	Lodge	501825	5553543	2021-10-23	KJ; BB	Active	Active	Active	Active
Wildlife Refuge, southwest side of middle pond	Lodge	501709	5553226	2021-10-23	KJ; BB	Active	NR	NR	NR
Wildlife Refuge, w. side of south pond near main dam	Lodge	501830	5553068	2021-10-23	KJ; BB	Active	NR	NR	NR
Wildlife Refuge, west side of middle pond	Lodge	501750	5553298	2021-10-23	KJ; BB	Active	Active	NR	NR
Wolverine Creek	Lodge	501201	5549629	2021-11-13	BB	Inactive	Inactive	Inactive	Inactive

Appendix C: Northern Goshawk Site Data

Site	Station	Tree Species	Struct. Stage	Tree Ht. (m)	Avg. DBH (cm)	Canopy Closure (%)	Slope Position	Slope (%)	Nesting Platforms	Flyways	Understorey (<10m)	Habitat Rating
Taluswood	TA1	broadcast only										
Millar's Pond	MP1	FdHw(Cw,Ba)	7	>26	50	80	Mid	25	3	4	4	4
	MP2	FdHw(Cw,Ba)	7	>26	45	70	Upper	20	2	4	4	3
	MP3	Hw(Ba,Fd,Cw)	7	20-26	30	60	Crest	10	2	3	4	2
Comfortably Numb n. of Jeff's Tr.	CNN1	FdHw(Cw)	7	>26	60	65	Lower	0	3	4	4	3+
	CNN2	FdHw(Cw,Ba)	7	>26	60	65	Middle	15	3	3-	3-	3
	CNN3	FdHw(Cw)	7	>26	55	60	Upper	35	3	3-	3	3
	CNN4	HwFd(Cw)	7	>26	45	50	Upper	40	3-	3-	3	3-
	CNN5	HwFd(Cw,Ba)	7	>26	55	65	Upper	25	3-	4	4	3
	CNN6	Hw(Fd,Cw)	7	14-20	35	35	Upper	20	1	3	2	2
	CNN7	Hw(Fd,Ba,Pw)	7	14-20	35	35	Lower	5	2	3	2+	2
	CNN8	HwFd(Cw,Ba)	7	>26	55	60	Middle	25	3+	3+	3+	3+
	CNN5	HwFd(Cw,Ba)	7	>26	55	65	Upper	25	3-	4	4	3
Bring on the Weekend to Comf. Numb.	CNM1	FD(Pl,Cw,Hw,Pw)	7	<14	30	20	Upper	15	1	4	4	2-
	CNM2	Fd(Hw,Cw,Pl,Ba)	7	14-20	35	30	Middle	20	2	4	4	2+
	CNM3	HwFd(Cw,Ba)	7	20-26	45	50	Upper	35	2+	2+	3	3-
	CNM4	broadcast only										
	CNM5	HwBa(Cw,Fd)	7	20-26	45	55	Lower	10	2+	3	3	3-
	CNM6	HwBaFd(Cw,Yc)	7	20-26	50	60	Lower	5	3	2+	3-	3-
	CNM7	HwCwBa(Fd,Yc)	7	20-26	50	40	Lower	0	3	3	3	3
	CNM8	Hw(Fd,Pl,Cw,Pw)	7	14-20	30	25	Crest	0	1	2	2	2
	CNM9	Hw(Fd,Cw,Ba)	7	20-26	45	50	Upper	15	2+	2+	3	2+
	CNM10	FdPl	7	<14	35	20	Crest	0	1	4	4	2
Yo Mama (Nordic to NW Passage)	YM1	HwFd(Cw)	7	20-26	45	60	Upper	50	3	2	2	2+
	YM2	Hw(Fd,Cw)	7	14-20	45	40	Upper	45	2	2	2	2+
	YM3	Fd(Pl,Hw)	7	14-20	40	25	Crest	0-15	2	3	3	2
	YM4	BaHw(Fd)	5	14-20	35	80	Middle	25	1	1	2	1+
3 Birds/Danimal Middle trails	3B1	broadcast only										
	3B2	Fd(Pl,Cw,Hw)	7	14-20	40	50	Middle	25	2-	4	4	2
	3B3	Hw(Ba,Cw)	5	<14	25	30	Crest	0	1	2-	2	2-
	3B4	Hw(Fd,Cw,Ba)	7	14-20	40	60	Middle	20	2+	2+	3	2+
	3B5	Hw(Ba,Cw,Fd)	4	<14	30	50	Middle	25	1+	2-	2	2
	3B6	broadcast only										
	3B7	FdHw(Cw)	7	20-26	50	80	Middle	20	3	3	4	3
	3B8	broadcast only										
	3B9	FdHw(Cw)	7	20-26	40	80	Middle	30	3	3+	4	3
	3B10	FdHw(Cw)	7	14-20	40	60	Upper	20	2	2+	3	2+

Appendix D: Northern Goshawk Survey Call/Response

Site	Station	Date	Time	Surveyor	Easting	Northing	Broadcast	Response(s)
Taluswood	TA1	2021-07-04	09:30	B. Brett	501787	5548679	Adult	
Millar's Pond	MP1	2021-07-05	09:45	B. Brett	499558	5548271	Adult	
	MP2	2021-07-05	10:18	B. Brett	499583	5548169	Adult	
	MP3	2021-07-05	11:10	B. Brett	499447	5548135	Adult	
Comfortably Numb	CNN1	2021-07-08	10:10	B. Brett	506426	5555538	Juvenile	
n. of Jeff's Tr.	CNN2	2021-07-08	10:30	B. Brett	506508	5555376	Juvenile	DOSQ
	CNN3	2021-07-08	10:53	B. Brett	506499	5555455	Juvenile	
	CNN4	2021-07-08	11:11	B. Brett	506711	5555475	Juvenile	
	CNN5	2021-07-08	11:30	B. Brett	506853	5555458	Juvenile	1 male? Adult; 1(2?) juv.
	CNN6	2021-07-08	13:18	B. Brett	507167	5555451	Juvenile	
	CNN7	2021-07-08	13:41	B. Brett	507122	5555495	Juvenile	CAJA?
	CNN8	2021-07-08	14:23	B. Brett	506939	5555483	Juvenile	DOSQ, CAJA
	CNN5	2021-07-08	14:44	B. Brett	506853	5555458	Juv./Adult	CAJA?
Bring on the	CNM1	2021-07-09	09:10	B. Brett	505586	5555653	Juvenile	
Weekend to Comf.	CNM2	2021-07-09	09:28	B. Brett	505689	5555480	Juvenile	
Numb.	CNM3	2021-07-09	10:57	B. Brett	505656	5554848	Juvenile	
	CNM4	2021-07-09	11:12	B. Brett	505777	5554819	Adult	
	CNM5	2021-07-09	11:58	B. Brett	505822	5554481	Juvenile	
	CNM6	2021-07-09	12:19	B. Brett	505957	5554389	Juvenile	CAJA?
	CNM7	2021-07-09	12:35	B. Brett	506024	5554581	Juvenile	
	CNM8	2021-07-09	13:01	B. Brett	505949	5554958	Juvenile	
	CNM9	2021-07-09	13:20	B. Brett	505875	5555030	Juvenile	
	CNM10	2021-07-09	14:08	B. Brett	505552	5555471	Juvenile	
Yo Mama (Nordic to	YM1	2021-07-10	08:49	B. Brett	501507	5550008	Juvenile	
NW Passage)	YM2	2021-07-10	09:11	B. Brett	501557	5549859	Juvenile	
	YM3	2021-07-10	09:35	B. Brett	501613	5549822	Juvenile	
	YM4	2021-07-10	09:55	B. Brett	501668	5549739	Juvenile	
3 Birds/Danimal	3B1	2021-07-24	07:44	B. Brett	499658	5549452	Juvenile	
Middle trails	3B2	2021-07-24	08:02	B. Brett	499583	5549594	Juvenile	CORA, DOSQ
	3B3	2021-07-24	08:20	B. Brett	499544	5549823	Juvenile	NOGO?? CAJA, DOSQ
	3B4	2021-07-24	08:40	B. Brett	499465	5549750	Juvenile	NOGO? CAJA, DOSQ
	3B5	2021-07-24	09:01	B. Brett	499305	5549854	Juvenile	DOSQ
	3B6	2021-07-24	09:15	B. Brett	499354	5549794	Adult	
	3B7	2021-07-24	09:25	B. Brett	499379	5549659	Juvenile	
	3B8	2021-07-25	07:48	B. Brett	499363	5549827	Juv/Adult	NOGO; STJA, DOSQ
	3B9	2021-07-25	08:17	B. Brett	499275	5549919	Juv/Adult	
	3B10	2021-07-25	08:50	B. Brett	499266	5549994	Juv/Adult	

Appendix E: Northern Goshawk Records, 2001-2021

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Location	Date	No.	?	Easting	Northing	Record	Observer(s)	Affiliation
Blackcomb Alpine	2000-03-14	1		507070	5549311	Visual	B Max Götz	Personal
Valley Trail to Rainbow Beach	2001-03-03	1		501773	5552539	Visual	B Max Götz	Naturalists' bird count
Valley Trail to Rainbow Beach	2007-06-02	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Valley Trail to Rainbow Beach	2008-02-02	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Blackcomb Alpine	2009-02-14	1		507070	5549311	Visual	Peter Dunwiddie	Personal
Whistler Village and vicinity	2009-08-22	1		503156	5551541	Visual	Daniel Airola	Personal
Whistler Golf Club	2011-08-06	1		502208	5551354	Visual	Christopher Di Corrado	Whistler BioBlitz
Valley Trail to Rainbow Beach	2011-08-15	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Fitzsimmons Fan & Nicklaus North GC	2011-11-02	1		503656	5554556	Visual	Chris Dale	Personal
Valley Trail to Rainbow Beach	2011-11-05	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Valley Trail to Rainbow Beach	2012-02-13	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Valley Trail to Rainbow Beach	2012-05-05	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Valley Trail to Rainbow Beach	2013-03-02	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Valley Trail to Rainbow Beach	2013-03-14	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Valley Trail to Rainbow Beach	2013-05-04	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Comfortably Numb w. of Wedge Creek	2014-06-30	5		506935	5555480	Nest	Pablo Jost, Naomi Sands	BC MOE
Valley Trail to Rainbow Beach	2014-08-02	2		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Valley Trail to Rainbow Beach	2014-12-06	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Lost Lake and vicinity	2015-03-15	1		504636	5552716	Visual	Cole Gaerber	Personal
Tantalus Lodge	2015-04-14	1		502960	5550983	Visual	Catherine Meyer	eBird
Valley Trail to Rainbow Beach	2015-07-04	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Brew Creek	2015-07-24	1+		490637	5545029	Audible	T. Tripp, C. Churchland	MFLNRO & Madrone 201
Comfortably Numb @ Jeff's Trail	2015-07-24	1+		506387	5555458	Active Nest	T. Tripp, C. Churchland	MFLNRO and Madrone
Blackcomb Alpine	2016-03-12	1		507070	5549311	Visual	Nina Rach	Personal
Valley Trail to Rainbow Beach	2016-05-07	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Millar's Pond	2016-05-20	4		499601	5548228	Active Nest	Brent Matsuda	RMOW Eco. Mon. Prog.
Millar's Pond	2016-06-06	1		499601	5548228	Visual	Bob Brett	RMOW Eco. Mon. Prog.
Millar's Pond	2016-06-09	1		499601	5548228	Visual	Bob Brett	RMOW Eco. Mon. Prog.
Callaghan Valley Road	2016-06-10	1		490798	5549818	Visual	BBS Team	Breeding Bird Survey
Millar's Pond	2016-06-12	1		499601	5548228	Visual	Bob Brett	RMOW Eco. Mon. Prog.
Millar's Pond	2016-06-12	1		499601	5548228	Active Nest	B. Brett, G. Clulow & others	Breeding Bird Survey
Valley Trail to Rainbow Beach	2016-07-02	1		501773	5552539	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Musical Bumps Trail	2016-09-12	1		504873	5543244	Visual	Bob Brett	Personal
Millar's Pond	2016-09-20	1		499601	5548228	Visual	Bob Brett	RMOW Eco. Mon. Prog.
Millar's Pond	2016-09-20	1		499601	5548228	Visual	Bob Brett	RMOW Eco. Mon. Prog.
Whistler Village and vicinity	2016-11-30	1		503156	5551541	Visual	Daniel Tinoco	Personal
Millar's Pond	2017-06-03	5		499601	5548228	Active Nest	B. Matsuda & Mike Toochin	Whistler BioBlitz

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Location	Date	No.	?	Easting	Northing	Record	Observer(s)	Affiliation
5302 Alta Lake Rd.	2017-06-21	1		500162	5550088	Visual	C Palmer	Personal
Decker Trail	2017-07-31	1		508618	5546519	Visual	Dan Wilson	Personal
Millar's Pond	2017-08-17	0		499601	5548228	Visual	Bob Brett	RMOW Eco. Mon. Prog.
Bayshores, ~500m e of active nest	2017-10-09	1		500005	5543876	Visual	Dave McPeake	RMOW Eco. Mon. Prog.
Westside Road (unspecified)	2018-04-14	1		499982	5550268	Visual	Christa Vandeberg	Personal
Alta Lake Road n. of Wildlife Refuge	2018-05-01	1		501524	5553719	Visual	Bob Brett	RMOW Eco. Mon. Prog.
Lost Lake and vicinity	2018-06-09	1		504636	5552716	Visual	Mike Farnworth	Personal
Callaghan Valley Road	2018-06-15	1		490798	5549818	Visual	BBS Team	Breeding Bird Survey
Singing Pass Trail	2018-08-28	1		503836	5550171	Visual	Sharon Cormier-Aagaard	eBird
Kadenwood 2018 FireSmart site	2018-10-02	1	?	500291	5548095	Visual	Bob Brett	RMOW project
Kadenwood 2018 FireSmart site	2018-10-10	1	?	500386	5548095	Visual	Leo Coudrau	RMOW project
Near Emerald Forest south gravel pit	2019-01-05	1		501730	5552795	Visual	C. Dale, H. Baines & others	Naturalists' bird count
Lost Lake (beach area)	2019-04-25	1		504629	5552704	Visual (?)	Jagoda Kozikowska	RMOW
Chateau Golf Course, n. of hole #8	2019-05-25	1	?	504431	5553657	Visual (?)	Dan Nash	Personal
Whistler Olympic Park	2019-06-22	1		491761	5554069	Visual	Paul Maury	Personal
Baxter Creek, Rainbow Housing	2019-07-01	1		503086	5556357	Visual (?)	Scott Aitken	Personal
Kadenwood Drive	2019-07-01	1	?	500168	5548864	Visual (?)	Arthur De Jong	Personal
Lost Lake disc golf, hole 21	2019-07-14	1	?	503973	5553968	Visual (?)	Bob Brett	Personal
Comfortably Numb w. of Wedge Creek	2019-07-20	1 (2?)		506935	5555480	Auditory	Trystan Willmott, Bob Brett	AWARE
Sarajevo Drive, Creekside	2019-08-01	1		500615	5548650	Visual	Unknown (via W. Naturalists)	Personal
Kill Me Thrill Me vicinity	2019-08-06	1	?	506279	5557196	Visual (?)	Dan Raymond	WORCA
Powderwood condos, Whistler Road	2019-12-14	1		501356	5549526	Visual	Elizabeth Barrett	WNS Christmas Count
Base 2 (Glacier Lane), flying overhead	2020-03-21	1	?	503619	5550760	Visual	Bob Brett	Personal
Bud Light Trail, flying overhead	2020-03-20	1	?	505082	5552139	Visual	Kristina Swerhun	Personal
2118-2122 Nordic Drive	2020-04-26	1		501394	5549736	Visual	Victor A.	eBird
3 Birds/Bush Doctor vicinity, westside	2020-06-01	1		499466	5549887	Poss. Nest	Bruce Worden	Personal
Fitzsimmons Fan & Nicklaus North GC	2020-08-19	1		503656	5554556	Visual	Chris Dale	eBird
Fitzsimmons Fan & Nicklaus North GC	2020-08-30	1		503656	5554556	Visual	Liz Barrett	eBird
Powderwood condos, Whistler Road	2020-06-01	1		501356	5549526	Visual	Elizabeth Barrett	email
Valley Trail to Rainbow Beach	2020-08-30	1		503656	5554556	Visual	Liz Barrett	eBird
Millar's Pond	2020-05-05	0		499601	5548228	Visual	Bob Brett	RMOW Eco. Mon. Prog.
Millar's Pond, uphill	2020-05-05	1	?	499601	5548228	Visual (?)	Ella	Personal
Nordic & Creekside	2021-03-10	1		501356	5549526	Visual	Elizabeth Barrett?	Karl Ricker (WNS)
Powderwood condos, Whistler Road	2021-04-01	1		501356	5549526	Visual	Elizabeth Barrett	Personal
Alta Lake	2021-04-20	1		NR	NR	Visual	Whistler Naturalists	Karl Ricker (WNS)
Callaghan Valley Road	2021-04-25	1		NR	NR	Visual	Whistler Naturalists	Karl Ricker (WNS)
Comfortably Numb n. of Jeff's Tr.	2021-07-08	2+		506853	5555458	Active Nest	Bob Brett	RMOW project
3Birds/Danimal	2021-07-25	1	?	499363	5549827	Prob. Nest	Bob Brett	RMOW project
Lower Sproatt Trail	2021-09-24	2		499610	5549307	Photo/Video	Bruce Worden	Pers. comm. to B. Brett