Final Report

Amphibians in the Cheakamus River Watershed

BCRP Project Number: 10.W.CMS.01

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EXECUTIVE SUMMARY

The Cheakamus River watershed lies along the Sea to Sky highway between Squamish and Whistler. Three listed amphibian species occur in the area—Western Toad, Red-legged Frog, and Coastal Tailed Frog. The highway and rail line isolate amphibian populations on the east and west sides of the Sea to Sky corridor to some degree. As well, amphibians have been impacted by the construction of the BC Hydro Daisy Lake dam and reservoir. No wildlife studies had been conducted in the Cheakamus River watershed under the BCRP program before 2010. The main objectives of this project were to: 1) confirm whether amphibians breed in Daisy Lake; 2) conduct an inventory of amphibians and small wetland and stream habitats within a 1-km radius of Daisy Lake, and 3) identify potential wetland construction sites.

As many small wetlands and streams within a 1-km radius of Daisy Lake as possible were surveyed for amphibians following standard provincial techniques. At wetlands, surveyors visually searched for all life stages of amphibian. Stream surveyors held hand nets immediately downstream of overturned cobbles and pebbles to catch Coastal Tailed Frogs released into the current. All life stages of amphibian observed and the general habitat features of each wetland and stream were recorded. During the small wetland and stream surveys, potential wetland construction sites were also identified.

A total of 38 small wetlands were surveyed for lentic-breeding amphibians around Daisy Lake. Most wetlands occurred along the north and west side of Daisy Lake. Breeding was confirmed in 82% of the wetlands. No amphibians were observed in Daisy Lake. Red-legged Frogs and Western Toads were confirmed breeding in 10.5% (4) and 2.6% (1) of the wetlands surveyed respectively. The average distance between detected Red-legged Frog breeding sites was 2.4 km. Six streams were surveyed for Coastal Tailed Frogs on the east side of Daisy Lake and tadpoles were found in five. The relative abundance of tadpoles was low and the minimum distance between occupied streams was approximately 800 m.

Nine sites were surveyed for potential wetland construction sites each containing numerous areas where a wetland could be built for a total of 66 possible wetlands. The majority of sites assessed did not have access to ground water so liner wetlands would need to be built. One area that did contain ground water was being rehabilitated by the Cheakamus Community Forest (CCF). Discussions with the CCF about the site resulted in the construction of three small wetlands in fall 2010. A site along the south end of Daisy Lake also contained areas where future small wetlands could be built by tapping into ground water.

The distribution of breeding sites for listed amphibian species in the Daisy Lake area follows trends observed elsewhere—they were relatively rare compared to other native amphibian species. This likely reflects specific habitat needs for breeding, summer range, and/or overwintering. Daisy Lake does not appear to serve as breeding habitat for local amphibians. The large distance between occupied wetlands and streams for listed amphibian species puts local populations at risk of becoming extirpated if in-migration is affected by barriers to movement, such as the highway or large rivers. Improving shoreline habitat within Daisy Lake to create wetlands and breeding sites, and constructing small wetlands across the landscape that may serve as breeding sites or stepping stones will help maintain connectivity among local amphibian populations.

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1.0 INTRODUCTION

Southwestern British Columbia (BC) has a unique climate and terrain that have resulted in relatively high species diversity and endemism. However, these conditions have also made the area highly desirable for agriculture and urban development. As a result, natural areas are becoming increasingly isolated and fragmented (e.g., Ward et al. 1998). One group of organisms particularly vulnerable to habitat fragmentation and isolation is amphibians—population declines have occurred on a global scale, and amphibians have been identified as indicators of environmental health. Almost 70% of native amphibians in southwest BC are dependent on both aquatic and terrestrial environments to meet their annual life history needs and the ability to migrate between these habitats is critical. Many of these species utilize small, ephemeral wetlands for breeding, as they do not contain predators (e.g., fish). As well, the Coastal Tailed Frog (*Ascaphus truei*) is a unique, endemic species that breeds in small, cool, mountain streams. These small wetlands and streams act at stepping-stones within the landscape, maintaining genetic connectivity among populations. However, small wetlands and streams are difficult to identify from air photos and maps and they have no legal protection. As a result, large numbers have been impacted or lost as a result of development.

The Cheakamus River watershed is intersected by the Sea to Sky highway between Squamish and Whistler. The Sea to Sky corridor has received extensive media coverage over the past few years as a result of highway upgrades that took place in preparation for the 2010 winter Olympics. Three species of interest in the area are the Western Toad (*Bufo boreas*), Red-legged Frog (*Rana aurora*), and Coastal Tailed Frog—all are species of *Special Concern* federally, while the latter two are also Blue listed (Threatened) provincially. The highway and rail line have likely isolated amphibian populations on the east and west sides of the Sea to Sky corridor to some degree. Roads are a major issue for migrating amphibians, resulting in extensive annual mortality rates (Andrews et al. 2006). South of Whistler, amphibians have also been impacted by the construction of the BC Hydro Daisy Lake dam and reservoir. Areas that contain dams and reservoirs have the combined impacts of the loss of ephemeral wetlands and streams and the introduction of non-native species (e.g., stocked fish). At least 12 ha[1] of wetland habitat was lost when Daisy Lake was enlarged as a result of the Cheakamus Dam construction (Conlin et al. 2000), and fluctuating water levels reduce habitat suitability for amphibians within the reservoir itself. Daisy Lake lies at the northeast edge of the range for the Red-legged Frog, and breeding populations are relatively rare (Wind 2008). Coastal Tailed Frogs are closely associated with small creeks and rarely venture away from riparian habitats. The reservoir isolates populations on either side of the valley. No wildlife studies had been conducted in the Cheakamus River watershed under the BCRP program until 2010 (S. Allen, pers. comm.) so amphibian species occurrence and distributions were unknown for the area.

1.1 Objectives

Experts agree that one of the best ways of protecting native amphibian populations in the face of environmental stressors such as habitat loss, fragmentation, introduced species, and disease is through habitat protection, especially small, ephemeral wetlands and streams. The main objectives of this project were to:

[1] During initial impact assessments of Daisy Lake information on small wetlands would have been absent or grossly underestimated as recent studies have shown that at least 70% of small wetlands may be missed during air photo interpretation (Wind 2003), especially at the scale used during the Watershed Plan habitat assessment (i.e., 1:30,000 or 40,000 historic air photos).

- conduct an inventory within a 1-km radius of Daisy Lake to determine the distribution of small, ephemeral wetland and stream habitats and associated amphibian species
- determine whether amphibians breed in Daisy Lake, and
- identify potential wetland construction sites.

Although the primary focus of this project was amphibian populations, numerous other wetland- and stream-associated species benefit from the information gleaned from this work (e.g., shrews, bats, birds, invertebrates).

This project was directly aligned with Objective 4 of the BCRP Strategic Plan for the Cheakamus River watershed (Conlin et al. 2000; Volume 2, Chapter 13, Section 3.4): which addresses wildlife limiting factors 1 (Habitat Changes) and 2 (Loss of Habitat):

> *Objective 4: Improve the knowledge base on rare, endangered and threatened species and habitat utilization in the Cheakamus watershed.*

This project was also linked to program objectives by fostering partnerships and community outreach.

2.0 METHODS

2.1 Study Area

This project was located in the Cheakamus River watershed just south of Whistler, BC. Surveys for small, ephemeral wetlands and amphibians took place within a 1-km radius of Daisy Lake in order to map their distribution in relation to what is known about dispersal and genetic neighbourhoods for amphibians (e.g., Berven and Grudzien 1990; Fig. 1). A large proportion of the area around the lake is managed for timber harvesting by the Resort Municipality of Whistler (RMOW) / Cheakamus Community Forest (CCF) and the west side contains major linear transportation corridors (e.g., Sea to Sky highway, rail line, hydro right of ways). Brandywine Provincial Park borders the north edge of Daisy Lake.

2.2 Small Wetland and Stream Surveys

To meet the study objectives, as many small wetlands and streams within a 1-km radius of Daisy Lake as possible were surveyed for amphibians. Given the work that the Ministry of Environment has put towards amphibian and wetland studies in the Pinecrest area, surveys were not conducted in the area east of the decommissioned highway to Daisy Lake in order to allocate limited resources elsewhere. Wetlands and streams in the area were identified on maps, access determined, and then surveyed for amphibians in 2010—any incidental, unmapped small wetlands or streams encountered were also surveyed and the location recorded with a hand-held GPS. Wetland surveys followed standard provincial techniques (RISC 1998)—surveyors slowly walked the perimeter of each site visually searching for all life stages of amphibian within the water and along the shoreline. Stream surveys also followed standard techniques (RISC 2000)—surveyors held hand nets immediately downstream of overturned cobbles and pebbles to catch Coastal Tailed Frog tadpoles and adults released into the current. All life stages of amphibian observed and the general habitat features of each wetland and stream were recorded (e.g., canopy cover, percent cover of emergent vegetation, water temperature, etc.).

2.3 Identification of Wetland Construction Sites

During the small wetland and stream surveys, potential wetland construction sites were also identified. Ideal sites included those that were relatively level (less than 2% slope), had access for machinery, would not affect forest harvesting (e.g., would not require the removal of trees), and contained suitable soil conditions (e.g., at least 50 cm depth of non-rocky soil). Under the guidance of a wetland construction expert (e.g., Biebighauser 2007; Mr. Biebighauser has built over 1,000 wetlands during his career), numerous areas were surveyed as potential wetland construction sites and information was gathered regarding the construction technique to be used (e.g., groundwater versus liner wetland), materials needed, and approximate cost. All sites were recorded using a handheld GPS and a photo was taken. Additional information gathered for each site included identifying the land owner where possible and discussions with the RMOW / CCF about site plans.

3.0 RESULTS

3.1 Small Wetland and Amphibian Surveys

A total of 38 small wetlands were surveyed for lentic-breeding amphibians around Daisy Lake (Table 1, Fig. 1). The majority of small wetlands identified from maps and subsequently surveyed were clustered along the north and west end of Daisy Lake. Only two wetlands were surveyed along the east side of the lake (D3 and D33). Three wetlands were surveyed on an island within Daisy Lake and a number of small wetlands were found along the south shore.

Breeding was confirmed in 82% of the wetlands surveyed in 2010. No amphibians were observed in Daisy Lake itself. The most common species confirmed breeding in small wetlands was the Pacific Chorus Frog (58%), followed by the Long-toed Salamander (32%). Northwestern Salamanders were confirmed breeding at six (16%) wetlands. The maximum number of lentic-breeding species confirmed at any site was three—four wetlands had three confirmed breeding species. Most wetlands (47%) had only one confirmed lentic-breeding amphibian species.

Red-legged Frogs and Western Toads were confirmed breeding in 10.5% (4) and 2.6% (1) of wetlands surveyed respectively. Another Western Toad breeding site occurs southwest of Daisy Lake based on an observation of dispersing toadlets on a small side road in late August (see DLtoadlets Fig. 1). The exact location of this breeding site is unknown. The average distance between detected Red-legged Frog breeding sites was 2.4 km (including known breeding sites in the Pinecrest area). The distance between the confirmed Western Toad breeding site and the dispersing toadlets was 1.5 km.

3.2 Small Stream and Coastal Tailed Frog Surveys

A total of nine small streams were investigated with six of these surveyed for Coastal Tailed Frogs (Table 2, Fig. 1)—three streams were not surveyed because the flow in two was too low and one stream was too cold. Four of the six streams identified from maps and subsequently surveyed were on the east side of Daisy Lake—most streams on the west side of Daisy Lake were inaccessible or occurred outside of the 1-km radius study area. Tailed frog tadpoles were found in five of the six streams surveyed. An adult male was also found in one of the streams (DLMarbleTrib). The relative abundance of tadpoles in all streams surveyed was low—four streams had only one tadpole captured, while one had two tadpoles (DLBrew2). The minimum distance between occupied streams was approximately 800 m.

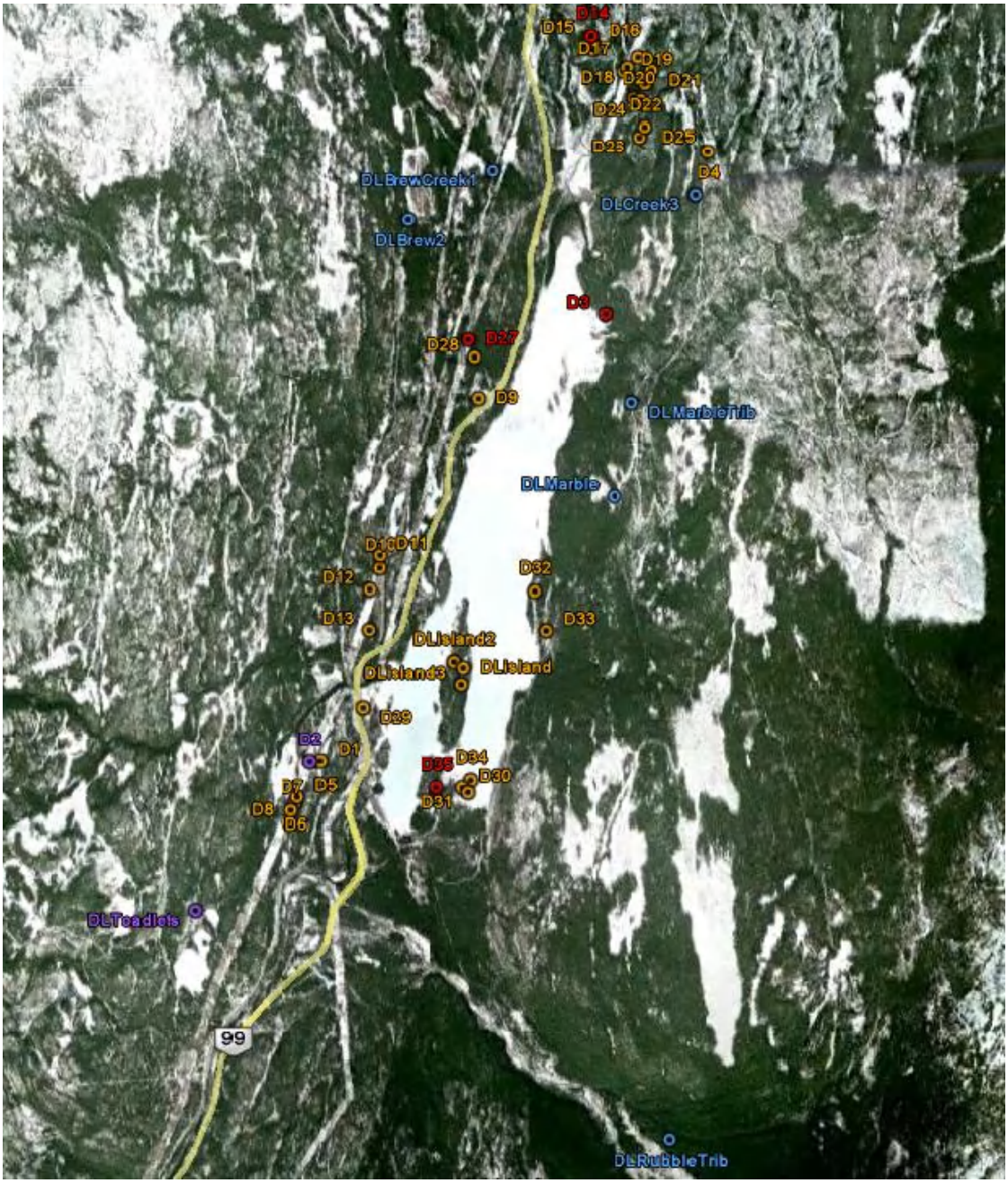
3.3 Potential Wetland Construction Sites

A total of 9 sites were surveyed for potential wetland construction areas. Each of the nine sites contained numerous areas where a wetland could be constructed for a total of 66 possible wetlands (Table 3, Fig. 2). The majority of sites assessed did not have access to ground water, so wetlands would need to be built using liners. In some cases the soil was too rocky or shallow so that even a liner wetland could not be built (e.g., within the new northern extension of Brandywine Provincial Park). One site that did contain an area with accessible ground water was WC6, a parking lot that was being rehabilitated by the CCF. Discussions with the CCF about the site resulted in the construction of three small wetlands in fall 2010. Site WC7 along the south end of Daisy Lake also contained areas where small wetlands could be built by tapping into ground water. Some of the sites assessed appeared to be private land, while others were crown or BC Hydro land (e.g., site WC7).

Table 1. Amphibian species (and life stages) observed at each small wetland surveyed in 2010 around Daisy Lake (see Fig. 1 for map locations of wetlands).

Wetland	*Ambystoma sp.*	Northwestern Salamander	Long-toed Salamander	Red-legged Frog	Western Toad	Pacific Chorus Frog	Unid. Frog	# Breeding Sp.
D1	E[a]							1
D2			L		T	T		3
D3				T		E, T		2
D4		E						1
D5						E, T		1
D6						E, T		1
D7						E, T		1
D8						E, T		1
D9		E	L			T		3
D10						E, T, A	A	1
D11						T		1
D12			L			T		2
D13						E, T		1
D14			E?	T		E?		2
D15						E, T		1
D16								0
D17			E			T		2
D18								0
D19			E			E, T		2
D20		E, N						1
D21								0
D22						T		1
D23						A		0
D24						E		1
D25			E?			E, T, A		1-2
D26		E						1
D27			L	T		T		3
D28								0
D29								0
D30			L			T		2
D31			L			T		2
D32		E						1
D33	L							1
D34						E, T		1
D35			L	T		T		3
DLisland		E						1
DLisland2			L	A		T		2
DLisland3								0
# wtlds with breeding	**2**	**6**	**12**	**4 (+ 1 A)**	**1**	**22 (+ 1 A)**	**1 (+ 1 A)**	**Total # wtlds surveyed = 38**
% wtlds with breeding	**5.26%**	**15.79%**	**31.58%**	**10.53%**	**2.63%**	**57.89%**	**2.63%**	

[a] E=egg, L=larva, T=tadpole, A= adult



a) Overview map showing all points

b) North end of Daisy Lake points

c) South end of Daisy Lake points

Figure 1. Location of small wetlands (orange) and streams (blue) surveyed within a 1-km radius around Daisy Lake in 2010. Red points indicate wetlands where Red-legged Frogs were found and purple where Western Toads were observed.

Table 2. Number and life stage (tadpole or adult) of Coastal Tailed Frogs found in streams surveyed around Daisy Lake in 2010 during a 30-person minute survey.

Stream	GPS/Map i.d.	# & life stage found	W. Temp. (°C)	Grad. (°)	Aspect	Clarity	Boulders	Cobbles	Pebbles	Sand / Fines	Rip.	Wet W (m)	Max W (m)	Aver D (cm)	Max D (cm)
Marble Crk	DLMarble	1T	12	9	NW	clear	10	40	40	10	OG buffer	3	6	10	25
Marble Crk trib.	DLMarbleTrib	1T +1A	10	8	NW	clear	15	50	20	15	OG buffer	3	4	10	40
Marble Crk trib.	DLCreek3	1T	12	4	W	clear	35	40	20	5	OG buffer	7	9	20	40
Rubble Crk trib.	DLRubbleTrib	1T	11	16	W	clear	60	30	10	Trace	OG	2	2.5	5	15
Brew Crk	DLBrewCreek 1	0	10	4	SSW	clear	Trace	45	40	15	Mixed mat.	4.5	5	5	15
Brew Crk	DLBrew2	2T	11	4	S	clear	Trace	70	25	5	OG buffer?	2	6	8	20
SSRC	SSRCcreek1	*not surveyed - trickle out of hillside*													
SSRC	SSRCcreek2	*searched briefly - too little water (< 0.25 m)*													
Brandywine Creek		*started search but water was too cold for tadpoles (5*C)*													

Table 3. Potential wetland construction sites investigated in 2010.

Site	Proposed Wetland I.D.	Area/Description	Wtld Type	Liner Size (feet)	Land Owner
WC1	**Parking lot**	**7-Jun-10**			Private
	WC 1-a	drainage ditch	Stream		
	WC 1b-1	access road (private?)	Liner Wetland	30 x 30	
	WC 1b-2		Liner Wetland	30 x 30	
	WC 1b-3		Liner Wetland	30 x 30	
	WC 1c-1	eph. stream with vertical cut	Head-cut		
	WC 1c-2		Liner Wetland	34 x 34	
	WC 1c-3		Liner Wetland	40 x 40	
	WC 1c-4		Liner Wetland	40 x 40	
	WC 1-d	borrow pit	Liner Wetland	40 x 40	
	WC 1-e	by propane tanks	Liner Wetland	40 x 40	Owned by Crown Provincial but has an assessed area which represents a provincial lease in the name of BC Hydro & Power Authority
	WC 1f-1	on fill pile	Liner Wetland	50 x 60	
	WC 1f-2		Liner Wetland	40 x 40	
	WC 1f-3		Liner Wetland	40 x 40	
	WC 1f-4		Liner Wetland	40 x 40	
	WC 1f-5		Liner Wetland	40 x 40	
	WC 1f-6		Liner Wetland	40 x 40	
	WC 1f-7		Liner Wetland	40 x 40	
	WC 1g	wtld by road - protect by putting in cross vein	Head-cut		
	TOTAL NUMBER OF WETLANDS = 18				
WC2	**Parking lot**	**7-Jun-10**			Private?
	WC 2a-1	on top of mound	Liner Wetland	30 x 30	
	WC 2a-2	on top of mound	Liner Wetland	20 x 20	
	WC 2a-3	along access road	Liner Wetland	26 x 30	
	WC 2a-4	along access road	Liner Wetland	26 x 30	
	WC 2a-5	along access road	Liner Wetland	26 x 30	
	WC 2b-1	in ROW	Liner Wetland	40 x 40	
	WC 2b-2	in ROW	Liner Wetland	50 x 60	
	WC 2b-3	in ROW	Liner Wetland	40 x 40	
	WC 2c	in ROW	Liner Wetland	40 x 40	
	WC 2d-1	in upper parking lot	Liner Wetland	40 x 40	
	WC 2d-2	in upper parking lot	Liner Wetland	40 x 40	
	WC 2d-3	in upper parking lot	Liner Wetland	40 x 40	
	WC 2d-4	in upper parking lot	Liner Wetland	40 x 40	
	WC 2d-5	in upper parking lot	Liner Wetland	40 x 40	
	WC 2d-6	in upper parking lot	Liner Wetland	40 x 40	
	WC 2e-1	in lower parking lot	Liner Wetland	40 x 40	
	WC 2e-2	in lower parking lot	Liner Wetland	40 x 40	
	WC 2e-3	in lower parking lot	Liner Wetland	40 x 40	
	WC 2e-4	in lower parking lot	Liner Wetland	40 x 40	
	WC 2e-5	in lower parking lot	Liner Wetland	40 x 40	
	WC 2e-6	in lower parking lot	Liner Wetland	40 x 40	
	TOTAL NUMBER OF WETLANDS = 21				
WC3	**Small borro**	**7-Jun-10**			Private?
	WC 3	smal borrow pit	Liner Wetland	40 x 40	
	TOTAL NUMBER OF WETLANDS = 1				
WC4	**Waste area**	**7-Jun-10**			Private?
	WC 4a	Waste area	Liner Wetland	40 x 40	
	WC 4b	Waste area	Liner Wetland	40 x 40	
	WC 4c	Waste area	Liner Wetland	40 x 40	
	WC 4d	Waste area	Liner Wetland	30 x 34	
	TOTAL NUMBER OF WETLANDS = 4				

Site	Proposed Wetland I.D.	Area/Description	Wtld Type	Liner Size (feet)	Land Owner
WC5	**Gravel Pit**	**7-Jun-10**			Private?
	WC 5	Gravel Pit	Liner Wetland	34 x 34	
	TOTAL NUMBER OF WETLANDS = 1				
WC6	**Parking Lot**	**8-Jun-10**			Comm Forest
	WC 6a-1	riparian wetlands	Grdwater Wetland		
	WC 6a-2	riparian wetlands	Grdwater Wetland		
	WC 6a-3	riparian wetlands	Grdwater Wetland		
	WC 6b	in canopy gap at n end of P.L.	Liner Wetland	40 x 40	
	WC 6c	in east edge of forest	Liner Wetland	40 x 40	
	WC 6d	on mound	Grdwater Wetland		
	WC 6e	***grd water wtld****	Grdwater Wetland		
	WC 6f	***grd water wtld****	Grdwater Wetland		
	WC 6g	***grd water wtld****	Grdwater Wetland		
	WC 6h	grd water wtld	Grdwater Wetland		
	****CONSTRUCTED IN FALL 2010 BY CCF***				
	TOTAL NUMBER OF WETLANDS = 10 (remaining = 7) - site has been rehabbed				
WC7	**Daisy Lake**	**8-Jun-10**			BC Hydro
	WC 7-1	grd water wtld at back end of Daisy Lake	Grdwater Wetland		
	WC 7-2	grd water wtld at back end of Daisy Lake	Grdwater Wetland		
	WC 7-3	grd water wtld at back end of Daisy Lake	Grdwater Wetland		
	WC 7-4	grd water wtld at back end of Daisy Lake	Grdwater Wetland		
	WC 7a	small vernal pool area by P.L.	Liner Wetland	40 x 40	
	WC 7b	small opening at forest edge	Liner Wetland	40 x 40	
	WC 7c	large grd water wtld	Grdwater Wetland		
	TOTAL NUMBER OF WETLANDS = 7				
WC8	**Comm Forest/Olympic Parking Lot**				Comm Forest?
	WC8a	gully with grd water	Grdwater Wetland		
	TOTAL NUMBER OF WETLANDS = 1 or 2 (site has been rehabbed)				
WC9	**Decommiss**	**7-Jun-10**			MoT?
	WC	on old hwy	Liner Wetland	40 x 40	
	WC	on old hwy	Liner Wetland	40 x 40	
	WC	on old hwy	Liner Wetland	40 x 40	
	TOTAL NUMBER OF WETLANDS = 3				

a) North of Daisy Lake b) South end of Daisy Lake

Figure 2. Location of potential wetland construction sites investigated in 2010.

4.0 DISCUSSION

4.1 Wetland Surveys

Five amphibian species were confirmed breeding in wetlands around Daisy Lake in 2010, with most wetlands being utilized by at least one species for breeding. Two listed lentic-breeding amphibian species were detected breeding in wetlands around the lake—Red-legged Frogs were observed at four wetlands and Western Toads at one. Breeding sites for these species are less common on the landscape on the coast relative to other native amphibian species (e.g., Pacific Chorus Frog; Wind, pers. obs.). The reason for this is unclear, but likely reflects specific habitat needs for breeding, summer range, and/or overwintering.

No amphibians were observed in Daisy Lake, likely due to fluctuating water levels, continual inflows of cold water from adjacent streams (e.g., glacier fed), and the presence of fish. One of the Red-legged Frog breeding sites found was immediately adjacent to Daisy Lake (i.e., D3 Fig. 1). It is unclear whether this wetland is attached to Daisy Lake when the lake is at full capacity (e.g., D3 becomes inundated), exposing tadpoles to fish or potentially flushing tadpoles out into the lake. The latter would likely lead to a low to nil survival rate of tadpoles as amphibians are susceptible to fish predation (Wind 2008). Interestingly, the April 9, 2009 Google Earth image for the wetland shows it as being ice/snow free and fully inundated with water—at the time of survey on May 21, 2010 it contained only pockets of water. The ice/snow free status suggests

that this wetland may be slightly warmer in spring relative to other wetlands in the area which allows for earlier egg laying—a feature critical for Red-Legged Frogs due to the slow development of their tadpoles relative to other amphibian species whose larva metamorphose the first summer after egg laying. The other three wetlands where Red-legged Frog tadpoles were observed did not appear to be ice/snow free on the Google Earth image (D14, D27, D35).

The occupancy rate of lentic-breeding amphibians in the Daisy Lake area is likely higher than observed in 2010 due to factors that affect detection rates. Only one visual survey was conducted at each wetland. As such, some species or life stages were likely not detected, especially if survey conditions were not ideal at the time of the survey (e.g., overcast). For example, the spring survey of D33 resulted in no amphibian detections (e.g., egg masses). However, during a return visit to the area in summer for tailed frog surveys salamander small larva were observed at this pond. Habitat may affect detectability as well—the denser the shoreline or in-pond vegetation, the larger the wetland, or the more difficult shoreline access or movement is due to steep terrain, deep water, or a soft muck substrate the less likely amphibians or life stages will be detected.

4.2 Stream Surveys

There was a large distance between occupied Coastal Tailed Frog streams and tadpoles were detected in low densities. For example, surveys for tailed frogs in the Whistler area immediately north of Daisy Lake detected on average a five- to six-fold higher density of tadpoles. From 38 reaches an average of 6 tadpoles were detected per survey in streams where tadpoles were found (median = 5; Whistler Biodiversity Project, unpublished data). In addition to low densities, the two west side Brew Creek streams surveyed were separated from east side streams by Brandywine Creek, a large, cold, and fast river, and by Daisy Lake. Generally, within the 1-km radius of Daisy Lake the terrain is steeper on the east versus west side of the lake—the terrain west of the lake gets steeper further from the lake.

4.3 Wetland Construction

Ideal wetland construction sites are both cost effective and occur on land that can be protected from disturbance over the long term (e.g., development). Some of the sites assessed on the ground in 2010 appear to be privately owned and identifying or contacting the land owner could be difficult. Site conditions that require the use of a liner for wetland construction limits the size of the wetland that can be built due to logistical and cost constraints. Site WC7 is desirable site for wetland construction for 2011 as it is closest to the land impacted by the Daisy Lake inundation and BC Hydro presumably has control over any future development in the area.

One of the best sites identified in 2010 for wetland construction was site WC6, a parking lot constructed for the 2010 Olympics. It was highly disturbed (e.g., wetland and forest habitat were lost), the RMOW / CCF had funding to rehabilitate the area, Red-legged Frogs had been confirmed to occur in the area, and it contained groundwater. Communications with the RMOW / CCF determined that the funds for rehabilitation needed to be spent in 2010 so the information we had gleaned about the site regarding wetland construction (e.g., location, design, materials) was shared with the contractor and three small wetlands were built on the site in September. The goal of the CCF is harvesting timber in a sustainable way while protecting biodiversity. Ideally, the partnership established in 2010 will lead to future wetland construction projects in the area.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Amphibians in the Daisy Lake area are confronted with habitat loss due to reservoir inundation and extensive transportation and hydro transmission line corridors. These disturbances fragment the habitat and lead to direct mortality (e.g., road kill). In addition, reservoirs serve as poor breeding habitat for amphibians due to fluctuating water levels, lack of aquatic vegetation, and the presence of fish (e.g., stocking). Effective management and conservation of local amphibian populations requires an understanding of their current distribution.

The amphibian work around Daisy Lake in 2010 was the first wildlife survey conducted in this area under BC Hydro's BCRP. A total of 38 small wetlands were surveyed for amphibians and their location recorded and mapped. Listed species were confirmed breeding in only five of these wetlands. In addition to occurring at a low percentage of sites, it was determined from the surveys that these breeding sites are scattered and distant from one another. Coastal Tailed Frogs were found in most streams surveyed in 2010, but few streams occurred in the area, they were distant from one another, and the density of tadpoles per stream was relatively low compared to areas north and south of Daisy Lake. Now that amphibian breeding sites have been identified, work can be done to ensure their protection from future development.

In addition to protecting existing breeding sites, small wetlands can be constructed to compensate for some of the wetland habitat that was lost as a result of reservoir creation. Numerous sites were identified around Daisy Lake in 2010 where small wetlands could be constructed.

Recommendations:

- Due to the extensive nature of habitat loss and disturbance around Daisy Lake, which may have contributed to the scattered and low abundance of listed amphibian species in the area, it is recommended that BC Hydro support the construction of small wetlands around the lake.
- Work with researchers to determine ways of enhancing Daisy Lake for amphibian populations (e.g., create gentler banks and ledges that may support aquatic vegetation, assess fish stocking programs, construct wetlands along shoreline areas).

6.0 REFERENCES

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APPENDIX A. BUDGET SUMMARY

	BUDGET		ACTUAL	
	BCRP	**Other**	**BCRP**	**Other**
INCOME				
Total Income by Source	$19945.00	$900.00	$18550.57	$798.00
Grand Total Income (BCRP + other)	***$20,845.00***		***$19,348.57***	
EXPENSES	**Note: Expenses must be entered as negative numbers (e.g. – 1000, etc.) in order for the formulas to calculate correctly.**			
Project Personnel				
Wages	-$12450.00	-$900.00	-$12366.10	-$448.00
Consultant Fees				
(List others as required)				
Materials & Equipment				
Equipment Rental	-$600.00		-$515.00	
Materials Purchased			-$83.59	
Travel Expenses	-$6895.00		-$5475.88	-$350.00
Permits				
(List others as required)				
Administration				
Office Supplies				
Photocopies & printing				
Postage				
(List others as required)				
Total Expenses	***-$19,945.00***	***-$900.00***	***-$18,550.57***	***-$798.00***
Grand Total Expenses (BCRP + other)	***-$20,845.00***		***-$19,348.57***	
BALANCE (Grand Total Income – Grand Total Expenses)	The budget balance should equal $0 ***$0***		*The actual balance might not equal $0** ***$0***	

APPENDIX B: PERFORMANCE MEASURES

A copy of the final report for the ***Amphibians in the Cheakamus Watershed*** project were provided to BC Hydro, the Lil'wat and Squamish FN Bands, the Ministry of Environment, the RMOW / CCF, Whistler Biodiversity Project, Squamish River Watershed Society, and the Sea to Sky Retreat Centre.

Results will be communicated to the public in the Squamish and Whistler areas via a Powerpoint presentation given by E. Wind in winter 2011. These events will be organized by the Whistler Naturalists and the Squamish River Watershed Society, and advertised in local newspapers.

Project Outcomes:

- A greater understanding of the distribution of lentic-breeding amphibians and small wetland and stream habitats in the Daisy Lake area, which is important information for the future direction of BCRP. The low density of breeding sites for listed species in the area, combined with the relatively large distances between these sites helps guide future projects. For example, priorities could be set to protect existing breeding sites and establish / maintain connective corridors between them.

- Distribution map showing the location of known breeding sites and an associated database of wetlands and streams surveyed that includes location information and habitat descriptions.

- Amphibian field survey training for a member of the Squamish Nation.

- Numerous potential wetland construction sites were identified in 2010 that can be used for future projects / funding.

- Partnerships were established with the RMOW / CCF, Sea to Sky Retreat Centre, and the Ministry of Environment that will likely result in continued amphibian and wetland work in the area.

APPENDIX C. CONFIRMATION OF BCRP RECOGNITION

Results will be communicated via oral presentations to the public via events organized by the Whistler Naturalists and the Squamish River Watershed Society. These events will be advertised in local newspapers.