



**Identification and Protection of Critical Breeding
Habitat for Red-legged Frogs (*Rana aurora*) in the
Campbell River Watershed**

BC Hydro BCRP Project ID – 09.W.CBR.01

for:

**BC Hydro Bridge Coastal Restoration Program (BCRP)
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Dossier 09.0027

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We would also like to thank the BC Hydro BCRP for funding the project.



Ted Lewis of the Cape Mudge Indian Band surveying a small pond for Red-legged Frog egg masses.



EXECUTIVE SUMMARY

Through B.C. Hydro Bridge Coastal Restoration Program (BCRP) funding, Madrone Environmental Services Ltd. (Madrone) conducted field surveys to identify suitable breeding sites for Red-legged Frogs (*Rana aurora*, a Provincially Blue-listed and Federal species of *Special Concern*) within the Campbell River watershed. The ultimate goal was to locate critical breeding habitat for this species and to recommend suitable sites for protection under the *Forest and Range Practices Act* as Wildlife Habitat Areas (WHAs).

A total of 26 sites (wetlands and lakes) in the Campbell River watershed were assessed by Madrone for qualities suitable for Red-legged Frog breeding in 2009. Of the 26 sites assessed, 16 displayed suitable habitat characteristics and were surveyed for egg masses.

At 13 of the 16 sites surveyed at least one of the following amphibian species was confirmed breeding: Red-legged Frog, Pacific Treefrog (*Pseudacris regilla*), Northwestern Salamander (*Ambystoma gracile*) and Long-toed Salamander (*Ambystoma macrodactylum*). Western Toad (*Bufo boreas*), a Federal species of Special Concern, was also encountered at one site, but breeding was not confirmed.

At the peak of the 2009 breeding season (April 22 to May 8), Red-legged Frog egg masses were observed in 6 of the 16 sites surveyed. Two sites of particularly high quality (Brewster – Bridge and Diver 1) show promise as potential WHA candidates, and we have mapped suggested WHA boundaries. The draft outline of a potential WHA boundary for Brewster Bridge encompasses 6 hectares while the proposed Diver 1 site is approximately 16 hectares. The area consists of the breeding site as well as an adjacent buffer to provide foraging habitat as adults and overwinter habitat. Prior to proposal of these sites for WHA designation, the Ministry of Environment, Regional Office in Black Creek recommends obtaining another year of data to justify their protection. Ideally, at least three survey seasons would be completed at the sites for proposed WHAs.



IDENTIFICATION AND PROTECTION OF CRITICAL BREEDING HABITAT – RED-LEGGED FROGS



1.0 INTRODUCTION

BC Hydro operations in the Campbell River watershed date back to the mid 1940's when they began installing and managing hydro electric power facilities and diversions within the watershed. BC Hydro development in the watershed consists of three dams – John Hart, Ladore, and Strathcona. The Ladore dam is located on Lower Campbell Lake, the Strathcona dam is situated on the Upper Campbell Lake, and the John Hart dam is situated on the Campbell River. In addition BC Hydro has a series of diversions to the north (Salmon), south (Quinsam) and west (Heber) of the watershed (BC Hydro 2000).

Flooding of Lower Campbell Lake resulted in a net loss of approximately 934 ha of small natural lake habitat, 138 ha of riparian habitat and 241 ha of wetland habitat (Blood 1993, BC Hydro 2000). Although reservoir impoundment can create large expanses of aquatic habitat, they generally lack shallow shoreline areas where emergent vegetation can develop, and regulated water fluctuations further inhibit the growth of those aquatic plants. Moreover, fluctuating water levels caused by seasonal water storage and releases can strand frog egg masses, thereby killing embryos through desiccation or freezing (Hawkes 2005). Mortality of embryos also increases with the increasing depth of egg masses in the water column as the water levels rise (Hayes *et al.* 2008).

Due to the loss of these important habitat types, the flooding of Lower Campbell Lake may have negatively impacted local populations of Red-legged frogs (*Rana aurora*) and other amphibians. Increased flows from the Salmon River diversion and spring runoff have changed the channel hydraulics through the Brewster, Gray, Whympier and Fry lakes portion of the watershed (Lewis *et al.* 1996, cited in BC Hydro 2000). Red-legged Frogs are known to be vulnerable to habitat loss and degradation, and the cumulative effects of these processes are of concern throughout their range, including on Vancouver Island (Ovaska *et al.* 2004). The sedentary nature and act of philopatry that Red-legged Frogs display increases their vulnerability to habitat loss and degradation (Biolinx Consulting and E. Wind Consulting 2003).

Established in 1999, the goal of the B.C. Hydro Bridge Coastal Restoration Program (BCRP) is to restore fish and wildlife resources that have been negatively impacted by the development of the hydroelectric facilities. Impacts include historical effects on fish and wildlife that have occurred as a result of reservoir creation, diversion of watercourses and the construction of dams.

Madrone Environmental Services Ltd. (Madrone) was funded by the B.C. Hydro BCRP to identify and survey suitable breeding sites for Red-legged Frogs (*Rana aurora*) within the Campbell River watershed. Egg mass surveys were carried out during the spring 2009 breeding season to identify specific sites and types of aquatic/wetland habitat being used by Red-legged Frogs in the area. The ultimate goal was to locate regionally critical¹ breeding habitat for this blue-listed species of Special Concern and to recommend suitable sites for protection under the *Forest and Range Practices Act* as Wildlife Habitat Areas (WHAs).

1.1 Project Objectives

Project objectives consisted of the following:

- I. To survey and map occupied Red-legged Frog breeding habitat in the Campbell River Watershed.
- II. To determine the relative importance of each documented breeding site as judged from egg mass counts, which can provide a reliable measure of the minimum effective breeding population size for that season.
- III. To recommend specific habitat areas for protection and or enhancement as warranted by the data.

1.2 Study Area

The Campbell River watershed, which encompasses an area over 1,400 km², is located on central Vancouver Island, approximately 275 km from Victoria. This area lies within the Coastal Western Hemlock (CWH) biogeoclimatic zone and is situated within the CWHxm2 subzone variant (Green and Klinka 1994). Warm, dry summers and moist, mild winters with little snowfall characterize this area. Forests are comprised predominantly of second growth Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*) that were established after the Sayward fire in 1938. Habitats of concern with regard to this project include primarily aquatic and wetland ecosystems.

The area of focus for this study was the Brewster, Gray, Whympier and Fry Chain of lakes, as well as the lakes around the Salmon River diversion (Figure 1). The Salmon River diversion takes water from the upper reaches of the Salmon River and Paterson Creek through a flume and channels that water eastward to Brewster Lake. The water then flows through the Brewster chain of lakes. These four lakes are connected by a 3rd order stream (Gray Lake Outlet) that drains the system in to Lower Campbell Lake (formed by the Ladore Dam) and then the Campbell River (Figure 1). The specifications for the facilities and reservoirs associated with the study area are presented in Table 1.

Table 1. Specifications of facilities and reservoirs associated with the Campbell River Watershed (adapted from BC Hydro 2000).

Dam	Strathcona	Ladore	John Hart
Nameplate Capacity (MW)	67.5	54	126
Dependable Capacity (MW)	60	47	126
Dam Function	Storage	Storage	Diversion
Date Constructed	1955	1949	1945
Date Operational	1958		1947
Date Reconstructed	1986-88	1955-57	1988
Height (m)	53	37	30
Length (m)	510	94	250
Fishway at Dam	No	No	No
Historic Anadromous Fish Presence	No	No	No

Table 1. Specifications of facilities and reservoirs associated with the Campbell River Watershed (adapted from BC Hydro 2000) (continued)

Reservoir	Upper Campbell Lake/Buttle Lake	Lower Campbell Lake	John Hart
Cleared/Not Cleared	C		
Present Area (ha)	6769	2610	346
Watershed Area (km ²)	1249	1849	
Present Elevation a.s.l. (m)	221	178	139
Normal Drawdown Range (m)	21.4	15.2	1.2
Mean Depth (m)	15/70	17	12
Maximum Depth (m)	90/130	60	23
Storage (million m ³)	823	321	3.3
Mean Water Retention Time	3.9 months	1.1 month	1.5 days
Diversion	To Powerhouse	To Powerhouse	To Powerhouse
Structure Type	Canal (1km)	tunnel	Penstock (1.9 km)
Licensed Flow (m ³ /sec)			114
Fish Flow Release (m ³ /sec)	None	None	34
Mainstem Length Diminished (km)	3		2



FIGURE 1: Study Area Location Map

PROJECT: Protection of Critical Breeding Habitat for Red-Legged Frogs

DOSSIER NO.: 09.0027

GEOGRAPHIC AREA: Campbell River, BC

CLIENT: BC Hydro BCRP

FIELD DATES: June 9, 2009

MAP SCALE: 1:75,000

MAPPING DATE: Sept 24, 2009

DRAWN BY: P. Berst, B.Sc.

Scale 1:75,000

0 1000 2000 3000 m



1.3 Red-legged Frog

The range of Red-legged Frogs extends from northern California to British Columbia. In BC Red-legged Frogs are found on Vancouver Island and the Gulf Islands, on the mainland adjacent to the Strait of Georgia, and through the Fraser Valley to Hope (IWMS 2004).

Red-legged frogs utilize both aquatic and terrestrial habitats. Adults and juveniles forage primarily in terrestrial habitats, typically spending up to 90% of their time in moist forested areas with abundant leaf litter and woody debris (Waye 2002). Breeding habitats include a variety of aquatic and wetland sites with still or slow moving water, adequate water depth (> 50 cm) for larval rearing, and emergent vegetation suitable for egg mass attachment (IWMS 2004). Submergent vegetation and large woody debris can also be important breeding habitat attributes, as they provide attachment substrates for egg masses and protective cover from predation, particularly for larvae and small juveniles. Aquatic sites may be either permanent or ephemeral in nature, but in the latter case the site must have a hydroperiod of at least five months to allow for successful rearing of tadpoles.

In southwestern BC, breeding activities typically begin between late February and early March. Adult frogs become active from a state of torpor and migrate to breeding habitat in late winter and early spring. Migration to breeding sites begins when daylight temperatures exceed 4-5°C. Males begin calling to potential mates when air and water temperatures have been at least 6°C for several days (Brown 1975). Breeding activities can last anywhere from 2 – 4 weeks, depending on the weather conditions. On average, females lay 680 eggs in a single mass. Once laid, the eggs take up to 5 weeks to hatch. Red-legged Frog tadpoles then take from 3 – 4 months to metamorphose (IWMS 2004). Adults reach sexual maturity by 2-3 years after metamorphosis (Licht 1974).

Tadpoles are herbivorous and feed on algae and decomposing vegetation. Juvenile and adult Red-legged Frogs are opportunistic foragers that forage principally in terrestrial habitats. Their diet includes slugs, spiders, and numerous insect species (IWMS 2004).

1.3.1 Egg Masses

Red-legged Frog egg masses are roughly the size of a grapefruit or cantaloupe (Corkran and Thoms 1996). Eggs that are in developmental stage 1 are those that have been recently laid.

Each egg is approximately 3 mm in size, black on top and white below, and is surrounded by a layer of thick jelly. As the eggs progress through development they take on a kidney shape (stage 2), at which time the entire egg mass commonly floats to the surface where it begins “foaming” as air bubbles accumulate around the eggs (Corkran and Thoms 1996). In stage 3 of development, the egg becomes a tadpole about 4 – 6 mm long. As the tadpole continues to grow it eventually hatches out of the jelly egg mass and is free swimming (stages 4 & 5).

1.3.2 Status of Red-legged Frog

The Red-legged Frog (*Rana aurora*) is a federal species of *Special Concern* (COSEWIC 2004) and provincially Blue Listed. This species’ range is restricted in BC and the Vancouver Island population is disjunct from mainland populations. Frog populations are susceptible to habitat degradation as well as to predation and competition from introduced species such as Bullfrogs, Green Frogs, and predatory fish (COSEWIC 2004).

2.0 METHODOLOGY

Prior to commencing fieldwork, GIS-based field maps of the study area were produced using Terrain Resource Inventory Management (TRIM) Data at a scale of 1:60,000 for overview reference and 1:5,000 to 1:15,000 for site surveys. More detailed maps aided in identifying areas to concentrate survey efforts.

Systematic, visual surveys of the lakes and wetlands were carried out by boat and wading (RISC 1998). A boat was only used to conduct surveys when water levels were too high to safely wade. Lake shorelines, for the most part, were surveyed along a single curvilinear transect, circling the fringe of the entire water body. In the more suitable and complex wetland habitats multiple transects were used in order to cover all portion of the wetland. Because females lay only one clutch per season, complete counts of egg masses can be used to gauge the breeding population size (Couch and Paton 2000, Campbell and Grant 2005, Sendak 2008).

Each lake/wetland was given a unique identification code, and data were recorded with respect to weather conditions, location, littoral area, water body description, water searchability, water temperature, elevation, fish presence and amphibian egg mass presence. Information pertaining to substrate (*i.e.*, rocky or soft organic substrate), vegetation type (*i.e.*, within the water body and riparian area) and water pH were also recorded.



All of the project field data were recorded on the Ministry of Environment Ecosystems Section Amphibian Survey Data Forms (Appendix I). Each surveyed site was documented and marked in the field using GPS coordinates and digital photography.

Although Red-legged Frog breeding activity was the main focus of our surveys, any indication of breeding by other aquatic amphibians was also recorded, including information on the size and developmental stage of all observed egg masses. The field guide *Amphibians of Oregon, Washington and British Columbia* (Corkan and Thoms 1996) was used to assist with identification where needed.

During our initial field session, Brewster Lake, Gray Lake, Whympere Lake, Fry Lake and the surrounding area was screened for habitat suitability. All sites that were considered for egg mass surveys were within 5 km – 7 km of this main chain of lakes. Each site was assigned a breeding habitat suitability rating of High, Moderate or Low. Only those sites that had quality emergent vegetation (for egg mass attachment), large woody debris for cover from predators and suitable water depth (*i.e.*, >50 cm) were surveyed for egg masses. Because our primary objective was to identify critical breeding sites, our level of effort generally scaled with site quality and documentation of focal species presence. Multiple visits within the season occurred at the highest rated sites and/or where Red-legged Frog breeding was confirmed.

3.0 RESULTS

A total of 26 lake and wetland sites within the Campbell River Watershed study area (Figure 1) were selected as candidates for egg mass surveys on the basis of characteristics apparent from either air photos or initial field reconnaissance (Appendix II, Table A). Upon further evaluation in the field, we concluded that 16 of the 26 candidate sites had the characteristics to warrant at least one egg mass survey, while 10 sites were judged to be largely unsuitable for breeding and as a result were not surveyed (Appendix II, Table B and Appendix III). Habitat suitability ratings of 7 of the 16 sites surveyed were subsequently reduced to “Low” after observing habitat characteristics more closely during the egg mass surveys. In consequence, we surveyed 5 of 5 sites rated as having high suitability, 4 of 4 sites rated as having moderate suitability, and 7 of 17 sites rated as having low suitability.

Five survey sessions for Red-legged Frog egg masses were completed at approximately weekly intervals between March 30th and May 8th, 2009. A total of 68.75 hours was spent surveying the 16 sites.

Red-legged Frog breeding was documented at six of the sites, with peak counts of from one to 50 egg masses per site (Tables 2 and 3). Breeding was confirmed at all five sites that were judged to have high suitability and at one of the four sites judged to be of moderate suitability. No egg masses were detected at any of the seven low suitability sites surveyed.

Only a small number of egg masses were observed early in the breeding season, prior to April 15th (Table 3). As the season progressed the air and water temperatures increased as did the breeding activity. The site with the highest apparent productivity was Brewster Bridge, which had the highest single survey count of 50 Red-legged frog egg masses, within a wetland <0.5 ha. Spawning chronology for this site is shown in Figure 2.

Table 2. Numbers of amphibian egg masses counted during surveys of potential Red-legged Frog breeding sites in the Campbell River Watershed study area in 2009.

Wetland ID	Survey Date	Water Temp (°C)	RAAU Egg Masses	HYRE Egg Masses	AMGR Egg Masses	AMMA Egg Masses
Boot 5	April/23/09	8	8	476	8	0
	May/07/09	11	0	144	8	0
Brewster-South	March/30/09	3	0	1	0	0
	April/6/09	9	0	11	0	0
	April/22/09	8	0	2	0	0
Brewster-Bridge	March/30/09	3	1	0	0	0
	April/6/09	4	4	0	0	0
	April/15/09	11	24	0	24	2
	April/22/09	9	50	13	59	0
	May/06/09	9	15	0	41	0
Com1	May/06/09	8	0	0	0	0
Cran 1	April/6/09	12	0	0	0	0
Cran Lake	May/07/09	14	0	0	2	0
Diver 1	April/15/09	11	0	0	0	0
	April/23/09	7	2	0	0	0
	May/08/09	12	32	0	3	0
Gos2	May/07/09	10	0	66	1	0
Martha 1	April/23/09	7	1	0	0	0
	May/06/09	8	1	0	0	0
Mohun1	May/07/09	10	0	0	12	0
MW056	May/08/09	10	0	103	42	0
MW10K	May/07/09	8	0	0	7	0
Pat A	April/15/09	6	0	3	0	0
	April/24/09	4	0	0	0	0



Table 2. Numbers of amphibian egg masses counted during surveys of potential Red-legged Frog breeding sites in the Campbell River Watershed study area in 2009 (continued).

Wetland ID	Survey Date	Water Temp (oC)	RAAU Egg Masses	HYRE Egg Masses	AMGR Egg Masses	AMMA Egg Masses
Pat B	April/15/09	7	0	3	0	0
	April/24/09	6	3	4	0	0
	May/08/09	11	4	33	23	0
Pat C	April/24/09	9	2	35	0	0
	May/08/09	12	3	443	1	0
Pat D	May/06/09	8	0	0	0	0
Totals			150	1,337	231	2

A-RAAU (*Rana aurora*) = Red-legged Frog, HYRE (*Hyla regilla*) = Pacific treefrog, AMGR (*Ambystoma gracile*) = northwestern salamander, AMMA (*Ambystoma macrodactylum*) = long-toed salamander

Table 3. Egg mass counts at confirmed breeding sites for Red-legged Frogs in the study area during 2009 and average water temperature by survey date.

Survey Date	Sites Surveyed						Total Count	Average Water Temperature
	Boot 5	Brewster-Bridge	Diver 1	Martha 1	Pat B	Pat C		
30-Mar-09		1					1	3
06-Apr-09		4					4	8.3
15-Apr-09		24	0		0		24	8.7
22-Apr-09		50					50	8.5
23-Apr-09	8		2	1			11	7.3
24-Apr-09					3	2	5	6.3
06-May-09		15		1			16	8.3
07-May-09	0						0	10.6
08-May-09			32		4	3	39	11.3
Total Count	8	94	34	2	7	5	150	

Note: Only the cells with values were surveyed on those days (zero indicates that no egg masses for Red-legged Frogs were observed on that survey date).

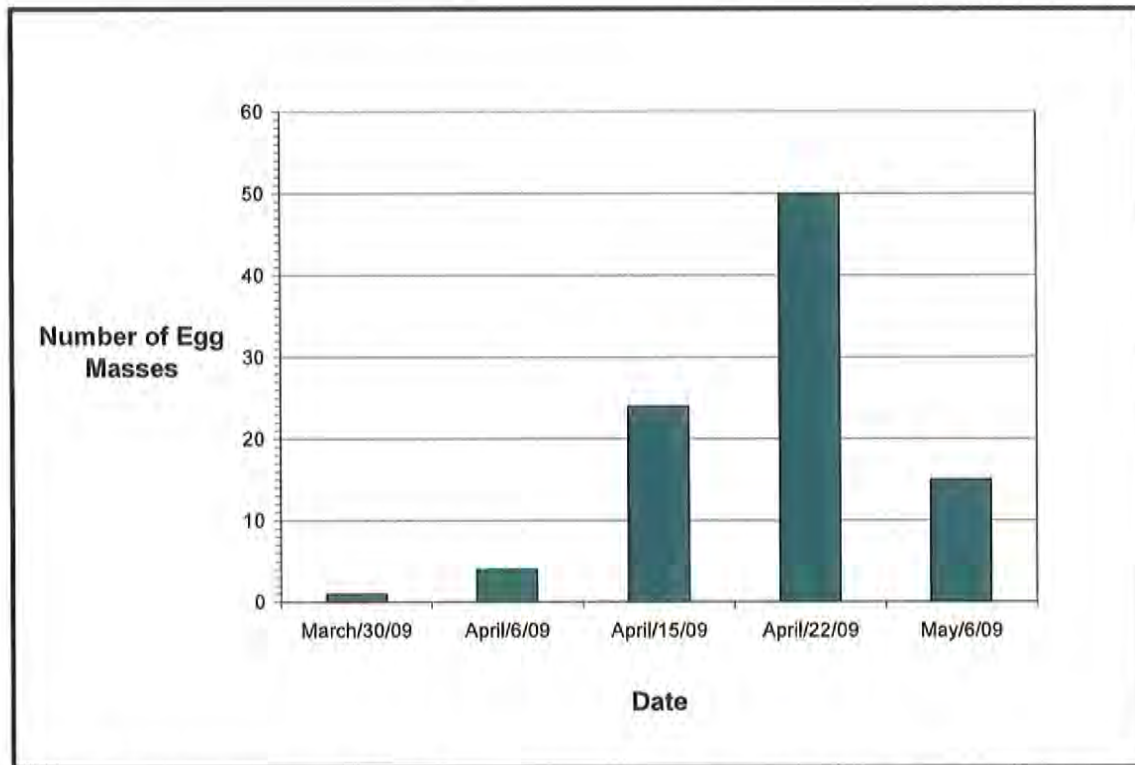


Figure 2. Red-legged Frog (RAAU) breeding activity trend for the Brewster-Bridge wetland during the 2009 breeding season.

In addition to Brewster-Bridge, the Diver 1 site was also of particularly high quality, with confirmed breeding by Red-legged Frogs and a peak count of 32 egg masses (Table 3, Figure 2). Both of these sites have potential for designation as Wildlife Habitat Areas (WHA's) for protection of Redlegged Frog critical breeding habitat. Recommendations for WHA designation have been discussed in detail with MoE (Erica McClaren, M.Sc., R.P.Bio., Wildlife Biologist, Black Creek).

Breeding was also confirmed at 11 of the 16 sites for three additional species of aquatic amphibians: Pacific Treefrog (*Hyla regilla*), Northwestern Salamander (*Ambystoma gracile*) and Long-toed Salamander (*Ambystoma macrodactylum*) (Tables 2 and 3). Pacific Treefrog egg masses were recorded at 8 sites, northwestern salamander at 9 sites, and long-toed salamander at 1 site. Other amphibian species of interest encountered during surveys included adult Western Toads (*Bufo boreas*), a Federal species of Special Concern. A total of three adult toads were seen at the Diver 1 site on April 23 and May 8, 2009, but no eggs were found.



3.1 Site Descriptions

Most of the sites that were assessed for Red-legged Frog breeding habitat suitability had very soft organic bottoms and lacked rocks or gravel. Some of the larger water bodies had some gravel along the fringe, but like the wetlands, were dominated by soft organic substrate. All of the sites that were assessed were at elevations of 180 m – 320 m. Water quality tests for pH indicated that all of the sites were very similar to one another. The pH ranged between 6.2 – 6.6 for each site and the water temperature had a range of 3°C – 14°C depending on the elevation and the timing of the sampling event. As the season progressed the water temperature consistently ranged between 8°C and 12°C.

The following section describes each of the sites in order of productivity (*i.e.*, those sites with Red-legged frog breeding and those without). Sites were rated as High, Moderate or Low for breeding habitat suitability. Ratings were determined by comparing each site against a set of criteria that included; protection from predators (*i.e.*, fish presence), quality of vegetation for egg mass attachment, and pond permanence.

3.1.1 High Habitat Suitability Sites

Boot 5

The “Boot 5” site is located southeast of Boot Lake (Figure 1). This site is a small wetland (<0.5 ha) that contains ideal amphibian habitat characteristics. The depth of water throughout the wetland is approximately 1.0 m to 1.5 m. The entire wetland has emergent vegetation which provides sites for egg mass attachment and downed trees that provide security. Emergent vegetation consisted mainly of slough sedge (*Carex obnupta*), yellow pond-lily (*Nuphar polysepalum*) and small-flowered bulrushes (*Scirpus microcarpus*). This site lacks dense hardhack growth.

Eight Red-legged frog egg masses were observed at this site on April 23rd. It is possible that fish are present in this wetland and that is of importance, because predation on developing amphibian eggs would likely occur. This site was highly productive for Pacific treefrogs (620 egg masses as a combined total of 5.75 hours conducted over two surveys – April 23rd and May 7th).

Brewster Bridge

Brewster Bridge (Brew 2) is a small wetland (approximately 1ha) connected through a short drainage under Gray Lake Road to “Brewster South”. This site is one of two

survey areas that have potential to become Wildlife Habitat Area (WHA) candidates (Figure 3). The potential WHA boundary is approximately 6 hectares in total and includes the breeding site as well as an adjacent buffer to provide foraging habitat as adults and overwinter habitat.

This wetland has excellent habitat for amphibian breeding, particularly the northern half of the wetland. The wetland has large expanses of emergent vegetation including cat-tails (*Typha latifolia*) and slough sedge. There is a significant amount of large woody debris providing habitat complexity. In the middle of the wetland is a beaver lodge, which has a positive influence in that it is helping to retain water for a longer period of time. If no beaver lodge existed the water would drain much quicker and less wetland habitat would exist.

The depth of the water in this wetland ranges from 0.5 m – 2 m. On the northeast side of the wetland forest cover is available for foraging and on the southwest side is Gray Lake Road. Gray Lake road is likely a source of sediment in to the wetland.

The Brewster Bridge wetland was first surveyed on March 30th, 2009, at which time the site was surrounded by snow and covered by a sheet of ice. A single egg mass was found. On subsequent surveys, we counted 4, 24, 50 and 15 egg masses on April 6th, 15th, 22nd and May 6th respectively. This wetland also supported breeding populations of Pacific treefrog, northwestern salamander, and long-toed salamander (Table 3).



FIGURE 3: Brewster-Bridge Potential WHA

PROJECT: Protection of Critical Breeding Habitat for Red-Legged Frogs

DOSSIER NO: 09.0027

GEOGRAPHIC AREA: Campbell River, BC

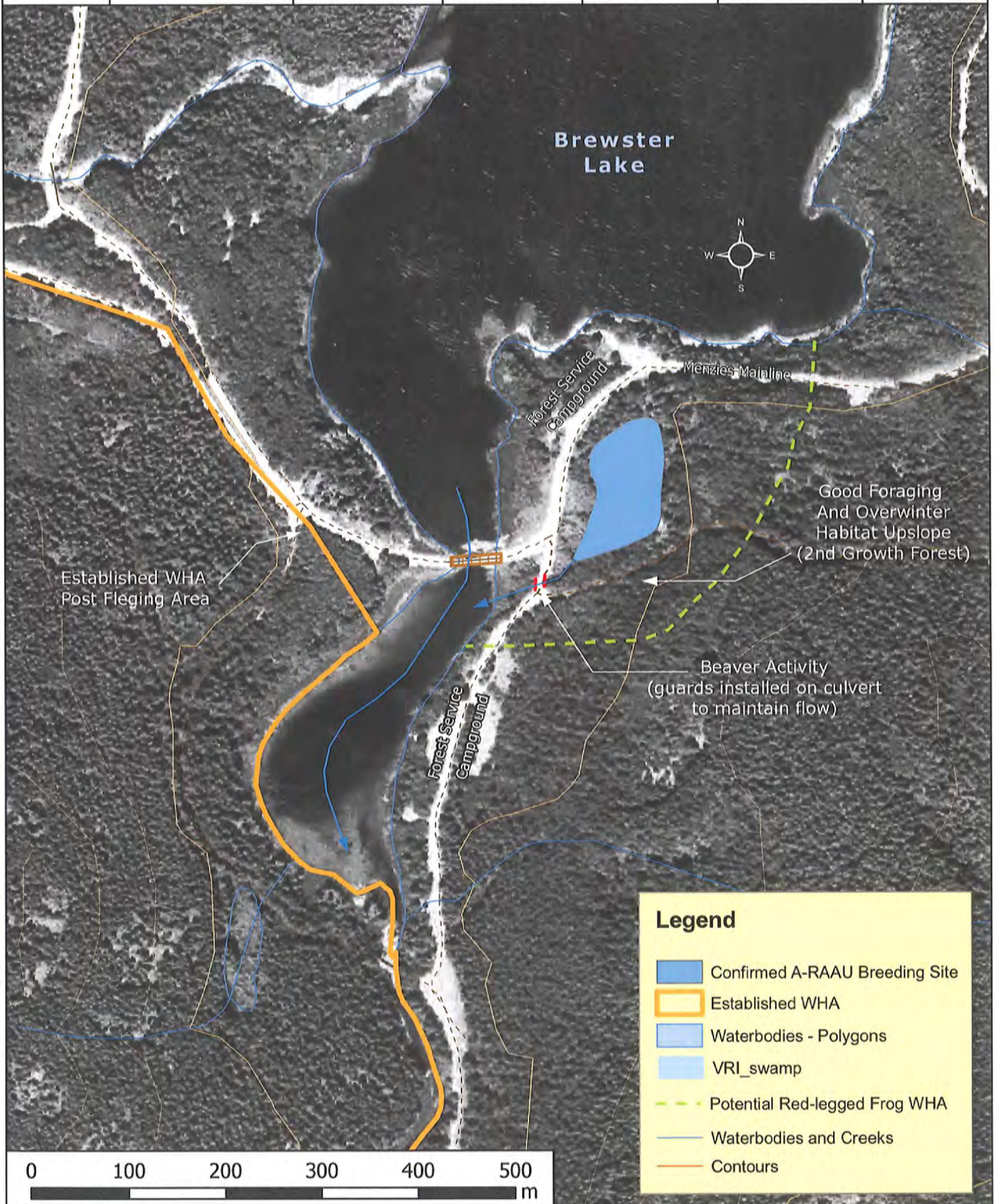
CLIENT: BC Hydro BCRP

FIELD DATES: June 9, 2009

MAP SCALE: 1:5,000

MAPPING DATE: October 15, 2009

DRAWN BY: Anna Jeffries



Diver 1

The “Diver 1” site is located adjacent to Menzies Mainline on the south side of the raised mainline that runs parallel to Diver Lake, which is influenced by the Salmon River Diversion (Figure 1). Based on egg mass survey data and wetland habitat attributes, this site is a potential candidate Wildlife Habitat Area (WHA) (Figure 4). The proposed WHA boundary for Red-legged frogs is approximately 16 hectares in size and includes the breeding site as well as an adjacent buffer to provide foraging habitat as adults and overwinter habitat. The WHA for the frogs would be located within an already established WHA post fledging area for the red-listed subspecies of Northern Goshawks (*Accipiter gentilis laingi*). The post fledging area WHA allows for some forest harvesting. Therefore, the WHA for frog breeding habitat would delineate a no harvesting zone.

This site is a small wetland (<0.5 ha) that contains ideal amphibian habitat characteristics and was rated as having high breeding habitat suitability for the Red-legged Frogs. The wetland is the result of extensive beaver activity (three beaver lodges, multiple dams and a layered series of small pond terraces are present). A series of deep beaver channels, which may be over 3 m in depth, criss-cross the wetland complex. Fish are likely present in this wetland and is of importance, in that predation on developing amphibian eggs may occur.

The entire wetland has emergent vegetation that provides sites for egg mass attachment and downed trees that provide security. Emergent vegetation consisted mainly of slough sedge (*Carex obnupta*). This site lacks dense hardhack growth.

Two Red-legged frog egg masses were observed at this site on April 23rd and 32 egg masses were seen on May 8th, 2009. It is likely that additional egg masses were missed, as only the perimeter could be searched due to beaver activity and resulting safety issues. Northwestern salamander egg masses were also identified at this site.



FIGURE 4: Diver 1
Potential WHA

PROJECT:
Protection of Critical Breeding Habitat for Red-Legged Frogs

DOSSIER NO:
09.0027

GEOGRAPHIC AREA:
Campbell River, BC

CLIENT:
BC Hydro BCRP

FIELD DATES:
June 9, 2009

MAP SCALE:
1:8,774

MAPPING DATE:
October 15, 2009

DRAWN BY:
Anna Jeffries



Pat B

This is a small lake that is separated from “Pat A” by Paterson Lake Mainline. The southeast channel of “Pat B” supports large clumps of cat-tails. Within the main portion of “Pat B”, the fringe of the lake has patches of sedges, and hardhack, and many downed trees extend into the water. In the middle of the lake pondweed (*Potamogeton sp.*) was growing. This particular site also has a great amount of beaver activity. Three beaver lodges were observed along the shoreline with underwater entry tunnels. At its deepest point, “Pat B” is approximately 6 m – 7 m deep. A high count of four Red-legged Frog egg masses was recorded at this site on May 8th. Breeding was also documented for Pacific Treefrog and Northwestern Salamander. Fish are likely present in this lake and is of importance, in that predation on developing amphibian eggs may occur.

Pat C

This wetland is situated north of “Pat A” and “Pat B” along Paterson Lake Mainline. The outflow creek from “Pat A” flows into “Pat C”. Hardhack dominates the eastern, southern and western shorelines, while sedges dominate the northern shoreline. The wetland is shallow and ranges from 1 m – 1.5 m. A peak count of three Red-legged Frog egg masses was recorded on May 8th. Breeding was also documented for Pacific Treefrog and Northwestern Salamander.

3.1.2 Moderate Habitat Suitability

Com 1

“Com 1” is another site that displays good qualities for amphibian breeding. The habitat has a good mix of slough sedge and large woody debris. The depth of the water along the fringe is ideal (1 m – 1.5 m) and as a result the emergent vegetation thrives. The only negative aspect of this wetland is that a dense covering of filamentous algae blankets the vegetation along the fringe. It did not appear as though the wetland was eutrophic; however, otherwise the entire wetland would have been overcome with algae growth. No evidence of amphibian breeding was recorded at this site in a single survey.

Gos 2

“Gos 2” is an extension of “Gos 1” and for the most part lacks suitable breeding habitat. However a small “bay” in the southeast corner having reed-canary grass (*Phalaris arundinacea*) provided limited suitable habitat.

Hardhack dominates the majority of the shoreline and the water was 3 m – 4 m deep in some areas. Pacific Treefrogs and Northwestern Salamanders were breeding at this site.

Martha 1

This wetland is another one that is affected by beaver activity. The beavers have assembled a dam at the head of the outflow creek; as a result there is a trench running the length of the wetland and the water is about 4 m deep. Emergent vegetation is lacking within the wetland, while hardhack dominates the fringe. Pockets of swamp with skunk cabbage (*Lysichiton americanum*) exist adjacent to the wetland. Single Red-legged Frog egg masses were recorded at this site on April 23rd and May 6th.

MW056

This wetland is located 1.8 km up the spur-road MW056 off Mohun West Mainline. The lake has a 5 – 6 ha littoral zone, and is surrounded by a mature forest of mostly western redcedar. Habitat suitability is moderate as the fringe of the wetland is dominated by Labrador tea (*Ledum groenlandicum*), but the northwest corner has some slough sedge growth. There are also plentiful amounts of coarse woody debris along the shore and in the water adding to the complexity of the habitat. Pacific Treefrogs and Northwestern Salamanders were breeding at this site.

4.0 DISCUSSION

This study successfully documented the presence of Red-legged Frog breeding and of important breeding habitats at multiple locations within the Campbell River watershed. Based on our findings in 2009, it may now be possible to more efficiently identify additional potentially critical breeding habitats for protection in this watershed. All of the wetlands and lakes where Red-legged Frog breeding was detected in 2009, the water depth was consistently between 1 m – 2 m and had large amounts of quality egg mass attachment substrate (*i.e.*, emergent vegetation). These areas also had large woody debris for cover and they were in close proximity to suitable foraging habitat. These wetland attributes can be characterized as providing suitable security, foraging and thermal habitat (Hawkes 2005). It is likely that less predation on eggs and juveniles occurs in these small well-vegetated wetlands compared to larger lakes because the vegetation and woody debris provide cover from predators such as fish, dragonfly nymphs, garter snakes and leeches (Licht 1974).

Commonly associated with these sites were beavers. Much of the beaver activity was a benefit to the Red-legged Frogs. The damming of areas by beavers helps to provide permanent waterbodies and consistent depths by holding back water flow, which is ideal for breeding (egg laying through successful development of tadpoles). Without beaver activity many of these wetlands would have much lower water levels or dry up too early in the year to allow frog larvae sufficient time to metamorphose. For example, if Brewster-Bridge (Brew 2) did not have a beaver dam the water would drain much faster into Brewster Lake exposing the substrate in portions of the wetland.

Through discussions with other biologists and MoE, we believe that the onset of the breeding season for 2009 was delayed due to inclement weather conditions (a long, cold, snowy spring). Air temperatures were close to seasonal at the time of the surveys, however prolonged cold ($< 0^{\circ}\text{C}$) periods existed during the winter giving lakes and wetlands thicker ice surfaces. Historical data from Environment Canada also show that compared to previous years (1971 – 2000) a greater amount of snow fell during the winter (Table 3) (Environment Canada 2009). These factors combined, delayed the increase of water temperature for all of the lakes and wetlands.

Generally Red-legged Frogs begin breeding in late February and early March (IWMS 2004). During the 2009 breeding season many of the lakes were covered in snow and ice until late April delaying the water bodies reaching $4^{\circ}\text{C} - 5^{\circ}\text{C}$, at which point breeding activities begin (Calef 1973a). Breeding activities in 2009 took place in late April and throughout May.

Red-legged Frog egg mass abundance at our study sites was low compared to counts obtained on the south and west coast of Vancouver Island. As many as 800 Red-legged Frog egg masses have been observed in wetlands near Tofino (Personal contact – Erica McClaren, MoE). Surveys at additional sites and in multiple years within the Campbell River watershed would help clarify whether breeding populations tend to be significantly smaller than in coastal and lower elevation areas of Vancouver Island.

Because of the lack of information and historical studies in the Campbell River watershed, it is not possible to know whether the area has ever supported a large Red-legged Frog population. It is possible that past activities of implementing hydro stations within the watershed have decimated a portion of the population that used to inhabit the area around the Brewster, Gray, Whympier, and Fry chain of lakes.

If a decline in the Red-legged Frog population took place it would be a result of their vulnerability to environmental alterations (*i.e.*, legged Frog embryos and tadpoles will not survive in water with a pH < 3.5 or > 9, water temperatures > 21°C, or water velocities > 5 cm/sec (Hayes et al. in press). The Campbell River sites displayed pH's between 6.4 and 6.6, water temperatures < 14°C and water velocities well below 5 cm/sec, providing ideal conditions.

Based on our findings and our knowledge of Red-legged Frog breeding and living habitat requirements, we believe that current BC Hydro activities are not negatively impacting Red-legged Frogs. Those lakes that are being influenced by fluctuating water levels (1 m – 22 m drawdown) (Bridge-Coastal Fish and Wildlife Restoration Program Volume 2: Campbell River Watershed) at this point in time via hydro activities do not provide sufficient habitat for breeding or security as they lack the required emergent vegetation and large woody debris. These lakes also possess large Rainbow Trout, Cutthroat Trout and Dolly Varden Char populations, meaning predation rates on amphibians would potentially be high. It is likely that the larger water bodies have never supported Red-legged Frog breeding activities as a result of unsuitable conditions.

4.1 Project Limitations

The main project limitations were related to accessibility of survey sites due to weather and/or site conditions. Early in the spring (late March) surveys were limited by lack of access due to snow. Many of the lakes were still frozen until late April (Photo 1). The snow and frozen lakes hampered search efforts. Once the snow and ice receded, previously inaccessible areas were searched for amphibian egg masses.



Photo 1. Brewster – Bridge (Brew 2) covered in snow and ice. Photo was taken during the March 30, 2009 survey.

In addition, some of the wetlands had very soft organic bottoms making wading difficult at times. When wading was difficult crew members simply tried to find a solid substrate to scan the immediate area for egg masses. Other sites were too small for boat surveys, but too soft to enable full coverage by wading. Therefore, it is likely that we missed some of the egg masses in our total counts (*i.e.*, these sites were only surveyed from the edge looking towards the centre).

Another factor that limited our ability to search a site was that some of the deeper lakes/wetlands were overgrown with hardhack. This thick vegetation prevented us from launching a boat. In these situations, the crew waded accessible portions and covered the area as best as we could, concentrating on the best looking habitat. Therefore, some of the sites had a smaller area surveyed than what would be ideal.

5.0 RECOMMENDATIONS

Degradation of habitat is a threat to survival for the Red-legged Frog. It is for this reason that we recommend WHA designation for sites located on Provincial Crown land that have high suitability as breeding habitat and confirmed breeding activity (*i.e.*, Brewster – Bridge and Diver 1) (Figures 3 and 4). Buffers should be at least 500 m as Red-legged Frogs have been known to travel such distances from their natal wetland (Hawkes 2005). Protection of these wetlands will prevent encroaching development and logging activities that could degrade water quality and destroy migration corridors that lead to sensitive breeding habitat. Protection of these sensitive habitats helps to ensure that all amphibian life history phases will be completed (Wind 2003). The implementation of WHA's will benefit not only amphibians, but a variety of other wildlife including waterfowl, songbirds, ungulates and fish.

Due to annual fluctuations in weather conditions, water levels and local amphibian populations, establishment of WHAs based on one year of data is not scientifically defensible. Ideally, at least three survey seasons would be completed at the sites for proposed WHAs (pers. comm. Erica McClaren, MoE, RPBio, Black Creek). Therefore, as directed by MoE, we recommend completing at least one more year of surveys at the High and Moderate suitability sites prior to submission of the sites as WHA candidates. In addition, we recommend expanding our search area to identify additional sites of high suitability for breeding by Red-legged frogs in the Campbell River Watershed.



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APPENDIX I. – Field Form

Ecosystems Section Amphibian Survey Data Form- 2009

General Information:

Date: _____ Location: _____ UTM Zone _____
 Surveyor(s): _____ Easting _____
 _____ Northing _____

Location Description (include landscape context surrounding wetland): _____
 Wetland ID: _____ Littoral Area (ha): _____ Bottom Substrate: _____

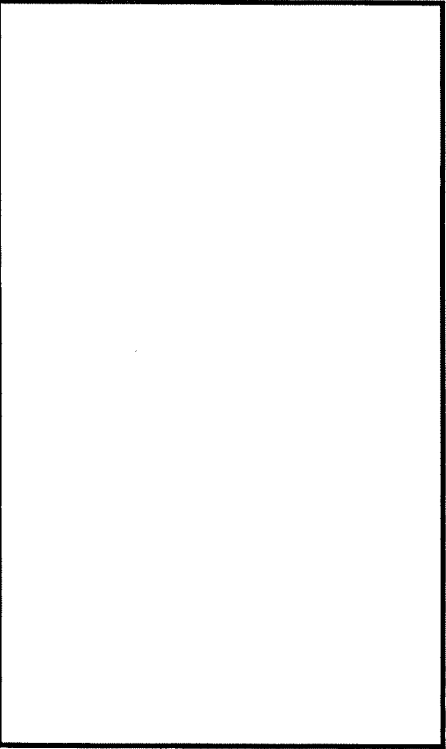
Seral Stage/Age Class: _____ Elevation (m): _____ Fish Species Present?: _____

Time: Start _____ Water Temperature: _____ / 5
 End _____ Number of Trap Nights: _____
 (1 = very difficult; 5 = very good)

Survey Type: (select) visual survey / trapping funnel trap () , other trap () / _____
 Search Conditions: _____ / 5
 Survey Timing: early / ok / late
 (circle one)

Weather	Ceiling	CC	Wind	Precip	Temp	Water Condition
Start						
End						

Ceiling: a/b t = above/below tree tops; a/b r = above/below ridges; h/v h = high/very high CC: 1 = clear; 2 = scattered clouds (<50%); 3 = scattered clouds (>50%); 4 = unbroken
Wind: 0 = <2 km/h (calm); 1 = 2-5 km/h (light air); 2 = 6-12 km/h (leaves rustle); 3 = 13-19 km/h (leaves and twigs in constant motion); 4 = 20-29 km/h (small branches move,
 dust rises) 5 = 30-39 km/h (small trees sway); 6 = 40-50 km/h (large branches moving, wind whistling)
Precip: N = none; F = fog; M = misty drizzle; LR = light rain; HR = hard rain; S = snow
Temp (in degrees C); **Water Condition:** maximum vertical depth of visibility in cm.
 (should be measured with a Secchi disk)



Site Diagram:
 (e.g., inflow, outflow, oviposition sites, open water areas, emergent vegetation, access, etc.)

Scale: 1 square = _____ m

Amphibian Observations:

Trap No.	Photo (s) #	Egg Mass Aggregates		Dev. Stage #	Larval Stage		Adults		Comments													
		Species	Diameter (cm)		Species	Gos. Stage	SNVL	#		Species	SNVL											

Comments: add information such as cardinal direction of pond that observations occurred (i.e. if egg masses were all on one side), malformations, etc.
Species: *salamanders* = AMMA (long-toed); TAGR (rough-skinned newt); AMGR (northwestern); PLVE (western red-backed); ENES (ensatina); ANVA (wandering); *anurans* = BUBO (western toad), HYRE (pacific treefrog); RAAU (red-legged); RACA (bullfrog); RAEL (green); UNSP (unknown sp.)
Dev. Stage: 1 = round eggs, 2 = kidney (crescent) eggs, 3 = tadpoles, 4 = hatching, 5 = hatched-out (each egg mass or round to 10s of % for large #s)



APPENDIX II. – Result Summary Tables

Table A. Summary of waterbodies assessed for potential Red-legged Frog breeding habitat.

Wetland	Habitat Suitability Rating	Completed Egg Mass Surveys	Confirmed Breeding
Pat A	Low	Yes	No
Pat B	High	Yes	Yes
Pat C	High	Yes	Yes
Pat D	Low	Yes	No
Boot 1	Low	No	No
Boot 2	Low	No	No
Boot 3	Low	No	No
Boot 4	Low	No	No
Boot 5	High	Yes	Yes
Brewster Bridge	High	Yes	Yes
Brewster – South	Low	Yes	No
Com 1	Moderate	Yes	No
Cran 1	Low	Yes	No
Cran Lake	Low	Yes	No
Diver 1	High	Yes	Yes
Fry Lake	Low	No	No
Gos 1	Low	No	No
Gos 2	Moderate	Yes	No
Gray Lake	Low	No	No
Lawson Lake	Low	No	No
Martha 1	Moderate	Yes	Yes
Menz L	Low	No	No
Mohun 1	Low	Yes	No
MW056	Moderate	Yes	No
MW10K	Low	Yes	No
Whymper Lake	Low	No	No

Table B. Sites surveyed in 2009 for Red-legged Frog egg masses.

Wetland ID	Date Surveyed	Easting	Northing	Elevation (m)	Water Temperature (°C)	Air Temperature (°C)	Egg Masses
Brewster Bridge	30-Mar-09	314894	5550524	180	3	5	1
	06-Apr-09				4	7	4
	15-Apr-09				11	14	24
	22-Apr-09				9	7	50
	06-May-09				9	8	15
Brewster - South	30-Mar-09	314757	5550320	180	3	4	0
	06-Apr-09				9	14	0
	22-Apr-09				8	12	0
Com 1	06-May-09	318432	5559377	237	8	9	0
Cran 1	06-Apr-09	322867	5551261	228	12	12	0
Cran Lake	07-May-09	324281	5551479	201	14	10	0
Diver 1	15-Apr-09	311588	5552503	226	11	14	0
	23-Apr-09				7	12	2
	08-May-09				12	13	32
Gos 2	07-May-09	321551	5548893	258	10	11	0
Martha 1	23-Apr-09	313591	5546114	194	7	10	1
	06-May-09				8	8	1
Mohun 1	07-May-09	319713	5556177	277	11	11	0
MW056	07-May-09	321278	5560186	311	10	9	0
MW10K	07-May-09	319709	5556158	233	8	11	0
Pat A	15-Apr-09	309236	5550473	262	6	12	0
	24-Apr-09				4	5	0
Pat B	15-Apr-09	309227	5550473	262	7	12	0
	24-Apr-09				6	8	3
	08-May-09				11	8	4
Pat C	24-Apr-09	309204	5550975	265	9	12	2
	08-May-09				12	12	3
Pat D	06-May-09	310317	5550107	265	8	10	0
Boot 5	23-Apr-09	319824	5546799	273	8	7	8
	07-May-09				11	9	0



APPENDIX III. – Climate Data

Climate Data from Environment Canada for Campbell River

Air Temperature (°C)	January	February	March	April	May	June
Climatic Norms						
1971-2000	1.3	3	4.8	7.7	11.2	14.2
1971-2000 High	4.6	6.9	9.5	13	16.8	19.7
1971-2000 Low	-2	-1	0.1	2.3	5.6	8.7
Annual Monthly Means						
1999	3.2	3.2	4.4	7.4	9.8	13.1
2000	1.2	3.3	5.4	8	10.3	14.9
2001	3.5	2.7	5.2	7.4	10.7	13.1
2002	3.2	3.3	3.1	7.9	10.4	15.2
2003	5.1	3.8	5.5	7.9	10.8	16.2
2004	2.6	4.2	6.2	9.5	12.8	16.4
2005	2.3	3.3	7	9.3	13.6	14.8
2006	4.1	2	4.3	8.3	12.3	16
Daily Means for 2009						
01-Feb-09		2.0				
15-Feb-09		2.1				
28-Feb-09		3.3				
10-Mar-09			-1.9			
15-Mar-09			1.1			
20-Mar-09			4.6			
01-Apr-09				2.0		
15-Apr-09				8.4		
30-Apr-09				14.0		
15-May-09					11.3	
30-May-09					18.2	

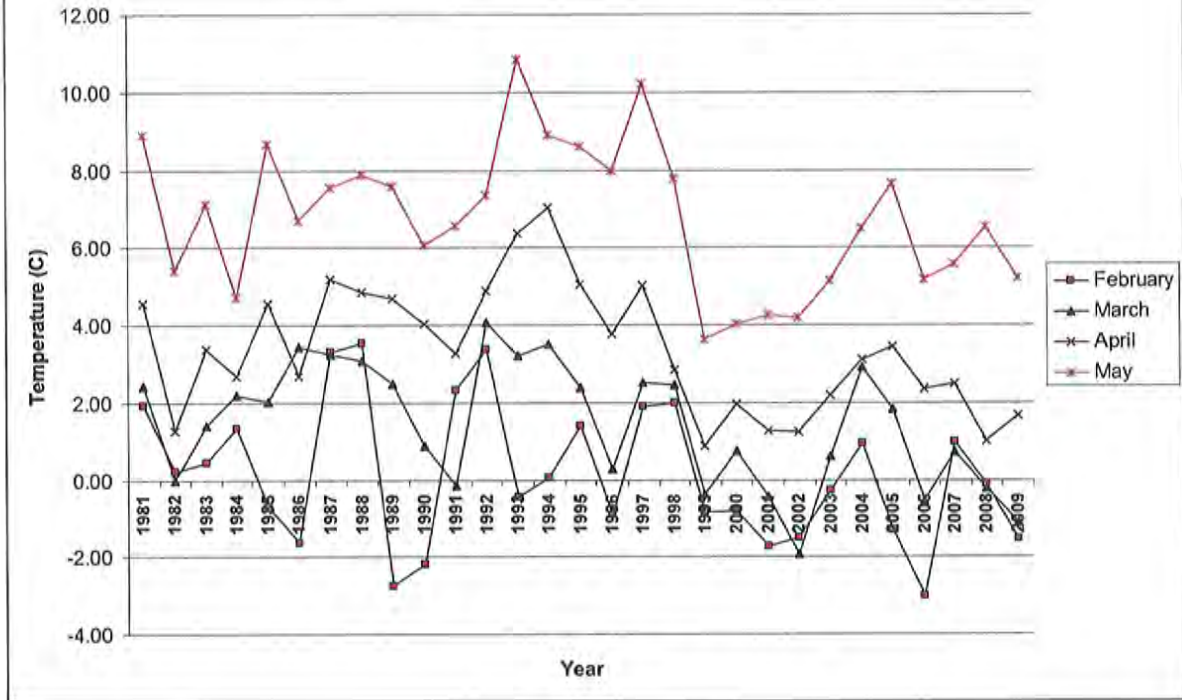


Climate Data from BC Hydro – Strathcona Dam, Campbell River Watershed.

Air Temperature - Mean Monthly Minimums for Strathcona Dam						
Year	January	February	March	April	May	June
1981	4.10	1.91	2.42	4.57	8.91	10.81
1982	-1.89	0.20	-0.03	1.27	5.40	9.45
1983	1.84	0.44	1.41	3.37	7.13	9.98
1984	0.10	1.32	2.18	2.69	4.73	7.86
1985	0.38	-0.71	2.03	4.54	8.68	8.86
1986	2.39	-1.63	3.45	2.69	6.70	8.64
1987	2.84	3.29	3.25	5.19	7.55	9.98
1988	0.13	3.53	3.06	4.84	7.87	10.00
1989	0.69	-2.74	2.49	4.69	7.59	10.20
1990	0.24	-2.20	0.87	4.03	6.08	8.89
1991	-2.19	2.32	-0.14	3.28	6.56	9.31
1992	2.56	3.37	4.05	4.87	7.36	11.10
1993	-3.14	-0.45	3.21	6.38	10.84	11.66
1994	4.40	0.06	3.52	7.04	8.92	11.21
1995	1.75	1.40	2.38	5.04	8.60	11.39
1996	-0.29	-0.92	0.27	3.75	7.99	11.78
1997	0.84	1.89	2.52	5.02	10.24	12.87
1998	-0.42	2.00	2.45	2.86	7.77	10.70
1999	-0.14	-0.84	-0.39	0.88	3.65	8.16
2000	-1.44	-0.80	0.73	1.97	4.02	7.55
2001	0.09	-1.73	-0.43	1.26	4.27	7.32
2002	-0.49	-1.50	-1.93	1.23	4.20	8.67
2003	1.77	-0.26	0.61	2.20	5.16	8.32
2004	-0.93	0.92	2.92	3.12	6.51	9.83
2005	-0.94	-1.30	1.81	3.45	7.66	9.35
2006	0.48	-3.03	-0.54	2.35	5.17	8.71
2007	-1.20	0.98	0.71	2.49	5.58	9.76
2008	-1.48	-0.11	-0.21	1.01	6.54	8.09
2009	-1.31	-1.54	-1.10	1.66	5.23	11.35



Annual Mean Monthly Minimum Air Temperatures for February through May at the Strathcona Dam 1981-2009





APPENDIX IV. – Low Suitability Habitat Descriptions

Pat A

“Pat A” is the most northern part of Paterson Lake. Site conditions are very similar to Brewster - South. There are small patches of emergent vegetation scattered throughout the lake. Hardhack dominates the edge of the lake. Paterson Lake has various fish species such as Rainbow Trout (*Oncorhynchus mykiss*) and Cutthroat Trout (*Oncorhynchus clarkii clarkii*) that would likely prey on amphibian eggs and tadpoles. “Pat A” has a bottom that slowly drops off; the deepest point of this portion of the lake was approximately 3.5 m. At the northeastern corner of the lake a large outlet creek exists, which flows in to the “Pat C” sample site. Pacific Treefrogs were breeding at this site.

Pat D

The “Pat D” site is a medium sized, deep lake that has a very thin littoral zone (approx. 3 m wide). Exposure to predation is likely as fish were observed jumping. Confirmation with the Fish Wizard Database indicated that Rainbow Trout do inhabit the lake. The eastern side of the lake showed the best potential for amphibian breeding habitat as it had slough sedge and lake pondweed. The rest of the lake was somewhat less suitable for amphibian breeding as the fringe was composed of hardhack and downed trees.

Boot 1

This area is more characteristic of a bog and the water that did exist was very shallow (0.15 m maximum). Vegetation was composed of dense hardhack, Labrador tea and *sphagnum sp.* moss. This site was excluded from surveys because of the low breeding characteristics associated with it. “Boot 1” is concealed within a small stand of second growth Douglas fir adjacent to a logging clear-cut.

Boot 2

“Boot 2” is a small lake that drops off quickly from the shoreline (narrow littoral zone approx. 2 m wide) and is very deep. The only vegetation that was observed along the fringe of the accessible areas was hardhack. The poor breeding habitat suitability prompted this site to be excluded from surveys.

Boot 3

This is a small wetland with open water that was very shaded and lacked emergent vegetation. Large woody debris was abundant, while hardhack and skunk cabbage were scattered throughout. This was another site that was excluded from egg mass surveys because of the poor quality of habitat.



Boot 4

The “Boot 4” site constitutes the northern most portion of Boot Lake (Figure 1). The lake at this site is very shallow and was dry in places at the time of our visit. The deepest part of the site was a 1.5 m – 2.0 m trench that ran down the middle and was full of Rainbow Trout, Cutthroat Trout and stickleback (*Gasterosteus aculeatus*). Surrounding the trench were grass mats growing in water with a maximum depth of 12”. The presence of fish in the area would likely mean high predation on amphibian eggs and tadpoles, therefore this site was excluded from surveys.

Brewster South

Brewster - South is the southern-most portion of Brewster Lake. The lake has sharp drop offs, lacks cover for protection from the Rainbow Trout, Cutthroat Trout and Dolly Varden Char (*Salvelinus malma*) and lacks emergent vegetation such as sedges (*Carex sp.*) for attachment of egg masses. The fringe of the lake is dominated by thick hardhack, although a portion of the northwest corner has shallow (1 m – 1.5 m) margins with *Carex sp.* This area of the lake appeared to be the best area for amphibian breeding to take place; Pacific Treefrogs were breeding at this site, but no Red-legged Frog egg masses were observed in 2009.

Cran 1

This wetland has characteristics that would be suitable for amphibian breeding.

Compared to previous years, however, this wetland was much shallower (1 m) in 2009 and portions had dried up (Personal contact – Erica McClaren, MoE) making for low breeding habitat suitability. The vegetation consisted mainly of emergents such as slough sedge and cat-tails. There was also abundant large woody debris along the fringe that was intermingled with hardhack shrubs. Cran 1 is adjacent to Menzies Mainline Logging Road.

Cran Lake

Cran Lake is located off Cranberry Lake Road, via Menzies Mainline. Vegetation along the lake fringe is composed almost entirely of hardhack, especially at the north end. The lake dropped off quickly and was very deep in the middle (approx. 10 m). Cutthroat Trout and stickleback were confirmed to exist in the lake (Fish Wizard Database). All of these qualities combined make for low breeding habitat suitability. Breeding by Northwestern Salamanders was confirmed at this site.

Gray Lake

This is a large lake that is very deep and lacks cover from predation. The lake lacks suitable emergent vegetation such as slough sedge for egg mass attachment.



Like the southern part of Brewster Lake, most of the fringe was barren and dominated by hardhack. Also, Cutthroat Trout, Rainbow Trout and Dolly Varden Char exist in Gray Lake. For these reasons Gray Lake was excluded from being suitable breeding habitat for Red-legged Frogs.

Fry Lake

Fry Lake has many of the same qualities as Gray Lake. Fry Lake has a narrow littoral zone (approx. 2 m in spots), lacks emergent vegetation, is dominated by hardhack and possesses fish, including Cutthroat Trout, Rainbow Trout, Dolly Varden Char and Steelhead Trout (*Oncorhynchus mykiss*). Fry Lake was excluded from surveys due to low suitability breeding habitat.

Gos 1

“Gos 1” was quickly excluded from being surveyed due to the lack of high quality breeding habitat. The water body was a deep trench surrounded by dense hardhack and there was no emergent vegetation growth.

Lawson Lake

Lawson Lake is a large, deep lake that is surrounded by dense hardhack. The edges have very steep drop offs with a narrow littoral zone (approx. 2 m) and as a result emergent vegetation growth is severely limited in the lake. With the presence of Rainbow Trout and Cutthroat Trout, predation is also a factor. As a result of its low suitability as breeding habitat, Lawson Lake was excluded from the egg mass surveys.

Menz L

“Menz L” is a small wetland along Menzies Mainline that has swamp-like characteristics. The site does not contain enough water to support amphibian breeding (water depths ranged from 0.15 m – 0.40 m). There was evidence of the wetland drying in early spring most years. Skunk cabbage was the main vegetation type, although, where “Menz L” joined to a larger neighboring water body dense pockets of hardhack were present.

Mohun 1

This site is located along the Mohun West Mainline logging road, and was created by water backing up behind a beaver dam. The vegetation consists principally of woody shrubs such as hardhack, and patches of skunk cabbage. Lack of emergent vegetation qualifies this wetland for low habitat breeding suitability. The depth of water within the wetland is approximately 1.5 m, except where beaver activity has created a 2.5 m deep trench. Northwestern Salamanders were found breeding at this site.



MW10K

This wetland is located along the east side of Mohun West Mainline close to the 10 kilometer road marker. There is a small beaver dam located on the west side of the wetland. Small vegetated islands with western redcedar, western hemlock, and skunk cabbage are scattered throughout the wetland. The depth of the water ranged from 10 cm to well over 1 m, and the water was discolored from tannins leaching in. The substrate is very soft and muddy with moderate amounts of woody debris cover. Breeding by Northwestern Salamanders was confirmed.

Whymper Lake

Whymper Lake is a medium sized lake that is surrounded by dense hardhack shrubs. The littoral zone appeared to be less than 1m wide, and then drops off suddenly. Overall, the water depth in the lake was approximately 6 m – 8 m. Rainbow Trout and Cutthroat Trout are present. Whymper Lake has a narrow littoral zone (approx. 1 m wide) at which point the lake drops off sharply. There is no emergent vegetation. This lake was excluded from surveys due to low breeding habitat suitability.

