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Observations and Conservation of Coastal Tailed Frog (*Ascaphus truei*) on Sumas Mountain, Southwestern British Columbia

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A Tribute

This article is dedicated to the memory of the late Glenn R. Ryder (1938-2013) who had a challenging life but contributed seven decades of natural history observations in British Columbia that have already been chronicled in a special edition of Wildlife Afield.[4] He was an exceptional naturalist and note-taker and was the first to record Coastal Tailed Frog on Sumas Mountain, on the southwest mainland coast of British Columbia. Between 1955 and 2006, he found these frogs on various dates and at various locations in pristine streams on the mountain. By 2006, he realized the significance of his discovery and started to include more detailed notes for an environmental assessment to help with protection of critical habitats.

Glenn R. Ryder checking a stream on Sumas Mountain, BC, for Coastal Tailed Frog larvae. He discovered an isolated population in 1955 and immediately recognized its vulnerability to logging, mining and quarrying extractions, and later to increasing use by recreationists. *Photo by Phillip S. Henderson*, *October 3, 2006.*

Abstract

The range of Coastal Tailed Frog (*Ascaphus truei*) in British Columbia includes clear fast-flowing mountain streams along the mainland coast. Within this narrow band over 800+ km of mountainous terrain, there remains suitable habitat that has not been identified. This article highlights an isolated population on Sumas Mountain, in the extreme southwestern portion of the frog's range in the province, to bring attention to the need to protect a few small intact watersheds and mitigate the effects of industry, residential development, and recreational use by a burgeoning population in the Lower Mainland.

Introduction

The Coastal Tailed Frog (*Ascaphus truei*; Figure 1) is one of two species in the genus *Ascaphus*, the only taxon in the family Ascaphidae. Both species occur in British Columbia. Until recently they were considered the same species, Tailed Frog (*A. truei*), although they had previously been recognized as separate "races": Olympic Frog (*A. t. truei*) and Rocky Mountain Tailed Frog (*A. t. montanus*).[21] Phylogeographic studies[28] resulted in a split of the species into the Coastal Tailed Frog of the west coast mountains and the Rocky Mountain Tailed Frog (*A. montanus*) of southeastern British Columbia. The two species have been geographically isolated in British Columbia for about 10,000 years.

The Coastal Tailed Frog occurs from northwestern mainland British Columbia south through coastal Washington and Oregon to northern California. In British Columbia, the species is found in coastal mountains from the Skeena watershed south and west Kitwanga, north of Terrace to the Fraser Valley and the Chilliwack River watershed east of Vancouver to the south (Figure 2).[24] Its distribution closely follows that of the upper limit of the Coastal Western Hemlock (CWH) Biogeoclimatic Zone in British Columbia. Eastward expansion of the Coastal Tailed Frog's range in British Columbia is restricted by low temperatures and frozen creeks. Its range extends the farthest east in southern British Columbia where it occurs near Lytton in the Cayoosh Range, northeast of Boston Bar, and in Cathedral Provincial Park in the Cascade Mountains near the United States border.[10,13]

Figure 1. Coastal Tailed Frog, formerly known as Tailed Frog, is a tiny amphibian, less than 40 mm (1.5 in) long, that lives year-round in cold, fast-moving mountain streams from the Skeena River in British Columbia along the coast of North America to northern California. *Photo by Phillip S. Henderson, Wades Creek, BC, October 3, 2006.*

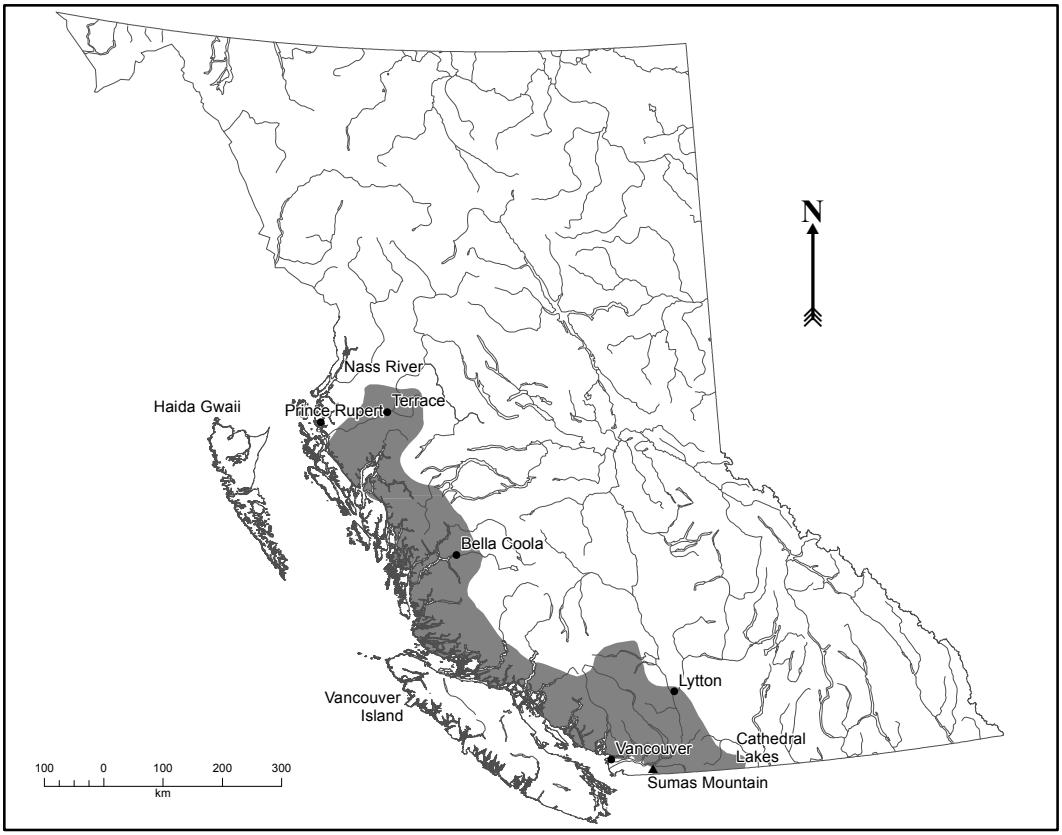

Figure 2. General distribution of Coastal Tailed Frog in British Columbia. It occurs in at least 26 known clusters along the mainland coast that closely follows the upper limit of the Coastal Western Hemlock Biogeoclimatic Zone. It has not been found on offshore islands. Sumas Mountain (extreme south) is identified by a triangle.

The Coastal Tailed Frog is a small frog (30 to 40 mm in length) uniquely adapted to turbulent, cool mountain streams. A visibile "tail", its copulatory organ, makes the male distinct from all other frogs (Figure 3). It is the longest lived North American frog at 15 to 20 years and has the longest period of growth and development (embryo and tadpole stages) of any known amphibian.[18,36] The larval or tadpole stage (Figure 4) may last from 1 to 5 years depending on environmental conditions, with populations at higher elevations taking the longest time and attaining the largest size at metamorphosis.[40] Adults tend to remain near creeks where they feed on insects at night and shelter beneath rocks and logs or in the water during the day.[20] Long distance movement over land is more likely in contiguous mature forest and adults have been found to be twice as abundant in mature forests than in clear-cuts.[23,31,41]

The Sumas Mountain Coastal Tailed Frog population, first discovered in 1955, is geographically isolated with no obvious source for recruitment or replenishment, making it particularly vulnerable to habitat destruction from land clearing, human-related activities, and climate change. As new information became available on the distribution and biology of the frog in the province, the federal conservation status was listed as a Species at Risk and later adjusted downward.[8] It is ranked provincially as,

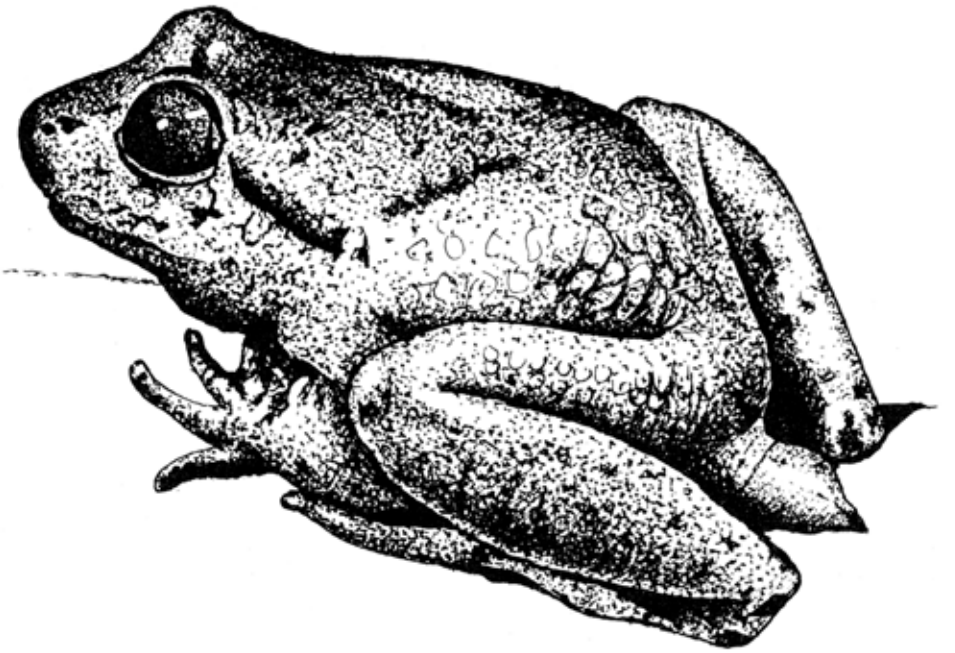

Figure 3. The male Coastal Tailed Frog is the only frog in British Columbia with a prominent "tail". The species has vertical pupils, does not vocalize, and fertilization is internal. *Drawing by Brigitta Van Der* Raay.[5]

"Apparently secure, with some cause for concern". This conservation assessment was based on a review of the Committee on the Status of Endangered Wildlife in Canada reports, expert threats assessments, and new records from eDNA detections.

There are no formally published records for Coastal Tailed Frogs south of the Fraser River and west of the Chilliwack River watershed in the Lower Mainland.[17] However, there are many unpublished records for occurrences on Sumas Mountain (10U 563644E 5441227N). Most of these are from the field notes of the late Glenn R. Ryder including his first (1955) record that was later documented in a 1996 unpublished report.[37] In that report Ryder provided lists of species at risk on Sumas Mountain for consultants preparing environmental assessments and for conservation groups preparing reports on the mountain. Research for that paper uncovered new, unpublished records for Coastal Tailed Frogs on Sumas Mountain previously unknown to the author. These new records are all from the 2000s.

The main goals of this paper are to document all known records for this species on Sumas Mountain, acknowledge Glenn R. Ryder's efforts to protect the Coastal Tailed Frog, and highlight the vulnerability of the Sumas Mountain tailed frog population from habitat loss and degradation by human activities and climate change. Changes in environmental conditions and threats to the Sumas Mountain frog population may be more severe, immediate, and permanent than for less isolated populations.

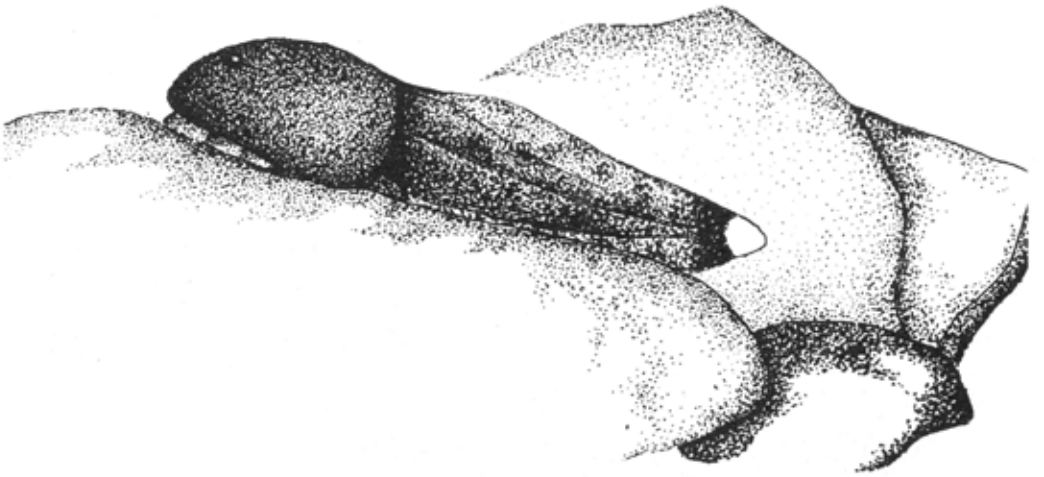

Figure 4. The length of the larval period for Coastal Tailed Frog, to metamorphosis, usually occurs in four to five years depending on such factors as stream temperatures and length of growing season.[3] *Drawing by Brigitta Van Der Ray.*[5]

Sumas Mountain Location and Characteristics

Sumas Mountain is located on the south side of the Fraser River, approximately 10 km north of the United States-Canada border and 60 km east of the city of Vancouver (see Figure 2). The mountain is approximately 6.4 km (4 miles) wide and 15 km (9.4 miles) long, extending southwest-northeast along the south bank of the Fraser River. It consists of a series of small peaks increasing in elevation from southwest to northeast: McKee Peak at 460 m (1,509 ft), Taggart Peak at 780 m (2,560 ft), and Sumas Peak at 900 m (2,952 ft). The total area of Sumas Mountain, using the 80-m elevation cline as its base, is approximately 6,330 ha (15,642 acres). The adjacent lowland along that 80-m elevation cline is predominantly floodplain/agriculture along the northwest and southeast (76%), river features (Fraser River, Sumas River) along the north and northeast (16%), and non-floodplain lowland (urban) features along the southwest (8%).

Biogeoclimatic Zone

Sumas Mountain is in the Coastal Western Hemlock (CWH) Biogeoclimatic Zone, the region with which Coastal Tailed Frog distribution in British Columbia is most closely associated. Sumas Mountain comprises three subzones of CWH, two of which occur above 80 m elevation (Table 1).

- Coastal Western Hemlock dry maritime (CWHdm) above the CWHxm1 and covering most of the mountain

- Coastal Western Hemlock very wet maritime (CWHvm2) in a small area at the highest elevation.

Table 1. Areas of Sumas Mountain above 80 m elevation by biogeoclimatic zone and climate characteristics.[32]

Biogeoclimatic Zone	Area (ha)	% of Total	Climatic Characteristics
Coastal Western Hemlock dry maritime	6,123	97	mean annual precipitation (1,827) mm)
(CWHdm)			mean annual temperature (9.8° C)
Coastal Western Hemlock very wet maritime	207	3	mean annual precipitation (2,787) mm)
(CWHvm2)			mean annual temperature (8.2° C)
Total	6,330	100	

The CWHdm subzone predominates on Sumas Mountain. The CWHvm2 subzone occupies a small area at the highest elevation and CWHxml occupies the mountain base and surrounding lowland.[30]

Coastal Tailed Frogs have been recorded in all three of these CWH subzones elsewhere in British Columbia but only in CWHdm on Sumas Mountain. Table 1 shows the relative contribution of CWHdm and CWHvm2 on Sumas Mountain above 80 m and the general climatic characteristics of each.

Geology

The eastern half of Sumas Mountain, the area of highest elevation, is granitic rock. Adjoining this to the west is the second largest distinctive geologic area, comprised of volcanic rock. A more detailed description of the mountain's geology, including bedrock and glacial deposits, has been published by Huntley and Thompson.[16] All records of Coastal Tailed Frogs on Sumas Mountain are in these two areas. This fits their expected distribution based on known habitat characteristics of stream substrate which includes large, solid rocks not easily moved or reduced (fractured) and often granitic. They are not found in streams with readily fracturing sedimentary substrate that produces an abundance of fine gravel and sand or where sediment collects (Figure 5).

Figure 5. Coastal Tailed Frog cannot survive in sections of waterways with fine sand, gravel, or where sediments collect. *Photo by Phillip S. Henderson, Wades Creek, BC, 2 October 2015.*

Land Ownership

Land tenure on Sumas Mountain falls into six categories. The approximate contribution of each category to the area of the mountain is: private land (47%), un-surveyed crown land (23%), parks (18%), crown land (11%) and first nations (1%). Crown land and recreation areas occupy most of the north and northeast half of the mountain. The Bert Brink Wildlife Management Area is present in the lowlands across Sumas River to the northeast. Private property projects eastward and in towards the centre of the mountain and occupies a large portion along the Fraser River, the location of a large gravel quarry.

Walking and biking trails and pathways for off-road vehicles have grown rapidly over the last 10 years[4] and will continue to grow as the human population increases in the surrounding area and on the mountain itself. Not included on most maps is "Ryder Trail" built by Glenn Ryder for nature observation, which ascends the mountain northward from just west of Goose Lake.

Coastal Tailed Frog Records for Sumas Mountain

There are three sources of records for Coastal Tailed Frog on Sumas Mountain; the field diaries of the late Glenn Ryder (Figure 6), updated research by Phil Henderson, and incidental observations by municipal employees, wildlife consultants, and conservationists.

Figure 6. Glenn Ryder was an astute observer of nature and carefully documented everything he saw. *Photo by Phillip S. Henderson, Sumas Mountain, BC, 8 May 2005.*

Glenn R. Ryder Field Notes (1955-1992)

Records prior to 2006 were extracted from Glenn's notes that were discovered by Wayne Campbell and sent to Phil Henderson in 2016. In his notes from 1955, 1956 and 1961 Glenn refers to the frogs as "Tailed Toads[1] or Tailed Frogs" and "*Ascaphus truei*" following the current references at that time.[6] In the record from 1992 he refers to them as "Coastal Tailed Frogs"[2] and "*Ascaphus truei*" possibly anticipating a name change to full species status.[28]

Phrases in italics are direct quotes from Glenn Ryder's field notes.

Glenn Ryder recorded Coastal Tailed Frogs on Sumas Mountain between May 7 and September 26 at least 10 times in six different years – 1955, 1956, 1957, 1959, 1961, and 1992. Some of his trips were extended overnight camping expeditions to explore the area. His initial 1955 observation is the most frequently noted record for Sumas Mountain and was first documented in a consultant's report of wildlife on Sumas Mountain.[37]

Glenn recorded Coastal Tailed Frogs along Wade's Creek and its tributaries (Figure 7a,b,c,d) and along Chadsey Creek and Poignant Creek. Glenn's records, for which specific locations were given, range from 365 m elevation in Bakstad Brook, a tributary of Wade's Creek, to 642 m in Chadsey Creek at the Chadsey Lake outflow. Glenn's observations along Poignant Creek were probably between 180 and 295 m elevation in areas away from roads and houses which he tended to avoid. Records by other individuals in the 2000s were all from Wade's Creek and its tributaries and ranged in elevation from 145 m at the footbridge over the Wade's Creek tributary near Sumas Mountain Road to 335 m in Dickie Brook beside Batt Road.

Glenn's field notes have been extracted verbatim from his diaries. He was self-taught and never completed his primary education, yet his collection of writings is the most extensive and comprehensive for British Columbia.[4]

Figure 7. Portions of Wades Creek, on Sumas Mountain, BC, in winter (January) and autumn (October). From left to right, 31 January 2013, 2 October 2014, 2 October 2014, and 30 October 2014. Note the clarity of the creek. *All photos by Phillip S. Henderson.*

• **May 7, 1955** [Chadsey Creek at Chadsey Lake outflow; 10 U 5623545E 5441685N; 642 m el; weekend trip]

(1) found in a pool at Base of a small waterfall [cascade] *I caught It* Ascaphus truei. *Just down the Creek from the Lake the small toad was just a little more than one inch in length Colour on the Back is Darkish grey with Black patterns on Back and on the legs. Also a Dark line on the head, plus the short tail. More work is needed on these small Amphibians.*

• **June 18, 1955** [as above; on 6-day camping trip exploring Sumas Mountain; Figure 8]

At Chadsey Creek out flow from the Lake I find a few (5) small Toads these are the Adult Tailed Toads or frogs hopping about above the creek.

• **June 21, 1956** [as above; on 4-day camping trip exploring Sumas Mountain]

Tailed Toad or frog Ascaphus truei *(6) Adults only seen at the outflow Creek edges this are very small frogs for sure and hard to spot in the rocks and dirt.*

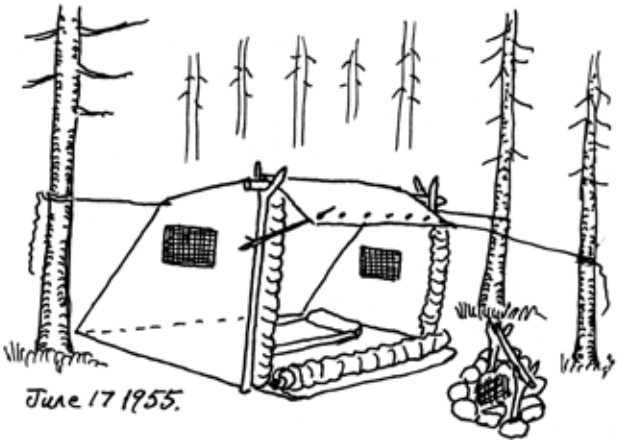

Figure 8. At 18 years old, Glenn was already a veteran outdoorsman and was very well prepared for extended camping trips. During seven days exploring Sumas Mountain in June, 1955, he accumulated 14 pages of field notes with many new distributional records for amphibians, birds, and mammals. *Drawing by Glenn R. Ryder, Chadsey Lake, BC, June 17, 1955.*

• **June 22, 1956** [Poignant Creek; 10U 560585E 5440467N. 420 m el; on 4-day camping trip exploring Sumas Mountain]

I clear out a spot for my Camp and tent above the Creek. I go down to Poignant Creek for water for Cooking and Drinking (Figure 9)*. I find a number of small Adult Tailed Toad or frogs (9)* Ascaphus truei Stejneger*. I walked the Creek edges counting these small frogs as they jumped out of my way. I also seen the Tadpoles in the Rocky Pools of this creek Black to grey looking young with the large mouth Disk sucker that holds them onto smooth rocks in the fast moving waters. I counted some (15) Tadpole in Pools, etc.*

• **June 23, 1956** [as above]

I am up early this morning to a good day and start off with a hike down to Poignant Creek to a pool and have a swim in It the waters are much warmer than at Chadsey Lake. During my time at the Creek I seen more small Tailed Toads or frogs and some Tadpoles but not at the pool I was in. Tailed Frogs (Frogs) (9+) Adults were found on the top of the Creek Bank and hopped over the edge and into the Creek and hid from me. Tadpoles (18+) seen in the rocks in the Creek and I counted their numbers in the area.

• **May 4, 1957** [details as for May 7, 1955]

Tailed Toads Ascaphus truei. *(2) one seen jumping into the water at the outflow from this Lake* [Chadsey] *Creek area. The second Toad seen under a log at edge of Creek.*

• **June 27, 1959** [Poignant Creek; west of the Upper Sumas Mountain Road]

Tailed Toad or frog Ascaphus truei *(6) seen these very small Adults on sides of Poignant Creek in the gravel. But No Tadpoles were to be found.*

• **September 26, 1961** [Poignant Creek; Figure 9]

I made a count during my hike on this stream well up from North Clayburn Creek. Likely a mile or Two. Adults small little creatures seen some (4) was all. Tadpoles some (62) counted in various pools between rocks along this creek. Blackish grey with Big sucker type of a Mouth to hold onto smooth stones. Water level low now. Three American Dippers getting some of the young tailed toads.

Figure 9. General location of Glenn's camp near Poignant Creek on Sumas Mountain, BC, during four-day camping trip on Sumas Mountain, BC, June 21-24, 1956. *Sketch by Glenn R. Ryder.*

• **September 27, 1961** [Poignant Creek]
I went Down to the Creek for a wash. While at the creek I noticed more Tailed Toads or frogs. Seen some (3) small Adults at Creek side above the Creek also seen some (14) Tadpoles n pools between the Rocks and Stones. I sat by the Creek edge taking notes.

• **On September 25, 1992,** Ryder observed 58 tadpoles and 5 adults on Sumas Mountain:

• **Friday September 25 1992.** *(Area Poignant Creek.) Tadpoles (58) are counted up this stream in various pools and between the rocks in the Creek. I caught a couple to check them. I used a small plastic Cup. These Tadpoles are well equipped with a large suction mouth to hold onto smooth rocks in the Creek to keep them from being swept downstream. The ones I checked over do not yet have any legs, others have become Juveniles and have left the Creek Pools for the edges of this Creek.*

• **August 11, 1992** (Chadsey Creek; 5 day camping trip to Sumas Mountain; details as for May 7, 1955]

I visited the Chadsey Lake out flow Creek [Chadsey]. *Here I find some (5) Adults plus some (7) Tadpoles Tailed Frogs.*

• **September 25, 1992** [Poignant Creek; 2 day-trip]

Adults (5) seen while hiking at creek edge and up at woods and (58) Tadpoles counted in various pools and between rocks in the creek. I caught a couple in a small plastic Cup to check them out.

• **October 2, 2006** [Wade's Creek at Bakstad Brook (name from Abbotsford online WebMap 2016); inventory with author; 375 m el.]

Tailed Frog Tadpole at Wade's Creek Canyon. One captured on rock in creek. Creek waters now very low.

• **October 3, 2006** [as above; 380 m el.]

One young frog (2 cm snout to vent length) on forest floor near edge of creek by a bike trail coming off a residential property at the end of Brown Road. Tailed Frog Tadpoles (12) at Wade's Creek Canyon attached to rocks in creek (Figure 10)*. Largest tadpole was 4 cm.*

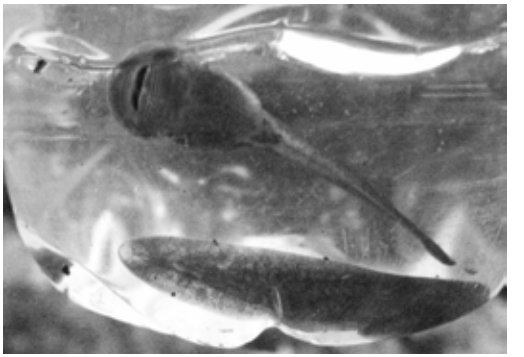

Figure 10. The water level in the creek was very low. *Photo by Phillip S. Henderson, Wades Creek, BC, 3 October 2006.*

Phil Henderson Surveys (2006-2017)

In 2006, Glenn Ryder and the author recorded tailed frogs on Sumas Mountain and the author subsequently confirmed their presence in the same stream reach in 2013, 2014, and 2015, after Glenn's death in October, 2013.[4] Those searches did not follow rigorous protocol but relied on the detection of larvae on surfaces visible from above while walking the creek. Few in-stream rocks and no large boulders were displaced to examine hidden surfaces for larvae. Creek banks and near creek terrestrial features were examined for juveniles and adults. On two occasions an underwater camera was used to scan hidden and obscured surfaces. The objective of these surveys was not to enumerate all individuals but simply to detect presence or absence of Coastal Tailed Frog larvae or adults.

The results of these informal surveys are presented below. No adults were observed and larvae were only observed on surveys conducted in early October.

• **November 27, 2013** [Bakstad Brook (Wade's Creek); private land; el. 365 to 375 m; time: 12:38 to 13:42 hr; temperatures: air 8° C, water 6.5° C]

No adults or tadpoles located.

• **October 2, 2014** [Wade's Creek and Bakstad Brook; private lands; el. 388 and 447 m; time:15:12 to 15.59 hr; temperature: water 9° C]

Two tadpoles on angular rocks in creek about 1.5 m apart and three tadpoles on rocks in clear shallow brook (Figure 11).

• **October 30, 2014** [as above; el. 401 to 455 m; time: 11:26 to 12:28 hr; point observation at 10U 569403E 5440180N; temperatures: air 10° C, water 8° C.

No adults or tadpoles located.

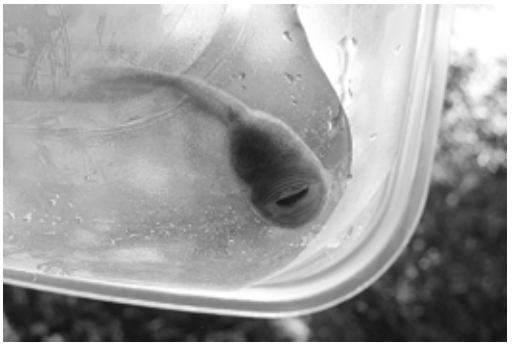

Figure 11. One of the captured Coastal Tailed Frog tadpoles that was captured for photos. *Photo by Phillip S. Henderson, Wades Creek, BC, 2 October 2014.*

• **October 2, 2015** [as above; el.401 to 458 m; time: 12:14 to 14:51 hr]

One tadpole in pool 60 cm x 36 cm; 11 cm water depth; attached to bottom of large pebbles and 5 to 10 cm rocks; tadpole swam to base of large boulder in 4 cm of water.

• **January 13, 2017** [as above; el. 410 to 467 m; time: 11:45 to 12:45 hr]

No adults or tadpoles located.

Miscellaneous Records (2007-2015)

Additional observations of Coastal Tailed Frogs on Sumas Mountain by other individuals were discovered during research for this paper. Sources included Tanya Bettles (City of Abbotsford), Ryan Durand (Taara Environmental), Joanne Neilson and Sofi Hindmarch (Fraser Valley Conservancy), and Natasha Cox (Fraser Valley Watersheds Coalition).

• **2007** [Dickie Brook (tributary of Wade's Creek); private land; el 320 m; Tanya Bettles]

One tadpole located.

• **2009 [Wade's Creek** (10 U 559256E 5441278N); el. 160 m; Ryan Durand]

Unknown number and age reported.

• **2010** [Wade's Creek (unnamed western tributary); private land; el. 190 m; Tanya Bettles]

More than one tadpole located.

• **2015** [Wade's Creek (10 U 559256E 5441278N); private land; el. 145 m; Tanya Bettles]

More than one tadpole located.

• **July, 2015** [Wade's Creek in Sumas Mountain Inter-regional Park; private land; el. 310 m; Tanya Bettles]

One adult located.

• **July, 2015** [Dickie Brook (tributary of Wade's Creek); private land; el. 335 m; Tanya Bettles]

More than one tadpole located.

• **July, 2015** [Wade's Creek (10U 559256E 5441278N); private land; el.160 m; Joanne Neilson]

More than one tadpole located; additional larvae reported by trail users.

Additional Comments From Glenn's Notes

In 1992, Glenn Ryder noted his concern for the effects of outdoor recreation on a frog with such a restricted population.

• **Tuesday, August 11, 1992.** *I hope that people who hike the Centennial Trail* [on Sumas Mountain] *watch where they step at the Creek* [Chadsey] *and area as these tailed frogs are found well away from the Creek and on the Trail that Cuts through the Chadsey Lake area.*

Glenn Ryder and the author spent four field days covering an area of approximately 62 ha (153 ac) for a 2006 environmental assessment on Sumas Mountain for Binpal Engineering Ltd.[1] Glenn's notes from their first outing show that the tranquility he found on visits to Sumas Mountain was being eroded by a sense of dismay and contempt for those who abuse the mountain's natural history.

• **Wednesday September 27, 2006.** *Weather: sunny and clear. We Phil Henderson and G.R Ryder Drove up the Upper Sumas Mtn Rd then up Batt Road to turn off for the Sumas Mtn Road up to the study site an area of ATV Trails and Dumped out Garbage.*

This paints a bleak picture but it was brightened by his time in the field far from the roadside garbage and by his rediscovery of the Coastal Tailed Frogs during that field work. It was near the end of the second field day that Glenn and the author were rewarded with our first sighting of Coastal Tailed Frog larvae.

• **Monday October 2, 2006.** *(Area Sumas Mtn Batt Rd to Wade's Creek). Tailed Frog Tadpole (of interest). A Blackish gray Tadpole* (Figure 12) *is seen in Creek pool by rocks in area 3-B Coastal Tailed Frog* – Ascaphus truei. *Wade's Creek Northwest Creek Canyon or Gully. Creek waters now very low.*

Figure 12. Coastal Tailed Frog tadpole placed in "lunch container" for examination and photographs. *Photo by Phillip S. Henderson, October 3, 2006.*

Further investigations the following day yielded more Coastal Tailed Frogs. Tadpoles were collected for examination and photography:

• **Tuesday Oct 3rd 2006.** *(Area Sumas Mtn Batt Rd to Wade's Creek). As I sat having lunch I seen a Blackish Tadpole of the Tailed Frog. I had my small Dip net so I Caught (2) at a pool with rocks to be checked out properly. We Phil Henderson and myself placed these (2) in a Clear Bottle with the Creek water from Wade's Crk. And checked their sucker like mouth parts all was well these are Coastal Tailed Frogs –* Ascaphus truei. *So I collected some (5) in all for the Bottle some are placed in my shallow lunch container for photographing by Phil. H. I walked the Creek Counted some (12+).*

Threats

This isolated Coastal Tailed Frog population may be harmed by human activity because of the species' restricted range, habitat specificity, physiology and behaviour (Figure 13). Habitat degradation from human activities ensures that the Coastal Tailed Frog's distribution remains restricted and its status in British Columbia (or at least the status of certain individual populations) remains precarious. Threats related to human activities may be obvious, direct and immediate or insidious and unapparent at a particular point in time.

Logging has been the main impetus for studies of Coastal Tailed Frogs throughout its range.[9,35,39] Coastal Tailed Frogs are particularly vulnerable to forest harvesting because of their long larval periods, limited periods of activity during the year and low reproductive rates.[34] The reduction of vegetation cover directly and indirectly affects Coastal Tailed Frogs.

Forest harvesting activities harmful to the Coastal Tailed Frog and its habitat are ongoing in British Columbia,[35] despite its designation as a Species at Risk (currently by COSEWIC and formerly by the British Columbia government), the recommendations and guidelines developed to conserve the species, and our knowledge of the effects of logging on the species from the many studies completed in British Columbia, Washington, Oregon and California (Figure 14). Under the Canadian Forest Stewardship Council or British Columbia's FRPA there are no reserve zone width requirements (width = 0) for small, non-

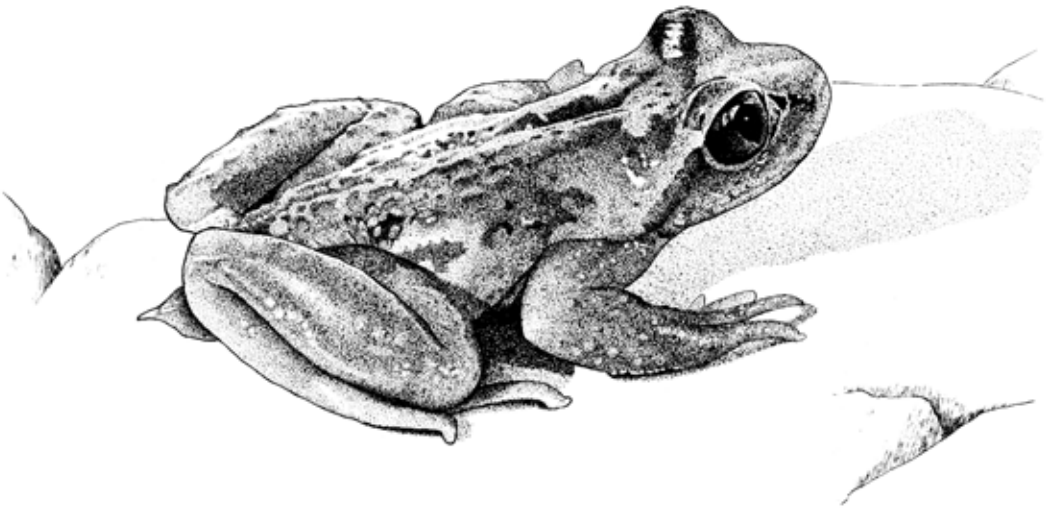

Figure 13. The Sumas Mountain population of Coastal Tailed Frog is in jeopardy because of its isolated nature. *Sketch courtesy Keith Taylor.*[12]

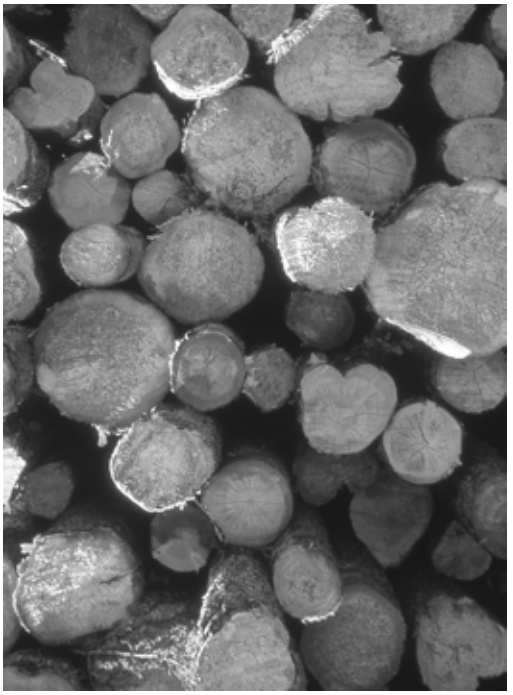

Figure 14. Forestry guidelines for protecting small, non-fish-bearing streams in BC do not address specific habitat requirements for the Coastal Tailed Frog. *Photo by R. Wayne Campbell.*

fish-bearing streams (rated S6 as non-community watershed streams without fish and an average width of ±3 m) that typify Coastal Tailed Frog habitat on Sumas Mountain and elsewhere.[34,35,38] Guidelines for forestry in British Columbia are rooted in the protection of fish habitat and although they protect habitat for other organisms such as Coastal Tailed Frogs this protection is unintentional and haphazard, its effectiveness unknown and presumably variable and unreliable.

Much of Sumas Mountain has been logged, leaving regenerating and mature second growth forests and little area of original forest. Two current woodlot licences adjoin one another and occupy most of the un-surveyed Crown Land in the north portion of the mountain. They comprise approximately 18 percent of the area shown in Figure 7. Additional woodlot licences are highly unlikely (G. Klassen, pers. comm.). The author was unable to determine whether logging may occur under other programs such as in Supply Blocks within the Timber Supply Area.

Mining and small hydroelectric projects with associated roads also threaten this species. There are currently three operational quarries on Sumas Mountain. Mineral claims are present on approximately 36 percent of the area and include locations of Coastal Tailed Frog observations.[2] They cover most un-surveyed Crown Land. Additional industrial, commercial and residential development may also affect frog populations. Outdoor recreation near urban centres results in trails, small clearings, stream crossings for foot, bicycle and off-road vehicle traffic, and the intrusion of humans and their dogs which may disrupt physical stream features or stream processes, impede species' movement, alter species' behaviour, or result in direct mortality.[25,26]

Glenn Ryder expressed his concerns about the potential adverse effects of residential development and mountain biking on Sumas Mountain Coastal Tailed Frogs:

- **Tuesday October 3, 2006.** *We also found older Mtn Bike trails with wooden Bridges over Wade's Creek some high places with Devils Club below some trails at Creek low down that Came from a House off of Bakstad Road at S/West end of Brown Road in area of the Big old growth Douglas firs etc I find this property and house much too close to Wade's Creek and more likely to be Built in the area. At this point we don't know how many Coastal Tailed frogs are to be found here and just how vulnerable they are with the presence of Humans so close to this Creek.*

At the Creek where the Mtn Bike trail comes from a House at the end of Brown Road I see a Young Tailed frog and capturer It. Phil Henderson took Photos. Having the Bike trail so near to Creek that the Biker likely runs over these small Frogs without a thought.

The risk of fire may increase as the number of people visiting the mountain increases. The Fraser Valley Regional District and Metro Vancouver closed Sumas Mountain Regional Park to visitors in July of 2015 due to high fire risk during a prolonged period of drought. The mountain was again closed to the public on August 4, 2017 due to "high temperatures and dry conditions."[11] Evidence of "campfires" along Ryder Trail on the east side of Sumas Mountain and the carelessness of some park users highlight this risk. The effect of fire on Coastal Tailed Frogs is poorly understood.[15]

For Coastal Tailed Frogs, a temperate species that depends on a cold environment, increased temperatures and reduced thermal cover will threaten population viability. A major anticipated problem for "cold-blooded" animals in the face of climate change will be staying cool. If they are unable to adjust their behaviour, alter their activities and seasonal timing of reproduction, then an evolutionary shift will be required for their survival.[19]

For many of his discoveries, Glenn Ryder maintained a cautious approach in publicizing new (formerly unknown) occurrences of organisms for fear this would attract the attention of naturalists, consulting biologists and government biologists that, despite good intentions, would bring harm to the organism. For important discoveries of vulnerable species he often felt it was better for the organism that their location not be publicised. In these cases he would request that Wayne Campbell, to whom he sent all his wildlife notes, withhold information on the species and their locations (R.W. Campbell, pers. comm.).

Glenn was aware that by suppressing information on rare organisms, development may proceed without considering its effects on the organism he hoped to protect. When he discovered that populations he was familiar with were threatened by development, he provided information to conservation groups and consultants in hopes they would be protected. He also volunteered his time to conduct surveys of properties for which he knew development was proposed. He was very much troubled when the information he provided was not given the importance or weight he felt it merited to stop or alter development to ameliorate its effects. This did nothing to encourage him to divulge information about the organisms he cherished.

The formal publication of records for Coastal Tailed Frogs on Sumas Mountain may attract the attention of biologists eager to further understand this population, or naturalists simply eager to see one without having to travel to remote locations with difficult access. This highlights an additional threat seldom considered: the adverse effects of conducting surveys. Despite the lack of direct evidence for population or habitat destruction through sampling, researchers still believe that a "light touch[3]" approach will reduce the potential for impacts on the target populations and their habitats, especially for sensitive or restricted populations.[27,33] In isolated mountains or mountain ranges, habitat alteration of small areas may imperil populations and species.[7] This includes the threat of disruptive sampling on sensitive and restricted populations of Coastal Tailed Frogs. Survey methods should be chosen after carefully considering what information is required and what level of accuracy is required to better understand and protect the population (M.P. Hayes pers. comm.).

Discussion

For much of his life, Sumas Mountain was Glenn Ryder's mountain. No one spent more time on the mountain than he did in discovering its secrets, unravelling its mysteries and recording it all (Figure 15). Animals and plants were the focus of his outings in addition to the cultural history of the Sumas First Nation (The Sema:th people). Since 1954 he studied Sumas Mountain and cared for it as best he could until the increasing number of people and signs of disrespect for nature overwhelmed him. His failing health made the trips difficult while the people made them less desirable. "His" mountain was becoming "their" mountain. He spent his last years exploring woods in lowlands closer to home where the absence of humans allowed him to focus on nature.

Figure 15. It the mid-1950s, Glenn Ryder and his brother Donald, had to take their camping gear on a bus the 60 km from Surrey to Sumas Mountain. Once Glenn stepped off the bus, note-taking began! *Photo by Phillip S. Henderson, 23 April 2010.*

Figure 16. As the human population increases and expands in the Fraser River valley, Sumas Mountain is becoming a favourite site to hike, walk, and enjoy other recreational activities. *Photo by Phillip S. Henderson,*

The geographic isolation of Sumas Mountain and other characteristics, such as its small size, low maximum elevation which provides limited opportunity for habitat elevation shifts with climate change,[14] increased urbanization and recreational use (Figure 16), suggest that the Coastal Tailed Frog and other organisms of conservation concern on Sumas Mountain are threatened. We do not know whether populations of Sumas Mountain frogs are stable, increasing or decreasing. Past human disturbances, including logging, quarrying, road construction and high elevation clearing for telecommunication towers (Figure 17), may have contributed to population declines that may not be evident for some time. We must address current issues and threats with the knowledge that their effects may not be immediately apparent and that their contributions to species' declines are cumulative.

Glenn Ryder was the first to identify the Sumas Mountain population of Coastal Tailed Frogs and to recognize its vulnerability. Threats to Coastal Tailed Frogs and other organisms of conservation concern on Sumas Mountain are cumulative and multiplicative. Habitat degradation and destruction

Figure 17. Telecommunication and broadcasting towers, usually tall structures built on high points of land, may require access roads for maintenance, spraying to control vegetation, and stream crossings. *Photo by R. Wayne Campbell.*

from human activities are the most significant and obvious threats whose effects will be exacerbated by climate change.

While Glenn Ryder was aware of climate change he was more attuned to immediately apparent threats, particularly those resulting from human activity. Climate change has garnered much attention but the greatest current threat to species and ecosystems is land use change. Land use change from human activity includes forest clearing for residential development and industry and conversion of natural spaces for agriculture. It is progressing at such a rate that adaptation by organisms to climate change will be impossible.[29] Methods for increasing ecological resilience at a large scale can be applied to smaller areas such as Sumas Mountain. When assessing the ecological features of a smaller unit or area it is important to consider the influence of the surrounding features.

A cautious, conservation-focussed approach to development and recreation on Sumas Mountain is necessary to ensure that the mountain's population of Coastal Tailed Frogs and other species at risk persist. Guarding against the degradation and destruction of habitat for Coastal Tailed Frogs on Sumas Mountain may allow them to persist over a longer period and contribute to ecological resilience on the mountain. Since much of the Coastal Tailed Frog habitat on Sumas Mountain is on private land, political incentives and possibly, legislative adjustments, may be required. Studies on the Coastal Tailed Frogs should only be undertaken after a careful appraisal of what information is required to help conserve the population and how best to acquire it without harming the population.

The need to protect the Sumas Mountain population of Coastal Tailed Frogs is possibly greater than for any other known population of this species in British Columbia. Critical habitat should be identified and protected since it is not mandated for species of special concern and can therefore be destroyed. The conservation of Coastal Tailed Frogs on Sumas Mountain will take the effort and cooperation of many – property owners, industry, recreationalists, and governments – but above all it will take their willingness.

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Figure 18. Layers vegetation that helps maintain a cool environment for the Coastal Tailed Frog is a critical component of the amphibian's habitat. *Photo by Phillip S. Henderson, Wades Creek, BC, 2 October 2014.*

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Figure 19. A tiny frog, about the size of a thumb, which lives in cold, clear streams, has recently been the focus of herpetologists and government workers because of its unique habitat along the North American coast. *Courtesy of David. M. Green.*

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Figure 20. It takes the Coastal Tailed Frog 1-3 years to metamorphose and it reaches sexual maturity 3-5 years later. *Courtesy of David M. Green.*

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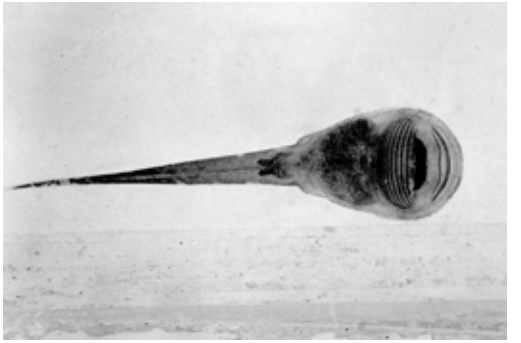

Figure 21. During the transition period from tadpoles to young adults, Coastal Tailed Frog uses its sucking mouth parts to scrape off algae and diatoms on which it feeds. *Courtesy of David M. Green.*

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About the Author

Phil Henderson is an environmental consultant who travels widely through British Columbia and Alberta conducting studies on plants and animals for other consultants, industry, government and conservation organizations. He first met Glenn Ryder in Fort Nelson in 1977 when Glenn visited with a group of investigators led by Wayne Campbell who were gathering information on birds for the seminal *Birds of British Columbia* volumes. After settling in Fort Langley in the 1990s, Phil got to know Glenn and teamed up with him on projects and accompanied him on forays into local woods. Frequently, those outings were to Sumas Mountain, Glenn's favourite local haunt. With Glenn's knowledge of Sumas, he was the obvious choice to help out on a consulting assignment that led to his re-discovery of the tailed frog on Sumas Mountain and Phil's introduction to the species. In his spare time, Phil continues to gather information on plants and animals near and far.