Assessing the impacts of vehicular mortality of migrating amphibians near Ryder Lake, British Columbia

Measuring a dead Northern Red-legged Frog that was hit by a passing vehicle (Walter 2010)

Prepared For:

Fraser Valley Conservancy
Placing lands in trust for our future

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PREFACE

The Fraser Valley Conservancy (FVC) is a not for profit charitable organization located within the Fraser Valley of British Columbia. It is dedicated to placing lands in trust for our future and has mandated goals to, i) protect and preserve the land and watercourses that have recognized local and regional ecological value; ii) to promote, facilitate and engage in land stewardship activities; iii) to protect, preserve and enhance habitat for native species including rare and endangered species, and; iv) to protect and preserve land of recognized local and regional historic value.

The Fraser Valley Conservancy initiated the *Ryder Lake Amphibian Protection Program* in 2007 when the issue of mass migrations and the resulting vehicular mortality was brought to our attention by local landowners. Since its inception, the program has developed from volunteers picking up and moving toadlets off the road by hand to the full road closures currently used during key migratory times.

Through monitoring, research, and community consultation long term solutions are sought. This report outlines our finding to date and provides insight into possible options for future mitigation and stewardship activities.

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1.0 INTRODUCTION

Amphibian populations have been shown to fluctuate regionally and temporally, yet the trend over the last five decades is one of a global decline (Houlahan et al 2000, 752). As amphibians have thin permeable skin and spend time in both aquatic and terrestrial habitats, they are subjected to a greater number of ecosystem disturbances like ultraviolet radiation, disease, and chemicals than animals with a single habitat niche (Cormier 2008). As a result, amphibians are useful bioindicators of environmental stressors (Blaustein 1994, 85) from both natural and anthropogenic sources (DeGaradya and Halbrook 2006). This quality enables amphibians to act as sentinels for human health as they will react to environmental contaminants or stressors earlier than humans and indicate possible human health hazards to come (van der Schalie et al 1999, 311). We stand to loose the benefit of this early detection system as we continue to fragment and destroy amphibian habitat for human development and roadways despite knowing that these activities pose one of the greatest threats to amphibian survival (Ministry of Environment 2010).

With the global proliferation of roads and vehicle use, a correlation has been found between increasing amphibian deaths and areas of increasing traffic intensity (Fahrig et al 1995). Not only can whole populations of native species be indirectly affected by roads intersecting and, thus, fragmenting their habitats (Reed et al 1996, 1105), individual amphibians can also suffer directly from vehicular mortality (Ministry of Environment 2010). Compared to many other species, aquatic breeding amphibians are more likely to be killed on roadways due to their periodical migrations between their three critical habitats: breeding, feeding, and hibernating (Hartel et al 2007, 127; Hels and Buchwald 2001, par. 2). Many of the amphibians making these three yearly migrations are explosive breeders (Wells 1977). A single Northern Red-legged Frog or Western Toad can lay 750 - 1300, and 12,000 - 16,500 eggs respectively (Ministry of Environment 2010). Despite the high fecundity of these animals, over 99% of the offspring will not survive to adulthood (Ministry of Environment 2010) and the addition of vehicular mortality on the remaining one percent can cause significant loss to a local population.

The intent of this report is to assess the timing and location of amphibian road crossings near Ryder Lake, British Columbia, to determine the most appropriate sites for migration tunnels under the roadways. Between February and June 2010, 17 night-time monitoring sessions were conducted along roads surrounding an amphibian breeding site to determine overall biodiversity and species composition during different migratory times. GPS points from all individuals found are used to determine the location of key migratory corridors. Considering assessments of crossing density, road characteristics, and surrounding habitat, four key migratory corridors, and therefore migration tunnel sites, are suggested.

1.1 STUDY SITE

South East of Chilliwack, British Columbia, lies the community of Ryder Lake which is located on an elevated bench-land at the northwest termination of the Cascade Mountains (Figure 1). The study site is between 190m and 265m above sea level and exists within an Eastern variant of the Very Wet Maritime subzone of the Coastal Western Hemlock Biogeoclimactic Zone (CWHxm1); (Ministry of Forests Lands and Mines 2008).The CWHxm1 zones dominant forest cover consists of douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*); (Ministry of Forests and Range 2010).

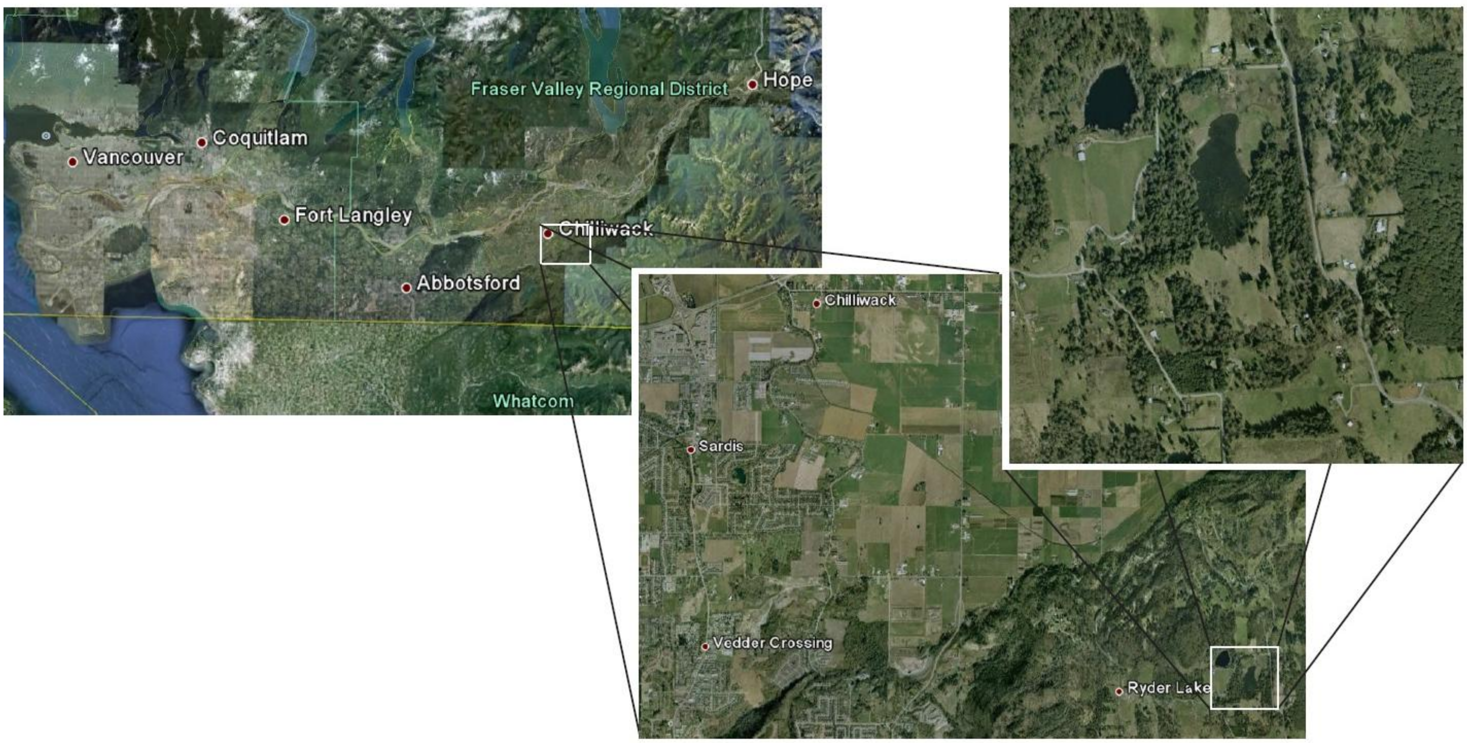

Figure 1: The study site is found within British Columbia's Fraser Valley, south east of the City of Chilliwack, and lies in the rural community of Ryder Lake. (Google. 2010)

The area surrounding the main breeding site consists of residential and agricultural lands with high levels of disturbance such as hay fields, landscaped yards, and cattle pastures. Early successional vegetation such as red alder (*Alnus rubra*), paper birch (*Betula papyrifera*), thimbleberry (*Rubus parviflorus*) and bigleaf maple (*Acer macrophyllum*) line the nearby roads and forest edges. Roads wrap around the West, North and East sides of the wetland and come within 100m at the closest point.

The breeding wetland is shared between three private property parcels. The site used to be a moist cedar swamp in a natural depression that was dammed by beavers in the 1960's (Local Landowner, 2010). In its current state, the wetland is shallowest in its northern end with a maximum depth of ~2.5m and ~50% of its shoreline is domesticated with either mowed lawn or field grass. High levels of natural woody debris, from the now inundated old cedar swamp, occupies the south end of the wetland while the north half is primarily open water with large patches of aquatic vegetation.

1.2 METHODS

A survey route was chosen to encompass portions of Ryder Lake Rd, Huston Rd, and Elk View Rd that surround the main breeding site in the area. The same route was followed each monitoring night by walking in one road lane heading out and the other road lane heading back in order to cover new area with each pass for a total of 5.6 km return. This method of road survey was adapted from the Western Toad / Amphibian Monitoring Program Survey Protocol developed by the BC Ministry of Environment (Ministry of Environment 2009, 6). For consistency, the same person completed all monitoring sessions individually or with volunteers depending on their availability. Data collection began on February 24, 2010 and continued intermittently until June 9, 2010 for a total of 17 sessions. Monitoring nights were selected based on suitable weather conditions for amphibian movement such as rain, fog, or dense cloud cover as amphibians are susceptible to desiccation (Timm et al 2007, 444).

Surveys always began near dark and continued for one hour to four hours depending on the number of amphibians found. Each time an individual was encountered the following information was collected: species name, alive or dead, sex (if determinable), snout-to-vent length, GPS location (Using a Garmin 60CSx), and likely cause of death (if dead). To avoid double counting, live amphibians were moved to the side of the road they were headed to when found and if dead they were moved off to the closest shoulder.

With the collected data, biodiversity calculations were performed using the Simpson Index of Diversity, which represents the probability that two individuals selected from a sample at random will belong to different species (Biofilms and Biodiversity 2011). As Western Toads and Northern Red-legged Frogs are yellow and blue listed species (Ministry of Environment 2010), and are of local conservation concern, this study places more emphasis on these species when considering harm mitigation measures. As a result, the Simpson Index of Diversity was chosen to analyze the species diversity over the Shannon Wiener Index because the Simpson calculations highlight these dominant species in the data set (Nagendra 2002, 175). Further, alpha diversity was calculated for each month of monitoring sessions. Next, a comparison was made to the preceding and subsequent month using beta diversity. This is intended to illuminate the slight changes in the types of species migrating at different times of the year.

It is important to note the following two limitations to this study. First, GPS points were not taken for the first two survey nights; therefore 64 GPS points are absent. Secondly, the data analyzed in this report only covers one year of adult amphibian migration habits. Data gathered in the study's planned second year will need to be compiled before conclusive results can be drawn. Until then, results contained herein are tentative.

1.3 RESULTS

During the monitoring sessions a total of 723 individuals were found from six different amphibian species including Northern Pacific Treefrog *(Pseudacris regilla)*, Western Toad *(Anaxyrus boreas)*, Northern Red-legged Frog *(Rana aurora)*, Rough-skinned Newt *(Taricha granulosa)*, Northwestern Salamander *(Ambystoma gracile)*, and Western Red-backed Salamander *(Plethodon vehiculum)*. Of the 723 individuals 307 (42%) were found alive while 416 (58%) were found dead (Table 1).

Table 1: The composition of all amphibians found is shown in order of abundance along with the percent of individuals found alive and dead during the 17 monitoring sessions in Ryder Lake.

Common Name	**Scientific Name**	**Amount**	**Alive %**	**Dead %**
Northern Pacific Treefrog	*Pseudacris regilla*	334	41%	59%
Western Toad	*Anaxyrus boreas*	266	52%	48%
Northern Red-legged Frog	*Rana aura*	115	25%	75%
Rough-skinned Newt	*Taricha granulosa*	5	0%	100%
Northwestern Salamander	*Ambystoma gracile*	2	100%	0%
Western Red-backed Salamander	*Plethodon vehiculum*	1	100%	0%

The minimum number of individuals found on a single monitoring session was two. The median number of individuals derived from all 17 monitoring sessions was 31. A maximum of 175 individuals were found on April 20th 2010. This monitoring session marked the observed shift in amphibian migration to and from the breeding wetland. Before April 20th the directional trend of amphibian movement was towards the wetland. In contrast, after April 20th the directional trend of amphibian movement was away from the wetland back to forested upland habitat (Figure 2).

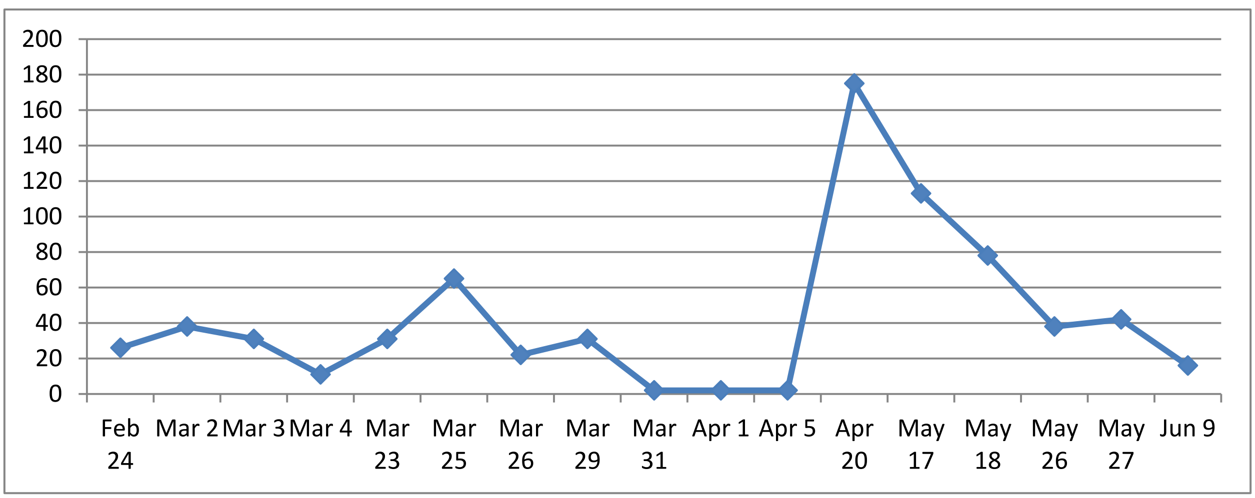

Figure 2: Number of amphibians found during 17 night-time monitoring sessions in Ryder Lake, British Columbia between February 24 and June 9, 2010. Note the lull of amphibian movement in early April that separates migration to the breeding site from the spike of mass movement back to forested habitat in late April.

Applying the count data above to the Simpsons Index of Diversity a D value of 0.63 out of 1.0 is calculated. Next, alpha and beta diversity values were examined in relation to migratory timing. Alpha diversity was lowest in February as only two species had begun to migrate. In contrast, March had the highest alpha diversity as all six species were actively migrating to the breeding grounds. Alpha diversity in April was three while May and June's were four and three respectively. Only the Western Toad and Northern Red-legged Frog were found consistently across all months surveyed. Regarding beta diversity, February and March held the highest values of four and three respectively. These diversity measures may suggest that monitoring and mitigation activities for adult amphibians in Ryder Lake are most warranted during March as it holds the highest alpha and second highest beta values of all months sampled.

Amphibians were found traveling both to and from the breeding site along all areas of the monitoring route. However, by analyzing this study's aggregate GPS data in the computer program Mapsource, four sections of the monitoring route were visually determined to be key migratory corridors as they showed dense or clustered amphibian crossings in both migratory directions. The general migratory directions were assessed by looking closer at the GPS points within the suggested four corridors and cross referencing the point numbers with the date the points were taken. The corridor shown in Figure 3, as an example, contains various points such as #189, 367, 550, and 753 that were found in March, April, May, and June, respectively. This demonstrates that these corridors sustained concentrated amphibian movement in both migratory directions as aggregate migration before April 20th was towards the wetland while aggregate migration after April 20th was away from the wetland.

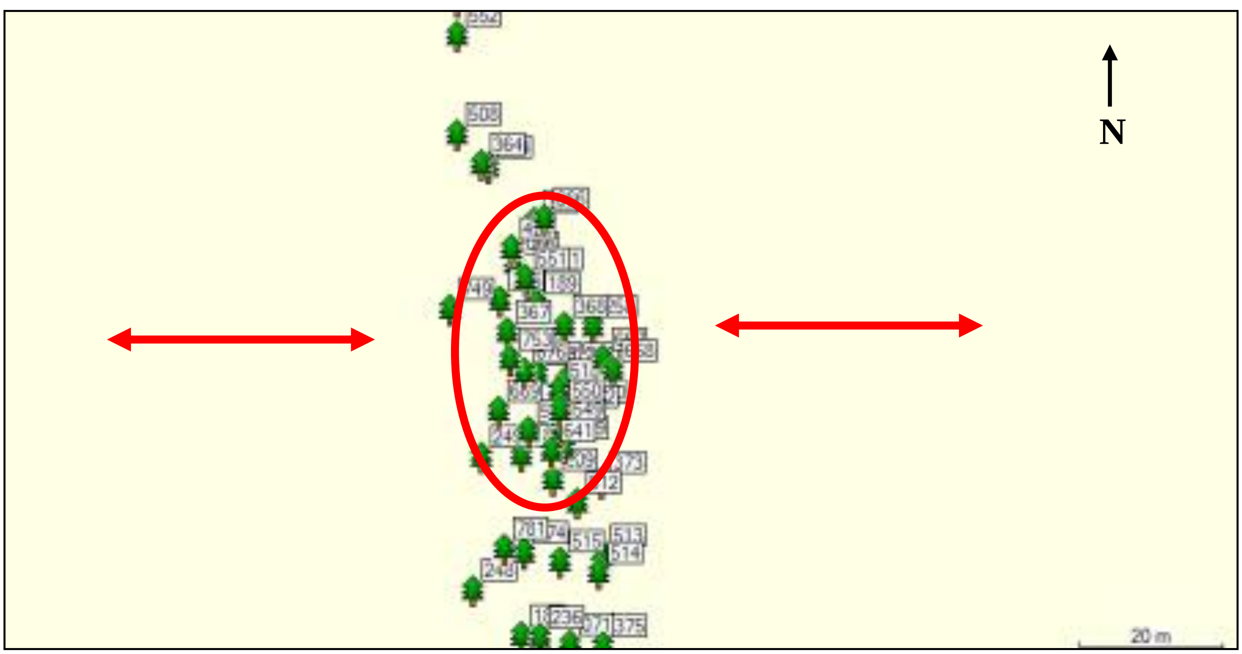

Figure 3: The location of one Key Migratory Corridor is indicated by the red arrows as frequent crossings happen in this location perpendicular to the road. The area for the proposed amphibian tunnel is in the center of the clustered points circled in red.

1.4 DISCUSSION

The diversity of species found during this study is comparable to that of a similar study on Vancouver Island where a D value of 0.73 was found (Derived from Beasley 2006). The increase in D value is, in part, owing to greater evenness in that study's species counts. However, in contrast to expectations the bias of the Species-Area Relationship, where larger areas are expected to have a greater number of species, (Lomolino and Weiser 2001, 431) did not apply when comparing these two studies. The Vancouver Island study site covered 40 km one way (Beasley 2006, 24), 14.3 times longer than this Ryder Lake study area's one way distance, yet the two areas had the same species richness of six. Interestingly, although the mortality rates were higher in the Vancouver Island (VI) study than the Ryder Lake (RL) study, both shared the same top three negatively affected species. These species were the Northern Pacific Treefrog with 82% dead (VI) 59% (RL), Northern Red-legged Frog with 90% (VI) 75% (RL), and Rough-skinned Newt with 92% (VI) 100% (RL). It is possible that the Vancouver Island study's death rates were higher because the contorted bodies of dead individuals may have been easier to spot from a moving vehicle as opposed to stationary live amphibians camouflaged by mottled asphalt or hidden in potholes, surface cracks, and gravel on the road shoulder. While slowly monitoring on foot with a headlamp, live amphibians were often found in those cryptic spots (pers.obs.). Further, we speculate that the Northern Red-legged Frog and the Northern Pacific Treefrog had proportionately higher death rates than other amphibians because these species are capable of jumping high enough and far enough to come into contact with passing vehicles that would have otherwise missed them if the frogs had remained stationary (pers.obs.). This is evidenced by Hels and Buchwald in their 2001 study where they state "amphibians get killed if they are hit, even if only partly, by a wheel but usually not if they remain still under a passing vehicle" (Hels and Buchwald 2001, par. 16) However, as Rough-skinned Newts do not jump, this does not explain why they have the highest mortality rate across both studies and therefore warrants further investigation.

Various forms of prevention and mitigation have been tried around the world to lower the number of amphibian deaths due to vehicular mortality. In Ryder Lake, multiple temporary mitigation measures have been attempted by local residents, volunteers, and the Fraser Valley Conservancy. The placement of temporary signage has been considered, but not implemented in this case because aside from generating public awareness the signs are known to be ineffective (Water, Land, Air Protection 2004, 28). The transport of amphibians from one side of the road to the other via volunteers has been determined to be safe and effective (Water, Land, Air Protection 2004, 28). Yet, the FVC used this method during the summer juvenile migration of 2008 and found that the amphibians' directional orientation was compromised after being placed, and transported, in a bucket (Fox 2010). Further, added stress to the toadlets, inadvertent mortality due to trampling by volunteers, and the possibility of disease transfer was too great a risk to continue this method of mitigation for the juveniles or adults alike (Fox 2010). The FVC has also utilized temporary road closures to protect the short-duration mass-migration of juvenile Western Toads. However, due to the long migration period of the adult amphibians discussed in this report, intermittent road closures from February to June are not likely to be accepted by the community.

To overcome the challenges of short term fixes and unsustainable levels of volunteer effort, permanent long-term solutions are sought. Tunnels are commonly used to permit the simultaneous operation of vehicles on the road surface while amphibians travel below the passing vehicles unharmed (Water Land, Air Protection 2004, 28; Langton, 1989). Such tunnels have been used since 1969 in Switzerland and later in Massachusetts, Texas, California, Florida, and multiple British Columbian locations with varied success (Water Land, Air Protection 2004, 29; Beasley 2006, 26; Ryser and Grossenbacher 1989, 7). Taking into account lessons learned from previously constructed tunnels, and best management practices for amphibians in urban and rural environments, four tunnel sites are suggested here (Figure 4 B). Two of the four locations are relatively vegetated on both sides of the road allowing amphibians to travel primarily under the protective cover of native vegetation. Further, to help avoid desiccation, three of the locations follow waterways such as ditches and streams, while the fourth is almost the shortest route between the breeding wetland and the next closest water body. All four proposed tunnel locations direct amphibians to and from the shallow northern end of the wetland where the adults naturally congregate to mate and the resulting offspring undergo metamorphosis (Ministry of Environment 2010). Consideration was also given to avoid placing tunnels near certain road features such as steep grades and tight corners as tunnels with grated metal tops can become slippery when wet (City of Kingston 2003; Friedman 2009).

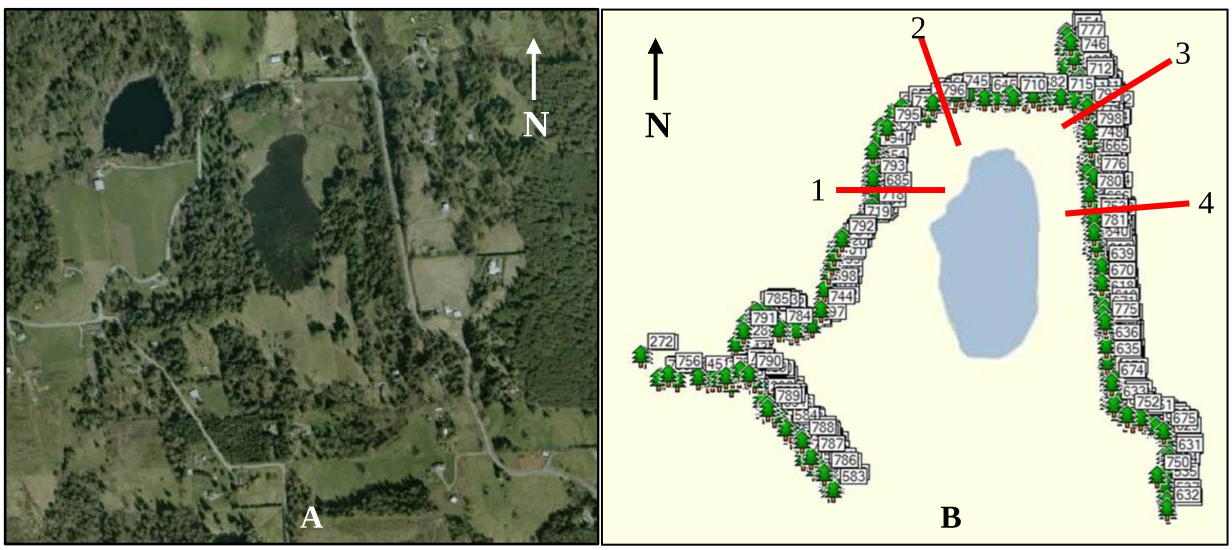

Figure 4: A) This map shows the sections of Ryder Lake Rd, Huston Rd, and Elk View Rd that comprise the survey route and surround the breeding site (Google. 2010). B) This graphic shows the GPS points (as indicated by trees and their coresponding number) marking the location of individual adult amphibians found crossing roads whithin the survey route. The four proposed tunnels are shown as red lines with their coresponding number.

1.5 CONCLUSION

The data shown above is derived from this study's first year. This two-year small-scale study is meant to highlight local issues that could form the base of community stewardship initiatives and inform municipal decision making. It is anticipated that the results of the second year will corroborate the findings from the first and shape the type of long term solution sought. Input and participation from the local community, municipality, biologists, and engineers will be imperative during the planning and construction of any structure. Lastly, ongoing monitoring will be vital to determine effectiveness of any mitigation measures attempted.

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