Western Toad Migration at Summit Lake

2014 Field Season

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EXECUTIVE SUMMARY

Summit Lake hosts a significant breeding population of western toads (*Anaxyrus boreas*). The western toad is internationally listed as *Near Threatened* by the World Conservation Union, federally listed as *Special Concern* by the Committee on the Status of Endangered Wildlife in Canada and *Blue-listed* by the B.C. Conservation Data Centre. Substantial numbers of adult and juvenile toads (toadlets) are killed by vehicle traffic every year on Highway 6 as they migrate to and from the lake. There are three main migrations as adults move to and from the lake for breeding and toadlets leave the lake for upland habitat. Migration is intermittent, taking place primarily during warm, wet nights for adult toads and following rain events for toadlets.

This is the fifth year of an ongoing project initiated to assess road mortality on long-term western toad population trends. The objectives are to estimate the location, timing, direction and severity of highway mortality; determine the efficacy of two underpass tunnels installed by the Ministry of Environment in 2006; and investigate and outline potential remedial measures. In 2011, we began efforts to identify breeding distribution and adult abundance using mark-recapture techniques and through the 2014 field season, we increased our efforts to document nocturnal adult migration locations.

In 2014, breeding was confirmed at most known breeding sites but activity was highest at the three main sites known from previous years. Breeding was first observed on 30 April and the first hatchlings were seen on 21 May 2014.

From 2011-2014, of a total of 1236 adult toads on the highway during surveys, 509 were alive (178 females, 309 males and 22 unknown sex) and 727 had been killed (131 females, 102 males and 494 undetermined) by vehicular traffic.

In 2014, we PIT-tagged an additional 465 adult western toads, bringing the total number of tagged adults to 1964 since 2011. The 2014 mark-recapture data will be analysed in the next annual report.

Across-year recaptures of females (n=22) were examined to determine female breeding intervals at Summit Lake. Twenty-one females were captured two years and one was captured three years. Of these, only two individuals were confirmed to be breeding twice.

In 2014, MoTI installed a new concrete toad tunnel along Summit Lake and migrating toads (and at least four species of small mammal) have already been recorded using it. We are testing fence design and layout options to use with the new tunnel including plastic, mesh and concrete materials. While many adults and toadlets have been recorded using the new tunnel, toadlets are often reluctant to enter the tunnel during migration. We will continue to investigate why this is the case.

We tested a new camera system to monitor the use of the new highway underpass. The system was designed to record every adult toad (and other animal) passing through the

tunnel. So far, the system has been successful in capturing migrating adult toads and other animals using the tunnel. In 2015, we will install similar systems in the other underpasses to compare usage rates.

This season, we incorporated radio telemetry into the project and followed five toads to their hibernation sites near Summit Lake. Movement patterns prior to hibernation varied greatly among radio-tagged animals and movements ranged from 0 to 1700 m between tracking visits. Different individuals also used different forest types including wetter, older forest on the south side of the lake and drier, more open forest on the north side of Summit Lake.

Ground-level habitat complexity was important to all radio-tagged toads and individuals often used small mammal burrows, squirrel middens, mature tree root cavities, and habitat under fallen logs and within moss-covered talus.

On 26 and 27 August 2014, 400-500 people attended the fifth annual Toadfest and an estimated 6853 toadlets were successfully moved in 317 buckets across Highway 6.

ACKNOWLEDGEMENTS

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Thanks also to John Boulanger, Bruce Lintott (happy retirement!), Katie Ward, Chris Price, Dave Heagy and Terry Anderson for partnering on this project. Angus Glass organized Toadfest and designed the new interpretive signs. Thank you to all the Toadfest volunteers who make every year a success. We wish to extend a special thanks to Debra Haas and Jim Hawes, operators of the Summit Lake Provincial Park campground, for their genuine concern for the toads and their continuing, enthusiastic support for the project.

Also, thanks very much to the BC Ministry of Transportation and Infrastructure for funding the installation of a new wildlife underpass at Summit Lake in the summer of 2014.

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1.0 Introduction

The western toad (*Anaxyrus boreas*), has undergone dramatic population declines in southern parts of its range and as a result was assessed as "Near Threatened" by The World Conservation Union (Hammerson et al. 2004). Federally, it is considered a species of special concern (COSEWIC 2002) and it is blue-listed provincially (CDC 2012). Canadian populations appear stable, however little information exists on population trends (COSEWIC 2002) and there is concern that Lower Mainland and Vancouver Island populations may be declining (Davis 2002). The species decline is attributed to a combination of factors including disease, habitat loss and modification, susceptibility to UV radiation, acid precipitation, road mortality and predation (Davis 2002).

The western toad occurs in forested habitats in western North America over a wide range of elevations. The species is predominantly terrestrial but requires standing or slow moving water less than 50 cm deep for breeding (Corkran and Thoms 1996). Communal mating takes place in ponds, lakes, permanent wetlands and flooded meadows from late January to August, depending on environmental conditions (Davis 2002). Females lay eggs in long strands which average 12,000 eggs. Eggs hatch in seven to ten days and tadpoles remain in the breeding body of water for two to three months. Some breeding sites support millions of tadpoles and they often metamorphose into small toads (metamorphs or toadlets) synchronously (Davis 2002). These concentrated abundances of tadpoles and toadlets support a diversity of predators including reptiles, birds and mammals. Toadlets may disperse greater than one kilometer from breeding ponds into terrestrial and wetland habitat and home range sizes are less than one hectare (Davis 2002). Adults spend most of their time under cover and important terrestrial habitat features include coarse woody debris and mammal burrows. During dry periods, adults may be found near streams or wetlands.

The West Kootenay region supports a high density of breeding western toads (Dulisse and Hausleitner 2010). The population of western toads at Summit Lake likely represents a significant portion of the species' breeding population regionally and provincially. However, toads experience significant annual road mortality when migrating individuals cross a five kilometer stretch of Highway 6 (Ohanjanian 1997, Seaton et al. 2005, Seaton 2008, Dulisse et al. 2011). The toad migration at Summit Lake consists of: 1) adults moving from upland, non-breeding habitat in the early spring to the lake to breed; 2) adults leaving the lake and returning to their non-breeding habitat in late spring through fall after breeding; 3) toadlets leaving the lake for non-breeding habitat in late summer or in some cases the following spring. Migration is intermittent; taking place at night for adults and during the day for toadlets, but in all cases involves crossing the highway (Dulisse et al. 2012).

This project was initiated to assess the implications of road mortality on long-term western toad population trends. 2014 project tasks and objectives were as follows:

(a) Adult Toad Mark-recapture data- Data summaries will include; sex weight and SVL

of all captures location, environmental conditions, and documented movements of individual recaptures both within year and between years. Population estimates will be produced through a separate contract with a statistician.

(b) Migration of Adult Toads - Timing, numbers and location of adult western toads migrating to and from Summit Lake. Data are collected from drive-by-surveys, time elapsed surveys and monitoring crossing structures. Adult Toad Mortality documented on the hwy or elsewhere will be summarised. Sex specific differences in timing, location of migration of highway mortality will be analysed and discussed. 2014 data will be presented and compared with previous years data.

(c) Toadlet Migration data - data will be collected following the protocols established in Dulisse and Boulanger 2013. Previously established transects will be sampled during the toadlet migration period. Plot data will be summarised to determine live and dead toadlet densities by established highway sections. The location, seasonal timing and environmental conditions related to toadlet densities will be presented for 2014 and compared with data from previous years.

(d) Assessment and testing of mitigation structures - The contractor will assess the effectiveness of fencing and tunnels at reducing mortality of western toads. Fencing costs and installation will be provided by the MFLRNO-FWCP-section. This section of the report will describe the fence and tunnel design and materials and effectiveness. Photo monitoring to determine toad use of tunnels; adult captures and toadlet numbers and behaviour observed along the fence, comparisons of adult and toadlet mortality estimates in fenced and adjacent unfenced areas.

(e) Recommendations for mitigating structures - Based on the above analyses the contractor will assess the effectiveness of current structures and recommend any changes to these to reduce mortality. Recommendations will include photos and a map of the locations of existing and recommended future crossing structures and associated fencing. Recommendations should be supported by population or demographic data to the greatest extent possible. Methods to monitor the effectiveness of mitigation options should also be detailed.

(f) Deliverables will include excel databases in WSI format for items a) through d), spatial data points, maps and photographs.

1.1. Study Area

Summit Lake is located adjacent to Highway 6, 15 km southeast of Nakusp and 27 km northwest of New Denver (Figure 1). The lake is located at 764 m in elevation and covers an area of 150 hectares with 8400 m of shoreline. It is approximately 3.6 km in length and ranges from 360 m to 611 m wide with a mean depth of 4.4 m and a maximum depth of 17 m. Eight creeks flow through culverts under Highway 6 and into Summit Lake and Bonanza Creek drains Summit Lake to the East (Figure 1).

Highway 6 runs along the south shore of the lake and ranges from 5-300 m from the shoreline. An abandoned rail right of way runs along the north shore of the lake. This rail line has been converted to a multi-use trail. Summit Lake Provincial Park (6 ha) is

located on a peninsula which extends northward into the lake from the highway (Figure 1). Facilities in the park include a boat launch, day use picnic area, public beach and 35 vehicle-access camp sites. The park is open seasonally from 27 April to 27 September. To the east of the park, there is a day-use rest area with picnic tables and a boat launch (Figure 1).

Summit Lake falls within Moist Warm Interior Cedar-Hemlock (ICHmw2) biogeoclimatic subzone of the Arrow-Boundary Forest District. The ICHmw2 subzone occurs between 500 m and 1450 m in elevation and is characterised by hot, moist summers and very mild winters with light snowfall (Braumandl and Curran 1992). Tree cover is made up of mixed species including Douglas-fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), hybrid white spruce (*Picea engelmannii X glauca*), western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*). The most common shrubs are falsebox (*Paxistima myrsinites*) and black huckleberry (*Vaccinium membranaceum*). Common herbs include twinflower (*Linnaea borealis*), prince's pine (*Chimaphila umbellata*), queen's cup (*Clintonia uniflora*) and one-leaved foamflower (*Tiarella trifoliata*) (Braumandl and Curran 1992).

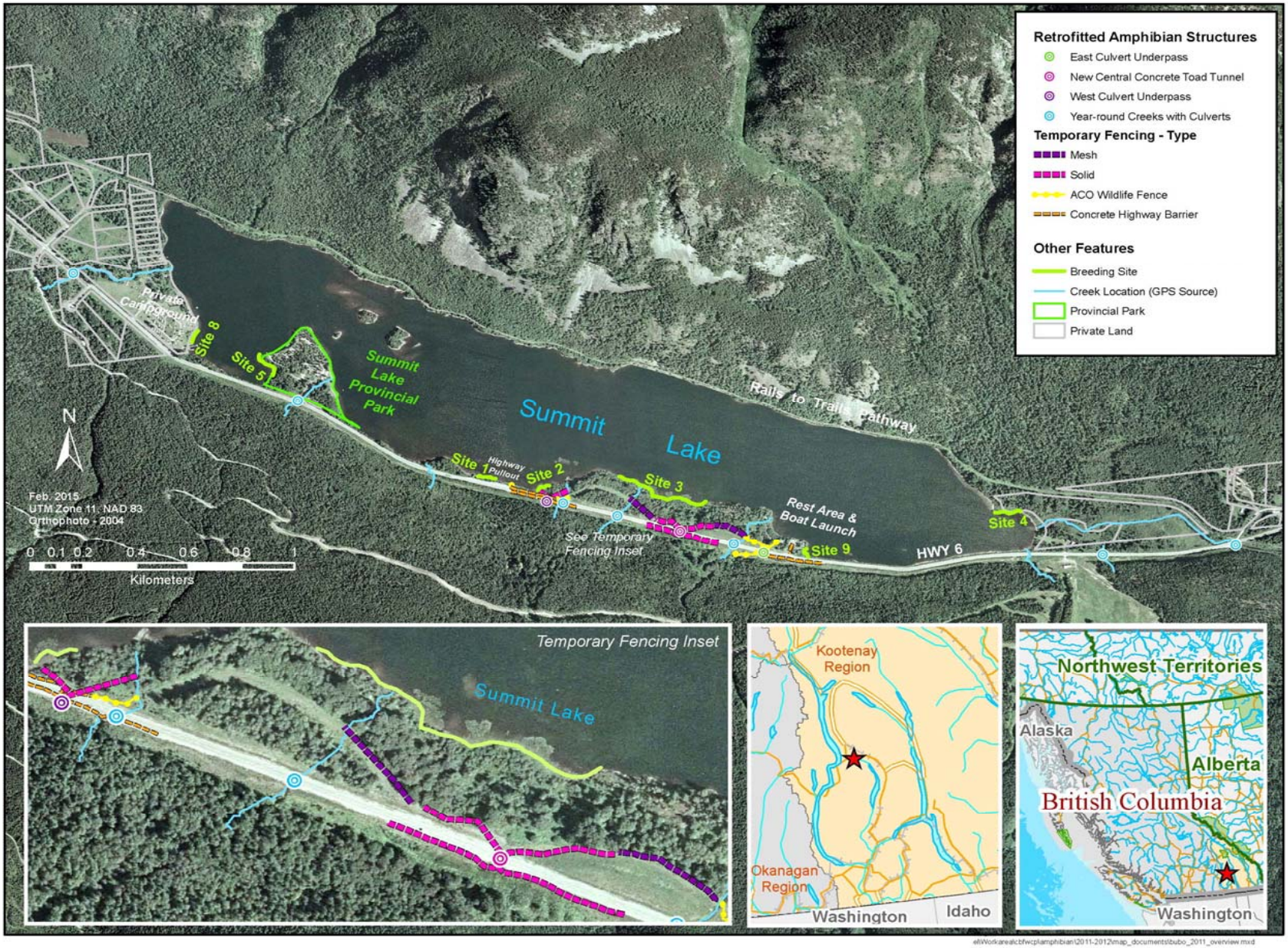

Figure 1. Summit Lake study area showing the locations of existing amphibian infrastructure, creeks and 2014 test fence locations.

2.0 Methods

2.1. Adult Migration

In 2014, we used two methods to sample for adult toads on Highway 6: drive-by surveys and incidental toad detections. Drive-by surveys were conducted from 01 May to 23 September along a 4.8 km stretch of Highway 6 from Summit Road just east of Summit Lake to Kingfisher Road, west of Summit Lake (Figure 1). A daytime pass was made prior to sampling where all carcasses were recorded as incidental and removed from the highway. These surveys were conducted from a vehicle driving 30-40 km/hour. They were conducted after sunset between 21:55 and 00:23 and took an average of 15 minutes.

For each survey, we recorded start and end time, humidity, current precipitation, rain in the past 24 hours, air, pavement and lake temperatures, whether the toad was alive or dead, age (adult vs. subadult), gender, recapture identification and location (UTMs) of the toad.

All live and dead adult toads observed outside of the drive-by surveys were recorded as incidentals.

2.2. Breeding Surveys

We conducted canoe surveys throughout the 2011-2014 breeding seasons to document the timing and location of breeding and to capture and PIT-tag adult toads. The entire shoreline of the lake was surveyed but survey effort was concentrated near known breeding areas during the breeding season. We recorded current weather, wind, rain in the past 24 hours and start and end times. Breeding sites were identified as those having multiple pairs of adult toads in amplexus (mating position).

2.3. Mark-recapture

We captured individual adults for mark-recapture by net or hand. Individuals > 40 mm and in good physical condition were marked with a uniquely numbered Biomark HTP9 (9mm), 134.2 kHz glass passive integrated transponder (PIT) tag (Ferner 2007). An insertion was made on the upper dorsal section using a new scalpel and a sterilized PIT tag was massaged under the skin toward the back of the animal. Starting in 2013, we began using smaller Biomark HPT8 (8mm) PIT-tags injected with MK165 Implanter/N165 needles. This reduced handling time and animal stress. We followed provincial hygiene protocols for amphibian fieldwork (MoE 2008) to help reduce the risk of spreading disease. For each animal, we used a single pair of disposable talc-free latex gloves, a new scalpel blade and new plastic sandwich bags for measuring and weighing.

Toads were placed in a holding bucket and released at the site of capture after processing. We did not capture any females while they were laying eggs. Pairs in amplexus were processed and placed, together in a separate chamber until they were reunited and

released as a pair. At the time of capture, we determined the gender and mass of each individual and measured snout-vent length. We recorded the capture location, date, search time, pavement, air and lake temperatures, current precipitation, rain in past 24 hours, overcast or sunny, wind, humidity, time of processing, the estimated number of individuals in the group, and recorded if they were vocalizing, in amplexus or basking.

After the first capture, all toads recaptured were scanned using a hand-held PIT-tag scanner. For each recapture event, we recorded the date, time and location and whether individuals were vocalizing, in amplexus or basking. Early in the field season, recaptures were done at the breeding sites and as adults dispersed from the breeding sites, recaptures were conducted by searching the perimeter of the lake for basking individuals. This season, we increased our nocturnal sampling efforts on the highway to capture more migrating adults.

2.4. New Concrete Toad Tunnel and Associated Test Fences

In early July 2014, MoT installed a new concrete toad tunnel located approximately half way between the east culvert underpass (metal) and west culvert underpass (plastic) (Figure 1). The box culvert was installed in 3m lengths and measures 1.2m x 1.5 m in cross section (Photographs).

FWCP and FLNRO staff installed temporary wing fences on both sides of Highway 6 to direct adult and juvenile toads toward the new underpass (Figure 1 and Photographs). On the north side of the highway, the two outer fence sections (116 and 125m long) were constructed with marine aquamesh (used in the aquaculture industry) and rebar in order to be semi-passable for toadlets but impassable for adult toads (Figure 1). The fence sections nearest the underpass on both sides of the highway were made with solid 6 mil plastic sheeting taped to wood stakes (Figure 1 and Photographs).

In October, construction began on a test section of spray-on concrete wing walls adjacent to the lake side of the new concrete underpass (Photographs). This technique involved spraying concrete onto plywood forms enforced with rebar.

To determine toadlet use patterns, several daytime behavioural observations were made at the both entrances of the new underpass during the peak migration period on 16 and 17 August.

2.5. Infrared Camera Trap in New Concrete Toad Tunnel

In 2014, we tested a new camera system to monitor the use of the new highway underpass. The system was designed to record every adult toad (and other animal) passing through the tunnel—we tested the system from 25 August to 20 September, 2014.

The system consisted of an infrared trigger system (Phototrap Model 33) connected to Canon EOS Rebel XT digital SLR camera with a Canon EF-S 18-55mm F3.5-5.6 II lens powered by a 12v 35Ah battery. The camera was triggered by a broken beam setup with

an infrared emitter and sensor placed at ground level across the floor of the tunnel (Photographs). The camera was fixed to the ceiling of the tunnel and the built-in flash was used to obtain high quality, colour JPEG images of animals passing through the infrared beam.

2.6. Radio Telemetry

Between 17 August and 30 October 2014, we radio-tagged 15 adult western toads in order to test the transmitter attachment technique described by Burow et al. (2012) and to find overwintering sites. The technique involves attaching the transmitter with a waist belt made from silicon tubing (Cole-Parmer Item# RK-95802-02), AlphaWire PVC tubing (Mouser Electronics Part # PVC10518 CL005) and copper wire (Artistic Wire 28-gauge bare copper wire) (Burow et al. 2012) (Photographs). We used Holohil 3.5g BD-2 transmitters with a 1mm diameter plastic tube embedded in the epoxy of the transmitter. Tagged toads ranged in weight from 72 to 238 g and we gave priority to tagging females. Locations were obtained every 3-7 days until the transmitter came off (n=9), stopped transmitting or disappeared (n=1) or until the toad was confirmed to be hibernating (n=5). We tracked radio-tagged toads for time periods ranging from less than one night (slipped or broken harnesses) to 74 days, and we concluded tracking on 30 October 2014 when all remaining tagged toads (n=5) were confirmed to be occupying hibernation.

2.7. Toad Outreach Event

The fifth annual toadfest bucketing event, hosted by FWCP, BC Parks, Ministry of Environment, MoTHI and CBT, was held on the afternoon of 26 August and the morning of 27 August 2014 at Summit Lake Provincial Park. Several agencies and organizations, including FWCP, attended with information tables. Volunteer tour leaders escorted groups to carefully collect toadlets for transfer across the highway—the crossing location was controlled by MoTI flaggers. After collection and prior to release, toadlets were counted or weighed at the FWCP table in order to estimate the total number of individuals moved across the highway. Toadlets that were not developed enough (ie, those that still had tails present) were removed from attendee's buckets and released without transporting them across the highway.

3.0 Results and Discussion

3.1. Adult Migration

In 2014, from 29 April to 23 September adult toads were present on the Highway 6 adjacent to Summit Lake throughout that time period. We estimated the direction of travel for the live individuals and safely transported them across the highway. Out of 352 adult toads detected during these surveys, 195 were alive (82 females, 110 males and 3 unknown sex) and 157 had been killed (40 females, 28 males and 89 undetermined) by

vehicular traffic. Where sex could be determined, we estimated 25 of the 40 dead females we detected on the highway were gravid.

From 2011-2014, of a total of 1236 adult toads on the highway during surveys, 509 were alive (178 females, 309 males and 22 unknown sex) and 727 had been killed (131 females, 102 males and 494 undetermined) by vehicular traffic.

Dead and live adult highway detections are summarised from 2011-2014 by 100m highway segment in Figure 2. Fourteen highway segments show adult migration hotspots of 30 or more adult toads per 100m and 7 segments show a density of 35 or more adult toads per 100m with A1 showing the highest (Figure 2). The segments with existing underpass and fence structures in place (C3 and D) show the lowest numbers of adult toads recorded on the highway (Figure 2).

These surveys will continue in 2015 and this information will be used to inform the locations of recommended additional underpass structures. Highway 6 along Summit Lake will be repaved in the next 5 years (Bruce Lintott, pers. comm.)—it would be a good time to install additional wildlife underpasses during this work. Therefore, there is an important opportunity to design and recommend locations for potential "shovel-ready" structures.

The subdivision at the west end of the lake is currently undergoing rapid development. As this area is an important post-breeding season area for adult toads (especially females), we should target local residents for an educational outreach program.

3.2. Breeding Surveys

The first observations of breeding activity at Summit Lake on 30 April 2014 was the earliest observed by approximately one week compared to 2010-2013.

Breeding activity was noted at all seven known breeding areas but, as in most years, the majority of activity was observed at breeding sites 3, 4 and 5 (Figure 1). 2014 was the busiest season observed so far at breeding site 4: on 02 May, there were an estimated 400-500 breeding adults present with eggs being laid. Limited breeding activity was noted at breeding sites 1, 2, 8 and 9 (Figure 1).

The first hatchlings were observed on 21 May 2014 at breeding site 4 and on 29 May at breeding sites 3, 4 and 5 (Figure 1). Adult breeding activity was observed at late as 02 June.

Metamorphs were first observed staging and emerging from Summit Lake on 04 August 2014 at the Rest Area boat launch. By 12 August, numbers of migrating toadlets were high and MoTI closed the Rest Area to reduce mortality at this site. Overall toadlet migration peaked between 12-17 August, 2014. On 15-17 August, significant toadlet movement and mortality was observed in highway segments A1 through A5 (Figure 2), which is east of the main toadlet movements in previous years.

3.3. Mark-recapture

In 2014, we PIT-tagged an additional 465 adult western toads (129 females and 336 males) to bring the total number of PIT-tagged adults to 1964 (477 females and 1487 males) since 2011. The 2014 mark-recapture data will be analysed in the next annual report.

Across-year recaptures of females (n=22) were examined to determine female breeding intervals at Summit Lake. Twenty-one females were captured two years and one was captured three years (Table 1). Most were captured at different locations in different years and only two individuals were confirmed to be breeding twice (both in amplexus, at the same breeding area).

Table 1. Summary of adult female toad across-year recapture events, 2011-2014.

Capture Years	Number Females	Number Confirmed Breeding All years
2011, 2012	2	0
2011, 2013	3	2
2011, 2013, 2014	1	0
2012-2013	13	0
2013-2014	3	0

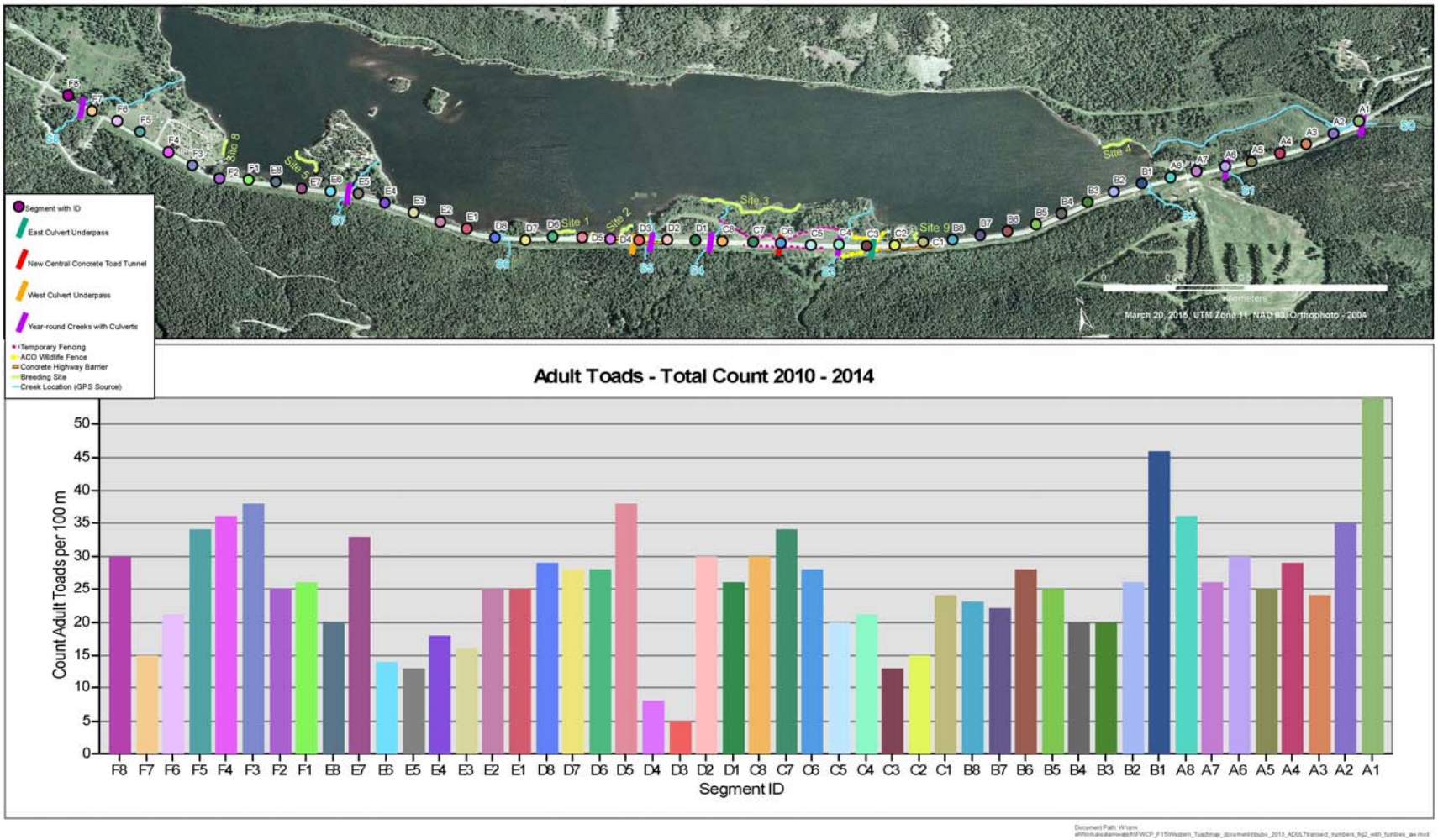

Figure 2. Adult western toads recorded on the Highway 6 at Summit Lake. 2010-2014 field seasons are combined and total counts are shown by highway segment. The colour-coded segment bars below correspond to the segment locations on the map at the top of the figure.

3.4. New Concrete Toad Tunnel and Associated Test Fences

The new tunnel was used by adult western toads and at least four mammal species (see following section).

The temporary wing fences seemed to work well in directing toadlets. As hoped, the aquamesh allowed some toadlets to pass through but the solid plastic fencing closer to the tunnel entrance directed individuals in the correct direction (Figure 1) (Photographs). However, many toadlets became trapped on the wrong (highway) side of the solid plastic fencing (north and south of the highway). In order to address this problem, we cut small holes (spaced at approximately 2m intervals) at ground level in the SE and SW plastic fences to allow the passage of toadlets trapped on the highway side of the fence. The holes were large enough for toadlets but too small to allow adult toads through.

Behavioural observations of migrating toadlets suggest that the fencing on the lake side of the highway worked well in directing the toadlets toward the new tunnel entrance; the main direction of movement was west. Direct observations large groups of individuals near the tunnel on the south side of the tunnel indicate that many did travel through the tunnel. Behavioural observations, however, suggest that many toadlets were reluctant to enter the tunnel, even though they were already moving toward the entrance. Many toadlets passed by the tunnel in groups, some went inside only to turn around within 2-3m and some continued to travel through the tunnel.

More behavioural observations should be completed. This might help us understand why many toadlets are hesitant to enter the tunnel.

The spray-on concrete wing walls proved more difficult to construct than originally anticipated. Although there was some cracking, the concrete walls survived the winter snow loads well (Photographs). The success of this design will be evaluated during the 2015 field season.

3.5. Infrared Camera Trap in New Concrete Toad Tunnel

This system proved to be successful in photographing adult western toads using the new tunnel between 25 August and 20 September 2014 when a total of 49 adult western toads were recorded using the tunnel (Photographs). Of these, 48 were identified as adult females, 37 (76%) were travelling north (toward the lake), 11 (23%) were travelling south and one was travelling in an undetermined direction. The busiest movement period was during the nights of 18 and 19 September when a total of 24 adult females travelled through the tunnel. All toads were recorded using the tunnel between the times of 7:22 PM and 6:00 AM.

In addition to toads, the camera system recorded deer mice (n=79), voles (n=21), shrews (n=6) species and one short-tailed weasel using the new tunnel (Photographs).

When we first installed the system, we were using a lens which did not provide coverage of the entire floor width of the tunnel. Consequently, we almost certainly missed many animals travelling along the walls of the tunnel prior to 18 September, when we switched to a Canon EF-S 18-55mm F3.5-5.6 II lens which provided complete coverage of the tunnel floor.

Battery life for the system is from between 7-14 days, depending on how often the system is triggered (the flash consumes the most power of all components).

We recommend using similar camera traps in all three tunnels during the 2015 field season to compare relative toad use. The camera system should be placed within metal housings to deter theft.

3.6. Radio Telemetry

We had mixed results with the original copper wire belt system—it broke prematurely in at least four cases so we switched to 26 gauge silver wire (Artistic Wire, non-tarnish, silver) and had no further problems. Some toads seemed to have a natural ability to quickly escape an intact harness (i.e without breaking the wire), even when it was reattached and tightened. We did not attempt to radio-tag these individuals after a second escaped harness.

Five toads (four females and one male) were followed to hibernation sites near Summit Lake (Figure 3 and Table 1). Movement patterns prior to hibernation varied greatly among radio-tagged animals and movements ranged from 0 to 1700 m between tracking visits. The largest and quickest movements incorporating aquatic travel within the Summit Lake (Figure 3) and the largest overland movement was 446 m recorded over a 6 day period (Table 2 and Figure 3).

Different individuals also used different forest types. For example, two toads (PIT-tag # 63610882 and 63610808) that ended up hibernating on the north side of Summit Lake used drier, south-facing habitat and were sometimes found basking in the sun on warmer days. The remainder of the radio-tagged toads were using much wetter forest types with more closed canopies and were not observed basking in the weeks and days prior to hibernation.

Ground-level habitat complexity seemed to be important to all radio-tagged toads (Photographs). Unseen individuals were often underground in small mammal burrows, squirrel middens, mature tree root cavities, under fallen logs of varying decay and within moss-covered talus. When the toads were visible, they were always in well protected, cryptic positions including under fallen leaves, coarse woody debris, root balls, dense shrub or fern cover, in moss cavities, and wedged in rock crevices (Photographs). Hibernation sites included a small mammal burrow, under rocks in a talus slope, a squirrel midden, under a large, decayed nurse log and under a deep deposit of coarse woody debris (Table 3 and Photographs).

Radio telemetry efforts should continue next season with a focus on post breeding movements of adult females and hibernacula selection.

3.7. Toad outreach event

An estimated 400-500 people attended Toadfest in 2014 and approximately 6853 toadlets were successfully moved in 317 buckets across the highway. The mean weight of each toadlet in 2014 was 0.45 g, which compared to previous years. Although attendee numbers were similar in 2014 compared to other years, fewer toadlets were moved (Table 2), likely because the toadlet migration peaked before the Toadfest date.

Table 2. Summary of Toadfest results 2010-2014.

	2011	**2012**	**2013**	**2014**
Total number buckets weighed/counted		541	495	317
Estimated total number of toadlets moved	5000	14753	13253	6853
Average number of toadlets per bucket		27.3	26.8	21.6
Average weight of each toadlet (g)	0.47	0.44	0.43	0.45

This is a very successful outreach/education project and will continue as a yearly event.

Table 3. Capture and telemetry summary of five adult western toads followed to hibernacula at Summit Lake, 2014.

PIT tag no. Radio Freq Sex	SVL(mm)/wt(g)	Date	Time	Air Temp	Surface Temp	Dist fr previous location (m)	Visual?	Comments
63610808 151.379 female	97/124	17-Aug-14	22:11	16.9	17.6	new	Y	Captured crossing highway near Bonanza Cr at east end of lake
		18-Aug-14	11:30			375	Y	Under dense shrub (red-osier dogwood) and woody debris
		21-Aug-14	15:54			55	N	under moist western redcedar roots with fern cover
		27-Aug-14	16:06			985	Y	inactive on top of log (no sun) 3 m from edge of lake with thick willow/alder cover
		31-Aug-14	15:05			76	N	under log approx 1m from lake shore
		4-Sept-14	13:53			0	N	Same place
		29-Sept-14	11:17			547	Y	among coarse woody debris, open canopy with more sun exposure
		3-Oct-14	15:30			68	Y	in shallow coarse woody debris alongside Douglas-fir debris; edge of *Armillaria* root-rot centre
		9-Oct-14	13:40			34	N	underground in small mammal burrow; signal coming from 50 cm west of entrance; top end of same *Armillaria* root-rot centre with good solar exposure in mature forest
		14-Oct-14	12:06			0	N	Same place; likely hibernaculum
		30-Oct-14	11:00			0	N	Same place; likely hibernaculum
63610882 151.419 male	83/72	23-Sept-14	20:55	14.0	17.2	new	Y	Captured on forest service road above Summit Lake
		24-Sept-14	13:35			772	Y	Under dense shrubs 5 m from edge of lake; Saskatoon and red-osier dogwood
		29-Sept-14	16:28			726	N	On private land; triangulation location
		3-Oct-14	14:05			0	N	On private land; triangulation location
		9-Oct-14	17:15	15.0	28.0	1700	N	Under logs at lake shoreline; very warm water
		14-Oct14	11:33	11.0	10.6	54	Y	in forest at base of talus slope; under kinnikinnick, ferns, snowberry
		18-Oct-14	14:05	12.1	15.4	46	Y	basking under dead leaves next to rock; antenna coming out from under rock; kinnikinnick, mature Douglas-fir with paper birch leaves covering ground; near rock crevices on talus slope
		22-Oct-14	12:00	8.2	10.4	25	N	under rocks at base of talus slope; rocks covered in moss and dead leaves (Ep, maple); kinnikinnick cover
		24-Oct-14	11:30	7.6	7.9	0	N	Same place; likely hibernaculum
		30-Oct-14	11:30			0	N	Same place; likely hibernaculum

63610887 150.560 female	94/111	23-Sept-14	20:59	14.0	17.2	new	Y	Captured on forest service road above Summit Lake
		24-Sept-14	12:13			41	Y	under kinnikinnick with fern cover; mature forest
		29-Sept-14	15:30			21	Y	under kinnikinnick at base of mature western redcedar
		3-Oct-14	13:45			51	N	in small mammal burrow at base of mature Douglas-fir (DBH=42cm); burrow goes into roots; good ground cover with kinnikinnick, moss and smaller coarse woody debris; mature forest
		9-Oct-14	16:20	14.0	12.0	13	N	in small mammal burrow at base of large Douglas-fir
		14-Oct14	10:07	9.0	9.6	4	Y	in squirrel midden; visible in hole
		18-Oct-14	12:18	8.5	9.2	0	Y	same place
		22-Oct-14	8:45	7.3	8.2	32	N	under squirrel midden; spongy ground with no obvious entrance but several options within 5 m
		24-Oct-14	13:45	7.6	7.9	0	N	Same place; likely hibernaculum
		30-Oct-14	14:20			0	N	Same place; likely hibernaculum
63610893 150.498 female	114/238	19-Sept-14	20:47	12.0	14.6	new	Y	Captured on the road in the subdivision
		20-Sept-14	11:50			40	Y	in very dense thimbleberry 1m off rail trail
		23-Sept-14	18:59			27	Y	in wetland with dense *Carex* cover
		29-Sept-14	16:00			17	N	under old western redcedar log at base of western redcedar with devil's club, red alder
		3-Oct-14	14:00			0	N	Same place
		9-Oct-14	15:17	14.0	12.4	13	N	under old, mossy, rotten western redcedar logs; lots of old growth features here in wetland with skunk cabbage; down mammal hole?
		14-Oct-14	10:26	9.0	9.6	24	N	under old, very decayed nurse log lying on ground
		18-Oct-14	12:32			0	N	Same place
		22-Oct-14	9:20	7.7	9.4	57	Y	in leaves, wild ginger with fern cover under western redcedar/paper birch with wet soil
		24-Oct-14	14:20	7.6	7.9	41	N	under large mostly decomposed nurse log, several openings into ground visible at base
		30-Oct-14	13:30			0	N	Same place; likely hibernaculum
No PIT tag 150.498 female	101/151	19-Sept-14	22:34	12.0	14.6	new	Y	Captured against concrete barrier on highway side; moving away from lake?
		20-Sept-14	11:15			14	Y	backed into rock crevice on highway cut bank very close to capture spot; just visible with flashlight
		24-Sept-14	11:32			74	Y	In moss under woody debris, kinnikinnick and fern cover with small Douglas maple, western white pine and western hemlock dominant forest

	29-Sept-14	15:00	15.0		70	Y	under paper birch deadfall (DBH=20 cm); lots of coarse woody debris and moss; forest interior
	3-Oct-14	13:15	11.1		62	Y	quite deep between paper birch (DBH=15 cm) and trembling aspen (DBH=35 cm) coarse woody debris with lots of moss and large amount of woody debris; closed canopy mature forest
	9-Oct-14	14:53	14.0	12.4	446	Y	Huge move!;in visible location but open protected by coarse woody debris at base of paper birch with devil's club cover
	14-Oct-14	10:42	9.0	9.6	32	Y	in protected spot under trembling aspen leaves and devil's club
	18-Oct-14	12:53	8.3	10.4	28	Y	under paper birch leaves with devil's club cover adjacent to very rotten coarse woody debris
	22-Oct-14	10:46	7.2	8.2	149	Y	head just visible under bark/branches at base of steep bank approx. 4m from small creek; 1m under fallen log
	24-Oct-14	13:00	7.6	7.9	21	N	beneath deep deposit of coarse woody debris and leaves in riparian area near stream
	30-Oct-14	12:15			0	N	Same place; likely hibernaculum

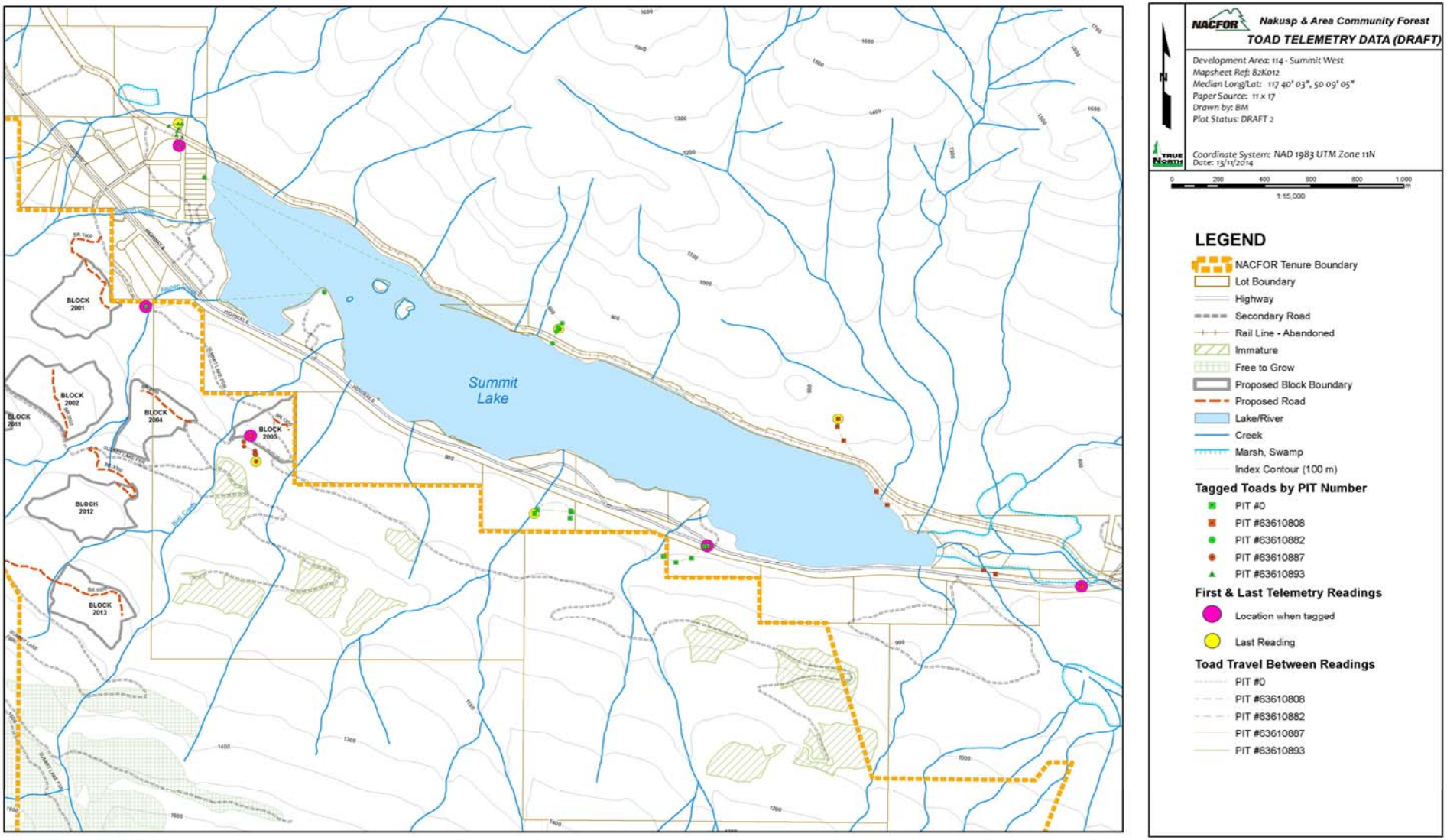

Figure 3. Movement summary of five radio-tagged adult western toads followed to hibernacula at Summit Lake, 2014

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3.0 Photographs

Installing the new concrete toad tunnel. July 2014.

Installing the new concrete toad tunnel. July 2014.

New concrete toad tunnel entrance. No topsoil on floor yet.

Solid plastic test fence at new tunnel entrance.

Camera trap setup in the new concrete toad tunnel. Camera is mounted on the ceiling, sensors on either side of floor, control box and battery on wall.

Adult female western toad showing radio transmitter attachment.

Adult female western toad showing radio transmitter attachment.

Adult female western toad showing radio transmitter attachment after backward movement into "day roost" location.

Ventral view of radio belt attachment.

Side view of radio belt showing some minor skin sloughing just below transmitter.

Adult western toad under water with transmitter attached.

Toadlets along solid plastic test fence.

Adult female travelling toward lake in new concrete underpass.

Adult female travelling away from lake in new concrete underpass.

Deer mouse photographed using new concrete underpass.

Vole species photographed using new concrete underpass.

Shrew species photographed using new concrete underpass.

Short-tailed weasel photographed using new concrete underpass.

Radio-tagged adult toad day roost site in mature western redcedar roots cavity.

Radio-tagged adult toad day roost site under dense shrub cover.

Radio-tagged adult toad day roost site under shrub cover.

Radio-tagged adult toad day roost site under dense shrub cover.

Radio-tagged adult toad day roost site under woody debris cover.

Radio-tagged adult toad day roost site under woody debris cover. Toad is visible in centre of image.

Radio-tagged adult toad day roost site under mossy woody debris cover.

Radio-tagged adult toad day roost site under woody debris and shrub cover.

Radio-tagged adult toad day roost site under woody debris cover. Toad is visible under log just right of centre of image.

Radio-tagged adult toad day roost site under small, decayed log.

Day roost site habitat. Toad was under the small, decayed log.

Radio-tagged adult toad day roost. Adult is visible basking in leaf litter adjacent to mossy rocks on south-facing slope.

Radio-tagged adult toad hibernation site in small mammal burrow.

Radio-tagged adult toad hibernation site under large decayed nurse log.

Radio-tagged adult toad hibernation site in squirrel midden.

Radio-tagged adult toad hibernation site under mossy rocks at base of talus slope.

Spray-on concrete wing wall test section.

Detail of spray-on concrete wing wall surface.