Northern leopard frog reintroduction to the Columbia Marshes

Report on Year 3

Penny Ohanjanian

for

Columbia Wetlands Stewardship Partners

Kootenay Conservation Program

Northern Leopard Frog Recovery Team

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EXECUTIVE SUMMARY

Ongoing recovery of the Northern Leopard Frog in British Columbia has included the translocation of 4,000 tadpoles from a captive assurance population at the Vancouver Aquarium to a pond near Brisco in the Columbia Marshes. In 2015, 3533 hatchling tadpoles were added to the site, of which 616 were captive-bred and 2917 were from wild stock at the Creston Valley Wildlife Management Area. The goal of these translocations is to establish a self-sustaining population of northern leopard frog in the Columbia marshes.

Work in 2015 focused on three areas: calling male surveys (to determine if frogs survived the winter and returned to the pond), tadpole release, and visual encounter surveys to record metamorphosis and size and body condition of Young-of-Year (YOY). In addition, several reconnaissance surveys took place at other locales near the release area to assess habitat.

Calling male surveys were done through remote sensing using Songmeters as well as at listening stations both in the Brisco Release Pond (BRP) and near the Brisco bridges. None were detected in 2015.

Tadpoles were released on May 27 and June 5 (Creston-sourced) and on June 10 (Van. Aquarium-sourced) following a night in enclosures at the release pond. Mortality was extremely low (1%), indicating that hatchling tadpoles are resilient to transfer. The numbers released to date are likely inadequate for population establishment

Metamorphosis occurred in mid-July. Young-of-Year were captured and measured during weekly Visual Encounter Surveys from July 20 to October 15. Mean snout-vent length was 52.6 mm (n = 60) and mean shank length was 30.1 mm (n = 62). The mean weight of 62 individuals was 15.6 g. These values were not significantly different from the sizes of YOY in 2014. Body condition was good overall.

Movements out of the pond were evident within a few weeks of metamorphosis. One individual on August 8 was reported having jumped into a canoe. Although not captured and measured, photographs of its thumbs indicate a blackening of the nuptial pad area. As August 8 is very early for displaying sexual characteristics, it is possible that individual was a juvenile from 2014.

No developmental abnormalities were observed at BRP in 2015.

Reconnaissance surveys indicated that potential breeding habitat occurs on an island in the Columbia River and in one area of Trescher Lake. Excellent foraging sites are present south of the BRP.

Recommendations:

1. Translocate a minimum of 8,000 tadpoles per year in 2016, 2017 and 2018
2. Obtain confirmation of availability of wild-bred leopard frogs from Creston early in season
3. Use PIT tags in addition to spot patterns to increase sample size for Mark-Recapture to obtain population size estimates in future
4. Place Songmeters after spring reconnaissance on island “A” and at Trescher Lake, in addition to BRP and TP (Figure 8).

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1.0 INTRODUCTION

As part of recovery efforts to reintroduce northern leopard frogs, *Lithobates pipiens*, to the Columbia marshes tadpoles from a captive assurance population in the Vancouver Aquarium were released in 2013 and 2014 into a pond at Brisco (Ohanjanian et al. 2013, Ohanjanian 2014). In 2015, northern leopard frog tadpoles from both the Vancouver Aquarium and from wild egg masses at Creston were released. The goal of these translocations is the establishment of a self-sustaining population of the species in the Columbia marshes in accordance with recovery actions identified in the Northern Leopard Frog Recovery Strategy (NLFRT 2012).

Reintroductions of northern leopard frogs have been ongoing on the Upper Kootenay Floodplain (UKF) since 2003 using wild stock from Creston. Results to date are encouraging: at least 19 distinct males, both adult and juvenile, were calling in 2015 at that location (Ohanjanian *in prep.*). It is hoped that, with continued leopard frog translocations, a similar result will be achieved at Brisco. This document includes results of Nocturnal Calling Surveys at the Brisco Release Pond (BRP) and environs, the 2015 translocation of northern leopard frog tadpoles and Visual Encounter Surveys to monitor their metamorphosis, growth and movements.

2.0 STUDY AREA

For a detailed description of the BRP please refer to Ohanjanian (2014) and Ohanjanian and Carli (2010)[1]. In 2015 pH was very stable between April 21 and Oct 17 (Mean = 8.75, SD = 0.3, Range = 8.3 - 9.2) and not dissimilar to 2014 (Ohanjanian 2014). Mean conductivity was 631 µS/cm, (SD = 220, Range = 321 – 1153), more variable than in 2014 when it ranged between 267 and 705 µS/cm.

A partial floristic list of the vegetative community observed on July 30, 2015 is shown in Table 1.

Table 1. Partial floristic list of major submergent and emergent plant species of Brisco Release Pond (BRP)

Submergent vegetation	Emergent vegetation
Pond lily	Bulrush
Stonewort	Cattail
Sago pondweed	Arrowhead
Bladderwort	Equisetum
Floating pondweed	Carex spp.
Richardson's pondweed	
Hippuris	

The south end of the BRP is shown in Figure 1.

[1] Detailed information on water chemistry (as collected by C. Carli) is available from the author.

Figure 1. Brisco Release Pond in mid-summer, 2015

Net sweeps (*ad libitum*) for aquatic invertebrates revealed dragonfly and damselfly nymphs, giant water bugs, water striders, water boatmen, back swimmers, scuds and aquatic snails. Potential vertebrate predators that were observed included two species of garter snake (*Thamnophis sirtalis* and *T. elegans*) and Sandhill Cranes. Long-toed salamander larvae were present on July 30, and these may also prey on ranid tadpoles (Tyler et al. 1998) but it is unlikely that adults were still breeding in the pond when tadpoles were very small and vulnerable. Fish were also seen, likely brought in by the river which enters the wetland during high water.

This year the study area also included Trescher Lake, Trescher Pond (TP) and various wetlands along the Columbia River, including those at the Brisco bridges (see Figure 8 below, for locations)

3.0 METHODS

3.1 Remote Sensing

In order to maximize the probability of detecting calling leopard frogs, three Songmeters (SM2+, Wildlife Acoustics) were deployed on April 17, and programmed to record nightly for 3 hours from 11 pm to 2 am. Two were located 400 m apart in the Brisco Release Pond (BRP) (Figure 2). SM-BRPn was located on a snag on a peninsula to capture both the middle and north end of the pond. SM-BRPs was positioned opposite the 2014 release site. Water temperatures at the north and south deployment sites were 14.4°C and 13.°C , respectively, which was exceptionally warm for that date. The pH was 8.6 and 8.9 in the north and south, and conductivity was 496 and 655 µS/cm, respectively.

Figure 2. Location of Songmeters in north and south areas of BRP.

The third Songmeter was positioned at a potential downstream dispersal site on private property at Trescher's Pond (TP, Figure 8). Here, habitat appeared to be highly suitable for breeding leopard frogs. Water temperature was warm (15.5°C), pH was 8.4, and conductivity 573 µS/cm. The depth was 20 to 50 cm at that time. The perimeter of TP was predominantly cattail with some reed canary grass (Figure 3). Submergents that were in evidence on April 17 included mare's tail (*Hippuris*) and pond lily.

Figure 3. Songmeter deployed at small pond (TP) on Trescher property

Songmeter recordings were reviewed both aurally and visually in the office by listening and scanning sonograms using SongScope software.

Two HOBO temperature loggers were placed at the BRP on April 17 to record hourly temperatures in the water[2] and in the air. Data from these was downloaded on October 17, 2015.

3.2 Nocturnal Calling Surveys

In addition to remote sensing, we conducted Nocturnal Callling Surveys (NCS) at four stations along the east shore of the BRP on six nights between May 3 and May 31. A call playback experiment was carried out concurrently to test the hypothesis that responses of calling males could be elicited using recordings of male vocalizations, and thus increase the efficiency of NCS. Surveys consisted of nine minutes of passive listening followed by 3 three-minute periods of listening after broadcasting calls using a TOA ER-604W megaphone.

A NCS was also carried out once along a transect consisting of four stations between the Brisco Mill Pond and the Botts channel bridge on May 31. A simultaneous NCS using a kayak took place on Trescher Lake. Environmental conditions (air temperatures, water temperature, wind speed, and cloud cover) were recorded at the start and finish of all surveys.

3.3 Tadpole Transport and Release

Three tadpole releases took place in 2015. Hatchling tadpoles from egg masses that had been enclosed and protected in the marsh at Creston were collected[3] and placed in thermoses for translocation to Brisco. Following translocation guidelines outlined in Kendell and Precott (2007), the pH, dissolved oxygen levels and temperature were monitored during transport. Upon arrival at the site, water from the release pond was gradually added to acclimatize tadpoles to the different conditions (Figure 4). When pH and temperature were equalized, tadpoles were contained in enclosures in the release pond overnight, and counted and released the following day.

Figure 4. Water changes at the Brisco Release Pond to acclimate tadpoles.

[2] Data from May 14 to May 21 was not useable as the HOBO was exposed to air due to water receding.
[3] Tadpoles collected by the FWCP (Columbia) at Creston.

3.3 Visual Encounter Surveys

Prior to the tadpole translocation two Visual Encounter Surveys (VES) were carried out in April to detect individuals that may have over-wintered successfully. VES were again undertaken in mid-July after metamorphosis had occurred. These VES followed protocols and amphibian hygiene guidelines developed by the BC government and the NLFRT (Adama and Davidson 2007, British Columbia 2008). Frogs were captured with nets and individual-specific nitrile gloves and placed in a plastic bag for measurement. As in previous years weights (to nearest 0.5 g), and both snout-vent lengths and shank lengths (to nearest 0.1 mm) were recorded. Overall health was noted by visual inspection and assessment of righting reflex. Photos of dorsal spot patterns were taken for entry into the UKF frog archive for potential Mark-Recapture analysis in future. All leopard frogs were geo-referenced and captives were released within 5 minutes at the capture site.

3.4 Reconnaissance Surveys

Three reconnaissance surveys to assess habitat, identify potential breeding sites and dispersal areas, and locate access points, were carried out on October 6, 15 and 17 using a canoe and on foot. Photographs were taken and recommendations made for further study in 2016. VES were also carried out *ad libitum* during the reconnaissance along the shores of the Columbia River to detect basking leopard frogs that may have dispersed.

4.0 RESULTS

4.1 Calling Male Surveys

No calling males were detected in 2015, either on Songmeters or during Nocturnal Calling Surveys. The call playback experiment could not be tested at Brisco as no frogs were heard with which to compare the efficacy of using elicited responses. Although the experiment was not successful at this site, it was also carried out at the UKF and the results of that analysis are pending (Ohanjanian *in prep*).

Water conditions of Trescher Lake during the calling survey were not optimal for breeding northern leopard frogs. The shallowest area accessed by the kayak that night was 50 cm deep and the temperature was only 11.5°C. This contrasts with the temperature in the shallows near the Brisco Mill Pond on the same night (17°C). Another, more marsh-like, area of Trescher Lake (see below) was not accessed for calling surveys in 2015. The site requires more investigation in 2016.

Unlike previous years, no Pacific chorus frogs, *Pseudacris regilla*, were heard near the Brisco Mill Pond and adjacent marshes on May 31.

4.2 Tadpole Releases

Leopard frog tadpoles were released into the Brisco Release Pond on May 27, June 5 and June 10, following containment overnight in enclosures (Figure 5). A total of 3,533 tadpoles were released into the BRP. An additional 36 died in transport or overnight prior to release from the enclosure. Overall mortality rate was very low (1%) (Table 2).

Figure 5. Northern leopard frog tadpole enclosures *in situ.*

Table 2. Numbers of northern leopard frog tadpoles translocated to the Columbia marshes in 2015

	Total live	Total dead	Total	% mortality
27-May-15 (Creston sourced)				
Bin A	277	4	281	1.4%
Bin B	301	2	303	0.7%
Bin C	360	0	360	0.0%
Bin D	317	4	321	1.2%
Bin E	233	3	236	1.3%
Bin F	366	0	366	0.0%
Total	**1854**	**13**	**1867**	**0.7%**
5-Jun-15 (Creston sourced)				
Bin A (EA23)	320	4	324	1.2%
Bin A (SW25)	276	3	279	1.1%
Bin B (EA23)	272	9	281	3.2%
Bin D (EA23)	195	1	196	0.5%
Total	**1063**	**17**	**1080**	**1.6%**
Total from Creston:	**2917**	**30**	**2947**	**1.0%**
10-Jun-15 (Van Aquarium sourced)				
Bin A	202	3	205	1.5%
Bin B	179	0	179	0.0%
Bin C	235	3	238	1.3%
Total from Van Aq	**616**	**6**[4]	**622**	**1.0%**
Total tadpoles (all sources):	**3533**	**36**	**3569**	**1.0%**

[4] Four of these were dead upon arrival.

4.3 Metamorphosis, Size and Body Condition

Metamorphosis occurred in mid-July. One froglet was observed on July 20, with a tail stub (Gosner stage 45[5]). Mean snout-vent length was 52.6 mm (n = 60) and mean shank length was 30.1 mm (n = 62). The mean weight of 62 individuals was 15.6 g (Table 3).

Table 3. Sizes of leopard frog Young-of-Year at Brisco, July 20 to Oct 15, 2015

	Wgt (g)	SVL (mm)	Shank (mm)
Mean	15.6	52.6	30.1
SD	4.8	4.8	3.4
Range	5.8 – 26.0	41.1 – 61.8	20.9 – 34.8
n	62	60	62

The mean ratio of shank length : snout-vent length was 0.58 (SD = 0.03), a value that is similar to that of 2014 (mean = 0.55, SD = 0.02).

4.4 Health and Mortality

No developmental abnormalities were observed during observations at BRP in 2015.

4.5 Movements

Dispersal out of the Brisco Release Pond was evident early, when one YOY was observed on August 8 over 250 meters from the release area on the bank of the Columbia river upstream (L. Halvorsen, pers. comm.). Another individual jumped into a canoe on the same date (Figure 8). This individual appeared relatively large and darkening of nuptial pad area of the thumb is apparent in photos. While it is possible that this was a juvenile from the previous year's release, this could not be confirmed as it was not captured and measured.

[5] Metamorphosis is defined as complete at Gosner stage 46, when the tail is fully resorbed

Figure 6. Leopard frog in canoe showing darkened nuptial pads, August 8, 2015

As in 2015, distance between recaptures was highly variable (Figure 7). There was no consistent direction noted either (Table 4).

Figure 7. Locations of recaptured leopard frog YOY at Brisco Release Pond 2015

Table 4. Distances between recaptures of nine leopard frog YOY at Brisco Release Pond in 2015

Distance (m)	Time interval (days)	Direction of movement
185	14	nw
12	12	n
114	12	nw
273	12	se
250	12	se
186	22	sse
182	10	nw
10	10	se
5	10	se

4.6 Reconnaissance

Reconnaissance surveys focused on the areas highlighted in Figure 8. No frogs were observed incidentally on the banks of the Columbia River.

The Island across from the cabins (Figure 8 "A") south of the BRP appeared to have some potential for breeding habitat when surveyed in mid-October (Figure 9). Water attributes of this water body during the breeding season are not known. It is recommended that it be visited in April 2016 and if found suitable, a Songmeter should be deployed.

The channel and water body to the south (Figure 8 "B") were shallow on October 15, with abundant ducks. Its water volume is regulated by the river and there is little submergent vegetation. On the survey date, it was relatively warm with virtually no current. This area could be a good foraging area for dispersing metamorphs. It is recommended that it be surveyed more intensely for YOY in September of 2016.

An area in the south of Trescher Lake (Figure 8 "C") had good potential breeding habitat, and was shallow and marsh-like. That area was accessed from the river (UTMs 11U 550410 E 5629765 N) on October 6. It is recommended that further recconnaissance be carried out there, and that a Songmeter be deployed in 2016.

Reconnaissance of the island between Botts channel and the main Columbia River (Figrue 8 "D") was not complete in 2015. This area is subjected to large inflows of river water and great fluctuations in depth. Good quality breeding habitat likely does not occur here, however further exploration is suggested.

Figure 8. Reconnaissance areas, October 2015

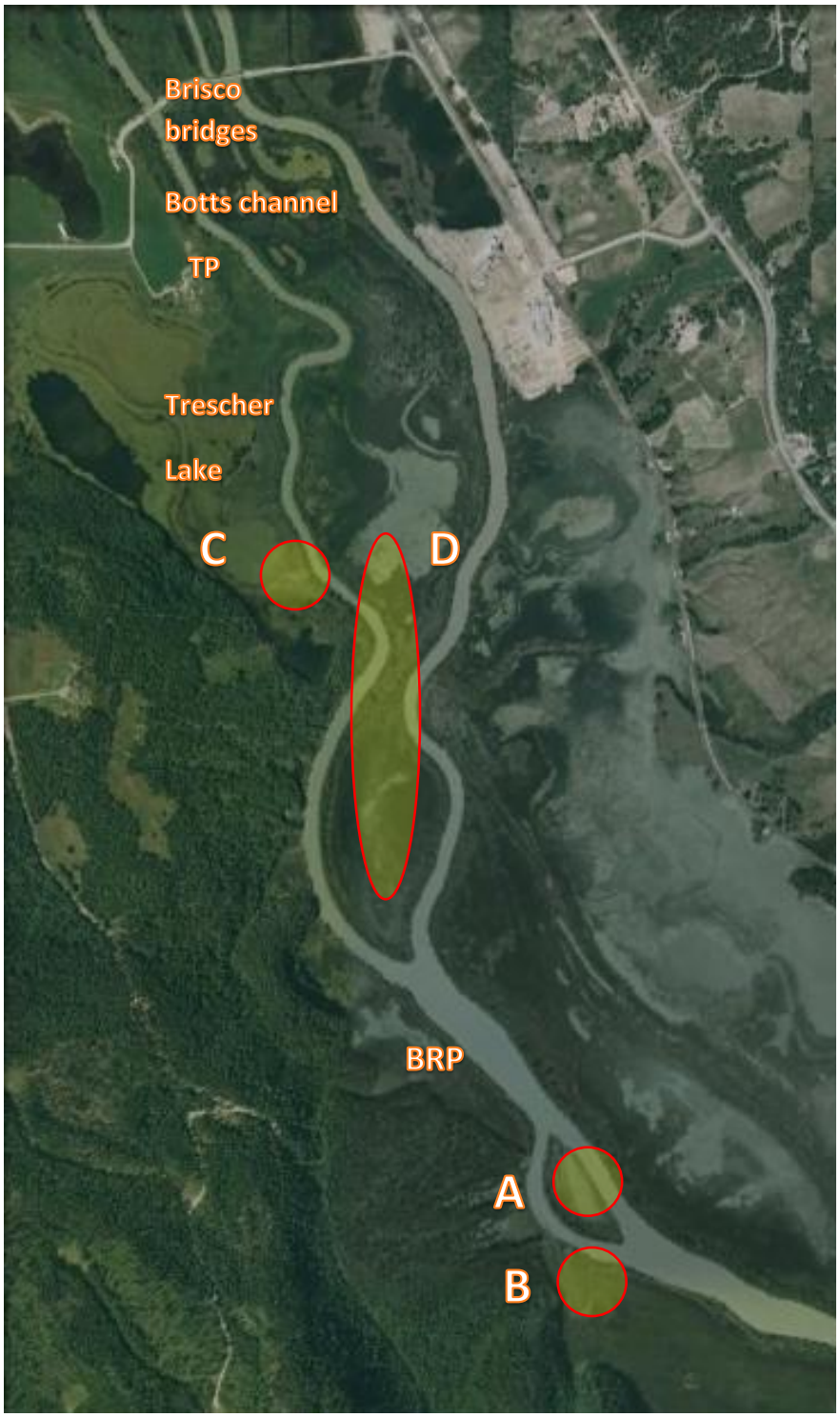


Figure 9. Pond on island (A) in Columbia River

5.0 DISCUSSION AND RECOMMENDATIONS

As in 2013 and 2014, mortality of translocated tadpoles was exceedingly low, indicating that moving them at that life stage is not detrimental. Hatchling tadpoles and/or egg masses are the preferred life stages for transport for several reasons. The chance of transferring chytrid fungus from one site to the other is decreased and it is easier to collect hatchling tadpoles while they are still clinging to the gelatinous egg mass (Kendell and Prescott 2007). At Creston, egg masses were contained in predator exclosures which allowed hatchlings to be gathered with ease. In addition, genetic diversity of transplanted individuals was ensured by removing eggs from several different egg masses rather than just one or two.

Survivorship from tadpole to metamorph is typically very low for ranids; on average, only 5 of every 100 individuals survive. In 2015, 108 leopard frog YOY were observed. This represents 3% of the total number released (3533). Allowing for the fact that not all metamorphs would have been captured, this suggests that survivorship in the crucial tadpole stage was close to expectations. Although fish are winter-killed in this marsh, the influx of the Columbia river that recharges it in June would also bring in fish, and thus predators.

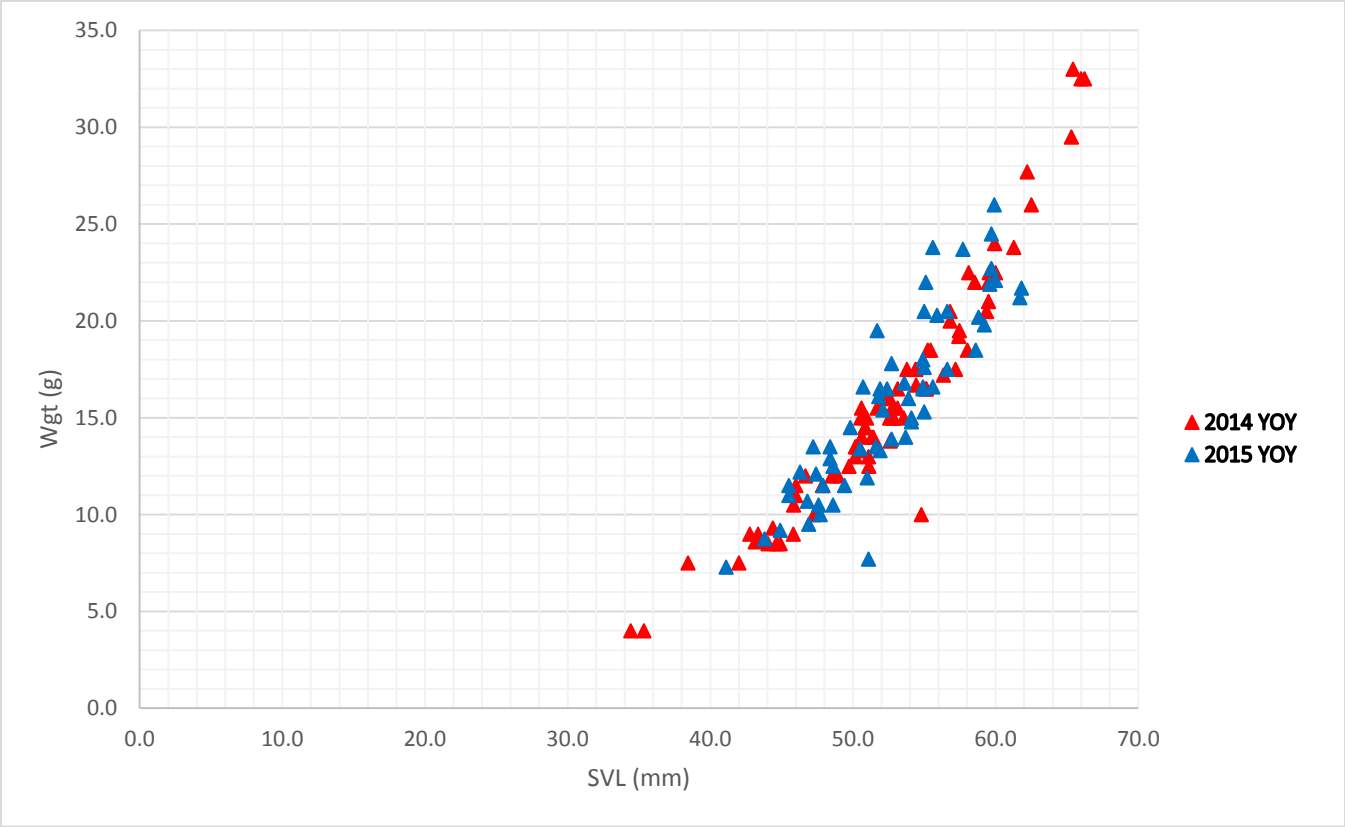
There was no significant difference in size of YOY in 2015 and YOY in 2014 (SVL length, unequal variances t-test, $t(136.8) = -.21$, $p = 0.836$ (Table 5).

Table 5. A comparison of SVL and shank length of leopard frog YOY at Brisco in 2015 and 2014

		Wgt	SVL mm	Shank mm
2014	Mean	15.9	52.4	29.5
	SD	6.1	6.6	3.8
	n	79	79	78
2015	Mean	15.6	52.6	30.1
	SD	4.8	4.8	3.4
	n	62	60	62

Body condition (measured as weight as a function of SVL) appeared to be the same in both years (Figure 10). A few individuals in the 52 to 58 mm size range appear on the graph to be heavier than in 2014. Four had longer snout-vent lengths in 2014. This variability is likely an artifact of sample size and more data would be required to determine if this represents a real difference.

Figure 10. Weights as a function of snout-vent length of YOY leopard frogs at Brisco, 2015 and 2014.



Likewise, the same intrinsic rate of development (as measured by shank:SVL ratio) in both years suggests that factors such as food availability and predation rate during the tadpole stage may have been similar in 2014 and 2015 at the BRP. Ficetola and De Bernardi (2006) have presented data indicating that there may be a trade-off between growth rate vs development rate in ranid tadpoles - pressure to leave a pond soon (as a result of competition, predation or low food supply) may manifest itself in smaller shank size relative to body length in metamorphs. In contrast, food abundance during the tadpole stage leads to longer leg length in ranid metamorphs (Tejedo et al. 2010). It is not known if this effect also occurs in northern leopard frogs.

Successful over-wintering has not yet been confirmed. The individual that jumped into a canoe on August 8 was not captured and measured. The blackening of the nuptial pad area of the thumbs may indicate it was a juvenile from the 2014 release. An attempt will be made to estimate size by comparing the frog with markings on the canoe when the canoe can be accessed in 2016.

In 2013 and in 2014 only 2000 individuals were released each year into the BRP. All came from the captive assurance population at the Vancouver Aquarium. In 2015, however, only 622 tadpoles from the Vancouver Aquarium were available for reintroduction. In anticipation of this, a contingency plan to move some tadpoles from the wild source population was put into effect, resulting in over 3500 tadpoles being released. This number, while it seems large, represents only one egg mass. The number of individuals translocated to date has been too small to effectively establish a population. Germano and Bishop (2008) report that the number of animals released during amphibian translocation significantly affects success, and Semlitsch (2002) suggests that the release of 10,000–50,000 eggs over several years is required to reach an adult population of 100 individuals.

Therefore, to greatly increase the chances of successfully establishing a self-sustaining population at Brisco, the Northern Leopard Frog Recovery Team supports the plan to move at least 8,000 tadpoles each year, beginning in 2016. This will be possible because transplants to the Upper Kootenay Floodplain have ceased, and animals from the wild source population will be available for the Columbia marshes. Unlike previous years, Creston will now become the primary source of leopard frogs for Brisco, with the Vancouver Aquarium only providing supplementary individuals if their captive breeding program is successful.

RECOMMENDATIONS

5. Translocate a minimum of 8,000 tadpoles per year in 2016, 2017 and 2018
6. Obtain confirmation of availability of wild-bred leopard frogs from Creston early in season
7. Use PIT tags in addition to spot patterns to increase sample size for Mark-Recapture to obtain population size estimates in future
8. Place Songmeters after spring reconnaissance on island “A” and at Trescher Lake, in addition to BRP and TP (Figure 8).

6.0 LITERATURE CITED

Adama, D. B. and A. Davidson 2007. Survey Manual for the Monitoring of the Southern Mountain Population of the Northern Leopard Frog, 2nd draft

Adama, D. B. and M. A. Beaucher. 2006. Population monitoring and recovery of the northern leopard frog (Rana pipiens) in southeast British Columbia 2000-2005. Prepared for: Columbia Basin Fish and Wildlife Compensation Program, Columbia Basin Trust, Creston Valley Wildlife Management Area, Ministry of Environment, and the Northern Leopard Frog Recovery Team. 32 pp

British Columbia 2008. Standard operating procedures: hygiene protocols for amphibian fieldwork, 2008. Ecosystems Branch, Ministry of Environment, Prov. of BC. 8 pp

Ficetola, G.F. and F. De Bernardi 2006. Trade-off between larval development rate and post-metamorphic traits in the frog Rana latastei. Evolutionary Ecology (2006) 20: 143–158

Germano, J.M. and P.J. Bishop. 2008. Suitability of Amphibians and Reptiles for Translocation. Conservation Biology 23(1): 7-15

Kendell, K., and D. Prescott. 2007. Northern leopard frog reintroduction strategy for Alberta. Technical Report, T-2007-002, produced by Alberta Conservation Association, Edmonton, Alberta, Canada. 31 pp + App.

Northern Leopard Frog Recovery Team. 2012. Recovery plan for the Northern Leopard Frog (Lithobates pipiens) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 47pp.

Ohanjanian, P. 2014. Northern Leopard Frog Reintroduction to the Columbia Marshes – Year 2. Unpublished report for Columbia Wetlands Stewardship Partners, Kootenay Conservation Program and Northern Leopard Frog Recovery Team. 21 pp

Ohanjanian, P. 2015 (*in prep*). Northern Leopard Frogs on the Upper Kootenay Floodplain – 2015). Unpublished Report for the Columbia Basin Trust, Fish & Wildlife Compensation Prog. (Columbia) and the Northern Leopard Frog Recovery Team.

Ohanjanian, P. and C. Carli. 2010. The Northern Leopard Frog: An assessment of potential reintroduction sites in the Columbia marshes. Report to the Local Conservation Fund, the Columbia Basin Environmental Initiatives Fund and the Columbia Wetlands Stewardship Partners. 29 pp.

Ohanjanian, P., C. Conroy and L-A. Isaac. 2013. Northern Leopard Frog Reintroduction to the Columbia Wetlands: Monitoring Report for Year 1. Report for the Columbia Wetlands Stewardship Partners, the Columbia Valley Local Conservation Fund and the Northern Leopard Frog Recovery Team. 23 pp.

Semlitsch, R. 2002. Critical elements for biological based recovery plans of aquatic-breeding amphibians. Conservation Biology 16:619–629.

Tejedo, M., F. Marangoni, C. Pertoldi, A. Richter-Boix, A. Laurila, G. Orizaola, A.G. Nicienza, D. Alvarez, I. Gomez-Mestre. 2010. Contrasting effects of environmental factors during larval stage on morphological plasticity in post-metamorphic frogs. Climate Research Vol. 43: 31–39.

Tyler, T.J., W. Liss, L.M. Ganio, G.L. Larson, R. Hoffman, E. Deimling and G. Lomnicky. 1998a. Interaction between introduced trout and larval salamanders (Ambystoma macrodactylum) in high-elevation lakes. Conservation Biology 12:94–10