Northern Leopard Frog Project: 2017 Field Season Report

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Ministry of Forests, Lands and Natural Resource Operations and Rural Development

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Submitted by:
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1. INTRODUCTION

Once widespread and common throughout south-eastern British Columbia (B.C.), the Northern leopard frog (*Lithobates pipiens*) (LIPI) has declined in recent decades and as of the 1990's was believed to be restricted to a single extant remnant native population located in the Creston Valley Wildlife Management Area (CVWMA) near Creston, B.C. Currently the B.C. population, referred to as the Rocky Mountain population, is listed as Endangered nationally by the Committee On the Status of Endangered Species In Canada (COSEWIC, 2009) and is on Schedule 1 of the *Species at Risk Act* (SARA, 2006); provincially, it is ranked S1 (critically imperiled; 2010) and is on the British Columbia Red list (B.C. CDC, 2016). For additional information on species status, reasons for decline, current threats and general species information see the Recovery plan for the Northern Leopard Frog (*Lithobates pipiens*) in British Columbia (British Columbia Northern Leopard Frog Recovery Team, 2012).

The Fish and Wildlife Compensation Program (FWCP) has been working on recovery efforts for the Endangered Northern leopard frog since 2000. A captive-rearing and reintroduction program ran from 2001-2005 and since then the focus has been monitoring the Creston population, protecting wild egg masses from predators, helping to establish a captive assurance colony at the Vancouver Aquarium and conducting reintroductions at historically occupied locations.

This report summarizes the results of the 2017 field season program for the Northern leopard frog project administered by the Ministry of Forests, Lands and Natural Resource Operations (FLNRO).

The main objectives for the 2017 field season were to:

- Monitor the population of LIPI in the CVWMA, using calling male surveys, egg mass surveys, visual encounter surveys and mark-recapture with passive integrated transponder (PIT) tags
- Document LIPI breeding, locate and protect egg masses
- Support re-introduction and captive assurance colony efforts

2. STUDY AREA

The main study area is the CVWMA located in the Creston Valley within the Kootenay region of south-eastern B.C (Figure 1). The area is located within the very dry warm (xw) subzone of the Interior Cedar – Hemlock (ICH) Biogeoclimatic Ecosystem Classification (BEC) zone, which is characterized by warm dry summers and wet, cool winters with high snowfall (Ketcheson et al.,1991). The managed wetland complex is a 7,000 ha (17,000 acre) area of provincial Crown land located along the Kootenay River system near the town of Creston. The wetland complex is predominantly composed of shallow warm water wetlands dominated by cattails which support a large amount of biodiversity. For site locations within the CVWMA used in this report see Appendix 1.

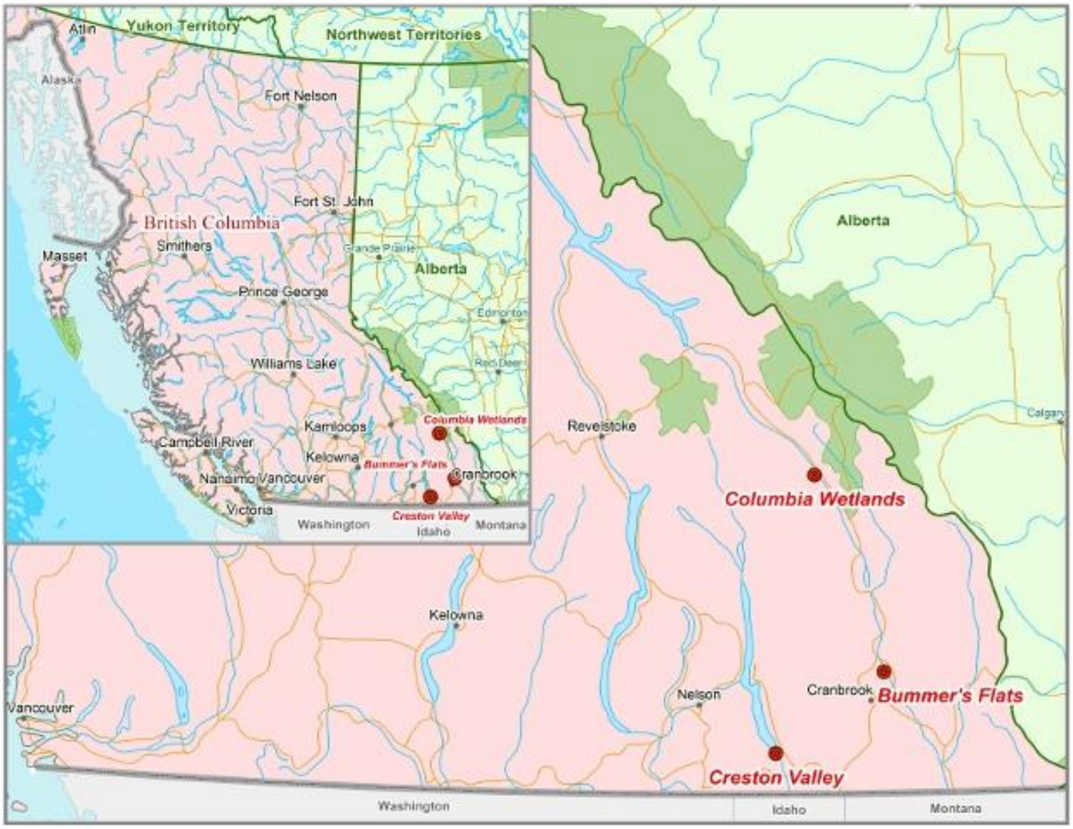

Figure 1. Map of main study area in the Creston Valley and the 2 reintroduction sites (Bummer's Flats and the Columbia Wetlands near Brisco).

3. METHODS

In order to meet the objectives for the project, fieldwork was carried out from April 18 through October 30, 2017 and 6 types of survey methods were utilized: Songmeters, nocturnal calling surveys, egg mass surveys, visual encounter surveys, road surveys and tadpole trapping.

3.1 General Weather and Habitat Conditions

General weather conditions are noted during surveys and HOBO temperature data-loggers are used to record hourly water and air temperature at various sites in the CVWMA (Appendix 1). For the 2017 field season new temperature data loggers were purchased to replace the older model HOBO H08-001-02 as they are now obsolete (Figure 2). Onset waterproof HOBO 64 K Pendant temperature data loggers (model UA-001-64), a HOBO waterproof shuttle with Optic USB interface and couplers (model U-DTW-1) and Hoboware Pro software were purchased. The new units were installed in mid-May in the same locations as the old units. Since the new units were not deployed during early spring, data from the old units is primarily used in this report. The new units have now replaced the old units and will be used exclusively. Data from the old loggers was offloaded using a serial cable and managed using Boxcar software; data from the new units is offloaded using the HOBO waterproof shuttle with Optic USB interface and coupler and is managed using Hoboware Pro software.

Figure 2. Temperature data logger photos (left to right): old style HOBO model H08-001-02; new HOBO Pendant model UA-001-64.

Water levels at the EDLNA and WDLNA staff gauges are recorded during surveys to supplement other water level data collected by CVWMA (Appendix 1).

Due to concerns about Canadian watershield (*Brasenia schreberi)* ingrowth at the DLNA a watershield removal test plot was established in May of 2016 (Houston, 2017a). Condition of the test plot was re-evaluated in 2017.

3.2 Songmeters

Four Songmeter units were deployed at Leach Lake during the spring breeding season from May 3-25, 2017. They were programmed to record daily at 21:00 for 3 hours. Analysis was completed by scanning .wav files at high speed using Songscope software.

3.3 Nocturnal Calling Surveys (NCS)

To locate calling males, NCS were conducted in suitable conditions during the egg laying season. NCS survey protocol was as described in Houston (2017a) with some minor modifications. Due to higher than normal water levels in spring 2017 survey methods were modified to detect breeding locations. Reconnaissance level surveys were conducted while walking and/or canoeing new areas listening for calling LIPI. These data were used to identify new NCS stations which were surveyed along with permanent NCS stations (Appendix 1).

3.4 Egg Mass Surveys (EMS)

Egg Mass surveys are conducted following NCS to search for and document egg masses in areas where LIPI calling is detected. Methods for egg mass surveys have been developed and optimised during previous years of the project (see Houston 2017a for details). Care must be taken to locate and document egg masses without causing disturbance or siltation. Egg mass variables documented include: volume, water depth, vegetation attached to, condition, percent fertilization and estimated age. Egg masses are caged in protective enclosures to provide protection from predators and facilitate reintroduction efforts. More details on egg mass enclosures are available in Houston (2017a).

In 2017 small samples were collected from 2 egg masses detected with health problems on May 31, 2017 and submitted to the Ministry of Agriculture and Lands, Animal Health Center (AHC), Abbotsford, B.C. for testing under the direction of veterinary pathologist Dr Stephen Raverty. A small portion of EM170523-KM06 was collected after it had died and a small portion of what remained from the hatched remnant of EM170525-TH07 was collected for submission. The samples were placed in lidded plastic containers with no water immersion and shipped on ice overnight via courier. Lab analysis included: histopathology, bacteriology (aerobic culture and fungal culture) and molecular diagnostics (Frog Iridovirus and *Batrachochytrium dendrobatidis*).

3.5 Tadpole Surveys

To monitor developmental stage and estimate date of metamorphosis, tadpole trapping was conducted at the WDLNA known breeding site (Figure 3, Appendix 1). Methods for tadpole trapping have been developed and optimised in previous years (see Houston 2017a).

Figure 3. Minnow trap used for tadpole trapping (WDLNA July 12)

3.6 Visual Encounter Surveys (VES)

To gather information on the health and status of the northern leopard frog population, as well as to get an indication of habitat use, dispersal patterns and migration corridors and to monitor habitat quality in various seasons VES are conducted. As habitat use for the northern leopard frog varies by life stage and season, VES are targeted towards specific life stages during different seasons. During the summer, daytime VES are carried out in an effort to target LIPI young of year (YOY) in their preferred habitat within natal ponds before dispersal. During late summer and fall, migration corridors and over-wintering areas are surveyed during the daytime in the CVWMA; methodology usually involves walking the perimeter of the water body searching for LIPI along the shoreline and in the near-shore upland areas. Environmental data is collected as in NCS and EMS. LIPI are captured and processed using methods outlined in the Section on Animal Capture and Health Assessment (Section 3.9).

3.7 Spring Migration Surveys

A limited number of spring migration surveys were conducted by FLNRO staff who developed the survey plan and carried out surveys in an effort to PIT tag animals. Survey results were added to the master NLF Filemaker Pro database and a brief summary of results has been provided in this report (Section 4.7). Combination surveys consisting of nocturnal DLNA dike road surveys and shoreline surveys in the Pumphouse channel and south shoreline of Duck Lake were conducted beginning at dusk. Survey methodology was based on that utilized by the Creston Northern Leopard Frog Crew (CNLFC) previously with some modifications; for detailed methods and results see FLNRO-Ecosystems summary (Kirton, 2017; in prep).

3.8 Late-summer and Fall Road Surveys

To gather information on migrating frogs and associated road mortality as they cross over the Duck Lake dike (a gravel roadway) while moving from summer foraging grounds to the primary over-wintering area in late-summer and fall, road surveys are conducted. In 2017, CNLFC partnered with the FLNRO-Ecosystems crew to conduct road surveys under the direction of FLNRO-Ecosystems staff. Survey methodology was based on that utilized by the CNLFC in previous years (Houston, 2012-2016) with some modifications; for detailed methodology and survey results, see report in preparation by FLNRO-Ecosystems staff. Dorsal spot pattern photos from all road surveys were added to the image library and survey results were added to the master NLF Filemaker Pro database; a brief summary of results is provided in this report (Section 4.8).

3.9 Animal Capture and Health Assessment

When time permits effort is made to capture LIPI detected for full processing (recorded as a *capture)*. When the surveyor is unable to make a capture, or time prohibits it, the observation is noted as a *visual*; if it is heard calling and a location noted, but not seen or captured, it is recorded as an *auditory* detection; if only a photo and UTM are taken it is recorded as a *photo only* observation. Each animal that is captured is processed to collect information about the physical attributes, including: snout to vent length (SVL), weight, health (good, fair, poor, dead), visible signs of Chytridiomycosis, age class (YOY, juvenile, adult), and sex. The UTM location of all observations is marked by GPS, the general habitat noted, and a digital photo of the animal's dorsal spot pattern is taken. When an animal is captured, the surveyor puts on a pair of single-use disposable gloves, and places the animal into a one-time use Ziploc bag. The animal is then weighed, measured, visually assessed for health and any signs of chytridiomycosis, swabbed, put back in the net for a photo and then released as quickly as possible to minimize stress (processing occurs in order listed and the length of time the animal is in the bag is minimal; Figure 4).

The health of each LIPI captured is assessed in the field by visual inspection. The surveyor looks for any abnormalities or injuries and for signs of chytridiomycosis such as sloughing skin, redness, vascularisation, lethargy, abnormal body positioning, or loss of righting reflex. General health and whether or not an animal is suspected of a chytridiomycosis infection is noted. An animal's general health is defined to be *good* if it has no injury or signs of illness; it is deemed to be *fair* if it has a minor injury such as a wound, which it is expected to fully recover from, or minor symptoms suspected to be from chytridiomycosis; and it is considered to be in *poor* health if it has a major injury, that will likely cause death, or if it is showing major signs of disease, such as chytridiomycosis. If Chytridiomycosis is suspected, details of the symptoms are noted. If health is deemed to be anything other than good, the reason for the designation is noted and photos of the specific issue are taken where possible.

To test for the presence of *Batrachochytrium dendrobatidis (Bd)*, which causes the disease chytridiomycosis, sterile Mediwire MW100 rayon tipped swabs stored in a dry labelled test tube are used to collect body swabs. The process involves swabbing the animal a total of 33 times, in the following order to minimize the spread of *Bd*: 5 times on each side, 5 times on the ventral surface, 5 times on each thigh, and once on the webbing between each toe. Once swabbing is completed the swab is put back into the sterile, dry test tube and labelled. Swabs are stored in the refrigerator until submitted to the lab for testing. The swab is not stored in any type of fixative, as it impairs the DNA extraction process, and is not required to maintain the integrity of the *Bd* DNA. In 2017 a subset of swabs were taken from high priority animals; samples were not analyzed but are stored for future analysis as required.

If a recently deceased animal is found in relatively good body condition (i.e., decomposition is not in advanced stages) it is immediately submitted for a full work up to determine the cause of death and general condition.

Fieldwork methods follow the Ministry of Environment Standard Operating Procedures: Interim Hygiene Protocols for Amphibian field staff and researchers (MoE 2008). The Live Animal Capture and Handling Guidelines for Wild Mammals, Birds, Amphibians and Reptiles (MoE, 1998) and the Canadian Council on Animal Care Species Specific Recommendations on Amphibians and Reptiles (CCAC, 2011) were consulted during field program development to ensure proper standards were being followed; see Northern Leopard Frog Project Description for Wildlife Act Permit (Houston, 2012).

Figure 4. Photos (left to right): the process of weighing, measuring SVL and swabbing LIPI for *Batrachochytrium dendrobatidis (Bd),* which causes the disease chytridiomycosis.

3.10 Passive Integrated Transponder (PIT) Tagging

In an attempt to begin a mark-recapture population estimate, PIT tagging was initiated during late-summer and fall field surveys in 2016 and was resumed in 2017. Effort was put forth to tag animals during spring migration surveys and again during late-summer and fall surveys; animals were not PIT tagged or scanned for PIT tags during the breeding season as efforts were focused on egg mass detection. When the project was initiated in 2016, it was decided that animals 25.0 grams and larger would be PIT tagged, however in 2017, with input from the British Columbia Northern Leopard Frog Recovery Team (BC-NLFRT), FLNRO staff decided that when suitable smaller animals would be PIT tagged, so animals as small as 16.0 grams were PIT tagged by FLNRO staff.

The PIT tagging procedure was carried out using individually packaged, 10 mm PIT tags pre-loaded in 16 gauge sterile single use syringe-style implanter (Biomark MiniHPT10 Individual Sterile). PIT tags were inserted after all other processing was completed (weight, SVL, swab, photo, etc.). They were inserted just under the surface of the skin by pinching a flap of the dorsum skin and injecting the needle horizontally. The syringe needle tip was inserted on the upper dorsal section of the body behind the head and once inserted the PIT tag was gently massaged back towards the pelvic bones. Single use gloves were worn when handling the animal. Every effort was made to safely process animals as quickly as possible to minimize stress and animals were released at the site of capture immediately after the procedure. After PIT tag insertion, the PIT tag code sticker from the package was added to the datasheet and the animal was scanned by a handheld PIT tag reader (Biomark model 601).

When possible, the majority of the late-summer and fall detections in the CVWMA were scanned to determine if they had previously been PIT tagged, if they had not been, they were PIT tagged if possible (difficult to do solo and equipment not always available). PIT tag recaptures were given a PIT code: *s-recap* for same day recaptures, *w-recap* for within-year recapture (but not same day) and *b-recap* for between-year recaptures. In addition to the PIT tag code, PIT recaptures are also assigned a unique frog id in the Filemaker database in the same way that recaptured animals identified by dorsal spot patterns in the past were. The format is based on the year of the first recapture event, followed by a unique number of the format 001 (for example, RC17001 was the first recaptured individuals detected in 2017, RC17002 was the second of the recaptured individuals detected in 2017 and so on).

3.11 Constructed Wetlands

In 2017, monitoring occurred at the 6 new wetlands constructed in late November-early December of 2016. LIPI surveys, including NCS and VES were completed by the CNLFC (using methods described above in Section 3.3 and 3.6). Wetland monitoring was also conducted by FLNRO staff, using the New Wetland Monitoring Protocol, which includes: photo points, amphibian occupancy surveys (June – September), water level monitoring, temperature data logger installation and invasive plant surveys (McGlynn, 2017).

During a site visit on July 12 by the author, Marc-Andre Beaucher and Tom Biebighauser (who designed the wetlands) it was noted that cattail ingrowth was occurring in many of the newly constructed wetlands. As a result a small scale hand-pulling cattail removal test project was conducted in OGCS-2 during the fall of 2017 (Morrison, 2017).

3.12 Data Management

Data collected in the field, including survey information, observation data, egg mass data and tissue data is recorded on survey datasheets and entered into the custom designed Northern Leopard Frog Project FileMaker Pro 13.0v3 master database where it is managed along with all other records dating back to 2000. The new data is exported annually to Wildlife Species Inventory (WSI) managed by the Knowledge Management Branch in the Ministry of Environment using the General Survey template with the addition of some user-defined fields. Project data is available at: http://a100.gov.bc.ca/pub/siwe/details.do?id=4955

Mapping was completed in ArcGIS 10.3.1 by the FWCP Section of Resource Management – Kootenay-Boundary Region of FLNRO Geomatics Specialist. SPOT 6/7 orthomosaic imagery from 2014/2015 was used to create the maps in this report is; this is the most recent imagery available to FLNRO. Unfortunately, 2017 imagery was not available, so to show the approximate location of the shoreline in spring of 2017 due to flooding, a 200 m buffer was added to the typical spring shoreline of DLNA (Appendix 8).

4. RESULTS

All data summaries are based on detections, they are observations in time and should not be assumed to represent individuals since recaptures (if any) have not been removed.

4.1 General Weather and Habitat Conditions

Over the winter of 2016-2017 there was a large amount of snow in the valley bottom, this, mixed with large amounts of rain in the early spring resulted in higher than usual water levels during the breeding season in the DLNA. There were periods of cool temperatures in the spring, followed by a summer with little to no precipitation and the largest number of wildfires on record for the Province. Weather in the early fall was fairly average.

As a result of the flooded conditions in the spring, water levels in the DLNA were much deeper than has ever been observed by the author while working in the area since 2005. WDLNA typically has approximately 20 cm of water (staff gauge reading of ~550 mm and dry is ~350 mm), however, in the spring of 2017 there was approximately 51 cm of water (staff gauge reading of ~860 mm in early May). This is 31 cm above the usual spring level at this site and is 2.5 times the usual depth, resulting in deeper, colder water. As a result of the high water levels, fields around the perimeter of DLNA were flooded in the spring, increasing the number of possible breeding areas where shallow warm open water was present (Figure 5).

Figure 5. WDLNA photos (clockwise from top left): Staff gauge showing normal spring levels (June 2016 ~550 mm); staff gauge on May 4, 2017 showing flooded conditions (~860 mm); flooded field west of main unit; main unit looks like a large lake at beginning of field season (taken May 4); thick watershield ingrowth (taken May 29)

Water levels were sufficient throughout the tadpole development period; DLNA did not dry out until mid-August.

The East Ditch and portions of the Squiggle Channel dried out a number of times during the summer and fall seasonal migration period of 2017. Water control gates at the Pumphouse were opened numerous times to let water in and while it was possible to get water in temporarily, the area dried out very quickly; it was not possible to keep water in the area consistently. To try and troubleshoot the problem the dry channel was surveyed and it was noted that there is a section of very dense cattails (*Typha latifolia*) between the area of high LIPI use in the East Ditch and the water supply in the Pumphouse Channel.

The watershield ingrowth problem is still occurring. It was not floating on the surface of the wetlands when we arrived to do spring surveys in late April as it has been in the last few years due to a lack of winter die back but by mid to late May the watershield had grown in even though the water levels were still deeper than usual for that time of year (Figure 6).

During the spring of 2017 the watershield removal test plot that was established at WDLNA in May of 2016 was revisited (Appendix 1). During the first site visit to evaluate the plot on May 4, 2017 there was no sign of the test plot or markers due to the flooded conditions. As of May 29, 2017 the watershield had grown in at WDLNA and it was found that while the overall size of the test plot had decreased slightly due to some ingrowth around the edges, there was limited regrowth within the plot itself (Figure 6).

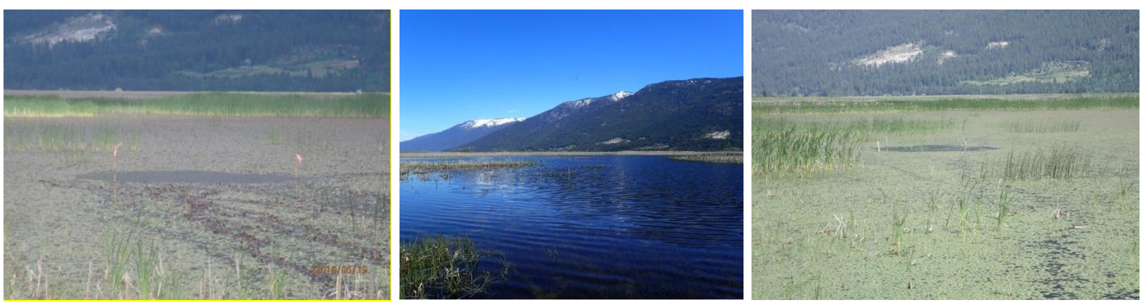

Figure 6. Watershield removal test plot photos (left to right): upon completion May 19, 2016; no sign of plot or markers May 4, 2017 due to flood conditions (staff gauge ~840mm = much deeper than last year); limited regrowth within plot with original stakes as of May 29, 2017 (note increased cattail ingrowth in background).

4.2 Songmeters

There were no calling LIPI detected on the Songmeters deployed at Leach Lake during the spring of 2017.

4.3 Nocturnal Calling Surveys (NCS)

In the CVWMA, 125:48 person-hours were dedicated to NCS between April 18 and June 6. Modified calling surveys were conducted in areas of DLNA where calling has been detected in the past (WDLNA, EDLNA and East Ditch) as well as extensive other areas in the DLNA to try and locate calling males as it was suspected they may have moved to other areas since the historically occupied breeding areas were inundated with deep water (Section 4.1). Due to the observed changes in habitat, other areas within DLNA were surveyed, including: open water areas throughout the large DLNA wetland complex (surveyed by canoe), flooded margins, DLNA North Peninsula, Southwest ditch, areas adjacent to the Pumphouse channel and squiggle channel that were flooded as well as the large pond adjacent to the DLNA dike on the south side. In addition to this the newly constructed wetlands which were completed late in 2016 (EDL-1, EDL-2 and OGCS-1 thru 4) and surrounding areas were surveyed (Table 1, Appendix 2). No NCS were conducted at Leach Lake due to the flood conditions which limited access.

NCS had to be cancelled on 8 nights during the spring breeding season due to poor weather conditions including, very cold temperatures (<5°C), heavy rain, thunderstorms and high winds. Surveys from mid-May onward were limited in some areas due to the dense watershield ingrowth and associated poor visibility because of the potential to unintentionally trample new egg masses.

Table 1. Number of nocturnal calling surveys at 5 areas in CVWMA in spring of 2017. Bold numbers indicate Northern Leopard frogs were detected calling.

Date Range	WDLNA	EDLNA Pond	East Ditch	DLNA Other	New Wetlands
April 18 -22	**1**	**1**	0	0	0
April 23-29*	**1**	**1**	1	0	0
April 30 – May 6	**1**	**1**	1	2	1
May 7 – 13*	**5**	0	0	**2**	0
May 14 – 20*	1	1	1	4	1
May 21 – 27*	**3**	1	1	1	1
May 28 – June 3	**4**	1	1	0	1
June 4 - 6	1	1	1	0	1

*some NCS during this week had to be cancelled due to poor weather

Calling was detected primarily at WDLNA (in flooded field to the west and within main area) with very little calling detected at the EDLNA Pond. Aside from some calling detected in the DLNA North Peninsula, no calling was detected elsewhere. (Table 1, Appendix 3, 4).

At WDLNA calling was detected on the first NCS on April 19 weekly through May 30 (with the exception of the week of May 14-20 when no calling was detected during the 1 NCS) and peak calling occurred May 22 when an estimated 35 individuals were detected calling. Aside from the survey results from May 22, only 1-14 individuals were detected per survey. This is lower than what was documented in 2016, when a maximum of 49 individuals were detected calling in the spring (Houston, 2017a). In comparison to recent years, calling activity was very sporadic (often faint) and individuals were spread out across the landscape, with very few large clustered calling groups detected (aside from the results of May 22, when calling groups with as many as 4-5 animals in each group were detected). Calling was already underway on the first NCS of the season at WDLNA on April 19. All of the detected calling early in the season was in the flooded field west of the usual shoreline at WDLNA, it wasn't until May 9 that calling was detected in the main body of water at WDLNA (near NCS SAS stations 3 and 4) where historically breeding has taken place.

The first time in April that air and water temperatures at WDLNA reached the critical point at which Seburn indicated males tend to begin calling (10°C water and 15°C air; Seburn, 1992) was on April 22.

At the EDLNA ponds calling was only confirmed on 2 (with a possible detection on a 3rd) of the surveyed 7 nights; all calling was detected between April 18- May 1. Calling was very limited, with only 1 or 2 individuals detected calling per survey. In contrast to other years, calling was very faint and sporadic which made it difficult to pinpoint their location. These results are lower than what was documented at the site in 2016, when a maximum of 7 individuals were detected calling per survey (Houston, 2017a) and is the lowest level of calling documented at the site over the last 5 years, which ranged from a maximum number of 7-23 individuals detected each spring in the years between 2012 -2016 (Houston, 2013-2017).

Of the other areas within DLNA that were surveyed, LIPI were only detected calling in the North Peninsula; this occurred on May 10 when 2 individuals were heard calling in flooded grass; again calling was very faint and sporadic so it was difficult to pinpoint their location.

During spring NCS a total of 128 LIPI detections were made (Table 2), the majority of which were at WDLNA (n=126, 98.4%), with only 2 detections at EDLNA ponds; overall detection rate was 1.0 LIPI per person-hour of effort. Of the total observations made during NCS, the majority were male (n=126, 98.4%), 1 was female and 1 was a visual observation of unknown sex. The majority of the male detections (n=124, 98.4%) were undetermined (unknown) stage as they were auditory detections.

Table 2. LIPI observations by stage and sex during NCS at CVWMA

	Adult	Juvenile	Unknown*	Total
Male	0	2	124	126
Female	1	0	0	1
Unknown	0	1	0	1
Total	1	3	124	128

*not possible to determine stage with auditory detection so *unknown* assigned

4.4 Egg Mass Surveys (EMS)

In the CVWMA, there were 209:54 person-hours (n=27 surveys) dedicated to EMS between April 20 and June 6. EMS were primarily conducted at WDLNA in 2017 as that is where the majority of the calling was detected. EMS were conducted less frequently at the EDLNA Ponds, East Ditch, North DLNA Peninsula and the newly constructed wetlands (Table 3); no EMS were conducted at Leach Lake as it was not possible to access the area due to flooding. In total, there were 7 egg masses detected in the CVWMA, all at WDLNA, 5 of which were considered to be in good health overall (Table 3, Appendix 1). Due to the lack of strong calling data, it was sometimes a challenge to delineate EMS search areas. A number of EMS had to be cancelled due to poor weather conditions which limited visibility; surveys from mid-May onward were limited in some areas due to the dense watershield ingrowth and associated poor visibility because of the potential to accidentally trample new egg masses.

Table 3. Summary of survey effort/egg mass by site in the CVWMA in spring 2017

	WDLNA	EDLNA Pond	East Ditch	DLNA Other*	New Wetlands
Number of surveys	21	2	1	1	2
Effort (person-hours)	195:25:00	6:09:00	0:19	7:28:00	0:33
# of egg masses detected	7	0	0	0	0
Survey effort/egg mass	**27.9**	**n/a**	**n/a**	**n/a**	**n/a**

*calling was detected at the North DLNA Peninsula so an EMS was done

Overall, in 2017 it took a much greater amount of survey-time to detect each egg mass than it did in any of the years dating back to 2012 (Table 4).

Table 4. Summary of survey effort/egg mass in the CVWMA (all sites); 2012-2017

	2012	2013	2014	2015	2016	2017
Number of surveys	29	26	16	22	27	27
Effort (person-hours)	104:17	167:42	120:52	176:49	132:58	209:54
# Egg masses detected	22	21	39	26	23	7
Survey effort/egg mass	**4.7**	**8.0**	**3.1**	**6.8**	**5.8**	**30.0**

Egg masses were detected between April 20 and May 25 and were estimated to have been laid between April 18 and May 22; egg masses were estimated to be 1-10 days old upon detection. The majority (n=5, 71.4%) were laid during the 3 day period between April 18-21 within a few meters of each other in the flooded field west of the main WDLNA unit; the greatest number laid in one day was 2, which occurred on both April 18 and 21 (Table 5, Appendix 1).

Table 5. Details of LIPI egg masses detected in the CVWMA in 2017

Egg mass #	~Date Laid*	Fertilization*	Condition*	Hatch out	Overall
EM170420-SW01	18-Apr	99 %	good	average	G
EM170420-SW02	18-Apr	97 %	good	average	G
EM170425-SW03	21-Apr	90 %	good	average	G
EM170425-SW04	21-Apr	99 %	good	average	G
EM170426-BH05	20-Apr	97 %	good	average	G
EM170523-KM06	22-May	99 %	good	zero	B
EM170525-TH07	15-May	n/a	poor	poor	B

*estimated upon detection; n/a as it had already begun to hatch when detected
Overall category takes into account *condition* and *hatch out*: G=Good, B=Bad

Of the 7 egg masses detected in 2017, the majority (n=6, 85.7%) were still in the early stages of development when detected, percent fertilization was estimated to be 90-99 %. All 6 of these were average size and did not appear to have any issues so were deemed to be in good condition *upon detection*, however only 5 of these ultimately developed properly and hatched out. The 6th egg mass, laid in deep water in the main WDLNA unit died during development. When checked on May 26 it was noted that the egg mass appeared cloudy and the health was questioned; it did not appear to develop any further after this point (Figure 7). The 7th egg mass was hatched out when detected but appeared to be in poor health. It was covered in a green algal like substance with a large number of dead eggs in the egg mass remnant and very few hatchlings clinging to the egg mass remnant (Figure 7).

AHC lab results for tests on samples submitted from EM170523-KM06 and EM170525-TH07 were received July 14, 2017. A complete work-up was completed and nothing significant was discovered that would explain the degeneration of the eggs; findings were consistent with loss of viability and secondary microbial colonization. Histopathology detected extracellular coccobacilli admixed with variable numbers of pseudohyphae, hyphae and algal like structures that may have been opportunists secondary to loss of viability or possible primary pathogens related to suboptimal water quality, temperature, flow, nutrient content or microbial plumes. *Aeromonas hydrophila* (light to moderate growth) and a *Pseudaeromonas sp*. were isolated during aerobic culture. No fungi were isolated during fungal culture and results for both Frog Iridovirus and *Batrachochytrium dendroba* were negative. For a complete summary of the lab findings see Final Report AHC Case: 17-2702.

There was some concern about the possibility of a *Saprolegnia spp.* (common water mould) infection within the egg masses deposited in the flooded field as this was documented in 2001 (when flooding also occurred) and resulted in high egg mortality (Adama, 2016). However, the egg masses were monitored and no signs of a *Saprolegnia* infection or associated mortality were detected.

Figure 7. Photos (clockwise from top left): EM170523-KM06 appeared healthy upon detection May 23; the health of EM170523-KM06 was questioned when checked May 26 due to its cloudy appearance; EM170523-KM06 on May 31, 2017 when collected sample for AHC lab diagnosis, note green on surface and cloudiness; EM170525-TH07 upon detection at approximately 10 days old, note fuzzy green appearance.

Five of the 7 egg masses detected this year appeared to have average hatch-out, this includes all 5 that were laid in the flooded grass field adjacent to the WDLNA. While development of all egg masses was not thoroughly monitored and it was not possible to do precise hatchling counts as the egg masses were not caged, it was estimated that each contained approximately 2000-3000 hatchlings. Development rate is temperature dependant but the majority of the viable egg masses appear to have hatched within 7-10 days from the date laid and hatchlings reached the free-swimming stage after approximately another week in most cases. Hatch out was poor in the 2 egg masses laid in deep water within the main WDLNA unit (EM170523-KM06 and EM170525-TH07); one of the egg masses died during development so there were no hatchlings, and the other had very poor hatch out with less than 100 hatchlings observed. Since no tadpoles were removed for captive assurance colonies or the reintroduction program, 100% of the viable hatchlings remained in situ at WDLNA.

It was not possible to cage any of the 5 viable egg masses as they were laid in a flooded field which made it impossible to do so safely. Due to the water depth, nature of the substrate and the fact that the egg masses were interwoven within the grass they were attached to it was decided it would not be in the best interest of the health of the egg masses to try and cage them. The egg mass that was laid in deeper water in the main WDLNA unit (EM170523-KM06) which ultimately died was caged part way through development (on May 26) but at that time it was noted that it appeared cloudy and the overall health was questioned, ultimately it did not develop any further and there were no hatchlings. On May 26, at the same time it was caged, approximately 100 eggs were collected for the Calgary Zoo even though it was noted at the time that the health was questionable as this was the only opportunity for egg collection; the Calgary Zoo reported that these eggs did not hatch out either.

Water depths in the flooded field west of the main WDLNA unit where 5 of the egg masses were laid ranged from 18-21 cm, and the top of the egg masses were approximately 3-4 cm below the surface of the water, while the 2 in the main WDLNA unit were laid in much deeper water at 47-52 cm and the tops of the egg masses were approximately 12-20 cm below the surface. In comparison to 2016 water depths at egg mass deposition sites, the depths in the flooded field were similar to 2016 depths, while the 2 in the main WDLNA unit were much deeper than anything detected in 2016 (Figure 8).

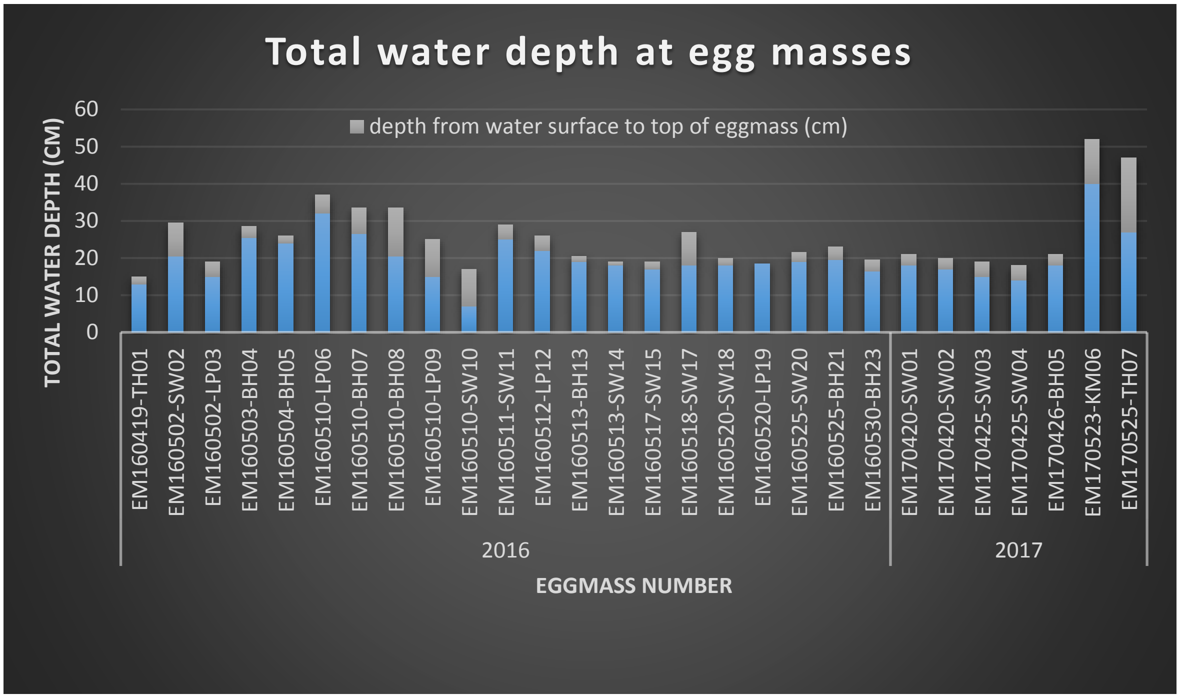

Figure 8. Comparison of 2016/2017 total water depth (cm) where egg masses detected

During the period of April 1 – May 31, air temperatures at DLNA ranged from a low of -3.4°C on April 4 to a high of 34.4°C on May 30; water temperature for the same period ranged from a low of 6.2°C on April 2 to a high of 20.6°C on May 29 (Figure 9). During the peak egg laying period (April 18 – 21) temperatures ranged from 2.0°C - 19.0°C for air and 8.6°C -10.2 °C for water.

In general, temperatures were fairly consistent (or increased) during the development period for the 6 egg masses estimated to have been laid between April 18 – May 15, however they dropped sharply during the development period of EM170523-KM06. It was estimated to have been laid on May 22 when water temperatures were 19.0 °C, the highest they had been all spring in the deep water where it was laid, however, on May 25 it dropped down to 12.1 °C, a drop of 6.9 °C during the critical development period.

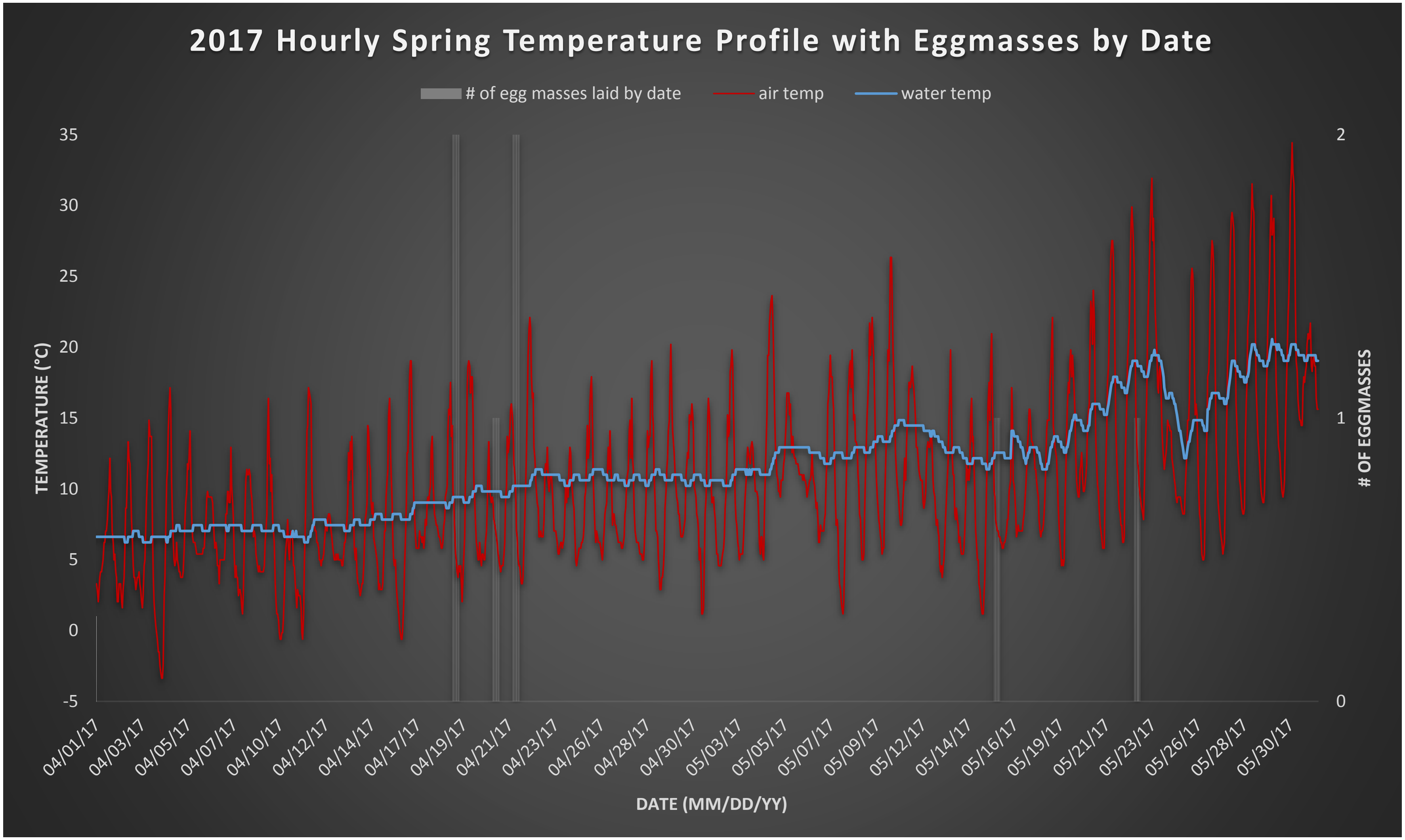

Figure 9. Hourly air and water temperatures at DLNA from April 1 – May 31 with number of egg masses detected by date laid. Data from HOBO Temperature data loggers #05 and #06*.

While greater than 20 egg masses were detected annually across the CVWMA since 2012, there was a significant drop in the number of detected egg masses in 2017, to just 7, this is the lowest number of egg masses detected since 2010, but within the range of 4-16 (mean=8.2, SD=3.8, n=11) detected annually across the CVWMA from 2000-2010 (Table 6). In 2017, no egg masses were detected in EDLNA, so as in the previous 6 years, the greatest proportion were detected at WDLNA.

Table 6. LIPI egg masses detected in the CVWMA 2000-2017

Year	EDLNA pond	East ditch	WDLNA	Leach #4	Total
2000	8	0	8	*	16
2001	12	*	0	*	12
2002	1	2	2	*	5
2003	4	0	2	*	6
2004	3	0	1	*	4
2005	0	0	4	3	7
2006	3	2	2	0	7
2007	3	1	4	5	13
2008	3	0	1	2	6
2009	4	0	3	0	7
2010	5	**	2	**	7
2011	2	0	15	**	17
2012	3	0	19	**	22
2013	2	0	19	**	21
2014	6	0	33	***	39
2015	3	*	23	**	26
2016	4	*	19	**	23
2017	0	**	7	**	7
Total	66	5	164	10	245

* indicates area not surveyed

**indicates no EMS in area because no calling detected during NCS

***YOY observed in summer so possible undetected breeding occurred

4.5 Tadpole Surveys

Tadpole trapping was conducted at WDLNA on July 11-12. A total of 12 tadpole traps were set for 24-hours for a combined total of approximately 288 trap-hours. This level of trapping took 3:17 person-hours of effort on site to deploy, check and remove the traps. No tadpoles were trapped but while deploying traps on July 11 metamorphs with small tail stubs were detected, the first sign of metamorphosis for the year. Tadpoles (Gosner stage 39) and metamorphs were also detected at EDLNA ponds on July 18 (Appendix 5).

4.6 Visual Encounter Surveys (VES)

In 2017 at the CVWMA 127:07 person-hours were dedicated to visual encounter surveys (n=64 surveys) in summer and fall (Table 7).

Table 7. Summary of VES efforts in the CVWMA for 2017

	Summer	Fall	Total
Number of surveys	46	18	64
Survey effort (person-hours)	85:53	41:14	127:07
Number of LIPI observations	116	23	139
LIPI catch/effort during NCS	1.4	0.6	1.1

A total of 127:07 person-hours were spent on VES (n=64 surveys) from July 10 to October 26. VES were done in known breeding areas to search for YOY, in possible breeding areas to search for YOY, in the migration corridors to search for all age classes as they move between seasonal habitats and in over-wintering areas. Surveyed areas include: Duck Lake, East ditch, EDLNA ponds, EDL-2, Old Goat channel, Kootenay River, Leach Lake (compartments 2, 4 and 6), OGCS-1 through 4, Pumphouse channel, Southwest ditch, Squiggle channel and WDLNA. Attempts were made to search the frog-bear channel but it has become too overgrown with weeds to survey and the East Ditch was dry on many occasions. A number of VES had to be called off during the field season due to circumstances beyond our control (some of these reasons included: heavy smoke from widespread wildfires in the province which was a health concern for surveyors at times, overgrown vegetation along shorelines preventing visibility and impairing detectability, low and/or no water in the East Ditch and Squiggle Channel and cattle in over-wintering areas).

During VES a total of 139 LIPI detections were made between July 11 and October 26, a catch per effort of 1.1 LIPI per person-hour of survey effort. As expected, the majority of the VES detections were YOY (n=121, 87.1%), most of which were detected at the WDLNA known breeding area (n=52, 43.0%). A large number of YOY were also detected in the Southwest ditch (n=33) and in the East pond (n=17). LIPI were detected in some of the known migration areas in the DLNA but none were detected in Leach Lake (Table 8, Appendices 5-6).

Table 8. CVWMA VES (n=64surveys) with LIPI observations by age class

VES Sites (n=64 surveys)	Adult	Juvenile	YOY	Unknown	TOTAL
Duck Lake (n=2)	0	0	0	0	**0**
East Ditch (n=7)	1	0	0	0	**1**
EDLNA Pond (n=5)	0	0	17	0	**17**
EDL-2 (n=1)	0	0	1	0	**1**
Old Goat channel (n=16)	3	0	10	2	**15**
Kootenay River – East channel (n=4)	1	1	8	0	**10**
Kootenay River – Leach Lake (n=2)	0	0	0	0	**0**
Leach Lake 2 (n=1)	0	0	0	0	**0**
Leach Lake 4 (n=1)	0	0	0	0	**0**
Leach Lake 6 (n=1)	0	0	0	0	**0**
OGCS-1 (n=2)	0	0	0	0	**0**
OGCS-2 (n=3)	0	0	0	0	**0**
OGCS-3 (n=2)	1	0	0	0	**1**
OGCS-4 (n=1)	1	0	0	0	**1**
Pumphouse channel (n=4)	0	0	0	0	**0**
Other**(n=1)	0	0	0	0	**0**
Southwest ditch (n=5)	5	0	33	1	**39**
Squiggle channel (n=1)	0	0	0	0	**0**
WDLNA (n=5)	0	0	52	0	**52**
TOTAL	**12**	**1**	**121**	**3**	**137***

* In addition to this there were 2 tadpoles detected in the EDLNA Pond during VES
** Other survey site refers to a VES done at night from Frog-bear channel to Pumphouse

4.7 Spring Migration Surveys

Surveys were conducted between March 31 and April 19 on 10 nights, the majority of the surveys occurred from April 4-12; a total of 46:50 person-hours of survey effort was put forth. A total of 4 LIPI observations were made, 3 of which were implanted with PIT tags; no recaptures were made (Appendix 4). There were 2 detections on the road, 1 on the south shore of Duck Lake and 1 on the shoreline of the Pumphouse channel – east. There were no road mortalities detected as the Duck Lake dike road was temporarily closed to vehicular traffic due to soft, muddy, unsafe conditions from February 27-April 28, 2017. No other herpetofauna species detections were confirmed during these surveys.

4.8 Late-summer and Fall Road Surveys

Nocturnal road surveys during the late-summer and fall migration period were conducted along the Duck Lake dike between August 31 and October 12, during which time a total of 40 night surveys were completed. A total of 178:26 person-hours of survey effort was dedicated to these surveys, with a combined total of 155 LIPI observations, a catch per effort of 0.87 LIPI/person-hour of survey effort (Table 9, Appendices 5-6).

Table 9. Summary of 2017 late-summer & fall night road survey effort

	Road surveys
Number of surveys	40
Number of LIPI observations	155
Survey effort (person-hours)	178:26
LIPI catch/effort during road surveys	0.87

Overall, 17 of the 155 LIPI detections (11.0%) were road mortalities (Table 10). Of the 155 LIPI observations made during night road surveys 7 were adults, 7 were juveniles and 141 were YOY (Appendix 3-4). In addition to this there were 5 LIPI detected via eyeshine during the migration period (4 along the south shore of Duck Lake and 1 in the Pumphouse channel-west; recorded as incidental detections). For recapture results, see Section 4.10 Passive integrated transponder (PIT) tagging.

Other herpetofauna observations during late summer and fall night road surveys along Duck Lake dike included: Pacific chorus frogs *(Pseudacris regilla*), long-toed salamanders *(Ambystoma macrodactylum)* and garter snakes *(Thamnophis species).*

Table 10. Late-summer and fall night road survey results at Duck Lake dike 2017

Species (age class)	Live	Dead	Total	Proportion Live	Proportion Dead
LIPI - Adult	7	0	7	100.0%	0%
LIPI - juvenile	5	2	7	71.4%	28.6%
LIPI - YOY	126	15	141	89.4%	10.6%
LIPI - Overall	**138**	**17**	**155**	**89.0%**	**11.0%**
Pacific chorus frog	66	3	69	95.6%	4.4%
Long-toed salamander	12	0	12	100.0%	0%
Garter snake	1	1	2	50.0%	50.0%
Other Species – Overall	**79**	**4**	**83**	**95.2%**	**4.8%**
Grand Total (all species)*	**217**	**21**	**238**	**91.2%**	**8.8%**

*does not include 1 live unconfirmed species detected during road survey or 2 incidental live adult Pacific chorus frog observations made on road outside standard road survey transect

The voluntary road closure signage that was originally installed in 2016 was put up again this year, with some re-wording as recommended (Houston, 2017a) but vehicles were still detected on the road causing road mortality (Figure 10). Vehicles were encountered on 26 of 40 nights surveyed, with a range of 0 to 5 vehicle passes per survey and a total of 61 vehicle passes detected during surveys throughout the entire survey period (August 31-October 12).

Figure 10. Photos (left to right): voluntary road closure sign installed by the Province of B.C. on Duck Lake dike road for the second year; LIPI road mortality

Mean air temperature at dusk for the subset of night surveys where LIPI encountered was 16.5°C (n=21, SD=4.02, range 9.0°C to 25.1°C). LIPI were encountered in 21 of 40 night road surveys (52.5%). LIPI were already on the road the first night of surveys on August 31, and were last detected on the road October 2; there were no LIPI detections on the road during the 7 nights surveyed from October 3 - 12. The majority of LIPI detections (91 of 155, 58.7%) were made between Sept 1-12, and the maximum number of LIPI detected in a single night on the road was 23 (September 29). Behaviour was similar to that observed in previous years (for details, see Houston, 2017a)

4.9 Animal Health

Of the post-metamorphic LIPI whose health was assessed visually in the field, the majority were deemed to be in good health. Aside from the 17 road mortalities described previously (Table 10), there were 3 dead LIPI dead during the field season (Table 11, Figure 11).

Table 11. Health assessment of LIPI CVWMA field observations

Season	Age Class	Good	Fair	Poor	Dead*	Total
Spring	**Adult**	4	1	0	0	5
	Juvenile	7	2	0	3	12
	All age class	11 (64.7%)	3 (17.7%)	0	3 (17.7%)	17
Summer	**Adult**	8	0	0	0	8
	Juvenile	3	0	0	*	5
	YOY	91	2	0	*	104
	All age class	102 (98.1%)	2 (1.9%)	0	0	104
Fall	**Adult**	5	0	0	0	5
	Juvenile	3	0	0	0	3
	YOY	53	0	1	*	58
	All age class	61 (98.4%)	0	1 (1.6%)	0	62
Over all seasons	**All age class**	174 (95.1%)	5 (2.7%)	1 (0.6%)	3 (1.6%)	183

*not including road mortalities as these are described in Table 10

Of 174 LIPI deemed to be in good health, there were 17 adults, 13 juveniles and 144 YOY.

Of the 5 live LIPI deemed to be in fair condition, there was 1 adult, 2 juveniles and 2 YOY. Three of them (1 female adult and 2 juvenile males, all detected during the spring breeding season at WDLNA) exhibited one or more symptoms associated with chytridiomycosis, including sloughing skin, redness, lethargy and emaciation. The other 2 were YOY detected in the summer, of which one was missing its left hand (likely from a predator attack) and the other appeared to have dropsy (edema) as its abdomen was extremely swollen and appeared to be fluid filled, possibly caused by a lymphatic drainage problem (Figure 11).

The 1 LIPI in poor condition was a YOY detected during the fall migration on the DLNA dike road. It had been severely injured with its leg split open, extremely swollen with bare tissue exposed.

It was not possible to determine the cause of death of the 3 dead juvenile LIPI detected during the spring breeding season at WDLNA as the bodies had already begun to decompose so it was not possible to look for symptoms or have them tested. As shown in Figure 11 there was severe redness on the decomposing bodies. All 3 corpses were detected on May 17 and from the state of decomposition appear to have died within a few days of each other.

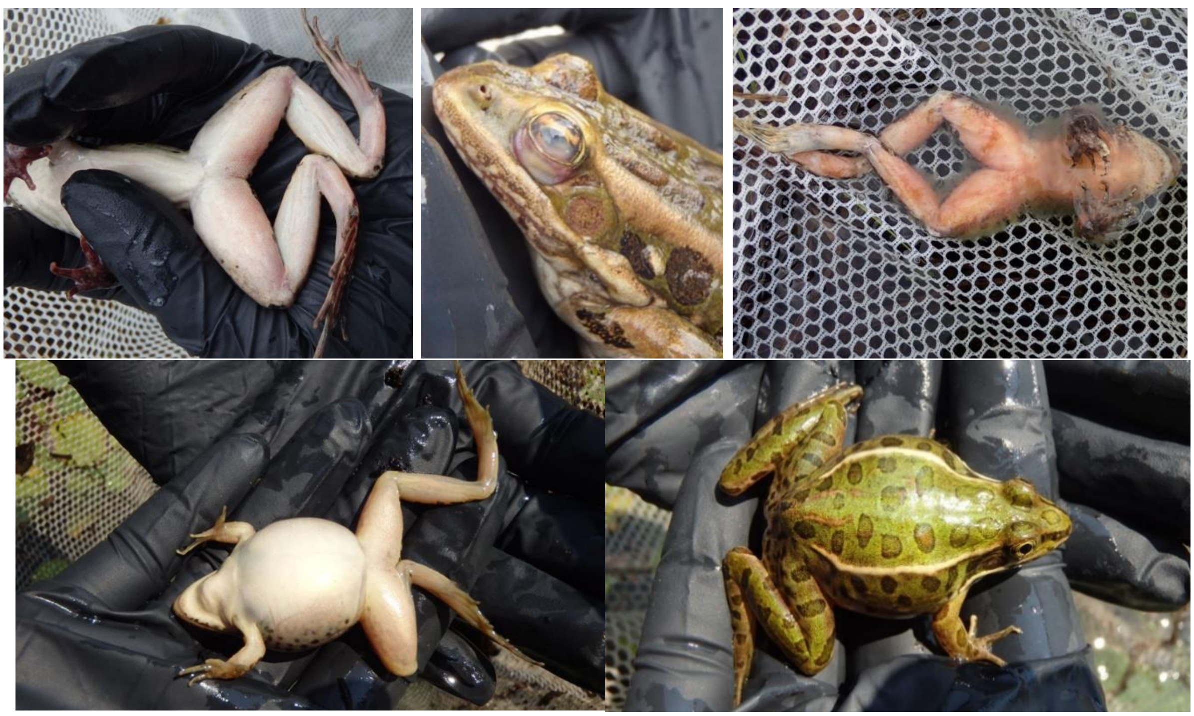

Figure 11. Health photos (clockwise from top left): redness on the ventral surface, likely from chytridiomycosis; severe vascularization of the eye, likely from chytridiomycosis; 1 of 3 dead juveniles detected during the spring breeding season; dorsal surface of LIPI YOY with what appears to be dropsy (edema); as in previous, but ventral surface.

In total there were 200 LIPI detections that were visually inspected for signs of chytridiomycosis during 2017, this includes 20 dead specimens (cause of death for majority was road mortality). Chytridiomycosis was suspected in 6 (3.0%), 1 adult and 5 juveniles all of which were detected during the spring breeding season at WDLNA (Table 12).

Table 12. Field observer's determination if chytridiomycosis suspected by visual inspection of CVWMA LIPI detections in 2017 (n=200*) by season and stage

		Chytridiomycosis Suspected*		
Season	**Stage**	**No**	**Yes**	**Total**
Spring	Adult	4	1	5
	Juvenile	7	5	12
	All age class	11 (64.7%)	6 (35.3%)	17
Summer	Adult	8	0	8
	Juvenile	5	0	5
	YOY	104	0	104
	All age class	117 (100.0%)	0	117
Fall	Adult	5	0	5
	Juvenile	3	0	3
	YOY	58	0	58
	All age class	66 (100.0%)	0	66
Over all seasons	All age class	194 (97.0%)	6 (3.0%)	200

*includes dead specimens (n=20, of which 17 were road mortalities)

4.10 Passive Integrated Transponder (PIT) Tagging

In total during the 2017 field season 104 LIPI were PIT tagged: 11 adults, 5 juveniles and 88 YOY. Of these, 3 during incidental detections, 80 during late-summer and fall road surveys, 18 during visual encounter surveys and 3 during the spring migration.

There were a number of PIT tag recapture events, all in the late-summer and fall, including 2 same-day (and within survey) recapture events, 7 within-year (but not same day) recapture events and 1 between-year recapture events (the first between-year PIT tagged recapture since PIT tagging project began); each of the recaptures were detected once after originally being PIT tagged (Table 13, Appendix 7).

The same-day recaptures both occurred during road surveys along the Duck Lake dike, when recaptured animals, both alive on road, were detected approximately 1.0 m (80 minutes later) and 23.0 m (107 minutes later) away from where they were originally PIT tagged.

Of the 7 within-year (but not same day) recapture events, 4 were detected between-season (summer to fall) and 3 were within-season (2 in summer and 1 in fall). The majority of the within-year recaptures were made on the road (n=5), one was in the Kootenay River East channel and the other was in the newly constructed OGCS wetland. Within-year recapture events ranged from 1 to 25 days from the original tagging event (mean=12.3 days, n =7, SD=9.6). All were recaptured within the same general area as they were originally PIT tagged and the distance between capture events for each animal ranged from 1 to 825 m (mean=273.7 m, n=7, SD=301.6). All but one of the recaptures were in good general health upon recapture, the exception was a YOY road mortality found 1 day after it had originally been tagged in the Pumphouse channel-west (RC17005). Of the 6 within-year recapture events with morphometrics (not possible to get an accurate weight or SVL for the road mortality recapture due to the condition of the carcass), 3 gained weight, 1 remained the same and 2 lost weight. The mean difference in weight overall for the within-year recaptures was 0.83 g (n=6, SD=2.6, range = -2.0 to 4.0g). With SVL between capture events, 3 animals measured larger and 3 smaller upon recapture; mean SVL was 0.45 mm (n=6, SD=4.8, range = -3.6 to 9.3 mm).

The between-year recapture was detected on August 31, 2017 in OGCS-4 (one of the newly constructed wetlands completed in December of 2016). This adult female was originally PIT tagged in 2016, across the Old Goat Channel on the east shoreline of the over-wintering area on September 8 (approximately 230 m from the recapture site). When she was originally PIT tagged she weighed 97.0 g and measured 88.5 mm SVL, upon recapture nearly a year later, she weighed 133.0 g and measured 98.0 mm SVL, a weight gain of 36.0 g and increase in SVL of 9.5 mm. She was deemed to be in good health during both detections.

There were no obvious signs of infection or other health problems detected at the PIT tag incision site in the recaptures made this year.

Table 13. Weight and SVL differences between recapture events of PIT tagged LIPI in the CVWMA in 2017. Bold numbers indicate reduced size on recapture.

Frog Id [1]	Events [2]	PIT code [3]	Time (days)	Weight (g)	SVL (mm)	~Distance (m)
RC17001	1	s-recap	0	0	0	23
RC17002	1	s-recap	0	0	0	1
RC17003	1	w-recap	23	**-2**	**-3.6**	300
RC17004	1	w-recap	25	3.5	9.3	518
RC17005	1	w-recap	1	n/a	n/a	11
RC17006	1	w-recap	14	4	1.9	825
RC17007	1	w-recap	15	**-2**	**-1.9**	147
RC17008	1	w-recap	5	0	0.2	19
RC17009	1	w-recap	3	1.5	**-3.2**	96
RC17010	1	b-recap	356	36	9.5	230

[1] Frog Id: a unique number assigned to each individual determined to be a recapture
[2] Events refers to number of times animal was recaptured after originally being PIT tagged
[3] PIT codes: s-recap = same day recapture; w-recap = within-year recapture (but not same day); b-recap = between-year recapture
n/a: accurate weight and SVL not available as recapture dead (road mortality)

4.11 Morphometrics of Creston LIPI

Size data was gathered on 178 LIPI observations that were captured during the 2017 field season, this data includes all live field captures where both a weight and snout vent length were measured; recaptures included (Tables 14, 15, Figure 12).

Table 14. Weight of 2017 CVWMA LIPI captures by stage and sex

Weight (grams)	Stage - sex	n	Mean	SD	Range
Spring	Juvenile - male	8	33	11.2	19.0 - 48.0
	Juvenile – sex unknown	1	10	n/a	n/a
	Adult - male	1	54.5	n/a	n/a
	Adult - female	4	75.8	19.6	54.0 - 100.0
	Total (combined)	14	45.1	25.2	10.0 - 100.0
Summer	YOY - all	93	21.3	7.99	4.0 - 35.0
	Juvenile - female	2	46.5	0.71	46.0 - 47.0
	Juvenile – sex unknown	1		n/a	n/a
	Adult - male	1		n/a	n/a
	Adult - female	6	86.8	24.8	65.0 - 133.0
	Total (combined)	103	26.2	18.7	4.0 - 133.0
Fall	YOY - all	53	23.6	5.91	10.5 - 34.0
	Juvenile - male	1	38.5	n/a	n/a
	Juvenile – sex unknown	2	36.5	0.71	36.0 - 37.0
	adult - male	1	55.5	n/a	n/a
	adult - female	4	79.3	9.5	65.0 - 84.0
	Total (combined)	61	28.5	15.6	10.5 - 84.0

Table 15. Snout-Vent Length (SVL) of 2017 CVWMA LIPI captures by stage and sex

SVL (mm)	Stage - sex	n	Mean	SD	Range
Spring	Juvenile - male	8	66.5	8.3	54.8 - 77.1
	Juvenile – sex unknown	1	42.3	n/a	n/a
	Adult - male	1	76.0	n/a	n/a
	Adult - female	4	89.1	3.9	83.4 – 92.0
	Total (combined)	14	71.9	14.8	42.3 - 92.0
Summer	YOY - all	93	56.1	8.7	32.8 - 67.0
	Juvenile - female	2	74.1	0.1	74 - 74.2
	Juvenile – sex unknown	1	68.0	n/a	n/a
	Adult - male	1	82.0	n/a	n/a
	Adult - female	6	87.6	5.8	80.9 - 98.0
	Total (combined)	103	58.7	11.6	32.8 - 98.0
Fall	YOY - all	53	60.0	5.8	43.5 - 70.5
	Juvenile - male	1	70.3	n/a	n/a
	Juvenile – sex unknown	2	66.0	2.8	64.0 - 67.9
	adult - male	1	74.7	n/a	n/a
	adult - female	4	85.6	5.4	77.5 - 89.3
	Total (combined)	61	62.3	8.7	43.5 - 89.3

Figure 12 provides a visual representation of the morphometrics of Creston LIPI detections detailed in Table 14 and 15; based on weight the following clusters have been identified during each season:

Spring detections (blue symbols) fall into 3 general clusters:

1. The smaller sized LIPI (less than 35.0 g; 6 detections), all male (except 1 unknown sex) the majority of these weights range from 19.0 – 26.0 g (54.8 – 69.0 mm SVL), with the exception of 1 smaller LIPI detection (unknown sex) at 10.0 g (SVL 42.3 mm) and 1 larger detection at 33.0 g (SVL 69.0 mm).
2. Medium sized LIPI (the majority, 4 of 5 detections are males) clustered around the 50.0 g line, with weights ranging from 43.0 – 54.5 g (SVL 73.4 -83.4 mm).
3. Largest LIPI, 3 female detections, ranging in weight from 68.0 -100.0 g (SVL 90.5 - 92.0 mm).

Summer detections (red symbols) fall into 3 main clusters:

1. The smaller LIPI which are all 35.0 g or less (n=93 detections); weights range from 4.0 – 35.0 g (SVL 32.8 - 61.0 mm); the majority of the summer detections fall into this category. Within this group there is a subset of smaller animals (n=12 detections) with weights ranging from 4.0 – 9.0 g (SVL 32.8 – 40.5 mm).
2. Medium sized LIPI (n= 3 detections; 2 female, 1 unknown) ranging from 38.0 – 47.0 g (SVL 68.0 – 74.2 mm).
3. Larger sized LIPI, all greater than 50.0 g, ranging in size from 65.0 – 93.0 g (SVL 80.9 – 87.0 mm); 5 of 6 detections were female. The majority of this group is 93.0 g or less but there is 1 female detection at 133.0 g (SVL 98.0 mm)

Fall detections (grey symbols) fall into 3 general clusters:

1. LIPI less than 39.0 g (n=56 detections); the majority of these detections (48 of 56; 85.7%) range in weight from 17.0 – 34.0 g (SVL 55.2 – 68.4 mm) but there is a subset of smaller sized detections (n=5; 10.5 g/45.0 mm – 14.0 g/43.5 mm) and a subset of larger sized detections (n=3; 36.0g/67.9 mm – 38.5 g/70.3 mm).
2. Medium sized LIPI (1 male and 1 female) in the 55.0 – 65.0 g range (SVL 74.7 – 77.5 mm).
3. The largest LIPI, 3 female detections, all weighing 84.0 g (SVL 88.2 -89.3 mm)

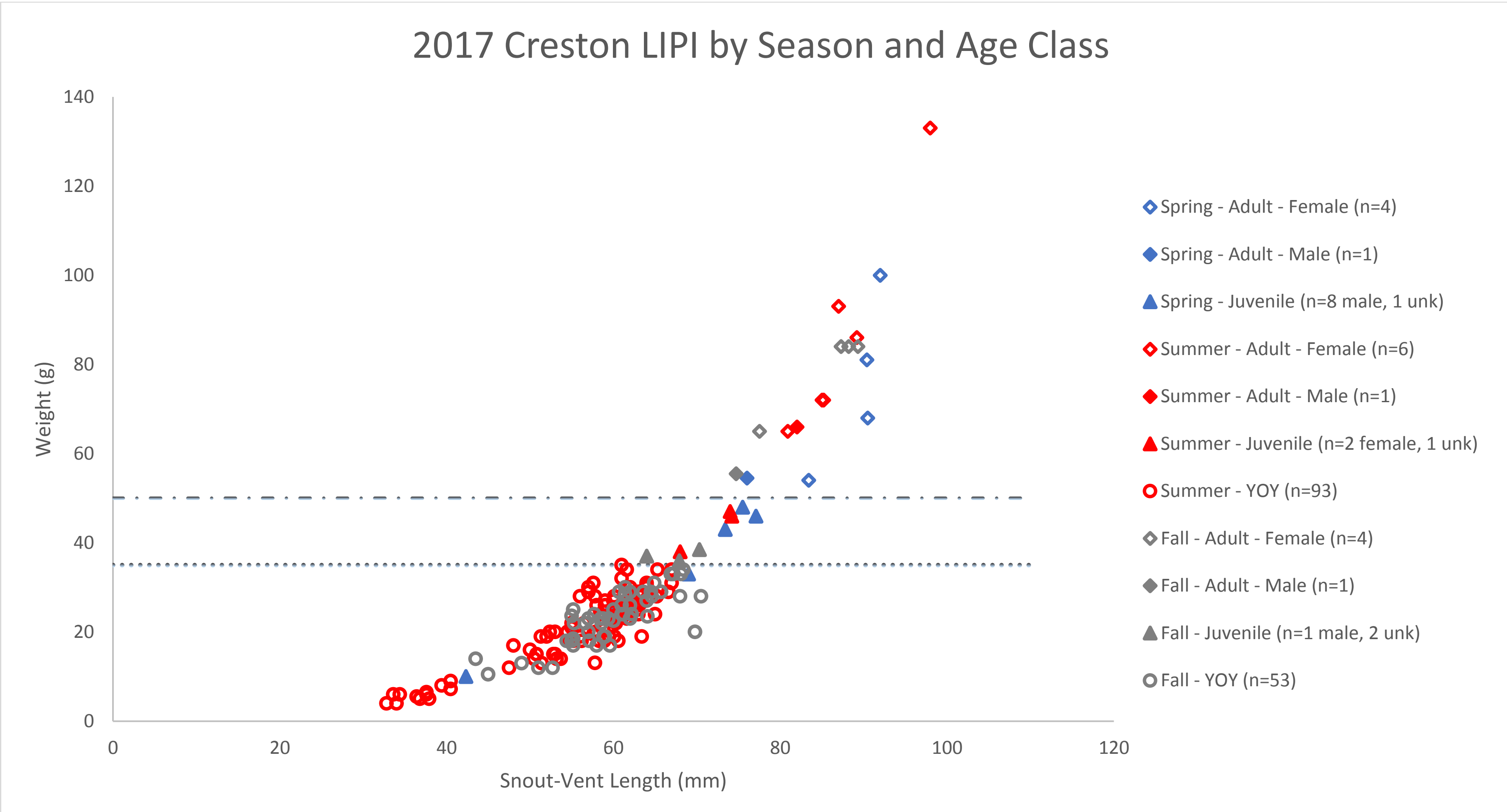

Figure 12. Size Chart: 2017 CVWMA LIPI Captures (n=178) by Season, Age Class (determined by weight) and Sex

A multi-year comparison of size data of YOY captured in the fall shows that 2017 YOY had larger mean weight and mean SVL than was documented in 2016 and were also the largest observed in the dataset dating back to 2010 (Table 16). Results of a non-paired t-test between sizes of 2016 and 2017 YOY captured in the fall show that the difference between the means for both weight and SVL are statistically significant at the 0.05 level (weight p-value = 0.0000000204; SVL p-value = 0.00000676).

Table 16. Size data for fall YOY LIPI detections in the CVWMA 2010 – 2017

Year	Date*	n	$\bar{x}$ Weight (g)	SD	Range	$\bar{x}$ SVL (mm)	SD	Range
2010	9/28 – 10/20	25	20.2	7.4	8.0 – 33.0	57.6	6.8	46.1 – 67.2
2011	9/24 – 10/19	9	13.2	7.4	7.5 – 32.0	53.3	7.9	45.1 – 69.5
2012	9/26 – 10/11	52	19.3	6.1	9.0 – 32.0	56.8	6.2	44.7 – 66.1
2013	9/21 – 10/18	10	18.3	9.0	9.0 – 37.0	52.6	8.9	41.1 – 68.1
2014	9/22 – 10/20	58	21.0	9.0	6.0 – 39.0	56.1	8.8	37.6 – 70.8
2015	9/21 – 10/16	23	11.4	5.0	6.0 – 27.0	46.5	5.7	39.1 – 57.0
2016	9/21 – 10/25	32	14.5	6.6	5.0 – 30.0	51.2	8.7	37.1 – 69.3
2017	9/23 – 10/26	53	23.6	5.9	10.5 – 34.0	60.0	5.8	43.5 – 70.5

*captures made in 2012 and 2016 in November omitted for date range consistency between years

4.12 Captive Assurance Colonies

It was not possible to provide tadpoles to the Vancouver Aquarium as the number of viable egg masses detected during the breeding season was very limited and unfortunately, no animals were set aside from the few healthy egg masses laid in late April as it was assumed there would be more to collect from in May based on breeding in recent years, which did not happen.

While efforts were made to provide Calgary Zoo with the LIPI eggs they requested to initiate a new captive assurance colony there were limited opportunities as it turned out that the only viable egg masses detected prior to hatching were laid in April; it was thought that there would be additional egg masses detected in May as this is usually the peak of the breeding season, but this did not appear to be the case in 2017. Eggs were collected from the one egg mass detected pre-hatch in May but it turned out that the egg mass died during development. Since no other viable eggs were detected in May it was not possible to supply any eggs.

4.13 Columbia Marsh Reintroduction Program

Since the detected number of healthy egg masses in the CVWMA was below the threshold of 10 required to support the reintroduction program (as established by the BC-NLFRT) it was not possible to provide Creston LIPI to supplement the number the Vancouver Aquarium captive breeding program provided for the reintroduction in 2017.

4.14 Constructed Wetlands

In the spring of 2017 the newly constructed wetlands were visited 5 times between May 1 and June 5 to conduct nocturnal calling surveys to determine if any LIPI were calling in the area. On each survey date between 1 and 6 of the new wetland ponds were visited; no calling was detected.

A total of 6 LIPI were detected using the new wetlands in the summer and fall during visual encounter surveys by the CNLFC or during amphibian occupancy surveys by the FLNRO-FWCP crew as part of the New Wetland Monitoring Protocol (Table 17). They were detected in 5 of the 6 new ponds, OGCS-2 was the only one with no detections (Appendix 3).

Table 17. 2017 LIPI detections in the newly constructed wetlands

Location	Age Class	Sex	Detection Date	Recapture*	Frog Id
EDL-1	YOY	Unknown	August 31, 2017	no	n/a
EDL-2	YOY	Unknown	August 11, 2017	no	n/a
OGCS-1	adult	Female	September 20, 2017	no	n/a
OGCS-3	adult	Female	October 5, 2017	no	n/a
OGCS-4	adult	Female	October 5, 2017	yes	RC 17007
OGCS-4	adult	Female	August 31, 2017	yes	RC 17010

*See Section 4.10 for recapture information

In addition to LIPI detections in the new wetlands, recently metamorphosed YOY Pacific tree frogs (*Pseudacris regilla*) were detected incidentally on July 12 during a site visit by wetland designers to see how the new wetlands were looking. They were detected in all of the new wetlands, except OGCS-4, which was not visited. Many other species have been detected in the new wetland areas, including many avian species, ungulates, coyotes as well as both grizzly and black bear.

In general the wetlands appear to have performed well during their first year, native species of both submergent and emergent vegetation has begun to fill in, including the desirable plant wapato (*Sagittaria latifolia*), also known as broadleaf arrowhead. However some invasive plants have also been detected and cattails (*Typha spp*.) appear to be coming back at a greater density than is optimal (Figure 13). It was found that hydroperiods were variable, while most of the new wetlands retained water throughout the summer, EDL-1 was detected dry on August 11 (Figure 13). For detailed data on water levels, temperatures and general results of the FLNRO-FWCP New Wetland Monitoring Program, see the report entitled *Overview of Wetland Monitoring on DL 881 Wetlands in Meadow Creek and Goat Channel and Duck Lake Restored Wetlands Field Season 2017 (*McGlynn, 2017).

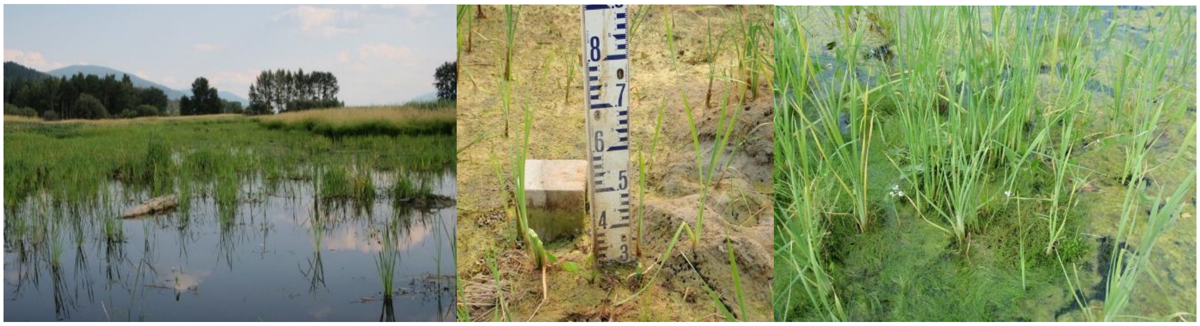

Figure 13. Photos (left to right): OGCS in the summer of 2017 showing vegetation growth; EDL-1 staff gauge on August 11 when detected dry; emergent vegetation growth, including wapato (*Sagittaria latifolia*) in OGCS-1.

During the small scale cattail removal test project conducted in the fall of 2017, cattails were removed from an 852 m^2 plot (approximately 20 x 45 m in size) within OGCS-2 (Figure 14). It took 10 person-hours to complete the project which was carried out as time permitted between September 25 and October 6. All plant material and rhizomes that were successfully pulled from the wetland were disposed of off-site to prevent regrowth; for more details on the project see the report entitled *Cattail Removal Project in the Creston Valley Wildlife Management Area Constructed Wetlands* (Morrison, 2017)

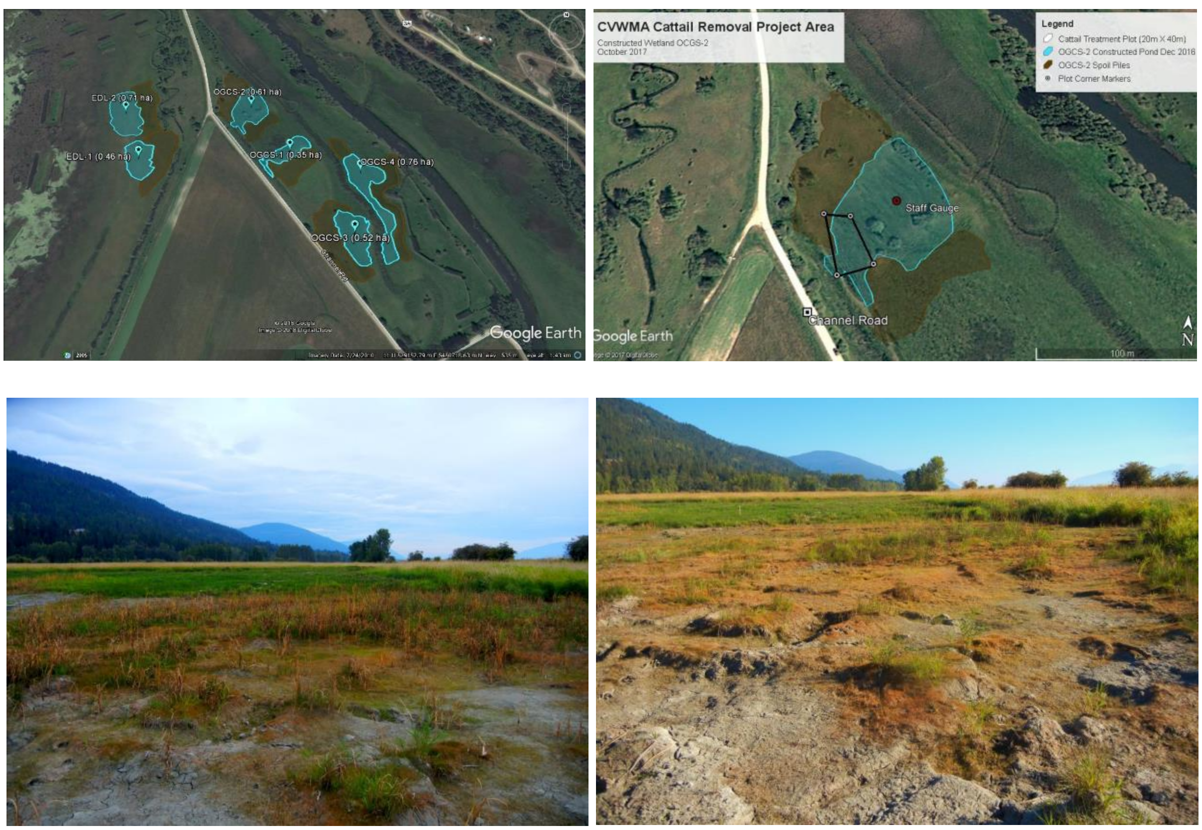

Figure 14. Cattail removal project images (clockwise from top left): Google Earth (GE) image of 6 newly constructed wetlands completed in December 2016; GE image of cattail removal treatment area in OGCS-2; treatment area before work began; treatment area when work was completed. Images 2-4 taken from Morrison, 2017.

5. DISCUSSION

5.1 General Weather and Habitat Conditions

Some of the weather observed in 2017 was extreme. The flooded conditions at DLNA in the spring may have impacted LIPI breeding.

The flooded conditions and high water levels in the spring likely contributed to the decrease in detected breeding activity at the WDLNA as habitat conditions were less than ideal, with very deep cold water present in the areas where breeding has typically been detected in previous years; this may have had impacts since LIPI exhibit strong breeding site fidelity (Waye and Cooper, 1999). As a result of the flooded conditions breeding activity was documented in the shallow flooded field west of the main WDLNA unit. Deep cold water was likely the cause of mortality in at least 1 egg mass laid in the main WDLNA unit.

Given the large volume of water present in the DLNA in the spring it is not surprising that the DLNA did not experience low water levels during the tadpole development period of 2017 as had been observed in 2015 and 2016 (Houston, 2016, 2017a). What was surprising though was that it did dry out at all. This is an enormous amount of water to disappear through evaporation alone which provides further evidence that there may be a water retention issue in the DLNA. The cause of the water retention issue is unknown, but a number of muskrat and beaver burrows as well as a large beaver lodge were detected along the south cross dike adjacent to the southwest ditch during a CVWMA dike inspection in November of 2016 (Houston, 2017). The CVWMA repaired the burrows in the fall of 2017, however it is not clear if they were the source of the problem since they did not go very far into the dike (Marc-Andre Beaucher, pers. comm.). It is recommended that water levels continue to be monitored during the 2018 field season to determine if the water retention issues at DLNA continue to be a problem.

As it was not necessary to bring water into the DLNA this summer it is unknown if the filling issues observed during the 2016 field season (Houston, 2017a) are still present but it is likely they are as no remedial measures have been taken to date; it is recommended that the source of the problem be investigated and remedial measures taken as this is the only way to get water in or out of the main LIPI breeding area and maintaining appropriate water levels are critical.

Sections of the East ditch were dry during the summer and fall migration period, since a number of LIPI have been observed using this ditch in previous years during this this time of year it is thought to be an important aquatic migration corridor between seasonal habitats. The problem appears to be caused by excessive ingrowth of cattails and infilling through succession in the ditch between the area of high LIPI use and the water source, which is preventing water from reaching the area. It is recommended that the ditch be dredged to remove the cattails that are plugging it and preventing water from reaching the far end.

Watershield ingrowth at DLNA was re-evaluated in 2017 and it was determined that it is still a problem which could potentially have negative effects on LIPI breeding as they seem to prefer open water areas for egg mass deposition. Surprisingly even with the deep water during the flooded conditions in the spring, watershield still managed to form a dense mat by mid to late May. Unfortunately there have been no clear solutions that are applicable to this site presented to date so it is recommend that the BC-NLFRT discuss it further.

The level of regrowth in the watershield removal test plot one year post treatment was evaluated and it was found that it was fairly limited. While these results are encouraging and may provide evidence that small scale openings can be created it should be noted that conditions were atypical in 2017; deep water may have impacted the growth of watershield in 2017. As a result it is recommended that the test plot be re-evaluated in the spring of 2018 to assess the regrowth 2 years post treatment. If at that point regrowth is still limited, it may be worth creating additional openings and setting up an experiment designed to determine whether or not LIPI will select the openings for egg mass deposition sites.

In addition to the ingrowth of Canadian watershield, other aquatic vegetation, including cattail (*Typha latifolia*) ingrowth has been observed in the DLNA. Attempts have been made to document changes in the area of extent of some of the ingrowth using a GPS tracklog on the ground but a comparison of the changes using satellite imagery would be a better method.

5.2 Songmeters

Even though there were no detections of LIPI calling on the Songmeters deployed at Leach Lake during the spring breeding season it was valuable to have them deployed since surveyors were not able to conduct any blitz style surveys at Leach Lake this year due to a combination of factors. Early in the season there was no time to conduct these surveys with the increased work load at DLNA trying to identify areas of LIPI calling with the changes in habitat due to the widespread flooding and change in landscape; later in the season Leach Lake become flooded as the Kootenay River levels rose and the area became inaccessible.

As bullfrogs are likely a significant threat to LIPI it was recommended in the 2016 field season report that the LIPI project continue to loan their Songmeters to the American bullfrog surveillance team (Houston, 2017). During the 2017 field season it was possible to use them for both projects since the peak calling periods do not overlap.

5.3 Nocturnal Calling Surveys (NCS)

Although NCS were conducted in both historic breeding sites and new areas at DLNA (where it was thought animals may have moved to due to the change in habitat associated with high water levels and flooding since there was limited calling detected in historically strong breeding sites at the beginning of the season), it was not possible to survey all sites each week given the enormous size of the DLNA. In addition to this it was difficult to quantify the level of calling at DLNA. For the majority of the surveys, the calling was sporadic, often very faint, individuals were spread out and there were very few large clusters or calling groups detected, which is unusual. It was only during a few NCS that calling levels above 15 individuals were detected. The maximum number of LIPI detected calling during the entire survey period was 35 individuals, which occurred on May 22 at WDLNA; this is less than the reported maximum of 49 in 2016 (Houston, 2017a). It is possible that the observed sporadic, faint calling and lack of large clusters of calling males was caused by a combination of environmental conditions (cool weather) and changes in habitat due to high water levels and associated perimeter flooding. LIPI are known to exhibit strong breeding site fidelity so it is possible that since habitat conditions were not optimal (deep cold water instead of shallow warm water) upon arrival at the historic breeding site, animals scattered in search of optimal habitat, resulting in decreased competitive calling male clusters and a decrease in male-female encounter rates across the landscape due to decreased density. In addition to this there was a larger area of habitat to survey and while extensive surveys were conducted, due to the enormous size of DLNA, it was not possible to survey every area, certainly not every night so some calling may have gone undetected. For these reasons it is unknown if the reported results reflect the actual level of calling activity in 2017 and therefore caution should be exercised when interpreting the results and making between year comparisons.

In addition to the unexpected and atypical NCS results at the WDLNA, the very low level of detected calling at the EDLNA ponds was surprising as this site typically has some calling male LIPI each spring. While it is unknown if this is an anomaly and possibly just a function of the flooding and associated changes to habitat for this year (and cool weather), it should be monitored in the future as the number of calling males decreased from at least 12 in 2014 and 2015 down to 7 in 2016. If numbers continue to decrease at the site, it may suggest there is something driving the change. In addition to the fact that the amount of calling was limited, the period of calling was much different than normal. Calling was only detected between April 18-May 1, with no further calling detected in May, despite surveying 4 times from May 14 - June 6 (once per week). In comparison to previous years this is very early as the peak of calling activity typically occurs sometime in May, for comparison, the peak of calling activity at EDLNA in 2016 was on May 24 (Houston, 2017a).

Calling male LIPI were already present at DLNA when the first NCS was conducted on April 18, which should be an indication that the critical temperatures believed to trigger male LIPI calling had already been reached (Seburn, 1992; Houston, 2015). Spring temperature data shows that these temperatures were not reached until April 22, after the first egg masses had been detected. This can be explained by the fact that the water temperature data was from HOBO data logger #6, which is located at the staff gauge in the main unit of WDLNA which was inundated with very deep water, impacting temperatures. Water temperatures in the shallow flooded field adjacent to the main WDLNA unit where calling and egg masses were detected in late April were much warmer but unfortunately we do not have a full set of spring temperature data for that location. Given the nature of the habitat in that location it is possible that the critical temperatures believed to trigger male LIPI calling, occurred much earlier than is usually observed in the main DLNA unit; this may have resulted in earlier breeding.

5.4 Egg Mass Surveys (EMS)

Although the amount of EMS effort in 2017 was much greater than any of the 5 previous years, fewer egg masses were detected, resulting in a very high amount of survey-effort per detected egg mass. This indicates that either there were fewer egg masses deposited at the site, or some egg masses went undetected (or a combination of both).

While the actual level of reproduction is unknown, it was likely down in comparison to recent years, however, it is also likely that some egg masses went undetected.

There are 2 main reasons why egg masses may have gone undetected:

1. There was a lack of strong calling data due to the fact that calling was often faint and sporadic which made it challenging to plan EMS since this data is used to define the EMS search area
2. While it is not thought that any egg masses were missed in the areas searched within the search timeframe, there was a larger than normal area of possible breeding due to high water levels and associated flooded margin of DLNA. Due to the large size of the DLNA, it is just not possible to survey all areas, especially not every 7-10 days, which would be the frequency required to detect them prior to hatching.

There is evidence to suggest that at least 1 egg mass did go undetected as some tadpoles observed at WDLNA in spring were outside the range of sizes expected from the detected egg masses and additionally, tadpoles and metamorphs were detected at EDLNA. Since no egg masses were detected at ELDNA this may indicate that at least 1 egg mass went undetected at the site.

In addition to the factors discussed above, egg mass detectability was impaired by a number of factors in 2017. With calling in the flooded fields west of the main WDLNA unit extensive EMS were conducted in the area, however visibility was limited by the long grass. In areas of the main WDLNA unit where calling was detected in deep water EMS visibility was impaired by total water depth, if egg masses were not located within 12 cm of the water surface they would be very hard to detect. Although watershield was not a problem at the beginning of the spring it impaired detectability later in the season as it formed a dense mat.

In 2017 the majority of the egg masses were laid from April 18-21. In comparison to other years this is early and the egg laying period was very short, the peak typically occurs in May and the egg laying period is usually longer in duration. In 2016, there was an early egg mass laid on April 12, but the majority of the egg masses (18 of 23, 78.3%) were laid during an 11 day period from April 30-May 11, followed by a 9 day period of no detected egg masses until another 4 were laid between May 21-29 (Houston, 2017).

Since a full lab work-up was completed by the AHC and nothing significant was discovered that would explain the degeneration of the eggs in EM170523-KM06 and EM170525-TH07 it is not possible to conclusively determine the cause of mortality. However it is thought that the loss of viability in EM170523-KM06 was likely due to cold shock as there was a significant drop in temperature of 6.9°C overnight during the development period. This theory is consistent with what was observed, as the egg mass appeared well fertilized and did not show any abnormalities until May 26, the day after the drop in temperature, when it was noted to have become cloudy in appearance, after which time no further development was detected. Cold shock has been known to cause an alteration in embryonic development in some species of amphibian eggs by reducing the animal/vegetal cleavage ratio (AVCR) resulting in reduced survival during early developmental stages (Yokota, 1992). Temperatures were consistent (or increased) during development of EM170525-TH07 so it is not thought that cold shock was responsible for the poor hatch-out and large number of dead eggs, but since it was already hatched upon detection it was not possible to determine condition upon deposition, fertilization or determine when during development eggs died. Since a portion of the egg mass was viable (as there were some hatchlings detected), it is not likely that an environmental issue caused the observed egg mortality. Overall, there could be a number of causes for loss of egg mass viability including: disease, infertility, congenital issues, environmental conditions, contaminants or other causes and it is not possible to isolate which was responsible for the observed losses in 2017. While it is not unusual to see some loss of eggs, any level of loss is concerning when dealing with a small endangered population.

After having 6 years of greater than average number of detected egg masses (17-39 annually from 2011-2016), the results of the 2017 spring breeding season were disappointing with a total of only 7 detected egg masses. However, it is important to keep 2 things in mind:

1. these results are within the reported range of 4-16 egg masses detected annually at the entire CVWMA (including Leach Lake) from 2000-2010 and only slightly below the mean of 8.2 for this period (SD=3.8, n=11) and the population persisted
2. the actual level of breeding is unknown due to multiple factors discussed in this report

While the number of detected egg masses appears to have declined in comparison to recent years, it is unknown if this represents a true decline in breeding as 2017 was an atypical year and there were many confounding factors associated with the high water levels, flooding and weather conditions that may have impacted breeding and detectability at DLNA. For this reason, it is not possible to draw conclusions about the state of the DLNA breeding population based exclusively on 2017 results.

5.5 Tadpole Surveys

The detection of tadpoles and metamorphs at the EDLNA ponds may indicate that successful breeding did take place at the site this year despite the fact that very little calling was detected and no egg masses were found. While it is possible that these LIPI moved into the site over the course of the development period from egg masses that were deposited at WDLNA it is not likely as egg masses were deposited approximately 1750 m (in a straight line) away from the site at EDLNA where tadpoles and metamorphs were detected. It is more likely that at least 1 egg mass was deposited at EDLNA ponds but went undetected.

The first sign of metamorphosis (July 11) indicates that the minimum development time from egg to metamorphosis was 85 days, this is similar to the 91 days reported in 2016 (Houston, 2017). This indicates that developing tadpoles were able to find sufficient shallow warm water areas for development within the largely flooded DLNA and that the flooding and associated deep cold water areas may not have had an impact on developmental rate.

5.6 Visual Encounter Surveys (VES)

There were no detections of LIPI during VES in the Leach Lake area. However this does not necessarily indicate no breeding occurred as survey effort was limited, the area is vast and not all areas were surveyed extensively. All that can be concluded is that there was no detected evidence of successful breeding.

There were issues with detectability due to overgrown vegetation in many areas which impacted VES. It is thought that the observed overgrowth was a result of the wetter than usual spring followed by a very warm summer, providing optimal growing conditions. As a result of the East Ditch being dry intermittently throughout the late summer and fall there were fewer than usual LIPI detections as would be expected.

Also of note is the fact that Columbia spotted frogs (*Rana luteiventris*) continue to be detected in the southwest ditch (SWD). While this species is regularly detected in many other areas of the CVWMA, they have not been detected in the DLNA prior to 2016, when they were first detected in the SWD (Houston, 2017a).

5.7 Spring Migration Surveys

While FLNRO staff scheduled the sampling period based on temperatures as it was believed this would result in the highest probability of encountering LIPI, the limited number of detections indicates the peak movement happened outside of the nights surveyed. Assuming the LIPI moved at night, the peak movement either occurred before the sampling period, during the nights not surveyed within the sampling period (maximum of 3 consecutive nights) or after the sampling period.

It is most likely that the peak movement occurred in March before the sampling period began, which is consistent with the results observed in 2013, when the majority of the movement was detected during an 8 night period from March 28-April 4 (Houston, 2014, 2017b). It is also possible that the peak movement occurred on the nights not surveyed within the March 31-April 19 survey period (April 1-3; 7; 9-11) given that a large portion of the spring 2013 LIPI detections were made within a few days (110 LIPI detected on the shoreline with very few on the road for 5 nights then 40 LIPI detections on road in 3 nights; Houston, 2013 and 2017b); however it is not likely. If the majority did move across the road within the 3 night period of no surveys you would expect to see more than 1 or 2 animals on the surveyed nights before and after, especially given that both the shoreline and road were surveyed during each survey. It is not thought that many animals moved after the sampling period as breeding was underway at DLNA already.

5.8 Late summer and Fall Road Surveys

Road mortality is still occurring on the dyke road at Duck Lake, 11.0 % of the total LIPI detections in 2017 were road mortality. Despite the voluntary road closure people are still driving in the area during the restricted hours and vehicles were documented on 65% of the nights surveyed, with a range of 0 to 5 vehicle passes per survey night and a total of 61 vehicle passes throughout the entire survey period. It is recommended that an effective solution to this ongoing problem be implemented. Since the BC-NLFRT is concerned with road mortality rates and the voluntary road closure has been ineffective they have submitted a proposal for a legal regulation change under the Wildlife Act to institute a seasonal motorized use closure during the spring and fall; the proposal is currently being reviewed.

5.9 Animal Health

While the majority (87.0%) of the LIPI detections throughout the year were reported to be in good health, it should be noted that health was only assessed by visual inspection in the field and the majority of those assessed were YOY detected in the summer and fall (81.0%). Since this is not the cohort that chytridiomycosis is usually associated with combined with the fact that symptoms are not always overt (Voordouw, 2010 and Houston, 2014) it is not possible to draw any conclusions about the prevalence of this disease in the population, all that can be concluded is that very few animals are showing overt symptoms. Since chytridiomycosis has been documented in the Creston LIPI population since 2000 (Adama and Beaucher, 2006), it is most likely still prevalent in the population.

Although no new (previously undetected) health issues were detected (aside from the 1 YOY with suspected dropsy or edema), and there were no signs of frog chiggers or necrotic tissue detected (both issues detected previously in the spring breeding population at DLNA), this could simply be an artifact of the small sample size of LIPI whose health was assessed in the spring, as most of these issues tend to show up in the spring. Therefore it is not possible to draw any conclusions on whether or not these health issues are still present in the spring breeding population.

It was not possible to determine the cause of death for the 3 juveniles detected dead at the WDLNA during the spring breeding season as the bodies had already begun to decompose. However, there was severe redness on the decomposing bodies and although this was likely exacerbated by decomposition it is suspected that the cause of death may have been a disease that presents with this symptom of cutaneous erythema of the ventrum and extremities, such as chytridiomycosis, red-leg syndrome (bacterial dermatosepticemia), ranavirus or another disease. In *Diseases of Amphibians*, Densmore and Green noted that there are multiple and diverse pathogens of amphibians that may present clinically or after death with cutaneous erythema (Densmore and Green, 2007). It is recommended that the BC-NLFRT discuss whether or not to implement a new disease sampling program.

5.10 Passive Integrated Transponder (PIT) Tagging

During this second year of PIT tagging the number of animals PIT tagged and the number of recaptures was greater than in 2016. Of the marking sessions attempted in 2017, the greatest number of LIPI were PIT tagged while conducting road surveys during the late-summer and fall migration period; this was as expected and was recommended given the large number of LIPI that pass through the area at that time of year (Houston, 2016b).

Weight loss was documented in 2 of the 6 within-year PIT recaptures with morphometrics (1 adult and 1 YOY). While this is a fairly small sample size, it is concerning since LIPI should be gaining weight at this time of year. It is recommended that this be monitored in future recaptures.

While there were no obvious signs of infection or other health problems detected at the PIT tag incision site in the recaptures made this year, and it is not anticipated that there will be any health problems associated with the process of injecting PIT tags, since it is a widely accepted method of marking amphibians, as a precaution it is recommended that surveyors continue to examine the incision site of any recaptures for any potential problems that may occur over time as a result of PIT tagging.

5.11 Morphometrics of Creston LIPI

The number of recaptures and unique individuals within the overall number of detections is unknown and the number of detections per age group by season is not large enough in some cases to identify distinct clusters or to discuss demographics, however there are some general trends that can be discussed.

In the spring the limited data shows that, as in previous years there are 2 main age groups of males at the DLNA breeding site: males less than 35.0 g and males clustered around the 50.0 g mark. The smaller males (<35.0 g) are believed to be 1 year olds; they are likely not reproductively mature but do come to the breeding site and have often been observed calling (pers. obs.). The larger males (43.0 – 54.5 g) are believed to be 2 years old and should all be reproductively mature. There were no detections of any males larger than 55.0 g, which would represent 3 year olds and greater, which is fairly consistent with previous data, but given the limited number of detections it is not possible to determine if there are any males older than 2 years in the breeding population. Female detections are generally very limited at during the breeding season as they are quite elusive during this period, but the limited data shows they range in weight from 54.0 – 100.0 g (SVL 83.4 – 92.0 mm), indicating that they are reproductively mature animals likely in the 2 year old and greater range.

In the summer, as observed in previous years, there appears to be a distinct line on the morphometrics graph around the 35.0 g mark, below which the majority of the detections fall into. These are believed to be the YOY. Within this cohort, there is a distinct cluster of smaller sized detections in the 4.0 – 9.0 g (SVL 32.8 – 40.5 mm) range which may indicate there was a late egg mass or simply a small group of slow growing individuals.

In the fall, the majority of the detections were YOY, all of which were less than 35.0 grams which is consistent with reported results in other years; very few YOY reach greater than 35.0 grams their first fall. There are 3 detections in the 36.0 -38.0 gram range, which may be larger than average YOY or smaller than average 1 year olds but there are very few detections in the fall between 35.0 g and 50.0 g; this is consistent with previous observations.

The comparison of YOY observed in the migration corridors and overwintering areas during the fall of 2017 show they had larger mean weight and mean SVL than any of the years from 2010-2016 and the differences between means for 2016 - 2017 were statistically significant at the 0.05 level. This indicates that on average the 2017 animals were larger which could be an indication that overall body condition was optimal. This would be beneficial as animals are heading into the over-wintering period as it may put them at an advantage to get through the winter. It should be noted that while the overall date range of detections have been standardized in the multi-year comparisons (November detections removed as detections not made in all years), time since metamorphosis was not. To determine if this observed difference in size of LIPI for the fall period is real, detection dates and time since metamorphosis would have to be factored in. For example, if the majority of the animals in a given year were caught late in the fall and compared to animals of the previous year where the majority of the animals were caught in the early fall it would not be a valid comparison as YOY can grow at a rapid rate during their first year.

5.12 Constructed Wetlands

While no LIPI were detected using the newly constructed wetlands in the first spring, so it is not thought any breeding took place in the area, it is hoped that they will utilize them in the spring of 2018 now that the habitat complexity has begun to develop. It is recommended that NCS be carried out in the spring of 2018 and if calling is detected, NCS should be followed up by EMS to determine if successful breeding occurs.

A relatively low amount of survey effort was dedicated to VES in the constructed wetlands in the summer and fall of 2017 but LIPI were detected, some during VES and some incidentally while travelling through the areas. The detection of LIPI using 5 of the 6 new wetlands in the summer and fall of 2017 indicates that the wetlands provide suitable habitat. Interestingly, of the 10 PIT tag recaptures made in 2017, 2 were in the new wetlands (1 between year and 1 within season). It is significant that 1 adult LIPI was recaptured 15 days later still using the new wetlands (147 m away) as it shows that she was not just quickly moving through the area on her way to the main over-wintering area at the Old Goat Channel, but was using the area, likely for foraging prior to hibernation as the last detection was as late as October 5. It is recommended that VES continue in the summer and fall of 2018.

It is also positive to see other species using the newly constructed wetlands, which indicates that they are providing not only suitable breeding habitat for species such as the Pacific tree frog (which likely bred there as recently metamorphosed YOY were detected in the summer), but also provides beneficial habitat for many avian species as well as coyotes, ungulates, black bear and grizzly bear whose tracks were detected in the area.

The small scale cattail removal test project that was conducted in the fall of 2017 to test if cattail removal at an early stage can be effective in allowing more desirable native vegetation to become established and prevent a dense monotypic stand of cattails from becoming established was completed with a fairly low level of effort. It is recommended that the regrowth be evaluated in 2018 to determine how successful this method was. If successful, other problem areas could be treated. Depending on the scale of the project, it may not be logistically feasible to do this by hand-pulling; heavy equipment may be required. It would also be beneficial to quantify the cattail ingrowth in all 6 of the constructed wetlands to monitor growth, this would also allow us to prioritize any future removal work.

The FLNRO New Wetland Monitoring Program will provide useful information and determine how the wetlands perform over time, this could be valuable information for other potential wetland restoration and creation projects. It is recommended that the invasive plant species documented in the area continue to be monitored and if they become problematic, treatment options should be considered.

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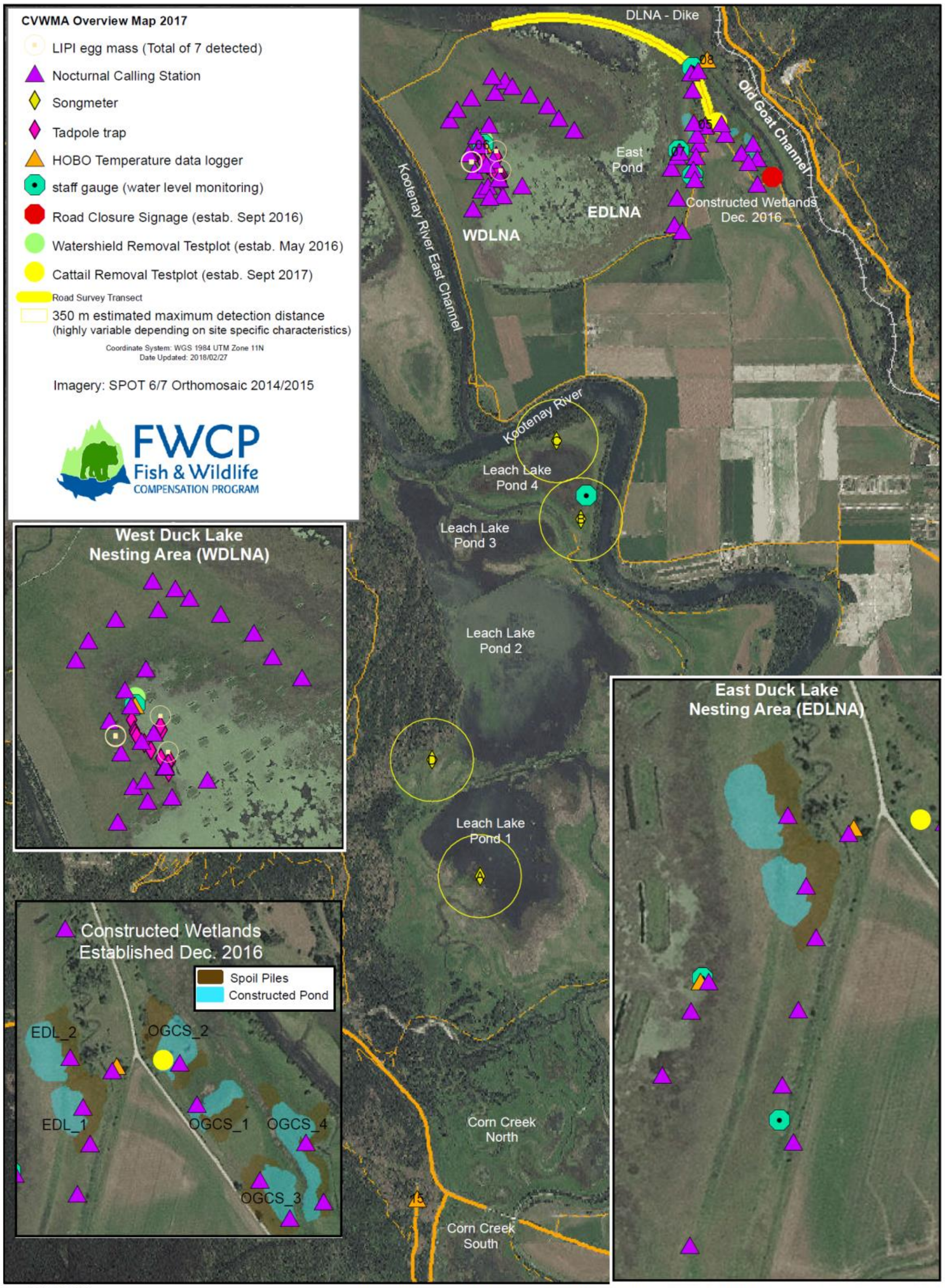
Appendix 1. CVWMA Overview Map



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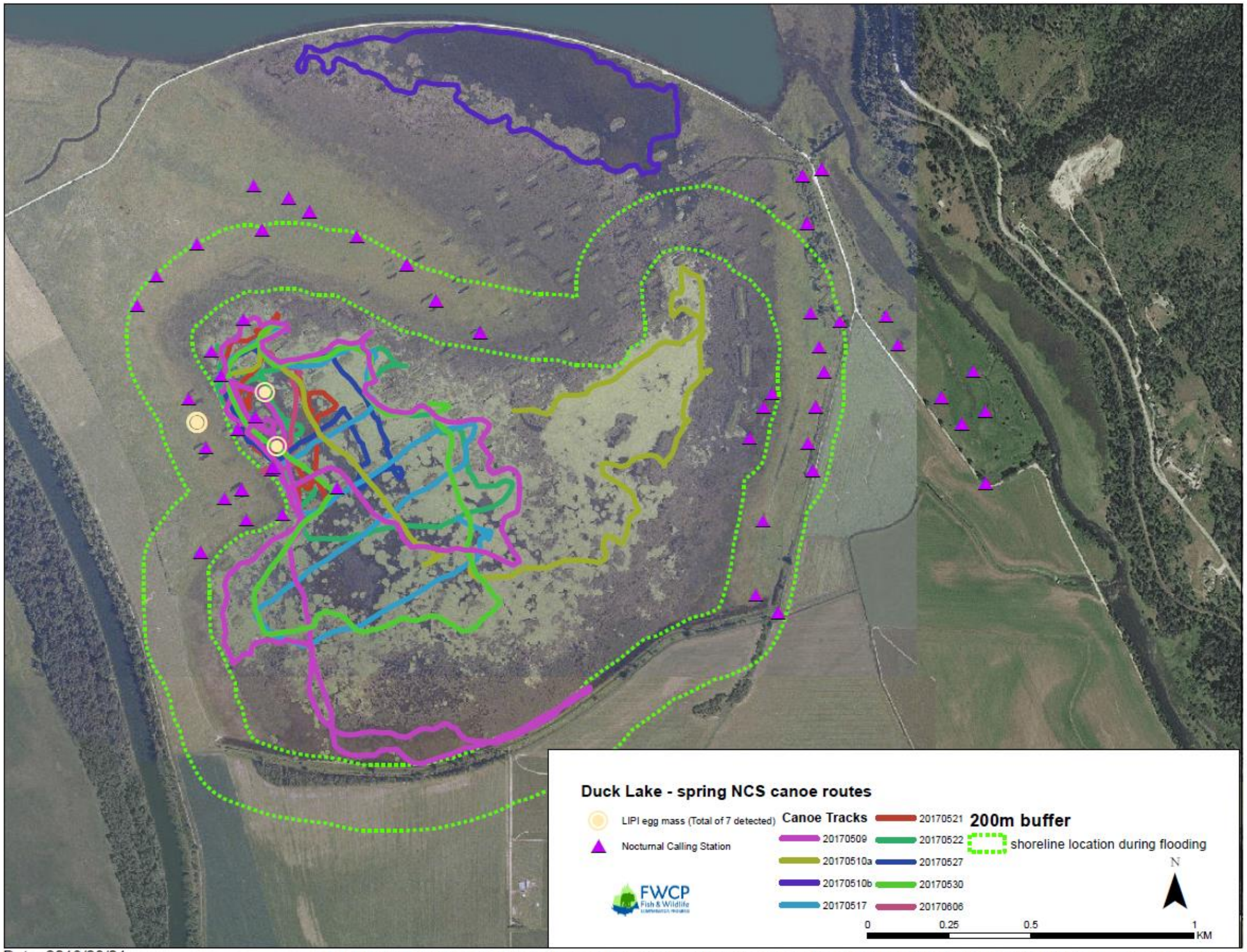
Appendix 2. Map of Spring NCS Canoe Routes at DLNA and approximate location of flooded shoreline



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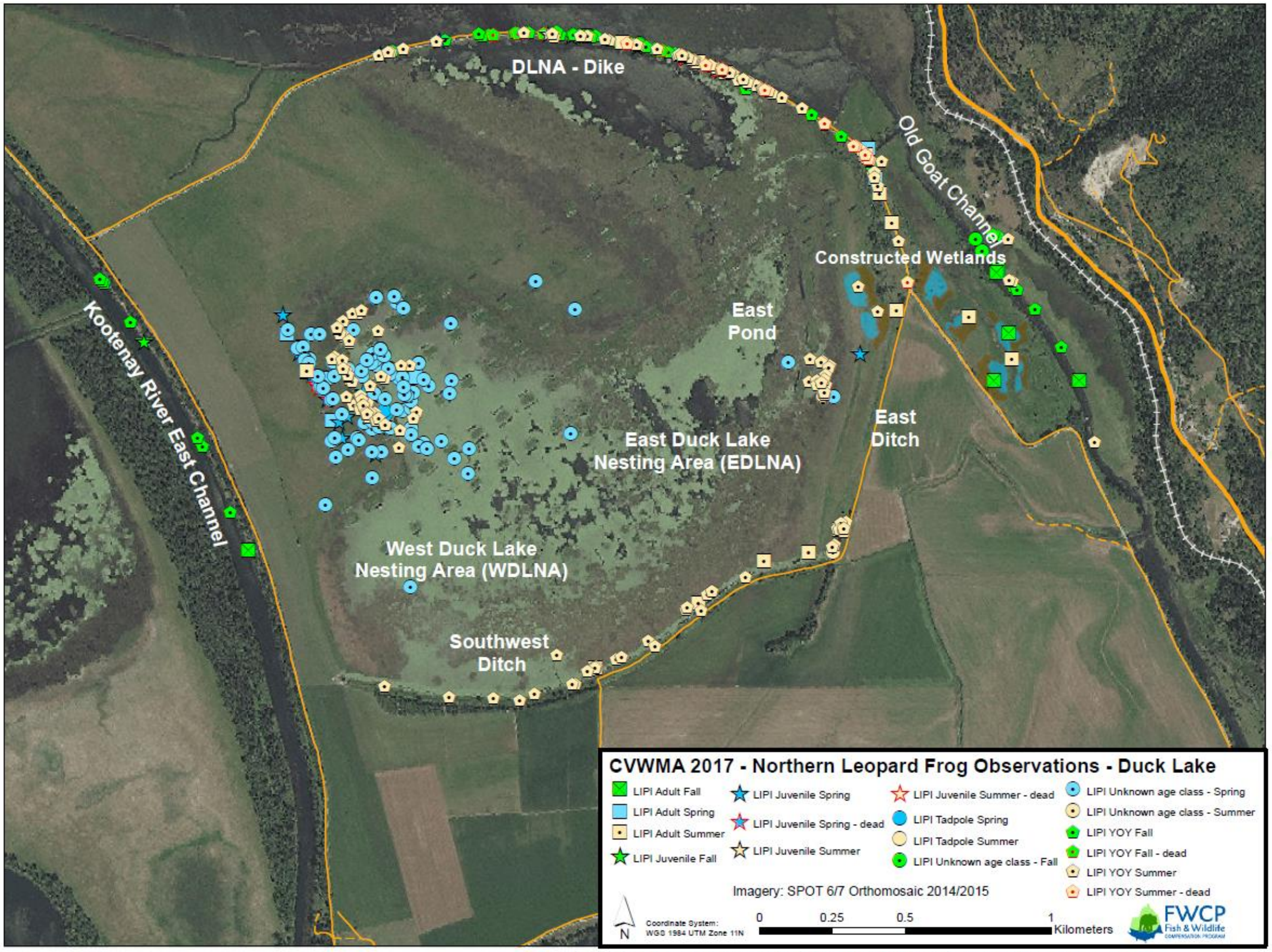
Appendix 3. Map of Duck Lake Area LIPI Observations (all seasons)



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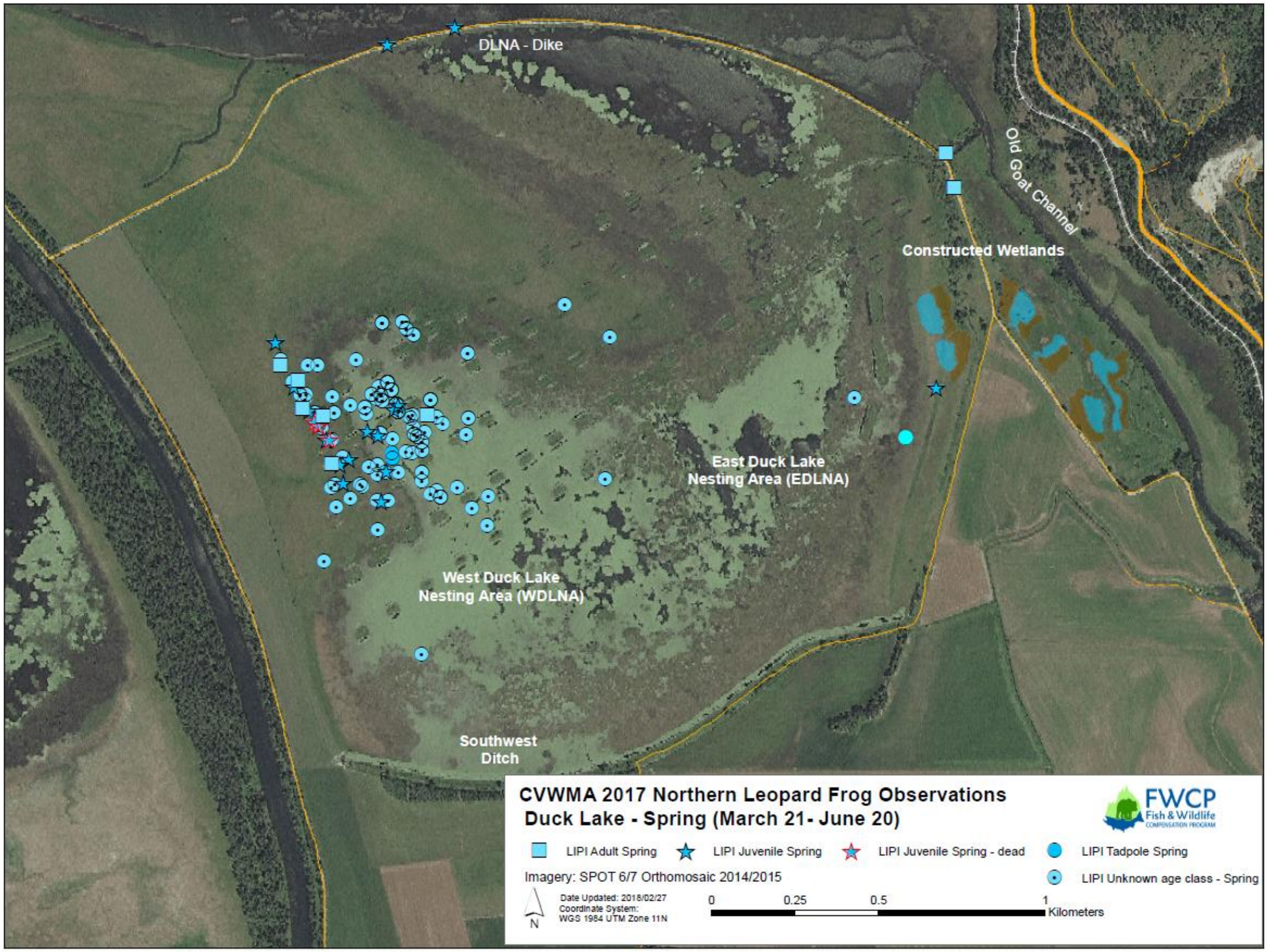
Appendix 4. Map of Duck Lake Area LIPI Observations - Spring



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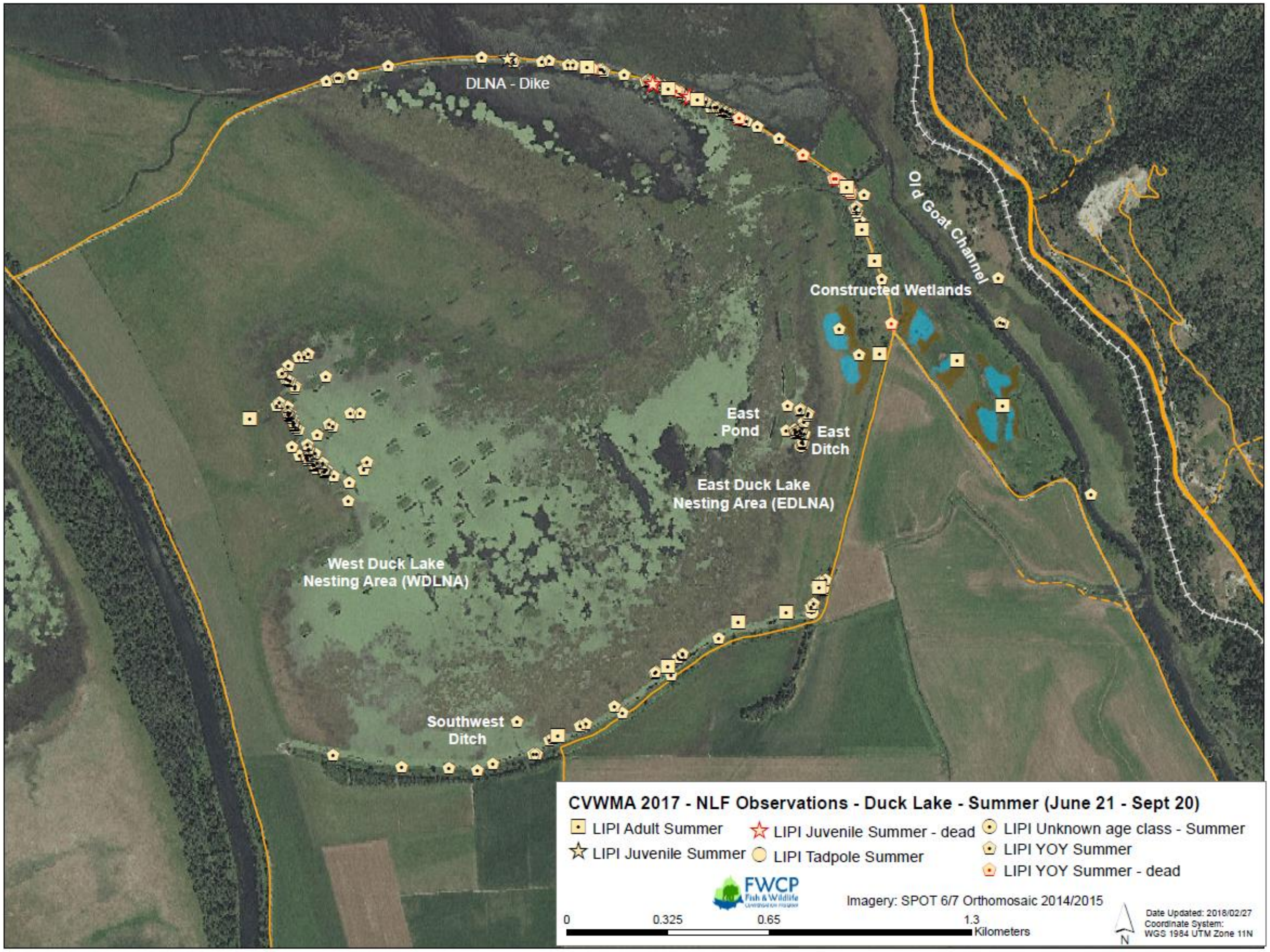
Appendix 5. Map of Duck Lake Area LIPI Observations - Summer



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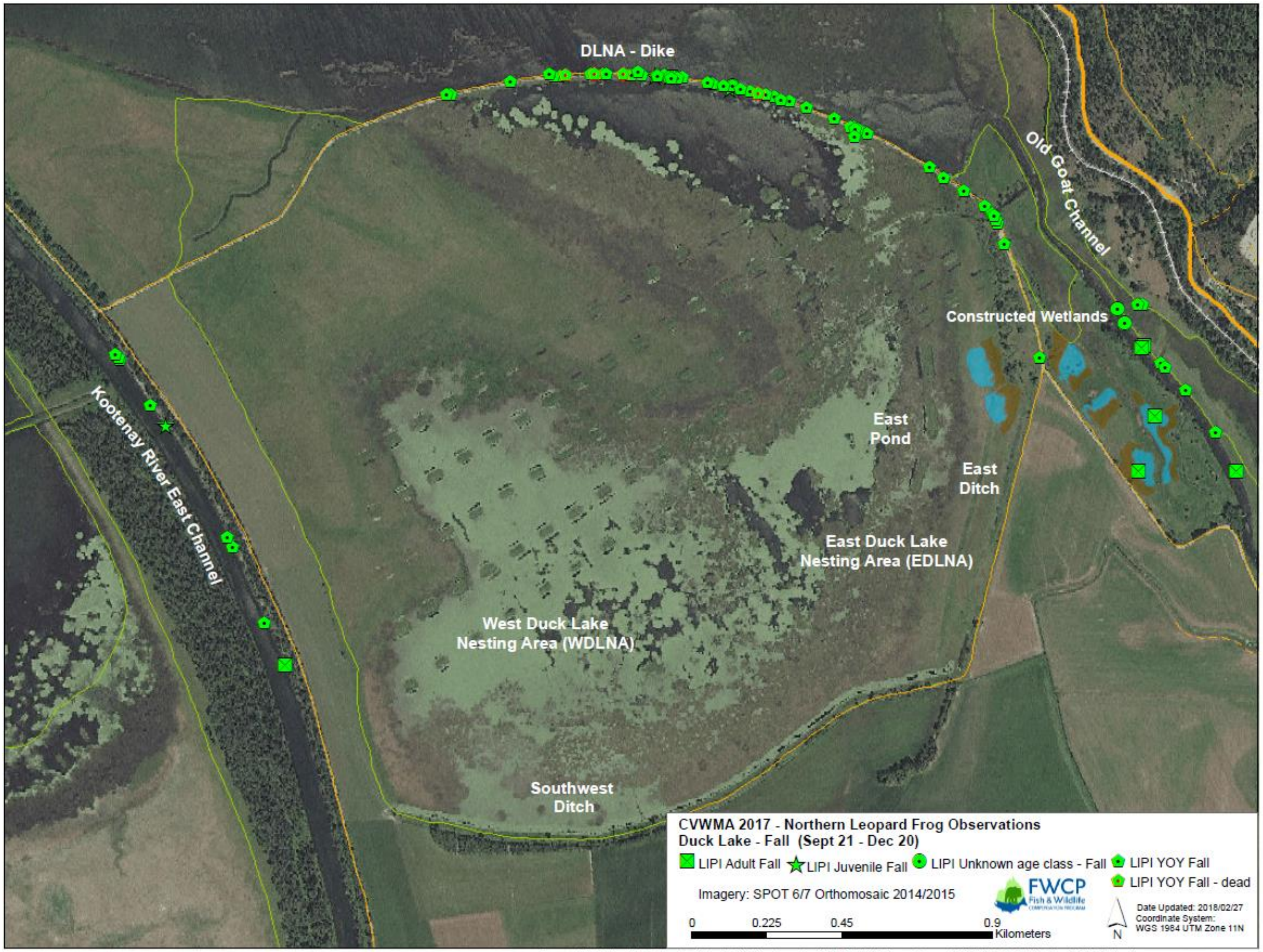
Appendix 6. Map of Duck Lake Area LIPI Observations - Fall



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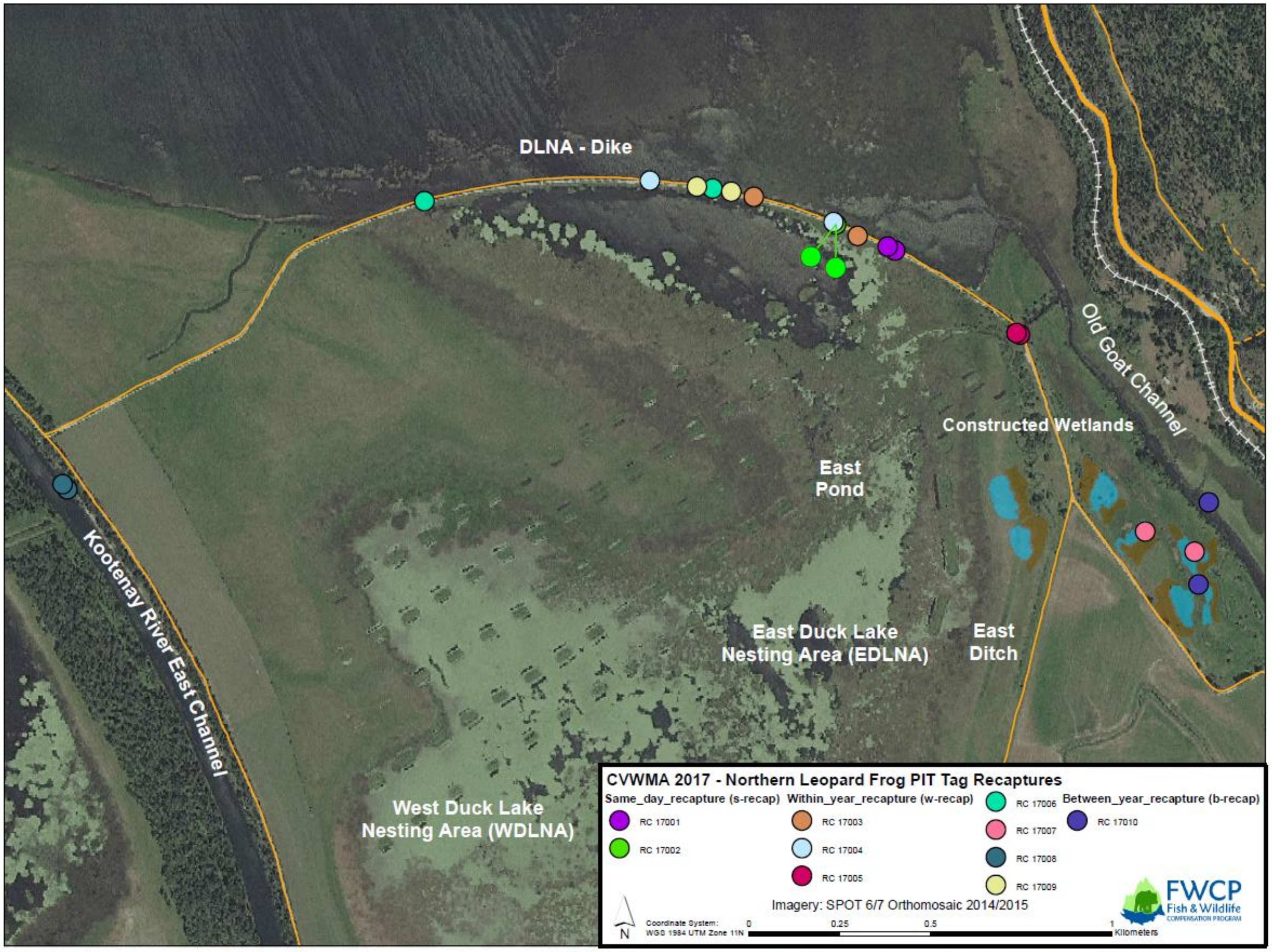
Appendix 7. Map of all 2017 LIPI PIT Tag Recaptures



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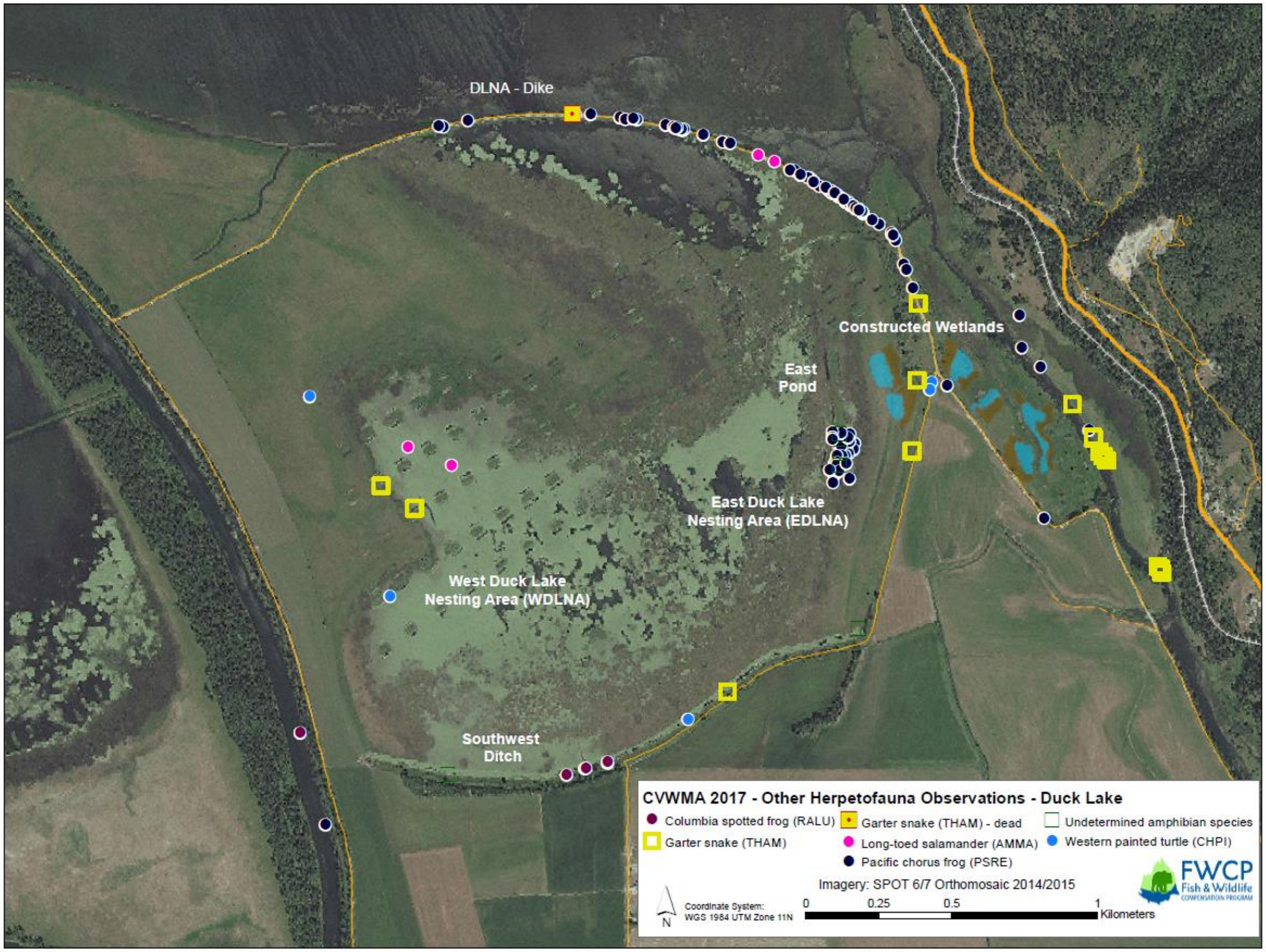
Appendix 8. Map of Duck Lake Area Other Herpetofauna Species Observations



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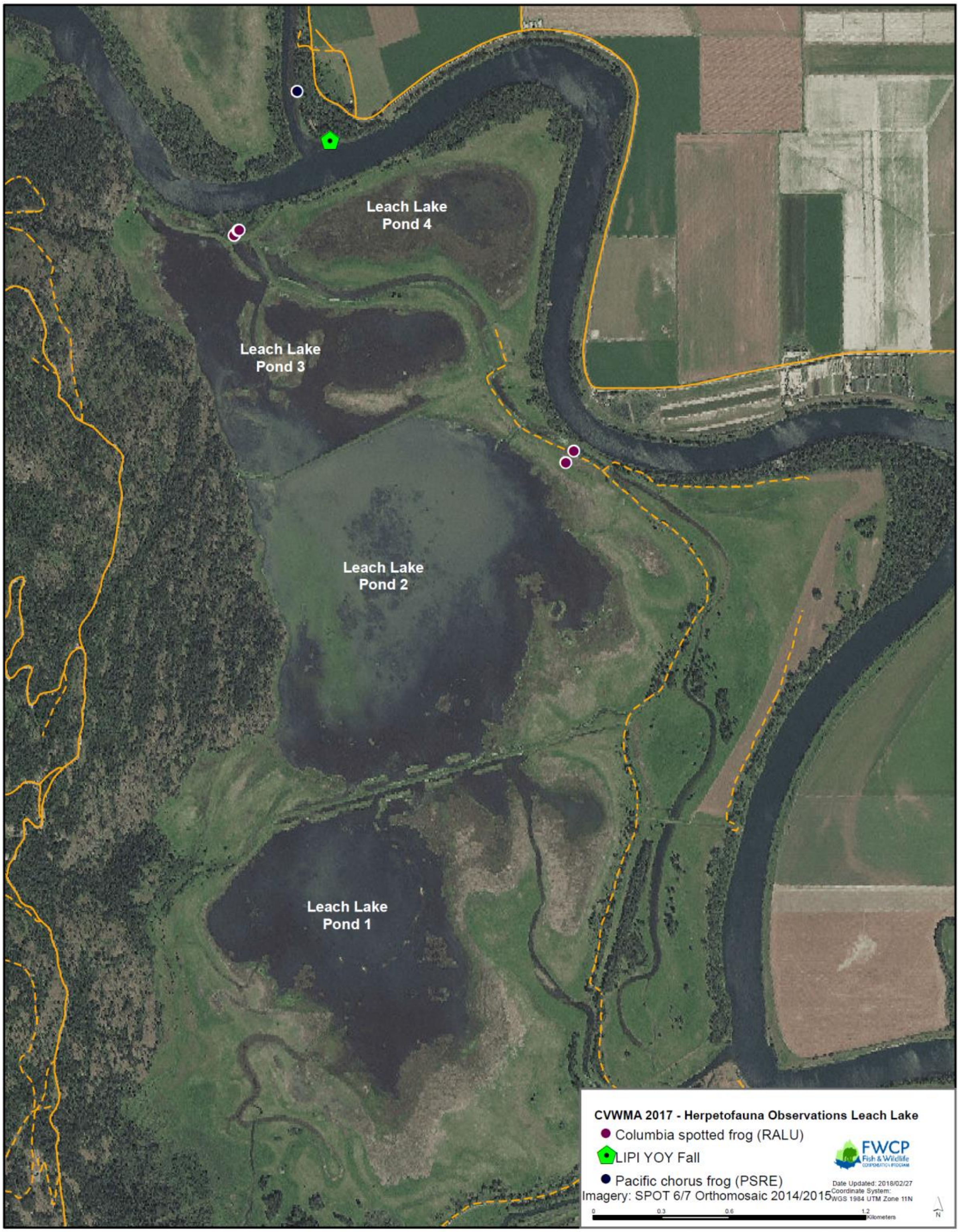
Appendix 9. Map of Leach Lake Area Herpetofauna Observations



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