An amphibian inventory of the East Kootenays with an emphasis on *Bufo boreas*, 2005.

by

P. Ohanjanian[1], D. Adama[2], and A. Davidson[3]

for

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[1]Penny Ohanjanian, Consulting Biologist, 4481 LD Ranch Rd., Kimberley, B.C. V1A 3L4
[2]Doug Adama, Adama Wildlife Consulting, Box 158, Golden, B.C. V0A 1H0
[3]Andrea Davidson, Wildlife Technician, 3-2322 Campbell Rd, Golden, B.C. V0A 1H0

EXECUTIVE SUMMARY

Amphibians have experienced declines throughout the world. The western toad, *Bufo boreas*, has undergone rapid declines in the western US, but its status in south-eastern British Columbia is unclear. The objectives of this project were to 1) carry out amphibian inventories at wetlands throughout the East Kootenay 2) determine presence of western toad at historical breeding sites 3) re-survey historical northern leopard frog sites 4) collect tissue samples for future disease diagnostics and 5) provide recommendations.

The study was located in the southern Rocky Mountain Trench. We carried out Visual Encounter Surveys at 57 wetlands from 29-Jun to 10-Oct, 2005. Survey sites included 23 historic toad breeding sites and 11 historic northern leopard frog occurrence sites. Visits to toad breeding sites were timed to maximize the probability of detecting tadpoles. To prevent the potential transfer of pathogens between sites all gear was disinfected. Environmental conditions, survey effort and wetland attributes were recorded. Amphibian species and developmental stages were identified, and snout-to-vent lengths and weights of metamorphs, juveniles and adults obtained. To assess chytrid prevalence, toe clips and swabs were collected and preserved for future lab analysis. UTMs of all amphibian sightings were recorded and maps depicting amphibian distribution were generated.

Amphibians were detected at 27 of 57 sites. Western toads were found at 12 sites. Toad breeding was confirmed at 30.4% the 23 historic breeding locales visited in 2005. Other species detected were Columbia spotted frog (14 sites), long-toed salamander (6 sites) Pacific chorus frog (3 sites) wood frog (1 site) and tailed frog (1 site). No northern leopard frogs were detected. We observed >1 species at only 7 of 57 sites. Although western toads and spotted frogs were detected in a wide geographical area, the actual number of occurrence sites was low.

Gross inspection of 92 amphibians revealed no obvious disease-related morbidity. Tissue samples and swabs were obtained from 24 animals for future PCR testing for chytrid. Recent research has shown that chytrid has a profound effect on *B. boreas* tadpoles. In 2005, metamorphosis was only confirmed at 2 toad breeding sites; we cannot say with certainty that reproduction was successful at 9 other sites based solely on the observation of tadpoles.

This report provides preliminary evidence that a decline in western toads may be underway in southeastern British Columbia. To substantiate this, a statistically sound, multi-year monitoring program should be initiated. The issue of chytridiomycosis must be investigated, including tissue sampling and lab analysis. The presence of toad tadpoles alone does not indicate successful reproduction - surveys must continue through to metamorphosis and beyond. All future amphibian surveys should follow a rigorous disinfection protocol to prevent the spread of pathogens between ponds.

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1.0 INTRODUCTION

Amphibian declines have been well-documented around the globe (Houlahan et al. 2000, Carrier and Beebe 2003, Lips et al. 2004). Factors implicated in these declines include drought, climate change, U-V radiation, pollution, habitat loss and disease (Pounds et al. 2006, Daszak et al. 2005, Blaustein et al. 1994, Lehtinen et al. 1999, Longcore et al. 1999). In the East Kootenay region of southeastern British Columbia, declines of the northern leopard frog, *Rana pipiens*, have been documented (Ohanjanian and Teske 1996, Gillies and Franken 1999, Adama and Beaucher 2006) but the status of other species, including the western toad, *Bufo boreas*, remains unclear.

The western toad has experienced rapid population declines and extirpations in the United States (Muths et al. 2003, Drost and Fellers 1996) prompting its designation as a red-listed species by the International Union for the Conservation of Nature (IUCN) (World Conservation Union 2000). *B. boreas* has been designated a species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), although there is little information on current abundance or population trends in this country (Davis 2002, Wind and Dupuis 2002).

The objectives of this project were to:

- carry out amphibian inventories at wetlands throughout the East Kootenay
- determine presence of western toad at historical breeding sites
- re-survey historical northern leopard frog sites
- collect tissue samples for future disease diagnostics
- provide recommendations based on the outcome of these surveys

2.0 STUDY AREA

Amphibian surveys were conducted in the Rocky Mountain Trench of south-eastern British Columbia. The study area ranged from Bush Arm, north of Golden, to Newgate, near the Canada-US border (Figures 1 & 2). Sites were distributed throughout five areas: Golden, Invermere, Cranbrook , Yahk (southeast of Kootenay Lake) and in Kootenay National Park.

Survey sites were located in a broad range of biogeoclimatic sub-zones. These sub-zones included the Dry Warm Interior Cedar-Hemlock (ICHdw), the Moist Warm Interior Cedar-Hemlock (ICHmw), the Dry Mild Interior Douglas Fir (IDFdm), the Dry Hot Ponderosa Pine PPdh and the Dry Cool Montane Spruce (MSdk) and Dry Cool Engelmann Spruce-Subalpine Fir (ESSFdk) (Braumndl and Curran 1992). As expected with the diverse elevations, slopes and aspects represented by these sub-zones, the climate is highly variable throughout the study area. At one extreme is the PPdh sub-zone, located in the Cranbrook area; it is very dry, has hot summers and mild winters with low snow accumulations (Braumandl and Curran 1992). Soil moisture is a limitation and the hydro-period of some wetlands may be affected by drought.

Climax vegetation in the wetter areas of the PPdh consist of black cottonwood, (*Populus balsamifera*), hybrid white spruce (*Picea glauca x engelmannii*) red-osier dogwood (*Cornus stolonifera*) and nootka rose (*Rosa nutkana*). The ICH sub-zone, located primarily in the Golden area, is at the other extreme, being wetter, with deeper snow accumulations in the winter and less likelihood of wetland desiccation. Climax vegetation consists of western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), high bush cranberry (*Viburnum edule*) and a well developed moss layer. Vegetation at wetlands and ponds varies less, with stands of sedge (*Carex spp*), cattail (*Typha latifolia*), bulrush (*Scirpus acuta*), and water smartweed (*Polygonum amphibium*) throughout the study area.

3.0 METHODS

3.1 Amphibian Surveys

Prior to the start of field surveys, several sources were examined for historical records of *Bufo boreas* and *Rana pipiens*. These sources included data from recent surveys conducted in 1994, 1995 and 1998 (Orchard and Ohanjanian 1994, Ohanjanian and Teske 1996, Gillies and Franken 1999), as well as databases from the Royal British Columbia Museum (RBCM) and the Canadian Museum of Nature (CMN). A survey list was compiled from records that noted the presence of eggs, larvae, metamorphs, or breeding adults. Historical sites were also included if several adults and/or juveniles had been observed. Within each geographical area, sites were stratified into low (500-800 m), mid (800-1000 m) and high elevation (>1000m). To fill in elevational or geographical gaps in survey site distribution, additional sites were added.

Visual Encounter Surveys (VES) were carried out from June 29 to October 10, 2005 at 57 wetlands (Resource Information Standards Committee 1998, Heyer et al. 1994). Environmental conditions, survey effort and distance covered were recorded, as were the Biogeoclimatic Ecosystem Classification (BEC) subzone, wetland size, class and site association (MacKenzie and Moran 2004). The structural and vegetative characteristics of each wetland were recorded, and included water depth, substrate type, percent cover of emergent and submergent vegetation, major species, and adjacent vegetation. The distance between the wetland and nearest road, railway and forest was estimated, as was coarse woody debris (rated as nil, low, moderate or high) and percent crown cover. The presence of fish was noted. Where possible, aquatic insects were identified from 10 two-metre sweeps of the water column. If a wetland was very small, 5 sweeps were done.

Each site was visited only once due to limited resources. To maximize the probability of observing western toads at historic breeding locations, we directed our surveys at tadpoles, paying special attention to past survey dates and water temperatures, and taking care not to arrive too late, after metamorphs had dispersed.

Amphibians were identified to species and their developmental stage and sex (when possible) were recorded. We distinguished between metamorphs (young-of-the-year), juveniles, and adult frogs based on body size, using snout-to-vent lengths (SVL) and weights. Total lengths (TL) were estimated for salamander larvae, and tadpole development was described using Gosner stage (Gosner 1960). Snout-to-vent lengths were obtained for young-of-year (YOY), juvenile and adult toads and frogs using vernier calipers ($\pm$ 0.1 mm). Adults, juveniles and metamorphs were weighed to the nearest gram using a 100-gram Pesola scale. The general health of each animal caught was assessed and its distance from shore, microhabitat, substrate and UTM coordinates were recorded. A sample datasheet is provided in Appendix C.

Figure 1. Northern sites surveyed during the 2005 CBFWCP amphibian inventory.

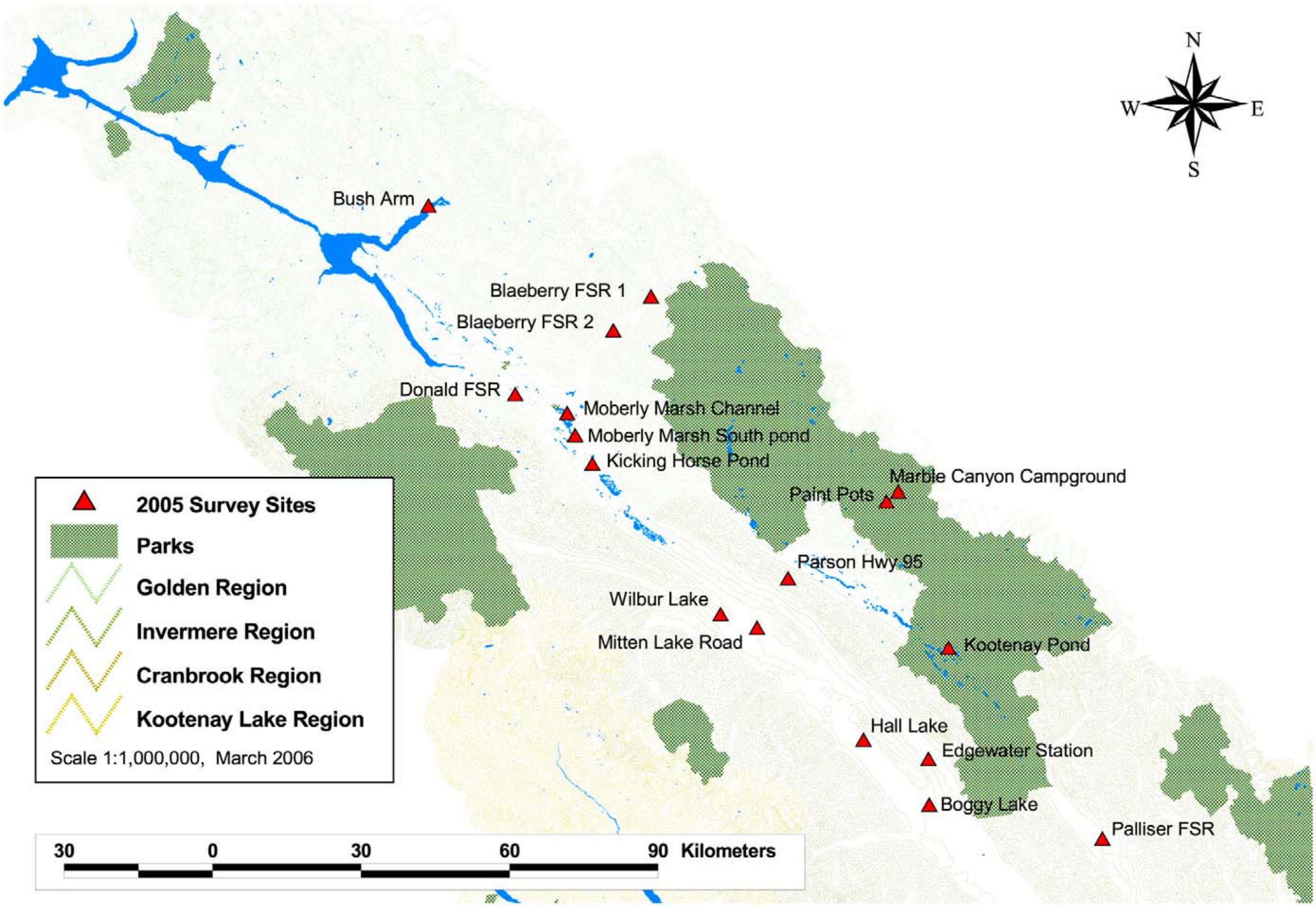
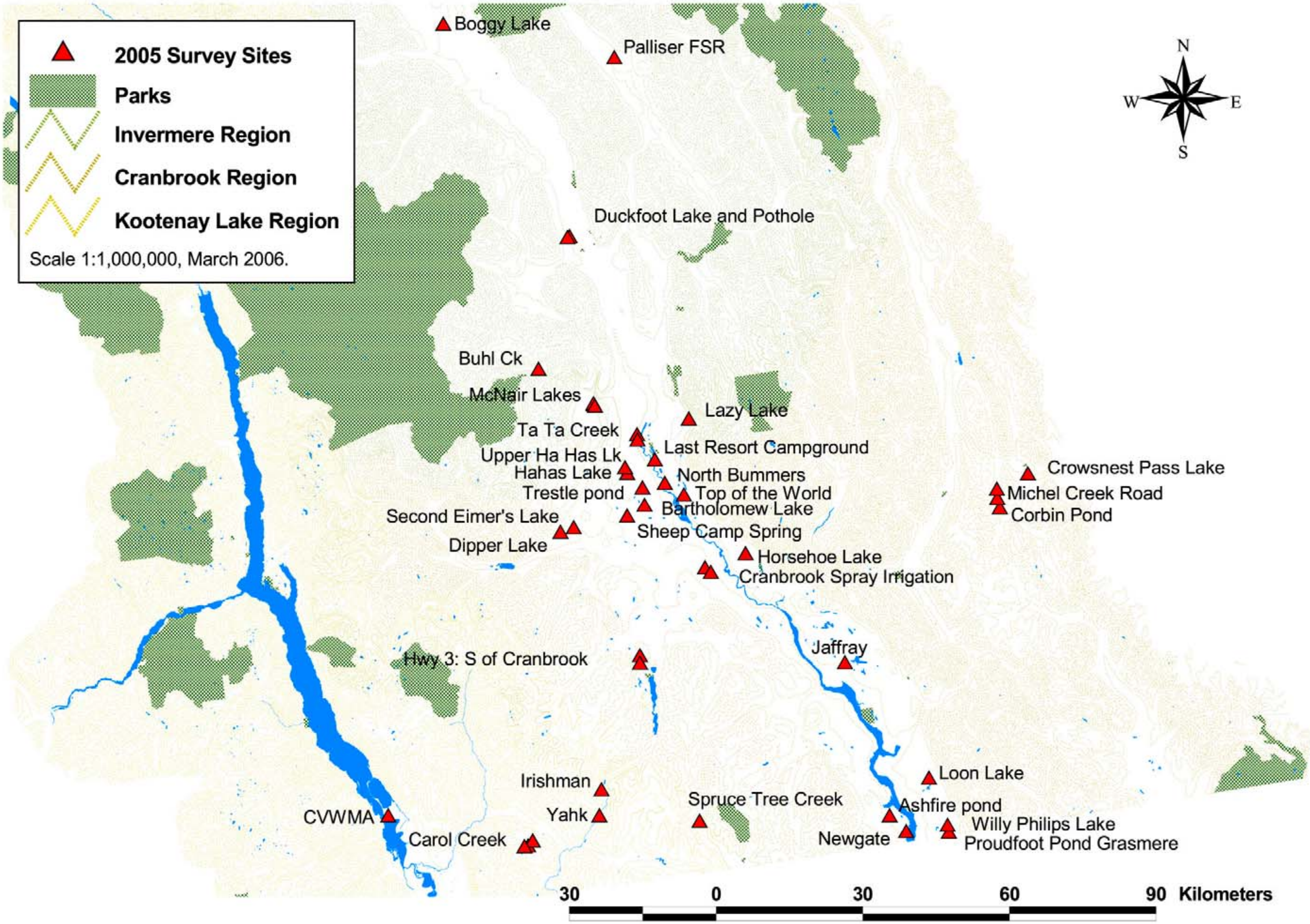


Figure 2. Southern sites visited during the 2005 CBFWCP amphibian inventory.



To obtain baseline data on the prevalence of chytridiomycosis in amphibians in south-eastern British Columbia, tissue samples were collected from YOY, juvenile and adult amphibians. Using surgical scissors, toe-clippings were taken from the fourth digit of a hind foot by removing the end of the digit to the first joint. Immediately afterwards an antiseptic (Bactine) was applied to the wound and the scissors were washed in 95% isopropyl alcohol. Captured animals were also swabbed with a sterile swab ten times along the abdomen, groin and thighs. Swabs and toe clippings were placed in sterile tubes with 95% isopropyl alcohol or ethanol and labeled with the capture number, species and location. These tissue samples will be submitted to a lab for analysis at a later date.

In order to prevent the spread of potential infectious agents such as chytrid fungus, all field equipment and clothing were disinfected between survey sites. Nets, boots and hip waders were thoroughly rinsed in a 10% bleach solution, and thermometers, pH meters and conductivity meters were wiped with isopropyl alcohol.

3.2 Data Management, Mapping, and Analysis

Data from the 2005 field season was entered into three MS Excel spreadsheets: Survey Data, Site Data and Animal Observation Data. Location data for the surveys and animal observations were recorded with a GPS in either the NAD83 or WGS84 mapping datum. Historical records were converted to NAD83 using Pathfinder Office (Trimble 2003). These co-ordinates were then exported as ArcView shapefiles, and brought in ArcView (ESRI 1999) to display the location of the historical leopard frog and western toad occurrences and breeding sites. UTMs of all survey sites, dates and species observed are presented in Appendix A. Amphibian occurrences in 2005 are shown on maps in Appendix B, and historic *R. pipiens* locations are listed in Appendix D.

4.0 RESULTS

4.1 Survey Results

Between June 29 and October 10, 2005, a total of 81 hours and 42 minutes were spent conducting surveys at 57 sites. Amphibians were detected at 27 of 57 (47.4%). The western toad was observed at only 12 sites (21.1%). Other species were the Columbia spotted frog, *R. luteiventris* (14 sites), long-toed salamander, *A. macrodactylum* (6 sites), and Pacific chorus frog, *P. regilla,* (3 sites). The wood frog, *R. sylvatica* and Rocky Mountain tailed frog, *A. montanus*, were each observed at 1 site. No northern leopard frogs were detected.

A summary of the site occupancy by geographical area for all amphibians encountered during this study is shown in Table 1. Western toads and Columbia spotted frogs were observed over the greatest geographical area, yet the actual number of occurrence sites was small.

Table 1. Number and proportion of sites occupied by each amphibian species by geographic location

Area	No. sites surveyed	*B. boreas*	*R. pipiens*	*R. luteiventris*	*R. sylvatica*	*P. regilla*	*A. montanus*	*A. macrodact.*
Golden	7	1 (14.3%)	-	1 (14.3%)	1 (14.3%)	-	-	-
Invermere	14	4 (28.6%)	-	7 (50.0%)	-	-	-	2 (14.3%)
Cranbrook	27	6 (22.2%)	-	3 (11.1%)	-	1 (3.7%)	-	3 (11.1%)
Yahk	6	1 (16.7%)	-	3 (50.0%)	-	2 (33.3%)	1 (16.7%)	1 (16.7%)
KNP	3	-	-	-	-	-	-	-

Twenty three historic western toad breeding sites were surveyed in 2005 (Table 2). Toad breeding was confirmed at only 7 of 23 (30.4%). Two breeding ponds that were active in 1995 (Ohanjanian and Teske 1996) had dried out. (Maps of historic and present toad observations are shown in Appendix B)

Table 2. Results of surveys at historic *Bufo boreas* breeding sites

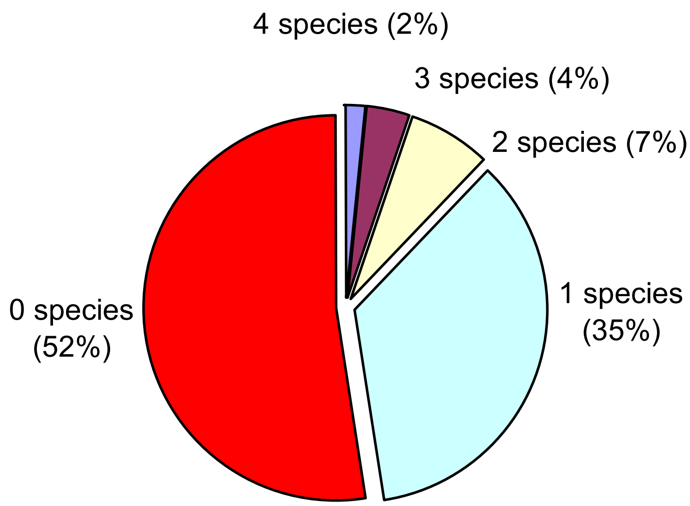
General Area	Detected in 2005	Not detected in 2005	Dried out
Golden Area:	CPR/Kicking Horse pond*	Donald For Rd Bush Arm	
Invermere Area:	McNair Lakes**	Buhl Cr Warm Springs Duckfoot Lk Edgewater Pond	
Cranbrook Area:	Horseshoe Lk Dipper Lake Crowsnest Pass Michel Cr (NW of Corbin) Lazy Lake	Bartholomew Lake Cranbrook Spray Irrig. Top of the World Ranch Railway Trestle Pond North Bummers Ta Ta Cr N Wetland Upper Hahas Lake	Proudfoot Pond Second Eimer's
Kootenay Park		Kootenay Pond Marble Canyon	
	Total detected: 7 (30.4%)	**Total not detected: 14 (60.9%)**	**Total lost: 2 (8.7%)**

* (erroneously reported as Golden sewage lagoons in Gilles and Franken 1999)
** McNair Lakes consist of 3 water bodies separated by < 100 m – considered here as one occurrence site

Although *Rana pipiens* was not detected at any of the 11 historical sites revisited during this study (Appendix D), two concurrent studies at Bummer's Flats near Cranbrook, located leopard frogs that had been re-introduced to that locale (Adama and Beaucher 2006; Ohanjanian and Wigle 2006).

Amphibian species richness was very low at the majority of sites (Figure 3). Dipper Lake, in the Kimberley Nature Park, was the only site at which four species were detected. These were the western toad, spotted frog, chorus frog and long-toed salamander. Carrol Creek/Little Moyie and Wilbur Lake were the only sites at which three species were observed. Two species were seen at four sites: Carrol Creek First Lake, Spruce Tree Creek, and at McNair Lakes (North and Middle Lakes).

Figure 3. Number of species observed (n = 57 wetlands)



4.2 Habitat characteristics of *B. boreas* breeding locales in 2005

In 2005, western toads were found breeding from 786 to 1357 m (Table 3). The water bodies in which they bred (n =11) ranged in size from a small pond (< 0.5 ha) to lakes > 10 ha in size. Depths of these water bodies were also highly variable, ranging from 40 cm to over 10 m (Table 3). At the larger lakes, tadpoles were observed swimming along the warmer, shallow shorelines.

The quantity of emergent vegetation was typically low to moderate (Table 3), and included cattails, sedge, bulrush, water smartweed, and grasses. Percent cover of submergent vegetation was very low (<5%) at most sites; one exception to this was the CPR/Kicking Horse Pond, which supported a thick submergent community (80% cover). Predominant submergent species at *B. boreas* breeding sites included Richardson's pondweed, *Potomogeton perfoliatus richardsonii,* milfoil, *Myriophyllum exalbescens*, white water crow foot, *Ranunculus aquatilis*, algae, and stonewort, *Chara sp*. Most of the sites had predominantly mud or muck substrates (7/11) with some gravel or cobble at four of these. Acidity was well within species' tolerances, with ph values at toad breeding ponds ranging from 8.4 to 9.4 (Table 3). Seven sites supported fish populations and four did not.

Table 3. Summary table of habitat characteristics at *B. boreas* breeding locales 2005

Site	Type of water body	Elev. (m)	% Cover emergent veg.	% Cover submerg. veg.	pH	Max. depth (cm)	Substrate
Kicking Horse Pond	Marsh / pond	786	5	80	9	150	gravel, cobble
Wilbur Lake	Lake	1305	5	<1	8.8	>200	mud, cobble
Boggy Lake	Marsh	1007	5	0	9.4	100	muck
McNair (N. Lk)	Lake	1092	0	5	8.6	800	mud, sand, gravel
McNair (Middle Lk)	Flooded depression	1092	5	20	8.4	40	mud, sand
Lazy Lake	Lake	906	5	1	8.8	>1000	mud, cobble
Dipper Lake	Lake	1324	50	<1	9.1	>100	mud
Crowsnest Pass Lk	Lake	1357	20	No data	9.3	>100	gravel
Michel Creek Road	Stream-fed pond	1327	15	20	8.6	80	mud
Horeshoe Lake	Lake	852	0	<1	8.7	>1000	gravel, cobble
Carrol Cr: 1st lake	Lake	975	0	No data	N/A	> 500	rock, gravel

4.3 Other Species

R. luteiventris

Columbia spotted frogs were observed at elevations ranging from 800 m to 1324 m and breeding was confirmed at 8 of the 14 sites at which they were detected. Habitat attributes of these sites are presented in Appendix E. Percent cover values for emergent and submergent vegetation were highly variable. In general, habitats occupied by this frog were more marsh-like, and had higher cover values for both emergent and submergent vegetation, than did sites occupied by breeding toads. Bulrush and sedges were the most common emergent species. Other species included spikerush, *Eleocharis palustris,* water smartweed, and cattail. A variety of pondweeds, (including *Potomogeton pusillus, P. natans and P. pectintus)*, as well as algae, milfoil, white-water crowfoot and chara, characterized the submergent communities at spotted frog sites. Maximum water depths ranged from as little as 30 cm (Buhl Cr "Cool" Pond) to 9 m (McNair South Lake), and substrates were predominantly mud. pH values were fairly narrow, ranging from 8.0 – 9.1. Fish were present at 5 of 14 sites, and absent at 6 of 14. The presence or absence of fish was not determined for 3 sites.

P. regilla, R. sylvatica, and A. montanus

Pacific chorus frog reproduction was observed at three sites in 2005. A recent historic report of young-of-year *P. regilla* at Lazy lake (Gillies and Franken 1999) was not confirmed,. Wood frog reproduction at Bush Arm was reported by Ohanjanian and Teske (1996); tadpoles were observed in 2005, indicating that the species was still present and reproducing. Five adult tailed frogs were observed at Spruce Tree Creek in the Yahk watershed.

A. macrodactylum

Long-toed salamander larvae were detected at six sites. One of these, Sheep Camp Spring, was man-made, consisting of a vertical culvert placed to pool water from a spring. Three larval stages were seen here, the oldest of which were inside the culvert.

4.4 Amphibian health and predation

Tissue samples and swabs were obtained from 24 animals, and testing (PCR) to detect chytridiomycosis will be conducted at a later date. Gross inspection of 92 captured amphibians of all species revealed no obvious morbidity.

A toad tadpole with a chewed tail was seen in Dipper Lake and one spotted frog was observed without a front foot at McNair Lakes (Middle Lake). These were probably the result of predation attempts. Predation of newly metamorphosed spotted frogs by an adult conspecific was observed in Buhl Creek warm springs (Figure 4), a behavior that has been reported for northern leopard frogs and bullfrogs (Nussbaum et al. 1983). Garter snakes (both *Thamnophis sirtalis* and *T. elegans*) were observed at Bartholomew Lake, Duckfoot Lake, Loon Lake, and at Middle and North McNair Lakes.

Sampling for aquatic invertebrates was carried out at 43 survey sites. Potential invertebrate predators, including water scorpions, giant water bugs, dragonfly and damselfly nymphs and predacious diving beetles, were present at 33 of these. A Pacific chorus frog tadpole was seen being eaten by a predacious diving beetle at Carrol Creek. Dragonfly larvae, particularly darners, *Aeshna spp*. are voracious predators of tadpoles (Barnett and Richardson 2002).

One albino spotted frog tadpole was observed in Buhl Creek “Cool” Pond (Figure 5). Although rare, albinism has been observed in other ranids. A recently metamorphosed albino foothill yellow-legged frog, *Rana boylii* was discovered in 1994 in California (Norman and Mollier 2002). The albino *R. luteiventris* tadpole found at Buhl Creek Cool Pond appeared healthy, but its coloration may make it more vulnerable to predation.

Figure 4. Cannibalism of newly metamorphosed *R. luteiventris* by adult (above)

Figure 5. Albino *R. luteiventris* tadpole (below)

5.0 DISCUSSION

5.1 Western Toad

Our observation that western toads bred at less than one third of the historical breeding sites surveyed in south-eastern British Columbia suggests that this species may be in decline. There was no obvious pattern to the lack of breeding, which was not confined to a single portion of the study area, a specific elevation range, or water body size. With the exception of two ponds that had dried up, the majority of historic locales did not appear to be hydrologically or structurally altered, nor did disturbance levels appear to be higher than when visited previously in the 1990s (Gilles and Franken 1999, Ohanjanian and Teske 1996). Although sample size in the present study was too small to yield statistically meaningful results, at least from a cursory glimpse, habitat change does not appear to be a factor.

The evidence of decline found in this study cannot be confirmed from only one year of data collection. Skelly et al. (2003) found that a single year of data resulted in a 45% decline in species presence whereas a five-year re-survey yielded an estimated 3% decline. Detecting trends in amphibian numbers is fraught with difficulties due to inherent population fluctuations and stochastic events (Pechmann et al 1999, Marsh 2001). Failure to sample sites randomly can bias results because targeting historic locations can only “capture” neutral or negative trends (Skelly et al. 2003) and failure to include adjacent habitats may overlook shifting of populations to new sites (Petranka et al. 2004). Finally, relying on historical observations may lead to error as location data may not be accurate. It is vital, therefore, that a multi-year approach be taken when attempting to determine the status of western toads in south-eastern British Columbia.

A long-term monitoring program is needed. We strongly recommend that a statistician be consulted during the development of this program to address sampling intensity and frequency, imperfect detection, and the statistical power of the monitoring program to detect trends. Pyare et al (2004) describe a monitoring program developed by the USGS Amphibian Research and Monitoring Initiative (ARMI), which maybe applicable. This model is based on estimating site occupancy rates using the Proportion of Area Occupied (PAO), and attempts to address detection errors by modeling detection probabilities across covariant information such as habitat type (Mackenzie et al 2002).

5.2 Northern Leopard Frog

That leopard frogs were not detected during this study confirms the observations of previous studies that concluded the species disappeared from the East Kootenay (Ohanjanian and Teske 1996, Gillies and Franken 1999). Presently, only a single population of *R. pipiens* currently exists in British Columbia at the Creston Valley Wildlife Management Area (CVWMA), near Creston, B.C. A reintroduction program has been under way since 2001 with the goal of establishing additional populations in the CVWMA and the East Kootenays (Adama and Beaucher 2006). Although the final outcome of these recovery efforts is still unknown, results to date have been positive, as two new leopard frogs breeding sites were established in 2005 (Adama and Beaucher 2006).

5.3 Other Species

Recent assessments of Columbia spotted frogs suggest that this species may be in decline in the western United States (Reaser and Pilliod 2005; Wente et al. 2005). Chytrid fungus has been reported by Bull (2005) at *R. luteiventris* breeding ponds in eastern Oregon. Spotted frog status, as well as that of the Pacific chorus frog and the long-toed salamander, has not yet been examined in British Columbia. One surprising result of the current study was the relative scarcity of larval long-toed salamanders. Many sites appeared to have excellent adjacent terrestrial habitat for the species but they were found at only six locations. There is also an anecdotal report of a historic Pacific chorus frog site from the mid 1980s north east of Kimberley (B. Olson, pers. comm.). The species has not been heard in that locale since that time. It is recommended, therefore that these species be investigated more closely in future.

Different survey methodologies are required for different groups of amphibian species. To effectively sample adult toads, adult long-toed salamanders and wood frogs, spring road counts, early-season breeding pond surveys and searches under cover objects should be included as survey techniques. Similarly, tailed frogs require specific survey protocols (Resource Information Standards Committee 2000) as they are stream-dwelling amphibians. The single sighting of five adults at Spruce Tree Creek was incidental and not reflective of that species' status, abundance or distribution.

5.4 Amphibian Health and Predation

Chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatidis*, has been implicated in amphibian declines around the world (Bell et al. 2004, Berger et al. 1998, Bonaccorso et al. 2003, Bradley et al. 2002, Lips et al. 2004). In the wild, animals may appear to be healthy, but die abruptly from the disease (D. Adama pers. obs.). Although amphibians in this study looked healthy, the lack of obvious signs of illness may be misleading. Chytrid has been documented in *B. boreas, R. lutieventris*, and *R. pipiens* in British Columbia (Adama and Beaucher 2006, Raverty & Reynolds 2001) and a long-term study of toads in Colorado has determined that the observed decline there is related to infection by *B. dendrobatidis* (Muths et al. 2003).

The dynamics of chytrid transmission, persistence and extinction properties are complex and variable (Briggs et al 2005). Furthermore, recent lab experiments have shown that *B. boreas* tadpoles are extremely vulnerable to chytrid (Blaustein et al. 2005). While care must be taken when extrapolating from experimental data to effects at the population level (Beebee and Griffiths 2005), it is possible that larval mortality could be occurring in field conditions as well. In the present study, more than fifty adults were seen spawning at Carrol Creek in early May (M-A. Beaucher, pers. comm.). When the site was re-visited on July 6, no tadpoles or metamorphs were seen. A similar phenomenon was also observed at Leach Lake in Creston - spawning toads and tadpoles were observed, but surveys conducted later in the summer and fall did not detect any metamorphosis (Adama and Beaucher 2006). The emergence of *B. boreas* toadlets was confirmed only at Dipper Lake and North McNair Lake (Figure 1). It cannot be said with certainty, therefore, that reproduction was successful at the other nine toad breeding sites. It is vital, therefore, to check for chytrid at breeding locales and follow investigations through to metamorphosis and beyond.

Negative effects of non-native fish on amphibians have been well documented and include disease transmission, competition and direct predation on adults and larvae (Kiesecker et al. 2001, Knapp 2005, Knapp et al. 2001). The negative effect is not the same for all species - bufonids have been reported to co-exist with fish where other amphibians do not (Knapp 2005, Martínez-Solano et al. 2003). The presence of fish at 7 of 11 *B. boreas* breeding locales in the present study may support this, but further research is needed.

6.0 RECOMMENDATIONS

Recognizing the limitations of this study, our results suggest that western toads may be declining in southeastern British Columbia. A long-term monitoring program must be established to substantiate this. We recommend the following:

i) Engage a statistician to develop a *statistically defensible* monitoring program capable of detecting trends in *B. boreas* populations. This would include determining (a) sampling intensity and frequency, (b) duration of the monitoring program, and (c) expected levels of population change such a program could detect. We suggest the monitoring program developed by the USGS Amphibian Research and Monitoring Initiative (ARMI) that utilizes occupancy rates to assess population trends, as a potential model.

ii) Resurvey historic *B. boreas* locales at which the species was not detected. Toads are capable of moving over 7 km (Davis 2002). If they are not observed, the survey area should be expanded to include other water bodies nearby. In addition, where breeding is confirmed, we suggest that sites be revisited to determine whether metamorphosis occurs.

iii) Increase survey efficiencies. This may be done by reducing the geographical scope of a project, establishing efficient survey routes and engaging volunteers.

iv) Investigate disease. Chytridiomycosis has recently emerged as a threat to many amphibian species. All future amphibian inventories should incorporate tissue collection and analysis to obtain data on prevalence of the disease throughout British Columbia. To reduce the risk of transmitting diseases such as chytridiomycosis, researchers conducting amphibian surveys should adopt a rigorous disinfection protocol.

7.0 LITERATURE CITED

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APPENDIX A. UTMs and Survey Results

UTMs (Zone 11 U), dates and results of all surveys

Site Name	Area	Datum	Easting	Northing	Survey Date	***Species Observed***
Lazy Lake	Cranbrook	WGS84	599062	5520819	06-Jul-05	*B. boreas*
Ta Ta Creek 1	Cranbrook	WGS84	588217	5518956	07-Jul-05	*None*
Ta Ta Creek 2	Cranbrook	WGS84	588098	5517906	07-Jul-05	*None*
Last Resort Campground	Cranbrook	WGS84	591152	5513396	06-Jul-05	*B. boreas*
Upper Ha Has Lk	Cranbrook	NAD83	584862	5512575	12-Jul-05	*None*
Hahas Lake	Cranbrook	WGS84	585188	5511374	06-Jul-05	*None*
North Bummers	Cranbrook	WGS84	592567	5508345	06-Jul-05	*None*
Trestle pond	Cranbrook	NAD83	587910	5508046	13-Jul-05	*A. macrodactylum*
Top of the World	Cranbrook	WGS84	596093	5505534	07-Jul-05	*None*
Bartholomew Lake	Cranbrook	WGS84	587820	5504473	29-Jun-05	*None*
Sheep Camp Spring	Cranbrook	NAD83	584059	5502701	12-Jul-05	*A. macrodactylum*
Second Eimer's Lake	Cranbrook	NAD83	572893	5501741	14-Aug-05	*Site dried up*
Dipper Lake	Cranbrook	WGS84	570131	5501149	04-Aug-05	*B. boreas, A. macrodactylum, R. luteiventris, P. regilla*
Crowsnest Pass Lake	Cranbrook	WGS84	666407	5500811	05-Aug-05	*B. boreas*
Michel Creek Road Beaver dam	Cranbrook	WGS84	659700	5498493	05-Aug-05	*None*
Michel Creek Road	Cranbrook	WGS84	659540	5496644	05-Aug-05	*B. boreas*
Corbin Pond	Cranbrook	WGS84	659800	5494614	05-Aug-05	*None*
Horseshoe Lake	Cranbrook	WGS84	607012	5491995	05-Jul-05	*B. boreas*
Cranbrook Spray Irrigation 1	Cranbrook	WGS84	598481	5490191	04-Jul-05	*None*
Cranbrook Spray Irrigation 2	Cranbrook	WGS84	599513	5489130	04-Jul-05	*None*
Hwy 3: S of Cranbrook 1	Cranbrook	WGS84	582959	5474018	20-Jul-05	*R. luteiventris*
Hwy 3: S of Cranbrook 2	Cranbrook	WGS84	582799	5472479	20-Jul-05	*None*
Jaffray	Cranbrook	WGS84	624327	5467188	12-Jul-05	*R. luteiventris*
Loon Lake	Cranbrook	WGS84	638358	5441551	05-Jul-05	*None*
Ashfire pond	Cranbrook	WGS84	629423	5434951	05-Oct-05	*None*
Willy Philips Lake	Cranbrook	WGS84	640886	5431475	05-Jul-05	*None*
Newgate	Cranbrook	WGS84	632335	5431261	12-Jul-05	*None*

Proudfoot Pond Grasmere	Cranbrook	NAD83	640922	5429964	No survey	*Dried up*
Bush Arm	Golden	WGS84	474558	5740022	13-Jul-05	*R. luteiventris*
Blaeberry FSR 1	Golden	WGS84	516850	5716219	16-Aug-05	*None*
Blaeberry FSR 2	Golden	WGS84	508368	5710322	16-Aug-05	*None*
Donald FSR	Golden	WGS84	487092	5700165	12-Jul-05	*R. luteiventris*
Moberly Marsh Channel	Golden	WGS84	497062	5695050	27-Jul-05	*None*
Moberly Marsh South pond	Golden	WGS84	498057	5690388	27-Jul-05	*None*
Kicking Horse Pond	Golden	WGS84	500802	5684193	12-Jul-05	*B. boreas*
Parson Hwy 95	Invermere	NAD83	537106	5656319	26-Jul-05	*None*
Wilbur Lake	Invermere	NAD83	522622	5650821	26-Jul-05	*B. boreas, R. luteiventris A. macrodactylum*
Mitten Lake Road	Invermere	WGS84	529622	5647174	26-Jul-05	*R. luteiventris*
Hall Lake	Invermere	WGS84	548091	5622130	28-Jul-05	*None*
Edgewater Station	Invermere	WGS84	560584	5616589	28-Jul-05	*None*
Boggy Lake	Invermere	WGS84	559593	5607392	28-Jul-05	*B. boreas*
Palliser FSR	Invermere	WGS84	593412	5596175	18-Aug-05	*None*
Duckfoot Lake	Invermere	NAD83	579644	5561014	26-Jul-05	*R. luteiventris*
Duckfoot Pothole	Invermere	NAD83	579280	5560874	26-Jul-05	*None*
Buhl Ck "Cool" Pond	Invermere	NAD83	569960	5534820	26-Jul-05	*R. luteiventris*
Buhl Ck Warm Springs	Invermere	NAD83	569960	5534820	26-Jul-05	*R. Luteiventris*
McNair Lakes N. Lake	Invermere	NAD83	580202	5526424	27-Jul-05	*B. boreas, A. macrodactylum*
McNair Lakes Middle. Lake	Invermere	NAD83	580197	5526194	27-Jul-05	*B. boreas, R. luteiventris*
McNair Lakes S. Lake	Invermere	NAD83	580382	5525927	27-Jul-05	*R. luteiventris*
Marble Canyon Campground	KNP	WGS84	561471	5670872	18-Aug-05	*None*
Paint Pots	KNP	WGS84	558828	5669119	18-Aug-05	*None*
Kootenay Pond	KNP	WGS84	567476	5638255	18-Aug-05	*None*
Irishman	Kootenay Lk	NAD83	571646	5447758	13-Jul-05	*R. luteiventris*
Yahk	Kootenay Lk	WGS84	570615	5442577	20-Jul-05	*None*
Carrol Creek, small pond	Kootenay Lk	WGS84	556458	5439140	06-Jul-05	*R. luteiventris*
Spruce Tree Creek	Kootenay Lk	NAD83	590790	5438781	13-Jul-05	*A. montanus*
Carrol Creek: First lake N end	Kootenay Lk	WGS84	555396	5438289	06-Jul-05	*P. regilla, A. macrodactylum*
Carrol Creek: First lake S end	Kootenay Lk	WGS84	554623	5438167	06-Jul-05	*B. boreas, P. regilla, A. macrodactylum*

Confirmed *B. boreas* occurrences

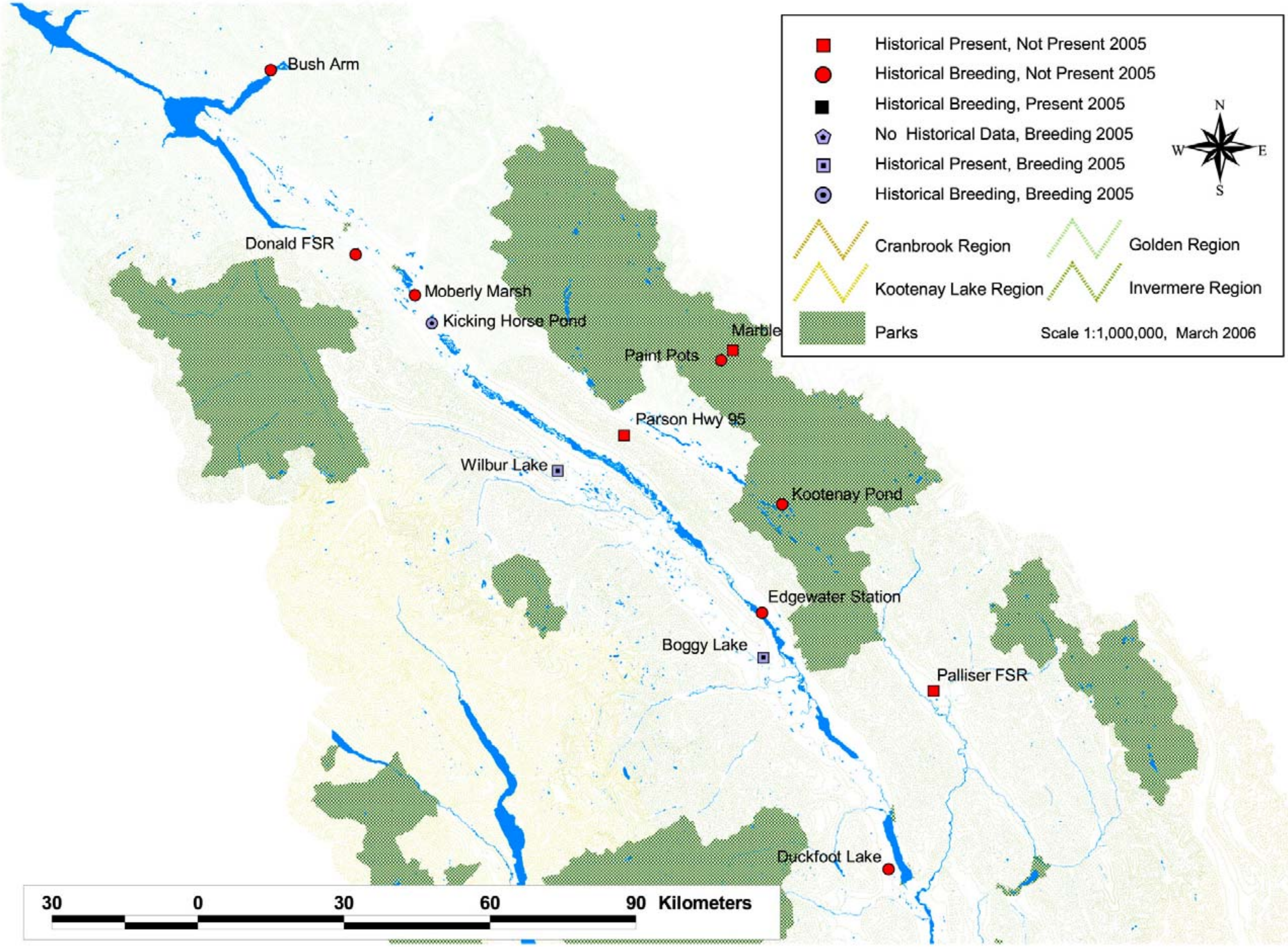
Site Name	Region	Zone	Datum	Easting	Northing
Last Resort Campground	Cranbrook	11	WGS84	591152	5513396
Lazy Lake	Cranbrook	11	WGS84	599062	5520819
Dipper Lake	Cranbrook	11	WGS84	570131	5501149
Crowsnest Pass Lake	Cranbrook	11	WGS84	666407	5500811
Michel Creek Road	Cranbrook	11	WGS84	659540	5496644
Horeshoe Lake	Cranbrook	11	WGS84	607012	5491995
Kicking Horse Pond	Golden	11	WGS84	500802	5684193
Wilbur Lake	Invermere	11	NAD83	522622	5650821
Boggy Lake	Invermere	11	WGS84	559593	5607392
McNair Lakes N. Lake	Invermere	11	NAD83	580202	5526424
McNair Lakes Middle. Lake	Invermere	11	NAD83	580197	5526194
Carrol Cr: First lake S end	Kootenay Lake	11	WGS84	554623	5438167

Confirmed *R. luteiventris* occurrences

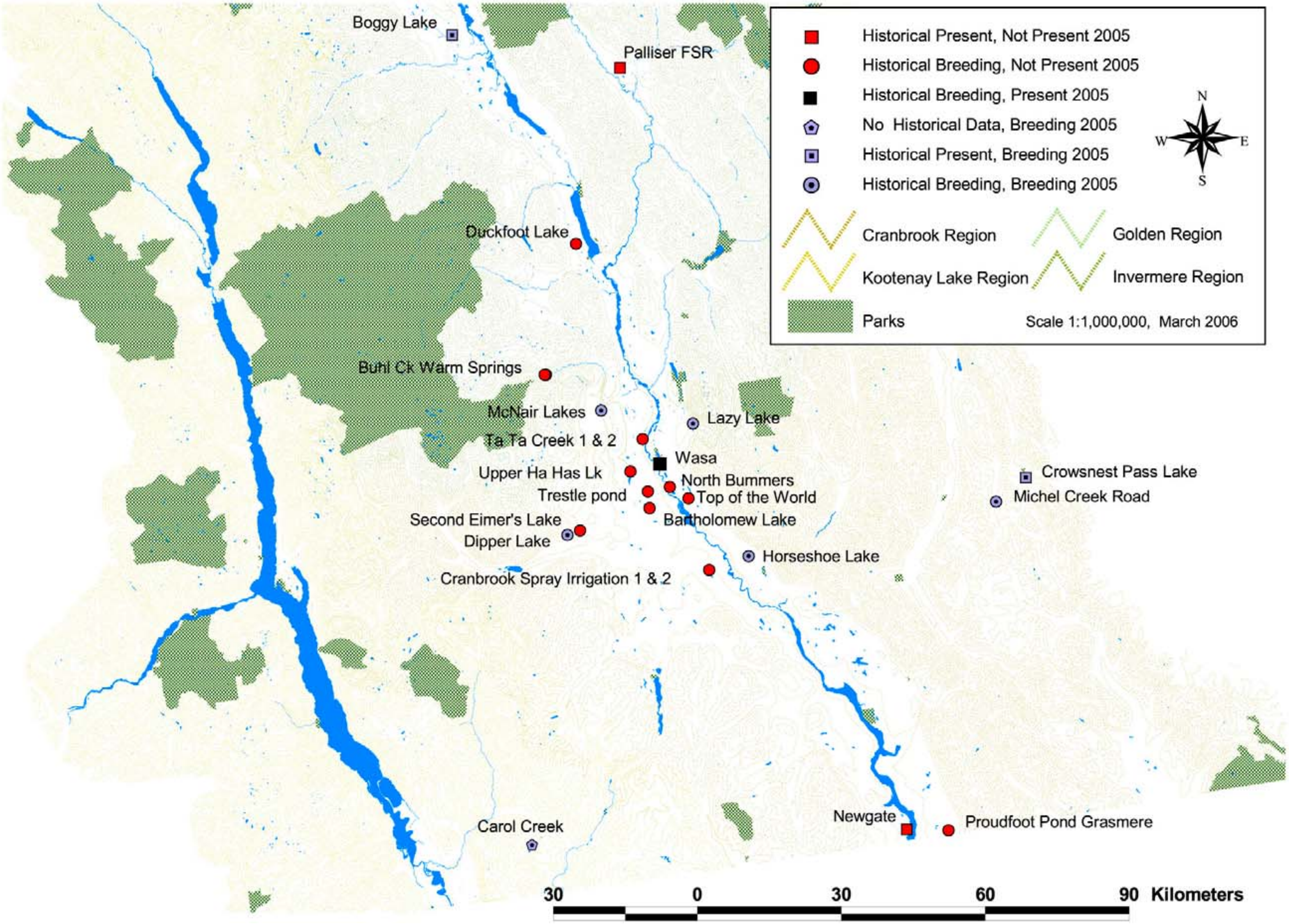
Site Name	Region	Zone	Datum	Easting	Northing
Hwy 3: S of Cranbrook 1	Cranbrook	11	WGS84	582959	5474018
Jaffray	Cranbrook	11	WGS84	624327	5467188
Donald FSR	Golden	11	WGS84	487092	5700165
Wilbur Lake	Invermere	11	NAD83	522622	5650821
Mitten Lake Road	Invermere	11	WGS84	529622	5647174
Irishman	Kootenay Lake	11	NAD83	571646	5447758
Carrol Cr. small pond	Kootenay Lake	11	WGS84	556458	5439140
Carrol Cr. 1st lake S end	Kootenay Lake	11	WGS84	554623	5438167
Dipper Lake	Cranbrook	11	WGS84	570131	5501149
Duckfoot Lake	Invermere	11	NAD83	579644	5561014
Buhl Ck "Cool" Pond	Invermere	11	NAD83	569960	5534820
Buhl Ck Warm Springs	Invermere	11	NAD83	569960	5534820
McNair Lakes Middle. Lake	Invermere	11	NAD83	580197	5526194
McNair Lakes S. Lake	Invermere	11	NAD83	580382	5525927

Appendix B: Maps of Survey Locations and Amphibian Detection

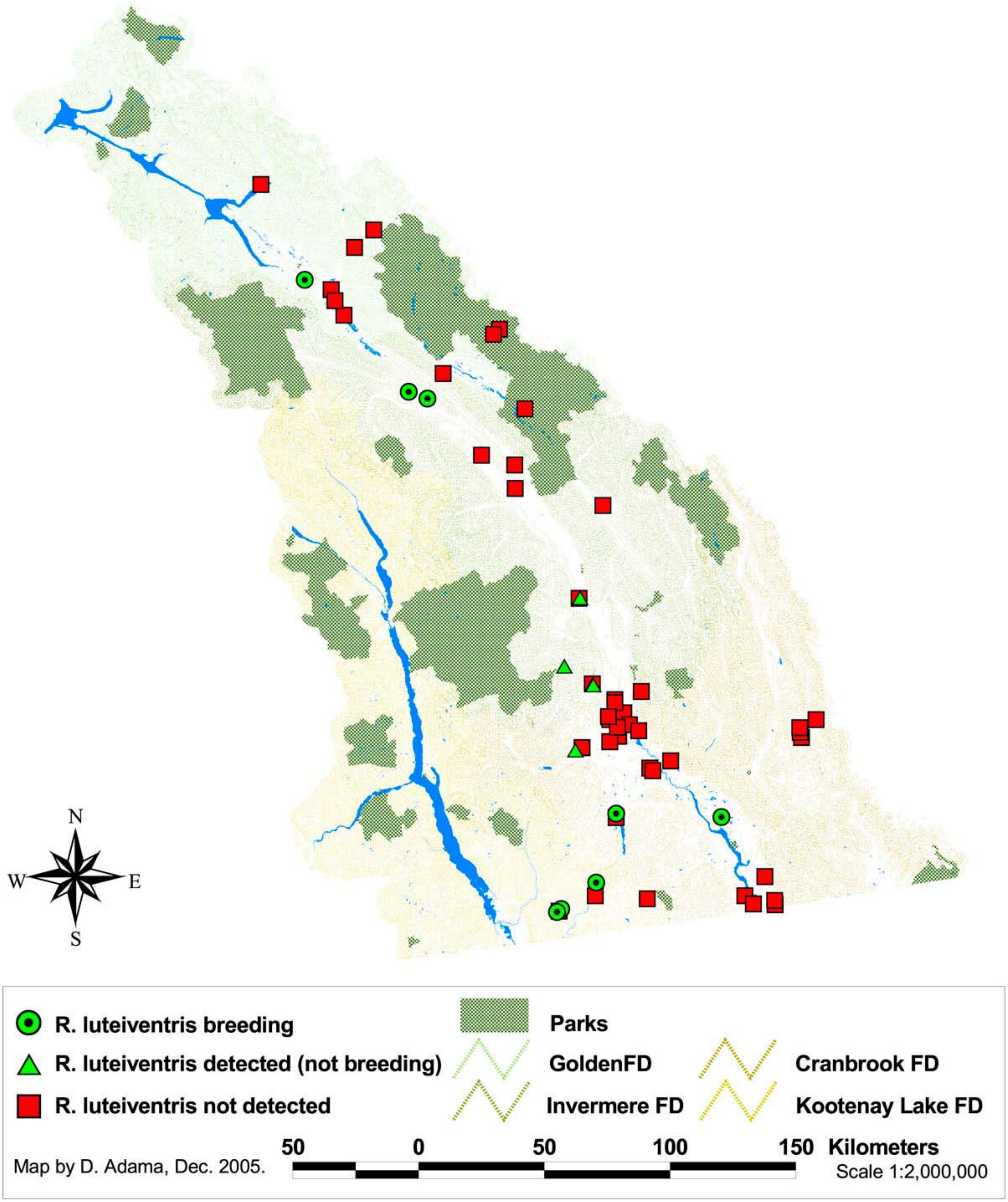
Appendix B-1. Status of historical western toad sites revisited in 2005, North.



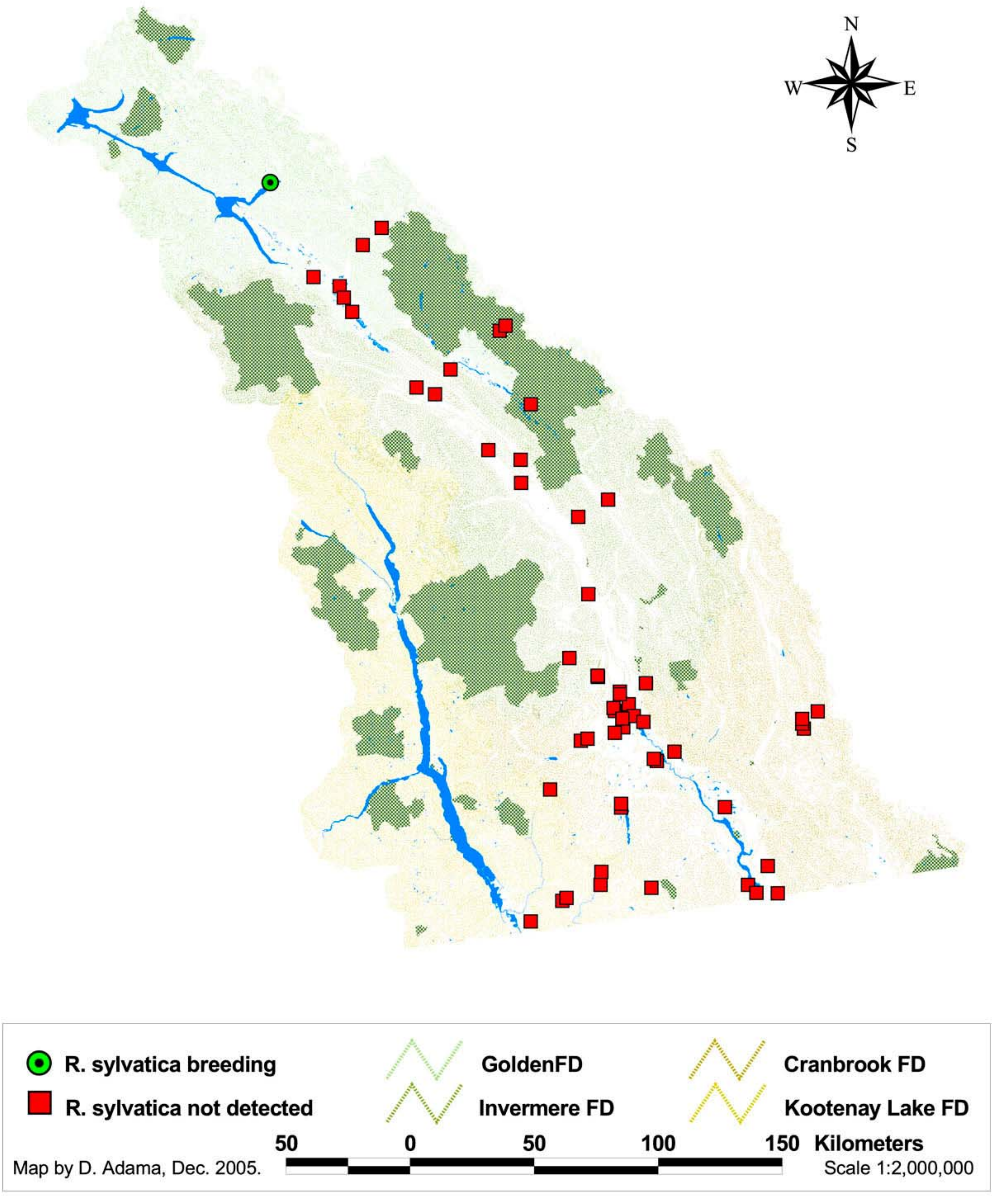
Appendix B-2. Status of historical western toad sites revisited in 2005, South.



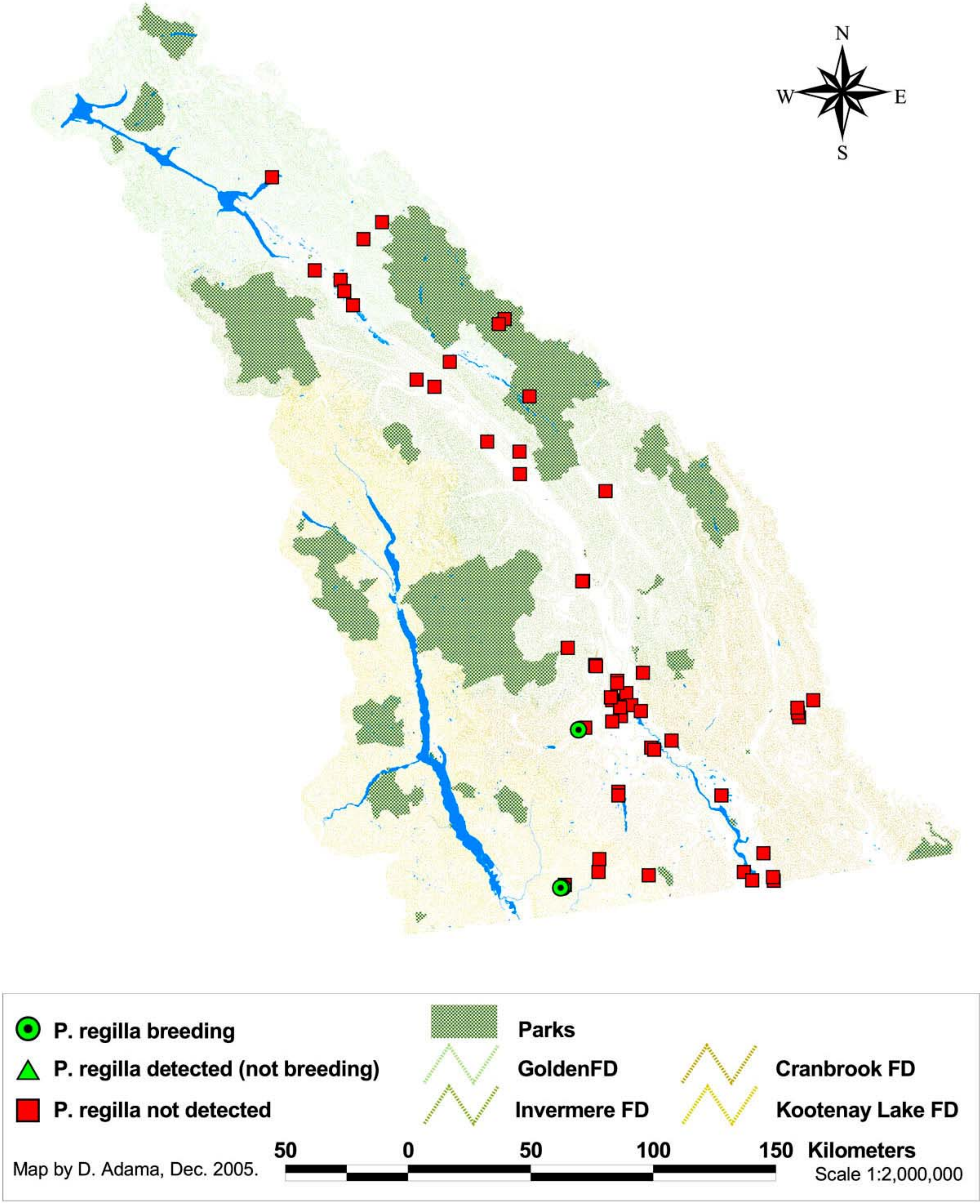
Appendix B-3 *Rana luteiventris* observations (2005)



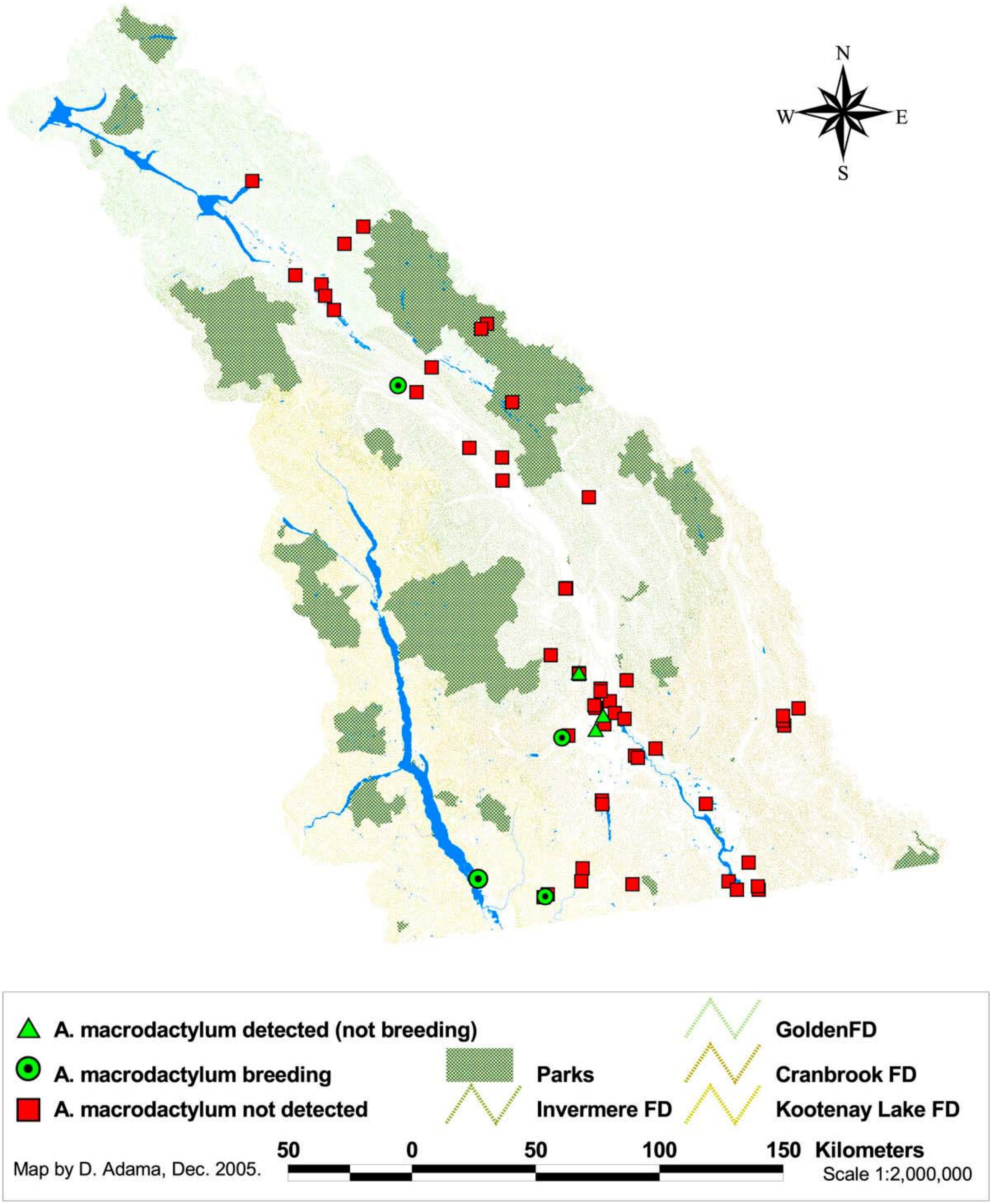
Appendix B-4 *Rana sylvatica* observations (2005)


N
W
E
S
R. sylvatica breeding
R. sylvatica not detected
GoldenFD
Invermere FD
Cranbrook FD
Kootenay Lake FD
50
0
50
100
150
Kilometers
Map by D. Adama, Dec. 2005.
Scale 1:2,000,000

Appendix B-5 *Pseudacris regilla* observations (2005)



Appendix B-6 *Ambystoma macrodactylum* observations (2005)



APPENDIX C: AMPHIBIAN SURVEY DATASHEET **Survey Record ___________Date:________________Personnel:_________**

Gen Loc:________________Location Description:____

Survey Type*:_________________ **Survey Distance/Area:_______m______m^2** **StartTime: ________EndTime:_________**

Elev	Datum	Easting	Northing	CC	Wind	Precip.	Temp: Air	Temp: Water	pH	DO	Salinity	Cond	

Wetland Description

BEC Subzone	Wetland† Size	Wetland† Class	Site Association‡	Avg Depth	Max Depth	Dist Road	Dist Rail	Dist to Forest	Sub strate	CWD	Crwn Cov	Fish

Emergent Veg.: ____________% Species list: ____

Submergent Veg.: ____________% Species list: ____

Adjacent Veg.: ____

Aquatic Insects:(5 sweeps x 2) (1) ____

(2) ____

Wetland Disturbance: ____

Animals Observations

Obs. # ie. C040624-01	D code	time	Spp	Qty	Stg	sex	TL mm	SVL mm	Wgt g	Location/UTM	L / W	Hlth	Dist to Shore m	Mac Hab	Photo #	Tissue	Comment Slope/aspect

D Code : Detection	**C= Calling; V = Visual; X = Captured;**	L/W	**L (land) or W (Water)**
Spp :	**RApi; RAIU; RASY; PEre; BUbO; AmMa**	Hlth	**G = Good; F = Fair; P = POOR; D= DeaD**
STG: Stage	**GS # (Gosner Stage: 25 to 46); T (Tadpole); YOY ; J (Juvenile/Sub-adult); A (Adult)**	Macro Habitat	**DOW (Deep Open Water); SOW (Shallow Open Water); Tall Grass; Low Grass; Shoreline; Typha**
Sex	**M (Male)/F (Female)/U (Unknown)**	Tissue	**Tissuesample taken: TC(toeclip)/BR (Bag Rinse), SB (SWAB)**

Map of Survey Area

Datasheet AMPHIBINV June 16, 2005

***Survey Type:** Egg Mass / Calling / Visual (Time or Area Constrained) / Dipnet/ Road/ Transect/ Other
†Wetland Size: 1 (0.1 – 0.5 ha); 2 (>0.5 ha – 1.0 ha); 3 (>1.0 – 2.0 ha); 4 (>2.0 – 5.0 ha); 5 (>5.0 – 10 ha); 6 (>10.0 ha).

†Wetland Classes		
Peatlands		
Wb	**Bog**	Nutrient poor, peat covered wetland. Sphagnum dominated. Acidic (pH 3.7 to 5.1). Anerobic.
Wf	**Fen**	Low to moderate nutrients, some water input/output, slightly acidic (4.6 to 6.0).
Mineral Wetlands		
Ws	**Swamp**	Standing/gently moving water, persisting seasonally. Neutral pH. Nutrient Rich. Vegetation dominated by conifer/deciduous of trees or shrubs
Wm	**Marsh**	Periodically inundated Neutral pH to slightly alkaline. Vegetation of reeds, rushes, cattails and sedges.
Ww	**Shallow Open Water**	Potholes, ponds or sloughs, less than 2 meters deep. Free of emergent veg.
Transition Units		
Wg	**Graminoid meadow Transition**	Grass, rush or sedge dominated meadows, which are periodically saturated, and occasionally inundated.
Wc	**Shrub-carr Transition**	Shrub-dominated sites, frost-prone with moist soils but rarely inundated
Wf	**Forb-Meadow Transition**	Forb dominated, occurring in cold, montane-subalpine regions with prolonged snow pack. Tall forbs and sedges.

‡ **McKenzie and Shaw (2000)**

APPENDIX D. Historic *R. pipiens* occurrence sites (after Seburn and Seburn 1998)

Historical northern leopard frog sites visited in 2005

General Area	Location*	Year detected
Golden Area:	Bush Lake	1948
	8 mi. NW. of Golden	1967
Invermere Area:	Pond at Edgewater	1967
	E. side of Skookumchuck*	1965
Cranbrook Area:	Wasa Slough, S. of Wasa	1973
	2 mi. S. on Hwy. 93 of Wasa	1967
	Hwy. 95, 7 mi. NW. of Fort Steele**	1973
	8 mi. NW. of Wardner (Hwy 3)	1967
	2 mi. S. of Jaffray	1967
	Loon Lake, 7 mi. NW. of Newgate	--
	9 mi. NW. of Corbin	1967
	Newgate	1967
		1953

* Site not found in 2005
** R. pipiens reintroduction site, Bummer's Flats (Adama and Beaucher 2006)

APPENDIX E. Summary table of habitat characteristics at *R. luteiventris* sites 2005

Site	Type of water body	Elev. (m)	% Cover emergent veg.	% Cover submergent veg.	pH	Max. depth water body (cm)	Substrate
Hwy 3: S of Cranbrook	Marsh	900	NA	NA	9.3	>100	gravel
Jaffray*	Pond	841	70	<5	8.0	>100	mud
Donald FSR*	Marsh	1049	40	80	8.5	150	mud
Wilbur Lake	Lake and Marsh	1305	5	<1	8.8	>200	mud, muck, cobble
Mitten Lake Road*	Marsh	1011	75	1	8.4	>200	mud
Irishman*	Old beaver pond	900	50	<5	8.5	150	muck
Carrol Cr, small pond*	Beaver pond	983	5	1	NA	100	muck
Carrol Cr: 1st lake S end*	Pond	975	0	<1	NA	>100	muck
Dipper Lake	Lake and marsh	1324	50	<1	9.1	>100	mud
Duckfoot Lake	Lake and marsh	920	40	90	8.6	200	mud
Buhl Ck "Cool" Pond*	Forest pond	1268	10	5	8.4	30	muck, rock
Buhl Ck Warm Springs*	Warm-fed pools	1268	5	10	9.1	40	rock, mud
McNair (Middle Lk)	Flooded depression	1092	5	20	8.4	40	mud, sand
McNair (S. Lk)	Lake	1092	0	10	8.6	900	sand, gravel, cobble

* Denotes breeding confirmed in 2005