Fish & Wildlife Division

RESOURCE STATUS AND ASSESSMENT BRANCH

Long-toed Salamander (*Ambystoma macrodactylum*) Monitoring Study in Alberta: Summary Report 1998-2001

Alberta Species at Risk Report No. 36

Alberta SUSTAINABLE RESOURCE DEVELOPMENT

Long-toed Salamander *(Ambystoma macrodactylum)* Monitoring Study in Alberta: Summary Report 1998-2001

Mai-Linh Huynh
Lisa Takats
and
Lisa Wilkinson

Alberta Species at Risk Report No. 36

January 2002

Project Partners:

SUSTAINABLE RESOURCE DEVELOPMENT

Alberta Conservation Association

Funded by Alberta Anglers, Hunters, and Other Conservationists

Publication No.: I/053
ISBN: 0-7785-2002-1 (Printed Edition)
ISBN: 0-7785-2003-X (On-line Edition)
ISSN: 1496-7219 (Printed Edition)
ISSN: 1496-7146 (On-line Edition)

Illustration: Brian Huffman

For copies of this report, contact:

Information Centre – Publications
Alberta Environment / Alberta Sustainable Resource Development
Main Floor, Great West Life Building
9920 108 Street
Edmonton, Alberta, Canada T5K 2M4
Telephone: (780) 422-2079

OR

Information Service
Alberta Environment / Alberta Sustainable Resource Development
#100, 3115 12 Street NE
Calgary, Alberta, Canada T2E 7J2
Telephone: (403) 297-3362

OR

Visit our web site at:
http://www3.gov.ab.ca/srd/fw/riskspecies/

This publication may be cited as:

Huynh, M., L. Takats and L. Wilkinson. 2002. Long-toed salamander (*Ambystoma macrodactylum*) monitoring study in Alberta: summary report 1998-2001. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 36. Edmonton, AB.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS v

EXECUTIVE SUMMARY vi

1.0 INTRODUCTION 1

2.0 STUDY SITES 2

2.1 Waterton Lakes National Park 2
2.2 Kananaskis Valley and Area 3
2.3 Athabasca Valley 4
2.4 Peace River 5

3.0 METHODS 6

3.1 Egg Searches 6
3.2 Larvae and Young-of-Year Searches 6
3.3 Minnow Traps 6
3.4 Trapping 6
3.5 Habitat data 7
3.6 Education 7

4.0 RESULTS 7

4.1 Waterton Lakes National Park 7
4.2 Kananaskis Valley and Area 8
4.2.1 Egg Counts 8
4.2.2 Larvae and Young-of-Year Searches 8
4.2.3 Trapping 9
4.2.4 Vegetation Inventory 10
4.2.5 Conservation and Management Actions 10
4.3 Athabasca Valley 10
4.3.1 Egg Counts 10
4.3.2 Larval and Young-of-Year Searches 11
4.3.3 Trapping 11
4.3.4 Vegetation Inventory 11
4.3.5 Conservation and Management Actions 12
4.4 Peace River 12
4.4.1 Trapping 12
4.4.2 Water Chemistry and Vegetation Inventory 12
4.4.3 Conservation and Management Actions 12
4.5 Crowsnest, Castle and Oldman 13

TABLE OF CONTENTS (Cont.)

5.0 DISCUSSION **13**

5.1 Site-specific Comparisons 13
5.1.1 Waterton Lakes National Park 13
5.1.2 Kananaskis Valley and Area 13
5.1.3 Athabasca Valley 14
5.1.4 Peace River 14
5.2 Between Site Comparisons 15
5.3 Inventory and Monitoring Recommendations 17

6.0 MANAGEMENT RECOMMENDATIONS **17**

7.0 REFERENCES **18**

8.0 APPENDICES **20**

APPENDIX 1 Wetlands surveyed for long-toed salamander presence in Waterton Lakes National Park, Alberta. 21
APPENDIX 2 Wetlands surveyed for long-toed salamanders in the Kananaskis Valley and area, Alberta. 22
APPENDIX 3 Number of eggs present and habitat type for wetlands used by long-toed salamander in Athabasca Valley, Alberta. 24
APPENDIX 4 Wetlands surveyed for long-toed salamander presence in the Peace River area, Alberta. 25

LIST OF TABLES

Table 1. Evidence of long-toed salamander breeding in wetlands in Waterton Lakes National Park, AB. 8
Table 2. Evidence of long-toed salamander breeding sites in wetlands in Kananaskis Valley and Area, AB. 8
Table 3. Total number of people educated about the monitoring project and amphibian conservation in the Kananaskis area.......... 10
Table 4. Evidence of long-toed salamander breeding in wetlands in the Athabasca Valley, AB. 10
Table5. Total number of people educated about the monitoring project and amphibian conservation in the Hinton, AB. 12

LIST OF FIGURES

Figure 1. Distribution of Long-toed salamanders in British Columbia and Alberta (modified figure from Graham and Powell 1999). 1
Figure 2. Long-toed salamander breeding areas in Alberta. 1
Figure 3. Surveyed ponds in Waterton Lakes National Park. 2
Figure 4. Surveyed ponds in Kananaskis Valley and area (not all ponds are represented). 3
Figure 5. Surveyed ponds in Athabasca Valley. (* denotes Wellsite) 4
Figure 6. Surveyed ponds in the Peace River Region (modified figure from Augustyn 2001, unpublished report). 5
Figure 7. Diagram of a pitfall trap and drift fence used for capturing salamanders. 7
Figure 8. Number of Long-toed Salamanders caught per trap night at the main monitoring pond in Kananaskis Valley , 1998-2001. 9
Figure 9. Number of Long-toed Salamanders caught per trap night at the Wellsite Pond in 2000 and 2001 field seasons, Weldwood FMA AB. 11

ACKNOWLEDGEMENTS

Funding and in-kind support for this project was provided from the following organizations:

Alberta Conservation Association
Alberta Sustainable Resource Development, Fish and Wildlife Division
Alberta Sport, Recreation, Parks and Wildlife Foundation
University of Alberta Biological Sciences Department
Canada Trust Friends of the Environment Fund
Student Career Placement Program (Human Resources Development Canada)
Student Temporary Employment Program
University of Calgary Kananaskis Field Station
Weldwood of Canada Limited, Hinton Division
William A. Switzer Provincial Park
The Foothills Model Forest
Waterton Lakes National Park

Thanks to the following people who offered advice and assistance: Cindy Smith, Don Page, Angela Braun, Troy Pretzlaw, Stephen Hanus and Terry Kosinski.

The following is recognition of field coordinators who participated in the monitoring project for each region:

Waterton: 1997-2001 Cleave Wershler and Kimberly Pearson
Kananaskis*: 1998 Jennifer Dober, 1999 Chad Wilms, 2000 Troy Pretzlaw, 2001 Robin Walsh
Athabasca*: 2000 Dawn Birn, 2001 Mai-Linh Huynh
Peace River: 2001 Teresa Augustyn

RANA program

EXECUTIVE SUMMARY

Long-toed salamanders are listed as 'sensitive' in Alberta due to isolated and discontinuous populations, limited breeding range, and vulnerability to habitat change. It is necessary to monitor populations for a minimum of five years to understand population trends and distribution, and ultimately re-evaluate status. There are several known breeding areas in Alberta, all of which have been the subject of inventory. Inventory technique, effort, and study objectives have varied between sites, although two sites have been established as long-term monitoring sites through the RANA program.

Variation in protocol makes it difficult to compare populations between years and study sites, and identify possible population trends. However, there has been a trend to discovering more breeding ponds with increased survey effort at the two RANA sites. In contrast, the 2001 survey in southern Alberta showed a reduction in the number of breeding ponds from 1995 to 2001. In general, long-toed salamanders are found in permanent, fishless ponds. Based on limited habitat evaluation, there are no apparent preferences for pond origin (*i.e.* natural or manmade), substrate, surrounding vegetation and water chemistry.

There are a number of threats to long-toed salamander populations, primarily due to alteration or destruction of breeding ponds, and direct disturbances in shoreline areas, such as cattle and human activities, which destroy eggs. Destruction of habitat, such as complete loss of ponds through draining, could have significant impacts on local populations if there are no other suitable ponds in close proximity. There is also evidence that salamanders are vulnerable to alteration and destruction of habitat surrounding ponds, such as forest harvest, although this has not been studied in Alberta.

Limited range and narrow habitat requirements necessitate continued monitoring and protection of long-toed salamander breeding ponds. This document is an account of study results at each of the breeding areas, including considerations for continued monitoring, management and conservation.

1.0 INTRODUCTION

In Canada, long-toed salamanders (*Ambystoma macrodactylum*) are found in isolated populations throughout British Columbia and western Alberta (Figure 1). In Alberta, long-toed salamanders are listed as ‘sensitive’ because of their limited breeding range, isolated populations, and vulnerability to habitat change (Graham and Powell 1999). Long-toed salamander status has yet to be assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

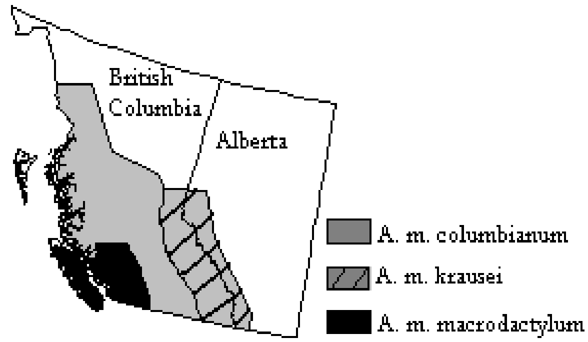

Figure 1. Distribution of Long-toed salamanders in British Columbia and Alberta (modified figure from Graham and Powell 1999).

Under the Conservation Action Statement outlined by the Alberta Endangered Species Conservation Committee (2000), long-toed salamander populations need to be monitored for five years. The main objective is to obtain baseline data on long-toed salamander population size, distribution and trends. Active management and conservation of breeding sites are also part of the Conservation Action Statement. The Researching Amphibian Numbers in Alberta (RANA) Program, directed by the Alberta Conservation Association, has played a vital role in meeting these objectives by incorporating long-toed salamander surveying and monitoring at relevant RANA sites.

There are several known long-toed salamander breeding areas in Alberta’s mountain passes and associated river valleys. These include Waterton Lakes, Castle River, Crowsnest Pass, Kananaskis Valley and area (Spray Lakes, Bow Valley), Athabasca Valley, and Peace River (Graham and Powell 1999; Figure 2). Monitoring and surveying activities have varied at each breeding area. Monitoring in Kananaskis and Athabasca has been part of the RANA program and represent the main provincial monitoring sites.
Details on all sites, including descriptions and inventory history, are discussed below.

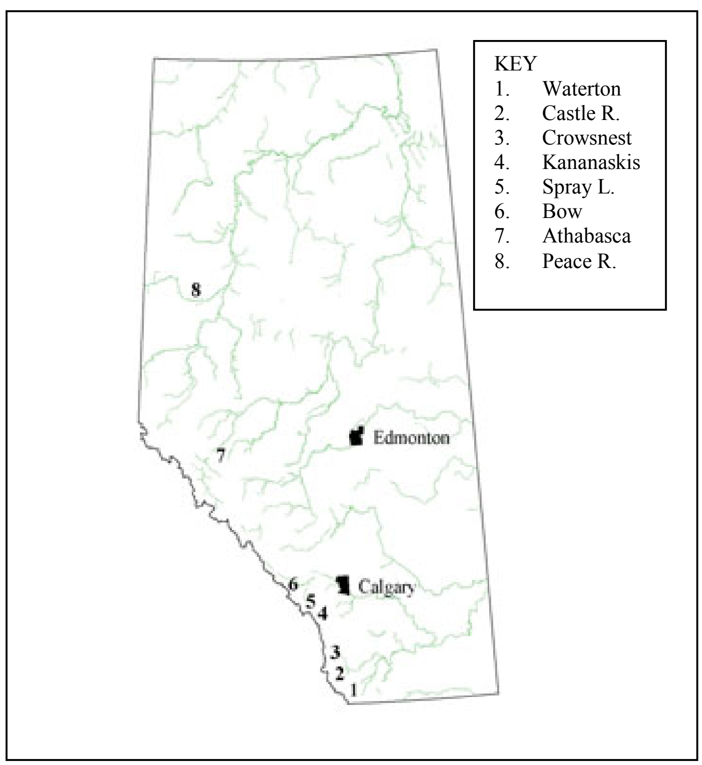

Figure 2. Long-toed salamander breeding areas in Alberta.

Long-toed salamanders are difficult to study because adults are forest-dwelling, cryptic, nocturnal, and spend most of their time underground, and are consequently rarely seen (Russell and Bauer 2000).

The best time to confirm presence is during breeding season when adults travel to ponds to breed. Long-toed salamander eggs are distinguishable from other amphibian eggs and are typically the best indicator of salamander presence; larvae are often more difficult to see but can also be used for confirmation of presence. Understanding population trends is further complicated by the inherent stochasticity of amphibian populations, and more specifically, the fact that salamanders may not breed every year (Heyer 1976). Surveys are focused during breeding season, and employ a combination of techniques (refer to Methods). There is also a capture component at some breeding areas, providing data on demographics and an index of relative abundance for local breeding populations that can be compared between years to determine population trends.

The following report is a site-specific account of long-toed salamander monitoring and surveying efforts in Alberta to date. Conservation and management actions, which include public education, are also discussed.

2.0 STUDY SITES

2.1 Waterton Lakes National Park

Waterton Lakes National Park (WLNP), located in the southwest corner of Alberta (Figure 2), is in a unique ecotone of mountain and prairie vegetation. Ecoregions in WLNP include Foothills Parkland, Montane, and Subalpine. Wetlands in this park have been surveyed for amphibians for five seasons, from 1997 to 2001. Surveys have been conducted primarily by volunteers. Ponds were chosen based on past research (Fukumoto 1995; Fukumoto and Herrero 1996; Figure 3).

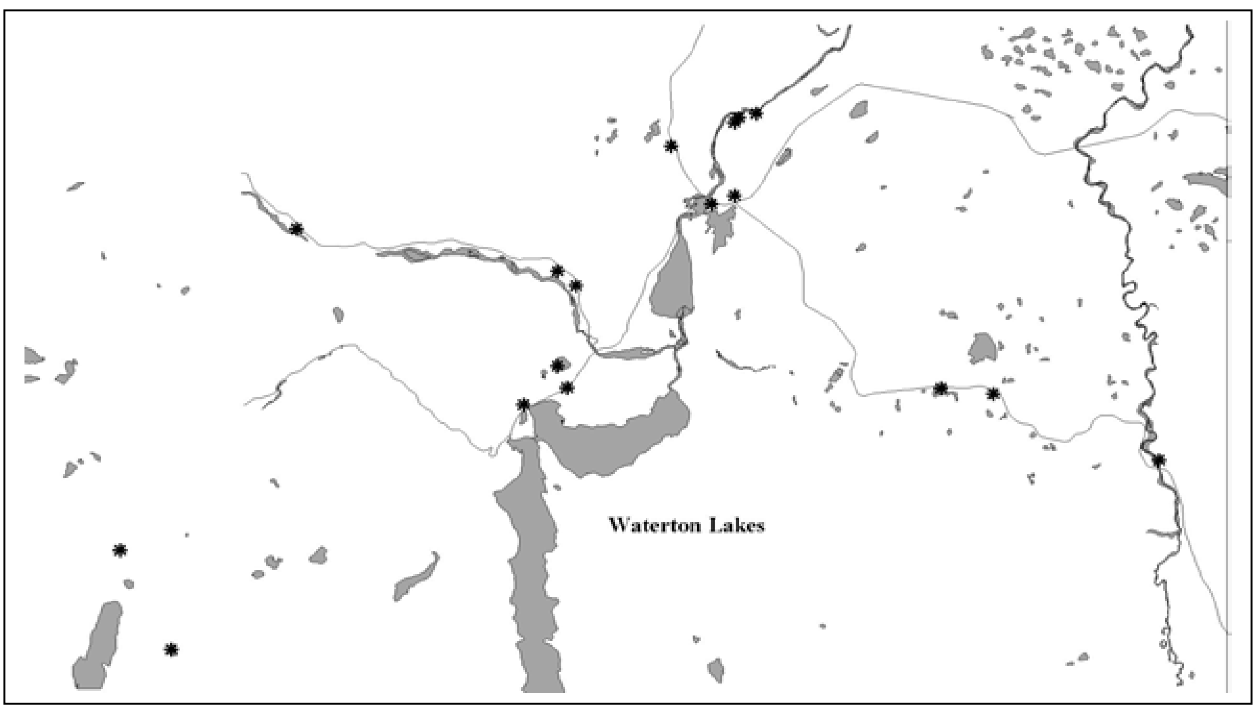

Figure 3. Surveyed ponds in Waterton Lakes National Park.

2.2 Kananaskis Valley and Area

This area is located 85 km west of Calgary (Figure 2). Ecoregions in this area include Upper and Lower Foothills and Montane. Most sites were chosen based on past studies of long-toed salamanders (Nelson *et al.* 1995; Powell and Russell 1996; Powell *et al.* 1993; Figure 4). The main monitoring pond (*i.e*. RANA pond), with fully enclosed fencing and pitfall traps, is located at the base of Mount Allen in Spray Lakes Valley. Surveyed wetlands are located throughout Kananaskis, Spray, Bow, and Sibbald Creek Valleys. Monitoring long-toed salamander populations in this area, as part of the RANA program, has been conducted for four seasons, from 1998 to 2001.

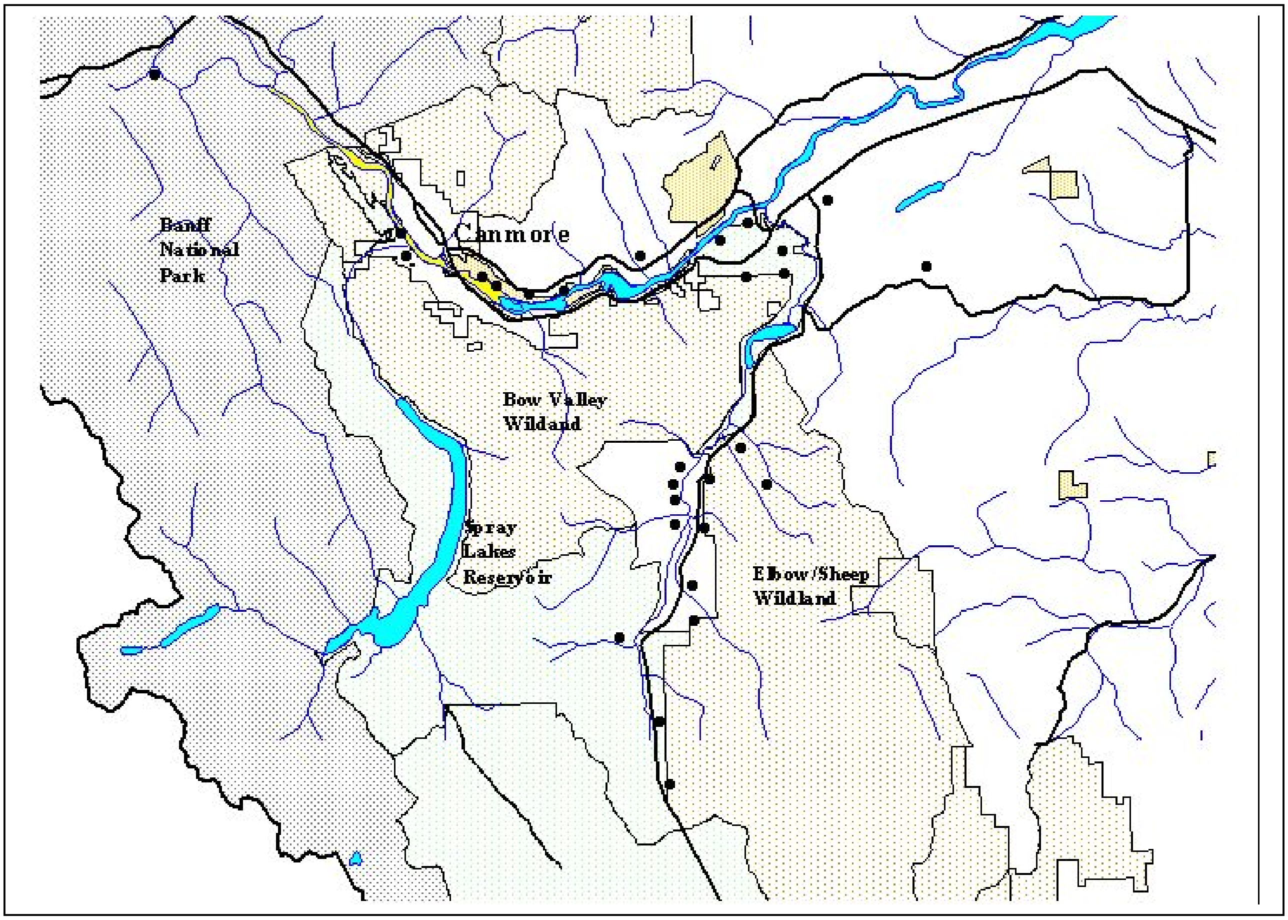

Figure 4. Surveyed ponds in Kananaskis Valley and area (not all ponds are represented).

2.3 Athabasca Valley

Athabasca Valley is located in west-central Alberta, near the Hinton townsite (Figure 2). Ecoregions in this area include the Upper and Lower Foothills. Most ponds are located within the Weldwood Forest Management Area and were chosen based on sites used in Graham's study (1997; Figure 5). The main monitoring pond (*i.e.* RANA pond with pitfall traps, known as Wellsite) has been operating for two seasons, 2000 and 2001. Two other sites that were installed with pitfall traps in 2001, M17 and Weigh Station, but are not currently in operation.

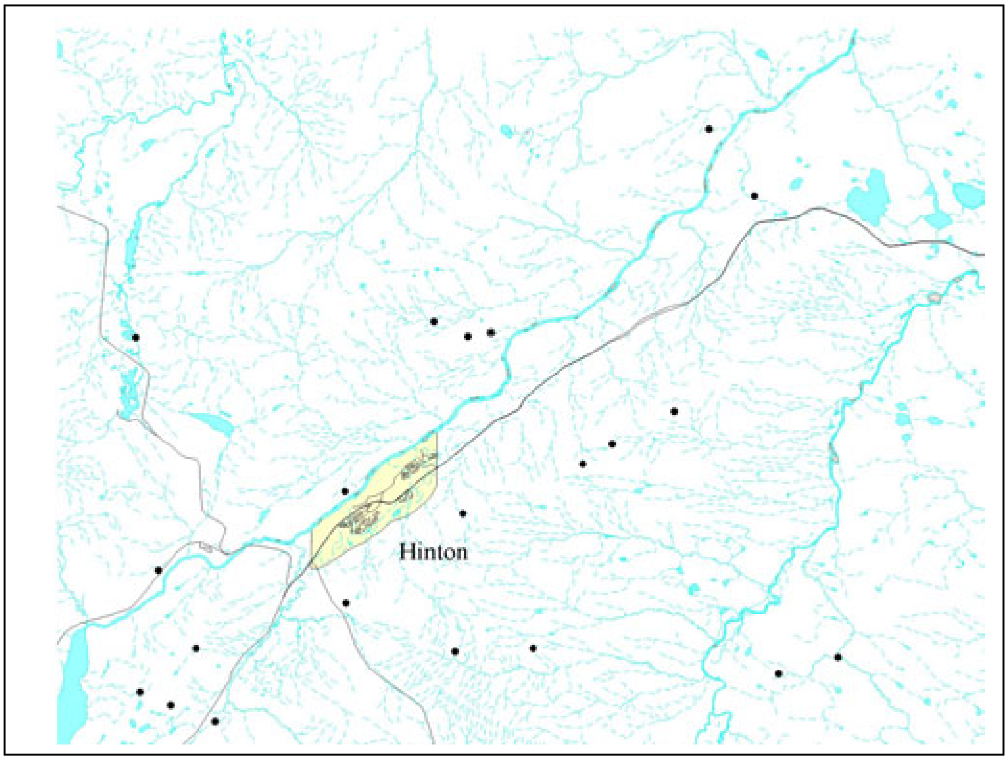

Figure 5. Surveyed ponds in Athabasca Valley. (* denotes Wellsite)

2.4 Peace River

The Peace River study area is located in northwest Alberta (Figure 2), and is dominated by the Prairie Parkland ecoregion. Study ponds are on private agricultural land south of Fairview, along the Peace River and Montagneuse River (Figure 6). Most sites were chosen based on Walsh's study (1998). The 2001 field season was the pilot year for the Peace River site, involving pitfall traps at one pond and minnow traps at several ponds (minnow traps were used instead of shoreline searches, refer to methods below).

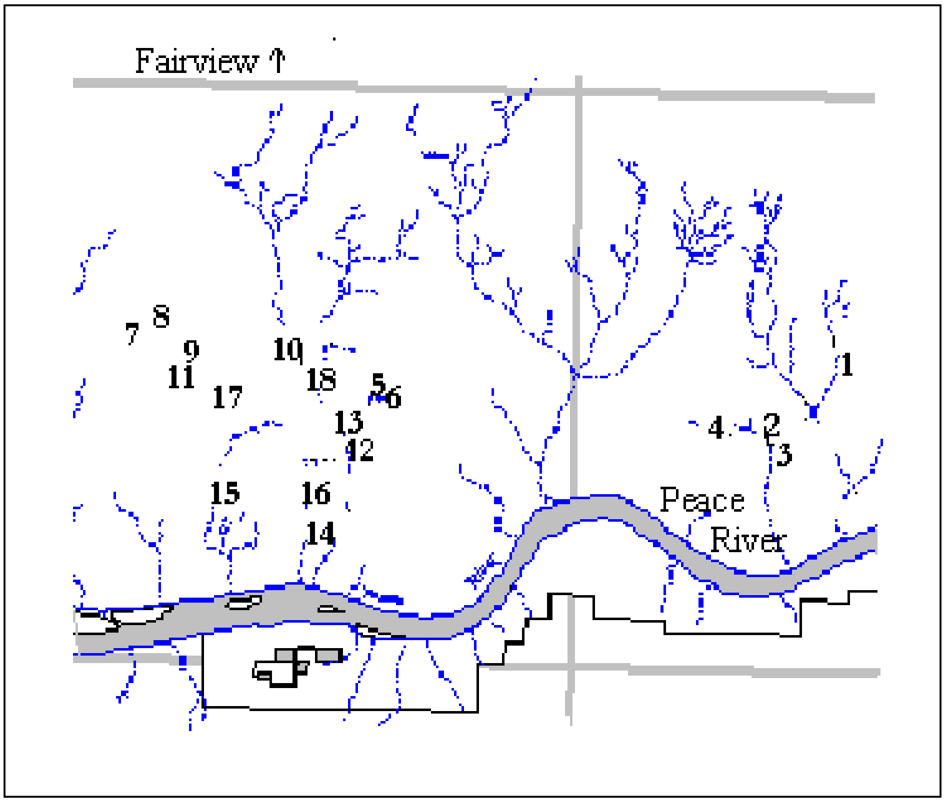

Figure 6. Surveyed ponds in the Peace River Region (modified figure from Augustyn 2001, unpublished report).

2.5 Crowsnest, Castle, and Oldman River

The Crowsnest, Castle, and Oldman River study areas are located in southwest Alberta (Figure 2), and are dominated by montane and subalpine subregions. Amphibian surveys were conducted here in 2001, which included ponds surveyed in 1995 (Nelson et al 1995), as well as new ponds. Details can be found in Paton (2002).

3.0 METHODS

The following are general accounts of methods used at breeding areas. Methods varied according to site characteristics, resources, and study objectives. A detailed protocol is available in Pretzlaw *et al*. (2002).

3.1 Egg Searches

Shoreline egg counts were conducted during spring; salamanders begin egg laying as soon as ice begins to leave ponds (Powell *et al*. 1993). Egg counts provide data on distribution and serve as an indirect measure of changes in population trends over time. Timing of egg counts was dependent upon pond and general site characteristics (*i.e*. water depth and surface area, and elevation), thus, timing of visits for each site varied. Shoreline counts were conducted around the entire pond perimeter or within permanent transects. Environmental data were also recorded, including pH, air and water temperatures, wind speed, and cloud cover.

Egg counts were conducted at all breeding areas, except Peace River where water turbidity limited visibility. At some breeding areas, ponds were visited up to three times during egg laying period to determine the maximum number of eggs laid.

3.2 Larvae and Young-of-Year Searches

In addition to egg searches in spring, shoreline larvae and young-of-year surveys were conducted in summer to gather additional distribution data. Searches were conducted following methods used for egg searches. Because larvae and young-of-year are relatively difficult to detect and count due to their mobility, these searches were used primarily to gather data on presence and were considered ancillary to egg counts. These surveys were conducted at all breeding areas except Peace River.

3.3 Minnow Traps

Minnow traps, which are designed to catch small fish for bait, were used at the Peace River area because water turbidity prevented shoreline searches. Traps were submerged for 24 hour periods at different times throughout spring breeding to capture adults.

3.4 Trapping

Pitfall traps were operated at one pond in Kananaskis, Athabasca, and Peace River. Capturing salamanders provided an opportunity to collect data on population demographics and establish a rough index of relative abundance (of the local population) that could be compared between years. Pitfall traps, consisting of plastic flowerpots flush with the ground, and silt drift fences (Eaton *et al.*, in draft) were installed to prevent salamanders from entering or leaving the wetland (Figure 7). In principle, salamanders are intercepted by the fence and will walk along the fence until they fall into a pitfall trap.

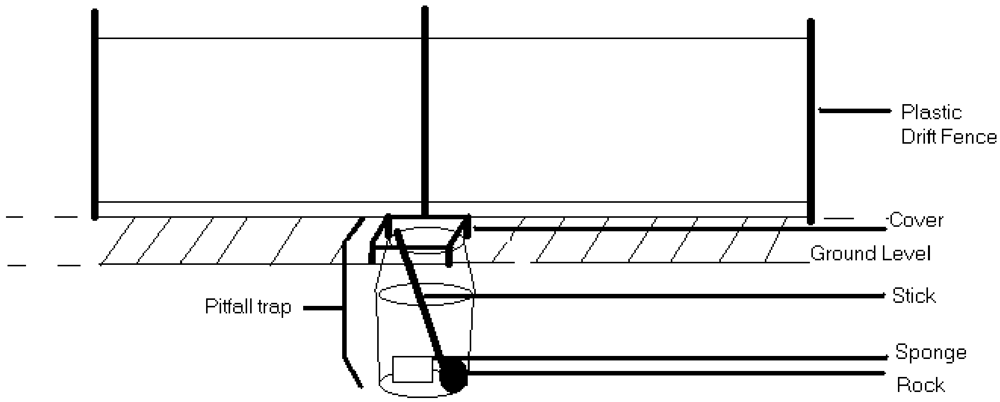

Figure 7. Diagram of a pitfall trap and drift fence used for capturing salamanders.

Each trap was equipped with a rock, which served as a perch or hiding place, a damp sponge or moss to prevent desiccation, and a stick to allow small mammals to escape.

Pitfall traps were operated primarily in spring to capture adult salamanders, and in Kananaskis and Athabasca traps were also operated in mid to late summer to capture emerging young-of-year. Trapping periods varied for each site. Upon capture, salamanders were sexed (during breeding season), weighed, measured from snout to vent, and then released on the opposite side of the fence.

3.5 Habitat Data

Habitat data were collected at most breeding ponds to characterize suitable salamander habitat, assess general species-habitat relationships, and monitor year-to-year and within-year variation (*i.e.* general forest cover or habitat disturbance). While a pilot vegetation inventory protocol was followed at some sites in 2001, habitat descriptions from previous years were cursory.

3.6 Education

An integral component of the long-term monitoring program is education. This includes school talks, interpretative talks at parks, and displays at community and park events.

4.0 RESULTS

4.1 Waterton Lakes National Park

Over the past five years, the number of surveyed wetlands increased from 12 to 20 and the number of wetlands with confirmed salamander sightings also increased from 4 to 11. For each of the 11 wetlands, number of egg masses, larvae, young-of-year, and breeding adults were recorded (Table 1). Names of wetlands and survey results from 1997 to 2001 are provided in Appendix 1. The 1999 field season had notably higher counts of salamander larvae at all breeding sites compared to other years.

Table 1. Evidence of long-toed salamander breeding in wetlands in Waterton Lakes National Park, AB.

	Wetland	A1	A3	A8	A9	A10	A11	A12	A13	A16	A17	A18
Year	1997	N	N	N	Y	Y	Y	Y	N/A	N/A	N/A	N/A
	1998	N	N	N	Y	Y	Y	N	N	Y	N/A	N/A
	1999	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N/A
	2000	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	2001	Y	N	Y	Y	Y	Y	Y	Y	N	N	Y

Note: (Y=present, N=not detected, N/A=not surveyed)

4.2 Kananaskis Valley and Area

4.2.1 Egg Counts

With an increase in the number of surveyed wetlands from 13 to 47 over the last four years, the number of confirmed long-toed salamander breeding sites increased from 6 to 19 (Table 2). Names of wetlands and survey results from 1998 to 2001 are provided in Appendix 2.

Table 2. Evidence of long-toed salamander breeding sites in wetlands in Kananaskis Valley and Area, AB.

	Wetland	C2	C7	C8	C10	C12	C14	C15	C16	C22	C24	C25	C26	C29	C32	C33	C37	C40	C41	C42
Year	1998	Y	N/A	N/A	N/A	N/A	Y	Y	N	Y	N/A	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	1999	N	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	N/A	N/A	N/A	N/A
	2000	N	Y	N	N	Y	Y	Y	N	N/A	N	Y	Y	Y	N	N	Y	Y	Y	Y
	2001	Y	Y	N	Y	N	Y	Y	Y	N/A	Y	Y	Y	Y	Y	Y	Y	Y	N	Y

Note: (Y=present, N=not detected, N/A=not surveyed)

4.2.2 Larvae and Young-of-Year Searches

Larvae and young-of-year surveys were conducted from mid-June to late August. All 13 wetlands with confirmed observations of larvae and young-of-year also had salamander eggs (Table 2).

4.2.3 Trapping

The RANA pond was established in 1998 (Figure 4, site C25 RANA). Trapping began May 15 and continued through August 11. A total of 203 salamanders were caught in pitfall traps. Average number of salamanders captured per trap night for May, June, July, and August were 0.099, 0.013, 0.284, and 0.222 respectively (Dober 1998; Figure 8). In 1999, trapping ran May 22 through August 21. Salamanders were only caught during the months of May and June because of mid-summer drought; a total of 10 salamanders were caught at the site. Average number of salamanders caught per trap night for May and June were 0.044 and 0.009 respectively (Wilms 1999; Figure 8). Similarly in 2000, trapping was limited to the months of May and June because of low water levels; a total of 6 salamanders were caught at the site. Trapping was from May 9 to 26 and from June 10 to 12. Trapping averages for May and June were 0.016 and 0.006 respectively (Pretzlaw 2000; Figure 8). In 2001, there was drought at the site for the third consecutive year, providing capture values for only May, June, and the first week of July. A total of 34 salamanders were caught at the site. Trapping was from May 6 to 27 and from June 29 to July 4. The trapping averages for May, June, and July were 0.104, 0.031, and 0.015 respectively (Walsh 2001; Figure 8).

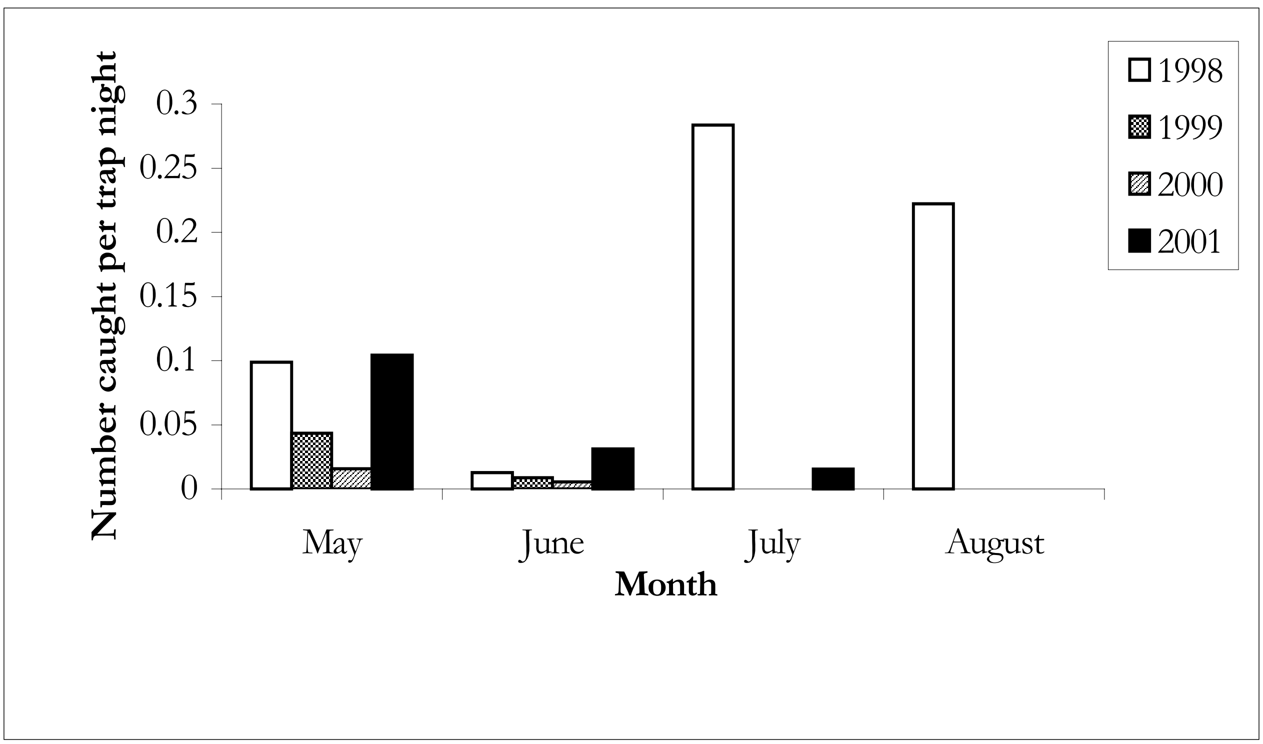

Figure 8. Number of Long-toed Salamanders caught per trap night at the main monitoring pond in Kananaskis Valley , 1998-2001.

4.2.4 Vegetation Inventory

Vegetation surveys were conducted at 11 of the 19 breeding ponds. Adjacent canopy cover varied at each site, and included black and white spruce, pine, and poplar stands. Dominant understory species included moss, grass, sedge, horsetail, willow, herb, bearberry, buffaloberry, prickly rose, and labrador tea.

4.2.5 Conservation and Management Actions

A total of 5110 people have been informed about the monitoring project and important roles that amphibians play in wetland ecosystems (Table 3).

Table 3. Total number of people educated about the monitoring project and amphibian conservation in the Kananaskis area.

Year	**Guided Hike**	**Interpretative Talk**	**Poster Presentations**	**Total**
1998	69	0	300	369
1999	84	0	252	336
2000	23	129	256	408
2001	22	57	4518	4997
			Total	**5110**

4.3 Athabasca Valley

4.3.1 Egg Counts

In 2000, 26 wetlands were surveyed, including 14 confirmed salamander breeding sites (Birn 2000). In 2001, 46 wetlands were surveyed, with 17 confirmed salamander breeding sites (Huynh 2001). There are currently 18 confirmed breeding sites, including three ponds newly discovered in 2001 (Table 4). Names of wetlands and survey results from 2000 to 2001 are provided in Appendix 3.

Table 4. Evidence of long-toed salamander breeding in wetlands in the Athabasca Valley, AB.

	Wetland	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
Year	2000	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N/A	Y	Y	N/A	N/A
	2001	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y

Note: (Y=present, N=not detected, N/A=not surveyed)

4.3.2 Larval and Young-of-Year Searches

In the past two years, larvae and young-of-year were only observed in two of the 18 breeding sites.

4.3.3 Trapping

Trapping was conducted during spring and late summer to catch breeding adults and dispersing young-of-year respectively. In 2000, traps were open from May 21 to June 10 and from August 2 to 24. The average number of salamanders caught per trap night in spring and summer was 0.11 and 0.24, respectively (Birn 2000; Figure 9). In 2001, traps were open from May 4 to June 5 and from August 5 to September 7. The average number of salamanders caught per trap night in spring and summer were 0.19 and 0.12, respectively (Huynh 2001; Figure 9).

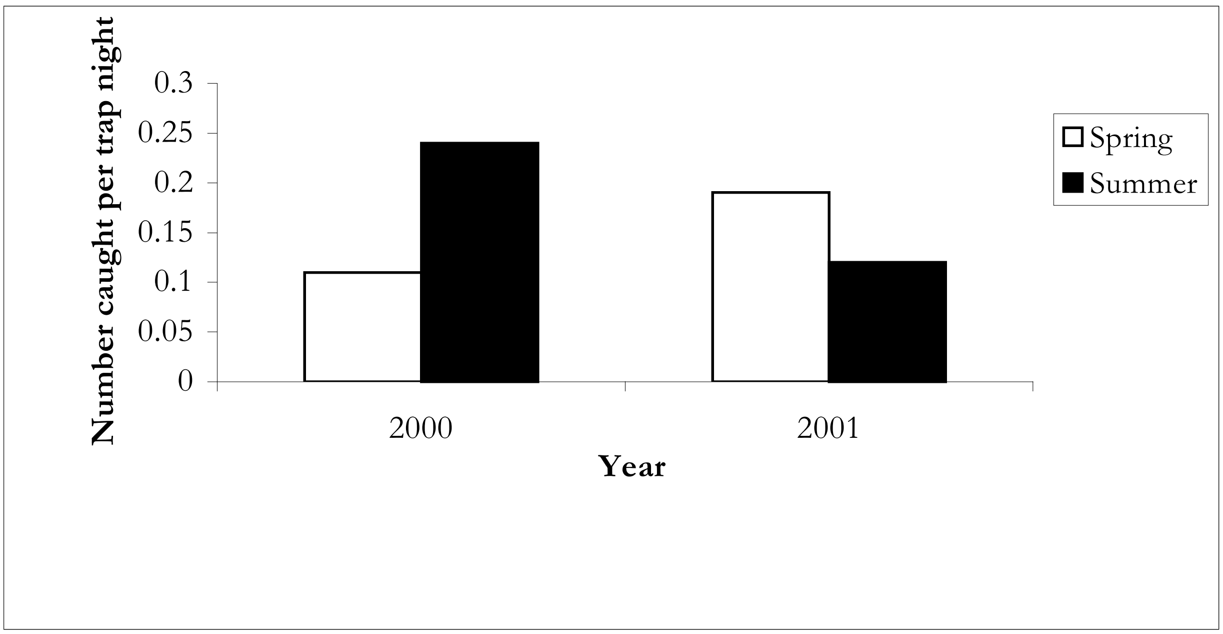

Figure 9. Number of Long-toed Salamanders caught per trap night at the Wellsite Pond in 2000 and 2001 field seasons, Weldwood FMA AB.

4.3.4 Vegetation Inventory

Vegetation inventories were conducted at 14 breeding sites and two non-breeding sites for comparison. Forest cover included poplar, pine, and spruce stands. Dominant understory species varied at each site, and included moss, sedge, grass, buckbean, willows, cow parsnip, bearberry, honeysuckle, herbs, buffaloberry, prickly rose, and Labrador tea.

4.3.5 Conservation and Management Actions

A total of 606 people were informed about the monitoring project and amphibian conservation issues within the last two years (Table 5). In addition, Protective Notations were assigned to long-toed salamander breeding ponds, identifying buffers around ponds.

Table5. Total number of people educated about the monitoring project and amphibian conservation in the Hinton, AB.

		Interpretative Plays	Volunteers	School Talks	Poster Presentations	Total
Year	2000	35	61	17	200	313
	2001	128	16	119	30	293
					Total	**606**

4.4 Peace River

4.4.1 Trapping

In the 2001 pilot season, 15 ponds were surveyed for breeding adults using minnow traps and one pond was surveyed with pitfall traps. Nine wetlands were confirmed to have salamanders present. Traps were operated between May 7 and 30. Fifty-nine salamanders were captured in pitfall traps and 15 were captured in minnow traps. The average number of salamanders caught per trap night was 0.07 (Augustyn 2001). Names of wetlands and survey results from 2001 are provided in Appendix 4.

4.4.2 Water Chemistry and Vegetation Inventory

Water chemistry and vegetation inventories were conducted for all surveyed wetlands. Dissolved oxygen and pH ranges were similar for breeding and non-breeding ponds. Shoreline slopes for both breeding and non-breeding sites ranged from flat (5^0) to steep (85^0). Adjacent forest cover for the breeding ponds consisted predominantly of aspen stands. Willow and grass were the dominant understory species.

4.4.3 Conservation and Management Actions

Five hundred people were informed about amphibians, including 106 children through school talks and 394 people through local community events such as Environment Week, Father's Day, and Canada Day. There was also considerable communication with landowners to explain the importance of wetland habitat for salamanders and other wildlife.

4.5 Crowsnest, Castle and Oldman

4.5.1 Egg, Larvae, and Young-of-year Searches

Sixty nine ponds were surveyed, including 24 from the 1995 survey and 45 new ponds. Of the 24 original ponds, only nine contained long-toed salamanders. Seventeen of the new ponds contained long-toed salamanders. Presence was established by egg, larvae and young-of-year observations (see Paton 2002).

5.0 DISCUSSION

5.1 Site-specific Comparisons

The following is a brief discussion of data highlights from each breeding area. Due to variation in timing and methods used, statistical analyses are not possible and only general trends are discussed. It should also be noted that in the absence of marking, population estimates are not possible.

5.1.1 Waterton Lakes National Park

Presence/not detected data were mainly based on larvae and young-of-year surveys; eggs were likely missed due to timing of surveys. The increase in number of breeding ponds is likely due to the increase in number of ponds surveyed. Some breeding sites did not have salamanders present every year. The 1999 field season was exceptional for long-toed salamander counts; most ponds had high numbers of larvae and young-of-year. In addition, ponds that lacked evidence of breeding in previous years were found to have salamanders breeding in that year. The reason for this is unknown, but the influence of heavy precipitation was suggested (C. Smith, pers. comm.).

5.1.2 Kananaskis Valley and Area

The number of breeding ponds has increased over the last four years, and is likely due to the increase in number of ponds surveyed. Most egg surveys were conducted in late May, likely missing most of the egg-laying period. As a result, presence/not detected data were gained primarily from larvae and young-of-year surveys. Most ponds in this area are clear and vegetation free, lending themselves well to larvae searches.

Relatively high larvae abundance at two ponds was possibly a function of pond characteristics that made salamanders highly visible. Both sites were comparatively small and shallow, centralizing eggs and larvae. Suitable pond and environmental characteristics could have also contributed to high abundance, supporting historically large populations in a relatively undisturbed environment where other suitable ponds were limited. There has been one notable salamander population decrease in the Lafarge borrow pit. Activity in the borrow pit has led to almost complete drainage of the pond which has historically supported a large breeding population. This has caused a considerable decrease in number of salamander larvae and young-of-year in the past two seasons.

Active management of the Lafarge borrow pit is needed to prevent further draining of the wetland and to initiate habitat enhancement for salamanders.

The number of salamanders captured at the main study pond has declined in the last four years. This trend is as a result of the pond drying up by mid-summer in the last three years. The site receives very little precipitation because it is in the rainshadow of Mount Allen (Pretzlaw 2000; Walsh 2001).

No species-habitat relationships were apparent from vegetation inventories conducted at selected wetlands. Wetlands were man-made or natural, and varied in canopy and understory cover. There were however, general similarities of breeding sites in that all ponds lacked fish and all but two of the ponds were permanent.

5.1.3 Athabasca Valley

An increase in the number of breeding ponds is likely a consequence of increased numbers of wetlands surveyed. At breeding sites, the presence of larvae and young-of-year was difficult to confirm, so surveys relied mainly on presence of salamander eggs. Egg surveys were the most effective way to gather distribution data in this region for two main reasons. First, the abundance of aquatic vegetation in summer limited visibility of larvae and young-of-years. Second, most wetlands had floating edges and marsh areas, which caused disturbances to the water and alarmed larvae or young-of-year nearby, causing them to move away before being observed.

Relative egg abundance of each pond cannot be quantitatively compared between years since permanent transects were randomly chosen and did not consider habitat heterogeneity. As a result, egg counts may have been under or overestimated. For example, at one pond in 2001, the within transect egg count was zero, but eggs (n=554) were discovered outside of transects (Hunyh 2001). Because it is unknown whether salamanders oviposit within the same location of the pond every year, entire pond surveys are recommended for egg searches. If transects are necessary due to the size of the pond, habitat heterogeneity should be considered when delineating transects (refer to Pretzlaw *et al*. 2002).

All breeding sites were permanent and fishless wetlands with adjacent forest cover. Breeding sites were man-made or natural and varied in canopy and understory cover. Differences in vegetation between breeding sites and non-breeding sites were not apparent from vegetation surveys. Specific microclimate analyses, such as soil moisture, are recommended.

5.1.4 Peace River

Because 2001 was the pilot year for monitoring salamanders, no comparisons or inferences can be made about population trends or changes in distribution for the region. This breeding population was first documented by Walsh (1998), but survey methods are not comparable. Minnow trapping proved to be a successful method in gathering distribution data (Walsh 1998; Augustyn 2001). Minnow trapping for breeding adults in spring and larvae and young-of-year in summer are recommended for future monitoring years.

Presence of cattle may negatively influence breeding habitat because more salamanders were found in wetlands with high aquatic vegetation (i.e. undisturbed) than in wetlands without vegetation. Five of the nine breeding sites were in ponds used for domestic water supply, whereas six of the nine non-breeding ponds were used for cattle water (Augustyn 2001). Habitat disturbances from cattle include trampling and consumption of herbaceous vegetation. They can also have a direct impact on salamander populations by trampling eggs.

Cover type may also have an effect on the selection of breeding habitat, with salamanders favouring ponds with increased canopy cover. Eight of the nine breeding wetlands had a poplar/willow buffer, whereas five of the nine non-breeding wetlands had a grass buffer (Augustyn 2001). Differences between water chemistry and shoreline slope were not apparent between breeding and non-breeding wetlands.

Landowner cooperation is an essential component to management of these breeding sites. Further work is needed to educate landowners and surrounding communities on the value of breeding wetlands.

5.1.5 Oldman River Basin

The survey in the Oldman River basin revealed a reduction in the number of ponds containing salamanders from 1995, only nine ponds contained salamanders in 2001, whereas 18 ponds contained salamanders in 1995 (Nelson *et al*. 1995, Paton 2002). Possible reasons for this reduction include changing environmental conditions and, habitat destruction and alteration (Paton 2002). Unlike many of the other breeding areas, ponds in this area were often ephemeral. Ephemeral ponds can be very productive breeding sites for amphibians, provided they do not dry up too early in the season.

5.2 Between Site Comparisons

It is difficult to make comparisons between sites due to variations in sampling effort, timing and methods, and in some cases, study objectives. Kananaskis and Athabasca have been subject to relatively extensive salamander surveys, and most breeding ponds in the vicinity have likely been discovered. Consistent, long-term sampling effort has been highest in Kananaskis. The Oldman River basin has good historic data and covers a large geographic area. Ideally, a RANA pond should be set up for long-term monitoring and a selection of ponds in the area should be surveyed annually, revisiting all known ponds every five years. Surveys conducted in Waterton were volunteer-based and consequently less intensive, so more regulated monitoring is recommended. In the Peace River area, 2001 was the pilot year and consequently the number of surveyed wetlands was relatively low because additional wetlands have yet to be identified.

High number of breeding ponds, as in Kananaskis, Oldman and Athabasca could be a function of higher survey effort and easy human access to wetlands. In addition, these areas could have more and/or easy access to corridors for salamander colonization and more suitable wetlands per area. Other factors influencing salamander colonization include differences in predator and/or food abundance, presence of fish, differences in environmental conditions, and type and magnitude of disturbances in the area, both natural and anthroprogenic. Finally, breeding population size may also be a reflection of historic migrations, such that salamanders at their northern limit (*i.e.* Peace River) likely represent smaller populations.

In addition to differences in sampling effort, survey methods varied between breeding areas, particularly the number and timing of visits. In some case, different survey and monitoring methods were required due to pond characteristics, such as high water turbidity in Peace River ponds preventing shoreline searches. Eggs could be missed if surveyed too late in the season, and mobility of larvae and young-of-year can also make detection difficult. In clear, relatively vegetation free ponds, larvae are more likely to be visible. Pond characteristics, as well as ambient conditions (*i.e.* wind, light levels) affect visibility and observer error. All of these factors are important considerations when planning the timing and number of survey visits, as well as interpreting data. Greater emphasis should be place on collecting environmental data to help understand changes in population trends.

General similarities between sites include an affinity for permanent, fishless ponds. A number of productive ponds in the Oldman were ephemeral, but clearly ponds must retain water for a minimal length of time to ensure egg development and larvae metamorphosis. As exemplified at the Kananaskis RANA pond, breeding effort is reduced when ponds consistently dry up before larvae can develop. Although long-toed salamanders coexist with game fish in some instances, stocking with game fish is generally a negative impact because fish are both competitors and predators of larvae (Tyler et al. 1998, Funk and Dunlap 2000). Despite considerable habitat variation between ponds and breeding areas, there is a general trend towards well developed and varied adjacent forest cover and understory plant communities. Ponds in the Peace River area were surrounded by aspen and grassland habitat within an agricultural landbase.

Absence of eggs or larvae could be due to observer bias, but research suggests that salamanders may not breed every year (Heyer 1976), or that salamanders used another pond in close proximity. Poor environmental conditions could have prevented or destroyed breeding effort (*i.e.* pond freezing after eggs have been laid). In the absence of marked cohorts, it is impossible to determine whether salamanders return to the same ponds to breed, but pond fidelity is suspected due to the relatively consistent use of the same ponds.

It is difficult to draw conclusions about amphibian populations based on relatively short term data given that they naturally undergo population fluctuations. However, long-toed salamanders show sensitivity to a variety of habitat changes, both natural and anthroprogenic. The primary natural change is drought; two of the initial ponds surveyed in 1995 in the Oldman River basin have dried up due to continued drought in the region. Loss of wetlands through draining is a comparable, direct anthroprogenic impact. Habitat alterations, which may reduce or destroy pond suitability for amphibian breeding include use of wetland areas for cattle watering and grazing, and contamination through herbicides and pesticides (Graham and Powell 1999). Recreational activities, particularly ATV use, was noted to impact both terrestrial and wetland long-toed salamander habitat in the Oldman River basin survey (Paton 2002).

Destruction and disturbance to wetlands is probably the greatest threat to the persistence of long-toed salamander populations. Gibbs (2000) observed that wetland mosaics were reduced in number and became more isolated in relation to increased human settlement. Long-toed salamander

populations in Alberta, at a provincial scale, exist in isolated populations; this vulnerability will be compounded by increased isolation at a local scale.
It is also important to consider the quality of terrestrial habitat surrounding breeding ponds. Most amphibians live in multiple habitats of close proximity, with periodic migrations typically associated with the breeding cycle. Average dispersal distance for most amphibians is less than 300m (Gibbs 2000). There is evidence that forest harvest around breeding ponds may reduce long-toed salamander populations (Naughton *et al*. 2000). Based on general habitat inventory data collected at breeding sites in Alberta, adjacent forest cover is important. Maintaining buffers around breeding ponds is critical.

5.3 Inventory and Monitoring Recommendations

In order to facilitate comparisons between years and study areas, it is important for all monitoring sites to follow the same protocol. The recently developed provincial protocol (Pretzlaw *et al*. 2002) should be followed. More consideration should be given to monitoring environmental conditions, which can affect salamander reproductive behaviour. The overall recommendation for provincial monitoring is to continue annual monitoring at Kananaskis and Athabasca for a minimum of five years. In other breeding areas, and after five years of data collection at the long-term study areas, the recommendation is to monitor a subsample of breeding ponds each year, and survey all ponds every five years. Where possible, new ponds should be surveyed, particularly in the Peace River area. Further research is recommended, including initiating mark-recapture at one breeding area to improve the understanding of population size and dynamics. There is also need to assess the influence of fish on salamander breeding (Paton 2002). Finally, education should continue to be an integral component of long-toed salamander and other amphibian monitoring programs.

6.0 MANAGEMENT RECOMMENDATIONS

Continued monitoring to acquire long term data is necessary to provide accurate information for management and conservation. In the interim, management actions should be initiated to protect all known breeding ponds. Protective notations should be assigned to all breeding sites located on Crown Land. Two hundred meter buffers from the high water level mark of all breeding sites is recommended. For breeding sites that fall on private land, landowner involvement and agreements are necessary to ensure the maintenance of breeding sites.

7.0 REFERENCES

Alberta Endangered Species Conservation Committee. 2000. First report of the Alberta Endangered Species Conservation Committee. Alberta Environment, Fisheries and Wildlife Management Division, Edmonton, AB. 24pp.

Augustyn, T. 2001. Long-toed salamander (*Ambystoma macrodactylum*) in the Peace Region in Alberta. Unpublished Report. Submitted to the Alberta Conservation Association and Alberta Sustainable Resource Development, Fish and Wildlife Division, Edmonton, AB.

Birn, D. 2000. *In*: L. Takats (ed.), RANA Researching Amphibian Numbers in Alberta 2000-2001 Final Report. Alberta Conservation Association, Edmonton, AB.

Dober, J. 1998. *In*: L. Takats (ed.), RANA Researching Amphibian Numbers in Alberta 1998-1999 Final Report. Alberta Conservation Association, Edmonton, AB.

Fukumoto, J. and S. Herrero. 1998. Observations of the Long-toed salamander, *Ambystoma macrodactylum*, in Waterton National Park, Alberta. The Canadian Field-Naturalist 112(4):579-585.

Fukumoto, J. 1995. Long-toed salamander (*Abystoma macrodactylum*) ecology and management in the Waterton Lakes National Park. M.E.D. thesis, University of Clagary, Calgary, AB. 108pp.

Funk, W.C. and W.W. Dunlap. 1999. Colonization of high-elevation lakes by long-toed salamanders (*Ambystoma Macrodactylum*) after the extinction of introduced trout populations. Canadian Journal of Zoology 7:1759-1767.

Gibbs, J.P. 2000. Wetland loss and biodiversity conservation. Conservation Biology 14:314-317.

Graham, K. and L. Powell. 1999. Status of the Long-toed salamander (*Abystoma macrodactylum*) in Alberta. Alberta Environmental Protection, Fisheries and Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 22, Edmonton, AB. 19pp.

Graham, K.G. 1997. Habitat use of Long-toed salamanders (*Abystoma macrodactylum)* at three different scales. M.Sc. thesis, University of Guelph, ON. 71pp.

Heyer, W.R. 1976. Studies in larvae amphibian habitat partitioning. Smithsonian Contrib. Zool. 242:1-27.

Huynh, M.L. 2001. *In* L. Takats (ed.): Researching Amphibian Numbers in Alberta, Final Report 2001. Alberta Conservation Association, Edmonton, AB.

Naughton, G.P., C.V. Henderson, K.R. Foresman, and R.L. McGraw II. 2000. Long-toed salamanders in harvested and intact Douglas-fir forests of western Montana. Ecological Applications 10: 1681-1689.

Nelson, S.J., G.L. Powell and A.P. Russell. 1995. Population survey of the Long-toed salamander (*Abystoma macrodactylum)* in southwestern Alberta. Alberta Environmental Protection , Fish and Wildlife Service, Edmonton, AB. 161pp.

Paton, D. 2002. Columbian mountain amphibian surveys, 2001. Alberta Sustainable Resource Development, Fish and Wildlife Division, Species at Risk Report No.39. Edmonton, AB.

Powell, G.L. and A.P. Russell. 1996. The Long-toed salamander in the Bow Corridor: a preliminary report. Alberta Environmental Protection, Fish and Wildlife Division, Edmonton, AB. 37pp.

Powell, G.L., S.J. Nelson, and A.P. Russell. 1993. The Bow Valley Long-toed salamander population study: a preliminary report on the 1992 field season. Alberta Environmental Protection, Fish and Wildlife Service, Edmonton, AB. 124pp.

Pretzlaw, T. 2000. *In*: L. Takats (ed.), RANA Researching Amphibian Numbers in Alberta 2000-2001 Final Report. Alberta Conservation Association, Edmonton, AB.

Pretzlaw, T., M.Huynh, L.Takats, and L.Wilkinson. 2002. Protocol for monitoring long-toed salamander (*Ambystoma macrodactylum*) populations in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, Species at Risk Report No.35. Edmonton, AB.

Russell, A.P. and A.M. Bauer. 2000. The amphibians and reptiles of Alberta. University of Calgary Press, Calgary, AB.

Tyler, T.J., W.J. Liss, R.L. Hoffman, and L.M. Ganio. 1998. Experimental analysis of trout effects on survival, growth, and habitat use of two species of Ambystomatid salamanders. J. of Herp. 32(3): 345-349.

Walsh, R. 2001. *In* L. Takats (ed.): Researching Amphibian Numbers in Alberta, Final Report 2001. Alberta Conservation Association, Edmonton, AB.

Walsh, R. 1998. An extension of the known range of the Long-toed salamander *Ambystoma macrodactylum* in Alberta. Can. Field-Nat. 112:331-333.

Wilms, C. 1999. *In*: L. Takats (ed.), RANA Researching Amphibian Numbers in Alberta 1999-2000 Final Report. Alberta Conservation Association, Edmonton, AB.

8.0 APPENDICES

APPENDIX 1 Wetlands surveyed for long-toed salamander presence in Waterton Lakes National Park, Alberta.

Wetland	1997			1998			1999			2000			2001		
	Adult	Larvae	Eggs	Adult	Larvae	Eggs	Adult	Larvae	Eggs	Adult	Larvae	Eggs	Adult	Larvae	Eggs
A1 Linnet Lake	0	0	0	0	0	0	7	0	0	2	0	40	4	0	2
A2 Lonesome Lake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A3 Maskinonge Picnic Area	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0
A4 Junction Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A5a Waterton River Pond A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A5b Waterton River Pond B	N/A	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0
A6 Indian Springs Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A7 Buffalo Springs Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A8 Blakiston Beaverponds A	0	0	0	0	0	0	0	20	0	0	0	20*	0	0	3
A9 Blakiston Beaverponds B	0	3	0	0	15	0	0	0	18	0	4	0	0	1	0
A10 Blakiston Roadside Pond	0	9	0	0	84	0	0	100	0	0	10	0	0	12	0
A11 Akamina Pools	4	8	0	0	8	0	0	2500	0	0	4	0	0	12	0
A12 Summit Lake	2	0	0	0	0	0	0	0	15	0	1	0	0	0	1
A13 Stable Pond	N/A	N/A	N/A	0	0	0	0	100	0	0	30	0	0	15	0
A14a Sofa Wetland A	N/A	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0
A14b Sofa Wetland B	N/A	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0
A15 Sofa Mountain Ponds	N/A	N/A	N/A	0	0	0	0	0	1	0	0	0	0	0	0
A16 Giant's Mirror	N/A	N/A	N/A	0	50	0	0	0	24	0	0	95	0	0	0
A17 Cameron Ponds	N/A	N/A	N/A	N/A	N/A	N/A	0	0	2	0	0	0	0	0	0
A18 Lost Lake	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	1	0	0	1
Total # of ponds with long-toed salamanders			4			4			10			10			8
Total # of ponds surveyed			12			17			18			20			20

APPENDIX 2 Wetlands surveyed for long-toed salamanders in the Kananaskis Valley and area, Alberta.

Wetland	1998		1999		2000		2001	
	E*	L/J/A**	E*	L/J/A**	E*	L/J/A**	E*	L/J/A**
C1 Baldy Pass Trail	0	0	0	0	0	0	0	0
C2 Barrier Dam	?	6L	0	0	N/A	N/A	?	18L
C3 Barrier Sewage Lagoon	0	0	0	0	N/A	N/A	N/A	N/A
C4 Sundance Beaver	0	0	0	0	0	0	0	0
C5 Chilver Lake	N/A	N/A	0	0	0	0	0	0
C6 Dew Drop	N/A	N/A	0	0	0	0	0	0
C7 Elcopa Viewpoint	N/A	N/A	?	29L	?	200L	?	5L
C8 Exshaw	N/A	N/A	75	?	N/A	N/A	N/A	N/A
C9 Flat	N/A	N/A	0	0	0	0	N/A	N/A
C10 Hay Meadows	N/A	N/A	0	0	0	0	?	2L
C11 Highway 40 Typha	0	0	0	0	N/A	N/A	0	0
C12 JameR	N/A	N/A	5	40L	146	?	0	0
C13 Kananaskis Field Station Water Supply	0	1A?	0	0	0	0	0	0
C14 Kuhn	0	>200L	?	140L	2205	1000L	771	?
C15 Lafarge Borrow Pit	0	5L	2000	50L	2400	2100L	6000	1009L
C16 Lusk Creek	0	0	0	0	0	0	Present	Present
C17 Marl Lake	N/A	N/A	0	0	N/A	N/A	0	0
C18 Middle Lake	0	0	0	0	0	0	0	0
C19 Mount Allen Overlook	N/A	N/A	0	0	N/A	N/A	0	0
C20 Mount Lorette	0	2L	0	0	0	0	0	0
C21 Pocaterra Fen	0	2L	0	0	0	0	0	0
C22 Pocaterra Trail	N/A	N/A	?	12L	N/A	N/A	N/A	N/A
C23 Powerline	N/A	N/A	0	0	N/A	N/A	0	0
C24 Quarry (Upper and Lower)	N/A	N/A	?	1L	0	0	1581	21L
C25 RANA site	12	203 A	100	10A	?	6A	139	37 A/2 L
C26 Sheppard	N/A	N/A	?	45L	75	6L	?	18L
C27 Sibbald Flat	N/A	N/A	0	0	N/A	N/A	N/A	N/A
C28 Smith Dorrien Beaver	N/A	N/A	0	0	0	0	N/A	N/A
C29 Smith-Dorrien Bend	N/A	N/A	?	19L	?	30L		10L

* Highest number of eggs counted
** Highest number of larvae (L), juveniles (J), or adults (A) counted

APPENDIX 2 (cont.) Wetlands surveyed for long-toed salamanders in the Kananaskis Valley and area, Alberta.

Wetland	1998		1999		2000		2001	
	E*	L/J/A**	E*	L/J/A**	E*	L/J/A**	E*	L/J/A**
C30 Another Roadside Attraction	N/A	N/A	0	0	0	0	0	0
C31 Stoney Trail	N/A	N/A	0	0	0	0	0	0
C32 Winter Gate I	N/A	N/A	0	0	0	0	14	?
C33 Winter Gate II	N/A	N/A	?	5L	0	0	?	1L
C34 Winter Gate III	N/A	N/A	0	0	0	0	0	0
C35 YMCA Road Pond	N/A	N/A	0	0	N/A	N/A	0	0
C36 Canmore Creek	N/A	N/A	N/A	N/A	0	0	N/A	N/A
C37 Buller	N/A	N/A	N/A	N/A	?	1L	?	1L
C38 Loon Lake	N/A	N/A	N/A	N/A	0	0	0	0
C39 Canyon Campground Fen	N/A	N/A	N/A	N/A	0	0	0	0
C40 Greg's Fen	N/A	N/A	N/A	N/A	?	6L	?	100L
C41 Boulton Campground	N/A	N/A	N/A	N/A	184	100L	0	0
C42 East Lower Kananaskis Lakes	N/A	N/A	N/A	N/A	110	?	563	3L
C43 William Watson Lodge	N/A	N/A	N/A	N/A	0	0	0	0
C44 Falling Rocks	N/A	N/A	N/A	N/A	0	0	0	0
C45 Highwood Pass	N/A	N/A	N/A	N/A	0	0	0	0
C46 Eau Claire Beaver	N/A	N/A	N/A	N/A	0	0	0	0
C47 Kananaskis Forestry Road	N/A	N/A	N/A	N/A	0	0	0	0
C48 Galatea Trail	N/A	N/A	N/A	N/A	0	0	0	0
C49 Wedge	N/A	N/A	N/A	N/A	0	0	0	0
C50 Wasootch Creek	N/A	N/A	N/A	N/A	0	0	N/A	N/A
C51 Mt.Allen	N/A	N/A	N/A	N/A	0	0	N/A	N/A
C52 Barrier Lake	N/A	N/A	N/A	N/A	0	0	N/A	N/A
C53 Willow Rock Beaver	N/A	N/A	N/A	N/A	0	0	0	0
C54 Sibblad Meadows	N/A	N/A	N/A	N/A	0	0	N/A	N/A
C55 Vermillion Lakes	N/A	N/A	N/A	N/A	0	0	N/A	N/A
C56 Boundary Ranch	0	0	0	0	0	0	N/A	N/A
Total Number of Confirmed Wetlands with Breeding Populations	6		10		11		14	
Total Number of Wetlands Surveyed	13		38		46		42	

* Highest number of eggs counted

** Highest number of larvae (L), juveniles (J), or adults (A) counted

APPENDIX 3 Number of eggs present and habitat type for wetlands used by long-toed salamander in Athabasca Valley, Alberta.

Wetland Habitat Type(s)	Year 2000*	2001*	Wetland Habitat Type(s)	Year 2000*	2001*	Wetland Habitat Type(s)	Year 2000*	2001*
D1 Wellsite Monitoring Pond LF-i1.1/SWm	1200	1400	D7 Robb UF-i1.1/SM4 UF-l2.1/SR	7 (transect)	0 (transect) 554 (outside) 0.77 eggs/m	D13 Dog Bath UF-j1.1SW3 UF-i1.1/SR No Transects	Not surveyed	610
D2 Weigh Station UF-b1.2/SV4 UF-i1.1/SR	156 (transect)	10 (transect) 0 (outside)	D8 Dans UF-f3.1/SM4 UF-j1.1/SWm	395 (transect)	150 (transect) 670 (outside) 1.47 eggs/m	D15 Airport UF-l2.1/SR	4 (transect)	40 (transect) 0.09eggs/m
D3 Raven UF-m2.1/SWm	136 (transect)	300 (transect) 200 (outside) 1.52 eggs/m	D9 Marsh Creek UF-m1.1/SWm UF-f3.1/SV4	215 (transect)	20 (transect) 0.026 eggs/m	D16 Bent-Kinky Lake UF-m3.1/SR UF-c1.1/SV4	30 (transect)	17 (transect) 0.04eggs/m
D4 M17 UF-f4.2/SM3	111 (transect)	125 (transect) 0 (outside)	D10 Obed UF-m1.1/SR	300 (transect)	45 (transect) 140 (outside) 0.316 eggs/m	D17 Dog Bath (#2)	Not surveyed	Present
D5 Calypso UF-m1.1/SWm	871 (transect)	491 (transect) 495 (outside) 1.08 eggs/m	D11 Sally LF-j1.1/SR no transects	70	1568 3.32 eggs/m	D18 Quad	Not surveyed	Present
D6 Tamarack	20 (transect)	25 (transect) 0.08 eggs/m	D12 Lisa no transects	Hatched eggs	0			

*Indicates maximum number of eggs observed

APPENDIX 4 Wetlands surveyed for long-toed salamander presence in the Peace River area, Alberta.

Wetland	2001*
E1 Kronast	40
E2 Walter Doll	4
E3 Walter Doll	0
E4 Kerschbaumer	0
E5 Weiben (A)	0
E6 Weiben (B)	4
E7 Weiben (C)	0
E8 Weiben (D)	0
E9 Mclaren (A)	0
E10 Mclaren (B)	49
E11 Hale	25
E12 Dacyk (A)	4
E13 Dacyk (B)	0
E14 Dacyk (C)	0
E15 Dacyk (D)	0
E16 Mckeachnie	0
E17 Walsh	3
E18 Pitfall Site	74

*Total # of adults caught in minnow traps

List of Titles in This Series
(as of February 2002)

No. 1 Alberta species at risk program and projects 2000-2001, by Alberta Sustainable Resource Development, Fish and Wildlife Division. (2001)

No. 2 Survey of the peregrine falcon (*Falco peregrinus anatum*) in Alberta, by R. Corrigan. (2001)

No. 3 Distribution and relative abundance of the shortjaw cisco (*Coregonus zenithicus*) in Alberta, by M. Steinhilber and L. Rhude. (2001)

No. 4 Survey of the bats of central and northwestern Alberta, by M.J. Vonhof and D. Hobson. (2001)

No. 5 2000 survey of the Trumpeter Swan (*Cygnus buccinator*) in Alberta, by M.L. James and A. James. (2001)

No. 6 2000/2001 Brassy Minnow inventory at Musreau Lake and outlet, by T. Ripley. (2001)

No. 7 Colonial nesting waterbird survey in the Northwest Boreal Region – 2000, by M. Hanneman and M. Heckbert. (2001)

No. 8 Burrowing owl trend block survey and monitoring - Brooks and Hanna areas, by D. Scobie and R. Russell. (2000)

No. 9 Survey of the Lake Sturgeon (*Acipenser fulvescens*) fishery on the South Saskatchewan River, Alberta (June-September, 2000), by L.A. Winkel. (2000)

No. 10 An evaluation of grizzly bear-human conflict in the Northwest Boreal Region of Alberta (1991-2000) and potential mitigation, by T. Augustyn. (2001)

No. 11 Harlequin duck monitoring in the Northern East Slopes of Alberta: 1998-2000 preliminary results, by J. Kneteman and A. Hubbs. (2000)

No. 12 Distribution of selected small mammals in Alberta, by L. Engley and M. Norton. (2001)

No. 13 Northern leopard frog reintroduction. Raven River - Year 2 (2000), by K. Kendell. (2001)

No. 14 Cumulative effects of watershed disturbances on fish communities in the Kakwa and Simonette watersheds. The Northern Watershed Project. Study 3 Progress report, by T. Thera and A. Wildeman. (2001)

No. 15 Harlequin duck research in Kananaskis Country in 2000, by C.M. Smith. (2001)

No. 16 Proposed monitoring plan for harlequin ducks in the Bow Region of Alberta, by C.M. Smith. (2001)

No. 17 Distribution and relative abundance of small mammals of the western plains of Alberta as determined from great horned owl pellets, by D. Schowalter. (2001)

No. 18 Western blue flag (*Iris missouriensis*) in Alberta: a census of naturally occurring populations for 2000, by R. Ernst. (2000)

No. 19 Assessing chick survival of sage grouse in Canada, by C.L. Aldridge. (2000)

No. 20 Harlequin duck surveys of the Oldman River Basin in 2000, by D. Paton. (2000)

No. 21 Proposed protocols for inventories of rare plants of the Grassland Natural Region, by C. Wallis. (2001)

No. 22 Utilization of airphoto interpretation to locate prairie rattlesnake (*Crotalus viridis viridis*) hibernacula in the South Saskatchewan River valley, by J. Nicholson and S. Rose. (2001)

No. 23 2000/2001 Progress report on caribou research in west central Alberta, by T. Szkorupa. (2001)

No. 24 Census of swift fox (*Vulpes velox*) in Canada and Northern Montana: 2000-2001, by A. Moehrenschlager and C. Moehrenschlager. (2001)

No. 25 Population estimate and habitat associations of the long-billed curlew in Alberta, by E.J. Saunders. (2001)

No. 26 Aerial reconnaissance for piping plover habitat in east-central Alberta, May 2001, by D.R.C. Prescott. (2001)

No. 27 The 2001 international piping plover census in Alberta, by D.R.C. Prescott. (2001)

No. 28 Prairie rattlesnake (*Crotalus viridis viridis*) monitoring in Alberta – preliminary investigations (2000), by S.L. Rose (2001)

No. 29 A survey of short-horned lizard (*Phrynosoma hernandesi hernandesi*) populations in Alberta, by J. James (2001)

No. 30 Red-sided garter snake (*Thamnophis sirtalis parietalis*) education and relocation project – final report, by L. Takats (2002)

No. 31 Alberta furbearer harvest data analysis, by K.G. Poole and G. Mowat (2001)

No. 32 Measuring wolverine distribution and abundance in Alberta, by G. Mowat (2001)

No. 33 Woodland caribou (*Rangifer tarandus caribou*) habitat classification in northeastern Alberta using remote sensing, by G.A. Sanchez-Azofeifa and R. Bechtel (2001)

No. 34 Peregrine falcon surveys and monitoring in the Parkland Region of Alberta, 2001, by R. Corrigan (2002)

No. 35 Protocol for monitoring long-toed salamander (*Ambystoma macrodactylum*) populations in Alberta, by T. Pretzlaw, M. Huynh, L. Takats and L. Wilkinson (2002)

No. 36 Long-toed salamander (*Ambystoma macrodactylum*) monitoring study in Alberta: summary report 1998-2001, by M. Huynh, L. Takats and L. Wilkinson (2002)

No. 37 Mountain plover habitat and population surveys in Alberta, 2001, by C. Werschler and C. Wallis (2002)

No. 38 A census and recommendations for management for western blue flag (*Iris missouriensis*) in Alberta, by R. Ernst (2002)

No. 39 Columbian mountain amphibian surveys, 2001, by D. Paton (2002)

No. 40 Management and recovery strategies for the Lethbridge population of the prairie rattlesnake, by R. Ernst (2002)

No. 41 Western (*Aechmophorus occidentalis*) and eared (*Podiceps nigricollis*) grebes of central Alberta: inventory, survey techniques and management concerns, by S. Hanus, H. Wollis and L. Wilkinson (2002)

No. 42 Northern leopard frog reintroduction – year 3 (2001), by K. Kendell (2002)

No. 43 Survey protocol for the northern leopard frog, by K. Kendell (2002)

No. 44 Alberta inventory for the northern leopard frog (2000-2001), by K. Kendell (2002)

No. 45 Fish species at risk in the Milk and St. Mary drainages, by RL&L Environmental Services Ltd. (2002)