Fish & Wildlife Division

RESOURCE DATA AND SPECIES AT RISK SECTION

Status of the Stonecat (*Noturus flavus*) in Alberta

Alberta Wildlife Status Report No. 52

Alberta Conservation Association

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

Status of the Stonecat (*Noturus flavus*) in Alberta

Prepared for:
Alberta Sustainable Resource Development (SRD)
Alberta Conservation Association (ACA)

Prepared by:
Susan M. Pollard

This report has been reviewed, revised, and edited prior to publication.
It is an SRD/ACA working document that will be revised and updated periodically.

Alberta Wildlife Status Report No. 52

March 2004

Published By:

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT
Fish & Wildlife

Alberta Conservation Association

Publication No. T/052
ISBN: 0-7785-2950-9 (Printed Edition)
ISBN: 0-7785-2951-7 (On-line Edition)
ISSN: 1206-4912 (Printed Edition)
ISSN: 1499-4682 (On-line Edition)

Series Editors: Sue Peters, Nyree Sharp and Robin Gutsell
Illustrations: Brian Huffman
Maps: Jane Bailey

For copies of this report,visit our web site at :
http://www3.gov.ab.ca/srd/fw/riskspecies/
and click on "Detailed Status"

OR

Contact:
Information Centre - Publications
Alberta Environment/Alberta Sustainable Resource Development
Fish and Wildlife Division
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) 297-6424

This publication may be cited as:

Alberta Sustainable Resource Development. 2004. Status of the stonecat (*Noturus flavus*) in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, and Alberta Conservation Association, Wildlife Status Report No. 52, Edmonton, AB. 22 pp.

PREFACE

Every five years, the Fish and Wildlife Division of Alberta Sustainable Resource Development reviews the general status of wildlife species in Alberta. These overviews, which have been conducted in 1991 (*The Status of Alberta Wildlife*), 1996 (*The Status of Alberta Wildlife*) and 2000 (*The General Status of Alberta Wild Species 2000*), assign individual species "ranks" that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A key objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general status exercise, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are *At Risk* or *May Be At Risk* in the province, that are of uncertain status (*Undetermined*), or that are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fish and Wildlife Division of Alberta Sustainable Resource Development. They are intended to provide detailed and up-to-date information that will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information that will assist Alberta's Endangered Species Conservation Committee in identifying species that may be formally designated as *Endangered* or *Threatened* under Alberta's *Wildlife Act*. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

The stonecat (*Noturus flavus*) is the only member of the catfish family native to Alberta. This bottom-dwelling species inhabits a wide range of riverine habitats including large rivers and smaller streams from the St. Lawrence/Great Lakes system, throughout the Mississippi drainage to the upper Missouri system. Although this species is fairly common in many areas south and east of Alberta, it is extremely rare within the province, with a known distribution limited to the lower and midsections of the Milk River mainstem and the lower North Milk River. Very little is known about the biology or habitat requirements of the stonecat. It appears to have a preference for riffles in boulder pools or rocky-bottomed sections of rivers, but is also found in some large lakes. The stonecat tolerates a wide range of turbidity levels, but is limited to warmer waters.

The stonecat is currently ranked *Undetermined*, according to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001). It is very difficult to determine whether any changes in stonecat distribution or abundance have occurred over time, because both attributes have likely been underestimated as a result of past sampling strategies. The species' present status in the Milk River is unclear because the combination of severe drought conditions, the operation of the St. Mary Canal and the removal of water for irrigation have left the lower Milk River (above and below the international border) almost completely dry, with the exception of a series of isolated pools during the fall and winter of 2001-2002. At least some portion of the population was maintained upstream of this area. Surveys conducted in October 2002 captured a single stonecat in the lower portion of the North Milk River, thus extending the known range in the Milk River system. Regardless, the stonecat's consistently low abundance and limited distribution in Alberta make this species extremely vulnerable to ecological perturbations that affect habitat availability in the Milk River.

ACKNOWLEDGEMENTS

I wish to acknowledge a number of people for their assistance in compiling information for this document, including Terry Clayton (Sustainable Resource Development, Lethbridge, Alberta), Bruce McCulloch (Fisheries and Oceans Canada, Prairies Area, Edmonton District Office, Edmonton, Alberta), Sean Stash (U.S. Forest Service, Glacier Ranger District, Girdwood, Alaska), Kent Gilge (Montana Fish, Wildlife and Parks, Havre, Montana), Wayne Roberts (Zoology Museum, University of Alberta, Edmonton, Alberta), Sue Peters (Alberta Conservation Association, Edmonton, Alberta) and Sue Cotterill (Sustainable Resource Development, Edmonton, Alberta). In particular, special thanks go to Terry Clayton and Bruce McCulloch. Terry provided excellent background information regarding fisheries and water issues in southern Alberta and took the time to show me the Milk and St. Mary rivers. Bruce provided some useful references and information from his own experiences with stonecats, as well as a thorough review of the manuscript.

Preparation of this report was funded by the Alberta Conservation Association and the Fish and Wildlife Division of Alberta Sustainable Resource Development.

TABLE OF CONTENTS

TABLE OF CONTENTS cont.

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The stonecat (*Noturus flavus* Rafinesque; Rafinesque 1818) is a relatively small catfish species occurring in a range of riverine habitats from the St. Lawrence/Great Lakes system, throughout the Mississippi River basin west to the upper Missouri River drainage. Its Canadian range is limited to the southernmost drainages of Quebec, Ontario, Manitoba, Saskatchewan and Alberta. In Alberta, the stonecat is found in only one river system, the Milk River (Scott and Crossman 1973, Nelson and Paetz 1992), which runs east through the grasslands along the border with Montana before joining the Missouri River system south of the border. The Milk River is unique in Alberta in that it is the only river system that is connected to the Missouri River and therefore contains some fish species, including the stonecat, with a very limited range in the province. Since first documented in the 1960s, the abundance of stonecats in the Milk River has remained consistently low, and the species' distribution does not appear to have changed over time, although both abundance and distribution may have been underestimated in the surveys conducted to date. Very little information is available regarding stonecat biology or limiting factors, but this species is usually restricted to the downstream sections of streams or in higher order stream systems (see glossary, Appendix 1) where water temperatures are warmer and gradients are lower.

In Alberta, the stonecat is currently ranked as *Undetermined** according to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001). The Committee on the Status of Endangered Wildlife in Canada has not provided a national status designation of this species to date (COSEWIC 2002). The intent of this status report is to provide a summary of relevant and current information and an update of the status of the stonecat in Alberta.

* See Appendix 2 for definitions of selected status designations.

HABITAT

1. Features. - The stonecat is found in a variety of fluvial habitats (i.e., moving water bodies) ranging from medium-sized to large streams (Scott and Crossman 1973, Schmidt 1986, Underhill 1986), as well as the wave-exposed rocky areas of large lakes where wave action produces stream-like conditions (Trautman 1981). Most commonly, the stonecat is found in deep boulder pools or over rocky bottoms in riffles and rapids in rivers (Scott and Crossman 1973, Nelson and Paetz 1992), but sand and gravel bars in lakes may also be selected (Scott and Crossman 1973). The stonecat is a nocturnal, bottom-dwelling (benthic) species, hiding beneath cobble and boulder substrates during the day and feeding at night (Kline and Morgan 2000, McCulloch 1994). Water conditions in stonecat systems range from clear to turbid (Nelson and Paetz 1992). The stonecat appears to be intolerant of both fast currents in high-gradient systems and silt-bottomed, low-gradient systems (Trautman 1981). The presence of stonecats in the low-gradient, silty Red River in Manitoba (Scott and Crossman 1973) and in the Milk River in Alberta appears to be an exception.

Several studies have been conducted on the Milk River in Alberta since the 1960s to describe fish species' presence and habitat use (Willock 1969, Clayton and Ash 1980, RL&L 1987, RL&L 2002a, 2002b). Willock (1969) noted that the stonecat was most commonly found in even-flowing sections of the mainstem over gravel beds, and sometimes in the creek mouths. Given the species' distribution within the Milk River, Willock (1969) concluded that the stonecat was tolerant of a wide range of turbidity levels, but was limited to warm water.

Most recently, surveys for stonecats in the Milk River determined that this species occupied predominantly shallow runs and flat habitats (RL&L 2002b). In fall 2000, they were also found predominantly in run/riffle boulder garden

types (see glossary, Appendix 1). However, the extreme drought conditions of fall 2001 prevented stonecats from selecting preferred habitats and they were restricted to isolated pools in the lower Milk River. This assessment noted a consistency in a number of microhabitat features among sites where stonecats were captured. In general, stonecats were captured in areas with low to moderate water velocities (0.0-0.19 m/s) and low silt depths (0.0-0.10 m), and they tended to be in close association with cover that was predominantly cobble and boulder (RL&L 2002b). These observations are consistent with earlier studies that found that all fish were captured near boulder rip-rap areas (see glossary, Appendix 1) associated with bridge crossings (Clayton and Ash 1980, RL&L 1987). The preference for angular rock substrate associated with crossings has also been observed elsewhere and demonstrates the ability of the stonecat to adapt to some human-induced habitat alterations (McCulloch and Stewart 1998). Water depths varied from 0.25 m to 0.6 m, but given the drought conditions in both 2000 and 2001, the significance of water depth in habitat selection could not be evaluated (RL&L 2002b). Interestingly, the habitat variables described for stonecat capture sites in the mid- to lower Milk River are also present in the upper sections of the Milk River (RL&L 2002b). However, stonecats were only found in the mid- to lower sections (RL&L 2002b). The recent microhabitat assessment on the Milk River supports another recent study conducted on stonecats in Maryland. Here, stonecats were found in run/riffle habitat where velocities were relatively slow (<0.2 m/s) and substrate was predominantly boulder and cobble (Kline and Morgan 2000). This study also noted that fish were captured in water depths of 0.1 m to 0.3 m.

Information regarding spawning habitat of the stonecat is limited. Spawning can take place in streams or in shallow, rocky areas of lakes in areas with large gravel or rocky substrate, where the eggs are deposited in nests beneath the rocks (Scott and Crossman 1973). In one Missouri river, nests were found beneath large rocks in water ranging from 0.53 m to 1.17 m deep, in moderate current and slightly turbid water (Walsh and Burr 1985). Interestingly, stonecats have been known to use artificial substrates for nests (e.g., bottles, cans and an open and inverted tool box), reflecting their opportunistic behavior (B. McCulloch, pers. comm.). Use of artificial substrates for spawning purposes has also been documented for *Noturus miurus* (brindled madtom) in Illinois (Burr and Mayden 1982).

In Alberta, where the stonecat is limited to the Milk River system, good potential spawning habitat exists in the lower and mid-sections of the system (0 km to approximately 160 km upstream of the international border) where boulder substrate areas occur (Clayton and Ash 1980). Similarly, numerous rubble and boulder areas exist throughout much of the Milk River, providing suitable habitat for early rearing (Clayton and Ash 1980). These coarse substrate areas vary in abundance, occurring in isolated patches in the lower reaches of the system (lowest 100 km in Alberta), but becoming more common upstream (RL&L 2002b). Given that good overwintering habitat probably consists primarily of adequate stream flow and cover (e.g., rocks), the same boulder areas of the lower and mid-Milk River are probably most suitable (Clayton and Ash 1980). The abundance of stonecats noted at Deer Creek Bridge (approximately 125 km upstream of the border) in November 1979 (see Appendix 3; Clayton and Ash 1980) suggests that this pool supported good overwintering habitat at this time. Unfortunately, this pool did not exist in fall 2000 or 2001 and could not be compared for stonecat abundance (RL&L 2002b). Finally, these same areas in the lower Milk River, where flow is sustained, probably support the best feeding opportunities as well (Clayton and Ash 1980).

2. Trends. **-** The greatest changes to habitat for the stonecat in Alberta have been associated with irrigation. In 1917, the St. Mary Canal was constructed in Montana to divert water from the

St. Mary River to the Milk River system for irrigation purposes. In most years, the canal diverts water from April to September, increasing the water volume in the North Milk River (into which the canal empties) and the Milk River mainstem. Before the construction of the dam, the Milk River was probably a typical small prairie stream, possibly intermittent in times of drought, and less turbid (Willock 1969). The even-flowing waters now observed in the lower Milk River in Alberta were likely restricted to mainly downstream of the international border (Willock 1969). The significant increase in water volume since the canal went into use is believed to have significantly altered the ecological regime of the Milk River (with the exception of the South Milk River fork) by shifting habitat types westward into the Alberta portion (Willock 1969, T. Clayton, pers. comm.). The result has been the creation of a more turbid, higher-flow system with more potential stonecat habitat available in the Alberta portion of the Milk River (Willock 1969).

Since 1917, there do not appear to have been any further long-term changes in habitat availability. Instead, availability is highly dependent on adequate water flows, which can vary significantly seasonally and from year to year. Specifically, the daily volume of water flowing at the Milk River station has ranged more than 10 000 fold in the past 12 years, from a minimum flow of 0.025 cms (cubic metres per second) on 31 December 2001 to 258 cms in a single day during June 2002 (T. Clayton, pers. comm.). It is impossible to quantify how flow affects habitat availability, but this range in volume will definitely result in some variability. For example, during periods of extremely low flows, stonecat habitat may become very restricted and even undergo temporary fragmentation under conditions such as those experienced in the fall and winter of 2001-2002. During this particular time, the lower portion of the Milk River (lower 60 km to the international border), where a number of stonecats have been documented, was reduced to a series of isolated pools, many of which were not deep enough to support overwintering fish (RL&L 2002a). A winter survey of a subset of these pools did not find any stonecats present (RL&L 2002a). For example, the Deer Creek bridge, where a large number of overwintering stonecats was previously documented (Clayton and Ash 1980), was void of water in fall 2001 (RL&L 2002b). Furthermore, south of the international border, the Milk River was completely dry to the Fresno Reservoir (located approximately 85 km downstream of the border) from September 2001 to February 2002, and the reservoir was at only 4% of its capacity (K. Gilge, pers. comm.).

The stonecat is present, but thought to be very rare, in the Fresno Reservoir (K. Gilge, pers. comm.). It is also present in the mid-sections of the Milk River mainstem above the section that was almost void of water in fall 2001. Therefore, natural re-colonization of the lower Milk River is possible from upstream and downstream sources. However, re-establishment of significant numbers of stonecats in the lower Milk River from these sources may take a number of years given that upstream and downstream populations are likely very small, and the distance upstream from the reservoir is significant (i.e., 85 km). For comparison, a sizable population of stonecats appeared to have established itself in the Red River in less than 20 years at a location over 100 km upstream of its previously documented occurrence (B. McCulloch, pers. comm.).

Elsewhere, information regarding habitat trends over time is virtually non-existent. One study noted that fragmentation of stonecat habitat was occurring in Maryland river systems in association with acid mine drainage (Kline and Morgan 2000). Kline and Morgan (2000) also noted that the stonecat disappeared from impoundments (see glossary, Appendix 1), likely because of the change in type of habitat available (i.e., loss of riffle areas), habitat fragmentation and/or a change in the aquatic

community. The recent work on the Milk River, south of the international border to its confluence with the Missouri River, found stonecats present within most impounded sections of the river, but at relatively low abundance (Stash 2001). However, a significantly larger number of stonecats was captured downstream of the impounded sections where connectivity with the Missouri River still remained (Stash 2001). It is not clear if the lower numbers upstream are a result of the effect of dams and impoundment on the habitat or other factors.

CONSERVATION BIOLOGY

1. Species Description.* - This species was first described by C.S. Rafinesque in 1818 in the Ohio River (Rafinesque 1818). The stonecat is the only catfish species from the Ictaluridae family currently native to Alberta (Nelson and Paetz 1992), and is one of the seven species from this family that occur in Canada. This relatively small catfish rarely exceeds 203 mm in total length, but is the largest of the three catfish species of the *Noturus* genus in Canada with an attached (adnate) adipose fin (Scott and Crossman 1973). The largest length recorded for a stonecat was in Ohio at 312 mm (Trautman 1957), whereas in Alberta the largest captured individual was 269 mm in fork length (RL&L 2002b). The 29 stonecats collected by Clayton and Ash (1980) near the Deer Creek Bridge ranged in total length from 170 mm to 240 mm.

The body of the stonecat is rounded at the anterior end but laterally compressed posterior to the pelvic fins (Scott and Crossman 1973). The head shape is broad and slightly compressed along the back (dorsally) (Nelson and Paetz 1992). The mouth of the stonecat is subterminal, with a large fleshy upper lip overhanging the lower lip (Scott and Crossman 1973). As with other members of the Ictaluridae family, the stonecat has eight sensory barbels on the head around the mouth, a spinous ray on the leading edge of the dorsal fin and each pectoral fin, an adipose fin and scaleless skin (Nelson and Paetz 1992). In addition, like other *Noturus* (madtom) species within this family, it has a venom gland connected to the pectoral spine that can inflict a wasp-like sting (Nelson and Paetz 1992). The back and sides of the stonecat range from purplish to yellowish-brown, whereas the belly tends to be light cream in colour (Nelson and Paetz 1992). The species' characteristics appear to be fairly stable over its entire range, although some variation has been observed for specimens from Alberta, particularly for gill raker number (Scott and Crossman 1973).

2. Life History. - Limited information is available regarding the life history of the stonecat in Canada or elsewhere (Scott and Crossman 1973). The potential spawning period extends from April to August, when temperatures exceed 25°C (Scott and Crossman 1973, Walsh and Burr 1985). In Canada, the peak spawning period appears to begin in June or July (Scott and Crossman 1973). Similarly, female stonecats from Illinois attained peak spawning condition from early June to late July, when temperatures ranged from 27°-29°C (Walsh and Burr 1985). Stewart and McCulloch (1990) and McCulloch and Stewart (1992) reported the lowest spawning temperature for stonecats to date, at 23°C in the Assiniboine and Little Saskatchewan rivers in Manitoba.

Fecundity (egg-producing capacity) appears to differ between stream and lake populations. For example, the average fecundity of females from Lake Erie is 973 eggs per female, with a range of 767-1205 (Langois 1954). However, fecundities documented in stonecats from a stream in Illinois were considerably lower, ranging from 189 to 570 eggs (Walsh and Burr 1985). Since fecundity is positively correlated with body length, the larger body size of lake populations probably accounts for the greater fecundity (Walsh and Burr 1985).

* See glossary in Appendix 1 for definitions of the following terms used in this subsection: adipose fin, fork length, barbels, gill raker and subterminal.

A mass of sticky eggs (each 3.5-4.0 mm in diameter) is deposited at the nest site (Scott and Crossman 1973), which is guarded by the male (Scott and Crossman 1973, Walsh and Burr 1985). At hatching, larvae range from 6.7 mm to7.5 mm in total length and demonstrate very tight schooling behaviour for protection (Walsh and Burr 1985).

The stonecat is the latest-maturing and longest-lived madtom species (Walsh and Burr 1985). Growth is relatively slow and the maximum age is probably 8-10 years (Scott and Crossman 1973). The most detailed information regarding growth rates and maturation is from a study conducted on stonecats from Illinois and Missouri rivers (Walsh and Burr 1985). Growth rate appeared to be highest during the first year, with the mean standard length (see glossary, Appendix 1) of one-year-old fish being 48.6 mm. Age at first maturation for females was 3-4 years, when females reached 90-134 mm (standard length). Although age at first maturation could not be confirmed for males, all males guarding nests in this study were found to be three years old and at least 85 mm long (standard length). However, variation in longevity and maximum size is apparent and dependent on location. For example, samples from Lake Erie included one 9-year-old specimen (standard length = 233 mm; Gilbert 1953). In contrast, stonecats rarely exceeded six years of age (mean standard length = 126 mm) in streams in Ohio (Gilbert 1953), or streams from Illinois and Missouri, where standard length rarely exceeded 180 mm (Walsh and Burr 1985).

3. Movement. **-** No information is available regarding stonecat movement associated with life history. Given the species' propensity for range expansion (e.g., McCulloch and Stewart 1998), it appears to be capable of moving into new upstream environments over relatively short periods of time (i.e., several generations). Within the Milk River, stonecats likely use different areas opportunistically, depending on water flows and season (T. Clayton, pers. comm.).

4. Diet. **-** The stonecat is a benthic, opportunistic feeder, using its sensitive barbels during the night to search for food on the river bottom. McCulloch (1994) found foraging activity to be greatest at 2:00 a.m. The stonecat eats a diversity of food items, but there may be some variation in selection associated with body size (Walsh and Burr 1985) and season (Stewart and McCulloch 1990). In general, its diet consists primarily of immature aquatic insects (especially mayflies), and secondarily of molluscs, minnows, fish eggs, isopods, amphipods, crayfish and plant material (Scott and Crossman 1973, Rohde 1980, Walsh and Burr 1985). In the Little Saskatchewan River in southern Manitoba, stonecats fed mostly on *Hydropsyche* caddisflies and *Gammarus* amphipods, which were the most abundant invertebrates at the study site (McCulloch 1994).

DISTRIBUTION

1. Alberta. **-** The majority of Alberta's native fish species, including stonecat, appear to be colonizers from the complex Missouri-Mississippi glacial refugium (see glossary, Appendix 1) (Nelson and Paetz 1992). The stonecat most likely dispersed directly from the Missouri drainage into the Milk River as habitat became available with the retreat of the last glacier (late Wisconsonian) about 13 000 years ago (Nelson and Paetz 1992).

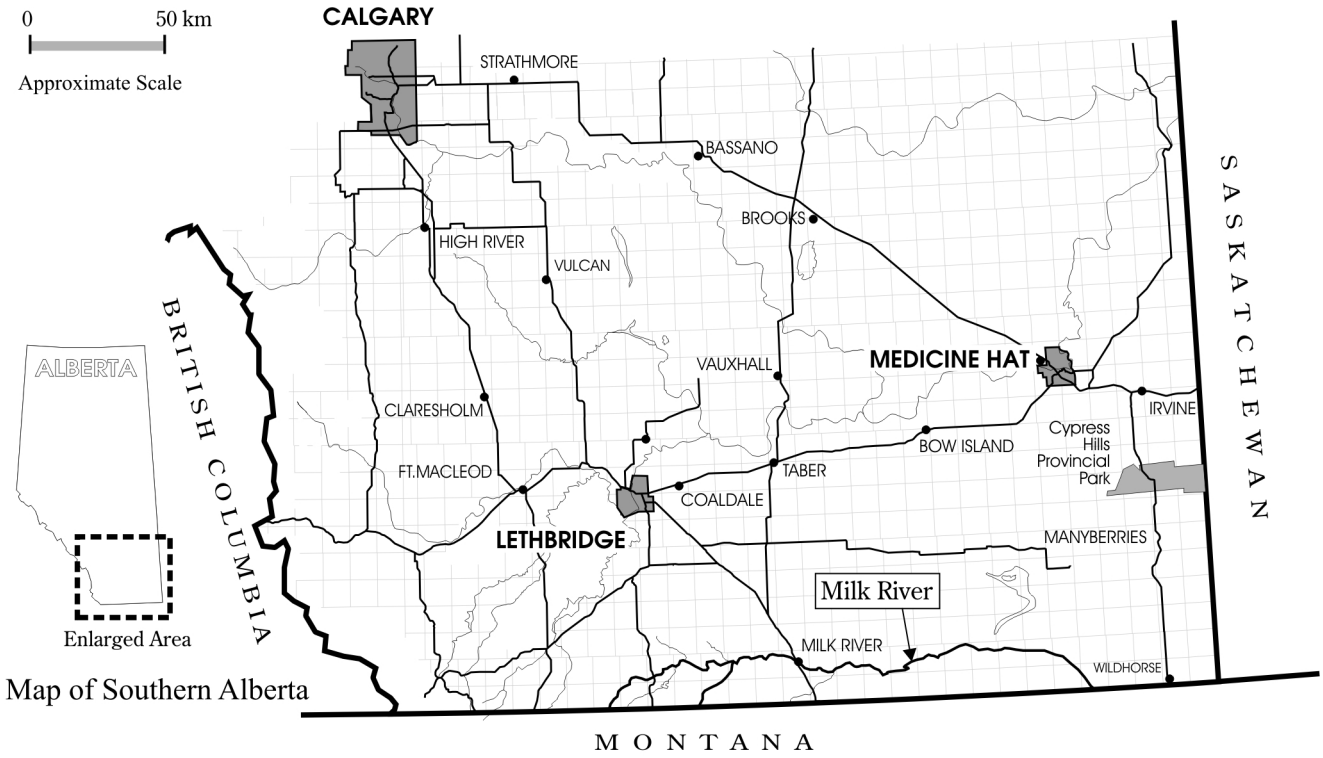
In Alberta, the stonecat's presence has only been confirmed in the Milk River system, which occurs in the Dry Mixedgrass and Mixedgrass natural subregions of Alberta (Alberta Natural Heritage Information Centre 2002a). Museum records indicate that the stonecat was first documented in the Milk River in 1962 (Nursall and Lewin 1964). Since this time, a limited number of surveys (in 1966, 1967, 1973, 1974, 1979, 1986, 1992, 1997, and most recently between 2000 and 2002) have recorded variable but low numbers of stonecats (see Appendix 3 for collection details).

The stonecat appears to be limited in distribution to the mid- and lower sections of the Milk River and the lower North Milk River, a distance approximately 250 km in length (Willock 1969, P&E 2002, RL&L 2002b) (Figure 1). A single specimen was also documented from Red Creek, a tributary of the Milk River, approximately 30 km downstream of the town of Milk River (Appendix 3). Unfortunately, the specific location within this tributary is unknown. No stonecats have been collected from any other tributaries (Willock 1969, Clayton and Ash 1980, RL&L 1987).

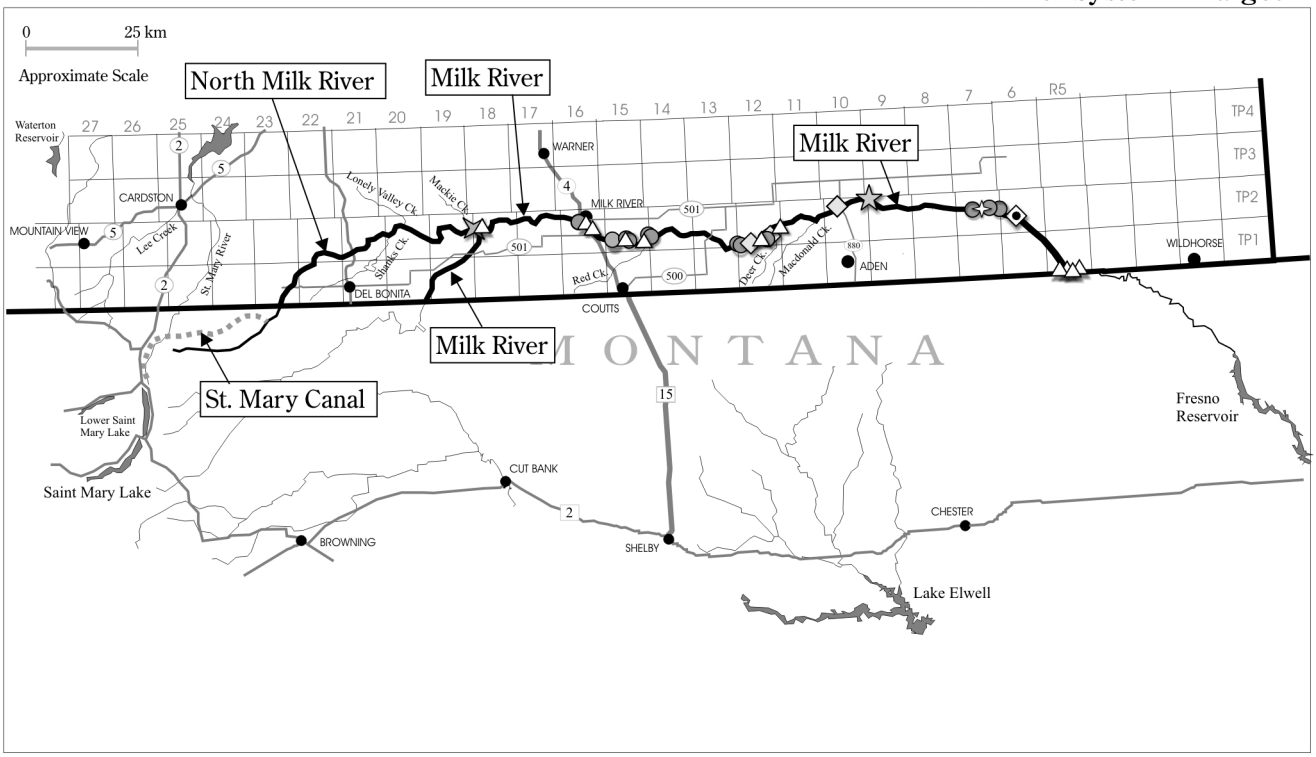
Given the variability in survey ranges over time, it is impossible to determine whether changes in the distribution of the stonecat in the Milk River have occurred. Most recently, extensive surveys found stonecat to be concentrated mainly in the mid-section of the Milk River mainstem and present at a few sites in the lower section; a single specimen was found in the lower North Milk River (RL&L 2001, 2002b, P&E 2002). Specifically, these surveys found the extent of distribution ranging from the North Milk River, approximately 10 km upstream of the confluence with the Milk River mainstem, to the lower Milk River, approximately 40 km upstream of the international border. In contrast, Willock (1969) documented stonecat distribution ranging from the Milk River mainstem, at the confluence with the North Milk River, downstream to the international border. However, the absence of stonecats in the lowermost section of the Milk River in the most recent surveys (P&E 2002) is likely a function of ineffective sampling methods and selection of sites not suited to stonecats rather than reflective of true stonecat distribution. Stonecat distribution, particularly in 2000-2001, also reflects habitat availability. In the middle reaches, high quality habitat is prevalent with extensive boulder-garden substrate types available 180-140 km upstream of the international border (RL&L 2002b). In the lower reaches of the Milk River, coarse substrate is much more sporadic (RL&L 2002b), and habitat availability was further limited by the extreme drought conditions in 2000-2001. It should be noted that the only record of stonecat presence in the North Milk River was documented in the most recent study in October 2002, and was represented by a single specimen. Furthermore, the only recent survey conducted in the lowermost 60 km of the Milk River was in October 2002.

Finally, there remains the likelihood that the stonecat presence in the Milk River is and has been greater than observed. Specifically, low numbers of stonecats may exist further upstream than has been apparent in surveys. First, by sampling during daylight hours (i.e., diurnal), as was done in the past, surveys did not specifically address the nocturnal behaviour of the stonecat and could easily underestimate its presence (B. McCulloch, pers. comm.). Second, upstream use might be seasonal and dependent on adequate water flow (T. Clayton, pers. comm.). Previous surveys have most often been conducted during the late summer or fall when water flows would be lower than in spring and early summer. As mentioned, the furthest upstream sample was collected in October 2002 in the North Milk River and water flows were unusually high during this time.

There is no information available on the number of subpopulations that exist in the Milk River. Habitat fragmentation is at most only temporary, occurring during extreme drought conditions. The distribution of stonecats in the Milk and North Milk rivers appears to be patchy, but this patchiness may be partly the result of difficulties associated with effective sampling for this species rather than a reflection of the true distribution of stonecats in the river. The potential for gene flow throughout this entire section in most years is high given the lack of physical barriers, and may prevent genetic isolation and the development of distinct subpopulations. Unfortunately, no genetic data have been collected in Alberta or elsewhere for stonecats. Conservatively, it is likely that



Milk River System Enlarged



Legend

- △ Pre-1986 data
- ● RL&L 2002b
- ◇ RL&L 1987
- ✕ P&E 2002
- ✧ Alberta Provincial Museum 2001
- ☆ Alberta Provincial Museum 1992
- ◈ T. Clayton, G. Clements, and C. Wall

Figure 1. The distribution of stonecat in Alberta. Note that specific locations correspond to collection sites summarized in Appendix 3. (Modified from RL&L 2002b).

Alberta contains only one population in the Milk River. Other factors such as fidelity to spawning grounds might result in further subpopulation structure, but movement and genetic data would be required to determine whether such structure exists. Given the lack of obvious physical barriers from the lower North Milk River in Alberta to the Fresno Reservoir in Montana, it is likely that the Alberta population of stonecats is part of a larger genetic population that includes the uppermost section of the Milk River in Montana. Again, population genetics work and detailed movement studies would be required to confirm this hypothesis. The presence of the dam on the Fresno Reservoir prevents any further potential gene flow, at least from downstream populations.

In summary, the distribution of the stonecat in Alberta appears to be limited to the mid- and lower Milk River and lower North Milk River. These sections are approximately 240 km in length and 10 km in length, respectively, with variable widths ranging from 0 m in some sections at lowest flows, to approximately 15-20 m at high flows (T. Clayton, pers. comm.). Within those sections, the area actually occupied by the species is difficult to calculate, given that no studies have conducted surveys of the entire length of the river. This stretch of the Milk River represents a relatively small proportion of the total present-day range of stonecats in North America (Figure 2). Too few data are available to evaluate annual fluctuation in the extent of distribution within Alberta, but some fluctuation appears to be associated with the variability in water levels. However, there do not appear to be any major changes in extent of distribution since the stonecat was first documented within the Milk River.

2. Other Areas. **-** The stonecat has the greatest longitudinal distribution of any of the 25 members of the *Noturus* genus in North America (Rohde 1980) (Figure 2). The majority of the stonecat's distribution occurs south of the international border, extending south from the St. Lawrence River to western North Carolina and northern Alabama, from central Tennessee west through Missouri, Kansas and northeastern Colorado, and northwest from Wyoming to Alberta (Scott and Crossman 1973, Rohde 1980). In Canada, the stonecat is native to the Great Lakes (Ontario, Erie and Huron) and their tributaries, the St. Lawrence River and tributaries, the lower Ottawa River, the Red, Assiniboine, and Brokenhead river systems in Manitoba, the Frenchman River in Saskatchewan and the Milk River in Alberta (Scott and Crossman 1973, McCulloch and Stewart 1998, McCulloch et al. 1998). The distribution of the stonecat in Saskatchewan and Alberta is therefore limited to rivers in the upper Missouri drainage, although its presence in the Qu'Appelle River (Assiniboine River tributary) in Saskatchewan is possible but, as of yet, not documented. Range extensions for this species have been documented in a number of areas including Kansas (Layher and Wood 1986), Kentucky (Warren et al. 1991) and in Canada, in upstream sections of the Red and Assiniboine rivers in Manitoba (McCulloch and Stewart 1998). In particular, the presence of stonecats in the Red and Assiniboine rivers is believed to be relatively recent (i.e., since the mid- to late-1960s), with dispersal from the Missouri drainage to the Hudson Bay drainage occurring naturally and opportunistically (McCulloch 1994).

POPULATION SIZE AND TRENDS

1. Alberta. **-** There is virtually no information available to establish stonecat population size or trends. It is likely that the stonecat has increased in numbers in Alberta since 1917 when the St. Mary Canal was constructed, diverting stream flow from the St. Mary River into the North Milk River and increasing water flows there (Willock 1969, Clayton and Ash 1980). A single collection in 1979 from one pool of the lower Milk River at Deer Creek Bridge (125.3 km from the international border) captured 29 specimens, suggesting that the stonecat was at

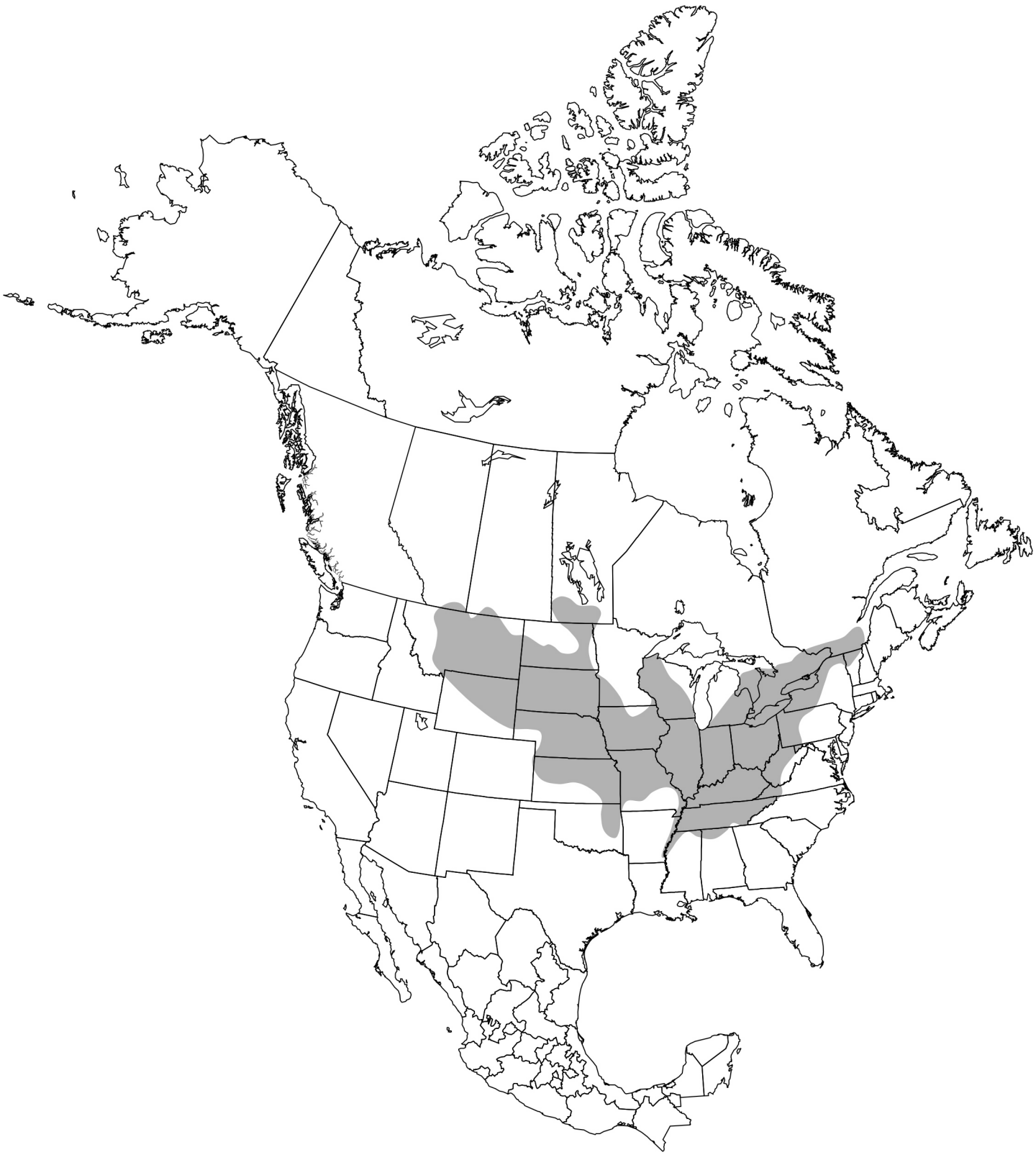


Figure 2. The distribution of stonecat in North America. From Rohde (1980) and McCulloch and Stewart (1998).

least locally abundant at that time (Clayton and Ash 1980) (Table 1). However, this survey was conducted during November and likely reflects a concentration of fish overwintering at this location (RL&L 1987). Relative abundance earlier in the year does not appear to have changed significantly between 1966 and the most recent collections, and is consistently less than 2% of the total composition, with the exception of the November 1979 sample (Table 1).

Recently, the stonecat population in the Milk River has been described as stable but of low abundance (RL&L 2002b). These studies (RL&L 2002b) appear to indicate higher relative abundance (Table 1) and higher catch-per-unit-effort (CPUE; see glossary, Appendix 1) values than the study in 1986 (RL&L 1987). In 1986, CPUE was 0.09 fish per minute, whereas in 2000-2001, CPUE values ranged from 0.1 to 1.8 fish per minute using a backpack electroshocking unit. However, this increase in CPUE likely reflects increased fishing efficiency associated with a better understanding of stonecat habitat preferences (T. Clayton, pers. comm.) and low, clear water conditions during the drought period, rather than an increase in abundance. Given that surveys in October 2002 were focused mainly on confirming the distribution of species, abundance estimates for stonecat cannot be compared with abundance values from previous years.

In addition to the possibility of underestimating the extent of stonecat distribution in the Milk River, it is likely that its abundance is higher in the Milk River than that previously observed (B. McCulloch, pers. comm.). The stonecat is a nocturnal species that tends to remain hidden beneath rocks during the day. The primary collection method for stonecats in the Milk River has been by backpack electroshocking during daylight hours. To adequately sample stonecats using daytime electroshocking, substrate must be moved to find anodotaxed (see glossary, Appendix 1) stonecats that might be wedged under the rocks (McCulloch 1994, B. McCulloch, pers. comm.). Past efforts likely did not incorporate this technique into

Table 1. Comparison of stonecat sample sizes[1] from the Milk River mainstem and creek mouths, and percent composition of total catch[2] of stonecat relative to other fish species over time.

Year	Season	Sample Size	% Total Composition	Reference
2001	October	29	0.4	RL&L 2002b
2000	October	34	1.5	RL&L 2001, 2002b
1986	July-October	3	<0.1	RL&L 1987
1979	November	29	5.9	Clayton and Ash 1980
1966/7	Spring-fall[3]	36	0.2	Willock 1969

[1] Sample sizes for RL&L data include both collected and encountered (seen) individuals.
[2] Usually sampled via backpack electroshocking because of habitat preferences.
[3] Note that the original thesis did not separate samples by date.

collections and thereby missed or underestimated the presence of stonecats. The need to lift rocks to locate stonecats during daytime sampling can be avoided by electrofishing at night with headlamps, when stonecats are actively foraging on the bottom substrate (B. McCulloch, pers. comm.).

2. Other Areas. **-** A U.S. study in the Milk River from the Fresno Reservoir (but not including the reservoir) in Montana to the international border found that stonecats represented approximately 1.1% of fish species composition (Stash 2001, S. Stash, pers. comm.). This value is within the range of percent composition observed in Alberta (Table 1). This same study found consistently low numbers throughout the remainder of the Milk River (0 to 1.2% of total composition), with the exception of the lowest section below the most downstream dam (Vandalia), where stonecats contributed slightly more to the total fish composition (3.9%), and more individuals were captured (Stash 2001).

LIMITING FACTORS

1. Alberta. **-** High quality habitats have been identified in the mid-reaches of the Milk River where large substrates are prevalent (RL&L 2002b). However, only low numbers of stonecats have been captured throughout this section to date. In the lower reaches, large substrate only occurred in isolated patches, and appeared to limit stonecat presence to a more spotty distribution (RL&L 2002b). The upper reaches of the Milk River also contained what is believed to be appropriate stonecat habitat; however, the stonecat was absent here (RL&L 2002b). It is apparent that factors other than habitat availability are influencing stonecat distribution and abundance in the Milk River.

Overwinter survival is probably a primary limiting factor for stonecat abundance in the Milk River. In most years, low winter water flows likely limit overwintering habitat availability (RL&L 1987, 2002b), and such refuges are highly variable from year to year. For example, the pool containing a large number of stonecats in November 1979 was not present in 2000 or 2001 (RL&L 2002b).

The low flows frequently observed in the Milk River are the result of a combination of geographic location and water use. The Milk River flows through the Dry Mixedgrass Subregion of southern Alberta, which receives less annual precipitation than any other area in the province. The system is subject to extreme yearly and seasonal climatic fluctuations, including periodic severe drought conditions during the summer and fall, such as those observed in 2000 and 2001. The resulting low flows may be exacerbated significantly by the seasonal operation of the St. Mary Canal and by local water removal, mainly for irrigation in the vicinity of the town of Milk River (T. Clayton, pers. comm.). For example, the canal gates were shut prematurely in 2001 (in August instead of September) for repair work (T. Clayton, pers. comm.), worsening the conditions associated with low water levels. For comparison, the mean monthly discharge during August 2000 was approximately the same as the average historical value since 1910 (RL&L 2002b). However, the mean discharge during October and December 2000 was 11% and 20% of historical values, respectively (RL&L 2001). In 2001, the situation was even worse with mean discharge in August, October and December being approximately 50%, 7% and 6% of the average, respectively (RL&L 2002b). Because the canal is the primary source of water to the Milk River, especially during the summer months, the removal of this water source even under non-drought conditions would reduce the flow significantly. The severe drought conditions in 2001 resulted in the isolated pools observed in the lower sections of the river during the fall and winter. Ten of the observed 32 isolated pools were evaluated in March 2002 for habitat quality (RL&L 2002a). Although oxygen levels were adequate, water depth was often considered

limiting and no stonecats were observed (RL&L 2002a). Stonecats trapped in isolated pools or limited to areas of restricted water flows could experience dangerously high water temperatures and low oxygen levels during the summer months as a result of such low water levels.

Given the distribution of apparently preferred habitat types (mainly in the upper and mid-reaches) compared to the distribution of stonecats (in the mid- and lower reaches only), it is likely that seasonal and annual water flows are responsible for the limited distribution and numbers of the stonecat in the Milk River. Willock (1969) believed that the stonecat's range expanded upstream after the construction of the St. Mary Canal. However, the extreme fluctuations in water flow may prevent further upstream movement because overwinter survival of existing populations in the mid- to lower reaches is very limited.

Finally, one other factor that appears to have limited the natural dispersal of stonecats northwards is water temperature. Although other species from the Mississippi refugium have moved north to become established in the South Saskatchewan River system and elsewhere, the stonecat appears to be limited to the warmer Milk River.

***2. Other Areas.* -** Very little information is available to describe factors limiting stonecat presence in other areas. A recent study in Maryland noted that stonecats were absent from first- to third-order streams, where temperatures were generally less than 22°C and gradients were higher (Kline and Morgan 2000). In general, this study noted that stonecat numbers steadily decreased upstream. This study also stated that the very limited numbers of juvenile stonecats observed may be the result of predation by significant numbers of introduced (non-native) fishes, including trout and bass species (Kline and Morgan 2000). The stonecat is a non-sport fish species native to many locations south of the international border. Like other species that share this category, it has been given little consideration for protection. Instead, many systems in which it occurs have received significant numbers of introduced sport fish species that may compete for resources or prey upon stonecats. Such introductions are often associated with impounded systems and tend to have negative effects on the native species (Stash 2001). Generally, impounded systems result in a whole suite of physical habitat and ecological alterations that are likely detrimental to native fish species such as the stonecat. Such species have adapted to unregulated systems where physical extremes in the aquatic ecosystem are common. When these systems become regulated, moderated conditions often result in the proliferation of introduced species to the detriment of the native community (summarized by Stash 2001).

STATUS DESIGNATIONS*

***1. Alberta.* -** The stonecat is currently ranked as *Undetermined*, according to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001), and is not currently listed under Alberta's *Wildlife Act*. The Alberta Natural Heritage Information Centre (2002b) tracks provincial and global rankings. Provincially, the stonecat is ranked as "S1" (as of April 2000), which is the highest "S" rank.

***2. Other Areas.* -** To date, the Committee on the Status of Endangered Wildlife in Canada has not provided a national designation for the stonecat (COSEWIC 2002). The national ranking for stonecat provided by the Natural Heritage Network (NatureServe Explorer 2002) for Canada is "N4" (December 1996). The stonecat has a provincial status of "S2S3" in Saskatchewan, "S3" in Quebec, "S4" in Ontario and "S5" in Manitoba (NatureServe Explorer 2002). The national ranking for the United States

* See Appendix 2 for definitions of the status designations referred to in this section.

is "N5" (December 1996). Of the 27 states in which the stonecat is reported, eight states rank the stonecat's status as "S1" or "S2" (Alabama, Arkansas, Colorado, Maryland, North Carolina, Oklahoma, Vermont and Virginia). The remaining states provide ranks of "S3" to "S5" or a "not ranked" status. Globally, the Natural Heritage Network ranks this species as "G5" (as of September 1996), which is the lowest rank.

RECENT MANAGEMENT IN ALBERTA

As of 1997, the provincial *Wildlife Act* enables the listing of endangered or threatened fish species. However, the stonecat has not been listed under the *Wildlife Act* to date.

No specific management for stonecat has occurred in Alberta. However, the extremely limited distribution of this and other fish species in the Milk River, as well as its potential vulnerability to water conditions, prompted the Fish and Wildlife Division of Alberta Sustainable Resource Development to commission ongoing surveys in the Milk River (2000 to present) that include an evaluation of the stonecat's status. The information collected will be used to help determine the provincial status of the stonecat and to provide recommendations with regards to its protection. Regular monitoring studies using standardized methods at representative index sites have been recommended (RL&L 2002b). It should be noted that, to date, no minimum water flows to address fisheries needs have been established for the Milk River in Alberta or Montana (T. Clayton, pers. comm.). A cessation of water extraction during the April - October period, when discharges drop below a minimum level, would be most beneficial (T. Clayton, pers. comm.).

SYNTHESIS

The stonecat is a unique species in Alberta because it is one of only two fishes (the other being western silvery minnow, *Hybognathus argyritis*) to have dispersed from the Missouri-Mississippi glacial refugium no further north than the Milk River. Stonecat distribution and abundance within the Milk River appear to be very limited, with occurrences documented in the lower and midsections of the mainstem upstream only to the confluence with the North Milk River branch, in the lower North Milk River and in Red Creek. The use of other tributaries has not been documented, but given the intermittent nature of these smaller systems it is likely opportunistic at best and dependent on adequate water flows. It is suspected that stonecat presence in the Milk River has expanded upstream since the construction of the St. Mary Canal in 1917; however, abundance does not appear to have changed since first documented in the 1960s. Potential stonecat habitat has been documented upstream, but further upstream dispersal may be limited by temperature and adequate water flows. The greatest limiting factor to the survival, and therefore abundance, of stonecats in the Milk River is probably related to the seasonal operation of the St. Mary Canal and water removal for irrigation, in combination with the extreme drought conditions experienced in recent years. This combination of limiting factors significantly reduces overwintering habitat or refuges available to stonecats.

Very little information exists regarding the biology, life history, population size or trends of stonecat in Alberta, or elsewhere. Given its very limited distribution and consistently low records of abundance, the stonecat warrants some level of protection in the province. The first step in the protection of the stonecat must be to confirm the upper extent of its range in the Milk and North Milk rivers, as well as in the most downstream section of the Milk River, using appropriate sampling techniques that address the particular behaviour of stonecats. This will ensure not only that this species' distribution in Alberta is correctly known, but also that abundance is not being underestimated. Further studies taking into account temperature tolerance should be considered to determine why

stonecats do not use available habitat upstream. Finally, it is essential that Montana and Alberta work collaboratively to put biologically meaningful minimum water flow limits in place for the Milk River, to ensure that refuges are always available for the stonecat.

LITERATURE CITED

Alberta Environmental Protection. 1996. The status of Alberta wildlife. Alberta Environmental Protection, Natural Resources Service, Wildlife Management Division. Edmonton, AB. 44 pp.

Alberta Forestry, Lands and Wildlife. 1991. The status of Alberta wildlife. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division. Edmonton, AB. 49 pp.

Alberta Natural Heritage Information Centre. 2002a. Natural regions and subregions of Alberta. URL: http://www.cd.gov.ab.ca/preserving/parks/anhic/natural_regions_map.asp (Updated October 2002).

Alberta Natural Heritage Information Centre. 2002b. Fish tracking list. URL: http://www.cd.gov.ab.ca/preserving/parks/anhic/fish_tracking.asp (Updated October 2002).

Alberta Natural Heritage Information Network (ANHIC). 2002c. Elements on the Tracking List. Alberta Natural Heritage Information Centre (ANHIC). URL: http://www.cd.gov.ab.ca/preserving/parks/anhic/index.asp [Last Updated: October 2002].

Alberta Sustainable Resource Development. 2001. The general status of Alberta wild species 2000. Alberta Sustainable Resource Development, Fish and Wildlife Service, Edmonton, Alberta. 46 pp.

Burr, B.M., and R.L. Mayden. 1982. Life history of the brindled madtom *Noturus miurus* in Mill Creek, Illinois (Pisces: Ictaluridae). American Midland Naturalist. 107(1): 25-41.

Clayton, T.B., and G.R. Ash. 1980. A fisheries overview study of the Milk River Basin. Prepared for Alberta Environment, Planning Division by RL&L Environmental Services Ltd. 93 pp.

COSEWIC. 2002. Canadian Species at Risk, May 2002. Committee on the Status of Endangered Wildlife in Canada. 34 pp. URL: http://www.cosewic.gc.ca. (Updated January 2002).

Gilbert, C.R. 1953. Age and growth of the yellow stone catfish *Noturus flavus* (Rafinesque). Unpublished M.Sc. Thesis, Ohio State University, Columbus, Ohio.

Kline, M.J., and R.P. Morgan II. 2000. Current distribution, abundance and habitat preferences of the stonecat (*Noturus flavus*) in Maryland. Prepared for Paul Kazyak, Maryland Department of Natural Resources, Monitoring and Non-Tidal Division, Annapolis, Maryland. PDF file at URL: http://www.dnr.state.md.us/streams/pubs/ea-00-7_stonecat.pdf.

Langois, T.H. 1954. The western end of Lake Erie and its ecology. J.W. Edwards Bros., Inc. Ann Arbor, Michigan. 479 p.

Layher, W.G., and R.D. Wood. 1986. New county records in Kansas for the stonecat and the slender madtom with descriptions of habitats at collection sites. Transactions of the Kansas Academy of Science 89:169-170.

McCulloch, B. R. 1994. Dispersal of the stonecat (*Noturus flavus*) in Manitoba and its interactions with resident fish species. M. Sc. Thesis, Department of Zoology, University of Manitoba, Winnipeg, Manitoba. 108 pp.

McCulloch, B.R., J. R. Duncan and R. J. Keith. 1998. Fish survey of the Saskatchewan portion of the Missouri River basin. Blue Jay 56(2): 107-115.

McCulloch, B.R., and K.W. Stewart. 1992. Diet and habitat comparisons between longnose dace (*Rhinichthys cataractae*) and stonecat (*Noturus flavus*) in the Little Saskatchewan River: interactions between a native and an invading species. Pages 176-193 in North Dakota Water Resources Research Institute. Proceedings of the North Dakota Water Quality Symposium Mar. 25-26, 1992. Bismarck, North Dakota. 391 pp.

McCulloch, B.R., and K.W. Stewart. 1998. Range extension and new locality records for the stonecat, *Noturus flavus*, in Manitoba: evidence for a recent natural invasion. Canadian Field-Naturalist 112:217-224.

National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, DC. 271 pp.

NatureServe Explorer: An online encyclopedia of life [web application]. 2002. Version 1.5. Arlington, VA, USA. Association for Biodiversity Information. URL: http://www.natureserve.org/explorer. (Updated October 2002).

Nelson, J.S., and M.J. Paetz. 1992. The fishes of Alberta. Second edition. The University of Alberta Press, Edmonton, Alberta, Canada. 437 pp.

Nursall, J.R., and V. Lewin. 1964. The stonecat, *Noturus flavus*, newly recorded in Alberta. Canadian Field-Naturalist 78:128-129.

P&E Environmental Consultants Ltd. 2002. Fish species of concern survey on the Milk River – October 2002. Final report. 12 pp. plus appendices.

Rafinesque, C.S. 1818. Further account of discoveries in natural history made during a journey through the western region of the United States. American Monthly Magazine of Critical Reviews 4:39-42.

RL&L Environmental Services Ltd. 1987. An inventory of aquatic habitats and fish resources in the Milk River, Alberta. Prepared for Alberta Environment, Planning Division. 80 pp. plus appendices.

RL&L Environmental Services Ltd. 2001. Fish species at risk in the Milk and St. Mary drainages. Prepared for Alberta Sustainable Resource Development. Alberta Species At Risk Interim Report. 53 pp. plus appendices.

RL&L Environmental Services Ltd. 2002a. Fish species at risk in the Milk River, Alberta – late winter 2002 survey. Prepared for Department of Fisheries and Oceans, Freshwater Institute. 13 pp.

RL&L Environmental Services Ltd. 2002b. Fish species at risk in the Milk and St. Mary drainages. Prepared for Alberta Sustainable Resource Development. Alberta Species At Risk Report No. 45. 82 pp. plus appendices.

Rohde, F.C. 1980. *Noturus flavus* Rafinesque. Stonecat. P. 455 in Lee, D.S., C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister and J.R. Stauffer Jr. (eds.). Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History, North Carolina Biological Survey Publication 1980-12. 854 pp.

Schmidt, R.E. 1986. Zoogeography of the Northern Appalachians. Pp. 137-160 in Hocutt, C.H., and E.O. Wiley (eds.). The zoogeography of North American freshwater fishes. John Wiley & Sons, Toronto, Canada. 866 pp.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada. Bulletin 184. 966 pp.

Stash, S.W. 2001. Distribution, relative abundance, and habitat associations of Milk River fishes related to irrigation diversion dams. M.Sc. Thesis, Montana State University, Bozeman, Montana. 67 pp.

Stewart, K.W., and B. McCulloch. 1990. The stonecat, *Noturus flavus*, in the Red River – Assiniboine River watershed: progress report on a study of an invading fish species. Pp. 69-86 in North Dakota Water Resources Research Institute. 1990 Interbasin Biota Transfer Study Program Proceedings, North Dakota Water Quality Symposium, March 20-21, 1990. Fargo, North Dakota. 144 pp.

Trautman, M.B. 1981. The fishes of Ohio. Ohio State University Press, Columbus, Ohio. 782 pp.

Trautman, M.B. 1957. The fishes of Ohio with illustrated keys. Ohio State Press, Columbus, Ohio. 683 pp.

Underhill, J.C. 1986. The fish fauna of the Laurentian Great Lakes, the St. Lawrence Lowlands, Newfoundland and Labrador. Pp. 105-136 in Hocutt, C.H., and E.O. Wiley (eds.). The zoogeography of North American freshwater fishes. John Wiley & Sons, Toronto, Canada. 866 pp.

Walsh, S.J., and B.M. Burr. 1985. The biology of stonecat, *Noturus flavus* (Siluriforms: Ictaluridae), in central Illinois and Missouri streams, and comparisons with Great Lakes populations and congeners. Ohio Journal of Science 85:85-96.

Warren, M.L., Jr., R.R. Cicerello, C.A. Taylor, E. Laundermilk and B.M. Burr. 1991. Ichthyofaunal records and range extensions for the Barren, Cumberland and Tennessee River drainages. Transactions of the Kentucky Academy of Science 51:17-20.

Willock, T.A. 1969. The ecology and zoogeography of fishes in the Missouri (Milk River) drainage of Alberta. M.Sc. Thesis, Carleton University, Ottawa, Canada. 210 pp.

Willock, T.A. 1968. New Alberta records of the silvery and brassy minnows, stonecat and sauger, with a preliminary list of the fishes of the Milk River in Alberta. Canadian Field-Naturalist 82:18-23.

Appendix 1. Glossary of terms

Adipose fin – The fleshy, rayless (boneless) dorsal fin structure located between the main dorsal rayed fin and the tail fin in trout, catfish and trout-perch families (Nelson and Paetz 1992)

Anodotaxed – stunned state resulting from a mild electric shock received from electrofishing gear

Barbels – The long, fleshy protuberances extending from the mouth area used as sensory organs for touch and taste; found in sturgeon, catfish, burbot and some minnows (Nelson and Paetz 1992)

Catch-per-unit-effort (CPUE) – A standard fisheries term that quantifies fish abundance in terms of effort applied to catch fish using a particular sampling methodology

Fork length – The straight length distance from the tip of the snout laterally to the central part of the margin of the tail fin (Nelson and Paetz 1992)

Gill raker – Row of small extensions lying along the gill arches behind the gill cover of a fish, can vary significantly in shape and number depending on species or population, and may aid in feeding

Impounded or impoundment – River systems that have been dammed, thus creating an altered river environment, are considered impounded. Impoundments are the lake-like areas that are produced

Refugium (glacial) – An ice-free area that provided habitat for species during glacial periods

Rip-rap – angular rock used to reinforce stream banks

Run/riffle boulder garden – Stream section with moderate to high current velocity and relatively unbroken water where the presence of large boulders in the channel offers instream cover (adapted from definition provided by R.L.&L. 2002b)

Standard length – The straight line distance from the tip of the snout to the end of the hypural plate (tip of spine) at the base of the tail fin (Nelson and Paetz 1992)

Stream order – Classification system of streams to describe how many tributaries removed from the original source a stream or river is. The higher the order, the more removed a stream is, and the bigger it becomes

Subterminal mouth – The upper jaw overhangs the lower jaw

Appendix 2. Definitions of selected legal and protective designations.

A. **The General Status of Alberta Wild Species 2000** (after Alberta Sustainable Resource Development 2001)

2000 Rank	**1996 Rank**	**Definitions**
At Risk	Red	Any species known to be *At Risk* after formal detailed status assessment and designation as *Endangered* or *Threatened* in Alberta.
May Be At Risk	Blue	Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment.
Sensitive	Yellow	Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.
Secure	Green	Any species that is not *At Risk, May Be At Risk* or *Sensitive*.
Undetermined	Status Undetermined	Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status.
Not Assessed	n/a	Any species known or believed to be present but which has not yet been evaluated.
Exotic/Alien	n/a	Any species that has been introduced as a result of human activities.
Extirpated/Extinct	n/a	Any species no longer thought to be present in Alberta (*Extirpated*) or no longer believed to be present anywhere in the world (*Extinct*).
Accidental/Vagrant	n/a	Any species occurring infrequently and unpredictably in Alberta, i.e., outside its usual range.

B. Alberta Wildlife Act/Regulation

Species designated as *Endangered* under Alberta's *Wildlife Act* include those listed as *Endangered* or *Threatened* in the Wildlife Regulation.

Endangered	A species facing imminent extirpation or extinction.
Threatened	A species that is likely to become endangered if limiting factors are not reversed.

C. **Committee on the Status of Endangered Wildlife in Canada** (after COSEWIC 2002)

Extinct	A species that no longer exists.
Extirpated	A species that no longer exists in the wild in Canada, but occurs elsewhere.
Endangered	A species facing imminent extirpation or extinction.
Threatened	A species that is likely to become endangered if limiting factors are not reversed.
Special Concern	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk	A species that has been evaluated and found to be not at risk.
Data Deficient	A species for which there is insufficient scientific information to support status designation.

Appendix 2 continued.

D. Heritage Status Ranks: Global (G), National (N), Sub-National (S) (after Alberta Natural Heritage Information Centre 2002c)

G1/N1/S1	5 or fewer occurrences or only a few remaining individuals. May be especially vulnerable to extirpation because of some factor of its biology.
G2/N2/S2	6-20 or fewer occurrences or with many individuals in fewer locations. May be especially vulnerable to extirpation because of some factor of its biology.
G3/N3/S3	21-100 occurrences, may be rare and local throughout its range, or in a restricted range (may be abundant in some locations). May be susceptible to extirpation because of large-scale disturbances.
G4/N4/S4	Typically >100 occurrences. Apparently secure.
G5/N5/S5	Typically >100 occurrences. Demonstrably secure.
GX/NX/SX	Believed to be extinct or extirpated, historical records only.
GH/NH/SH	Historically known, may be relocated in future.
GR/NR/SR	Reported, but lacking in documentation

E. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Appendix 3. Specific locations of all recorded stonecat collected in Alberta.

System	Directions	Coordinates	Date Collected	Reference[1]	Sample Size
Milk River	18 mi. (29 km) W of Wildhorse	NA	20-Jun-1962	UAMZ 100 (Nursall and Lewin 1964)	1
Milk River	18 mi. (29 km) W of Wildhorse	NA	20-Jun-1962	UAMZ 101 (Nursall and Lewin 1964)	1
Milk River	18 mi. (29 km) W of Wildhorse	NA	20-Jun-1962	UAMZ 102 (Nursall and Lewin 1964)	1
Milk River	Junction of North Fork and mainstem, 13 mi. (21 km) W, 1 mi. (1.6 km) S of town of Milk River	S.20, Tp.2, R.18	Jul-1966	NMC66-369 (Willock 1969) [2]	1
Milk River	0.5 mi. (0.8 km) E, 0.5 mi. (0.8 km) S of town of Milk River	S.22, Tp.2, R.16	May-1966 to Oct-1967	Willock 1969[2]	17
Milk River	1.5 mi. (2.4 km) E, 2.5 mi. (4.0 km) S of town of Milk River	S.14, Tp.2. R.16	Aug-1966	Willock 1969[2]	3
Milk River	7 mi. (11 km) E, 4 mi. (6 km) S of town of Milk River	S.2, Tp.2, R.15	Jun-1966	Willock 1969[2]	6
Milk River	Mouth of Red Cr., 8 mi. (13 km) E, 4 mi. (6 km) S of town of Milk River	S.35, Tp.1, R.15	May 1966-July 1967	Willock 1969	1
Milk River	8 mi. (13 km) E, 2.5 mi. (4.0 km) S of town of Milk River	S.1, Tp.2, R.15	May 1966-Aug. 1967	Willock 1969	3
Milk River	19.5 mi. (31.4 km) W, 1 mi. (1.6 km) N of Wildhorse	S.5, Tp.1, R.5	May-July 1966	Willock 1969	1
Milk River	16.5 mi. (26.6 km) W of Wildhorse	S.3, Tp.1, R.5	July 1966-Oct. 1967	Willock 1969	2
Milk River	15.5 mi. (24.9 km) W of Wildhorse	S.2, Tp.1, R.5	May 26, 1966	Willock 1969	1
Milk River	17 mi. (27 km) W of Wildhorse	NA	16-May-1973	UAMZ 3234.3	1
Milk River	1 mi. (1.6 km) W of Deer Creek (25 mi. [40 km] E of town of Milk River)	NA	23-Jul-1974	UAMZ 3548.8	1
Milk River	Near Deer Cr. Bridge	49°05’11.51”N 111°32’54.26”W	20-Nov-1979	Clayton and Ash 1980	29
Red Creek	-	NA	1979	UAMZ 6675	1
Milk River	129.0-124.5 km u/s (upstream) of border	49°05’03.36”N 111°34’52.25”W	27-Aug-1986	R.L.&L 1987	1

[1] Includes museum records UAMZ = University of Alberta Museum of Zoology, NMC = National Museum of Canada.

[2] Note that 27 of the specimens from Willock’s thesis (1969) were previously identified in Willock (1968) as museum specimens corresponding to NMC66-299, -302, -304, -323, -324, -325, -329, -342, -344, -355, -356, -360, -362, -395, -398, -401, -403, -415.

Appendix 3 continued.

System	Directions	Coordinates	Date Collected	Reference[1]	Sample Size
Milk River	124.0 km u/s of border	49°05'20.28"N 111°31'54.13"W	19-Oct-1986	R.L.&L 1987	1
Milk River	97.4 km u/s of border	49°08'40.79"N 111°18'36.47"W	20-Oct-1986	R.L.&L. 1987	1
Milk River	-	49°09'19.11"N 111°13'10.10"W	30-Apr-1992	N.B. McGillvray, Alberta Provincial Museum	1
Milk River	-	49°06'50.63"N 110°47'19.49"W	13-Aug-1997	T. Clayton, G. Clements & C. Wall	3
Milk River	Pinhorn Ranch	49°07'31.52"N 110°51'59.45"W	20-Oct-2000	R.L.&L. 2002b	4
Milk River	Writing-on-Stone Provincial Park	49°04'45.17"N 111°36'49.51"W	20-Oct-2000	R.L.&L. 2002b	3
Milk River	Deer Creek Bridge	49°05'11.76"N 111°32'09.59"W	22-Oct-2000	R.L.&L. 2002b	6
Milk River	Coffin Bridge	49°06'02.33"N 111°53'25.42"W	20-Oct-2000	R.L.&L. 2002b	2
Milk River	J. Chapman	49°05'51.26"N 111°56'39.92"W	22-Oct-2000	R.L.&L. 2002b	9
Milk River	Writing-on-Stone Provincial Park	49°04'44.74"N 111°36'44.77"W	21-Oct-2001	R.L.&L. 2002b	1
Milk River	Town of Milk River	49°07'04.68"N 112°04'53.45"W	22-Oct-2001	R.L.&L. 2002b	1
Milk River	Coffin Bridge	49°06'02.40"N 111°53'24.29"W	21-Oct-2001	R.L.&L. 2002b	1
Milk River	J. Chapman	49°05'46.58"N 111°56'38.40"W	22-Oct-2001	R.L.&L. 2002b	15
Milk River	Goldspring Park	49°05'45.15"N 111°59'29.05"W	22-Oct-2001	R.L.&L. 2002b	3
Milk River	Pinhorn Ranch	49°07'24.29"N 110°49'48.96"W	18-Oct-2001	R.L.&L. 2002b	4
Milk River	Pinhorn Ranch	49°07'29.05"N 110°54'38.93"W	19-Oct-2001	R.L.&L. 2002b	1
Milk River	-	49°07'27.11"N 110°52'28.23"W	8-May-2001	M. Steinhilber, Alberta Provincial Museum	1
North Milk River	-	49°08'26.28"N 112°28'40.10"W	October 2002	P&E 2002	1

[1] Includes museum records UAMZ = University of Alberta Museum of Zoology, NMC = National Museum of Canada.

List of Titles in This Series
(as of March 2004)

No. 1 Status of the Piping Plover (*Charadrius melodus*) in Alberta, by David R. C. Prescott. 19 pp. (1997)

No. 2 Status of the Wolverine (*Gulo gulo*) in Alberta, by Stephen Petersen. 17 pp. (1997)

No. 3 Status of the Northern Long-eared Bat (*Myotis septentrionalis*) in Alberta, by M. Carolina Caceres and M. J. Pybus. 19 pp. (1997)

No. 4 Status of the Ord's Kangaroo Rat (*Dipodomys ordii*) in Alberta, by David L. Gummer. 16 pp. (1997)

No. 5 Status of the Eastern Short-horned Lizard (*Phrynosoma douglassii brevirostre*) in Alberta, by Janice D. James, Anthony P. Russell and G. Lawrence Powell. 20 pp. (1997)

No. 6 Status of the Prairie Rattlesnake (*Crotalus viridis viridis*) in Alberta, by Sheri M. Watson and Anthony P. Russell. 26 pp. (1997)

No. 7 Status of the Swift Fox (*Vulpes velox*) in Alberta, by Susan E. Cotterill. 17 pp. (1997)

No. 8 Status of the Peregrine Falcon (*Falco peregrinus anatum*) in Alberta, by Petra Rowell and David P. Stepnisky. 23 pp. (1997)

No. 9 Status of the Northern Leopard Frog (*Rana pipiens*) in Alberta, by Greg Wagner. 46 pp. (1997)

No. 9 Update 2003. Status of the Northern Leopard Frog (*Rana pipiens*) in Alberta. Alberta Sustainable Resource Development. 61 pp. (2003)

No. 10 Status of the Sprague's Pipit (*Anthus spragueii*) in Alberta, by David R. C. Prescott. 14 pp. (1997)

No. 11 Status of the Burrowing Owl (*Speotyto cunicularia hypugaea*) in Alberta, by Troy I. Wellicome. 21 pp. (1997)

No. 12 Status of the Canadian Toad (*Bufo hemiophrys*) in Alberta, by Ian M. Hamilton, Joann L. Skilnick, Howard Troughton, Anthony P. Russell, and G. Lawrence Powell. 30 pp. (1998)

No. 13 Status of the Sage Grouse (*Centrocercus urophasianus urophasianus*) in Alberta, by Cameron L. Aldridge. 23 pp. (1998)

No. 14 Status of the Great Plains Toad (*Bufo cognatus*) in Alberta, by Janice D. James. 26 pp. (1998)

No. 15 Status of the Plains Hognose Snake (*Heterodon nasicus nasicus*) in Alberta, by Jonathan Wright and Andrew Didiuk. 26 pp. (1998)

No. 16 Status of the Long-billed Curlew (*Numenius americanus*) in Alberta, by Dorothy P. Hill. 20 pp. (1998)

No. 17 Status of the Columbia Spotted Frog (*Rana luteiventris*) in Alberta, by Janice D. James. 21 pp. (1998)

No. 18 Status of the Ferruginous Hawk (*Buteo regalis*) in Alberta, by Josef K. Schmutz. 18 pp. (1999)

No. 19 Status of the Red-tailed Chipmunk (*Tamias ruficaudus*) in Alberta, by Ron Bennett. 15 pp. (1999)

No. 20 Status of the Northern Pygmy Owl (*Glaucidium gnoma californicum*) in Alberta, by Kevin C. Hannah. 20 pp. (1999)

No. 21 Status of the Western Blue Flag (*Iris missouriensis*) in Alberta, by Joyce Gould. 22 pp. (1999)

No. 22 Status of the Long-toed Salamander (*Ambystoma macrodactylum*) in Alberta, by Karen L. Graham and G. Lawrence Powell. 19 pp. (1999)

No. 23 Status of the Black-throated Green Warbler (*Dendroica virens*) in Alberta, by Michael R. Norton. 24 pp. (1999)

No. 24 Status of the Loggerhead Shrike (*Lanius ludovicianus*) in Alberta, by David R. C. Prescott and Ronald R. Bjorge. 28 pp. (1999)

No. 25 Status of the Plains Spadefoot (*Spea bombifrons*) in Alberta, by Richard D. Lauzon. 17 pp. (1999)

No. 26 Status of the Trumpeter Swan (*Cygnus buccinator*) in Alberta, by M. Lynne James. 21 pp. (2000)

No. 27 Status of the Pygmy Whitefish (*Prosopium coulteri*) in Alberta, by William C. Mackay. 16 pp. (2000)

No. 28 Status of the Short-eared Owl (*Asio flammeus*) in Alberta, by Kort M. Clayton. 15 pp. (2000)

No. 29 Status of the Willow Flycatcher (*Empidonax traillii*) in Alberta, by Bryan Kulba and W. Bruce McGillivray. 15 pp. (2001).

No. 30 Status of the Woodland Caribou (*Rangifer tarandus caribou*) in Alberta, by Elston Dzus. 47 pp. (2001)

No. 31 Status of the Western Spiderwort (*Tradescantia occidentalis*) in Alberta, by Bonnie Smith. 12 pp. (2001)

No. 32 Status of the Bay-breasted Warbler (*Dendroica castanea*) in Alberta, by Michael Norton. 21 pp. (2001)

No. 33 Status of the Cape May Warbler (*Dendroica tigrina*) in Alberta, by Michael Norton. 20 pp. (2001)

No. 34 Status of the Whooping Crane (*Grus americana*) in Alberta, by Jennifer L. White. 21 pp. (2001)

No. 35 Status of Soapweed (*Yucca glauca*) in Alberta, by Donna Hurlburt. 18 pp. (2001)

No. 36 Status of the Harlequin Duck (*Histrionicus histrionicus*) in Alberta, by Beth MacCallum. 38 pp. (2001)

No. 37 Status of the Grizzly Bear (*Ursus arctos*) in Alberta, by John L. Kansas. 43 pp. (2002)

No. 38 Status of the Wood Bison (*Bison bison athabascae*) in Alberta, by Jonathan A. Mitchell and C. Cormack Gates. 32 pp. (2002)

No. 39 Status of the Bull Trout (*Salvelinus confluentus*) in Alberta, by John R. Post and Fiona D. Johnston. 40 pp. (2002)

No. 40 Status of the Banff Springs Snail (*Physella johnsoni*) in Alberta, by Dwayne A.W. Lepitzki. 29 pp. (2002)

No. 41 Status of the Shortjaw Cisco (*Coregonus zenithicus*) in Alberta, by Mark Steinhilber. 23 pp. (2002)

No. 42 Status of the Prairie Falcon (*Falco mexicanus*) in Alberta, by Dale Paton. 28 pp. (2002)

No. 43 Status of the American Badger (*Taxidea taxus*) in Alberta, by Dave Scobie. 17 pp. (2002)

No. 44 Status of the Yucca Moth (*Tegeticula yuccasella*) in Alberta. Alberta Sustainable Resource Development. 21 pp. (2002)

No. 45 Status of the White-winged Scoter (*Melanitta fusca deglandi*) in Alberta. Alberta Sustainable Resource Development. 15 pp. (2002)

No. 46 Status of the Lake Sturgeon (*Acipenser fulvescens*) in Alberta. Alberta Sustainable Resource Development. 30 pp. (2002)

No. 47 Status of the Western Silvery Minnow (*Hybognathus argyritis*) in Alberta. Alberta Sustainable Resource Development. 24 pp. (2003)

No. 48 Status of the Small-flowered Sand Verbena (*Tripterocalyx micranthus*) in Alberta. Alberta Sustainable Resource Development. 24 pp. (2003)

No. 49 Status of the Brown Creeper (*Certhia americana*) in Alberta. Alberta Sustainable Resource Development. 30 pp. (2003)

No. 50 Status of the Mountain Plover (*Charadrius montanus*) in Alberta. Alberta Sustainable Resource Development. 25 pp. (2003)

No. 51 Status of the St. Mary Shorthead Sculpin (provisionally *Cottus bairdi punctulatus*) in Alberta. Alberta Sustainable Resource Development. 24 pp. (2004)

No. 52 Status of the Stonecat (*Noturus flavus*) in Alberta. Alberta Sustainable Resource Development. 22 pp. (2004)