Fisheries & Wildlife Management Division

RESOURCE STATUS AND ASSESSMENT BRANCH

Status of the Plains Spadefoot (Spea bombifrons) in Alberta

Richard D. Lauzon

Alberta Wildlife Status Report No. 25

Alberta Conservation Association

Alberta ENVIRONMENT

Status of the Plains Spadefoot (*Spea bombifrons*) in Alberta

Richard D. Lauzon

Alberta Wildlife Status Report No. 25

December 1999

Published By:

Alberta ENVIRONMENT

Alberta Conservation Association

Publication No. T/496
ISBN: 0-7785-0920-6
ISSN: 1206-4912

Series Editor: Isabelle M. G. Michaud
Senior Editor: David R. C. Prescott
Illustrations: Brian Huffman

For copies of this report, contact:
Information Centre - Publications
Alberta Environment
Natural Resources Service
Main Floor, Great West Life Building
9920 - 108 Street
Edmonton, Alberta, Canada T5K 2M4

Telephone: (780) 422-2079

OR

Information Service
Alberta Environment
#100, 3115 - 12 Street NE
Calgary, Alberta, Canada T2E 7J2

Telephone: (403) 297-3362

OR

Visit our website at:
http://www.gov.ab.ca/env/fw/status/reports/index.html

This publication may be cited as:

Lauzon, R. D. 1999. Status of the Plains Spadefoot (Spea bombifrons) in Alberta. Alberta Environment, Fisheries and Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 25, Edmonton, AB. 17 pp.

PREFACE

Every five years, the Fisheries and Wildlife Management Division of Alberta Natural Resources Service reviews the status of wildlife species in Alberta. These overviews, which have been conducted in 1991 and 1996, assign individual species to 'colour' lists 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 primary 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 1996 *Status of Alberta Wildlife* review process, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are potentially at risk in the province (Red or Blue listed), that are of uncertain status (Status Undetermined), or which 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 Fisheries and Wildlife Management Division of Alberta Environment, and are intended to provide detailed and up-to-date information which 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 which will assist the Alberta Endangered Species Conservation Committee to identify species that may be formally designated as endangered or threatened under the Alberta 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 Plains Spadefoot (Spea bombifrons) is currently on Alberta's 'Blue List' of species that may be at risk of declining to non-viable population levels in the province. This nocturnal toad spends most of its time underground, only emerging to breed during favourable conditions or to feed. Observational records are therefore rare. This report reviews information on the Plains Spadefoot in Alberta, as a step in updating its status in the province.

The Plains Spadefoot generally occurs in the plains of North America. The species reaches its northern range limit in Alberta where it occurs in the south-eastern portion of the province. There is no evidence to suggest that the range of the Plains Spadefoot is contracting. The lack of historical records makes it difficult to accurately assess population trends, but Alberta populations appear to be stable.

The most important limiting factor for the Plains Spadefoot appears to be alteration and destruction of its habitat. However, basic information on the ecology of the species is necessary before the impacts of human use of its habitat can be fully assessed.

ACKNOWLEDGEMENTS

I would like to thank Andrew Didiuk for providing his extensive literature database and comments on the draft report, Larry Powell and Cleve Wershler for their valuable comments on the draft report, and Isabelle Michaud for her editing skills and comments. I would also like to thank Howard Troughton who contacted numerous individuals in order to compile the data for the distribution map and was instrumental in the literature review process.

I would like to thank the following individuals and organizations who contributed locality information, natural history information, status information, or suggestions:

Alberta Ecological InfoService, Alberta Energy Co., Alberta Natural Heritage Information Centre, American Museum of Natural History, Peter Balagus (Axys), Lloyd Bennett, Steve Brechtel (Alberta Environmental Protection), Francis Cook (Canadian Field-Naturalist), Ross Dickson (Canadian Wildlife Service), Andrew Didiuk (Canadian Wildlife Service), Teresa Dolman, Gary Erickson (Alberta Environmental Protection), Express Pipelines Ltd., Eugenia Farrar (University of Iowa), Foothills Pipe Lines Ltd., Les Fuller (Axys), Rob Gardner, Lindsay Giles (Axys), Scott Grindal (Axys), Wayne Harris (Saskatchewan Environment and Resource Management), Helen Schuler Coulee Centre, Ed Hofman (Alberta Environmental Protection), Garry Hornbeck (Wildlife and Company Ltd.), Mike Houser (Express Pipelines Ltd.), Hope Johnson, Michael Klassen, Jane Lancaster (Kestrel Research), Ross MacCullough (Royal Ontario Museum), Bruce McGillivray (Provincial Museum of Alberta), Mike Norton (Alberta Environmental Protection), Rob Owens (Foothills Pipe Lines Ltd.), Liz Parkin (Biophysical Scientist), Larry Powell (University of Calgary), Provincial Museum of Alberta, Wes Richmond (CFB Suffield), Rick Riddell, Wayne Roberts (University of Alberta), Tony Russell (University of Calgary), Elizabeth Saunders (City of Lethbridge), Bill Sharp, Wayne Smith, Michele Steigerwald (Canadian Museum of Nature), University of Calgary Vertebrate Collection, Ben Velner, Cliff Wallis, Cleve Wershler, Earl Wiltse (Saskatchewan Environment and Resource Management), Jonathan Wright.

Preparation of this report was funded by the Wildlife Management Enhancement Program of the Alberta Conservation Association.

TABLE OF CONTENTS

PREFACE iii

EXECUTIVE SUMMARY iv

ACKNOWLEDGEMENTS v

INTRODUCTION 1

HABITAT 1

CONSERVATION BIOLOGY 2

DISTRIBUTION 4
1. Alberta 4
2. Other Areas 6

POPULATION SIZE AND TRENDS 6
1. Alberta 6
2. Other Areas 6

LIMITING FACTORS 8
1. Habitat Alteration and Destruction 8
2. Oil and Gas Exploration/Development 9
3. Road Kills 9

STATUS DESIGNATIONS 9
1. Alberta 9
2. Other Areas 10

RECENT MANAGEMENT IN ALBERTA 10

SYNTHESIS 10

LITERATURE CITED 12

APPENDIX 1 16

INTRODUCTION

The Plains Spadefoot (Spea bombifrons) is a nocturnal toad that spends most of its life underground. The spadefoot toads are not true toads (Family Bufonidae) but belong to the primitive family Pelobatidae. The Plains Spadefoot is considered a 'Blue List[1]' species in Alberta (Alberta Wildlife Management Division 1996).

Because the Plains Spadefoot is so rarely observed, few records exist from Alberta. However, increased researcher effort in recent years has augmented the information available on this species. This report summarizes current and historic information on the Plains Spadefoot as a step in reviewing its status in Alberta.

HABITAT

Spadefoot toad species are confined to the more arid regions of western North America. The Plains Spadefoot occupies habitats ranging from deserts in the southwest United States to aspen parkland in the Canadian prairies (Cook and Hatch 1964, Cottonwood Consultants 1986). In Alberta, the Plains Spadefoot primarily occurs in the Grassland Natural Region although there have been observations from the Parkland Natural Region (Cottonwood Consultants 1986, Achuff 1994, Lauzon and Balagus 1998). Within these Natural Regions, the Plains Spadefoot occurs in the Dry Mixedgrass, Mixedgrass, Northern Fescue, Foothills Fescue, and Central Parkland Subregions.

The Plains Spadefoot is well adapted to a xeric environment (Bragg 1965). Habitats in which it has been found include unvegetated sand dunes, sand dunes with willow and cottonwood, upland prairie, desert, short and mixedgrass prairie, and sagebrush (Bragg 1944, Black 1970, Huggins 1971, Stebbins 1985). In Alberta, Plains Spadefoots have been observed in shortgrass prairie, mixed grassland and shrubland, fescue grassland, sand dunes, floodplains, and aspen parkland (Cottonwood Consultants 1986, Axys Environmental Consulting Ltd. 1996, Axys Environmental Consulting Ltd. 1997, R. Lauzon, unpubl. data).

Throughout most of its range, the distribution of the Plains Spadefoot is strongly correlated with the presence of sandy, gravelly, or sandy loam soils (Bragg 1944, Cook 1960, Black 1970, Huggins 1971, Femmer 1978, Collins 1982, Stebbins 1985). Likewise, the occurrence of the Plains Spadefoot in Alberta is strongly correlated with sandy soils. All known observations of Plains Spadefoots in the province originate from areas of sandy glacial outwash, sand dunes, and sandy stream channels (Cottonwood Consultants 1986). Similarly, all observations made of Plains Spadefoots during several pipeline projects in Alberta and Saskatchewan were in or adjacent to habitats with sandy soils (Axys Environmental Consulting Ltd. 1997, R. Lauzon, unpubl. data). This affinity for sandy soils presents the Plains Spadefoot with limited breeding opportunities because sandy eolian deposits are rapidly drained, thus inhibiting the development of wetlands. Plains Spadefoots therefore rely on pockets of fine-textured, less permeable soils, within sandier habitats where temporary wetlands are formed (A. Didiuk, L. Parkin, pers. comm.).

The Plains Spadefoot breeds in a variety of wetland types. Wetlands used for breeding are predominantly temporary with variable

[1] See Appendix 1 for definitions of selected status designations

amounts of vegetation and may occur in native as well as tame habitats (Bragg 1965, Farrar and Hey 1995, Klassen 1998). On the Canadian prairies, Plains Spadefoots have been observed in partially flooded fields (predominantly agricultural fields; F. Cook, pers. comm.), roadside ditches, flooded dugouts, shallow temporary wetlands in fallow fields, native prairie and tame pastures, sandy planted fields, temporary ponds in uplands, along streams, semi-permanent ponds, oxbow lakes, and stream meander channels (Cook 1965, Cottonwood Consultants 1986, Preston and Hatch 1986, R. Lauzon, unpubl. data). In the Milk River area, Klassen (1998) found Plains Spadefoots breeding in sloughs with little vegetation, marshy depressions, flooded cultivated fields, temporary wetlands in pastures, river backwaters, and ditches. Non-native habitats where breeding Plains Spadefoots have been observed include a construction site (Femmer 1978), flooded soybean fields and cornfields (Farrar and Hey 1995), a flooded wheat field (Trowbridge and Trowbridge 1937) and even driveways and bicycle paths (A. Didiuk, R. Gardner, pers. comm.).

Breeding pond depths vary from 10 cm to more than 1 m (Bragg 1945, 1965, Femmer 1978, Preston and Hatch 1986, Farrar and Hey 1995). In Alberta, Plains Spadefoots have been found in wetlands from 15 to 40 cm deep (R. Lauzon, unpubl. data).

CONSERVATION BIOLOGY

Spadefoot toads resemble true toads (Family Bufonidae) in body form but have smoother, thinner skin like that of frogs. Unlike true toads, spadefoot toads have a vertical elliptical pupil and no parotoid gland. The spadefoots are named for their large, sharp metatarsal tubercles that are used to dig backwards to depths of almost 1 m (Baxter and Stone 1980, Russell and Bauer 1993). The Plains Spadefoot is active in Alberta from late May to fall, but it is seldom seen outside of breeding periods (Russell and Bauer 1993).

Spadefoot toads are well adapted to the dry conditions of deserts and prairies and breed opportunistically depending on suitable environmental conditions. Spadefoot toads emerge quickly and migrate to breeding wetlands during periods of heavy rainfall and warm temperatures (Bragg 1965, Klassen 1998, Lauzon and Balagus 1998). Measurements of the amount of rainfall required for Plains Spadefoot emergence vary from 2.5 to 10.4 cm (Black 1970, Femmer 1978, Farrar and Hey 1995). Although large choruses of Plains Spadefoots are associated with heavy rainfall, small choruses have been observed in southern Alberta in temporary wetlands that form as a result of light rain or snow melt (P. Balagus, A. Didiuk, C. Wershler, pers. comm.). Breeding Plains Spadefoots were observed in Oklahoma and Missouri in temperatures as low as 9°C and 10°C, respectively (Bragg 1945, Femmer 1978). Similarly, in Alberta, Klassen (1998) observed Plains Spadefoots calling when daily maximum temperatures were 12.5°C to 23.5°C and daily minimum temperatures were 7°C to 10.5°C. Plains Spadefoots called at air temperatures of 8°C to 14°C and water temperatures of 10.5°C to 16°C at the Suffield National Wildlife Area (north of Medicine Hat; A. Didiuk, pers. comm.) and at 9°C near Medicine Hat (R. Lauzon, unpubl. data).

Spadefoots breed quickly in order to take advantage of favourable breeding conditions and to allow the eggs and larvae as much time as possible to develop. In Oklahoma, the the

the largest congregation of males and females occurred the first night after or during heavy rains and numbers of adults decreased drastically thereafter (Bragg 1965). Similar timing of breeding has also been observed in Alberta (Lewin 1963, Klassen 1998). At the Suffield National Wildlife Area, Plains Spadefoots were typically heard calling from only one to two nights after heavy rains (A. Didiuk, pers. comm.).

Males precede females to the breeding wetland and males generally outnumber females at any given time and place (Bragg 1945, Baxter and Stone 1980). The male Plains Spadefoot's call is loud and harsh and may carry up to 3 km (Bragg 1945). In Alberta, single Plains Spadefoots could easily be heard from 1 km away and one large chorus along the South Saskatchewan River, north of Medicine Hat, could be heard from greater than 2 km (R. Lauzon, unpubl. data). Both sexes are greatly stimulated by the male spadefoot call and larger choruses attract more individuals of both sexes (Bragg 1945).

The breeding season of the Plains Spadefoot is not well defined. In Alberta and Montana breeding has been observed from early May through June (Lewin 1963, Black 1970, Klassen 1998, Lauzon and Balagus 1998, A. Didiuk, pers. comm.). In Saskatchewan, Plains Spadefoots have been heard calling in mid-June to early July and in Manitoba breeding has occurred as late as 7 August (Cook 1960, Preston 1982, A. Didiuk, pers. comm.). If suitable environmental conditions do not occur during the active season, Plains Spadefoots may not breed at all (Bragg 1945, Bragg 1965, Klassen 1998). During extended drought periods between 1978 and 1992, breeding did not take place during one or more consecutive years in the Milk River and Empress regions of Alberta (C. Wershler, pers. comm.). Conversely, breeding may occur more than once in a single year if conditions are particularly favourable (Bragg 1945).

Female Plains Spadefoots lay up to 2000 eggs in masses of 10 to 250 eggs each (Bragg 1965, Collins 1982). Unlike true toads which lay their eggs in strings, spadefoot eggs are laid in spherical masses, attached to submerged vegetation (Baxter and Stone 1980). Suspended soil particles and other debris attach to the sticky surface of the egg mass helping to camouflage the mass from predators (Bragg 1965). The rate of egg development is temperature dependant and under typical conditions, spadefoot eggs will hatch in about two days whereas it may take up to one week for frog eggs in the same wetland to hatch (Bragg 1965). Justus et al. (1977) found temperatures of <10°C and >34°C were lethal to Plains Spadefoot eggs.

As a group, spadefoot toads have the fastest larval development rate known among amphibians (Bragg 1961). The rate of larval development, like egg development, is temperature dependant (Buchholz and Hayes 1996). This adaptation allows the tadpoles to develop faster as the rate of evaporation of temporary wetlands increases. In Oklahoma, Bragg (1967) reported the time from hatching to metamorphosis in the Plains Spadefoot may be as little as 14 days and in Missouri, Femmer (1978) found that tadpoles metamorphosed 17 to 20 days after hatching. Tadpole development rate appears to be somewhat slower in Alberta where metamorphosis has been observed 21 to 34 days after hatching with some tadpoles requiring up to 60 days (Klassen 1998).

During periods of drought, Plains Spadefoots do not remain underground for years at a time

but, especially during humid weather, emerge to forage during evenings (Bragg 1965, Ruibal et al. 1969). As summer progresses and the soil becomes drier, Plains Spadefoots burrow deeper into the soil and emerge less frequently (Bragg 1965). During very dry conditions, Plains Spadefoots may burrow 60 to 90 cm below the surface (Bragg 1965). Plains Spadefoots will most often burrow along the edge of a solid object or near a plant that offers security or shade (Bragg 1944).

Plains Spadefoots burrow deeply to avoid freezing and desiccation during the winter (Baxter and Stone 1980). In Arizona, Plains Spadefoots have been found at depths of 91 cm during hibernation (Dimmit 1975, Ruibal et al. 1969). There are no published accounts of hibernation depths in Canada. The Plains Spadefoot is intolerant of freezing and must burrow below the frost line during the winter. However, this species does exhibit super cooling to -4.3°C (toads did not freeze at temperatures as low as -4.3°C) which would help the Plains Spadefoot avoid freezing in shallower burrows during the winter (Swanson and Graves 1995).

Studies have not been conducted on summer movements and home range size of Plains Spadefoots. The Eastern Spadefoot (Spea holbrooki holbrooki) has an average home range size of 10.1 m² with male home ranges generally larger than female home ranges (Pearson 1955). Female Eastern Spadefoots migrate up to 400 m to breeding wetlands then return to their home range. Plains Spadefoots are capable of migrating at least 1.6 km to breeding sites (Landreth and Christensen 1971). In Alberta, Klassen (1998) found juvenile Plains Spadefoots over 2 km from known breeding wetlands within several weeks of metamorphosis. However, these juveniles may have originated from unknown breeding ponds.

Spadefoots forage above ground and prey on a variety of insects. Insect prey in Oklahoma included flies, hymenopterans, moths (Saturniidae, Noctuidea, Notodontidea and others), beetles (Carabidae, Cincindellidae, Chrysomellidae and Scarabaeidae), pentatomids, and various spiders (Bragg 1944).

DISTRIBUTION

1. Alberta. - The known range of the Plains Spadefoot in Alberta is based predominantly on information gathered in the last 20 years, although there are a few older records of the species in the province. Recent increases in observers and search effort has also resulted in more sighting locations. The paucity of historic records for the species, makes it difficult to assess whether the range of the Plains Spadefoot in Alberta is expanding, contracting, or stable.

The Plains Spadefoot ranges further north than any other species of spadefoot toad and the species reaches its northern limit in Alberta (Cottonwood Consultants 1986, Lauzon and Balagus 1998). The Plains Spadefoot was first documented in Alberta in 1930 (Moore 1952) and since that time has been recorded throughout much of southeastern Alberta (Figure 1). Until recently, the distribution of the Plains Spadefoot in Alberta was believed to be from the Montana border north to the Red Deer River (approximately the latitude of Red Deer) and from the Saskatchewan border west as far as Pincher Creek (Russell and Bauer 1993). Prior to 1996, scattered occurrences north of the Red Deer River near Reflex Lakes and Dillberry Lake Provincial Park (north of Provost), and Sounding Lake (southwest of

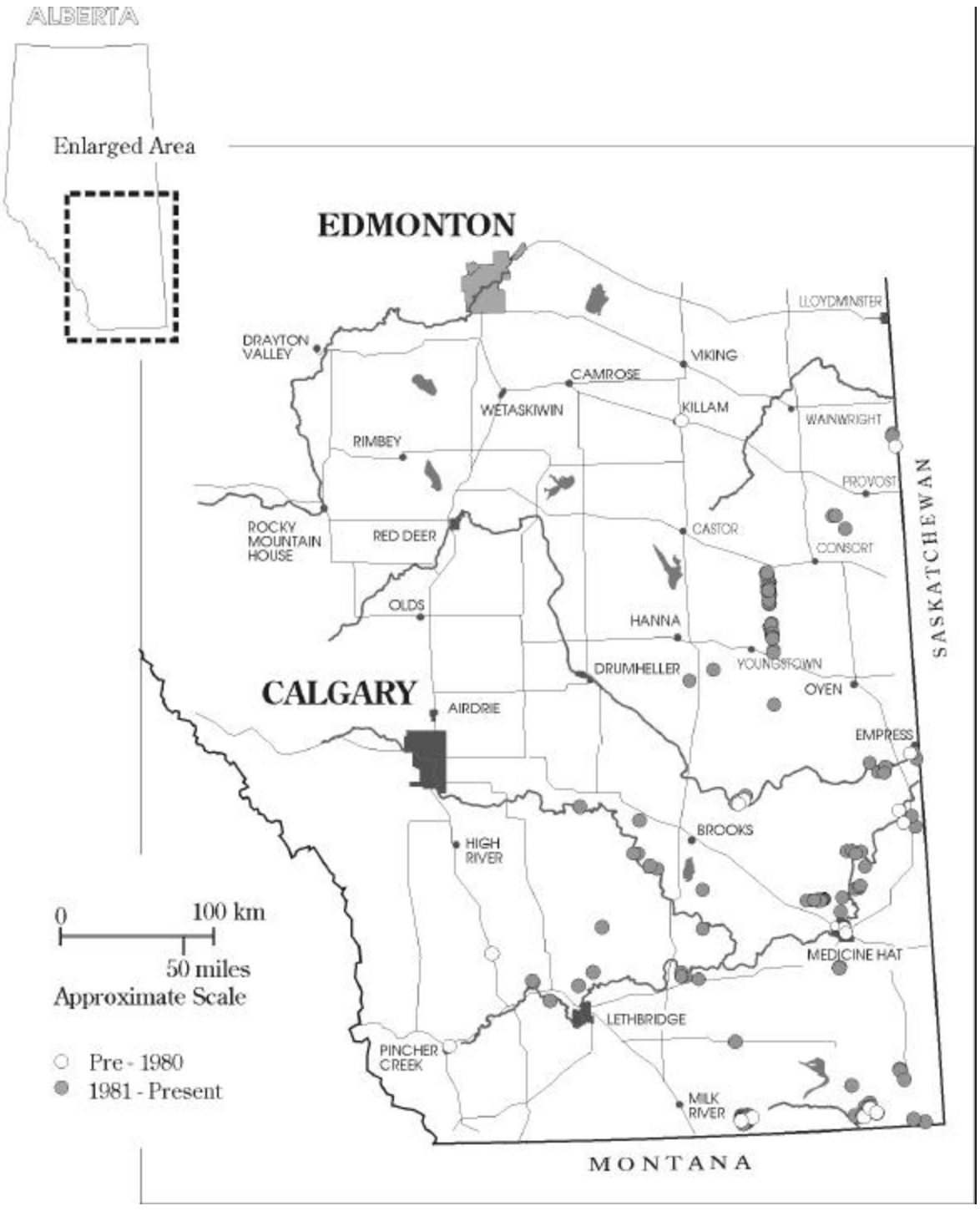

Figure 1. Distribution of the Plains Spadefoot in Alberta. Details of observation records are kept in the Biodiversity/Species Observation Database maintained by the Alberta Conservation Association and Alberta Environment.

Provost), as well as fossil records (Spea hammondi bombifrons) near Killam show that this species may be more widespread in the province (Bayrock 1964, Cottonwood Consultants 1986). Subsequent results of surveys conducted in 1996 have shown that this species is quite plentiful in sandy areas north of Youngstown (Lauzon and Balagus 1998; Figure 1).

2. Other Areas. - Stebbins (1985) describes the range of the Plains Spadefoot as the plains east of the Rocky Mountains from southern Alberta, Saskatchewan, and Manitoba to northwest Texas and Chihuahua, Mexico, east to Missouri and eastern Oklahoma and into eastern Arizona, with isolated populations in south Texas and Mexico (Figure 2). There is no published information to indicate that the range of this species is contracting in North America.

In Canada, the range of the Plains Spadefoot extends east through southern Saskatchewan and into the southwest corner of Manitoba (Figure 2). In Saskatchewan, Plains Spadefoots have been found as far north as Alsask along the Alberta border and near Saskatoon (Moore 1952, A. Didiuk, pers. comm.). The Plains Spadefoot has also been observed south of Saskatoon near Outlook and Elbow, in southwest Saskatchewan at Moose Jaw, Uren, Mortlach, northeast of Maple Creek, and Caron, and in southeast Saskatchewan at Roche Percée and near Moosomin (Cook 1965, Morlan and Matthews 1992, A. Didiuk, unpubl. data). It is likely that the Plains Spadefoot occurs in sandy areas in Saskatchewan adjacent to those in Alberta, such as the Manitou Hills. In southwest Manitoba, the Plains Spadefoot has been observed in only a few localities in the southwestern portion of the province (Cook and Hatch 1964, Preston 1982, Preston and Hatch 1986).

POPULATION SIZE AND TRENDS

1. Alberta. - Because historical data arelacking, it is difficult to assess the population size and trend of the Plains Spadefoot in the Alberta. Until recently, observations of Plains Spadefoots in Alberta were localized and widely scattered. Since 1990, the species has been observed more frequently and at more locations. The increased number of observations is likely a result of increased search effort combined with moist conditions during the 1990s rather than an actual population increase. Furthermore, many of observations lack information on the number of individuals observed at each location.

Dramatic spadefoot population declines observed during extended periods of drought (Cottonwood Consultants 1986) are likely a result of non-breeding during unfavourable conditions as opposed to actual population declines. Klassen (1998) found that Plains Spadefoots did not breed in one of the five years of his study near Milk River Provincial Park when no breeding wetlands were formed because of insufficient rainfall. Cottonwood Consultants (1986) noted that, taking natural fluctuations into account, Alberta populations appear to be stable and no long-term declines have been documented.

2. Other Areas. - Amphibian population declines in North America are most prevalent in the west and have affected amphibians in a variety of habitats (Corn 1994). However, spadefoot toads as a group do not include any declining species (Corn 1994).

In Saskatchewan, Plains Spadefoot populations

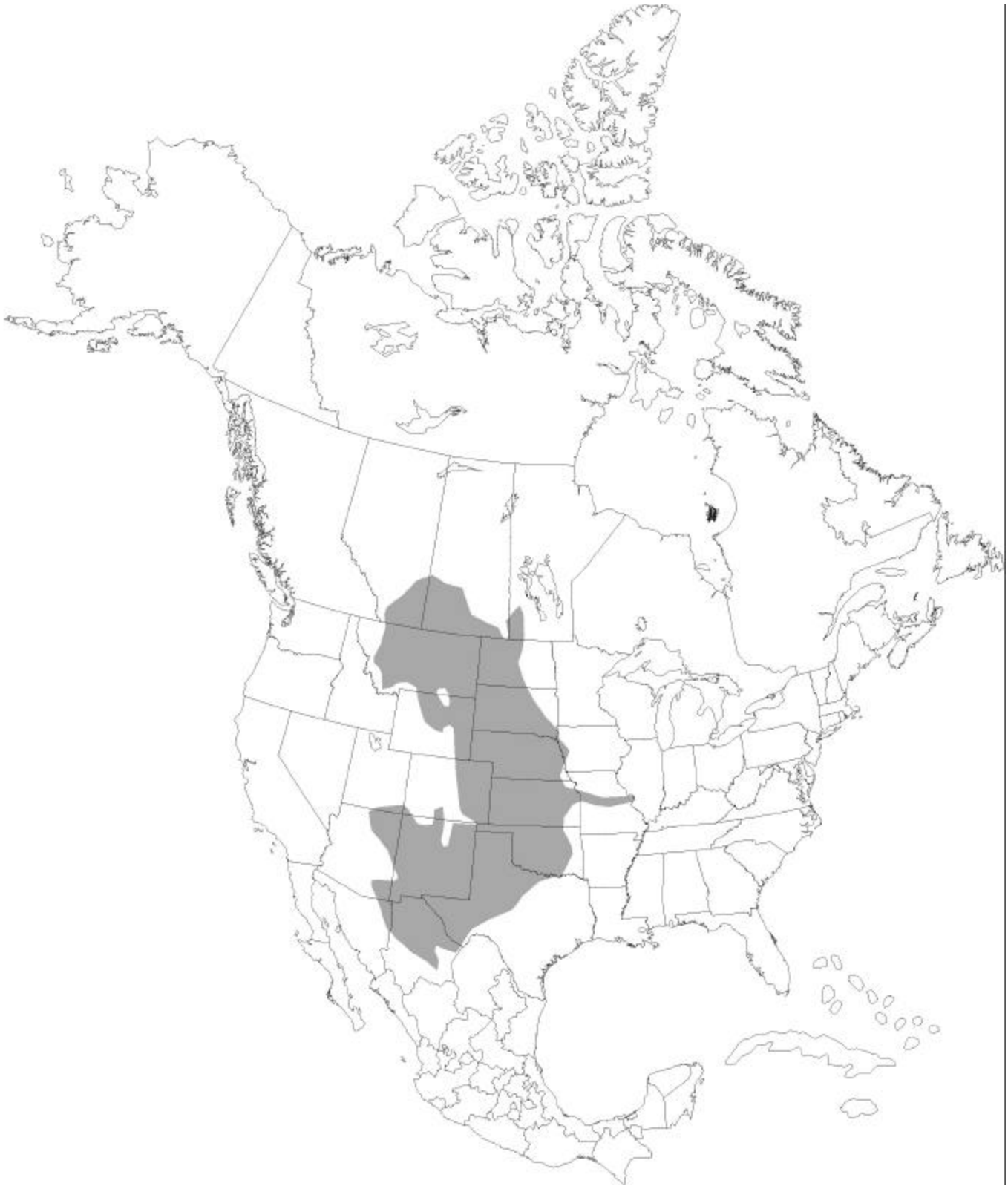

Figure 2. Distribution of the Plains Spadefoot in North America (adapted from Cook and Hatch 1964, Cook 1965, Stebbins 1985, Lauzon and Balagus 1998, A. Didiuk, pers. comm.).

are localized and are believed to be stable (Didiuk 1997). Secoy and Vincent (1976) indicated that the Plains Spadefoot was not numerous in Saskatchewan at that time and the status was unknown. The population estimate for Manitoba ranges from 3000-10 000 Plains Spadefoots occupying 6-20 locations (Duncan et al. 1994). The population is considered stable but moderately threatened by current land use practices. The lack of historic records across the Plains Spadefoot's range makes it difficult to assess population trends.

LIMITING FACTORS

Limiting factors are those that lower habitat quality or decrease survival and reproduction. Various factors that may affect Plains Spadefoots have been suggested, but few of these have been investigated as to their specific impacts. The population size of the Plains Spadefoot is likely limited by the availability of breeding and wintering habitat. The following section discusses factors that may affect breeding and wintering habitat with an emphasis on human-caused impacts.

1. Habitat Alteration and Destruction. - It is estimated that up to 77% of native Canadian prairie has been lost to cultivation, roads, urbanization and other human activities (Samson and Knopf 1994). In Alberta, up to 61% of native prairie in the Mixedgrass Ecoregion has been lost (Samson and Knopf 1994). Agriculture, which is responsible for the conversion of most native prairie habitat, may be the largest, most important threat to the Plains Spadefoot. Cultivation and drainage of wetlands, and flood control have been identified as threats to the Plains Spadefoot in Alberta (Cottonwood Consultants 1986). The extent to which the highly fragmented prairie landscape affects toad movements between populations or the re-colonization of extirpated populations is not known (Didiuk 1997). However, if breeding wetland basins are cultivated during dry years, the ability of those basins to hold water in wet years may be affected (Didiuk 1997). Although Plains Spadefoots have been observed in cultivated areas, the extent to which successful breeding occurs (Klassen 1998) and how their movements across or use of this habitat type outside the breeding season is affected is unknown.

Disturbance of wetlands by cattle has negatively affected other amphibian species and may have a negative impact on the Plains Spadefoot (Cottonwood Consultants 1986). In British Columbia, cattle prints in breeding wetlands trap Great Basin Spadefoot tadpoles preventing them from reaching deeper areas of the wetland as it dries (Orchard 1992). High turbidity, with high nutrient loading from cattle feces, resulting in greatly reduced dissolved oxygen content has been linked to complete die-offs of Tiger Salamanders (Ambystoma tigrinum) at Suffield National Wildlife Area and may have impacted other amphibian species (A. Didiuk, unpubl. data). However, Klassen (1998) found that Plains Spadefoots near Milk River successfully reproduced in wetlands that were heavily disturbed by cattle.

The widespread use of herbicides and pesticides can also have negative effects on amphibian development, habitat quality and prey species (Bishop 1992, Berrill et al. 1997, Bonin et al. 1997). The specific effects of these chemicals on Plains Spadefoots is unknown. It is also not known how species that utilize temporary wetlands are affected by water management projects such as damming of creeks, construction of dugouts, or creation of permanent wetlands in temporary wetland basins (C. Wershler, pers. comm.). These water management strategies may benefit some wide-

ranging species that do not normally occur in an area to the detriment of species already occurring in the same area such as the Plains Spadefoot. Water management projects may also have an effect on local ground water thus hindering the formation of temporary wetlands.

2. Oil and Gas Exploration/Development. - Activities associated with the oil and gas industry are common throughout the Alberta range of the Plains Spadefoot. Wershler and Smith (1992) listed disruption of groundwater resources, ground and surface water contamination, and the consumptive use of water sources by drilling activities as potential threats to the Great Plains Toad (Bufo cognatus) in Alberta. These activities may also pose a threat to the Plains Spadefoot which occurs in many of the same areas as the Great Plains Toad. Plains Spadefoots are likely to get trapped in sunken gas well caissons[2] and open pipeline trenches. Great Plains Toads were found trapped in caissons in CFB Suffield and at the Suffield National Wildlife Area (A. Didiuk, unpubl. data). Pipelines regulated by the Natural Resources Conservation Board are usually constructed during late summer to early winter to avoid the sensitive spring breeding season. This construction schedule helps reduce the impacts to Plains Spadefoots and other amphibians.

3. Road Kills. - Documentation of Plains Spadefoots in some areas has been as a result of observations of the species on roads at night (Nero 1959, Cook 1960, Cook 1965). In Oklahoma, Bragg (1944) observed hundreds of Plains Spadefoots on roads at night and reported that many fall victim to vehicles, especially when large numbers of toads are migrating to breeding wetlands. An additional effect of oil and gas activity is the increased traffic on roads resulting from pipeline development or maintenance of wells. During a pipeline construction project in eastern Alberta, numerous juvenile Plains Spadefoots and Canadian Toads (Bufo hemiophrys) were found on a sandy road adjacent to the pipeline right-of-way (Lauzon and Balagus 1998).

STATUS DESIGNATIONS

1. Alberta. - In both the 1991 and 1996 *Status of Alberta Wildlife* assessments (Alberta Fish and Wildlife 1991, Alberta Wildlife Management Division 1996), the Plains Spadefoot was included on the 'Blue List' of species that may be at risk of declining to non-viable population levels in the province (see Appendix 1). This status was assigned based on the species' highly variable population status, which is related to the annual availability of breeding wetlands. The Plains Spadefoot is included on the Alberta Natural Heritage Information Centre's (ANHIC 1999) watch list and is ranked as S3 (see Appendix 1 for explanation of ranks).

Butler and Roberts (1987) included the Plains Spadefoot among seven reptiles and amphibians in Alberta, most of which occur in prairie habitats, that are uncommon enough to be considered threatened and deserve "special consideration". The Prairie Conservation Action Plan (World Wildlife Fund 1988) recognized 10 species of reptiles and amphibians, including the Plains Spadefoot, as species of concern. In Alberta, the Plains Spadefoot is protected as a non-game species under the Alberta Wildlife Act.

[2] The caissons at CFB Suffield are square pits used to enclose well heads, meters, etc. They are covered by metal grating and plywood. The covers do not provide complete coverage, and various holes are present along the edges (A. Didiuk, pers. comm.).

2. Other Areas. - The Committee on the Status of Endangered Wildlife in Canada has not assigned a status to the Plains Spadefoot (COSEWIC 1999) but a status report is being prepared and the status will be assessed at a later date (A. Didiuk, pers. comm.). Natural Heritage Programs assess the conservation status of all the species and ecosystems in their databases, and provide ranks based on a globally congruous set of criteria (Appendix 1; see The Nature Conservancy 1999 and associated links). The Plains Spadefoot has a global rank of G5 meaning the species is 'demonstrably secure' across its global range (The Nature Conservancy 1999); the species is ranked as S3 in Saskatchewan and S3S4 in Manitoba (Manitoba Conservation Data Centre 1998, Saskatchewan Conservation Data Centre 1999). In Saskatchewan, Secoy (1987) tentatively assigned a status of 'rare' to the Plains Spadefoot based on the species being at the edge of its range, or having a narrow habitat requirement. Seburn (1992) stated that the status of the Plains Spadefoot is of particular concern, based on the few occurrences of this species in Saskatchewan. Saskatchewan has no legal designation for wildlife species at the current time (E. Wiltse, pers. comm.). No amphibian species in Manitoba were considered endangered in 1987 (Preston 1987). The Plains Spadefoot is generally regarded as being rare in the province but as a result of work by Preston and Hatch (1986), the species may be more abundant than originally thought (Preston 1987). In the states adjoining its Canadian range, the Plains Spadefoot is not included on any list of rare, endangered, threatened, or sensitive species (See The Nature Conservancy 1999 and associated links).

RECENT MANAGEMENT IN ALBERTA

There are no specific management plans or research projects on the Plains Spadefoot in Alberta.

SYNTHESIS

The Plains Spadefoot occurs at the northern edge of its continental range in Alberta. The species is very well adapted to the variable and often dry conditions of the prairies. There are currently no population estimates for Alberta, however, although populations fluctuate in response to varying environmental conditions, over the long term, they appear to be stable. Nevertheless, before the status of this species can be adequately assessed, a number of recommendations can be made to better evaluate the population trend and ecology of this species in the province.

Research into terrestrial habitat use, summer movements, home range size, and hibernation requirements is important to clearly identify impacts from industry and agriculture and to develop effective mitigation strategies. Understanding the ecology of this species in areas of native prairie versus agricultural areas would provide information on the effects of agriculture, which is perhaps the largest threat to this species in prairie Canada.

The Alberta Amphibian Monitoring Project, a volunteer program, was implemented to investigate changes in populations or ranges of Alberta amphibians and may provide important baseline information on populations and distribution. In order for this program, or any Plains Spadefoot monitoring program, to benefit data collection for the species, the survey methodology must be structured so that

volunteers are aware of the breeding habits of the species. Specifically, spadefoots may be present at breeding wetlands for only three days following heavy rains and may only be active at night so it is imperative that volunteers conduct surveys accordingly. Visits to the same wetlands during subsequent rainfalls may provide information on multiple breeding events during a single year. Identifying areas with sandy soils may help identify those areas of suitable habitat where future surveys could be conducted.

LITERATURE CITED

Achuff, P. 1994. Natural Regions, Subregions and Natural History Themes of Alberta: a classification for protected areas management. Alberta Environmental Protection, Edmonton, AB. 72 pp.

Alberta Fish and Wildlife. 1985. A policy for the management of threatened wildlife in Alberta. Alberta Fish and Wildlife, Edmonton, AB. 34 pp.

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

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

ANHIC. 1999. Elements on the watch list. Alberta Natural Heritage Information Centre. URL: http://www.gov.ab.ca/env/parks/anhic/wtchanhi.html [Revision date: 16 Feb. 1999].

Axys Environmental Consulting Ltd. 1996. 1996 wildlife surveys for the proposed Express Pipeline project. Prepared for Express Pipeline, a division of Alberta Energy Company Ltd. and TransCanada Pipelines Ltd., Calgary, AB. 49 pp. plus appendices.

Axys Environmental Consulting Ltd. 1997. 1997 wildlife surveys for the proposed AEC Suffield Gas Pipeline Project. Prepared for Alberta Energy Company Ltd., Calgary, AB. 29pp.

Baxter, G. T., and M. D. Stone. 1980. Amphibians and reptiles of Wyoming. Wyoming Game and Fish Dept., Cheyenne, WY. 137 pp.

Bayrock, L. A. 1964. Fossil Scaphiopus and Bufo in Alberta. J. Paleont. 38:1111-1112.

Berrill, M., S. Bertram, and B. Pauli. 1997. Effects of pesticides on amphibian embryos and larvae. Pp. 233-245 in Amphibians in Decline: Canadian studies of a global problem (D. M. Green, ed.). Herpetological Conservation No. 1. 338 pp.

Bishop, C. A. 1992. The effects of pesticides on amphibians and the implications for determining causes of declines in amphibian populations. Pp. 19-20 in Declines in Canadian amphibian populations: designing a national monitoring strategy (C.A. Bishop and K. Pettit, eds.). Can. Wildl. Serv. Occ. Paper No. 76, Ottawa, ON. 120 pp.

Black, J. H. 1970. Amphibians of Montana. (V. Craig, ed.) Montana Wildlife, Animals of Montana Series 1:1-32.

Bonin, J., M. Ouellet, J. Rodrigue, and J. DesGranges. 1997. Measuring the health of frogs in agricultural habitats subjected to pesticides. Pp. 246-257 in Amphibians in Decline: Canadian studies of a global problem (D. M. Green, ed.). Herpetological Conservation No. 1. 338 pp.

Bragg, A. N. 1944. The spadefoot toads in Oklahoma with a summary of our knowledge of the group. Amer. Nat. 78:517-533.

Bragg, A. N. 1945. The spadefoot toads in Oklahoma with a summary of our

knowledge of the group: II. Amer. Nat. 79:52-72.

Bragg, A. N. 1961. A theory of the origin of spade-footed toads deduced principally by a study of their habits. Anim. Behav. 9:178-186.

Bragg, A. N. 1965. Gnomes of the night: the spadefoot toads. University of Pennsylvania Press, Philadelphia, PA. 127 pp.

Bragg, A. N. 1967. Recent studies on spadefoot toads. Bios 38:75-84.

Buchholz, D. R., and T. B. Hayes. 1996. Comparative larval biology in spadefoot toads. Am. Zool. 36:97A.

Butler, J. R., and W. Roberts. 1987. Considerations in the protection and conservation of amphibians and reptiles in Alberta. Pp. 133-135 in Endangered species in the prairie provinces (G. L. Holroyd, W. B. McGillivray, P. H. R. Stepney, D. M. Ealey, G. C. Trottier, and K. E. Eberhart, eds.). Provincial Museum of Alberta, Nat. Hist. Occ. Pap. No. 9, Edmonton, AB. 367 pp.

Collins, J. T. 1982. Amphibians and reptiles in Kansas. Second edition. Univ. Kansas Mus. Nat. Hist., Kansas Pub. Edu. Ser. 8, Lawrence, KS. 356 pp.

Cook, F. R. 1960. New localities for the Plains Spadefoot Toad, Tiger Salamander and the Great Plains Toad in the Canadian Prairies. Copeia 1960:363-364.

Cook, F. R. 1965. Additions to the known range of some amphibians and reptiles in Saskatchewan. Can. Field-Nat. 79:112-120.

Cook, F. R., and D. R. M. Hatch. 1964. A spadefoot toad from Manitoba. Can. Field-Nat. 78:60-61.

Corn, P. S. 1994. What we know and don't know about amphibian declines in the west. Pp. 59-67 in Sustainable ecological systems: implementing an ecological approach to land management. U.S.D.A. Forest Service General Technical Report RM-247, Fort Collins, CO. 363 pp.

COSEWIC. 1999. Canadian species at risk. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 22 pp.

Cottonwood Consultants. 1986. An overview of reptiles and amphibians in Alberta's grassland and parkland natural regions. Prepared for Wild West Program, World Wildlife Fund Canada, Toronto, ON. 63 pp. plus appendices.

Didiuk, A. 1997. Status of amphibians in Saskatchewan. Pp. 110-116 in Amphibians in decline: Canadian studies of a global problem (D. M. Green, ed.). Herpetological Conservation No. 1. 338 pp.

Duncan, J., E. Bredin, G. Hanke, B. Koonz, R. Larche, K. Leavesley, B. Preston, D. Ross, C. Scott, D. Stardom, K. Stewart, and P. Taylor. 1994. Estimated status of Manitoba amphibians based on criteria used by The Nature Conservancy's Conservation Data Centre Network. Pp. 93-103 in Proceedings of the Fourth Annual Meeting of the Task Force on Declining Amphibian Populations in Canada 1-3 October 1994, Manitoba Museum of Man and Nature, Winnipeg, MB.

Farrar, E. S., and J. D. Hey. 1995. Plains Spadefoot (Scaphiopus bombifrons) distribution, breeding habitat characterization, and natural history studies in western Iowa: 1995 studies. Wildlife Diversity Program Grant Report 1995, Boone, IA. 8 pp. plus appendices.

Femmer, S. R. 1978. Distribution and life history studies of Scaphiopus bombifrons Cope and Bufo cognatus Say in Missouri. M.A. thesis, University of Missouri, Columbia, MO. 58 pp..

Huggins, D. G. 1971. Scaphiopus bombifrons Cope, a species new to Iowa. J. Herpetol. 5:216.

Justus, J. T., M. U. T. Sandomir, and B. O. Ewan. 1977. Developmental rates of two species of toads from the desert southwest. Copeia 1977:592-594.

Klassen, M. A. 1998. Observations on the breeding and development of the Plains Spadefoot, Scaphiopus bombifrons, in southern Alberta. Can. Field-Nat. 112:387-392.

Landreth, H. F., and M. T. Christensen. 1971. Orientation of the Plains Spadefoot Toad, Scaphiopus bombifrons, to solar cues. Herpetologica 27:454-461.

Lauzon, R. D., and P. Balagus. 1998. New records from the northern range of the Plains Spadefoot Toad, Spea bombifrons, in Alberta. Can. Field-Nat. 112:506-509.

Lewin, V. 1963. The herpetofauna of southeastern Alberta. Can. Field-Nat. 77:203-214.

Mills, G. S. 1977. American Kestrel rejects captured spadefoot toad. Wilson Bull. 89:623.

Moore, J. E. 1952. The spadefoot toad, Scaphiopus, in Alberta. Copeia 1952:278.

Morlan, R. E., and J. V. Matthews, Jr. 1992. Range extension for the Plains Spadefoot, Scaphiopus bombifrons, inferred from owl pellets found near Outlook, Saskatchewan. Can. Field-Nat. 106:311-315.

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

Nero, R. W. 1959. The spadefoot toad in Saskatchewan. Blue Jay 17:41-42.

Orchard, S. A. 1992. Amphibian population declines in British Columbia. Pp. 10-13 in Declines in Canadian amphibian populations: designing a national monitoring strategy (C. A. Bishop and K. Pettit, eds.). Canadian Wildlife Service, Occ. Pap. No. 76, Ottawa, ON. 120 pp.

Pearson, P. G. 1955. Population ecology of the spadefoot toad, Scaphiopus h. holbrooki (Harlan). Ecol. Monogr. 25:233-267.

Preston, W. B. 1982. The amphibians and reptiles of Manitoba. Manitoba Museum of Man and Nature, Winnipeg, MB. 128pp.

Preston, W. B. 1987. Amphibians and reptiles in Manitoba. Pp. 143-144 in Endangered Species in the Prairie Provinces (G. L. Holroyd, W. B.

McGillivray, P. H. R. Stepney, D. M. Ealey, G. C. Trottier, and K. E. Eberhart, eds.). Provincial Museum of Alberta, Nat. Hist. Occ. Pap. No. 9, Edmonton, AB. 367 pp.

Preston, W. B., and D. R. M. Hatch. 1986. The Plains Spadefoot, Scaphiopus bombifrons, in Manitoba. Can. Field-Nat. 100:123-125.

Ruibal, R., L. Tevis, Jr., and V. Roig. 1969. The terrestrial ecology of the spadefoot toad Scaphiopus hammondii. Copeia 1969:571-584.

Russell, A. P., and A. M. Bauer. 1993. The amphibians and reptiles of Alberta. University of Calgary Press, Calgary, AB. 264 pp.

Samson, F., and F. Knopf. 1994. Prairie conservation in North America. BioScience 44:418-421.

Saskatchewan Conservation Data Centre. 1999. Vertebrate Species List. URL: http://www.biodiversity.sk.ca/FTP.htm. [Accessed: 15 Sept. 1999].

Seburn, C. N. L. 1992. The status of amphibian populations in Saskatchewan. Pp. 17-18 in Declines in Canadian amphibian populations: designing a national monitoring strategy (C. A. Bishop and K. Pettit, eds.). Canadian Wildlife Service, Occ. Pap. No. 76, Ottawa, ON. 120 pp.

Secoy, D. M. 1987. Status report on the reptiles and amphibians of Saskatchewan. Pp. 139-141 in Endangered Species in the Prairie Provinces (G. L. Holroyd, W. B. McGillivray, P. H. R. Stepney, D. M. Ealey, G. C. Trottier, and K. E. Eberhart, eds.). Provincial Museum of Alberta, Edmonton, AB, Nat. Hist. Occ. Paper No. 9, Edmonton, AB. 367 pp.

Secoy, D. M., and T. K. Vincent. 1976. Part I: distribution and population status of Saskatchewan's amphibians and reptiles. Saskatchewan Department of the Environment, Regina, SK. 42pp.

Stebbins, R. C. 1985. A field guide to western reptiles and amphibians, second edition. Houghton Mifflin Co., Boston, MA. 336 pp.

Swanson, D. L., and B. M. Graves. 1995. Supercooling and freeze intolerance in overwintering juvenile spadefoot toads (Scaphiopus bombifrons). J. Herpetol. 29:280-285.

The Nature Conservancy. 1999. The Natural Heritage Network. URL: http://www.heritage.tnc.org/index.html [Accessed: 15 July 1999].

Trowbridge, A. H., and M. S. Trowbridge. 1937. Notes on the cleavage rate of Scaphiopus bombifrons Cope, with additional remarks on certain aspects of its life history. Amer. Nat. 71:460-480.

Wershler, C., and W. Smith. 1992. Status of the Great Plains Toad in Alberta – 1990. World Wildlife Fund Canada (Prairie for Tomorrow)/Alberta Forestry, Lands and Wildlife, Edmonton, AB. 23 pp.

World Wildlife Fund. 1988. Prairie Conservation Action Plan. World Wildlife Fund Canada, Toronto, ON. 38 pp.

APPENDIX 1. Definitions of selected legal and protective designations.

A. Status of Alberta Wildlife colour lists (after Alberta Wildlife Management Division 1996)

Red	Current knowledge suggests that these species are at risk. These species have declined, or are in immediate danger of declining, to nonviable population size
Blue	Current knowledge suggests that these species may be at risk. These species have undergone non-cyclical declines in population or habitat, or reductions in provincial distribution
Yellow	Species that are not currently at risk, but may require special management to address concerns related to naturally low populations, limited provincial distributions, or demographic/life history features that make them vulnerable to human-related changes in the environment
Green	Species not considered to be at risk. Populations are stable and key habitats are generally secure
Undetermined	Species not known to be at risk, but insufficient information is available to determine status

B. Alberta Wildlife Act

Species designated as 'endangered' under the Alberta Wildlife Act include those defined as 'endangered' or 'threatened' by *A Policy for the Management of Threatened Wildlife in Alberta* (Alberta Fish and Wildlife 1985):

Endangered	A species whose present existence in Alberta is in danger of extinction within the next decade
Threatened	A species that is likely to become endangered if the factors causing its vulnerability are not reversed

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 1999)

Extirpated	A species no longer existing in the wild in Canada, but occurring elsewhere
Endangered	A species facing imminent extirpation or extinction
Threatened	A species likely to become endangered if limiting factors are not reversed
Vulnerable	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 not to be at risk
Indeterminate	A species for which there is insufficient scientific information to support status designation

D. 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

E. Natural Heritage Element Rarity Ranks (after The Nature Conservancy 1999)

Global or G-rank: Based on the range-wide status of a species.
Sub-national or S-rank: Based on the status of a species in an individual state or province. S-ranks may differ between states or provinces based on the relative abundance of a species in each state or province.

G1 / S1	Critically imperiled because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction
G2 / S2	Imperiled because of rarity (6 to 20 occurrences), or because of other factors demonstrably making it very vulnerable to extinction throughout its range
G3 / S3	Either very rare or local throughout its range, or found locally in a restrcited range (21 to 100 occurrences)
G4 / S4	Apparently secure, though it might be quite rare in parts of its range, especially at the periphery
G5 / S5	Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery

List of Titles in This Series
(as of December 1999)

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. 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)