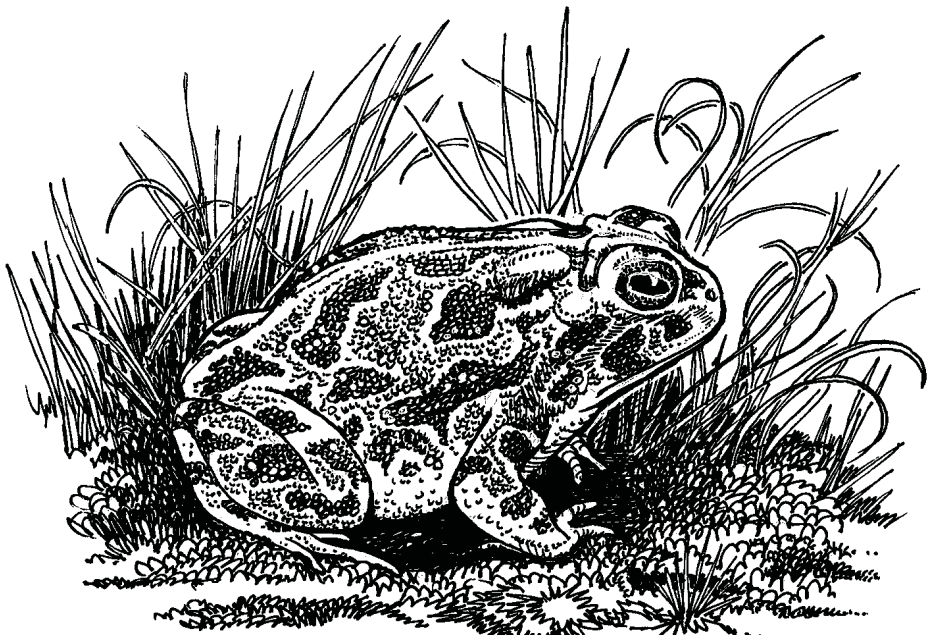
Fish & Wildlife Division

SPECIES AT RISK

Status of the Great Plains Toad (*Bufo* [*Anaxyrus*] *cognatus*) in Alberta:

Update 2009



Alberta Wildlife Status Report No. 14 (Update 2009)

Alberta Conservation Association

Government of Alberta

Status of the Great Plains Toad (*Bufo* [*Anaxyrus*] *cognatus*) in Alberta:

Update 2009

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

Update prepared by:
Kimberly J. Pearson

Much of the original work contained in the report was prepared by Janice D. James in 1998.

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

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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*), 2000 (*The General Status of Alberta Wild Species 2000*), and 2005 (*The General Status of Alberta Wild Species 2005*) 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 1998 review of the status of the Great Plains toad (*Bufo* [*Anaxyrus*] *cognatus*) in Alberta resulted in the species' designation as *Data Deficient*. The *General Status of Alberta Wild Species 2005* ranks the species as *May Be At Risk* and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designates the Great Plains toad as a species of *Special Concern* in Canada. This report reviews current information on the Great Plains toad in Alberta as a step towards updating its provincial status.

The Great Plains toad prefers ephemeral, clear, shallow ponds within areas of sandy soil in the mixed grasslands of southeastern Alberta, which is the northwestern extreme of the species' global range. The majority of the species' approximately 10-year lifespan is spent burrowed underground in upland habitats, and they are thus very difficult to detect. Most of the species' occurrences have been recorded during high spring precipitation events, which initiate breeding activity.

Based on data available to 2008 and the locations of preferred sand hill and sand plain habitats and less suitable cultivated areas, six general Great Plains toad populations appear to exist within Alberta. The largest of these extends south from Empress to Medicine Hat. Others are located in the Many Island Lake/Walsh, Wrentham/Skiff, Onefour, Tilley/Bow City/Rolling Hills, and Hays/Taber/Grassy Lake areas.

Despite severe drought conditions in southern Alberta during the early 2000s, many apparently new Great Plains toad occurrences were identified between 1998 and 2008 because of heavy rainfall events in 2000, 2005, and 2006. Given a lack of long-term, consistent, and standardized monitoring, estimating Alberta's Great Plains toad population size and trends can only be done roughly. Unfortunately, no null survey data are available to clarify where the Great Plains toad has been searched for but not found. However, based on available data, it is estimated that approximately 2100 to 10 000 Great Plains toads inhabit Alberta. Given the considerable degree of habitat loss and disturbance as a result of cultivation of sandy soil areas for agriculture, oil and gas developments, and other developments, the species has likely been experiencing a downward population trend in Alberta. To monitor the species for conservation purposes, long-term, repeat surveys should occur, and null survey data must be collected and managed appropriately.

Several anthropogenic influences such as hydrologic changes, habitat alteration and destruction, pesticides, roadway mortality, oil and gas exploration and development, and increasing rates of amphibian disease combine with natural climatic and predation impacts to threaten the long-term viability of the Great Plains toad population in Alberta. Aside from several surveys for Great Plains toad presence, no species-specific management or research has taken place in the province to date. The species' apparently small population, limited distribution, difficulty of detection, and the development and disturbance of native habitats warrant cautious consideration to ensure the long-term conservation of the Great Plains toad in Alberta.

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INTRODUCTION

The status of the Great Plains toad (*Bufo [Anaxyrus] cognatus*), a moderately large toad species whose range extends northwards into southeastern Alberta, has been of concern to wildlife managers for several years. An examination of the species' status in Alberta in 1998 resulted in its designation as *Data Deficient**. However, *The General Status of Alberta Wild Species 2005* (Alberta Sustainable Resource Development 2007) ranks the species as *May Be At Risk* and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designates the Great Plains toad as a species of *Special Concern* in Canada (COSEWIC 2006).

Several recent surveys for species presence, such as those conducted through the Alberta Volunteer Amphibian Monitoring Program, the Multi-species Conservation Program for Species at Risk (MULTISAR), and those related to oil and gas development have led to the description of a number of previously undocumented occurrences of Great Plains toad in Alberta. These additional occurrences, along with improved data collation and management through systems such as the Fish and Wildlife Management Information System (FWMIS), clarify the previously described species' range and area of occurrence. This report compiles and summarizes the most recent information available on the Great Plains toad in Alberta as a means toward updating the species' current provincial status.

SPECIES TAXONOMY

Based on the largest amphibian phylogenetic analysis undertaken thus far, Frost et al. (2006) suggested a reclassification of many amphibian species, including the Great Plains toad. They proposed that the Great Plains toad and all other Canadian species of the genus *Bufo* be transferred to the genus *Anaxyrus*. However, Green (2007) advised that for conservation purposes and until the new taxonomy is more widely adopted, it is most practical to use the traditional names with subgenera noted in brackets, as has been employed within this report update.

HABITAT

The Great Plains toad is a species primarily of dry, open grasslands and occurs throughout the grasslands of central North America, from short- to tall-grass prairie (Krupa 1990). In the southern U.S.A. and northern Mexico, the species also inhabits mesquite (*Prosopis* sp.) grasslands, desert riparian associations, and desert scrub (Krupa 1990), as well as creosote bush (*Larrea tridentata*) desert, mesquite woodlands, and sagebrush (*Artemesia tridentata*) plains (Stebbins 1985). It is strongly associated with sand plain and sand hill habitat types within the mixed grasslands of southeastern Alberta (Wershler and Smith 1992). This area endures wide climatic extremes with hot, dry summers and long, cold winter conditions.

A primary requirement of Great Plains toad habitat is the presence of moderately coarse to coarse, sandy soils that allow it to burrow and avoid dry conditions during summer and to hibernate during winter (Taylor 2004). The species is thought to avoid fine-textured soils dominated by silt and clay (C. Wershler pers. comm.). In Oklahoma, the species is positively associated with prairie dog (*Cynomys ludovicianus*) towns (Lomolino and Smith 2004); it may also use burrows of northern pocket gopher (*Thomomys talpoides*; C. Wershler pers. comm.).

The quality and availability of breeding sites is another critical habitat component. The Great Plains toad prefers temporary, clear, shallow pools ranging in size from small puddles to

* See Appendix 1 for definitions of selected status designations.

large wetlands and usually with considerable emergent vegetation (Bragg and Smith 1942, Bragg and Smith 1943). King (1932) also noted that they were found in irrigation ditches. The clarity of the water in breeding sites is of importance; the toad will not breed in muddy or turbid waters (Bragg and Smith 1942, Bragg and Smith 1943).

In Alberta, the majority of Great Plains toad breeding ponds are seasonal, though some permanent and semi-permanent water bodies may also be used (Wershler and Smith 1992). Temporary water bodies form in the spring, when winter runoff and spring rains have filled prairie depressions, creating shallow sloughs that generally dehydrate later in the summer. Wershler and Smith (1992) considered permanent and semi-permanent breeding sites as being sustained by springs, irrigation projects, waterfowl management projects or dikes in shallow drainages. These more permanent breeding sites remained productive even through long periods of drought, and are thus likely important habitats for long-term persistence of the species (Wershler and Smith 1992). Breeding sites located in irrigated areas appear to be more predictably productive for Great Plains toads than those located in non-irrigated regions; this is likely because of seepage from canals, or water tables that have risen following irrigation (Wershler and Smith 1992). Irrigated regions provide shallow breeding sites even under drought conditions, as documented in 1987 and 1990, when breeding sites in non-irrigated areas were dry (Wallis and Wershler 1988, Wershler and Smith 1992). However, these relatively recent and artificial additions to Great Plains toad habitat may be at risk; J. Nicholson (pers. comm.) noted that in many irrigation systems, canals have been or soon will be replaced by pipelines, which could result in elimination of the seepage and could be detrimental to otherwise perennial breeding habitats.

Wershler and Smith (1992) described typical Great Plains toad breeding habitat in Alberta as shallow ponds with relatively fresh, clear water in sandy soil. Tall emergent vegetation such as cattails (*Typha* spp.) was uncommon in these breeding ponds, but submerged vegetation (e.g., pondweeds such as *Potamogeton* spp.) was abundant in some ponds in non-irrigated areas (Wershler and Smith 1992). Most breeding ponds influenced by irrigation waters were found by those authors to have algal growths that were used as calling perches by males, and thought to be used as egg attachment sites and for shelter of tadpoles. Graves and Krupa (2005) reported that tadpoles' use of wetlands did not appear to be influenced by the use of cover and appeared to be influenced primarily by water temperature.

Wershler and Smith (1992) noted that of all ponds they surveyed between 1987 and 1990, those containing Great Plains toads were in regions of native vegetation, and that none of the toads were found in cultivated areas. However, the Great Plains toad was recorded at 14 sites described as "cultivated lands and ditches" in a heavily cultivated area during 2005 MULTISAR call surveys in the Wrentham/Skiff area (Downey 2006). Downey (2006) noted that ponds in cultivated areas tend to drain faster than those located within native prairie, which could result in mortality of unmetamorphized toads. The ability of cultivated areas to host stable toad populations over time is unknown, but may be limited. Cleve Wershler (pers. comm.) has observed that several Great Plains toad breeding ponds within irrigated areas were actually located within small remnants of native grassland rather than lands that have been cultivated.

On Canadian Forces Base (CFB) Suffield, 2690 km^2 of mostly native grassland in southeastern Alberta used as a military training area, the Great Plains toad has been recorded in a wide variety of water body types, including saline wetlands, which the species is typically

known to avoid (C. Wershler pers. comm.). Conversely, Dillon Consulting Limited (1998) found that the species appeared to avoid alkaline sloughs on the base. They were also found in seasonal water bodies, including the flooded margins of dugouts; however, they were not detected in permanent springs (Didiuk 1999).

The ability of the Great Plains toad to disperse through fragmented habitat has not been examined, though it is assumed that they require relatively intact, natural and/or unobstructed habitats through which to disperse. The toads have been observed using roadways (Smith and Bragg 1949); however, in these cases toads have a high risk of mortality from vehicular traffic. Individuals are known to experience mortality as a result of becoming trapped within gas well caissons (Dillon Consulting Limited 2006). In the Southern High Plains of the U.S.A., Anderson and Haukos (1999) found that presence of irrigation pits did not affect occurrence of Great Plains toad. The species is thought to be more tolerant of agricultural landscapes and drier conditions than most other bufonids (Degenhardt et al. 1996 in Graves and Krupa 2005).

Dispersal distance of individual Great Plains toads between overwintering, breeding and foraging areas has been recorded to range from approximately 308 m to 1300 m (Ewert 1969, Dillon Consulting Limited 1998, Fischer et al. 1999 in Graves and Krupa 2005, Werner et al. 2004). The inferred minimum extent of habitat use for bufonid toads, when the actual extent is unknown, is 500 m (NatureServe 2009). The degree of habitat fragmentation in the areas between known Great Plains toad populations in Alberta is moderate, with numerous high- and low-grade roadways, urbanized areas, and areas of cultivation separating the known sites. Significant loss of mixedgrass habitats took place in Alberta historically and has continued at a slower pace in recent years. Conversion of native grassland considered marginal for agriculture is continuing because of urbanization (acreage development), oil and gas exploration and extraction, recreational uses, gravel or sand extraction, transportation corridors and other types of development (J. Nicholson pers. comm.). It is difficult to ascertain future trends in loss of mixedgrass habitats in Alberta, as this will depend largely upon political and economic forces. However, the trends in habitat quality and quantity are likely to continue downward, as biofuel crops, oil and gas developments, and creation of new irrigation districts are possible developments that could result in decline in Great Plains toad habitat over the next decade and beyond.

Portions of the Milk River basin were identified by Taylor (2004) as potentially suitable habitat for the Great Plains toad; however, despite several surveys under appropriate conditions (Downey et al. 2007) the species is not known to occupy the majority of that drainage (other than several observations in the Lost River area). In addition, only one Great Plains toad occurrence has been recorded in the Pakowki Lake sand hill areas of southern Alberta, despite seemingly appropriate habitat and conditions during several search efforts (Wallis and Wershler 1988, Downey et al. 2007). D. Collister (pers. comm.) noted that despite regular, intensive surveys during wet conditions between Highway 36 and Bow City in spring 2005, no Great Plains toads were detected. That area is primarily cultivated but also contains some native grassland and saline wetlands; however, it does not contain soil that is as sand-dominated as the species often prefers (D. Collister pers. comm.).

CONSERVATION BIOLOGY

1. Appearance **-** The Great Plains toad is a moderately large toad species, with adult snout-to-vent length ranging from 47 mm to 115 mm (Graves and Krupa 2005). It is distinguished from other toad species by large parotid glands and cranial crests that form "L" shapes and come together to form a "V"-shaped boss between

the eyes. The toads have well-defined, pale-bordered, dusky, olive, or dark green blotches in sometimes symmetrical pairs on their backs, which are generally pale brown-grey or olive (Stebbins 1985). The abdomen is whitish and lacks spotting, and wart-like bumps, typically less than 1 mm in diameter, are scattered on the toad's back. A light-coloured mid-dorsal stripe is sometimes present. Juveniles are distinguished from other toad species by their numerous small, brick-red tubercles (Stebbins 1985).

2. Activity patterns - The Great Plains toad is active in Alberta from late April to September, and generally only at night or on overcast days, making it difficult to locate outside of the breeding season (Alberta Conservation Association and Alberta Sustainable Resource Development 2002). They typically aestivate (enter a state of dormancy) during daylight hours and for up to six days in shallow (< 5 cm) depressions, and have been documented burrowing down 55 cm in hot, dry weather (Ewert 1969). These deeper burrows are shaped like inverted question marks; the toads position themselves at the upper, terminal end (Tihen 1937 in Graves and Krupa 2005). In fall and winter, they are inactive and burrow below the frostline (Irwin 1993) to depths between 74 cm and 104 cm (Graves and Krupa 2005).

3. Reproduction - In Alberta, the Great Plains toad breeding season typically extends from approximately mid-May to mid- or late-June (Didiuk 1999, Wershler and Smith 1992) and lasts approximately 10 days (Bennett 2003). Male breeding calls are rapidly repeating, harsh, metallic-sounding trills up to 50 seconds long that can be heard from approximately 2 km away (Bennett 2003) and are extremely loud at close range. Calling may take place in late afternoon or early evening at the beginning of the breeding season, but typically occurs after sunset (Alberta Conservation Association and Alberta Sustainable Resource Development 2002).

Breeding activity is strongly associated with precipitation events, especially warm, heavy rainfall (Bragg and Smith 1942, Bragg and Smith 1943, Krupa 1994), although investigation of the species by Didiuk (1999) in the Suffield area of the province showed that breeding and rainfall may not be so tightly coupled in Alberta as indicated by more southern accounts (e.g., Krupa 1994). Didiuk (1999) suggested that, during wet years, the Great Plains toad will become active without a precipitation event, but that in years when conditions are drier, heavy spring rains may be required to fill ponds and stimulate breeding.

The Great Plains toad may form large breeding assemblages, established when males respond to each other's calls, often with high site fidelity (Bragg and Smith 1943, Stebbins 1985). Male and female toads may move several hundred metres to join such assemblages (Manitoba Conservation 2008). Christopher et al. (2006) found that female Great Plains toads preferred male's broadcast calls of longer duration. This was characteristic of males with non-calling "satellite" males (who optimize their reproductive success by associating with males producing long calls) in their proximity, and lower levels of corticosterone (a hormone that regulates amphibian immune and stress responses).

Female Great Plains toads lay between 1300 and 45 000 eggs; clutch size is positively and exponentially related to female size (Krupa 1994; Graves and Krupa 2005). Krupa (1988) reported a natural fertilization rate of 89%. Egg laying typically takes place between dawn and noon, though it can occur at other times (Krupa 1994). Laid in long, loose, gelatinous strings over debris and vegetation near the bottom of the pond (Krupa 1994), eggs hatch in two to seven days (Graves and Krupa 2005). Tadpoles metamorphose in 17 to 45 days, depending on environmental conditions such as temperature (Graves and Krupa 2005). Extremely high tadpole density often results in very low

annual tadpole survival as a result of predation, pond desiccation and competition for food (Krupa 1994). Tadpoles may be preyed upon by carnivorous morphs of plains spadefoot (*Scaphiopus bombifrons*) larvae where they co-occur. The plains spadefoot has a similar distribution and habitat to that of the Great Plains toad in Alberta (Russell and Bauer 2000) and, although experienced observers usually have no trouble distinguishing the two species, plains spadefoot individuals are sometimes mistakenly identified as Great Plains toads (K. Pearson pers. obs.). Brown and Ewert (1971) reported natural hybridization of Great Plains toad and Canadian toad (*Bufo* [*Anaxyrus*] *hemiophrys*) in Minnesota.

Krupa (1994) reported synchronous metamorphosis of Great Plains toad tadpoles. Wershler and Smith (1992) recorded that newly metamorphosed young were observed in Alberta as early as June 28. Newly metamorphosed toadlets are active diurnally (Graves and Krupa 2005) and feed in the area of their natal pond for about a month or until it desiccates (Smith and Bragg 1949). Ewert (1969) recorded first-year toads approximately 1 km away from the nearest pond. It takes young toads from two to five years to reach reproductive age (Hammerson 2000, Sullivan and Fernandez 1999).

4. Dispersal/Movement - Upon completion of the breeding season, adult and young toads have been observed in Alberta farmland or prairie until late August or early September (Bennett 2003). Adult Great Plains toads may move farther than 1 km from possible breeding ponds (A. Didiuk pers. comm.). In Oklahoma, mass unidirectional migrations of Great Plains toads down roadways, primarily after rain in May and June, suggest that these toads may move relatively long distances overnight while feeding (Smith and Bragg 1949).

5. Survival - Several of the adaptations of Great Plains toad for survival in dry, hot and cold environments have been widely studied (Krupa 1990). The toad will burrow deeper and for longer periods of time during hot, dry weather (Fischer et al. 1999 in Graves and Krupa 2005). It is tolerant of a wide range of temperatures compared with other toad species (Tester et al. 1965). However, a study of freezing tolerance found that they were intolerant of any internal freezing (Swanson et al. 1996); this may therefore be a limiting factor in the species' distribution in Canada.

Survival of the Great Plains toad in dry environments has been suggested to be related to their longevity. Lifespan of individuals is estimated to be 10 years or more, and perhaps as long as two decades. J. Krupa (pers. comm.) has suggested that this longevity may be key to their survival, an adaptation to wait out long, dry periods between appropriate breeding conditions. However, Sullivan and Fernandez (1999) found that in Arizona, Great Plains toads grew rapidly to reach maturity, especially in the second year, and purported that their longevity and extended reproductive lifespans were not specifically in response to highly variable, desert environments.

Great Plains toads feed heavily during favourable periods, then burrow and remain dormant in hot, dry weather (Bragg and Smith 1943). Adult toads are opportunistic feeders, eating ground-dwelling, nocturnal insects (Smith and Bragg 1949). Tadpoles are suspension feeders and graze on organic and inorganic materials associated with submerged substrates (Graves and Krupa 2005). During the first month after metamorphosis, toadlets feed day and night, eating almost any small insect they can swallow, but apparently avoid earthworms, even when plentiful (Bragg 1940, Smith and Bragg 1949). In West Texas playas (seasonal lakes) within grassland watersheds, Great Plains toad metamorphs had much more diverse diets than those using playas within cultivated watersheds (Smith et al. 2004).

DISTRIBUTION

1. Alberta - The extreme northwestern portion of the Great Plains toad's range extends into the Dry Mixedgrass and Mixedgrass subregions of the Grassland Natural Region in Alberta (Stebbins 1985, Russell and Bauer 2000, Alberta Natural Heritage Information Centre 2006). Toads have been recorded discontinuously throughout the southeastern corner of the province from the Red Deer River south to the Montana border, and from the Saskatchewan border west to Taber. It is difficult to confirm whether this distribution is continuous, as few null data (locations that were surveyed with no toads recorded) are available, and their populations are naturally variable making it difficult to rule out their presence in areas that are searched. However, it is unlikely to be continuous in nature, as the Great Plains toad tends to be fairly localized in areas of coarse soils (C. Wershler pers. comm.) and has experienced considerable habitat loss. Figure 1 shows Great Plains toad observation points in years prior to 1998, as well as those between 1998 and 2008. The latter is the period that has elapsed since the species' status was last assessed, or the period equivalent to approximately three generations of Great Plains toad.

Less than 5% of the entire range of the Great Plains toad occurs within Alberta. The extent of occurrence within Alberta is approximately 22 929 km^2 (using a convex hull polygon) and area of occupancy is approximately 1028 km^2, calculated by summing up occupied 2 km by 2 km squares.

Based on data available to 2008 and the locations of preferred sand hill and sand plain habitats and less suitable cultivated and fine soiled areas in the region, six general Great Plains toad populations (clusters of proximate occurrences) appear to exist within Alberta. The largest of these extends south from Empress to Medicine Hat, concentrated within the eastern portion of CFB Suffield. This population appears to be separate from one concentrated near Many Island Lake and Walsh, which was newly identified over the past decade, as was another population to the southwest near Wrentham and Skiff. A fourth population is at the Lost River near Onefour, and another extends from Tilley and Bow City south through the Rolling Hills to the South Saskatchewan River. A final population extends from the Hays area south through the Vauxhall Stock Grazing Association lease lands to Taber, Purple Springs and Grassy Lake. Known occurrences within each of these populations are relatively continuous, are located within habitats appropriate for the species, and are within approximately 12 km of one another. There are likely to be numerous unrecorded Great Plains toad occurrences between many of the known locations that help facilitate exchange of individuals within the populations. The six general populations are isolated from one another by expanses of less suitable habitat (i.e., finer soils, cultivation) and by distances of approximately 12 km to 70 km, which together are likely to result in little or no exchange of individuals.

The Great Plains toad was not recorded during surveys in the area between Highway 36 and Bow City (D. Collister pers. comm.; see Habitat section) or in the majority of the Pakowki Lake area (Wallis and Wershler 1988) or Milk River basin (Downey et al. 2007); therefore, these areas may not be suitable for the species. The majority of Great Plains toad habitat in Alberta is located on Crown land (C. Wershler pers. comm.), such as the Agriculture Canada Onefour Research Substation, CFB Suffield, and the Vauxhall Stock Grazing Association lease lands. The populations of Great Plains toad in Saskatchewan and Montana nearest the Alberta border are generally contiguous with the Alberta range (Krupa 1990, Montana Fish, Wildlife and Parks 2009).

The known distribution of the Great Plains toad within Alberta has increased in area and

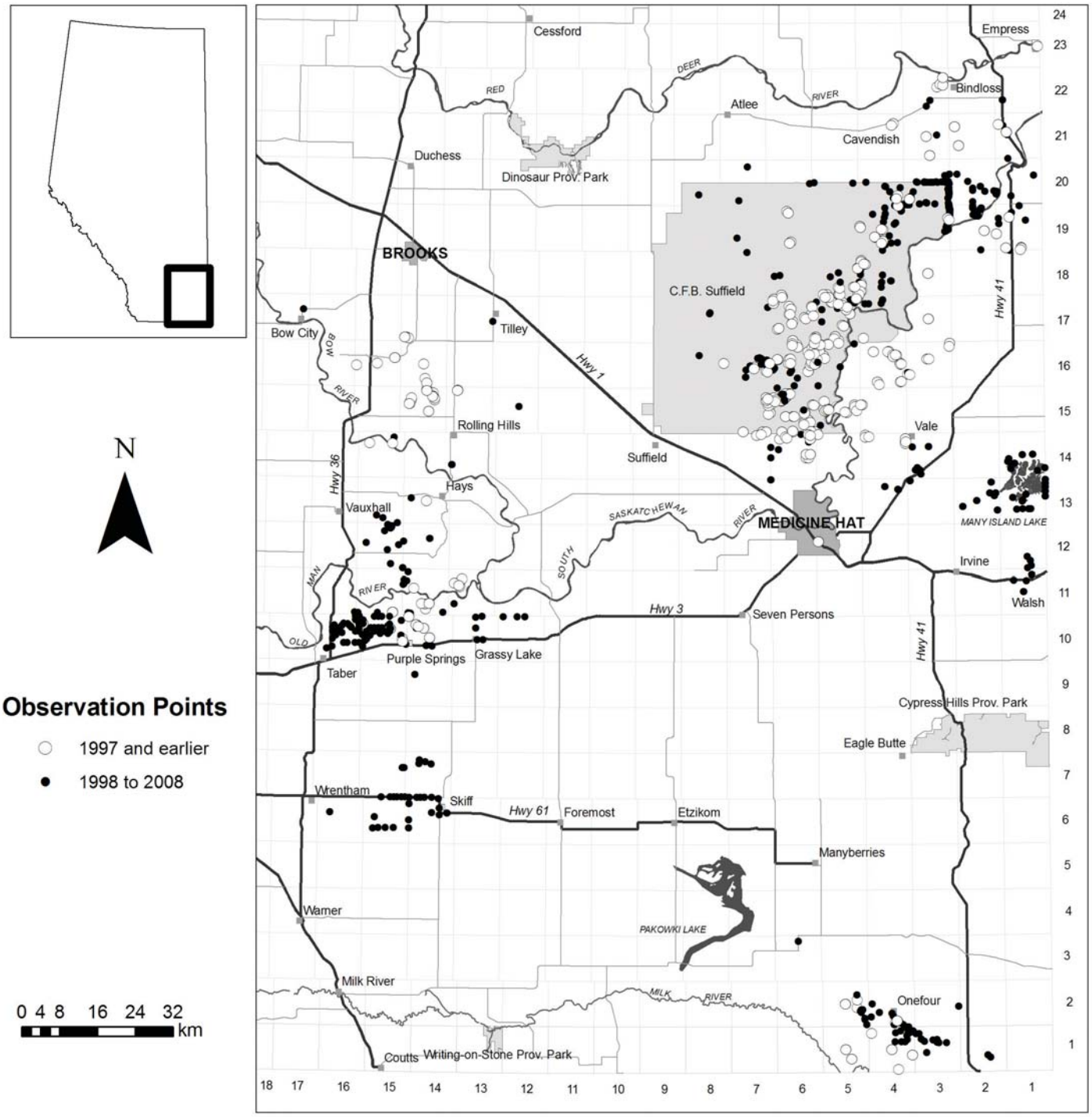

Figure 1: Known distribution of the Great Plains toad in Alberta, including observations made prior to 1998, and from 1998 to 2008. Most data are available from the Fisheries and Wildlife Management Information System database (of Alberta Sustainable Resource Development); additional data sources include: Alberta Natural Heritage Information Centre, environmental consultant reports, independent consultants and researchers, and the Alberta Volunteer Amphibian Monitoring Project[1].

[1] the complete Great Plains toad dataset will be entered into the FWMIS database in the near future.

number of occurrences since the original status report was prepared in 1998. This most likely reflects augmented survey effort rather than an actual expansion in the distribution of the toad; however, null survey data are not available to confirm this. As Browne (2009) noted with regards to the Canadian toad, the failure to report null data is a primary factor limiting our understanding of Great Plains toad distribution and populations. Several sites where occurrences were recorded prior to 1998 have not had occurrences recorded subsequently. It is unknown whether this is due to local extinctions of the toad from those sites (null data are not available) or, perhaps more likely, because those sites were not resurveyed. Additionally, some sites may have been resurveyed, but during inappropriate times of year or environmental conditions, or during dry years when the toads were inactive. Natural annual variation in Great Plains toad populations and the relatively short period over which inventories for this species have been carried out make it difficult to determine trends in the species' distribution. The historical range of the species in Alberta is not well documented, though it was likely greater than the current range, given the amount of habitat alteration (i.e., cultivation) and other developments that have taken place over the past century.

2. Other Areas - The Great Plains toad has been reported from southern Saskatchewan, south of the South Saskatchewan River in the west and near to the Montana border in the eastern portion of the province (J. James pers. comm.). It also occurs in the extreme southwestern corner of Manitoba, near the towns of Lyleton and Melita and Oak Lake (J. James pers. comm.). The species is described as "locally distributed in eastern Montana, with large gaps in [its] known range" (Reichel and Flath 1995, Maxell et al. 2003).

The global range of the Great Plains toad extends from extreme southern Canada to central Mexico, and from western Texas and Missouri to extreme southeastern California and southern Nevada (Stebbins 1985, Graves and Krupa 2005; Figure 2). Stebbins (1985) noted that the species' distribution is highly localized in the desert portions of its range. In the eastern Mojave Desert, historical records of Great Plains toad have not been repeated within the past 50 years, perhaps because of extreme habitat loss and modification (Bradford et al. 2005). Graves and Krupa (2005) noted several other possible range contractions and expansions in the U.S.A.; however, the sporadic nature of reliable observations makes it difficult to determine whether these were long-term changes, short-term population fluctuations, or a result of inconsistent population monitoring.

POPULATION SIZE AND TRENDS

1. Alberta – In 1988, Wallis and Wershler (1988) had estimated the provincial Great Plains toad population to be less than 1000 adults. In 1992, following the detection of toads at additional sites and higher numbers reported at previously known sites, Wershler and Smith (1992) estimated the total Alberta population to be approximately 1000–2000 toads. Despite a higher population estimate than that made in the late 1980s, Wershler and Smith (1992) reported that the provincial Great Plains toad population may have declined by as much as 50% between the mid- to late-1970s and 1990 because of prolonged drought conditions. Population estimates in both studies were made on the basis of the number of calling males recorded at known breeding sites. In most cases, the numbers of males recorded calling at these sites was less than 10, with only three sites having more than 50 and only one of those having more than 100 (Wershler and Smith 1992). Variation in precipitation and varying search efforts through this period may have contributed to this higher population estimate. The wetter weather patterns of the 1990s likely contributed to greater numbers of toads being detected, which may be why the population was estimated to be higher than in

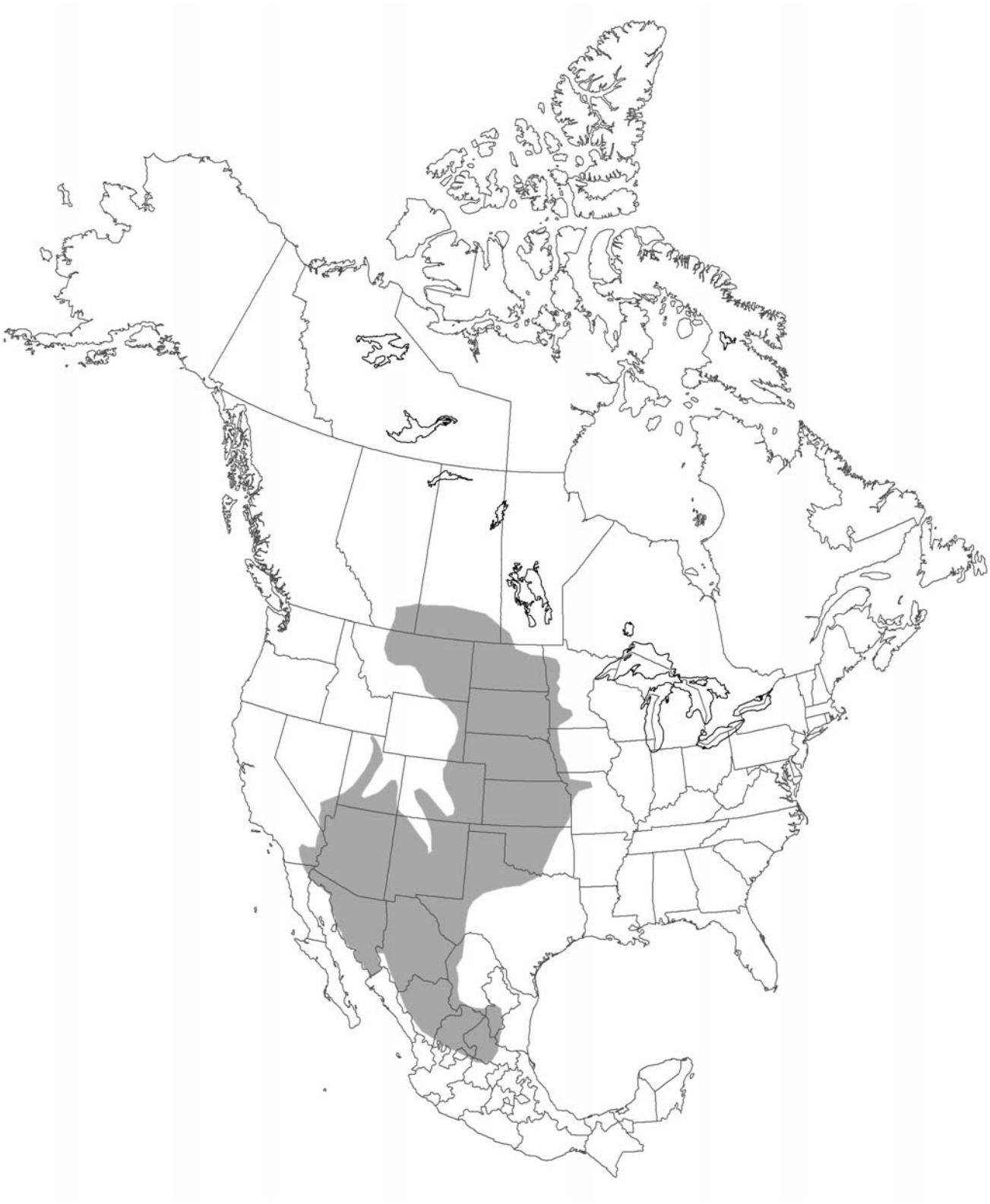

Figure 2: North American distribution of the Great Plains toad (adapted from Krupa 1994).

the drier years of the late 1980s. The above figures were based on limited survey data and did not present a comprehensive view of the species' Alberta population size, but were the best available estimates.

Despite severe drought conditions in southern Alberta during the early 2000s, many apparently new Great Plains toad occurrences have been identified in Alberta since 1998 (Figure 1), likely the result of heavy rainfall events in 2002 (Bennett 2003), 2005 (Downey 2006), and 2006 (Downey et al. 2007). For example, following a few decades of relatively dry conditions and generally few toads observed, the wetlands of the Many Island Lake area (east of Medicine Hat near the Saskatchewan border) hosted a major concentration of Great Plains toad in 2005 and 2006, indicating that more toads may have been actively breeding under wet conditions in the region than under dry drought-like conditions in the previous years (C. Wershler pers. comm.).

Amphibians are typically difficult to survey for abundance, especially species that breed in relatively irruptive cycles such as the Great Plains toad. Given this challenge, as well as a lack of long-term, consistent, and standardized monitoring, Alberta's Great Plains toad population size can only be estimated. In 1998, 202 Great Plains toad site records were compiled for the Alberta status report. From 1998 to 2008, approximately 583 sites with Great Plains toads were documented. No null data were reported for either period, and repeat surveys were not generally conducted at previously surveyed sites, making analysis of trends difficult. Using the same method as described above for Wershler and Smith's 1992 population estimate, approximately 2069 Great Plains toads were recorded at the 583 sites in Alberta from 1998 to 2008. This larger population estimate presumably reflects the greater number of surveys that have taken place since the 1992 estimate. Assuming that not all existing toads were surveyed and that the population has remained fairly constant between 1998 and 2008, the number of toads is almost certainly higher than the derived estimate; however, it is difficult to determine to what extent. Additionally, the estimate is largely derived from records of calling males and does not accurately represent the number of female toads. Based on these factors, it is likely a sound assumption that the Great Plains toad population in Alberta is somewhat greater than 2100 individuals, but fewer than 10 000. Given the above described limitations, it is difficult to estimate the proportion of the global Great Plains toad population occurring within Alberta, although based on global distribution it would likely be less than 5% (see Figure 2).

Population trends for the Great Plains toad in Alberta are even less evident than abundance. However, given the considerable volume of habitat loss and disturbance as a result of human-influenced changes in areas of sandy soils, it is likely that the species has been experiencing a downward population trend in Alberta.

2. Other Areas - No population size or trend estimates are available for other provinces or states in which the Great Plains toad is distributed (Graves and Krupa 2005). In the United States, Great Plains toad populations in the centre of the species' distribution are known to fluctuate widely, with vast numbers appearing above ground when conditions are favourable, then abruptly remaining underground during dry periods. It is also nearly impossible to ascertain the presence of this species outside of the period when mating and growth of young is taking place. However, even during the breeding season individuals may move between nearby breeding ponds from night to night, making censusing even more difficult. Or, toads may simply not attempt to breed during drought conditions, which may last for years, further complicating attempts to survey populations (J. Krupa pers. comm.).

LIMITING FACTORS

Several factors limit the habitat quality and availability, reproductive output, or survival of the Great Plains toad in Alberta, some of which were identified by Wershler and Smith (1992).

1. Hydrologic Changes:

a) Climatic - Dry conditions are a normal characteristic of the prairie environment, where the Great Plains toad's persistence shows it is well-adapted to such conditions. However, prolonged drought conditions potentially limit Great Plains toad populations. Without adequate rainfall, many breeding sites, especially in non-irrigated areas, may not contain water and thus diminish egg and tadpole survival. This effect may be compounded if drought conditions last longer than the species' approximately 10-year lifespan, and individuals do not gain an opportunity to reproduce in their lifetime. According to anecdotal observations, drought conditions are thought to have resulted in a 50% decline in Great Plains toad populations in Alberta between the mid-1970s and late 1980s (Wershler and Smith 1992).

Desiccation of breeding ponds prior to metamorphosis has been reported as the primary source of tadpole mortality in Oklahoma (Krupa 1994). Bragg (1940) suggested that desiccation of breeding ponds prior to tadpole metamorphosis was a factor that likely limited population size. Despite continued uncertainty regarding community and ecosystem trajectories under global climate change, consistent, system-wide ecological impacts of recent climate change are being identified (Walther et al. 2002). Should they prove as dramatic as predicted, shifts in climate are expected to pose challenges to surviving amphibian populations and to recovery efforts for species that have suffered declines (Carey and Alexander 2003). Pyke and Marty's (2005) California study found that cattle grazing can confound hydrologic changes driven by climate change and, somewhat counterintuitively, play a critical role in maintaining the hydrologic suitability of ephemeral wetlands for reproduction of endangered aquatic invertebrates and amphibians.

b) Anthropogenic - Construction of dams and canals, cultivation of native grasslands, and the practice of irrigation, combined with rising domestic and industrial water demands over much of southern Alberta, have affected the hydrology of much of the region. Wershler and Smith (1992) suggested that naturally occurring, permanent wetlands fed by groundwater discharge may be important Great Plains toad breeding sites during periods of drought. They further implied that many of those sites may have already been compromised by human-related demands for water in the region.

2. Habitat Alteration and Destruction - Evidence suggests that short-term impacts of habitat loss and fragmentation on amphibians increase with a species' dispersal ability; however, species with limited dispersal abilities are likely to be equally imperiled by habitat loss and fragmentation over longer time periods (Cushman 2006). Wetlands in Alberta have been affected heavily by agricultural practices. Between 1970 and 1990, annual wetland area loss rates in the settled area of Alberta ranged from 0.8% to 1.2%, which suggests that approximately 63% of the province's original wetland area had been lost since settlement (Strong et al. 1993). These impacts have undoubtedly reduced the available Great Plains toad breeding habitat.

In southeastern Alberta, widespread construction of dugouts in temporary wetland depressions to contain runoff for agricultural or other purposes has likely contributed to the degradation of some Great Plains toad breeding sites. Dugouts are designed to accumulate and store water from the immediate area into a deeper pond having less surface area for evaporation. If dugouts have low shoreline gradients with shallow, marshy edges, they may remain

suitable as breeding habitat for the Great Plains toad, as observed by Schowalter (2008) on the Vauxhall Stock Grazing Association lease. However, dugouts are not generally suitable as breeding pools because of their depth and steep sides (Schowalter 2008), as well as frequent visitations by livestock. Disturbance caused by livestock may cause turbidity, therefore making it a less appealing breeding site to the Great Plains toad. Tadpoles, however, have been documented to have fully developed in waters that were disturbed by livestock after egg laying and hatching had occurred (Bragg 1940). The hummocking that can be caused by livestock hooves in wet areas may entrap larval amphibians or make it difficult for metamorphs to access or exit the pond. Wershler and Smith (1992) noted that long-term, intensive use of wetlands by cattle could cause lasting damage, especially to shallow pools and permanent spring areas, in the form of introduced plant species, hummocking of shorelines, and disturbance of sandy substrates.

Water is a limited resource in semi-arid southeastern Alberta. The clear, temporary, springtime pools preferred for breeding by Great Plains toad may be compromised by development of some water management projects. Wershler and Smith (1992) stated that "any water control that results in deeper, more permanent water in a breeding habitat constitutes a potential threat." The majority of water management projects in southeastern Alberta, such as those constructed for waterfowl habitat, or for agricultural, industrial or domestic purposes, generally strive to collect and maintain water in permanent catchments. For example, McNeil and Sawyer's (2003) evaluation of water development projects south of the Cypress Hills documented 1890 impediments constructed within 50 townships (an increase from 535 impediments in 1951). The overall effect of these practices on Great Plains toads remains unknown. Further, creation of large-scale irrigation projects such as the proposed Meridian or Milk River Dams would likely result in direct loss of Great Plains toad habitat to both reservoirs and increased cultivation associated with increased availability of irrigation water (R. Quinlan pers. comm.).

The disruption or removal of native vegetation by cultivation poses extensive risk to Great Plains toad upland and breeding habitats. Smith and Bragg (1949) reported that in Oklahoma, large numbers of young toads moved into cultivated fields, where the soil was softer, to burrow if native prairie soils had become dried and hardened. However, J. Krupa (pers. comm.) suggested that one of the two leading causes of mortality of these toads in the United States is being run over in cultivated fields by tractors pulling discs. Establishment of potato farms, often sited in areas of sandy soils (also favoured by Great Plains toad) and thus requiring irrigation, and cultivation of native grasslands for biofuel crops pose potential habitat losses to the species. During dry years, small ephemeral wetlands that may provide Great Plains toad breeding habitat are often filled in order to increase cultivated area.

3. Pesticides **–** Though not documented for Great Plains toad populations in particular, the proven impacts of pesticides and herbicides on other amphibian species indicate that the species may also be negatively affected. Bridges and Semlitsch (2000) suggested that chemical contamination should be considered a contributing cause of declines in amphibian populations; whether at the lethal or sublethal level, chemicals can impact natural regulatory processes such as juvenile recruitment. Tadpoles of five species of anurans subjected to varying levels of exposure to pesticides or herbicides commonly used in Canadian crop and forest lands were either paralyzed or died (Berrill et al. 1997). Agricultural pesticides and herbicides were found to have a general mutagenic effect on *Rana clamitans* in Quebec, especially in potato fields, resulting in grotesque deformities (Bonin et al. 1997).

A variety of agricultural pesticides may be sprayed on potato and other crops in the range of the Great Plains toad in southern Alberta. An Alberta study, conducted in 2000, reported measurable levels of pesticide residues in 55 (92%) of the 60 semi-permanent wetlands tested (Wetlands Alberta 2008). Further, the rising issue of weed encroachment on native rangelands may result in degraded habitats and more prevalent use of pesticides within Great Plains toad habitats. The Alberta *Pesticide (Ministerial) Regulation* (Alberta Government 2003) of the Environmental Protection and Enhancement Act prohibits the use or application of pesticides in or on an open body of water and restricts what can be applied within 30 metres of an open body of water. However, this regulation is difficult to enforce and does not address the impacts of chemical application on amphibians using upland habitats.

4. Predation - Though adult Great Plains toads employ anti-predation mechanisms such as nocturnal activity, cryptic coloration and parotid gland secretions (Graves and Krupa 2005), they are preyed upon by western hog-nosed snakes (*Heterodon nasicus*), garter snakes (*Thamnophis* sp.), crows (*Corvus brachyrhynchos*) and other birds, and American badgers (*Taxidea taxus*) (Bragg 1940, Wershler and Smith 1992, Werner et al. 2004). Desiccation of aquatic habitats heightens Great Plains toad tadpole vulnerability to predation, which may be the primary cause of larval mortality (Graves and Krupa 2005). Great Plains toad tadpoles may fall prey to birds, insect larvae (i.e., dragonfly and giant water bug larvae), and carnivorous plains spadefoot tadpoles (Bragg 1940). Cannibalistic Great Plains toad tadpoles prey on conspecifics (Werner et al. 2004). Gray et al. (2004) reported that Great Plains toads were usually negatively associated with the plains spadefoot in the Southern High Plains of central U.S.A. because of predation. Woodward (1983) found that in New Mexico tadpoles of species that breed in temporary ponds, including Great Plains toads, were subjected to higher predation when they inhabited more permanent water bodies. This occurred because there were more aquatic predators in the more permanent pools and because of the nearly constant movement patterns of tadpoles within temporary ponds. Similar predation patterns may play a role in Alberta populations.

5. Roadway mortality - Vehicle traffic can pose significant threats to amphibian populations, especially those of more mobile species (Carr and Fahrig 2001). Smith and Bragg (1949) noted the phenomenon of large numbers of Great Plains toads moving in one direction along roadways, presumably capturing insects. If similar habits occur in Alberta populations, the possibility exists that large numbers of toads could be killed by passing vehicles within a short period. In fact, early records documenting the presence of Great Plains toad in Canada were acquired by the identification of toads that had been run over (e.g., Cook 1960). Roadkill, especially of migrating juvenile toadlets, has been suggested as one of the most significant causes of mortality for post-metamorphic Great Plains toads in the central part of their range (J. Krupa pers. comm.), although no reports of such widespread losses have been recorded in Alberta. C. Wershler (pers. comm.) noted that higher traffic volumes that coincide with the paving of historically unpaved roadways could result in an increase in road-killed toads.

6. Oil and Gas Exploration and Development- Oil and gas development is a major industry in Alberta, and many activities associated with hydrocarbon exploration and extraction may negatively affect the Great Plains toad. Wershler and Smith (1992) identified disruption of groundwater resources, ground- and surface water contamination, and the consumptive use of these water sources by drilling as potential impacts. Extraction of water from wetlands is common and can have significant negative consequences on Great Plains toad breeding efforts (J. Nicholson pers. comm.). In addition, on CFB Suffield in particular, toads and other

small animals may fall into and become entrapped in sunken gas well caissons (Didiuk 1999, Dillon Consulting Limited 1998), though this has never been formally documented (D. Boyd pers. comm.).

Management concerns regarding sensitive species such as Great Plains toad resulted in Alberta Sustainable Resource Development, Fish and Wildlife Division (FWD) creating a protocol for developments in the prairie region. This protocol requires that the developer or their agent proposing an activity contact FWD for known observation data, hire an experienced wildlife consultant to conduct a pre-construction wildlife inventory using FWD amphibian survey standards, report any conflicts with FWD setback distances and timing restrictions, and submit a mitigation plan to FWD (J. Taggart pers. comm.). Companies are obligated to observe year-round setbacks of 50 m (land surveying, wildlife/vegetation monitoring) and 100 m (human structures built, vegetation and soils disturbed, well sites, powerlines, pipelines, batteries, roads) from ephemeral and permanent wetlands and adjacent uplands that represent Great Plains toad habitats (Alberta Sustainable Resource Development 2006). A comprehensive, year-round human activity and disturbance (as defined by Alberta's *Water Act*) restriction is in place within 100 m of all wetlands on CFB Suffield (Rowland 2006a, Rowland 2006b).

Despite these governmental guidelines, C. Wershler (pers. comm.) noted that oil and gas exploration and development companies are not required to conduct their wildlife inventories at times of year when Great Plains toads are active, and thus, often base their assessments on existing records and/or potential habitat. This may result in inappropriate development sitings, as these methods alone do not necessarily indicate Great Plains toad populations (i.e., toads may be burrowed or moving throughout upland areas and breeding ponds may not be apparent beneath snowcover). Further, development companies frequently request and are granted permission to work inside established setback zones, which likely results in disturbance of dormant or breeding toads (C. Wershler pers. comm.). For example, J. Nicholson (pers. comm.) noted one instance when an adult Great Plains toad was excavated by a backhoe operator during a pipelining operation northeast of Medicine Hat.

***7. Disease* –** Pathogens and parasites have been implicated in numerous amphibian population declines (Daszak et al. 2003). The effects of climate change have been associated with massive amphibian extinctions as a result of disease in the tropics (Pounds et al. 2006). Ewert (1969) and Shively et al. (1981) reported fatal bacterial infections in Great Plains toad in the U.S.A.

In southeastern Alberta, amphibian chytridiomycosis and ranavirus have been identified in tiger salamander (*Ambystoma tigrinum*) (C. Goater pers. comm.), Canadian toad, and northern leopard frog (*Rana [Lithobates] pipiens*) (D. Prescott pers. comm.) populations. It has been suggested that emergence of both diseases may be driven by anthropogenic introduction (i.e., contamination of habitats by human contact) (Daszak et al. 2003). Though amphibian tissue samples were recently collected in southeastern Alberta for disease testing, no sampling of Great Plains toad has taken place to date (D. Prescott pers. comm.). Negative results were found when Great Plains toad was tested for chytridiomycosis at two sites in Montana; these were the only such tests performed on that species to date (D. Olson pers. comm.). However, it is likely that the species is also affected by these widespread ailments (C. Goater pers. comm.).

STATUS DESIGNATIONS*

1. Alberta - The Great Plains toad is currently listed as a Non-game Animal under Alberta's *Wildlife Act*, which makes it illegal to kill, possess, buy or sell toads in Alberta (Government of Alberta 2005). Alberta's Endangered Species Conservation Committee further recommended a designation of *Data Deficient* in 2001, as there was insufficient scientific information to support status designation (Fish and Wildlife Division 2008).

The species was considered *May Be At Risk* in *The General Status of Alberta Wild Species 2005* because of an apparently decreasing population size, and declining critical breeding habitat as a result of drought, cultivation, oil and gas activity and intensive livestock use (Alberta Sustainable Resource Development 2007). This status rank remained unchanged from that assigned to the species through the same process in 2000 (Alberta Sustainable Resource Development 2001). The Alberta Natural Heritage Information Centre (ANHIC) designates the Great Plains toad as S2 because of its restricted habitat in Alberta and the location at the periphery of its North American range (Alberta Natural Heritage Information Centre 2008).

Although the Great Plains toad was considered by Alberta's wildlife status publication of 1984 (Alberta Fish and Wildlife 1984), no provincial status was attributed to the species at that time. Great Plains toad was considered "common throughout its known range in Alberta, decreasing in abundance in the northern and western portions" (Alberta Fish and Wildlife 1984). The species was placed on Alberta's provincial Red List in 1991 (Alberta Fish and Wildlife 1991). This designation was based on the rarity of reports of the species and the resulting unknown population numbers, and a perception that those populations were declining. It was considered to be of concern because of loss of habitat to drought, drainage, and cultivation of wetlands, and habitat degradation by livestock in the remaining potential breeding ponds (Alberta Environmental Protection 1996).

2. Other Areas - The Great Plains toad was designated as a species of *Special Concern* in Canada by COSEWIC in 1999 and again in 2002 (COSEWIC 2006); an updated national status report is currently in preparation. The reason for this designation was that, despite being widespread, the species occurs as scattered populations that fluctuate widely in size, and it is adversely affected by fragmentation of habitats, limited dispersal and conversion of its habitat to agriculture (COSEWIC 2006).

The *Wild Species 2005: The General Status of Species in Canada* publication ranks the Great Plains toad as *Sensitive* (Canadian Endangered Species Conservation Council 2008). This rank was apparently changed from the designation of *May Be At Risk* assigned in 2000 as a result of a revised assessment by COSEWIC (Canadian Endangered Species Conservation Council 2008).

The global and Canadian national ranks for the Great Plains toad are G5 and N3, respectively (NatureServe 2009). The reasoning behind the G5 rank is that the species is common and widespread in western and central North America with no major threats (NatureServe 2009). The species is ranked as N5 in the United States.

Conservation ranks assigned to the Great Plains toad in neighbouring jurisdictions are S3 in Saskatchewan, and S2 in Manitoba and Montana (Saskatchewan Conservation Data Centre 2008, Manitoba Conservation Data Centre 2001, Montana Natural Heritage Program 2007).

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* See Appendix 1 for definitions of selected status designations.

The United States Fish and Wildlife Service and Bureau of Land Management both rank the species as *Sensitive* (U.S. Fish and Wildlife Service 2007). The Red List Category assigned to the Great Plains toad by the International Union for the Conservation of Nature (IUCN) is *Least Concern* (NatureServe 2009).

RECENT MANAGEMENT IN ALBERTA

Despite several recent survey projects and the development of a habitat-based model for the Great Plains toad (Taylor 2004), no direct management or research activities have been undertaken for this species in Alberta. Alberta's Fish and Wildlife staff continue to advise oil and gas developers to minimize impacts on the species and their habitat (J. Nicholson pers. comm.).

SYNTHESIS

At the northwestern extreme of its global distribution in southeastern Alberta, the Great Plains toad is found in six general populations, each apparently fragmented from one another by habitats containing less suitable soils and cultivation. A deficiency of null survey data makes it difficult to determine whether these populations are actually fragmented from one another or connecting populations have just not been identified. Likewise, the lack of abundance data makes population estimates and trends difficult to arrive at; however, the population is estimated to be between 2100 and 10 000 individuals. The population trend, based on recent patterns of Great Plains toad habitat development for agriculture and the oil and gas industry, is likely downward.

The Great Plains toad is well adapted to the widely varying environmental conditions of the prairies. Its potentially high fecundity, longevity, and ability to reproduce rapidly in appropriate conditions have likely enabled the species to survive frequent drought. The species' limited distribution and susceptibility to habitat destruction, hydrological changes, pesticides, road mortality and disease are all key features that may affect the long-term viability of Alberta's Great Plains toad populations, and need to be considered in management decisions. Retention of breeding and upland habitats within native grasslands will be crucial to the conservation of the species.

Several investigations would help to more clearly define the status of the Great Plains toad in Alberta and contribute to the species' conservation. Continued surveys of breeding Great Plains toads throughout southeastern Alberta during both drought and high rainfall conditions would help to more adequately determine population sizes and trends. Surveys under wetter conditions (120 mm in a week [Downey et al. 2007]) will help to clarify the species' range in Alberta; however, surveys should also take place during dry years so the impacts of drought conditions become clearer. Resources should be in place to permit completion of surveys upon short notice when favourable breeding conditions occur. Surveys should be conducted consistently at sites where breeding has been noted in the past. As well, searches for new populations should be conducted in previously unsurveyed areas. Null and positive data should be collected and maintained in a manner that is conducive to tracking populations in the long-term, and thus, effectively determining trends. The oil and gas industry should be required to survey diligently for the Great Plains toad and strictly follow guidelines appropriate to the species' conservation. Opportunities to investigate effects of various industrial developments on the species should be taken and their results applied to effectively conserving the Great Plains toad in the long-term.

Though many aspects of the life history of the Great Plains toad have been examined in the U.S.A. (e.g., Krupa 1994), relatively little research has taken place on the species at the periphery of its range in Alberta, where its life

history may differ. Research that examines various aspects of the species' population dynamics (e.g., larval survivorship, causes of mortality, adult movement patterns, longevity, habitat selection/requirements, breeding population size and structure) in agricultural areas of various types (i.e., cropland, tame forage, native grassland under various grazing regimes), as well as in relatively undisturbed areas (e.g., Onefour) should be undertaken. Further, an investigation (similar to that conducted by Pyke and Marty [2005]) examining the impacts of livestock use on longevity of ephemeral Great Plains toad breeding habitats should be conducted in Alberta. An understanding of the locations in which toads hibernate would facilitate appropriate management and conservation of those important habitats. Finally, the impact of disease on the species in Alberta should be investigated and managed accordingly. Any amphibian surveys or other activities completed in potential or known amphibian breeding habitats should stringently follow protocols to prevent disease transfer (Declining Amphibian Population Task Force 2003, Shock 2003).

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Appendix 1. Definitions of status ranks and legal designations.

A. The General Status of Alberta Wild Species 2005 (after Alberta Sustainable Resource Development 2007)

2005 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 that has not been examined during this exercise.
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 Species at Risk Formal Status Designations
Species designated as *Endangered* under Alberta's *Wildlife Act* include those listed as *Endangered* or *Threatened* in the Wildlife Regulation (in bold).

Endangered	**A species facing imminent extirpation or extinction.**
Threatened	**A species likely to become endangered if limiting factors are not reversed.**
Species of Special Concern	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Data Deficient	A species for which there is insufficient scientific information to support status designation.

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2009)

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 nothing is done to reverse the factors leading to its extirpation or extinction.
Special Concern	A species that may become threatened or endangered because of a combination of biological characteristics and identified threats.
Not at Risk	A species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient	A category that applies when the available information is insufficient to (a) resolve a wildlife species' eligibility for assessment, or (b) permit an assessment of the wildlife species' risk of extinction.

Appendix 1 continued:

D. Heritage Status Ranks: Global (G), National (N), Subnational (S) (after Alberta Natural Heritage Information Centre 2007, NatureServe 2009)

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 to 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 to 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 the future.
G?/N?/S?	Not yet ranked, or rank tentatively assigned.

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

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

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