PROPOSED

***Species at Risk Act***
Recovery Strategy Series

# Recovery Strategy for the Ord's Kangaroo Rat (*Dipodomys ordii*) in Canada

## Ord's Kangaroo Rat

**2011**

Environment Canada Environnement Canada

Canada

**Recommended citation:**

Environment Canada. 2011. Recovery Strategy for the Ord's Kangaroo Rat (*Dipodomys ordii*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. vi + 28 pp. + Appendices.

For copies of the recovery strategy, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk Public Registry (www.sararegistry.gc.ca).

**Cover illustration**: Royal Alberta Museum used with permission.

Également disponible en français sous le titre
« Programme de rétablissement du rat kangourou d'Ord (*Dipodomys ordii*) au Canada [Proposition] »


ISBN:
Catalogue no.:

# PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years.

The Minister of the Environment is the competent minister for the recovery of the Ord's Kangaroo Rat and has prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with the Alberta Government, Saskatchewan Government, Department of National Defence, and Agriculture and Agri-Food Canada.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Ord's Kangaroo Rat and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

# ACKNOWLEDGMENTS

Greg Wilson (Environment Canada), Ray G. Poulin, and L. Danielle Todd are acknowledged for preparing this document. The Alberta Kangaroo Rat Recovery Team [Arlen Todd (Lead and Co-Chair) – Alberta Sustainable Resources Development; Greg Wilson – Environment Canada; Drew Taylor (Co-Chair) – Canadian Forces Base Suffield; Darren Bender – University of Calgary; Bill Bristol – Agriculture and Agri-Food Canada; David Gummer – Scientist/Member-at-large; Dug Major – Special Areas Board; Journey Paulus – Cenovus Energy; Daryl Swenson – Rancher/Member-at-large] is acknowledged for reviewing various drafts of this document and providing valuable feedback. Special thanks is extended to Darren Bender, Julie Heinrichs, Randy Dzenkiw (University of Calgary) and David Gummer for providing information about the habitat model. Zhong Li, Robin Bloom, and Gillian Turney (Environment Canada) helped refine and map the critical habitat. Dave Duncan, Mark Wayland, Medea Curteanu, Lucie Métras, Manon Dubé, Olaf Jensen, and Darcy Henderson (Environment Canada) reviewed and provided comments on this recovery strategy. Gary Weiss (Environment Canada) prepared the Canadian distribution map.

Within this recovery strategy, critical habitat has been identified by Environment Canada based on data provided by Dr. Darren Bender, his students and collaborators at the University of Calgary. It has not been endorsed by, nor does it necessarily express the opinions of, the University of Calgary or Dr. Darren Bender, his students and collaborators.

# EXECUTIVE SUMMARY

Ord's Kangaroo Rats are habitat specialists whose Canadian extent of occurrence is restricted to 6, 030 $km^2$ centered around two sand hill regions in southwestern Saskatchewan and southeastern Alberta. The area of occupancy is estimated to be between 10 and 53 $km^2$.

In Canada, the Ord's Kangaroo Rat is listed as endangered due to this species' declining natural habitat, restricted geographic distribution, and small population size. Population size fluctuations can be large, and the species often experiences extremely high mortality rates and crashes during the winter, when mortality rates can reach 90%. The population is also geographically isolated from the nearest U.S. populations by 270 km.

The Canadian Ord's Kangaroo Rat population is limited by the availability and progressive loss of open actively-eroding and sparsely vegetated sandy habitats as well as by the extreme winter conditions that may result in high mortality. The most significant and current population threats include factors that cause stabilization of active sand dunes, creation of linear features, and the expansion of oil and gas development. Other potential threats include military activities, climate change, and conversion of native grassland to crop production.

There is an unknown regarding the feasibility of recovery of kangaroo rat about habitat availability over the long- term. In keeping with the precautionary principle, this recovery strategy has been prepared as per section 41(1) of SARA as would be done when recovery is determined to be feasible. This recovery strategy addresses the unknown surrounding feasibility of recovery. The population and distribution objectives for the Ord's Kangaroo Rat in Canada are to ensure that self-sustaining populations continue to occur at currently occupied sand hills in southeastern Alberta and in southwestern Saskatchewan.

Inventory, monitoring, management, and research activities needed to achieve these objectives include: surveying Ord's Kangaroo Rat throughout the species' Canadian range but especially within sand hills in Saskatchewan; investigating the effectiveness of translocations as a means for re-establishing populations in suitable habitat; developing knowledge of natural disturbance processes; continuing to examine mechanisms and feasibility of re-activating and maintaining active sand dunes; quantifying the severity of the most significant threats to the species, such as factors causing dune stabilization, creation of linear features that may become anthropogenic sink habitats and the expansion oil and gas development.

Critical habitat necessary for Ord's Kangaroo Rat survival and recovery is partially identified in this recovery strategy based on the best available information at the time this recovery document was prepared. It is identified as portions of 178 quarter-sections within or adjacent to Canadian Forces Base Suffield, Alberta. Within this area, critical habitat is defined using a spatially-explicit population viability model, as the area encompassing the reproductive habitat patches and associated dispersal corridors plus a 50 m distance surrounding these areas. Additional critical habitat will be identified in one or more Action Plans. Studies required to identify additional critical habitat are outlined in section 7.3.

Action Plans for the Ord's Kangaroo Rat populations in Alberta and Saskatchewan are to be completed by 2012 and 2015, respectively.

# RECOVERY FEASIBILITY ANALYSIS

Under the *Species at Risk Act* (Section 40), the competent minister is required to determine whether the recovery of the listed species is technically and biologically feasible. Analysis of recovery feasibility for this species, based on the four criteria outlined by the Government of Canada (2009), demonstrates that an uncertainty exists relating to the recovery of the Ord's Kangaroo Rat. In keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA, as is done when recovery is determined to be feasible. This recovery strategy addresses the uncertainty surrounding the feasibility of recovery.

**1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.**

*Yes.* Currently, there are several naturally occurring Ord's Kangaroo Rat populations which are successfully reproducing and are well distributed within native sand hill habitats. The species is capable of achieving high population growth rates under suitable conditions.

**2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.**

*Unknown.* Modelling work suggests that there is currently not enough habitat available in Alberta to support a self-sustaining population of Ord's Kangaroo Rats over the long-term (Heinrichs *et al.* 2008, Heinrichs *et al*. 2010). However further study is required to determine if this holds true for the Saskatchewan population, and the overall Canadian population, and if necessary, whether it will be possible to create sufficient habitat through management or restoration. Sand dune management and restoration activities can enhance or increase available habitat, while beneficial management practices will ensure that appropriate mitigation actions are undertaken to reduce harm and disturbance as well as the risk of further habitat loss or degradation. The species is capable of successfully re-colonizing unoccupied, suitable areas if any are created through sand dune management within dispersal distance of occupied habitat.

**3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.**

*Yes.* The most significant threats to the recovery of the Ord's Kangaroo Rat in Canada are those that cause dune stabilization. Sand dune stabilization is a natural phenomenon, but it is exacerbated by fire suppression and a reduction in periodic, intense grazing. Anthropogenic means will be required to reduce the primary threat to the species' habitat. This and other potential threats can be mitigated through habitat restoration, implementation of beneficial management practices, protection of the species and its habitat, and research and monitoring to guide management actions for the species.

**4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.**

*Yes.* Several recovery techniques are available, such as prevention of dune stabilization, restoration of stabilized dunes, and mitigation of the impacts of development. Evaluation of various techniques of translocating Canadian Ord's Kangaroo Rats from highly productive areas to unoccupied, suitable areas (Bender *et al.* 2010a) is slated to begin in the near future.

# TABLE OF CONTENTS

# 1. COSEWIC SPECIES ASSESSEMENT INFORMATION

**Date of Assessment:** April 2006

**Common Name (population):** Ord's Kangaroo Rat

**Scientific Name:** *Dipodomys ordii*

**COSEWIC Status:** Endangered

**Reason for Designation:** The species requires sand dune habitat, which may disappear over the short term (10 years). The area of occupancy is only about 53 km² and only 1,000 or fewer individuals are alive at the end of most winters. There is strong evidence for local adaptations of the Canadian population and a rescue effect is extremely unlikely because the nearest population in the United States is 270 km away.

**Canadian Occurrence:** Alberta and Saskatchewan

**COSEWIC Status History:** Designated Special Concern in April 1995. Status re-examined and designated Endangered in April 2006.

# 2. SPECIES STATUS INFORMATION

Globally, Ord's Kangaroo Rat (*Dipodomys ordii*, Woodhouse 1853) has been assessed as secure (G5; NatureServe 2008). The species is also considered secure (N5) in the United States (U.S.). In California, they are listed as vulnerable (S3S4); in the other 16 states in which the species occurs, the Ord's Kangaroo Rat is listed as secure (S5) or apparently secure (S4; NatureServe 2008). It should be noted that the Canadian Ord's Kangaroo Rat population is thought to be endemic, possessing unique northern climate adaptations (e.g. ability to enter torpor during harsh winter conditions), that would make successful translocations and establishment from these secure U.S. populations unlikely (COSEWIC 2006).

In Canada, Ord's Kangaroo Rat was listed as endangered under the *Species at Risk Act* (SARA) in May 2007. The species is designated as endangered under Alberta's *Wildlife Act* but is currently not listed in Saskatchewan. Nationally and provincially, the species has been ranked as imperiled (N2 and S2; NatureServe 2008). The Canadian distribution represents less than 1% of the species' global distribution.

# 3. SPECIES INFORMATION

## 3.1 Species Description

Despite its name, Ord's Kangaroo Rat (henceforth 'kangaroo rat') is not closely related to Norway *(Rattus norvegicus)* or Black Rats (*Rattus rattus),* but is in fact a member of a family of desert-dwelling rodents that includes pocket mice (*Perognathus* sp.) and kangaroo mice (*Microdipodops* sp.). The kangaroo rat is about three times the mass and twice the length of a deer mouse (*Peromyscus* sp.) or House Mouse (*Mus musculus*). Bipedal jumping is the usual means of locomotion and the species has large hind legs and feet that are well suited for hopping through their sandy environments. Kangaroo rats are mainly orange-brown with distinctive white markings on their flanks and underside. Their long, tufted tail accounts for more than half of their total length.

Kangaroo rats are nocturnal and highly adapted for digging and burrowing, spending the majority of the day in underground burrows and networks, and emerging aboveground only during the night to forage and mate (*see* COSEWIC 2006 for more details on the species and its ecology). Kangaroo rats reproduce from March to September and have exceptionally high reproductive rates. Juveniles reach sexual maturity at about 47 to 60 days of age and females can produce two to four litters per year (Gummer 1997a). During the winter period, kangaroo rats remain underground and enter into torpor to conserve energy on a daily basis, but arouse during the night to feed on underground food caches (O'Farrell 1974, Gummer 2005).

## 3.2 Populations and Distribution

The kangaroo rat is widely distributed in the interior arid grasslands and deserts of North America, extending through the Great Plains south to central Mexico (Figure 1). There have been no recent large-scale changes in the geographic distribution of the species, which encompasses approximately 3.37 million km$^2$ (COSEWIC 2006).

Figure 1. Global distribution map of Ord's Kangaroo Rat (adapted from maps published by NatureServe 2008 and COSEWIC 2006).

Currently, there are several naturally occurring kangaroo rat populations in Canada which are successfully reproducing and are well distributed within native sand hill habitats. The total extent of occurrence[1] of kangaroo rats in Canada is 6,030 km², within which the area of occupancy[2] is estimated to be between 10 and 53 km² (COSEWIC 2006). In Canada, the species is isolated by approximately 270 km from the closest populations in Montana (COSEWIC 2006). Kangaroo rat occurrence is limited to two discrete regions, one clustered around the Great Sand Hills of southwestern Saskatchewan (Epp and Waker 1980, Kenny 1989) and the other clustered around the Middle Sand Hills of southeastern Alberta (Figure 2; Smith and Hampson 1969, Gummer *et al*. 1997b). The extensive area of agricultural land separating these two regions and the South Saskatchewan River are expected to act as barriers to natural dispersal (Gummer and Robertson 2003a, COSEWIC 2006). Consequently, some level of isolation is believed to exist between these two regions (Figure 2; Alberta Ord's Kangaroo Rat Recovery Team [AOKRRT] 2005).

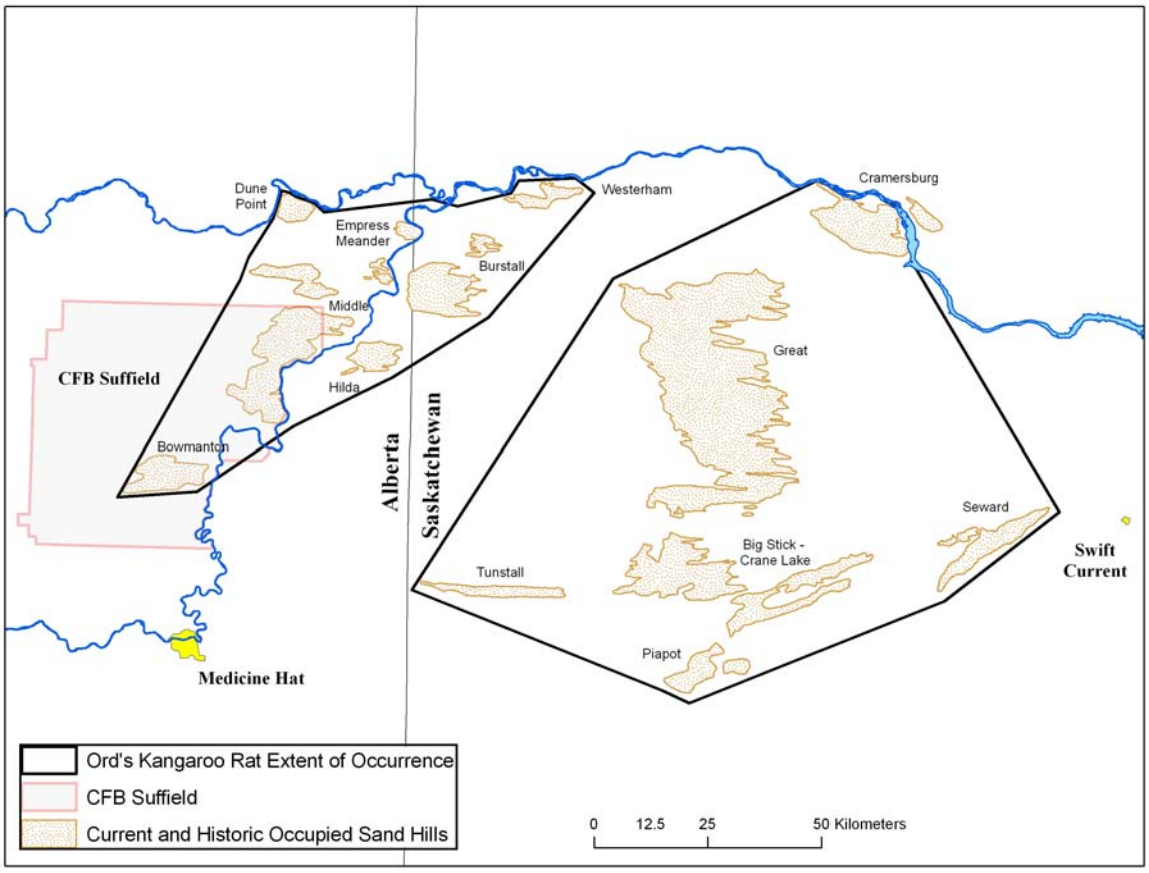



Figure 2. Canadian sand hills within which there have been recent or historic occurrences of Ord's Kangaroo Rat (adapted from COSEWIC 2006 map). The western region is centered around the Middle Sand Hills while the eastern region is centered around the Great Sand Hills.

[1] Extent of occurrence, or range of a species, is the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a species (COSEWIC 2009).

[2] Area of occupancy is the portion within the 'extent of occurrence' that is actually occupied by the species (COSEWIC 2009).

### *Saskatchewan range*

As much as 62% (3,765 km²) of the Canadian kangaroo rat range occurs in Saskatchewan (AOKRRT 2005, COSEWIC 2006). In this province the species has been reported to occur within the Great Sand Hills, Westerham Sand Hills, Burstall Sand Hills, Cramersburg Sand Hills, Piapot Sand Hills, Big Stick and Crane Lake Sand Hills (COSEWIC 2006). Kangaroo rats have recently been observed within Tunstall and Seward Sand Hills (D. Bender pers. comm. 2010).

### *Alberta range*

Approximately 38% (2,265 km²) (AOKRRT 2005) of the Canadian range occurs in Alberta within the Middle Sand Hills and adjacent sand hills[3] (Figure 2; Gummer 1997b, COSEWIC 2006). The Hilda Sand Hills have been historically occupied, but no recent occurrences are known (Gummer and Robertson 2003a). Systematic surveys carried out in 2001 did not find evidence of kangaroo rats in other sand hills of southeastern Alberta (Gummer and Robertson 2003a). About 36% of the Alberta range falls within the Canadian Forces Base (CFB) Suffield with a high percentage of the provincial population occurring within the Suffield National Wildlife Area (NWA) (AOKRRT 2005).

### *Canadian population size and trends*

The size of the Canadian kangaroo rat population is difficult to estimate due to the large fluctuations in population size perpetuated by high birth and death rates (Kenny 1989, Gummer 1997a). The only reported kangaroo rat population estimates come from Kenny (1989) who studied several populations in Saskatchewan (e.g. Burstall, Cramersburg and Great Sand Hills), and from Gummer (1997a) who studied the Middle Sand Hills population. Based on Gummer's (1997a) more recent population estimate, the overall Canadian population during the peak of the season has been estimated to be between 5,450 and 10,400 individuals (COSEWIC 2006). However, this population estimate was extrapolated from an unknown fraction of the total Canadian kangaroo rat range distribution and more robust estimates are required. Population surveys currently underway in Alberta may allow for a more precise quantification of kangaroo rat population size and trend (D. Bender pers. comm. 2010).

The Canadian kangaroo rat population experiences high and variable winter mortality rates (Gummer 1997a, Teucher 2007). Gummer (1997a) estimated 10% over-winter survival for the Middle Sand Hills population in 1995-1997. If mortality rates are consistent throughout the species' range, the number of breeding adults in certain years may drop by more than an order of magnitude to fewer than 1,000 individuals by early spring (COSEWIC 2006).

Historical population and distribution data are unavailable; however, based on historic occurrence of active sand dunes[4] and sandy habitats, it is presumed that kangaroo rats had a limited distribution in Canada within the past one or two centuries (Wolfe *et al*. 1995).

[3] The term "sand hills" refers to a well-defined region where several sand dune occurrences exist (David 1977).

[4] A sand dune is a "mound, hill or ridge of windblown sand, either bare or variously covered by vegetation, capable of movement from place to place through the development of a slip face, but always retaining its own characteristic shape for an extended period of time" (David 1977).

Furthermore, the progressive decline of sandy habitats in the last century has likely resulted in a parallel decline of kangaroo rat occurrence and distribution (COSEWIC 2006). There is evidence that several local populations have been extirpated in the last decade. For example, in 1985, one out of four known populations in the Great Sand Hills was reported to have been extirpated (Kenny 1989), while nine out of 19 local populations in the Middle Sand Hills were extirpated by 2002 (Gummer and Robertson 2003b, COSEWIC 2006).

## 3.3 Needs of the Kangaroo Rat

### *General habitat needs*

Natural kangaroo rat habitat is identified by sandy soils such as those associated with open, sparsely-vegetated sand dunes and sand flats (Nero 1956, Kenny 1989, Gummer 1995). Although exposed sandy slopes of river valleys were considered to be important to the species by some researchers (COSEWIC 2006, Teucher 2007) such habitat was determined to be non-critical to the persistence of the species at Suffield, Alberta (Heinrichs *et al.*, 2010), which constitutes a major portion of the range of the kangaroo rat in Canada. Sand dunes and other sandy soils are generally found within sand hills. However, sand hills also consist of a large amount of stabilized soils, which are not suitable kangaroo rat habitat. Loose textured, sandy soils are essential for kangaroo rats as they facilitate excavation of extensive burrow networks. Kangaroo rats depend on burrows to take shelter from the heat of the day, escape predators, cache food and eat, give birth, rear young, and rest (Germano and Rhodehamel 1995). Burrows are also extremely important to kangaroo rats for torpor, an adaptation critical for surviving harsh winter conditions (Gummer 2005). Suitable habitat also requires a high proportion of open ground with sparse vegetation to enable kangaroo rats to use their erratic, bipedal locomotion to evade predators (Bartholomew and Caswell 1951) while the surrounding vegetation provides food and cover from predators.

Kangaroo rats are solitary and actively defend territories, burrows, and food caches from conspecifics (Day *et al*. 1956, Gummer 1995) and other potential competitors. Members of the genus *Dipodomys* show no tolerance for intruders and in laboratory settings encounters have resulted in death (Day *et al.* 1956, Daly *et al.* 1984). With an average home range of 7,830 ± 2,930 $m^2$ (Gummer and Robertson 2003c) and dispersal distances generally less than 500 m (Gummer 1997a), large interconnected areas of suitable habitats are required to maintain connectivity for dispersal and mate-searching to sustain otherwise isolated populations.

### *Food resources*

Kangaroo rats typically forage at the margins of, and within, the sparsely vegetated areas surrounding open sand dunes and blow outs (Bender *et al.* 2007). Their diet primarily consists of a high diversity of native and non-native seeds which they gather in their cheek pouches and take to their burrows to consume or cache for winter. Based on analysis of seeds collected from the cheek pouches of captured kangaroo rats, scurf pea (*Psoralea lanceolatea),* Indian rice grass *(Oryzopsis hymenoides),* annual sunflowers (*Helianthus couplandii*), and spear grass (*Stipa comata*) were the most common native species comprising the diet of kangaroo rats in CFB Suffield, although non-native, introduced species were also prominent, especially of

individuals inhabiting anthropogenic habitats (Gummer *et al.* 2005). Being well-adapted to a desert environment, kangaroo rats obtain their metabolic water requirements from the food they consume, choosing seed types that are high in moisture content and thus eliminating any reliance on standing water (Frank 1988). Vegetation availability, composition, and quality are important aspects of suitable habitat, particularly during winter when the species relies solely on food collected during the snow-free months (Gummer *et al.* 2005).

## 3.4 Limiting Factors

### *Habitat Requirements*

The primary factor limiting the distribution of kangaroo rats in Canada is the availability and connectivity of open actively-eroding and sparsely vegetated sandy habitats (Gummer 1995, Gummer 1997b, AOKRRT 2005, COSEWIC 2006). Open active sand dunes and sandy habitats have a naturally small and patchy distribution throughout Alberta (AOKRRT 2005) as well as the Canadian prairies. Their rarity and small size are factors that limit the population size and distribution of the species in Canada. Natural changes in climate in the past century have further diminished the extent and amount of kangaroo rat habitat in Canada (Wolfe *et al*. 1995).
In particular, increased moisture has been cited as a major factor correlated with periods of vegetation growth and sand dune stabilization (David 1993, Wolfe *et al*. 1995, Wolfe *et al*. 2000).

### *Extreme Winter Conditions*

In Canada, kangaroo rats exist at the northern limit of their range and experience more extreme winter conditions (e.g. longer duration, lower temperatures, greater snow depth and depth of frost) than those in more southern localities. As an adaptation to these relatively unfavourable conditions, Canadian kangaroo rats use torpor to conserve energy (Gummer 2005). Climate-imposed limitations inflict a significant cost on kangaroo rats in Canada as they are prevented from augmenting their food and fat reserves throughout much of the winter. Winter mortality rates can reach 90%, and most deaths are presumed to be due to starvation and hypothermia (Gummer 1997a). This implies that kangaroo rats in Canada are existing precariously close to their physiological limits, and that any change in climate that results in an increase in extreme winter conditions has the risk of impacting the probability that this species will be able to survive in Canada, especially when considered in conjunction with the threats to the species.

# 4. THREATS

Kangaroo rats are affected by a number of threats of varying magnitude with the most significant being factors that cause dune stabilization, the creation of linear features that may become anthropogenic sink habitats, and the expansion of oil and gas development. Other potential threats include military activities, climate changes, and conversion of native grassland to crop production. These have been arranged in decreasing order of importance (*see* Appendix A for threat classification). It is important to stress that even in situations where the magnitude of an individual threat listed is small, the potential for the interaction and cumulative effects between

any or all of the threats could be significant, which in itself might be the greatest threat to the recovery of the species (AOKRRT 2005). Furthermore, the small spring populations of kangaroo rats could significantly add to the risk associated with these threats. Gummer (1997b) and Kenny (1989) both suggested that the spring population of kangaroo rats in Canada may fall below 1000 individuals. With such a population bottleneck each year, there is a potential for the following threats to drive kangaroo rat populations below some minimum viable threshold.

### *Factors that Cause Dune Stabilization*

Open actively-eroding and sparsely vegetated sandy areas appear to be essential for the persistence of kangaroo rats. In Canada, these unique habitats are almost exclusively associated with active sand dunes and sandy river slopes that are naturally maintained through a combination of climate (e.g. wind, precipitation, humidity, and temperature), and natural disturbances such as animal burrowing activity, grazing (e.g. bison, *Bison bison*, and elk, *Cervus canadensis*), and fire. The loss and degradation of these habitats which has likely resulted, in part, from natural changes in climate, may be further exacerbated by anthropogenic threats such as current land use practices that accelerate dune stabilization (Hugenholtz and Wolfe 2005, Muhs and Wolfe 1999, Vance and Wolfe 1996). Disturbances are extremely important for maintaining open natural eroding habitats, and without these perturbations vegetation can encroach, stabilizing and effectively eradicating the functionality of these areas (Hulett *et al*. 1966, Potvin and Harrison 1984) for kangaroo rats or other dune-adapted species.

Since European settlement, there has been an increase in fire suppression across the native grasslands of the Great Plains (Vinton and Collins 1997, Samson *et al.* 2004). In addition, livestock grazing patterns are more or less homogenous and rarely mimic the heterogeneous patterns of locally extirpated native bison (Frank *et al*. 1998). These recent anthropogenic impacts have likely exacerbated the rate of vegetation encroachment and dune stabilization, and altered the landscape structure (Hulett *et al*. 1966, Vance and Wolfe 1996).

Actively eroding sand dunes are currently being lost at a rate of 10-20% per decade (Wolfe 2002. 2001), although the overall loss rate may be as high as 30-90% since the 1940s (Wallis 1988). Bender *et al*. (2005) found that exposed sandy areas in the Middle Sand Hills declined at an average rate of 40% per decade over a 50 year period and an average of seven dunes were lost per decade. If this rate of decline continues, Bender *et al*. (2005) predicted that all active sand dunes in the Middle Sand Hills could disappear as soon as 2014. The current stabilization rates appear to be higher than historic rates, and pose a significant threat to the persistence of natural habitats.

Furthermore, the loss of natural open sandy areas can limit dispersal potential and reduce patch connectivity (Hanski *et al.* 1998). The interconnected patches inhabited by kangaroo rat populations allow for population rescue or the recolonization of extirpated patches through dispersal. If dispersal is reduced, rescue and recolonization may no longer occur, resulting in an increase in vacant patches. The scenario of extinction–colonization dynamics depends on a high degree of patch connectivity and influences the long-term persistence of the species. If a single patch is eliminated (e.g. by dune stabilization) the possibility of recolonization of neighbouring patches is reduced, putting the overall local population at a greater risk of local extirpation

(e.g. Hanski *et al*. 1998). Another possible consequence of the progressive stabilization of natural sand dune habitat, is that kangaroo rats may be forced to occupy human-disturbed habitats such as roads, trails, fireguards, bare ground associated with oil and gas fixtures, cattle trails, and the margins of cultivated agricultural lands (Stangl *et al*. 1992, Gummer 1997a, Gummer 1999, Bender *et al*. 2007, Kissner 2009) and these sites can act as population sinks as a result of higher direct and indirect mortalities and lower recruitment.

### *Linear Features*

A variety of activities including oil and gas development, military, residential development, and transportation create and maintain linear features such as access roads, trails, and fireguards that can be inhabited by kangaroo rats. These areas become free of vegetation and open, thus attracting kangaroo rats, particularly juveniles during dispersal. It has been suggested that more than half of the Alberta population of kangaroo rats may occupy these anthropogenic habitats during population peaks (D. Bender, pers. comm. 2010). Individuals that inhabit these anthropogenic sandy areas are exposed to human disturbances including traffic, mowing and grading, and can experience increased noise disturbance, collapse of burrows, changes to habitat characteristics, or increased direct risk of mortality (for review *see* Kissner 2009). Kangaroo rats inhabiting anthropogenic sites were found to have lower body condition, experience greater predation risks, and suffer higher botfly (*Cuterebra polita*) parasitism than those in more natural habitats (Bender *et al.* 2005, Robertson 2007, Teucher 2007). Linear features such as sandy roads, trails, and fire guards can also fragment populations by disrupting dispersal along natural corridors (Heinrichs *et al.* 2008, Heinrichs *et al*. 2010). It is believed that these disturbed anthropogenic areas may act as "sinks" habitats, low quality areas which individuals colonize, but where mortality likely exceeds recruitment and the overall survival is reduced (Gummer and Robertson 2003a Bender *et al.* 2005, AOKRRT 2005, COSEWIC 2006, Kissner 2009).

### *Oil and Gas Development*

The Canadian sand hills have been subject to perturbation from oil and gas development and this continues to increase within kangaroo rat range. Disturbances associated with oil and gas activities include exploration activities, drilling, the development and maintenance of linear features, installation of transmission lines, construction of well sites, installation of pipelines, increased vehicular traffic and abandonment and reclamation. These activities can result in the loss or degradation of natural habitat, as well as negative effects on aspects of kangaroo rat biology such as the amount of above-ground activity, home range size, use of torpor, dispersal and diet (Gummer and Robertson 2003c; Kissner 2009).

*Habitat alteration* - Infrastructure associated with oil and gas development (e.g. roads, access trails, well sites, compressor stations) can directly reduce or modify suitable habitat as well as limit dispersal among local populations (reviewed in Kissner 2009). Disturbed areas have the potential to become invaded by exotic species that out-compete native vegetation, and it is possible that non-native plants species may not meet kangaroo rat's nutritional and metabolic requirements (Gummer *et al.* 2005).

*Effects on behaviour* - Oil and gas activities such as drilling may generate night time

illumination, noise, and seismic vibrations that can alter kangaroo rat behaviour and negatively impact long term survival (Kissner 2009). Kangaroo rats are depredated by a wide range of species, and as such have adapted several anti-predator mechanisms. One adaptation is a reduction in overall activity during moonlit nights (Kaufman and Kaufman 1982, Gummer 1995, Gummer 1997b). Nocturnal illumination has the potential to mimic intense moonlight conditions, consequently increasing predation risk or minimizing the above ground time kangaroo rats spend foraging. Another morphological adaptation of kangaroo rats is the expansion of a portion of the tympanic bone, giving the species an acute sense of hearing to detect predators (Webster and Webster 1971, Sjoberg 1984). Excess noise and seismic vibrations from industrial activities may affect the ability of kangaroo rats to detect and escape predators, potentially resulting in higher rates of depredation.

### *Additional Threats*

Military activities, climate change, and conversion of native sandy habitats to crop production have all been identified as potential threats to the Canadian kangaroo rat population (AOKRRT 2005, COSEWIC 2006, Kissner 2009). These threats either occurred in the past, are relatively small and localized, or are unsubstantiated such that the impact of these activities on the Canadian population is believed to be low.

Military activities do not occur within the CFB Suffield NWA where the majority of the Alberta kangaroo rat population occurs, thus the direct threat to the species is small (AOKRRT 2005). Kangaroo rats living within the boundaries of the military base but outside of the NWA may be negatively impacted by some military activities such as exposure to heavy machinery use, live ammunition exercises, night time illumination, explosion of ordnance, and demolitions. Because less than 1% of the suitable kangaroo rat habitat in Alberta occurs within the CFB military training area (Kissner 2009), the potential negative impacts of military activities are thought to be low for the Alberta (D. Bender pers. comm. 2010) and the overall Canadian kangaroo rat population.

The cumulative effects of climate change on kangaroo rats are currently unknown, especially given the inherent uncertainty in all climate change models surrounding the spatial and temporal distribution of temperature and precipitation changes to sand dunes ecosystems. In Canada, kangaroo rats occur near their ecological limit for cold tolerance, and the species can experience extremely high winter mortality rates of up to 90% in severe winters (Gummer 1997a). The warming effect could have a positive impact on kangaroo rat overwinter survival rate but increased plant growth from longer, warmer summers could further reduce and fragment natural kangaroo rat habitat by increasing dune stabilization.

The historical conversion of native sandy grassland habitats to cultivated cropland has likely contributed to the loss of suitable kangaroo rat habitat as well as habitat fragmentation and creation of population "sinks". Currently, since the sand hill areas of southern Saskatchewan and Alberta are not regarded as high quality land for the production of crops due to their low soil moisture, low soil fertility, and high risk of wind erosion (Geological Survey of Canada 2001), the conversion of the remaining sandy grassland habitats for crop production is not likely to become a major threat to the Canadian kangaroo rat population (COSEWIC 2006).

# 5. POPULATION AND DISTRIBUTION OBJECTIVES

Based on the distribution of sandy sparsely vegetated habitats, the kangaroo rat likely had a limited historical distribution in Canada and as such there is no reasonable expectation that the species could expand its range beyond these natural boundaries. At a broad scale (i.e. the scale of sand hills), a reliable distribution objective can be set.

Population size is difficult to estimate for a species like the kangaroo rat whose abundance can vary by an order of magnitude seasonally. For this reason, only a qualitative population objective can be set at this time.

The population and distribution objectives for the kangaroo rat in Canada are to ensure that self-sustaining populations continue to occur at currently occupied sand hills in southeastern Alberta and in southwestern Saskatchewan.

# 6. BROAD STRATEGIES AND APPROACHES TO RECOVERY

## 6.1 Actions Already Completed or Currently Underway

In Alberta, extensive population surveys, monitoring, and research projects have taken place that will guide provincial recovery of kangaroo rats. From 1994 to 2005, research was done to evaluate seasonal behaviour, population demographics and distribution, and abundance of kangaroo rats in the Middle Sand Hills (Gummer 1997a, Gummer 2005). In 2001, surveys were carried out in Alberta at several potential sites to investigate the species' range within the southeastern portion of the province (Gummer and Robertson 2003a). In 2003, the Alberta Ord's Kangaroo Rat Recovery Team was initiated and a comprehensive recovery plan was developed for the Alberta population (AOKRRT 2005). A population monitoring protocol for Alberta's kangaroo rat population has been developed to meet provincial recovery goals (Bender *et al.* 2007) and population monitoring throughout the Alberta range has been ongoing since 2005 (D. Bender pers. comm. 2010). Additionally, during the construction of the North Suffield gas pipeline, specific mitigation measures were developed and implemented and kangaroo rat populations were monitored to assess effectiveness (Gummer and Robertson 2003b,c). Diet composition of kangaroo rats was investigated for potential applicability to reclamation of disturbed sites (Gummer *et al.* 2005), and beneficial management practices to minimize and mitigate anthropogenic disturbances have been published (Kissner 2009). Several projects that evaluated factors affecting kangaroo rats in natural and anthropogenic habitats have been completed in the CFB Suffield NWA by researchers at University of Calgary (Teucher 2007, Robertson 2007). A habitat restoration study using different fire and disturbance regimes commenced in 2007 within the Suffield NWA and is currently underway (D. Bender pers. comm. 2010). A habitat selection model has been recently developed for kangaroo rats in Alberta (Bender *et al.* 2010b) as well as a population viability model to identify partial critical

habitat (Heinrichs *et al*. 2010). Translocation protocols for kangaroo rats in Canada have been examined (Bender *et al.* 2010a).

In Saskatchewan, the province has published a comprehensive environmental study on the Great Sand Hills (Great Sand Hills Advisory Committee 2007). One of the recommendations within this document is a survey of localized sites predicted to support kangaroo rats to confirm their presence or absence, as well as a survey of localized sites predicted not to be occupied by kangaroo rats to ensure the accuracy of their predictive model (Great Sand Hills Advisory Committee 2007).

## 6.2 Recovery planning

**Table 1. Recovery Planning Table.** Priorities are defined as: High= top priority action; Medium = needed to evaluate and guide conservation actions; Low = action would be beneficial to the understanding of the species but not a priority.

| Priority | Threat or Limitation | General Description of Research and Management Approaches |
|---|---|---|
| **Broad Strategy: Habitat Management** | | |
| High | Factors that cause dune stabilization<br>Oil and Gas Development<br>Linear Features | • Continue to evaluate the effectiveness of Suffield NWA pilot restoration project to obtain long-term data, and investigate other means of dune destabilization.<br>• Evaluate and refine the effectiveness of Alberta's best management practices, and their application to Saskatchewan.<br>• Implement dune destabilization techniques in situations where they are required to meet the population and distribution objectives. |
| **Broad Strategy: Inventory and Monitoring** | | |
| High | All threats<br>Habitat requirements | • Monitor density and fine-scale distribution of kangaroo rats in Saskatchewan in order to establish severity of each threat and develop effective recovery actions.<br>• Confirm occupied sand hills in Saskatchewan, and predict occupied sand dunes based on amount of open sand to obtain coarse population estimate, and validate with population surveys.<br>• Continue to monitor density and fine-scale distribution of kangaroo rats in Alberta as required to meet the population and distribution objectives. |
| **Broad Strategy: Research** | | |
| Medium | Factors that cause dune stabilization<br>Linear features<br>Oil and gas development<br>Habitat requirements | • Determine most effective method for translocating kangaroo rats to unoccupied or sparsely occupied suitable habitat.<br>• Determine population boundaries and level of migration between populations using genetic studies to determine the degree of isolation among populations.<br>• Fill in other important knowledge gaps with respect to kangaroo rat ecology and microhabitat requirements, especially its use of potential sink habitat. |

## 6.3 Narrative to Support the Recovery Planning Table

### *Habitat Management*

Actively eroding sand dunes which are important for kangaroo rat survival and recovery are being stabilized at a rapid rate. As such, the evaluation of techniques and feasibility of destabilizing sand dunes is required to address the threat of habitat loss for this species. A project to destabilize small experimental sand dunes using fire and native ungulate grazers is currently underway in Suffield NWA and the effectiveness of these techniques in destabilizing and maintaining open sand dunes needs to be determined. The recommended best management practices, as described in Kissner (2009), to mitigate various forms of habitat disturbance and destruction, need to be analyzed throughout the range of kangaroo rats in Canada, and refined where appropriate.

### *Inventory and Monitoring*

While it is known whether most sand hills in Saskatchewan are occupied or unoccupied (D. Bender, pers. comm. 2010), baseline population abundance, fine-scale (i.e. sand dune level) distribution and population trend data are not available for the Saskatchewan populations. To achieve the population and distribution objectives, it is necessary to determine short- and medium-term trends in population numbers and distribution in Saskatchewan. This information is required for modeling and further identification of critical habitat and population viability analysis. As such, surveys must be carried out at known and potential sites to refine and map population occurrences. Alberta has conducted detailed population monitoring annually since 2005; monitoring and analysis should be continued. Although it is well established that kangaroo rats are associated with open actively eroding sand dunes and sand hills, the species is distributed at lower densities throughout semi-stabilized sand hills where sparse vegetation occurs (Bender *et al.* 2007), thus monitoring and inventory should be considered for such areas.

### *Research*

Modeling work suggests that, given the estimated current populations sizes, level of connectivity, and population demographics, some outlying kangaroo rat populations in Alberta could become extirpated in the near future (Heinrichs *et al.* 2008, Heinrichs *et al*. 2010). These outlying populations add significantly to the probability of having self-sustaining kangaroo rat populations in Alberta, and as such their persistence is important. Therefore, determining the most appropriate method for translocating kangaroo rats will provide the required tools for re-populating extirpated sand dune populations. Furthermore, some isolated populations of kangaroo rats may rely on local rescue effect for continued persistence. Genetic techniques can be used to identify these populations so that the continued migration of individuals into them can be ensured through the protection of dispersal corridors. Also, it is important to fill in other knowledge gaps with respect to kangaroo rat ecology and microhabitat use, especially the use of potential sink habitats. It is highly likely that individuals inhabiting anthropogenic habitats experience higher mortality and lower recruitment rates than those in natural habitats, thus these areas are likely acting as population "sinks". Since kangaroo rats frequently utilize human-modified habitats, a quantitative evaluation of the effect these habitats have on the persistence of local populations is required. To attain the population and distribution objectives, a better

understanding of the importance of suboptimal habitats (e.g. river valleys, agricultural areas, roads) as dispersal corridors would be beneficial. Finally, given the high levels of botfly parasitism affecting kangaroo rats in Canada, further research on the effect of botfly parasitism on the survival and reproduction of this species would help quantify the importance of this potentially-limiting factor.

# 7. CRITICAL HABITAT IDENTIFICATION

## 7.1 Identification of the Species' Critical Habitat

Critical habitat is defined in the *Species at Risk Act* (Subsection 2(1)) as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

Critical habitat for kangaroo rats is partially identified in this recovery strategy. Kangaroo rat critical habitat was identified within or immediately adjacent to CFB Suffield, Alberta (Appendix B), as this is the only area for which sufficient information was available to Environment Canada at the time that this document was prepared. A spatially-explicit population viability model was used to identify habitat patches that were considered to be productive over the long-term (Heinrichs *et al.* 2010). These productive habitat patches and their associated corridors were adjusted in size by taking into consideration the average size of kangaroo rat home ranges. Productive habitat patches are those where births minus deaths is greater than zero over the long term. Associated corridors are those connecting productive habitat patches located within 500 m of one another, which corresponds to the 75$^{th}$ percentile for juvenile dispersal distances (Gummer 1997a). A distance of 50 m, which is approximately ½ of the width of the majority of kangaroo rat home range sizes (Gummer and Robertson 2003c), was added to the productive habitat patches and their corridors. The 50 m distance ensures that kangaroo rats that set up their home range on the edge of the identified productive habitat patches or associated dispersal corridors would have their entire home range protected. Thus, kangaroo rat critical habitat is identified as the area encompassing the productive habitat patches and the associated corridors plus a 50 m distance surrounding these areas.

Sink habitats, which are habitat patches where births minus deaths were less than or equal to zero, were not identified as critical habitat. Because of their low quality (Heinrichs *et al*. 2010), road margins and exposed sandy river valley slopes, were also not identified as critical habitat.

The critical habitat identified in this recovery strategy is known to support kangaroo rats and to contain habitat attributes required for their survival. The biophysical attributes of kangaroo rat critical habitat include: loose exposed sandy soils (active sand dunes with negligible vegetation cover (<5%), and partially stabilized dunes with limited vegetation cover (<30%; Bender *et al*. 2010b) and sparsely vegetated habitat surrounding the previously identified loose sandy soils. Critical habitat for kangaroo rats excludes unsuitable habitat such as forests, marshes, permanent water bodies, and current anthropogenic features such as fences, buildings, structures, and roads.

Kangaroo rat critical habitat is identified in this recovery strategy within portions of 178 quarter-sections[5] in or immediately adjacent to CFB Suffield, Alberta (Appendix B). Out of these, 174 quarter-sections are federal lands occurring on the Suffield NWA, 1 quarter-section is DND federal land, 2 quarter- sections include both types of federal lands, and one quarter-section is Alberta Special Areas land (Appendix B). Quarter-sections that contain critical habitat are listed in Appendix C. Critical habitat boundaries displayed in Appendix B have not excluded existing human developments and infrastructure, but these are exempt from consideration as critical habitat as per the approach described above. All information is archived at Environment Canada, Prairie and Northern Region, and this information can be obtained by contacting the department.

There was not sufficient information available for identifying additional critical habitat in Alberta and/or Saskatchewan at the time this document was prepared. Studies to identify additional critical habitat are outlined in Section 7.3. Additional critical habitat will be identified in action plans to be completed by 2012 for Alberta and 2015 for Saskatchewan once more information is known.

## 7.2 Activities Likely to Result in the Destruction of Critical Habitat

Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time (Government of Canada 2009).

Critical habitat for kangaroo rats is destroyed by any alteration that adversely modifies any biological, chemical or physical features (e.g., topography, geology, soil/water/air conditions, vegetation, microclimate) to the extent that individuals can no longer use the above-ground or below-ground environment for foraging, locomotion, territory defense, communication, mating, escaping from predators, burrowing, taking shelter, caching food, rearing young, resting or hibernating. Destruction of critical habitat may happen if the ground is excavated, in-filled, compacted or stabilized by active efforts to discourage erosion, if the vegetation community or vegetation structure is purposely altered, or if the ambient auditory or night-time visual environment is modified. Subterranean activity (e.g. drilling, excavation, blasting/seismic survey) may be particularly acute forms of disturbance, resulting in the destruction of critical habitat. It should be noted that some activities may not destroy critical habitat in a single instance, but the combination and cumulative effect as well as the frequency and duration of the some activities could have a long-term destructive effect on critical habitat.

[5] The Dominion Land Survey system (McKercher and Wolfe 1986) is the grid system used in the Prairie Provinces to describe land locations. One unit of this system, the quarter- section (65 ha), is particularly useful for mapping critical habitat as it is used for ownership and management purposes. Townships are approximately 9.7 km x 9.7 km (6 miles x 6 miles) and are divided into thirty-six sections, each about 1.6 km x 1.6 km (1 square mile). Each section is further divided into four 0.8 km x 0.8 km (0.5 miles x 0.5 miles) quarter-sections, referred to as the southeast, southwest, northwest and northeast. The quarter -section level is used in this strategy to aid in describing the location of kangaroo rat critical habitat.

Examples of activities that are likely to result in destruction of critical habitat include, but are not limited to:

1) **Activities that promote stabilization of open sand in sand dune habitats.** Seeding, re-vegetation or the use of flax bales, straw crimping, drift fences, and landscape fabrics to actively stabilize dunes as a means to decrease soil erosion and improve land use productivity is considered destruction of kangaroo rat critical habitat. In addition to impeding movement, these activities can artificially promote vegetation cover, change plant diversity and structure, and stabilize dunes, thereby directly contributing to the loss of kangaroo rat critical habitat (Kissner 2009). Deliberate introduction or promotion on invasive plant species can also contribute to sand dune stabilization.

2) **Compression, covering, inversion, flooding, or excavation/extraction of soil**. Examples of compression include the creation or expansion of structures and linear features such as pipelines, transmission lines, fence lines, trails, roads and fireguards. Soil compression can lower soil temperatures in winter and increase the difficulty of digging burrows, such that critical habitat is destroyed. Examples of covering the soil include the creation or expansion of structures, spreading of solid waste materials, or road bed construction. Covering soil can affect the ability of kangaroo rats to move between regions and decrease the survival of forage plants, such that critical habitat is destroyed. Examples of soil inversion and/or extraction include new or expanded cultivation, sand and gravel extraction pits, dugouts, road construction, pipeline installation, and stripping of soil for well pads or fireguards. Soil inversion or excavation/extraction can alter soil porosity and temperature, thereby increasing the difficulty of digging burrows and decreasing winter survivorship, thus destroying critical habitat. Flooding can alter soil porosity and moisture content, which can result in direct mortality or the alteration of the vegetation community, such that critical habitat is destroyed. The listed activities also have the potential to introduce exotic species, which in turn contribute to dune stabilization.

3) **Light and noise pollution.** Various forms of disturbance may affect the ability of kangaroo rats to use critical habitat for shelter, forage, or search for mates. These forms of disturbance may also affect a kangaroo rat's ability or desire to disperse among suitable habitat patches, decreasing population viability and destroying critical habitat. Night-time illumination from industrial developments and installations at times of the year when kangaroo rats are active above-ground is considered destruction of critical habitat, as kangaroo rats are highly sensitive to ambient light, generally limiting movement to dark nights (Kaufman and Kaufman 1982). Kangaroo rats are also sensitive to auditory disturbance and seismic activity (Kissner 2009). As such, seismic surveys, drilling operations, and auditory disturbance (noise) from machinery or infrastructure is considered destruction of kangaroo critical habitat.

4) **Modification of open sand and sand dunes' native plant community.** Modification of the native plant community diversity and structure due to vehicular and recreational traffic, waste application, or deliberate introduction or promotion of invasive exotic species is considered destruction of critical habitat. The listed activities may reduce habitat availability or quality of food resources. Invasive species contribute also to displace native plants.

5) **Installation of perch sites**. The installation of structures such as poles, and some oil and gas structures can increase avian predation rates. Modification of critical habitat through the installation of these structures can first result in the direct mortality of kangaroo rats but also in the failure of kangaroo rats to use the habitat for shelter, foraging, and reproduction.

Kangaroo rats have persisted under domestic grazing regimes for many decades. Generally, conventional grazing practices benefit kangaroo rats by decreasing vegetation structure and increasing the amount of bare ground (Jones *et al.* 2003). Livestock grazing is considered compatible with kangaroo rat recovery and it is not an activity that destroys critical habitat. In addition, construction or repair of anthropogenic structures, such as fences, required to manage grazing by livestock in a manner that improves or maintains critical habitat is not considered destruction of critical habitat.

Existing roads are not included in the description of critical habitat and therefore the continuation of maintenance activities on the road bed are not likely to result in destruction of critical habitat.

Activities required to manage, inspect, or maintain existing facilities and infrastructure which are not critical habitat but whose footprints may be within or adjacent to the identified critical habitat are not examples of activities likely to result in the destruction of critical habitat provided that they are carried out following the current guidelines aimed at protecting kangaroo rats and their habitat (e.g., Kissner 2009).

Where a situation does not clearly fit in the activities described above, it is recommended that the proponent contact Environment Canada, Prairie and Northern Region, to ensure that the activity does not destroy critical habitat.

## 7.3 Schedule of Studies to Identify Critical Habitat

The critical habitat identified in this recovery strategy is necessary, but not sufficient, for the recovery of the kangaroo rat in Canada. Additional critical habitat within the species' range is necessary to meet the population and distribution objectives set for the recovery of kangaroo rats in Canada. Additional information is required before further critical habitat can be effectively delineated across the Canadian range, as outlined in Table 2. As more information becomes available, additional critical habitat will be identified in one or more action plans.

**Table 2. Schedule of Studies.**

| Description of Activity | Outcome/Rationale | Timeline |
|---|---|---|
| Obtain required habitat and occupancy data and apply the model to the rest of Alberta to identify critical habitat outside of Suffield. | Critical habitat is identified in Alberta. | 2010-2012 |
| Confirm occupied sand hills in Saskatchewan, and predict occupied sand dunes within sand hills based on amount of open sand. | Identify suitable habitat in Saskatchewan. | 2010-2012 |
| Survey suitable sand dunes in Saskatchewan to obtain baseline population distribution and abundance data and to verify model output as described above. | Collect site, population and habitat attribute data to identify critical habitat in Saskatchewan. | 2011-2014 |
| Quantify if the critical habitat identified will support self-sustaining populations of kangaroo rats. | Determine if more critical habitat has to be identified in order to meet the population and distribution objectives. | 2011-2014 |

# 8. ADDITIONAL INFORMATION REQUIREMENTS ABOUT THE SPECIES

- Better understanding into species' population boundaries and dispersal corridors among sand hills, in both natural and anthropogenic habitats, particularly for juveniles, and potential for inbreeding effects.
- The degree of connectivity, if any, between the Alberta and Saskatchewan populations, and the potential for population rescue at this scale through the natural movement when either population is declining.
- The effects of seismic disturbances from drilling, pipeline trenching, vehicular traffic, transport of heavy equipment, explosion of ordnance on species behaviour and overall fitness. Particularly, determine the proximity of activities allowable to prevent long-term negative effects.
- The quality of invasive plant seeds as food sources and the effects of invasive plants on habitat stabilization/degradation.
- The reason behind the high rates of botfly parasitism in the Canadian population.
- The effectiveness of grazing by elk and cattle on destabilizing and maintaining sand dunes, and their effects on kangaroo rat habitat quality.
- The short- and long-term suitability of recently burned areas as habitat for kangaroo rats.

# 9. MEASURING PROGRESS

**Table 3. Kangaroo rat recovery strategy performance measures.**

| General Description of Research and Management Approaches | Performance Measure |
|---|---|
| • Continue to evaluate the effectiveness of Suffield NWA pilot restoration project to obtain long-term data, and investigate other means of dune destabilization.<br>• Evaluate and refine the effectiveness of Alberta's best management practices, and their application to Saskatchewan.<br>• Implement dune destabilization techniques in situations where they are required to meet the population and distribution objectives. | • The effectiveness of NWA pilot restoration project has been evaluated; new approaches to dune destabilization have been investigated and evaluated. Results have been reported.<br>• Beneficial management practices for kangaroo rats in Saskatchewan have been developed and evaluated and incorporated into appropriate guidance documents.<br>• Dune destabilization techniques have been applied. |
| • Monitor density and fine-scale distribution of kangaroo rats in Saskatchewan in order to establish severity of each threat and develop effective recovery actions.<br>• Confirm occupied sand hills in Saskatchewan, and predict occupied sand dunes based on amount of open sand to obtain coarse population estimate, and validate with population surveys.<br>• Continue to monitor density and fine-scale distribution of kangaroo rats in Alberta in order to evaluate success of meeting the population and distribution objectives. | • Reliable baseline population data for kangaroo rats in Saskatchewan has been obtained and reported.<br>• Additional suitable habitats and populations have been identified in Saskatchewan.<br>• Monitoring density and fine scale distribution of the kangaroo rats in Alberta have been evaluated and reported. |
| • Assess the potential of translocation as an effective population management tool and evaluate translocation methods.<br>• Determine population boundaries and level of migration between populations using genetic studies to determine the degree of isolation among populations.<br>• Fill in any other knowledge gaps with respect to kangaroo rat ecology and microhabitat requirements, especially use of potential sink habitat. | • The potential effectiveness of translocation has been evaluated as a population management tool and the most effective method for translocating kangaroo rats has been determined.<br>• Genetic studies have been completed such that population boundaries and degree of isolation among populations have been determined.<br>• Studies into kangaroo rat ecology have been completed and knowledge gaps have been filled. |

# 10. STATEMENT ON ACTION PLANS

Action Plans for the kangaroo rat in Alberta and Saskatchewan are to be completed by 2012 and 2015 respectively. There is the potential for a multispecies or ecosystem-based Action Plan that could benefit multiple species at risk inhabiting this ecosystem (e.g., Multiple Species at Risk, or MultiSAR in Alberta, Downey *et al*. 2005).

# 11. REFERENCES

Alberta Ord's Kangaroo Rat Recovery Team (AOKRRT). 2005. Recovery plan for Ord's kangaroo rat in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species At Risk Recovery Plan No. 5. Edmonton, Alberta. 28 pp.

Bartholomew, G.A. and H.H. Caswell. 1951. Locomotion in kangaroo rats and its adaptive significance. Journal of Mammalogy 32:155-169.

Bender, D.J., R. Dzenkiw, and D.L. Gummer. 2010a. Translocation protocol for the Ord's kangaroo rat (*Dipodymus ordii*). Alberta Sustainable Resource Development, Fish and Wildlife Division. Alberta Species at Risk Report No. 131, Edmonton, Alberta.

Bender, D.J., D.L. Gummer, and R. Dzenkiw. 2007. Monitoring protocol for the Ord's kangaroo rat. Alberta Sustainable Resource Development, Fish and Wildlife Division. Alberta Species At Risk Report No. 113, Edmonton, Alberta.

Bender, D.J., D.L. Gumer, R. Dzenkiw, and J.A. Heinrichs. 2010b. An occurrence-based habitat model for the Ord's kangaroo rat (*Dipodomys ordii*) in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division. Alberta Species at Risk Report No. 136. Edmonton, AB. 17 pp.

Bender, D.J., D.L.. Gummer, S. Robertson, A. Teucher, P. Knaga, E. Baird, and E. Jochum. 2005. Conservation management of Ord's kangaroo rats and sandy habitats of the Middle and Hills of Alberta. Report for Canadian Forces Base Suffield, Medicine Hat, Alberta. 33 pp.

COSEWIC. 2006. COSEWIC assessment and update status report on the Ord's kangaroo rat *Dipodomys ordii* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, Ontario. vii + 34 pp.

COSEWIC. 2009. Species assessment: COSEWIC's assessment process and criteria. Available at: http://www.cosewic.gc.ca/eng/sct0/assessment_process_e.cfm#tbl6 (accessed December 15, 2009).

David, P.P. 1977. Sand dune occurrences of Canada: a theme and resource inventory study of eolian landforms of Canada. Department of Indian and Northern Affairs, National Parks Branch. Ottawa. 183 pp.

David, P.P. 1993. Great Sand Hills of Saskatchewan: an overview. Pages 59-81 *in*: Sauchyn, D.J. (ed.). Quaternary and Late Tertiary landscapes of southwestern Saskatchewan and adjacent areas. Special Publication of the Canadian Plains Research Centre, University of Regina, Regina, Saskatchewan.

Daly, M., I. Wilson, and P. Behrends. 1984. Breeding of captive kangaroo rats, *Dipodomys merriami* and *D. microps.* Journal of Mammalogy 65: 338-341.

Day, B.N., H.J. Egoscue, and A.M. Woodbury. 1956. Ord's Kangaroo rat in captivity. Science 124: 485-486.

Downey, B.L., B.A. Downey, R.W. Quinlan, and P.F. Jones. 2005. MultiSAR: A multi-species conservation strategy for species at risk: Year 3 report. Alberta Species at Risk Report No. 98. Fish and Wildlife Division, Alberta Sustainable Resource Development, Edmonton, Alberta. 56 pp.

Epp, H.T. and B.D. Waker. 1980. Terrestrial vertebrate fauna of the Great Sand Hills. Pages 75-89 *in* Epp, H.T. and L. Townley-Smith (eds.). The Great Sand Hills of Saskatchewan. Saskatchewan Environment, Regina, Saskatchewan.

Frank, C.L. 1988.The Influence of moisture content on seed selection by kangaroo rats. Journal of Mammalogy 69: 353-357.

Frank, D.A., S.J. McNaughton, and B.F. Tracy. 1998. The ecology of the earth's grazing ecosystems. BioScience 48: 513-521.

Germano, D.J. and W.M. Rhodehamel. 1995. Characteristic of Kangaroo rat burrows in fallow fields of the southern San Joaquin Valley. Transactions of the Western Section of the Wildlife Society 31:40-44.

Geological Survey of Canada. 2001. Sand dune and climate change studies in the Prairie Provinces. Geological Survey of Canada, Ottawa, Ontario.

Government of Canada. 2009 (*draft*). *Species at Risk Act* policies overarching policy framework. *Species at Risk Act* Policies and Guidelines Series. Government of Canada.

Great Sand Hills Advisory Committee. 2007. Great Sand Hills Environmental Study: Final Report. Submitted to the Government of Saskatchewan. 223 pp.

Gummer, D.L. 1995. Status report on the Ord's kangaroo rat *Dipodomys ordii* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, Ontario. 25 pp.

Gummer, D.L. 1997a. Effects of latitude and long-term isolation on the ecology of northern Ord's kangaroo rats (*Dipodomys ordii*). M.Sc. thesis, University of Calgary, Calgary, Alberta, Canada. 111 pp.

Gummer, D.L. 1997b. Status of Ord's kangaroo rat (*Dipodomys ordii*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 4. Edmonton, Alberta. 16 pp.

Gummer, D.L. 1999. Distribution and abundance of Ord's kangaroo rats in Canadian Forces Base Suffield National Wildlife Area. Report for Canadian Wildlife Service, Edmonton, Alberta. 29 pp.

Gummer, D.L. 2005. Geographic variation in torpor patterns: the northernmost prairie dogs and kangaroo rats. Ph.D. dissertation, University of Saskatchewan, Saskatoon, Saskatchewan, Canada. 210 pp.

Gummer, D.L. and S.E. Robertson. 2003a. Distribution of Ord's kangaroo rats in southeastern Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 63. Edmonton, Alberta. 16 pp.

Gummer, D.L. and S.E. Robertson. 2003b. Evaluation of survival and activities of Ord's kangaroo rats: one year after construction of the North Suffield gas pipeline. Report for Alberta Conservation Association. Edmonton, Alberta. 14 pp.

Gummer, D.L. and S.E. Robertson. 2003c. Evaluation of activities and survival of Ord's kangaroo rats during and post construction of the North Suffield pipeline. Report for EnCana Corporation, Calgary, Alberta. 43 pp.

Gummer, D.L., A.B. Beaudoin, and D.J. Bender. 2005. Diet of Ord's kangaroo rats and implications for reclamation of disturbed sites in the Middle Sand Hills. Report for EnCana, Alberta.18 pp.

Hanski I., T. Pakkala, M. Kuussaari, and G.C. Lei. 1995. Metapopulation persistence of an endangered butterfly in a fragmented landscape. Oikos 72:21-28.

Heinrichs, J.A., D.J. Bender, D.L. Gummer, and N.H. Schumaker. 2010. Assessing critical habitat: Evaluating the relative contribution of habitats to population persistence. Biological Conservation doi:10.1016/j.biocon.2010.06.009.

Heinrichs, J., R. Dzenkiw, D. Bender, and D. Gummer. 2008. A critical habitat model for the Ord's kangaroo rat, *Dipodomys ordii*, in Alberta. Research report prepared for Environment Canada. University of Calgary, Calgary, AB. 42 pp.

Hugenholtz, C.H., and S.A. Wolfe. 2005. Recent stabilization of active sand dunes on the Canadian prairies and relation to recent climate variations. Geomorphology 68:131-147.

Hulett, G.K., R.T. Coupland, and R.L. Dix. 1966. The vegetation of dune sand areas within the grassland region of Saskatchewan. Canadian Journal of Botany 44:1307-1331.

Jones, Z.F., C.E. Bock, and J.H. Bock. 2003. Rodent communities in a grazed and ungrazed Arizona grassland, and a model of habitat relationships among rodents in southwestern grass/shrublands. American Midland Naturalist 149: 384-394.

Kaufman, D.W., and G.A. Kaufman. 1982. Effect of moonlight on activity and microhabitat use by Ord's kangaroo rat (*Dipodomys ordii*). Journal of Mammalogy 63:309-312.

Kenny, R.J.L. 1989. Population, distribution, habitat use, and natural history of Ord's kangaroo rat (*Dipodomys ordii*) in the sand hill areas of south-western Saskatchewan and south-eastern Alberta. M.Sc. thesis, University of Manitoba, Winnipeg, Manitoba, Canada. 69 pp.

Kissner, K.J. 2009. Beneficial management practices for Ord's kangaroo rat in Alberta. Alberta Sustainable Resources Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 125. Edmonton, AB. 42 pp.

McKercher, R.B. and B. Wolf. 1986. Understanding Western Canada's Dominion Land Survey System. Division of Extension and Community Relations, University of Saskatchewan, Saskatoon, Saskatchewan.

Muhs, D.R., and S.A. Wolfe. 1999. Sand dunes of the northern Great Plains of Canada and the United States. Pages 183-197 *in* Lemmen, D.S. and R.E. Vance (eds.). Holocene Climate and Environmental Change in the Palliser Triangle: A Geoscientific Context for Evaluating the Impacts of Climate Change on the Southern Prairies. Geological Survey of Canada Bulletin 534, Ottawa, Ontario.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at: http://www.natureserve.org/explorer/servlet/NatureServe?init=Species (Accessed: August 6, 2008).

Nero, R.W. 1956. The kangaroo rat in Saskatchewan. Blue Jay 14:3-4.

O'Farrell, M.J. 1974. Seasonal activity patterns of rodents in a sagebrush community. Journal of Mammalogy 55:809-823.

Potvin, M.A. and A.T. Harrison. 1984. Vegetation and litter changes of a Nebraska sandhills prairie protected from grazing. Journal of Range Management. 37:55-58.

Robertson, S. 2007. Spatial patterns and effects of bot fly (*Cuterebra polita*) parasitism in Ord's kangaroo rat (*Dipodomys ordii*). M.Sc. thesis, University of Calgary, Calgary, Alberta, Canada. 122 pp.

Samson, F.B., F.L. Knopf, and W.R. Ostlie. 2004. Great Plains ecosystems: past, present, and future. Wildlife Society Bulletin 32:6-15.

Sjoberg, D. E., J. A. Young, K. McAdoo, and R. A. Evans. 1984. Kangaroo Rats. Rangelands 6: 11-13.

Smith, H.C. and M.J. Hampson. 1969. A kangaroo rat colony in Alberta. Blue Jay 27:224-225.

Stangl, F.B. Jr., T.S. Schafer, J.R. Goetze, and W. Pinchak. 1992. Opportunistic use of modified and disturbed habitat by the Texas kangaroo rat (*Dipodomys elator*). Texas Journal of Science 44:25-35.

Teucher, A. C. 2007. Impacts of anthropogenic habitat use on the Ord's kangaroo rat (*Dipodomys ordii*) in Alberta. M.Sc. thesis, Department of Biological Sciences, University of Calgary, Calgary, Alberta, Canada. 167 pp.

Vance, R.E. and S.A. Wolfe. 1996. Geological indicators of water resources in semi-arid environments: southwestern interior of Canada. Pages 251-263 *in* Berger, A.R. and W. J. Iams (eds.) Geoindicators: assessing rapid environmental changes in earth systems. A.A. Balkema, Rotterdam.

Vinton, M.A. and S.L. Collins. 1997. Landscape gradients and habitat structure in native grasslands of the central great plains. Pages 3-19 *in* Knopf, F.L. and F.B. Samson (eds.) Ecology and Conservation of Great Plains Vertebrates. Springer-Verlag, New York.

Wallis, C.A. 1988. The unsung benefits of wind erosion – stabilizing sand dunes spell trouble for rare plants. Iris Newsletter 3:1-2.

Webster, D.B. and M. Webster. 1971. Adaptive value of hearing and vision in kangaroo rat predator avoidance. Brain, Behaviour, and Evolution 4: 310-322.

Wolfe, S.A. 2002. Eolian deposits in the prairie provinces. Open File 4118. Geological Survey of Canada, Ottawa. Ontario.

Wolfe, S.A., D.J. Huntley, and J. Ollerhead. 1995. Recent and late Holocene sand dune activity in southwestern Saskatchewan. Pp. 131-140 *in* Current research 1995-B. Geological Survey of Canada.

Wolfe, S.A., D.R. Muhs, P.P. David, and J.P. McGeehin. 2000. Chronology and geochemistry of late Holocene eolian deposits in the Brandon Sand Hills, Manitoba, Canada. Quaternary International 67:61-74.

# 12. PERSONAL COMMUNICATIONS

Personal Communication: Darren. Bender, Professor, University of Calgary, 2010.

# APPENDIX A - THREAT CLASSIFICATION TABLE

| 1 | Factors that Cause Dune Stabilization | Threat Information | | |
|---|---|---|---|---|
| **Threat Category** | Habitat Loss or Degradation | **Extent** | Widespread | |
| | | | **Local** | **Range-wide** |
| **General Threat** | Change in land use practices (e.g. fire, grazing) since European settlement | **Occurrence** | Current/Imminent | |
| | | **Frequency** | Continuous | |
| **Specific Threat** | Alteration of habitat characteristics; habitat loss and fragmentation; reduced resource availability | **Causal Certainty**[1] | High | |
| | | **Severity**[2] | High | |
| **Stress** | Decreased dispersal among populations, reduced population size, increased local extinctions | **Level of Concern**[3] | High | |
| **2** | **Linear Features** | **Threat Information** | | |
| **Threat Category** | Habitat Loss or Degradation; Accidental Mortality | **Extent** | Widespread | |
| | | | **Local** | **Range-wide** |
| **General Threat** | Creation of sink habitats (e.g. access roads, trails, well sites, fireguards, crop fields) | **Occurrence** | Current/Imminent | |
| | | **Frequency** | Continuous | |
| **Specific Threat** | Alteration of habitat characteristics; reduced resource availability; high mortality rates | **Causal Certainty** | Medium | |
| | | **Severity** | High | |
| **Stress** | Decreased dispersal among populations, reduced population size, increased local extinctions | **Level of Concern** | High | |
| **3** | **Oil and Gas Development** | **Threat Information** | | |
| **Threat Category** | Habitat Loss or Degradation; Disturbance or Harm; Accidental Mortality | **Extent** | Widespread | |
| | | | **Local** | **Range-wide** |
| **General Threat** | Oil and gas exploration and extraction activities | **Occurrence** | Current | |
| | | **Frequency** | One-time/ Recurrent | |
| **Specific Threat** | Behavioural disruption; death of individuals; habitat loss/fragmentation | **Causal Certainty** | Medium | |
| | | **Severity** | Unknown | |
| **Stress** | Behavioural changes; increased parasitism; reduced population size; lower birth rate, higher death rate | **Level of Concern** | Medium | |

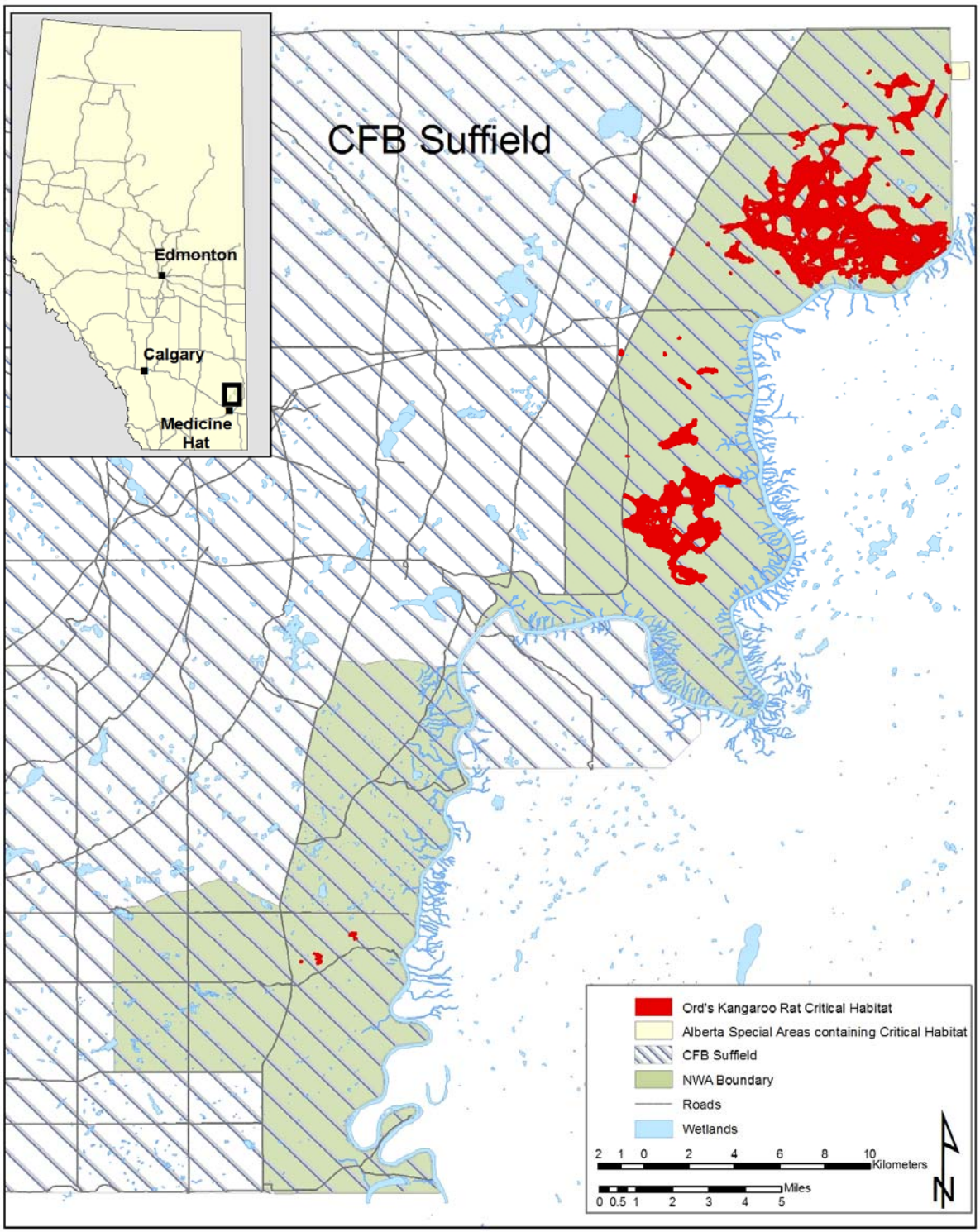
| 4 | Military Activities | Threat Information | | |
|---|---|---|---|---|
| **Threat Category** | Disturbance or Harm; Accidental Mortality | **Extent** | Localized | |
| | | | **Local** | **Range-wide** |
| **General Threat** | Military activities (e.g. heavy machinery use, live ammunition, nighttime illumination, explosion of ordnance | **Occurrence** | Current | Unknown |
| | | **Frequency** | Recurrent | Unknown |
| **Specific Threat** | Behavioural disruption; death of individuals | **Causal Certainty** | Low | Low |
| | | **Severity** | Low | Low |
| **Stress** | Behavioural changes; reduced survivorship | **Level of Concern** | Low | Low |
| **5** | **Climate Change** | **Threat Information** | | |
| **Threat Category** | Climate and Natural Disasters | **Extent** | Widespread | |
| | | | **Local** | **Range-wide** |
| **General Threat** | Changes in moisture; cold winters | **Occurrence** | Anticipated | |
| | | **Frequency** | Unknown | |
| **Specific Threat** | Habitat loss/fragmentation; freezing; starvation | **Causal Certainty** | Unknown | |
| | | **Severity** | Unknown | |
| **Stress** | Reduced population size; increased mortality | **Level of Concern** | Low | |
| **6** | **Conversion of Native Sandy Grassland Habitats to Crop Production** | **Threat Information** | | |
| **Threat Category** | Habitat Loss or Degradation | **Extent** | Widespread | |
| | | | **Local** | **Range-wide** |
| **General Threat** | Crop production; cultivation | **Occurrence** | Historic | |
| | | **Frequency** | Seasonal/Recurrent | |
| **Specific Threat** | Habitat loss and fragmentation; isolation; reduced resource availability | **Causal Certainty** | Low | |
| | | **Severity** | Medium | |
| **Stress** | Reduced population size; increased local extinctions; decreased dispersal among populations; lower birth rate, higher death rate | **Level of Concern** | Low | |

[1] *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species ,consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table).*

[2] *Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, Unknown).*

[3] *Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability e.g. expert opinion; Low: the threat is assumed or plausible).*

# APPENDIX B – MAP OF ORD'S KANGAROO RAT CRITICAL HABITAT IN OR IMMEDIATELY ADJACENT TO CFB SUFFIELD NATIONAL WILDLIFE AREA, ALBERTA



# APPENDIX C –LIST OF QUARTER-SECTIONS IN OR IMMEDIATELY ADJACENT TO CFB SUFFIELD NATIONAL WILDLIFE AREA, ALBERTA, THAT CONTAIN ORD'S KANGAROO RAT CRITICAL HABITAT[6]

| Province | Quarter(s) | Section | Township | Range | Meridian | Ownership |
|---|---|---|---|---|---|---|
| Alberta | NW | 11 | 20 | 3 | 4 | Federal-NWA |
| Alberta | NW | 7 | 20 | 2 | 4 | Provincial Special Areas |
| Alberta | SE | 13 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 6 | 16 | 5 | 4 | Federal-NWA |
| Alberta | SE, SW | 8 | 16 | 5 | 4 | Federal-NWA |
| Alberta | SE | 2 | 19 | 4 | 4 | Federal-NWA |
| Alberta | NE | 12 | 19 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW, SE | 13 | 19 | 4 | 4 | Federal-NWA |
| Alberta | NW | 14 | 19 | 4 | 4 | Federal-Suffield/NWA |
| Alberta | SE | 24 | 19 | 4 | 4 | Federal-NWA |
| Alberta | SW | 27 | 19 | 4 | 4 | Federal-Suffield |
| Alberta | NE, NW, SW | 1 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 2 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW, SE | 3 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE | 4 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, SE | 9 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 10 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 11 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 12 | 18 | 4 | 4 | Federal-NWA |
| Alberta | SE, SW | 13 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, SE, SW | 14 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NW | 15 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE | 16 | 18 | 4 | 4 | Federal-NWA |
| Alberta | SE | 22 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 23 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW | 26 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE | 33 | 18 | 4 | 4 | Federal-Suffield/NWA |
| Alberta | NE | 34 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NW, SE, SW | 35 | 18 | 4 | 4 | Federal-NWA |
| Alberta | SW | 36 | 18 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 35 | 17 | 4 | 4 | Federal-NWA |
| Alberta | NW, SW | 36 | 17 | 4 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 1 | 20 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 2 | 20 | 3 | 4 | Federal-NWA |
| Alberta | NW, SE, SW | 3 | 20 | 3 | 4 | Federal-NWA |
| Alberta | SE, SW | 4 | 20 | 3 | 4 | Federal-NWA |
| Alberta | SE | 5 | 20 | 3 | 4 | Federal-NWA |

[6] Ord's Kangaroo Rat critical habitat occurs only on portions of the listed quarter-sections and excludes unsuitable habitat such as forests, marshes, permanent water bodies, and current anthropogenic features such as fences, buildings, structures, and roads.

| Province | Quarter(s) | Section | Township | Range | Meridian | Ownership |
|---|---|---|---|---|---|---|
| Alberta | NE, SE | 10 | 20 | 3 | 4 | Federal-NWA |
| Alberta | NE, SE, SW | 11 | 20 | 3 | 4 | Federal-NWA |
| Alberta | NE, SE, SW | 12 | 20 | 3 | 4 | Federal-NWA |
| Alberta | NW | 7 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE | 8 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW | 9 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW | 10 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW | 11 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SW | 13 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 14 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 15 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 16 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 17 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 18 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 19 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 20 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 21 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 22 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 23 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NW, SE, SW | 24 | 19 | 3 | 4 | Federal-NWA |
| Alberta | SW | 25 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NW, SE, SW | 26 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE | 27 | 19 | 3 | 4 | Federal-NWA |
| Alberta | SW | 27 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 28 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 29 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, SE, SW | 30 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, SE, SW | 32 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 33 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE | 34 | 19 | 3 | 4 | Federal-NWA |
| Alberta | NE, NW, SE, SW | 35 | 19 | 3 | 4 | Federal-NWA |
| Alberta | SW | 18 | 18 | 3 | 4 | Federal-NWA |

# APPENDIX D – EFFECTS ON OTHER SPECIES

A number of federally-listed species at risk occur in the same area as the kangaroo rat such as: Loggerhead Shrike (*Lanius ludovicianus*), Sprague's Pipit (*Anthus spragueii*), Small-flowered Sand-verbena (*Tripterocalyx micranthus),* Tiny Cryptantha (*Cryptantha minima),* Smooth Goosefoot (*Chenopodium subglabrum),* Slender Mouse-ear-cress, (*Halimolobos virgata),* Gold-edged Gem (*Schinia avemensis*) and Dusky Dune Moth (*Copablepharon longipenne*).

Most of these species may benefit from recovery activities intended to maintain open sandy areas for the benefit of kangaroo rats. Management practices that include natural disturbance regimes (e.g. fire and grazing) are natural components of prairie ecosystems, and as a general rule should not negatively impact the persistence of other native species' populations. However, management strategies should strive to benefit as many species as possible while minimizing negative effects. Efforts should be coordinated with other recovery teams working in the dune ecosystem to help ensure the most efficient use of resources, and to prevent duplication of effort and conflicts with research.