Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Burrowing Owl (*Athene cunicularia*) in Canada

Burrowing Owl


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2012

Environment Canada Environnement Canada

Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (www.sararegistry.gc.ca/approach/act/default_e.cfm) outline both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. A period of three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the Species at Risk (SAR) Public Registry (www.sararegistry.gc.ca).

Recovery Strategy for the Burrowing Owl (*Athene cunicularia*) in Canada

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DECLARATION

This recovery strategy has been prepared in cooperation with the jurisdictions responsible for the Burrowing Owl. Environment Canada has reviewed and accepts this document as its recovery strategy for the Burrowing Owl, as required under the *Species at Risk Act* (SARA). This recovery strategy also constitutes advice to other jurisdictions and organizations that may be involved in recovering the species.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives.

This recovery strategy will be the basis for one or more action plans that will provide details on specific recovery measures to be taken to support conservation and recovery of the species. The Minister of the Environment will report on progress within five years, as required under SARA.

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. In the spirit of the Accord for the Protection of Species at Risk, the Minister of the Environment invites all responsible jurisdictions and Canadians to join Environment Canada in supporting and implementing this strategy for the benefit of the Burrowing Owl and Canadian society as a whole.

RESPONSIBLE JURISDICTIONS

Environment Canada, Canadian Wildlife Service
Parks Canada Agency
Government of Alberta
Government of British Columbia
Government of Manitoba
Government of Saskatchewan

CONTRIBUTORS

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STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process, based on national guidelines, directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below.

The SEA concluded that this recovery strategy will clearly benefit the environment by promoting the recovery of the Burrowing Owl and associated burrowing mammals and habitats, and that these benefits far outweigh any potentially adverse effects that may result. The strategy includes the possibility of using habitat management near Burrowing Owl nesting areas to modify breeding sites and mitigate the impacts of common predators that have increased in abundance above historical levels. The reader should refer to the following sections of this document for details: 1.4 Needs of the Burrowing Owl; 2.4 Approaches to Address Threats and Meet Recovery Objectives; and 2.7 Potential Effects on Other Species.

RESIDENCE

SARA defines residence as: *a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* **[Subsection 2(1)]**.

Residence descriptions for Burrowing Owls and other species at risk, or the rationale for why the residence concept does not apply to certain species, are posted on the SAR Public Registry: www.sararegistry.gc.ca/sar/recovery/residence_e.cfm.

PREFACE

The Burrowing Owl was officially listed as Endangered under the *Species at Risk Act* (SARA) in June 2003. SARA (Section 37) requires the competent minister to prepare recovery strategies for listed extirpated, endangered, or threatened species. The Canadian Wildlife Service Prairie and Northern Region, Environment Canada led the development of this recovery strategy, in cooperation with the British Columbia Ministry of Environment, Alberta Sustainable Resource Development, Saskatchewan Environment, Manitoba Conservation, Parks Canada Agency, Agriculture and Agri-Food Canada, and the Department of National Defence (Canadian Forces Base Suffield). These agencies, along with the Blood Tribe, Siksika Nation, Piapot First Nation, Osoyoos Indian Band, Nicola Tribal Association, Okanagan Nation Alliance, Shuswap Nation Tribal Council, Upper Nicola Indian Band, and numerous non-government organizations, were invited to review drafts of this strategy. Public and private landholders whose land includes critical habitat were consulted. This recovery strategy took into consideration the *Assessment and Update Status Report on the Burrowing Owl in Canada*, prepared by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2006), the *Recovery Plan for Burrowing Owl in Alberta*, prepared by the Alberta Burrowing Owl Recovery Team (2005), and the draft *Action Plan for the Burrowing Owl (*Athene cunicularia hypugaea*) in British Columbia* (Burrowing Owl Recovery Implementation Group 2008).

This document is a revised version of the *Recovery Strategy for the Burrowing Owl (*Athene cunicularia*) in Canada [Proposed]* originally posted on the Species at Risk Registry on July 23, 2007, for a 60-day comment period. Because significant changes have been made to the recovery strategy in response to comments received, this revised strategy was posted as '*proposed'* for a second 60-day comment period.

EXECUTIVE SUMMARY

- The Burrowing Owl was listed as Endangered under SARA in 2003, and its status was confirmed as Endangered upon re-assessment in April 2006, by the Committee on the Status of Wildlife in Canada (COSEWIC), largely due to significant population declines.
- Burrowing Owls once occupied most of the grassland regions of western Canada, but currently inhabit only 36% of their historical distribution within those regions. Over the past three decades, the population has declined from an estimate of more than 3000 pairs to fewer than 800 pairs.
- Burrowing Owls are generalists in terms of their habitat and prey requirements. The owls depend on a variety of primary excavators, such as badgers, ground squirrels, prairie dogs, or marmots, to dig burrows the owls use for nesting. Though Burrowing Owls do not depend on any species of prey in particular, their survival and reproductive success is high when their total prey intake is high. The mice, voles, grasshoppers, and beetles that Burrowing Owls consume occur in both native and non-native habitats.
- Potential threats that have been suggested for Burrowing Owls include loss and fragmentation of native and non-native grassland habitats, decreased prey, increased predation, inclement weather, vehicle mortalities, environmental contaminants, and loss of burrowing mammals in parts of the owls' range.
- No single factor has been identified as causing the decline of Burrowing Owl populations in Canada and the relative roles of suspected threats are unknown. The cumulative impacts of several factors might be responsible for the decline.
- Demographic metrics associated with annual changes in the Canadian owl population include poor reproductive success and low juvenile survival. The results of an isotope study suggested that more owls emigrate from Canada than immigrate to Canada from the United States.
- Recovery of Burrowing Owls within Canada is assumed to be feasible but dependent on a high level of effort and cooperation among governments, non-government organizations, industry, stakeholders, landowners, and the general public, in the three countries of North America.
- The long-term recovery goal for the Burrowing Owl is to reverse the population decline in Canada and maintain a self-perpetuating, well-distributed population of at least 3000 breeding pairs within the four western provinces. These pairs should encompass the 1993 distribution of Burrowing Owls in Alberta, Saskatchewan, and Manitoba, with at least 30 wild pairs distributed within their historical range in the Thompson/Nicola and Okanagan regions of British Columbia. The short-term (i.e., over the next 5 years) population and distribution objective for this Recovery Strategy is to reach the 2004 estimated population size (800 pairs) and distribution.
- Seven broad objectives are identified to achieve the recovery goal for Burrowing Owls:
    1) Develop an improved understanding of environmental and demographic factors associated with annual population changes in Burrowing Owls.
    2) Identify and implement protocols that mitigate factors contributing to population declines.
    3) Identify, maintain, enhance, and increase nesting and foraging habitat.
    4) Optimize nesting success, fledging rate, and survival on Canadian breeding grounds.
    5) Re-establish wild breeding populations of Burrowing Owls within their historical range in British Columbia and their 1993 range in Manitoba.

6) Encourage management, conservation, and research of Burrowing Owls and the habitats they use during each season, in the United States and Mexico.
7) Engage, support, and communicate with land holders and land managers about actions that may improve Burrowing Owl populations and habitats in their local areas.

- Burrowing Owl critical habitat is identified in this Recovery Strategy to the extent that is currently possible. It is defined as the area within the boundaries of the black-tailed prairie dog colonies in Canada as of 2007, excluding all existing roads and associated ditches within these colonies. Because of extremely high densities of burrows, these colonies constitute an identifiable and consistently occupied nesting habitat for Burrowing Owls. Each year for the past 5 years, the prairie dog colonies have held approximately 10–15% of the known population of nesting owls in Canada.
- All Burrowing Owl burrows on federal land are protected as residences under SARA. In addition, each province in western Canada has protective legislation in place for Burrowing Owl nests on all non-federal land. There is a need to discover many additional nesting areas because the locations of most owls estimated to exist in Canada are unknown. Statistical analysis to determine which environmental parameters are associated with a high probability of owl occurrence will help focus searches for additional owls, and thus lead to the identification and protection of additional nesting areas.
- Additional critical habitat cannot be identified for Burrowing Owls with currently available information. It is particularly difficult to identify and describe critical habitat for species, such as the Burrowing Owl, that are habitat and prey generalists, showing extreme flexibility in their environmental requirements aside from their reliance on burrows. In Canada's grassland regions, outside of prairie dog colonies, mammal burrows are naturally distributed at low densities over extremely large areas. Moreover, owls do not appear to require or prefer any particular habitat types for foraging in the vicinity of nest burrows. At the home-range scale, use of foraging habitat has been studied for a small number of owls to date. Findings thus far show contradictory selection for, or in other cases avoidance of, environments with relatively high densities of humans and human infrastructure, as well as use or avoidance of native versus non-native habitats around nests. Owls apparently occur, survive, and reproduce equally well in landscapes dominated by native rangeland and those dominated by cropland and introduced grasses, and in environments with high or low levels of other human influences. To identify additional critical habitat, there is an urgent need to continue the attempt to determine whether there are any particular landscape compositions, habitat types, or perhaps other detailed environmental and anthropogenic features that owls prefer to use or avoid around nest burrows, especially for successful foraging, and which environments are associated with high survival and reproductive success. Such studies have commenced and are scheduled for completion over the next few years, hopefully allowing additional critical habitat to be identified in action plans by December 2014.

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1. BACKGROUND

1.1 Species Assessment Information from COSEWIC

Date of Assessment: April 2006

Common Name: Burrowing Owl

Scientific Name: *Athene cunicularia*

COSEWIC Status: Endangered

Reason for Designation: This grassland owl has suffered significant declines across its North American range; Canadian populations declined 90% in the 1990s and the species is essentially extirpated from British Columbia and Manitoba. This population decline slowed somewhat between 1994 and 2004, but remained at approximately 57%. The true cause or causes of this widespread decline remain unknown.

Canadian Occurrence: British Columbia, Alberta, Saskatchewan, and Manitoba

COSEWIC Status History: Designated Threatened in April 1979. Status re-examined and confirmed in April 1991. Status re-examined and designated Endangered in April 1995. Status re-examined and confirmed in May 2000 and in April 2006. Last assessment based on an update status report.

1.2 Description of the Species

The Burrowing Owl is a small (125–238 g), brownish owl that has bright yellow eyes, a rounded head (i.e., no ear tufts), a short tail, and noticeably long legs (Figure 1). Males and females are almost identical in appearance, though the male's plumage may be lighter in colour throughout much of the breeding season. Adults have white spots on their head and wings and a white abdomen with brown barring. In contrast, young of the year have no spots on their head or wings, their abdomens are solid beige with no barring, and the tops of their wings have a conspicuous beige stripe across them when closed. From a distance, the size and general colour of Burrowing Owls is similar to that of the prairie dogs or ground squirrels with which they typically coexist. During the day, owls may be seen perching on fence posts or atop the earthen mounds of their burrows. They lay an average clutch of 9 eggs, with a range of 6–14 eggs (Wellicome 2000; Todd and Skilnick 2002). Hatchlings are altricial (relatively immobile, with eyes closed, and fed by parents), but they gain enough mobility within 10–15 days to venture outside of their burrow entrances (Wellicome 2005). By 35–40 days after hatch, young owls are capable of sustained flight (Wellicome 1997). Fledglings may begin dispersing from their nest area at 60–70 days of age, although some remain near their natal site until migration (Todd 2001a).

The Western Burrowing Owl (*A. c. hypugaea*) is the only subspecies of Burrowing Owl found in Canada (Wellicome & Haug 1995).

1.3 Populations and Distribution

1.3.1 National and Global Status

In Canada, the Burrowing Owl is listed federally as Endangered in Schedule 1 of the *Species at Risk Act*. Provincially, the species is listed as Endangered in British Columbia, Saskatchewan, Alberta, and Manitoba. The owl is also identified as a Priority Species in the Landbird Conservation Plan for the Prairie Pothole Bird Conservation Region (Canadian Prairie Partners in Flight 2004).

The Burrowing Owl is not listed under the U.S. *Endangered Species Act* but is a National Bird of Conservation Concern for the U.S. Fish and Wildlife Service. The Burrowing Owl is listed as Endangered in Minnesota; Threatened in Colorado; a Species of Concern in California, Montana, Oklahoma, Oregon, Utah, Washington, and Wyoming; and a candidate species for listing in Washington (Klute et al. 2003). In Mexico, the Burrowing Owl is ranked as a species with Special Protection (Diario Oficial de la Federación 2008).

Figure 1. Adult Burrowing Owl with leg-bands.

Burrowing Owls are given a Global Heritage Status rank of G4 (“apparently secure globally”) because of their widespread distribution throughout North America, with the caveat that there is “some cause for long-term concern due to declines” (NatureServe 2004). Within Canada, their national rank is N2B (imperiled, breeding), with specific ranks of S2B (imperiled, breeding; steep declines) in Alberta and Saskatchewan and S1B (critically imperilled; extreme rarity and risk of extirpation) in both British Columbia and Manitoba. In the United States, they are ranked as N4 (apparently secure; cause for long-term concern) for both the resident and migratory populations.

1.3.2 Canadian Distribution

Burrowing Owls were once found breeding as far east as Winnipeg, Manitoba, and as far west as Alberta’s foothills, with disjunct populations in the southern interior grasslands and the Fraser River delta of British Columbia (Figure 2). In the prairies, the owls are now confined mainly to southeastern Alberta and southwestern Saskatchewan, having disappeared from the parkland and northern fescue regions. They were considered to have disappeared from British Columbia as a breeding species by the early 1980s (Howie 1980). Several reintroduction attempts were made during the 1980s in the southern Okanagan and also from the 1980s to present day in the Thompson-Nicola region of British Columbia. Many captive-hatched owls bred successfully in the wild after being released as yearlings, and several have returned from migration to breed in years subsequent to their release. However, the wild B.C. population is not yet self-sustaining (J.

Surgenor, pers comm. 2007). In Manitoba, despite intensive management and translocations from the late 1980s until the mid-1990s, the Burrowing Owl is on the verge of extirpation (De Smet 1997), though a few individuals or nesting pairs are still observed in some years, including a recent high year with 11 pairs in 2008 (K. De Smet, pers. comm. 2008).

Historically, the breeding range of the Burrowing Owl in Canada covered roughly 450 000 km^2 (Figure 2). By the 1970s, the breeding range had contracted to 73% of its former area. By the early 1990s, the range had contracted further, covering 47% of its former area. By 2004, the range covered 36% (160 000 km^2) of the historical range. Apparently-suitable breeding habitat is still available to the owls in the areas from which they have disappeared.

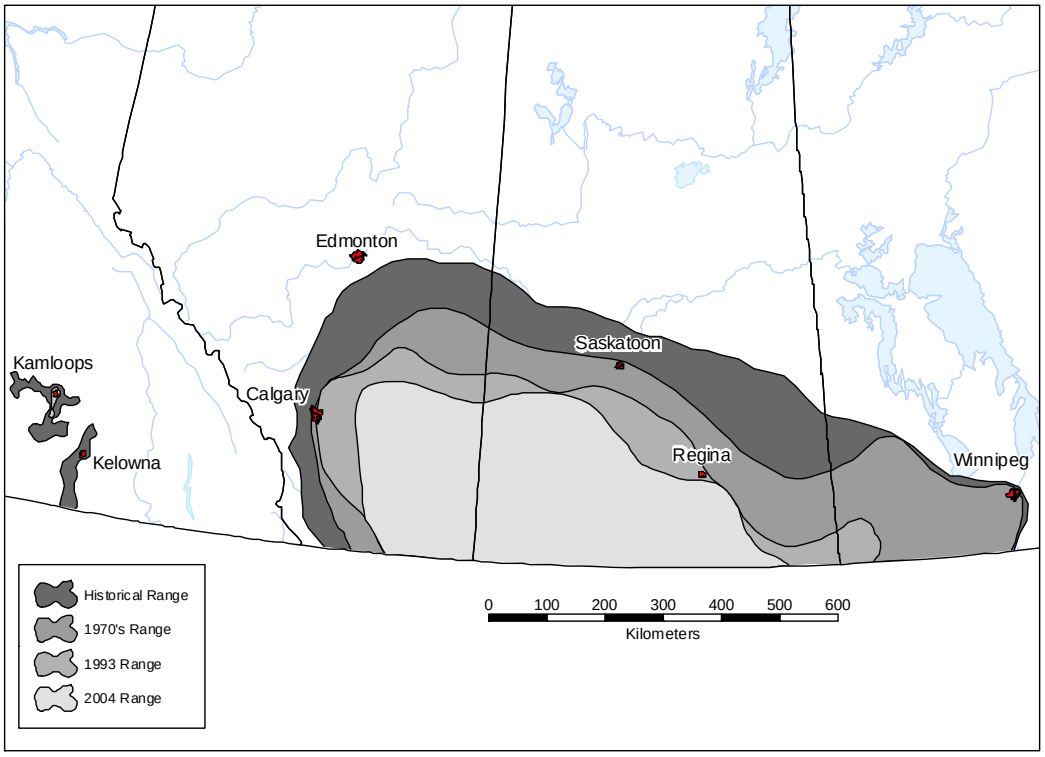

Figure 2. Change in the Canadian breeding distribution of the Burrowing Owl over time. The 2004 distribution was based on unprecedented search effort, through reports from Operation Grassland Community (Alberta) and Operation Burrowing Owl (Saskatchewan) landowners, extensive searches by biologists, and incidental sightings. The owls' 1993 breeding range is from Wellicome and Haug (1995), and the 1970–1977 breeding range is based on Wedgwood (1978). The owls' historical breeding range (~1880–1950) was constructed from a comprehensive literature review of written records from early explorers and naturalists (Wapple 2005), with B.C. portions updated by J. Surgenor (pers. comm. 2005). Although southwestern British Columbia is not shown on this map, there were records of a few pairs nesting in the Fraser River delta area from the early 1900s until 1976 (Campbell et al. 1990). These changes in breeding distribution over time differ from the geographic pattern of grassland loss (Canadian Prairie Partners in Flight 2004).

1.3.3 Global Distribution

The global breeding distribution of the Western Burrowing Owl has contracted over the past 30 years, particularly from the north and the east (Figure 3).

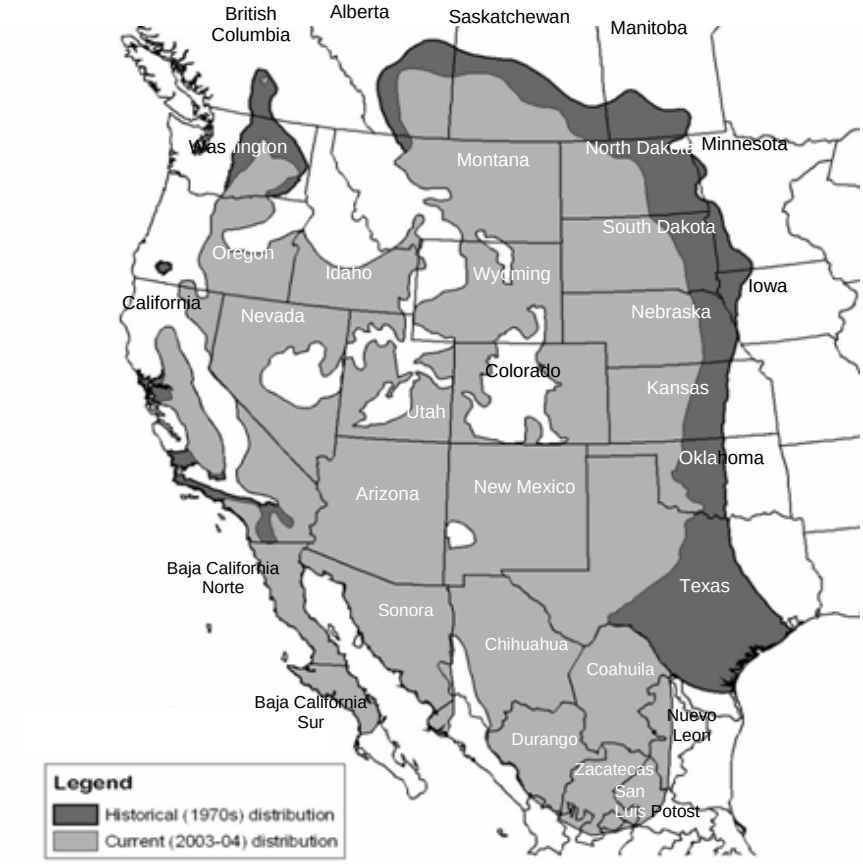

Figure 3. Change in distribution of the Western Burrowing Owl in North America between the 1970s and 2004 (Wellicome and Holroyd 2001, with Canadian portions modified and updated to the 2004 distribution). There are no data with which to assess historical distribution in Mexico.

No data are available with which to estimate changes in breeding distribution within Mexico. The 2004 Canadian distribution encompassed approximately 160 000 km^2, which is 4% of the North American distribution (4 million square kilometres). Historically, the Canadian distribution was approximately 450 000 km^2 (Figure 2), or about 11% of the North American range.

1.3.4 Population Size and Trends

Accurate, large-scale surveys do not exist for the Burrowing Owl, and the Breeding Bird Survey is unreliable for this species (Conway and Simon 2003). The crude methods used to estimate the total owl population in Canada vary markedly among status assessments written for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), with less-accurate and less-intensive methods employed in earlier reports. In the 1970's, when the species became Threatened (Wedgwood 1978), the Canadian Burrowing Owl population likely exceeded 3000 pairs. In the early 1990s, landowner reports and directed surveys in parts of the species' range were used to

estimate a total of 2500 pairs in Canada (Haug and Didiuk 1991). In 1995, landowner reports were used to estimate a total population of between 1015 and 1695 pairs, and the species was uplisted to Endangered (Wellicome and Haug 1995). The most recent population estimate is for 2004 (COSEWIC 2006). In that year, the combined total number of Burrowing Owls estimated by two landowner stewardship programs (Operation Grassland Community in Alberta and Operation Burrowing Owl in Saskatchewan) was 151 pairs, despite fairly consistent enrolment of landowners over time (Figure 4). In addition, expanded search effort by biologists and other land managers boosted this minimum known population to almost 400 pairs in 2004 (795 individuals: 288 in Alberta, 498 in Saskatchewan, 9 in British Columbia, and 0 in Manitoba). Though this count in 2004 was likely very accurate because of the amount of attention and effort being directed towards this species, there has never been (and still is not) a quantitative method by which to estimate the number of undetected or unknown owls in the Canadian population. Therefore, when estimating the total 2004 owl population, for every individual owl that was known to exist, one additional owl was assumed to be present without being detected or reported (COSEWIC 2006). Thus, the 2004 estimated total population (800 pairs) was arrived at by doubling the known minimum population (~400 pairs). This most recent speculative estimate of 800 pairs suggests that the country lost at least three-quarters of its total estimated owl population between 1978 and 2004. However, this rate of loss is likely an underestimate because the amount of search effort increased over this same period.

Rather than attempting to characterize trends in estimated total population size, one can more accurately examine relative changes using data from subsets of the total population. Within monitoring areas, methods have remained consistent over time. Using annually consistent methodology, Operation Burrowing Owl recorded a 91% decline in its Saskatchewan Burrowing Owl population index from 1988 to 2004 (Figure 4a; Skeel et al. 2001; OBO Saskatchewan unpubl. data). Equally severe declines were reported by Operation Grassland Community in Alberta, where the number of reported pairs declined by 91% from 1991 to 2001 (Figure 4b; OGC Alberta unpubl. data). Provincial declines were evident despite initially increasing, then later constant, membership in both programs over time. These trends were corroborated by more intensive surveys at smaller scales in Alberta (Shyry et al. 2001; Kissner and Skiftun 2004) and in Saskatchewan (Wellicome et al. 1997; R. Poulin, D. Todd, and T. Wellicome, unpubl. data 2007). Since 2001, modest increases were detected by Operation Grassland Community and Operation Burrowing Owl, and similar local increases were observed in small study areas in Alberta (Knapton et al. 2005) and Saskatchewan (Grasslands National Park), though numbers in each of those monitoring areas have again declined (National Burrowing Owl Recovery Team meeting 2010). In Manitoba, despite intensive monitoring and reintroductions of 249 adults and young owls from the early 1980s to the mid-1990s, known nesting populations declined from 76 pairs in 1982 to 1 pair in 1996 (De Smet 1997). Over the past 12 years, the number of owl pairs in Manitoba has fluctuated between 0 and 11 per year, with 0 pairs in five of the past 10 years (K. De Smet, unpubl. data).

Burrowing Owls had disappeared from British Columbia by the early 1980s (Leupin and Low 2001). Shortly before this disappearance, a recovery attempt was initiated to restore the wild owl population in the Okanagan using translocated owls. Unfortunately, that effort was ultimately unsuccessful. Following this attempt, releases using captive-bred owls occurred in the Thompson and Nicola regions near Kamloops. Beginning in 1989, owls were released each year, with a larger number of owls released in more recent years. For example, in April 2005, 84 adult owls were released, and they fledged 100 young in the wild later that summer, and in 2006, 112 adults were released, fledging 130 young. Although these reintroductions have not established a self-sustaining breeding population in the wild, a few released owls do return to release sites each year (e.g., 15 ‘wild’ adult owls returned to the area in 2006; J. Surgenor and Mike Mackintosh, pers.

comm. 2007). Reintroductions and recovery actions are continuing through adaptive trials in the Thompson region (Burrowing Owl Recovery Implementation Group 2008; Mitchell 2008).

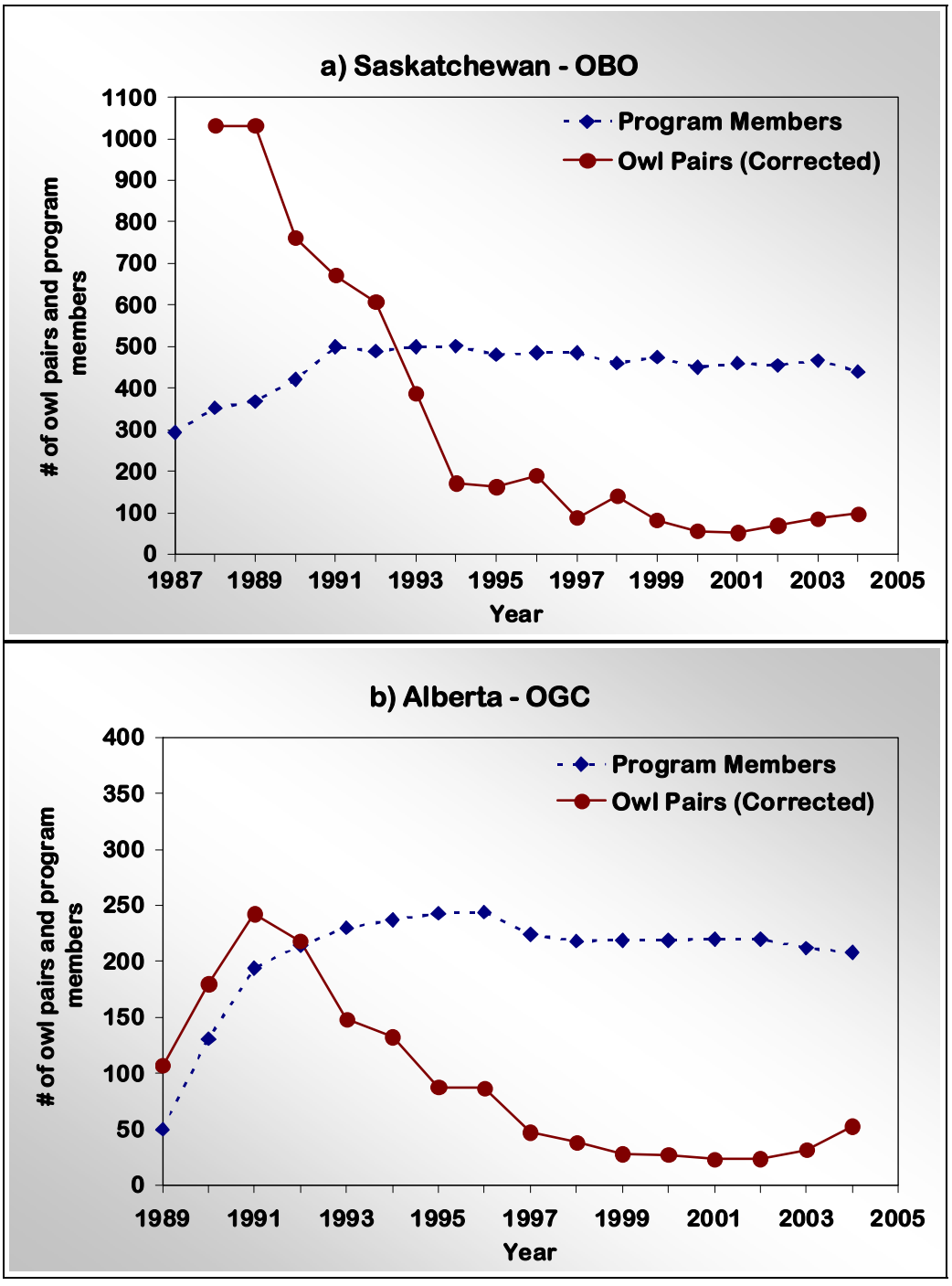

Figure 4. Total number of Burrowing Owl pairs reported annually (corrected for non-responding members; see Skeel et al. 2001) by landowner members in (a) Saskatchewan's Operation Burrowing Owl (OBO) and (b) Alberta's Operation Grassland Community (OGC) since the late 1980s (COSEWIC 2006).

1.4 Needs of the Burrowing Owl

1.4.1 Habitat and Biological Needs

Burrows

Burrowing Owls are known to have two types of burrows – nest burrows and roost burrows (also see RESIDENCE section on page iii). Burrowing Owls rely on burrowing mammals to create these underground holes that are typically used by the owls during breeding, dispersal (post-breeding), migration, and wintering. Consequently, occurrence of owls in the Prairie Provinces depends in part on adequate populations of badgers (*Taxidea taxus*), Richardson's ground squirrels (*Spermophilus richardsonii*), and black-tailed prairie dogs (*Cynomys ludovicianus*). B.C.'s Burrowing Owls currently nest in man-made artificial nest burrows (Mitchell 2008), but historically they nested in the burrows of badgers, yellow-bellied marmots (*Marmota flaviventris*), and Columbian ground squirrels (*Spermophilus columbianus*) (Burrowing Owl Recovery Implementation Group 2008). Unlike other burrowing mammals in Canada, black-tailed prairie dogs occur in conspicuous, high-density colonies. These aspects of black-tailed prairie dog colonies make them preferred nesting locations for Burrowing Owls. Accordingly, the highest known densities of owls in Canada occur within colonies of black-tailed prairie dogs (COSEWIC 2006). Over a 5-year period, the total number of owl pairs in prairie dog colonies has varied between 41 and 63 pairs (COSEWIC 2006 and G. Holroyd and H. Trefry unpubl. data), representing approximately 10–15% of the total breeding population known in Canada in 2004.

Burrowing Owl nest burrows can be found in a number of different types of habitats. Most nest burrows occur in pastures (grazed native or introduced grassland), although they are also commonly found in cropland, roadside ditches, hayland, golf courses, or suburban lawns (Clayton and Schmutz 1999; Poulin et al. 2005; COSEWIC 2006; T. Wellicome unpubl. manuscript). Studies in livestock pastures suggest that nesting owls select burrows in fields that are level and heavily-grazed, and thus have relatively short (<10 cm), sparse vegetation (James et al. 1991; Clayton and Schmutz 1999). Owls are also more likely to nest in fields that contain high densities of nearby burrows (James et al. 1991; Warnock and Skeel 2002; Poulin et al. 2005), which are used for roosting by both adult and juvenile owls.

Foraging home-ranges and diet

Food-pellets regurgitated by Burrowing Owls during the breeding season reveal that insects, such as grasshoppers and beetles, outnumber vertebrate prey eaten by adults, nestlings, and recently fledged juveniles (Leupin and Low 2001; Poulin 2003; Sissons 2003; Shyry 2005; Mitchell 2008; Floate et al. 2008). However, mice, voles, and other vertebrates comprise the vast majority of biomass in the owls' diets (Poulin 2003; Sissons 2003; Mitchell 2008; Floate et al. 2008). Vertebrate prey are captured at night, while most insects are captured during the day (Poulin and Todd 2006). Males capture >90% of each pair's total prey biomass during their approximately 90-day breeding period, at least until pre-fledging when both sexes forage day and night (Poulin and Todd 2006).

Very few studies have tracked adult male Burrowing Owls to see how far from nests they forage, and no studies have ascertained from which habitat types owls successfully obtain their prey. VHF-telemetry studies have been conducted at three local sites in Alberta and Saskatchewan. These few studies suggest home-range size for adult males varies considerably within and among study areas: home ranges for 6 adult male owls averaged 241 ha near Saskatoon, Saskatchewan

(range = 14-481 ha; Haug and Oliphant 1990), 34 ha for 4 males near Avonlea, Saskatchewan (8-47 ha; Sissons et al. 2001), and 328 ha for 11 males near Brooks, Alberta (34–756 ha; Sissons 2003).

Habitat composition within home ranges was found to vary within and among study areas. Habitat composition within the 6 home-ranges near Saskatoon averaged 55% farmland (crop and fallow), 21% pasture (grazed native or introduced grass), 23% ungrazed grass (roadsides, railways, haylands, etc., all with introduced grasses and forbs), and 1% wetland (Haug and Oliphant 1990). Composition within the 4 home-ranges near Avonlea averaged 67% farmland, 21% pasture, 9% ungrazed grass (roadsides and farmyards), and 3% riparian (Sissons et al. 2001). Though average composition of home-ranges was not presented, the Brooks study was in rangeland (Sissons 2003) where the land-base was 87% native pasture, 7% planted pasture, 5% small wetlands, and 1% farmland (irrigated and non-irrigated). Considering habitat composition and sizes of home-ranges in these studies, it appears that Burrowing Owls in the area dominated by native pasture required larger areas to forage (Sissons 2003). Comparing reproductive performance among sites, nesting success was lowest near Saskatoon (21% pasture; Haug and Oliphant 1990), and the number of fledglings per pair was lowest near Brooks (94% pasture; Sissons 2003). Thus, larger amounts of cropland around nests apparently does not lead to increased area requirements, nor does it reduce reproductive success.

Patterns of habitat selection *within* home ranges also varied among individual adult owls. Near Saskatoon, 3 of 6 owls showed a significant aversion to native pasture, 4 of 6 used crops less than expected, all 6 owls used both crop-fallow and wetlands in proportion to their availabilities, and 5 of 6 owls showed significant selection for roadsides (Haug and Oliphant 1990). Near Avonlea, 2 of 4 owls used cropland less than expected and one avoided fallow, but 2 of them selected pastures; roadsides were neither selected nor avoided (Sissons et al. 2001). Owls near Brooks were attracted to ephemeral wetlands and often avoided native grassland, with a neutral use of roadsides. At a finer scale, owls in this Alberta study avoided dugouts, pipelines, and trails, but were attracted to fencelines and fenced gas-well sites, which had introduced grass species (Sissons 2003). These preliminary results suggest that Burrowing Owls have very flexible foraging habitat requirements.

Although only a small amount of data has been collected, juvenile owls seem to show a similar diversity in nocturnal habitat use. Nine habitually-used nocturnal locations were studied in the Brooks study area (Shyry 2005). All 9 of the locations were associated with sites lacking vegetative cover, such as roads, truck trails, cattle dugouts, and gas-well pads. Six of these 9 locations were inside dried-up ephemeral wetlands. None of the locations were associated with upland native-grass habitat. In contrast, none of the 12 juvenile owls studied in the Nicola Valley of B.C. selected roads and only 1 selected wet meadows for nocturnal foraging. Instead, all of them selected grazed non-native grass whenever that habitat was available, and 6 of 12 owls showed a significant avoidance of native pasture (Mitchell 2008).

From the limited studies to date, no general conclusions can be drawn about which land uses or habitat types are detrimental and which are beneficial for foraging Burrowing Owls. Hence, there is an urgent need to ascertain what habitat types and features the owl population uses and needs, especially for successful foraging and reproduction, and thus what habitat management and protection would benefit owls beyond the protection of nest burrows. What amounts of beneficial habitats, within what distances, are adequate for owl occupancy, survival, and reproductive success? These are the questions that still need to be answered within the wide variety of landscapes in which owls nest in Canada.

Landscapes

In general, Burrowing Owls occupy regions with relatively flat plains that lack trees or dense shrub cover (Haug et al. 1993). Although owls are much more likely to occupy burrows that are immediately surrounded by grassland (native or non-native) than other habitat types (Clayton and Schmutz 1999, Poulin et al. 2005), the value of such grassland habitat to owls becomes unclear at scales beyond the immediate vicinity of the burrow.

At the landscape level, occurrence of Burrowing Owls is not concentrated within grassland-dominated landscapes, as illustrated by the lack of any obvious relationship between the amount of grassland on a given landscape and presence of owls in both Alberta (Figure 5) and Saskatchewan (Figure 6). Owl populations have been studied in regions that are 90% cropland (e.g., Poulin et al. 2005) and also in regions that are >85% native grassland (e.g., Clayton and Schmutz 1999, Sissons 2003). Interestingly, reproduction and survival has been similar among these study populations (Franken and Wellicome 2003), suggesting that reproduction and survival of Burrowing Owls is not affected by proportion of grassland. However, it has yet to be determined whether any subtle relationships exist at large scales. For example, within Saskatchewan, Warnock and James (1997) found that owls in low-density regions (< 6 owl sites / 4000 km^2) tended to nest where there was higher continuity of grassland within a 20-km radius compared to random sites. Conversely, owls in high-density regions (> 6 owl sites / 4000 km^2) nested in smaller patches of more fragmented landscapes compared to random sites. Additional detailed studies are needed to determine which combinations of environmental parameters predict Burrowing Owl presence, high survival, and successful reproduction.

Species Distribution Models were constructed (Stevens 2008) to examine which environmental variables influence where Burrowing Owls place their home ranges within the species range in Canada. The models indicated that Burrowing Owls in Canada (during the breeding season) are environmental generalists with a high tolerance for differences or changes in their environment (Stevens 2008). Soil type and soil parent material, along with average spring temperatures, were good predictors of environmental locations that Burrowing Owls select for nesting. In contrast, habitat variables such as land-use and land-cover (e.g., % grass) or grassland fragmentation were not important predictors of Burrowing Owl home-range habitat selection. Thus, abiotic factors were much more important than biotic factors in determining where owls chose to place their home ranges. These modeling results corroborate field studies, outlined above, that have observed high variation in selected habitats within and among home ranges and among individuals.

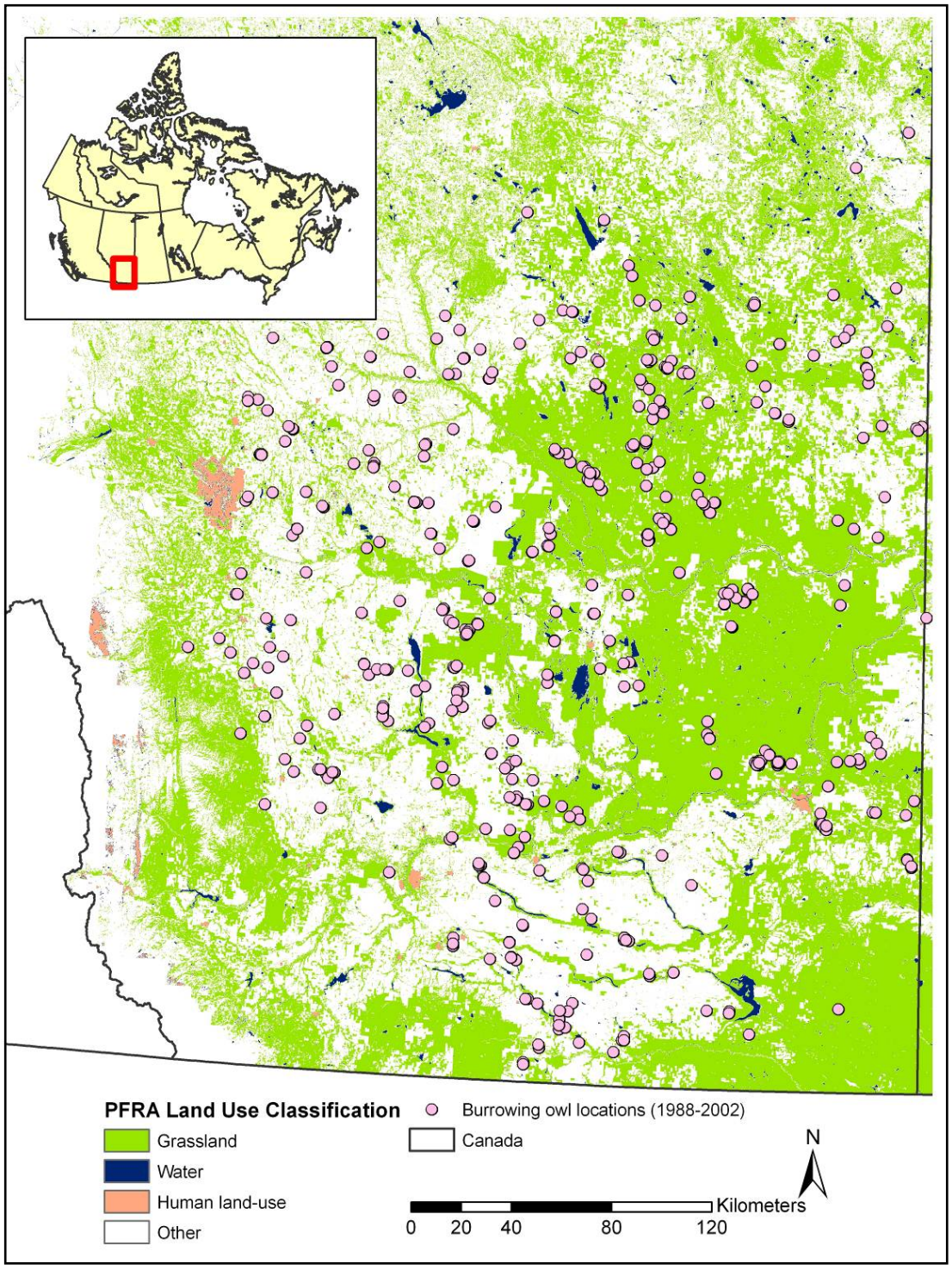

Figure 5. The apparent lack of relationship between amount of grassland within a landscape and the presence of Burrowing Owls is illustrated within the prairie region of Alberta using previous locations of owls (1988-2002) reported through the Operation Grassland Community program (Alberta Fish and Game Association). Owls are shown in relation to grassland (native or introduced) and 'other' cover types, where 'other' is predominantly farming land used for grain, canola, flax, and legume crops (mapped using land-use classification data from the Prairie Farm Rehabilitation Administration [now part of the Agri-Environment Services Branch] Western Grain Transition Payments Program).

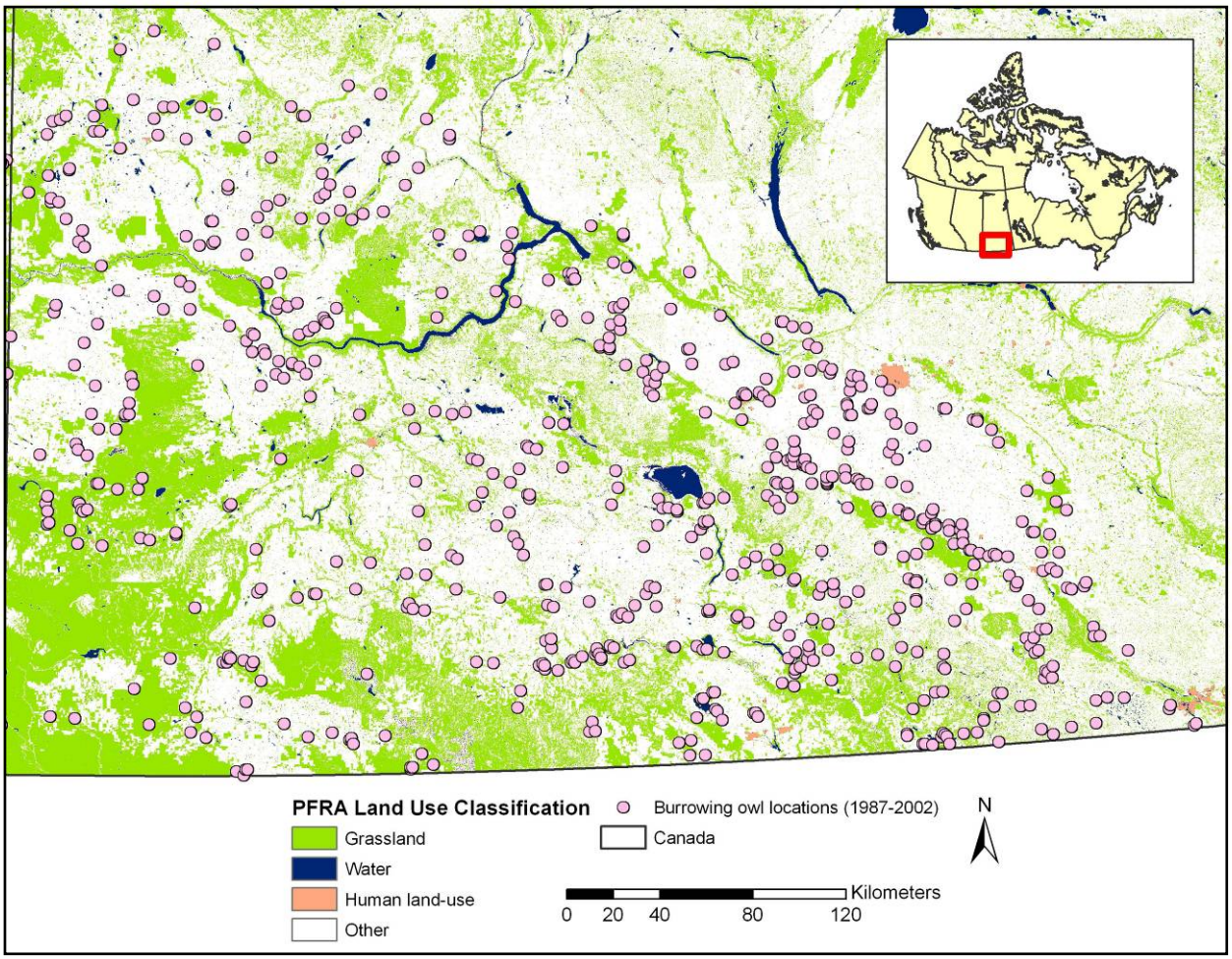

Figure 6. The apparent lack of relationship between amount of grassland within a landscape and the presence of Burrowing Owls is illustrated within the prairie region of Saskatchewan using previous locations of owls (1987-2002) reported through the Operation Burrowing Owl program (Nature Saskatchewan). Owls are shown in relation to grassland (native or introduced) and 'other' cover types, where 'other' is predominantly farming land used for grain, canola, flax, and legume crops (mapped using land-use classification data from the Prairie Farm Rehabilitation Administration [now part of the Agri-Environment Services Branch] Western Grain Transition Payments Program).

Certain behaviours of juvenile owls on the Regina Plain, Saskatchewan, were influenced by size of grassland patches. During the pre-migratory period, juveniles dispersed three times further when their natal burrow was within a patch of grassland > 64 ha (the size of a quarter-section) than when in a patch < 64 ha (Todd et al. 2007). However, it is unclear whether this restriction of pre-migratory movements has any negative influence on survival or future reproduction. It is conceivable that this might reduce recolonization of suitable but unoccupied grassland patches. If so, this could be the mechanism to explain why habitat fragmentation measures were negatively correlated with patch persistence of Burrowing Owls in Saskatchewan (Warnock 1996). On the other hand, if habitat continuity is important to owl populations, it is not clear why declines have been similarly severe in Alberta, Saskatchewan, and Manitoba, despite large differences among these provinces in their degree of grassland fragmentation (see sections 1.3.2 and 1.3.4 and COSEWIC 2006).

Habitat while migrating or wintering

Burrowing Owls that breed in Prairie Canada migrate through the Midwestern United States, across the Great Plains, to overwinter from southern Texas through to central Mexico (Holroyd et al. 2001). Owls that breed in British Columbia migrate through the western United States, wintering in coastal states from Washington to California and perhaps on the Baja California peninsula in Mexico (Burrowing Owl Recovery Implementation Group 2008). Observations of owls in Texas and Mexico suggest that habitat use during winter may differ markedly from habitat use during breeding in Canada. Besides using animal burrows, wintering owls roost under tufts of grasses and in small rock cliffs and quarries, culverts, pipes, debris fields, orchards, and shrubland (G. Holroyd and H. Trefry, unpubl. data). Because of loss of grassland, few natural burrows exist in some portions of these wintering areas.

1.4.2 Limiting Factors

The life history of the Burrowing Owl involves high fecundity (i.e., one of the largest average clutch sizes of any raptor in North America; Todd and Skilnick 2002) and a relatively short life-span of 1–6 years. As is the case in many species with this life history strategy, sensitivity analysis suggests that survival of adults is less influential for the population than survival of young owls through the nesting, post-fledging, and non-breeding periods (Franken and Wellicome 2003).

Burrowing Owls typically lay 9 eggs (range = 6–14) and hatch 90% of them, yet they often fledge only 3–5 young per successful nest because of losses of younger brood members (Wellicome 2000, 2005). However, in years of moderate rainfall or when food supplies are otherwise plentiful, productivity can average 8 young per successful pair (Wellicome 2000). Aside from losses of individual nestlings from broods, losses of entire clutches/broods also significantly reduce annual fledgling output (Wellicome et al. 1997). Overall rates of complete nest failure across the owl's range within Alberta and Saskatchewan were 15%, 14%, 27%, and 20%, from 2003–2006 (T. Wellicome, unpubl. data). Between 1987 and 1995, 78 of 200 nests (39%) in Manitoba failed (De Smet 1997). Analysis of the long-term data set from the Regina Plain suggests that there is a positive correlation between the number of fledglings produced per pair attempting to breed in a given year and the change in breeding population size in the following year (D. Todd, R. Poulin, and T. Wellicome, unpubl. data). In other words, a year in which fledging success is good is typically followed by a population increase in the subsequent year, and a year of poor fledging success is followed by a population decrease the next year. This same relationship was found in the population of south-western Manitoba (De Smet 1997).

Survival between fledging and migration is typically low for young owls. During this post-fledging period, juvenile survival was 53% when averaged over four seasons in Alberta (1995–1996 from Clayton and Schmutz 1999; 1999–2000 from Shyry 2005). In Saskatchewan, juvenile post-fledging survival averaged 55% from 1998 to 2000 (Todd et al. 2003). In contrast, juvenile survival was 100% in Saskatchewan in 1997, most likely because of an unusual peak in vole abundance that year (Poulin et al. 2001). Annual population size was measured each year in this same population, and post-fledging survival in a given year was related closely to the subsequent year's breeding population size (D. Todd, R. Poulin, and T. Wellicome, unpubl. data; Todd et al. 2003). In B.C., survival of wild-hatched juveniles averaged 47% in 2005 and 79% in 2006 (Mitchell 2008).

Telemetry showed that survival of adult males averaged 83% during breeding in Alberta (1998–1999: Sissons 2003). In Saskatchewan, adult female survival, based on resightings during regular nest visits, ranged from 88% to 100%, and male survival ranged from 94% to 100% (1992–1998: T. Wellicome, unpubl. data). Currently, there are no estimates for survival during migration. Overwinter survival estimates, from the combined results of two telemetry studies in Mexico and Texas, were a minimum of 70% and a maximum of 83% (winter period = 107 days; G. Holroyd and H. Trefry, unpubl. data). Determining mortality rates over the entire non-breeding period (north and south migrations, plus wintering) is difficult, because not all owls return to their original breeding areas in Canada. Banding studies suggest that adult owls (especially males) have fairly high fidelity to a given breeding area, but juvenile owls often move great distances between their hatch sites and where they breed as adults in their first year (range = 1–295 km; De Smet 1997; Wellicome et al. 1997). These observed dispersals may underestimate the true range of dispersal distances, given that most search effort for banded birds is expended within finite study areas.

Inadequate first-year recruitment into the breeding population is thought to be impacting the Canadian Burrowing Owl population. Local yearling recruitment was measured to be 3.5% during a multi-year study in southwestern Manitoba (De Smet 1997) and was estimated (with a correction) to be 6% for banded Burrowing Owls that fledged on the Regina Plain (Hoyt et al. 2001), suggesting that the majority of yearling owls either die prior to their first breeding attempt or disperse to other areas. Between-year dispersal for yearling (and adult) owls has not been adequately quantified; consequently, mortality cannot be separated from emigration when analyzing return rates in relation to annual population change. A preliminary attempt to predict the proportion of owls that emigrate from the Regina Plain study area, using an extrapolation of local band return data (see Baker 1995), suggests that an extra 71% of first-year females and 45% of first-year males might return to breed outside of that study area and thus go undetected (R. Poulin, T. Wellicome, and D. Todd, unpubl. data).

Duxbury (2004) performed stable isotope analyses on feather samples collected from sites across North America, with the goal of determining the general scale of inter-year dispersal of Burrowing Owls breeding in the United States and Canada. Duxbury (2004) reported a net loss of “Canadian” owls into the northern United States, resulting from a calculated imbalance between immigration and emigration rates between the two countries. However, it is not possible to discern whether emigration from Canada is too high or immigration from the United States is too low, in comparison with historical rates. Regardless, a high exchange of individuals across the international border means that factors affecting owls in the United States could have a greater effect on owls breeding in Canada than was previously thought.

1.5 Threats

There are numerous threats to Burrowing Owls in Canada. It appears that the population decline cannot be explained by a single factor; instead, it likely results from the cumulative impacts of several potential threats.

1.5.1 Habitat Modification

Loss and degradation of suitable nesting and foraging habitat are frequently stated as important threats to Burrowing Owls over most of their North American range (Hjertaas et al. 1995; Sheffield 1997a; McDonald et al. 2004), but such opinions are most often speculative rather than being based on quantitative analyses. Alteration of the native landscape – through widespread cropland development, petroleum exploration and extraction, and urban sprawl – definitely represents the most pressing habitat-related threat to *grasslands* in Canada (Canadian Prairie Partners in Flight 2004); however, it is unclear if, or to what extent, this loss of general grassland habitat, along with an increase in fragmentation, impacts the Burrowing Owl population. Warnock and Skeel (2004) reported that grassland loss, specifically from owl sites in southern Saskatchewan, averaged 6% per year from 1987 to 1993; whereas, the concurrent loss of owl pairs in that same region was 22% per year (Skeel et al. 2001). Within the Burrowing Owl's 1995 range, 19% of the historical grassland remained in Manitoba, 26% in Saskatchewan, and 46% in Alberta (Wellicome and Haug 1995), yet population declines over the past 15-30 years have been similar in each of these provinces and have outpaced greatly loss of grassland habitat (section 1.3.4 and COSEWIC 2006).

As cultivation increases on the landscape, remnant prairie patches disappear or are reduced in size and become isolated from other patches. In isolated grassland fragments, juvenile owls that fledge remain closer to their nests than juvenile owls in large areas of contiguous grasslands (Clayton and Schmutz 1999; Todd et al. 2007). However, additional research is required to determine whether these effects on juvenile behaviour might actually affect their ability to survive and eventually acquire a mate, or if these behavioural modifications are inconsequential to the owl population (Todd et al. 2007).

The influence of habitat degradation needs to be examined on wintering areas and migration routes. On wintering sites in southern Texas and Mexico, preliminary observations reveal extensive cultivation with little remaining pastureland and few burrows for roosting (G. Holroyd and H. Trefry, unpubl. data). Information on Burrowing Owl habitat use in these wintering regions prior to agricultural development is limited, making it difficult to draw conclusions on how intensive cropping and a paucity of burrows in certain regions may be affecting overwintering owls, so the impact of these habitat changes on owl populations is currently unknown. Curiously, overwintering populations in highly-cultivated regions of southern California consistently show some of the highest densities in North America (Klute et al. 2003, Rosenberg and Haley 2004).

1.5.2 Decreased Availability of Prey

Within broods, it is common for many younger owlets to die. One study, from 1992–1998 on the Regina Plain, found that 96% (169 of 176) of nestling deaths stemmed from food shortages (Wellicome 2000). However, it is unclear whether food shortages resulted most often from low prey abundance or from rainy weather that temporarily lowered the availability of prey to the owls (Wellicome 2000). The importance of abundant prey for the production of young became apparent during the 1997 peak vole year, when Burrowing Owl nestling survival, nesting success, and post-fledging survival all reached their highest recorded levels (Wellicome et al. 1997; Wellicome 2000; Todd et al. 2003). At the other extreme, the lowest nestling survival and highest frequency of nesting failure have been associated with periods of extended rain (De Smet 1997; Wellicome 2000; T. Wellicome unpubl. data).

At a regional scale, reproductive success of Burrowing Owls and subsequent population increases are associated with years of high prey availability (e.g., voles, grasshoppers; Wellicome 2000; Poulin et al. 2001). This relationship, combined with the high reproductive potential of the owls, allows their populations to respond substantially when prey populations peak. However, if prey peaks do not occur frequently enough, the Burrowing Owl population may decline over time (Poulin 2003).

Grazing intensity, wet–dry cycles, and climate change may influence the availability of prey for Burrowing Owls, but no studies have examined these potential effects.

1.5.3 Increased Predation

From 2003 to 2006, avian and mammalian predation caused 41% of 61 nest failures for which cause of failure could be determined (T. Wellicome, unpubl. data). The main cause of adult and juvenile mortality on Canadian breeding grounds is predation, followed by vehicle collisions and starvation/disease (Wellicome and Haug 1995; Leupin and Low 2001; Todd et al. 2003; Shyry 2005). Predation was also the primary cause of death for Burrowing Owls in one study conducted on the wintering grounds (G. Holroyd and H. Trefry, unpubl. data).

Current rates of predation on Burrowing Owl nests are likely higher than they have been in the past. Over the past century, agricultural practices and the extirpation of wolves (*Canis lupus*) from the prairies have encouraged increases in nest predators of Burrowing Owls, such as red fox (*Vulpes vulpes*), coyote (*Canis latrans*), striped skunk (*Mephitus mephitus*), and raccoon (*Procyon lotor*) (Wellicome and Haug 1995). The experimental installation of predator-proof nest burrows significantly reduced nest depredation by mammalian predators, though they did not stop local population declines (De Smet 1997; Wellicome et al. 1997).

Several species of diurnal and nocturnal raptors also prey on Burrowing Owls. Both the number of species and the population sizes of these avian predators have increased over the past century, presumably because fences, utility poles, outbuildings, shelterbelts, and trees, along with agricultural development and fire suppression, have all increased the availability of perches and nesting structures in grassland regions (Houston and Bechard 1983; Schmutz et al. 1984; Schmutz 1987; Wellicome and Haug 1995; Houston et al. 1998).

1.5.4 Inclement Weather

Extended rainy periods (2–3 consecutive days) lead to the deaths of youngest brood members (Wellicome 2000) or to nesting failures from flooding or starvation (T. Wellicome, unpubl. data 2003–2006). In 1993, which had a very rainy breeding season, owls on the Regina Plain fledged only 2.1 young per pair that attempted to breed. In comparison, during the 1997 vole peak, owls fledged 8.2 young per pair (Franken and Wellicome 2003; T. Wellicome, R. Poulin, and D. Todd, unpubl. data). Similarly, in Manitoba, only 30% of Burrowing Owl nests were successful, and less than 1.0 young fledged per nesting pair in 1993; both of these measures of nest success were less than half that observed in any other study year (De Smet 1997). Between 2003 and 2006, in Alberta and Saskatchewan, rain explained 54% of the 61 nest failures for which cause of failure could be determined (T. Wellicome, unpubl. data). If extended periods of rain have increased in duration or frequency over time, changing weather patterns may have contributed to the historical decline of the owl population.

1.5.5 Vehicles

Collisions with automobiles occasionally contribute to the mortality of both adult and juvenile Burrowing Owls (Wellicome 1997; Clayton and Schmutz 1999; Shyry and Todd 2000; Todd 2001b; Shyry 2005). For example, vehicle collisions were the second most common cause of juvenile mortality in concurrent Alberta and Saskatchewan studies, accounting for 6% of radio-marked fledglings in 1999–2000 (Shyry and Todd 2000). Similarly, 10% of all juveniles studied in 2005 and 2006, in the Nicola Valley, B.C., died from collisions with vehicles between the time of fledging and the start of migration (Mitchell 2008). Road systems in Canada have increased over the past 50 years. Therefore, one can speculate that current owl mortality rates may be higher than they were in previous years, especially given the importance of roadside ditches as potential foraging habitat (see section 1.4.1).

Adult females also occasionally die when they are accidentally buried inside their burrows by large vehicles during cultivation, highway repair, oil and gas activities, or lawn maintenance operations. From 2003 to 2006, 6% of failed nesting attempts were the result of nest destruction by heavy machinery; however, it is not known how many females were trapped inside burrows when nests were destroyed (T. Wellicome, unpubl. data).

1.5.6 Environmental Contaminants

Pesticides are used to control weeds, insects, and burrowing mammal populations on agricultural land and along roadside ditches. Although these chemicals do not target Burrowing Owls, they may have negative effects if ingested indirectly through prey or scavenged carcasses or if they significantly reduce Burrowing Owl food supplies at a critical period of the nesting cycle (Floate et al. 2008). For example, owls in pastures treated with strychnine-coated grain weighed less than owls in control pastures (James et al. 1990), and owls near carbofuran-sprayed fields had lower reproductive output than did control pairs (54% fewer young per nest and 50% reduction in the proportion of successful nests; James and Fox 1987). Most uses of carbofuran have been banned in Canada.

A variety of owl species are sensitive to these and other environmental contaminants (Sheffield 1997b), but whether Burrowing Owls in particular are affected by other contaminants is largely unknown. There is some evidence that lead poisoning might occur in raptors through scavenging of ground squirrels that have been shot with lead bullets (Knopper et al. 2006); Burrowing Owls are known to occasionally scavenge ground squirrels. The effects of Burrowing Owl exposure to persistent organochlorine residues, such as polychlorinated biphenyls (PCBs), dieldrin, and dichlorodiphenyldichloroethylene (DDE), need to be better understood, especially on the wintering grounds (Gervais and Anthony 2003). For example, although dichlorodiphenyltrichloroethane (DDT) has been banned in Canada since 1971 and in the United States since 1972, 5 of 11 owl carcasses in Saskatchewan were found to contain low levels (0.04–0.40 ppm) of its breakdown products, DDE and dichlorodiphenyldichloroethane (DDD); one of the five owls showing DDE contamination also contained low levels of DDT (0.02 ppm) (Haug 1985). Presumably, the bird showing traces of DDT was an adult that picked up the pesticide in Mexico during the winter (the use of DDT was not banned in Mexico until 2000). DDT has been linked with nest failures via shell-thinning in a number of avian species, particularly raptors; however, Burrowing Owls have not had low hatching rates in Canadian studies (Wellicome 2000, 2005)

1.5.7 Loss of Burrows

Because Burrowing Owls rely on burrowing mammals for the production of burrows, a reduction in burrowing mammal numbers can reduce potential nesting sites. In British Columbia, control of burrowing mammals for decades has resulted in a shortage of burrows. Howie (1980) identified a reduction in badger (*Taxidea taxus jeffersonii*) populations as the main factor responsible for the provincial Burrowing Owl decline, though this is not the consensus of the current Recovery Implementation Group in British Columbia (J. Surgenor, pers. comm. 2007). Currently, artificial burrows are placed in areas containing apparently suitable nesting and foraging habitats. Yellow-bellied marmot, Columbian ground squirrel, and badger are three native burrowing mammals that still persist in British Columbia's grasslands, albeit in lower numbers than historically observed. It is possible that installing artificial burrows in other parts of the Burrowing Owl range, where burrow availability is low because of a lack of burrowing mammals, may increase, or slow the decrease of, Burrowing Owl populations within those small study areas.

On the prairies, there are indirect and anecdotal indications that Richardson's ground squirrel populations have decreased locally in some parts of Alberta and Saskatchewan (e.g., Kirk and Banasch 1996; Schmutz et al. 2001), but population data are not available at larger scales because no large surveys exist for ground squirrels and their burrows cannot be detected from airphotos or satellite imagery (Michener and Schmutz 2002). However, it is common knowledge that there is still an abundance of ground squirrel and badger burrows in most landscapes of southern Alberta, southern Saskatchewan, and south-western Manitoba, yet an exceedingly small portion of the available burrows are occupied each year by owls.

In contrast, black-tailed prairie dog colonies represent a unique ecosystem in Canada that is consistently occupied by a relatively large concentration of owls. These prairie dog colonies have been accurately identified and delineated in the field. The high densities of mammal burrows found in these colonies provide an important nesting habitat for Burrowing Owls. Each year for the past 5 years, the colonies have held approximately 10–15% of the known population of nesting owls in Canada, and almost every colony has been occupied by one or more owl pairs each year (COSEWIC 2006 and G. Holroyd and H. Trefry unpubl. data). Within Canada, prairie dogs are naturally limited to the southernmost areas of Saskatchewan, but their populations are healthy and expanding (Management Plan for the Black-tailed prairie dog (*Cynomys ludovicianus*) in Canada, Tuckwell and Everest 2009). However, in the United States, more than 90% of prairie dogs were exterminated over the past century (Miller et al. 1994; Sheffield 1997a), undoubtedly affecting the availability of roosting habitat for Canada's migrating and wintering owls.

1.6 Actions Already Completed or Underway

The first National Burrowing Owl Recovery Team annual meeting was held in 1989, and the first recovery plan was prepared in 1991 and published in 1995 (Hjertaas et al. 1995). A wide variety of intensive and extensive Burrowing Owl recovery actions have been implemented in all four western Canadian provinces and in the United States and Mexico. For reviews of Burrowing Owl recovery actions in Canada and elsewhere in North America, please refer to Hjertaas et al. (1995), Wellicome and Haug (1995), De Smet (1997), Lincer and Steenhof (1997), Wellicome (1997), Wellicome et al. (2001), Franken and Wellicome (2003), Klute et al. (2003), McDonald et al. (2004), Warnock and Skeel (2004), Alberta Burrowing Owl Recovery Team (2005), Alberta Sustainable Resource Development and Alberta Conservation Association (2005), Commission for Environmental

Cooperation (2005), COSEWIC (2006), and Burrowing Owl Recovery Implementation Group (2008). Actions can be broadly categorized as recovery planning, population monitoring, voluntary stewardship, land-use management, nest protection, cropland conversion, productivity enhancement, education, outreach, media communications, captive breeding, reintroduction, translocation, and applied research. Research that has been completed or initiated includes such topics as nest habitat requirements, foraging habitat use, reproductive performance, diet, juvenile survival and dispersal, prey–habitat relationships, range-wide nesting success, weather effects, between-year movements, population and large-scale habitat modeling, comparison of release techniques, impact and mitigation of oil and gas activities, location of wintering grounds, and adult survival during breeding and wintering. All Burrowing Owl burrows on federal land are protected as residences under SARA. In addition, each province in western Canada has protective legislation in place for Burrowing Owl nests on all non-federal land.

1.7 Knowledge Gaps

Several important knowledge gaps still exist for Burrowing Owls in Canada. Currently, information that is unknown but required to adequately address threats and recovery objectives includes[1]:

1) Locations of the majority of Burrowing Owl nests in Canada;
2) Survival rates of the owls at life stages for which adequate data currently does not exist (e.g., juveniles during migration, adults during all seasons);
3) Extent and impact of between-year dispersal by juveniles and adults;
4) Quantitative habitat associations of Burrowing Owls, at multiple scales, during all seasons;
5) Quantitative assessments of any relationships between habitat loss and population decreases;
6) Best methods, numbers, and distribution for release of captive-bred owls to establish a self-perpetuating population in British Columbia and Manitoba;
7) Effects of a variety of environmental contaminants on reproduction and survival during breeding and non-breeding seasons;
8) Migratory routes used and winter range of “Canadian” owls; and
9) Improved survey methods for both breeding and wintering populations.

2. RECOVERY

2.1 Rationale for Recovery Feasibility

Recovery of Burrowing Owls within Canada appears to be feasible based on the criteria for determining 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

The Burrowing Owl population in Canada and United States is sufficiently large for both natural reproduction and captive breeding for reintroduction purposes. For example, the wild population in the Regina Plain study area increased by 170% after a year with particularly good food conditions

[1] A number of these knowledge gaps can be addressed through the use of artificial burrows, an accepted research tool for Burrowing Owls, as they facilitate measurements of such factors as reproductive success, survival and return rates, chick growth rates, and environmental contaminants.

(Poulin et al. 2001). Certain characteristics of the species contribute to this potential for rapid population increase, including high mobility and the production of large clutches.

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

Although the specific habitat needs of the Burrowing Owl are currently unknown (see 1.4.1), the general landscapes that appear to be suitable for breeding owls (flat, unforested land with burrows) is available or, where necessary, could be re-created in suitable flat landscapes.

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

Numerous recovery actions have been suggested for Burrowing Owls, and several are being implemented with success. Addressing knowledge gaps and narrowing the list of factors potentially explaining the population decline will provide further focus and efficiencies for these recovery efforts.

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

The actions thought to be necessary to achieve recovery of this species appear to be achievable using a variety of existing recovery techniques, although these actions depend on a high level of effort and cooperation among governments, non-government organizations, industry, stakeholders, landowners, and the general public. In addition, as the small Canadian population of Burrowing Owl occurs at the northern part of its continental range, and greater than 95% of its continental distribution and population occurs further south in the United States and Mexico (see section 1.3.3), it is important to note that population changes at the continental level may have a significant effect on recovery feasibility in Canada. As the continental population of Burrowing Owl is experiencing an ongoing downward population trend, its range may contract away from the current periphery, and individuals may immigrate towards the centre of the range. In such a case, despite best efforts described in this strategy to ensure that sufficient suitable habitat conditions are available and key threats are mitigated, the number of Burrowing Owls in Canada may continue to decline.

2.2 Recovery Goal

The long-term (>30 years) recovery goal for the Burrowing Owl is to reverse the population decline in Canada and maintain a self-perpetuating, well-distributed population of at least 3000 breeding pairs within the four western provinces. These pairs should encompass the 1993 distribution of Burrowing Owls in Alberta, Saskatchewan, and Manitoba, with at least 30 wild pairs distributed within their historical range in the Thompson/Nicola and Okanagan regions of British Columbia. The 1995 National Recovery Plan had the equivalent long-term population recovery goal (Hjertaas et al. 1995). All of these long-term goals should be met for the Burrowing Owl to be considered as recovered.

The short-term (i.e., 5-year) population and distribution objective for this Recovery Strategy is to achieve the 2004 estimated population size (800 pairs) and distribution.

2.3 Recovery Objectives

1) Develop an improved understanding of environmental and demographic factors associated with annual changes in Burrowing Owl population size.
2) Identify and implement protocols that mitigate factors contributing to population declines.[2]
3) Identify, maintain, enhance, and increase breeding and foraging habitat.
4) Optimize nesting success, fledging rate, and survival on the Canadian breeding grounds.[3]
5) Re-establish wild breeding populations of Burrowing Owls within their historical range in British Columbia and their 1993 range in Manitoba.[4]
6) Encourage management, conservation, and research of Burrowing Owls and the habitats they use, during each season, in the United States and Mexico.[5]
7) Engage, support, and communicate with land holders and land managers about actions that may improve Burrowing Owl populations and habitats in their local areas.

2.4 Approaches to Address Threats and Meet Recovery Objectives

Table 1 lists approaches recommended to address threats and meet recovery objectives.

[2] Known and potential factors are discussed in detail in sections 1.4.2, 1.5, and 1.6.
[3] Refer to section 1.4.2 for a detailed discussion.
[4] See Burrowing Owl Recovery Implementation Group (2008) for criteria to assess re-establishment in B.C., and see Figure 2 (this recovery strategy) for Manitoba range in 1993.
[5] See North American Conservation Action Plan for the Western Burrowing Owl (Commission for Environmental Cooperation 2005).

Table 1. Recovery Planning Table

Priority	Objective No.	Threats	Broad strategy	Recommended approaches to address threats and meet recovery objectives
High	2, 3, 6, 7	Habitat modification	Research Habitat protection Habitat restoration Stewardship Outreach Coordination	• Further characterize habitat associations for owls during the breeding and non-breeding seasons, and identify any unoccupied suitable owl habitat • Protect suitable habitats through conservation easements or other forms of voluntary or paid agreements; reduce damage to grassland habitat that may result from oil and gas exploration and extraction • Manage or increase grassland habitat to maintain or improve its suitability for Burrowing Owls • Cooperate with broad grassland conservation initiatives and agencies in the United States and Mexico to help ensure the conservation of habitat thought to be used for breeding, migration, and wintering
High	1, 2, 3, 4, 5, 6, 7	Decreased availability of prey	Research Habitat management Restoration Stewardship	• Increase knowledge of foraging habitat and prey availability, including: the relationship between diet, reproduction, and habitat characteristics; and the effects of grazing or haying on foraging habitats and availability of both nocturnal and diurnal prey • Improve habitats for small mammals • Maintain at least modest availability of insect prey near potential owl sites
High	2, 3, 4, 5, 6, 7	Loss of burrows	Habitat and species management Stewardship Outreach Reintroduction	• Discourage the extermination of burrowing mammals (ground squirrels, badgers, prairie dogs), and encourage their reintroduction to sites where they have been exterminated within the Burrowing Owl's former range across North America • Install artificial burrows where local burrowing mammal populations cannot yet or will not be re-established, or where burrow availability is low
High	2, 3, 4, 5, 6, 7	Increased predation	Habitat management Stewardship Species management Outreach Research	• Allow avian and mammalian predation pressure to return to lower, historical levels in Burrowing Owl nesting areas by managing habitat and anthropogenic nest/den structures • Use predator-proof artificial nest burrows to reduce high rates of nest depredation • Investigate relationship between nest predation and habitat fragmentation, and between nest predation and owl dispersal • Monitor rates of predation by black-footed ferrets in black-tailed prairie dog colonies where ferrets will be reintroduced
High	5	Several	Habitat management Reintroduction Reestablishment	• In British Columbia and Manitoba, manage formerly occupied sites to encourage Burrowing Owls to reoccupy sites via immigration from wild populations in adjoining states/provinces • In British Columbia and Manitoba, augment the small wild population by releasing captive-bred Burrowing Owls to breed and raise wild young at release sites

Medium	2, 4, 7	Vehicles	Education Outreach	• Reduce owl mortalities from vehicles by posting speed limit signs near nest sites • Reduce effects of potential nest disturbance and destruction by industrial vehicles and other heavy machinery
Medium	1, 2, 4, 6, 7	Environmental contaminants	Outreach Stewardship Monitoring Research	• Discourage the use of insecticides in the vicinity of Burrowing Owl nests and wintering sites • Determine environmental contaminant levels in owl blood, feathers, eggs, or carcasses; also determine levels in ground squirrels scavenged by owls and cached in owl burrows • Determine potential for exposure of owls to environmental contaminants during all seasons across North America
Medium	1, 3	All	Research Surveying Monitoring	• Develop an improved survey design to allow enough detections of owls to be able to improve population estimates and population change over a wider geographic area • Conduct targeted surveys, within suitable habitat types and areas of past sightings, to better identify distribution and potential concentrations of Burrowing Owls • Using GIS models that predict relative probability of owl occupancy should be used to improve the efficiency of surveys by stratifying search effort
Low	1, 7	Inclement weather	Research	• Examine the influence of climate change on patterns of inclement weather • Compare the probabilities of nest flooding in cropland, native and tame pasture

2.5 Critical Habitat

2.5.1 Identification of the Species' Critical Habitat

Burrowing Owl critical habitat is identified as the area within the boundaries of the black-tailed prairie dog colonies in Canada as of 2007 (Figure 7), excluding all existing roads and associated ditches within these colonies. Unlike other burrowing mammals in Canada, black-tailed prairie dogs occur in conspicuous, high-density colonies, making them preferred nesting locations for Burrowing Owls (see sections 1.4.1 and 1.5.7). Accordingly, the highest known densities of owls in Canada occur within colonies of prairie dogs (COSEWIC 2006). Each year over a 5-year period, the colonies held approximately 10–15% of the population of owls that were known to nest in Canada in 2004 (see section 1.3.4. Population size and trends; COSEWIC 2006; G. Holroyd and H. Trefry, unpubl. data).

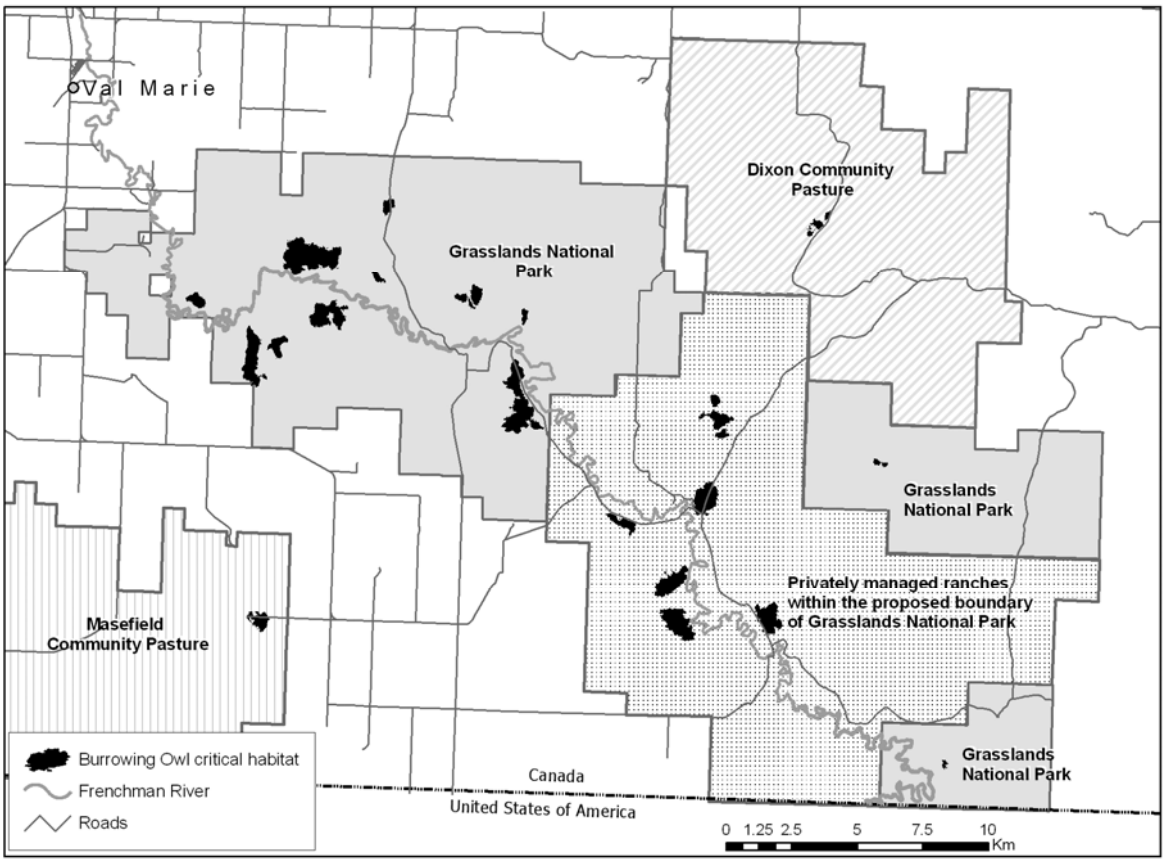

Figure 7. Critical habitat for Burrowing Owls identified as the area within the black-tailed prairie dog colonies in Canada as per 2007 boundaries. These colonies occur within the general vicinity of the Frenchman River Valley in Saskatchewan (Tuckwell and Everest 2009).

Although critical habitat is identified to the extent possible and based on the best available information at this time, it may be only part of what is ultimately needed to support the population and distribution objectives outlined in section 2.2. Additional critical habitat cannot be identified for Burrowing Owls with currently available knowledge (see sections 1.4.1

and 1.7). As indicated in those sections, the Burrowing Owl is a habitat and prey generalist, showing tolerance to habitat changes and extreme flexibility in its environmental requirements, aside from its reliance on a nest burrow. Therefore, although previous locations of many breeding owls have been recorded, characterizing the critical features of any particular habitats that are required by the owls for survival and recovery is not possible with current information and understanding. Furthermore, the majority of data for known owl nesting sites outside of prairie dog colonies are not held by Environment Canada. Permissions to obtain additional nest location data are currently being made to groups or agencies outside of Environment Canada, and these will greatly aid in future attempts to identify additional critical habitat (see Table 2 and section 2.5.3.).

All Burrowing Owl burrows on federal land are currently protected from damage or destruction as 'residences' under SARA, and each province in western Canada has protective legislation in place for all Burrowing Owl nests on all non-federal land. This legislation pertains to all Burrow Owl nests, whether their locations are recorded by EC, recorded by one of the provinces, or are otherwise known or unknown.

2.5.2 Examples of Activities Likely to Result in Destruction of Critical Habitat

Critical habitat for Burrowing Owls is destroyed when owls no longer have the potential to use any portion of a prairie dog colony for future nesting, shelter, or prey-caching. This happens when burrows are collapsed, excavated, filled in with soil or water, or otherwise blocked. Also, critical habitat is destroyed if the vegetation on the colony is allowed to become too tall, making it difficult for Burrowing Owls to detect approaching predators. This destruction could happen due to physical alteration of the land or if the prairie dogs on a colony are destroyed, and the colony and burrows are no longer maintained as a result. Some examples of activities that may result in destruction of this critical habitat include, but are not limited to:

- cultivation
- gravel extraction
- industrial exploration, development and infrastructure (e.g., roads, wells, and large diameter pipelines)
- construction of new permanent fire breaks
- deliberate flooding or filling
- development (including roads or buildings)
- extermination of enough prairie dogs (within the 2007 boundaries of their colonies) to destroy the function of the prairie dog town for Burrowing Owls

In contrast, properly managed grazing is unlikely to result in destruction of critical habitat. The creation of new shallow water pipelines may be compatible with critical habitat when they are introduced as a tool to better manage grazing to increase or maintain the suitability of vegetation for Burrowing Owls. Maintenance of existing roads, through activities such as mowing and grading, is unlikely to destroy critical habitat as existing roads are not included in the description of critical habitat. Other management practices that may not constitute destruction of critical habitat include the use and maintenance of:

- existing fence lines
- existing shallow water pipelines and dugouts
- salting locations

- existing prairie tracks for vehicles including two-track trails
- existing and emergency fire guards

2.5.3 Schedule of Studies to Identify Additional Critical Habitat

There is a need to understand what specific habitat types and habitat features in the vicinity of nest burrows constitutes critical habitat. Table 2 outlines the studies required to aid in the identification of additional critical habitat.

Table 2. General schedule of studies required to identify critical habitat for Burrowing Owls in Canada

Description of Research Activity	Start Date	Completion Date
Record the variety of habitat types and other environmental features/conditions in the vicinity of nests throughout the Burrowing Owl's range.	2003	2011
Estimate demographic parameters (e.g., productivity, survival, dispersal) for owls nesting throughout the owl's range.	2003	2011
Construct statistical models that use appropriate environmental variables, at multiple scales (see details in this section), to predict probabilities of Burrowing Owl occurrence across the variety of landscapes within their range.	2006	2012
Construct statistical models that use appropriate environmental variables to predict relative nesting success and fledging rates for a variety of landscapes within the range of the Burrowing Owl.	2007	2012
Throughout the owls' range in Canada, conduct high-accuracy nocturnal foraging studies to determine habitat composition within home ranges and to characterize environmental features and habitat conditions at successful foraging locations, including plant species composition, vegetation structure, availability of perches, etc. Determine which fine-scale habitats are also associated with high reproductive success.	2007	2012
Request and assemble existing raw data from multiple sources to determine probabilities of re-occupancy for any identifiable clusters of mammalian burrows that are known to have been occupied by owls in the past and to relate such probabilities to environmental factors.	2011	2014
Use results from the above studies to identify additional critical habitat for the Burrowing Owl population in Canada, and define destruction of that critical habitat.	2014	2014

Attempts to further identify critical habitat for burrowing owls can be divided into different levels of potential habitat requirements: burrows, foraging home ranges, and landscapes.

Burrows

Black-tailed prairie dog colonies represent a unique ecosystem in Canada that is consistently occupied by a relatively large concentration of owls. The high densities of mammal burrows found in these colonies provide an important nesting habitat for Burrowing Owls. However, outside of prairie dog colonies, mammal burrows are naturally distributed at low densities over extremely large areas. It is common knowledge that there is still an abundance of ground squirrel and badger burrows within Prairie Canada, and an exceedingly small portion of those available burrows are occupied each year by owls (perhaps 1 occupied per 1 million available). Nest burrow re-occupancy is less than 15% each year (unpublished data E. Bayne, University of Alberta), so improved methods of predicting which new areas will be occupied by owls each year need to be determined so that critical habitat can be adequately identified. Past studies have attempted to determine which environmental factors make particular burrows more attractive than others for nesting, but those factors remain unknown though they are important to ascertain.

Foraging home ranges

The nature and extent of foraging habitats required around Burrowing Owl nests is not known, as the population of owls studied to-date do not appear to prefer any particular habitat types for foraging in the vicinity of nest burrows. Use of foraging habitat has been studied using radio-telemetry on a very small number of owls, which showed a surprisingly wide variation in home-range sizes (between 8 and 756 ha). Telemetry work also indicated that owls show contradictory selection for, or in other cases avoidance of, environments with relatively high densities of humans and human infrastructure, as well as use or avoidance of native versus non-native habitats around nests (see section 1.4.1).

To identify additional critical habitat near prairie dog colonies or near nesting sites elsewhere in Canada, there is an urgent need to ascertain what detailed habitat types and compositions, or other environmental features owls require for foraging. Such studies are scheduled for completion over the next few years (see Table 1).

Landscapes

To date, studies suggest that owls occur, survive, and reproduce equally well in landscapes dominated by cropland and introduced grasses, compared to those dominated by native grassland. Simple metrics, such as the proportion of grassland within a region, are not predictors of suitability for the owls, and focussing conservation on large blocks of grassland, as opposed to smaller parcels of grassland, is a strategy that would capture few of the landscapes that Burrowing Owls are known to occupy (Figures 5 & 6).

Stevens (2008) determined that land-use and land-cover variables, and grassland habitat fragmentation, were not important environmental predictors for owls choosing where to nest within their range in Canada. However, abiotic factors, such as soil type and average spring temperatures, were very good predictors of the *relative* probability of owls placing their home ranges in a certain location. By combining these soil and climate variables, Stevens (2008) identified the relative suitability for Burrowing Owls of environments within their range in Prairie Canada. The highest category region identified by Steven's model covers 18,000km^2 of the total 18,000,000 km^2 Burrowing Owl range within Canada, and was predicted to contain

about 55% of Canada's owl population. Thus, using the estimated 2004 population total (800 pairs), we can calculate that the *absolute* probability of an individual plot of land, 1 km^2 in size, containing an owl pair would be approximately 0.02. Appropriately, Stevens et al. (2010) point out that regions identified in Steven's (2008) models should help narrow down the spatial search for critical habitats for the owls, but on their own cannot be used to identify critical habitat in part because any one piece of land identified as the highest suitability by this model would have an extremely low probability of being used by owls, or ever having been used, given the wide distribution of such a naturally rare species.

To identify additional critical habitat, there is a need to continue to attempt to determine whether there are any particular landscape compositions owls prefer or at least to identify those landscapes associated with high survival and reproductive success (section 2.5.3.), and in particular, which habitats might have availability of habitats/resources that owls require (for example adequate nesting burrows, small mammal prey, low predation risk, etc.).

2.6 Existing and Recommended Approaches to Habitat Protection

Much of the critical habitat for Burrowing Owls has yet to be identified, primarily because little or conflicting information is available regarding Burrowing Owl habitat requirements at the home-range scale and above (see sections 1.4.1 and 1.7).

In regards to the critical habitat identified herein, there are a number of tools for the protection of Burrowing Owl habitat. Portions of the critical habitat identified in this recovery strategy are managed by the Parks Canada Agency and Agriculture and Agri-Food Canada (Agri-Environment Services Branch).

There are a variety of mechanisms to protect critical habitat on non-federal lands. Prairie dog colonies in Canada occur on privately deeded land and provincially leased land, in addition to federal land. The colonies that occur on lands managed by two landholders, which are on a combination of private and provincially leased lands, are within the proposed future boundary of Grasslands National Park. As part of the 1988 Parks Canada – Province of Saskatchewan Grasslands National Park establishment agreement, section 12.1 specifies that "Saskatchewan agrees to manage the proposed national park in a manner that recognizes the need to maintain the lands in their existing natural state for park purposes prior to the transfer of administration and control of such lands to Canada". This implies that those lands and prairie dog colonies within the proposed park boundary are afforded some protection. Management of prairie dog colonies is specified in the Management Plan for the Black-tailed Prairie Dog (*Cynomys ludovicianus*) in Canada (Tuckwell and Everest 2009).

2.7 Potential Effects on Other Species

Habitat management for Burrowing Owls will positively affect many other species, including other species at risk. Burrowing Owls appear to use a diversity of habitat conditions for nesting and foraging. If a healthy mosaic of habitats is maintained, in combination with effective grazing and haying management practices, Burrowing Owls will be only one of many grassland species that benefit. Specifically, proper management of grassland habitats may also benefit other listed species, such as Sprague's Pipit (*Anthus spragueii*), Short-eared Owl (*Asio flammeus*), Ferruginous Hawk (*Buteo regalis*), Long-billed Curlew (*Numenius americanus*), swift fox (*Vulpes velox*), Greater Sage-Grouse (*Centrocercus urophasianus*), badger (B.C. population), and black-tailed prairie dog. Burrowing Owl breeding and survival are ultimately influenced by the availability of burrows. Therefore, Burrowing Owl recovery actions encourage the conservation of populations of native burrowing mammals, such as badgers, ground squirrels, prairie dogs, and marmots, which would also benefit several other wildlife species that prey on these burrowing mammals (e.g., Ferruginous Hawks, black-footed ferret, swift fox) or use their burrows. In specific local situations, owl recovery may include predator exclusion from nest burrows (via artificial nest burrows) and habitat management near Burrowing Owl nesting areas to discourage predators that have increased above historical levels because of positive associations with agricultural activities (e.g., Great Horned Owl (*Bubo virginianus*), Red-tailed Hawk (*Buteo jamaicensis*), striped skunk, red fox, and coyote; Wellicome and Haug 1995). Thus, there are potentially negative effects on these common predatory species at Burrowing Owl management sites, but their overall population numbers will undoubtedly still remain very high. Placement of hawk nesting substrates (natural or artificial) must also consider potential effects on nearby Burrowing Owls to allow for the concurrent management of Ferruginous Hawk and Burrowing Owl populations.

2.8 Statement of When One or More Action Plans Will Be Completed

Action plans compliant with the *Species at Risk Act* will be developed by 31 December 2014 to cover each jurisdiction within the range of the Burrowing Owl in Canada. The *Recovery Plan for Burrowing Owl in Alberta* has been published (Alberta Burrowing Owl Recovery Team 2005). In addition, a draft *Action Plan for the Burrowing Owl* (Athene cunicularia hypugaea) *in British Columbia* has been prepared (Burrowing Owl Recovery Implementation Group 2008).

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