PROPOSED

Species at Risk Act
Recovery Strategy Series

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

Burrowing Owl

July 2007

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/the_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. 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 SARA Public Registry (www.sararegistry.gc.ca/) and the Web site of the Recovery Secretariat (www.speciesatrisk.gc.ca/recovery/).

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

July 2007

Recommended citation:

Environment Canada. 2007. Recovery Strategy for the Burrowing Owl (*Athene cunicularia*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. v + 25 pp.

Additional copies:

Additional copies can be downloaded from the SARA Public Registry (www.sararegistry.gc.ca/).

Cover illustration: Dr. Gordon Court
Title page: Paul Geraghty

Également disponible en français sous le titre
« Programme de rétablissement de la Chevêche des terriers (*Athene cunicularia*) au Canada [Proposition] »

ISBN to come
Catalogue no. to come

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*. 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.

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
Parks Canada Agency
Government of Alberta
Government of British Columbia
Government of Manitoba
Government of Saskatchewan

AUTHORS

This recovery strategy was prepared by Troy I. Wellicome, L. Danielle Todd, David Stepnisky, and Geoff L. Holroyd.

ACKNOWLEDGMENTS

This recovery strategy is the culmination of a team effort over several years. The current document was prepared by T.I. Wellicome (Chair of the National Burrowing Owl Recovery Team, Canadian Wildlife Service) and L.D. Todd (formerly of the Canadian Wildlife Service), based in part on information contained in a 2001 draft National Recovery Plan compiled by G.L. Holroyd (Canadian Wildlife Service) and D. Stepnisky (formerly of the Canadian Wildlife Service). This document benefited through input from Recovery Team members and advisors. In addition to the authors, other team members and advisors included (in alphabetical order) F. Blouin (Operation Grassland Community, Alberta Fish and Game Association), B. Bristol (Prairie Farm Rehabilitation Administration, Agriculture and Agri-Food Canada), D. Brodie (Burrowing Owl Conservation Society of British Columbia), M. Chutter (British Columbia Ministry of Environment), K. De Smet (Wildlife and Ecosystem Protection, Manitoba Conservation), K. Dohms (Operation Burrowing Owl, Nature Saskatchewan), K. Grisley (Operation Grassland Community, Alberta Fish and Game Association), D. Johnson (Department of Environmental Science, University of Lethbridge), M. Mackintosh (Burrowing Owl Conservation Society of British Columbia), J. Manalo (Department of Biological Sciences, University of Alberta), S. McAdam (Saskatchewan Environment), G. McMaster (Saskatchewan Watershed Authority), A. Mitchell (Department of Animal Science, University of British Columbia), R. Poulin (Department of Biological Sciences, University of Alberta), C. Sanders (Saskatchewan Burrowing Owl Interpretive Centre), D. Scobie (Avocet Environmental Inc.), D. Shyry (Sage Environmental Consulting), R. Sissons (Grasslands National Park, Parks Canada Agency), C. Skiftun (Special Areas Office, Alberta Conservation Association), P. Strankman (Canadian Cattleman's Association), J. Surgenor (British Columbia Ministry of Environment), A. Todd (Alberta Fish and Wildlife Division, Sustainable Resource Development), H. Trefry (Canadian Wildlife Service, Environment Canada), L. Veitch (Lands Branch, Saskatchewan Agriculture and Food), and P. Williams (British Columbia Wildlife Park). Thanks are also extended to R. Franken, R. Poulin, C. Seburn, D. Ewing, and D. Duncan (Canadian Wildlife Service) for reviewing various drafts or portions of this recovery strategy.

STRATEGIC ENVIRONMENTAL ASSESSMENT

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 grassland habitat, 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 for 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 Recommended to Address Threats and Meet Recovery Objectives; and 2.6 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, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry: www.sararegistry.gc.ca/plans/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 proposed strategy. 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 *Recovery Action Plan for Burrowing Owl (Athene cunicularia hypugaea)*, prepared by the British Columbia Recovery Implementation Group (Leupin in review). This proposed strategy meets SARA requirements in terms of content and process (Sections 39–41).

EXECUTIVE SUMMARY

- Burrowing Owls once occupied most of the grasslands of the Prairie provinces and southern interior of British Columbia. The owls currently occupy only 36% of their historical Canadian distribution, with populations declining over the past three decades from an estimate of more than 3000 pairs to fewer than 800 pairs.
- Burrowing Owls depend on burrowing mammals (i.e., ground squirrels, badgers, prairie dogs, and marmots) to dig burrows that the owls use for nesting. Owl survival and reproductive success depend on ample populations of prey, such as mice, voles, grasshoppers, and beetles.
- No single factor has been identified as causing the decline of Burrowing Owl populations in Canada. Instead, the cumulative impact of several factors is thought to be responsible.
- Demographic measures related to changes in the Canadian owl population include poor reproductive success and low juvenile survival. The results of a recent isotope study also suggested that more owls were emigrating from Canada than were immigrating to Canada from the United States.
- Threats include habitat loss and fragmentation, loss of burrows, decreased prey, increased predation, inclement weather, vehicle mortalities, and environmental contaminants.
- 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. This should include at least 30 wild pairs distributed within their historical range in the Thompson/Nicola and Okanagan regions of British Columbia, and the remaining pairs encompassing the 1993 distribution of Burrowing Owls in Alberta, Saskatchewan, and Manitoba.
- Not enough information is available at this time to allow the identification of critical habitat for Burrowing Owls. As scheduled studies are completed, critical habitat will be designated in future action plans.
- Seven objectives are identified to achieve the recovery goal for Burrowing Owls:
    1) Identify factors associated with annual population changes.
    2) Identify and implement protocols that mitigate factors affecting population declines.
    3) Maintain, increase, and enhance breeding 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 on Burrowing Owls, and the habitats they use, during all seasons in the United States and Mexico.
    7) Engage, support, and communicate with land holders and land managers about actions to improve Burrowing Owl populations and habitat in their local areas.

TABLE OF CONTENTS

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

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 and wings, their abdomens are solid beige with no barring, and they have a conspicuous beige stripe across the tops of their closed wings. From a distance, Burrowing Owls are similar in size and colour to the ground squirrels with which they typically coexist. During the day, owls may be observed perched on fence posts or atop the mounds of their burrows. They lay an average 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).

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).

Figure 1. Adult Burrowing Owl with leg-bands.

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 federally Threatened (Amenazadas) species (Diario Oficial de a Federación 1994).

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 extirpated 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 region of British Columbia. Most captive-bred owls bred successfully in the wild after release, 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. 2005). In Manitoba, despite intensive management and translocations from the late 1980s until the mid-1990s, the Burrowing Owl is now nearly extirpated as a breeding species, although a few individuals or nesting pairs are still observed in some years, including a recent high of 7 pairs in 2006 (De Smet 1997; K. De Smet, pers. comm. 2007).

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 only 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 only 36% (160 000 km^2) of the historical range.

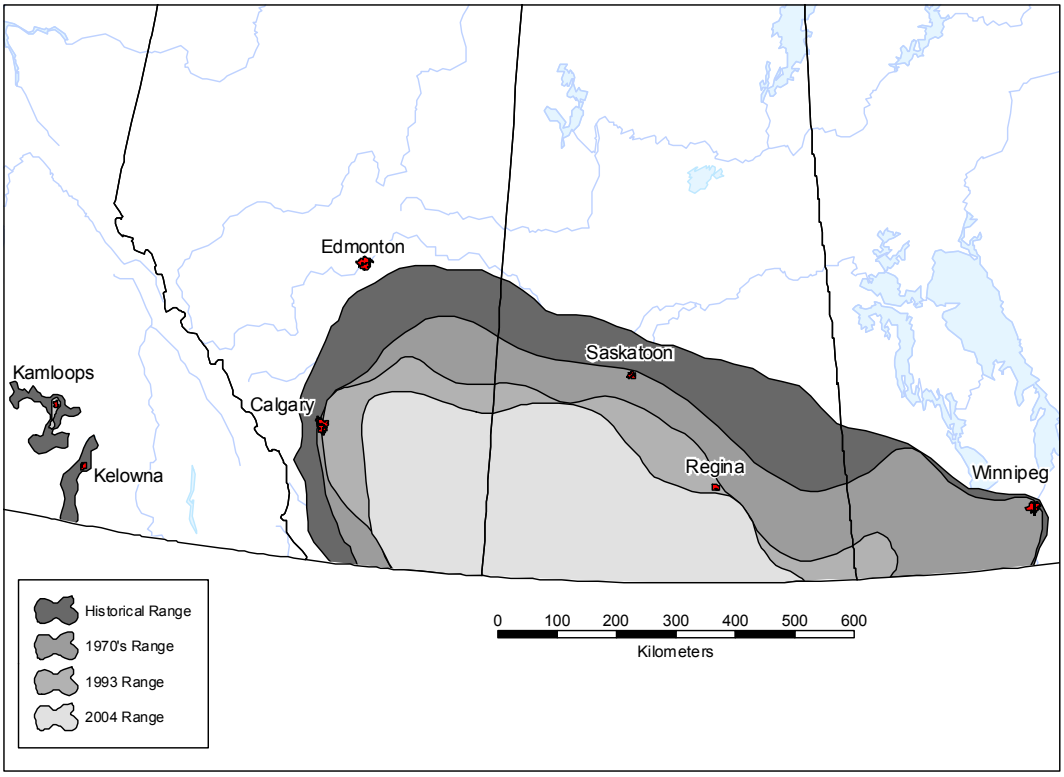

Figure 2. Change in the Canadian breeding distribution of the Burrowing Owl over time. The 2004 distribution was based on unprecedented search effort, through standardized surveys, reports from Operation Grassland Community (Alberta) and Operation Burrowing Owl (Saskatchewan) landowners, extensive searches 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).

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). 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.

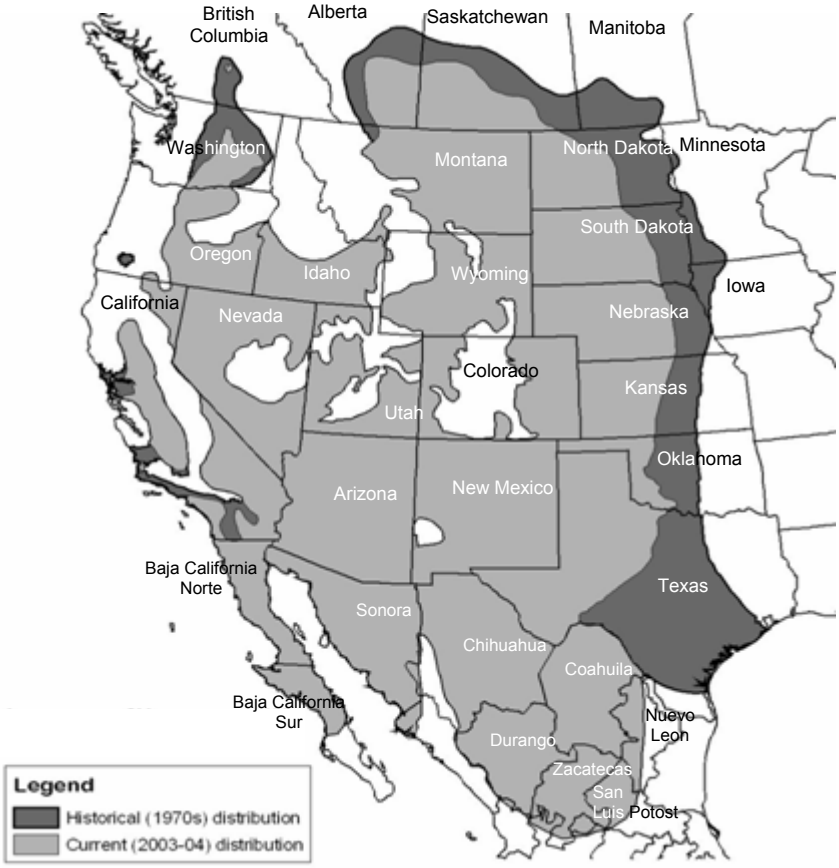

Figure 3. Change in distribution of the Western Burrowing Owl in North America between the 1970s and 2004 (Wellicome and Holroyd 2001, with Canadian portions modified and updated to the 2004 distribution). There were no data with which to assess historical distribution in Mexico.

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). Methods used to estimate the total owl population in Canada vary markedly among Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status assessments, with less accurate and less intensive methods employed in earlier reports. When the species became Threatened in 1978 (Wedgwood 1978), the Canadian Burrowing Owl population likely exceeded 3000 pairs. In the early 1990s, landowner reports and directed surveys in parts of its range were used to estimate the total of 2500 pairs in Canada (Haug and Didiuk 1991). In 1995, the total population was estimated to be between 1015 and 1695 pairs, and the species was uplisted to Endangered (Wellicome and Haug 1995). By 2004, the combined total number of Burrowing Owls estimated by two stewardship programs (Operation Grassland Community in Alberta and Operation Burrowing Owl in Saskatchewan) was only 151 pairs, despite fairly consistent enrolment of landowners over time (Figure 4). Expanded search effort by biologists and other land managers boosted this minimum known population to almost 400 pairs (795 individuals: 288 in Alberta, 498 in Saskatchewan, 9 in British Columbia, and 0 in Manitoba; National Burrowing Owl Recovery Team 2004). No quantitative method exists with which to determine the current total population of owls. However, it is unlikely that there are now more than 800 pairs breeding in Canada. This speculative estimate of 800 pairs suggests that the country has lost a minimum of three-quarters of its total owl population over the last three decades.

Rather than attempting to estimate trends in total population size, one can more accurately examine relative changes using data from subsets of the total population. Within monitoring areas, methods must remain 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; Operation Burrowing Owl 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; Operation Grassland Community 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 Saskatchewan (Wellicome *et al.* 1997; R. Poulin, D. Todd, and T. Wellicome, unpubl. data). 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; G. Holroyd and H. Trefry, unpubl. data). 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 decade, the number of owl pairs in Manitoba has fluctuated between 0 and 7 per year, with 0 pairs in 7 of the 10 years (K. De Smet, pers. comm. 2007).

Burrowing Owls were extirpated from British Columbia by the early 1980s (Leupin and Low 2001). Shortly before this extirpation, a recovery attempt was initiated to restore the owl population in the Okanagan. Unfortunately, that effort was ultimately unsuccessful. Other releases of captive-bred owls occurred in the Thompson region near Kamloops. Beginning in 1989, owls were released each year, with a larger number of owls released in more recent years. For example, in 2005, 84 adult owls were released, and they fledged 100 young into the wild

later that season, 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 (Leupin in review).

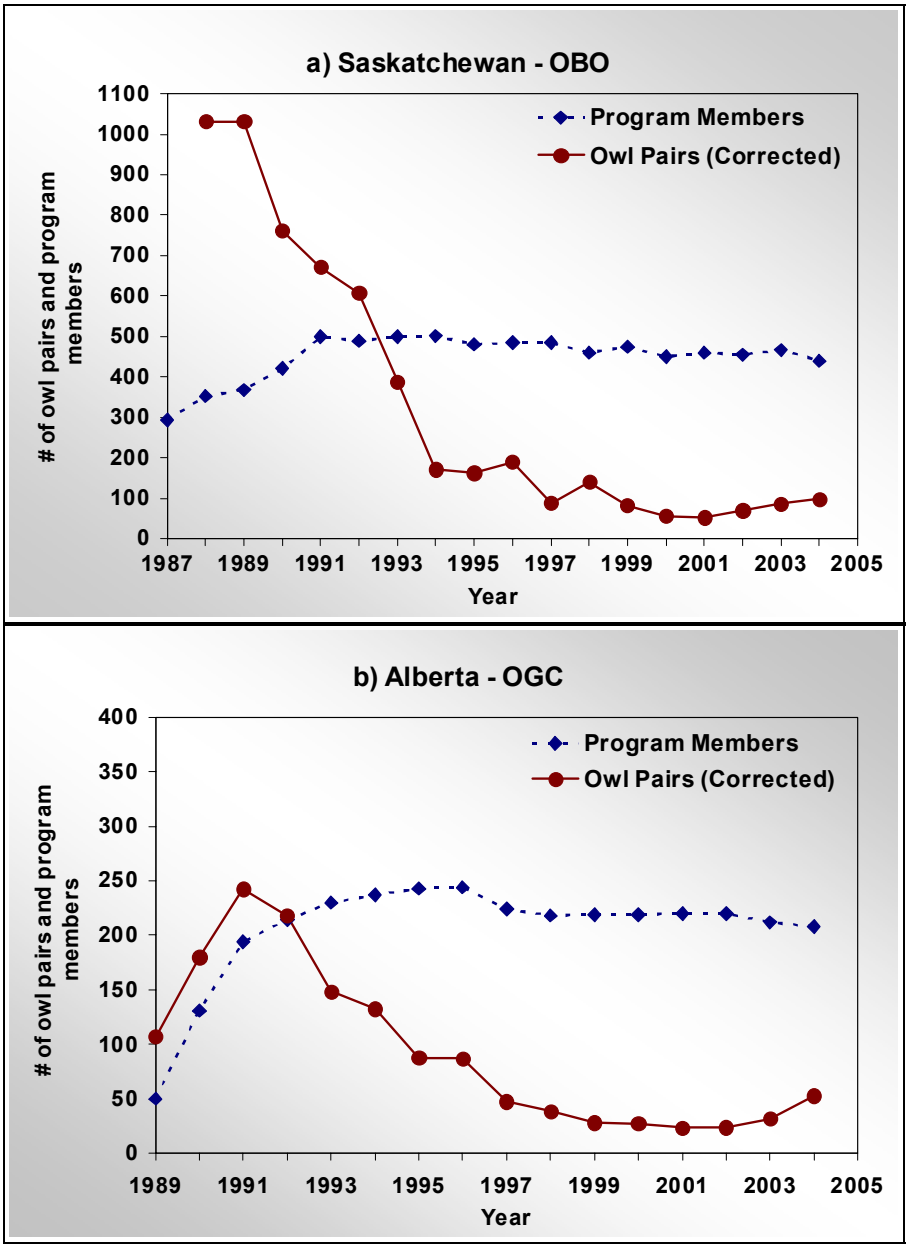

Figure 4. Total number of Burrowing Owl pairs reported annually (corrected for non-responding members; see Skeel *et al.* 2001) by landowner members in (a) Saskatchewan's Operation Burrowing Owl (OBO) and (b) Alberta's Operation Grassland Community (OGC) since the late 1980s. Unpublished data provided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

1.4 Needs of the Burrowing Owl

1.4.1 Habitat and Biological Needs

Burrowing Owls are found in relatively flat, open grasslands or arid regions, usually devoid of trees or dense shrubs (Haug *et al.* 1993). Almost all Burrowing Owls nest in pastures (native or planted grass), although a small proportion also nest in suburban lawns, ditches, and cropland (Poulin *et al.* 2005). Nesting owls select pastures that are level and well grazed, with relatively short (<10 cm), sparse vegetation (James *et al.* 1991; Clayton and Schmutz 1999).

Burrowing Owls rely on burrowing mammals to create burrows, which are typically modified by the owls for use during the breeding, dispersal (post-breeding), migration, and wintering stages. Consequently, the owls' distribution on the landscape depends on adequate populations of badgers (*Taxidea taxus*), Richardson's ground squirrels (*Spermophilus richardsonii*), black-tailed prairie dogs (*Cynomys ludovicianus*; Saskatchewan only), yellow-bellied marmots (*Marmota flaviventris*; British Columbia only), and Columbian ground squirrels (*Spermophilus columbianus*; British Columbia only). The owls select pastures containing high densities of nearby roosting burrows (James *et al.* 1991; Warnock and Skeel 2002; Poulin *et al.* 2005), which are used by both adult and juvenile owls (see "Residence" section above).

Insects such as grasshoppers and beetles comprise the vast majority of prey items eaten by nestlings (Leupin and Low 2001; Poulin 2003) and appear to dominate the diets of recently fledged juveniles (Shyry 2005). However, mice, voles, and other vertebrates comprise the majority of the biomass in the owls' diet during the breeding season (Wellicome 2000; Poulin 2003). Burrowing Owls hunt for small mammals within 1–2 km of nests, in areas with tall (>30 cm), dense vegetation, such as roadside ditches and low-lying ephemeral wetlands (Haug and Oliphant 1990; Sissons 2003; Shyry 2005). Higher densities of meadow voles (*Microtus pennsylvanicus*) are found in these moister habitats than are found in croplands or heavily grazed pastures (Sissons *et al.* 2001; Poulin 2003). Nocturnal foraging ranges averaged 3.3 km^2 in Alberta (range = 0.3–7.6 km^2; Sissons 2003) and 2.4 km^2 in Saskatchewan (range = 0.1–4.8 km^2; Haug and Oliphant 1990). Diurnal foraging is confined to the immediate vicinity of the nest burrow (Gleason 1978; Haug and Oliphant 1990).

Burrowing Owls that breed in Prairie Canada migrate through the Midwest, across the Great Plains, to overwinter in areas from southern Texas through to central Mexico (G. Holroyd and H. Trefry, unpubl. data). 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. Observations of wintering owls in Texas and Mexico show that habitat use differs 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 these southern 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). However, in dry years or when food supplies are plentiful, productivity can average 5–6 young per successful pair (De Smet 1997; Wellicome 2000). Aside from these losses of individual nestlings, 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%, and 27% in 2003, 2004, and 2005, respectively (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 productivity (number fledged per pair attempting to breed) and the change in breeding population size in the following year (D. Todd, R. Poulin, and T. Wellicome, unpubl. data). This same correlation was found in the population in southwestern Manitoba (De Smet 1997).

Survival is typically low for young owls between fledging and migration. During this post-fledging period, juvenile survival was 53% when averaged over four seasons in Alberta (1995–1996: Clayton and Schmutz 1999; 1999–2000: Shyry 2005). In Saskatchewan, juvenile post-fledging survival averaged 55% from 1998 to 2000. In contrast, juvenile survival was 100% in Saskatchewan in 1997, perhaps because of an unusual peak in vole abundance that year (Todd *et al.* 2003). Annual population size was also 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).

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 breeding site fidelity, 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 live banded birds is expended within finite study areas, and also given the difficulties of finding dead banded birds elsewhere in the wild.

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 only 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 the 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 throughout 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. The population decline likely cannot be explained by a single factor; instead, it appears to result from the cumulative impacts of several threats. These threats are discussed below, in order of their suspected importance in contributing to the decline.

1.5.1 Habitat Modification

Loss and degradation of suitable nesting and foraging habitat are cited as the most important threats to Burrowing Owls over most of their North American range (Hjertaas *et al.* 1995; Sheffield 1997a; McDonald *et al.* 2004). Alteration of the native landscape — through widespread cropland development, petroleum exploration and extraction, and urban sprawl — represents the most pressing habitat-related threat to grasslands in Canada (Canadian Prairie Partners in Flight 2004). Within the Burrowing Owl's 1995 range, only 19% of the historical grassland remained in Manitoba, 26% in Saskatchewan, and 46% in Alberta (Wellicome and Haug 1995). Warnock and Skeel (2004) reported that grassland loss, specifically from owl sites in southern Saskatchewan, averaged 6% per year from 1987 to 1993. As cultivation increases on the landscape, remnant prairie patches disappear or are reduced in size and become isolated from other patches. Fragmentation of rangeland by cultivated fields, roads, shelterbelts, and shrubby

habitat has the potential to discourage site selection by owls and increase risk of predation (Wellicome and Haug 1995). Between 2003 and 2006, nesting success was 10% higher in native prairie than in habitats composed of primarily non-native vegetation (T. Wellicome, unpubl. data). Fragmentation may also affect Burrowing Owl prey by limiting the frequency and extent of prey population outbreaks (Poulin 2003). Lastly, in isolated grassland fragments, young owls that fledge are constrained to disperse later, stay closer to their nests, and move less frequently than young owls in large areas of contiguous grasslands (Clayton and Schmutz 1999; Todd 2001b). These negative effects on juvenile dispersal may affect their ability to survive and eventually acquire a mate. Adult and juvenile survival in fragmented habitats is probably also impacted by the greater frequency of owls hunting along roadsides and being killed by passing vehicles (K. De Smet, pers comm. 2006). This would affect owls not only on fragmented breeding areas, but also on fragmented migration and wintering areas.

Habitat degradation is of concern on wintering areas in southern Texas and Mexico. Extensive cultivation in some regions has resulted in landscapes 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 may be affecting overwintering owls.

1.5.2 Loss of Burrows

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. Currently, artificial burrows are placed in areas containing suitable nesting and foraging habitats. Yellow-bellied marmot, Columbian ground squirrel, and badger are three native burrowing mammals that still persist, albeit in lower numbers, in British Columbia's grasslands.

On the prairies, there are also indications that Richardson's ground squirrels have decreased in number 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 (Michener and Schmutz 2002).

Within Canada, prairie dogs are naturally limited to the vicinity of Grasslands National Park, Saskatchewan, and their populations are healthy. 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.

1.5.3 Decreased Prey

Within broods, it is common for many younger owlets to die. One study found that 96% (169 of 176) of these deaths in 1992–1998 in the Regina Plain stemmed from food shortages (Wellicome 2000). However, it is unclear whether food shortages result most often from low prey abundance or from inclement weather that temporarily lowers 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). On the other hand, the lowest nestling survival and highest frequency of nesting failures have been associated with periods of extended rain (De Smet 1997; Wellicome 2000; T. Wellicome, unpubl. data).

At a large 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, may allow 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).

Climate change, wet–dry cycles, and grazing intensity may also influence the suitability of grasslands for Burrowing Owls or the availability of their prey, but no studies have examined these potential effects.

1.5.4 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). In addition, 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 is also the primary cause of death for Burrowing Owls during wintering (G. Holroyd and H. Trefry, unpubl. data).

Over the past century, agricultural practices and the extirpation of wolves (*Canis lupus*) from the prairies have encouraged increases in 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 boxes significantly reduced nest depredation by mammalian predators (De Smet 1997; Wellicome *et al.* 1997).

Both the number of species and the population sizes of avian predators have increased 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 over the past century on the prairies (Houston and Bechard 1983; Schmutz *et al.* 1984; Schmutz 1987; Wellicome and Haug 1995; Houston *et al.* 1998).

1.5.5 Inclement Weather

Extended rainy periods (2–3 consecutive days) lead to the deaths of the youngest brood members (Wellicome 2000) or to complete nesting failure (T. Wellicome, unpubl. data). In 1993, the rainiest breeding season of the past 13 years, 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 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.

1.5.6 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). Road systems on the prairies have increased over the past 50 years. Therefore, 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, Habitat and Biological Needs, above).

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 (T. Wellicome, unpubl. data).

1.5.7 Environmental Contaminants

Pesticides are used to control weeds, insects, and burrowing mammal populations on agricultural land. 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. 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). The application of granular carbofuran was banned in Canada in 1995.

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 through scavenging of ground squirrels that have been shot with lead bullets (Knopper *et al.* 2006). The effects of 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). 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 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).

1.6 Actions Already Completed or Under way

The first National Burrowing Owl Recovery Team 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. Actions can be broadly categorized as recovery planning, population monitoring, voluntary stewardship, land use management, habitat securement, cropland conversion, productivity enhancement, education, outreach, media communications, captive breeding, reintroduction, translocation, and applied research. Research topics include nesting 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 modeling, comparison of release techniques, impact and mitigation of oil and gas activities, location of wintering grounds, and adult survival during breeding and wintering. For reviews of the wide variety 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 Leupin (in review).

1.7 Knowledge Gaps

Several 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) survival rates of Burrowing Owls at life stages for which we do not currently have adequate data (e.g., juveniles during migration, adults during all seasons);
2) extent and impact of between-year dispersal by juveniles and adults;
3) quantitative habitat associations of Burrowing Owls, at multiple scales, during all seasons;
4) best methods, numbers, and distribution for release of captive-bred owls to establish a viable population in British Columbia;
5) effects of environmental contaminants on reproduction and survival during breeding and non-breeding seasons;
6) migratory routes used and winter range of “Canadian” owls; and
7) improved survey methods for both breeding and wintering populations.

2. RECOVERY

2.1 Rationale for Recovery Feasibility

Recovery of Burrowing Owls within Canada is definitely feasible. Indeed, with appropriate environmental conditions, local populations have increased more than 170% between consecutive years. Certain characteristics of the species contribute to this potential for rapid population increase, including high mobility and the production of large clutches. Although the detailed habitat needs of the Burrowing Owl are currently unknown, the general habitat requirements (open grassland with burrows) are met by the currently available habitat. 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. Overall, a high level of effort and cooperation will be required by governments, non-government organizations, industry, stakeholders, landowners, and the general public to control potential threats, conserve habitat, and share responsibilities for the conservation and recovery of this species in North America (Commission for Environmental Cooperation 2005). Despite the high level of effort and cooperation that is required, the actions necessary to achieve recovery of this species appear to be achievable using a variety of existing recovery techniques.

2.2 Recovery Goal

The long-term recovery goal for the Burrowing Owl is to reverse the population decline in Canada and maintain[1] a self-perpetuating, well-distributed[2] population of at least 3000 breeding pairs[3] within the four western provinces.

2.3 Recovery Objectives

1) Identify factors associated with annual population changes.
2) Identify and implement protocols that mitigate factors affecting population declines.[4]
3) Maintain, increase, and enhance Burrowing Owl breeding and foraging habitat.
4) Optimize nesting success, fledging rate, and survival of Burrowing Owls on the Canadian breeding grounds.[5]
5) Reestablish wild breeding populations of Burrowing Owls within their historical range in British Columbia and their 1993 range in Manitoba.[6]
6) Encourage management, conservation, and research on Burrowing Owls, and the habitats they use, during all seasons in the United States and Mexico.[7]

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[1] Over a minimum 10-year period.
[2] In the three Prairie provinces, the area covered by 95% of future owl locations should encompass the 1993 range (see Figure 2). In British Columbia, Burrowing Owls should be distributed within their historical range in the Thompson/Nicola and Okanagan regions.
[3] The 1995 National Recovery Plan (Hjertaas *et al.* 1995) had the equivalent population recovery goal. The current goal for population size should be calculated as a three-year running average, with at least 30 breeding pairs in British Columbia.
[4] Known and potential factors are discussed in detail in sections 1.4.2, 1.5, and 1.6.
[5] Refer to section 1.4.2 for a detailed discussion.
[6] See Leupin (in review) for criteria to assess reestablishment in British Columbia. See Figure 2 for Manitoba range in 1993.

7) Engage, support, and communicate with land holders and land managers about actions to improve Burrowing Owl populations and habitat in their local areas.

2.4 Approaches Recommended to Address Threats and Meet Recovery Objectives

Refer to Table 1 for a list of approaches recommended to address threats and meet recovery objectives.

2.5 Critical Habitat

2.5.1 Identification of the Species' Critical Habitat

Critical habitat cannot currently be defined for the Burrowing Owl in Canada because of inadequate knowledge of the majority of owl locations, a limited understanding of owl habitat associations during breeding at both landscape and home-range levels (see section 1.7, Knowledge Gaps), and because Burrowing Owls do not exhibit high site-fidelity to their nesting burrows. Critical habitat will be identified in action plans, by 31 December 2009, with input from the National Burrowing Owl Recovery Team and provincial Recovery Implementation Groups.

2.5.2 Schedule of Studies to Identify Critical Habitat

A schedule of studies required to aid in the identification of critical habitat is outlined in Table 2.

2.6 Potential Effects on Other Species

Habitat management for Burrowing Owls will positively affect many other prairie species, including other species at risk. Burrowing Owls appear to require a diversity of grassland habitat conditions for nesting and foraging. If a healthy mosaic of grasslands is maintained, in combination with effective grazing and haying management practices, Burrowing Owls will be only one of many native prairie species that benefit. Specifically, protection and proper management of native prairie will 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*), and black-tailed prairie dog. Burrowing Owl breeding and survival are 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) or use their

[7] See North American Conservation Action Plan for the Western Burrowing Owl (Commission for Environmental Cooperation 2005).

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 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.

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	Habitat protection Habitat restoration Stewardship Outreach Coordination Research	• On those sites deemed suitable for owls, protect grassland through conservation easements or other forms of voluntary or paid agreements • Reduce damage to grassland habitat that results from oil and gas exploration and extraction (e.g., place developments on cultivated land rather than grassland) • Convert cropland into grassland, especially at or near known Burrowing Owl nesting sites • Manage against shrub/brush encroachment on historically open grasslands • Cooperate with broad grassland conservation initiatives, including the Prairie Conservation Action Plan, Grasslands Conservation Council of British Columbia, South Okanagan–Similkameen Conservation Program, Prairie Habitat Joint Venture's North American Bird Conservation Initiative, and North American Conservation Action Plans for Burrowing Owl and Black-tailed Prairie Dog (Commission for Environmental Cooperation) • Cooperate with agencies in the United States and Mexico to help ensure the conservation of habitat used for breeding, migration, and wintering • Further characterize habitat associations for owls during the breeding and non-breeding seasons, and identify any unoccupied suitable owl habitat
High	1, 2, 3, 4, 5, 6, 7	Decreased prey	Habitat management Restoration Stewardship Research	• Improve habitats for small mammals, using best available knowledge and beneficial management practices (delayed haying of ditches, reduced grazing in wet meadows or wetland edges, etc.) • Convert cropland into grassland to encourage foraging (e.g., regrassing the banks of watercourses) • Maintain at least modest availability of insect prey by being strategic with insect spraying on native grassland, roadsides, and crops near potential owl sites • Improve our knowledge of the relationship between diet, reproduction, and habitat characteristics around nests and roost sites • Use radio-tracking to improve our knowledge of nocturnal foraging habitat use, particularly by males during the breeding season, but also by owls during the non-breeding season • Study the effects of grazing or haying on foraging habitats and availability of both nocturnal and diurnal prey
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) in Canada, the United States, and Mexico • Across North America, encourage the reintroduction of burrowing mammals to sites where they have been exterminated • Where local burrowing mammal populations cannot yet be reestablished, install artificial nest burrows as a temporary measure

Priority	Objective No.	Threats	Broad strategy	Recommended approaches to address threats and meet recovery objectives
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 • Discourage tree planting or construction of artificial structures that encourage the presence of larger hawks and owls in areas where those species were historically absent • Occasionally use predator-proof artificial nest burrows, but only where warranted by high local predation pressures • Determine whether habitat fragmentation is associated with higher levels of predation • Analyze existing data to see if nest predation increases probability/distance of future dispersal
High	5	Various	Habitat management Reestablishment Reintroduction	• In Manitoba, manage formerly occupied grassland sites (through habitat protection, stewardship, conservation of burrowing mammals, control of environmental contaminants, etc.) to encourage Burrowing Owls to reoccupy sites via immigration from wild populations in adjoining states/provinces (De Smet 1997; K. De Smet, pers. comm. 2006) • In British Columbia, use these same approaches but also augment the small wild population by annually releasing captive-bred Burrowing Owls to breed and fledge wild young at release sites (Leupin in review)
Medium	2, 4, 7	Vehicles	Education Outreach	• Reduce owl mortalities from vehicles by posting speed limit signs near nest sites • Produce communication documents that teach operators of heavy machinery (used for cultivating, haying, mowing, and road construction/maintenance) how to recognize Burrowing Owl nests and avoid destroying them • Reduce the effects of industrial disturbance
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 • Use standardized protocols to collect/store Burrowing Owl carcasses and unhatched eggs for chemical analysis • Determine strychnine, lead, organochlorine, and anti-cholinesterase insecticide levels in blood, feathers, eggs, or carcasses • Determine lead and strychnine levels in ground squirrels scavenged by owls and cached in owl burrows • Determine potential for exposure of owls to environmental contaminants during all seasons
Low	1, 7	Inclement weather	Research	• Examine the influence of climate change on patterns of inclement weather (e.g., lengthy periods of excessive rain) • Compare the probabilities of nest flooding in native vs. tame pasture

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

Description of Research Activity	Start Date	Completion Date
Targeted surveys, within generally suitable habitat types and areas of past sightings, to better identify the species' distribution and potential concentrations	1987	Ongoing
Estimate demographic parameters (e.g., productivity, survival, dispersal) in relation to habitat types/conditions	2003	2007
Conduct breeding season habitat mapping and habitat association modelling, based on nesting habitat associations and productivity, to inform the definition of critical habitat	2003	2007
Conduct nocturnal foraging studies to determine home-range sizes and habitat use vs. prey and habitat types or conditions, to inform the definition of critical habitat	1999	2009
Refine critical habitat definition, incorporating any new information as needed	2010	Ongoing as required

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

Action plans compliant with the *Species at Risk Act* are scheduled for development by December 31, 2009, to cover jurisdictions 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 *Recovery Action Plan for Burrowing Owl (*Athene cunicularia hypugaea*)* has been prepared by the British Columbia Recovery Implementation Group (Leupin in review). Both of these plans will have to be reviewed for SARA compliancy if they are to serve as Action Plans under SARA.

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