

A POPULATION DECLINE RECORDED BY OPERATION BURROWING OWL IN SASKATCHEWAN

MARGARET A. SKEEL¹

Nature Saskatchewan, 206-1860 Lorne Street, Regina, SK S4P 2L7 Canada

JEFF KEITH

Saskatchewan Conservation Data Centre, Saskatchewan Environment and Resource Management, 3211 Albert Street, Regina, SK S4S 5W6 Canada

CARLA S. PALASCHUK²

Nature Saskatchewan, 206-1860 Lorne Street, Regina, SK S4P 2L7 Canada

ABSTRACT.—Operation Burrowing Owl (OBO) is a prairie stewardship program launched in Saskatchewan in 1987 to preserve Burrowing Owl (*Athene cunicularia*) habitat from cultivation. As of 2000, 459 OBO members were protecting 61 259 ha of grassland habitat. Of the sites protected, 97% (466) involved privately-owned land (21 376 ha) and the remaining sites were publicly owned (39 883 ha). Participants signed a voluntary agreement to report annually the number of owls on their land and to conserve the owls' nesting areas, even if sites became unoccupied. In recent years, the program has promoted conservation easements and assisted landowners with owl habitat enhancement. In recognition of participation, members received a gate sign, an annual newsletter, and educational material. In addition to conserving habitat, OBO has increased public awareness of the owl, participated in research, and monitored owl population changes. In 2000, 459 OBO members reported a total of 54 pairs, considerably fewer than the 681 pairs reported by 352 members in 1988. After correcting for non-responding members each year, the annual census indicated a 95% decline in estimated number of pairs over 13 yr from 1988 (1032 pairs) to 2000 (56 pairs); this represents an average decline of 21.5% per year. Between 1987–93, the mean number of sites with ≥ 5 pairs of owls was 26 (range = 10–42; 5–11% of sites). In contrast, by 2000, 94% of all formerly-occupied sites had zero owls, two sites had five pairs (<1% of sites), and no site had ≥ 5 pairs of owls.

KEY WORDS: *Burrowing Owl; Athene cunicularia; population decline; stewardship; endangered species; habitat conservation; Saskatchewan.*

Registro del declive de una población por la operación Búho Cavador en Saskatchewan

RESUMEN.—La Operación Búho Cavador (OBO) es un programa de manejo de praderas lanzado en Saskatchewan en 1987 para preservar el hábitat del Búho Cavador (*Athene cunicularia*) de la agricultura. Hasta el 2000, 459 miembros de la OBO estaban protegiendo 61 259 ha de hábitat de pastizal. De los sitios protegidos, 97% (466) involucraban terrenos de propiedad privada (21 376) y los sitios restantes eran de propiedad pública (39 883 ha). Los participantes firmaron un acuerdo voluntario para reportar anualmente el número de búhos en sus tierras y conservar las áreas de anidación de los búhos, aun si los sitios quedaban desocupados. En años recientes, el programa ha promovido servidumbres para la conservación y ha asistido a los propietarios de las tierras mediante el mejoramiento del hábitat para los búhos. En reconocimiento a su participación, los miembros reciben un letrero en la puerta, un boletín de prensa anual, y material educativo. En adición a la conservación de hábitats, la OBO ha incrementado la conciencia pública hacia el búho, ha participado en investigación, y ha monitoreado los cambios en la población del búho. En el 2000, 459 miembros de la OBO reportaron un total de 54 parejas, considerablemente más pocas que las 681 parejas reportadas por 352 miembros en 1988. Después de llamar la atención a los miembros que no responden cada año, el censo anual indicó un declive del 95% en el número estimado de parejas en 13 años desde 1988 (1032 parejas) al 2000 (56 parejas);

¹ E-mail address: info@naturesask.com

² Present address: P.O. Box 102, Mont Vernon, NH 03057 U.S.A.

con una declinación promedio de 21.5% por año. Entre 1987–93, el número medio de sitios con ≥ 5 parejas de búhos fue 26 (rango = 10–42; 5–11% de los sitios). En contraste, para el 2000, 94% de todos los sitios antiguamente ocupados no tenían búhos, dos sitios tenían cinco parejas (<1% de los sitios), y ningún sitio tenía ≥ 5 parejas de búhos.

[Traducción de Victor Vanegas y César Márquez]

The Burrowing Owl (*Athene cunicularia*) was classified as endangered in 1995 by the Committee on the Status of Endangered Wildlife in Canada (Wellcome and Haug 1995). Burrowing Owls nest in grassland plots ranging from <1 ha to vast tracts of prairie. Many of the owls are found in small tracts of land because most native-prairie habitat in Saskatchewan has been lost to cultivation. It is estimated that only 23% of natural terrestrial habitats remain in the Prairie Ecozone of Saskatchewan (James et al. 1999), and in many of the more arable municipalities, native prairie comprises <2% of the landscape (J. Moen publ. comm.). Accompanying the disappearance of grasslands are habitat fragmentation and changes in plant and animal species composition. Habitat loss, degradation, and fragmentation, and the associated low productivity and high mortality, have been identified as primary causes contributing to the Burrowing Owl's decline in Saskatchewan (e.g., Hjertaas et al. 1995, Wellcome and Haug 1995, Warnock and James 1997, Clayton and Schmutz 1999).

Because almost all arable land in Canada's prairie landscape is privately owned, conservation initiatives largely depend on, or are driven by, landowners. The need for public awareness and habitat protection was demonstrated in 1986, when a study in the Regina Plain (Hjertaas and Lyon 1987) found that suitable Burrowing Owl nesting habitat was vanishing rapidly, and owls were found on only 13 of 703 grassland plots searched. Operation Burrowing Owl (OBO) was launched in Saskatchewan in 1987, and in Alberta in 1989, to protect from cultivation those grassland parcels used by nesting Burrowing Owls. Although privately-held lands were initially targeted, participants now also include stewards of public lands, including provincial community and federal Prairie Farm Rehabilitation Administration (PFRA) pastures and urban centers. The initiation and first 7 yr of the OBO program was described by Hjertaas (1997). OBO has been delivered by Nature Saskatchewan (formerly Saskatchewan Natural History Society), with support from other agencies, since 1990.

The evolving objectives of the OBO program are

to: (1) conserve prairie habitat where Burrowing Owls are currently nesting, or have previously nested, through voluntary habitat-protection agreements with landowners and public recognition of the role of landowners in conserving habitat; (2) promote conservation easements as a means of conserving native habitat in perpetuity (following passage of *The Conservation Easements Act* in Saskatchewan in 1997); (3) assist landowners with enhancement and restoration of Burrowing Owl habitat; (4) increase and maintain awareness of the Burrowing Owl as an endangered species, and at the same time increase awareness of the prairie ecosystem and the interrelationships of the species within that ecosystem; (5) annually census Burrowing Owls at OBO sites, and use this information to determine population trends; and (6) facilitate research in determining factors driving the population decline.

METHODS

Voluntary Agreements. The core of Operation Burrowing Owl continues to be a one-page voluntary agreement that OBO staff discuss and sign with landowners who have Burrowing Owls nesting on their property in the first year of contact (Hjertaas 1997). The OBO agreement is a "handshake agreement," not a legally binding agreement, and can be canceled by the member at any time. Participating landowners report annually the number of Burrowing Owls on their site and agree not to cultivate the described nesting area. The area of land in each agreement covers all or part of a quarter-section (65 ha), and landowners with owls on more than one location (quarter-section) sign an agreement for each location. One exception to this is that public lands have only one agreement for the entire area they enroll rather than for each quarter-section. All landowners are encouraged to continue to participate in OBO, even if owls do not return to breed, and thus to continue conserving habitat and reporting numbers (or absence) of owls. In recognition of their participation, landowners receive either a certificate or an OBO gate sign with their name (almost all request a sign). Participants are also sent educational material, including an annual newsletter about the Burrowing Owl, its status, and current research.

Initially, agreements were renewed after a period of 5 yr, but starting in 1994, agreements became indefinite, expiring only upon request. Landowners receive a 5-yr certificate of recognition after every 5 yr of participation.

Conservation Extension. Since 1998, conservation easements with Nature Saskatchewan (NS) or Nature

Conservancy Canada (NCC) have been promoted to OBO members. Easements conserve prairie habitat in perpetuity by placing cultivation or development restrictions through legal agreements between NS or NCC and an owner of ecologically-significant land. Each landowner is eligible for a tax benefit for his/her donation equal to the change in land value caused by the easement.

In 1999–2001, OBO members were invited to apply for incentives to enhance and to restore Burrowing Owl habitat on their land. This program helps approved landowners convert cultivated land back to grassland by purchasing seed mixtures for native or tame grass (excluding crested wheatgrass [*Agropyron cristatum*] and smooth brome grass [*Bromus inermis*], two highly invasive exotic species). In 2001, assistance with fencing and water development were also offered (in partnership with Saskatchewan Wetland Conservation Corporation) to protect native pasture through deferred grazing management. Land targeted for these programs is near sites that recently supported breeding Burrowing Owls and near existing pastures, especially in highly-fragmented areas.

Public Awareness. Since the initiation of OBO, the program has been widely promoted through annual newsletters, brochures, advertisements in rural newspapers, and presentations to schools, nature clubs, landowner meetings, and other groups. Articles on the Burrowing Owl and on OBO have appeared in the newsletters of other agencies, and media coverage has been solicited. Promotional tools have included owl-shaped refrigerator magnets, t-shirts, a poster, a portable display, youth and adult versions of slide shows, and fact sheets on *Operation Burrowing Owl and Conservation*, *Burrowing Owl Behavior and Biology*, and *Burrowing Owl Research*.

As an educational complement to the OBO program, the Saskatchewan Burrowing Owl Interpretive Centre (SBOIC) opened in Moose Jaw, in 1997, at a site that had Burrowing Owls nesting in the wild. The launch of the Centre was a joint initiative of the Moose Jaw Exhibition Company, Saskatchewan Environment and Resource Management, NS, and Wildlife Habitat Canada. In a small indoor facility, displays describe ongoing research and promote the role of the Burrowing Owl in the prairie ecosystem. The facility also contains a walk-in replica of a Burrowing Owl burrow, with giant eggs and a model owl that is 1.5 m tall. The Centre has two imprinted captive-bred owls that visitors can touch, and 12 other Burrowing Owls that can be observed in captivity. From a nearby permanent blind, visitors use spotting scopes to view wild owls at their nest burrows. The Centre now has year-round educational programming.

Burrowing Owl road signs, similar to other highway wildlife warning signs, alert drivers to exercise care along stretches of road with nearby nesting owls. Signs feature a black drawing of an owl, on a yellow background, with the words "Slow Down, Burrowing Owls, Next 2 km."

Annual Census. To determine the number of owls at each site, census cards were mailed to all OBO members every June. Reported owls and hectares enrolled in the program for a given year are based on members in the program as of 30 June of that year. To facilitate reporting, a toll free "HOOT line" (1-800-667-HOOT) was introduced in 1991. In recent years, landowners were also asked if they were interested in receiving conservation

easement information and roadside warning signs. In each year except 1996, almost all of the landowners who did not mail in their census card were contacted by phone for information.

In 1994, the OBO database was restructured and all OBO data entries were proofed against original records. Small discrepancies occurred between annual OBO summaries and the updated database. Because our results are based on this updated database, some of our numbers differ slightly from those reported by Hjertaas (1997)

Correction for Non-reporting OBO Members. Some members often failed to respond to our annual mail-outs requesting information on the number of owl pairs per OBO site. To estimate the total number of pairs per year on all OBO sites combined, we assumed that members from which we did not obtain owl counts (i.e., 'Unknowns') had the same mean number of owls per site as members from which we obtained counts (i.e., 'Knowns'). However, this assumption would be invalid if members who had no owls were less likely to respond to mail-outs than members who had owls. We therefore tested our assumption through follow-ups (phone calls or visits) to a large subset of the non-responding members each year from 1997–2000. This allowed us to compare the mean number of owls per member between 'Respondents' (those members who returned their census cards, e-mailed us, or phoned) and 'Follow-ups' (non-responding members who we later contacted). The mean (SE) number of owls per member, for Respondents vs. Follow-ups, was 0.20 (0.04) vs. 0.19 (0.04) in 1997, 0.21 (0.06) vs. 0.30 (0.06) in 1998, 0.21 (0.06) vs. 0.11 (0.03) in 1999, and 0.13 (0.05) vs. 0.10 (0.03) in 2000. The mean number of owls did not differ significantly between Respondents and Follow-ups (1997, $t = 0.12$, $P = 0.90$, $df = 404$; 1998, $t = -0.87$, $P = 0.38$, $df = 412$; 1999, $t = 1.52$, $P = 0.13$, $df = 404$; 2000, $t = 0.50$, $P = 0.62$, $df = 380$). Given these results, attributing the same number of pairs per member to non-responding Unknowns as to Knowns seems to be reasonable.

RESULTS AND DISCUSSION

OBO Membership. The OBO program began with 293 landowners in 1987, and grew steadily to 499 members by 1991 (Fig. 1). Membership in OBO remained fairly constant after 1991, fluctuating between 459 and 501 participants. Most members were private landowners (97% in 1998–99), and the remainder were stewards of public lands. Each year new landowners with owls joined the program, while others left the program, resulting in a relatively stable membership from one year to the next. New participants generally resulted from changes in owl distribution or through media efforts and recruitment efforts of the OBO coordinator.

Landowners leaving the OBO program usually did so because they wanted to cultivate formerly protected areas or they no longer owned the land. More recently, however, some landowners cited

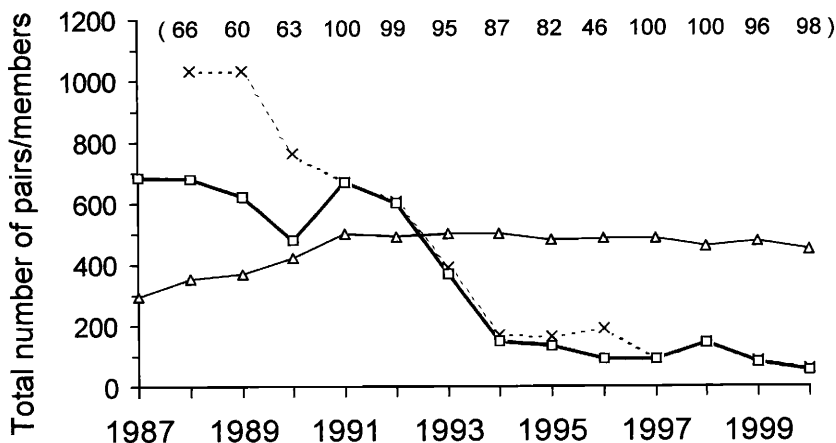


Figure 1. The total number of Operation Burrowing Owl (OBO) members in Saskatchewan between 1987–2000 (thin line). The thick line represents the number of Burrowing Owl pairs reported by participating OBO members ('Knowns' in methods section). By assuming that OBO members who did not report owl data ('Unknowns' in methods section) had the same mean number of pairs as members that reported data (Knowns), we estimated the total number of pairs that likely existed in each year (dashed line). Values in parentheses indicate the percent of all OBO members for which the number of breeding pairs was known each year.

concern about the Canadian Species at Risk legislation. Although not having owls for several years caused some landowners to leave the program, most continued to participate. Of the 675 individuals who joined the OBO program between 1987 and 1994, 504 (75%) of these were still enrolled 5 yr after joining, even though ca. 70% of them no longer had owls. In addition, members that remained in the program for 5 yr tended to remain to at least 1999 (<2% dropped out after 5 yr).

The proportion returning their OBO census cards varied from 1990 to 2000, and was lowest in the last 3 yr (36% in 1990, 33% in 1991, not applicable in 1992 [because all members were contacted directly], 60% in 1993, 55% in 1994, 52% in 1995, 34% in 1996, 58% in 1997, 20% in 1998, 21% in 1999, and 19% in 2000). Response via the toll-free HOOT-line (introduced in 1991) has remained low at about 2–4%. Providing postage-free OBO census cards, from 1991–95 (except 1992), did not improve the return rate of cards. It is possible that returns have decreased because members have learned that someone will phone if they do not mail in their census card.

Habitat Conservation. The total area enrolled by private landowners in the OBO program increased from 8962 ha in 1987 to 21 376 ha in 2000, a 139% increase over 13 yr. At public sites, 44 ha were enrolled in 1987, increasing to 39 883 ha in 2000 (the

vast majority were in three PFRA pastures). The total area of private and public sites enrolled in 2000 was 61 259 ha. Of the area enrolled in 1987, 61% of that same area was still enrolled in 2000.

Between 1998–2000, >20 OBO members requested further information about conservation easements. In 2000, NS signed four conservation-easement agreements (one with an OBO member) conserving over 524 ha of grassland habitat. Four additional agreements are in negotiation, and NS referred 16 OBO landowners to NCC. In 2000, three landowners were approved for habitat-enhancement incentives, seeding a total of 178 ha of cropland to pasture.

Population Trend. Although the number of OBO members grew in the initial 4 yr of the OBO program and leveled-off thereafter, the known number of Burrowing Owls on OBO sites declined at an alarming rate (Fig. 1). In 2000, 459 OBO members reported a total of 54 pairs of owls, considerably fewer than the 681 pairs reported by the 352 members in 1988.

A correction for non-responding Unknowns is necessary to obtain a more accurate estimate of the total number of owls on all OBO sites each year. The total estimated number of pairs per year (Fig. 1) declined a dramatic 95% from 1988 (1032 pairs) to 2000 (56 pairs), a mean population decline of 21.5% per year. Mapping of pairs for 1987–2000

Table 1. Size distribution of Burrowing Owl 'colonies' at Operation Burrowing Owl sites in Saskatchewan from 1987–2000. Each value is expressed as a percent of the total sites for the year.

| YEAR | TOTAL SITES | NO. OF PAIRS PER SITE | | | | | | | |
|------|-------------|-----------------------|----|----|----|----|----|------|-----|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6–10 | ≥11 |
| 1987 | 418 | — | 61 | 21 | 7 | 4 | 3 | 3 | |
| 1988 | 378 | 19 | 37 | 22 | 11 | 3 | 2 | 4 | 1 |
| 1989 | 383 | 31 | 26 | 15 | 13 | 4 | 4 | 5 | 2 |
| 1990 | 343 | 41 | 29 | 13 | 6 | 3 | 3 | 3 | 1 |
| 1991 | 496 | 46 | 25 | 9 | 11 | 3 | 2 | 3 | 1 |
| 1992 | 488 | 53 | 23 | 11 | 4 | 4 | 2 | 2 | 1 |
| 1993 | 509 | 71 | 17 | 6 | 3 | 2 | 1 | 1 | |
| 1994 | 422 | 80 | 12 | 6 | 1 | 1 | | | |
| 1995 | 440 | 83 | 10 | 5 | 1 | | | | |
| 1996 | 223 | 77 | 15 | 4 | 3 | | | 1 | |
| 1997 | 598 | 89 | 8 | 2 | | 1 | | | |
| 1998 | 599 | 86 | 7 | 4 | 2 | 1 | | <1 | |
| 1999 | 610 | 92 | 5 | 2 | 1 | <1 | | | |
| 2000 | 605 | 94 | 5 | 1 | <1 | | <1 | | |

indicates a disappearance of breeding owls over the entire Burrowing Owl's range within Saskatchewan (OBO unpubl. data).

Intensive field studies by researchers on the Regina Plain, Saskatchewan, corroborated the dramatic decline in the Burrowing Owl population through the 1980s and 1990s (James et al. 1997, Wellicome et al. 1997). When the percent annual decline estimated from OBO data (1991–99) was compared with the percent annual decline measured by biologists on the Regina Plain, no difference was found, supporting the reliability of the OBO data (paired *t*-test, $P = 0.66$; J. Hoyt and T. Wellicome unpubl. data).

Trend in Pairs per Site. Before 1993, sites with ≥ 5 pairs of owls were fairly common (5–11% of OBO sites); however, almost all sites since 1993 supported < 5 pairs of owls (Table 1). Although at least 1% of sites had ≥ 11 pairs each year from 1988–92, no sites had that many pairs thereafter. In 1988, 1 yr after the OBO program started, 19% of sites had no owls, but many sites (43%) had > 1 pair of owls. By comparison, in 2000 there were no Burrowing Owls at 94% of sites, and only a few sites (2%) had > 1 pair of owls. New members (with owl pairs) join the OBO program each year, and their reports are included in annual owl totals. Sites occupied by one pair of owls seemed more likely to become unoccupied the following year (34%) than sites that originally had two (23%) or more pairs (6%).

Sources of Error. Rates of decline calculated from OBO data are approximate and are subject to inaccuracies such as miscounting, annual movement of owls, changes in number of sites being monitored from year to year, and changes in program delivery. Counts are likely accurate for sites with few owls (≤ 5 pairs), and prior to 1993 attempts were made to have biologists verify sites with > 5 pairs (Hjertaas 1997). Because all sites are occupied when they are initially included in the OBO program, a decline might be expected over time even if the population was stable overall. Such an apparent decline might result from between-year movements of owls from OBO sites to previously unoccupied sites (Rich 1984, Hjertaas 1997). Some owls move to nearby sites and are not noticed or are not reported. This bias is at least partially offset by enrollment of landowners who report owls for the first time (Wellicome and Haug 1995).

Factors Contributing to the Decline. Factors that reduce habitat quality, decrease productivity, or increase mortality cause Burrowing Owl population declines (Wellicome and Haug 1995). In Saskatchewan, habitat change (loss, fragmentation, and degradation) appears to have adversely affected the population (James and Fox 1987, Wellicome and Haug 1995, James et al. 1997, Warnock and James 1997). Conversion of grassland to cropland in the last century resulted in the loss of over 75% of native prairie in Saskatchewan (James et al.

1999). In addition, habitat quality for Burrowing Owls has been reduced by fragmentation of large expanses of prairie, decreased prey availability, and a reduction in burrow providers (Wellicome and Haug 1995). Fragmentation likely results in greater predation pressure because of increases in edge habitats (Sugden and Beyersbergen 1986). Fragmented habitats may also affect dispersal and pairing success of the owls (Wellicome and Haug 1995, Todd 2001). Food shortage contributes to low survival of nestlings (Wellicome 1997, 2000), and possibly increases predation on juveniles and adults by reducing alternate prey for predators (Todd 2001). Other mortality factors include collision with vehicles (Todd 2001), and pesticides that suppress prey populations and directly affect Burrowing Owls (James and Fox 1987).

ACKNOWLEDGMENTS

Operation Burrowing Owl has been successful through the dedicated efforts of Saskatchewan Environment and Resource Management (SERM) staff (D.G. Hjertaas, W. Lyon, C. Palmer, and J. Pollock in the first year, and D.G. Hjertaas in the following two years) and Nature Saskatchewan staff (C. Bjorklund, D. Thornton, H. Dundas, C. Palaschuk, and P. Moore) in subsequent years. OBO has been supported financially by Canada Trust Friends of the Environment Foundation, Canadian Council for Human Resources in the Environment Industry, Canadian Wildlife Service of Environment Canada (EC), EcoAction 2000 and Action 21 (EC), Elsa Wild Animal Appeal of Canada, Endangered Species Recovery Fund (World Wildlife Fund and EC), Environmental Partners Fund (EC), Fish and Wildlife Development Fund (SERM), Human Resources Canada Summer Career Placements, Long Point Bird Observatory, Moose Jaw Exhibition Company, Mountain Equipment Co-op Environment Fund, Natural Legacy 2000 (Government of Canada Millennium Partnership Program), Nature Saskatchewan, Saskatchewan Partnerships Program, and Saskatchewan Wildlife Federation. We thank the dedicated summer students and many volunteers who have ensured the program's success, including the participating landowners and regional phoning volunteers. We appreciated the comments provided by T.I. Wellicome, R. Warnock, K. De Smet, J.K. Schmutz, and S.W. Hutchings on drafts of the manuscript. Thanks also to L.D. Todd, University of Regina, for sharing unpublished information, and to J. Moen, Saskatchewan Wetland Conservation Corporation, for providing a public communication on remnant native prairie in Saskatchewan.

LITERATURE CITED

- CLAYTON, K.M. AND J.K. SCHMUTZ. 1999. Is the decline of Burrowing Owls *Speotyto cunicularia* in prairie Canada linked to changes in Great Plains ecosystems? *Bird Conserv. Internat.* 9:163–185.
- HJERTAAS, D.G. 1997. Operation Burrowing Owl in Saskatchewan. Pages 112–116 in J.L. Lincer and K. Steenhof [Eds.], *The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium*. J. Raptor Res. Report 9.
- , S. BRETCHEL, K. DE SMET, O. DYER, E.A. HAUG, G.L. HOLROYD, P. JAMES, AND J.K. SCHMUTZ. 1995. National recovery plan for the Burrowing Owl. Report No. 13. Recovery of Nationally Endangered Wildlife, Ottawa, ON Canada. http://www.cws-scf.ec.gc.ca/es/Burrowing_Owl.html.
- AND W. LYON. 1987. A stratified random survey for Burrowing Owls on the Weyburn (62E) and Regina (72I) map areas. Wildl. Tech. Rep. 87-2. Sask. Parks and Renew. Resources, Regina, SK Canada.
- JAMES, P.C., T.J. ETHIER, AND M.K. TOUTLOFF. 1997. Parameters of a declining Burrowing Owl population in Saskatchewan. Pages 34–37 in J.L. Lincer and K. Steenhof [Eds.], *The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium*. J. Raptor Res. Report 9.
- AND G.A. FOX. 1987. Effects of some insecticides on productivity of Burrowing Owls. *Blue Jay* 45:65–71.
- , K.M. MURPHY, F. BEEK, AND R. SEGUIN. 1999. The biodiversity crisis in southern Saskatchewan: a landscape perspective. Provincial Museum of Alberta Nat History Occas. Paper 24:13–16.
- RICH, T. 1984. Monitoring Burrowing Owl populations: implications of burrow re-use. *Wildl. Soc. Bull.* 12:178–180.
- SUGDEN, G.L. AND G.W. BEYERSBERGEN. 1986. Effect of density and concealment on American crow predation of simulated nests. *J. Wildl. Manage.* 50:9–14.
- TODD, L.D. 2001. Dispersal patterns and post-fledging mortality of juvenile Burrowing Owls in Saskatchewan. *J. Raptor Res.* 35:282–287.
- WARNOCK, R. AND P.C. JAMES. 1997. Habitat fragmentation and Burrowing Owls (*Speotyto cunicularia*) in Saskatchewan. Pages 477–486 in J.R. Duncan, D.H. Johnson, and T.H. Nicholls [Eds.], *Biology and conservation of owls of the northern hemisphere: 2nd international symposium*. USDA Gen. Tech. Rep. NC-190, St. Paul, MN U.S.A.
- WELLCOME, T.I. 1997. Reproductive performance of Burrowing Owls (*Speotyto cunicularia*): effects of supplemental food. Pages 68–73 in J.L. Lincer and K. Steenhof [Eds.], *The Burrowing Owl, its biology and management including the proceedings of the first international Burrowing Owl symposium*. J. Raptor Res. Report 9.
- . 2000. Effects of food on reproduction in Burrowing Owls (*Athene cunicularia*) during three stages of the breeding season. Ph.D. dissertation, Univ. Alberta, Edmonton, AB Canada.
- AND E.A. HAUG. 1995. Second update of status re-

port on the Burrowing Owl *Speotyto cunicularia* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON Canada. <http://www.cosewic.gc.ca>.

———, G.L. HOLROYD, K. SCALISE, AND E.R. WILTSE. 1997. The effects of predator exclusion and food sup-

plementation on Burrowing Owl (*Speotyto cunicularia*) population change in Saskatchewan. Pages 487–497 in J.R. Duncan, D.H. Johnson, and T.H. Nicholls [Eds], *Biology and conservation of owls of the northern hemisphere: 2nd international symposium*. USDA Gen. Tech. Rep. NC-190, St. Paul, MN U.S.A.