J Raptor Res. 35(4):392–398

BURROWING OWL REINTRODUCTION EFFORTS IN THE THOMPSON-NICOLA REGION OF BRITISH COLUMBIA

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ABSTRACT.—British Columbia (BC) designated the Burrowing Owl (*Athene cunicularia*) as endangered in 1980. In 1989, non-government organizations and local resource users, under the direction of the Ministry of the Environment, Lands, and Parks, launched a cooperative, captive-breeding and release program to restore Burrowing Owl populations in BC. The first phase of this program (1992–97) emphasized refining breeding protocols and identifying critical habitat features necessary for owl survival and reproduction in the wild. Successive releases provided insight into the feasibility of re-establishing populations to the grasslands of the Thompson-Nicola region. Results indicate that 1-yr-old, captive-bred owls are capable of: 1) surviving at release sites, 2) raising broods, 3) over-wintering at or near release sites, and 4) migrating south and sometimes returning to release sites the following spring. Given these general results, the potential for a successful reintroduction of Burrowing Owls in BC exists, provided that more owls are released, and key habitat is enhanced. The second phase will emphasize ecosystem restoration, taking into account historical changes in natural processes (i.e., fire, grazing, and the resulting impact on faunal and floral composition on grassland habitats). In the second phase, the number of released owls will be increased to 50 pairs/year.

KEY WORDS: *Burrowing Owl*; Athene cunicularia; *captive breeding*; *reintroduction*; *grasslands*; *British Columbia.*

Esfuerzos de reintroduccion del Búho Cavador en la region de Thompson-Nicola, Colombia Británica

RESUMEN.—En Colombia Británica, el Búho Cavador (*Athene cunicularia*) se designó especie en peligro de extinción en 1980. En otras partes de el Canadá, esta designación le fue dada en 1995. En 1989 se estableció un programa bajo la dirección del ministerio del medio ambiente para re-establecer la población usando lechuzas criadas en cautiverio. La primera fase de este programa (1992–97) tuvo como propósito refinar la crianza de lechuzas, e identificar las particularidades del habitat que son criticos para la supervivencia y reprodución de dichas lechuzas. Las liberaciones consecutivas han proveido resultados que permiten evaluar la posibilidad de re-establecer poblaciones de lechuzas en praderas de la region de el Thompson-Nicola. Los resultados obtenidos sugieren que lechuzas criadas en cautiverio pueden: 1) sobrevivir en los lugares de liberación, 2) reproducirse, 3) hibernar en los lugares de liberación, y, 4) emigrar y retornar. Dados los resultados observados, pensamos que las posibilidades de reintroducir a esta especie es posible siempre y cuando se liberen mas lechuzas y se restaure la integridad de su habitat. La segunda fase tendrá como propósito restaurar la integridad del habitat tomando en cuenta disturbios naturales (asi como fuego y sus efectos a la fauna y flora de las praderas) e implementar liberaciones en grupos que consistan de no menos de 50 pares.

[Traducción de autores]

Burrowing Owls (*Athene cunicularia*) in British Columbia (BC) are at the northern extent of the interior Great Basin grassland system of Oregon, Washington, and south-central BC. Historically in BC, the owls were found most commonly in the grasslands of the Southern Interior, although the species' range may have stretched as far north as the Cariboo Chilcotin grasslands (R. Cannings unpubl. data). Historical accounts between the

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1960s–80s from ranchers in the area suggest that the Burrowing Owl was a regular and widespread breeding species in the early part of this century. However, decades of habitat alteration, through urban and agricultural development, incompatible grazing practices, eradication of fossorial mammals, and suppression of natural disturbance, resulted in the extirpation of the Burrowing Owl from BC (Howie 1980). The last reported breeding colony of Burrowing Owls disappeared in the mid-1960s from the Vernon Commonage, southwest of Vernon (Vernon Naturalist Club unpubl. data). Since then, sporadic reports of breeding Burrowing Owls have come from several areas within the Thompson-Nicola region. The last authenticated record was in August 1979 by W. Campbell, of the BC Royal Provincial Museum, who saw five Burrowing Owls southwest of Sabin Lake on Douglas Lake Ranch east of Merritt, BC, and a single bird at nearby Stoney Lake (R. Ritcey, D. Jury, and D. Low unpubl. data).

The Burrowing Owl was designated as an endangered species in BC in 1980. As a result of this listing, the Ministry of the Environment, Lands, and Parks (MoELP) launched a recovery program to restore the owl population in the province. Over a number of years between 1983–88, Burrowing Owls obtained from the Owl Rehabilitation and Research Foundation, Vineland, Ontario were released into the Thompson and Nicola valleys in an attempt at reintroduction (R. Ritcey, D. Jury, D. Low, D. Murphy unpubl. data). A subsequent attempt at reintroduction involved the translocation of Burrowing Owl families from the Moses Lake area in Washington to the South Okanagan (Dyer 1991). This project had limited success and monitoring efforts ceased in 1994 (O. Dyer pers. comm.). In view of these results, another attempt was initiated in 1989, but this time a captive breeding and reintroduction program was developed. This project's goal was to reintroduce Burrowing Owls into selected grassland habitats in three or more locations in the Thompson-Nicola region.

The Burrowing Owl captive-breeding and reintroduction project is a cooperative effort between government, private landowners, non-profit organizations, and a large body of volunteers. Because the amount of monitoring that could be done in a given year depended on funding, which varied among years, monitoring was not consistent among years and sites.

The first phase of the reintroduction project was aimed at refining breeding protocols and identifying factors that would improve the probability of successful reintroduction. Specifically, we examined mortality, diet, productivity, and migratory behavior of captive-bred and released birds and compared the results to those of wild populations.

METHODS

Breeding Facilities. There are two breeding facilities in BC. They are geographically separated from each other to reduce the risk of catastrophic loss of the limited gene pool. Both facilities were established and operated by private organizations. Construction of facilities was accomplished with government financial assistance, and corporate and private donations.

Kamloops Wildlife Park breeding centre. Constructed in 1989, the Kamloops Wildlife Park is the main breeding facility for the Burrowing Owl program. The wildlife park has space for 10 breeding pairs. A central sheltering building (5 m × 10 m) contains eight separated nesting burrows that lead into individual exterior flyways for paired birds. A common flyway (3 m × 33 m) surrounds the individual enclosures and can be used by all birds outside of the breeding season. Public viewing is restricted to one side of the building. In 1996, a new juvenile pen (8 m × 30 m) was constructed beside the breeding enclosure. The pen, which contains six nesting chambers, also serves as a second breeding facility.

San Rafael Aviaries breeding centre. From 1992–97, a small facility was maintained at Stanley Park in Vancouver, BC When park changes forced the removal of this enclosure, the new facility was constructed at San Rafael Aviaries, near White Rock, BC, with the support of the University of BC Animal Science Department. The breeding center consists of a large outdoor aviary (18 m × 18 m) that is divided into three sections to accommodate three breeding pairs. Two small buildings that adjoin the flight cage contain nesting burrows for each enclosure. These nesting burrows are connected to the outdoor flight pen by underground pipes. After the breeding season, partitions can be removed to allow communal use of the flyway space.

Release Sites. Releases were conducted in grassland systems within the Thompson/Nicola region, near the cities of Kamloops and Merritt (Fig. 1). Grasslands in BC range from 350–1250 m in elevation. Lower elevation grasslands (350–900 m) are characterized by low annual precipitation rates (range = 160–458 mm) and are dominated by big sagebrush (*Artemisia tridentata*), bluebunch wheatgrass (*Agropyron spicatum*), and needle-and-thread grass (*Stipa comata*). Higher elevation grasslands (900–1250 m) are characterized by higher precipitation rates (range = 376–512 mm) and are dominated by pasture sage (*Atemisia frigida*), rabbitbrush (*Chrysothamnus nauseosus*), rough fescue (*Festuca scabrella*), and introduced Kentucky bluegrass (*Poa pratensis*). A total of nine areas was used between 1992–97 (Fig. 1). Selection of specific release sites in the Thompson-Nicola region (Fig. 1) was based on several criteria: historical and current sightings of wild owls, grassland condition, quality of habitat for rodents, existing grazing regimes, land ownership, and long-term availability of habitat.

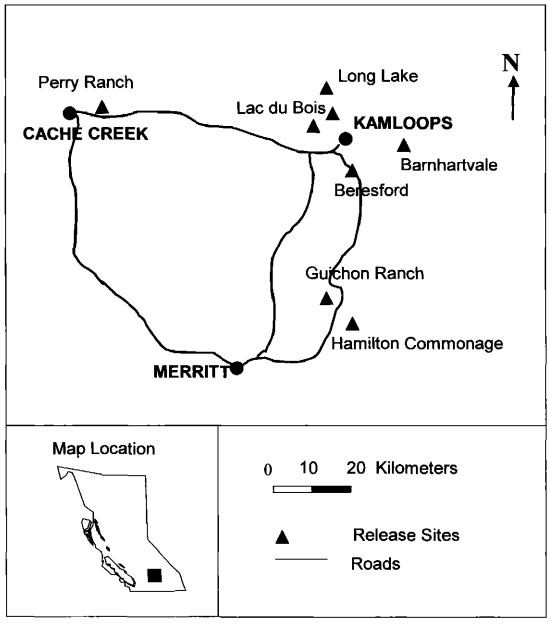

Figure 1. Burrowing Owl release sites in the Thompson-Nicola region of south-central British Columbia.

Releases. Owls were released as 10-mo-old birds (hereafter, 'yearlings'). Releases were conducted between April–June at pre-determined sites. Because burrow availability is a limiting factor in British Columbia (Howie 1980), artificial burrow networks were constructed at each release site. Each burrow network consisted of two to four burrows in upland areas, so owls could nest and avoid predators, and four to eight security burrows, placed 15–50 m apart near meadow vole (*Microtus pennsylvanicus*) habitat, for foraging males. Burrows were made of 15-cm diameter perforated flexible plastic pipe that was 2.0–2.8 m in length. Nesting burrows were a combination of three 11–19 L plastic buckets (two buckets placed bottom against bottom, with human-access holes through the bottoms, and the third bucket placed inside the upright bucket). The owls accessed the inverted bottom bucket nest chamber through a pipe leading to the base of the lower bucket.

Two months prior to releases, owls were segregated by gender to prevent premature breeding attempts. Standard blood DNA analyses for sexual identification were used to determine sex (Griffiths et al. 1988). One-week prior to release, owls were provided with live prey. Shortly before release, yearlings were fitted with United States Geological Survey bands and numbered color bands. Siblings were released at separate locations to minimize the potential for inbreeding. At release sites, owls were placed into artificial burrows. Burrow openings were blocked to allow owls to acclimate to their new burrows for up to an hour. Once or twice weekly for the first 4 wk after the release, day-old chicks were provided to all owls except those released in more remote areas, where feeding took place once every 2 wk.

Owl Monitoring (1993–97). Monitoring consisted of recording owl movements, site persistence, predation, and breeding success. Monitoring of released owls was conducted from the date of release until the departure of owls to wintering grounds. Monitoring intensity varied from site to site and among years. Areas close to the Kamloops center were monitored every second day, while those more than 80 km away from Kamloops were visited only once per week. In 1996, radio-telemetry transmitters (collar-style) were fitted on male owls to determine both the location of missing individuals and movement patterns during daily activities. Only males were fitted with radio-transmitters because females seldom move from the burrows during oviposition, incubation, and early-brooding.

Prey Consumption (1993–97). Prey consumption and seasonal shifts in prey availability were determined by examining regurgitated pellets. Pellets were collected primarily at burrow entrances, and were then air-dried and later dissected. The various taxa that made up each pellet were separated. Diet composition was expressed for each taxa in each pellet as the mass of dry remains of that taxa divided by the total mass of the pellet. Supplemental feed was occasionally found in pellets, but was excluded from the mass measurements. Diet composition was then separated into 3 periods: April–May (pair bonding and egg laying), June–July (incubation and fledging), and August–September (dispersal), and expressed as a percent

RESULTS

Releases. A total of 106 owls were released between 1992–97 at eight separate sites (Table 1). Selection of sites and the number of owls released at each site was guided primarily by the availability of releasable owls and previous success in a particular site. Sex ratios were close to the expected 50:50 ratio, although in 1995 the ratio was strongly skewed toward males.

Site Fidelity. Released yearlings showed high fidelity to release sites; once released, 95% of the owls remained at release sites. In most instances when birds did leave, we were unable to relocate them. However, one female bird moved 4 km from the original release site to a second release site. This movement occurred after all other birds at the first site were killed by predators. Owls often utilized structures other than the artificial burrows that we provided. Such structures included culverts, spaces under abandoned buildings, discarded tires, and, on one occasion, a natural burrow.

Mortality. Mortality of released yearlings was difficult to ascertain because many individuals disappeared. However, telemetry studies in 1996 (N = 6) and 1997 (N = 7) showed that 12 (92%) owls that disappeared from their release sites were killed by predators. Therefore, we assumed for previous years that all individuals that could not be

Table 1. Number of yearling owls (males/females) released at various sites each year.

SITE	DATE OF RELEASE 24 MAY 1992	27 MAR 1993	9 APR 1994	25 MAR 1995	30 MAR 1996	18 APR 1997	TOTAL
Beresford	—	—	8 (4/4)	5 (3/2)	4 (2/2)	5 (3/2)	22
Lac du Bois	9 (?/?)	7 (?/?)	5 (3/2)	4 (4/0)	4 (2/2)	4 (3/1)	33
Long Lake	—	—	—	4 (3/1)	6 (3/3)	4 (2/2)	14
Perry Ranch	—	—	—	—	4 (2/2)	2 (1/1)	6
Guichon Ranch	—	—	5 (2/3)	5 (3/1)	3 (2/1)	3 (1/2)	16
Barnhartvale	—	4 (?/?)	—	—	—	—	4
Agriculture Canada	—	4 (?/?)	3 (2/1)	—	—	—	7
Hamilton Commonage	—	—	—	—	—	4 (2/2)	4
Total Number	9 (?/?)	15 (?/?)	21 (11/10)	18 (14/4)	21 (11/10)	22 (12/11)	106

located at their release site, or at adjacent release areas, were killed by predators. Using this assumption, mean mortality for all years combined was 34% (range = 10–54%). Eighty-five percent of mortalities occurred within the first 4 wk of release. Based on recovered carcasses, 14 deaths were caused by avian predators, two by coyotes, and one from internal parasites. Northern Harrier (*Circus cyaneus*), Great Horned Owl (*Bubo virginianus*), Red-tailed Hawk (*Buteo jamaicensis*), and coyote (*Canis latrans*) were identified as the main predators.

Reproductive Success. Between 1994–97, 28 young were produced from 12 nesting attempts (Table 2). Mean (SD) clutch size was 5.6 (2.1). Five of the 12 pairs that laid eggs failed to produce a brood. Failures were attributed to loss of one or both members of the pair as a result of predation or to inadequate forage availability. There were no instances where eggs were depredated. However, once an entire brood ($N = 5$) of 5-d-old nestlings was cannibalized by the female when the male failed to return. All chicks had been decapitated and their bodies partially consumed. The mean (SD) number of fledglings per successful pair was 4.1 (1.3). Females in three separate instances (data on re-nests not included in Table 2) re-nested after abandoning their first clutch, and one female re-nested after abandoning two clutches. Reasons for abandonment were unknown.

Dietary Habits. Prey data are presented for one release site, where an adequate number of pellets were collected. Owls were able to secure natural prey soon after release. Main prey items were meadow vole, deer mouse (*Peromyscus maniculatus*), northern pocket gopher (*Thomomys talpoides*), carrion beetle (*Silphidae*), several species of ground beetle (*Carabidae*), and spur-throated grasshopper (*Acrididae*). Prey remnants less frequently found in pellets included those of great basin spadefoot toad (*Scaphiopus intermontanus*), western toad (*Bufo boreas*), Western Meadowlark (*Sturnella neglecta*), Vesper Sparrow (*Pooecetes gramineus*), Mountain Bluebird (*Sialia currucoides*), and western terrestrial garter snake (*Thamnophis elegans*). The proportion of vertebrate remains in pellets was highest during

Table 2. Clutch size and number of fledglings observed per nesting attempt of released yearling Burrowing Owls. Dash indicates that no data were recorded.

RELEASE SITE	YEAR 1994	1995	1996	1997
Beresford	—	6 (3)	—	2 (0)
Lac du Bois	—	9 (5)	—	6 (0), 5 (2), 2 (0)
Long Lake	7 (4)	—	—	7 (0)
Guichon Ranch	9 (6)	5 (3)	9 (5)	5 (0)
Hamilton Commonage	—	—	—	—

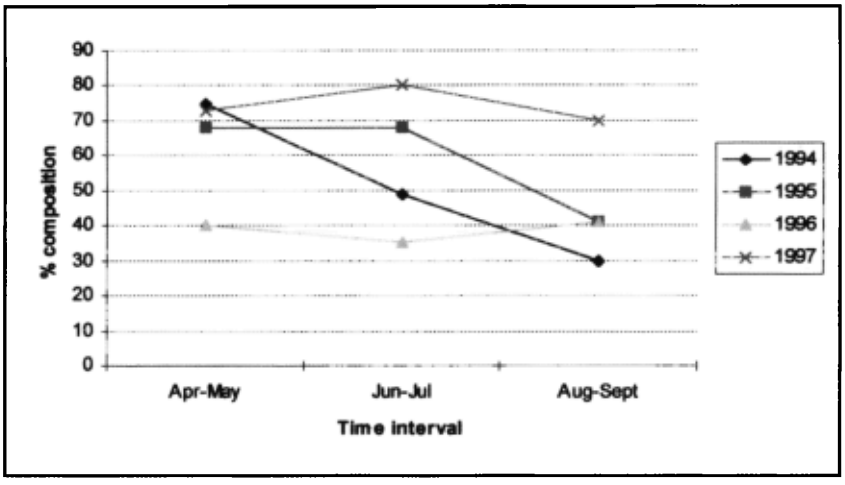

Figure 2. Percent vertebrate prey from pellets collected at Guichon Ranch, 1994–97.

April and May and gradually decreased as the seasons progressed (Fig. 2). In contrast, invertebrate prey was lowest during April–May and by September made up the bulk of the owl's diet (Fig. 3). Of the available insects, Burrowing Owls consumed coleopterans almost exclusively during the spring and early-summer and gradually shifted to grasshoppers as the season progressed.

Migration and Overwintering. Released owls rarely overwintered. Five of the 108 released owls remained at or near their release sites year-round, and two owls did so for three consecutive years. This behavior was observed only in males. In the winter, nest chambers contained as many as 23 stored rodents. Pellets ($N = 45$) collected for one owl in 1996 showed that meadow voles (56%) were the main prey items, followed by deer mice (28%), pocket gophers (10%), and orthopterans (6%). Despite temperatures <15°C, overwintering owls did not appear to be adversely affected by winter conditions. In fact, the mass of an owl recorded during its third winter at the Guichon Ranch release site in December was 260 g and a second one was 213 g when measured in February (the mean mass of a yearling owl at our facilities prior to release was 192 g). During these cool periods, nest

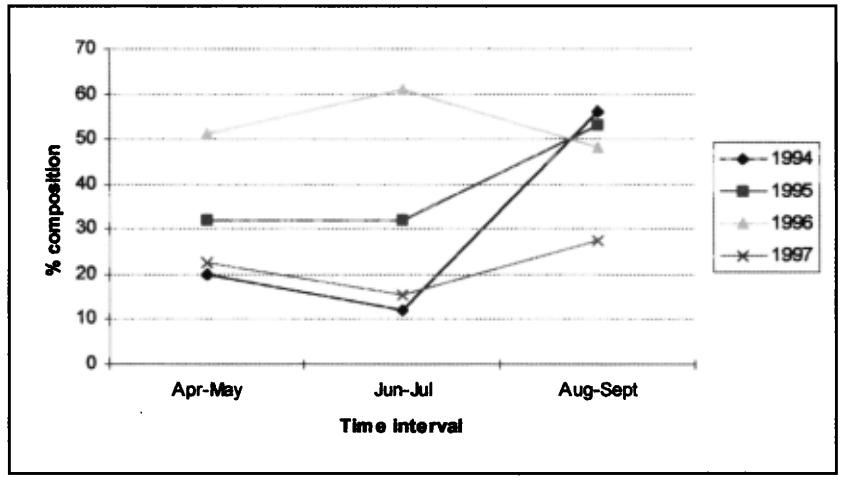

Figure 3. Percent invertebrate prey from pellets collected at Guichon Ranch, 1994–97.

chamber temperatures were near or slightly below 0°C. At this time, owls preyed exclusively on meadow voles and appeared to be active, except on days that temperatures dropped below −25°C or when burrow entrances where covered with excessive snow.

Most owls failed to return in spring after migration. Since 1993, only two released owls were known to return to their original release sites. In both instances, the returning owls were males that had been released in the previous year. The location of the owls' wintering grounds were unknown; however, a band from one released owl was recovered in Ephrata, Washington, in the winter of 1996.

DISCUSSION

Our results suggest that yearling captive-bred owls are able to secure natural prey and reproduce; they sometimes overwinter at release sites, or else migrate, and occasionally return to their breeding grounds the following year. These results are similar to those from other studies of captive-bred or transplanted Burrowing Owls elsewhere within their range in North America (De Smet 1997, Martell et al. 2001, L. Todd unpubl. data). Released owls in our study increased their consumption of invertebrates as the breeding season progressed, a behavior commonly reported for wild Burrowing Owls (Haug et al. 1993). Maser et al. (1971) and Grimm et al. (1985) have shown that this seasonal shift in food habits is a response to seasonal changes in prey availability. Brood sizes were within the range of brood sizes observed in a long-term study of wild owls in Alberta (Clayton 1997). Although infrequent, the few instances of owl returns, and the band recovery in Washington, suggest that captive-bred owls are capable of migrating and returning to original release sites. However, return rates were far lower than those observed in some wild populations. J. Schmutz, D. Wood, and G. Wood (unpubl. data) estimated that the return rate in a small sample of Burrowing Owls in Alberta was 44%. In Saskatchewan, James et al. (1997) reported annual return rates of 37–51%.

Mean mortality following release was high for captive-bred owls in all years. Mortality rates in 1997 were 20% lower than in 1996. In most years, releases were carried out soon after the onset of spring (between March–early-April), which happened to coincide with major hawk migrations. It appeared that delaying the releases to mid-April (Table 1) gave these 'naive' owls an opportunity to acclimate to the release sites and reduced their exposure to avian predators.

Our observations provide grounds for optimism about the eventual re-establishment of Burrowing Owl populations in BC. However, productivity and survival rates of the released owls are similar or lower to those observed in declining populations elsewhere in Canada (Wellicome and Haug 1995, De Smet 1997, Wellicome 1997). Therefore, our immediate efforts will focus on habitat management strategies in an attempt to improve productivity, increase the number of returning owls, and reduce mortality rates.

In a natural situation, the bulk of the Burrowing Owl's diet is made up of small mammals (E. Leupin and D. Low unpubl. data). Wellicome (2000) showed that supplemental feeding of pairs in Saskatchewan during the nestling period resulted in increased production of young compared to unfed pairs. Hence, increases in prey availability may increase owl productivity in BC. Current grazing regimes in BC provide little residual security cover for small mammals. Burrowing Owls prefer to nest in grazed areas with little vegetation (Coulombe 1971, Rich 1984), yet this habitat type is unsuitable for many small mammals. Small mammals, particularly meadow voles, are associated with riparian areas and dense cover (T. Dickinson, E. Leupin, V. Collins, M. Murphy unpubl. data). We intend to work closely with landowners to implement quick-rotation grazing strategies that create habitat heterogeneity and thus provide suitable habitat for Burrowing Owls and their primary prey species, such as the meadow vole that requires cover and fresh shoots of green grass (Jones 1990).

The breeding of owls at the two BC facilities has become finely-tuned over time; we now have the potential to produce almost 100 juveniles annually. This will allow us to conduct group releases of as many as 25 pairs at three separate release sites each year. We suggest that group releases will improve owl survival by increasing the number of individuals available to warn of approaching predators.

Finally, burrow availability has been cited as a key factor contributing to the decline of Burrowing Owls in BC (Howie 1980). The shortage of burrows has come about from a reduction in fossorial mammal populations. Currently, artificial burrows are placed in nesting and foraging habitats. Although artificial burrows are an effective short-term enhancement technique, they should not be consid-

ered an ultimate solution (Bryant 1990). Yellow-bellied marmot (*Marmota flaviventris*) and badger (*Taxidea taxus*) are two species that still persist in BC's grasslands. In future years, we will concentrate in restoring populations of these burrowing mammals, which should in turn provide a natural source of burrows for the owl.

ACKNOWLEDGMENTS

Funding for this project was provided by the Habitat Conservation Trust Fund. Additional funding was kindly provided by the following organizations: Trans Mountain Pipeline Ltd., Shell Environmental Fund, Petro Canada, Fredrick Metcalf Charitable Foundation, Imperial Oil, Canada Trust Friends of the Environment Foundation, and Molson Industries. We owe a great deal of gratitude to all volunteers and landowners, for without their support and involvement, this project would not have been possible. The British Columbia Conservation Foundation provided administrative support and aided with fundraising. All fieldwork would not have been possible without the efforts of the people at the captive-breeding facilities and education programs; we would like to thank Dawn Brodie, Mike Macintosh, Bill Gilroy, the Kamloops Wildlife Park, and the Stanley Park Ecology Society for their efforts. Finally, we thank Myke Chutter, bird specialist in Victoria, for valuable comments on an earlier version of this manuscript and also J. Barclay, M. Martell, and an anonymous reviewer for their thoughtful suggestions.

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