Burrowing Owls in B.C.—Science and Stewardship in Action

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Abstract: By 1980, the burrowing owl (*Athene cunicularia*) was designated as Endangered in British Columbia. Translocation attempts made from 1983 to 1988 were unsuccessful. In 1990, the Burrowing Owl Recovery Program, a captive-breeding and reintroduction program, was initiated under the direction of the provincial Ministry of Environment in partnership with volunteer groups located in Vancouver and Kamloops. The goal was to reestablish self-sustaining populations of burrowing owls within their historic range.

Two geographically distinct captive-breeding facilities, established at Vancouver and Kamloops, were initially provided with 21 wild-captured founding individuals from Washington State. Since 1992, 454 owls have been released to grassland habitats on public and private lands.

The recovery program has developed gradually since its inception in 1990. Captive-breeding protocols have been refined and improved to ensure yearlings are produced annually for release. Additionally, over 600 artificial burrows have been constructed in release habitats, and field monitoring of released owls, their offspring, and migrant returns has been conducted.

The program's progress would not be possible without the provision of financial, professional, and physical resources. Since 1990, a strong community base has developed which includes a committed volunteer organization involved in all husbandry and field maintenance activities, a group of supportive landowners who recognize the value of conservation programs and provide access for the recovery activities on their property, an established nonprofit society with charitable status that provides connection with corporate sponsorship and linkage with government agencies and funding, and an education program that raises awareness about the burrowing owl and fosters stewardship of grassland habitats in British Columbia.

The Burrowing Owl Recovery Program is community based. It provides opportunities for people from many backgrounds to become directly involved in conservation and stewardship activities connected with British Columbia's grasslands. The program has shown gradual progress over its 13 years of reintroductions and fieldwork. A benefit of the program has been the raising of public awareness about the difficulties of trying to reverse environmental change and the need to ensure effective conservation measures are developed for grassland species and habitats.

Key Words: burrowing owl, *Athene cunicularia*, captive breeding, recovery programs, stewardship, migratory returns, grasslands, volunteer programs, British Columbia

Introduction

The burrowing owl (*Athene cunicularia*) is a small, long-legged owl that is found mainly in grassland ecosystems in western North America. It lives and raises its young in underground burrows that are usually constructed by burrowing mammals such as badgers (*Taxidea taxus*), prairie dogs (*Cynomis* spp.), and Columbian ground squirrels (*Spermophilus columbianus*). The burrowing owl is a migratory species whose historical breeding range extended into southern British Columbia (B.C.) and the Prairie provinces (Wellicome et al. 1997). In B.C., its range included the south Okanagan, and extended west and north as far as Cache Creek and east as far as Vernon (Howie 1980).

The grassland habitat of southern B.C. is the northern breeding limit for the burrowing owl. These grasslands have been heavily impacted by human encroachment, which has led to the loss of breeding habitat and the disappearance of the burrowing mammals that provided suitable habitat conditions for the owls (Leupin and Low 2001).

By 1980, severe population declines had occurred, and the burrowing owl was designated an endangered species in B.C. (Howie 1980). As a result, from 1983 to 1989, the B.C. Ministry of Environment attempted a reintroduction of burrowing owls in the south Okanagan using wild birds from Washington State. This was halted, however, due to limited success of the reintroduction efforts.

In 1990, the provincial Wildlife Branch, together with private organizations, began a second major reintroduction effort in the Thompson-Nicola region. This project, the Burrowing Owl Recovery Program, involves releasing year-old offspring from a captive-breeding program into selected historical habitats. The goal of the program is to establish self-sustaining populations of burrowing owls in the wild within their natural historic range. Although the approach of the program is seemingly simple, there are some complexities associated with it—captive breeding, field monitoring, community involvement, and stewardship must be coordinated to achieve positive results.

The Burrowing Owl Recovery Program has completed its thirteenth year of work in the grasslands of southern B.C. Over this time, we have learned a great deal about the burrowing owls, the grasslands, and the human dynamics of planning, organizing, and carrying out a conservation-related venture. Although British Columbia's grasslands are limited and the number of owls that live in B.C. is relatively low, our experience and the knowledge gained from our efforts may help guide other groups who share an interest in burrowing owl conservation. Given that burrowing owl numbers are declining throughout much of North America, information from our program may help in developing a network with others who are working with the owls in other regions of the species' range (Holroyd et al. 2001).

This report provides an update on the B.C. burrowing owl program for the period 2000–2003. The report highlights release results and presents a summary of stewardship and community involvement, which is crucial to the success of the program (see Leupin and Low 2001 for an earlier summary of results).

Breeding Facilities

Breeding facilities are an integral component of the Burrowing Owl Recovery Program in that they need to provide a reliable source of one-year-old owls for release. There currently are two captive-breeding facilities in B.C.: one is in White Rock, the other is in Kamloops. The facilities are geographically separated, which is an important factor in reducing the risk of catastrophic loss of the limited gene pool. The facilities were initially provided with 21 wild-captured founding individuals from Washington State. The Kamloops Wildlife Park (now B.C. Wildlife Park) Society and the Burrowing Owl Conservation Society of B.C. operate the breeding facilities.

B.C. Wildlife Park

In 2002, two smaller facilities were replaced by a new, larger, and more isolated breeding facility on the grounds of the B.C. Wildlife Park in Kamloops. The new structure incorporates a central heated building with 13 separate breeding burrows and adjoining communal flyways (4 x 7 m) surrounding the building. The total breeding area including building, flyways, and pens is 750 m^2. Adjoining the breeding section are two juvenile rearing enclosures totaling 500 m^2. The enclosures can be restricted, and contain multiple nest chambers for the shelter and safety of the birds. Low maintenance vegetation is used throughout the facility.

San Rafael Aviaries Breeding Center

A second, smaller breeding facility was constructed at San Rafael Aviaries, White Rock, in 1997 (a previous facility had been located at Stanley Park from 1992 to 1997). The breeding center consists of an outdoor aviary of 230 m^2, and is partitioned into three sections to accommodate three breeding pairs of owls. Two small buildings adjoining the outdoor aviary contain nesting burrows for each enclosure. These connect via underground pipes to the outdoor flight pen. After the breeding season, the partitions can be removed to allow communal use of the flyway space. Each breeding section contains additional nesting burrows, constructed above ground level and insulated with soil. Since 2000, the facility has been operated by the Burrowing Owl Conservation Society of B.C.

Burrowing Owl Production

From 2000 to 2003, the two breeding facilities produced a total of 188 young for release; however, there was high variability in juvenile production among years. Some of the variability was due to human disturbance. In 2002, disturbances from construction activity near the Kamloops breeding facilities resulted in only nine young being successfully raised at the site.

Aging female founders also had an impact on productivity. As females aged, production of young decreased significantly (r^2 = 0.27, $F_{1,42}$ = 15.24, P < 0.001). Males, however, showed no significant trend between age and juvenile production (r^2 = 0.06, $F_{1,42}$ = 2.57, P = 0.10) (Fig. 1).

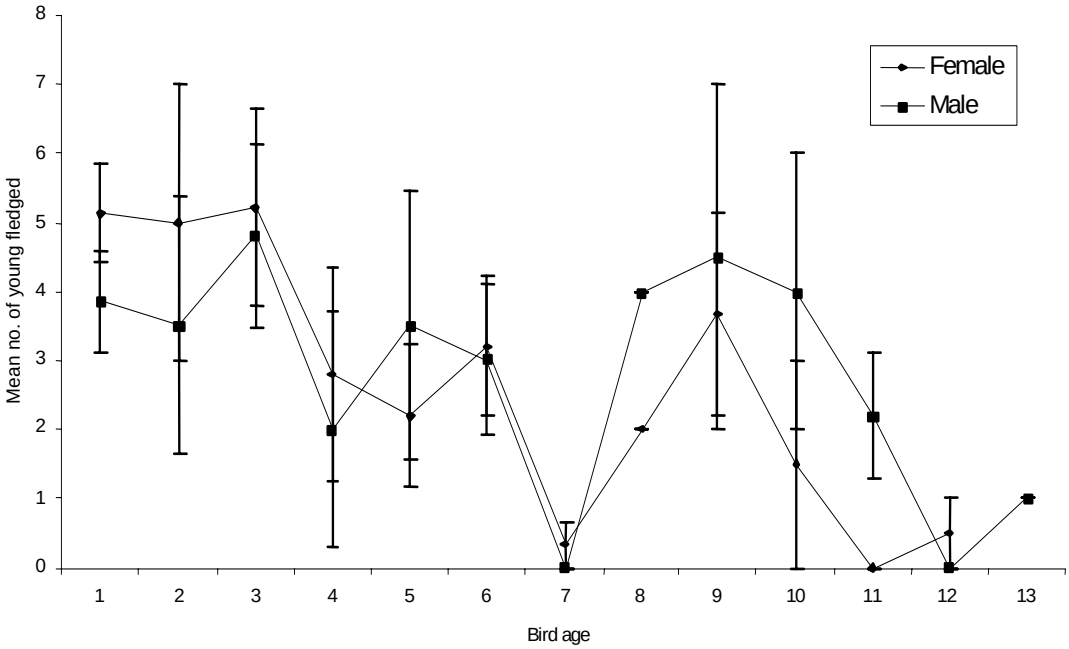

Figure 1. Mean number of young produced in captivity from 2000 to 2003 by male and female burrowing owls of various ages (*n* for each sex = 42).

Community Participation

Community participation is an integral component of the reintroduction effort. Stewardship and community involvement are largely responsible for the viability of this project. There were some notable activities and changes to the program that occurred from 2000 to 2003.

Burrowing Owl Conservation Society of B.C.

In 2000, the Burrowing Owl Conservation Society of B.C., a nonprofit organization with charitable status in Canada, was formed. The society's goals and objectives support the province's recovery program and seek to provide financial and professional support for the program's initiatives. The society provides a means for fundraising within the private sector and can work with government to acquire grants and disburse funds for project activities. In 2003, the society received government funding from the federal Habitat Stewardship Program and the provincial Habitat Conservation Trust Fund. Both of these grants focused on grassland habitat research and enhancement. Corporate sponsorship and private donations have provided ongoing financial support to maintain the breeding facility at San Rafael Aviaries, and to allow for sexing

of releasable juveniles (which is important given that the sexes must be segregated prior to the breeding season to prevent premature breeding attempts).

The society also has an extension aspect. It produces educational brochures, signage, and other promotional materials to promote awareness of burrowing owls and grasslands.

The society's directors are members of the B.C. Recovery Implementation Group. They participate in planning activities for the program and give educational talks and presentations to schools, universities, and community groups.

Volunteer Program

The volunteer program offers opportunities for people with many different skills to become directly involved with the conservation project; consequently, much of the work can be done at a relatively low cost. Additionally, many people of different age groups, from students to senior citizens, are able to participate in a conservation project in a hands-on manner. The following activities are part of the volunteer program.

Burrow Construction and Maintenance

Due to a lack of burrowing mammals and limited natural nesting habitat, volunteers from the Lower Mainland and Kamloops area meet twice a year to build new underground burrows and maintain existing structures at sites that have been preselected by the recovery team. A nest burrow consists of a 3-m run of plastic pipe fitted to an inverted bucket which serves as the nest chamber. A second bucket assembly, placed back to back with the nest bucket allows for the relatively easy inspection of the nest chamber through inspection holes cut in both buckets. The whole burrow is laid below ground level and is marked with a cairn of rocks, which allows for easy field identification and serves as a vantage point for the owls. A series of 'satellite' burrows without nest chambers are built close to the nest chambers to provide security for hunting adults and dispersing juveniles. Burrowing owls are a colonial species, so several burrow colonies are usually built at a release site.

From 1992 to 1999, volunteers constructed nearly 500 artificial burrows throughout the release areas (Leupin et al. 1999). From 2000 to 2003, another 145 nest and satellite burrows were built, mainly in two locations that have consistently had demonstrable success. Due to the large number of available sites within the release areas, volunteers have focused on repairing and inspecting the large network of burrows.

Habitat Mapping

In 2001, volunteers began mapping all burrows using a submetric GPS. Comprehensive habitat mapping has also commenced in the release areas. Improved baseline information has

resulted in more accurate field data and provides greater understanding of the habitat requirements of released owls.

Breeding Facility Maintenance

The B.C. Wildlife Park takes full responsibility for the care and management of the recovery program's main breeding facility. This is a major undertaking, with annual costs estimated at over $28,000/year.

At the San Rafael breeding facility, a group of 12 qualified volunteers handles daily husbandry activities, record keeping, maintenance of enclosures, and production of the food supply. This group contributes over 3100 hours of volunteer time to the program every year.

Public Education and Outreach

Burrowing owls are very charismatic, which makes them ideal ambassadors for grassland habitats. Both breeding facilities have hand-raised owls that are regularly used for school and community programs to raise awareness about endangered species and habitats. The B.C. Wildlife Park's education programs are especially well developed. Each year, over 8000 school students are told the burrowing owl story, with two live owls providing a personal and direct contact with the conservation program. In 2003, the Burrowing Owl Conservation Society directors delivered over 30 live-subject presentations to school and community groups. Presentations are also given to corporations. These events provide valuable opportunities to spread the message of burrowing owl and grassland conservation, and to enlist support and sponsorship.

Landowner Participation

Approximately 90% of the grasslands in B.C.'s southern interior are privately owned (Holmes 2002); therefore, the success of the burrowing owl recovery program relies heavily on the support of landowners. In general, major property owners have been supportive of the reintroduction program. In 2003, a limited amount of habitat modification commenced near the release sites in the Hamilton Commonage area. Over the last several years of the program, contributing landowners have also modified their grazing regimes to support our work. They are using management practices that support a healthy grassland ecosystem, which will provide an opportunity for the reintroduction program to be successful.

Field Monitoring

Field monitoring is necessary to evaluate the success of any reintroduction effort. With the formation of the Burrowing Owl Conservation Society of B.C. in 2000, field monitoring became

more formalized. Funding was established for the months of May through October to allow for a full monitoring program. The society administers the grants for the field monitoring work.

Release Locations

When the owls reach one year of age, they are prepared for release to the wild. Although the recovery team has released birds at eight locations in the Thompson-Nicola Valley, the majority of releases for 2000–2003 occurred in two locations that have shown success over the long term. The two main release locations, the Guichon Ranch and the Hamilton Commonage, are 35 km apart and are considered to be geographically distinct. The Guichon Ranch site represents valley-bottom grassland (640 m elevation); the Hamilton Commonage is located in upper grasslands (1100 m elevation). Each site is visited twice weekly to determine survivorship, reproductive output, site fidelity, and dietary habits of the released owls.

Site Fidelity and Survivorship

Releases of juvenile owls are scheduled for early spring, usually the end of April, just prior to the commencement of breeding activity. A total of 188 owls were released to the wild from 2000 to 2003 (Table 1).

Survival rates for newly released burrowing owls are difficult to assess due to large initial movements experienced during the first two weeks after release. As a result, we are unable to determine if these owls have been predated or have relocated; however, after the initial two-week period, remaining owls show high site fidelity. In 2002, there was no mortality among seven returning and three overwintering owls at any of the release locations. In 2003, only one of eight returning owls disappeared during the breeding season. The major cause of mortality on the release grounds was predation. Common predators were northern harriers (*Circus cyaneus*) and coyotes (*Canis latrans*).

Diet

In each of the study years, pellets were collected from May to October at regularly used burrows and were catalogued for future analysis. Pellet content analysis indicated that during the cool, wet spring season, the main prey items post-release were meadow voles (*Microtus pennsylvanicus),* deer mice *(Peromyscus maniculatus)*, and northern pocket gophers *(Thomomys talpoides)*. As temperatures increased, the quantity of insect prey increased and included carrion beetles *(Silphidae* spp.*)* and spur-throated grasshoppers *(Melanoplus* spp.*)* Burrowing owls will feed on many other species when the opportunity permits. Earlier studies showed that they will prey on western toads *(Bufo boreas),* vesper sparrows *(Pooecetes gramineus)*, mountain bluebirds

(*Sialia currucoides),* western meadowlarks *(Sturnella neglecta),* and garter snakes *(Thamnophis* spp.*)* (Leupin et al. 1999; Brodie 2003).

Breeding Activity

From 2000 to 2003, 149 young were produced from 39 successful nests (Table 1). Mean clutch size from 2000 to 2003 ranged from 4.0 to 6.5, and fledging success, calculated as the ratio of number of young fledged to the number hatched, ranged from 63% to 78%. Both figures are consistent with pre-2002 nesting records (Leupin and Low 2001). In 2002, one released male sired two broods, and two juveniles fledged from each nest.

There were eight recorded nesting failures from 2000 to 2003 (Table 1). Nest failure rate was 17%, which is consistent with data reported in a study by Haug (1985) in Saskatchewan. Nest failure rate was also considerably lower than for the period 1992–1997 when the average annual rate was 44% (Leupin and Low 2001). Nest failure was usually due to the disappearance of a parent bird, likely due to predation; however, in 2001, after the disappearance of the adult female, an adult male successfully raised five young (approximately 3–4 weeks old) to fledging. In 2002, two nests were also abandoned during egg laying when a badger disturbed the nests.

When they were four weeks old, all juveniles were banded with a U.S. Fish and Wildlife Service aluminum band on the left leg, and a distinctive green over black alphanumeric coded aluminum band on the right leg. The owls were weighed and examined for general health before being returned to the nest chamber. The owls appeared to be sensitive to disturbance during brood rearing. In 2002, 6 of 11 broods moved to adjacent burrows after the capture and banding process. In 2003, burrow inspections were conducted later to prevent disruption.

Table 1. Productivity of captive-bred burrowing owls after release to the wild in British Columbia, 2000–2003.

Year	*No. of captive-bred owls released to wild*	*No. of successful nests*	*No. of failed nests*	*No. of owls fledged*	*Mean (SE) clutch size*	*Mean (SE) no. of fledglings*
2000	33	5	2	16	4.0 (1.02)	3.2 (0.80)
2001	71	17	2	60	6.3 (0.42)	3.4 (0.44)
2002	46	11	3	45	6.5 (0.56)	4.2 (0.65)
2003	38	6	1	28	6.2 (1.32)	4.6 (1.05)
Total	188	39	8	149		

Burrow Use

Burrow networks that consisted of a nest burrow and 3–4 blind burrows within 10 m of the main burrow were established. In 2003, some paired owls established territories of 4–6 burrows,

which were regularly used despite the presence of other burrows in the area (D. Brodie, pers. obs.).

High temperatures (43ºC) in the burrow may have caused one brood to move to an adjacent site. Further collection of nesting records, sampling of internal burrow temperatures, and studies of active burrow usage during brood rearing will help improve the design of new burrows.

Parasitism

In 2002, fleas (*Pulex irritans*) were identified on juvenile and adult owls at the Guichon Ranch release site. The high parasite loads at several of the burrows were considered to be a health hazard for juvenile owls. In 2003, a parasite control program reduced parasite loads considerably on the birds and in the burrows.

Overwintering

Most surviving owls and their young leave the release sites by October. We have little information regarding location of the wintering grounds. There were limited winter sightings of B.C. owls in Oregon and Washington between 2001 and 2003. From November 2001 to January 2002, a single captive-raised male that was released in the Nicola Valley in April 2001 was observed living in a culvert near the Portland International Airport. After a summer away, he returned to the culvert site in November 2002. Another captive-raised male from 2002 was sighted at Port Townsend, Washington in the fall of that year. Neither of these birds returned to their release sites.

A few owls have overwintered in the release area (Table 2). Most of these owls were males that remained near the existing burrow sites or wintered within a few kilometers of the release site. Some have lived for more than one year without migrating, and have fed mainly on meadow voles (Leupin and Low 2001). Most birds seem capable of acclimating to winter conditions, even during years with heavy snowpacks and abnormally cold temperatures. Supplemental feeding has been provided in limited amounts over the winter months but not in sufficient quantities for the birds to survive without hunting for themselves.

Migratory Returns

The measure of success for this program will be when sufficient numbers of burrowing owls return each year to the breeding grounds to sustain a natural population. Migratory returns to the breeding grounds have increased during the study period from two owls in 2000 to eight in 2003 (Table 2), which is the highest recorded return number to date. The owls that returned in 2003 arrived at the Guichon Ranch and Hamilton Commonage sites between 7 and 16 April. Three sightings, presumably of returning migrants, were also reported from other areas in B.C. in April

2003. Those sightings were made in Maple Ridge, Abbotsford, and the Lac du Bois grasslands in Kamloops.

Table 2. Numbers of released, wild-fledged, returning migratory, and overwintering burrowing owls, and number of migratory sightings, 2000–2003.

Year	*No. of captive-bred owls released to wild*	*No. of owls fledged in the wild (from captive-bred parents)*	*No. of overwintering owls*	*No. of migratory returns*	*No. of migratory sightings*
2000	33	16	1 (Guichon A)	2 (males)	-
2001	71	60	1 (male: Guichon A)	7	-
2002	46	45	3	7 (4 juveniles, 3 adults)	2
2003	38	28	3 (males)	8 (3 males, 5 females)	3
Total	188	149	8	24	5

Discussion

B.C.'s Burrowing Owl Recovery Program presents an important model for recovery projects, one that includes community involvement with a diverse group of participants. Since its inception in 1990, the program has been fortunate to have a cooperative relationship among government, private organizations, and volunteers with conservation interests.

The B.C. Wildlife Park Society and the Burrowing Owl Conservation Society of B.C. are vital in managing the breeding facilities and providing owls for release. They are also the primary source of volunteers. They work in all areas of the program including captive breeding and maintenance, nest burrow construction and repair, site improvements, coordination of field research, and education and interpretation.

Breeding facility management and husbandry techniques continue to be refined and better understood, especially as they relate to the management of a small population with limited outside genetic input. With conditions remaining fairly stable in a captive environment, it would be expected that output of young would be fairly constant from year to year; however, a few factors have affected production. Disruption due to new construction at the B.C. Wildlife Park in 2001 and 2002 resulted in significant declines in recruitment. A similar drop in production occurred in 1996–1997 when operations were moved to San Rafael Aviaries from their previous location in Stanley Park. Additionally, clutch sizes have declined as the age of females increases.

Given the small gene pool, breeding facilities are now working from a common database to provide consistent, accurate record keeping for the captive owl populations so that inbreeding or line-breeding is avoided. The Recovery Implementation Group is currently seeking to obtain additional founders to replace aging birds. In 2003, seven additional owls were obtained from Washington State to serve as founders in the program.

A common assumption is that to obtain increased returns of migrating owls, larger numbers of juvenile owls will need to be released. A target number of 100 yearling owls for annual release from the breeding facilities has not yet been reached (maximum 71 owls in 2001). There are several points to note in this regard:

- The Recovery Implementation Group is currently doing a minimum viable population analysis to help determine the annual numbers required for release.
- The new, expanded breeding center at the B.C. Wildlife Park has been completed, and normal routines have been established. Recruitment is expected to increase significantly in the upcoming years.
- The Burrowing Owl Conservation Society of B.C. is considering establishing an additional breeding site in the next few years in the south Okanagan region.
- The San Rafael breeding facility will be moved to a new location, one that will allow for more breeding pairs.

Migratory return numbers have increased during the recent study period, although the numbers continue to be lower than required for the population to be sustainable. In general, population numbers are declining throughout much of the western migratory range of the burrowing owl (Holroyd et al. 2001). There have been few reported sightings of B.C.-raised owls on their presumed wintering grounds; however, it has been encouraging to receive reports such as those from Portland, Oregon where one owl has returned two successive years to the same winter range.

Previous studies have indicated that nesting burrowing owls require relatively open areas in close proximity to suitable foraging habitat (Coulombe 1971; Dickinson et al. 1994). In 2003, funding was obtained from the federal Habitat Stewardship Program for enhancement of grassland habitat in selected areas. In July 2003, a program of forest encroachment control was carried out in selected areas of the Hamilton Commonage breeding area. The funding also allowed for communication with landowners regarding the use of alternate grazing regimes and fencing to maintain grassland ecosystem integrity.

A number of landowners have supported the reintroduction efforts on their property. This is important since breeding and foraging habitats are limiting factors in the southern interior grasslands, especially where intensive grazing occurs. Drought conditions in recent years have also affected grassland habitat, resulting in low densities of vertebrate prey species, such as meadow voles, in some areas selected for group releases.

The Recovery Implementation Group agreed to begin a mapping exercise (with funding from the Habitat Conservation Trust Fund and the Burrowing Owl Conservation Society of B.C.) that identifies and ranks grassland habitats in the Thompson-Nicola and Okanagan-Similkameen Regions according to habitat suitability. Site assessments will also be needed to determine grassland condition, stewardship opportunities, prey bases and availability, grazing regimes, and long-term protection of release areas. With the information that will be developed from the

mapping, the Recovery Implementation Group will be contacting additional landowners to encourage their participation in the program.

The B.C. program currently involves a diverse group of volunteers, naturalists, landowners, and biologists who share a common interest in grasslands stewardship activities. One task the Recovery Implementation Group could undertake would involve establishing more contacts with similar groups that reside in areas along the presumed migratory routes and wintering grounds of the B.C.-raised burrowing owls. The objectives would be to improve communication with other stewardship groups, perhaps by promoting a network of additional small recovery projects. This would help provide information on migration, wintering behavior, mortality, and other key issues that would assist the B.C. program.

British Columbia has been releasing owls since 1992. The recovery efforts have shown that the yearling owls are capable of surviving, reproducing, migrating, and returning (with some overwintering) to the release site. Group releases at a limited number of sites selected for their habitat values resulted in the production of multiple broods of wild offspring from 2000 to 2003; however, despite these efforts, there is no indication that the establishment of viable populations is imminent. Conservation biologists have stressed that reintroduction efforts should strive to release 100+ individuals to maximize the probability of successful reintroduction. Although we are attempting to attain this number of birds for release, the number does not ensure success because it does not take into account the suitability of the release site habitat for burrowing owls or their prey species.

The International Union for Conservation of Nature and Natural Resources (IUCN) Reintroduction Strategy Group Mission Statement reads:

> To combat the ongoing and massive loss of biodiversity by using reintroductions as a responsible tool for the management and restoration of biodiversity through actively developing and promoting sound inter-disciplinary scientific information, policy, and practice to establish viable wild populations in their natural habitats.

In keeping with the IUCN mission, the Burrowing Owl Recovery Program is making steady progress toward the goal of returning sustainable burrowing owl populations to southern B.C. The program continues to build on the concept of communities working with government agencies to benefit the environment. As with most work involving endangered species, there must be a collaborative approach if success is to be attained. It will continue to take knowledge, patience, and persistence for the goals to be realized.

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