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IS THE OPERATIONAL USE OF STRYCHNINE TO CONTROL GROUND SQUIRRELS DETRIMENTAL TO BURROWING OWLS?

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ABSTRACT.—We evaluated the potential impact of the use of strychnine-coated grain to control Richardson's Ground Squirrels (*Spermophilus richardsonii*) on breeding Burrowing Owls (*Athene cunicularia*) in southern Saskatchewan during 1988. Adult owl survival, breeding success (percent of pairs producing at least 1 chick), number of chicks produced per successful nest or nest attempt, and chick weights were not significantly different between 8 operationally poisoned and 7 control pastures. Adult owl weights, however, were significantly higher on the control pastures indicating a possible sublethal effect. We conclude that the use of strychnine-coated grain, applied to control ground squirrels as indicated by the manufacturer, is not detrimental to breeding Burrowing Owls in the short term. Other potential sublethal effects, however, were not investigated. Non-target species were observed feeding or attempting to feed on the dead ground squirrels.

Es el uso de estricnina para controlar ardillas de tierra Richardson (*Spermophilus richardsonii*), perjudicial a los buhos de la especie *Athene cunicularia*?

EXTRACTO.—Hemos evaluado el potencial efecto que tiene el control de ardillas de tierra Richardson (*Spermophilus richardsonii*), envenenadas con granos cubiertos de estricnina, en buhos de la especie *Athene cunicularia* en época de reproducción, en el sur de Saskatchewan durante 1988. La sobrevivencia de estos buhos en estado adulto, los exitosos apareamientos (porcentaje de parejas que producen por lo menos 1 polluelo), los números de crías por nido, y los pesos de los polluelos, no fueron significativamente diferentes al comparar los resultados de 8 áreas de pastos tratadas con el veneno y 7 áreas de pastos de control (no tratadas). Los pesos de los buhos adultos, sin embargo, fueron significativamente mayores en estas áreas de control, lo que indicaba un posible efecto sub-letal. Concluímos que el control de ardillas de tierra, por medio de granos tratados con estricnina de acuerdo con las instrucciones del fabricante, a corto plazo, no es perjudicial a los buhos de la especie *Athene cunicularia*. Sin embargo, otros efectos sub-letales no han sido investigados. También informamos sobre observaciones hechas en otras especies de aves de presa, que se alimentaban o trataban de alimentarse con cadáveres de ardillas de tierra.

[Traducción de Eudoxio Paredes-Ruiz]

The use of strychnine for rodent control was first reported by Aristotle in 350 B.C.; it is still in widespread use today. Significant secondary hazards of strychnine to scavenger and predatory animals have been assumed, but few data are available to substantiate these assumptions (e.g., Hegdal and Gatz 1976, Bortolotti 1984, Schafer 1984, Barnes et al. 1985, Wobeser and Blakley 1987). This is particularly true for birds of prey (Newton 1979, Redig et al. 1982, Cheney et al. 1987, Wiemeyer 1989).

The Burrowing Owl (*Athene cunicularia*) has been "Blue-Listed" in the United States since 1972. This list is intended to provide early warning of North American bird species undergoing population or range reductions (Arbib 1971). In Canada, the Burrowing Owl is classified as "threatened," indicating that it is likely to become endangered if the factors affecting its vulnerability are not reversed. One of the factors potentially affecting its numbers is secondary poisoning via rodenticides, including strych-

nine, that are used for rodent control. Again, however, secondary poisoning of Burrowing Owls has usually been inferred with little or no substantiating data (Butts 1973, Eckert 1974, Zarn 1974, Ehrlich et al. 1988). The possibility exists because the owls nest in close association with ground squirrels, and even occasionally take them as prey. This is particularly true in Saskatchewan, where the main provider of nest holes for Burrowing Owls is the Richardson's Ground Squirrel (*Spermophilus richardsonii*).

In 1987, we conducted a survey of 62 farmers who had breeding Burrowing Owls on their land. Forty-seven percent of them reported that they used rodenticides to control numbers of ground squirrels on Burrowing Owl pastures and 97% of these farmers used strychnine. The objective of the present study was to evaluate the potential impact of this poisoning on Burrowing Owls.

STUDY AREA

The study was conducted in an area of approximately 100,000 ha on the Regina Plain south of Regina, Saskatchewan (50°27'N, 104°37'W) during the summer of 1988. The Plain occurs within the Grassland Ecoregion of Saskatchewan (Harris et al. 1983), and is intensively cultivated for cereal production. This has resulted in the preferred breeding habitat of Burrowing Owls being highly fragmented and dispersed. Most of the owls in the area breed on the relatively few remaining heavily-grazed pastures, most of which are not native.

METHODS

We compared breeding owl survival and reproduction between control pastures and pastures operationally poisoned with strychnine. Seven control pastures containing 28 pairs of owls and 8 treated pastures containing 27 pairs were used for this purpose. A 2% solution of commercially-available strychnine (Gopher-Cop, Saskchem Inc.) was prepared and applied according to label specifications. Strychnine was mixed with wheat grain to provide a final concentration of 2.5 mg/g dry grain bait. Approximately 10 g (one tablespoon) of treated seed was placed into every hole on the treated pastures ($N \cong 3000$). A similar amount of untreated grain was placed into every hole on the control pastures ($N \cong 3000$) to ensure that both pasture types were equally disturbed. Baiting took place in the early morning between 9 and 19 May. Following baiting, the treated pastures were kept under close observation until early evening when dead ground squirrels were picked up for disposal. The numbers of owls and ground squirrels on the pastures were counted 1 hr before and the day after the application at the same time of day by using instantaneous counts every 15 minutes. In addition, notes were kept of feeding and attempted feeding behavior by non-target species on dead ground squirrels. The pastures were monitored during the remainder of the summer and the number of young produced by each owl pair was noted. In addition, adults and chicks were livetrapped between 20 May and 28 July, banded, weighed to the nearest g, and their wings measured to the nearest mm. As the age of chicks was variable and unknown, their masses were standardized for age by dividing by their respective wing lengths resulting in a chick mass index which could be compared between treated and control pastures.

RESULTS

No breeding owls were lost on either the treated or control pastures following treatment (Table 1). In addition, breeding success (percent of pairs raising at least one chick), number of chicks produced per nest attempt or successful pair, and chick mass index were not significantly different between treated and control pastures (Table 1). Mean adult mass, however, was significantly higher on the control pastures (Table 1). The mean $\pm$ SD maximum number of ground squirrels counted on the 8 treated pastures declined significantly from 6.0 ± 3.7 prior to poisoning to 0.8 ± 1.4 one day after poisoning (Mann-Whitney U-test, $P < 0.005$). Forty-one dead ground squirrels were picked up from the treated pastures; it is assumed that the majority of animals died underground. Six non-target species were recorded feeding or attempting to feed on dead ground squirrels on 11 occasions (Table 2). None of these individuals were seen to be adversely affected by the poisoned ground squirrels.

DISCUSSION

The results indicate that the use of strychnine for ground squirrel control is not detrimental to breeding Burrowing Owls. No owls were killed as a result of the poisoning and their reproductive success was not significantly affected (Table 1). The owls almost entirely ignored the dead and dying ground squirrels. The one owl that did feed on a dead ground squirrel rejected the gastrointestinal tract, thereby avoiding the greatest amount of strychnine residue. Other researchers have noted this for both Burrowing Owls and other raptors (see Schmutz et al. 1989). Some owls, however, were also seen feeding on microtine rodents which may have been killed by the treatment. Significant sublethal effects of strychnine on behavior have been demonstrated in other raptors (Cheney et al. 1987) so we cannot dismiss the possibility that some owls were affected in this way. This may explain why breeding success and adult masses were higher on the control pastures, the latter significantly so. The removal of some unknown portion of the small rodent prey base also may have had some influence on adult owl masses. However, one

Table 1. Adult survival, breeding success, number of chicks produced, chick masses, and adult masses of Burrowing Owls on control pastures and pastures poisoned with strychnine. Sample sizes in parentheses.

PARAMETER	POISONED	CONTROL	*P*
Adult survival (%)	100.0 (54)	100.0 (56)	NS[a]
Breeding success (%)	77.8 (27)	92.9 (28)	NS[a]
No. chicks produced per nest attempt (Mean ± SD)	4.0 ± 2.6 (27)	5.0 ± 2.2 (28)	NS[b]
No. chicks produced per successful pair (Mean ± SD)	5.2 ± 1.6 (21)	5.4 ± 1.7 (26)	NS[b]
Chick mass index (Mean ± SD)	1.1 ± 0.2 (51)	1.1 ± 0.3 (85)	NS[b]
Adult mass (Mean ± SD)	160 ± 11.5 (29)	168 ± 16.2 (37)	<0.05[c]

[a] Chi-square test.
[b] Wilcoxon test.
[c] *t*-test.

study of foraging behavior using radiotelemetry showed that Burrowing Owls in Saskatchewan spend little time foraging on the breeding pasture itself (Haug and Oliphant 1990). Our removal of the dead ground squirrels also may have had some unknown influence on the outcome of the study.

The number and diversity of non-target species attracted to the treated pastures indicates that a potential risk to these species exists (Table 2). Again, none were killed by feeding on poisoned ground squirrels although sublethal effects may have occurred. It is also possible that, they too, rejected the gastrointestinal tracts. The poisoned grain was placed into the holes. It is likely that the gulls and corvids would have fed on the grain had it been placed above ground, thereby substantially increasing their chances of mortality (Wobeser and Blakley 1987). In 1983, the United States Environmental Protection Agency banned outdoor above ground use of strychnine bait due to risks to non-target wildlife. The agency now permits strychnine use for rodent control if baits are placed below ground.

Table 2. The number of observations of non-target bird species that fed, or attempted to feed, on dead ground squirrels poisoned with strychnine.

SPECIES	NUMBER OF OBSERVATIONS	TOTAL INDIVIDUALS
American Crow *Corvus brachyrhynchos*	4	14
Black-billed Magpie *Pica pica*	2	5
Swainson's Hawk *Buteo swainsoni*	2	2
California Gull *Larus californicus*	1	2
Northern Harrier *Circus cyaneus*	1	1
Burrowing Owl *Athene cunicularia*	1	1

This study indicates that the use of strychnine for ground squirrel control is not lethal to Burrowing Owls if poison is applied below ground. The finding is noteworthy because of the conservation status of Burrowing Owls in both the United States and Canada. Long-term reduction of ground squirrels through poisoning, however, may still have a significant impact on the owls. In Saskatchewan, for example, the majority of owls use old ground squirrel holes for breeding purposes. The removal of such holes over a period of years will ultimately result in fewer owls. Further study is therefore needed to evaluate the long-term implications of ground squirrel control on Burrowing Owl populations.

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