Peer Reviewed

Use of Playback Alarm Calls to Detect and Quantify Habitat Use by Richardson's Ground Squirrels

BRAD A. DOWNEY,[1] *Alberta Conservation Association, Southern Business Unit, Lethbridge, AB T1J 2J8, Canada*

PAUL F. JONES, *Alberta Conservation Association, Southern Business Unit, Lethbridge, AB T1J 2J8, Canada*

RICHARD W. QUINLAN, *Sustainable Resource Development Alberta Fish and Wildlife Division, Lethbridge, AB T1J 2J8, Canada*

GARRY J. SCRIMGEOUR, *Alberta Conservation Association, Edmonton, AB T5J 4M9, Canada*

Abstract

As part of a larger study on prairie ecosystems, we evaluated the use of playback alarm calls as a monitoring protocol to obtain more representative measures of the detection rate and abundance of Richardson's ground squirrels (Spermophilus richardsonii). *Using these data we quantified habitat preferences of Richardson's ground squirrels by comparing availability and use of native pastures and cultivated lands. Lastly, we determined whether grass height influenced Richardson's ground squirrel habitat use. Results from surveys indicated that the playback of alarm calls increased levels of detection of Richardson's ground squirrels in 2003 ($t_{24} = -6.82$, $P < 0.001$) and 2004 ($t_{32} = -5.91$, $P < 0.001$) and estimates of abundance in 2003 ($t_{24} = -4.35$, $P < 0.001$) and 2004 ($t_{32} = -6.82$, $P < 0.001$). Our habitat comparisons showed that Richardson's ground squirrels preferred native pasture and selected against cultivated lands when compared to habitat type availability ($\chi^2_1 = 45.22$, $P < 0.001$). Ground squirrels selected native pasture with grass heights between 0–30 cm and selected against areas with tall grass (>30 cm; $\chi^2_1 = 7.69$, $P = 0.0056$). Our results suggest that playback alarm calls may constitute an important monitoring protocol to determine Richardson's ground squirrel abundance and habitat use.* (WILDLIFE SOCIETY BULLETIN 34(2):480–484; 2006)

Key words

Alberta, grasslands, habitat use, playback alarm calls, Richardson's ground squirrel, Spermophilus richardsonii, *wildlife surveys.*

Biologists use several methods to quantify the distribution and abundance of wildlife species (Powell et al. 1994, Lancia et al. 1996, Van Horne et al. 1997). These methods include protocols that adjust for low detection (e.g., sightability corrections), are conducted when environmental conditions provide increased levels of detection, or are associated with methods that increase the probability of detection by altering an animal's behavior (Lishak 1982, Warkentin et al. 2001). Because many species elicit alarm calls in response to chemical, visual, or auditory cues provided by their predators, playback alarm calls can potentially be used to increase detection of many wildlife species. For example, in response to playback alarm calls, Richardson's ground squirrels (*Spermophilus richardsonii*) can become increasingly detectable, albeit for short periods of time, by standing erect, returning rapidly to burrows, or may themselves respond to alarm calls (Hare and Atkins 2001, Warkentin et al. 2001).

Richardson's ground squirrels are distributed throughout the Grassland Natural Region of Canada and represent an important ecological component of the prairie ecosystem. This is, in part, because they are an important prey species for numerous predators including ferruginous hawks (*Buteo regalis*), prairie falcons (*Falco mexicanus*), American badgers (*Taxidea taxus*), and Swainson's hawks (*Buteo swainsoni*) (Schmutz and Hungle 1989, Hunt 1993, Michener 2000). Their modified burrows also provide den sites for swift foxes (*Vulpes velox*), burrowing owls (*Athene cunicularia*), and various snake species (Wellicome 1997, Pruss 1999, Kissner 2004). Thus, studies on Richardson's ground squirrels are important to improve knowledge of the species, but also to assist in the management of species that rely on them.

Populations of Richardson's ground squirrels are known to fluctuate considerably, coinciding with dramatic changes in the production, recruitment, and survival of their predators (Michener 1996). Previous surveys to assess ground squirrel populations have been limited to small study areas. Survey methods include mark–release–recapture and burrow counts, both of which require large amounts of time and effort (Schmutz and Hungle 1989, Powell et al. 1994, Van Horne et al. 1997).

As part of a larger study on prairie ecosystems, we evaluated the use of playback alarm calls as a visual monitoring protocol to obtain more representative measures of the detection rate and abundance of Richardson's ground squirrels. We identified 3 specific objectives of the study. First, using a paired-sample design, we quantified the use of playback alarm calls versus no alarm call to influence visual estimates of detection and abundance of ground squirrels. Second, using these data we determined whether ground squirrels displayed any preference between native pasture and cultivated lands. Lastly, we evaluated whether grass height influenced their selection of native pasture. We predicted that the use of playback alarm calls would increase detection of ground squirrels and also result in higher estimates of overall abundance. We also predicted that ground squirrels would not occupy the 2 land cover types based on their availability and that grass height also would influence their use of native pastures.

Study Area

Fieldwork was completed in the natural grassland region of southern Alberta along transects totalling 70.46 km^2 (Fig. 1). The study area was composed of Dry Mixed Grass, Mixed Grass, and Foothills Fescue subregions (Achuff 1994). Average precipitation ranged from 260 mm in the Dry Mixed Grass Subregion to 650 mm in the southern parts of the Foothill Fescue Subregion (Achuff 1994). Average summer temperatures typically ranged from 11°C in the Foothills Fescue Subregion to 17°C in the Dry

[1] *E-mail: brad.downey@gov.ab.ca*

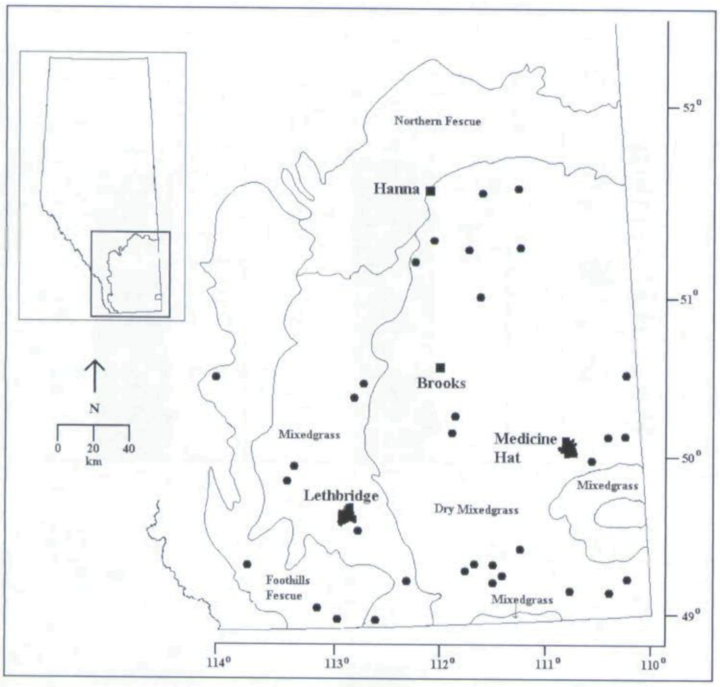

Figure 1. Location of transects within the study area in southeastern Alta., Canada, in 2003 and 2004.

Mixed Grass Subregion (Achuff 1994). The warm air mass brought in by Chinook winds in early spring played a major role in the southern half of the study region by allowing ground squirrels to emerge several weeks before their northern counterparts. Oil and gas development, irrigation, cultivation, and livestock grazing represent the major land uses throughout the grassland region. The Grassland Natural Region is home to some of the most unique species in Canada, many of which rely on Richardson's ground squirrels either directly or indirectly.

Methods

Call Surveys

We conducted surveys of Richardson's ground squirrels during the first 3 weeks of April in 2003 and 2004 when only adults ventured above ground. We completed surveys during a relatively short time period in the spring to minimize variability in density estimates associated with the emergence of juveniles. We conducted surveys in the morning and late afternoon to early evening when ground squirrels would be the most active (Downey 2003).

Surveys involved a single observer driving along a 12.8-km predetermined road transect. Twenty-five replicate transects representing 425 stops and 1,700 quadrants in 2003 and 33 transects representing 561 stops and 2,244 quadrants in 2004 were chosen for Richardson's ground squirrel surveys in conjunction with a larger monitoring program relating to ferruginous hawks (Taylor 2003). We evaluated the use of playback alarm calls to influence measures of detection and abundance by completing surveys of transects before and after playback of alarm calls (Downey 2003). Terrestrial predator alarm calls (long high-pitched whistle) from adult Richardson's ground squirrels were recorded and kindly provided by Dr. James Hare, University of Manitoba, Winnipeg, Manitoba, Canada.

For individual surveys an observer stopped every 800 m and, using binoculars, counted the number of Richardson's ground squirrels within a 200-m radius for 30 seconds in each of the 4 quadrants (NW, NE, SW, and SE; i.e., before playback of a CD containing an alarm call sequence). When surveying, we determined distance by using power poles, spaced roughly 100 m apart, or fence lines. On completion of the original count, the observer then played a 30-second recording of an alarm call produced by an adult Richardson's ground squirrel, using a Dennis Kirk Game Caller (NLC Products Inc., Clarksville, Arkansas), while facing each quadrant and subsequently repeated the survey method. The observer recorded both counts in order to analyze the effectiveness of detecting Richardson's ground squirrels using playback alarm calls. We quantified detection as the percentage of stops per transect in which at least 1 ground squirrel was seen.

We recorded the dominant habitat and grass heights in 2004 in each of the 4 quadrants. We divided habitat information collected in 2004 into 2 categories: native pasture and cultivated land. Cultivated land refers to cereal crops (wheat, barley, oats, etc.) used for forage production. Lands usually were seeded in early spring and harvested in late summer. Our surveys were completed prior to seeding when the cultivated lands were still idle. Comparisons of habitat availability versus use were conducted only on stops that had homogenous habitat in each quadrant in order to prevent biases in which one habitat type influenced the others. We based grass height estimates in 2004 for each quadrant on three categories: Low 0–10 cm, Medium 10–30 cm, and High >30 cm. We used quadrants as the unit of replication due to a limited number of stops containing homogenous grass heights. Observers would use the ground squirrel as a means to estimate grass heights, as low grass would allow the entire ground squirrel to be visible and medium grass allowed the top half of a ground squirrel or just its head to be seen looking through the grass. In high grass, observers would only see ground squirrels between individual blades of grass. While grass communities dominated all sites, communities typically were sparse and sites containing tall grass did not reduce our capability of detecting ground squirrels. When ground squirrels were not present, grass near fence posts or birds were used to estimate heights. We then grouped pastures with low grass heights and medium grass heights together so that there were only 2 categories ≤30 cm and >30 cm for analysis. Based on the average height of a ground squirrel, areas with grass height >30 cm would limit a ground squirrel's ability to detect predators while areas with grass height ≤30 cm would not be restrictive.

Statistical Analyses

We evaluated use of the playback alarm calls to influence mean levels of detection and abundance using paired *t*-test and completed analyses separately for data collected in 2003 and 2004 using Statistical Package for the Social Sciences (SPSS®) 11.0 (Zar 1984, SPSS 2001). We also completed normality tests to ensure that differences in detection and abundance before and after the playback were normally distributed (Zar 1984). Replicated measures of both detection and abundance were taken along transects and used to create an overall average for each transect. As a result our comparisons are based on using transects as the unit of replication.

Chi-square tests were conducted on Richardson's ground squirrel habitat characteristics for each stop that contained similar habitat in all 4 quadrants and on grass height for each quadrant to determine whether Richardson's ground squirrels were selecting habitat or grass height in proportion to their availability (Zar 1984). If a significant result was detected, we conducted the Bonferoni Z-statistic to determine which habitats or grass heights were used more or less frequently then expected (Neu et al. 1974).

Results

Estimates of Detection and Abundance

We completed surveys to quantify the effects of the alarm call playback on estimates of detection and abundance of Richardson's ground squirrels on 25 transects in 2003 and 33 transects in 2004. Ground squirrels were present on all transects in 2003 and 94% of transects in 2004. Results from paired *t*-tests showed that detection rates were higher following the call playback in 2003 ($t_{24} = -6.82$, $P < 0.001$) and 2004 ($t_{32} = -5.91$, $P < 0.001$; Fig. 2). Similarly, abundance estimates of ground squirrels also were higher following playback of the alarm call in both 2003 ($t_{24} = -4.35$, $P < 0.001$) and 2004 ($t_{32} = -6.82$, $P < 0.001$; Fig. 2).

Habitat Use

The majority of stops ($n = 148$) were cultivated crops followed by native pasture ($n = 97$). Using stops as the unit of replication, our habitat analyses showed that ground squirrels were located disproportionately more often in native pasture and disproportionately less often in cultivated lands ($\chi^2_1 = 45.22$, $P < 0.001$; Table 1).

Using quadrants within native pasture ($n = 738$) as the unit of replication, our grass height analyses showed that ground squirrels were located disproportionately more often in ≤30-cm-high grass and disproportionately less often in >30-cm-high grass ($\chi^2_1 = 7.69$, $P = 0.0056$; Table 2).

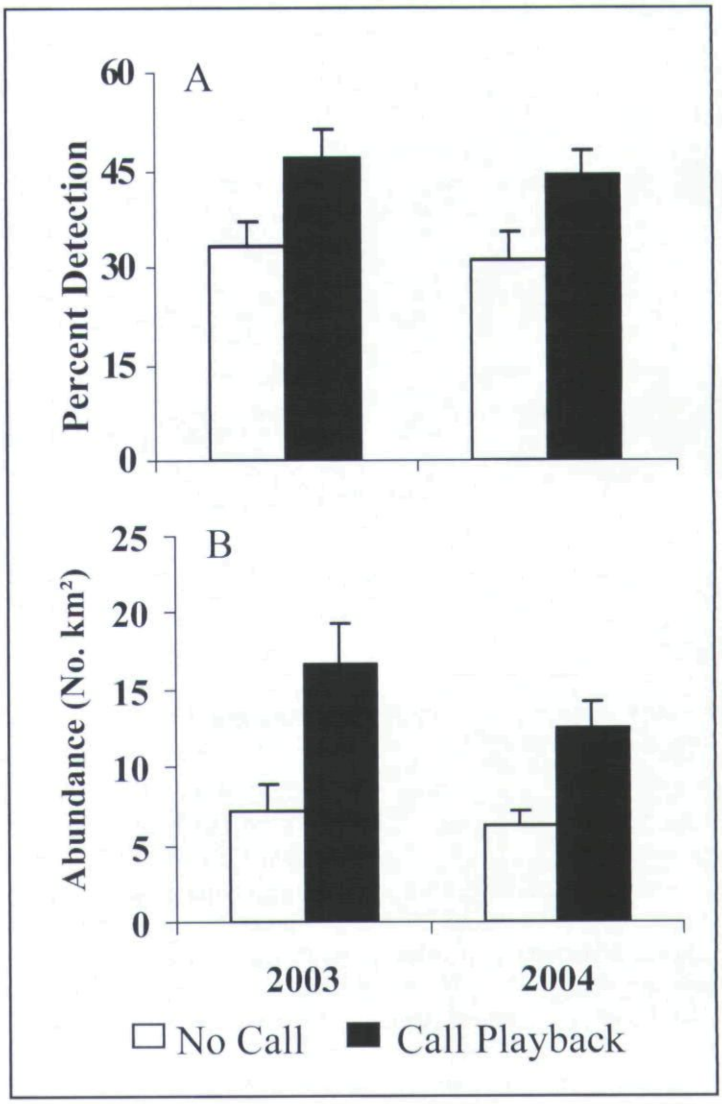

Figure 2. Effect of an alarm call playback on percent detection and mean abundance of Richardson's ground squirrels in the grasslands of southern Alta., Canada. Comparisons were completed using 25 transects in 2003 and 33 transects in 2004.

Discussion and Management Implications

Playback of alarm calls produced by conspecifics is known to alter ground squirrel behavior including increase in vigilance where individuals intersperse feeding behaviors with periods of time spent standing upright with their head erect to scan the area, often accompanied with alarm calls (Hare and Atkins 2001, Warkentin et al. 2001). These behaviors combined with rapid movements, often to burrows, increases the ability of human observers to detect and subsequently observe ground squirrels.

Results from our study suggest that incorporating playback of conspecific alarm calls may be a useful addition to standard visual survey techniques to quantify the detection rate and abundance of Richardson's ground squirrels. Our data suggest that playback of alarm calls produced by conspecifics increased overall levels of detection and abundance by about 1.5- and 2-fold, respectively. Warkentin et al. (2001) also noted significant increases in the number of alert Richardson's ground squirrels when using call playback during their study on how different rates of anti-predator calls influence Richardson's ground squirrels. Other studies have reported the utility of alarm call playbacks to detect thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*; Lishak 1977, 1982). For instance Lishak (1977) reported that counts of thirteen-lined ground squirrels increased by 44–47% when accompanied with playback of alarm calls.

The extent that playback calls enhance estimates of detection and abundance of Richardson's ground squirrels is influenced by

Table 1. Comparing the use of cultivated land and native pasture by Richardson's ground squirrels in the grasslands of southern Alta., Canada, in 2003 and 2004.

Habitat	Available[a]	Available (%)	Observed (*n*)	Expected (*n*)	χ^2	Bonferoni 95% confidence interval	Utilization
Cultivated land	148	60.41	16	44.1	17.9	0.124–0.314	Proportionately less than expected
Native pasture	97	39.59	57	28.9	27.3	0.686–0.876	Proportionately more than expected

[a] A stop includes the entire 400-m diameter circle and only stops, which consisted of similar habitat in all 4 quadrants, were used for analysis.

Table 2. Influence of grass height (cm) on the use of native pastures by Richardson's ground squirrels in the grasslands of southern Alta., Canada, in 2003 and 2004.

Grass height	Available[a]	Available(%)	Observed (*n*)	Expected (*n*)	χ^2	Bonferoni 95% confidence interval	Utilization
≤30 cm	635	86.04	257	240.92	1.07	0.886–0.950	Proportionately more than expected
>30 cm	103	13.96	23	39.08	6.62	0.050–0.114	Proportionately less than expected

[a] A quadrant is 25% of a 400-m-diameter circle or 31,415 m^2.

the proximity of ground squirrels to the call playback stimulus. For example, ground squirrels occasionally were observed prior to playback of the alarm call sequence but were subsequently not visible after the playback. While not quantified this typically occurred when ground squirrels were located in close proximity (e.g., <5 m) to the playback location. In these cases some ground squirrels fled the area, often to topographically variable areas (e.g., low-lying areas interspersed with topographic highs) where the observers could no longer locate them. Alternatively, some individuals immediately sought refuge in their burrows. Thirteen-lined ground squirrels also were found to respond negatively (hide in their burrow) when alarm calls were played too close to their burrows (Lishak 1977). The extent to which these behavioral responses underestimate ground squirrel detection and abundance likely is small but, currently, is not quantified.

We designed our playback sampling protocol to reduce variance in ground squirrel counts by completing surveys within relatively short duration. Our design of systematically counting ground squirrels before and after playback raises the potential concern of treatment-order bias, where counts following playback could be elevated because the observer may recall the locations of previously detected ground squirrels. While not quantified, we expect that this bias is minimal for the following reasons. First, the relatively large size of the plot (radius 200 m) reduces the ability of observers to recall the location of previously identified ground squirrels. Secondly, our data also occasionally included higher counts of ground squirrels prior to playback of the predator alarm call suggesting that the treatment-order bias may not be substantial.

Our analyses suggest that Richardson's ground squirrels display distinct habitat preferences by utilizing native pasture disproportionately more then would be expected based on availability and cultivation disproportionately less than expected based on availability. In addition, ground squirrels used pastures with high grass disproportionately less than expected while short- and medium-grass pastures were used proportionately more than expected. This may be related to the ground squirrels' inability to detect predators when grass heights exceed 30 cm. Alternatively, grass heights ≤30 cm enable ground squirrels to detect predators. Several other studies also have documented habitat selection by Richardson's ground squirrels. For instance, Smith (1993) noted that Richardson's ground squirrels preferred habitats comprised of extensive short and mixed grasslands, whereas Schmutz (1989) documented low densities of Richardson's ground squirrels in areas with >30% cultivation compared to areas with <30% cultivation. Several hypotheses could explain differential habitat use by ground squirrels including permanence of ground squirrel dens, availability of suitable food resources, or changes in habitat structure that influence their vulnerability to predators.

Agricultural practices that include >30% cultivation and native pastures with grass heights exceeding 30 cm likely are detrimental to Richardson's ground squirrels. The extent to which cultivation also may be detrimental to other species (e.g., such as burrowing owls, and ferruginous hawks) is not well understood; however, Schmutz (1989) found that ferruginous hawk populations decreased in areas with >30% cultivation, similar to ground squirrels. Lastly, Richardson's ground squirrels represent an abundant component of food webs in prairie ecosystems. The extent that spatial and temporal variation in ground squirrel biomass influences other components of prairie ecosystems is poorly understood and represents an important gap in our understanding of functions of prairie ecosystems.

Acknowledgments

Funding for this project was provided by Alberta Sustainable Resource Development (Fish and Wildlife Division), Alberta Conservation Association (ACA), and a grant from the Habitat Stewardship Program for Species at Risk (Environment Canada). We are also grateful to G. Michener (University of Lethbridge), J. Murie (University of Alberta), and U. Banasch (Canadian Wildlife Service), for reviewing and providing input on the survey design. We thank B. L. Downey for her comments on earlier drafts of the manuscript. J. Hare (University of Manitoba) kindly provided the Richardson's ground squirrel alarm call in electronic format. We thank the Richardson's ground squirrel field survey teams of J. Nicholson, L. Dube, B. L. Downey, E. Hofman, and P. Young (Alberta Fish and Wildlife Division), L. Cerney, C. Skiftun, B. Taylor, and J. Landry-DeBoer (ACA). Lastly, the authors wish to thank Jeff Bowman and the 2 anonymous reviewers for their comments.

Literature Cited

Achuff, P. L. 1994. Natural regions, sub-regions and natural history themes of Alberta: a classification for protected areas management (revised December 1994). Prepared for Alberta Environmental Protection, Parks Services, Edmonton, Canada.

Downey, B. A. 2003. Survey protocol for the Richardson's ground squirrel. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 69, Edmonton, Canada.

Hare, J. F., and B. A. Atkins. 2001. The squirrel that cried wolf: reliability detection by juvenile Richardson's ground squirrel (*Spermophilus richardsonii*). Behavioural Ecology and Sociobiology 51:108–112.

Hunt, L. E. 1993. Diet and habitat use of prairie falcons (*Falco mexicanus*) in an agricultural landscape in southern Alberta. Thesis, University of Alberta, Edmonton, Canada.

Kissner, K. J. 2004. Habitat suitability index model: prairie rattlesnake (*Crotalus viridis viridis*). Pages 112–124 *in* B. A. Downey, B. L. Downey, R. W. Quinlan, O. Castelli, V. Remesz, and P. F. Jones, editors. 2004. MULTISAR:

the Milk River Basin habitat suitability models for selected wildlife management species. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 86, Edmonton, Canada.
Lancia, R. A., J. D. Nichols, and K. H. Pollock. 1996. Estimating the number of animals in wildlife populations. Pages 215–253 *in* T. A. Bookhout, editor. Research and management techniques for wildlife habitats. Fifth edition, revised. The Wildlife Society, Bethesda, Maryland, USA.
Lishak, R. S. 1977. Censusing 13-lined ground squirrel with adult and young alarm calls. Journal of Wildlife Management 41:755–759.
Lishak, R. S. 1982. Thirteen-lined ground squirrel. Pages 156–159 *in* D. E. Davis, editor. Handbook of census methods for terrestrial vertebrates. CRC, Boca Raton, Florida, USA.
Michener, G. R. 1996. Establishment of a colony of Richardson's ground squirrels in southern Alberta. Pages 303–308 *in* W. D. Willms, and J. F. Dormaar, editors. Proceedings of the fourth prairie conservation and endangered species workshop. Provincial Museum of Alberta, Natural History Occasional Paper, Edmonton, Canada.
Michener, G. R. 2000. Caching of Richardson's ground squirrels by North American Badgers. Journal of Mammalogy 81:1106–1117.
Neu, C. W., C. R. Byers, and J. M. Peek. 1974. A technique for analysis of utilization-availability data. Journal of Wildlife Management 38:541–545.
Powell, K. L., R. J. Robel, K. E. Kemp, and M. D. Nellis. 1994. Aboveground counts of black-tailed prairie dogs: temporal nature and relationship to burrow entrance density. Journal of Wildlife Management 58:361–366.
Pruss, S. D. 1999. Selection of natal dens by the swift fox (*Vulpes velox*) on the Canadian prairies. Canadian Journal of Zoology 77:646–652.
Schmutz, J. K. 1989. Hawk occupancy of disturbed grasslands in relation to models of habitat selection. Condor 91:362–371.
Schmutz, J. K., and D. J. Hungle. 1989. Populations of ferruginous and Swainson's hawks increase in synchrony with ground squirrels. Canadian Journal of Zoology 67:2596–2601.
Smith, H. C. 1993. Alberta mammals—an atlas and guide. The Provincial Museum of Alberta, Edmonton, Canada.
Statistical Package for the Social Sciences (SPSS). 2001. SPSS® Base 11.0 user's guide. Prentice Hall, Chicago, Illinois, USA.
Taylor, B. N. 2003. Stratification and standardisation: ferruginous hawk population estimates and a protocol for ferruginous hawk surveys in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 70, Edmonton, Canada.
Van Horne, B., R. L. Schooley, S. T. Knick, G. S. Olson, and K. P. Burnham. 1997. Use of burrow entrances to indicate densities of Townsend's ground squirrels. Journal of Wildlife Management 61:92–101.
Warkentin, K. J., A. T. H. Keeley, and J. Hare. 2001. Repetitive calls of juvenile Richardson's ground squirrels (*Spermophilus richardsonii*) communicate response urgency. Canadian Journal of Zoology 79:569–573.
Wellicome, T. I. 1997. Status of the burrowing owl (*Speotyto cunicularia hypugaea*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 11, Edmonton, Canada.
Zar, J. H. 1984. Biostatistical analysis. Second edition. Prentice Hall, Englewood Cliffs, New Jersey, USA.

Brad A. Downey (photo) is a wildlife technician with the Alberta Conservation Association in Lethbridge, Alberta. He received his Renewable Resource Management diploma and Fish and Wildlife Specialization certificate from Lethbridge Community College and is obtaining his B.Sc. from Athabasca University. He currently works on the MULTISAR Project which focuses on stewardship and wildlife habitat enhancements for species at risk within the Milk River Basin of Alberta. ***Paul F. Jones*** is a wildlife biologist with the Alberta Conservation Association in Lethbridge, Alberta. He received a B.Sc. in biology from the University of Lethbridge and his M.Sc. in wildlife ecology and productivity from the University of Alberta. His interests are ungulate and native prairie ecology and conservation. ***Richard W. Quinlan*** is a Species at Risk biologist with Alberta Fish and Wildlife Division in Lethbridge, Alberta. He achieved his B.Sc. in biology from the University of Alberta in 1977. He has been with Alberta Fish and Wildlife Division for 24 years, and before that worked for the Canadian Wildlife Service, a natural resource agency in New Zealand, and various consulting companies. ***Garry Scrimgeour*** joined the Alberta Conservation Association as the Manager of Science and Research in 2002. He has a Ph.D. from the University of Calgary (Alberta) and Masters and Bachelors degrees from the University of Canterbury (New Zealand). He is an Adjunct Professorship at the University of Alberta and an Associate Editor with the Journal of the North American Benthological Society.

Associate Editor: Jeff Bowman.