24 August 2004
Courtney J. Conway
Arizona Cooperative Fish and Wildlife Research Unit
104 Biological Sciences East
University of Arizona
Tucson, AZ 85721
520-626-8535; FAX 520-621-8801; E-mail cconway@ag.arizona.edu



# EFFECTS OF RADIOTRANSMITTERS ON NATAL RECRUITMENT OF BURROWING OWLS

COURTNEY J. CONWAY,[1] USGS, Arizona Cooperative Fish and Wildlife Research Unit, School of Natural Resources, 104 Biological Sciences East, University of Arizona, Tucson, AZ 85721, USA

VICTORIA GARCIA, Arizona Cooperative Fish and Wildlife Research Unit, School of Natural Resources, 104 Biological Sciences East, University of Arizona, Tucson, AZ 85721, USA

***JOURNAL OF WILDLIFE MANAGEMENT 00(0):000-000; 2004***

***Key words:*** *Athene cunicularia*, burrowing owl, Columbia river basin, natal recruitment, radiotelemetry, survival, Washington.

---

Radiotelemetry is often used to estimate survival and home range size, to locate nests, and to determine migration patterns and causes of mortality in birds (Amlaner and Macdonald 1980, White and Garrott 1990, Pride and Smith 1992, Kenward 2000, Millspaugh and Marzluff 2001). Most studies implicitly assume that radio-marked

[1]E-mail: cconway@ag.arizona.edu

individuals behave and survive normally. Studies evaluating the effects of radiotransmitters on survival are not uncommon in waterfowl and upland game birds (Herzog 1979, Paquette et al. 1997, Bro et al. 1999) but are much less common for other avian taxa (but see Paton et al. 1991, Powell et al. 1998).

Western burrowing owls are listed as endangered in Canada and populations have declined in many areas of the U.S. (James and Espie 1997, Sheffield 1997, Kirk and Hyslop 1998, Desmond et al. 2000, Klute et al. 2003). To prevent further population declines and to design and implement effective recovery efforts, we need to identify which demographic parameter(s) are impaired in areas where owls are declining. Telemetry has proven useful in this regard and recent studies have affixed radiotransmitters to adult (Haug and Oliphant 1990, Sissons et al. 2001, Gervais et al. 2003, Rosenberg and Haley 2004) or juvenile (King and Belthoff 2001, Todd 2001, Todd et al. 2003) burrowing owls. Burrowing owls might be more inhibited by transmitters than other birds due to their use of narrow underground burrows. However, few studies have examined the effects of radiotransmitters on behavior or survival of burrowing owls (but see Clayton and Schmutz 1999, J. Gervais, Utah State University, personal communication).

We were interested in the effects of radiotransmitters on juvenile recruitment into the local population (natal recruitment) because natal recruitment may be particularly important for recovery of burrowing owls in local areas. For example, endangered burrowing owl populations in Canada have had lower natal recruitment compared to owl populations near the center of their breeding range (Haug 1985, Haug et al. 1993). As part of a long-term study on natal dispersal and nestling mortality, we examined the effects of radiotransmitters on natal recruitment of burrowing owls in eastern Washington.

**STUDY AREA**

Our study area spanned approximately 3,600 $km^2$ in Adams and Grant Counties in eastern Washington. The elevation in the study area varied from 316-398 m above sea level. Much of the native shrub-steppe ecosystem that once dominated the area has been converted to irrigated croplands. Our study area was east of the Columbia River and annual precipitation in this region is typically <25 cm, which comes primarily as rain from October to May (Blackwood et al. 1997). The 2 largest towns within the study area are Moses Lake and Othello.

**METHODS**

For 4 years (2000-2003), we caught, banded, and radio-collared juvenile burrowing owls at their nests. We conducted roadside point-count surveys (Conway and Simon 2003) to locate nests and also found nests via incidental observations. We attempted to catch and color-band all juveniles at each nest. Traps were a 6x6x18-inch rectangular box made of galvanized wire mesh. At each end of the rectangular box was an angled door that allowed owls to push past to get in but not out. We placed these traps at the entrance to a nest burrow during early morning or late afternoon once juveniles at the nest were >14 d old.

We banded all captured juveniles with a U.S. Fish and Wildlife Service (USFWS) aluminum band on 1 leg and an aluminum color-band (Acraft Bird Bands, Edmonton, Alberta, Canada) on the other leg. Each color band had a unique alpha-numeric code so that we could identify each individual owl from a distance. We also put a radiotransmitter on a subset of juvenile burrowing owls as part of a study to document causes of juvenile mortality and dispersal. When we caught more than 1 juvenile owl at a nest, we randomly selected which brood mate(s) received a transmitter. Radio transmitters (Model SOPB-2140 from Wildlife Materials International Inc., Carbondale, Illinois, USA in 2000; Model PD-2C from Holohil Systems Ltd., Ontario, Canada in 2001-2003) were sewn into a fabric collar designed to slip over the owl's head (also see Gervais et al. 2003). The collar fitted loosely around the owl's neck, the transmitter rested on the owl's chest, and the antenna stuck down and out from the back of the owl's neck. All methods were approved by the University of Arizona's Institutional Animal Care and Use Committee (approved protocols #01-089 and #03-052). We used both the stage of emergence of wing, tail, and back feathers and a photographic aging guide to estimate age (in days) of each captured juvenile. The aging guide was developed based on photographs of owls of known age (modified from Priest 1997). For this paper, we only included birds from nests where $\geq$1 juvenile was banded and radio-collared and $\geq$1 juvenile was banded only. This approach ensured that potential differences in natal recruitment between radio-collared and banded owls were not confounded by differences in territory or parental quality. Over the course of the 4 breeding seasons, we banded 595 juvenile burrowing owls from 150 nests, and we also radio-marked 174 of the 595 owls. We put radio collars on 1 (126 nests) or 2 (24 nests) juvenile owls per nest and put bands on the remaining juveniles ($\bar{x}$ = 3, range = 1-9) in each nest (*n* = 421 juveniles). The age at which we put radio collars on juvenile owls varied from 15 to 55 days of age ($\bar{x}$ = 30.7 $\pm$ 1.0 d old) and did not differ ($t$ = 1.3, $P$ = 0.203) from the age of juvenile owls that received only leg bands ($\bar{x}$ = 29.7 $\pm$ 0.5 d old). Transmitter packages (including the associated collar material) weighed 3.2 - 6.0 g ($\bar{x}$ = 5.0 g) in 2000 and 4.6 g in 2001-2003. Body mass of juveniles receiving transmitters varied from 96 to 184 g ($\bar{x}$ = 141.2 $\pm$ 1.7 g) and did not differ ($t$ = 1.4, $P$ = 0.151) from body mass of juveniles that received only leg bands ($\bar{x}$ = 137.8 $\pm$ 1.3 g).

In each subsequent year (2001-2004), we visited all known nests in the study area weekly from late February through early September. We also conducted roadside point-count surveys to locate new nests each year. We used binoculars and spotting scopes to read color bands on the adults at each nest during weekly visits. We also conducted winter re-sight surveys to determine which individuals in the population were winter residents. We visited all known burrows twice during January in both 2002 and 2003 and used binoculars and spotting scopes to read color bands on any owls observed. We also looked around each burrow for signs of recent use (e.g., regurgitated pellets, feces, or feathers) and continued to return to burrows that had signs of use until we observed an owl. We used contingency table analysis to evaluate whether the proportion of juvenile owls that returned as breeders differed between banded owls and radio-collared owls.

**RESULTS**

Juvenile owls with transmitters occasionally grabbed and pulled the antenna or the collar with their bill. We also observed siblings pulling on the antenna of the transmittered juvenile after they were poked by the antenna. The radiotransmitter caused mortality of at least 2 of the 174 radio-marked owls; 2 owls were found dead with their foot caught in the collar. Even with these 2 transmitter-caused mortalities, we failed to detect a difference ($\chi^2 = 0.27$, df =1, $P = 0.630$) in the probability of natal recruitment between owls that were banded (21 of 421; 4.99%) and those that were banded and received radio collars (7 of 174; 4.02%). The radio-marked birds were not easier to detect than banded birds because their transmitters were no longer emitting signals the year in which they were re-sighted. Having a transmitter did not cause owls to overwinter; only 2 banded juveniles and 0 radio-marked juveniles were detected during winter re-sight surveys. For those birds that did return the following year, we did not notice any adverse affects of transmitters on subsequent reproduction. Although our sample size is small, owls with transmitters did not initiate nests later nor did they fledge fewer offspring.

**DISCUSSION**

We failed to find an effect of radio collars on the probability of natal recruitment in juvenile burrowing owls. Similarly, radio collars did not appear to affect behavior or survival of juvenile or adult burrowing owls in Alberta (Clayton and Schmutz 1999). Numerous studies have examined the effect of radiotransmitters on probability of adult survival in other avian taxa. Some studies have shown that transmitters lower survival (Johnson and Berner 1980, Marks and Marks 1987, Paton et al. 1991, Cotter and Gratto 1995, Ward and Flint 1995) whereas others have reported no effect (Lance and Watson 1977, Marcström et al. 1989, Gammonley and Kelley 1994, Thirgood et al. 1995, Powell et al. 1998). Fewer studies have examined the effect of transmitters on survival of juvenile birds; transmitters did not affect juvenile survival in blue grouse (*Dendragapus obscurus*; Hines and Zwickel 1985) or wood duck (*Aix sponsa*; Davis et al. 1999).

As demonstrated by the 2 birds who got a foot stuck in the collar, attaching a radiotransmitter to a small bird can have negative effects. The challenge to wildlife researchers who use telemetry is to examine the extent to which transmitters affect survival (or other parameters of interest) and to find ways to minimize any negative effects. Future studies should experiment with the diameter of the collar; tighter fitting collars than those used here (ours were 2.8 cm diameter) may prevent problems of entanglement in burrowing owls.

Estimates of natal recruitment are influenced by the size of the study area and the proportion of the nests located within that study area. The size of our study area was large (~3,600 $km^2$), but we do not know the proportion of nests that we detected within our study area. Despite these sources of variation across studies, estimates of natal recruitment in migratory populations of burrowing owls have been similar (2.1-5.0%; Martin 1973, Haug 1985, Haug et al. 1993, Plumpton and Lutz 1993) and the overall probability of natal recruitment in our population (4.7%) was typical for this species. The effects of radiotransmitters on survival or behavior of birds differs among species and among individuals depending on the weight of the transmitter (Warner and Etter 1983, Burger et al. 1991), the method of attachment (Small and Rusch 1985, Marcström et al. 1989, Wheeler 1991, Rotella et al. 1993, Paquette et al. 1997, J. Gervais, Utah State University, personal communication), and the age and body condition of the individual bird (Johnson and Berner 1980). Effects of radiotransmitters on survival can even vary among years within the same population (Bro et al. 1999, J. Gervais, Utah State University, personal communication). Hence, radiotransmitters may not be as innocuous to burrowing owls in other parts of their range, when different attachment methods (or larger units) are used, or among different age classes (J. Gervais, Utah State University, personal communication). Future studies using radiotransmitters on juvenile burrowing owls should evaluate the effects of the transmitters in the study area during each year of the study.

The use of radiotelemetry can provide the information on depressed demographic parameters of local burrowing owl populations that is needed prior to designing and implementing recovery efforts. State and federal agencies must make decisions on whether to allow researchers to put radiotransmitters on threatened or endangered species, knowing that the transmitters may affect survival. Clearly, the 2 cases of observed entanglement emphasizes the need to minimize negative effects through careful transmitter attachment. However, we were unable to find a negative effect of radiocollars on the probability of natal recruitment in burrowing owls. We recommend that all radiotelemetry studies evaluate and report the effects of their transmitters on the behavior and/or survival of individuals.

*Management Implications*.—Agencies responsible for managing rare or declining species should request that researchers incorporate evaluation of potential effects of their research methods into their study design. Putting radio collars on juvenile burrowing owls does not appear to be a research method that adversely affects first-year survival. Future researchers and managers should use slightly tighter-fitting collars than those we used (2.8 cm diameter).

*Acknowledgments*.—C. Nadeau, C. Beckman, L. Ellis, D. Westerman, E. Seal, S. Gearhart, E. Sullivan, A. Mitchell, J. Jarrell, K. Altvater, and J. Talamas assisted with field work. J. Whitney and T. Thompson of the Spokane Office of the Bureau of Land Management provided funding, radiotransmitters, and logistical assistance. U.S. Geological Survey provided radiotransmitters and use of field vehicles. National Fish and Wildlife Foundation provided funding. B. Flores and R. Hill of Columbia National Wildlife Refuge (U.S. Fish and Wildlife Service) provided use of a field vehicle and temporary housing. E. Cummins, J. Pierce, L. Stream, and D. Hays of the Washington Department of Fish and Wildlife provided use of a field vehicle. Many private landowners throughout eastern Washington gave us permission to work on their land. D. Rosenberg provided helpful comments on an earlier draft of the manuscript.

**LITERATURE CITED**

Amlaner, C. J., Jr., and D. W. Macdonald. 1980. A handbook on biotelemetry and radio tracking. Pergamon Press, Oxford, England.

Blackwood, J., L. Colville, J. May, S. Mealey, and P. Geehan. 1997. Eastside Draft Environmental Impact Statement. BLM-OR-WA-PL-96-037+1792. U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management.

Bro, E., J. Clobert, and F. Reitz. 1999. Effects of radio transmitters on survival and reproductive success of gray partridge. Journal of Wildlife Management 63:1044-1051.

Burger, L. W., Jr., M. R. Ryan, D. P. Jones, and A. P. Wywialowski. 1991. Radio transmitters bias estimation of movements and survival. Journal of Wildlife Management 55:693-697.

Clayton, K. M., and J. K. Schmutz. 1999. Is the decline of burrowing owls *Speotyto cunicularia* in prairie Canada linked to changes in Great Plains ecosystems? Bird Conservation International 9:163-185.

Conway, C. J., and J. Simon. 2003. Comparison of detection probability associated with burrowing owl survey methods. Journal of Wildlife Management 67:501-511.

Cotter, R. C., and C. J. Gratto. 1995. Effects of nest and brood visits and radio transmitters on rock ptarmigan. Journal of Wildlife Management 59:93-98.

Davis, J. B., D. Miller, R. M. Kaminski, M. P. Vrtiska, and D. M. Richardson. 1999. Evaluation of a radio transmitter for wood duck ducklings. Journal of Field Ornithology 70:107-113.

Desmond, M. J., J. A. Savidge, and K. M. Eskridge. 2000. Correlations between burrowing owl and black-tailed prairie dog declines: a 7-year analysis. Journal of Wildlife Management 64:1067-1075.

Gammonley, J. H., and J. R. Kelley, Jr. 1994. Effects of back-mounted radio packages on breeding wood ducks. Journal of Field Ornithology 65:530-533.

Gervais, J. A., D. K. Rosenberg, and R. G. Anthony. 2003. Space use and pesticide exposure risk of male burrowing owls in an agricultural landscape. Journal of Wildlife Management 67:155-164.

Haug, E. A. 1985. Observations on the breeding ecology of burrowing owls in Saskatchewan. Thesis, University of Saskatchewan, Saskatoon, Canada.

___, B. A. Millsap, and M. S. Martell. 1993. Burrowing owl (*Speotyto cunicularia*). In A. Poole and F. Gill, editors. The Birds of North America, Number 61. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, D.C., USA.

___, and L. W. Oliphant. 1990. Movements, activity patterns, and habitat use of burrowing owls in Saskatchewan. Journal of Wildlife Management 54:27-35.

Herzog, P. W. 1979. Effects of radio-marking on behavior, movements, and survival of spruce grouse. Journal of Wildlife Management 43:316-323.

Hines, J. E., and F. C. Zwickel. 1985. Influence of radio packages on young blue grouse. Journal of Wildlife Management 49:1050-1054.

James, P. C., and R. H. M. Espie. 1997. Current status of the burrowing owl in North America: an agency survey. Pages 3-5 *in* J. L. Lincer and K. Steenhof, editors. The burrowing owl: its biology and management. Raptor Research Report Number 9.

Johnson, R. N., and A. H. Berner. 1980. Effects of radio transmitters on released cock pheasants. Journal of Wildlife Management 44:686-689.

Kenward, R. F. 2000. A manual of wildlife radio tagging. Academic Press, San Diego, California, USA.

King, R. A., and J. R. Belthoff. 2001. Post-fledging dispersal of burrowing owls in southwestern Idaho: Characterization of movements and use of satellite burrows. Condor 103:118-126.

Kirk, D. A., and C. Hyslop. 1998. Population status and recent trends in Canadian raptors: a review. Biological Conservation 83:91-118.

Klute, D. S., L. W. Ayers, M. T. Green, W. H. Howe, S. L. Jones, J. A. Shaffer, S. R. Sheffield, and T. S. Zimmerman. 2003. Status Assessment and Conservation Plan for the western burrowing owl in the United States. U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication FWS/BTP-R6001-2003, Washington, D.C., USA.

Lance, A. N., and A. Watson. 1977. Further tests on radio-marking on red grouse. Journal of Wildlife Management 41:579-582.

Marcström, V., R. E. Kenward, and M. Karlbom. 1989. Survival of ring-necked pheasants with backpacks, necklaces, and leg bands. Journal of Wildlife Management 53:808-810.

Marks, J. S., and V. S. Marks. 1987. Influence of radio collars on survival of sharp-tailed grouse. Journal of Wildlife Management 51:468-471.

Martin, D. C. 1973. Selected aspects of burrowing owl ecology and behavior. Condor 75:446-456.

Millspaugh, J. J., and J. M. Marzluff. 2001. Animal radio tracking. Academic Press, San Diego, California, USA.

Paquette, G. A., J. H. Devries, R. B. Emery, D. W. Howerter, B. L. Joynt, and T. P. Sankowski. 1997. Effects of transmitters on reproduction and survival of wild mallards. Journal of Wildlife Management 61:953-961.

Paton, P. W. C., C. J. Zabel, D. L. Neal, G. N. Steger, N. G. Tilghman, and B. R. Noon. 1991. Effects of radio tags on spotted owls. Journal of Wildlife Management 55:617-622.

Plumpton, D. L., and R. S. Lutz. 1993. Nesting habitat use by burrowing owls in Colorado. Journal of Raptor Research 27:175-179.

Powell, L. A., D. G. Krementz, J. D. Lang, and M. J. Conroy. 1998. Effects of radio transmitters on migrating wood thrushes. Journal of Field Ornithology 69:306-315.

Pride, I. G., and S. M. Smith. 1992. Wildlife telemetry: remote monitoring and tracking animals. Ellis Horwood, New York, New York, USA.

Priest, J. E. 1997. Age identification of nestling burrowing owls. Pages 125-127 *in* J. L. Lincer and K. Steenhof, editors. The burrowing owl: its biology and management. Raptor Research Report Number 9.

Rosenberg, D. K., and K. L. Haley. 2004. The ecology of burrowing owls in the agroecosystem of the Imperial Valley, California. Studies in Avian Biology 27:120-135.

Rotella, J. J., D. W. Howerter, T. P. Sankowski, and J. H. Devries. 1993. Nesting effort by wild mallards with three types of radio transmitters. Journal of Wildlife Management 57:690-695.

Sheffield, S. R. 1997. Current status, distribution, and conservation of the burrowing owl (*Speotyto cunicularia*) in Midwestern and Western North America. Pages 399-407 *in* J. R. Duncan, D. H. Johnson, and T. H. Nicholls, editors. Biology and conservation of owls of the Northern Hemisphere, Second International Symposium. U.S. Forest Service General Technical Report NC-GTR-190.

Sissons, R. A., K. L. Scalise, and T. I. Wellicome. 2001. Nocturnal foraging and habitat use by male burrowing owls in a heavily-cultivated region of southern Saskatchewan. Journal of Raptor Research 35:304-309.

Small, R. J., and D. H. Rusch. 1985. Backpacks vs. ponchos: survival and movements of radio-marked ruffed grouse. Wildlife Society Bulletin 13:163-165.

Thirgood, S. J., S. M. Redpath, P. J. Hudson, M. M. Hurley, and N. J. Aebischer. 1995. Effects of necklace radio transmitters on survival and breeding success of red grouse *Lagopus lagopus scoticus*. Wildlife Biology 1:121-126.

Todd, L. D. 2001. Dispersal patterns and post-fledging mortality of juvenile burrowing owls in Saskatchewan. Journal of Raptor Research 35:282-287.

___, R. G. Poulin, T. I. Wellicome, and R. M. Brigham. 2003. Post-fledging survival of burrowing owls in Saskatchewan. Journal of Wildlife Management 67:512-519.

Ward, D. H., and P. L. Flint. 1995. Effects of harness-attached transmitters on premigration and reproduction of brant. Journal of Wildlife Management 59:39-46.

Warner, R. E., and S. L. Etter. 1983. Reproduction and survival of radio-marked hen ring-necked pheasants. Journal of Wildlife Management 47:369-375.

Wheeler, W. E. 1991. Suture and glue attachment of radio transmitters on ducks. Journal of Field Ornithology 62:271-278.

White, G. C., and R. A. Garrott. 1990. Analysis of wildlife radio-tracking data. Academic Press, San Diego, California, USA.

*Received* 31 October 2003.

*Accepted* .

*Associate Editor:* .