THE ECOLOGY OF WESTERN BURROWING OWLS WITHIN BLACK-TAILED PRAIRIE DOG COLONIES IN THUNDER BASIN NATIONAL GRASSLANDS

By Sarah J. Lantz, Stanley H. Anderson and Courtney J. Conway

Abstract—Burrowing owls (Athene cunicularia) are inhabitants of the prairie grassland ecosystem throughout midwestern and western North America. They are a species of concern in Canada, the United States, and Mexico. Despite widespread decline, few conservation efforts exist to reverse losses. Many wildlife agencies are becoming increasingly concerned with conservation of burrowing owls and their habitat. Identification of the reasons for population decline requires an examination of the factors influencing distribution, demographics, and habitat selection. Such examinations have been underway in the Thunder Basin National Grasslands of Wyoming since 2001. Our burrowing owl research in Thunder Basin is based on the following questions: 1) Are there demographic consequences of habitat use?; 2) Can we identify burrowing owl habitat?; and 3) Can we provide managers with effective tools to identify, enhance, and protect burrowing owl habitat in the Great Plains? This presentation discusses our methods and management implications as we attempt to answer these questions about burrowing owls in Thunder Basin. This research is part of a collaborative effort with national and international researchers. Collaborative data collection among researchers, as well as the continued cooperation and support from local managers, landowners and user groups, will allow for pro-active, effective management of burrowing owls in the west.

INTRODUCTION

Burrowing owls (*Athene cunicularia*) are inhabitants of the prairie grassland ecosystem throughout midwestern and western North America. They are a species of concern in Canada, the United States, and Mexico, having suffered dramatic population declines and significant range contraction throughout the prairie ecosystem (Dechant et al. 1999, Sheffield 1997). Despite the widespread declines and increased concern for burrowing owls throughout North America, few conservation efforts exist to reverse losses (Holroyd et al. 2001). Because burrowing owls are still present in many areas in the West (Dechant et al. 1999), there is a need to implement effective on-the-ground conservation efforts to reverse declining population trends.

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Identification of the ultimate cause of population decline requires an examination of the proximate factors influencing local distribution, reproductive success, and habitat selection. In this presentation, I will present information on our investigations into the ecology of a burrowing owl population located in the Thunder Basin National Grasslands of north-eastern Wyoming. I will discuss the objectives of two major aspects of our research: estimation of demographic parameters and quantification of patterns of burrowing owl nest site selection.

Burrowing owls are small, diurnal, ground-dwelling owls found throughout western North America, with small populations in Florida and the Caribbean. They are often found in association with fossorial mammals: prairie dogs (*Cynomys* spp.), ground squirrels (*Spermophilus* spp.), badgers (*Taxidea taxus*), and marmots (*Marmota* spp.), as the burrows of these species are used by nesting burrowing owls. Burrowing owls show patterns of coloniality, and clumped distributions of nesting owls occur even when burrows are in low availability across the landscape (Desmond et al. 1995, Desmond et al. 2000, Korfanta 2001). They exhibit a wide spectrum of migratory behavior, from resident to completely migratory with increasing latitude (Conway unpubl. data, Haug et al. 1993). In the northern Great Basin (Wyoming, Montana, and Canada), burrowing owls are thought to be completely migratory (Conway and Lantz 2002, Holroyd et al. 2001). They have a monogamous breeding system, breeding from April through September in Wyoming, and clutch sizes range between one and 12 eggs. Diet, examined from a Wyoming population of burrowing owls, contained invertebrates, birds, and small mammals (Thompson and Anderson 1988). Invertebrates were encountered with the greatest frequency and small mammals contributed to the most biomass, consistent with the results from Green and Anthony (1989) in Oregon. Burrowing owls in Wyoming are often sympatric with black-tailed prairie dogs (*Cynomys ludovicanus*), and high prairie dog abundance may attract nesting burrowing owls (Desmond et al. 1995, Desmond et al. 2000, Korfanta et al. 2001, Lutz and Plumpton 1999, MacCracken et al.1985, Orth and Kennedy 2001, Plumpton and Lutz 1993, Sidle et al. 2001).

CONSERVATION STATUS OF BURROWING OWLS

Historically burrowing owls were found throughout the western Americas, but many wildlife agencies in North America are becoming increasingly concerned about declining burrowing owl populations (Holroyd et al. 2001). The burrowing owl is a neotropical migrant protected under the Migratory Bird Treaty Act (1918) and the Convention on International Trade in Endangered Species (CITES, http://www.natureserve.org/explorer). The burrowing owl is a National Bird of Conservation Concern in the United States (U.S. Fish and Wildlife Service 2002) and is of conservation concern in U.S. Fish and Wildlife Service (USFWS) Regions 1, 2, and 6 (Klute et al. 2003). Within the Badlands and Prairies Conservation Region, Wyoming Partners-in-Flight categorizes the burrowing owl as a Level I species, recommending conservation action to reverse declining population trends and curb habitat loss (Nicholoff 2003). The U.S. Forest Service lists burrowing owls as a Sensitive Species within Region 2 under the National Forest Management Act (NFMA). Conservation designations apply in nine Western states, and burrowing owls are a Species of Concern for the state of Wyoming (Wyoming Game and Fish Department, Luce et al. 1999). Burrowing owls are listed as endangered in Canada and threatened in Mexico (Diario Oficial de la Federacion 1994, Wedgwood 1978).

As with many grassland birds in the prairie ecosystem, research postulates that a loss of habitat availability is the major cause of burrowing owl population decline (Holroyd et al. 2001, Sheffield 1997). However, such postulation requires more specific questions: 1) Are there demographic consequences of habitat use?, 2) Can we identify burrowing owl habitat?, and 3) Can we provide managers with effective tools to identify, enhance, and protect burrowing owl habitat in the Great Plains? With regard to the first question, if burrowing owl habitat is declining in quality or areal extent, one might expect to see depressed demographic rates among populations (e.g. low adult annual survival, low reproductive success, reduced juvenile recruitment into the breeding cohort, etc.). The assumption is if habitat were available…that is, if the resources necessary to ensure burrowing owl survival and high productivity were available…then we would expect a healthy population. As such, the first step is to measure the demographic parameters for the population.

METHODS

Demography Study

The goals of our demography research are to 1) conduct standardized population surveys for nesting burrowing owls in Wyoming to determine local population status and estimate population trends, 2) locate, confirm, and monitor active nesting burrows weekly, and 3) estimate annual fecundity, natal recruitment, and adult survival of burrowing owls in Wyoming for comparison with populations in other portions of their breeding range.

Population Surveys

We perform standardized population surveys for nesting burrowing owls from April through July every year on the Thunder Basin National Grasslands in northeastern Wyoming. In 2001, we developed standardized surveys for burrowing owls, and the same methods were repeated in 2002, 2003, and are currently underway in 2004 (see Appendix A, Conway and Simon 2003, on page 58). Burrowing owls in Wyoming are quite secretive and often flush in response to human presence. Hence, surveys are conducted from a vehicle to maximize the area surveyed and to prevent owls from flushing before being detected. We conduct standardized point-count surveys at 0.32-km intervals (0.2-mi intervals) along all roads and established two tracks in and around each prairie dog colony. Point-count surveys consist of a one-minute passive period followed by a three-minute call-broadcast of the primary male song (coo-coooo; Haug et al. 1993) of burrowing owls and an alarm call (quick-quick-quick). Nesting burrow locations are confirmed on subsequent visits to the areas where owls were detected. We conduct surveys at all times of day provided wind speeds are <12 km/hr.

Burrowing owl population surveys are extremely informative for many aspects of our investigations. For example, these surveys provide an index of burrowing owl density within prairie dog colonies for our study area. We are also capable of using the survey information to determine burrowing owl occupancy and the reuse rate of prairie dog colonies within Thunder Basin in order to identify important management areas. The surveys are also our primary source for detecting burrowing owl nests, which is the unit of measurement to estimate reproductive success.

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Nest Monitoring

To document occupancy, we monitor all known burrowing owl burrows every year. We monitor historic, previously identified burrowing owl nests, as these sites can be occupied in subsequent years, and we also monitor all newly discovered burrowing owls nests as encountered during population surveys. To document reproductive success, we visit all active burrows weekly from April through October. Using binoculars and spotting scopes, we first survey the burrow area for owl activity from >100m before approaching the burrow on foot to look for signs of use (castings, feathers, prey remains) or vacancy (presence of cobwebs at the burrow entrance). We record presence/absence of owls and/or sign on each visit and use this information to determine nest status, nest success, and the number of young fledged. On every other nest visit, we use an infrared video probe to examine nest status, clutch size, and brood size at each of our nests.

This monitoring effort allows us to estimate two important demographic parameters: site fidelity and reproductive success. By monitoring burrow occupancy over several years we can measure the degree of site fidelity exhibited by burrowing owls. We can also make inferences about how changes in the landscape are affecting the distribution of nesting burrowing owls over time. By monitoring nest success at active burrowing owl burrows, we can develop robust estimates of reproductive success to relate to habitat quality and compare these estimates with other populations of burrowing owls throughout the West. In order to estimate reproductive success of each nest, we are using a Mayfield Daily Exposure method, where the daily probability of surviving to the next breeding stage is multiplied appropriately to get an overall probability of nest success. With this method, we can get the probability of each nest surviving the incubation, nestling, and fledgling periods within the nesting cycle.

Banding and Resighting

Trapping attempts are made at all active burrowing owl nests on public and private land (with landowner consent). Using spring traps and two-way traps, we capture and band adult and juvenile burrowing owls. Trapped birds are banded with uniquely numbered ACRAFT© color bands and USFWS aluminum bands. Using mark-recapture methods, we can identify and track the fates of individuals within the population. This method has several advantages: 1) If we know the sex and the age of each owl banded, we can attempt to resight, or re-encounter, that individual in later seasons or years to estimate survival of that individual; 2) Over time, the percentage of marked individuals that are re-encountered can be used to estimate population size; and 3) Banding juvenile owls allows us to determine if young birds eventually breed within the population.

Nest-Site Selection Study

As a range-wide decline in burrowing owls becomes more apparent, management agencies in the prairie ecosystem are becoming increasingly concerned with how changes in land-use practices may affect burrowing owl habitat. Thus, a unified definition of burrowing owl habitat for the region is needed, as is a predictive tool with which managers can identify, conserve, and enhance burrowing owl habitat. The goals of our burrowing owl nest-site selection study are 1) to identify vegetation, landscape and prairie dog colony attributes that are important predictors of nesting burrowing owl occupancy, and 2) to develop a model that managers can use to assess the ability of their lands to provide habitat for nesting burrowing owls in the Great Plains.

While habitat studies have been done for nearby burrowing owl populations in short/mixed-grass prairie regions in South Dakota, Colorado, Montana and Nebraska, habitat studies for burrowing owls in Wyoming do not exist. In the nest-site selection studies conducted on prairie dog colonies in other states, few variables emerge with significant signals of selection by burrowing owls. Those variables include prairie dog activity within the colony; distance to nearest perch; distance to nearest road; aerial extent of bare ground; and vegetation height near the nest burrow (Desmond et al. 1995, MacCracken et al. 1985, Plumpton and Lutz 1993, Restani et al. 2001). It is important to quantify resource selection for burrowing owls at several points within their range, as selection cues may differ regionally, thus the impetus for a habitat study within Thunder Basin.

Within Thunder Basin, we measure habitat characteristics at all burrowing owl nests. We have selected seven variables for measurement at each nest burrow: percent bare ground within 30m, percent shrub cover within 30m, number of burrows within 30m, distance to the nearest perch, distance to the nearest permanent water source, distance to the nearest drainage (hunting flyways for burrowing owls), and the index of prairie dog activity within 200m. In addition to measurement at all burrowing owl nests, we measure the same seven habitat variables at a sample of randomly selected, unused burrows. Comparisons drawn between the habitat attributes at used sites versus unused sites permits inference about patterns of burrowing owl nest-site selection, relative to what is available on the landscape. We are using logistic regression to develop a model(s) of burrowing owl nest-site selection, and we will make this model available to land managers upon completion.

EFFECT OF SYLVATIC PLAGUE

Spatial distribution of nesting burrowing owls is influenced by the distribution of fossorial mammals (Haug et al. 1993, Desmond and Savidge 1996). In areas of range overlap, burrowing owls primarily nest in black-tailed prairie dog colonies (Conway and Hughes 2001, Desmond et al. 1995, Desmond and Savidge 1996, Desmond et al. 2000, Restani et al. 2001, Sidle et al. 2001). In the last century, the distribution of black-tailed prairie dogs in the U.S. has greatly contracted. In fact, sources cite contractions as great as 98 percent since the early 1900s (Miller 1994). Losses of prairie dogs are due to eradication programs and the sylvatic plaque (*Yersinia pestis*).

Thunder Basin National Grasslands have been experiencing a rapid decline in black-tailed prairie dog colony area since 2001. Eradication programs were halted on federal land within Thunder Basin in 1999. Recreational shooting is allowed in 85 percent of the grasslands, but has not been an effective form of prairie dog control (Byer 2001). Plague is the only source of mortality known to cause significant (>95 percent) die-offs in black-tailed prairie dogs (Barnes 1993, Cully and Williams 2001). Thus, a recent sylvatic plague epizootic is implicated in an 89 percent decline in colony area in the Thunder Basin National Grasslands since 2001 (Cully and Johnson 2002). Plague has altered natural patterns of colony extinction and recolonization, and has changed the population dynamics of black-tailed prairie dogs (Antolin et al. 2002). There are few data describing the ecology of the sylvatic plague. Its pattern of movement across the landscape and mode of transmission are not well understood (Antolin et al. 2002, Cully and Williams 2001). However, the influence of plague may cascade to other taxa associated with black-tailed prairie dogs, e.g. the burrowing owl. If burrowing owls select black-tailed prairie dog colonies for nesting, changes in the distribution of those colonies as a result of a plague epizootic may affect the distribution of nesting burrowing owls across the landscape.

A 14-year burrowing owl demography study on the Rocky Mountain Arsenal National Wildlife Refuge studied the number of nesting burrowing owls as it related to prairie dog population size and colony area (Lutz and Plumpton, as cited in Antolin et al. 2002). The Rocky Mountain Arsenal was affected by multiple plague epizootics during the 14 years of the study. Numbers of nesting burrowing owls tracked fluctuations in black-tailed prairie dog population size. The association of plague epizootics and burrowing owl nesting density and distribution has not been examined elsewhere, and may be a driving force in patterns observed in the Thunder Basin Grasslands. As such, current plague research in the Thunder Basin National Grasslands stands to benefit current burrowing owl research.

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MANAGEMENT IMPLICATIONS

Reliable population trend information and accurate estimates of demographic rates require long-term data sets for most wildlife species. The Wyoming burrowing owl demography study is in its fourth year, and estimation of survival and productivity rates are currently underway. Upon completion, these estimates will be compared with other populations of burrowing owls throughout the West. All methods for estimating demographic parameters are standardized; survey and monitoring protocols are repeatable across time and across populations. Development of these standardized methods involved collaboration with researchers in many states, provinces, agencies, and universities throughout North America. As a result, researchers in Canada, Mexico, and the United States are using similar methods to estimate burrowing owl survival, reproductive success, and other demographic parameters. We are fortunate to have this level of collaboration, as it has paved the way for meaningful comparisons among populations. As these populations differ in degrees of migratory behavior (from fully migratory to fully resident), and as they differ in habitat type and quality, comparisons of demographic trends between populations will help to identify critical management areas within the species' range. In addition, our nest-site selection research will be very useful in burrowing owl management, as it helps to provide a more complete understanding of the ecology of the species throughout its range. We will develop a habitat model for managers to use, and such a model will give managers the opportunity to measure a minimal number of habitat characteristics in the field, and use these measurements to predict the probability of their sites being used by a nesting burrowing owl. Thus managers can identify the vegetation, landscape and colony attributes that are important to nesting burrowing owls. Collaborative data collection among researchers, as well as the continued cooperation and support from local managers, landowners, and user groups will allow for proactive, effective management of burrowing owls in the west.

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APPENDIX A [for Ecology of Burrowing Owls Presentation]:
Standardized roadside point-count survey protocol for burrowing owls in North America (Conway and Simon 2003).

Roadside point-count survey routes should be selected within some structured sampling frame to ensure that observers do not preferentially place survey routes in areas with high breeding densities. For example, we recommend establishing one point-count survey route within each township/range that falls within the known breeding range of burrowing owls in each state. Each survey route will follow a secondary road, beginning within the center four sections of each township/range (sections 15, 16, 21, and 22). Location of each route will be selected in advance of the survey based on perceived suitable habitat for burrowing owls. The location of these point-count survey routes should in no way be influenced by previous knowledge of burrowing owl observations, historic records, or known nest sites. If no suitable habitat is available within the center four sections, a route can be located in the surrounding 12 sections. We also recommend supplemental survey routes (in addition to the systematic survey routes outlined above) based on areas of known burrowing owl breeding locations. These routes should be treated separately from the systematic survey routes because they will be located in areas of known burrowing owl activity (current or historical). If surveys occur only within prairie dog colonies, attempts should be made to survey all prairie dog colonies within a study area. Surveys should begin at the edge of the colony where burrows are first observed, and each survey route should follow all secondary roads within the prairie dog colony, with point-counts at 0.8-km intervals.

We recommend that each survey route be >7.2 km (4.5 mi) in length and include 10 survey points separated by >0.8 km (0.5 mi). This interval will help ensure that observers do not re-count individual owls at adjacent points but still provide adequate detection probability. The exact location of each survey point should be chosen to provide an optimal viewing radius of the surrounding area. Adjacent survey points may be located >0.8 km (0.5 mi) apart if no suitable habitat is available or visibility of surrounding habitat is not optimal at the 0.8 km interval. The permanent location of each survey point should be marked or recorded using a GPS receiver so that the exact survey location can be re-surveyed in future years.

Because detection probability associated with a single point-count survey is only 64 percent, we recommend three replicate surveys of each route so that overall detection probability will be 95 percent. Surveys should be conducted after birds have returned from migration but prior to the date when young disperse (e.g., 15 Apr–7 Aug in Wyoming; 1 Apr–21 Jul in Washington). One replicate survey should be conducted during each of three 30-day survey windows with each survey window separated by 10 days (e.g., 20 Apr–19 May; 30 May–28 Jun; 9 Jul–7 Aug in Wyoming). This approach will ensure survey effort during each of three nesting stages (pre-incubation, incubation/hatching, and nestling) that differ in vocal and visual detection probability. Standardized burrowing owl surveys should include an initial three-minute passive segment followed by a three-minute, call-broadcast segment. For the three-minute call-broadcast segment, we recommend a series of 30 second call-broadcasts (coo-coo call and alarm call-broadcast at 90 dB measured 1 m in front of the speaker) interspersed with 30 seconds of silence.

Surveys should be restricted to the early morning (e.g., 0.5 hr before sunrise until 0900 hr) and evening hours (e.g., 1700 hr until 0.5 hr after sunset) because vocalization probability and above ground activity is often higher during these times compared to mid-day (Grant 1965, Climpson 1977, Johnsgard 1988). However, more studies are needed to evaluate daily variation in detection probability during all stages of the nesting cycle. Surveys should not be conducted during rain or when wind speed is >20 km/hr. At each point, observers should record 1) the number of adult owls; 2) the number of juvenile owls; and 3) the number of presumed nest sites. Implementing this survey protocol over a large geographic area is feasible. For example, we estimate approximately five seasonal surveyors could conduct all of the surveys needed for the state of Washington (approx. 450 routes) following this recommended survey protocol.