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Population Trajectory of Burrowing Owls (*Athene cunicularia*) in Eastern Washington

Abstract

Anecdotal evidence suggests that burrowing owls have declined in Washington. The Washington Department of Fish and Wildlife is currently conducting a status review for burrowing owls which will help determine whether they should be listed as threatened or endangered in the state. To provide insights into the current status of burrowing owls (*Athene cunicularia*) , we analyzed data from the North American Breeding Bird Survey using two analytical approaches to determine their current population trajectory in eastern Washington. We used a one-sample *t*-test to examine whether trend estimates across all BBS routes in Washington differed from zero. We also used a mixed model analysis to estimate the rate of decline in number of burrowing owls detected between 1968 and 2005. The slope in number of burrowing owls detected was negative for 12 of the 16 BBS routes in Washington that have detected burrowing owls. Numbers of breeding burrowing owls detected in eastern Washington declined at a rate of 1.5% annually. We suggest that all BBS routes that have detected burrowing owls in past years in eastern Washington be surveyed annually and additional surveys conducted to track population trends of burrowing owls at finer spatial scales in eastern Washington. In the meantime, land management and regulatory agencies should ensure that publicly managed areas with breeding burrowing owls are not degraded and should implement education and outreach programs to promote protection of privately owned areas with breeding owls.

Introduction

Burrowing owl (*Athene cunicularia*; Molina 1782) populations are thought to be declining in several portions of their breeding range in North America (Dechant et al. 1999, Wellicome and Holroyd 2001). Burrowing owls are listed as a "Species of National Conservation Concern" on the federal level and in every U.S. Fish and Wildlife Service Region in which they occur (U.S. Fish and Wildlife Service 2002). They are listed as endangered, threatened, or a species of concern in nine U.S. states (Klute et al. 2003). Washington Department of Fish and Wildlife is currently evaluating the status of burrowing owls, and this status review will be used by the Fish and Wildlife Commission to determine whether owls should be listed as threatened or endangered in Washington.

Anecdotal evidence suggests that burrowing owls have declined in eastern Washington (Smith et al. 1997, Klute et al. 2003, Conway et al. 2005) and recent analysis (Sauer et al. 2005) of data from the U.S. Geological Survey's (2006) North American Breeding Bird Survey (BBS) suggest that burrowing owl populations declined by 3.1% per year in Washington between 1968 and 2005, but this trend estimate was not significant ($P = 0.78$, $n = 8$). Sauer et al. (2005) rank the credibility of trend estimates for each bird species within each state, and the credibility of the trend estimate for burrowing owls in Washington was considered low. Previous authors have also suggested that burrowing owls are not sampled adequately by the BBS because owls typically have low breeding densities and are patchily distributed (Andelman and Stock 1994, Holroyd and Wellicome 1997). The ability to detect a significant trend for burrowing owls in Washington is compromised because the number of burrowing owls per route was very low (<0.1 birds per route) and the number of routes on which owls were detected was also low ($n = 16$).

Sauer et al. (2005) controlled for variation in surveyor detection probability by estimating

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trends separately for each surveyor on each survey route and including surveyor as a covariate in subsequent analyses. This approach improves accuracy of trend estimates when estimating trends for species whose detection probability varies greatly among surveyors (Sauer et al. 1994), but limits the data available for analysis when species are rarely detected and surveyors change frequently. For example, the trend estimates for burrowing owls in Washington included in Sauer et al. (2005) include data from only eight of the 16 survey routes along which owls have been detected (U.S. Geological Survey 2006). Data from 5 routes were not included because owls were only detected during one year, data from 1 route was not included because owls were detected during 3 years by 3 different surveyors, and data from 2 routes were not included because the routes were not randomly located. We believe that variation in the probability of different surveyors to detect burrowing owls is less of a concern than for other species because burrowing owls: 1) are typically detected visually, not aurally, during daytime point-count surveys such as the BBS, 2) prefer open areas where visibility is usually excellent, 3) are hard to mistake for other species, and 4) are usually detected near their nest burrow and typically make their presence known (rather than fly away) when humans come near their nest site. For example, 100% of the 53 burrowing owl detections during roadside point-count surveys throughout eastern Wyoming were visual (not aural) detections and 78% of those were owls perched (and hence easy to see) either on a fence or on the ground near a burrow (Conway and Simon 2003). Hence, we wanted to estimate population trend for burrowing owls without controlling for surveyor variation to help provide further insights into the current population trajectory of burrowing owls in eastern Washington.

Methods

We used data from the BBS to examine population trends for burrowing owls in Washington. The BBS is a continent-wide avian monitoring program initiated in 1966 in which qualified surveyors record the number of individual birds detected each year for all species at pre-selected points along survey routes throughout North America (Robbins et al. 1986). Survey routes follow secondary roads and their locations are randomly chosen within grid blocks in each state. Each survey route consists of 50 survey points placed at 0.5-mile intervals along a survey route.

We analyzed data from the BBS collected between 1968 and 2005 using two approaches. First, we used a one-sample *t*-test to examine whether trend estimates across all BBS routes in Washington differed from zero. We log transformed the trend estimates prior to conducting the *t*-test because the distribution of raw trend estimates was skewed. However, the slope from each survey route receives equal weight using this approach despite variation among the 16 routes in the quality of the data available. Hence, we also used linear mixed-model analyses (weighting the residuals by the number of years each survey route was surveyed) to estimate the population trend of burrowing owls in Washington. For the mixed-model analysis, we included the number of owls detected as the dependent variable, route as the subject and as a random effect, the year surveyed as a fixed effect (a covariate), and a first-order autoregressive covariance structure. We only used data from surveys that met the BBS quality standard (Sauer et al. 2005). Two of the 16 BBS routes were not randomly located, so we conducted analyses with and without those data. We set the level of significance for all tests at $P = 0.05$.

Results

Burrowing owls were detected during ≥1 year on 16 BBS routes (Figure 1) in Washington (U.S. Geological Survey 2006). The average slope among these 16 routes differed from zero ($t_{15} = -2.2$, $P = 0.043$). Three routes (037, Quincy; 026, Bickleton; and 900, Hanford Site) had significant ($P < 0.05$) trends and all three were declines (Figure 2). Based on our mixed-model analysis, numbers of burrowing owls have declined 1.5% annually in Washington ($t_{249} = -2.1$, $P = 0.036$). The results were the same whether or not we included data from the two non-random BBS routes. The five BBS routes that either have a significant trend or where burrowing owls have been detected in ≥5 yrs show the nature and extent of these declines (Figure 2).

Discussion

Interpreting whether or not burrowing owl populations in Washington have significantly declined based on BBS data depends upon the analytical

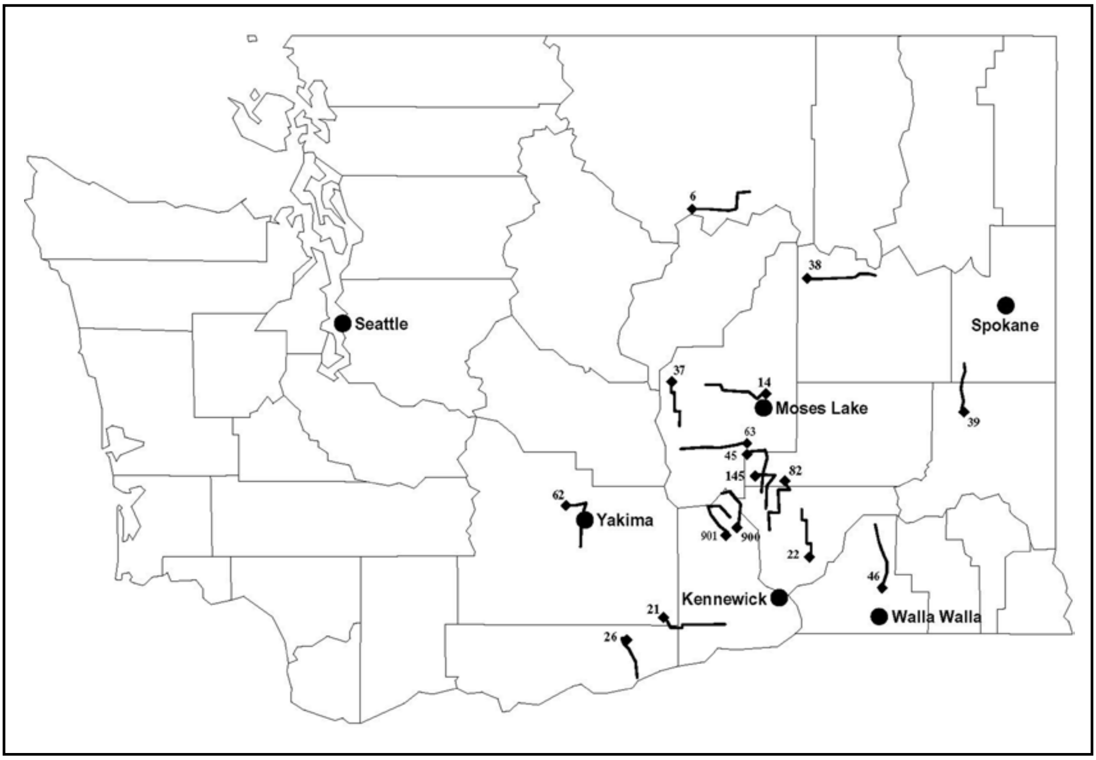

Figure 1. Location of the 16 North American Breeding Bird Survey routes in eastern Washington along which burrowing owls have been detected during $\geq$1 yr (006 = Brewster; 014 = Moses Lake; 021 = Mercer; 022 = Connell; 026 = Bickleton; 037 = Quincy; 038 = Wilbur; 039 = Ewan; 045 = Othello; 062 = Harwood; 063 = Potholes; 075 = Moses Coulee; 082 = Mesa; 145 = Columbia NWR; 900 = Hanford Site; and 901 = Arid Lands ER). Route 045 (Othello) was discontinued and replaced by route 145 in 1992. Route 62 (Harwood) was discontinued in 1997 due to stricter restrictions on access imposed by the Yakima Indian Nation.

method used. Our estimate of a 1.5% annual rate of decline was lower than the estimated decline (3.1% annual decline) in Sauer et al. (2005). Controlling for observer variation resulted in a more negative trend estimate, but that trend estimate was not statistically significant. Failure to include observer as a covariate usually results in positive bias in trend estimates (Sauer et al. 1994). A 1.5% annual decline over a 40-yr period equates to a 45% overall decline, and a 3.1% annual decline equates to a 72% overall decline. The trend estimates reported here for burrowing owls in Washington should be interpreted cautiously because these trend estimates are based on a small number of survey routes on which relative abundance is low. However, this is a problem for estimating trends for any species that is rare, and yet these are the species for which reliable trend estimates are most desirable to land managers. Population declines in Washington are also evident because burrowing owls have been extirpated from much of their former range in Washington; their historical breeding range in Washington has been reduced by 56% (Wellicome and Holroyd 2001, Conway et al. 2005). Burrowing owls have declined in other states and provinces near the northern extent of their breeding range (Grant 1965, Desmond et al. 2000, Murphy et al. 2001, Hjertaas 1997), but numbers have increased in Idaho (Sauer et al. 2005).

Interpreting estimates of population trend derived from data from the BBS requires some caveats. BBS routes are all roadside surveys so the trends produced represent population trends of burrowing owls near roads. We believe this is less likely to bias trend estimates of burrowing owls compared to other species because burrowing owls seem to preferentially nest near roads in eastern Washington and in other portions of their range (especially areas outside of black-tailed

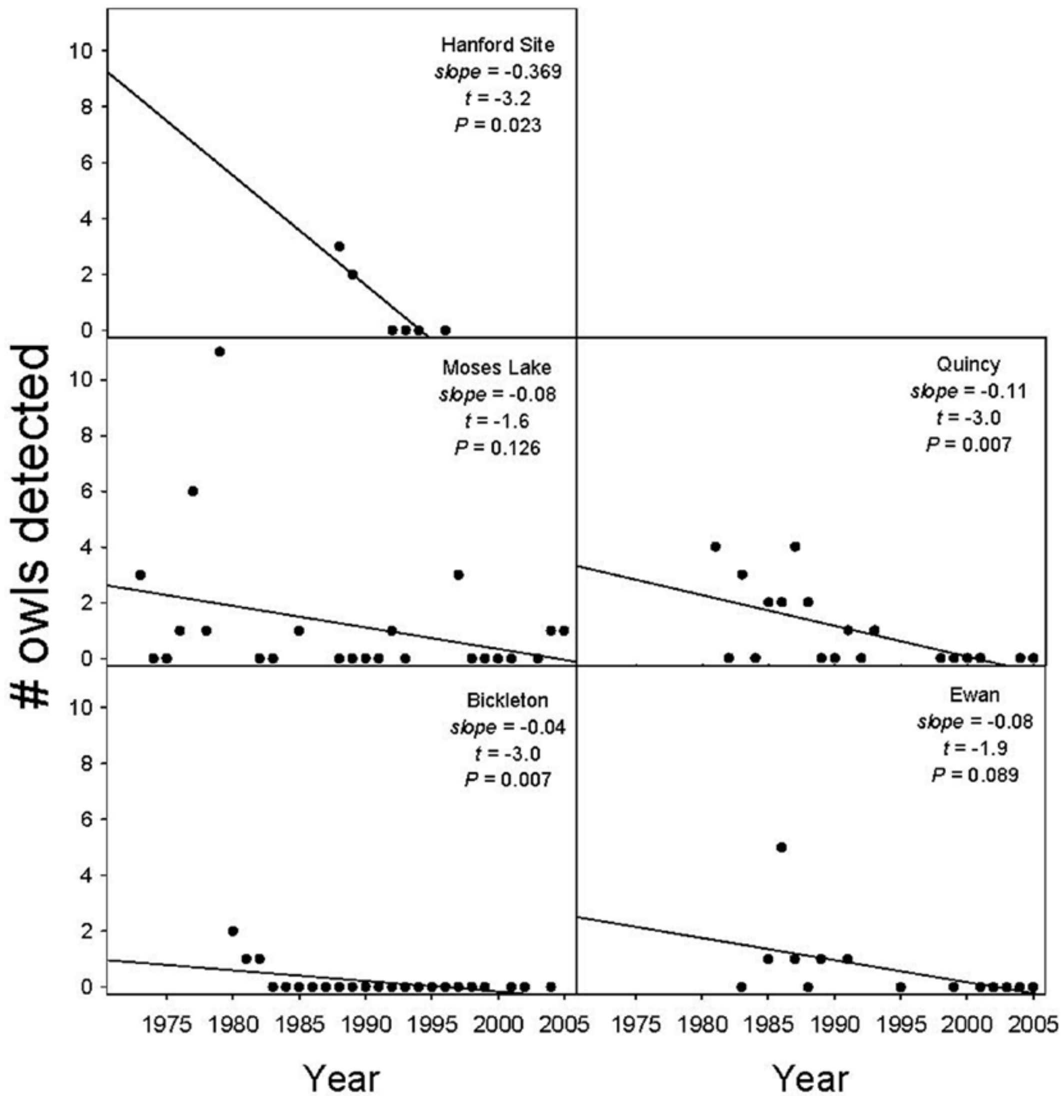

Figure 2. Number of burrowing owls detected per yr on the five North American Breeding Bird Survey routes in Washington that had a significant population trend or where owls were detected during ≥5 yrs (from U.S. Geological Survey 2006). Solid lines represent the slopes of simple linear regression, with number of owls detected as the response variable and year as the explanatory variable.

prairie dog colonies) (Haug et al. 1993). For example, Conway et al. (2002) conducted extensive walking surveys along 120 1-mile survey transects for burrowing owls in roadless areas in eastern Washington and did not detect any burrowing owls. Moreover, a small number of samples and few birds per route (both problems present in the data set used here) typically lead to a positive bias (i.e., over estimation) in trend estimates (Sauer et al. 2005). Hence, the negative trend estimates for Washington despite these data insufficiencies are cause for concern.

Another potential bias with estimating trends from BBS data (or any count data) is the first-time effect, whereby an observer's ability to count birds increases after their first year on a given survey route (Kendall et al. 1996). However, this bias (if real) causes trend estimates to be positively biased (Kendall et al. 1996). Hence, the rate of decline may be even more extreme if this bias exists in the data presented here. One final concern with using BBS data to estimate population trend is changes in surveyors over time. But as we discussed above, we believe that changes in surveyors over time can not explain the observed declines (Figure 2). Finally, the trend estimate for Washington may be unduly influenced by several years when large numbers of owls were observed on a couple routes 014, Moses Lake and 039, Ewan; Figure 2). Additional years of survey data and surveys in additional areas would improve available estimates of population trend for burrowing owls in Washington and help regulatory agencies make decisions on levels of legal protection that are warranted in the state. Past (Conway et al. 2005) and ongoing (i.e., BBS routes in eastern Washington) survey efforts should be repeated regularly so that trend estimates for burrowing owls are accurate and current. Five BBS routes in Washington where burrowing owls have been detected in past years have either not recently been surveyed (163, Potholes) or have been discontinued (045, Othello; 162, Harwood; 900, Hanford Site; and 901, Arid Lands ER). The BBS program discontinued the Hanford Site and the Arid Lands ER routes due to the lack of public access to these areas. However, periodic surveys of these discontinued routes in future years would help improve our estimates of burrowing owl population trend in Washington. Implementing a statewide burrowing owl survey (Conway and Simon 2003) or repeating the standardized roadside survey routes conducted by Conway et al. (2005) periodically (i.e., every 1-3 yrs) will help complement the data available from the BBS surveys and allow greater statistical power (and hence greater confidence) in estimating burrowing owl population trends in eastern Washington.

The reasons why burrowing owls appear to be declining in Washington are not currently known. Burrowing owl declines in Washington are not related to prairie dog declines as they are elsewhere in North America (Desmond et al. 2000) because Washington is not within the historical range of prairie dogs. Burrowing owl declines in Washington are probably due to loss of native grassland and shrub-steppe and eradication of ground squirrels (*Spermophilus* spp.), yellow-bellied marmots (*Marmota flaviventris*), and American badgers (*Taxidea taxus*). Burrowing owls depend on these species for excavation of nesting burrows (Haug et al. 1993, Klute et al. 2003). Since the early 1900s, the amount of shrub-steppe in the interior Columbia River Basin has been reduced by 30% (Hann et al. 1997). Moreover, marmots are considered pests in eastern Washington and eradication by humans poses a threat because groups are isolated and individuals mature slowly so losses are not quickly replaced (Yensen and Sherman 2003). Further research is needed to help understand why burrowing owls appear to be decreasing in Washington but increasing in Idaho. Increased legal protection for fossorial mammals in Washington will likely help prevent further declines in numbers of burrowing owls. Efforts to protect existing nest burrows from destruction will also help maintain populations of burrowing owls in eastern Washington (Conway et al. 2006). Most burrowing owls in Washington nest on private land, so education and outreach progams are needed to promote protection of privately owned areas with breeding owls.

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