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Population Ecology

Survival of Mountain Quail Translocated From Two Distinct Source Populations

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ABSTRACT Translocation of mountain quail (*Oreortyx pictus*) to restore viable populations to their former range has become a common practice. Because differences in post-release vital rates between animals from multiple source populations has not been well studied, wildlife and land managers may arbitrarily choose the source population or base the source population on immediate availability when planning translocation projects. Similarly, an understanding of the optimal proportion of individuals from different age and sex classes for translocation would benefit translocation planning. During 2006 and 2007, we captured and translocated 125 mountain quail from 2 ecologically distinct areas: 38 from southern California and 87 from southwestern Oregon. We released mountain quail in the Bennett Hills of south-central Idaho. We radio-marked and monitored a subsample of 58 quail and used them for a 2-part survival analysis. Cumulative survival probability was 0.23 ± 0.05 (SE) at 150 days post-release. We first examined an a priori hypothesis (model) that survival varied between the 2 distinct source populations. We found that source population did not explain variation in survival. This result suggests that wildlife managers have flexibility in selecting source populations for mountain quail translocation efforts. In a post hoc examination, we pooled the quail across source populations and evaluated differences in survival probabilities between sex and age classes. The most parsimonious model indicated that adult male survival was substantially less than survival rates of other mountain quail age and sex classes (i.e., interaction between sex and age). This result suggests that translocation success could benefit by translocating yearling males rather than adult males, perhaps because adult male breeding behavior results in vulnerability to predators. Published 2013. This article is a U.S. Government work and is in the public domain in the USA.

KEY WORDS Idaho, mountain quail, *Oreortyx pictus*, radiotelemetry, reintroduction, source population, survival, translocation.

The process of translocation has become common in avian management, particularly for gallinaceous birds (Wolf et al. 1996, Lamont 2009), but information on the process of translocation success (defined as establishment of a viable population by moving animals from one location to another) is limited. Decisions during the planning stage of translocation efforts may influence subsequent success in restoring a population. For example, wildlife managers often capture birds from multiple source populations and release those birds at the same restoration site, something that may explain differences in post-release performance among individuals (Pope and Crawford 2004, Frair et al. 2007).

The current range of mountain quail (*Oreortyx pictus*) populations are restricted to western North America from Baja Mexico to southern British Columbia and east into Nevada and Idaho. Mountain quail populations are in decline across the eastern portion of their range (Howard 2003). In Idaho, mountain quail were once distributed across most of the western portion of the state, but are now classified as a "species of greatest conservation need," and at risk of possible extirpation from the state (Brennan 1990).

During the last 33 years, wildlife management agencies throughout California, Oregon, Nevada, Idaho, and Washington have been using translocation as a means of restoring mountain quail populations in the western Great Basin. In aggregate, these restoration efforts have resulted in the translocation of >3,000 mountain quail originating from source populations in 2 ecologically distinct regions (Vogel and Reese 2002; D. Budeau, Oregon Department of Fish and Game, personal communication). The 2 regions are 1) the Coso and Argus Mountain Ranges within the Mojave Desert of southern California and 2) the Pacific Coastal Ranges of southern Oregon.

Research that compares survival and other vital rates between individuals originating from distinct source populations is limited. Furthermore, choices in the number of individuals per age and sex class in translocation programs often are arbitrary or based on expediency. Studies that focus

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on these factors that influence population demographics are beneficial to restoration efforts. Our primary objective was to estimate and compare survival rates among mountain quail derived from 2 distinct source populations and released into the Bennett Hills of south-central Idaho under experimentally controlled conditions. We carefully monitored post-release survival of a radio-marked subsample of quail from each source. In a post hoc analysis, we evaluated sources of variation in post-release survival based on age and sex classes.

STUDY AREA

Release Site

We conducted field research in the Bennett Hills, Elmore County, Idaho (UTM 633589, 4788659, Zone 11, North American Datum 1983). The Bennett Hills encompass approximately 2,330 km^2 with elevation ranging from 900 to 2,300 m. Vegetation at elevations above 1,600 m included intermittent patches of quaking aspen (*Populus tremuloides*) and conifer forests intermixed with deciduous shrubs 0.5–4.0 m in height. Conifer forests were dominated by Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*). Shrub-steppe, comprised largely of sagebrush (*Artemisia* spp.) with an understory consisting primarily of non-native grasses (*Bromus* spp.), was characteristic of lower elevations. Vegetation communities across aspect and elevation in the Bennett Hills were diverse. Other prevalent shrub species included currant (*Ribes* spp.), chokecherry (*Prunus* spp.), serviceberry (*Amelanchier* spp.), and buckbrush (*Ceanothus* spp.). Steep canyons with riparian corridors consisted of a variety of deciduous trees and shrubs. During this study, mean annual precipitation in the area was 37 cm with maximum and minimum mean annual temperatures of approximately 19.7° C and −3.2° C, respectively (Western Regional Climate Center, Reno, NV, http://www.wrcc.dri.edu).

Lands at lower elevations were mostly private owned throughout the study area, whereas middle and upper elevations primarily consisted of public, managed lands by the United States Department of Interior, Bureau of Land Management (BLM) and the United States Department of Agriculture, Forest Service. Livestock grazed most of the release area annually.

Source Population 1

Trapping of mountain quail in the Cascade and Coast Ranges (CCR) of southwestern Oregon (UTM 490529, 4788584, Zone 10T, North American Datum 1983) occurred within the ranges of 2 historically described subspecies, *O. p. pictus* (Douglas 1829) and *O. p. palmeri* (Oberholser 1923). These subspecies' taxonomic assignments are dubious (Gutiérrez and Delehanty 1999) and genetic analysis of *pictus* versus *palmeri* does not indicate genetic distinctiveness (D. Delehanty, Idaho State University, unpublished data). Mountain quail were abundant and relatively evenly distributed throughout this region (Pope and Crawford 2004).

The CCR source area consisted of dense conifer forests with an understory comprised of diverse flora. Overstory was dominated by Douglas-fir, western hemlock (*Tsuga heterophylla*), Oregon white oak (*Quercus garryana*), and Pacific madrone (*Arbutus menziesii*). Timber removal in the CCR was extensive and resulted in a mosaic of early to late succession forest habitats (Pope and Crawford 2004). Elevation ranged from 600 m to 1,800 m, with most winter trapping below 900 m. The CCR experienced hot, dry summers and cool, moist conditions in fall, winter, and spring. Relative to the Bennett Hills of southern Idaho, climate conditions in the Oregon source area were moderate, as well as more mesic, with mean precipitation of 142 cm and maximum and minimum mean annual temperatures of approximately 19.1° C and 5.4° C, respectively (Western Regional Climate Center, Reno, NV, http://www.wrcc.dri.edu).

Source Population 2

The Mojave Desert, California, the other source area for quail, was an area within the geographic range of 1 historically described subspecies of mountain quail, *O. p. eremophilus* (van Rossem 1937). These quail came from the Coso and Argus Mountains within the China Lake Naval Air Weapons Station in Inyo County, California (UTM 447366, 3987797, Zone 11S, North American Datum 1983). This population was distinguishable from the *pictus-palmeri* population of Oregon based on genetic analysis (D. Delehanty, unpublished data). Trapping in the Mojave source area occurred primarily at artificial wildlife watering tanks (guzzlers) located in the Coso Range.

The California source area consisted of mixed desert scrub, irregular Joshua tree (*Yucca brevifolia*) woodlands, and open singleleaf pinyon (*Pinus monophylla*) woodlands. The shrub component was comprised of a black bush (*Coleogyne ramosissima*), bladder sage (*Salazaria mexicana*) association with some local dominance by antelope bitterbrush (*Purshia tridentata*). A large portion of the area included very sparse shrub cover, primarily saltbush (*Atriplex* spp.) scrub with an invasive cheat grass (*Bromus tectorum*) understory. Elevation of water developments ranged from 1,600 m to 2,000 m with mountain quail using elevations above and below guzzlers (Delehanty et al. 2004). Average annual precipitation in the Coso-Argus Mountain area was approximately 12 cm with maximum and minimum mean annual temperatures of approximately 27° C and 8° C, respectively (Western Regional Climate Center, Reno, NV, http://www.wrcc.dri.edu).

METHODS

Field Methods

We trapped 125 mountain quail (males = 63, females = 62) from the 2 source populations (Mojave = 38, CCR = 87; Table 1) and released them into the Bennett Hills, Idaho. We trapped quail using modified treadle traps baited with grain or located at watering sites during late summer and winter months of 2005–2007. We determined age based on plumage characteristics (Delehanty and Turek 2003). We classified quail as <1 year or >1 year old. Additionally, we collected blood samples for disease testing and sex identification (Avian Biotech International, Tallahassee, FL).

Table 1. Number of released and radio-monitored mountain quail translocated to the Bennett Hills in south-central Idaho during 2006–2007.

	California		Oregon	
	Released	Monitored	Released	Monitored
Female				
Adult	3	0	23	10
Yearling	9	6	27	9
Male				
Adult	6	4	13	3
Yearling	20	15	24	11
Total	38	25	87	33

Mountain quail from both populations were negative for disease upon release.

We held mountain quail at Idaho State University (ISU), Pocatello, Idaho in a certified aviary (Association for Assessment and Accreditation of Laboratory Animal Care, Frederick, MD). The average amount of time spent in the aviary was 146 days (range: 103–217 days). To allow social interaction among mountain quail from both source populations, we held quail communally in a pen (53 m^2) with an elastic mesh roof. The pen consisted of 3 wire mesh walls and a solid 28-gauge metal panel wall.

To control for pre-release diet, we fed quail ad libitum a commercial feed formulated for game birds (Purina Mills® Game Bird Breeder Layena® Product 5438 & Game Bird Maintenance Chow® Product 5440, St. Louis, MO). Although we did not estimate body condition at time of release, we intended to achieve high body condition upon release for quail in both source populations. We included supplemental green vegetable food (broccoli and various lettuces) and hard seed (primarily white proso millet) in the feeding program to better approximate a wild diet. Six of 44 (13.6%) quail from China Lake died either in transport or during captivity, whereas 3 of 90 (3.0%) from Oregon died either in transport or during captivity.

We fitted a random sample of mountain quail, stratified by source population, age, and sex, with necklace-style radio transmitters and conducted post-release radio-monitoring to estimate survival ($n = 58$; Table 1; Holohil Systems Ltd., Ontario, Canada). We classified quail as yearlings if they were <1 year old at time of capture and adult if they were >1 year at capture. Transmitters (3.8 g) were ≤2% of their body mass (245.1 ± 2.3 SE) to reduce transmitter-caused mortality (Caccamise and Hedin 1985). We bent antennas of radio-transmitters at approximately 90° relative to the collars so the antennas rested along the back of quail to minimize interference during flight (Coates 2001). We released quail into the Bennett Hills on 14 April 2006 (released: $n = 52$; radio-marked and monitored: $n = 33$) and 13 April 2007 (released: $n = 73$; radio-marked and monitored: $n = 25$). We chose the release dates that were as early as possible in the breeding season while allowing for availability of herbaceous food and cover in the wild.

Using handheld radio receivers and Yagi antennas (Advanced Telemetry Systems, Isanti, MN), we attempted to locate radio-marked quail every 10 days after the release through the breeding season. We usually did not attempt to observe mountain quail during the first 10 days following the release to minimize disturbance and potential flushing (Musil et al. 1993). To minimize disturbance, we limited our approach to a minimum distance of approximately 15–30 m (Musil et al. 1993) from radio-marked quail and used triangulation to determine their location. Radio-transmitters were not equipped with mortality sensors. Therefore, when locating a mountain quail during a second time interval at the same location, we approached the quail to determine survival. We determined survival through visual or auditory cues. Often, flushing quail was necessary to determine survival because of dense vegetation and the difficulty in visually or acoustically locating quail. We recorded quail locations using hand-held global positioning system units. We periodically used aerial telemetry (typically once per 4–5 weeks) when we could not locate mountain quail from the ground.

Data Analyses

We used known-fate survival analysis in Program R (R Development Core Team 2009) package RMark (Laake and Rexstad 2007) that implements Program MARK (White and Burnham 1999). To establish intervals for known-fate models, we partitioned the initial 150-day monitoring period into 15, 10-day intervals. We selected a 10-day interval to reflect an amount of time in which we relocated mountain quail, with the exception of the first 10 days when we did not monitor quail. We did not include the first 10-day interval in the analysis.

We carried out a 2-part data analysis. First, we developed a model that represented an a priori hypothesis that survival probabilities differ between 2 distinct source populations. Source population was included as a group-level covariate. We also included year in the model. Because we did not find differences between years, we pooled data across years to evaluate source populations. We evaluated evidence of support using Akaike's Information Criterion (AIC) with the second-order correction ($_c$) for small sample sizes (Anderson 2008) by comparing the a priori model to a model without the covariate (null). We evaluated uncertainty among models using log-likelihood values, AIC_c differences (ΔAIC_c), and calculated model probabilities (w_i; Anderson 2008).

In an attempt to identify other sources of variation in survival probabilities, we then conducted a post hoc analysis that evaluated differences between sex and age classes. We pooled the data across the source populations because lack of support for a source population effect and then evaluated sex and age effects. Hypothesized effects were 1) survival differs between males and females, 2) survival differs between yearlings and adults, and 3) survival differs between males and females but the difference is dependent on the age of quail (i.e., interaction between age and sex). We developed separate models for each effect and evaluated model evidence using log-likelihood values, ΔAIC_c, and model probabilities. The purpose of the post hoc examination was to identify information on other group-level sources of variation that explain post-release survival, findings that would be

Table 2. Analyses of survival models based on a priori hypotheses for translocated mountain quail in south-central Idaho during 2006–2007. Number of parameters is denoted by *K*. *Log L* represents the natural logarithm of the model likelihood value. ΔAIC_c represents difference between the model of interest and most parsimonious model of the model set. Akaike weight (w_i) denotes the model probability (Anderson 2008).

Analysis[a]	Model	Description	*K*	*Log L*	ΔAIC_c	w_i
I		Null (intercept-only)	1	−126.8	0	0.64
	1	Source + year	3	−125.3	1.2	0.36
II	2	Sex × age (interaction)	4	−119.1	0	0.97
	3	Age	2	−125.2	8.0	0.02
		Null (intercept-only)	1	−126.8	9.3	0.01
	4	Sex	2	−126.1	10.0	0.01

[a] Analysis I estimated the effect of the group-level covariate source population (California vs. Oregon) and evaluated model support. Analysis II estimated the effects of group-level covariates age and sex and evaluated model support. We pooled data across sources in analysis II because we found no support for source population in analysis I.

beneficial to translocation planning efforts. We derived 10-day interval and cumulative survival probabilities from the model coefficients and calculated 95% confidence intervals for these estimates.

RESULTS

We radio-monitored 58 of 125 translocated mountain quail (Table 1). Of the radio-monitored quail, 25 were from California and 33 were from Oregon. The effective sample size, which represents the number of sampling intervals after accounting for mortalities and censoring (Cooch and White 2012), for these survival analyses was 390. We did not find support for a model that consisted of the group-level covariate of distinct source population (model 1; Table 2). A model without this covariate (null; $w_i = 0.64$, Table 2) showed stronger support from these data. This indicates that source population did not explain variation in survival probabilities. Furthermore, the 95% confidence intervals of the estimated parameter for source overlapped zero (estimate = 0.21; 95% CI = −0.47–0.89), which also indicated no difference between survival probabilities among source populations. The 10-day survival probabilities for quail translocated from California and Oregon were 91.1% (95% CI = 85.7–94.5%) and 89.2% (95% CI = 84.4–92.7%), respectively.

Because we did not detect a difference in survival probabilities between source populations and years (2006, 10-day 95% CI = 87.6–94.6%; 2007, 10-day 95% CI = 81.0–92.0), we pooled the data to explore differences between age and sex classes in a post hoc analysis. The most parsimonious model consisted of an interaction between sex and age of quail (model 2, $w_i = 0.97$; Table 2), which indicated that survival differed between ≥2 of the 4 sex and age class combinations. Adult males showed a substantially lesser 10-day survival probability (0.50, 95% CI = 0.26–0.74) than any other sex and age category (Fig. 1). We found no differences in 10-day survival probabilities between adult females

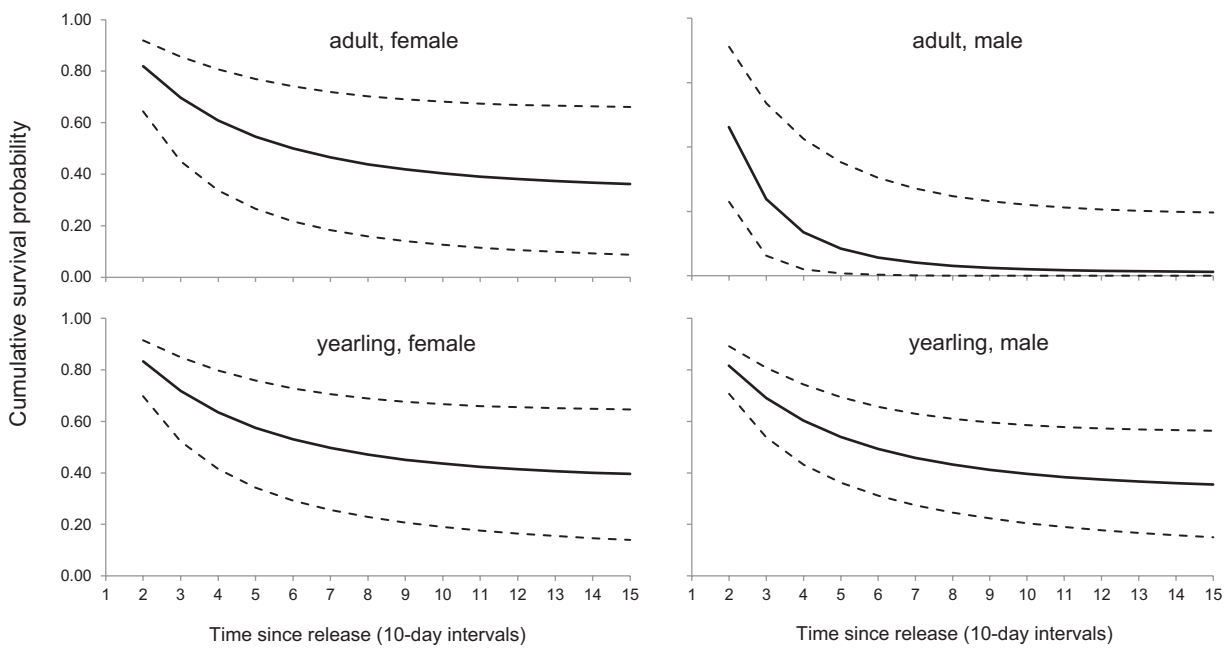

Figure 1. Cumulative survival probabilities of radio-monitored mountain quail by sex and age class translocated to Bennett Hills, south-central Idaho during 2006 and 2007 ($n = 58$). Dashed lines represents 95% confidence intervals of the cumulative survival curves. We did not monitor mountain quail during the first 10-day interval.

(0.91, 95% CI = 0.82–0.96), yearling males (0.91, 95% CI = 0.86–0.94) and yearling females (0.92, 95% CI = 0.85–0.96). In addition, adult males showed a substantially lesser cumulative (150 days) survival estimate (<0.001) than all other age and sex classes (0.27–0.31). The 95% confidence intervals of the estimated parameter for the interaction term did not overlap zero (0.65–3.82), indicating that the interaction had substantial support from these data. A model with only sex as a covariate (data pooled across ages) did not show any support from these data (model 4, $w_i = < 0.01$; Table 2), which had a greater ΔAIC_c value than an intercept-only model (null). Furthermore, a model with the age covariate (pooled across sexes) showed very little support from these data (model 3, $w_i = 0.02$; Table 2).

Thirty-seven of 58 quail died during the 150 days post-release period (Fig. 2). Mortality appeared to be primarily a result of predation based on observations of carcasses following death. However, deceased mountain quail could have been scavenged before we arrived, leaving diagnostic sign similar to that of predation. In addition, reliably identifying the predator species or type was not usually possible. Other possible sources of mortality were starvation, disease, transmitter placement, roadkill, or collision with anthropogenic features in the environment.

DISCUSSION

Source population, that is, mountain quail captured in the Mojave Desert of California from an *O. p. eremophilus* population versus mountain quail captured in the Pacific Coastal and Cascade Ranges of Oregon from the poorly defined subspecies boundary area of *O. p. pictus* and *O. p. palmeri*, was not a meaningful factor explaining post-release survival of mountain quail translocated into the Bennett Hills of south-central Idaho. Our results are consistent with a translocation study on greater sage-grouse *(Centrocercus urophasianus)*, in which source population also was not found to be among the parsimonious models describing survival (Baxter et al. 2008).

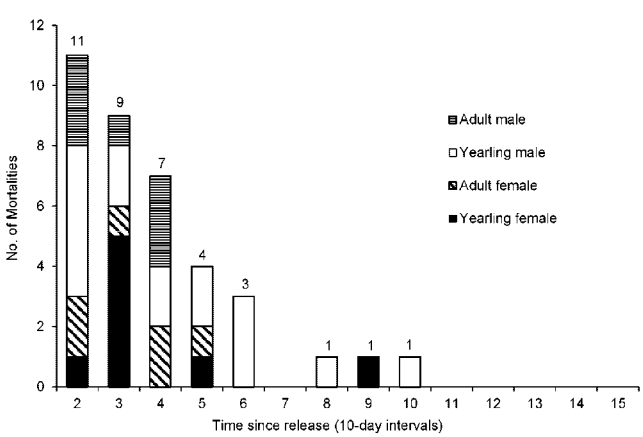

Figure 2. Number of mountain quail mortalities by sex and age during 10-day intervals following translocation to Bennett Hills of south-central Idaho. Number above bar represents total for each time interval. We did not monitor mountain quail during the first 10-day interval.

Our results indicate that factors other than source population influence mountain quail survival following translocation. Based on these results, we hypothesize that mountain quail from multiple sources similarly adjust to novel environments following translocation. For example, if source population explained variation in survival rates, then we might conclude that survival is a function of shared environmental factors between the source and release sites. We did not find evidence for this effect. However, other factors may explain variation in survival among individual quail. Our results are consistent with previous findings indicating that survival of mountain quail translocated from Cascade Mountains to an ecologically distinct area in the Columbian Basin showed similar survival rates to the local, native population of mountain quail (Pope and Crawford 2004). Survival capability in this study does not appear to be linked to small genetic differences or previous ecological exposure. It may mean that mountain quail have a behavioral repertoire sufficiently broad to adjust their behavior relative to prevailing circumstances rather than fixed in their behavioral response based on past exposures.

We did find evidence of a relationship between sex and age and post-release survival. In particular, adult males perished at a high rate relative to other age and sex classes. One hypothesis for lesser survival rates in adult males is that they may be especially vulnerable to predation. During the breeding season, predation is the most significant factor limiting survival of translocated animals (Seddon et al. 2007). Male mountain quail signal their location during the breeding season through loud, conspicuous crowing (Gutiérrez and Delehanty 1999), a behavior that might also signal predators and increase predation (Nelson 2007). Older males are more active than younger males during the breeding season in other species (Miller and Brooks 2005) and, perhaps, breeding displays in older male mountain quail are more frequent or conspicuous than displays of younger males. We released mountain quail at the onset of the breeding season and all radio-marked adult males died in <35 days post-release. Although we did not quantify post-release behavior, we did observe male mountain quail crowing in open areas more often than juvenile quail. A translocation study conducted in southeastern Oregon (Nelson 2007) concluded that survival estimates for male mountain quail were less than females, particularly during the breeding period. Consistent with our study, crowing behavior in males may have increased predation rates in those males (Nelson 2007). Conversely, a recent study from western Idaho and Washington of translocated and native mountain quail concluded no differences between sexes (Stephenson et al. 2011). However, this study did not consider relationships between age and sex. Additional research is necessary to address the role of age in post-release survival.

We recognize that the interaction between age and sex on post-release survival estimates should be interpreted cautiously because our limited number of sampled male quail. Nevertheless, these are the first findings to express this relationship and may guide further studies that seek to

explain the inconsistent findings currently prevailing in the literature. Research, for example, that quantifies crowing or other post-release breeding behaviors by males in relation to survival probability would be an important next step. We judged the release site fit for translocated mountain quail based on a habitat suitability index, but the amount of escape cover or other habitat features were probably insufficient to support the survival of conspicuous adult males advertising their presence with breeding calls. Studies that examine post-release breeding behavior as a cause for mortality should consider the role of escape cover and other habitat features.

In this study, both sexes and age classes experienced high mortality rates relatively soon after translocation, within a 60-day period. Lesser survival rates immediately following release are common in mountain quail (Nelson 2007, Stephenson et al. 2011). These lesser survival rates typically are attributable to release of a species into a novel environment where presumably individuals are particularly vulnerable as they search for adequate cover, food, water, and conspecifics.

MANAGEMENT IMPLICATIONS

With respect to survival, our results indicate that managers have flexibility in restoration alternatives when choosing among source populations for mountain quail translocations. This study provides evidence that managers are not limited to populations from ecologically matched source sites relative to release sites. However, managers may benefit by considering other sources of variation in source populations, particularly quail age. Yearling mountain quail appear to be good candidates for release insofar as yearling females survive at a rate similar to females >1 year in age, and yearling males survive at a rate greater than males >1 year in age. High mortality during the 60 days following release remains a challenge in mountain quail translocations. With our current understanding, this challenge may be best addressed by developing and testing methods that minimize physiological stress during the translocation process and releasing mountain quail into areas with adequate escape cover.

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LITERATURE CITED

Anderson, D. R. 2008. Model based inference in the life sciences: a primer on evidence. Springer, New York, New York, USA.

Baxter, R. J., J. T. Flinders, and D. L. Mitchell. 2008. Survival, movements, and reproduction of translocated greater sage-grouse in Strawberry Valley, Utah. Journal of Wildlife Management 72:179–186.

Brennan, L. A. 1990. What happened to the mountain quail in Idaho? Quail Unlimited 9:42–43.

Caccamise, D. F., and R. S. Hedin. 1985. An aerodynamic basis for selecting transmitter loads in birds. Wilson Bulletin 97:306–318.

Coates, P. S. 2001. Movement, survivorship and reproductive behavior of Columbian sharp-tailed grouse translocated to Nevada. Thesis, University of Nevada Reno, Reno, USA.

Cooch, E., and G. White. 2012. Program MARK: a gentle introduction. Eleventh edition. <http://www.phidot.org/software/mark/docs/book>. Accessed on 15 Feb 2013.

Delehanty D. J., and N. C. Turek. 2003. Using wing plumage to determine age of mountain quail. North American Bird Banding 28:116–120.

Delehanty, D. J., S. S. Eaton, and T. G. Campbell. 2004. From the field: mountain quail fidelity to guzzlers in the Mojave Desert. Wildlife Society Bulletin 32:588–593.

Douglas, D. 1829. Observations on some species of Tetrao and Ortyx, natives of North America; with descriptions of four new species of the former, and two of the latter genus. Linnean Society of London 16: 133–149.

Frair, J. L., E. H. Merrill, J. R. Allen, and M. S. Boyce. 2007. Know thy enemy: experience affects elk translocation success in risky landscapes. Journal of Wildlife Management 71:541–554.

Gutiérrez, R. J., and D. J. Delehanty. 1999. Mountain quail (*Oreortyx pictus*). Account 457 *in* A., Poole and F., Gill, editors. The birds of North America. The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.

Howard, R. 2003. Endangered and threatened wildlife and plants; 90-day finding for a petition to list the mountain quail as threatened or endangered. Federal Register 68:3000–3005.

Laake, J., and E. Rexstad. 2007. RMark—an alternative approach to building linear models. Appendix C *in* E., Cooch, and G., White, editors. Program MARK "a gentle introduction." <http://www.phidot.org/software/mark/docs/book/>. Accessed on 21 March 2010.

Lamont, M. M. 2009. Conservation introductions: a potential tool for galliform conservation management. International Journal of Galliformes Conservation 1:63–71.

Miller, L. K., and R. Brooks. 2005. The effects of genotype, age, and social environment on male ornamentation, mating behavior, and attractiveness. Evolution 59:2414–2425.

Musil, D. D., J. W. Connelly, and K. P. Reese. 1993. Movements, survival, and reproduction of greater sage-grouse translocated into central Idaho. Journal of Wildlife Management 57:85–91.

Nelson, J. N. 2007. Survival and nest site characteristics of translocated mountain quail on Steens Mountain, Oregon. Thesis, Oregon State University, Corvallis, USA.

Oberholser, H. C. 1923. Notes on the forms of the genus *Oreortyx* Baird. Auk 40:80–84.

Pope, M. D., and J. A. Crawford. 2004. Survival rates of translocated and native mountain quail in Oregon. Western North American Naturalist 64:331–337.

R Development Core Team. 2009. R: a language and environment for statistical computing. R Foundation for statistical computing, Vienna, Austria.

Seddon, P. J., D. P. Armstrong, and R. F. Maloney. 2007. Developing the science of reintroduction biology. Conservation Biology 21: 303–312.

Stephenson, J., K. P. Reese, P. Zager, P. E. Heekin, P. J. Nelle, and A. Martens. 2011. Factors influencing survival of native and translocated mountain quail in Idaho and Washington. Journal of Wildlife Management 75:1315–1323.

van Rossem, A. J. 1937. A review of the races of the mountain quail. Condor 39:20–24.

Vogel, C. A., and K. P. Reese. 2002. Mountain quail (*Oreortyx pictus*) distribution and conservation in the eastern portion of their range. Idaho Department of Fish and Game, Boise, USA.

White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46: 120–138.

Wolf, C. M., B. Griffith, C. Reed, and S. A. Temple. 1996. Avian and mammalian translocations: update and reanalysis of 1987 survey data. Conservation Biology 10:1142–1154.

Associate Editor: Leonard Brennan.