Western North American Naturalist

Volume 64 | Number 3 Article 6

8-27-2004

Survival rates of translocated and native Mountain Quail in Oregon

Michael D. Pope
Oregon State University, Corvallis

John A. Crawford
Oregon State University, Corvallis

Western North American Naturalist 64(3), © 2004, pp. 331–337

SURVIVAL RATES OF TRANSLOCATED AND NATIVE MOUNTAIN QUAIL IN OREGON

Michael D. Pope[1,2] and John A. Crawford[1]

ABSTRACT.—We estimated survival rates for 232 radio-tagged native (n = 157) and translocated (n = 75) Mountain Quail (*Oreortyx pictus*) from 1997 to 1999 in Hells Canyon National Recreation Area (HCNRA) in northeastern Oregon and in the Cascade Mountain Range (CMR) of southwestern Oregon. For the combined areas the estimated survival rate during 150-day intervals was 0.42 ± 0.04. Estimated survival was 0.41 ± 0.04 for Mountain Quail in HCNRA and 0.34 ± 0.34 for quail in CMR. There were no differences in survival functions for native quail in HCNRA and CMR (P = 0.91), for translocated and native quail in HCNRA (P = 0.93), for native quail in CMR and translocated quail in HCNRA (P = 0.97), or for birds released in the fall and birds released in the winter (P = 0.57). Male and female survival functions were significantly different (χ^2_1 = 4.61, P = 0.02). The estimated risk ratio for males was 0.66 that of females. Translocated wild Mountain Quail appeared to have survival rates similar to native quail. Mountain Quail experienced mortalities of >50% over a 150-day interval in both the conifer forests of the western Cascade Mountain Range and the semiarid habitats of northeastern Oregon. With the ability to rapidly expand their populations and exploit marginal habitats, Mountain Quail are excellent candidates for reintroduction programs, and translocated wild Mountain Quail could be used to supplement declining populations.

Key words: Mountain Quail, Oreortyx pictus, *Oregon, survival rates, translocated and native quail.*

Mountain Quail (*Oreortyx pictus*) distributions have contracted in the western Great Basin during the 20th century, particularly in western Nevada, eastern Oregon, and western Idaho (Heekin 1993, Brennan 1994, Crawford 2000). Concerns about the status of Mountain Quail in the Snake River basin provided the impetus to petition this species for listing under the Endangered Species Act. However, much of their life history is poorly documented or unknown (Gutiérrez and Delehanty 1999). Like most quail in North America, Mountain Quail are presumed to have high annual mortality (Gutiérrez and Delehanty 1999). Age ratios for Mountain Quail captured in the Mojave Desert from 1993 to 1997 suggest that populations may experience high rates of turnover (Gutiérrez and Delehanty 1999), but no studies have determined survival rates for Mountain Quail. The continued decline of Mountain Quail in eastern ranges makes accurate estimates of Mountain Quail survival critical for restoration planning and population management.

Translocations have been used as a conservation technique to reestablish or increase native populations in regions where these species have been extirpated or have undergone decline (Scott and Carpenter 1987). Yet only a few studies (Liu et al. 2002, Perez et al. 2002) have compared survival of translocated with resident populations.

During the breeding season Mountain Quail may produce multiple clutches and large broods (Pope and Crawford 2001, Pope 2002); yet high reproductive potential is likely counterbalanced by high mortality. The objectives of our research were to compare estimated survival rates of Mountain Quail in 2 ecologically different areas, the Cascade and Coast Ranges of southwestern Oregon and the Hell's Canyon area of northeastern Oregon. Mountain Quail in southwestern Oregon are generally abundant with populations distributed homogeneously in the coniferous forests of the Coast and Cascade Mountain Ranges. Mountain Quail in the semiarid regions of eastern Oregon are sparsely distributed and mostly confined to narrow, disjunct riparian zones. Males actively participate in nest incubation and brood care (Pope and Crawford 2001). Males may experience similar risks (e.g., increased exposure to predation and lower survival) by sharing extensively with females in the costs of reproduction during the breeding season (incubation and brood

[1]104 Nash Hall, Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331-7501
[2]Corresponding author.

rearing). We hypothesized that survival rates for Mountain Quail in the semiarid regions of northeastern Oregon and the coniferous forests of the Cascade Mountains would be different because of dissimilar environmental conditions. We also hypothesized that males and females would have comparable survival rates because of their similar roles during the breeding season. For restoration planning we compared survival rates of native populations of Mountain Quail in northeastern and southwestern Oregon with translocated wild Mountain Quail.

STUDY SITES

We studied Mountain Quail from 1997 to 1999 in Hells Canyon National Recreation Area (HCNRA) located on the Columbia Plateau in northeastern Oregon and in the western Cascade Mountain Range (CMR) of southwestern Oregon. The 2000-km^2 study site in HCNRA is characterized by steep canyons dissected by stream systems. Forests above 1600 m are dominated by ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), and grand fir (*Abies grandis*). Canyon lowlands contain common understory and transition zone shrubs including hawthorns (*Crataegus* spp.), snowberry (*Symphoricarpos albus*), and mallow ninebark (*Physocarpus malvaceus*). Grassy uplands are primarily composed of Idaho fescue (*Festuca idahoensis*) and bluebunch wheatgrass (*Agropyron spicatum;* Pelren 1996, Crowe and Clausnitzer 1997). Most of the lowlands are private holdings primarily managed for livestock grazing or managed by the U.S. Forest Service as part of HCNRA. Uplands are mostly administered by the U.S. Forest Service or the Bureau of Land Management. Hunting is allowed for Mountain Quail in northeastern Oregon from October to December with a 2 bird per day limit. Elevations range from 900 m to 2000 m. Temperatures in 1999 ranged from an average monthly low of 0°C in January to an average monthly high of 26°C in August, and mean annual precipitation was 40 cm (Oregon State University, Climate Center, Corvallis, OR).

The 1400-km^2 study site in CMR is characterized by dense conifer and mixed hardwood forests dominated by Douglas-fir, western hemlock (*Tsuga heterophylla*) or Oregon white oak (*Quercus garryana*), and Pacific madrone (*Arbutus menziesii;* Franklin and Dyrness 1988). Common understory shrubs include manzanita (*Arctostaphylos* spp.), ceanothus (*Ceanothus* spp.), vine maple (*Acer circinatum*), salal (*Gaultheria shallon*), poison oak (*Rhus diversiloba*), and Oregon grape (*Berberis* spp.) Most of the land in CMR is managed by the U.S. Forest Service or the Bureau of Land Management. Mountain Quail in CMR are hunted from September to January with a 10 bird per day limit. Elevations range from approximately 600 m to 1800 m. Mean monthly temperatures in 1999 ranged from 9°C in January to 29°C in August, and average annual precipitation was 76 cm (OSU Climate Center, Corvallis, OR).

METHODS

We captured Mountain Quail with treadle traps baited with grain (Pope 2002). Captured birds were fitted with flexible, necklace-style transmitters weighing 3.6 g (Model PD2C, Holohil Systems, Ltd., Woodlawn, Ontario, Canada), <2% of their body weight. All birds were banded, weighed, and blood was extracted and analyzed for gender identification (PE AgGen, Davis, CA). Beginning 1 week after release, all birds were relocated visually from the ground at least 2 times per month to determine survival during the projected life of the radio transmitter (150 days).

Statistical Analysis

We used the maximum partial likelihood estimation method (Cox 1972) with PROC PHREG (SAS Institute, Inc. 1999) to develop proportional hazard models for Mountain Quail in CMR and HCNRA. We combined data from both locations and included 6 explanatory variables in our global model: (1) sex (male or female), (2) location (HCNRA or CMR), (3) type (translocated or native quail), (4) year 1 (1997), (5) year 2 (1998), (6) year 3 (1999). All birds were classified as died, censored (disappeared or radio-failed), or lived. Interval estimates were derived by subtracting the date of release after capture from date of last encounter. For CMR we tested proportional hazard models with sex, year 1, year 2, and year 3 as explanatory variables, and for HCNRA we used sex, type, year 1, year 2, and year 3 as explanatory variables. To determine if hazard functions were different for native quail in CMR and HCNRA, CMR native and HCNRA translocated quail, and HCNRA translocated and native quail, we used the Kaplan-Meier (KM; Kaplan and Meier 1958, Pollack 1989) estimator and the log-rank (Mantel-Haenszel test) chi-square test in PROC LIFETEST (SAS Institute, Inc. 1999) and the BASELINE statement in PROC PHREG (SAS Institute, Inc. 1999, Allison 2001). Additionally, log-rank tests were used to determine differences in survival functions for male and female quail in HCNRA and CMR, for native quail captured in the fall and winter in HCNRA, and between different years.

RESULTS

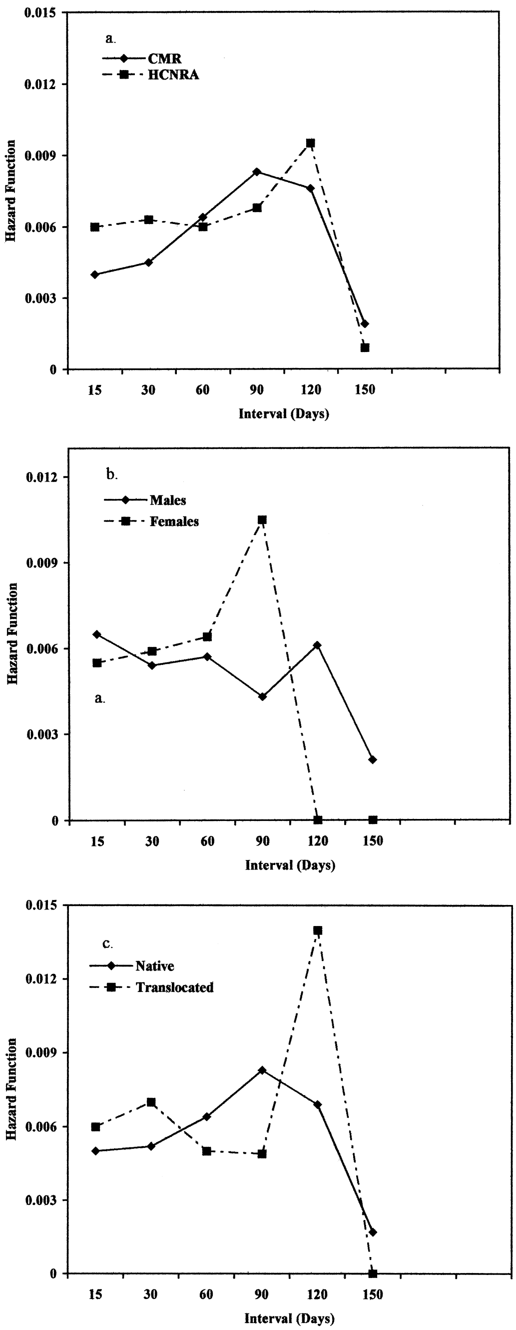
We captured 235 Mountain Quail in CMR and HCNRA from 1997 to 1999. Eighty-six birds captured in CMR were fitted with transmitters and released at the trap sites in late winter and early spring 1997–1999. Seventy-five birds captured in CMR were transported to HCNRA, fitted with transmitters, and released in 2 drainages in late winter 1997–1998. Seventy-four Mountain Quail in HCNRA were captured, equipped with transmitters, and released at their trap sites in fall and spring 1998–1999. We excluded 3 birds from the analysis because they were not relocated after release. Of 232 radio-tagged Mountain Quail used in the analysis, 102 (44%) were males, 119 (51%) were females, and 11(5%) were birds of unknown sex. One hundred nineteen (51%) Mountain Quail died during and 53 (23%) lived throughout the entire interval (166 days). Sixty (26%) disappeared or their radios prematurely failed before the interval ended. Forty-seven (46%) males died, 70 (59%) females died, and 2 Mountain Quail of unknown sex died. In HCNRA 78 of 149 (52%) radio-tagged Mountain Quail died, 33 (22%) lived throughout the interval, and 38 (27%) disappeared or had premature radio transmitter failures. Thirty (48%) males, 46 (60%) females, and 2 birds of unknown sex died. In CMR 41 of 83 (49%) radio-tagged Mountain Quail died, 24 (29%) lived the entire interval, and 18 (22%) disappeared or the radios failed. Seventeen of 39 (44%) males died, and 24 of 42 (57%) females died. Thirty-six of 72 (50%) translocated Mountain Quail died in HCNRA, 18 (25%) lived throughout the interval, and 18 (25%) disappeared or the radio transmitters prematurely failed. Forty-two of 74 (57%) native Mountain Quail in HCNRA died, 15 (20%) lived, and 17 (23%) disappeared or their radios failed. We had no band returns of birds killed by hunters.

For HCNRA and CMR combined, the only model with a significant effect ($\chi^2_1 = 4.6$, $P = 0.03$) contained sex as the single explanatory variable. The risk of mortality for males was 0.67 that of females. Models tested for the individual study areas showed no significant effect for variables in the global model or subsets of the global model. For Mountain Quail in HCNRA, the hazard function declined after 120 days and for CMR after 90 days (Fig. 1a). The hazard function declined for females after 90 days and increased for males after 90 days but declined after 120 days (Fig. 1b). For native quail the hazard function declined after 90 days and declined for translocated quail after 30 days but increased after 90 days (Fig. 1c).

At the end of the interval (150 days) the survival rate was 0.42 ± 0.04 for the combined areas (Table 1). The survival rate for HCNRA was 0.41 ± 0.04, and the survival rate for CMR was 0.34 ± 0.09. There was no difference in survival functions for native quail in HCNRA and quail translocated from CMR ($\chi^2_1 = 0.001$, $P = 0.97$; Fig. 2a). There was a significant difference in survival functions for males and females ($\chi^2_1 = 4.61$, $P = 0.032$; Fig. 2b), but no differences were found for native quail in CMR and translocated quail in HCNRA ($\chi^2_1 = 0.006$, $P = 0.93$; Fig. 2c) or for native quail in HCNRA and CMR ($\chi^2_1 = 0.002$, $P = 0.91$; Fig. 2d). Additionally, no differences for survival functions were found for fall and winter survival of quail ($\chi^2_1 = 0.31$, $P = 0.57$) in HCNRA or between different years of the study ($\chi^2_2 = 2.31$, $P = 0.23$).

DISCUSSION

Contrary to expectation, survival rates for Mountain Quail in southwestern Oregon and northeastern Oregon were similar during winter, spring, and summer. No previous studies exist that have compared survival rates of Mountain Quail in areas with different ecological conditions. Different estimates of annual survival for Northern Bobwhite (*Colinus virginianus*; Burger et al. 1995) and Gambel's Quail (*Callipepla gambelii;* Brown et al. 1998) have been reported from different locations across their ranges. Differences in survival estimates between studies may be caused by variations in techniques, locations, or time



Figs. 1a–c. Daily hazard estimates for Mountain Quail in Hell's Canyon National Recreation Area (HCNRA) and Cascade Mountain Range (CMR), Oregon, 1997–1999.

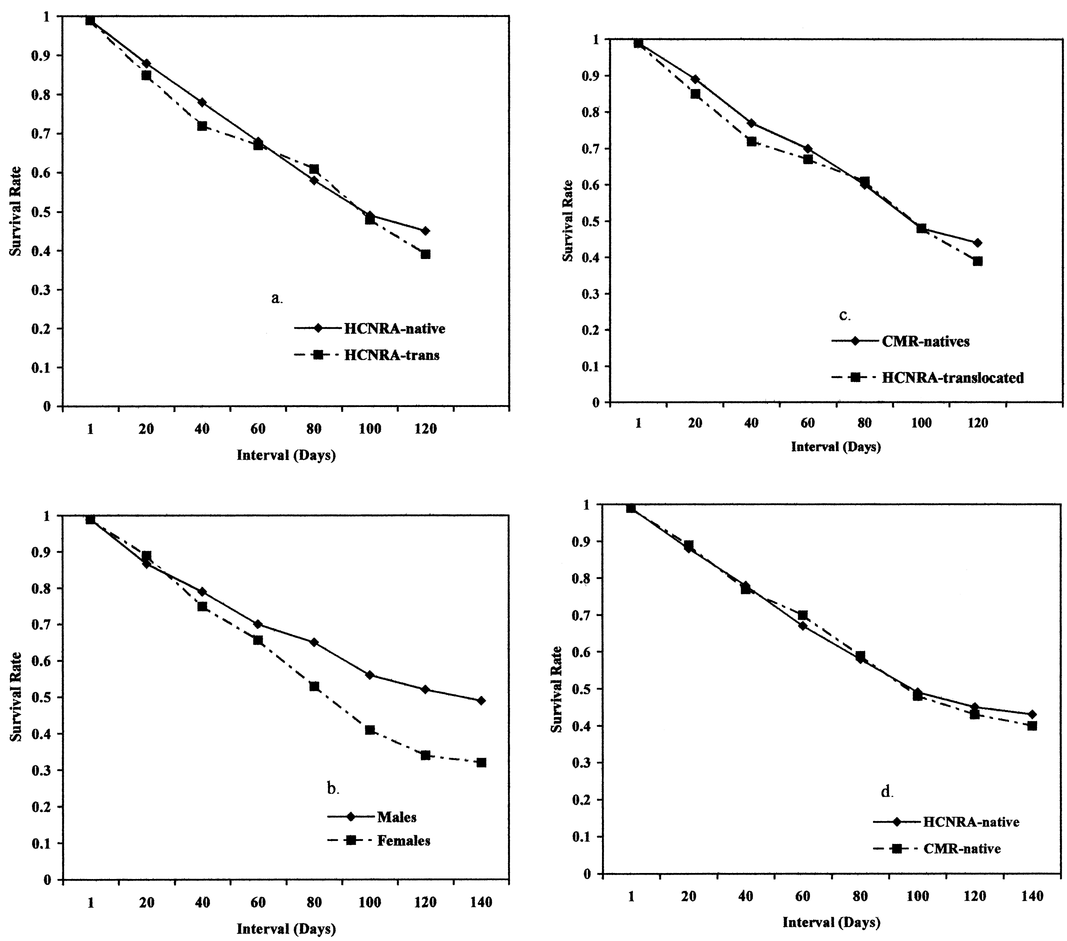
(Burger et al. 1995), or may be confounded by proximate factors such as erratic cycles of explosive population growth followed by rapid declines in populations. A number of species in the Odontophoridae demonstrate irruptive, locally based population growth with boom and bust years (Rollins and Carroll 2001). Irruptions have been attributed to droughts (Wallmo 1957, Campbell et al. 1973), vitamin A deficiencies (Lehmann 1953), and lack of nesting cover (Rollins 1999). Mountain Quail likely experience similar population fluctuations that may not appear in year-to-year survival comparisons, and long-term trends may be more useful for population management.

We hypothesized that males and females would have similar survival rates because of the equal investment that males have in parental care (Pope and Crawford 2001), but our results indicated that the hazard of death for males is less than for females. Pollack et al. (1989) reported that male survival for Northern Bobwhites in fall and winter is higher, but Burger et al. (1995) and Curtis et al. (1988) found no difference in survival by gender. A number of studies have reported male bias in Northern Bobwhite populations (Burger et al. 1995), and the authors suggested that bias results from differential survival during the breeding season (Roseberry and Klimstra 1992) or from higher harvest rates for females during hunting season (Pollack et al. 1989). Brown and Gutiérrez (1980) found that most New World quail appear to have male-biased populations but speculated that the least dimorphic members of the New World quail (e.g., Scaled Quail [*Callipepla squamata*] and Mountain Quail) may exhibit the lowest ratio of males to females. Population sex ratios have not been adequately determined for Mountain Quail, but data from this study and more recent Mountain Quail research in Oregon (Jackle et al. 2002) found that 53% of 513 Mountain Quail captured from 1997 to 2003 in Oregon were females. The bias in male survival that we observed may be attributed to the limited sample of birds used in our analysis, and larger samples may provide more accurate assessments of survival differences for males and females.

No differences in survival functions were found for Mountain Quail captured and released in the fall and Mountain Quail captured and released in the winter in HCNRA. No comparable study was attempted in the Cascade

TABLE 1. Survival rates, $s_{\bar{x}}$, and median (50th percentile) time of death of Mountain Quail in Hell's Canyon National Recreation Area (HCNRA) and the southwestern Cascade Mountain Range (CMR), Oregon, 1997–1999.

Category	Survival rate	$s_{\bar{x}}$	n	Median death rate (days)
Males	0.49	0.05	102	102
Females	0.32	0.05	119	88
Native quail	0.40	0.04	157	100
Reintroduced quail	0.43	0.06	72	108
HCNRA quail	0.41	0.04	149	100
Males	0.48	0.07	63	135
Females	0.31	0.06	77	94
Natives	0.41	0.06	77	106
CMR quail	0.34	0.09	83	100
Males	0.50	0.09	39	130
Females	0.35	0.08	42	85
1997	0.54	0.07	59	60
1998	0.37	0.06	87	96
1999	0.39	0.07	86	100



Figs. 2a–d. Survival plots for Mountain Quail in Hell's Canyon National Recreation Area (HCNRA) and Cascade Mountain Range (CMR), Oregon, 1997–1999.

Mountains in southwestern Oregon. Differential seasonal mortality has been noted for Northern Bobwhites (Pollack et al. 1989, Burger et al. 1995), but these survival differences may have resulted from the additivity of hunting mortality for populations harvested in late winter (Pollack et al. 1989). Mountain Quail are hunted during the fall in HCNRA but the restricted harvest (2 birds per day), remote location of our study site, and secretive nature of this species suggest that hunting had little impact on survival.

Differences in seasonal predator abundances and the relationship of exposure to predators and seasonal behaviors have not been adequately studied. Burger et al. (1995) observed that male bobwhites are more vulnerable to avian predation during the breeding season because males often display in exposed areas such as fence posts and roadsides. They noted that during the same period females are more affected by mortality associated with incubation and brood rearing. Rollins and Carroll (2001) reviewed impacts of predation on Scaled Quail and Bobwhite populations and concluded that, while predation is the primary cause of mortality, habitat degradation and fragmentation likely exacerbate the risk of predation by changing the dynamics of predator and prey communities.

Management Implications

Mountain Quail captured in CMR and translocated to HCNRA had similar survival rates compared to native quail in HCNRA and in CMR. Translocations of wildlife to supplement or reestablish populations of native species have become an important and broadly accepted conservation technique (Griffiths et al. 1996). A survey of translocation programs estimated that nearly 90% of approximately 700 translocations between 1973 and 1986 were game species, and gallinaceous birds accounted for a significant proportion (43%) of these translocation efforts (Griffiths et al. 1989). Few translocation efforts incorporated post-release monitoring that evaluated the effectiveness of the program or compared survival of native and translocated populations (Griffith et al. 1989). Game farm or pen-raised animals are usually less successful than wild birds as a source for translocations (Fellers and Drost 1995, Perez et al. 2002). The wild Mountain Quail translocated to HCNRA survived for as long as or longer than the native quail in the same area. With the ability to rapidly expand their populations and opportunistically exploit marginal habitats, Mountain Quail are excellent candidates for translocations, particularly given the abundant sources of wild populations in western Oregon. This species can withstand repeated handling, long-term captivity, and transport (Pope 2002). Mountain Quail have been successfully introduced into parts of Washington, Oregon, and British Columbia, demonstrating an ability to colonize habitats with significantly different topographic and edaphic conditions (Mclean 1930, Aldrich and Duvall 1955, Crawford 2000).

Acknowledgments

We thank A. Martin, M. Hansen, and S. Kiffe for their field assistance. We also thank K. Durbin and E. Rickerson (Oregon Department of Fish and Wildlife); K. Martin (U.S. Forest Service); M. Kniesel, G. Miller, E. Campbell, and J. Ramakka (Bureau of Land Management); J. Wells (Oregon Hunter's Association); and J. Crafton and R. Wells (Quail Unlimited) for helping to fund this project. We are sincerely grateful to V. Coggins, M. Black, and S. Denney for their technical advice and infinite wisdom, and to D. Edge and C. Smith for reviewing this manuscript. We also thank L. Brennan and the other reviewers from WNAN for their excellent suggestions and comments. This is Oregon Agricultural Research Station manuscript 11853.

Literature Cited

ALDRICH, J.W., AND A.J. DUVALL. 1955. Distribution of American gallinaceous game birds. USDI, Fish and Wildlife Service, Circular 34.

ALLISON, P. 2001. Survival analysis using the SAS system: a practical guide. SAS Institute, Inc., Cary, NC. 292 pp.

BRENNAN, L.A. 1994. Broad-scale declines in four species of North American quail: an examination of possible causes. Pages 160–169 *in* Sustainable ecological systems: implementing an ecological approach to land management. USDA, Forest Service, General Technical Report RM-247, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

BROWN D.E., AND R.J. GUTIÉRREZ. 1980. Sex ratios, sexual selection, and sexual dimorphism in quail. Journal of Wildlife Management 44:198–202.

BROWN D.E., R.J. GUTIÉRREZ, J.C. HAGELIN, M. TAYLOR, AND J. GALLOWAY. 1998. Gambel's Quail (*Callipepla gambelii*). *In:* A. Poole and F. Gill, editors, The birds of North America, No. 321. The Birds of North America, Inc., Philadelphia, PA.

BURGER, L.W., T.V. DAILEY, E.W. KURZEJESKI, AND M.R. RYAN. 1995. Survival and cause-specific mortality of Northern Bobwhite in Missouri. Journal of Wildlife Management 59:401–410.

CAMPBELL, H., D.K. MARTIN, P.E. FERKOVICH, AND B.K. HARRIS. 1973. Effects of hunting and some other environmental factors on Scaled Quail in New Mexico. Wildlife Monograph 34.

COX, D.R. 1972. Regression models and life tables. Journal of the Royal Statistical Society 34:187–220.

CRAWFORD, J.A. 2000. Historic distribution of Mountain Quail in the Pacific Northwest. Pages 194–197 *in* L.A. Brennan, W.E. Palmer, L.W. Burger, Jr., and T.L. Pruden, editors, Quail IV: Proceedings of the Fourth National Quail Symposium. Tall Timbers Research Station, Tallahassee, FL.

CROWE, E.A., AND R.R. CLAUSNITZER. 1997. Mid-montane wetland plant associations of the Malheur, Umatilla and Wallowa-Whitman National Forests. USDA, Forest Service, Pacific Northwest Region 8, Technical Paper R6-NR-ECOL-TP-22-97, Portland, OR.

CURTIS, P.D., B.S. MUELLER, P.D. DOERR, AND C.F. ROBINETTE. 1988. Seasonal survival of radio-marked Northern Bobwhite Quail from hunted and non-hunted populations. International Biotelemetry Symposium 10:263–275.

FELLERS, G.M., AND C.A. DROST. 1995. Handbook for restoring native animals. USDI, National Park Service Report, NPS/NRPORE/NRR-95/19, Denver, CO.

FRANKLIN, J.F., AND C.T. DYRNESS. 1988. Natural vegetation of Oregon and Washington. Oregon State University Press, Corvallis. 452 pp.

GRIFFITHS, B.J., J.M. SCOTT, J.W. CARPENTER, AND C. REED. 1989. Translocation as a species conservation tool: status and strategy. Science 245:477–480.

GRIFFITHS, H.I., A. DAVISON, AND J. BIRKS. 1996. Species reintroductions. Conservation Biology 10:923.

GUTIÉRREZ, R.J., AND D.J. DELEHANTY. 1999. Mountain Quail (*Oreortyx pictus*). *In:* A. Poole and F. Gill, editors, The birds of North America, No. 457. The Birds of North America, Inc., Philadelphia, PA.

HEEKIN, P.E. 1993. Radio-telemetry reveals secrets of Mountain Quail in Idaho. Quail Unlimited 12(2):8–11.

JACKLE, G., E.V. RICKERSON, M.D. POPE, D. ZALUNARDO. 2002. Mountain Quail translocations in eastern Oregon. Unpublished annual report, Department of Fisheries and Wildlife, Oregon State University, Corvallis. 36 pp.

KAPLAN, E.L., AND P. MEIER. 1958. Nonparametric estimation from incomplete observations. Journal of the American Statistical Association 53:457–481.

LEHMANN, V.M. 1953. Bobwhite populations and vitamin A. Transactions North American Wildlife Conference 18:199–246.

LIU, X., R.M. WHITING, D.S. PARSONS, AND D.R. DIETZ. 2002. Movement patterns of resident and relocated Northern Bobwhites in East Texas. Pages 168–172 *in* S. DeMaso, W.P. Kuvlesky, F. Hernández, and M.E. Berger, editors, Quail V: Proceedings of the Fifth National Quail Symposium. Texas Parks and Wildlife Department, Austin.

MCLEAN, D.D. 1930. The quail of California. California Fish and Game, Bulletin 2.

PELREN, E.C. 1996. Blue Grouse winter ecology in northeastern Oregon. Doctoral dissertation, Oregon State University, Corvallis.

PEREZ, R.M., D.E. WILSON, AND K.D. GRUEN. 2002. Survival and flight characteristics of captive-reared and wild Northern Bobwhites in South Texas. Pages 81–85 *in* S. DeMaso, W.P. Kuvlesky, F. Hernández, and M.E. Berger, editors, Quail V: Proceedings of the Fifth National Quail Symposium. Texas Parks and Wildlife Department, Austin.

POLLACK, K.H. 1989. Estimation and analysis of survival distributions for radio-tagged animals. Biometrics 45:99–109.

POLLACK, K.H., C.T. MOORE, W.R. DAVIDSON, F.E. KELLOGG, AND G.L. DOSTER. 1989. Survival rates of Bobwhite Quail based on band recovery analyses. Journal of Wildlife Management 53:1–6.

POPE, M.D. 2002. The ecology of Mountain Quail in Oregon. Doctoral dissertation, Oregon State University, Corvallis.

POPE, M.D., AND J.A. CRAWFORD. 2001. Male incubation and biparental care in Mountain Quail. Condor 103: 865–870.

ROLLINS, D. 1999. Is there a place for predator control in quail management? Pages 45–48 *in* K.A. Cearley, editors, Preserving Texas quail heritage into the 21st century. Texas Agricultural Extension Service, Abilene.

ROLLINS, D., AND J.P. CARROLL. 2001. Impacts of predation on Northern Bobwhite and Scaled Quail. Wildlife Society Bulletin 29:39–51.

ROSEBERRY, J.L., AND W.D. KLIMSTRA. 1992. Further evidence of differential harvest rates among bobwhite sex-age groups. Wildlife Society Bulletin 20:91–93.

SAS INSTITUTE, INC. 1999. SAS/STAT user's guide. Release 8.0. SAS Institute, Inc. Cary, NC.

SCOTT, M.J., AND J.W. CARPENTER. 1987. Release of captive-reared or translocated endangered birds: what do we need to know? Auk 104:544–545.

WALLMO, O.C. 1957. Ecology of Scaled Quail in west Texas. Doctoral dissertation, Texas A&M University, College Station.

Received 11 December 2001
Accepted 16 July 2003