Cause-specific Mortality of Northern Bobwhites on an Area with Quail Feeders in Western Oklahoma

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Abstract: We investigated the effect of quail feeders on cause-specific mortality of 910 radio-marked northern bobwhites (*Colinus virginianus*). Research was conducted from 1 October 1991 through 1 October 1996 on the Packsaddle Wildlife Management Area (WMA) in western Oklahoma. Thirty-two feeders filled with milo were located near the center of every 8.1 ha on the 283.3-ha (1.6 km × 1.8 km) treatment area. The unfed area was 283.3 ha (1.6 km × 1.8 km). Treatments were separated by a 194.3-ha (1.2 km × 1.8 km) buffer area. Four-hundred-seventy-seven mortalities occurred on the control treatment and 433 mortalities on the feeder treatment. Avian and mammalian predators and hunting were the primary mortality agents. Direct mortality due to weather was low and no birds died from disease. Avian and hunting mortalities pooled over years different among months ($P < 0.05$). Monthly mortality rates (M) pooled over years differed between adult and juvenile bobwhites during October and November ($P < 0.05$). Pooled over months and years, mammal, hunting, and unknown mortalities differed between adults and juveniles ($P < 0.05$). Monthly mortality rates pooled over years differed ($P < 0.05$) between female (M = 0.069) and male (M = 0.099) bobwhites only in May. During May, avian mortality was higher ($P < 0.05$) on males (M = 0.047) than females (M = 0.020). Pooled over years, mortality differed ($P < 0.05$) between the control and feeder area during January, February, and December. Cause-specific mortality rates were similar ($P > 0.05$) when pooled over months and years. Mean annual mortality rates were 82.1% on the control area, 79.0% on the feeder area, and 80.2% pooled over areas. Supplemental feeding did not have an effect on annual bobwhite mortality, but did affect the distribution of cause-specific bobwhite mortality.

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In Oklahoma, about 85,000 quail hunters harvest about 2.0 million bobwhites annually (LaPierre 1997). However, Oklahoma, like many states in the Southeast, has not been immune from the steady decline in bobwhite populations since the early 1970s (Brennan 1991, Church et al. 1993). Suspected reasons for the decreasing and fluctuating bobwhite populations in the southeastern United States and Oklahoma include habitat changes, changes in agricultural practices, weather, disease, predation, and overharvest (Brennan 1991).

Supplemental feeding is commonly used in Oklahoma and throughout the bobwhite's range in an attempt to augment bobwhite populations (Frye 1954, Guthery 1986:48, Peoples 1992). However, few studies have examined effects of supplemental feeding on wild bobwhite populations (Frye 1954, Peoples 1992) and those studies provide conflicting results. Frye (1954) reported an increase in bobwhite numbers from supplemental feeding in south Florida. In Kansas, Robel et al. (1979) found bobwhites had lower weights, lower fat content, and increased mortality when supplemental feed was not available during winter. Supplemental feeding may increase survival during stressful periods (i.e., severe winter weather and drought) and increase productivity if applied properly (Guthery 1986:48).

Estimates of cause-specific mortality have been reported for few bobwhite populations (Burger et al. 1995). Adult bobwhite sex ratios are skewed toward males (Roseberry and Klimstra 1984:136). There are competing hypotheses regarding sources and timing of differential mortality that cause sex-ratio bias. Stoddard (1931:94) suggested that females have lower winter survival; Pollock et al. (1989*a*), Shupe et al. (1990), and Roseberry and Klimstra (1992) reported higher female harvest rate; and Leopold (1933), Buss et al. (1947), and Bennitt (1951) suggested that females experience higher mortality during incubation. Mortality rates of northern bobwhites on supplementally fed and control areas are absent in the literature.

Our objective was to 1) identify the causes and rates of northern bobwhite mortality in western Oklahoma and 2) determine if quail feeders affected rates and causes of bobwhite mortality.

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Methods

Research was conducted on the Packsaddle WMA in southern Ellis County, Oklahoma. Cole et al. (1966) described the soils, ecological, and climatic conditions in the county. DeMaso et al. (1997) and Parry et al. (1997) provided details on the Packsaddle WMA study area. Soils in the area include Nobscot fine sand, Nobscot-Brownfield, and Pratt-Tivoli loamy fine sand. Grasses on these soils were sand bluestem (*Andropogon hallii*), little bluestem (*A. scoparius*), indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), sand paspalum (*Paspalum stramineum*), blue grama (*Bouteloua gracilis*), hairy grama (*B. hirsuta*), and sand dropseed (*Sporobolus cryptandrus*). Forb species included western ragweed (*Ambrosia psilostachya*), Texas croton (*Croton texensis*), erect dayflower (*Commelina erecta*), and prairie sunflower (*Helianthus petiolaris*). Woody vegetation included shinnery oak (*Quercus harvardii*), sand sagebrush (*Artemisia filifolia*), and sand plum (*Prunus angustifolia*) (Cole et al. 1966).

The study area was divided into 2 areas, each 283.3 ha. One area was supplemented with milo *ad libitum* in gravity-flow feeders, distributed at about 1 feeder/8.1 ha. The second area served as a control and was separated from the feeder area by a 1.2 km wide buffer zone.

Trapping occurred throughout the year to achieve an adequate sample size. Bobwhites were captured in modified Stoddard funnel traps (Wilbur 1967) baited with milo or wheat. Traps were placed at a density of 1/32 ha, but were not evenly distributed. Bobwhites trapped on the control area were assigned to the control treatment and bobwhites caught on the feeder area were assigned to the feeder treatment. Sex and age (adult or young of year) of captured bobwhites were determined by plumage characteristics and molt patterns (Rosene 1969:44–54). Radio transmitters and marking methods were described by DeMaso et al. (1997). Bobwhites had to be at least 8 weeks old before being fitted with a radio transmitter.

Radio-marked bobwhites were located ≥5 days/week using hand-held 3-element yagi antennas. Aircraft were used to locate widely dispersed individuals. Radio-marked bobwhites were approached on foot until radio signal and strength indicated the observer was about 20 m from the bird. The bird was then circled to determine an exact location. When a mortality signal was detected, transmitters were located and the proximate cause of mortality was determined from evidence at the recovery site and condition of the transmitter (Dumke and Pils 1973). Because of variation in the daily location schedule it is possible that the cause of mortality could be misidentified. For example, a bird that was shot, but not retrieved during a controlled hunt could have been found by a mammalian predator before the transmitter was recovered. Therefore, evidence at the recovery site would indicate the mammal, not hunting, was the cause of mortality. When an entire bird was recovered and the cause of mortality could not be identified, they were necropsied at the Oklahoma Animal Disease Diagnostic Laboratory at Oklahoma State University, Stillwater. Mortalities were assigned to 1 of 6 classes. Classes included 1) avian, 2) mammal, 3) hunting, 4) weather, 5) unknown, and 6) other. The other category included birds that survived ≥7 days but were found dead in traps or birds that died due to the radio package. Birds that slipped their transmitter, contact was lost, or were collected for other research needs were right censored.

Species of avian predators found at the Packsaddle WMA include Cooper's hawks (*Accipiter cooperii*), sharp-shinned hawks (*A. straitus*), red-tailed hawks (*Buteo jamaicensis*), and northern harriers (*Circus cyaneus*). Species of mammalian predators found on the area include bobcats (*Lynx rufus*), coyotes (*Canis latrans*), gray foxes (*Urocyon cinereoargenteus*), raccoons (*Procyon lotor*), swift fox (*Vulpes velox*), and striped skunk (*Mephitis mephitis*).

We estimated cause-specific mortality rates by month (M) for the entire study period. We used the computer program MICROMORT which uses the Heisey-Fuller method (Heisey and Fuller 1985) to estimate mean daily survival rates by month, generalized to the staggered entry case (Pollock et al. 1989*b*, *c*). We assumed birds were randomly sampled, survival times for individuals were independent, left-censored individuals (Stagger entered) had survival distributions similar to previously marked individuals, and causes for censoring (i.e., radio failure) were independent of the bird's fate. Birds had to survive ≥7 days after radiomarking to ensure survival probabilities were not biased by trapping or handling (Pollock et al. 1989*b*, *c*; White and Garrott 1990).

Cause-specific mortality rates are presented as the probability of an animal dying during a given interval (month) due to a specific mortality agent, given that other competing mortality agents were present (Heisey and Fuller 1985). The Heisey-Fuller approach makes the same assumptions as Kaplan and Meier (1958), that daily survival rate is constant within an interval and that each animal radio-day is an independent event. Censored observations were included up to the day the animal was censored, but we did not consider it a mortality (Vangilder and Sheriff 1990).

We used a z-test to compare cause-specific mortality rates between treatments, ages, and sexes (Heisey and Fuller 1985). We used the method of Sauer and Williams (1989) to test for differences among cause-specific mortality rates when estimates were from different time periods.

Results

We estimated cause-specific mortality rates from 910 observed mortalities of 1,115 radio-marked bobwhites. Four-hundred-seventy-seven mortalities were observed from 579 radio-marked bobwhites on the control treatment and 433 mortalities were observed from 536 radio-marked bobwhites on the feeder treatment. Raptor, mammal, and hunting were the primary mortality agents on both areas. Direct mortality due to weather was low on both areas. No birds died because of disease.

Unknown mortality was different among years ($P < 0.05$). Raptor and hunting mortalities pooled over years differed among months ($P < 0.05$) (Fig. 1). Mortality rates pooled over years differed between adult and juvenile bobwhites during October and November ($P < 0.05$). Pooled over months and years, mammal, hunting, and unknown mortalities differed between adults and juveniles ($P < 0.05$). Monthly mortality rates pooled over years differed ($P < 0.05$) between female (M = 0.069) and male (M = 0.099) bobwhites only in May. During May, avian mortality was higher ($P < 0.05$) on males (M = 0.047) than females (M = 0.020).

Pooled over years, mortality differed ($P < 0.05$) between the control and feeder area during January (control = 0.24, feeder = 0.26), February (control = 0.22, feeder = 0.14), and December (control = 0.25, feeder = 0.21) (Fig. 1). Cause-specific mortality rates differed ($P < 0.05$) between treatments for mammalian (control = 0.23, feeder = 0.17) and other mortality (control = 0.08, feeder = 0.02) when pooled over

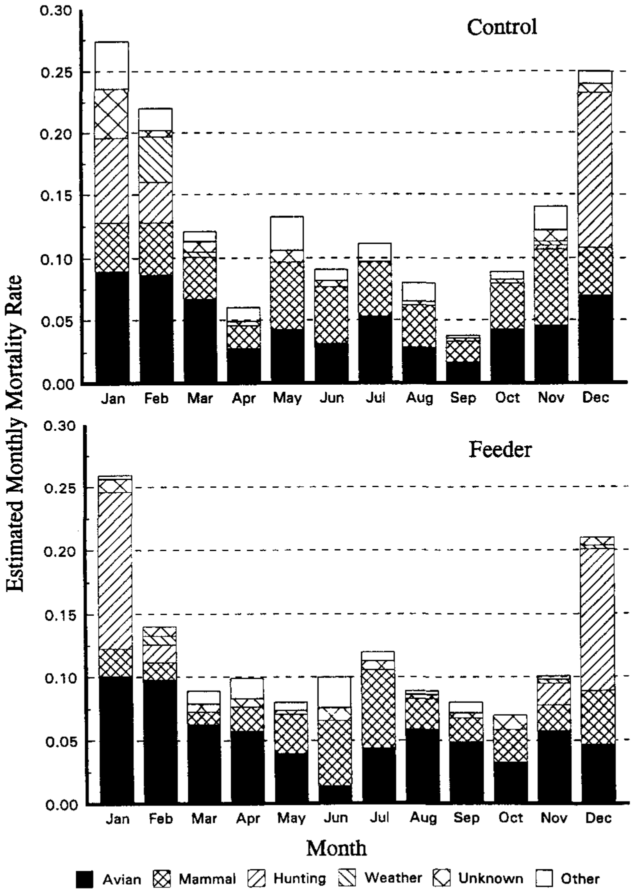

Figure 1. Distribution of estimated northern bobwhite monthly mortality of northern bobwhites by month, mortality agent, and treatment, on Packsaddle WMA, Ellis County, Oklahoma, 1991–1996.

months and years (Fig. 1). Mean annual mortality rates were 82.1% on the control area, 79.0% on the feeder area, and 80.2% pooled over areas.

Discussion

Predation was the primary cause of bobwhite mortality. Overall rates and causes of mortality were similar to the results of other studies in Illinois (Roseberry and Klimstra 1984), southern Alabama (Sermons 1987), North Carolina (Curtis et al. 1988), northern Florida (Mueller et al. 1988), and northern Missouri (Burger et al. 1995). However, our estimate of annual mortality is lower than what is reported for other bobwhite telemetry studies (Curtis et al. 1988, Burger et al. 1995). Our observations of high avian predation during the fall and increased mammalian predation during the spring are consistent with Curtis et al. (1988) and Burger et al. (1995). Our data suggest that cause-specific mortality was similar between feeder and control areas, except for mammalian predation which was higher on the feeder area. We could not find any other estimates of cause-specific bobwhite mortality on supplementally fed areas in the literature.

We feel that quail feeders tended to concentrate quail around feeders, thus increasing predation when food was limited during the 5-year study period. During our study, hunting mortality was higher on the feeder area ($M = 0.21$) than on the control area ($M = 0.17$). This may be because quail were concentrated around feeders and were found easier by hunters. Quail feeders may be beneficial in the context of a commercial hunting operation.

We did not find any mortalities caused by disease. Our data do not support the hypothesis (Guthery 1986:54) that quail feeders may augment the transmission of avian diseases (through digestion of diseased birds' feces while feeding) by concentrating bobwhites around quail feeders.

Management Implications

Although bobwhite populations have declined in Oklahoma, our research suggests that food availability is not the cause of the decline on our study area. Supplemental feeding of bobwhites in western Oklahoma did not increase survival of birds on the feeder area.

Bobwhite managers should focus management activities on habitat manipulation. Management activities such as prescribed burning, strip discing, and cattle grazing can be used to augment the late fall and winter supply of bobwhite food. Also, these techniques can increase the amount of insects available to bobwhites during the spring and summer. These activities should take place in close proximity ($\leq$100 m) to woody (escape) cover to minimize predation.

The decline of the bobwhite throughout its range is a complex problem. Many factors may be responsible for suppressing bobwhite numbers; however, it is unlikely that any one individual factor is cause for the decline. Further research is needed to understand the factors, their mechanisms, and dynamics that are responsible for bobwhite population fluctuations.

Literature Cited

Bennitt, R. 1951. Some aspects of Missouri quail and quail hunting 1938–1948. Mo. Conserv. Comm. Tech. Bull. 2, Jefferson City. 51pp.

Brennan, L. A. 1991. How can we reverse the northern bobwhite population decline? Wildl. Soc. Bull. 19:544–555.

Burger, L. W., Jr., T. V. Dailey, E. W. Kurzejeski, and M. R. Ryan. 1995. Survival and cause-specific mortality of northern bobwhite in Missouri. J. Wildl. Manage. 59:401–410.

Buss, I. O., H. Mattison, and F. M. Kozlik. 1947. The bobwhite quail in Dunn County, Wisconsin. Wisc. Conserv. Bull. 12:6–13.

Church, K. E., J. R. Sauer, and S. Droege. 1993. Population trends of quails in North America. Proc. Natl. Bobwhite Quail Symp. 3:44–54.

Cole, E. L., A. J. Conradi, and C. E. Rhoads. 1966. Soil survey of Ellis County, Oklahoma. U.S. Soil Conserv. Serv., Washington, D.C. 81pp.

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. Biotelemetry 10:263–275.

DeMaso, S. J., A. D. Peoples, S. A. Cox, and E. S. Parry. 1997. Survival of northern bobwhite chicks in western Oklahoma. J. Wildl. Manage. 61:846–853.

Dumke, R. T. and C. M. Pils. 1973. Mortality of radio-tagged pheasants on the Waterloo wildlife area. Dep. Nat. Resour., Tech. Bull. No. 72. Madison, Wisc. 52pp.

Frye, O. E., Jr. 1954. Studies of automatic quail feeders in Florida. Trans. North Am. Wildl. Conf. 19:298–319.

Guthery, F. S. 1986. Beef, brush, and bobwhites: quail management in cattle country. Caesar Kleberg Wildl. Res. Inst. Press, Kingsville, Texas. 182pp.

Heisey, D. M. and T. K. Fuller. 1985. Evaluation of survival and cause-specific mortality rates using telemetry data. J. Wildl. Manage. 49:668–674.

Kaplan, E. L. and P. Meier. 1958. Non-parameteric estimation from incomplete observation. J. Am. Stat. Assoc. 53:457–481.

LaPierre, A. K. 1997. Upland game harvest surveys. Okla. Wildl. Restor. Proj. W-82-R-36, Job 004. 70pp.

Leopold, A. 1933. Game management. Charles Scribner's Sons. New York, N.Y. 481pp.

Mueller, B. S., J. B. Atkinson, Jr., and T. DeVos. 1988. Mortality of radio-tagged and unmarked northern bobwhite quail. Biotelemetry 10:139–144.

Parry, E. S., S. J. DeMaso, S. A. Cox, and A. D. Peoples. 1997. Recovery rates of banded vs. radiomarked northern bobwhites in western Oklahoma. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 51:342–351.

Peoples, A. D. 1992. Production, utilization, and nutritional value of supplemental feed to northern bobwhites in western Oklahoma. M.S. Thesis, Okla. State Univ., Stillwater. 121pp.

Pollock, K. H., C. T. Moore, W. R. Davidson, F. E. Kellogg, and G. L. Doster. 1989*a*. Survival rates of bobwhite quail based on band recovery analyses. J. Wildl. Manage. 53:1–6.

———, S. R. Winterstein, C. M. Bunck, and P. D. Curtis. 1989*b*. Survival analysis in telemetry studies: the staggered entry design. J. Wildl. Manage. 53:7–15.

———, ———, and M. J. Conroy. 1989*c*. Estimation and analysis of survival distributions for radio-tagged animals. Biometrics 45:99–109.

Robel, R. J., A. R. Bisset, T. M. Clement, Jr., and A. D. Dayton. 1979. Metabolizable energy of important foods of bobwhites in Kansas. J. Wildl. Manage. 43:982–987.

Roseberry, J. L. and W. D. Klimstra. 1984. Population ecology of the bobwhite. Southern Ill. Univ. Press, Carbondale. 259pp.

——— and ———. 1992. Further evidence of differential harvest rates among bobwhite sex–age groups. Wildl. Soc. Bull. 20:91–93.

Rosene, W. 1969. The bobwhite quail: its life and management. Rutgers Univ. Press. New Brunswick, N.J. 418pp.

Sauer, J. R. and B. K. Williams. 1989. Generalized procedures for testing hypotheses about survival or recovery rates. J. Wildl. Manage. 53:137–142.

Sermons, W. O. 1987. Reproductive ecology of the bobwhite quail in southern Alabama. M.S. Thesis, Auburn University, Auburn, Ala. 54pp.

Shupe, T. E., F. S. Guthery, and R. L. Bingham. 1990. Vulnerability of bobwhite sex and age classes to harvest. Wildl. Soc. Bull. 18:24–26.

Stoddard, H. L. 1931. The bobwhite quail: its habits, preservation, and increase. Charles Scribner's Sons, New York, N.Y. 559pp.

Vangilder, L. D. and S. L. Sheriff. 1990. Survival estimation when fates of some animals are unknown. Trans. Mo. Acad. Sci. 24:57–68.

White, G. C. and R. A. Garrott. 1990. Analysis of radio-tracking data. Acad. Press, San Diego, Calif. 383pp.

Wilbur, S. R. 1967. Live-trapping North American upland game birds. U.S. Fish and Wildl. Serv. Spec. Sci. Rep., Wildl. 106. 37pp.