Survival of Northern Bobwhite on Hunted and Nonhunted Study Areas in the North Carolina Sandhills

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SURVIVAL OF NORTHERN BOBWHITE ON HUNTED AND NONHUNTED STUDY AREAS IN THE NORTH CAROLINA SANDHILLS

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Abstract: Radio-tagged northern bobwhite (*Colinus virginianus*) were monitored in the Sandhills region of North Carolina to investigate the influences of hunting on seasonal survival. We used the Kaplan-Meier product limit method with staggered entry design to calculate survival estimates and distributions for 79 radio-tagged bobwhite representing 33 coveys during November-February 1987-89. Estimated winter survival rates for year 1 (59%) and for pooled years (67%) in the nonhunted study areas were greater than in the hunted areas (31 and 45%, respectively; $P < 0.05$). Survival trends for the second winter were again greater in the nonhunted study areas (74%) but not different than hunted study areas (63%; $P > 0.05$). Avian predation was the major proximate cause of mortality, accounting for 66% of the known losses. Summer whistle count surveys indicated that nonhunted study areas contained more ($P < 0.05$) whistling bobwhite per station than hunted areas following winter hunting seasons.

Key words: *Colinus virginianus*, hunting, North Carolina, northern bobwhite, Sandhills region, survival, whistle counts.

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Despite the popularity of northern bobwhite as a game bird, the influence of sport hunting on their numbers is poorly documented (Roseberry 1979, Brennan 1991). It has been assumed that annual harvest would substitute for natural population reductions, based primarily on the works of Errington (1934, 1967). Several studies concluded that hunting appeared to have little effect on standing densities of quail (Mosby and Overton 1950, Gallizioli and Swank 1958, Glading and Saarni 1958, Vance and Ellis 1972). Others have voiced concern for the possible effects of hunting on small game populations (Wagner 1969, Nixon et al. 1974, Destefano and Rusch 1982, Bergerud 1985). Stoddard (1931:226) suggested bobwhite hunting losses could become additive to other forms of mortality. Recent evidence suggests that bobwhite harvest and other natural losses may not be completely compensatory (Curtis et al. 1988, Pollock et al. 1989*a*). The later in the winter that harvest losses occur, the more likely they will add to natural mortality (Roseberry and Klimstra 1984:140-150).

The northern bobwhite population at Fort Bragg, North Carolina, has declined steadily during the past decade. Reported bobwhite harvests on the military reservation dropped from about 9,000 birds annually in the mid-1970's to 600 in 1984 (W. M. Hunnicutt, Ft. Bragg Wildlife Branch, unpubl. data). In 1983, a cooperative agreement was established between North Carolina State University and the Department of Defense to investigate the causes of the population reduction and attempt to improve bobwhite management on the reservation. Valuable baseline data were the result of initial phases of the research (Curtis 1990). However, more information was needed upon which to base management decisions. The objectives of our work were (1) to investigate the possible influence of hunting and predation mortality on survival of bobwhite and (2) to examine bobwhite population trends in hunted and nonhunted study areas. If minimal influences were to occur, then we hypothesized that bobwhite survival and population trends on control (hunted) and treatment (nonhunted) areas should be similar.

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STUDY AREA

We studied the northern training portion of Fort Bragg Military Reservation in Cumberland and Hoke counties, North Carolina. The 55,000 ha base is located in the Sandhills physiographic region. Climate was hot and generally humid in summer with a moderately cold, but short winter. Mean annual daily temperature was 16.2 C. Average daily winter temperature was 6.3 C. As reported by Hudson (1984), 60% of the average annual precipitation (115.7 cm) falls between April and September. Mean yearly snowfall total of about 8 cm occurs from December to February.

Predominant overstory species on upland sites were longleaf pine (*Pinus palustris*) and turkey oak (*Quercus laevis*), with a ground cover of primarily wiregrass (*Aristida stricta*). Dense evergreen shrubs (e.g., *Lyonia* and *Ilex* spp.) characterized the mesic habitat. The natural plant communities of the Sandhills region have been described by Wells and Shunk (1931).

The research area was divided into study blocks I and II. Each block contained 2 quail study areas (QSAs) with buffer areas to attenuate impacts of movements between treatment areas. QSAs (approximately 278 ha each) were selected on the assumption that there would be minimal movements between areas. During bobwhite hunting seasons in 1987 and 1988 (November 19-20 to February 28-29), Block I was open to hunting. Hunter trips into this area were controlled by Fort Bragg Hunting and Fishing Center. Block II was used for comparison and was posted and closed to bobwhite hunting.

METHODS

We trapped northern bobwhite during September and October each year with baited funnel traps (Stoddard 1931:443). We placed aluminum leg bands (size 7) on birds and classified them as adults or juveniles according to plumage characteristics and molting stages (Haugen 1957, Rosene 1969). Wing molt and primary feather length were used to estimate date of hatch of juvenile birds (Rosene 1969:44-54). Plumage pattern and coloration were used in sex determination (Stoddard 1931:81).

Birds were fitted with an activity-sensitive chest mounted radio transmitter (7-8 g) (Shields et al. 1982). Efforts were made to distribute radio transmitters on 2-3 birds per covey. Often, captured birds were too immature to carry the transmitter. Occasionally, a single bird was captured with unsuccessful captures of covey mates. Coveys were monitored once every 1-2 days during the hunting season. Bobwhite that died within 7 days of instrumentation were excluded from survival analyses.

Seasonal and annual bobwhite survival rates were estimated by the Kaplan-Meier or product limit estimator (Kaplan and Meier 1958) with staggered entry design (Pollock et al. 1989*b*). Survival rates, confidence intervals, and survival distributions were estimated and compared between nonhunted and hunted QSAs by use of normal approximation *Z*-tests and log-rank tests. Our test is not a direct experimental test of hunted versus nonhunted survival rates, but rather a test of whether bobwhite survival for the 2 hunted areas is different from bobwhite survival for the 2 nonhunted areas.

Characteristic field evidence and postmortem conditions were used to assess the proximate cause of death (after Einarsen 1956). A combination of the evidence was used to classify apparent agent-specific causes of death as follows: (1) small avian predators, (2) large avian predators, (3) mammalian predators, (4) hunting, and (5) other or unknown.

Whistle count surveys were conducted during June 1987-89. A route with 4 listening stations (8 stations per treatment) 1/2 mile apart, was incorporated into each QSA. Surveys began at sunrise on mornings having <50% cloud cover, <19 km/hour winds, and no rainfall. Bobwhite whistles and number of individual birds whistling were recorded at each station for 2 consecutive 5-minute periods. Occasionally disturbance levels due to military activity were high during 1 period, but acceptable during the other period. When this disturbance occurred, the period with the high count was used as the day total for that station. Call-count routes were repeated 5 times each June. Student's *t*-test ($P < 0.05$) was used to detect differences in mean number of whistling bobwhite and mean number of calls heard between nonhunted and hunted QSAs for the 3 years.

RESULTS

Forty-three radio-tagged bobwhite, representing 16 coveys, were at risk during the 1987-88 winter season. Thirty-six bobwhite (17 coveys) were radio-tagged during the 1988-89 winter season. Log-rank tests indicated no differences ($P > 0.05$) in survival functions within hunted and

Table 1. Kaplan-Meier survival estimates of radio-tagged northern bobwhite in the Quail Study Areas (QSAs) at Fort Bragg, NC, winters 1987–89.

Year	QSAs	n[a]	Survival	SE	95% CI[b]
1987–88	Hunted	17	0.308	0.104	0.104–0.512
	Nonhunted	26	0.593[c]	0.098	0.401–0.785
1988–89	Hunted	15	0.629	0.135	0.364–0.894
	Nonhunted	21	0.737	0.097	0.547–0.927
1987–89	Hunted	32	0.453	0.089	0.278–0.627
	Nonhunted	47	0.670[c]	0.070	0.533–0.807

[a]Number of bobwhite at risk at least 1 full week during the winter season.
[b]CI= Confidence interval.
[c]Survival significantly greater ($P < 0.05$) than the hunted QSAs.

nonhunted QSAs between years, so data were pooled to reduce variation.

During the 1987-88 winter season, estimated survival of bobwhite was greater (P = 0.023) in nonhunted QSAs (0.593 ± 0.098) (mean ± SE) than in hunted QSAs (0.3077 ± 0.104) (Table 1). During 1988-89, bobwhite survival in nonhunted QSAs was again higher (0.737 ± 0.097) than in hunted QSAs (0.629 ± 0.135), but not significantly (P = 0.258) (Table 1). For the 2 years combined, winter survival was greater (P = 0.028) in nonhunted QSAs (0.670 ± 0.070) than hunted QSAs (0.453 ± 0.089).

Survival schedules for the QSAs were not uniform throughout the hunting season, but appeared to show a sharp decline in midwinter in nonhunted QSAs. For hunted QSAs, survival began to decline with onset of the hunting season (Fig. 1). A difference was detected (P < 0.05) in survival distributions between nonhunted and hunted QSAs for pooled years. Monthly estimates of survival indicated that the probability of dying (1-survival estimate) was highest in December for hunted QSAs and in January for nonhunted QSAs. The greatest number of bird deaths (14) for all QSAs 1987-89 occurred in January. Predation was the major direct cause of bobwhite mortality during winter, with avian predators accounting for 66% of known mortalities. In hunted QSAs, direct hunter-bagged birds amounted to 14% of bobwhite mortality.

We did not detect a difference in the number of whistling bobwhite heard (P = 0.320) between designated hunted and nonhunted QSAs in 1987, prior to manipulating hunting seasons. Following establishment of the nonhunted QSAs, whistle count surveys indicated more calling individuals per station for nonhunted than for hunted QSAs in 1988 (P = 0.022) and 1989 (P = 0.015) (Fig. 2).

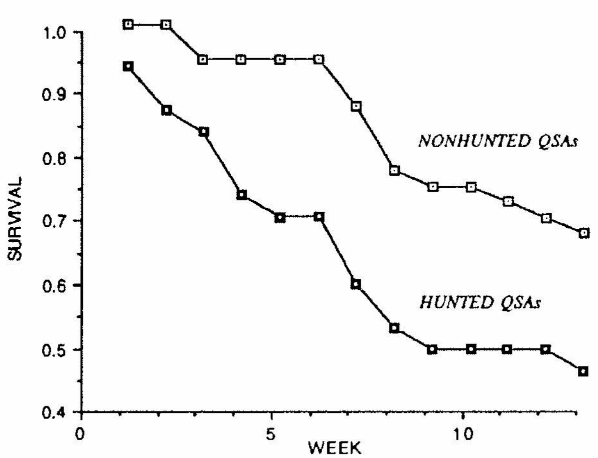

Fig. 1. Northern bobwhite winter survival schedule for hunted and nonhunted Quail Study Areas (QSAs) at Fort Bragg, NC, 1987-89.

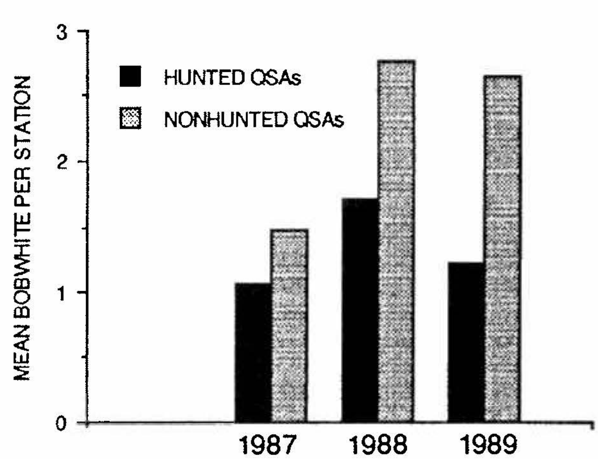

Fig. 2. Frequency distribution of mean number of whistling bobwhite heard per station during June surveys in hunted and nonhunted Quail Study Areas (QSAs) at Fort Bragg, NC, 1987-89.

DISCUSSION

Northern bobwhite naturally exhibit low annual survival. Roseberry and Klimstra (1972, 1984:37-55) and Lehmann (1984:303) suggested that adverse effects could result, depending on when during the winter season losses might occur. Kabat and Thompson (1963) estimated that winter losses for bobwhite were greatest in early winter (mid-November-December) on their Wisconsin study areas. Curtis et al. (1988) observed high natural mortality during January-March in unhunted bobwhite in Florida and hunted birds at Fort Bragg. The lower survival estimates and population trends of bobwhite in our hunted QSAs compared to nonhunted QSAs seemed to suggest hunted birds have higher risks for survival to the breeding season than unhunted bobwhite.

Similar to other workers in the southeastern U.S. (Sermons 1987, Curtis et al. 1988), we observed high depredation on bobwhite. Common predation theory (Errington 1934, 1967) may at times inadequately explain predator-bobwhite relationships in the Southeast (Errington and Stoddard 1938, Curtis et al. 1988, Brennan 1991). Thought should be given to the survival of birds based on disturbance leading to indirect mortality from harvesting activities. Field observations in the QSAs found that coveys disturbed by hunters are vociferous in attempting to reassemble, possibly increasing vulnerability to natural predation. This interpretation remains to be thoroughly tested.

One primary approach used to argue that compensatory natural mortality occurs is that hunted populations are commonly the same as unhunted populations when spring counts are taken (Bergerud 1988). Our whistling count surveys provided some evidence of the response of northern bobwhite populations to hunting. We should not consider ourselves obliged to harvest the surplus, as unharvested surplus birds are not wasted. There is a carryover effect from year to year (Roseberry 1979, 1982) and managers should ensure that these carryover populations are not consistently lower than natural carrying capacity. Low bobwhite populations cannot be expected to recover if hunting activities impede reproductive potential by reducing breeding densities.

Currently, the evidence for compensatory mortality is conflicting (Wagner 1969). However, there is mounting evidence that hunting, particularly late season hunting, and natural mortality are additive. Pollock et al. (1989*a*) argued that it was hard to devise a compensatory mechanism because hunting season coincided with a time of high natural bobwhite mortality. As bobwhite managers charged with the maintenance of a wildlife resource, we should take a more tenable and scientific approach to managing this harvestable crop.

MANAGEMENT IMPLICATIONS

Our work at Fort Bragg suggested that hunting may be a potential factor depressing bobwhite populations, particularly low populations. We should emphasize that this is what occurred on an area with excellent road access and constant hunter effort throughout the season. While recognizing that factors other than hunting contribute to wildlife population declines, hunting is often the most readily controlled cause of mortality (direct and indirect). An underlying theme in what bobwhite do results from the need to remain inconspicuous to avoid predators. If, at existing low densities, predation mortality is excessive and hunting indirectly influences this mortality, then managers should include practices that improve upon these influences. There is a need to determine acceptable limits of harvest pressure while maintaining optimum numbers of breeding bobwhite. Attention should be given to experimental testing of bobwhite population responses to varying exploitation and disturbance levels.

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