Northern Bobwhite Home Range and Survival in Response to Baiting Multiple Roads in Southern Texas: An Observation of Management Concern

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ABSTRACT

An increasingly common practice in southern Texas is baiting roads with grain to facilitate northern bobwhite (*Colinus virginianus*) harvest. Unfortunately, such a practice has the potential to negatively affect bobwhite survival and covey home range size, especially during relatively dry periods. However, the pattern of baiting (i.e., single road vs. multiple road baiting) could influence how baiting of roads affects bobwhites. The objective of the project was to document the effects of multiple-road baiting on bobwhite survival and movements in contrast to baiting only a single road. The project involved two study sites in Jim Hogg County, Texas (one area with a single baited road and one area with multiple baited roads) which were monitored over 3 periods, pre-baiting (Sep – Oct), baiting (Nov – Dec), and post-baiting (Jan – Feb). Bobwhite survival, home range size, and predator abundance was assessed for each area. Bobwhite survival and home range size and predator abundance did not differ between the two baiting patterns. However, during dry conditions, baiting multiple roads in a pasture may be less detrimental to the survival of bobwhite populations than just baiting one road in a pasture.

Keywords: *Colinus virginianus*, movement, northern bobwhites, road baiting, supplemental feeding, survival

Supplemental feeding is used in northern bobwhite (*Colinus virginianus*) management to potentially maintain or increase bobwhite populations (Boyer 1989). Supplemental feeding is thought to achieve this result by correcting potential nutritional deficiencies and mitigating effects of severe climatic stress such as during the harsh winters (Townsend et al. 1999). Supplemental feed is provided to bobwhites by various means such as fixed feeders or by spreading bait along roads. The impacts of supplemental feeding through fixed feeders has been researched extensively (Robel 1969, Boyer 1989, Robel and Kemp 1997, Townsend et al. 1999, Doerr and Silvy 2002, Madison et al. 2000, 2002), but the effects of baiting roads on bobwhites is less well known (Lehmann 1984, Sisson et al. 2000, Haines et al. 2004).

A potential negative effect of baiting roads is that bobwhites are thought to concentrate along baited roads thereby increasing their vulnerability to predation. Research has provided conflicting results. Lehmann (1984) found that road-baiting did not benefit bobwhite quail populations in southern Texas. However, Sisson et al. (2000)

documented that bobwhite survival in Georgia was greater on areas with baited roads than on areas without baited roads, but that such effects varied among years due to weather and condition of native vegetation. More recently, Haines et al. (2004) documented that baiting roads lowered bobwhite quail survival and localized their movements but only during relatively dry conditions when plant seed and arthropod resources were likely to be low. Thus, it appears that the effects of baiting roads on bobwhites can vary with rangeland conditions.

Another potential factor influencing the effect of baiting roads on bobwhites might be pattern of baiting (i.e., single road vs. multiple roads). For example, if bait is spread along multiple roads instead of one road, then bobwhites might not concentrate because they would have numerous feeding opportunities as opposed to only one road. Whether multiple-road baiting achieves this result is unknown. During the study of Haines et al. (2004), an opportunity arose to document the effects of multiple-road baiting on bobwhite survival and movements. Herein we report the observational results of this opportunity.

STUDY AREA

The study area was located on a private ranch 5 miles east of Hebbronville, Texas in Jim Hogg County, within the Rio Grande Plains ecoregion (Gould 1975). Topography was level to rolling with elevation ranging from sea level to 361 yards. The Rio Grande Plains was characterized by rangeland and open prairies dissected with drainages with a growth of mesquite (*Prosopis glandulosa*), huisache (*Acacia farnesiana*), granjeno (*A. berlandieri*), and pricklypear (*Opuntia engelmannii*). Annual rainfall was 14–26 inches and soils ranged from clays to sandy loams (Correll and Johnston 1979). Although large acreages of cultivated land existed within the Rio Grande Plains, predominant land use was livestock production (i.e. rangeland). Land holdings were predominately cattle ranches with abundant wildlife (Correll and Johnston 1979). Potential predators of bobwhites included bobcats (*Lynx rufus*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), opossums (*Didelphis virginiana*), Cooper's hawks (*Accipiter cooperi*), red-tailed hawks (*Buteo jamaicensis*), Harris' hawks (*Parabuteo unicinctus*), sharp-shinned hawks (*A. striatus*), white-tailed hawks (*B. albicaudatus*), and great horned owls (*Bubo virginianus*).

Mean monthly rainfall for July 2001 through February 2002, was 1.3 inches with a mean monthly high temperature of 78.8°F (National Climatic Data Center; http://www.ncdc.noaa.gov). Mean monthly rainfall from July 2002 through February 2003, was 2.2 inches with a mean monthly high temperature of 76.8°F (National Climatic Data Center; http://www.ncdc.noaa.gov).

MATERIALS AND METHODS

The study of Haines et al. (2004) was a two year project that involved a control site (no baiting) and a treatment site (single road baited only during November–December). During their second year of study, the opportunity arose to monitor a third site (i.e., multiple-road baiting). This multiple-road site was contained within a 2,548 acre pasture and separated by > 1.86 miles from the control and single-road site. Approximately twenty roads were baited during the fall-winter season (September – January). This study could not be replicated because nearby landowners were unwilling to halt the use of supplemental feed on roads during the bobwhite hunting season (Oct–Feb).

The impacts of baiting multiple roads on bobwhites on the multiple-road bait site during September–February 2002–2003 were documented. Roads were unpaved secondary roads that traversed through the multiple-road bait site. Beginning in September, land managers distributed a mixture of corn and milo liberally throughout the multiple-road bait site until the end of January. Haines et al. (2004) identified three distinct time periods relative to baiting on the single-road site: September–October ("pre-baiting," with no bait being spread on the single-road site), November–December ("baiting," with bait being spread on the single-road site) and January–February ("post-baiting," with no bait being spread on the single-road site). This schedule allowed for more direct comparison of the effects of road baiting between the multiple-road and single-road bait sites.

The protocol of Haines et al. (2004) was followed to estimate bobwhite survival, home range, and predator abundance on the multiple-road site in order to make this study comparable to their findings. A condensed description of this protocol is provided.

Radio-telemetry

Monitoring of bobwhite survival, home range size, and surveying for predator abundance was conducted along one road on the multiple-road bait site chosen at random. Bobwhites were captured along the selected road using standard funnel traps baited with milo (Stoddard 1931) during the month of August. Four coveys along the road and four coveys > 437 yards from the road were captured, classified by age and sex (Rosene 1969) and weighed to the nearest gram. All captured birds were banded and individual birds weighing >150 grams were radiomarked with a 6-gram, 150–MHz, neck-loop radiotransmitter (American Wildlife Enterprises, Tallahassee, Flor.). To maintain a sample size of > 20 radiomarked bobwhites for each study site, bobwhites were trapped and radiomarked throughout the study period by night-netting roosting coveys (Labisky 1968).

Each bobwhite covey was monitored five times a week (i.e., > 30 locations per time period) via radiotelemetry to document survival and estimate covey home range size (Haines 2003). Home ranges were obtained for each covey for the pre-baiting, baiting, and post-baiting periods, and home range size was determined using the 95% fixed kernel method (Worton 1989, Seaman et al. 1999). All locations were analyzed using the Animal Movement Extension (Hooge and Eichenlaub 1997) of the program ArcView 3.2 (Environmental Systems Research Institute, Inc. Redlands, Calif.).

Predator surveys

Raptor abundance. Following the protocol of Fuller and Mosher (1987), raptor surveys were conducted once per week during morning hours (0730–1100 hrs) using an all-terrain vehicle traveling at approximately 5 miles/hr along each road using the road as the transect line. The number of raptors observed and identified were recorded according to species.

Mammalian predator activity. Scent station surveys were conducted (Conner et al. 1983) for mammalian predator activity every week. Five rows of 5 scent stations were arrayed (n = 25) perpendicular to the road, each row separated by 0.5 miles. Scent stations within a row were located 109 yards apart. Two scent stations extended from each side of the road with a third scent station along the roadway so that scent stations covered approximately 219 yards along both sides of the roads.

Each station consisted of a 1.1-yard diameter circular area cleared of debris and vegetation according to the design of Linhart and Knowlton (1975). Each week, soil in the scent stations was sifted and leveled and a scent capsule with a fish oil attractant was

placed in the middle. Scent stations were prepared in the late afternoon (1400–1830 hrs), and checked the next morning (0730–1200 hrs). The number of operable scent stations visited by mammalian predators were recorded. Because of the proximity between individual scent stations and rows of scent stations, scent stations were not considered independent within study sites, only between study sites.

Statistical analysis

Statistical analysis was conducted to make direct comparisons of the effects of road baiting between the multiple-road and single-road bait sites. Bobwhite survival was determined by using the staggered entry design with individual bobwhites as experimental units (Pollock et al. 1989) and assuming that individual bobwhite survival was not affected by bobwhite covey size. Kaplan-Meier (1958) survival curves using the STAGKAM program (Kuloweic 1988) were calculated for survival for each period. Bobwhites that died or were lost within seven days of capture were consored and excluded from analysis to mitigate the effects of transmitters on bobwhite survival (Pollock et al. 1989). Also censored were all bobwhites that were lost due to radio failure (Pollock et al. 1989). Censored bobwhites were used for survival probabilities up until the date signal loss occurred, but they were not considered mortalities (Burger et al. 1995). Survival curves were compared using log-rank chi-square tests (Pollock et al. 1989) run on a SAS program developed by Kuloweic (1989).

There has been some debate concerning the use of inferential statistics (i.e., ANOVA) for pseudoreplicated studies (Hurlbert 1984, Stewart-Oaten et al. 1986). Because this study was replicated (i.e., psuedoreplication through time), observations were not analyzed using a repeated measures ANOVA design because improper error terms would be used to analyze the main effects. Instead, covey home range sizes were analyzed using a univariate general linear model to test for interaction between treatment and time period. This was done using Proc Mixed in SAS (SAS Institute, Inc. 1989–1996). The statistical model was

$$Y_{ijk} = \mu + T_i + d_{ij} + B_k + (TB)_{ik} + e_{ijk}$$

Where:

Y_{ijk} = Home range size associated with the j^{th} covey in treatment i at time period k

$i = 1,2$

$k = 1,2,3$

$j = 1,\ldots,n_{ik}$

μ, T_i, B_k, and $(TB)_{ik}$ are fixed parameters such that the mean for the i^{th} treatment at time period k is $\mu_{ik} = \mu + T_i + B_k + (TB)_{ik}$

μ = Average of the treatment population means

$T_i = i^{th}$ treatment effect

dij = Random error associated with the j^{th} covey in treatment i

$B_k = k^{th}$ time period

$(TB)_{ik}$ = Interaction between treatment and time period

e_{ijk} = Random error associated with the j^{th} covey in treatment i at time period k

In addition, because this study was not replicated, raptor abundance and mammalian predator activity observations were analyzed using the randomized intervention analysis (RIA) following the methods of Carpenter et al. (1989). Randomized intervention analysis allows for comparison of the paired differences of time series observations for ecosystems before and after manipulation (i.e., baiting). In addition, RIA is not affected by non-normal data (Carpenter et al. 1989). In this case, the RIA method was used to compare paired differences of the weekly number of raptors counted along roads and the weekly number of scent stations visited by mammalian predators between the pre-baiting and baiting periods, and between the baiting and post-baiting periods among study sites for each year. Significance for all statistical tests was inferred at P-Value <0.05.

RESULTS

Survival and home range size

From August 2002–December 2002, 30 bobwhites (n = 15 males, n = 8 females, n = 7 unknown, n = 10 adults, n = 17 juveniles, n = 3 unknown) were trapped on the single-road bait site (Haines et al. 2004), and 21 bobwhites (n = 6 males, n = 8 females, n = 7 unknown, n = 9 adults, n = 12 juveniles) on the multiple-road bait site. Bobwhite survival on the single-road bait site did not differ ($P \geq 0.16$) from the multiple-road bait site during all 3 periods (Table 1).

Table 1. Kaplan-Meier survival estimates ($\hat{S}$) of northern bobwhites on the multiple-road bait and single-road bait sites by time period (pre-baiting [no baiting during Sept–Oct], baiting [baiting during Nov–Dec], and post-baiting [no baiting during Jan–Feb]) in Jim Hogg County, Texas, USA, September–February, 2002–2003.

	Single-Road Bait			Multiple-Road Bait			
Period	n[a]	$\hat{S}$	S.E.	n	$\hat{S}$	S.E.	P-value
Pre	27	0.89	0.069	20	0.92	0.066	0.74
Feeding	22	0.78	0.094	17	0.81	0.094	0.76
Post	17	0.88	0.072	13	0.69	0.015	0.16

[a] Number of northern bobwhites monitored.

No interaction was documented in mean home range size between treatment and time period ($P > 0.10$) for the single-road bait site (Pre-baiting: 0 = 11.50 ± 2.35, n = 8, Baiting: 0 = 9.19 ± 2.1, n = 8, Post-baiting: 0 = 10.27 ± 2.0, n = 8) (Haines et al. 2004) and multiple-road bait site (Pre-baiting: 0 = 16.00 ± 3.35, n = 6, Baiting: 0 = 9.70 ± 1.93, n = 6, Post-baiting: 0 = 5.64 ± 1.54, n = 4).

Predator Survey

Raptor abundance. Species that were counted included Cooper's hawks, sharp-shinned hawks, red-tailed hawks, white-tailed hawks, Harris' hawks, great-horned owls, northern harriers (*Circus cyaneus*), and burrowing owls (*Athene cunicularia*). A difference was found (P = 0.03) between the paired differences of the number of avian predators counted on the single-road bait site compared to the multiple-road bait site between the pre-baiting and baiting periods (Table 2), with more raptors being encountered on the single-road bait site (n = 27) during the baiting period than on the multiple-road bait site (n = 10). However, there was no difference (P = 0.27) between the paired differences of avian

predators counted on the single-road bait site compared to the multiple-road bait site during the baiting and post-baiting periods.

Table 2. Comparison of mean number of raptors counted weekly on the multiple-road bait and single-road bait sites by time period (pre-baiting [no baiting during Sept–Oct], baiting [baiting during Nov–Dec], and post-baiting [no baiting during Jan–Feb]) in Jim Hogg County, Texas, USA, September–February, 2002–2003. Surveys were conducted along a 2 mile transect on each site in the morning (0730–1100 hrs).

	Multiple-road bait			Single-road bait			
Year	n[a]	0	SE	n	0	SE	P-value[b]
Period							
2002–2003							
Pre-	17	2.13	1.32	15	1.88	1.06	
							0.03
Baiting	10	1.25	1.02	27	3.38	1.40	
							0.27
Post-	5	0.63	0.55	12	1.50	1.03	

[a] Total number of raptors counted during each period.
[b] P-value indicates the paired differences of the number of raptors counted during the pre-baiting and baiting periods, and the baiting and post-baiting periods between sites using the Randomized Intervention Analysis.

Mammalian predator activity. Mammalian predators recorded from scent stations included (in order from most to least prevalent) coyotes, feral hogs (*Sus scrofa*), skunks (all skunks assumed to be striped skunks), bobcats, and raccoons (Table 3). No significant difference ($P > 0.24$) was found between the paired differences of the number of scent stations visited by mammalian predators on the single-road bait site compared to the multiple-road bait site during the pre-baiting and baiting periods, and the baiting and post-baiting periods (Table 3). However, during the baiting period there was a trend for a higher number of visits by mammalian predators per 100 scent station nights on the multiple-road bait site ($n = 21.1$) compared to the single-road bait site ($n = 12$) (Table 3).

Table 3. Comparison of the number of visits by species per 100 scent-station nights, surveyed weekly on the multiple-road bait and single-road bait sites by time period (pre-baiting [no baiting during Sept–Oct], baiting [baiting during Nov–Dec], and post-baiting [no baiting during Jan–Feb]) in Jim Hogg County, Texas, USA, September–February, 2002–2003.

	Multiple-road bait			Single-road bait		
Species	Pre-	Baiting	Post-	Pre-	Baiting	Post-
Coyote	2.9	12.0	9.1	7.4	6.3	9.1
Hog	2.9	4.0	1.7	2.3	5.7	1.7
Skunk	4.0	3.4	5.1	1.7	0.0	0.0
Bobcat	1.7	0.6	0.0	0.0	0.0	2.3
Raccoon	1.7	1.1	0.6	0.6	0.0	0.0
Total	13.1	21.1	16.6	12.0	12.0	13.1

DISCUSSION

Baiting multiple roads, over a five month period, had no effect on bobwhite survival, home range, or predator abundance, and observation of similar bobwhite and predator response supports previous research (Lehmann 1984, Doerr and Silvy 2002, Haines et al. 2004). Lehmann (1984) found that road-baiting did not benefit bobwhite quail populations in southern Texas. Doerr and Silvy (2002) reported no difference in

relative predator abundance between sites with and without supplemental feed. All these studies were conducted in southern latitudes (southern Texas) where winters are relatively mild. Thus, it appears that supplemental feed might not affect bobwhite survival in areas with mild winter temperatures. However, drought is common in these southern latitudes and could possibly influence the effect that road baiting has on bobwhites.

Haines et al. (2004) documented that baiting a single road within a pasture concentrated bobwhite movements along the baited road and lowered bobwhite quail survival during one of two years. Haines et al. (2004) attributed this difference to a potential interaction of environmental conditions with road baiting. They observed a treatment effect during a relatively dry year but not in more mesic conditions. Haines et al. (2004) speculated that during dry conditions seed and arthropod production were reduced thereby causing bobwhites to concentrate their foraging activities around baited areas and making them more susceptible to predation.

In theory, baiting multiple roads in a pasture might be less detrimental to bobwhites than single-road baiting during dry conditions. If bobwhites and other prey species feed over an extended area consisting of multiple sites instead of within a single concentrated area, predators and hunters theoretically cannot concentrate their activities to only one area. However, it is difficult for us to determine if the lack of treatment effect resulted from a dispersing effect or mesic conditions. This study was conducted during relatively wet conditions (Haines et al. 2004) when food availability likely was greater. The fortuitous nature of this study did not allow for extension and documentation of the bobwhites' response during more xeric conditions. Thus, it cannot be determined if the lack of effect of road baiting on bobwhite response is due to multiple roads being baited or environmental conditions.

CONCLUSIONS

The study indicates that baiting multiple ranch roads in South Texas offered no discernible benefit for bobwhites during relatively mesic conditions. However, during dry conditions, baiting multiple roads in a pasture might be less detrimental to the survival of bobwhites than baiting a single road through a pasture, but no empirical data exists to support this conjecture.

Further, as suggested by Haines et al. (2004) and Doerr and Silvy (2002), the effects of supplemental feeding might be more apparent in latitudes where winters are more severe and where there are substantially lower temperatures ($< 0^0$ C) (Robel 1969, Robel and Kemp 1997, Madison et al. 2000, 2002). However, such severe winters rarely occur in southern Texas.

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