REPRODUCTIVE ECOLOGY OF NORTHERN BOBWHITE IN SHACKELFORD COUNTY, TEXAS

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Abstract: Northern bobwhite (*Colinus virginianus*) populations have experienced a widespread decline, largely as a result of habitat changes at the landscape level. Although this decline has occurred throughout most of their historic range, quail populations have remained relatively stable in the Rolling Plains of Texas. Prickly pear cactus (*Opuntia* spp.) has invaded thousands of rangeland acres of this ecoregion, thus the control of prickly pear has become a recent and common practice for landowners, especially in Shackelford County, Texas. While the effectiveness of such a practice has been documented (> 95% prickly pear mortality), its effect on northern bobwhite has not. Our objectives were to evaluate the impact prickly pear control has on bobwhite survival and nesting ecology.

Introduction

Quail managers are all too familiar with the "boom and bust" phenomenon of northern bobwhite. Although this is an accepted phenomenon that does not raise many eyebrows, the predicted future of bobwhites is one that may stop people dead in there feet. Bobwhites have experienced a decline throughout most of their geographic region. In fact, it has been predicted that bobwhites will become extinct throughout much of the southeastern US by the year 2005 (Brennan 1991). This decline is often attributed to habitat changes at the landscape level (Brennan 1991). Texas is one of the few states where bobwhite populations have remained relatively stable, especially in the Rolling Plains ecoregion (Church et al. 1993).

Prickly pear cactus (*Opuntia* spp.; hereafter prickly pear) has invaded millions of hectares of Texas rangelands and is perceived as a serious range management problem (Lundgren et al. 1981). Dense stands of prickly pear interfere with forage utilization and livestock movement (Ueckert 1997), while ingestion of prickly pear fruits can cause ulceration and bacterial infection in the lips, tongue, palate, and gastrointestinal tracts of livestock (Merrill et al. 1980). Therefore, many landowners seek to control prickly pear on their rangelands.

Prickly pear control can be achieved through prescribed fire and a subsequent aerial spraying of the herbicide picloram usually applied at a concentration of 0.25 lbs./ac. This tandem of fire and picloram spraying is very effective, achieving 98% mortality of prickly pear (Ueckert et al. 1988). Prickly pear control has become a common practice for the Rolling Plains, especially Shackelford County, to benefit livestock (A. Heirman, Natural Resource Conservation Service, personal communication).

Because of the economic value of quail, the effects of prickly pear control on bobwhite survival and reproduction needed to be evaluated. Prickly pear control may have several negative repercussions for northern bobwhite. Important seed-producing plants (e.g., ragweed [*Ambrosia psilostachya*]) for bobwhite are eliminated from treated areas for several years, a phenomenon referred to as forb shock (A. Heirman, Natural Resources Conservation Service, personal communication). Further, recent research (Carter 1995) in west Texas indicated about 57% and 67% of bobwhite and scaled quail (*Callipepla squamata*) nests, respectively, were situated in prickly pear.

Thus, the widespread control of prickly pear could be detrimental to bobwhite populations.

We conducted a study to document the potential impacts prickly pear control may have on bobwhite survival and nesting ecology. Our objectives were to: (1) compare bobwhite survival between areas of prickly pear control (3-5 years post treatment) and untreated areas; (2) document the use of prickly pear as a nesting site in areas with adequate nesting cover (i.e., bunchgrasses); (3) compare nest success between prickly pear and bunchgrass nests; and, (4) compare bunchgrass density between successful and depredated nests.

Study Area

The study was conducted on 4 private ranches (termed ranch 1, 2, 3, and 4), which are located in Shackelford County, Texas. The eastern portion of the county contained more riparian habitat than the western counterpart (D. Rollins, Texas Agricultural Extension Service, personal communication). Because ranch 1 and ranch 2 were located on the western side of the county, they were termed the west block. Ranch 3 and ranch 4 were located on the eastern side of the county, and thus termed the east block. Each ranch contained untreated and treated (burned and sprayed) sites.

Shackelford County is located in the Rolling Plains of Texas (Gould 1975). The Rolling Plains, an extension of the Great Plains of the central United States, consist of gently rolling to moderately rough topography in northwestern Texas. Average annual rainfall for the Rolling Plains ranges from 55 cm in the west to 75 cm in the east. Seasonal precipitation is lowest during the summer when temperatures and evaporation rates are highest. May and September are the wettest months (Correll and Johnston 1979).

Honey mesquite (*Prosopis glandulosa*) is the predominant woody plant and has increased its density over much of the region in the last 50 years (Guthery and Rollins 1997). Prickly pear is a codominant with mesquite over many areas (Guthery and Rollins 1997). The Rolling Plains is a mosaic of range and cropland, with the majority of the acreage being used for cattle grazing (Correll and Johnston 1979).

Methods

We captured bobwhites within treated (burned and sprayed) and untreated areas using standard funnel traps during spring and summer 1997 and 1998. Bobwhites were fitted with a 6-7 g neck-loop radio transmitter and monitored via radiotelemetry. This allowed us to document bobwhite mortality and nest locations. We categorized bobwhite mortalities as avian, mammalian, unknown predator, or exposure following the criteria listed by Carter (1995). An avian kill site was characterized by a skeleton with the meat stripped off, while the radio transmitter had crimped marks on the antenna. A typical mammalian kill site was characterized by scattered feathers, with carnassial indentations on the radio transmitter.

Once nests were located, they were categorized by fate (successful or depredated), nest habitat (bunchgrass, prickly pear, or shrub), and degree of mechanical protection (bunchgrass, obstructed, mechanical). Concerning nest habitat type, a bunchgrass nest was constructed only of bunchgrasses. Prickly pear nests were those nests situated in, or adjacent to prickly pear, while shrub nests were situated in or adjacent to a shrub (e.g., catclaw). Regarding degree of mechanical protection, bunchgrass nests were those located in bunchgrass only and offering screening but no mechanical protection against nest predators. Obstructed nests were those located along the perimeter of prickly pear or shrub and offered partial mechanical protection. Mechanical nests were those located near the center of prickly pear or shrubs and (presumably) offered the greatest mechanical protection against predators.

Bunchgrass and prickly pear densities were estimated for each nest site (Batcheler 1973). Prickly pear availability also was calculated for treated and untreated sites at each ranch using a belt transect method (Slater 1996). Five 503-m transects were systematically placed within each treated and untreated site. We distributed these transects systematically in order to obtain density estimates representative of the site. We walked along these transects with our arms outstretched perpendicular to the transect. The number of prickly pear plants within this 2-m wide belt transect was recorded. Density for prickly pear for treated and untreated sites then was calculated.

Results

We used 218 radio-marked bobwhites for analysis. Because there was no difference in bobwhite survival between years ($P = 0.97$) or sexes ($P = 0.75$), we pooled data across these factors.

Bobwhite survival did not differ between treated and untreated sites for the west or east blocks (Figure 1). We also detected no difference in type of mortality (i.e., avian, mammalian, or unknown predator) between treatments (Table 1; $P = 0.28$). Because only 1 bird was found dead from exposure during the study, this mortality was not included in analysis.

Eighty-one nests were located, of which 10 (12%) were in shrubs, 24 (30%) were in prickly pear, and 47 (58%) were in bunchgrass. Nest success did not differ among nest habitats (Figure 2; $P = 0.35$), but was dependent on the degree of protection ($P = 0.001$). Mechanical nests had higher nest success than obstructed or grass nests (Figure 3).

Additionally, successful nests were located in areas of higher bunchgrass density ($\bar{x} = 3.1$ plants/m^2) than unsuccessful nests ($\bar{x} = 1.5$ plants/m^2; $P = 0.001$). Nest-site prickly pear densities also were higher than corresponding study site prickly pear densities (Figure 4; $P = 0.000$).

Discussion

Prickly pear control appeared to have no effect on bobwhite survival 3-5 years post treatment under the conditions of our study. We believe this may be attributed to proper grazing management and age of the treatment. In our study areas, grazing is normally postponed (about 90-120 days) following a burn and spray treatment until vegetative growth is sufficient to accommodate moderate grazing pressure. Moderate stocking rates (1 AU/10 ha) were and have been used throughout in our study areas for several years (A. Heirman, Natural Resources Conservation Service, personal communication). Also, Cable (1967) noted the immediate effect from fire on cover and yield of perennial grasses only lasted 1 - 2 years in Arizona. Because of these practices and the fact that our treatment pastures were 3-5 years post treatment, our untreated and treated sites were similar regarding amount of bunchgrass nesting cover. Although treated areas generally were more open (i.e., less brush) than untreated areas, both untreated and treated sites did have loafing coverts (e.g., lotebush) and shelter motts (e.g., chittam) scattered throughout. Predator abundance also did not differ between sites (Hernandez 1999). This similarity in structural vegetation and predator abundance between untreated and treated sites may explain why no difference in bobwhite survival was detected.

Although prickly pear control did not appear to affect bobwhite survival 3-5 years post treatment, it may exert a more long-term impact on bobwhite nesting ecology. Carter (1995) reported a high use (> 57%) of prickly pear as a suitable nesting substrate. However, we questioned whether Carter's (1995) bobwhites were nesting in prickly pear due to overgrazing, prickly pear availability, or protection against predators.

The study sites in Carter's (1995) study were grazed heavily. Thus, the tendency for quail to nest in prickly pear could have resulted from limited bunchgrass availability. However, we observed moderate use (30% of nests) of prickly pear in areas where nesting cover (i.e., bunchgrasses) was not limited (i.e., > 900 nesting clumps/ha). Thus, we speculate that limited nesting cover was not the sole reason why Carter (1995) observed bobwhites nesting in prickly pear.

The placement of bobwhite nests in prickly pear also may be a function of prickly pear availability. If prickly pear is readily available in a pasture, then bobwhites may nest in prickly pear by chance alone. However, we observed that prickly pear densities at nest sites were higher than study site prickly pear densities. Thus, it appears that bobwhites were selecting for prickly pear as a nesting substrate. Unfortunately, Carter (1995) did not document prickly pear density to support his findings.

We believe prickly pear serves as a nest predator deterrent. However, the effectiveness of prickly pear as a deterrent may depend on nest placement. Nest success did not differ by nest habitat, but was influenced by the degree of mechanical protection. A nest placed near the center of a prickly pear (protected from all directions) was less vulnerable to predators than a nest located along the perimeter of a prickly pear (partially protected) or located in bunchgrass (no protection).

Slater (1996) reported that simulated bobwhite prickly pear nests survived better than nests in bunchgrass habitat in areas with limited nesting cover (< 690 potential nest sites/ha). In areas where nesting cover was not limited (> 690 potential nest sites/ha), he observed no difference in nest success between nests in prickly pear or bunchgrass habitats. Our data in Shackelford County support his findings. Successful nests had a higher bunchgrass density than unsuccessful nests.

Besides the study conducted in west Texas by Carter (1995) and this study, evidence bobwhites exhibiting preferences for prickly pear as nesting cover is lacking. For example, in south Texas, only 1 of 189 bobwhite nests was located in prickly pear (Lehmann 1984). In the Oklahoma panhandle, only 1 of 50 scaled quail nests was placed in prickly pear (Schemnitz 1961). This apparent contradiction between prickly pear use in the Rolling Plains of Texas and south Texas may be explained by prickly pear morphology. The structure of prickly pear differs between the 2 ecoregions of Texas, potentially because of different soil compositions, amounts of precipitation, species, or varieties. In the Rolling Plains, prickly pear (*Opuntia lindheimeri*) tends to be multi-stemmed and decumbent (low-growing, about 0.3 m in height). Growth may be characterized as horizontal. In South Texas, prickly pear tends to grow more upright (extending up to 1.5 m) which then branches out into many pads. This growth may be characterized as vertical. The vertical growth of prickly pear, coupled with the fact that surrounding bunchgrass often is absent near the base may explain why bobwhites do not nest in prickly pear in south Texas. Lower density and smaller dimensions of prickly pear in the Oklahoma panhandle (D. Rollins, Texas Agricultural Extension Service, personal communication) may explain the low use of prickly pear as nesting cover by scaled quail in Schemnitz's (1961) study.

Management Implications

We recommend landowners in this region consider an approach of prickly pear management instead of prickly pear eradication. Prickly pear appears to provide a suitable nesting substrate for northern bobwhite. Perhaps, landowners should manage prickly pear with prescribed fire and picloram only in areas of heavy infestations (i.e., solid, expanse stands of prickly pear). Periodic (every 5-7 years) prescribed fire by itself may be used to manage prickly pear in areas of low infestation (Ueckert 1997). A grazing management scheme that ensures adequate nesting cover (> 600 potential nest sites/ha) also is recommended. This management approach would maintain moderate levels of cactus interspersed across the landscape and ensure adequate nesting cover for bobwhites.

Future research is needed to document the immediate impacts (0-3 years post treatment) prickly pear control may have on northern bobwhite. The duration of forb shock and its effect on bobwhite diet and survival also need to be addressed.

Acknowledgments

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Table 1. Fate of radio-marked northern bobwhites (*n* = 218) in Shackelford County, Texas, March-August, 1997-98.

	1997		1998	
Fate	Untreated	Treated	Untreated	Treated
Avian	11	10	10	2
Mammalian	6	5	15	2
Unknown	7	12	4	4
Exposure	1	0	0	0
Accidental[a]	0	2	0	2
Lost signal	6	14	19	26
Slipped radio	2	1	5	3
Alive	1	10	28	10
TOTAL	34	54	81	49

[a] deaths resulting from vehicles or leg entangled in radio transmitter.

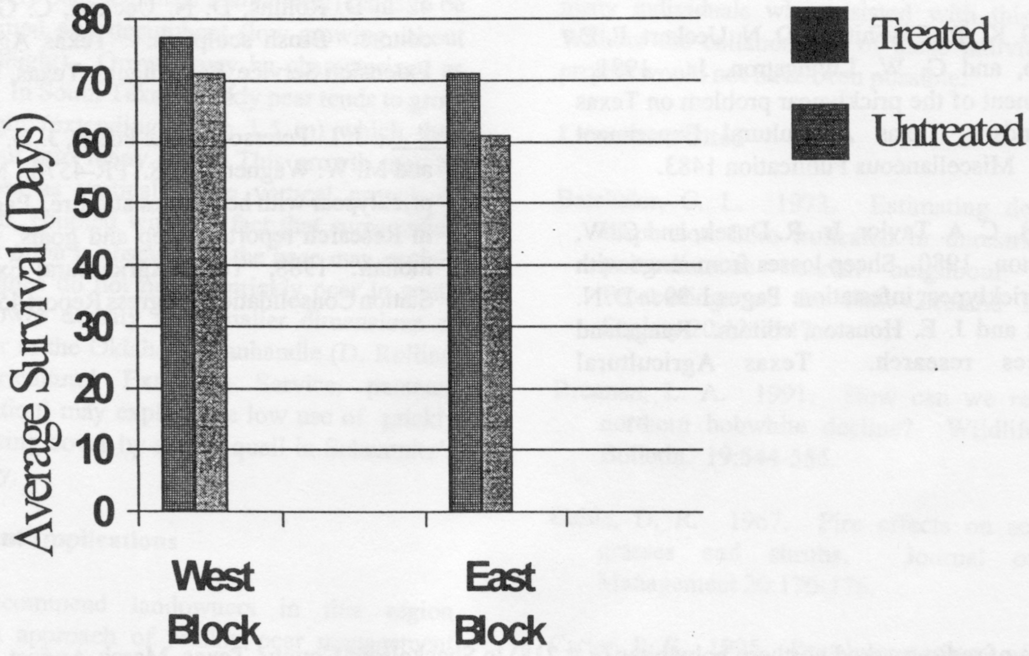

Figure 1. Average survival in days for radio-marked bobwhites in treated (burned and picloram sprayed) and untreated sites in Shackelford, County, Texas, March-August 1997-98. Sample size for west block are treated ($\bar{x}$ = 77 days; n = 57) and untreated ($\bar{x}$ = 71 days; n = 68); east block sample size are treated ($\bar{x}$ = 71 days; n = 58) and untreated ($\bar{x}$ = 61 days; n = 35).

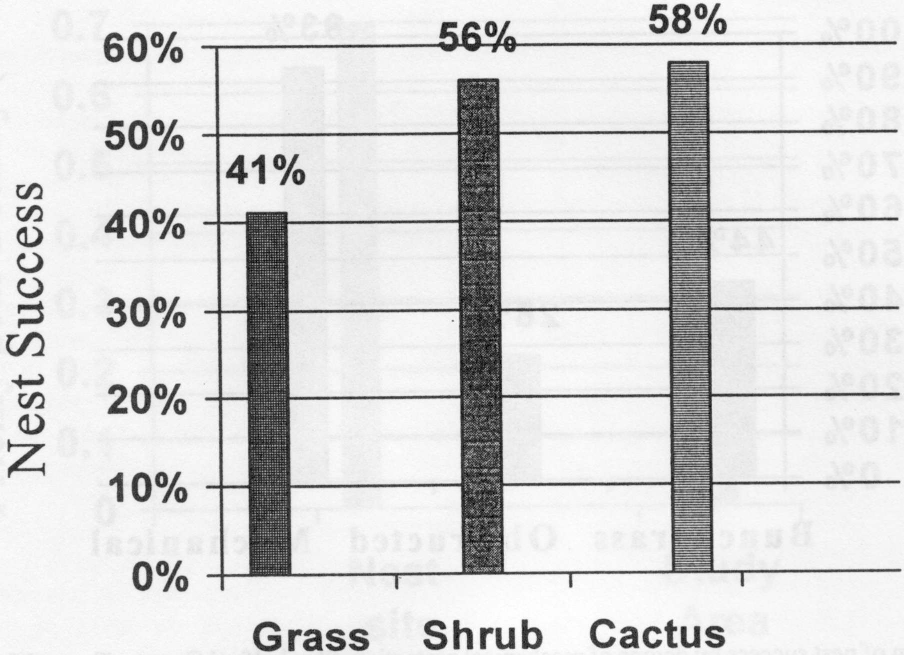

Figure 2. Comparison of nest success by type of nesting habitat, Shackelford County, Texas, March-August 1997-98 (n = 81 nests). Sample size by habitat are bunchgrass (n = 44 nests), shrub (n = 9 nests) and prickly pear cactus (n = 24 nests).

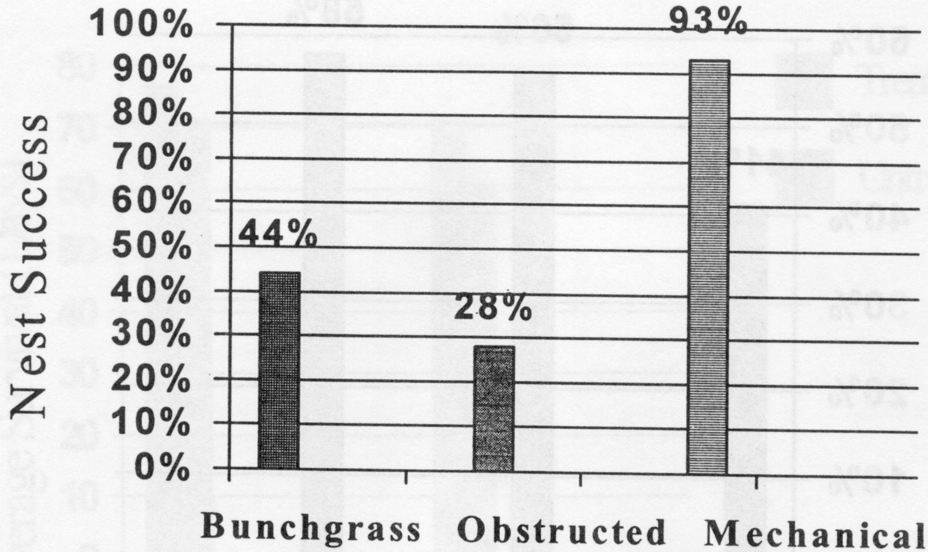

Figure 3. Comparison of nest success by degree of mechanical protection, Shackelford County, Texas, March-August 1997-98 (n = 81 nests). Sample size by mechanical protection are bunchgrass (n = 44 nests), obstructed (n = 18 nests) and mechanical (n = 15 nests).

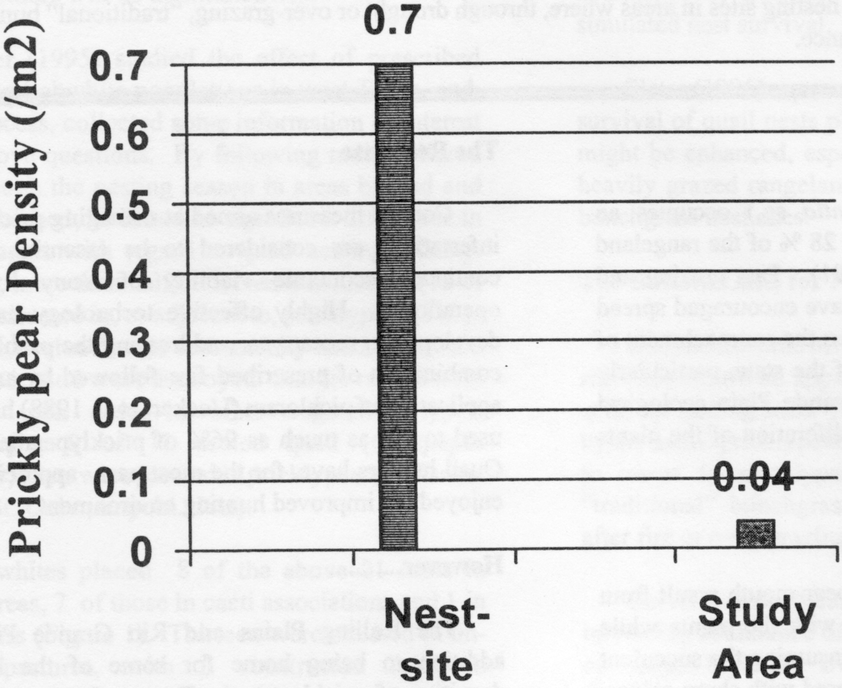

Figure 4. Prickly pear density at bobwhite nest-site locations and study area, Shackelford County, Texas, March-August 1997-98.