Effects of Deer Browsing on Important Quail Food Plants

Sammy W. Stokes, Jr.,[1] *Daniel B. Warnell School of Forest Resources, University of Georgia, Athens, GA 30602-2152*

Philip E. Hale, *Daniel B. Warnell School of Forest Resources, University of Georgia, Athens, GA 30602-2152*

A. Sydney Johnson, *Daniel B. Warnell School of Forest Resources, University of Georgia, Athens, GA 30602-2152*

D. Clay Sisson,[2] *Tall Timbers Research Station, Rt. 1, Box 678, Tallahassee, FL 32312*

Gregory D. Balkcom,[3] *Daniel B. Warnell School of Forest Resources, University of Georgia, Athens, GA 30602-2152*

Abstract: Some land managers think that the effects of increasing numbers of deer (*Odocoileus virginianus*) on habitat have been a factor in the long-term decline of northern bobwhite (*Colinus virginianus*) populations in the Southeast. We studied effects of deer browsing of selected quail foods in northern Florida on an area managed for quail and supporting a population of about 40 deer/km^2. Periodic observations of permanently tagged plants indicated use of some taxa by deer, especially in early autumn. In sample quadrats from which deer were excluded, seed production was greater for partridge peas (*Cassia nictitans* and *C. fasciculata*) ($P = 0.096$) and butterfly pea (*Centrosema virginiana*) ($P = 0.007$) than in quadrats open to deer. Also, vegetative cover was greater inside exclosures for partridge peas ($P = 0.013$) and beggarweeds (*Desmodium* spp.) ($P = 0.009$). Trends for seeds and vegetation of all genera studied, except milk peas (*Galactia* spp.), suggested reductions resulting from deer browsing. Although we demonstrated that deer reduced seed production of some important quail foods, we do not know if this reduction affected the quail population. The question remains whether managed quail populations such as the one we studied are limited by their food supplies, even in the presence of a large deer population.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 48:220–226

[1] Present address: South Carolina Department of Natural Resources, 2007 Pisgah Road, Florence, SC 29501.

[2] Present address: Auburn University, Albany Area Game Management Project, Pineland Plantation, Rt. 1, Box 115, Newton, GA 31770.

[3] Present address: Georgia Department of Natural Resources, Wildlife Resources Division, Game Management Section, Rt. 3, Box 75, Fort Valley, GA 31030.

Northern bobwhite (quail) populations in the southeastern United States have been declining for several decades, even on areas intensively managed for quail. Many factors have been suggested as causes of the decline (Brennan 1991). While quail numbers have declined, white-tailed deer populations have greatly increased. Inverse long-term population trends for deer and quail have led some managers and biologists to speculate that there may be a causal relationship between high deer densities and low quail numbers. In the 1980s, a survey of quail hunting courses on plantations in the Coastal Plain showed an inverse relationship between deer density and quail abundance and revealed that the best quail-producing range had the highest legume biomass (Tall Timbers Res. Sta., unpubl. data).

A review of 27 quail food habits studies, including nearly 20,000 birds, shows that legume seeds are important fall and winter foods of northern bobwhites in the Piedmont and Coastal Plain (Landers and Johnson 1976). Although there are few studies of deer diet in good quail habitat during the growing season, legumes are known to be eaten by deer in the Southeast. Warren and Hurst (1981) rated 267 plant species found in pine plantations in Mississippi according to deer foraging sign. Many important quail foods, including legumes, had high deer use ratings.

Deer need protein-rich foods in spring and summer for lactation, growth, and development (Verme 1962, Murphy and Coates 1966). Native legumes, including important quail foods, fix a substantial quantity of nitrogen, which is stored in the foliage (Hendricks 1989) and becomes an available source of protein to deer. Deer foraging intensively on legumes in summer could diminish the fall and winter quail food resource. The primary objective of our study was to determine the effect of deer browsing on seed production and vegetative cover of selected genera of legumes in managed quail habitat.

Financial support was provided by the University of Georgia Daniel B. Warnell School of Forest Resources, Tall Timbers Research, Inc., and Quail Unlimited. J. L. Landers and J. B. Atkinson formerly of Tall Timbers Research Station and E. G. Darracq formerly of the University of Georgia assisted with this study.

Methods

This study was conducted on Tall Timbers Research Station (TTRS), located in northern Leon County, Florida. This area of the Gulf Coastal Plain, known as the Tallahassee Red Hills, is characterized by red clay soils and gently rolling topography. Most of the region was farmed until the late 1800s when the large quail hunting estates were developed (Komarek 1977).

Most uplands on the 1,375-ha study area have been burned annually for about 70 years and this practice has resulted in an open, parklike landscape. The overstory was dominated by loblolly pine (*Pinus taeda*), shortleaf pine (*P. echinata*), longleaf pine (*P. palustris*), and live oak (*Quercus virginiana*), but other fire-tolerant broad-leaved species also occurred. The understory consisted of a variety of shrubs, forbs, and grasses. Overstory vegetation in the mesic hammocks, where fire was excluded generally, was composed of various deciduous species as well as southern magnolia (*Magnolia grandiflora*) and spruce pine (*P. glabra*).

Deer harvest on TTRS was insignificant (<5/year) until 1988. This allowed deer density to increase to a pre-study level of approximately 38 deer/km^2. In November 1988, TTRS personnel began reducing the population by selective removal of adult does. By the end of our study, 218 deer had been harvested, and estimated density was 17 deer/km^2, based upon repeated track counts and spotlight surveys (unpubl. data). Rumen contents of 37 deer collected in August and September of 1989 and 1990 were analyzed to confirm deer use of important quail food plants on TTRS (Stokes 1992).

Before burning in winter 1989, 20 pairs of upland, annually burned, forested sites that contained abundant native legumes were located. Members of each pair were ≤100 m apart. One member of each pair was randomly selected to receive an exclosure, and the other remained accessible to deer. Twenty 3- × 6-m deer exclosures were built in February 1989. These exclosures were sized to allow a different quadrat to be sampled each year and provide a minimum 1-m buffer strip around the future sampling areas to reduce any effect the wire fencing might have on the experimental plots. The bottom of the fencing was approximately 15 cm above ground to allow access to herbivores other than deer. Total height of each exclosure was approximately 2.5 m. Annual burning was not impeded by the exclosures and continued throughout the study.

Percent vegetative cover and availability of seeds of 5 taxa of important quail food plants were measured inside and outside deer exclosures to determine the effects of deer foraging. Plants sampled included the annual partridge peas and the following perennial legumes: butterfly pea, beggarweeds, milk peas, and lespedezas (*Lespedeza* spp.). Percent cover by each taxon was estimated in 0.5- × 4-m quadrats in October 1989, before frost-kill. Quadrats were subdivided into 4 segments 1 m long and each was assigned 1 of 5 percent-cover classes (<1%, 1–10%, 11–30%, 31–50%, 51–75%, 76–100%) by ocular estimate. A mean value was then calculated for the quadrat by using the midpoint of the percent-cover class for each segment. In December 1989, 0.25- × 4-m transects within quadrats were vacuumed to collect seeds. A 1- × 0.20-m cloth bag was placed in the intake tube of a gasoline-powered vacuum device to catch leaf litter and seeds.

In February 1990, 20 additional pairs of sites were located, and exclosures were constructed for similar sampling in that year. In 1990, percent cover was estimated (October) and seed samples were taken (December) from the additional sites selected in February 1990 as well as from the paired sites established in 1989. Quadrats sampled were adjacent to those sampled previously. No sampling was done in 1991. In October and December 1992, all available pairs of sites were again sampled in quadrats not sampled previously. Each year some site pairs were eliminated because of loss or damage to exclosures or associated unexclosed sampling areas.

Vacuumed litter samples were dried to facilitate storage and seed extraction. Sifting removed most of the leaf litter from the samples. Residual material was separated from seeds and small soil aggregates with a "South Dakota" seed blower column (E. L. Erickson Products, Brookings, S.D.). Soil aggregates were then removed by washing samples over a fine-mesh sieve. Seeds of each of the 5 taxa studied were recorded separately.

Data on percent-cover were arcsine-square root-transformed, and seed count data were square root-transformed before statistical analysis. First, we determined if seed production and percent-cover of each taxon increased over time after deer were excluded. We used 1-way analysis of variance with exclosure age (1, 2, 3, or 4 growing seasons) as the main effect. Each age-site combination was represented in the analysis by the difference in number of seeds (and percent cover) for each taxon between the inside exclosure and outside exclosure quadrats for that age-site combination. Finding no differences, we then pooled data from all years and used paired t-tests to test the null hypothesis of no difference between inside exclosure and outside exclosure sample means. Significance was indicated at $P \leq 0.10$.

Frequency of deer browsing on individual plants was monitored throughout the growing seasons of 1991 and 1992, incidental to a study addressing other objectives (Balkcom 1994). Specimens (N = 250 each) of the dominant or only species representing each of the perennial legume genera studied were located, tagged, and revisited monthly, at which time evidence of browsing by deer was recorded. Number of plants of each species browsed during a month was expressed as a percentage of all plants of that species examined that month. Tagged plants were located along transects established on 10 annually burned, upland sites distributed throughout TTRS (Balkcom 1994) and interspersed among our exclosure locations.

Results

Based on analysis of variance, number of growing seasons that deer were excluded apparently had no effect on percent cover ($P \geq 0.240$) or seed density ($P \geq 0.175$) for any of the taxa we examined. Therefore, we pooled data from all years sampled and compared means inside and outside the exclosures.

Partridge peas, the only annual we studied, had lower coverage (Table 1) and produced fewer seeds (Table 2) in quadrats outside the exclosures. Of the perennial legumes examined, seed density was significantly lower outside the exclosures only for butterfly pea (Table 2); however, numerically, means also were lower for all other taxa except milk peas. Similarly, only beggarweeds had significantly lower coverage outside exclosures (Table 1); but, again for all but milk peas, means were numerically lower outside.

Measurement of deer use of perennial legumes along transects supported data obtained from the exclosure experiment. Monthly examination of these plants indicated most frequent browsing on butterfly pea and beggarweed (Table 3). During September and October, the time of greatest deer use of most

Table 1. Percent groundcover by vegetation of important quail seed food plants sampled inside and outside of deer exclosures, Tall Timbers Research Station, 1989–92.

	Inside (N = 88)[a]		Outside (N = 88)[a]		
Food plants	x	SE	x	SE	P-value[b]
Partridge pea	6.67	1.32	3.62	0.67	0.013
Butterfly pea	2.60	0.44	1.25	0.15	0.159
Beggarweed	2.84	0.40	2.00	0.30	0.009
Milk pea	1.75	0.30	2.32	0.44	0.412
Lespedeza	1.17	0.40	0.69	0.16	0.278

[a]20 exclosures were established in 1989 and 20 more in 1990. We sampled quadrats inside and outside of 20 exclosures in 1989, 38 in 1990 and 30 in 1992.
[b]P-values result from paired t-tests conducted on arcsine-square root-transformed data.

Table 2. Mean seed density (seeds/m^2) of important quail seed food plants sampled inside and outside of deer exclosures, Tall Timbers Research Station, 1989–92.

	Inside (N = 78)[a]		Outside (N = 78)[a]		
Food plants	x	SE	x	SE	P-value[b]
Partridge pea	126.36	43.59	74.82	19.42	0.096
Butterfly pea	10.85	2.15	6.63	1.05	0.007
Beggarweed	0.54	0.21	0.46	0.29	0.379
Milk pea	22.49	6.65	22.85	5.40	0.391
Lespedeza	7.62	2.03	5.56	1.93	0.372

[a]20 exclosures were established in 1989 and 20 more in 1990. We sampled quadrats inside and outside of 10 exclosures in 1989, 38 in 1990 and 30 in 1992.
[b]P-values result from paired t-tests conducted on square root-transformed data.

species examined, 14.5% and 5.6% of butterfly pea and beggarweed plants, respectively, were browsed.

Discussion

Summer diet of deer on TTRS reported by Stokes (1992) supports the apparent use of legumes that we detected. Although percent volume of legumes was low, 17 stomachs of 37 deer collected during August 1989 and September 1990 containing partridge pea fruits and/or vegetation, and at least 4 contained leaves and stems of butterfly pea (Stokes 1992). Additional unidentified legume vegetation fragments occurred in the rumens, and these probably included more of the same taxa and beggarweeds as well. Butterfly pea also has been reported as a deer food on a coastal island in Georgia where it occurred in collections from April through December (Osborne et al. 1992).

During our study, 2 factors may have confounded the potential differences

Table 3. Incidence of browsing by deer on tagged specimens of 4 perennial legumes (N = 250 each) revisited monthly, Tall Timbers Research Station, 1991–92.

	% of plants browsed								
Species	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Butterfly pea	0.8	1.0	1.8	1.3	0.9	13.6	15.4	0.6	0.0
Beggarweed	0.0	0.0	0.2	0.6	0.1	4.0	7.2	0.2	0.0
Milk pea	0.0	0.0	0.6	0.2	0.1	2.0	2.0	0.2	0.0
Lespedeza	0.6	2.4	1.7	0.7	0.3	0.8	0.6	0.2	0.0

between exclosed and open quadrats. The fence used to exclude deer provided additional structural support for climbing legumes, including butterfly pea and milk peas, and may have increased productivity of these species. Although we allowed a buffer ≥1 m around sampling quadrats, seeds from plants growing on the fence may have been propelled into the quadrats when they dehisced. In contrast, deer population reduction that occurred during the 4-year study period may have obscured possible cumulative differences inside and outside exclosures. Nevertheless, deer do appear to have reduced cover and/or seed production of several species of quail food plants on TTRS. Those we found most affected include partridge peas, butterfly peas, and beggarweeds. Comparisons of mean values of seed densities inside and outside exclosures indicate that deer browsing reduced seed production of partridge peas and butterfly pea by 40%. Mean percent-cover of partridge peas and beggarweeds was reduced by 46% and 30%, respectively. Even after these significant reductions, seed densities were high at TTRS.

Effects of deer browsing on legume seeds and vegetation probably vary among locations within the region, and results from our study may not apply to other locations. For example, some areas emphasizing quail management are located on poorly drained acidic soils. These areas, unlike TTRS, produce few legumes, and relatively light browsing pressure might affect quail food production. Also, areas that have been under intensive quail management for a short period with a dense deer herd may not have large seed banks or well developed legume rootstock. Relief from browsing pressure may greatly increase legume productivity on such areas. Additionally, forages growing on inherently poor soils have lower nutritional value, so a deer herd on such an area may make greater use of the nitrogen-fixing legumes.

We do not know at what point deer might actually limit a quail population through reduction of its food supply. Therefore, results from our study do not allow us to determine the role, if any, deer may play in regulating quail numbers. We were unable to locate data on seed densities from an earlier era when densities of quail were high and deer were scarce. Experiments with supplemental feeding might reveal if an inadequate food supply limits quail numbers. Ongoing research in other areas of the Southeast could improve our understanding not only of how deer may affect quail, but also how deer may affect other wildlife species and plant communities. Regardless of any effects of deer on quail, managers should employ a deer harvest strategy that will minimize effects upon plants and maintain a healthy deer herd.

Literature Cited

Balkcom, G. D. 1994. Effects of a September prescribed fire on perennial legume and hardwood survival, groundcover composition, and small mammals in a mature pine forest of northern Florida. M.S. Thesis, Univ. Ga., Athens. 89pp.

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

Hendricks, J. J. 1989. Nitrogen-fixation and litter quality of understory legumes in a burned pine forest of the Georgia Piedmont. M.S. Thesis, Univ. Ga., Athens. 88pp.

Komarek, E. V., Sr. 1977. A quest for ecological understanding. Tall Timbers Res. Sta., Tallahassee, Fla. 140pp.

Landers, J. L. and A. S. Johnson. 1976. Bobwhite quail food habits in the southeastern United States. Misc. Publ. No. 4, Tall Timbers Res. Sta., Tallahassee, Fla. 89pp.

Murphy, D. A. and J. A. Coates. 1966. Effects of dietary protein on deer. Trans. North Am. Wildl. Nat. Resour. Conf. 31:129–139.

Osborne, J. S., A. S. Johnson, P. E. Hale, R. L. Marchinton, C. V. VanSant, and J. M. Wentworth. 1992. Population ecology of the Blackbeard Island white-tailed deer. Tall Timbers Res., Inc. Bul. 26. 108pp.

Stokes, S. W., Jr. 1992. The effects of deer browsing on quail foods in annually burned pine woods in Leon County, Florida. M.S. Thesis, Univ. Ga., Athens. 73pp.

Verme, L. J. 1962. Mortality of white-tailed deer fawns in relation to nutrition. Proc. Natl. White-tailed Deer Disease Symp. 1:15–38. Cent. Continuing Educ., Univ. Ga., Athens.

Warren, R. C. and R. G. Hurst. 1981. Ratings of plants in plantations as white-tailed deer food. Miss. Agric. For. Exp. Sta. Inf. Bul., Miss. State Univ., Starkville. 14pp.