Quality of Spring Deer Diets on Louisiana Pine-Hardwood Sites

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Abstract: Nutritional quality of diets selected by 3 tame deer (*Odocoileus virginianus*) during spring 1980 were determined on forested and clearcut, unburned pine-hardwood sites in central Louisiana. Diets were dominated by leafy browse from plants of moderate to high preference for wild deer. From mid-March to late May, nutritive values of deer diets decreased an average of 43.1% for crude protein, 56.9% for phosphorus, and 9.3% for digestibility. Deer diets from clearcuts were generally higher in nutritive value than diets from forests.

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Abundant rainfall, high temperatures, and heavily leached, moderately to strongly acid soils of the southern coastal plain combine to produce an abundance of native forage of seasonally limited nutritional value. Considering white-tailed deer growth requirements, many native forages are deficient in phosphorus all year (Blair and Halls 1968, Blair et al. 1977, Blair et al. 1980) and adequate in protein only during early spring (Blair and Epps 1969, Short 1969). Southern woody plants typically initiate spring growth from late March to early April, with twig elongation and tissue maturation essentially complete by early summer (Blair and Halls 1968, Halls and Alcaniz 1972). Thus, availability of existing nutrients is further limited by decreased digestibility resulting from rapid forage maturation.

Information on average seasonal quality of many forage species eaten by southern deer is readily available (Blair and Halls 1968, Blair and Epps 1969, Short et al. 1975). Few studies, however, have documented within-

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season changes in the quality of animal-selected diets (Whelan et al. 1971). Although seasonal nutritional averages may be meaningful for much of the year, they are less useful during spring because of rapid changes in plant growth and maturation. Nutritional requirements are especially high during spring because deer must replenish fat reserves, replace winter pelage, grow antlers, and nourish developing fetuses. Thus, knowledge of changes in diet quality during spring is crucial to understanding deer nutrition.

This paper discusses nutritional and botanical composition of spring diets selected by 3 tame white-tailed deer on forested and clearcut, unburned, loblolly-shortleaf pine- (*Pinus taeda-P. echinata*) hardwood sites in central Louisiana from 18 March to 29 May 1980. Nutritional aspects discussed are crude protein, phosphorus, calcium-to-phosphorus ratios, and predicted dry-matter digestibility.

Methods

Study Areas

Four areas, 2 forested and 2 clearcut, were studied on the Kisatchie National Forest in central Louisiana. Forested areas 1 and 5 (a replacement for area 2 that was modified by fire) were multiple-age, second growth stands dominated by loblolly pines 28 to 46 cm in diameter. Clearcut areas 3 and 4 were logged and sheared in 1975 and planted in loblolly pines in 1976. Areas 1 and 3 were located within an 850-ha experimental allotment grazed yearlong by cattle since 1969 (Thill and Wolters 1979). Four 16- to 24-ha clearcuts, 1 of which contained area 3, were created within this allotment in 1975 and 1976. Cattle use had been moderate to heavy on these clearcuts and light in the surrounding forest prior to this study. Herbage removal by cattle was estimated at 35% on area 3 and 10% on area 1 in September 1979 (Thill and Martin 1980). Area 5 and area 4 were located on nearby ungrazed sites. None of the study areas had been burned for at least 5 years prior to study initiation.

Soils are upland coastal plain types with low natural fertility and moderate to poor drainage. Predominant soil series are: area 1—Metcalf silt loam and Beauregard fine sandy loam; area 5—Keithville silt loam and Caddo silt loam; area 3—Susquehanna fine sandy loam and Metcalf; area 4—Mayhew silt clay loam. Slopes vary from 0% to 5%.

Climatic data are for Winnfield, 12 miles north of the study area (National Oceanic and Atmospheric Administration 1980).

Procedures

Tree density (stems/ha $\geqq$ 1.37 m tall) and basal area were determined on areas 1 and 5 using point-sampling techniques (Grosenbaugh 1952) and a 10-factor wedge prism at 50 to 85 points. Current-year production of browse (≤1.52 m tall), forbs, grasses, and grasslike plants was estimated during September 1978 (1979 for area 5) using weight-estimate procedures (Blair 1959). Actual weights were determined from 20% of the 102 to 242 circular plots (0.89 m^2) inventoried on each forested site and from 20% of the 60 to 70 circular plots (0.22 m^2) on each clearcut. All measurements were taken at fixed intervals along randomly selected parallel transects.

Trials were conducted during 6 spring sampling periods of 2 days each at approximately 2-week intervals: 18 and 21 March, 31 March and 1 April, 14 and 15 April, 28 and 29 April, 13 and 14 May, and 28 and 29 May. Areas 1 and 3 were sampled on the first day of each sampling period, areas 4 and 5 on the second day. Trials lasted for 30 to 90 minutes per animal during each period. Animals were harnessed, but allowed to graze freely.

The 3 deer consisted of a doe and castrate buck born in 1977, and a doe born in 1978. All animals were harness-trained and thoroughly familiarized with each study area. Deer were maintained between trials on commercial horse and mule feed supplemented with a wide variety of native plants. The commercial feed contained 13% crude protein (dry-matter basis), 0.44% phosphorus, 0.48% calcium, and had an estimated digestibility (Van Soest 1965) of 65.4%.

Diet composition was quantified using bite-count procedures (Wallmo et al. 1972). Each bite of a plant species was tallied as 1 bite regardless of the number of individual leaves, flowers, or fruits in that bite. If a single bite contained 2 or more species, 1 bite was recorded for each species. Botanical composition values presented for each area are a percentage of the total bite-count for all 6 sampling periods. Botanical nomenclature follows Radford et al. (1968).

Samples for nutritional analyses were hand-plucked during the trials. As far as possible, the samples duplicated deer diets with respect to botanical composition, bite size, and phenology. Where possible, samples were collected from the same browsed plant.

Samples were dried in a forced-air oven at 50° C, ground through a 1-mm screen in a Wiley mill, and analyzed for crude protein, calcium, and phosphorus by AOAC (1980) methods. Cell wall constituents, acid detergent fiber, and lignin were determined following procedures of Goering and Van Soest (1970) and were used in estimating dry-matter digestibility (Van Soest 1965). Although they may not accurately depict actual forage digestibility, these values do indicate relative digestibility associated with seasonal changes (Short 1969). All nutritional values were expressed on a dry-matter basis. Analyses were conducted by the Feed and Fertilizer Laboratory, Louisiana Agricultural Experiment Station, Baton Rouge.

Nutritional data were analyzed using factorial analysis of variance procedures with 4 areas, 5 sampling periods, and 3 deer/area per period. Duncan's new multiple range test (Steel and Torrie 1960) was used to test differences among interaction or main effect means when the area-period interaction term was significant or nonsignificant, respectively. Only periods 2 through 6 were analyzed, because inclement weather prevented sampling of area 5 during period 1. All tests were at the 5% level of significance.

Results

Overstory-Understory Conditions

Area 1 supported nearly twice as many pines as area 5, but total pine basal area was approximately equal, averaging 18.6 m²/ha (Table 1). Hardwoods were 2.6 times as abundant on area 5, and accounted for 2.1 times more basal area than on area 1.

Total understory production averaged 379 kg/ha on forested sites and 3,104 on the clearcuts (Table 1). Forage on both forested sites was limited primarily to browse, but both clearcuts produced an abundance of graminoids (grasses and grasslike plants collectively), forbs, and browse.

Hardwoods, shrubs, and vines were common on all sites. Principal taxa included *Liquidambar styraciflua, Quercus falcata, Q. stellata, Q. alba, Nyssa sylvatica, Acer rubrum, Ulmus alata, Callicarpa americana, Gelsemium sempervirens, Rubus* spp., *Smilax* spp., *Vaccinium* spp., *Crataegus* spp., and *Vitis* spp. Common herbaceous taxa present on both forested sites included *Panicum* spp., *Uniola sessiliflora, U. laxa, Carex complanata, Scleria oligantha, Scutellaria integrifolia, Andropogon scoparius, Mitchella repens, Euphorbia*

Table 1. Stand characteristics of 2 forested sites and understory production (ovendry weight) on all 4 study sites in central Louisiana.

	Forest		Clearcut	
	Area 1	Area 5	Area 3	Area 4
Overstory[a]				
Stocking (stems/ha)				
Pine	612	383		
Hardwood	377	961		
Total	989	1,344		
Basal area (m²/ha)				
Pine	18.7	18.6		
Hardwood	4.0	8.5		
Total	22.7	27.1		
Understory production (kg/ha)				
Grasses	69	92	1,358	1,308
Grasslikes	2	8	254	600
Forbs	32	21	839	222
Browse[b]	301	233	876	750
Total	404	354	3,327	2,880

[a] Overstory measurements included trees 1.37 m or taller. Stocking and basal area were not determined for either 4-year-old clearcut.
[b] Current-year production of leaves and twigs to a height of 1.52 m.

Table 2. Percent contribution of forage classes to spring diets of 3 tame deer on forested (areas 1 and 5) and clearcut (areas 3 and 4) pine-hardwood sites of central Louisiana, 1980.

Area	Forage class	Sampling period[a] 1	2	3	4	5	6	Season mean
1	Browse	81.6	80.3	91.7	89.8	83.2	94.1	86.8
	Mast	0.0	0.0	0.0	0.4	1.4	0.0	0.3
	Graminoids	0.2	0.0	0.2	0.0	3.6	1.2	0.9
	Forbs	18.2	18.1	5.2	9.8	11.3	4.7	11.2
	Fungi	0.0	1.6	2.9	0.0	0.5	0.0	0.8
5	Browse		100.0	89.0	98.0	85.1	92.2	92.9
	Mast		0.0	0.0	0.0	0.1	0.3	0.1
	Graminoids		0.0	7.8	0.1	0.8	2.5	2.2
	Forbs		0.0	3.2	1.9	14.0	5.0	4.8
	Fungi		0.0	0.0	0.0	0.0	0.0	0.0
3	Browse	91.9	77.7	91.9	91.3	80.8	79.6	85.5
	Mast	0.0	0.0	0.0	0.0	4.8	9.6	2.4
	Graminoids	3.8	9.3	2.3	3.3	6.4	0.4	4.3
	Forbs	3.5	13.0	5.8	5.4	8.0	10.3	7.7
	Fungi	0.8	0.0	0.0	0.0	0.0	0.0	0.1
4	Browse	99.8	94.6	76.8	86.5	76.8	81.9	86.1
	Mast	0.0	0.0	0.0	0.0	0.0	2.9	0.5
	Graminoids	0.0	2.4	21.4	10.3	19.2	9.9	10.5
	Forbs	0.2	3.0	1.8	3.2	3.6	5.3	2.9
	Fungi	0.0	0.0	0.0	0.0	0.3	0.0	0.1

[a] Sampling periods: 1 = 18, 21 Mar., 2 = 31 Mar., 1 Apr., 3 = 14, 15 Apr., 4 = 28, 29 Apr., 5 = 13, 14 May, 6 = 28, 29 May.

corollata, and *Stylosanthes biflora.* In addition to the first 5 herbaceous taxa listed above, the following plants were common on both clearcuts: *Andropogon virginicus, Carex flaccosperma, Rhynchospora inexpansa, R. globularis, Aster dumosus, Oxalis stricta,* and *Solidago rugosa.*

Botanical Composition

Food-habits data were based on total bite-counts of 4,762 for area 1, 3,651 for area 5, 4,353 for area 3, and 4,725 for area 4. Browse (consisting of leaves and some young twigs) was the principal forage class consumed throughout spring on all areas, averaging 87.8% of the diets on all areas and on all dates (Table 2). Little mast was eaten until mid-May. Graminoids comprised from 0.9% of seasonal diet on area 1 to a maximum of 10.5% on area 4. Forbs were the second most important forage class on 3 of the 4 areas. Fungi were not abundant and generally comprised less than 1% of the diet, but were readily eaten when encountered. As a group, herbaceous plants comprised an average of 11.4% of the diet across all areas and dates.

Table 3. Principal plants eaten by 3 tame deer on forested and clearcut pine-hardwood sites in central Louisiana, 18 March to 29 May 1980. Values are percentages of the total bite-count for each area.

Species[a]	Forest		Clearcut	
	Area 1	Area 5	Area 3	Area 4
Woody				
Baccharis halimifolia	0.0	0.0	3.0	0.9
Berchemia scandens	9.2	0.9	0.4	1.8
Crataegus crus-galli	2.7	0.4	13.6	4.7
Crataegus marshallii	5.2	0.0	0.3	3.8
Ilex decidua	11.5	15.6	8.8	5.8
Lonicera japonica	0.0	0.3	0.5	19.1
Nyssa sylvatica	4.6	20.3	2.1	16.1
Rhus radicans	3.1	0.6	2.5	0.8
Rubus spp.	4.1	2.8	12.0	6.6
Sassafras albidum	0.0	11.5	0.0	0.0
Smilax bona-nox	2.4	2.7	1.1	3.9
Smilax glauca	0.3	4.8	0.2	0.8
Ulmus alata	15.2	1.5	22.4	1.1
Vaccinium arboreum	1.3	5.1	0.3	1.9
Viburnum dentatum	9.6	0.5	0.6	0.3
Subtotal	69.2	67.0	67.8	67.6
Herbaceous				
Mitchella repens	7.6	0.1	0.0	0.0
Panicum spp.[b]	0.1	0.4	1.3	4.7
Subtotal	7.7	0.5	1.3	4.7
Total	76.9	67.5	69.1	72.3

[a] Species listed contributed 3.0% or more of the total bite-count on at least 1 of the 4 sampling areas.

[b] Low panicum grasses producing basal rosettes during winter.

Principal forage plants (i.e., those comprising 3% or more of the diet on at least 1 area) accounted for 76.9% of the diet on area 1, 67.5% on area 5, 69.1% on area 3, and 72.3% on area 4 (Table 3). Except for *Vaccinium arboreum,* principal woody species selected by the tame deer are also generally considered moderately to highly preferred by wild deer (Goodrum and Reid 1962, Lay 1967). In pine-hardwood sites of east-central Mississippi, Warren and Hurst (1981) assigned *Vaccinium arboreum* a high preference rating for wild deer during spring.

Nutritional Composition

Crude protein (CP) requirements of white-tailed deer have been suggested as 13% to 16% for optimum growth and 6% to 7% for maintenance (French et al. 1956). Protein content of hand-plucked samples exceeded 7% CP for all dates on all sites (Table 4). Samples from clearcuts exceeded 13% CP from mid-March through late April, but forest samples did not exceed 13% CP until late March and contained significantly ($P < 0.05$) less CP than

Table 4. Crude protein content ($\bar{x} \pm$ SE) of spring forage samples that duplicated diets of 3 tame deer feeding in pine-hardwood forests and clearcuts of central Louisiana.

Sampling period	Dates (1980)	Forest		Clearcut	
		Area 1	Area 5	Area 3	Area 4
1[a]	18, 21 Mar	12.0 ± 2.3	—	16.8 ± 0.9	18.1 ± 0.7
2	31 Mar, 1 Apr	14.3 ± 1.6A[b]	15.0 ± 0.2A	18.6 ± 0.6B	19.7 ± 2.0B
3	14, 15 Apr	16.8 ± 0.7AB	19.1 ± 1.2B	18.6 ± 0.8AB	16.2 ± 0.3A
4	28, 29 Apr	14.6 ± 0.2A	16.0 ± 0.8A	14.9 ± 0.2A	16.6 ± 1.4A
5	13, 14 May	11.6 ± 0.5A	14.4 ± 0.6B	12.9 ± 0.7AB	12.5 ± 0.3AB
6	28, 29 May	10.4 ± 0.2A	11.6 ± 0.1A	10.6 ± 0.9A	9.5 ± 0.2A

[a] Period 1 data were excluded from statistical tests because of area 5 missing data.
[b] Means within rows without letters in common are significantly different ($P < 0.05$).

either clearcut during that period. Peak CP levels occurred later on forests than on clearcuts, but differences were generally not significant after late March. Considering all areas, CP declined an average of 43.1% (8.1 percentage points) from maximum to minimum levels within an average span of 47.5 days, or 0.91%/day.

Dietary phosphorus requirements for deer have generally been reported as 0.25% to 0.30% for maintenance and 0.56% for optimum growth (French et al. 1956, Magruder et al. 1957). However, Verme and Ullrey (1972) reported excellent growth in fawns fed a ration containing 0.35% phosphorus. The maximum phosphorus content encountered here was 0.34%. Levels at or above 0.25% occurred during 4 sampling periods on area 3, during 1 period on areas 4 and 5, but were not encountered in area 1 samples (Table 5). Phosphorus content of area 3 samples were significantly greater than either forest during periods 2 through 6, and area 4 samples contained significantly more phosphorus than either forest during periods 2 and 4. Considering all areas, phosphorus declined an average of 56.9% (0.16 percentage points)

Table 5. Phosphorus content ($\bar{x} \pm$ SE) of spring forage samples that duplicated diets of 3 tame deer feeding in pine-hardwood forests and clearcuts of central Louisiana.

Sampling period	Dates (1980)	Forest		Clearcut	
		Area 1	Area 5	Area 3	Area 4
1[a]	18, 21 Mar	0.17 ± 0.04	—	0.27 ± 0.02	0.22 ± 0.01
2	31 Mar, 1 Apr	0.22 ± 0.04A[b]	0.19 ± 0.01A	0.34 ± 0.01C	0.27 ± 0.01B
3	14, 15 Apr	0.24 ± 0.01A	0.25 ± 0.01A	0.34 ± 0.02B	0.24 ± 0.01A
4	28, 29 Apr	0.18 ± 0.01A	0.18 ± 0.01A	0.25 ± 0.01B	0.22 ± 0.02B
5	13, 14 May	0.13 ± 0.01A	0.12 ± 0.01A	0.20 ± 0.01B	0.15 ± 0.01A
6	28, 29 May	0.11 ± 0.01A	0.09 ± 0.01A	0.17 ± 0.01B	0.11 ± 0.01A

[a] Period 1 data were excluded from statistical tests because of area 5 missing data.
[b] Means within rows followed by unlike letters are significantly different ($P < 0.05$).

Table 6. Calcium-to-phosphorus ratios ($\bar{x} \pm$ SE) for spring forage samples that duplicated diets of 3 tame deer feeding in pine-hardwood forests and clearcuts of central Louisiana.

Sampling period	Dates (1980)	Forest		Clearcut		Period mean
		Area 1	Area 5	Area 3	Area 4	
1	18, 21 Mar	11.2 ± 5.3	—	3.1 ± 0.3	4.2 ± 0.5	6.2
2	31 Mar, 1 Apr	6.9 ± 2.3	4.5 ± 1.2	2.6 ± 0.3	3.1 ± 0.6	4.3A[a]
3	14, 15 Apr	5.3 ± 0.3	3.8 ± 2.0	2.4 ± 0.4	2.5 ± 0.2	3.5A
4	28, 29 Apr	7.6 ± 0.6	4.1 ± 0.3	3.0 ± 0.5	2.3 ± 0.4	4.3A
5	13, 14 May	12.2 ± 1.0	5.9 ± 1.6	4.8 ± 0.7	3.5 ± 0.5	6.6B
6	28, 29 May	14.8 ± 2.3	6.4 ± 1.2	7.8 ± 2.1	4.3 ± 0.6	8.3C
	Area mean[b]	9.4C	4.9B	4.1AB	3.1A	

[a] Sampling period means without letters in common are significantly different ($P < 0.05$); likewise for area means.

[b] Period 1 data were excluded from statistical analyses because of missing data and are not reflected in column means.

from maximum to minimum levels within an average span of 47.5 days, or 1.21%/day.

Optimum calcium-to-phosphorus (C:P) ratios have not been established for deer, but ratios from 2:1 to 1:2 are often suggested for other ruminants. Although there is evidence that high ratios are not critical provided there are sufficient amounts of each, high levels of calcium reduce rates of phosphorus assimilation (Maynard and Loosli 1956). Ratios above 10:1 are not uncommon in southern deer foods (Blair and Epps 1969).

Minimum C:P ratios occurred in mid-April on areas 1, 3, and 5, and in late April on area 4 (Table 6). The highest ratio of 14.8:1 occurred in late May on area 1. The area mean for area 1 was significantly higher than the other 3 areas. Mean sampling-period C:P ratios for periods 2 through 4 were similar ($P > 0.05$), but were significantly lower ($P < 0.05$) than those for periods 5 and 6. When averaged across all areas, C:P ratios increased an average of 139.9% (4.9 units) from minimum to maximum levels within an average span of 40.5 days, or 3.5%/day.

Predicted digestibility of samples from clearcuts were significantly greater than for forested sites (Table 7). Maximum levels of digestibility occurred during mid-April for areas 3 and 5, and in late April for areas 1 and 4. Digestibility of samples collected from late March through late April were not different ($P > 0.05$), but digestibility had declined significantly by mid-May. Changes in digestibility as spring progressed were substantially less than observed for protein and phosphorus. Considering all areas, digestibility declined an average of 9.3% (5.5 percentage points) from maximum to minimum levels within an average span of 37 days, or 0.25%/day.

Table 7. Predicted digestibility ($\bar{x} \pm$ SE) of spring forage samples that duplicated diets of 3 tame deer feeding in pine-hardwood forests and clearcuts of central Louisiana.

Sampling period	Dates (1980)	Forest		Clearcut		Period mean
		Area 1	Area 5	Area 3	Area 4	
1	18, 21 Mar	53.2 ± 5.2	—	60.2 ± 1.6	59.3 ± 0.9	57.6
2	31 Mar, 1 Apr	55.5 ± 2.2	55.4 ± 2.8	62.9 ± 1.8	61.6 ± 1.8	58.9B[a]
3	14, 15 Apr	54.4 ± 2.4	56.5 ± 0.2	63.3 ± 0.8	59.9 ± 0.2	58.5B
4	28, 29 Apr	56.5 ± 0.9	54.8 ± 0.6	61.0 ± 0.7	62.1 ± 0.8	58.6B
5	13, 14 May	55.1 ± 0.6	51.5 ± 2.1	58.5 ± 0.4	56.3 ± 1.7	55.4A
6	28, 29 May	53.3 ± 0.3	49.5 ± 2.1	57.2 ± 2.7	56.3 ± 1.6	54.1A
	Area mean[b]	55.0A	53.5A	60.6B	59.2B	

[a] Sampling period means followed by unlike letters are significantly different ($P < 0.05$); likewise for area means.

[b] Period 1 data were excluded from statistical analyses because of missing data and are not reflected in column means.

Discussion

Average temperatures during March, April, and May 1980 were 1.2°, 2.5°, and 0.4° C below the 1941–1970 averages of 13.1°, 17.0°, and 22.7° C, respectively. Rainfall during the 3 months in 1980 exceeded long-term averages (12.7, 13.8, and 14.7 cm) by 11.2, 12.1 and 5.0 cm, respectively. Halls and Alcaniz (1972) reported that initiation of spring growth by 16 browse species was closely and positively correlated with March temperatures. Kozlowski (1964) reported delays in spring growth initiation under higher soil moisture conditions. The combination of below normal temperature and above normal rainfall experienced during the spring of 1980 would be expected to slow growth and delay phenological development. Consequently, nutritional quality may peak earlier than encountered here in years with a drier and/or warmer spring.

Deer in this study were restricted to specific sites having fairly uniform conditions. Wild deer would normally have access to a wider variety of sites including recent burns. Within 1 or 2 years after burning, diets from burned sites would likely be higher in quality than those reported here (Lay 1957*a*).

Nutritional quality of simulated diets from both clearcuts was higher earlier and generally reached higher nutritional levels than those from both forests, suggesting that deer may benefit nutritionally through greater use of young clearcuts during early spring. The fact that protein content of clearcut samples were substantially higher than 13% by 18–21 March suggests that deer may be able to obtain sufficient protein for growth even in late winter on comparable sites.

Diets of tame deer consisted primarily of plants preferred by wild deer; however, the quality of diets selected by wild deer inhabiting similar sites are unknown. Effects of commercial feed on quality of diets selected by tame deer are also unknown. It appeared, however, that tame deer selected as good a diet as possible for these particular sites; i.e., diets consisted primarily of young leaves for preferred forage species.

Dietary deficiencies are considered the principal cause for small body size and low deer populations in upland forests in the South (Short et al. 1969). It has long been recognized that deer inhabiting southern upland sites are generally more limited by forage quality than forage availability (Lay 1957*b*). Data presented here further substantiate this contention, and further suggest that deer diets from comparable unburned sites may become deficient in protein and phosphorus for optimum growth well before the end of spring.

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