United States
Department of
Agriculture

Forest Service

**Southern Forest
Experiment Station**

New Orleans,
Louisiana

Research Paper
SO-289
September 1995

Effects of Prescribed Burning and Cattle Grazing on Deer Diets in Louisiana

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SUMMARY

A study was conducted on the dietary and nutritional effects of cattle grazing and rotational prescribed burning on the diets of three to five captive white-tailed deer (*Odocoileus virginianus)* on longleaf pine (*Pinus palustris* Mill.)–bluestem *(Andropogon* spp. and *Schizachyrium* spp.) sites in central Louisiana from October 1980 through February 1987. Deer diets were evaluated under ungrazed, moderate year-long, heavy seasonal, and heavy yearlong cattle grazing treatments. Deer diets were composed mostly of browse and forbs under all grazing treatments, but were less diverse under heavy grazing when compared with moderate and no grazing treatments. Foraging efficiency (computed as the ratio of forage intake per 30-minute trial to the distance traveled) was comparable among treatments during spring and fall but was lower under the heavy grazing treatment during summer and winter. Diets selected under ungrazed conditions contained the highest percentage of uncommon and ephemeral plant taxa during all seasons except fall. Dietary crude protein (CP), phosphorus (P), and calcium-to-phosphorus ratios varied significantly under various grazing treatments for certain seasons. Prescribed burning did not significantly affect diet diversity; however, diets from areas of first-year burns were higher in CP and P than from areas of older burns during spring and summer, but these differences disappeared by the first fall after burning. From a nutritional standpoint, burning and seasonal influences generally had more impact than grazing treatments on deer diets. No evidence was found that seasonal or yearlong cattle grazing at moderate levels (40- to 50-percent herbage removal) adversely affected deer nutrition.

ACKNOWLEDGMENTS

Thanks are extended to W.R. Thacker and R.D. Her-rick for many hours of dedicated field assistance and to J.G. Kie, H.S. Crawford, and H.A. Pearson for reviewing earlier drafts of the manuscript.

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INTRODUCTION

This study was initiated to evaluate the effects of cattle grazing and associated prescribed burning on white-tailed deer *(Odocoileus virginianus)* diets and nutrition within the longleaf pine (*Pinus palustris* Mill.)-bluestem *(Andropogon* spp. and *Schizachyrium* spp.) range type of the Southeastern United States. Bluestem grasses dominate the herbaceous understory on about 2 million ha in southern Louisiana, Mississippi, and Alabama and northwestern Florida. Cattle grazing has been a controversial issue throughout this region for many years (Thill 1985).

Although often abundant, southern deer forage on these sites is typically low in nutritional value. Deer diets are phosphorous (P) deficient all year (Blair and others 1977) and adequate in crude protein (CP) for optimum growth only during spring (Short 1969). Consequently, southern upland deer herds are considered to be limited more by forage quality than by quantity (Lay 1957).

Prescribed burning is used extensively throughout southern Coastal Plain forests for preparation of pine seedbeds, fuel reduction, wildlife habitat enhancement, forage quality improvement, and rotating livestock distribution. Winter burning on a 3-year rotation is generally advocated for livestock forage management (Duvall and Whitaker 1964) and fuel reduction (Sackett 1975). Burned sites attract deer and cattle, and diets derived from recently burned sites are temporarily higher in quality than on older burned or unburned sites (Lay 1967, Stransky and Harlow 1981, Thill and others 1987). Nevertheless, the availability of deer forage may be sufficiently reduced by concentrated cattle use of recently burned sites, and this may affect the botanical and nutritional composition of deer diets.

The objective of this study was to evaluate the effects of prescribed burning and several grazing treatments on deer diets relative to botanical and nutritional composition, foraging efficiency, and diet selectivity.

STUDY AREAS AND METHODS

The study was conducted from October 1980 through February 1987 on adjacent east and west pastures of what was known historically as the headquarters pasture of the Palustris Experimental Forest in central Louisiana. Both the east and west pastures were divided by firelines into three subunits for burning purposes (each about 18 ha) that served as separate sampling areas. One subunit per pasture per year was burned in late February on a 3-year rotation. Prior to this study, both pastures had been burned at about 3- to 5-year intervals since 1959.

The study was conducted in two phases of 3 years each. In phase 1, deer and cattle diets were studied in the east pasture under moderate yearlong grazing (MY); only deer diets were studied in the adjacent ungrazed (UG) west pasture (table 1) (Thill 1982, Thill and Martin 1986). Phase 1 nutritional aspects have already been reported by Thill and others (1987). In phase 2, cattle stocking on the MY pasture was doubled to obtain heavy yearlong grazing (HY), and the UG pasture was subjected to heavy seasonal grazing (HS) from mid-April through October. Deer and cattle dietary overlap for phase 2 was summarized by Thill and Martin (1989). In this report, the effects of burning and heavy yearlong and heavy seasonal cattle grazing on deer nutrition and foraging behavior are summarized and compared with the results of phase 1 data.

The 30-year-old pine overstory of both pastures had been thinned in 1976, and in 1984 averaged 15.2 m^2/ha of longleaf pine and 1.1 m^2/ha of hardwood basal area. Current-year browse production averaged >400 kg/ha on both pastures during phase 1 (Thill and Martin 1989) and was estimated at or slightly above this level during phase 2. Herbage production and use varied with years since last burn (table 1). For additional study area and treatment details, see Thill(l982) and Thill and Martin (1986, 1989).

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Table 1.— ***Overstory basal area, cattle stocking, and herbage standing crop and use by study phase, grazing treatment, and year after burning for central Louisiana study areas***

			Basal area*				Herbage¶	
Study phase*	Pasture	Treatment+	Pines	Hardwoods	Cattle stocking*	Year after burning	Standing crop	Use
			········ *m²/ha* ········		*AU/mo.*		*kg/ha*	*Percent*
1	East	MY	13.4	1.3	1.8	1st	1,098	46
						2nd	567	29
						3rd	847	26
	West	UG	13.5	1.0	0.0	1st	1,036	**
						2nd	1,084	
						3rd	965	
2	East	HY	14.6	1.4	3.8	1st	1,135	67
						2nd	770	52
						3rd	884	50
	West	HS	15.8	0.8	3.4	1st	1,260	77
						2nd	1,025	58
						3rd	983	61

*Inclusive sampling dates: phase 1 = Oct. 1980 to Aug. 1983; phase 2 = Apr. 1984 to Feb. 1987.

†UG = ungrazed, MY = moderate yearlong grazing, HS = heavy seasonal (15 Apr. to 1 Nov.) grazing, and HY = heavy yearlong grazing.

*Mean overstory basal area of pines and hardwoods across subunits in 1981 (phase 1) and 1984 (phase 2).

§Mean cattle stocking (animal units [AU] per month) over the entire grazing season (i.e., yearlong for all but the heavy seasonal grazing treatment).

¶Measured in October following the procedures of Thill (1982).

**Herbage use was not measured because cattle were excluded from this pasture.

Data on deer food habits were obtained by direct observation of leashed, tame deer during four sampling periods: spring (21 March to 10 June), summer (23 June to 13 September), fall (22 September to 25 November), and winter (5 January to 4 March). Methods employed during both phases of the study were identical except for minor differences in starting and ending dates of seasonal trials. Four to five feeding trials (each involving three to five deer) were conducted on each subunit at about equal time intervals throughout each season. Trials were begun at random starting points and were conducted between 0730 and 1500 hours. Distances walked by each animal during the 30- to 45-minute trials were estimated to the nearest 0.1 km on a pedometer worn by the observer. As most trials were conducted for 30 minutes, all distances traveled for shorter or longer trials were adjusted to a 30-minute basis as follows:

Estimated travel distance per 30 minutes =

(actual distance traveled) (30) / actual trial duration.

Two deer (a doe and a castrate) used throughout the 6-year study were 3.5 years old at study initiation (October 1980). A 2.5-year-old doe was also used throughout phase 1. Two additional does (8 months old) were added during 1981 winter trials; one of these was used throughout the remainder of the study and the other was used only during the remainder of phase 1. Thus, three to five deer were used during most of phase 1, and three deer were used throughout phase 2. Deer were maintained between trials on commercial horse and mule feed (13 percent CP, 0.44 percent P, and 0.48 percent calcium [Cal) and a variety of native plants. Feed was removed the evening before each trial to assure sufficient foraging.

As each deer foraged, simulated diet samples were handplucked that mimicked the deer's foraging in species composition, plant parts, phenology, and forage weight. Simulated diet samples were dried to a constant weight at 50°C, weighed, and ground through a l-mm screen. Weights were used as estimates of forage intake. The ratio of forage intake to the distance traveled per 30 minutes was used as an index of foraging efficiency. A composite forage sample was prepared for each subunit and date by mixing 15 g of the diet sample for each deer observed. Composite samples were analyzed for CP, Ca, and P (Association of Official Analytical Chemists 1984) and for cell wall constituents (CWC), acid detergent fiber (ADF), and acid detergent lignin (ADL) (Goering and Van Soest 1970). Forage intake per 30 minutes was multiplied by CP and P percentages to derive estimates of CP and P intake. Nutritional analyses were conducted by the Louisiana State University Feed and Fertilizer Laboratory, and results were expressed on a dry matter basis.

Diets were quantified using bite-count procedures (Thill 1984). Bite-count data from all animals were cornposited across dates for each subunit to derive diet composition values for each season. Data presented on diet diversity are based on these cornposited data, not on the individual diets from each foraging trial. We evaluated the effects of burning and grazing on diet selectivity by calculating the percentage of the diet composed of uncommon and/or ephemeral species (Hobbs and others 1983). Uncommon species were defined as those having a frequency of occurrence in the fall averaging <1 percent over 162 permanent 0.89-m^2 quadrats per subunit. As a measure of the contribution of ephemeral or uncommon foods to the diet, high values suggest greater selectivity.

Nutritional data were analyzed in a three-factor (four seasons, four grazing treatments, and three burn ages) complete block analysis of variance (ANOVA) with blocking over years (3 years per phase for all parameters except selectivity with 2 years) using BMDP statistical software (Dixon and others 1985). The following two-way interactions were considered: grazing by season, grazing by year, burn by season, and grazing by burn. Within-pasture (phase 1 versus phase 2) differences in forage-class use were tested with a similar ANOVA. Differences among means were tested using Tukey's multiple range test (Steel and Torrie 1960). All tests were at the 0.05 alpha level. Because treatments were not replicated, inferential statistics were used only to interpret the data; it is acknowledged that treatment and site effects were confounded (Hurlbert 1984). However, because both of these adjacent pastures have historically received similar burning and forest management treatments and have predominantly similar soils (primarily Ruston fine sandy loam and Smithdale sandy loam), the authors feel that observed differences are due to treatment effects rather than site differences.

Findings for phases 1 and 2 are based on 706 and 497 hours of deer observations and a total of 303,773 and 130,225 bite-counts, respectively. Observation time was distributed equally among subunits within each season. For our purposes, ferns were grouped with forbs, and browse included leaves and tender twigs of trees, shrubs, and vines. Graminoids refer collectively to grasses and grasslike plants.

RESULTS

Forage-Class Use

Deer diets were dominated by browse and forbs throughout both phases of this study (tables 2 through 4) (Thill and Martin 1986, 1989). Browse comprised ≥50 percent of the yearlong diet except for the most recent burns during spring under UG and MY grazing. Within-pasture (phase 1 versus phase 2) comparisons of forage-class use indicated that grazing treatments did not significantly affect browse use on either pasture (tables 2 and 3), except for year 3 when browse use increased under HY grazing compared with MY grazing (table 3). Fruit use was significantly greater under UG and MY treatments than under the HS and HY grazing of phase 2 (tables 2 and 3). Graminoid use declined significantly on the MY-HY pasture from phase 1 to phase 2 (table 3), but declined only during year 1 on the UG-HS pasture (table 2). Forb use was comparable under UG and HS grazing (table 2); however, HY grazing was accompanied by significantly greater second-year forb use, but lower third-year forb use relative to MY grazing (table 3).

Burning did not significantly affect graminoid or fungi use by deer in either pasture or browse use in the UG-HS pasture (table 4). Browse and forb use on the MY-HY pasture varied with the year of the study as well as years since burning, but forb use was generally highest the first year after burning in both pastures. Fruit availability and use were reduced throughout the first year after burning relative to the second and third year after burning (table 4).

Diet Diversity

Prescribed burning did not affect diet diversity (i.e., the number of plant taxa eaten by deer) in either the UG-HS (P = 0.603) or MY-HY ((P = 0.372) pasture. Diet diversity was affected by grazing intensity (P <0.0001) and season (P <0.0001) in both pastures and by the study year (P = 0.0005) in the UG-HS pasture; none of the interaction terms were significant (P >0.357). Within pastures, diet diversity decreased significantly with increased cattle use during phase 2 (fig. 1). Diet diversity followed consistent seasonal trends for all four grazing treatments, declining from highest levels during spring to lowest levels during winter (fig. 1). Deer selected less diverse diets at the end than at the beginning of this study (fig. 2); furthermore, diet diversity declined even during phase 1 on the UG pasture, suggesting that deer use alone may have affected the availability of preferred, uncommon plant species on these relatively small sampling areas.

Table 2.— *White-tailed deer forage class use under ungrazed conditions (1980–83) and heavy seasonal grazing (1984–87) of a pine–bluestem range in central Louisiana**

Forage class	Year of study	Ungrazed		Heavy seasonal		
		$\bar{x}$	SE	$\bar{x}$	SE	*P*†
Browse		64.3 a	2.4	69.4 a	2.1	0.191
Fruits		6.9 a	1.4	3.5 b	0.7	0.018
Graminoids	1st	5.3 a	1.3	2.1 b	0.5	0.027
	2nd	2.3 a	0.5	3.2 a	1.0	
	3rd	3.6 a	1.2	1.5 a	0.9	
Forbs		23.8 a	2.5	21.7 a	2.0	0.433
Fungi		1.2 a	0.2	3.2 b	0.9	0.014

*Values are grazing main-effect means (n = 34 to 36) and grazing-by-year interaction means (n = 11 to 12). Means within rows followed by unlike letters are significantly (P <0.05) different.

†*F*-value probabilities for grazing main effects. The probability listed for graminoids is for the grazing-by-year interaction term.

Table 3.— *White-tailed deer forage class use under moderate yearlong (1980–83) and heavy yearlong (1984–87) cattle grazing of a pine–bluestem range in central Louisiana**

Forage class	Year of study	Moderate yearlong		Heavy yearlong		
		$\bar{x}$	SE	$\bar{x}$	SE	*P*†
Browse	1st	63.3 a	3.1	64.6 a	3.5	0.003
	2nd	60.2 a	2.9	54.8 a	4.1	
	3rd	52.4 a	5.0	68.4 b	3.0	
Fruits		5.3 a	0.9	2.3 b	0.4	<0.001
Graminoids		7.5 a	1.4	2.3 b	0.4	<0.001
Forbs	1st	22.5 a	3.4	25.4 a	4.0	<0.001
	2nd	26.1 a	4.5	38.0 b	4.2	
	3rd	32.7 a	4.1	25.3 b	3.2	
Fungi		1.5 a	0.3	3.2 b	0.9	0.011

*Values are grazing main-effect means (n = 34 to 36) and grazing-by-year interaction means (n = 11 to 12). Means within rows followed by unlike letters are significantly (P<0.05) different.

†*F*-value probabilities for grazing main effects. The values listed for browse and forbs are for the grazing-by-year interaction term.

Grazing Effects by Season

Grazing effects varied by season for all nutritional and foraging variables evaluated (P 50.006); the most apparent differences were for CP, P, and Ca:P ratios (figs. 3 through 5). Except for forage selectivity, ADL, ADF, and CWC (figs. 4 and 5), nutritional and foraging variables were not significantly affected by grazing treatments during spring, nor were CP, CP intake, P, P intake, ADL, or CWC affected during summer. Although forage selected during fall and winter was generally significantly higher in CP and P under the heavier grazing of phase 2, reduced forage intake due to grazing-induced reductions in forage availability largely negated this grazing benefit (fig. 3).

Forage Ca levels were generally lowest during spring and highest during summer (fig. 3). During the entire year, Ca:P ratios exceeded the 2:1 to 1:2 ratios often recommended for domestic ruminants (Maynard and Loosli 1969).

Except for spring UG-HS pasture data, heavier cattle grazing reduced deer forage intake, but differences were significant only during winter (both pastures) and on the UG-HS pasture during summer (fig. 4). Intake under each grazing treatment was generally highest during spring and consistently lowest during winter. Deer traveled comparable distances per 30 minutes under all grazing treatments during spring and fall, but traveled significantly farther during summer and winter under HY than under MY grazing (fig.

Table 4.— *Prescribed burning effects on within-pasture forage class use by white-tailed deer on a pine–bluestem range in central Louisiana**

Pasture†	Forage class	Year of study	1st year $\bar{x}$	1st year SE	2nd year $\bar{x}$	2nd year SE	3rd year $\bar{x}$	3rd year SE	P‡
West (UG-HS)	Browse		66.5 a	2.9	65.2 a	2.8	70.0 a	2.5	0.386
	Fruits		2.2 a	0.7	8.0 b	1.7	5.3 b	1.0	<0.001
	Graminoids		3.0 a	0.8	2.7 a	0.5	3.3 a	0.9	0.331
	Forbs		25.7 a	3.0	22.1 ab	2.5	19.3 b	2.2	0.014
	Fungi		2.7 a	0.8	1.9 a	0.9	2.1 a	0.9	0.755
East (MY-HY)	Browse	1st	61.1 a	5.3	67.7 a	3.9	63.1 a	2.6	0.002
		2nd	50.3 a	4.3	57.1 ab	4.4	65.1 b	3.1	
		3rd	62.6 a	4.5	47.6 b	6.2	71.0 a	2.8	
	Fruits		1.4 a	0.5	5.3 b	1.1	4.6 b	0.9	<0.001
	Graminoids		3.5 a	1.0	5.9 a	1.9	5.3 a	1.0	0.369
	Forbs	1st	31.5 a	6.0	18.3 b	2.8	22.1 b	2.8	<0.001
		2nd	42.7 a	6.0	31.2 b	4.9	22.3 b	3.5	
		3rd	29.8 a	3.7	37.7 a	5.3	19.5 b	2.2	
	Fungi		2.5 a	0.7	2.5 a	0.8	2.4 a	1.0	0.923

*Values are burning main-effect means (n = 18 to 26) and burning-by-year interaction means (n = 8). Means within rows followed by unlike letters are significantly (P <0.05) different.

†UG = ungrazed, HS = heavy seasonal grazing, MY = moderate yearlong grazing, HY = heavy yearlong grazing.

*F-value probabilities for burning main effects. Values listed for east pasture browse and forbs are for the year-after-burning by year-of-study interaction terms.

4). Foraging efficiency was similar among grazing treatments during spring and fall, but was significantly lower during summer and winter for both pastures under heavier phase 2 grazing (fig. 4).

The contribution of uncommon and/or ephemeral plant species ("selectivity") was highest under ungrazed conditions (fig. 4). Heavier phase 2 grazing significantly reduced forage selectivity on both pastures during spring and on the UG-HS pastures during winter.

Grazing Effects by Years After Burning

For a number of variables, grazing effects varied by number of years after burning (**P ≤0.038**) **(fig. 6).** Acid detergent fiber was significantly greater on third-year than on first-year burns under UG conditions. Calcium-to-phosphorus ratios were significantly lower on second- and third-year burns than on first-year burns under UG conditions. Deer traveled significantly farther on first-year than on second- or third-year burns under UG and HS grazing. Foraging efficiency tended to be greater on second- and third-year burns than on first-year burns, and these differences were significant for UG conditions and for first- versus second-year burns under MY grazing. Deer tended to forage more selectively on first- and second-year burns, but patterns were inconsistent among grazing treatments.

Burning Effects by Season

For a number of response variables, the effects of burning varied by season (P ≤0.003) **(fig. 7).** Within seasons, differences were most apparent on first-year burns; none of the differences (except for P intake

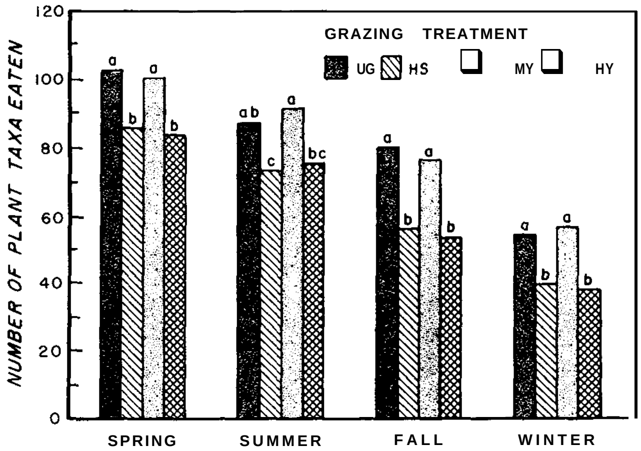

Figure 1.-*Number of plant taxa eaten by white-tailed deer on a pine-bluestem range, in central Lousiana, under ungrazed (UG), heavy seasonal (HS), moderate yearlong (MY). and heavy yearlong (HY) grazing by season. Values are means for composited diets of three to five deer over four to five sampling dates per season averaged across 3 years and three burned subunits. Means within seasons labeled with unlike letters are significantly (P <0.05) different.*

during summer> between second- and third-year burns were significant. Compared with second- and third-year burns, first-year burns yielded diets significantly higher in CP and P during spring and summer, and these differences tended to be reflected in CP and P intake. Nevertheless, the effects of burning were short lived, as fall and winter CP and P intake tended to be higher on older (second- and third-year) burns. Calcium, Ca:P ratios, and CWC were also influenced significantly by burn ages (fig. 7).

Only forage intake and ADL had nonsignificant burning-by-season interaction terms. Values for both variables were significantly lower for first-year burns (n = 237) than for second- (n = 232) or third-year burns (n = 195), but values for second- and third-year burns were alike ($\bar{x} \pm$ SE: intake-1.34 ± 0.03, 1.54 ± 0.03, 1.49 ± 0.04; ADL-9.67 ± 0.15, 11.09 ± 0.17, 10.89 ± 0.16 [values are for the first, second, and third years after burning, respectively]).

DISCUSSION

Available information indicates that forage preferences are similar for wild and tame deer (Neff 1974, Olson-Rutzand Urness 1987, Wallmo and Neff 1970) and that use of tame deer with extensive familiarity with the study area should minimize potential biases (Bartmann and Carpenter 1982). All of the deer used in this study received extensive familiarization with study areas prior to their use, and the two older deer had 3.5 years of experience on grazed and ungrazed forested range prior to this study.

Supplemental feeding apparently has little effect on forage preferences (Regelin and others 1976), but its effects on nutritional selectivity are unknown. Whether wild deer on a lower nutritional plane would (or could) select higher quality diets is unknown, but it appeared that the deer in this study were attempting to maximize diet quality through selective foraging of phenologically young material from preferred species. Findings by Thill and others (1987) and Hobbs and others (1983) have shown that selection for uncommon and/or ephemeral species is positively correlated with diet quality. Thus, although nutritional levels presented here should be viewed only as estimates for wild deer, the approach used in this study should be valid for making relative comparisons when the same animals and techniques are employed across treatments.

High dietary overlap is insufficient evidence of competition in the absence of concomitant data on reproduction, fawn survival (as it relates to nutrition and hiding cover), or behavioral responses of deer to cattle grazing practices. The findings from this study demonstrate that grazing and burning can affect deer by altering forage composition and availability, which in turn affect foraging selectivity, foraging efficiency, diet diversity, and diet quality. These interactions are often inconsistent and difficult to interpret (Mackie 1978). Some nutritional factors improved following heavy grazing whereas others worsened. For example, fall diets contained more P on both pastures after heavy grazing, but estimated P intake declined during winter due to grazing-induced reductions in forage intake.

By late October, herbage removal across subunits averaged 34, 56, and 65 percent for MY, HY, and HS treatments, respectively (table 1); herbage removal on recently burned subunits averaged 46, 77, and 67 percent for MY, HY, and HS treatments. If herbage use had been measured on MY and HY pastures just prior

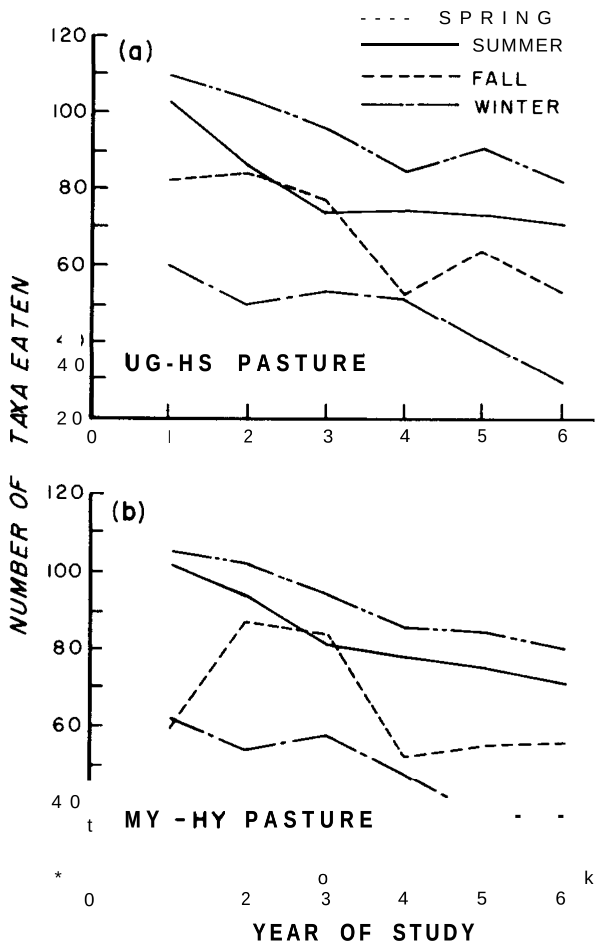

Figure Z.-Yearly *changes in the number of plant taxa eaten by white-tailed deer on a pine-bluestem range in central Louisiana. Each mean is based on composited data for three to five deer over four to five dates per season for three sampling areas (burned subunits) for (a) ungrazed (UG) / heavy seasonally (HS) grazed pasture and (b) moderate yearlong (MY) / heavy yearlong (HY) grazed pasture.*

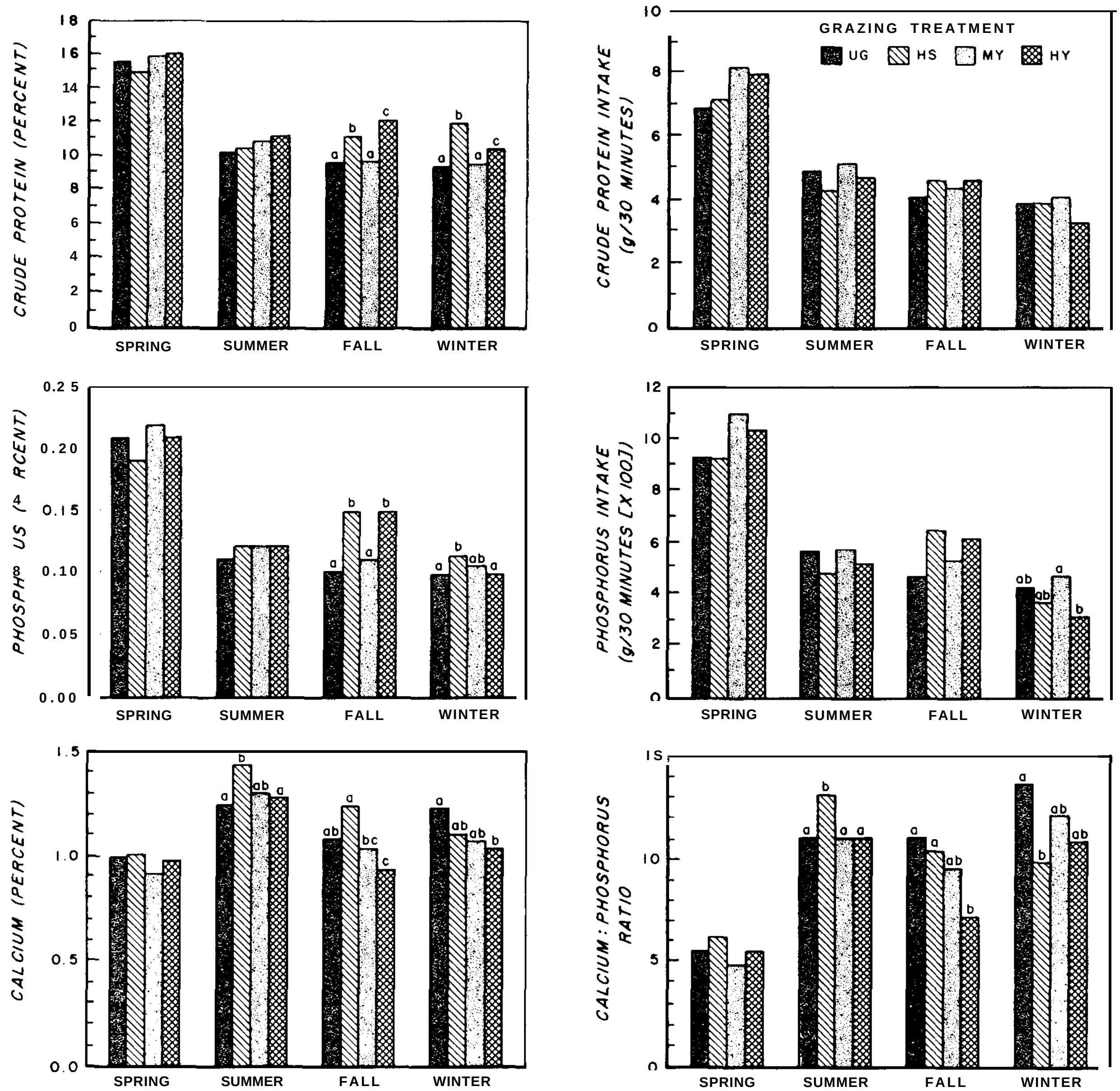

Figure 3.-Grazing-by-season *effects on white-tailed deer diet quality on a pine-bluestem* range *in central Louisiana, 198047, for crude protein, crude* protein *intake, phosphorus, phosphorus intake, calcium, and calcium-to-phosphorus ratio. UG = ungrated, HS = heavy seasonal grazing, MY = moderate yearlonggrazing, HY = heavy yearlong grazing. Values are grazing-by-season interaction means (*n = 36 *to* 45). *Significant differences within seasons are denoted by unlike letters.*

to spring greenup, use would have been considerably higher than in late October because grazing continued yearlong. Consequently, deer were exposed to relatively high grazing pressure under all three grazing treatments, and especially so on the recently burned areas. Nevertheless, from a nutritional standpoint, deer were generally more affected by burning and seasonal influences than by cattle grazing. None of the grazing treatments adversely affected CP, CP intake, P, or (with the exception of HY grazing during winter) P intake. Although cattle grazing was associated with some increase in dietary fiber levels (fig. 5), the small differences observed from spring through fall are likely of little biological significance. Thus, these data suggest that any negative effect that cattle grazing may have on wild deer using comparable sites would likely be more related to reductions in cover, availability of preferred forage, and/or forage diversity than to reduction in forage quality per se.

Heavy seasonal and heavy yearlong grazing both resulted in reduced floral diversity and availability of preferred forages, and these reductions were accompanied by greater deer movement, reduced forage intake, and diets of lower diversity. At some threshold following increasingly heavier cattle stocking, reductions in such factors as availability of preferred forage, forage diversity, and hiding cover presumably would limit deer use of these areas despite possibilities for obtaining higher quality diets. Loft and others (1991) found that female mule deer (0. *hemionus*) were not displaced from established home ranges by moderate or heavy cattle grazing of their summer range. However, in response to grazing, deer made greater use of less preferred habitats that were avoided by cattle, and deer home range sizes increased accordingly. Other accounts of spatial displacement of deer by cattle are largely anecdotal; however, displacement may be as or more important in deer/cattle interactions than forage competition. Despite close association with cattle for most of their lives, the deer in this study always seemed skittish whenever cattle were within sight or sound. Michael (1967) reports that cattle and deer that grazed in close proximity usually displayed mutual indifference. Others report displacement, movement of deer from heavier stocked to lighter stocked pastures, or movement to areas with greater grazing deferment (Cohen and others 1989, Ellisor 1969, Hood and Inglis 1974, Kramer 1973, Reardon and others 1978, Suring and Vohs 1979).

From a nutritional standpoint, late February burning resulted in significantly higher (relative to burns from previous years) levels of forage CP and P during spring and summer and P intake during spring in the year immediately following burning (fig. 7). Deer also consumed more uncommon and ephemeral species on recent than on older burns of UG and MY treatments (fig. 6), presumably due to increased physical availability following litter removal. The fact that deer were

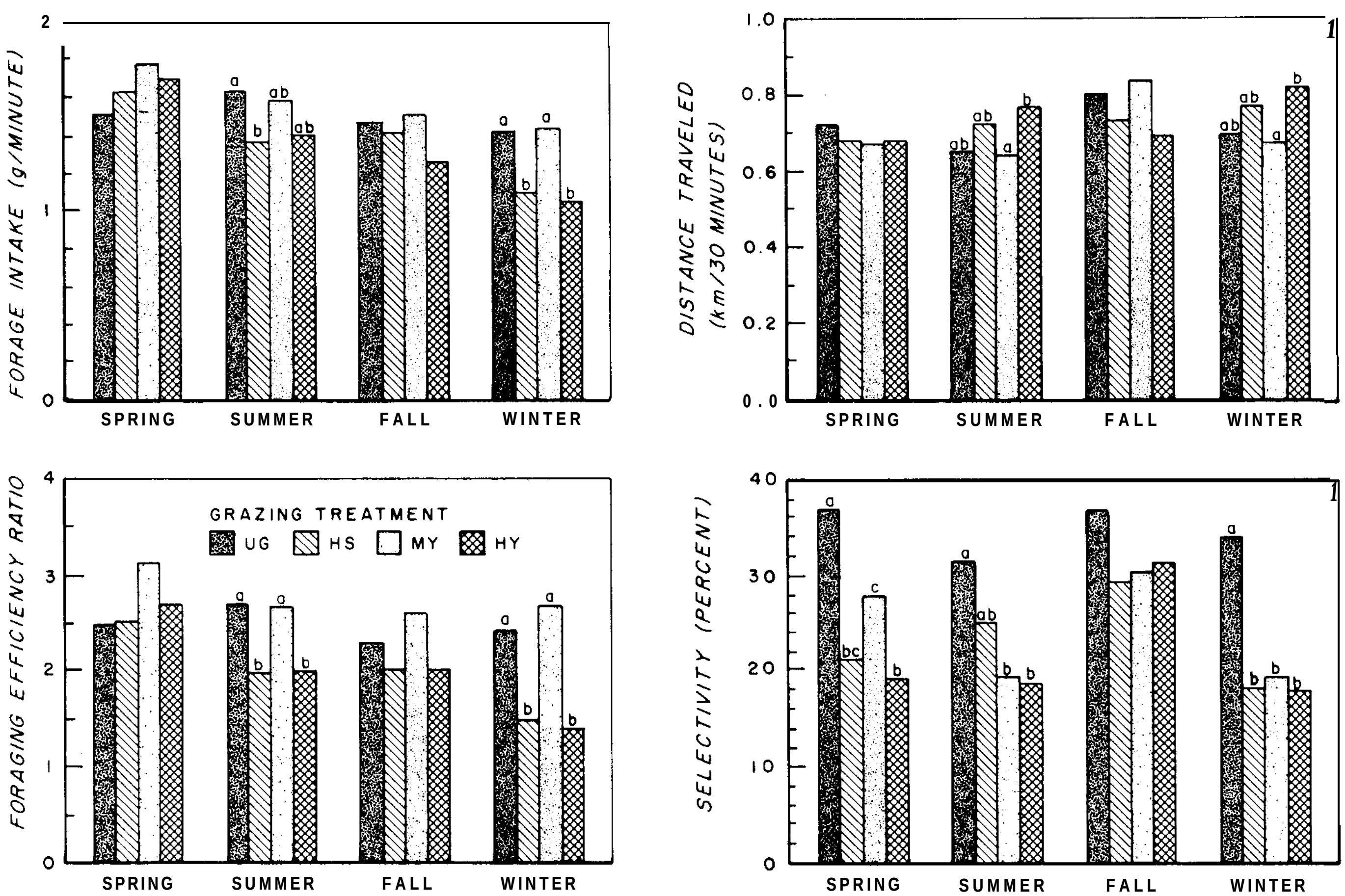

Figure 4.-Grazing-by-season *effects on white-tailed deer foraging activity on a pine-bluestem range in central Louisiana, 1980–87, for forage intake, distance traveled, foraging efficiency, and selectivity. Foraging efficiency ratio is the ratio of forage intake to distance traveled per 30 minutes. UG = ungrazed, HS = heavy seasonal grazing, MY = moderate yearlonggrazing, HY = heavy yearlonggrazing. Values are grazing-by-season interaction means (n = 36 to 45 except for selectivity where n = 24 to 30). Significant differences within seasons are denoted by unlike letters.*

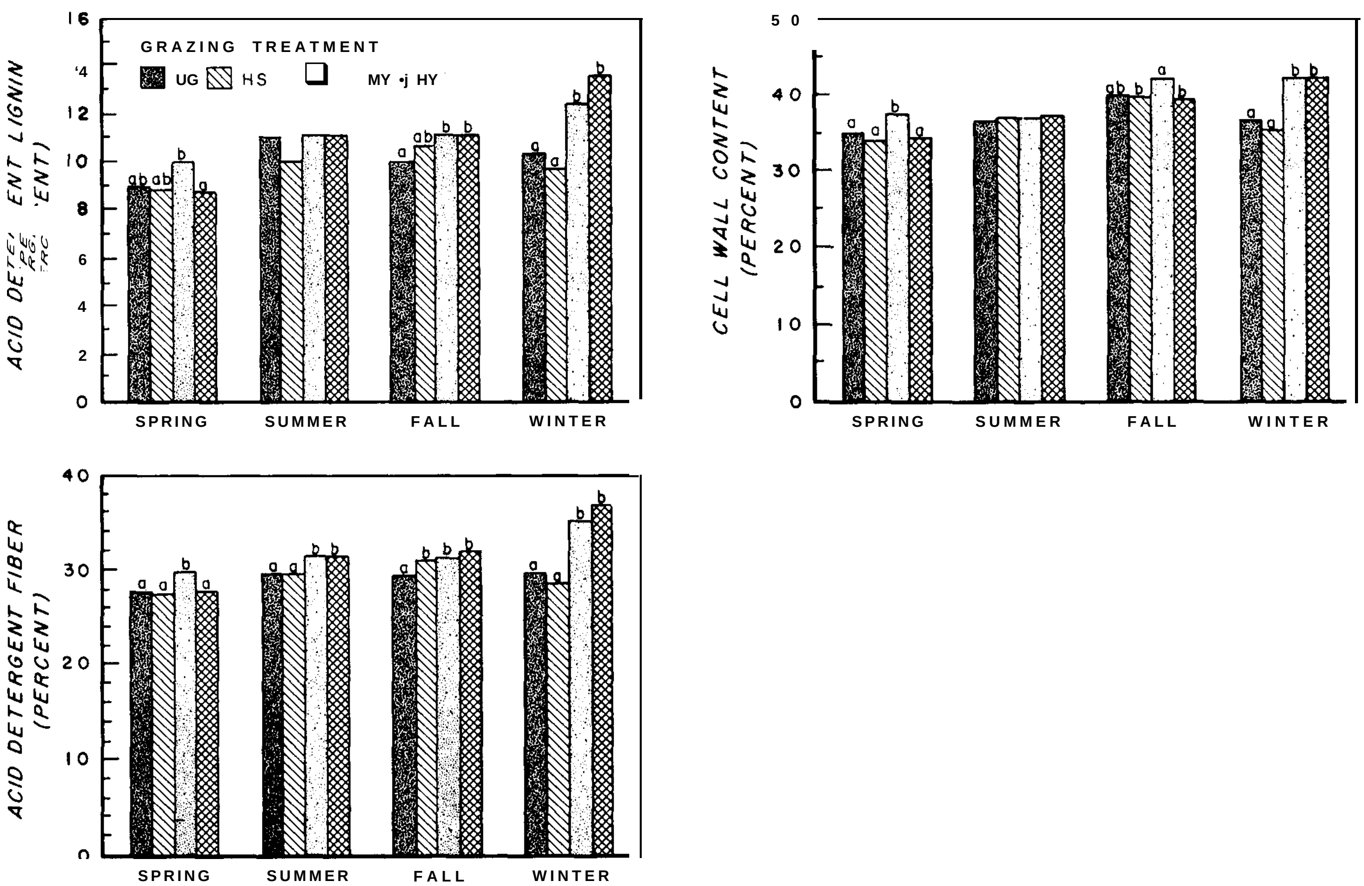

Figure 5.—*Grazing-by-season effects on white-tailed deer diet quality on a pine–bluestem range in central Louisiana, 1980–87, for acid detergent lignin, acid detergent fiber, and cell wall content. UG = ungrazed, HS = heavy seasonal grazing, MY = moderate yearlong grazing, HY = heavy yearlong grazing. Values are grazing-by-season interaction means (n = 36 to 45). Significant differences within seasons are denoted by unlike letters.*

less selective on first-year burns of HS and HY treatments (fig. 6) likely resulted from reduced floral diversity due to much heavier cattle grazing. On the negative side, burning reduced soft mast availability and use (Thill and Martin 1986) and forage intake on recent burns. Deer also generally traveled farther on recent burns, which tended to lower foraging efficiency (fig. 6).

Like others (Long and others 1986, Wood 1988), this study shows that nutritional benefits of burning for deer are short lived, but indicates that burning-induced differences in P intake and Ca:P ratios are substantial and likely of biological significance, especially if P deficiency is the most limiting factor for southern deer. Without periodic burning of southern pine ranges, deer-carrying capacity would rapidly diminish as browse grew beyond their reach and pine needle accumulations reduced forage production and availability. Furthermore, burning will be required for restoration and maintenance of longleaf pine stands, which now occupy only about 1.6 million ha of an estimated 24 million ha prior to European settlement (Boyer 1990).

MANAGEMENT IMPLICATIONS

The earlier findings for longleaf pine-bluestem sites (Thill and Martin 1989) revealed substantial dietary overlap between deer and cattle from late fall through early spring, but largely complementary diets the remainder of the year, with deer using mostly browse and forbs and cattle using mostly grasses. From late fall through early spring, deer and cattle both sought diets high in evergreen and tardily deciduous browse and herbaceous winter rosettes. Because these items are generally in limited supply, seasonal grazing from late spring through early fall appeared less detrimental to deer (from a dietary overlap standpoint) than yearlong grazing. However, data reported here reveal no evidence to suggest that MY grazing by cattle would be nutritionally detrimental to deer using similar sites. Forage selectivity was significantly reduced under MY grazing (relative to UG conditions), but diet quality under MY grazing was comparable or better than under UG conditions. There would be less hiding cover

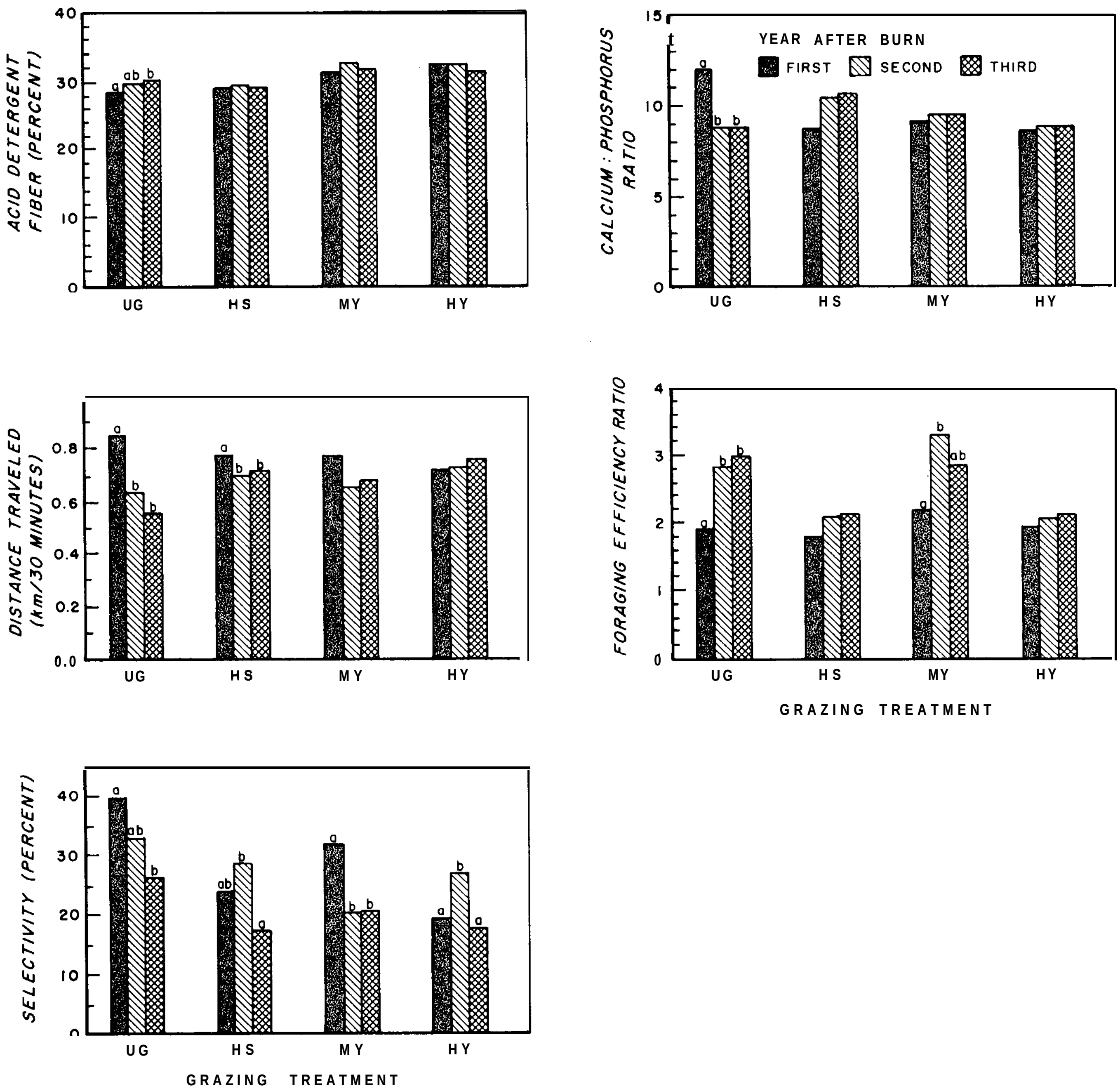

Figure 6.—*Grazing and burning effects on white-tailed deer diet quality and foraging activities on a pine-bluestem range in central Louisiana, 1980-87. Foraging efficiency ratio is the ratio of forage intake to distance traveled per 30 minutes. Values are grazing-by-burning interaction means (n = 28 to 71,* $\bar{x}$ *= 52.8). UG = ungrated, HS = heavy seasonal grazing, MY = moderate yearlong grazing, and HY = heavy yearlong grazing. Significant differences within grazing treatments are denoted by unlike letters.*

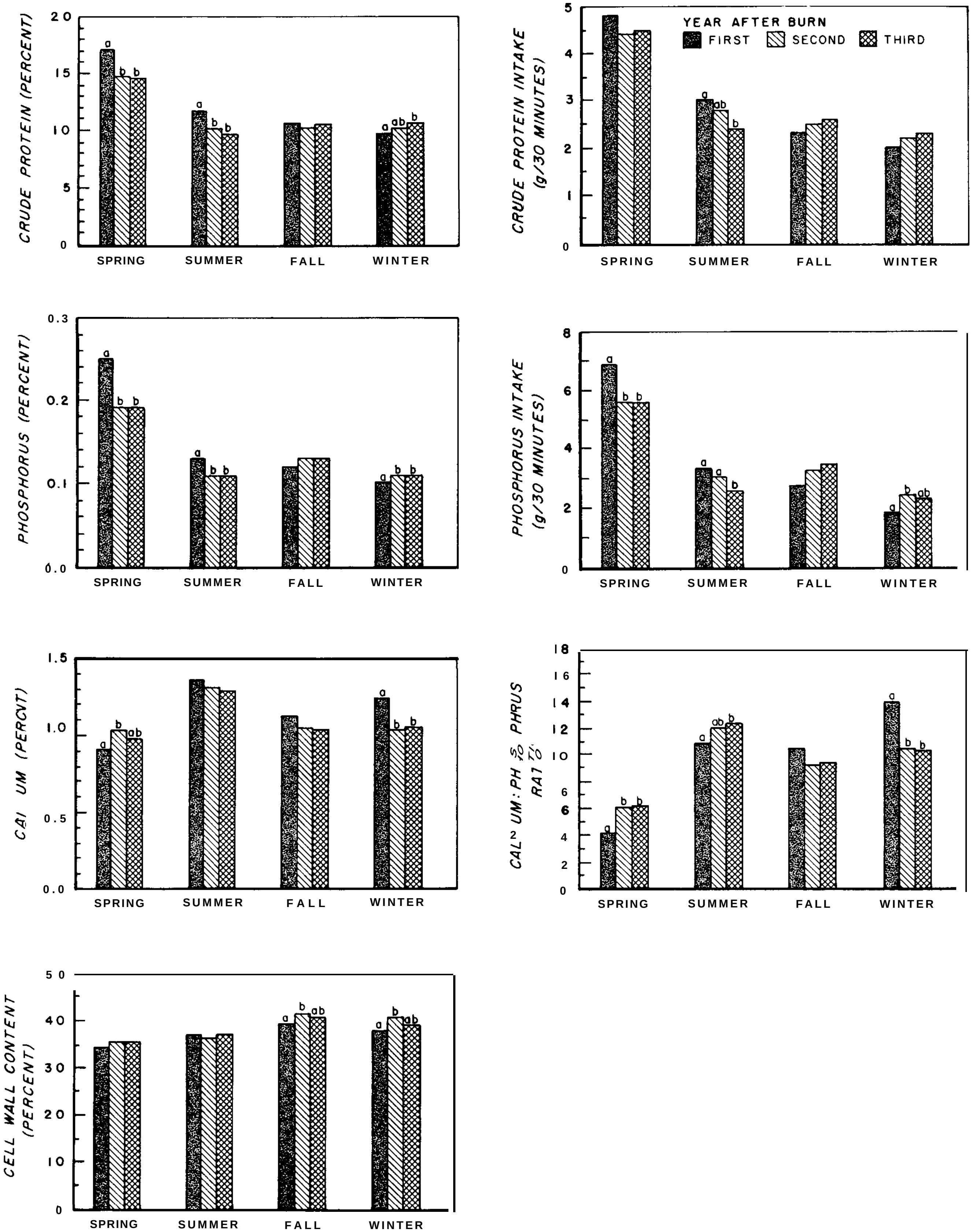

Figure T.-Effects *of season and burning on quality of diets selected by white-tailed deer on a pine-bluestem range in central Louisiana, 1980–87.* Values *are season-by-burn interaction means* (n = 36 *to* 45). *Significant differences within seasons are denoted by unlike letters.*

on recently burned, moderately grazed range than on UG range, but with rotational burning on a 3-year cycle, hiding cover should be adequate on roughly two-thirds of each grazing allotment. Furthermore, burning was largely beneficial to deer and is required for maintenance of healthy longleaf pine communities.

Because cattle tend to prefer graminoids (Thill 1985), which are used little by deer, grazing policies should be flexible enough that cattle release and removal dates can be adjusted to graminoid abundance. Where low rainfall, early fall freezes, or a late spring reduce graminoid supplies, stocking levels of cattle and timing of grazing should be adjusted accordingly.

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The effects of cattle grazing and rotational prescribed burning on diets of white-tailed deer were studied on longleaf pine-bluestem sites in central Lousiana.

Keywords: Diet diversity, intake, nutrition, ***Odocoileus virginianus***

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Department of Agriculture

Forest Service

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