NUTRIENT ANALYSIS OF SELECTED FORBS ON CLEARCUT AREAS IN SOUTHEASTERN OKLAHOMA

By

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CHAPTER I

INTRODUCTION

The format and style of Chapter II in this thesis was written to meet manuscript specifications to expedite submission to the PROCEEDINGS OF THE SOUTHEASTERN ASSOCIATION OF GAME AND FISH COMMISSIONERS. Chapter II is complete and needs no supportive information.

Data and information not used in Chapter II, but of potential value to future studies, are included in the appendixes. A study of the seasonality and frequency of head abscission in stiff-haired sunflower (*Helianthus hirsutus* Raf.) during August, September, and October, 1977, is included in Appendix D. Chapter II and the head abscission study are smaller parts of a large cooperative study (McIntire-Stennis 1554 - *Wildlife and Pine Clearcut Relationships*) initiated in 1973 by the Oklahoma Agricultural Experiment Station and supported in part by funds provided by Weyerhaeuser Company.

CHAPTER II

NUTRIENT ANALYSIS OF SELECTED FORBS ON CLEARCUT AREAS IN SOUTHEASTERN OKLAHOMA

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Abstract: Select forbs were collected in 2 geologic provinces in southeastern Oklahoma to determine nutrient content and dry matter digestibility of specific plant parts. Sampling was conducted from May to September, 1977, on 5-year-old clearcuts. Six species were chosen for analyses on the basis of their suspected importance in the diet of white-tailed deer (*Odocoileus virginianus* L.) (Silker 1977, unpublished). Parameters analyzed were field dry matter, crude protein, calcium, phosphorus, ash, and *in vitro* dry matter digestibility. High moisture content of plants, especially during spring growth, may have diluted the nutrients sufficiently to reduce dry matter intake by deer. Crude protein content (range of 9.2 to 16.8 percent) was generally low for all species. Calcium and phosphorus concentrations (range of 0.75 to 1.57 percent Ca and 0.19 to 0.37 percent P) appeared adequate to meet estimated daily maintenance requirements for white-tailed deer,

although calcium exceeded a desirable level, especially for stiff-haired sunflower causing a high Ca:P ratio. Dry matter digestibility ranged from 31.4 to 46.7 percent and averaged 40.8 percent. Differences in nutrient content and dry matter digestibility were not evident between the Ouachita Highlands and the Coastal Plain geologic provinces in this study.

Prior to 1969, most of the pine-hardwood forests in southeastern Oklahoma were harvested by cutting individual trees or selected groups of trees. In 1969, Weyerhaeuser Company purchased approximately 323,890 ha of pine-hardwood forests from Dierks Company in Oklahoma and initiated a high-yield practice of intensive timber management. Large blocks of timber were clearcut, and undesirable hardwoods were cleared or chemically sprayed. The large openings were planted with loblolly pine (<u>Pinus</u> <u>taeda</u> L.).

These large openings produced an abundance of herbs and forbs potentially useful by deer for forage. Vegetative production and timber stand density are inversely related (Della-Bianca and Johnson 1965, Moore and Downing 1966, Blair 1967, Schuster and Halls 1973, Wolters 1973). A large amount of plant biomass was produced, and many plant species were present. Nutrient content of these forages has not been studied in southeastern Oklahoma. For this reason, 6 plant species (Table 1), assumed to be highly preferred plants or plant parts for white-tailed deer were harvested

Table 1. Scientific and common names of plants collected in southeastern Oklahoma for analyses of nutrient contents and dry matter digestibility.

Scientific name	Common name
Aster patens Ait.	Late purple aster
Aster lateriflorus (L.)	(None)
Helianthus hirsutus Raf.	Stiff-haired sunflower
Helianthus silphoides Nutt.	(None)
Bidens polylepis Blake	(None)
Lactucca canadensis (L.)	Wild lettuce

from these clearcut areas for analyses of nutrient content and dry matter digestibility.

Nutrient content of a few select forages cannot be used to estimate total nutrient value of deer range. Yet, if preferred foods are deficient in essential nutrients or exhibit low dry matter digestibility, then less preferred forages may also exhibit similar deficiencies. Deer have been reported to consume the most palatable and nutritious plants and plant parts available (Swift 1948, Klein 1962, Longhurst et al. 1968).

STUDY AREA

Study locations were established on 5-year-old clear-cuts of Weyerhaeuser Company in McCurtain County, southeastern Oklahoma (Fig. 1). Three locations were in the geologic Ouachita Highlands, and 3 were in the Coastal Plain. Study areas in the Ouachita Highlands were located about 16 km southwest of Smithville, Oklahoma. Locations in the Coastal Plain were about 8 km southeast of Eagletown, Oklahoma. The harvested locations ranged in size from 131 to 267 ha (Fig. 2, 3).

Climate in McCurtain County is hot and humid in summer. Winters are generally mild. The mean frost-free season for the Ouachita Highlands averages 190 days between April 15 and October 22. Average annual precipitation is 137 cm. The mean frost-free season for the Coastal Plain averages 220 days between March 27 and November 22. Average annual precipitation is 119 cm (Reasoner 1974).

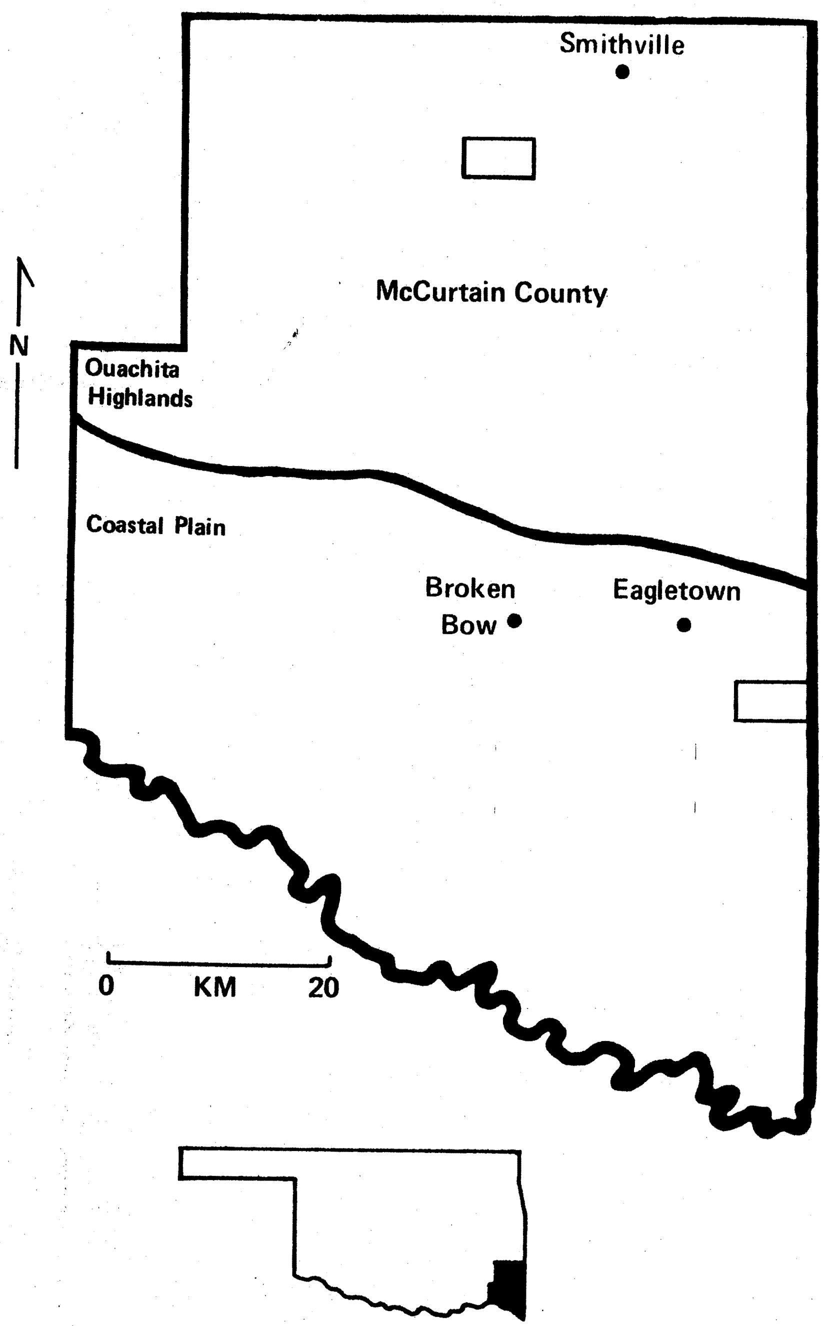

Fig. 1. Location of clearcuts in Ouachita Highlands and Coastal Plain provinces in southeastern Oklahoma where forb samples were collected from May to September, 1977. Blocks show general area where clearcuts were located.

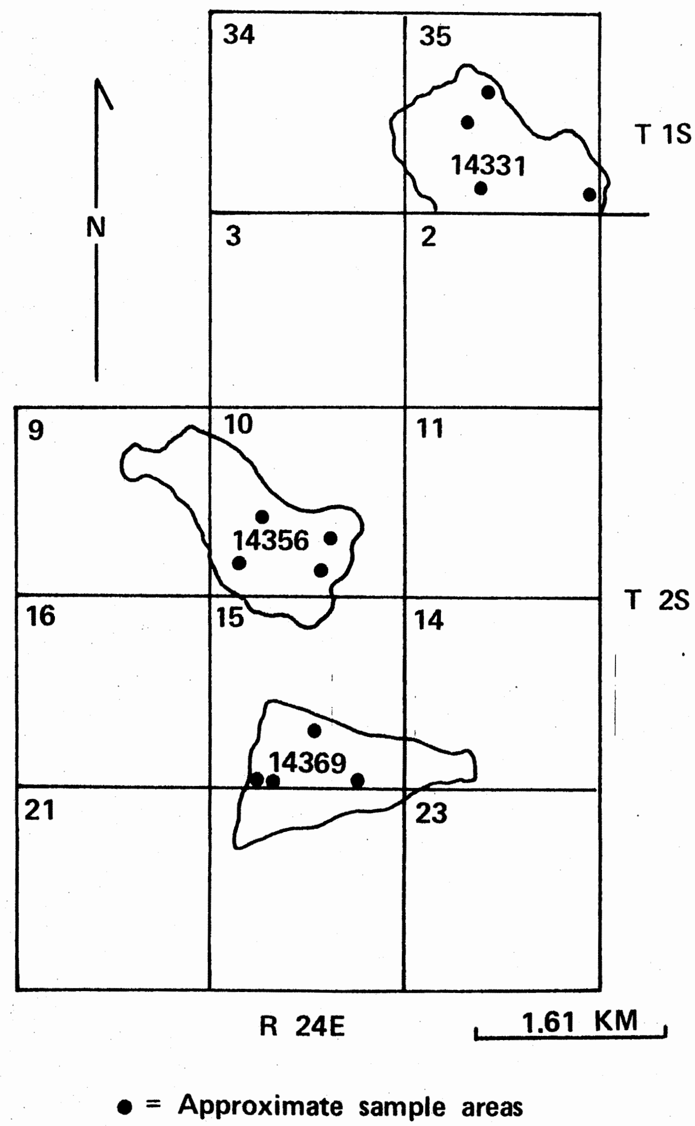

Fig. 2. Five-year-old clearcuts in the geologic Ouachita Highlands in McCurtain County, Oklahoma where forb samples were collected from May to September, 1977.

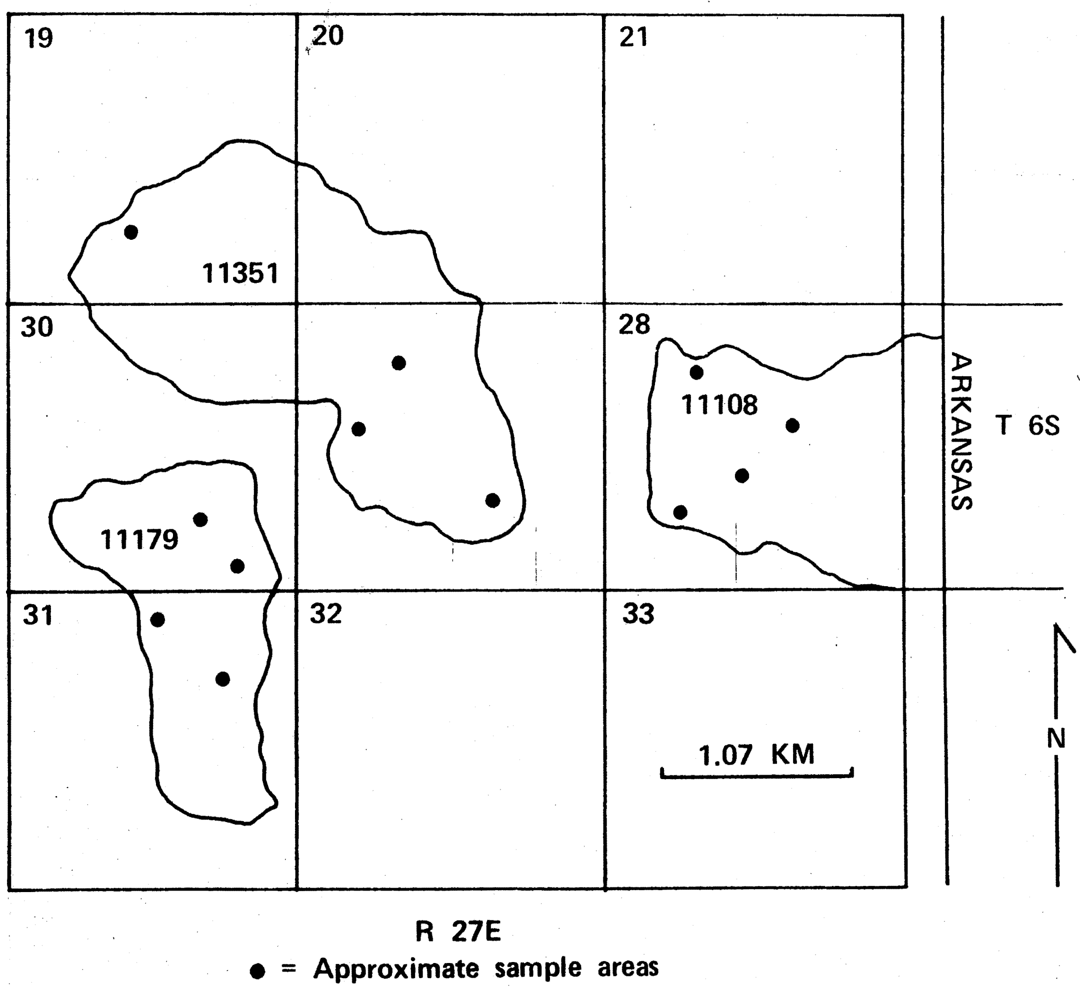

Fig. 3. Five-year-old clearcuts in the geologic Coastal Plain in McCurtain County, Oklahoma where forb samples were collected from May to September, 1977.

The terrain of the Ouachita Highlands is rugged and mountainous with elevations varying from about 91 m on the lowest valley floors to about 823 m on mountain peaks. The soils developed from shales and sandstones. The terrain of the Coastal Plain is gently rolling with local relief seldom greater than 15 m. Elevation varies from about 107 m in the southeastern corner of McCurtain County to about 200 m in its western extremity. The soils developed from clayey and loamy sediments (Gray and Galloway 1959).

METHODS AND MATERIALS

Four plots were randomly chosen from 24 0.101 ha cattle-exclosures built in 1973 on each of the 6 clearcuts. Enough plant biomass was collected from the 4 plots on each location to conduct laboratory analyses. Samples from plots within a location were composited to represent that location and respective province (Table 2). *Aster lateriflorus* was not sampled in the Coastal Plain. *Helianthus silphoides* was not sampled in the Ouachita Highlands (Table 2). The 2 species were not present in these respective provinces.

Bidens were available in low, moist areas in both provinces and were collected as near to established plots as possible. Late purple aster, stiff-haired sunflower, and wild lettuce appeared about 1-2 weeks further along in development in the Coastal Plain and were collected accordingly.

Table 2. Dates of composite sampling of forbs in Ouachita Highlands and Coastal Plain provinces in 1977 on clearcuts in southeastern Oklahoma.

Province and Location	Species and Plant Parts Sampled							
	Aster patens	Aster lateriflorus	Helianthus hirsutus		Helianthus silphoides	Bidens polylepis	Lactucca canadensis	
	Vegetative	Vegetative	Vegetative	Head	Head	Vegetative	Vegetative	Flowering stalk
Ouachita Highlands								
14331	May 19	May 19	May 19	August 4	---	---	May 19	July 8
14356	May 20	May 20	May 20	August 4	---	---	May 20	July 8
14369	May 20	May 20	May 20	August 4	---	---	May 20	July 8
						[a]July 8		
Coastal Plain								
11108	May 10	---	May 10	August 3	September 18	---	May 10	July 8
11151	May 10	---	May 10	August 3	September 18	---	May 10	July 8
11179	May 10	---	May 10	August 3	September 18	---	May 10	July 8
						[a]July 8		

--- = No samples collected

a = Not sampled in established plots

Vegetative parts of plants, including leaves and stems, were clipped to an approximate 0.3 cm diameter. Flowering stalks of wild lettuce were clipped to an approximate 0.6 cm diameter. Heads from sunflowers were sampled by severing stems just below the heads.

Dried plant tissues were ground through a 2 mm screen in a Wiley mill and analyzed for percentage content of crude protein, phosphorus, calcium, and ash by methods of the Association of Official Agricultural Chemists (1960).

In vitro dry-matter digestibility was determined by the 2-stage Tilley and Terry (1963) technique using a ruminally fistulated white-tailed deer. Values reported were an average of duplicate samples.

Analysis of variance was used to test for differences at the 5 percent level of rejection (Barr et al. 1976).

RESULTS AND DISCUSSION

Six plant species and selected plant parts were collected for nutrient content analyses and in vitro dry matter digestibility from the Ouachita Highlands and Coastal Plain provinces in southeastern Oklahoma. Nutrient contents for each species within each province are presented in Table 3. Province differences were not evident except for ash content. No explanation for this difference was apparent.

Nutrient contents of individual species and parts, averaged across provinces, are presented in Table 4. Field dry matter differed markedly with species ($P < .05$) and

Table 3. Percentage means, by province, of nutrient contents for forbs collected from May to September, 1977 in Ouachita Highlands and Coastal Plain provinces in southeastern Oklahoma.

Province	Species and Part	Nutrient: Field Dry Matter (DM)	Crude Protein, % of DM	Calcium, % of DM	Phosphorus, % of DM	Ca:P Ratio	Ash, % of DM	IVDMD, % of DM
Ouachita Highlands	Aster patens, vegetative	29.5[+]	10.3	0.79	0.19	4.3:1	9.7	42.0
	Helianthus hirsutus, vegetative	24.9	12.6	1.78[c]	0.24	7.7:1	13.3	41.7
	Helianthus hirsutus, head	31.7	8.8	1.14	0.21	5.5:1	8.9[c]	33.7
	Lactucca canadensis, vegetative	15.6	16.8	0.99	0.31	3.3:1	13.6	44.7
	Lactucca canadensis, flowering stalk	16.8[c]	13.5	0.77	0.34	2.3:1	10.8[c]	35.4
Province mean		23.7	12.4	1.09	0.26	4.6:1	11.3[a]	39.4
Costal Plain	Aster patens, vegetative	28.1	9.0	0.77	0.18	4.5:1	9.4	41.1
	Helianthus hirsutus, vegetative	22.4	12.8	1.35[d]	0.22	6.0:1	11.1	46.4
	Helianthus hirsutus, head	33.9	9.6	1.13	0.24	4.7:1	10.3[d]	29.1
	Lactucca canadensis, vegetative	14.6	15.5	0.91	0.38	2.5:1	12.4	48.6
	Lactucca canadensis, flowering stalk	20.7[d]	13.7	0.72	0.39	1.8:1	9.3[d]	38.3
Province mean		23.9	12.1	0.98	0.28	3.9:1	10.5[b]	40.7
Least–significant differences (.05 level)								
Location (Province); Error A		2.74	1.57	0.228	0.066	1.29	0.67	2.91
Location * species (Province); Error B		1.55	1.11	0.147	0.040	0.93	0.86	3.47
Species * location (Province)		2.20	1.58	0.208	0.057	1.32	1.22	4.91
Between 2 provinces for same species		3.34	2.09	0.291	0.080	1.73	1.27	5.23

[+] Values in Table represent a mean of 3 composited samples; 1 composited sample from each clearcut (location) within a province.

[ab] Means in a column for provinces with different superscripts differ statistically ($P < .05$) across provinces.

[cd] Means in a column for species with different superscripts differ statistically ($P < .05$) across provinces.

Table 4. Percentage means, averaged across provinces, of nutrient contents for forbs collected from May to September, 1977 in Ouachita Highlands and Coastal Plain provinces in southeastern Oklahoma.

Species and Part	Nutrient						
	Field Dry Matter (DM)	Crude Protein, % of DM	Calcium, % of DM	Phosphorus, % of DM	Ca:P Ratio	Ash, % of DM	IVDMD, % of DM
Aster patens, vegetative	28.8[a]	9.7[a]	0.78[a]	0.19[a]	4.4[b]	9.5[a]	41.5[c]
Helianthus hirsutus, vegetative	23.7[b]	12.7[b]	1.57[c]	0.23[b]	6.9[c]	12.2[b]	44.1[cd]
Helianthus hirsutus, head	32.8[c]	9.2[a]	1.13[b]	0.23[b]	5.5[b]	9.6[a]	31.4[a]
Lactucca canadensis, vegetative	15.1[d]	16.1[c]	0.95[b]	0.35[c]	2.9[a]	13.0[b]	46.7[d]
Lactucca canadensis, flowering stalk	18.7[e]	13.6[b]	0.75[a]	0.37[c]	2.1[a]	10.1[a]	36.9[b]
*Aster lateriflorus, vegetative	23.6	11.3	0.87	0.26	3.3	10.2	46.5
*Helianthus silphoides, head	23.8	12.0	0.96	0.25	3.8	9.4	36.2
**Bidens polylepis, vegetative	19.1	16.8	0.91	0.26	3.7	8.5	43.6

* Sampled in 1 province—No tests conducted.

**Means not available—No tests conducted.

[a] Means in columns with different superscripts differ statistically ($P < .05$).

ranged from 15.1 percent in vegetative parts of wild lettuce to 32.8 percent in stiff-haired sunflower heads. Leaves and stems collected had lower ($P < .05$) field dry matter than heads and flowering stalks. In very succulent plants, water dilutes nutrients, and due to bulkiness may reduce dry matter intake (Amman et al. 1973). This in turn reduces the amount of all nutrients consumed by deer (Dietz 1965). Low dry matter intake, and the associated deficiencies in nutrients and energy may be a problem for deer in the study areas.

Species differed ($P < .05$) in crude protein content. Vegetative parts from bidens (16.8 percent) and wild lettuce (16.1 percent) contained sufficient amounts of crude protein. All other species were low in crude protein content. The percentage of crude protein required for maximum growth of deer, including growing fawns and lactating does, has been reported to be 16 to 17 percent of their diets (McEwen et al. 1957, Verme and Ullrey 1972). White-tailed deer collected from McCurtain County in September, 1977, and in March and September, 1978, had markedly depleted fat reserves possibly due to low energy and/or protein intake. This was especially evident in the winter and spring seasons. Deer seemed normal in external appearance; however, pathologic, physiologic, and histologic analyses indicated acute and chronic disease and nutritional stress (Kocan 1978).

Species and plant parts ranged from 0.75 to 1.57

percent Ca and exceeded 0.40 percent Ca reported to be the desirable dietary level (Ullrey et al. 1973). Late purple aster was lowest in P content (0.19 percent). All other species and plant parts approached or exceeded the 0.26 percent P recommended for optimum development of weaned male and female fawns (Ullrey et al. 1975). Although P content is usually expected to be low on southern deer ranges because of leaching (Lytle 1960), it was higher than that reported from other areas in the south (Lay 1969, Blair and Brunett 1977).

All species and parts exceeded the recommended Ca:P ratio of 1.5:1 for white-tailed deer (Ullrey et al. 1973). The unfavorable imbalance of Ca to P in this study was a result of an excessive Ca percentage rather than a deficient P percentage. Stiff-haired sunflower parts had a Ca:P ratio of 6.2:1. Other species, while exceeding the ideal ratio of Ca to P, were within an acceptable range for deer (Dietz et al. 1962, Halls 1970). An adequate supply of vitamin D permits utilization of Ca and P outside of acceptable ranges (Maynard and Loosli 1969) and may be helpful in the nutritional status of deer in the study areas.

Dry matter digestibility differed ($P < .05$) among species ranging from 31.4 to 46.7 percent. Because of bacterial adaptation, true digestion values of these plants for deer from the study areas may be higher than those reported herein. The white-tailed deer used in this study was maintained on a balanced commercial ration and alfalfa hay. Microorganism numbers and strains vary with the type of food consumed and adjust over time to new feeds (Lay 1969). Deer in the study areas eating native forages therefore may be more adapted for digesting plant parts from these areas. Vegetative parts were higher in dry matter digestibility than other parts sampled. The leaves in these samples presumably contained less undigestible fiber than heads or flowering stalks. Whether these values reflect true digestion or lower than true digestion, digestibility does not appear to be a severe problem for deer consuming these forages.

The ability of deer to obtain sufficient amounts of dry matter and nitrogen (crude protein = N X 6.25) appear to be the critical nutritional problem of white-tailed deer in the study areas. This thesis is supported by histological analysis of tissues and selected blood chemistry analysis from deer collected in 1977 and 1978 (Kocan 1978).

LITERATURE CITED

Amman, A. P., R. L. Cowan, C. L. Mothershead and B. R. Baumgardt. 1973. Dry matter and energy intake in relation to digestibility in white-tailed deer. J. Wildl. Manage. 37(2):195-201.

Association of Official Agricultural Chemists. 1960. Official methods of analysis. 9th ed. Assoc. Off. Agric. Chem. Washington, D. C. 832 pp.

Barr, A. J., J. H. Goodnight, J. P. Sall, and J. T. Helwig. 1976. The ANOVA Procedure, pp. 57-65. In: A user's guide to SAS. Sparks Press, Raleigh, North Carolina. 329 pp.

Blair, R. M. 1967. Deer forage in a loblolly pine plantation. J. Wildl. Manage. 31(3):432-437.

Blair, R. M., and L. E. Brunett. 1977. Deer habitat potential of pine-hardwood forests in Louisiana. USDA For. Serv. South. For. Exper. Sta., New Orleans, Res. Pap. SO-136, 11 pp.

Della-Bianca, L., and F. M. Johnson. 1965. Effect of an intense cleaning on deer-browse production in the southern Appalachians. J. Wildl. Manage. 29(4): 729-733.

Dietz, D. R. 1965. Deer nutrition research in range management. Trans., N. Am. Wildl. Nat. Resour. Conf. 30: 274-285.

Dietz, D. R., R. H. Udall and L. E. Yeager. 1962. Chemical composition and digestibility by mule deer of selected forage species, Cache la Poudre Range, Colorado. Colorado Game and Fish Dept. Tech. Publ. 14. 89 pp.

Gray, F., and H. M. Galloway. 1959. Soils of Oklahoma. Okla. State Univ. Misc. Publ. MP-56, Stillwater. 65 pp.

Halls, L. K. 1970. Growing deer food amidst southern timber. J. Range Manage. 23(3): 213-215.

Klein, D. R. 1962. Rumen contents analysis as an index to range quality. Trans., N. Am. Wildl. Nat. Resour. Conf. 27:150-162.

Kocan, A. A. 1978. Deer herd health evaluation. Semi-annual Progress Report: Oklahoma Cooperative Wildlife Research Unit, Okla. State Univ. 31(2):27-30.

Lay, D. W. 1969. Foods and feeding habits of white-tailed deer. In: White-tailed Deer in Southern Forest Habitat. Proc. of a Symp., Nacogdoches, Texas. pp. 8-13.

Longhurst, W. M., H. K. Oh, M. B. Jones and R. E. Kepner. 1968. A basis for the palatability of deer forage plants. Trans., N. Am. Wildl. Nat. Resour. Conf. 33:181-192.

Lytle, S. A. 1960. Physiography and properties of southern forest soils. In: Southern Forest Soils. Proc., 8th Annu. For. Symp. La. State Univ., Baton Rouge. pp. 1-8.

McEwen, L. C., C. E. French, N. D. Magruder, R. W. Swift and R. H. Ingram. 1957. Nutrient requirements of the white-tailed deer. Trans., N. Am. Wildl. Nat. Resour. Conf. 22:119-132.

Maynard, L. A., and J. K. Loosli. 1969. Animal Nutrition. 6th ed. McGraw-Hill, New York. 613 pp.

Moore, W. H., and R. L. Downing. 1966. Some multiple-use benefits of even-aged management in the southern Appalachians. Proc., Soc. Am. Foresters. 65:227-229.

Reasoner, R. C. 1974. Soil survey of McCurtain County, Oklahoma. USDA Soil Conser. Serv., Washington, D. C. 99 pp.

Schuster, J. E., and L. K. Halls. 1963. Timber overstory determines deer forage in shortleaf-loblolly pine-hardwood forests. Proc., Soc. Am. Foresters. 62: 165-167.

Silker, T. H. 1977. Wildlife and pine clearcut relationships. Unpublished. Dept. of For., Ok. State Univ., Stillwater.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc., New York. 481 pp.

Swift, R. W. 1948. Deer select most nutritious forages. J. Wildl. Manage. 12(1):109-110.

Tilley, J. M. A., and R. A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. British Grassland Soc. 18(2):104-111.

Ullrey, D. E., W. G. Youatt, H. E. Johnson, A. B. Cowan, F. D. Fay, R. L. Covert, W. T. Magee and K. K. Keahey. 1975. Phosphorus requirements of weaned white-tailed deer fawns. J. Wildl. Manage. 39(3):590-595.

Ullrey, D. E., W. G. Youatt, H. E. Johnson, L. D. Fay, B. L. Schoepke, W. T. Magee and K. K. Keahey. 1973. Calcium requirements of weaned white-tailed deer fawns. J. Wildl. Manage. 37(2):187-194.

Verme, L. J., and D. E. Ullrey. 1972. Feeding and nutrition of deer. In: The Digestive Physiology and Nutrition of Ruminants. Vol. 3. Practical Nutrition. D. C. Church, Corvallis, Ore. pp. 275-291.

Wolters, G. L. 1973. Southern pine overstories influence herbage quality. J. Range Manage. 26(6):423-426.

APPENDIXES

APPENDIX A

STATISTICAL MODEL

The experiments were set up in nested designs, for which the model may be written as:

$$Y_{ijk} = \mu + P_i + L_{(i)j} + S_{(ij)k}, \text{ where:}$$

μ = overall mean

P_i = the effect due to the ith province
$i = 1, 2$

$L_{(i)j}$ = the effect due to the jth location within the ith province
$j = 1, 2, 3$

$S_{(ij)k}$ = the effect due to the kth sample in the jth location in the ith province
$k = 1$ (Composited plant samples)
$k = 1, 2, 3, 4$ (Observations of heads)

The data were analyzed as a nested design. The sources of variation and degrees of freedom (d. f.) associated with each source were as follows:

Source	d. f.
Total	5
Provinces	1
Locations (Province 1) 2	4
Locations (Province 2) 2	

The pooled mean square for locations within provinces was used as the error mean square for testing for differences between provinces. Tests of the hypothesis of no overall province effect were made at the 5% level of rejection. A series of least-significant differences (LSD) were generated for Table 3 in Chapter II to allow for comparisons.

APPENDIX B

SIGNIFICANCE OF NUTRIENT PARAMETERS AND METHODS OF NUTRITIONAL ANALYSES

Significance of Nutrient Parameters

Field Dry-Matter

Field dry matter is the percentage of dry matter in a plant. Dry-matter intake for proper growth performance in mature white-tailed deer has been reported to be 3-4% (% of dry matter) of their body weight (French et al. 1956, Halls 1973). Short (1969) reported that during and shortly after lactation, does with fawns ingest 1/3 more food than those without fawns to meet the increased need for energy.

Dry-matter intake may be limited due to an excessive moisture content of spring forage. This can occur on overused winter range as deer switch to lush green grasses and forbs early in the spring. Reduced dry-matter intake reduces the amount of all nutrients consumed by deer (Dietz 1965). Theoretically, increased energy demands can be met by increasing food intake, but deer can only increase forage intake to the capacity of their rumen (Amman et al. 1973).

Crude Protein

Protein is essential for body maintenance, growth, reproduction and lactation. Ruminants need ammonia for the rumen micro-organisms to effectively digest and metabolize fiber and other carbohydrates in the rumen. If ammonia levels fall below a minimum (2-5 mg/deciliter), rumen fermentation becomes severly impaired and protein synthesis by bacteria reduced (Dietz 1965). Murphy and Coates (1966) suggested that protein may be the most critical nutrient on some ranges. Deer fed 7% protein diets throughout the year were physically stunted. Does fed diets with 7-11% protein produced fewer fawns than those fed a higher percentage protein diet. Body weight and antler development of adult male deer were drastically retarded by a diet of 7% protein (French et al. 1956). McEwen et al. (1957) reported that fawns fed a low protein ration (4-5%) from 6-18 months of age were physically stunted, runty in appearance and produced no antlers. Greatest skeletal and antler growth occurred in deer fed a diet containing 17% crude protein. Ullrey et al. (1967) stated that crude protein concentrations of 20.2% for male fawns and 12.7% for female fawns maximized weight gain. Verme and Ullrey (1972) concluded that 16-17% crude protein diets would meet the maximum needs of deer, including those of growing fawns and lactating does.

Minerals

Aside from sodium (Na), chlorine (Cl), calcium (Ca), and phosphorus (P) most of the essential elements appear to be present in forage in sufficient amounts to meet dietary needs (Oelberg 1956). Some soils in the south, however, are deficient in other elements. Smith et al. (1956) reported that areas deficient in cobalt (Co), P, and crude protein produced fewer and smaller deer.

Calcium plays an important part in skeletal development and is an important component of blood. Phosphorus is an essential part of the skeleton and the intracellular fluid, and is necessary in the production of muscle energy via adenosine triphosphate (ATP). McEwen et al. (1957) reported that white-tailed deer fawns fed only 0.09% Ca with 0.25% P failed to survive. French et al. (1956) reported that quantitative requirements for Ca and P for growth and development of white-tailed deer are in excess of 0.09% Ca and 0.25% P. Magruder et al. (1957) noted that a 16.9% protein diet, containing 0.59% Ca and 0.54% P resulted in best antler growth when compared to lower protein diets with other levels of Ca and P. In contrast, Cowan and Long (1962) reported that 0.30% dietary P did not limit antler development of 2-year-old bucks. Ullrey et al. (1975) reported that when the diet contained 0.46-0.51% Ca, weaned male and female fawns did not require more than 0.26% P for optimum development.

Excess Ca in ruminant diets interferes with P metabolism. Wise et al. (1963) found that performance and feed efficiency of Hereford calves decreased severely with Ca:P ratios less than 1:1 and decreased significantly but less severely with ratios greater than 7:1. Dietz et al. (1962) suggested that Ca may be excessive for mule deer (_O. hemionus_) diets if Ca:P ratios exceed 5:1. Ullrey et al. (1973) reported that weaned white-tailed fawns tolerated a wide range of dietary Ca without severely affecting bone strength or antler development. There were adverse affects, however, when Ca levels were as low as 0.18% and 0.22% in the presence of 0.27% or 0.25% P. In the presence of 0.25% to 0.27% P, Ca levels as high as 0.62% were not deleterious. Four-tenths percent Ca was concluded to be the desirable level.

Ash

Percent ash is the percentage of the plant consisting of all mineral matter. Ash is an intermediate stage in analysis of most minerals. It does not indicate the type or quantity of individual minerals but can be used to compare differences within and between species of plants. Ash dilutes protein and energy of the dry matter of feedstuffs.

Dry Matter Digestibility

Although best estimated in complex feeding trials, digestibility can be estimated by a laboratory procedure called *in vitro* dry matter digestibility (IVDMD) technique (Tilley and Terry 1963). Due to its simplicity, this procedure is used very commonly. Correlations between *in vitro* and *in vivo* digestibilities have been high. Scales et al. (1974) and McLeod and Minson (1974) reported that *in vitro* and *in vivo* digestion coefficients were highly correlated and absolute values were approximately equivalent to the range of 40-60%. *In vitro* digestion coefficients for a ration fed to two white-tailed deer by Ruggiero and Whelan

(1976) averaged 94.7% (range of 86.3-99.7%) of in vivo coefficients.

The Tilley and Terry (1963) IVDMD technique involves two stages. Plant materials are digested first with rumen fluid, water and buffer and second by pepsin and hydrochloric acid. Pearson (1970) evaluated 3 combinations of in vitro solution components for their ability to digest dry matter of grasses and shrubs from Arizona chaparral. Average dry matter loss for the buffer was 20.9%, microorganisms digested 21.9% and pepsin accounted for 7.0% solubility or disappearance of dry matter. Uresk et al. (1975) reported similar trends after evaluating each component of the in vitro technique separately, and then in combinations, for dry matter disappearance of some South Dakota plants. Short (1971) and Urness et al. (1971) reported that estimates of dry matter intake paralleled the fiber levels in forage and were inversely related to the digestibility of the forage.

Schwartz and Nagy (1972) reported a 7.7% decrease ($P < .05$) in digestion of dry matter for rumen fluid from mule deer after the rumen fluid had been stored for 2.5 hours. There was a second large decrease in digestion after 5-6 hours of rumen fluid storage as pH of the fluid decreased. Straining through cheesecloth and maintaining at 38.5 C provided the best means for storage of rumen fluid from the point of collection to the laboratory.

Methods of Nutritional Analyses

Laboratory techniques for determing nutrient content of plants were those described by the Association of Official Agricultural Chemists (1960). *In vitro* dry matter digestibility (IVDMD) was determined using deer rumen fluid and pepsin, employing the 2-stage procedure of Tilley and Terry (1963).

Field Dry Matter

After a collection period, plant samples were weighed and placed in a forced-draft oven at 65 C. Upon attaining a constant weight, samples were allowed to equilibrate in the air. Samples were re-weighed, and field dry matter calculated (A.O.A.C. 1960), (Appendix C, Table 5). Dried tissues were ground through a 2 mm screen in a Wiley mill and stored in plastic containers for later analyses.

Oven-dry Matter

Two-gm samples of the ground plant material were weighed in porcelain crucibles and dried in a forced-draft oven at 105 C for 24 hours. The samples were placed in a dessicator, allowed to cool, and re-weighed. The 105 C oven-dry matter values were calculated (A.O.A.C. 1960). All values were reported on this 105 C oven-dry basis in order to compensate for differences in the moisture content of the field dry samples.

Ash

Oven-dry samples were placed in a muffle furnace at 580 C for 4 hours. The samples were placed in a dessicator, allowed to cool, and re-weighed. The ash content was calculated (A.O.A.C. 1960), (Appendix C, Table 6).

Calcium and Phosphorus

The ashed material from the total mineral matter determinations were digested in 20% hydrochloric acid. The digested samples were brought up to 50 ml with 20% hydrochloric acid in volumetric flasks to await mineral analysis.

Calcium concentrations were determined using an atomic absorption spectrometer. Phosphorus interference in the Ca determinations was eliminated by the addition of lanthanum (A.O.A.C. 1960), (Appendix C, Table 7). Phosphorus concentrations were determined through spectrophotometric determination of P as molybdenum blue (A.O.A.C. 1960), (Appendix C, Table 8). Calcium:phosphorus ratios were calculated for each plant species (Appendix C, Table 9).

Crude Protein

One-gm ground samples were used in the determination of crude protein. The macro-kjeldahl procedure was used (A.O.A.C. 1960), (Appendix C, Table 10). Crude protein represents protein and non-protein nitrogen. Crude protein was calculated by multiplying the nitrogen percentage by the constant 6.25 (Dietz 1965).

<u>In Vitro Dry Matter Digestibility</u>

The two-stage procedure of Tilley and Terry (1963) was used for estimating digestibility. The ruminal fluid donor was a yearling white-tailed buck. This animal was loaned for use from the captive deer herd of the Department of Veterinary Parisitology, College of Veterinary Medicine.

A sheep cannula was surgically implanted in the rumen wall of the deer. A 1-m length of tubing with an inside diameter of approximately 2.5 cm was used with a vacuum pump to remove rumen material from the animal. Although the animal was hand-raised and relatively tamed, an anesthetic was administered prior to removing a sample. This made sampling easier and also reduced the possibility of injury to the deer.

The sample of rumen material was strained through 4 layers of cheesecloth into a collecting bottle to remove bulky feed particles. The bottle, filled to capacity to force air out and maintain anaerobic conditions, was placed in a thermos of water pre-warmed to 39 C for transport to the animal nutrition laboratory at O.S.U. Approximately 60 minutes elapsed from the start of collection to the time the samples were placed in a 39 C water bath.

Ground, 0.6-gm plant samples were used for determination of IVDMD values. To eliminate oxygenation of rumen fluid, tubes were gassed with carbon dioxide. After 48 hours of digestion with nutrient buffer and rumen fluid and a subsequent 48 hours of digestion in a pepsin-hydrochloric acid solution, the supernatant was decanted and the samples were placed in a forced-draft oven at 60 C to dry. Dry samples were re-weighed and the percent IVDMD was calculated (Appendix C, Table 11).

LITERATURE CITED

Amman, A. P., R. L. Cowan, C. L. Mothershead and B. R. Baumgardt. 1973. Dry matter and energy intake in relation to digestibility in white-tailed deer. J. Wildl. Manage. 37(2):195-201.

Association of Official Agricultural Chemists. 1960. Official methods of analysis. 9th ed. Assoc. Off. Agric. Chem. Washington, D. C. 832 pp.

Cowan, R. L., and T. A. Long. 1962. Studies on antler growth and nutrition of white-tailed deer. Proc., First Natl. White-tailed Deer Disease Symp. Univ. Georgia Cent. Contin. Educ., Athens. pp. 54-60.

Dietz, D. R. 1965. Deer nutrition research in range management. Trans., N. Am. Wildl. Nat. Resour. Conf. 30:274-285.

Dietz, D. R., R. H. Udall and L. E. Yeager. 1962. Chemical composition and digestibility by mule deer of selected forage species, Cache la Poudre Range, Colorado. Colorado Game and Fish Dept. Tech. Publ. 14. 89 pp.

French, C. E., L. C. McEwen, N. D. Magruder, R. H. Ingram and R. W. Swift. 1956. Nutrient requirements for growth and antler development in white-tailed deer. J. Wildl. Manage. 20(3):221-232.

Halls, L. K. 1973. Managing deer habitat in loblolly-shortleaf pine forest. J. Forestry 71(12):752-757.

McEwen, L. C., C. E. French, N. D. Magruder, R. W. Swift and R. H. Ingram. 1957. Nutrient requirements of the white-tailed deer. Trans., N. Am. Wildl. Nat. Resour. Conf. 22:119-132.

McLeod, M. N., and D. J. Minson. 1974. Predicting organic matter digestibility. J. Brit. Grassl. Soc. 29(1): 17-21.

Magruder, N. D., C. E. French, L. C. McEwen and R. W. Swift. 1957. Nutritional requirements of white-tailed deer for growth and antler development. II. Pennsylvania Agric. Exp. Stn. Bull. 628. 21 pp.

Murphy, D. A., and J. A. Coates. 1966. Effects of dietary protein on deer. Trans., N. Am. Wildl. Nat. Resour. Conf. 31:129-138.

Oelberg, K. 1956. Factors affecting the nutritive value of range forage. J. Range. Mange. 9(5):220-225.

Pearson, H. A. 1970. Digestibility trials: In vitro techniques. Range and Wildlife Evaluation-a research symposium. USDA Misc. Publ. 1147. pp. 85-92.

Ruggiero, L. F., and J. B. Whelan. 1976. A comparison of in vitro and in vivo digestibility by white-tailed deer. J. Range Manage. 29(1):82-83.

Scales, G. H., C. L. Streeter, A. H. Denham and G. M. Ward. 1974. A comparison of indirect methods of predicting in vivo digestibility of grazed forage. J. Anim. Sci. 38(1):192-199.

Schwartz, C. C., and J. G. Nagy. 1972. Maintaining deer rumen fluid for in vitro digestion studies. J. Wildl. Manage. 36(4):1341-1343.

Short, H. L. 1969. Physiology and nutrition of deer in southern upland forests. In: White-tailed Deer in Southern Forest Habitat. Proc. of a Symp., Nacogdoches, Texas. pp. 14-18.

Short, H. L. 1971. Forage digestibility and diet of deer on southern upland range. J. Wildl. Manage. 35(4): 698-706.

Smith, F. H., K. C. Beeson and W. E. Price. 1956. Chemical composition of herbage browsed by deer in two wildlife management areas. J. Wildl. Manage. 20(4): 359-367.

Tilley, J. M. A., and R. A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. British Grassland Soc. 18(2):104-111.

Ullrey, D. E., W. G. Youatt, H. E. Johnson, A. B. Cowan, F. D. Fay, R. L. Covert, W. T. Magee and K. K. Keahey. 1975. Phosphorus requirements of weaned white-tailed deer fawns. J. Wildl. Manage. 39(3):590-595.

Ullrey, D. E., W. G. Youatt, H. E. Johnson, L. D. Fay and B. F. Bradley. 1967. Protein requirement of white-tailed deer fawns. J. Wildl. Manage. 31(4):679-685.

Ullrey, D. E., W. G. Youatt, H. E. Johnson, L. D. Fay, B. L. Schoepke, W. T. Magee and K. K. Keahey. 1973. Calcium requirements of weaned white-tailed deer fawns. J. Wildl. Manage. 37(2):187-194.

Uresk, D. W., D. R. Dietz and H. E. Messner. 1975. Constituents of in vitro solution contribute differently to dry matter digestibility of deer food species. J. Range Manage. 28(5):419-421.

Urness, P. J., W. Green and R. K. Watkins. 1971. Nutrient intake of deer in Arizona chaparral and desert habits. J. Wildl. Manage. 35(3):469-475.

Verme, L. J., and D. E. Ullrey. 1972. Feeding and nutrition of deer. In: The Digestive Physiology and Nutrition of Ruminants. Vol. 3 Practical Nutrition. D. C. Church, Corvallis, Ore. pp. 275-291.

Wise, M. B., A. L. Ordoveza and E. R. Barrick. 1963. Influence of variations in dietary calcium:phosphorus ratio on performance and blood constituents of calves. J. Nutr. 79(1):79-84.

APPENDIX C

VALUES FOR NUTRITIONAL PARAMETERS ANALYZED

Table 5. Percentage field dry matter for nutritional study.

Province and Location	Species and Plant Parts Sampled							
	Aster patens	*Aster lateriflorus*	*Helianthus hirsutus*		*Helianthus silphoides*	*Bidens polylepis*	*Lactucca canadensis*	
	Vegetative	Vegetative	Vegetative	Head	Head	Vegetative	Vegetative	Flowering stalk
Ouachita Highlands								
14331	30.0	23.0	25.0	32.9	---	---	15.3	19.5
14356	31.1	25.1	27.1	31.5	---	---	16.0	16.5
14369	27.6	22.8	22.4	30.6	---	---	15.5	14.5
						[a]19.7		
Coastal Plain								
11108	28.1	---	21.2	31.8	21.2	---	14.0	18.9
11151	26.9	---	22.2	36.2	26.1	---	14.5	21.1
11179	29.2	---	23.8	33.7	24.2	---	15.3	22.0
						[a]18.6		

--- = No samples collected

[a]Species not sampled in established plots

Table 6. Percentage ash for nutritional study.

Province and Location	Species and Plant Parts Sampled							
	Aster patens	Aster lateriflorus	Helianthus hirsutus		Helianthus silphoides	Bidens polylepis	Lactucca canadensis	
	Vegetative	Vegetative	Vegetative	Head	Head	Vegetative	Vegetative	Flowering stalk
Ouachita Highlands								
14331	9.9	10.4	13.6	8.4	---	---	13.8	12.2
14356	9.5	9.8	13.0	8.9	---	---	13.4	11.2
14369	9.7	10.5	13.3	9.5	---	---	13.5	9.0
						[a]9.5		
Coastal Plain								
11108	8.3	---	11.0	10.4	9.8	---	12.9	9.2
11151	10.6	---	11.6	10.1	9.0	---	12.5	9.3
11179	9.3	---	10.6	10.2	9.4	---	12.0	9.3
						[a]7.5		

--- = No samples collected

[a]Species not sampled in established plots

Table 7. Percentage calcium for nutritional study.

Province and Location	Species and Plant Parts Sampled							
	Aster patens	Aster lateriflorus	Helianthus hirsutus		Helianthus silphoides	Bidens polylepis	Lactucca canadensis	
	Vegetative	Vegetative	Vegetative	Head	Head	Vegetative	Vegetative	Flowering stalk
Ouachita Highlands								
14331	0.77	0.86	2.02	1.14	---	---	1.02	0.85
14356	0.81	0.86	1.95	1.22	---	---	1.00	0.75
14369	0.79	0.90	1.37	1.05	---	---	0.94	0.72
						[a]1.03		
Coastal Plain								
11108	0.81	---	1.41	1.33	1.03	---	0.94	0.92
11151	0.78	---	1.40	1.01	0.97	---	0.94	0.66
11179	0.73	---	1.23	1.04	0.88	---	0.86	0.59
						[a]0.80		

--- = No samples collected

[a]Species not sampled in established plots

Table 8. Percentage phosphorus for nutritional study.

Province and Location	Aster patens	Aster lateriflorus	Helianthus hirsutus		Helianthus silphoides	Bidens polylepis	Lactucca canadensis	
	Vegetative	Vegetative	Vegetative	Head	Head	Vegetative	Vegetative	Flowering stalk
Ouachita Highlands								
14331	0.18	0.24	0.21	0.21	---	---	0.25	0.30
14356	0.17	0.26	0.23	0.22	---	---	0.29	0.32
14369	0.21	0.29	0.27	0.19	---	---	0.38	0.40
						[a]0.33		
Coastal Plain								
11108	0.21	---	0.24	0.25	0.25	---	0.47	0.39
11151	0.15	---	0.23	0.23	0.25	---	0.33	0.41
11179	0.17	---	0.20	0.23	0.26	---	0.33	0.38
						[a]0.19		

--- = No samples collected

[a]Species not sampled in established plots

Table 9. Calcium phosphorus ratio for nutritional study.

Province and Location	Species and Plant Parts Sampled							
	<u>Aster patens</u>	<u>Aster lateriflorus</u>	<u>Helianthus hirsutus</u>		<u>Helianthus silphoides</u>	<u>Bidens polylepis</u>	<u>Lactucca canadensis</u>	
	Vegetative	Vegetative	Vegetative	Head	Head	Vegetative	Vegetative	Flowering stalk
Ouachita Highlands								
14331	4.3:1	3.6:1	9.6:1	5.4:1	–––	–––	4.1:1	2.8:1
14356	4.8:1	3.3:1	8.5:1	5.5:1	–––	–––	3.4:1	2.3:1
14369	3.8:1	3.5:1	5.1:1	5.5:1	–––	–––	2.5:1	1.8:1
						[a]3.1:1		
Coastal Plain								
11108	3.9:1	–––	5.9:1	5.3:1	4.1:1	–––	2.0:1	2.3:1
11151	5.2:1	–––	6.1:1	4.4:1	3.9:1	–––	2.8:1	1.6:1
11179	4.3:1	–––	6.1:1	4.5:1	3.4:1	–––	2.6:1	1.5:1
						[a]4.2:1		

––– = No samples collected

[a]Species not sampled in established plots

Table 10. Percentage crude protein values for nutritional study.

Province and Location	Species and Plant Parts Sampled							
	Aster patens	*Aster lateriflorus*	*Helianthus hirsutus*		*Helianthus silphoides*	*Bidens polylepis*	*Lactucca canadensis*	
	Vegetative	Vegetative	Vegetative	Head	Head	Vegetative	Vegetative	Flowering stalk
Ouachita Highlands								
14331	9.2	10.7	11.3	8.9	---	---	14.9	12.4
14356	10.2	10.7	13.6	9.3	---	---	16.7	13.3
14369	11.3	12.4	12.9	8.4	---	---	18.7	14.7
						[a]17.5		
Coastal Plain								
11108	8.2	---	13.0	9.3	11.7	---	17.1	14.5
11151	9.2	---	12.5	10.3	11.7	---	14.3	14.1
11179	9.7	---	12.8	9.3	12.5	---	14.9	12.5
						[a]16.1		

--- = No samples collected

[a]Species not sampled in established plots

Table 11. Percentage *in vitro* dry matter digestibility values for nutritional study.

Province and Location	Species and Plant Parts Sampled							
	Aster patens	Aster lateriflorus	Helianthus hirsutus		Helianthus silphoides	Bidens polylepis	Lactucca canadensis	
	Vegetative	Vegetative	Vegetative	Head	Head	Vegetative	Vegetative	Flowering stalk
Ouachita Highlands								
14331	40.3	48.6	47.0	29.9	---	---	45.2	36.2
14356	44.3	47.1	41.7	34.3	---	---	45.9	36.9
14369	41.5	43.9	36.4	36.9	---	---	42.9	33.2
						[a]46.3		
Coastal Plain								
11108	39.7	---	46.7	26.7	38.4	---	48.6	34.4
11151	39.1	---	47.8	29.3	32.4	---	48.5	40.9
11179	44.6	---	44.6	31.5	37.7	---	48.7	39.5
						[a]40.9		

--- = No samples collected

[a]Species not sampled in established plots

APPENDIX D

SEASONALITY AND FREQUENCY OF HEAD ABSCISSION FOR STIFF-HAIRED SUNFLOWER

Introduction

This study involved observations of head abscission for stiff-haired sunflower (*Helianthus hirsutus* Raf.) plants. Objectives were to determine the seasonality and frequency of head abscission before first frost. Seasonality implied how long the heads were available as potential food for white-tailed deer into the fall season. Frequency of natural head abscission would be compared with past data from MS 1554 (McIntire-Stennis 1554- *Wildlife and Pine Clearcut Relationships*). Observations and data from the beginning of MS 1554 (1973) indicated that all missing heads were attributable to deer use. It was later discovered that head abscission unrelated to deer use occurred. Knowledge of the relative incidence of natural abscission to deer use was needed to re-evaluate past data.

Methods

The first 4 randomly selected plots from each of the 6 clearcuts (Chapter II, Fig. 2, 3) were used as observation plots. Collecting nets were placed around groups of sunflower plants in early August. A collecting net consisted of 4 1.2-m stakes driven into the ground with a cheesecloth basket, interwoven with galvanized steel wire, connected to the top of the stakes. Holes were made in the cheesecloth for each plant and sewn up around the stem. Enough cheesecloth was used to make a loose basket-shaped net that would catch any heads which abscissed. The number of collecting nets varied by plots.

Observations were made on all plots in each of the months of August, September, and October, 1977 (Table 12). Individual plants were observed for missing heads. The net was inspected if a head was missing from a plant. Heads were listed as missing if not found in the net. Stems were marked with small pieces of flagging, so as not to be recorded during another observation period. Heads found in the collecting net were removed.

Results and Discussion

Collecting nets were not located in deer exclosures. It was not known if missing heads were eaten by deer or missing for some other unknown reason. Four plants in each Province had at least 1 head missing for the August observations. One plant in the Ouachita Highlands and 2 plants in the Coastal Plain had at least 1 head missing for the September observations and the same number for the October observations. The number of heads missing was minimal (14) when compared to total number of plants observed (787) or plants having abscissed heads (88). Consequently, missing heads were not considered statistically important in this study.

Some individual plants had multiple heads, and some plants were observed as having an abscissed head more than once. Each sampling period, an individual plant was

Table 12. Dates of observations in Ouachita Highlands and Coastal Plain provinces for head abscission of stiff-haired sunflower plants.

Location	Ouachita Highlands	Location	Coastal Plain
14331	August 25	11108	August 23
	September 18		September 10
	October 16		October 15
14356	August 25	11151	August 23
	September 18		September 10
	October 16		October 15
14369	August 25	11179	August 23
	September 18		September 10
	October 16		October 15

Year: 1977.

regarded as an independent observation with the assumption that a previous abscissed head or no abscission would have no effect on other heads of the same plant. This assumption was made because the frequency of plants with at least 1 abscissed head for a certain time period, compared to the total number of plants available during that time period was needed to correct previous data. Length of time that heads were available as deer-food was also of interest. For each of the 3 sampling periods, the number of independent observations was equal to the number of plants sampled. When sampling periods were combined, the number of independent observations was equal to approximately 3 times the actual number of plants in the sample. Plant mortality from rabbit damage occurred between September and October sampling periods in location 14369 in the Ouachita Highlands and in location 11179 in the Coastal Plain. Six plants from the same plot accounted for the mortality in location 14369. Five plants, 4 on 1 plot and 1 on another, accounted for the mortality in location 11179.

Total independent observations indicated a greater activity of head abscission from plants in the Ouachita Highlands than in the Coastal Plain (Fig. 4). See Table 13 for values of total observations and head abscission by location. Monthly observations indicated the greatest activity of head abscission was during September for both provinces (Table 14). No head abscissions were observed for location 11108 during the study.

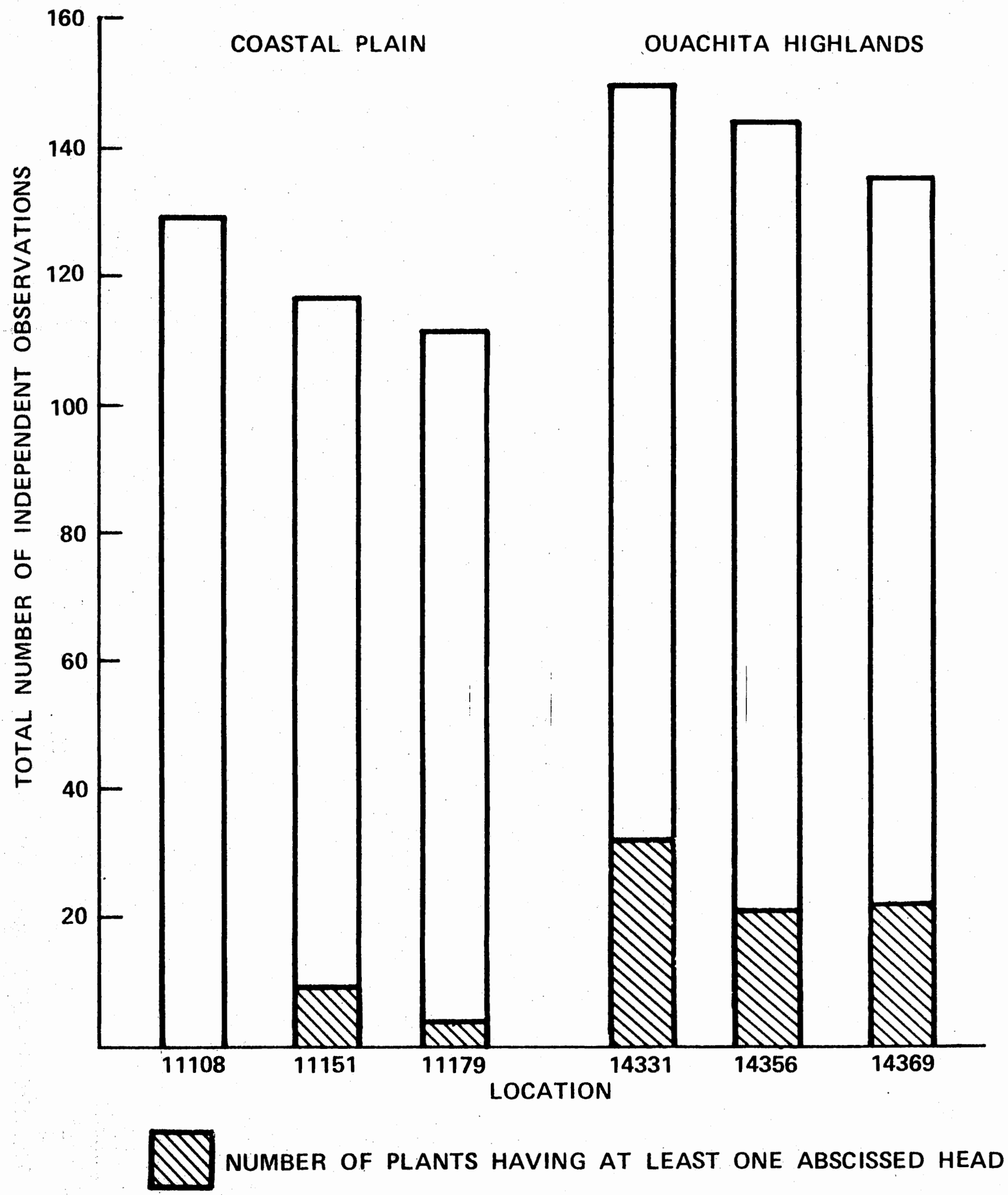

Fig. 4. Total independent observations of stiff-haired sunflower plants compared to the number of observations of plants having at least one abscissed head.

Table 13. Total observations, by location, for three sampling periods, and number of stiff-haired sunflower plants having at least one abscissed head.

Location and Province	Total observations	Plants having at least one abscissed head
Coastal Plain		
11108	129	0
11151	117	9
11179	112	4
Ouachita Highlands		
14369	135	22
14331	150	32
14356	144	21

Year: 1977.

Table 14. Total observations, by months and Province, and number of stiff-haired sunflower plants having at least one abscissed head.

Location and month	Total observations	Plants having at least one abscissed head
Coastal <u>Plain</u>		
August	121	2
September	121	8
October	116	3
Ouachita <u>Highlands</u>		
August	145	24
September	145	39
October	139	12

Year: 1977.

An interaction was detected for each of the 3 monthly observations. Province differences were significant ($P < .05$) for each sampling period.

Summary

Seasonality and frequency of head abscission of stiff-haired sunflower plants were observed during August, September, and October in the Ouachita Highlands and Coastal Plain provinces. This was accomplished by:

1. Collecting nets constructed around groups of sunflowers.
2. Individual plants observed for head abscission, once for each month.
3. Observations of head abscission recorded; heads removed from nets; and stems marked with flagging.

Conclusion

Percentages could not be used for comparisons because of unequal base numbers (total observations, by locations); however, percentages could be used as inferences for the frequency of head abscission for a single location. The highest frequency of head abscission was in September; 26.9% in the Ouachita Highlands and 6.6% in the Coastal Plain. Frequency of plants having at least 1 abscissed head compared to total observations, by provinces, were; 17.5% for the Ouachita Highlands and 3.6% for the Coastal Plain. Province differences were significant ($P < .05$) for all months, and an interaction was present in each month.

Inferences made from this study were:

1. Head abscission, unrelated to deer use, was greater in the Ouachita Highlands Province than in the Coastal Plain Province.
2. September had the highest frequency of head abscissions in both provinces.
3. Large majority (73% and up) of heads, potentially useful as deer-food, remained on the plants at least through mid-October.

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Education: Graduated from Althoff Catholic High School, Belleville, Illinois, in June 1970; received Bachelor of Science degree in Zoology from Oklahoma State University in May 1976; completed requirements for Master of Science degree at Oklahoma State University in July 1979.

Memberships in Organizations and Societies: Society of American Foresters; Xi Sigma Pi National Honorary Forestry Association; American Forestry Association; Graduate Student Council (Oklahoma State University).