Determining Deer Habitat Capability in Ouachita National Forest Pine Stands

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Abstract: On the Ouachita National Forest of Arkansas and Oklahoma, mean total forage yields in various age shortleaf pine (*Pinus echinata*) stands ranged from 1,914 kg/ha in young stands to 172 kg/ha beneath mature stands. Forage nutrient analysis in late summer revealed low phosphorus (0.12%), low crude protein (7.72%), high calcium (1.07%), and wide Ca:P ratio (9.5) averages. Average crude protein was significantly higher (8.22%) in stands with site index <61 than in stands with site index $\geqslant 61$ (7.23%). Timber stand age and basal area related to deer (*Odocoileus virginianus*) forage yields will help managers assess present and future deer habitat capability levels.

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The 637,520-ha Ouachita National Forest, located in west central Arkansas and southeastern Oklahoma, is intensively managed for timber and wildlife. To better plan and coordinate management programs, forest resource managers must be able to assess the effects of forest practices on the quantity and quality of forage available to white-tailed deer.

Earlier deer habitat data for the forest were available only from a 1964 study by Segelquist and Pennington (1968) who recorded forage yields of 113 kg/ha and 168 kg/ha on undisturbed and thinned pine stands, respectively. On nearby commercial forest land in Oklahoma, Fuller (1976) found that selectively cut stands generally had higher, less desirable Ca:P ratios than clearcut stands.

The purpose of this study was to develop predictive models dealing with deer forage production and nutrient values in shortleaf pine stands as related to stand age, basal area, and site index. Furnished with such models, managers can ascertain the effects of both present and future management practices on the quantitative and qualitative aspects of deer habitat. The technique may be adapted to measure effects of other wildlife management practices as well as intermediate timber cultural treatments.

This study was conducted on all districts of the Ouachita National Forest except the 17,456-ha coastal plain region. The terrain varied from nearly flat to rolling hills and steep ridges. Soils were of sandstone, shale, novaculite, and chert origin and ranged from low to moderate in productivity for pine timber. In the sampled stands, shortleaf pine and loblolly pine (*Pinus taeda*) predominated in association with a hardwood midstory of white oak (*Quercus alba*), northern red oak (*Q. rubra*), black oak (*Q. velutina*), southern red oak (*Q. falcata*), blackgum (*Nyssa sylvatica*), post oak (*Q. stellata*), hickories (*Carya* spp.), and sweetgum (*Liquidambar styraciflua*). Common understory species included: blueberry (*Vaccinium* spp.), poison ivy (*Rhus radicans*), dogwood (*Cornus florida*), and red maple (*Acer rubrum*), with young sprouts of hickories, oaks, and blackgum. Mixed red oak-white oak-hickory stands were common on north facing ridges and along stream bottoms.

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Methods

Under present management, timber stand information is constantly updated in a computerized Continuous Inventory of Stand Condition (CISC) system that records stand age, size, site index, basal area, cultural treatments, and various other data. Only a single sampling effort was needed to measure deer habitat criteria which, when combined with CISC data, provide the means for future estimates of deer forage quality and availability.

The 45 shortleaf pine stands sampled for deer forage were selected using site index and stand age data from CISC. Stands were chosen in 5 age classes: 0–4, 5–10, 11–20, 21–50, and $\geq$51 years with a range of 1–83. These age classes were selected as being representative of distinctly recognizable phases in the life of the stand in terms of both habitat and silviculture. At least 3 replications of each age class were examined. Stands with site indices of either $<$61 or $\geq$61 were examined and only those which had not been disturbed by recent burning, thinning, or grazing were selected. Data collection began on 20 August and terminated on 12 September 1979. This period coincided with the late summer stress period for deer (i.e., before mastfall when vegetation begins hardening and is lowest in moisture content).

On 1-m^2 plots, annual woody and herbaceous growth of all ground and understory vegetation to a height of 1.5 m was clipped and weighed using techniques outlined by Harlow (1977). Plots were spaced at 20-m intervals on parallel transect lines located 40 m apart. Atypical inclusions such as hardwood stream bottoms and roads were omitted. Green weights were recorded for forage groupings as follows: grasses and grasslike plants, legumes, forbs, and woody plant parts (leaves, stems, and vines). Subsamples were air-dried and all forage weights converted to kg/ha dry weight.

Preliminary data were obtained on 20 plots along each transect. Additional plots were taken only if the data from the preliminary plots failed to detect a difference of $\leqslant 30\%$ from the sample mean at $P \leqslant 0.70$ (Harlow 1977). The number of additional plots was determined by the use of Stein's formula (Steel and Torrie 1960). Lack of manpower and funds limited the number of forage sample plots to a level that would detect a difference of 30% of the sample mean at the 70% confidence interval. This margin of error was sufficiently accurate to obtain habitat capability information for making management decisions and reduced field time for data collection.

In addition, basal area (BA) of stems $\geqslant 2$ cm in diameter breast height (dbh) was calculated on alternate plots from caliper measurements. Plot size was variable as determined by a 2-m^2 factor prism.

Various qualitative aspects of nutrient analyses were performed by the Ohio Agricultural Research Station of Ohio State University, University of Arkansas, and Oklahoma State University using standard analytical techniques (mass spectrometer, Kjeldahl digestion trials). Forage was tested for crude protein, phosphorus, calcium, and total digestible nutrients (TDN).

Predictive curves were developed by regressing forage production weights on individual stand ages and basal areas. Best fit curves (power curves) for weight vs. age were obtained by logarithmicly transforming weight and age values. Best fit curves (exponential curves) for weight vs. BA were obtained by logarithmically transforming weight values only.

Results and Discussion

Quantitative Analysis

Mean weights of total forage produced on all sites ranged from 1,914 kg/ha on 0–4-year-old stands to 172 kg/ha on $\geqslant$51-year-old stands (Table 1). Woody vegetation generally accounted for about half of the total (38%–75%). Grasses and forbs accounted for most of the rest, with legumes making up a smaller percentage. Forage yields showed similar trends when grouped according to basal area of stands (Table 2). Production ranged from a mean of 1,676 kg/ha on stands with $\leqslant 5$ m^2/ha BA to 131 kg/ha on stands with 24+ m^2/ha BA. Again, woody vegetation accounted for about half of the total (30%–70%) with grasses, forbs, and legumes accounting for correspondingly less. Data in Tables 1 and 2 were obtained from the same samples. However, age and BA classes were not directly comparable since stands in similar age classes did not always fall into the same basal area class.

Table 1. Mean air-dry forage weights (kg/ha) (±SE) by stand age class and forage species group on the Ouachita National Forest, 1979.

		Forage weight (kg/ha air-dry)									
		Woody		Grasses		Forbs		Legumes		Total	
Age class	*N*	*x*	SE	*x*	SE	*x*	SE	*x*	SE	*x*	SE
0–4	10	721	(320)	556	(339)	561	(571)	76	(93)	1,914	(816)
5–10	8	722	(453)	406	(282)	144	(142)	60	(38)	1,332	(297)
11–20	6	234	(116)	148	(90)	71	(51)	73	(102)	526	(236)
21–50	12	227	(153)	54	(42)	36	(34)	7	(4)	324	(161)
51+	9	137	(93)	17	(13)	13	(15)	5	(3)	172	(77)

Regression curves showed that total forage weight was well correlated ($r^2 = 0.72$) with stand age (Fig. 1). Total forage weight peaked the first few years after clearcutting, declined sharply after 10 years and leveled off at 30 to 40 years. Production by forage group followed similar trends (range $r^2 = 0.49$–0.63) (Fig. 2). However, yield of grasses, forbs, and legumes declined more rapidly than that of woody vegetation. Weights for all forage groups and for total yield were similarly correlated ($r^2 = 0.84$) with BA (Figs. 3, 4). Peak forage production occurred on newly regenerated sites with little or no BA of suppressing woody plants. Production was found to decline rapidly as the tree canopy closed and BA approached 12–14 m^2/ha. Again, production of woody vegetation declined less rapidly than that of other forage groups (range $r^2 =$ 0.42–0.77).

No significant difference was found between yield on high and low site index stands for the forb or grass groups or for total forage production ($P \geqslant 0.10$, t [43]). However, production of woody and legume groups was significantly higher on higher site indices ($P \leqslant 0.10$, t [43]) when compared for both stand age and BA classes. Most of this difference in favor of better sites was accounted for by high initial production of legumes and woody vegetation in young, open stands which decreased as stand age and BA increased (Figs. 5, 6). Older, more dense stands did not exhibit such a marked forage yield difference between high and low site index stands.

Table 2. Mean air-dry forage weights (kg/ha) (±SE) by stand BA class and forage species group on the Ouachita National Forest, 1979.

		Forage weight (kg/ha air-dry)									
		Woody		Grasses		Forbs		Legumes		Total	
BA class	*N*	*x*	SE	*x*	SE	*x*	SE	*x*	SE	*x*	SE
⩽5	15	771	(363)	456	(325)	383	(503)	66	(76)	1,676	(757)
6–12	6	297	(94)	305	(342)	164	(151)	103	(84)	869	(393)
13–17	7	309	(159)	68	(59)	40	(43)	5	(4)	422	(160)
18–23	10	148	(81)	32	(39)	18	(28)	7	(4)	205	(101)
24+	6	83	(55)	26	(21)	16	(17)	6	(3)	131	(49)

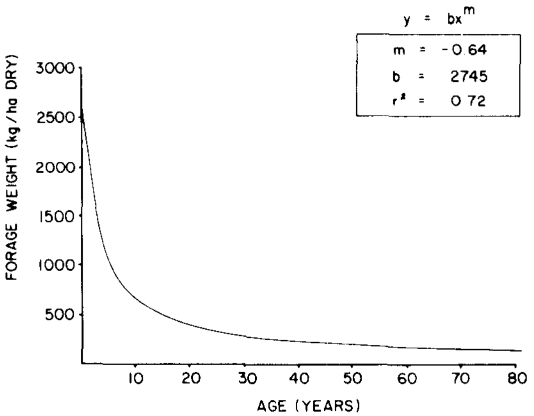


Figure 1. Predicted air-dry forage weights (kg/ha) vs. stand age (years) on the Ouachita National Forest, 1979.

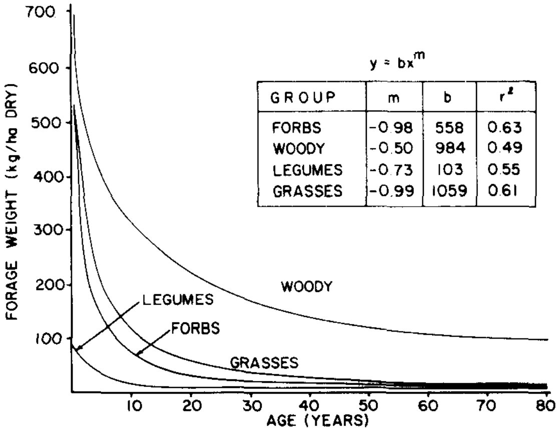
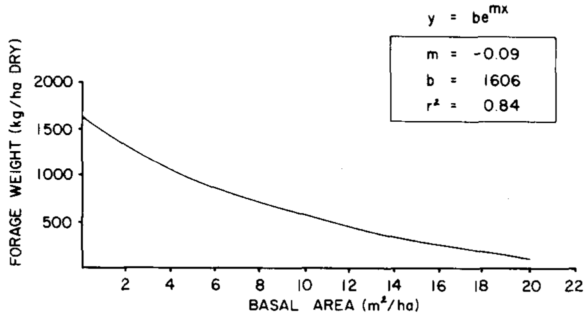


Figure 2. Predicted air-dry forage weights (kg/ha) by forage group vs. stand age (years) on the Ouachita National Forest, 1979.

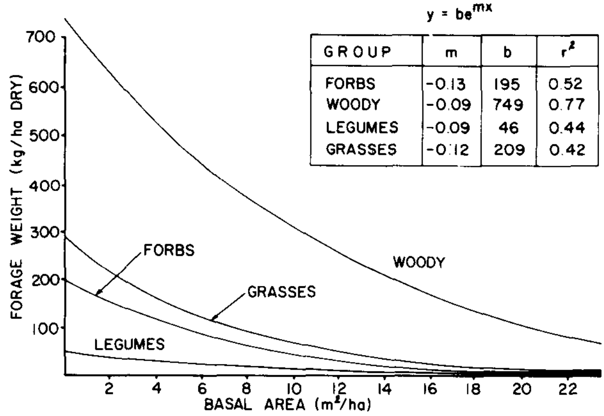
Results of this study corroborate the work of other investigators (Halls and Schuster 1965, Blair 1969, Wolters 1973, and Wiggers et al. 1978) who found that total forage yield was significantly related to overstory characteristics with greatest production occurring in stands with lowest BA. Harlow et al. (1980) sampled sandpine (*Pinus clausa*)–scrub oak (*Quercus* spp.) and longleaf pine (*P. palustris*)–turkey oak (*Q. laevis*) stands in Florida and measured greatest total forage weights in 2 to 7-year-old stands. Similarly, Blair and Burnett (1977) found that in pine and mixed pine-hardwood stands in Louisiana, forage peaked at 2 years of age. Hurst et al. (1980) found biomass of forbs and grasses in Mississippi to be inversely related to stand BA, age, and several other characteristics. In 20- to 35-year-old managed loblolly stands in Virginia, Conroy et al. (1982) recorded forage weights of 309 to 1,549 kg/ha, with yields related inversely to canopy closure.

When total forage production figures for Ouachita National Forest pine stands were examined, it became clear that production was quite low in all but



m = -0.09
b = 1606
r² = 0.84

Figure 3. Predicted air-dry forage weights (kg/ha) vs. stand basal area (m^2/ha) on the Ouachita National Forest.



GROUP	m	b	r²
FORBS	-0.13	195	0.52
WOODY	-0.09	749	0.77
LEGUMES	-0.09	46	0.44
GRASSES	-0.12	209	0.42

Figure 4. Predicted air-dry forage weights (kg/ha) by forage group vs. stand basal area (m^2/ha) on the Ouachita National Forest, 1979.

those stands in the youngest age classes. Furthermore, since these figures represented total yields, palatable and preferred deer foods would account for even smaller amounts. The conclusion is that undisturbed stands >10 years provided little in the way of deer food. Caution should be used, however, when interpreting forage yield in stands of the 0- to 4-year age class because of the way stand age was recorded in the CISC system. A stand was assigned the age of 0 only when it was certified as adequately stocked with pine seedlings. This may have been several years after clearcutting, depending on the timing of the harvest cut, site preparation, and planting.

Qualitative Analysis

Percentages of phosphorus, crude protein, calcium, and TDN showed no apparent relationship when plotted against age or BA. Mean values for these

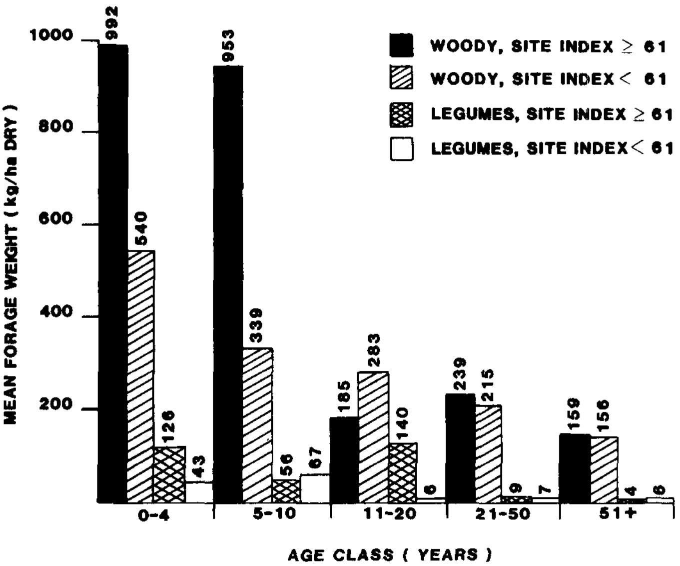


Figure 5. Mean air-dry forage weights (kg/ha) by site index for woody and legume groups vs. stand age class (years) on the Ouachita National Forest, 1979.

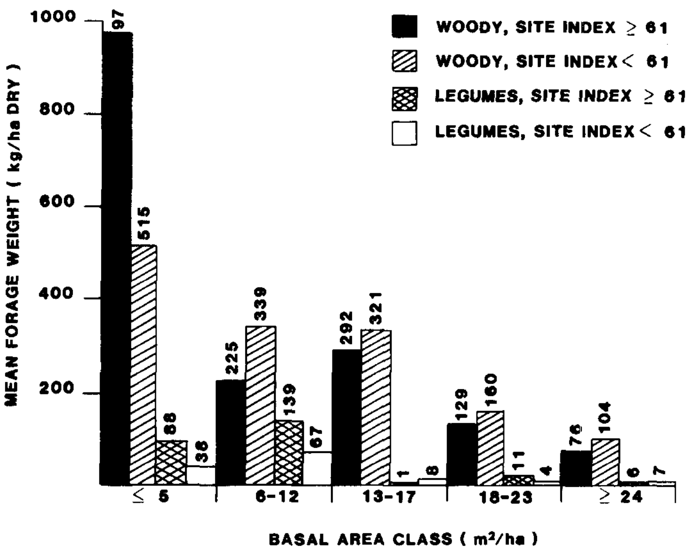


Figure 6. Mean air-dry forage weights (kg/ha) by site index for woody and legume groups vs. stand basal area class (m^2/ha) on the Ouachita National Forest, 1979.

variables were as follows: crude protein, 7.7%; P, 0.12%; Ca, 1.07%; and TDN, 40.9%. Crude protein was significantly higher on stands with site index <61 ($P \leqslant 0.10$, t [41]). Mean values were 8.22% for site index <61 and 7.23% for site index ⩾61. This difference may be because vegetative growth was inhibited by 1 or more factors, causing nitrogen to accumulate, or because of leaching from mature or dry plants by rainfall (Laycock and Price 1970).

Studies by Halls and Epps (1969) revealed that plants occurring in open areas in east Texas contained more phosphorus and crude protein but less calcium than plants grown beneath a pine overstory. In contrast, a similar study in Texas by Valentine and Young (1959) indicated that open sites produced browse with less crude protein and phosphorus than sites with overstories. Conroy et al. (1982) found crude protein to be unrelated to overstory and site characteristics of loblolly pine plantations. Their studies led them to conclude that 4.7% to 21.9% crude protein was required to sustain white-tailed deer, although a minimum of 6% to 7% was actually more likely to be required for maintenance. French et al. (1956) estimated that 13% to 16% crude protein was required for growth. Magruder et al. (1957) gave minimum percentages of Ca and P for survival as 0.30 and 0.25, respectively, and for best antler development as 0.64 and 0.56, respectively.

Data for the Ouachita National Forest showed that protein, phosphorus, and TDN during late summer were at or below minimum levels for maintenance of white-tailed deer. Conversely, calcium levels were high and compounded the problem in that the resulting Ca:P ratio ($\bar{x} = 9.5$) was much wider than the 1:2 to 2:1 recommended by Dietz (1970) and could adversely affect optimum metabolism. As others have noted, deer apparently are able to select foods that best meet their nutritional requirements. Tests on preferred plant species would have more closely reflected nutrient levels of actual forages consumed than the figures in this study, which were means for all forage species. Nonetheless, it appeared that low phosphorus levels and the resultant Ca:P ratio could be limiting factors in deer diets.

Survey Implications

Harvest data suggest that white-tailed deer populations are not high in the Ouachitas (Arkansas Game and Fish Commission, unpubl. data); and the low quantity and quality of late summer forage, as determined by this survey, appear to be important factors limiting white-tailed deer populations. While the inherently low soil fertility of the region cannot be expected to change, other factors may be influenced. As clearcutting on private commercial and Federal lands increases and rotation ages are shortened, available deer forage supplies can be expected to increase. On the Ouachita National Forest, activities such as reduction in clearcut size, increase in volume harvested, shaping of clearcuts, retention of mast-producing hardwood species, planting of winter green strips, prescribed burning, and midstory thinning are directly or indirectly aimed at improving deer habitat.

Each of the prediction curves in Figs. 1–6 can be used to estimate forage yield and composition in various age pine stands after clearcutting. In combination with CISC data and projected timber harvest levels, estimates of present and future deer habitat capability are possible.

In conclusion, the type of deer forage prediction models developed from this study provides forest resource managers with the following advantages: a satisfactory means of assessing present and future deer habitat capability levels, the means to interpret the effects of future management practices, and the knowledge necessary to occasionally modify these practices to best suit the habitat requirements of deer (or other species of wildlife). Future plans call for extending this kind of survey to other forest types.

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