DEER FORAGE PRODUCTION ASSOCIATED WITH THE PRACTICE OF SITE CONVERSION IN A NORTH CAROLINA POCOSIN[1]

by

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ABSTRACT

A study was made to determine the effects of site conversion on the production of forage for deer on industrial timberlands in an eastern North Carolina pond-pine pocosin. Natural as well as site prepared regenerated stands were sampled. The diversity of species was significantly greater on regenerated sites than either of the two types of natural sites. As a result of site conversion forage production was increased reaching a maximum of 728 kilograms per hectare during the fourth growing season compared to a maximum of 100 kilograms per hectare for the natural sites. A decline in both species diversity and forage production occurred during the fifth growing season following site preparation. When compared to un-fertilized sites, fertilization with triple super-phosphate applied during site preparation increased forage production for several years without significantly increasing species diversity. Of particular significance is the contribution of windrows to forage production during the initial years following site preparation.

In recent years considerable effort has been expended on developing improved methods of wood fiber production on pocosins and other wetlands of the Coastal Plain of North Carolina. Characteristically, these lands in their natural state are dominated by sub-marginal stands of pond pine (*Pinus serotina*) and are sub-marginal, at best, for forest production. In converting these sites to acceptable levels of usable wood production, the sequence of treatments, as a rule, includes (a) first, the clear-cutting of all marketable material, (b) yarding the logging debris and brush into windrows, (c) burning the windrows as soon as they are dry enough, (d) bedding the strips of land between windrows at a spacing with adjacent beds on about 2.7 meter centers to provide micro-relief for the pine seedlings to be planted on them, and (e) planting loblolly pine. (In recent years the application of phosphate fertilizer at time of bedding has been incorporated into the sequence of site preparation practices.)

In this process of converting pocosin lands to a commercial level of wood production, very little attention has been devoted to the effects of the conversion practices on the composition and diversity of understory vegetation and the resulting habitat alteration on populations of wildlife. "Understory" as used here means all plants normally dominated by a high canopy of forest trees, recognizing that in the stand conversion process the early stages include periods when the overstory is lacking. The understory plant community includes mosses and other lower plants, grasses, fungi, herbs, vines, shrubs, and tree seedlings. Sossaman and Weber (1974) have demonstrated that the understory level in this community structure serves as the interface for the transfer of energy from green plants to such primary consumers as the white-tailed deer (*Odocoileus virginianus*).

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Demands for sustaining current levels of hunting opportunity, and even increasing them, have provided the impetus for the production of multi-product yields from industrial timberlands. With knowledge of the effects of site conversion and intensive silvicultural practices on wildlife habitat, the industrial timberland owner can practice management systems that sustain both timber production and wildlife habitat.

The objective of this study was to quantify the production of deer forage in natural and site prepared regenerated stands on pocosin sites. This study was conducted concurrently with a deer food habits study reported by Sossaman and Weber (1974), and directs emphasis mainly on developing estimates of deer forage production.

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STUDY AREA

Extending from Virginia to Georgia, along the lower Atlantic Coastal Plain, is a series of wet upland bogs known as "pocosins." Their origin is obscure, but they are characterized by a lack of pronounced slope gradients, poor drainage, and organic soil of varying depths (Teate, 1967). The area selected for this study was the "Big Pocosin" which encompasses portions of Craven, Pamlico, and Beaufort counties in North Carolina. The "Big Pocosin" is a typical "pond-pine pocosin" as described by Wells (1932). The area on which this study was conducted includes portions of the approximately 21,000 hectares of the "Big Pocosin."

Two distinct communities of typical pocosin vegetation occur on natural sites. These are the pond-pine community and the hardwood drains. The pond-pine community usually includes a ragged overstory of pond and loblolly pines (*P. taeda*) with an understory of cane (*Arundinaria gigantea*), hollies (*Ilex sp.*), and ericaceous plants such as fetterbush (*Lyonia lucida*) and blueberries (*Vaccinium sp.*). Although the topography is generally flat, the surface is laced with a dendritic pattern of narrow sinuous depressions, with a dominant hardwood overstory, providing nominal surface drainage. These drains are characteristically wet and have an overstory of red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), yellow poplar (*Liriodendron tulipifera*), sweetbay (*Magnolia virginiana*), and black gums (*Nyssa sp.*). Without disturbance of the canopy, these hardwood drains are generally open and have little or no understory. Neither the pond-pine community nor the hardwood drains contain a significant mast producing component.

Temperatures range annually from 17° to 41° C. On the average there are 230 frost free growing days annually (Hardy and Hardy, 1971). The mean annual rainfall is 132 centimeters (Saucier *et al.*, 1973).

Soils on the study area are of three major series: Bladen, Coxville, and Portsmouth (Jurney *et al.*, 1929). All three soils series are imperfectly to poorly drained. Muck and peat soils varying in thickness up to a meter underlain by impermeable, massive, and structureless subsoils predominate.

During the last decade approximately 45 percent of the residual stands in the "Big Pocosin" have been harvested by clear-cutting, followed by intensive site preparation, then replanted with loblolly or slash pine (*Pinus elliottii*). Site preparation was accomplished by felling and piling of non-merchantable material with tractors equipped with KG blades, root rakes, or drum choppers into windrows which were subsequently burned, then the inter-windrow strips were drawn into ridges to provide micro-relief by the use of bedding plows.

METHODS

Due to a lack of consistency in site preparation practices during the past 15 years, only one combination of practices had been repeated extensively enough to permit a sufficient number of replications. This combination of practices included the shearing of unmerchantable stems with a KG blade, pushing the slash into windrows and burning them, bedding, then planting loblolly pine on the beds and in the burned windrows. Site preparation was usually done in late summer or early fall followed by planting in spring. This site treatment, currently in use, provided a sufficient number of stands for study through each of five growing seasons following site preparation and planting. Growing seasons are referred to here in the order of occurrence of each succeeding site preparation (*i.e.*, with site preparation in fall and planting in the following spring, the first growing season would be the same year that planting took place). In addition, regenerated stands with similar site treatment practices which had also been fertilized at the time of bedding with triple superphosphate (0-46-0) at the rate of 45-56 kilograms of phosphorus per hectare were selected and sampled. A sufficient number of fertilized stands were available to characterize this practice through only two growing seasons. Natural pond pine sites and undisturbed hardwood drains were also sampled.

Browse production was estimated by means of the total clip method (Pechanec and Pickford, 1973). This method consists of clipping all current annual growth of woody species from ground level to a height of 1.5 meters. In addition, obviously, sampling mushrooms and pokeweed required clipping the entire plant. The clipped material was bagged, oven dried for 12 hours at 75°C and weighed. All estimates of browse production presented here are expressed as kilograms per hectare on a dry-weight basis. It should be noted that since estimates were made from data collected during the latter portion of the growing season, they represent the maximum available production of browse, except parts that had dried and fallen prior to sampling—at best a negligible portion.

Prior to the sampling of the stands, uniformity trials (Snedecor and Cochran, 1967) were used to determine primary sampling unit size and the intensity of primary sampling units. It was determined from the uniformity trials that a rectangular shaped primary sampling unit 1.01 square meter in size was the most efficient when allocated at approximately 40 primary sampling units per stand. Plots were randomly allocated within a randomized complete block (RCB) design.

Frequency distribution tables were compiled for each of the nine site conditions examined (see Table 1). These tables include a list of all vegetation occurring on each site in the order of decreasing stem frequency. Species were grouped into frequency classes on the following basis:

"abundant" .... 24,703 plus stems per hectare

"frequent" .... 2473-24,702 stems per hectare

"occasional" .... 249-2472 stems per hectare

"rare" .... 248 or less stems per hectare

Treatment means were calculated to examine the differences between treatments for forage weight using Duncan's Multiple Range Test (Duncan, 1955).

Regression analysis (Snedecor and Cochran, 1967) was used to partition and analyze variation in forage production and to prepare estimates of forage production during the five growing seasons after site preparation and planting using the RCB model:

$$wt = \beta_o + \beta_1 R_i + \beta_2 T_j + \beta_3 T_j^2 + \beta_4 T_j^3 + \varepsilon$$

where wt = weight of available forage (kilograms per hectare),

R_i = the linear effect of the j^{th} growing season, where j = 1-5,

T_j^2 = the quadratic effect of the j^{th} growing season, where j = 1-5,

T_j^3 = the cubic effect of the j^{th} growing season, where j = 1-5,

β = regression coefficients, and

ε = residual error.

An index of species diversity was calculated on a per plot basis using the Brillouin form $H = 1/N \text{ Log } \frac{N!}{n_1!n_2!...n_3!}$ as set forth by Lloyd *et al.* (1968) and Pielou (1966). This index provided a method for combining or summarizing the great mass of data on community structure into a single quantitative characteristic (Wilhm and Dorris, 1968). Duncan's Multiple Range Test (Duncan, 1955) was used to evaluate differences between diversity index values for treatments. The term treatment here is used to identify the nine distinct site conditions studied; site prepared, un-fertilized stands which had experienced one, two, three, four or five growing seasons since planting; site prepared, fertilized stands which had experienced one or two growing seasons since planting; and two undisturbed sites, hardwood drains and pond-pine sites.

An index of importance was also computed using rumen frequency and volume data (Sossaman and Weber, 1974) and a calculation developed by McCaffery *et al.* (1974). Production and, hence, availability of selected species was ranked within each treatment. Production of the same selected species was ranked among treatments.

RESULTS AND DISCUSSION

Vegetation returns rapidly after site preparation of harvested pocosin areas. Of the 128 plant species found growing on the nine treatments, 44 percent occurred during the first growing season (Table 1).

Despite the high variability in forage production among the nine different treatments a definite trend was discernible (Table 2). Overstory removal and site preparation resulted in an initial increase in forage production consistent with other studies that have evaluated deer forage in young regenerated pine plantations (Shuster and Halls, 1963; Murphy and Ehrenreich, 1965; Blair, 1968; McKee, 1972). One hundred fifty-two kilograms of forage of the total of 186 kilograms per hectare (oven-dried) produced the first growing season was pokeweed (*Phytolacca americana*). However, this species did not reappear during the second growing season, thus accounting for the drastic decline in browse production the second year.

During the first growing season more than 20 times the forage was produced on windrows than on the bedded areas between windrows. This superiority of windrow sites may be attributed to the apparent effect of improved drainage, "earliness" due to favorable spring temperatures and aeration, and the release of nutrients due to burning of slash.

During the third growing season, forage production on prepared sites reached 241 kilograms per hectare. This level of production is considerably greater than the 133 kilograms per hectare reported by McKee (1972) in a three-year old second generation loblolly pine plantation on the interior flatwoods of Mississippi.

Forage production peaked during the fourth year and was approximately seven times as great as the production in natural pond-pine stands and almost 17 times the production measured in hardwood drains. This peak in production was followed by a decline during the fifth growing season. Duncan's new multiple range test indicated that the third, fourth, and fifth growing seasons had significantly ($P \leq .05$) greater forage production than was measured in other years after planting, and in the areas not subjected to the disturbance of stand conversion.

Fertilized stands produced nearly 300 percent more forage than unfertilized stands during the first growing season. This increased production was due primarily to the increased abundance of pokeweed and to increased vigor of blackberry (*Rubus sp.*) and related species. The margin of difference decreased to 75 percent for the second growing season. One and two year old fertilized stands had significantly ($P \leq .05$) higher production than one and two year old un-fertilized stands.

The plotted estimated total available browse is presented in Figure 1. The model weight $= \beta_0 + \beta_1 R_i + \beta_2 T_j + \beta_3 T_j^2 + \beta_4 T_j^3 + \varepsilon$ accounted for more than 80 percent of the variation associated with treatment means for the first five growing seasons (Table 3). Several factors accounted for the observed configuration presented. During the first growing

Table 1. The Relative Abundance of Plants Occurring on Selected Sites in the Big Pocosin.

Common name	Scientific name	Years since planting of pine: Non-fertilized 1	2	3	4	5	Fert. 1	2	Pond Pine	Hard-wood Drain
Red maple	*Acer rubrum* L.	o*	o	o	o	f*	o	o	f	f
Pepper-vine	*Ampelopsis arborea* (L.) Koehne			r*						
Hercules club	*Aralia spinosa* L.	r	r		r	r	r	r		
Cane	*Arundinaria gigantea* (Walter) Muhl.	f	f	a*	a	a	o	f	a	f
Aster family	Asteraceae	a	a	a	a	a	a	a		f
Partridge pea	*Cassia fasciculata* Michaux		f	f	f			f		
Sweet pepperbush	*Clethra alnifolia* L.	f	f	f	a	a	f	a	a	a
Sedge family	Cyperaceae	f	a	a	a	a	f	a		f
Swamp cyrilla	*Cyrilla racemiflora* L.	o			o	o		f		
Climbing hydrangea	*Decumaria barbera* L									o
Sundew	*Drosera leucantha* Shinners	o	o	f	f	o	r	o		o
Yellow jessamine	*Gelsemium sempervirens* (L.) Ait. f.	o	o	f	f	o	r	o		o
Cranesbill	*Geranium* spp.	o	o	r			o			
St. Johns' wort	*Hypericum* spp.	o	o	f	f	f	f	f		
Large gallberry	*Ilex coriacea* (Pursh) Chapm.								o	
Little gallberry	*Ilex glabra* (L.) Gray	f	o	f	a	f	o	f	f	r
American holly	*Ilex opaca* Ait.				r					
Morning glory	*Ipomoea purpurea* (L.) Roth				r	o				
Rush family	Juncaceae	o		o	f	o				
Lespedeza	*Lespedeza* spp. Michaux		r	f	f	o	o			
Leucothoe	*Leucothoe axillaria* (Lam.) D. Don				r	r				
Sweetgum	*Liquidambar styraciflua* L.	r	o	f	f	o	o	f	f	a
Yellow poplar	*Liriodendron tulipifera* L.			r			r			o
Japanese honeysuckle	*Lonicera japonica* Thunb.	o	o	f	f	o	r	o		o
Ludwigia	*ludwigia* spp.		r				r			
Angle-stemmed fetterbush	*Lyonia lucida* (Lam.) K. Koch	r		o	o			o		r
Sweetbay	*Magnolia virginiana* L.	r		f		o	o		o	o
Wax myrtle	*Myrica cerifera* L.		r	o	o	r	r	r		
Bayberry	*Myrica pennsylvanica* Loisel	r						r	r	
Swamp blackgum	*Nyssa biflora* (Walter) Sargent		o							o
Blackgum	*Nyssa sylvatica* Marshall			f						
Virginia creeper	*Parthenocissus quinquefolia* (L.) Planchon	f		r	o	f	f	o	f	f
May pops	*Passiflora incarnata* L.		o							
Red bay	*Persea borbonia* (L.) Spreng.	o		r		o			f	f
Pokeweed	*Phytolacca americana* L	o	r				o			
Pond pine	*Pinus serotina* Michaux								o	
Grass family	Poaceae	a	a	a	a	a	a	a		o
Polygala	*Polygala ramosa* Ell.		r		o	r		r		
Bracken fern	*Pteridum aquilinum* (L.) Kohn			r			r	r		
Ferns	Pteridophyta							o		
Water Oak	*Quercus nigra* L.	r					r	r		
Meadow beauty	*Rhexia* spp.		f	f	f	f	r			
Shining sumac	*Rhus copallina* L.	r	f	f	f	f	o	o		
Poison ivy	*Rhus radicans* L.	r	o	o	o	r	f	o	r	f
Blackberry	*Rubus argutus* Link.	o	o	f	f	f	f		o	
Blackberry	*Rubus cuneifolius*	o	o	r	r	r	o	o		
Dewberry	*Rubus hispidus* L.	f	o	f	f	o	o			
Figwort	*Scrophularia marilandica* L.									
Meadow spikemoss	*Selaginella apoda* (L.) Spring				o	r			o	f
Saw greenbrier	*Smilax bona-nox* L.	f	o	f	f	o	o	f		r
Cat greenbrier	*Smilax glauca* Walt.	o	o	f	f	f	r	o	o	a
Laurel greenbrier	*Smilax laurifolia* L.	o	f	o	f	f	o	o	f	o
Lanceleaf greenbrier	*Smilax smallii* Morong	o		o		o	r	o		o
Nightshade	*Solanum carolinnese* L.		r		o					
Red chokeberry	*Sorbus arbutifolia* (L.) Heyn.	f	o	o	f	f	r	f	f	r
Cat-tail	*Typha latifolia* L.	r			f					
Blueberry	*Vaccinium* spp.	o	f	f	a	a	o	f	r	
Muscadine grape	*Vitis rotundifolia* Michaux	o	r	o	o	o	r	o		r
Yellow-eyed grass	*Xyris* spp.	r	o	o	o	o		o		

*o = occasional, f = frequent, r = rare, a = abundant.

season both tolerant and intolerant plant species returned to the prepared site. The intolerant species reached maximum production during the third and fourth years following site preparation and declined in both vigor and number thereafter as demonstrated by *Rubus* spp. (Figure 2). Tolerant species such as red maple tend to grow out of reach of deer after two growing seasons (Figure 3).

The production of forage was observed to be more pronounced and advanced on windrows than on beds. Figures 4 and 5 illustrate the typical patterns of production of forage by two important species. Plants growing on windrows were more prolific and

Table 2. The estimated weight of available forage, total stems per hectare and species diversity index.

Stand Condition-Years After Planting	*Un-fertilized*			*Fertilized*		
	Kilograms/Hectare Oven-dried Forage	*Stems per Hectare*	*Species Diversity Index*	*Kilograms/Hectare Oven-dried Forage*	*Stems per Hectare*	*Species Diversity Index*
1	186	180,074	1.339	391	188,147	1.354
2	83	244,790	1.685	140	315,847	1.690
3	241	407,324	2.343			
4	728	643,224	2.251			
5	459	471,545	2.096			
Natural pond pine	100	334,296	1.339			
Natural hardwood drain	44	168,638	1.042			

Table 3. Analysis of Variance Table, Regression Coefficients, and Statistics of Fit for Dependent Variable Weight.

(Model, weight = $B_0 + \beta_1 R + \beta_2 T + \beta_3 T^2 + \beta_4 T^3 + \varepsilon$)

Source	*DF*	*Sum of squares*	*Mean square*	*F value*	*Prob>F*	*R-square*	*C.V.%*
Regression	4	957085650.69249	239271412.67312	10.45528	0.0017	0.80702850	37.37797
Error	10	228852214.58654	22885221.45865			Std. Dev.	
Corrected total	14	1185937865.27903				4783.85006649	

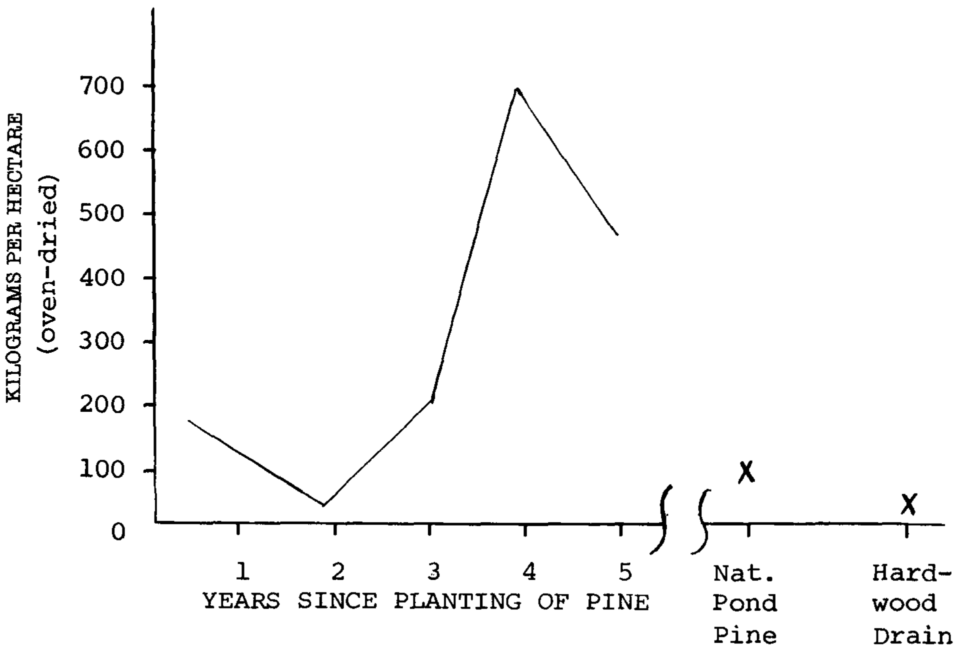

Figure 1. The estimated total production of available browse production.

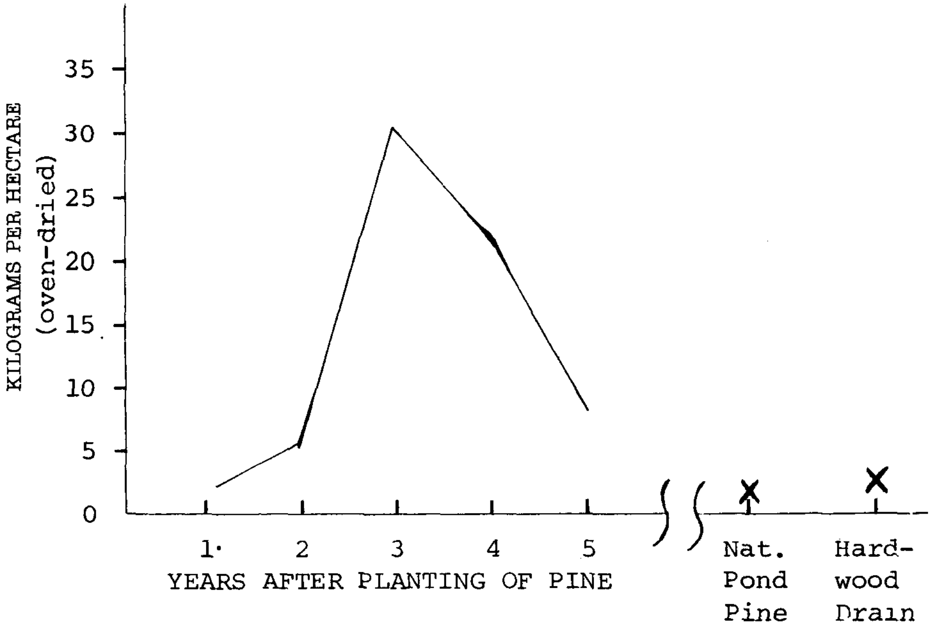

Figure 2. The estimated production of available *Rubus* spp. (kilograms per hectare).

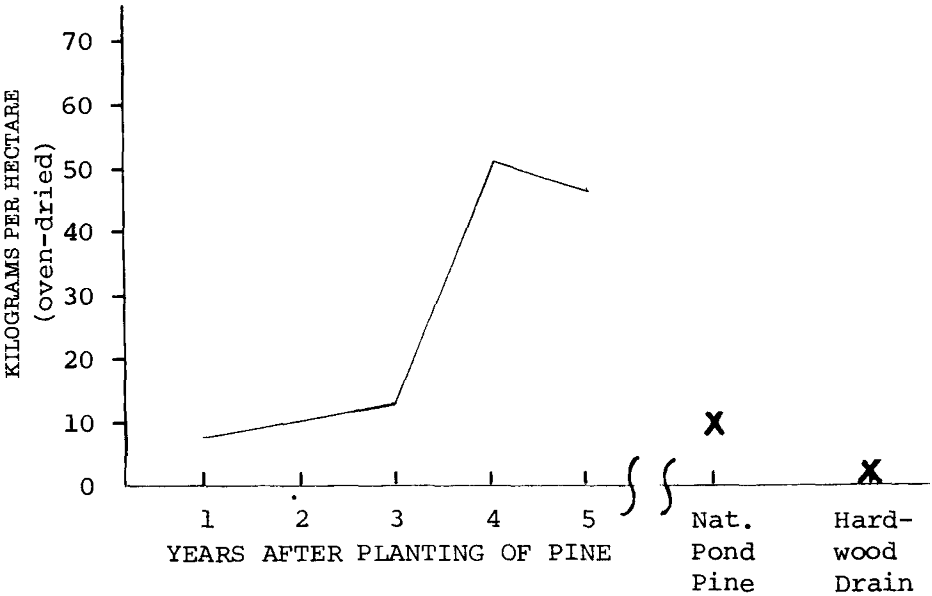

Figure 3. The estimated production of red maple.

vigorous than on beds, resulting in higher availability in early years following site preparation. Also observed was a more rapid decline in production for many intolerant species while many tolerant species grew out of reach sooner on windrows than on beds.

The general trend observed in forage production on a dry weight basis is also observed in the number of plant stems per acre (Table 2). The combined number of stems for all species peaked during the fourth growing season and declined during the fifth season paralleling the decline in forage production. During the growing season following site preparation, grasses and sedges comprised almost 49 percent of the total plant stems (Table 1), while woody stems on a per hectare basis comprised less than 12 percent of the total. Approximately one-half of the number of species occurring during the first growing season were woody species, but the total number of annual stems greatly outnumbered perennial stems because of the abundance of such annuals as members of the families *Asteraceae* and *Poaceae*. Observations indicated that the majority of the woody species originated as coppice regeneration. The fourth growing season had the highest number of stems per hectare while hardwood drains had the lowest. Excluding the hardwood drains, sweet pepperbush *(Clethra alnifolia)* and cane were the most frequently occurring perennials and were "frequent" or "abundant" in all situations observed in this study.

The species diversity index values are presented in Table 2. The third and fourth growing seasons had a greater diversity of species than any of the other treatments. These differences were significant ($P \leqslant .05$). The diversity index values exhibit the same general pattern observed in both the forage estimates and stems per hectare. No significant differences ($P \leqslant .05$) in species diversity were observed between fertilized and non-fertilized areas.

It is apparent from these data that the dynamics involved in the development of an individual stand create a period of abundance of high quality forage, but at some stage also one of low or poor quality. Although dependent upon rotation age, these data suggest that the duration of production of forage is considerably shorter than the period when production is low. Because hard mast is generally not available and soft mast is limited as a source of food in the pocosin, deer are largely dependent upon browse.

The impact of the forage production of the respective stands on carrying capacity is rather dramatic. Obviously deer do not find all forage plants palatable. However, a ranking of summer food items by index of importance, production within years serves to illustrate this point.

The five most important summer food items in order of importance were miscellaneous greenbrier, red maple, pokeweed, red chokeberry, and grape (Table 4). However, when these same species were ranked by production within years (Table 5) and among years (Table 6), two patterns occurred.

The ranking of browse species by production among years indicates that the production of the major sources of food occurs during the third and fourth growing season (Table 6). Natural pond pine stands and hardwood drains ranked the lowest in production for most species, many being absent altogether. Although misc. greenbrier and red maple rank relatively high in production in natural stands when species were ranked within years (Table 5), the ranking of species among years indicates that these same two species did poorly in natural stands when compared with converted stands illustrating the relatively low browse productive capability of natural pond pine stands and hardwood drains.

These data serve to illustrate a major variable that contributes to the "boom" and "bust" of deer populations.

CONCLUSIONS

Several conclusions are evident from these data. Conversion of the existing communities of vegetation into commercial wood production clearly improves the deer carrying capacity of pocosin sites through increased production and diversity of browse when compared to natural stands. The stand conversion increased the kilograms per hectare of available forage by a factor of approximately 7. The quality of forage was increased by improved species diversity over natural sites. With such pronounced differences in forage production between untreated and recently treated sites, the temporal and spatial

Table 4. Rank of species importance in summer food habits.

Species	Rank by index of importance[a]
Misc. greenbrier	1
Red maple	2
Pokeweed	3
Red chokeberry	4
Grape	5
Laurel greenbrier	6
Blueberry	7
Blackberry	8
Hawthorn	9
Swamp cyrilla	10
Red bay	11
Misc. oak	12
Lespedeza	13
Misc. holly	14

[a]Computed from rumen data (Sossaman and Weber, 1974) and from McCaffery *et al.* (1974).

Table 5. Rank of species production within years of production.

Species	Rank of production								
	Years since planting of pine							Pond pine	Hard-wood Drain
	Non-fertilized					Fertilized			
	1	2	3	4	5	1	2		
Misc. greenbrier	8	5	6	7	5	8	8	5	2
Red maple	2	1	3	2	3	3	4	2	1
Pokeweed	1	—	—	—	—	1	—	—	—
Red chokeberry	4	8	7	10	6	9	7	4	7
Grape	9	6	5	6	9	4	6	—	8
Laurel greenbrier	11	7	8	9	8	7	9	6	3
Blueberry	5	4	4	3	2	5	2	7	—
Blackberry	6	3	1	4	5	2	6	8	4
Hawthorne	—	—	—	—	—	—	—	—	—
Swamp cyrilla	7	—	—	8	4	—	10	—	—
Red bay	10	—	9	—	7	—	—	3	5
Misc. oak	—	—	—	—	—	—	11	—	—
Lespedeza	—	9	10	5	10	—	5	—	—
Misc. holly	3	2	2	1	1	6	1	1	6

distribution of these final harvests are crucial in sustaining forage, and should be meaningfully allocated in relation to operations.

Fertilization may increase browse production 300 percent on treated sites during early years. Other studies (Duncan *et al.*, 1970) have shown improved browse quality resulting from fertilization. In this study, fertilization did not significantly change species diversity.

Results suggest the need for continued studies to determine the effects of stand conversion, site preparation, and forest renewal stages over an entire rotation. Also of importance is the assessment of the silvicultural practices applied as intermediate treatments in regenerated stands. Although data on thinning and prescribed burning of

Table 6. Rank of species production among years of production.

Species	Rank of production — Years since planting of pine — Non-fertilized 1	2	3	4	5	Pond pine	Hard-wood Drain
Misc. greenbrier	4	5	1	3	2	7	6
Red maple	3	5	2	1	4	6	7
Pokeweed	1	—	—	—	—	—	—
Red chokeberry	3	6	4	2	1	5	7
Grape	5	3	2	1	4	7	6
Laurel greenbrier	5	4	3	1	2	6	7
Blueberry	5	4	3	1	2	6	—
Blackberry	5	4	1	2	3	7	6
Hawthorn	—	—	—	—	—	—	—
Swamp cyrilla	3	—	—	2	1	—	—
Red bay	4	—	5	—	3	1	2
Misc. oak	3	—	1	2	—	—	—
Lespedeza	—	—	2	1	3	—	—
Misc. holly	6	5	4	1	2	3	7

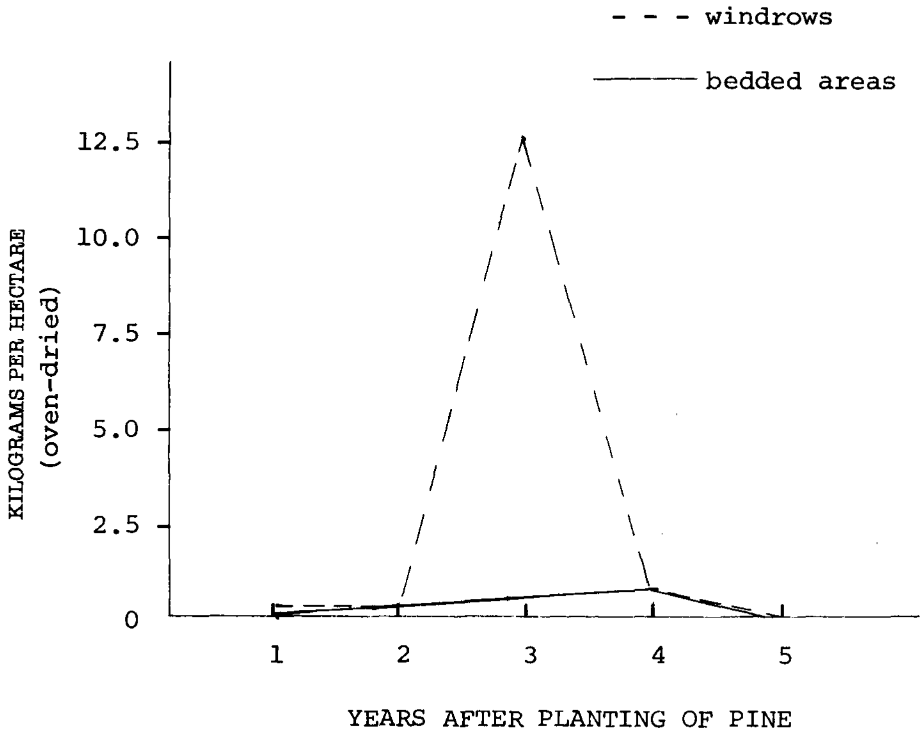

Figure 4. Estimated production of grape on beds vs windrows.

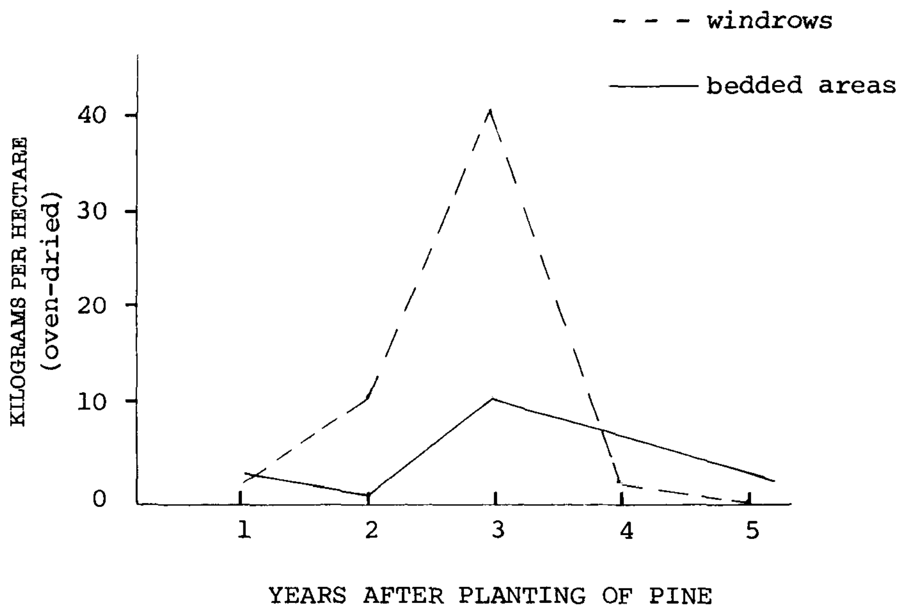

Figure 5. Estimated production of all greenbrier species on beds vs windrows.

pocosin pine sites is lacking, it is generally recognized that a thinning regime in conjunction with regular prescribed burns could do much to maintain desired levels of forage production above those encountered in natural stands (Blair, 1960; Blair, 1967; Carter and Dow, 1969; Cushwa *et al.*, 1969; Halls and Epps, 1969; Shrauder and Miller, 1969).

In the future, more intensive forest management will be required because of increasing demands for wood fiber in the Southeast. Coupled with this increased demand for timber is an increased recreational demand particularly in the form of hunting. Conversion of pocosin sites with proper scheduling and distribution of regeneration activities accompanied by the same attention to the scheduling of intermediate stand treatments could serve to stabilize the energy flow for deer on any forest land, but especially on the extensive industrial forests that are intensively managed.

LITERATURE CITED

Blair, R. M. 1960. Deer forage increased by thinnings in a Louisiana loblolly pine plantation. J. Wildl. Manage. 24(4):401-405.

____________________. 1967. Deer forage use in a loblolly pine plantation. J. Wildl. Manage. 31(3):432-437.

____________________. 1968. Keep forage low to improve deer habitat. For. Farmer 27(1):8,9,22,23.

Carter, V. E., and S. A. Dow. 1969. Effects of timber harvesting and regeneration on deer food and cover, pp. 62-65. *In* White-tailed Deer in the Southern Forest Habitat: A Symposium. South For. Exp. Sta., Southeast. Section of The Wildlife Society, and Stephen F. Austin University., Nacogdoches, Texas. 130 pp.

Cushwa, C. T., E. Czuhai, R. W. Cooper, and W. H. Julian. 1969. Burning clearcut openings in loblolly pine to improve wildlife habitat. Ga. For. Res. Coun. Pap. 61. 5 pp.

Duncan, D. A., and L. O. Hylton, Jr. 1970. Effects of fertilization on quality of range forage, pp. 57-70. *In* Range and Wildlife Habitat Evaluation: A Symposium. U.S.D.A., For. Serv. Misc. Pub. 220 pp.

Duncan, D. B. 1955. Multiple range and multiple F tests. Biometrics 11:1-42.
Halls, L. K., and E. A. Epps. 1969. Browse quality influenced by tree overstory in the south. J. Wildl. Manage. 33(4):1028-1031.
Hardy, A. V., and J. D. Hardy. 1971. Weather and climate in North Carolina. N. C. State Univ. Agri. Exp. Sta. Bull. No. 396.
Jurney, R. C., W. A. Davis, and J. J. Morgan. 1929. Soil survey of Craven County, North Carolina. U.S.D.A., Bureau of Chemistry and Soils Bulletin No. 23.
Lloyd, M., J. H. Zarr, and J. R. Karr. 1968. On the calculation of information—theoretical measures of diversity. Amer. Midl. Nat., 79: 257-272.
McCaffery, K. R., J. Tranetzki, and J. Piechura, Jr. 1974. Summer foods of deer in northern Wisconsin. J. Wildl. Manage. 38(2):215-219.
McKee, C. W. 1972. Habitat productivity of the interior flatwoods in Kemper County, Mississippi. M.S. Thesis, Miss. State Univ., State College. 64 pp.
Murphy, D. A., and J. H. Ehrenreich. 1965. Effects of timber harvest and stand improvements on forage production. J. Wildl. Manage. 29(4):734-739.
Pechanec, J. D., and G. D. Pickford. 1937. A weight estimate method for the determination of range or pasture production. J. Amer. Soc. Agron. 29:894-904.
Pielou, E. C. 1966. The measurement of diversity in different types of biological collections. J. Theoret. Biol. 13:131-144.
Saucier, W. J., A. H. Weber, and C. K. Bayne. 1973. Precipitation variability over North Carolina. Water Resources Research Inst., Univ. of North Carolina, Report No. 84. 185 pp.
Shrauder, P. A., and H. A. Miller. 1969. The effects of prescribed burning on deer food and cover, pp. 81-84. *In* White-tailed Deer in the Southern Forest Habitat: A Symposium. South. For. Exp. Sta. Southeast. Section of The Wildlife Society, and Stephen F. Austin Univ., Nacogdoches, Texas. 130 pp.
Shuster, J. L., and L. K. Halls. 1963. Timber overstory determines deer forage in shortleaf-loblolly pine-hardwood forests. Proc. Soc. Amer. For. Meeting, 1962: 165-167.
Snedecor, G. W., and W. G. Cochran. 1967. Statistical Methods. Iowa State Univ. Press, Ames, Iowa, 593 pp.
Sossaman, E. C., and A. J. Weber. 1974. Seasonal food habits of white-tailed deer (*Odocoileus virginianus*) in a treated North Carolina pocosin. Proc. Ann. Conf. Southeastern Assoc. of Game and Fish Commissioners. 28:125-142.
Teate, J. L. 1967. Some effects of environmental modifications on vegetation and tree growth in a North Carolina State University at Raleigh. 108 pp.
Wells, B. W. 1932. The Natural Gardens of North Carolina. The Univ. of North Carolina Press, Chapel Hill, pp. 47-48.
Wilhm, J. L., and T. C. Dorris, 1968. Biological parameters for water quality criteria. Bioscience 18:477-481.