Forage Response to Overstory Reduction on Loblolly-Shortleaf Pine-Hardwood Forest Range

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Abstract

Herbage and browse production after selectively cutting uneven-aged stands of loblolly-shortleaf pine to various densities were generally related to residual pine basal area and site quality. Exceptions were at least partially the result of shrub and hardwood crown cover development on the triennially burned range. Uniolas were the principal forage species under stands having high residual pine basal area, bluestems were the major forage component on clearings. Browse made up about one-fourth of the forage under stands having high residual pine basal area but represented considerably lower proportions on clearings.

Loblolly pine *(Pinus taeda)* and shortleaf pine *(P. echinata)* are the dominant trees in the most extensive forest type in the South. Although timber production is the principal use of these forests, they also provide valuable habitat for white-tailed deer *(Odocoileus virginianus)* and are grazed extensively by cattle. Management techniques for maintaining or improving the forage resource need refinement, however. This paper reports a study to determine the relation of quantity and composition of understory vegetation to a wide range of overstory densities. The study, begun in 1969, was carried out in uneven-aged stands subjected to a 3-year rotational winter burn.

Study Area

Three forest blocks at elevations between 42.6 and 48.8 m above sea level in north-central Louisiana were studied. Blocks were 1.6 to 2.2 km apart, and topography within blocks was nearly level.

Before cutting treatment, loblolly-shortleaf pine basal area averaged 25.79 m^2/ha. Pines ranged in size up to 71.12 cm dbh. Pine 2.54 cm dbh or larger averaged 278/ha, and pine seedlings were abundant. Loblolly was the dominant pine, having an average site index of 29.88 m at age 50, and a site index range of from 25.50 to 33.54 m. Shortleaf pine site index averaged 26.22 m. The average age of pines was about 50 to 60 years.

Differences in tree site quality and corresponding differences in soil series and A-horizon depth were apparent on the study area. Site indices less than 27.50 m included soil series Susquehanna and Keithville, with less than 15.24 cm A-horizon depths; indices more than 29.00 m included series Susquehanna, Keithville, Metcalf, Mantachie, Malbis, Beauregard, and Messar, with A-horizon depths 15.24 to 30.48 cm. Established descriptions for these soil series by the Soil Conservation Service indicate that the Susquehanna and the Keithville series generally have lower site indexes for loblolly pine than the other soil series. Since soils were intermingled on the plots, site index served as the primary measure of site productivity.

Hardwood trees, primarily blackgum *(Nyssa sylvatica)*, sweetgum *(Liquidambar styraciflua)*, southern red oak *(Quercus falcata)*, white oak *(Q. alba)*, post oak *(Q. stellata)* and black oak *(Q. velutina)*, produced a moderately dense midstory. These hardwoods were as large as 38.10 cm dbh and provided 6.89 to 11.48 m^2 basal area/ha when the study began. Abundant small trees and shrubs included red maple *(Acer rubrum)*, flowering dogwood *(Cornus florida)*, witch-hazel *(Hammamelis virginiana)*, snowbell *(Styrax grandifolia)*, American beautyberry *(Callicarpa americana)*, hawthorn (*Crataegus* spp.) and blueberry (*Vaccinium* spp.). The major herbaceous species were longleaf uniola (Uniola sessiliflora), spike uniola *(U. laxa)*, panicums (*Panicum* spp.), and bluestems (*Andropogon* spp.) in a mixture with composites, legumes, and other forbs.

Annual precipitation averaged 144.7 cm; distribution was relatively uniform throughout the year except for a typical 4- to 6-week dry period in late summer. Domestic and wild herbivores have historically used the area yearlong; however, livestock were excluded during this study. No burning occurred from the mid-1930's to 1967.

Methods

Each of the three study blocks was divided into five plots 80.49 by 80.49 m (0.6478 ha). Cutting treatments with residual pine basal area (BA) of 0, 6.89, 13.77, 20.66, and 27.55 m^2/ha—were randomly assigned to plots within blocks. Pines were removed during winter 1968-1969 to obtain prescribed basal areas. Because the plots assigned to 27.55 BA treatment levels had only 23.65, 24.79, and 30.07 m^2/ha BA of pine before treatment, two plots remained uncut and only a few trees were selected for removal from the other. Except in the clearcuts (0 BA), approximately 1.61 m^2/ha of hardwoods (12.70 to 30.48 cm dbh), primarily southern red oak, white oak, and a few sweetgum, were left for mast production and cover on each plot. Merchantable hardwoods and pines selected for removal were harvested; noncommercial trees were injected with undiluted 2, 4-D during the summer of 1969. Controlled burning (backfires) took place on all treatment plots during March 1967, 1970, and 1973.

In February 1969 and January 1975, trees 2.54 cm dbh or larger were inventoried on a 0.16-ha sampling plot (40.23 × 40.23 m) centered in each of the fifteen 0.6478-ha treated areas. Number and diameter of pines and hardwoods were determined on sampling plots and values were converted to a per-hectare basis.

Shrub and hardwood stems less than 2.54 cm dbh, excluding pines and vines, were counted and crown diameters within 1.52 m of the ground were estimated on six 41.63-m^2 quadrats within each 0.16-ha sample plot in spring 1975. Crown cover (m^2/ha) was

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This paper reports research involving silvicides. It does not report recommendations for their use, nor does it imply that any uses described have been registered. All use of silvicides must be registered by appropriate State or Federal agencies or both before they can be recommended.

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Table 1. Number and basal area (BA, m²/ha)[1] of pines before and after treatment by treatment level.

Year	0 BA	6.89 BA	13.77 BA	20.66 BA	27.55 BA
			Trees/ha		
1969					
Before-Treatment	[2]	245±3	316±99	277±82	272±89
After-Treatment	96±59	72±7	131±42	255±77	247±74
1975	974±635	121±15	119±35	237±72	230±57
Change					
1969-75	878	49	12	-18	-17
			Basal area in m²/ha		
1969					
Before-Treatment	[2]	28.89±2.53	26.38±0.92	21.72±0.23	26.17±1.84
After-Treatment	0.07±0.23	7.30±0.23	13.11±0.23	20.25±0.23	25.55±1.15
1975	2.39±1.84	8.72±0.92	15.38±0.69	23.30±0.69	28.26±1.15
Change					
1965-75	2.32	1.42	2.27	3.05	2.71

[1]Means ± standard error of the mean, N = 3, for trees ≥2.54cm dbh.
[2]Pretreatment stand characteristics were not quantified on the clearcut plots.

calculated from canopy diameters and stem densities for each species.

Current year's herbage and browse growth up to 1.52 m was clipped in November on twenty 0.2232-m² quadrats (47.24×47.24 cm) systematically selected each year and pooled for a single estimate of production from each of the 0.16-ha sample plots. Ovendry production was determined for species or species groups in 1970 and 1973 and for herbage and browse groups in 1971, 1972, and 1974.

The relation of forage production to residual basal area, site index, and shrub and hardwood crown cover was screened by simple and multiple linear and curvilinear regression analysis. Only significant, best-fit regressions tested are presented. All tests were considered significant at the 0.05 probability level. (Treatment means, standard error of mean, and sample size are presented in the text or tables.)

Results and Discussion

Timber Overstory

Pines 2.54 cm dbh and greater ranged from 72 to 255 stems/ha after treatments were installed in 1969 (Table 1). In 1975, 0BA (clearcut) treatment averaged 974 pines with basal area of 2.39 m²/ha; over 900 of these pines were in the 2.54- and 5.08-cm dbh size classes and about 50 in the 7.62 to 10.16-cm classes. Four treatments, 0 BA, 6.89BA, 13.77BA, and 20.66BA in one block had low site indexes (25.30 to 27.13 m); all other treatments were high quality sites (29.27 to 33.54 m). The 0 BA treatment with a low site index had only 42 natural regenerated pines per hectare, whereas the same treatment on high index sites averaged 1,379 natural regenerated pines. On pine-stocked treatments, the low site index group also had less pine reproduction than the high-quality sites. The change in number of trees per hectare from 1969 to 1975 appeared to be influenced primarily by residual pine basal area and site quality, although other conditions may have affected the results.

Basal area of pines increased at an average rate of 0.39 m²/ha/year on all treatments including 0 BA from 1969 to 1975. The rapid height and diameter growth of natural pine regeneration on high-quality sites accounted for the pine basal area increase on the clearcuts between 1969 and 1975; pine basal area in 1975 on the low-quality site was essentially zero, but on high-quality sites it averaged 3.56 m²/ha.

After treatment was established in 1969, hardwoods 2.54 cm dbh and greater averaged 40 to 44/ha on stocked plots with basal areas varying from about 1.17 to 1.74 m²/ha (Table 2). In 1975, hardwoods ranged from 49 to 460/ha with basal areas from 1.38 to 2.07 m²/ha. On the clearcut, 151 hardwoods, primarily red maple 2.54 to 5.08 cm dbh, survived the silvicide; by 1975 there were 1,509 hardwood stems 2.54 to 11.16 cm dbh providing 2.43 m²/ha basal area despite the triennially prescribed winter burns. Regeneration of hardwoods, primarily from root and stump sprouts, also appeared to be influenced by site quality and residual pine basal area.

Understory Vegetation Production

Herbage, browse, and total forage production fluctuated greatly from year to year apparently as a result of environmental conditions, including prescribed burn history and recovery from logging (Table 3). The 0 BA and 6.89 BA treatments were most productive in 1970 following heavy logging and a prescribed burn. Production was 25 to 50% less in 1971 and 1972 but appeared to increase in 1973 after the March burn. Maximum production on 13.77 BA, 20.66 BA, and 27.55 BA treatments was generally not obtained until after the 1973 burn.

Loblolly-shortleaf pine-hardwood forest can provide substan-

Table 2. Number and basal area of hardwood trees after reduction of pine density to various levels (BA,m²/ha)[1]

Year	0 BA	6.89 BA	13.77 BA	20.66 BA	27.55 BA
			Trees/ha		
1969	151±82	40±10	42±25	44±5	40±7
1975	1505±929	460±124	324±91	220±64	49±7
Change					
1969-75	1354	420	282	176	9
			Basal area, m²/ha		
1969	0.16±0.23	1.17±0.23	1.26±0.23	1.74±0.23	1.49±0.23
1975	2.43±1.38	1.49±0.46	1.68±0.23	2.07±0.69	1.38±0.46
Change					
1969-75	2.27	0.32	0.42	0.33	-0.11

[1]Means ± standard errors of the mean, N = 3 for trees ≥2.54-cm dbh.

Table 3. **Average annual herbage and browse production by basal area (BA,m²/ha) treatment and year.**

Year and forage group	0 BA	6.89 BA	13.77 BA	20.66 BA	27.55 BA
			Kg/ha[1]		
1970					
Herbage	4403±852	2554±230	1037±293	616±161	256±86
Browse	461±150	467±208	250±121	164±100	164±41
Total	4864	3021	1287	780	420
1971					
Herbage	1903±294	1244+73	739+130	666±159	449+121
Browse	272±84	224±77	150±28	126±36	72±5
Total	2175	1468	889	792	521
1972					
Herbage	1471±587	1061±291	720+76	1024±296	716±164
Browse	467±120	360±104	260±44	309±102	174±9
Total	1938	1421	980	1333	890
1973					
Herbage	2273±510	1366+407	1056+252	892+161	930+277
Browse	609±215	602±263	481±158	444±178	367±187
Total	2882	1968	1537	1336	1297
1974					
Herbage	1186±727	1202±340	952±222	1188±317	871±152
Browse	409±129	481±154	463±108	382±44	323±72
Total	1595	1683	1415	1578	1194

[1]Means ± standard error of the mean, N = 3

tial amounts of range forage, although abundance of such forage depends on management objectives. Generally, herbage, browse, and total forage production declined with increased increments of residual pine basal area; however, there were exceptions. Apparently, factors in addition to residual pine basal area, such as site quality, also influenced forage production.

Schuster and Halls (1963) and Schuster (1967) reported that forage yields, though more closely correlated with timber stand conditions, were influenced by soils and physiographic factors; Cromer and Smith (1968) reported that availability of browse was influenced by site indices. Throughout the current study, browse production was significantly related to both residual pine basal area and site quality; herbage production, however, was related to both pine basal area and site quality only during 1970, 1971, and 1973 (Table 4).

Shrub and hardwood crown cover may have limited herbage production in 1972 but in general herbage production increased substantially in 1973 after shrubs and hardwoods were reduced by the March control burn. When shrub and hardwood crown cover (CC) was added to the 1974 herbage equation as the third independent variable with pine basal area and site index, the equation, $Y=2503.5 - 55.0BA - 23.4SI - 0.182CC$, (s.e. 477.8) explained a significant amount (52%) of the variation in herbage production.

Thus, it is reasonable to expect that herbage and browse production would increase with increased site quality so long as other factors remained constant; however, shrub and hardwood crown cover, whether influenced by site quality or not, could conceivably limit herbage production equally or to a greater extent than residual pine basal area or site quality. Thus, Blair and Feduccia (1977) reported from Louisiana that the presence of a hardwood midstory offset the benefits of managing pine at a lower level of basal area to stimulate greater forage yields.

Fire had been excluded from the present study area for 30 to 40 years before the triennial winter burn program began in 1967. The timber stand contained a profusion of small diameter, low-to-midstory hardwood trees and shrubs. These hardwoods sprouted prolifically after thinning and burning and soon appeared to limit forage production. Similar findings were reported by Blair (1968) and Schuster and Halls (1963).

Table 4. Results of regression analysis, illustrating relation of browse and herbage production to residual pine basal area (BA,m²/ha) and loblolly pine site index (SI m at age 50) by year.

Year	Equation	Standard error of estimate	R^*
	Browse		
1970	$Y = -1163.8 - 20.4BA + 57.8SI$	150.6	0.71
1971	$Y = -2009.1 - 9.0BA + 19.5SI$	68.8	0.66
1972	$Y = -744.3 - 12.3BA + 41.2SI$	90.2	0.74
1973	$Y = -2095.5 - 16.1BA + 94.6SI$	187.5	0.69
1974	$Y = -687.8 - 6.7BA + 40.0SI$	139.4	0.42
	Herbage		
1970	$Y = -1639.8 - 171.2BA + 191.6SI$	691.8	0.86
1971	$Y = 396.6 - 57.7BA + 47.1SI$	296.6	0.79
1973	$Y = 4185.1 - 46.4BA - 76.3SI$	559.7	0.50

*Significant at the 0.05 level of probability, with 2 and 12 df.

Understory Composition

Uniolas were the most abundant forage species on all treatments the first year after thinning. Three years later, they still produced 35 to 45% of the total on 27.55 BA but less than 10% on 0 BA. Similar findings were reported in Texas (Schuster 1967); uniolas require shade for maximum production and are diminished with increasing light (Wolters 1974).

Pinehill bluestem *(A. scoparius var. divergens)* and broomsedge bluestem *(A. virginicus)* were the most common bluestem species and were about equally abundant. In 1970 bluestems produced 27% of the forage on cleared areas; by 1973 bluestems produced about 50% of the forage on the control but produced less than 10% of the forage yield under 27.55 BA. These results agree with east Texas studies where bluestems were abundant under sparse tree canopies but gave way to uniolas as timber density increased (Halls and Schuster 1965, Schuster 1967).

Panicums (*Panicum* spp.) produced almost one-fourth of the production in the 27.55 BA treatment plot in 1970 but diminished to less than 7% in 1973. During both years, the 0 BA treatment consisted of about 11% panicums.

Combined the sedges (Cyperaceae) and rushes (Juncaceae) produced less than 10% of the forage throughout the study and legumes, composites, and other forbs contributed less than 12% of the total forage regardless of treatment.

Browse yielded from 9 to 26% of the total forage and its relative yield was greatest on 27.55 BA. From 1970 to 1973, browse percentages increased, especially American beautyberry,which usually grows best under fairly open canopies and is persistent on ranges periodically burned (Grelen and Duvall 1966). Blackberry (*Rubus* spp.) and greenbriars (*Smilax* spp.) declined slightly on all treatments. Other species, such as sassafras *(Sassafras albidum)*, hypericum *(Hypericum* spp.), rattan *(Berchemia scandens)*, Carolina jessamine *(Gelsemium sempervirens)*, and other vines and browse, contributed a small but fairly uniform proportion to the total browse under all treatments.

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