Forage Production After Hardwood Control in a Southern Pine-Hardwood Stand

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Abstract. After hardwoods were removed from an all-aged pine-hardwood stand in central Louisiana, herbage available in late summer increased for 2 to 4 years, then declined rapidly as the density and growth of pine seedlings increased. Browse production increased for 6 to 8 years, but together with herbage production returned to pretreatment levels within 10 years. Competition from natural pine regeneration prevented long-term increases in forage biomass. ***Forest Sci. 17:279–284.***

Additional key words. *Pinus taeda, Pinus echinata, Quercus stellata,* animal nutrition, wildlife management, biomass.

BOTH timber and deer managers are increasingly concerned about controlling undesirable hardwoods on commercial pinelands in the South. Timber growers must convert millions of acres of upland pine-hardwood stands to pure pine over the next 15 years to sustain the rapid growth of southern forest industries (So. Forest Resource Anal. Comm. 1969). Game managers, who also face rapidly rising demands for their products, must see to it that deer and other game populations are not jeopardized by the elimination of mast- and fruit-producing hardwoods over extensive acreages. Data reported here indicate that the task of providing sustained crops of nutritious food for deer in conjunction with intensive pine production will be difficult.

Study Area

An all-aged and understocked stand of loblolly (*Pinus taeda* L.) and shortleaf pine (*P. echinata* Mill.) interspersed with hardwoods, encompassing about 2,500 acres, was selected for study on the Kisatchie National Forest in central Louisiana. The forest type is common in the Southern United States; in Louisiana alone, it occupies more than 4 million acres of commercial forest land (Sternitzke 1965).

On the study area 74 percent of the tree stocking and 73 percent of the average basal area were hardwood. Post oak (*Quercus stellata* Wang.) made up 75 percent of the hardwood stocking. Other common hardwoods included sweetgum (*Liquidambar styraciflua* L.), southern red oak (*Q. falcata* Michx.) and blackjack oak (*Q. marilandica* Muench.).

Since trees were unevenly distributed, many hardwoods were overcrowded and suppressed, even though the average stand basal area was only 77 ft^2/acre. The stocking of trees 1.5 inches dbh and larger averaged 398 stems/acre. About 65 percent of the hardwoods were less than 6 inches dbh. Pines were clustered in small groups; their diameters (breast high) ranged up to 24 inches, with 75 percent of the stems less than 6 inches dbh. Pine volume ranged from 2,000 to 3,000 bd ft/acre. The site index for loblolly pine was between 75 and 85 ft at age 50.

Oaks predominated in a multilayered and dense midstory beneath the dominant pine canopy. Since little light penetrated this canopy, understory vegetation was suppressed and consisted of a wide scattering of pine seedlings, shade-tolerant shrubs,

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and occasional clumps of grass in small openings.

Terrain varies from flat to gently rolling. Surface drainage is very poor on the flats but good on the slopes. Internal drainage is poor.

Soils are mainly very fine sandy loams in the Sawyer, Summerfield, and Susquehanna series. In general, these are thinly developed and very slowly permeable soils with heavy clay substrata. Along intermittent streams erosion has exposed the clay substrata. The soils are acid and of low fertility.

Rainfall averages about 52 inches annually and is well distributed throughout the year. Soil moisture is usually plentiful in winter and spring.

Fire had been excluded for over 10 years, and the study area was fenced to exclude cattle.

Methods

On areas undergoing hardwood control, a number of mast- or fruit-producing hardwoods, plus den trees, are often retained in small groups, in narrow strips along streams or transecting the uplands, or as individual trees randomly interspersed over the area to benefit wildlife (Bateman 1958, Reid and Goodrum 1958, Strode 1957, Vincent 1956). In this study, specific numbers of randomly located hardwoods were retained per acre as game-food trees.

During mid-December of 1957 four intensities and two methods of hardwood removal were imposed on 1.28-acre plots. A 0.25-acre quadrat was centered within each of these plots for sampling the timber, pine regeneration, and understory vegetation. Treatments were replicated three times in a randomized block design. Plots were grouped into blocks on the basis of site homogeneity, or proximity where site differences were not discernible.

Treatments were:

(a) *Complete hardwood control*: All hardwoods 4 inches dbh and larger were girdled. Hardwoods less than 4 inches dbh competing with pine reproduction were felled.

(b) *Eight mast trees retained per acre (girdle)*: Four oaks at least 8 inches dbh and four between 4 and 8 inches dbh were retained per acre. The remaining hardwoods were controlled as prescribed in treatment (a).

(c) *Eight mast trees retained per acre (herbicide)*: Prescriptions were identical to treatment (b), except hardwoods were controlled by applying Ammate (80-percent ammonium sulfamate) in basal notches to prevent stump sprouting.

(d) *Sixteen mast trees retained per acre*. Eight oaks at least 8 inches dbh, and eight oaks between 4 and 8 inches dbh were retained per acre. The remaining hardwoods were controlled as prescribed in treatment (a).

(e) *Untreated control*. All hardwoods were retained.

Potentially merchantable oaks were selected for retention as food trees, whenever possible. Crowns of most mast trees were thin and small from years of crowding. The retained oaks were numbered and their diameter growth was observed.

Pines and hardwoods 1.6 inches dbh and larger on each 0.25-acre quadrat were inventoried by 1-inch diameter classes and species. Pine reproduction less than 1.6 inches dbh was sampled on 16 permanent 0.004-acre circular plots in a grid pattern within each 0.25-acre quadrat. Stems up to 0.5 inch dbh were recorded by 1-ft height classes, while those from 0.6 to 1.5 inches dbh were recorded in the 1-inch diameter class.

To estimate forage biomass available in mid and late summer, the current season's growth of leaves and stems on understory vegetation was clipped from the ground to a height of 5 ft on 16 1-milacre quadrats on a grid pattern within each 0.25-acre plot. Herbage was sampled in five vegetal classes: grasses, grass-like plants, composites, legumes, and miscellaneous forbs. No estimate was made of production of spring ephemerals or basal rosettes of various forbs that are present in the winter. Browse, consisting of the current twigs and leaves of shrubs, small hardwoods, and woody vines,

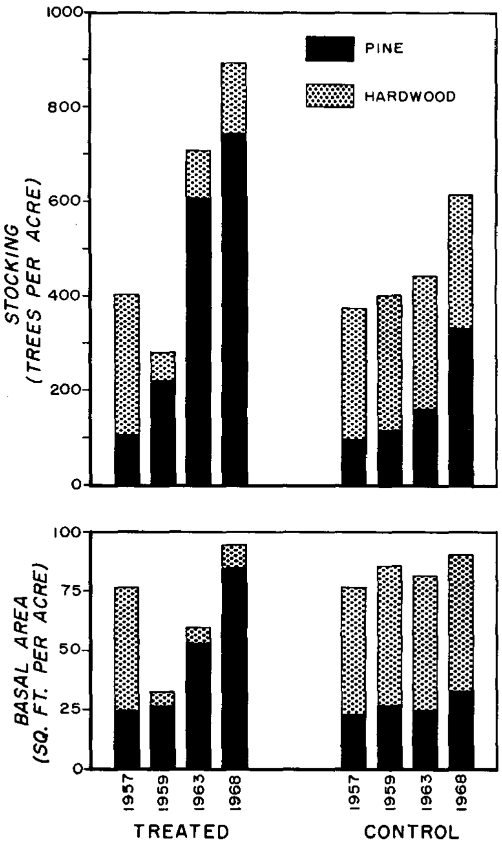

FIGURE 1. *Number and basal area of pines and hardwoods 1.6 inches dbh and larger on treated and untreated plots.*

was sampled by species or species groups. Current growth was not removed from young pines because the impact of pine growth on forage production was being measured. A new group of sampling quadrats was selected for each measurement to avoid repeated clipping of individual plants.

Clipped plant tissue was dried to a constant weight in a forced-draft oven at 65°C and weighed to determine summer yield. For an estimate of the browse available in late fall and winter, after leaf abscission, weights of deciduous and semi-evergreen browse twigs were added to those of leaves and twigs of evergreen species.

Measurements and vegetation samples were taken initially in the late summer of 1957, prior to hardwood control treatments, and again in the late summers of 1959, 1963, and 1968.

Differences in forage available in late summer were examined by analysis of variance. In addition, treatment means were compared by Duncan's (1955) multiple range test employing Harter's (1960) table of critical values. All tests were made at the 0.05 level of probability.

Results

Among treatments in which hardwoods were controlled, differences in herbage and browse production, and in growth of young pines, were seldom of practical or statistical significance. It was expected that treating hardwoods with herbicide would curtail sprouting and therefore reduce browse production. The lack of such differences among hardwood control treatments must be attributed largely to masking by rapid development of young pines after overstory reduction. In consequence, results from all treated plots were combined and are compared with those from untreated controls.

Timber Stand. From the standpoint of timber management, the treatments were highly successful. Pine stems on treated areas increased rapidly in size and number, and by 1968 accounted for 90 percent of the total basal area of 95 ft^2/acre (Fig. 1). On control plots, total basal area increased from 77 to 91 ft^2 /acre between 1957 and 1968. Although pines accounted for much of the increase, hardwoods still made up more than half the basal area, 58 ft^2/acre.

Before treatment, plots contained an average of about 1,200 pine seedlings per acre. These were sparsely needled and spindly due to suppression by the dense midstory. When released, the seedlings rapidly developed full, heavily needled crowns. In addition, seedling stocking increased 4- to 6-fold in treated plots as a result of good pine seed crops in 1957 and 1968 (Fig. 2). Seedling survival was good on treated plots. By 1968 the density of stems 1.6 feet tall to 1.5 inches dbh averaged 2,605 per acre. Smaller stems, less than 1.6 inches tall had declined consider-

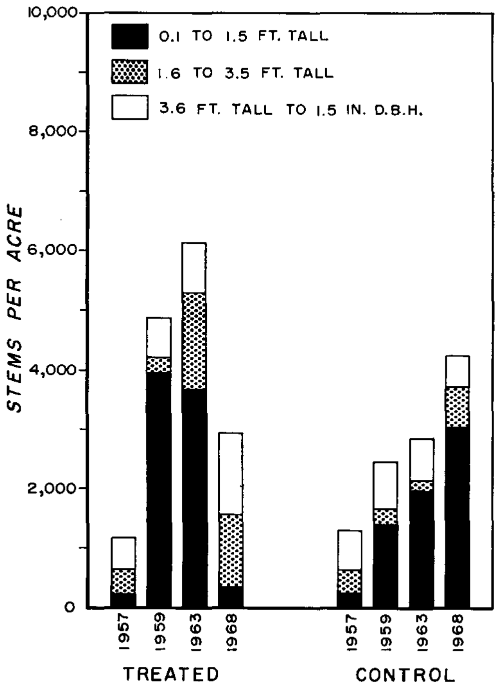

FIGURE 2. *Effects of overstory hardwood control on numbers of pines smaller than 1.6 inches in diameter.*

ably due to excessive competition from proximate vegetation.

Seedling numbers more than doubled on control plots from 1957 to 1968, but survival was poor. Less than a third of the stems reached a height of 1.5 ft before succumbing to drought, disease, and competition.

Oaks retained in treated stands as food producers responded slowly to release. Between 1957 and 1968, their average dbh increased from 8.8 to 10.4 inches. The crowns expanded very slowly. Since the hardwoods were chosen partially on the basis of vigor, their development after release was less rapid than expected.

Herbage. Grasses responded most rapidly to hardwood removal, but the gains were short-lived (Table 1). Before treatment in 1957, production averaged only 72 lb of oven-dry matter per acre and did not differ significantly among stands. Yields on the treated plots in 1959 had increased to 440 lb/acre, significantly more than the 156 lb on control plants. By 1963 grass production beneath treated stands had declined markedly to 239 lb/acre, little more than on the controls. Thus, within 6 years after overstory reduction, a dense midstory of young pines in treated stands was suppressing the growth of grasses to about the same extent as the dense hardwood midstory in untreated stands. By 1968, yields were similar on treated and control plots.

Principal grasses were *Andropogon divergens* (Hack.) Anderss. ex Hitchc., *Panicum* spp., *Uniola sessiliflora* Poir., and *Aristida purpurascens* Poir. Occurrence of *U. sessiliflora*, which is shade-tolerant, increased substantially beneath treated stands as the canopy of young pine closed, while that of intolerant *Andropogon* declined.

Responses of grass-like plants, primarily *Rhynchospora* spp. and *Scleria* spp., to reduction in overstory hardwoods were similar to that of grasses though yields were considerably lower.

About 9 lb/acre of forbs, an important source of deer forage, were present in the stands in 1957. Forb yields did not differ significantly by treatment during the study period.

Of the forbs, composites consistently produced the greatest weight of herbage. Principal species were *Aster exilis* Ell., which tended to decline rapidly in abundance as pine reproduction increased in density; *A. dumosus* L., which increased appreciably in open stands; *Solidago odora* Ait.; and *Eupatorium* spp. Legumes of greatest abundance were *Desmodium* spp., *Galactia regularis* (L.) BSP., and *Lespedeza procumbens* Michx. Other common forbs were *Acalypha gracilens* Gray, *Ruellia* spp., *Euphorbia corollata* L., and *Scutellaria* spp.

Browse. Browse yields beneath the dense pine-hardwood canopy in 1957 averaged 92 lb/acre, 49 percent of the total forage. By 1959, yields appeared to be increasing on treated plots due largely to improved growth of established plants. New plants were just becoming established. In 1963 the mean yield of 258 lb/acre on treated plots was significantly greater than the 65

TABLE 1. Effects of hardwood removal in a pine-hardwood stand on herbage and browse yields per acre in late summer.

(In pounds per acre, ovendry weight)

Vegetation class	Hardwoods removed 1957[a]	1959	1963	1968	Untreated control 1957	1959	1963	1968
Herbage								
Grass	69	440	239	106	86	156	180	118
Grass-like plants	14	60	20	3	13	12	16	2
Forbs	10	56	20	13	8	5	10	6
Total herbage	93	556	279	122	107	173	206	126
Browse	96	163	258	124	77	73	65	88
Total forage	189	719	537	246	184	246	271	214

[a] 1957 yields were determined prior to removal of overstory hardwoods.

lb in untreated stands. By 1968, however, competition from dense young pines had reduced browse production in the treated stands so it no longer differed significantly from that in the controls.

Browse considered palatable to deer was sparse in 1957; production averaged only 26 lb/acre. Yields increased under treated stands to an average of 58 lb/acre in 1959 and 81 lb in 1963. By 1968, production had declined to 44 lb/acre. Some plants had been shaded out while others had grown above the foraging zone for deer.

Beneath untreated stands palatable woody forage was sparse throughout the study period. Yields averaged 10 lb/acre in 1957, 24 lb in 1959 and 1963, and 17 lb in 1968.

With leaf abscission from deciduous species in autumn, the supply of palatable browse declined sharply. Weight of current twigs of deciduous species and the leaves and twigs of broadleaved evergreens averaged about a third of that available during the summer.

The predominant species of palatable browse were *Crataegus* spp., *Callicarpa americana* L., *Ilex decidua* Walt., *Rubus* spp., *Smilax bona-nox* L., and *Gelsemium sempervirens* (L.) Ait.

Common species of nonpalatable browse were sweetgum, post oak, southern red oak, winter huckleberry (*Vaccinium arboreum* Marsh.), and blackjack oak.

Discussion

Eradication of fruit- and mast-producing hardwoods over large areas eliminates a highly variable, yet important supply of high-energy food for fall and winter when forage quality is low (Blair and Epps 1969, Short 1969). Annual yields of mature, sound acorns from more open stands of pine-hardwood near the study site ranged from about 1 to 23 lb/acre (oven-dry) over a 10-year period (R. M. Blair, unpublished data).

Opening the forest canopy created an environment conducive to the production of forage, which is a more dependable though a lower energy food source than mast. Had they been sustained, the observed increases in forage production probably would have been sufficient to compensate for the loss of acorns. But herbage yields returned to pretreatment levels within about 6 years, and browse yields in 10 years.

Pine regeneration was the major deterrent to long-term increases in forage production. Previous studies have shown that dense stands of young pine severely limit growth of forage species (Blair 1960, Gysel 1957, Strode 1957). Good pine seed crops such as those that occurred concurrently with hardwood treatment in the present study cannot always be expected, but without assurance that a fully stocked pine stand will readily appear, a timber manager is not likely to invest in hardwood removal. In other words, the factors contributing to a decline in forage production also contribute to successful type conversion.

It appears, then, that additional treatments must be considered if deer are to benefit from type conversion by receiving a sustained forage supply. Plans could be made for precommercial thinning where dense stands of pine seedlings appear. Hardwoods that have grown beyond the deer feeding zone and produce little mast or fruit could be eliminated to prevent the formation of a dense midstory, which severely inhibits growth of forage plants (Blair 1967). Where large acreages are scheduled for hardwood reduction, deer populations will benefit if blocks of 40 to 50 acres arranged in a patchwork design or strips can be treated at intervals of perhaps 3 years. The dispersion of stages in forage succession and stand development provides valuable variety in food sources. In addition, a reasonable number of oaks of mast-bearing size per acre should be retained.

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