In: Edwards, M. Boyd, comp. 1995. Proceedings of the eighth biennial southern silvicultural research conference; 1994 November 1-3; Auburn, AL. Gen. Tech, Rep, SRS-1. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 512-516.

# RESPONSES OF GROUNDCOVER UNDER LONGLEAF PINE TO BIENNIAL SEASONAL BURNING AND HARDWOOD CONTROL[1]

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Abstract - R & of understory vegetation to season of bum were followed in young, naturally established, stands of longleaf pine (*Pinus palustris* Mill.). Treatments included biennial bums in winter, spring, and summer, plus a no-burn check. Groundcover biomass was measured before treatment and again 7 and 9 years later. Total green biomass on the forest floor was not significantly affected by treatment, but its components were. Green woody biomass constituted 91 percent of the total on unburned and 49 percent on burned plats. Woody understory vegetation and grasses were unaffected by season of burn. Forbs were most abundant with winter and summer burns, and legumes, with winter and spring burns.

## INTRODUCTION

Control of understory hardwoods in young pine stands can increase growth of the overstory, reduce fuel loads, improve access, reduce cost of future site or seedbed preparation, and increase cover of grasses and other herbaceous vegetation.

A study was initiated in 1973 to determine the long-term effects of several hardwood control treatments on understory succession and overstory growth. Combinations of fire. mechanical, and chemical treatments were applied. A major objective was to record treatment effects on stand development over time and determine the composition and structure of midstoty and understory vegetation that ultimately stabiied under the different treatment regimes.

I have already reported effects of treatments on growth of the longleaf pine (*Pinus palustris* Mill.) overstory (Boyer 1987, 1994). I also have reported the effects of a single chemical treatment, with and without fire, on development of woody vegetation (Boyer *1991).* as well as development of hardwoods in relation to season of biennial bums (Boyer 1993).

## METHODS

The study was established in 1973 on a sandy upland Coastal Plain site on the Escambia *Experimental* Forest in southwestern Alabama ( maintained by the USDA Forest Service, Southern Research Station, in cooperation with the T.R. Miller Mill Company). Study sites supported natural stands of longleaf pine that were 14 years old from seed and 12 years from removal of a seed-tree overstory. Pine stocking averaged about 700 trees per acre. The last fire on all study areas was a prescribed burn in January 1962.

Three Mocks were established, each with 12, square, Od-acre treatment plots. Plots were thinned to 500 well-distributed dominant and codominant pines per acre. All pines in O.l-acre measurement plots at the centers of treatment plots were marked and numbered, and their height and d.b.h. recorded. Trees averaged 22 feet in height and 3.2 inches in d.b.h. Basal area (BA) averaged 30 square feet/acre. Based on heights of dominant and codominant trees recorded in 1992, at age 33, estimated age-50 site indexes for longleaf pine (Farrar 1981) ranged from 77 to 81 feet on study blocks.

Twelve treatment combinations were randomly assigned to the 12 plots in each Mock. Each of four fire treatments-prescribed fire at 2-year intervals in winter (January or February), spring (April or May), and *summer* (July *or* August), plus an unburned check-was combined with three supplemental treatments. These were:

(1) injection of all hardwood stems above l-inch in diameter with a herbicide in the spring of 1973, (2) cutting just above groundline of all woody stems, induding volunteer pines, more than 4.5 feet tall in 1973 and as needed thereafter, and (3) untreated check. All plots with fire treatments were first burned in January 1974. Then season of burn treatments were begun. Spring burns were always in odd-numbered years. Since 1979, winter burns have been in even-numbered and summer burns in odd-numbered years.

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[1]Paper presented at the Eighth Biennial Southern Silvicultural Research Conference. Auburn, AL, Nov. 1-3, 1994.

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The pretreatment composition and biomass of groundcover vegetation were determined through destructive sampling of nine 3.1 foot by 3.1 foot sample plots within each 0.1-acre measurement plot in the late summer of 1973. The above-ground portions of all living woody plants 0.5-inch or less in diameter 6 inches above groundline were harvested and species or genus was recorded. All remaining living vegetation in each sample plot was aiso harvested and sorted into three categories: (1) grasses and grass-like, (2) forbs, and (3) legumes. All harvested vegetation was ovendried to a constant weight at 70° C, and dry weight was recorded . by measurement plot, sample plot, and category. Surface fitter (all organic material above mineral soil) was collected from a 1.0-square-foot plot nested within each Q&square-foot sample plot. Litter was ovendried at 70° C and weighed.

Understory vegetation and organic litter were resampled, as described above, in the late summer and early fall of 1980 and 1982. Vegetation was harvested from nine new sample plots per measurement plot during each of these two examinations.

Information on understory biomass and composition from this study was compared with similar information from a study in mature longleaf pine. We&stocked stands were thinned in 1957 to densities of 18, 27, 36, and 45 square feet of BA/acre. The same four burning treatments (biennial burns in winter, spring, summer plus unburned check) were established in 1970 under each of the four densities on two blocks. In all, there were 32 0.625-acre treatment plots. In 1970, residual pines averaged 60 to 70 years old. Understory vegetation and titter were sampled as in the present study before treatment and five times thereafter, with the last in 1981. At each of the periodic examinations, understory vegetation and litter on 10 sample plots per treatment plot were harvested, ovendried, and weighed.

## RESULTS

### Biomass Changes over Time

Understory biomass was sampled before burning treatments were initiated and nearly 12 years after the last bum. Plots had been burned four or five times before the first remeasurement, and once more before the second remeasurement Total biomass averaged 8,281 lbs/acre before treatment, increased to 10,663 lbs/acre in 1980 and fell to 9,178 lbs/acre 2 years later (Table 1). Green biomass averaged 10 percent of total under-story biomass at each examination. Overstory pine density increased from 30 square feet of BA/acre in the winter of 1973 to 75 square feet/acre in the winter of 1983. Despite the increase in overstory density, both green and totai understory biomass were higher in 1982 than 1973. Despite biennial burning, the principal change was a steady increase in woody biomass from 55 to 62 percent of understory green 'biomass, and a parallel decline in the herbaceous component Thii decline was entirely due to toss of grass biomass, which fell from 238 to 132 lbs/acre. Forb biomass actually increased from 131 to 204 lbs/acre and that of legumes rose from 8 to 10 lbs/acre from 1973 to 1982

## Biomass and Burning Treatments

### Green Biomass.

Total green biomass in the understory was not significantly affected by burning treatments, but ail components were (Table 2). Woody understory vegetation was most abundant on unburned and least on burned plots. Thii component amounted to 91 percent of total green understory biomass on unburned plots in 1982, but only 49 percent of the total on burned plots. All nonwoody components were least abundant on unburned plots.

Biomass of woody vegetation and grass were not significantly affected by season of bum, but those of forbs and legumes were. Forb biomass was significantly lower with spring than with winter or summer burns. Legume biomass was significantly lower with summer than with winter or spring bums. Legume biomass on summer-burned plots, however, was not significantly greater than that on unburned plots.

Table 1. Change in ground cover biomass with time (all plots).

| Year | Stand basal area/acre | Green biomass: Woody | Herbaceous | Total | Organic litter | Total |
|---|---|---|---|---|---|---|
| | ($Ft^2$) | (Lbs/acre) | | | | |
| 1973 | 30 | 454 | 377 | 831 | 7420 | 8251 |
| 1980 | 60 | 624 | 432 | 1056 | 9607 | 16663 |
| 1982 | 75 | 568 | 346 | 914 | 8264 | 9178 |

Table 2. Effect of burning treatments on understory biomass in 1982.

| Component | Season of burn | | | |
|---|---|---|---|---|
| | Winter | Spring | Summer | None |
| | (Lbs/acre) | | | |
| Woody | 344b[1] | 455b | 421b | 1054a |
| Grasses | 178a | 154a | 158a | 39b |
| Forbs | 292a | 164b | 298a | 61c |
| Legumes | 13a | 16a | 6b | 4b |
| Total green | 827 | 789 | 883 | 1158 |
| Litter | 4072c | 7196b | 6748b | 15042a |
| Total biomass | 49OOc | 7985b | 7631b | 16200a |

[1] Row means followed by the same letter do not differ significantly at 0.05 level, according to Duncan's test.

Overall, green understory biomass dedined 13 percent between 1980 and 1982. The decline was higher on burned (18 percent) than on unburned (6 percent) plots. The composition of green biomass on all burned plots appeared to be nearing steady state in relation to season of bum. Shii among the four components over the 2 years were quite small. The woody component increased from 48 to 49 percent of total green biomass, while grasses declined from 21 to 20 percent and other components were unchanged. Groundcover conditions on unburned plots had not yet stabiiiied, as woody vegetation increased from 86 to 91 percent of total green biomass between 1980 and 1982.

Litter.

Large quantities of fitter accumulated on unburned plots. Twenty years after the last bum, dry weight of organic litter was 15,042 lbs/acre, more than double that with any burning treatment. litter biomass was least plentiful with the winter bum, which was the fast. bum before sampling. The difference in fitter biomass between spring and summer bums was too small to be significant. Most of the annual leaf and needle fall followed the spring and summer burns but preceded the winter burn..

## Biomass and Supplemental Treatments

Supplemental treatments did not significantly affect total green biomass, organic litter, or any green biomass component in either 1980 or 1982 with the lone exception of forbs in 1982. At that time, forb biomass Was significantly higher on hand-cleared than on untreated plots. There were no significant burn by supplemental treatment interactions for any biomass component in either year.

## Biomass in Young versus Mature Pine Stands

Understory biomass in the young pine stands in 1982 was compared with understory biomass under the highest density mature stands sampled in 1981 (Table 3). At the time of sampling, young stands were 24 years old with an average of 482 trees and BA of75 square feet/acre. Mature stands averaged 77 years old, with 48 trees and BA of 66 square feet/acre.

Table 3. Understory biomass in Young and mature pine stands.

| Component | Young stand | Mature stand | Difference | |
|---|---|---|---|---|
| | (Lbs/acre) | | | (Pct) |
| woody | 568 | 957 | 389 | +68.5 |
| Grasses | 132 | 169 | | |
| Forbs | 204 | 376 | 37 | +28.0 |
| | | | 172 | +84.3 |
| legumes | 10 | 19 | 9 | +90.0 |
| Total green | 914 | 1521 | 607 | +66.4 |
| litter | 8264 | 7838 | 426 | -5.2 |
| Total biomass | 9178 | 9359 | 181 | +2.0 |

Total organic biomass was almost the same in young stands as in mature stands. it averaged only 2 percent higher in mature stands. However, green *biomass* in mature stands made up 16 percent of the organic biomass on the forest floor, compared to 10 percent in young stands. As a result, green biomass was 66 percent higher in mature than in young stands. Each component of green biomass was also higher in mature stands, but the difference for grasses was less than that for any other component Organic litter, however, was 5 percent lower in mature than in young stands.

The composition of green understory biomass in all mature stands in 1981 (32 treatment plots) was almost identical to that in all young stands (36 treatment plots) in 1982 (Figure 1). The woody component comprised 61 .O percent of green biomass in mature compared to 62.2 percent in young stands. Grasses made up 14.9 percent of green biomass in mature and 14.4 percent in young stands. Forbs made up 22.6 and legumes 1.5 percent of green biomass in mature stands compared to 22.3 and 1.1 percent, respectively, in young stands.

The difference between mature and young stands in composition of green understory biomass on burned and unburned plots was also quite similar. Woody ground cover in young stands comprised 49 percent of green understory biomass on burned and 91 percent on unburned plots. The woody component of green biomass in mature stands amounted to 47 percent of the total on burned and 89 percent on unburned plots. Organic iiier on unburned plots was 15,442 lbs/acre in mature and 15,042 lbs/acre in young stands, nearly equal. Litter on burned plots averaged 5,303 lbs/acre in mature and 6,005 lbs/acre in young stands.

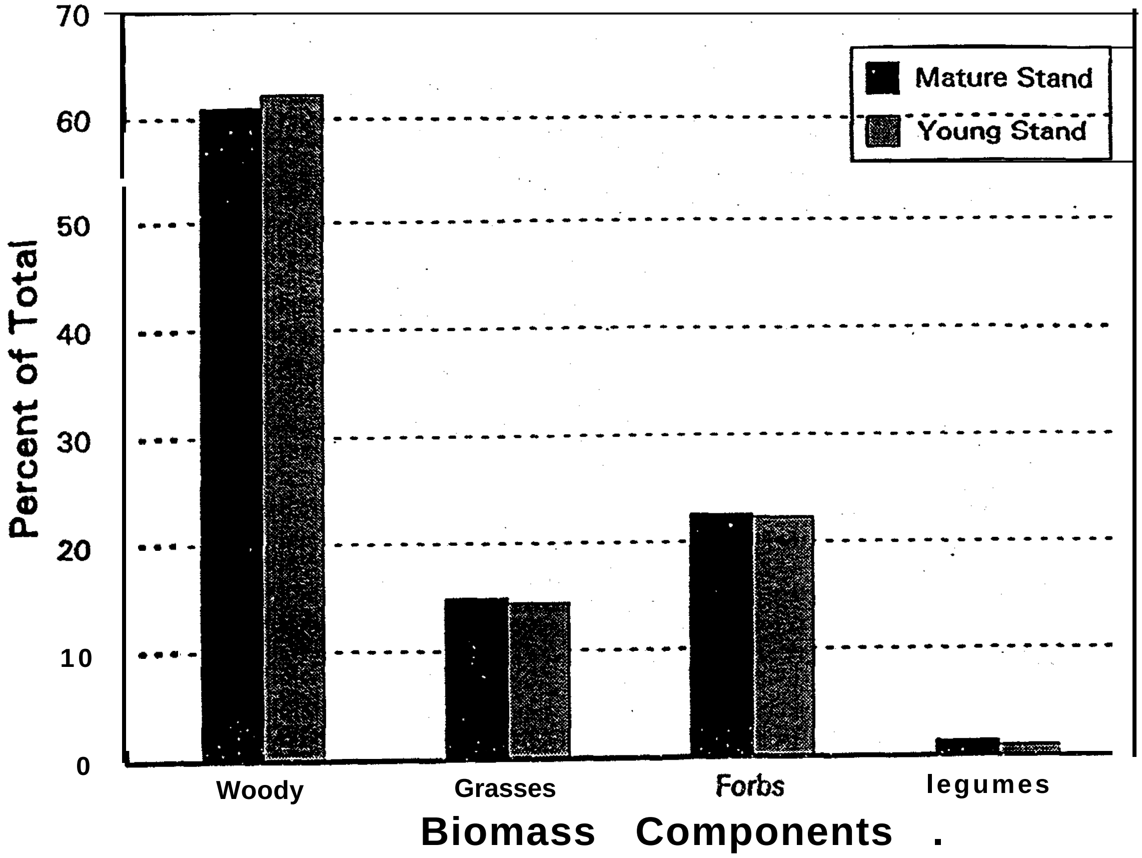


Figure 1 .-Composition of green biomass under young and mature longleaf pine stands.

## DISCUSSION AND CONCLUSIONS

Green biomass constituted only 10 percent of total understory biomass in study areas for all three measurements. Total green biomass increased 10 percent from 1973 to 1982 even as pine density increased from 30 to 75 square feet of BA/acre. Thii rise was attributable to a 25-percent increase in woody understory biomass and a 56-percent increase in forb biomass. Grass biomass declined by 44 percent during thii period Grasses appear to be particularly vulnerable to increasing density of overstory pine. Halls (1955) reported a decline in grass production from about 1,000 lbs/acre in the *open to* about 300 lbs/acre under canopies ranging from 35 to 50 percent In a study sampling 960 acres on the Escambia Experimental Forest, Gaines and others (1954) reported that herbaceous biomass as a whole declined from 1,000 lbs/acre in the open to a low of about 475 lbs/acre where stand BA reached 110 square feet. In that study, a decline in herbaceous biomass was more closely related to an increase in weight of tree litter (needles and leaves). Herbaceous biomass fell to about 260 lbs/acre when litter loads reached 8,000 lbs/acre. While Gaines and others (1954) did not separate herbaceous biomass into grass and forb components, they did observe declines in grass cover near pines. They reported a zone of influence extending about 6 to 8 feet from the bases of single trees, and 20 to 30 feet from groups of trees.

In the present study, burning treatments did not significantly affect total green understory biomass but it did affect all components of the total. Woody biomass increased while herbaceous biomass decreased on unburned plots. Woody biomass had reached 91 percent of total green biomass on unburned plots. It appeared to be stabilizing near 49 percent of the total *on* burned plots, down from 54 percent before treatment.

Season of burn did not affect biomass of woody understory vegetation or that of the grasses. Forb biomass, however, was lower with spring than with winter or summer burns. Legume biomass was lower with summer than with winter or spring burns. In a similar study in Louisiana, initiated in a longleaf pine seedling stand, Grelen (1975) also found no significant differences in herbage biomass or composition associated with burning treatments. However, grasses made up 90 to 94 percent of the herbaceous biomass in his study. He measured effects of burning every 2 years for 12 years in March, May, and July.

Supplemental hardwood control treatments in the present study had no effect on any component of understory biomass with the exception of forb biomass in 1982. In that year, forb biomass was higher on periodically handcleared than on untreated plots. Particularly in combination with burning, supplemental treatments have had a major impact on the hardwood midstory (Boyer 1991). but not on hardwood regeneration on the forest floor (Boyer 1993). Sprout proliferation with periodic handclearing might have been expected to add to woody understory biomass, but it did not

Total organic biomass beneath young stands in 1982 was only slightly less than that found in 1981 beneath mature stands approaching the same overstory density. Green biomass under the mature stands, however, was 66 percent higher than that under the young stands. The 9 square feet/acre higher BA in the young stands in 1982 does not appear to have been a factor. In 1980, both total and green understory biomass in young stands were higher and BA was lower than in 1982. Yet mature stands, with a slightly higher stand BA, still had 44 percent more green understory biomass than young stands.

Although green understory biomass was lower in young than mature stands, its composition was remarkably similar. This similarity between young and mature pine stands suggests that ground cover composition may be approaching steady-state conditions with respect to the burning treatments.

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