

CHARACTERIZATION OF THE HARDWOOD COMPONENT IN SOUTHERN PINE COVER TYPES IN THE SOUTHEAST

Gregory A. Ruark and William A. Bechtold¹

Abstract.— Forest Inventory and Analysis (FIA) data indicate that pine cover types comprise 41 percent of the total forest land in Florida, Georgia, South Carolina, North Carolina, and Virginia. Of these, 12.7 million acres are planted and 22.0 million acres are naturally regenerated. Many of these pine stands contain considerable amounts of hardwood. Understanding the dynamics of growth in these stands therefore requires knowledge of pine-hardwood interactions. Information is provided on the hardwood component within natural and planted stands of loblolly and slash pine, as well as natural stands of longleaf, pond, shortleaf, and Virginia pine on both Coastal Plain and Piedmont sites in the Southeast.

INTRODUCTION

While only 11 percent of the forested landbase in the Southeast (Florida, Georgia, South Carolina, North Carolina, and Virginia), is classed as oak-pine, an additional 26 percent is classed as naturally regenerated pine (figure 1). These proportions are similar for both the Coastal Plain and the Piedmont. However, total acreage differs, with 11.8 million acres of natural pine on the Coastal Plain and 7.8 million acres in the Piedmont. Large amounts of hardwood basal area are frequently encountered in these pine stands. In some cases the degree of hardwood competition is sufficient to suggest that these stands function more as mixed pine-hardwood than as pure pine stands.

This paper uses Forest Inventory and Analysis (FIA) data from the most recent (1983 thru 1987) State surveys to provide distributional information on stand-level variables of age, stocking, site quality, and hardwood competition within the major planted and naturally regenerated pine cover types in the Southeast (Bechtold and Ruark 1988). Our objective is to identify situations where pine forests are moving towards a pine-hardwood composition.

METHODS

The design of FIA is predicated on the collection of a well-distributed, systematic sample, with proportionate sampling of all major forest types, sites, and ownerships. Approximately 25,000 permanent plots are measured during the course of a survey cycle within the five state region administered by the Southeastern Forest Experiment Station. Each plot represents an average of about 3,400 acres.

Stand-level characteristics are measured on clusters of five sampling points per plot with a basal area factor (BAF) prism of 37.5. The basal area and

Coastal Plain (45,322,367 acres) Piedmont (26,974,967 acres)

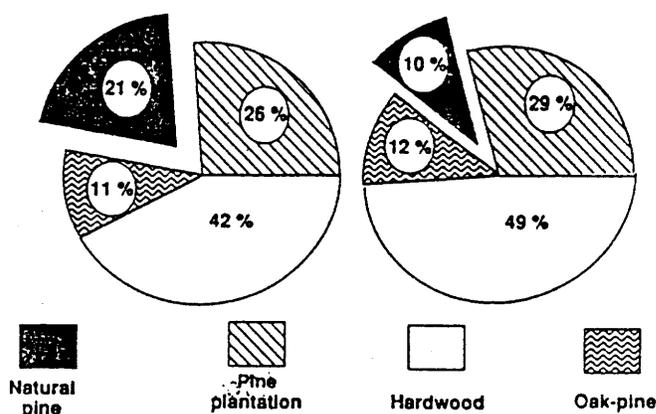


Figure 1. Percentage distribution of all timberlands in the Southeast, by broad forest type and physiographic region.

number of stems per acre are calculated for each major species on the plot (Beers and Miller 1964). Stand age and site index are determined from increment cores and height data from dominant and codominant trees in the stand (Schumacher and Coile 1960).

There are three to five survey units in each of the five States. Each survey unit is confined to one of three major physiographic associations (Coastal Plain, Piedmont, or Appalachian Mountains).

In this paper stand composition is evaluated by physiographic region averaged over all five States and by individual States averaged over physiographic regions. Means and standard deviations (weighted by acreage), as well as other statistics required to characterize the stand-level distribution of age, stocking, site index, and hardwood competition for a cover type are provided by Bechtold and Ruark (1988). Only mean values are discussed in this paper.

¹Project Leader and Resource Analyst, respectively. USDA Forest Service, Southeastern Forest Experiment Station.

TABLE 1. Average characteristics of naturally regenerated pine stands by ownership^a

	Age	Site index	Pine stems	Hardwood basal area	Acres	Plots
	Year	Feet	No./acre	pct	1000	No.
Coastal Plain						
National Forest	47	67	209	16	701	285
Other Public	41	64	225	20	1,253	561
Forest Industry	32	68	286	24	2,172	785
Farmer	36	73	259	24	2,918	1,030
Other Private	33	67	264	23	4,958	1,776
Piedmont						
National Forest	49	74	391	26	215	64
Other Public	40	67	357	21	336	194
Forest Industry	31	68	459	24	984	292
Farmer	33	68	383	28	1,917	535
Other Private	30	67	407	26	4,385	1,209

^a From Tables 23-25, Bechtold and Ruark (1988)

RESULTS AND DISCUSSION

Ownership

Five ownership categories are recognized: National Forest, other public, forest industry, farmer, and other private. The average age of natural pine stands on National Forest lands exceeds that of other ownerships for both Coastal Plain and Piedmont sites (table 1). Site index does not vary greatly among ownerships, but site index is higher for farmers than others on the Coastal Plain and higher for National Forests on the Piedmont. The number of natural pine stems per acre is always much higher on Piedmont than on Coastal Plain sites. However, the average proportion of total stand basal area comprised by hardwoods ranges from 16 to 28 percent and does not differ greatly between the two physiographic regions. The lowest

proportion of hardwood basal area is on Coastal Plain, National Forest sites, while the highest levels are manifested on Piedmont farmer ownerships.

The situation differs for planted pine stands (table 2). The average age of plantations ranges from 12 to 19 years across all ownerships. The greatest average age for plantations, 19 years, is for the other public category on the Coastal Plain. The lowest average site index on the Coastal Plain for National Forest land and the highest for farmer holdings. On the Piedmont, average site quality is similar for all owner groups. The average proportion of total stand basal area allocated to hardwoods ranges from 9 to 21 percent, with a notably high proportion of hardwoods in Piedmont National Forest plantations.

TABLE 2. Average characteristics of planted pine stands by ownership^a

	Age	Site index	Pine stems	Hardwood basal area	Acres	Plots
	Year	Feet	No./acre	pct	1000	No.
Coastal Plain						
National Forest	13	61	562	9	247	104
Other Public	19	65	358	10	418	207
Forest Industry	14	69	373	9	6,170	2,243
Farmer	13	72	331	12	747	269
Other Private	15	68	345	10	1,877	698
Piedmont						
National Forest	13	70	457	21	74	23
Other Public	15	73	408	14	50	33
Forest Industry	12	70	377	11	1,606	485
Farmer	16	74	288	16	323	90
Other Private	17	73	299	10	767	210

^a From Tables 23-25, Bechtold and Ruark (1988)

Overall, the ownership data in tables 1 and 2 suggest that there is a substantial hardwood component in naturally regenerated pine stands regardless of ownership. The situation exists on both the Coastal Plain and Piedmont across a range of age classes and sites.

South to North

On Coastal Plain sites the proportion of stand basal area relegated to hardwood species increases with latitude from south to north; ranging from 12 percent in Florida to 29 percent in Virginia (figure 2). These values reflect an average for all pine cover types. The difference in hardwood competition with latitude on the Coastal Plain is not related to the greater acreage of plantations on the south end of the gradient (figure 3). The same trend in hardwood competition is evident when planted and natural stands are viewed separately. There is no apparent latitude gradient on Piedmont sites, where the proportion of stand basal area occupied by hardwoods averages 24 percent in all five States.

TABLE 3. Average characteristics of naturally regenerated stands in the Coastal Plain (CP) and the Piedmont (P) of the Southeast^a

	Age	Site Index	Total basal area	SDI ^b	--Hardwood--		Acres
					Stems	Basal area	
	Year	Feet	Ft ² /acre		---	pct	1000
----- LOBLOLLY -----							
CP	34	75	103	256	66	29	4,326
P	31	72	98	243	51	23	4,449
----- LONGLEAF -----							
CP	43	60	55	127	46	13	2,309
P	43	-	56	123	54	14	99
----- POND -----							
CP	37	58	69	181	64	22	1,239
----- SHORTLEAF -----							
CP	38	69	100	232	60	28	114
P	36	64	101	253	46	28	1,535
----- SLASH -----							
CP	31	67	71	181	44	18	3,818
P	19	-	43	147	43	9	50
----- VIRGINIA -----							
CP	35	68	121	301	49	27	109
P	32	66	105	265	51	24	1,571

^a Calculated from Tables 2-5, Bechtold and Ruark (1988)
^b Stand Density Index (Reineke 1933)

Naturally Regenerated Cover Types

Table 3 gives average age, stocking, site index, and hardwood composition for naturally regenerated pine stands in the Coastal Plain and Piedmont of the Southeast. The number of hardwood stems in each cover type ranges from 43 to 66 percent. Since many of the hardwoods are small diameter coppice sprouts, their basal area better reflects their influence on the pine than does the number of stems.

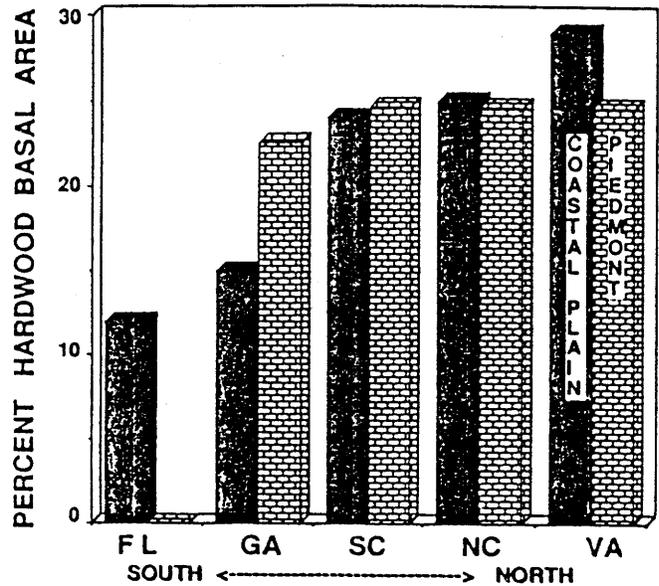


Figure 2. Percent of stand basal area in hardwood species by state and physiographic region, averaged for all pine cover types. (tables 6 and 11-20 from Bechtold and Ruark, 1988).

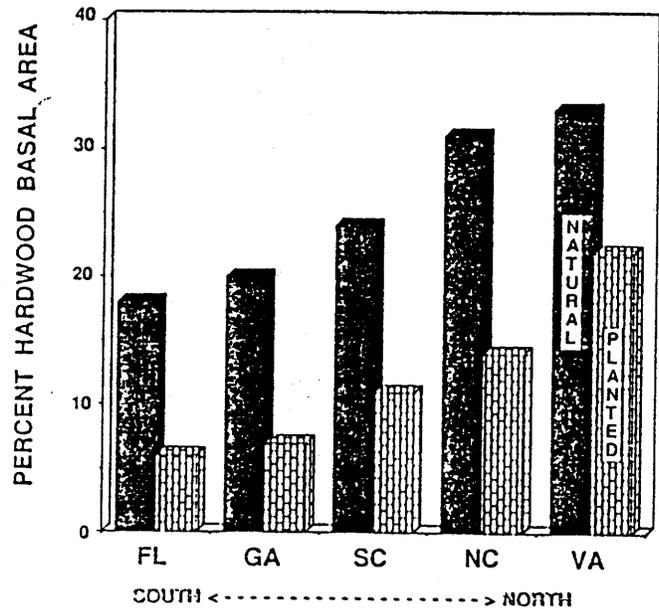


Figure 3. Percent of stand basal area in hardwood species in natural and planted stands on the Coastal Plain. Averaged and weighted by acreage for loblolly and slash pine. (tables 6, 11, 14, 17, and 19 from Bechtold and Ruark, 1988).

Loblolly, pond, shortleaf, and Virginia pine stands all average in excess of 22 percent hardwood basal area on both the Coastal Plain and Piedmont. Longleaf stands are the oldest and are often poorly stocked with low total basal area, but have only 13 and 14 percent hardwood basal area on the Coastal

TABLE 4. Average characteristics of natural (N) and planted (P) pine stands^a

	---- Coastal		Plain ----		----- Piedmont -----			
	Loblolly		Slash		Loblolly		Slash	
	N	P	N	P	N	P	N	P
Age (Years)	34	12	31	16	31	13	19	19
Site Index (Feet)	75	71	67	67	72	72	-	75
Basal area (Ft ² /acre)	103	60	71	53	98	59	43	67
<u>Hardwood</u>								
Stems (pct)	66	46	44	26	51	45	43	35
Basal (pct) area	29	15	18	8	23	12	9	7

^aCalculated from Tables 2-5, Bechtold and Ruark (1988).

Plain and Piedmont, respectively. These low values may reflect the strong tendency of longleaf stands to form associations with scrub oaks. Natural slash pine stands have 18 percent hardwood basal area on Coastal Plain sites, but only 9 percent on the Piedmont. Piedmont slash pine stands are notably younger and may reflect recent changes in management. However, sample size was small for this resource.

Planted vs. Natural Stands

Loblolly and slash pine are planted across large areas in the Southeast. In excess of 1.2 and 2.4 million acres are planted to loblolly pine on the Coastal Plain and Piedmont, respectively. Slash pine plantations are concentrated onto 5.6 million acres of coastal sites, with only 337,000 acres planted on the Piedmont (Bechtold and Ruark 1988). Coastal Plain plantations of both species have roughly half the hardwood basal area proportion of corresponding natural stands, reflecting the success of site preparation practices and prescribed burning (table 4). This holds true for Piedmont loblolly pine plantations, but naturally regenerated slash pine stands on the Piedmont exhibit a characteristically low level of hardwood competition, but the sample size is small for this situation. For both loblolly and slash pines, the proportion of hardwood basal area was always greater on Coastal Plain than on Piedmont sites, regardless of stand origin. On Coastal Plain sites planted stands averaged as much as 15 percent hardwood basal area and natural stands ranged up to 29 percent.

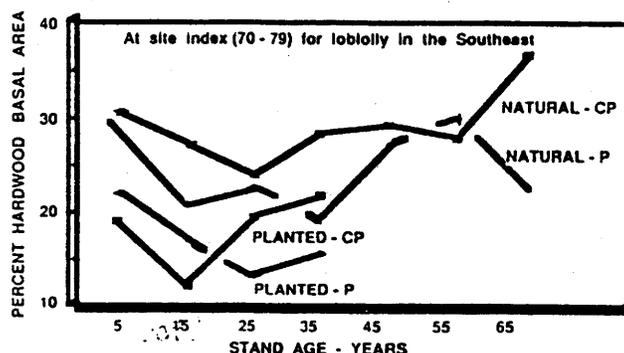


Figure 4. Basal area proportion of hardwoods by stand age on site index 70-79 loblolly pine sites in the Southeast. For planted and naturally regenerated Coastal Plain (CP) and Piedmont (P) sites. (figures. 18C, 19C, 26C and 27C from Bechtold and Ruark, 1988).

Hardwood competition varies with stand age (figure 4). Medium quality (site index 70-79 feet) loblolly pine sites in the Southeast were grouped by stand origin and physiography. The proportion of hardwoods was lowest between ages 15 and 25 for both natural and planted loblolly pine on the Coastal Plain. However, the hardwood component increased as stand age increased, with hardwoods comprising 37 percent of the basal area of natural loblolly pine stands by age 65. Piedmont sites showed a general decrease in percent hardwood basal area from age 5 to 25 regardless of stand origin, but no clear trend was present in more mature stands. In general, at any given age the proportion of hardwoods was greater in natural stands; the only exception was age 35, at which Coastal Plain plantations had more hardwood competition than natural Piedmont sites.

State vs. State

Statewide totals for naturally regenerated loblolly pine on Coastal Plain and Piedmont sites were estimated for medium quality sites (site index 70-79 feet) in North Carolina and South Carolina (figure 5). At all ages, the proportion of hardwoods in North Carolina substantially exceeds that on comparable sites in South Carolina. Whether this difference is due to management, site, and/or environment is not apparent, but it clearly occurs throughout the length of the rotation.

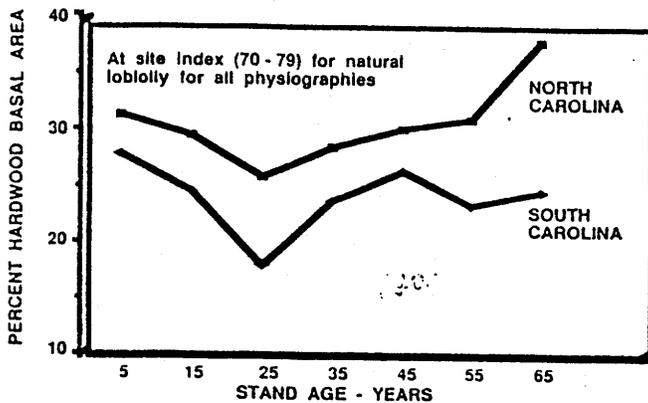


Figure 5. Comparison of hardwood basal area proportion in natural loblolly pine stands of North Carolina and South Carolina for site index 70-79 lands. (figures. 48C and 55C from Bechtold and Ruark, 1988).

Site Index

The proportion of hardwood basal area in planted loblolly pine stands declines as site quality improves (figure 6). On low quality loblolly pine sites, hardwood encroachment is large in both planted and natural stands. The tendency to intensively manage better sites may explain this difference. However, alternative explanations, such as the slower rate of canopy closure on poor sites, may result in more hardwood competition. On the best Piedmont sites, the hardwood competition in natural stands is notably low. For slash pine, the hardwood component is generally small across site classes, regardless of stand origin. Except for natural slash on the best coastal sites, slash does not seem to be severely challenged by hardwoods. However, our analysis does not examine competition from herbaceous plants that could substantially compromise the water and nutrient resources available to pines.

CONCLUSIONS

The mounting pressure to restrict the use of prescribed fire and herbicides, as well as economic constraints on management inputs, will likely present more obstacles towards limiting the degree of hardwood encroachment in pine cover types. In

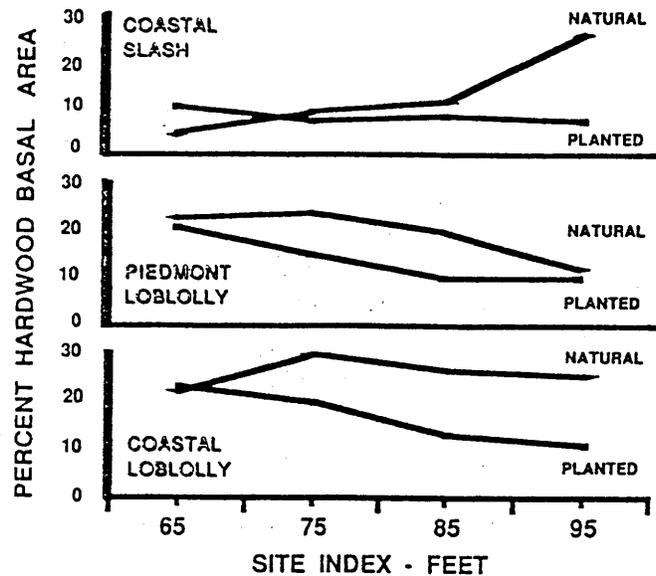


Figure 6. Hardwood competition within natural and planted pine stands by site quality in the Southeast at age 20-29 years. (figures. 18C, 19C, 20C, 21C, 26C, and 27C from Bechtold and Ruark, 1988)

the Coastal Plain and at increasingly northern latitudes, where hardwoods already comprise a large percentage of the stand basal area, lack of aggressive hardwood control measures at harvest will likely result in many of these stands being reclassified as pine-hardwood or pure hardwood cover types during the next rotation. Additionally, many naturally regenerated pine stands are already functioning as mixed pine-hardwood stands. This is particularly true of loblolly, shortleaf, and Virginia pine.

The structure of pine stands in the Southeast supports the need for accelerated research into pine-hardwood management.

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