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GROWTH AND SURVIVAL OF BALDCYPRESS PLANTED IN AN OLD RICE FIELD OF COASTAL SOUTH CAROLINA

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Abstract—Vast acreages of baldcypress [*Taxodium distichum* (L.) Rich.] swampland in coastal South Carolina were cleared for rice production starting in the late 1600s. When rice cultivation ended in the late 1800s, many cultivated areas became marshlands. Other fields failed to return to forest unless they were planted. In one such area, nine acres were planted with baldcypress in 1956 by MeadWestvaco near Walterboro, SC. Seedlings were planted on an 8- by 8-foot spacing. Beginning in November 1991, five 0.12-acre plots were established within the stand to monitor tree growth and survival and measured yearly. In addition to baldcypress, the stand now contains red maple (*Acer rubrum* L.), black willow (*Salix nigra* Marsh.), sweetgum (*Liquidambar styraciflua* L.), and persimmon (*Diospyros virginiana* L.). The number of trees per acre declined from 600 to 402 by year 2000. Average diameter of trees after 44 years was 9.1 inches. In 2001, MeadWestvaco clearcut half of the stand, thinned 1/4 of the stand, and left 1/4 intact. All stems were removed from the clearcut section, and the thinned section was reduced to 104 stems per acre (88 percent of remaining trees are baldcypress). Five regeneration plots were placed in the clearcut area to follow future regeneration patterns.

INTRODUCTION

Almost pure stands of baldcypress [*Taxodium distichum* (L.) Rich] were found in southern coastal plain river floodplains when settlers first arrived in America (Mattoon 1915). With the introduction of rice cultivation into South Carolina in the 1600s, the upper section of river swamps was diked to create water storage ponds, and the remainder of the swamp was cleared, leveled, and planted to rice. Eventually, the demand for land and the introduction of new cultivation techniques using tidal action to flood rice fields along rivers resulted in the extension of rice cultivation as far as 35 miles inland (Edgar 1998). From 1850-1860, 227 plantations reported over 72,000 acres of land under rice cultivation (Gresham and Hook 1982).

Rice culture effectively ended in South Carolina by the end of the 19th century and was entirely through by 1936, but the old rice fields can still be identified on the landscape today. In a survey conducted in the early 1980s, Gresham and Hook (1982) found that 32 percent were still under management (mainly for waterfowl). Of the rest, 42 percent were identified as having a grass-marsh plant cover while only 26 percent had a tree-marsh plant cover. Thus it can be concluded that many of the abandoned fields have not reverted to their former baldcypress-dominated status. In some cases, the old fields were planted with baldcypress seedlings in order to re-establish stands of trees. One such plantation was planted by MeadWestvaco in 1956. Beginning in November 1991, a study was initiated to determine long-term growth rates of the trees growing in the baldcypress plantation.

MATERIALS AND METHODS

The baldcypress plantation is near Jacksonboro, SC on soils classified as fine, mixed, thermic Typic Argiaquolls. These soils are very poorly drained; they are slowly permeable soils formed in clayey sediment. These nearly level soils are typical of broad depressional areas and drainageways (Stuck 1982), and they are frequently flooded. The site was planted in February 1956. Nine acres were planted with baldcypress on an 8- by 8-foot spacing (600 trees per acre). As far as is known, no cultural treatments were done on the site after planting.

Five 0.12-acre study plots were established in the central portion of the plantation in November 1991. All trees within the plots with a diameter at breast height (d.b.h.) greater than 4 inches were identified as to species and crown class, tagged, and their d.b.h. measured. Each year since 1991, d.b.h. has been recorded at the end of the year.

In 2001, MeadWestvaco clearcut half of the stand, thinned 1/4 of the stand, and left 1/4 intact. All stems were removed from the clearcut section. All five study plots fell within the thinned portion of the stand. An additional five 0.12-acre regeneration plots were placed in the clearcut area to follow future regeneration patterns.

All data were analyzed using repeated measures Analysis of Variance (ANOVA) through the Procedures of General Linear Models (PROC GLM) on the SAS Systems software version 8.0 (SAS 1999). In addition, a special macro called PDGLM800 was used with PROC GLM to create groups of similar growth means among plots, crown classes, and time (Saxton 1998). All groups of means were compared at the level of $P < 0.05$ for test of significance.

RESULTS

In 1991 baldcypress was the dominant tree species growing on the plantation site, representing 83 percent of the total stems measured (table 1). Black willow (*Salix nigra* Marsh.) was the second most common tree (12 percent of stems), with scattered red maple (*Acer rubrum* L.), persimmon (*Diospyros virginiana* L.), swamp blackgum [*Nyssa*

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Table 1—Mean number of trees per acre by species growing in a baldcypress plantation in coastal South Carolina between 1991 and 2000

Species	1991	2000	2001
	- - - - - *number* - - - - -		
Baldcypress	400	375	92
Black willow	58	7	3
Red maple	8	7	7
Persimmon	7	5	2
Swamp blackgum	5	5	0
Sweetgum	3	2	0
Total stems/acre	481	401	104

Plots were thinned in 2001.

Table 2—Diameter growth of baldcypress among crown classes

Year	Crown class D	CD	I	S
	- - - - - - - *-inches per year-* - - - - - - -			
1992	0.47a	0.35b	0.12c	0.05d
1993	0.20a	0.12b	0.02c	0.01c
1994	0.34a	0.24b	0.08c	0.05d
1995	0.44a	0.31b	0.11c	0.05d
1996	0.13a	0.08b	0.01c	-0.01c
1997	0.28a	0.24b	0.09c	0.07d
1998	0.20a	0.13b	0.04c	0.02d
1999	0.26a	0.18b	0.05c	0.03c
2000	0.07a	0.05a	0.01b	0.02b
Total	2.39a	1.70b	0.53c	0.26d

D = dominant; CD = co-dominant; I = intermediate; S = suppressed for 1992–2000. Mean values within a year with different letters are significant at 0.05 level.

sylvatica var. *biflora* (Walt.) Sarg.], and sweetgum (*Liquidambar styraciflua* L.). By the year 2000, natural mortality resulted a 17 percent decline in the number of trees per acre with the greatest decline occurring among the black willow. Eighty-eight percent of the black willow died during the 10 year period, while only 6.2 percent of all other tree species died. After the study plots were thinned in 2001, only 104 stems per acre were left. Baldcypress made up 88 percent of the total stems in the thinned stand with red maple, persimmon, and black willow making up the rest. All swamp blackgum and sweetgum were removed during thinning.

Overall, diameter growth differed significantly through time with respect to plots ($p = 0.0001$) and crown classes ($p < 0.0001$). Also, the interaction of time and crown classes ($p < 0.0001$) was significant although the time and plot interaction was not ($p = 0.3665$).

Mean diameter growth of trees within the five plots did not vary much, although trees in plot 5 tended to grow more than those in the other four plots from 1992 through 1998, with significant differences recorded in 1994 and 1996. In 1998, trees in plots 3 and 5 showed significantly greater diameter growth. During 1999 and 2000, trees in plot 3 exhibited the most diameter growth, but values were not significantly greater than other plots. There was no difference in respect to diameter growth in all five plots during 1999, while diameter growth was significantly lower in plots 1 and 2 during 2000.

When we look at the results for individual years by crown class (table 2), dominant trees grew significantly more than other crown classes (co-dominant > intermediate > suppressed) for all years except 2000. During 2000, there was no significant difference between dominant and co-dominant trees, but they still grew significantly more than intermediate and suppressed trees. In 1993, 1996, 1999, and 2000, intermediate and suppressed trees did not differ from each other in diameter growth. The growth trend among crown classes indicated that after 1996, growth differences between dominant and co-dominant trees was declining. As a result there were less significant differences among crown classes by 2000. Total baldcypress diameter growth during the study was 2.39, 1.70, 0.53, and 0.26 inches for dominant, co-dominant, intermediate, and suppressed trees, respectively. At the end of the study, mean diameter of baldcypress growing in the plantation was 9.1 inches. Dominant baldcypress averaged 13.9 inches d.b.h., while co-dominant, intermediate, and suppressed trees averaged 10.8, 6.7, and 5.0 inches, respectively.

DISCUSSION

Baldcypress is recognized as a tree species especially well-suited to planting in wet areas (Conner and others 1999, Peters and Holcombe 1951, Williston and others 1980, 1981). It thrives on a variety of soil types and tolerates flooding once established. Very little information exists on the success of plantation grown baldcypress. Krinard and Johnson (1976, 1987) do report that the average diameter of 21- and 31-year-old baldcypress growing in Mississippi was 6.1 and 8.6 inches, respectively, indicating a 10-year growth rate of 2.5 inches. This is higher than the 2 inches reported for natural stands by Mattoon (1915) and Langdon (1958) or the 1.5 inches reported by Williston (1969). In the current study, nine year growth of dominant baldcypress was 2.4 inches. Assuming similar growth for the next year, the 10-year growth rate would be similar to that reported by Krinard and Johnson (1987). Based on these rates, plantation grown baldcypress grow faster than those in natural stands.

Although baldcypress was the only species planted on the site and represented the majority of trees growing on the site, other species did become established. Most of these species are common pioneer species. Black willow is a short-lived species that rarely asserts dominance in a stand; nearly all of the individuals in the study were in the co-dominant crown class. Natural mortality is generally high with this species (Pitcher and McKnight 1990) as was observed in this study. The few remaining black willow nearly all showed signs of declining health (dead limbs,

dying tops). Red maple are a longer-lived successional species. They are tolerant of shade and are rapid growers (Walters and Yawney 1990). Diameter of dominant red maples was nearly 5 inches larger than that of dominant baldcypress. In other crown classes, there was no difference in diameter. Sweetgum is another rapidly growing pioneer species (Kormanik 1990) but not as fast a grower as red maple. Average diameter of sweetgum prior to thinning was 14.6 inches. Upon thinning, all the sweetgum and blackgum were removed from the plots as were the dominant maples.

While there are no reports of thinning studies in baldcypress plantations, studies in natural stands indicate that diameter growth can be expected to increase after thinning. Studies in Florida (Ewel and Davis 1992, McGarity 1979), Louisiana (Dicke and Toliver 1988, Toliver and others 1987), and Mississippi (Williston 1969) all report increases of around 0.5 inches in 10 year growth.

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Description: Ninety-two papers and thirty-six poster summaries address a range of issues affecting southern forests. Papers are grouped in 15 sessions that include wildlife ecology; fire ecology; natural pine management; forest health; growth and yield; upland hardwoods - natural regeneration; hardwood intermediate treatments; longleaf pine; pine plantation silviculture; site amelioration and productivity; pine nutrition; pine planting, stocking, spacing; ecophysiology; bottomland hardwoods - natural regeneration; and bottomland hardwoods—artificial regeneration.

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