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Hardwood Regeneration After Seed Tree Cutting

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Hardwood Regeneration After Seed Tree Cutting

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Seed tree cutting is a system of regeneration that theoretically favors the establishment and subsequent growth of chosen species—particularly those whose seeds are disseminated by wind. Since the system is used infrequently in hardwood forests of the Midsouth, little documentation is available to support or disprove the assumption. This paper reports establishment and growth of trees in two separate stands 18 years after seed tree cutting. Seed trees were mainly sweetgums and red oaks.

METHODS

Both stands are in southeastern Arkansas on sites laced with a series of small drainage or depressional channels. One is within the floodplain of the Saline River and has good drainage nearly year-round. The other borders Chemin-a-haut Creek, a minor bottom cutting through upland pine forests; this area has poor drainage, particularly in winter and spring.

[1] The authors are stationed at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station, Forest Service—USDA, in cooperation with the Mississippi Agricultural and Forestry Experiment Station and the Southern Hardwood Forest Research Group.

Soil is Chastain silt loam on the Saline and Wrightsville silt loam on the Chemin-a-haut. Site indexes of sweetgum (*Liquidambar styraciflua* L.) and water oak (*Quercus nigra* L.) are 94 and 89 feet on Chastain soil and 89 and 80 feet on Wrightsville.

Before cutting, most trees in the Saline forest were suitable for large sawtimber; there were about 11,000 board feet (Int. ¼-inch rule) and 85 square feet of basal area per acre. Nearly half of the trees were red oaks, mainly cherrybark (*Quercus falcata* var. *pagodaefolia* Ell.) and water oak; about one-fourth were sweetgum. The Chemin-a-haut forest contained about 4,000 board feet and 61 square feet of basal area per acre. Approximately two-thirds were sweetgum; red oaks accounted for only 10 to 15 percent.

Three 7 by 14 chain blocks were delineated in each area. Sawtimber and pulpwood were cut in fall 1956. All unmerchantable trees 1.0 inch d.b.h. and larger were killed either by cutting or by girdling and poisoning. This left an average of 7.4 well-spaced seed trees per acre on the Saline and 7.5 trees on the Chemin-a-haut. Composition of the stands after cutting was as follows:

	Saline	Chemin-a-haut
	Trees per acre	
Sweetgum	2.3	5.2
Red oaks	4.0	1.2
White oaks	.5	.5
Blackgum (*Nyssa sylvatica* var. *sylvatica*)	.0	.3
Baldcypress (*Taxodium distichum* (L.) Rich.)	.3	.3
Green ash (*Fraxinus pennsylvanica* Marsh.)	.3	.0

Seed trees were removed from the Saline in 1962 but were not cut on the Chemin-a-haut.

During the summer and fall of 1957—about 1 year after cutting—both areas were fenced to exclude livestock. Twenty permanent plots were then established in each block; 10 were 0.004-acre plots 13.2 feet square, and 10 were circular 0.033-acre plots. Both sets of plots were equally spaced through the center of each block. Trees smaller than 1.0 inch d.b.h. were measured on the 0.004-acre plots, trees larger than 1.0 inch d.b.h. were measured on 0.033-acre plots.

Reproduction was monitored as follows: all trees on the square plots were tallied by species in the falls of 1957, 1958 (Saline only) and 1959. Beginning in fall 1962 and again in the falls of 1965, 1971 (Saline only), and 1974, all trees were tallied by species on the circular

plots. In 1971 heights and diameters of the tallest tree of each species were recorded for all plots. In 1974 diameters of all trees and the height of a dominant or co-dominant tree for each species were recorded, and volume of reproduction was calculated for all plots except those containing seed trees or surviving girdled trees.

RESULTS

Saline

One, two, and three years after cutting there were 3,800, 7,300, and 13,000 total trees per acre, respectively; after 6 and 9 years, 700 and 1,600 trees per acre 1.0 inch d.b.h. and larger were tallied.

At the end of the 18 years, the stand had 1,800 trees per acre comprised of 34 species (table 1). Nearly three-fourths were American hornbeam (*Carpinus caroliniana* Walt.), sweetgum, or river birch (*Betula nigra* L.). These three species became plentiful during the second year after cutting. After 9 and 18 years, the number of sweetgum remained steady or increased slightly; American hornbeam increased substantially, and river birch decreased. Red oaks never comprised a large proportion of the reproduction even though they doubled or tripled in number between 9 and 18 years after cutting. After 18 years, they accounted for only 9 percent of the trees, and none was as large as 7.0 inches d.b.h. (table 2).

Proportionate numbers of trees by species varied considerably among blocks. For example, after 18 years one block had twice as many sweetgum as the other two; the second had two to three times as many red oaks, and the third block had two to four times as many American hornbeam.

By 1974, there were 150 to 200 dominant or co-dominant trees per acre (based on tree size and location) in fully stocked stands.

Table 1.—*Reproduction by species groups and measurement year*[1] *on the Saline*

Species	Measurement year					
	1957 1	1958 2	1959 3	1962 6	1965 9	1974 18
	Number of trees per acre					
Sweetgum	956	705	2,074	189	396	489
River birch	0	...[2]	3,566	226	548	308
Red oaks	969	398	710	7	63	153
American hornbeam	624	...[2]	887	112	271	513
Others	1,264	6,213	6,092	194	286	351
Total	3,813	7,316	13,330	728	1,564	1,814

[1] 1957, 1958, and 1959 data were from milacre plots; in 1962 and afterward, data were from 0.033-acre plots.

[2] Included under *Others*.

Table 2.—*Number of trees per acre after 18 years by species groups and d.b.h. class (Saline)*

D.b.h. class	Sweetgum	Red oaks	River birch	Other major species	American hornbeam	Other minor species	Total
	Number of trees per acre						
1.0–1.9	144	65	52	78	310	110	759
2	114	31	107	39	127	38	456
3	69	29	97	22	40	9	266
4	50	17	27	16	12	1	123
5	46	10	23	14	3	1	97
6	42	2	6	6	2	...	58
7	18		5	8	3	...	34
8	10		1	5	1	2	19
9	1			2			3
10	1						1
Total	495	154	318	190	498	161	1,816

Sweetgum was dominant or co-dominant on 86 percent of the plots, red oaks on 52 percent, and river birch on 45 percent. Only 9 percent of the dominant or co-dominant trees measured were established as new seedlings, 24 percent were advance reproduction (well-established when the stand was cut), and 68 percent were sprouts from stumps or roots of cut trees.

Most reproduction did not grow into the 2-inch diameter class until 1962, 6 years after cutting. In plots with poor stocking, trees did not emerge from the vines and briars until 1965. Dominant trees were 15 to 20 feet tall in 1962, 25 to 35 feet tall in 1965, 40 to 50 feet tall in 1971, and 55 to 65 feet tall in 1974. Average d.b.h. of all trees$\geq$1.0 inch was 3.2 inches in 1974, while dominants were 6 to 10 inches d.b.h.

Estimated plot volumes in 1974 for all trees 1.0 inch d.b.h. or greater ranged from 1,325 to 2,624 cubic feet per acre. Basal areas ranged from 73 to 142 square feet per acre. When considering only trees $\geq$5.0 inches d.b.h., plot volumes ranged from 118 to 2,134 cubic feet per acre and basal areas from 5.7 to 104.2 square feet per acre. Growth averaged 98 cubic feet annually for trees 1.0 inch d.b.h. or larger and 56 cubic feet for trees 5.0 inches or larger. Highest volume production was from plots with dense clumps of sweetgum, which contributed nearly 50 percent of the total volume compared to only 7 percent for red oaks.

Chemin-a-haut

One and 3 years after cutting, there were 5,700 and 2,700 total trees per acre, respectively; after 6 and 9 years, 600 and 900 trees per acre 1.0 inch d.b.h. and larger were tallied.

At the end of 18 years, the stand had 1,300 trees per acre made up of 23 species. Nearly 80 percent of the trees were about equally divided between sweetgum and American hornbeam (table 3). Both species were well represented the first year after cutting. Between years 9 and 18, sweetgum stocking remained generally stable, but the number of American hornbeam nearly doubled. Red oaks were never a major component of the stand, although the number tallied increased by about one-third between 9 and 18 years. By 1974, red oaks made up only about 5 percent of the trees; few were larger than 6 inches d.b.h. (table 4). No other species comprised more than 3 percent of the 18-year-old stands.

Table 3.—*Reproduction by species groups and measurement year*[1] *on the Chemin-a-haut*

Species	Measurement year				
	1957 1	1959 3	1962 6	1965 9	1974 18
	Number of trees per acre				
Sweetgum	567	558	363	517	584
Red oaks	142	83	31	51	63
American hornbeam	...[2]	...[2]	103	254	492
Others	4,950	2,042	82	118	195
Total	5,659	2,683	579	940	1,334

[1] 1957 and 1959 data were from milacre plots; in 1962 and afterward data were from 0.033-acre plots.

[2] Included under *Others*.

As on the Saline, there were about 150 to 200 dominant or co-dominant trees per acre in dense stands. Sweetgum was dominant or co-dominant on 97 percent of the plots and red oaks on 31 percent. About 63 percent of the dominants or co-dominants were of sprout origin; advance reproduction accounted for 28 percent and new seedlings for only 9 percent.

In 1974, average d.b.h. of trees $\geq$1.0 inch was 3.4 inches, whereas dominant trees were 50 to 65 feet tall and 6 to 10 inches d.b.h. Plot volumes based on trees 1.0 inch d.b.h. or larger ranged from 280 to 3,253 cubic feet per acre. Basal areas ranged from 20 to 157 square feet per acre. Volumes for trees 5.0 inches d.b.h. and larger ranged from 0 to 2,805 cubic feet (0 to 127 square feet of basal area). Growth averaged 86 cubic feet annually for trees 1.0 inch d.b.h. and larger and 53 cubic feet for trees 5.0 inches and larger.

Nearly 75 percent of the Chemin-a-haut volume was in sweetgum and only 9 percent in red oak.

Table 4.—*Number of trees per acre after 18 years by species groups and d.b.h. class (Chemin-a-haut)*

D.b.h. class	Sweetgum	Red oaks	Other major species	American hornbeam	Other minor species	Total
	Number of trees per acre					
1.0–1.9	106	18	70	300	38	532
2	113	9	25	140	17	304
3	108	18	13	45	13	197
4	91	3	7	7	7	115
5	80	3	5	1	1	90
6	58	5	...	...		63
7	22	...	3	1		26
8	7	2	1			10
9	5	1	1			7
10		1				1
11		1				1
Total	590	61	125	494	76	1,346

DISCUSSION

In the present study seed trees did not appear to affect establishment or development of reproduction. A clearcut would probably have given the same results, since most reproduction came from the stumps and roots of cut trees or from seedlings already in the understory at time of cutting (table 5). After 18 years, sweetgum of root and stump sprout origin was by far the leading commercial species both in number and stand position (dominance) on both areas (fig. 1). All red oaks present were already well-established in the understory at the time of cutting. The American hornbeams were a combination of new seedlings, advanced reproduction, and stump and root sprouts. The only new seedlings of significance were river birch and American sycamore on the Saline, although most of the sycamore were dead after 9 years.

After cutting, stands with a high percentage of sweetgums in the overstory will apparently reproduce heavily to sweetgum because of sprouting. In this test, sweetgum sprouts emerged for at least 3 years after cutting, and their early rapid growth—up to 6 feet the first year—enabled them to become dominant. We saw no reason to disfavor root or low stump sprouts in managing the stand, since they developed and competed well, showed no tendency to rot, and would therefore become suitable as sawtimber crop trees. Although sprouts from high stumps grew well, some contained rot and were unsuitable as sawtimber. It is therefore best to keep sweetgum stumps as low as possible.

Of the common commercial species, red oaks (cherrybark and water oak) appeared the most competitive. When these oaks received

Table 5.—*Predominant sources of reproduction 18 years after seed tree cutting on two sites*

Species	New seedlings	Advanced seedlings	Root and stump sprouts
American hornbeam	X	X	X
Ash, green		X	X
Baldcypress	X		
Birch, river	X		
Buttonbush (*Cephalanthus occidentalis* L.)	X		X
Eastern cottonwood (*Populus deltoides* Bartr.)	X		
Elm spp. (*Ulmus* L.)		X	
Gum, sweet			X
Gum, black		X	
Holly, American (*Ilex opaca* Ait.)	X	X	X
Hawthorn spp. (*Crataegus* L.)		X	
Hickory spp. (*Carya* Nutt.)		X	X
Honeylocust (*Gleditsia triacanthos* L.)			X
Maple, red (*Acer rubrum* L.)	X		X
Mulberry, red (*Morus rubra* L.)		X	X
Oak, cherrybark		X	
Oak, swamp chestnut (*Quercus michauxii* Nutt.)		X	
Oak, water		X	
Oak, willow (*Quercus phellos* L.)		X	
Pawpaw (*Asimina triloba* (L.) Dunal)		X	
Persimmon (*Diospyros virginiana* L.)		X	
Sassafras (*Sassafras albidum* (Nutt.) Nees)	X	X	
Sugarberry (*Celtis laevigata* Willd.)		X	
Sycamore, American (*Platanus occidentalis* L.)	X		
Water hickory (*Carya aquatica* (*Michx.* f.) Nutt.)		X	X
Willow, black (*Salix nigra* Marsh)	X		

direct overhead sunlight and when their growing tips were halfway up the live crowns of competitors, they appeared vigorous and eventually capable of dominating. A relatively high number of red oaks were dominant and co-dominant despite their comprising a small proportion of the total stocking. Stands made up predominantly of red oak before cutting may not reproduce to red oak. The best way to assure the presence of these trees in the mature stand is to leave many established seedlings in the understory. Advanced oak reproduction at least 5 to 10 feet tall at the time of cutting will apparently compete much better than oaks less than 2 feet tall.

River birch seedlings—the only important new growth—grew only on the Saline, which had a seedbed of bare mineral soil conducive

Figure 1.—*Eighteen-year-old sweetgum sprouts from a stump 6 inches in diameter. Machete is pointed at the top of the stump.*

to the establishment of light-seeded species. Also, overflow of the Saline River during the spring provided a favorable distribution of river birch seed and a moist seedbed during the germination period. River birch was a rapid early grower but a poor competitor. In competition with the other species, young river birch bent toward sunlight, resulting in a crooked tree that frequently succumbed as competition became intense.

American hornbeam sprouted prolifically and developed slowly in almost complete shade. Sprouts grew to 4 or 5 feet the first year. In spite of their rapid early growth, American hornbeam competing from ground level poses no threat to most commercial species. However, dense clumps of American hornbeam containing individual trees 3 to 6 inches d.b.h. and 20 to 30 feet tall will dominate and eventually kill reproduction of better species that attempt to develop underneath.

Results from this test suggest that seed trees will not lead to widespread establishment of red oak and sweetgum seedlings. Seed trees of most hardwood species are unlikely to play a significant role in establishing new stands because of competition from the advanced reproduction and sprouts common to hardwood forests in the Midsouth. Establishing a new stand from seeds after seed tree cutting apparently requires adequate seeds, a seedbed relatively free of grass or herbaceous plants, and adequate surface soil moisture during the germination period. When this unlikely combination occurs, the resulting seedlings must grow rapidly enough to move into an early dominant position.