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Rapid Growth Indicates Forestry Opportunities In Bottomland Hardwoods

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What are we going to do with our Southern bottomland hardwoods? When it is realized that here are 27 million acres of bottomland hardwoods in the Lower South it can be readily seen that this is a problem of major importance. The problem is particularly important in the Mississippi Delta region, which contains almost half of this timber. Sawmills in the Mississippi Valley from Memphis to New Orleans have in the past been one of the mainstays of the American hardwood industry. What is the future of this industry? Are cut-over bottomland hardwood forests worth managing? Will second-growth stands yield a satisfactory income? How do the yields compare with pine? To what extent will agricultural expansion affect the amount of forest land? Where will the forests of the Delta fit into the picture in the future?

These and similar questions are often asked the Southern Forest Experiment Station. Final answers are not at hand for all of them but limited research is under way at the Delta Experimental Forest, Stoneville, Mississippi, in cooperation with the Mississippi Agricultural Experiment Station. It is now planned to expand this research to give more attention to both the general economic and technical managemet angles of the problem.

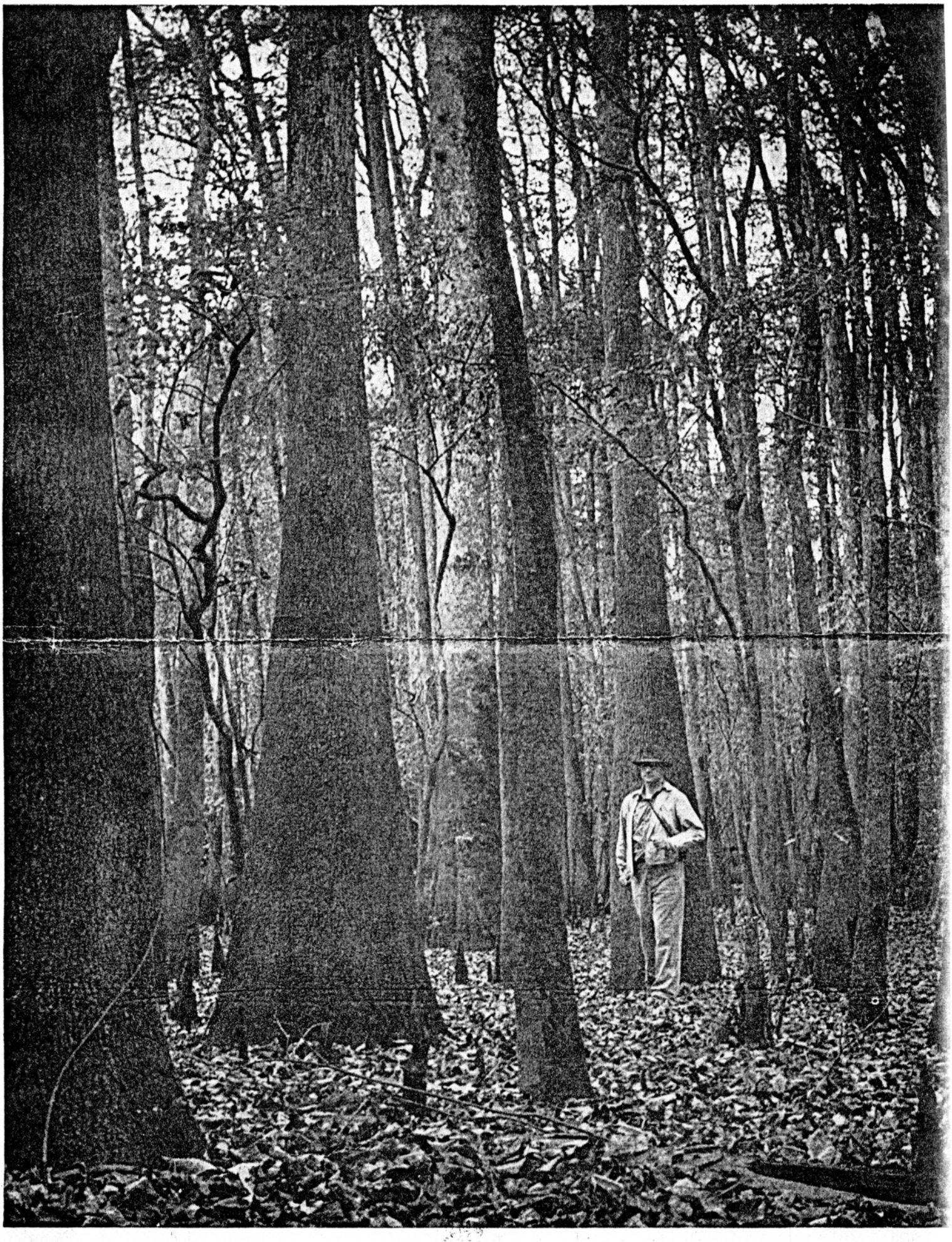
The extent of progress which will be made in forest management in the bottomlands depends largely on their timber-growing capacity. This article has been prepared, therefore, to present data on growth and yield as indication of the possibilities of profitable management.

Three Main Bottomland Types

Many species of hardwoods occur in the bottomlands, but they may be conveniently classified for this discussion into three main forest types:

1. *Cypress-tupelo* type, occurring mainly in swamps in the lower Delta of Louisiana, but also widely distributed in deep swamps and sloughs throughout the Lower South. This type occupies 1.8 million acres in the Mississippi River Delta region and 1.8 million acres in the longleaf-slash region from Texas to Georgia and Florida. Formerly largely cypress, the stands are now made up chiefly of second-growth tupelo with scattered cypress, willow, and several other species. Many stands are well stocked with small timber, the average log at the mill running about 100 board feet. Most companies con-

Second-growth mixed with hold-overs from logging about 30 years ago. The mixed hardwoods here include willow oak, bottomland red oak, green ash, elms, and hackberry. (Photograph by U. S. Forest Service.)



Pure stand of tupelo gum. Tupelo makes good growth on sites too low and wet for any other valuable tree except cypress.
(Photograph by Clement Mesavage, U. S. Forest Service.)

Young second-growth stand of oaks and mixed hardwoods two years after improvement cutting that removed wolf trees and small trees of poor quality for fuelwood. (Photograph by U. S. Forest Service.)

sider permanent management to be economically feasible, and several have purchased large holdings running in the neighborhood of 100,000 acres each. Markets for lumber, veneer, and other products from tupelo are good and the forest industries seem to be of a permanent nature. There is not much land either cleared or suitable for farms because of the prevailing swampy conditions. Taxes are reasonable and there seems to be a good opportunity for profitable forest management.

2. *Cottonwood-willow* type, occurring mainly on "batture" lands between the levees of the Mississippi and other large rivers from the Gulf north to Missouri. This type occupies 1.4 million acres in the Mississippi River Delta region. The stands are usually composed of second-growth stands in which either cottonwood or willow is predominant. Sycamore, ash, hackberry, and red gum are common associated species, typically coming in as an understory and replacing cottonwood and willow following cutting. Uncut stands are usually well stocked, and growth is very rapid, averaging better than that of loblolly and slash pines. Much of the bottomland inside the levees has been acquired by lumber companies or other owners who plan to grow timber. Because of annual or frequent floods, little land is used for agriculture and taxes are reasonable. With cheap water transportation, lumber companies go long distances for logs and other woods products, and such forest industries should be permanent. Possibilities for profitable forest management generally appear to be as good as with pine, although floods often hamper logging and prevent or damage reproduction.

3. *Mixed bottomland hardwoods,* occurring on various situations. This type occupies 10.3 million acres in the Mississippi Delta and 12.7 million acres elsewhere in the Lower South. Second-growth mixed stands often contain high-quality red and white oaks, red gum and many other species on better-drained sites but run heavily to poor-quality overcup oak and bitter pecan on low, poorly drained flats. On intermediate locations cypress, red gum, water and red oaks, ash, elms, hackberry, and other hardwoods occur in various mixtures. Many stands have been cut and burned so heavily that they are composed largely of cull trees and poor species and hold little promise of profitable management for some years. Other second-growth stands, however, including some old-field stands, are reasonably well stocked with trees of good quality. On many of the more tractable soils, improved drainage and clearing for agriculture are contemplated. Taxes are generally high and in areas including in drainage districts are often prohibitive to forest management. The forest industries in this type are less stable than in the other two, but profitable forest management appears feasible on extensive areas where suitable timber is present and where soils are not well suited for agriculture.

Diameter Growth

Most second-growth bottomland hardwoods grow rapidly and compare favorably with pines in this respect. This is due, in part at least, to the fact that bottomland hardwoods generally occupy the most fertile of our forest soils. Of great significance also is the ability of most of these hardwoods to regenerate themselves satisfactorily and to respond well to cultural measures.

Various species of hardwoods increase in diameter at different rates. Trees of various size-classes and ages also increase in diameter at different rates. Table 1 summarizes growth measurements by the Forest Survey of 4,000 trees of all species, uniformly scattered over an area of 2½ million acres in the northern half of the Louisiana Delta region.[1] The average 10-year diameter increase is approximately two inches. Individual species, however, vary considerably from this average. Cottonwood, willow, red oaks, and water oaks grow conspicuously faster than the average. Overcup oak, cedar, elm, black gum, bitter pecan, hickory, and hackberry make relatively slow growth. It is notable and encouraging that in general the better species are average or faster growers, whereas the less valuable species are the slower growers.

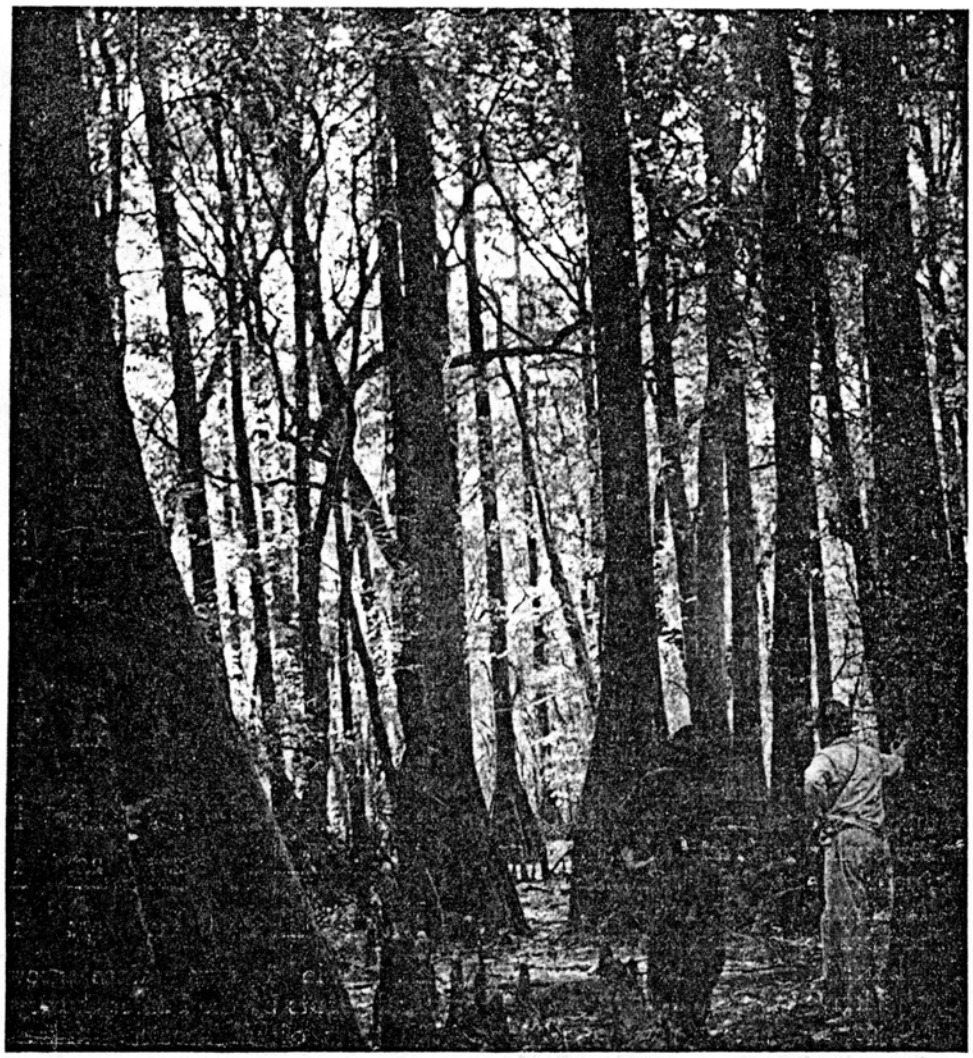
Table 1—Average Diameter Growth in 10 Years in the North Louisiana Delta

Species Group and Forest Condition	Growth in Diameter-Class Group of— 6-12 Inches	14-18 Inches	20-28 Inches	30+ Inches
Red Gum	2.12	2.18	2.02	1.49
Water Oaks	2.57	3.14	2.80	2.09
Red Oaks	3.62	3.05	3.93	1.70
White Oaks	2.35	1.92	1.79	1.80
Overcup Oak	1.52	1.71	1.37	1.35
Ash	1.52	2.03	1.55	1.16
Cottonwood	4.34	3.29	3.59	3.18
Willow	2.84	4.18	3.65	2.85
Elms	1.48	1.59	1.62	2.21
Tupelo	2.13	2.62	2.42	.....
Black Gum	1.44	1.80	1.57	1.98
Cypress	1.71	2.01	2.23	.90
Bitter Pecan	1.45	1.46	1.53	1.70
Hickory	1.68	1.33	1.50	.....
Sweet Pecan	1.92	2.73	2.08	2.25
Hackberry	1.57	1.55	1.47	.....
Pine	2.38	2.80	3.00	.....
Persimmon	1.48	1.23	2.23	.....
Red Maple and Boxelder	1.57	3.12	2.32	3.20
Other Hardwoods	2.48	2.23	2.00	2.27
Weighted Average	1.90	2.15	2.04	1.77
Summary by Forest Conditions:				
Old growth, uncut	1.49	1.45	1.42	1.64
Old growth, partly cut	1.68	1.75	1.91	1.86
Second growth: Sawlog size: Uncut	1.89	2.64	3.00	2.35
Partly cut	1.77	2.79	2.58	2.80
Under sawlog size	2.55	2.37	2.22	1.84
Weighted Average	1.90	2.15	2.04	1.77

The effect of size of the tree upon growth is chiefly a matter of relative position that trees of different sizes occupy in the crown cover. For instance, small trees in the saw-timber size condition often are overtopped, while the larger trees have their tops more or less in the open. The largest trees in second-growth conditions often do not show the best growth because they are mainly damaged and over-mature remnants of the original old growth.

On the basis of measurements made on the Delta Experimental Forest,

[1] Winters, R. K., Putnam, J. A., and Eldredge, I. F. Forest resources of the North-Louisiana Delta. U. S. Dept. Agr. Misc. Pub. 309, 49 pp., illus. 1938.



Pure stand of cypress. Cypress is often replaced after cutting by tupelo, which stands more shade and grows faster. (Photograph by Clement Mesavage, U. S. Forest Service.)

Stoneville, Mississippi, it is believed that dominant trees of saw-log size in well-stocked managed stands would make the following average diameter growth in 10 years: cottonwood, red oaks, and water oaks 3.5-4.0 inches; soft elm, honey locust, and red maple 3.0-3.5 inches; overcup oak, red gum, and green ash 2.5-3.0 inches; and hackberry, cedar or rock elm, and bitter pecan 2.0-2.5 inches.[2] The soil in the forest is a poorly drained heavy clay or "buckshot." On the well-drained sandy or loamy soils commonly occupied by cottonwood and willow along the Mississippi and other large rivers, cottonwood in managed stands would grow considerably more than 0.4 inch in diameter annually.

Current Volume Growth

The volumes of saw-logs and other forest products that can be cut at intervals from a particular forest are directly dependent upon the volume growth per acre. Most bottomland hardwoods have been cut at least once and second-growth stands are generally not only understocked in volume but also include a considerable quantity of low-grade trees. Actual current volume growth, therefore, falls far below the potential productivity or full growing capacity of bottomland hardwood forests. Table 2 gives the volume of growing stock and the net annual growth per acre for average second-growth stands of sawlog size found by the Forest Survey in four regions in the Delta and in four pine-hardwood regions. The volumes for the pine-hardwood regions include both pine and hardwood. The average volume per acre of second-growth bottomland hardwoods of saw-log size is 87 per cent of the corresponding volume of pine-hardwood and the net annual growth is 77 per cent of that for pine-hardwood. Except for the hardwood unit in northeast Louisiana, percentage rates of growth in Delta hardwoods compare very favorably with those for pine-hardwood.

Table 3 shows net annual growth per acre for different forest conditions in bottomland hardwoods and contrasts slow-growing overcup oak-bitter pecan forests with faster-growing mixed hardwoods. The data are from Forest Survey releases covering Delta units.

Net annual growth is the volume added to good trees, plus the merchantable volume newly created by small trees developing into merchantable sizes, minus the losses due to natural causes such as drought, fire, disease, storm, and competition for growing space. These losses are very important because if they were prevented entirely the average net growth of bottomland hardwoods could be increased about 50 per cent over the persent average. This loss is especially heavy in the over-ripe timber of old-growth conditions.

The marked difference between the growth on commercial and non-commercial areas in second-growth timber

Table 2—Growing Stock and Net Annual Growth Per Acre in Representative Bottomland Hardwood and Pine-Hardwood Regions

Region	Growing Stock Board Feet*	Net Annual Growth Board Feet*	Net Annual Growth Per Cent of Growing Stock
Delta Hardwoods			
Southeast Ark.	2,511	159	6.3
Northeast La.	4,445	187	4.2
Southeast La.	2,711	159	5.9
Northwest Miss.	3,155	189	6.0
Average (unweighted)	3,205	174	5.4
Pine-hardwood			
Southwest Ark.	3,757	238	6.3
Northwest La.	3,657	220	6.0
Southwest La.	3,351	213	6.4
Central Miss.	3,980	228	5.7
Average (unweighted)	3,686	225	6.1

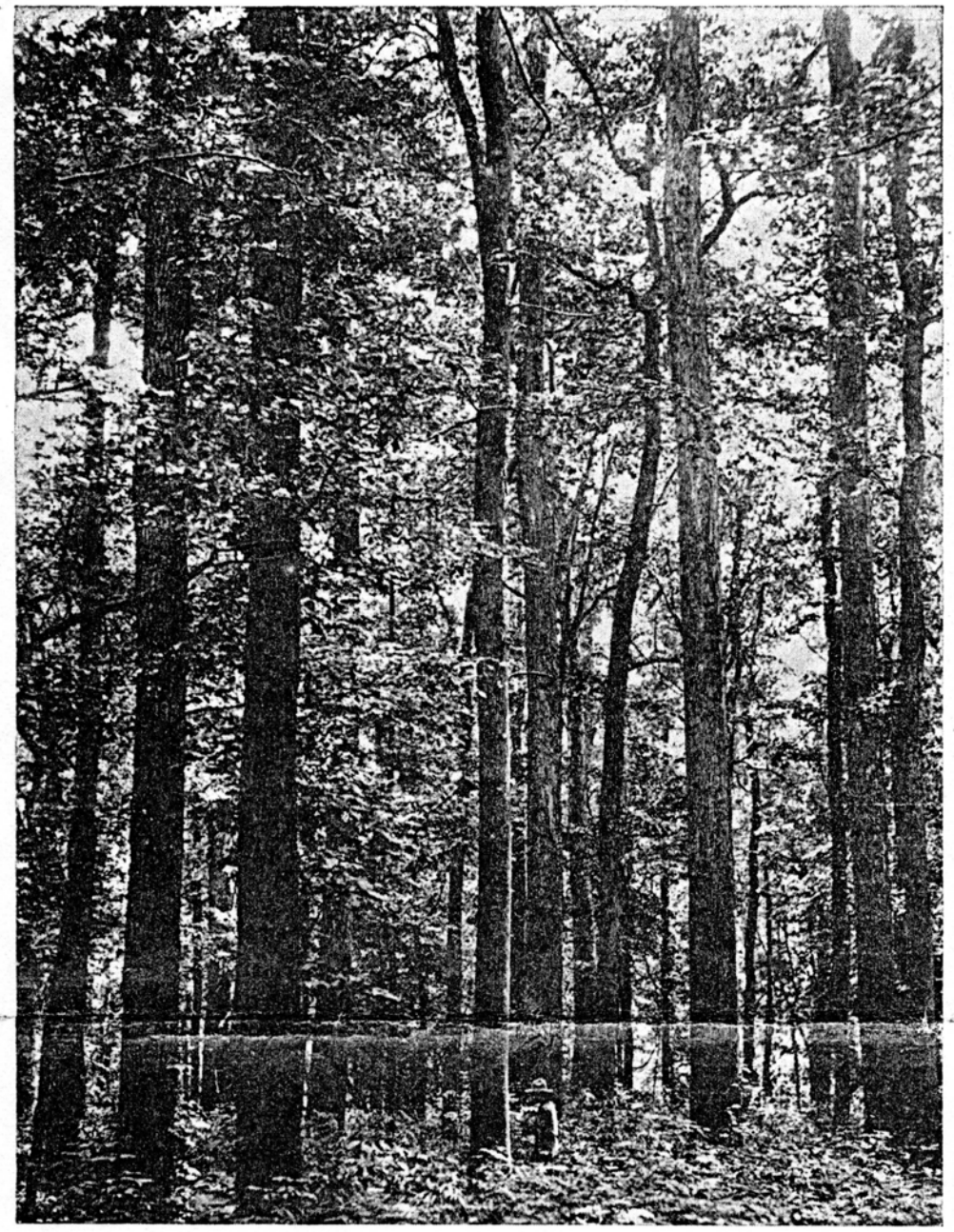
*International ¼" rule, which closely approximates green lumber tally.

Table 3—Net Annual Growth Per Acre in Different Bottomland Hardwood Conditions and Type

Forest Condition	Mixed Hardwood	Overcup-oak-bitter Pecan	All Types		
	Northeast La.	Northeast La.	Northeast La.	Southeast La.	Southeast Ark.
	Board Feet*	Board Feet*	Board Feet*		
Commercial area:†	19	22	20	118	143
Old growth, uncut	5	6	5	95	70
Old growth, partly cut	261	144	257	209	265
Second growth, sawlog size					
Noncommercial area:	52	55	55	53	121
Old growth, uncut	56	32	46	39	60
Old growth, partly cut	169	77	155	143	144
Second growth, sawlog size	67	57	66	53	42
Second growth, under sawlog size	2	—1	2	negl.	negl.
Clear-cut and reproduction					
All conditions	104	47	87	98	100

*International ¼" rule, which closely approximates green lumber tally.
†Areas with 1,000 board feet or more per acre of higher-grade products such as industrial lumber, cooperage stock, or veneer.

[2]Bull, Henry. Diameter growth of southern bottomland hardwoods. Jour. Forestry 43 (5): 326-327. 1945.



Second-growth red gum and cottonwood on batture land. This stand is only 75 years old but contains 45,000 bd. ft. per acre. Water usually stands 6 to 20 feet deep on this area part of each year. (Photograph by U. S. Forest Service.)

is due chiefly to difference in stocking. So long as the timber is thrifty and vigorous and the stand is not so dense as to cause stagnation through excessive competition for growing space, the more timber per acre the more total growth per acre. If cutting is postponed in second-growh stands, the growth will accelerate rapidly as trees below saw-log size develop into merchantable sizes, and trees of merchantable size also increase in volume. The board-feet growth per acre is substantially greater in the second-growth saw-log-size condition than in any other forest condition. The annual growth for various stand conditions in the overcup oak-bitter pecan type, where growth conditions are generally the least favorable, is substantially lower than growth in mixed hardwoods.

In considering the figures on growing stock and volume growth given in Tables 2 and 3, it is important to remember that they are actual woods-run averages under strictly natural or volunteer forest conditions, and not those that might be obtained under more favorable conditions resulting from good management practices. If protected from fire and other damage, and cut conservatively at intervals of from 5 to 10 years in such a way as to gradually remove the slower-growing trees as well as the culls, bottomland hardwoods on average or better sites should yield 400 to 500 board feet per acre per year in perpetuity after normal growing stock is built up. The overcup oak-bitter pecan type should yield about 200 board feet per acre per year.

The preceding section shows that growth rates of bottomland hardwoods compare favorably with those of pine. Can hardwoods also be managed profitably under a simple plan of selective cutting similar to that practiced by many pine operators in the South? Selective cutting is practiced by several large operations in bottomland hardwoods, but actual records of management practices and resulting yields and incomes are not available. A few studies of yields of well-stocked or fully stocked stands of bottomland hardwoods in various parts of the South have been made, however, and results from these will be discussed briefly in order to give an idea of the possible yield under management. Managed stands will, of course, yield more than unmanaged stands because of the utilization of trees that would otherwise die and because of the increase in growth rates of the better trees following good partial cutting. Reasonable stumpage prices have been applied to these yields in order to show possible gross incomes.

Selective cutting in old growth: One study of growth following a selective cutting in an old-growth stand of mixed bottomland hardwoods (mostly red gum and oaks) showed 175 board feet per acre, or 2.6 per cent net annual growth in the first eight years.[3] At a stumpage value of $6 per M this is an annual gross income of $1.05 per acre per year. The original stand contained 12,496 board feet per acre, and 46 per cent of this was removed, although only over-mature, deteriorating, and storm-damaged trees were cut. Ninety per cent of the trees cut were 30 inches or larger in diamater, and several trees per acre of this large size were left along with many smaller ones. The selection of trees in this cutting could have been greatly improved and would have resulted in better growth. Mortality, which averaged 0.8 per cent annually, was considered unusually high because of drought and storm damage. The importance of selective cutting in stands of this kind is shown by the fact that 74 per cent of the volume in trees 28 inches and larger in diameter was in logs of higher quality, whereas in smaller trees only 44 per cent of the volume was in logs of high quality. Selective cutting results in a large yield of high-grade logs from timber ripe for cutting, while the better small trees are left to increase in size and quality.

Selective cutting in second-growth red gum: A study of a fully stocked,

[3]Davis, V. B. Rate of growth in a selectively logged stand in the bottomland hardwoods. U. S. Forest Service, Southern Forest Expt. Sta. Occasional Paper 41. 1935.

80-year-old, second-growth red gum stand indicates the possibilities of selective cutting.[4] A selective cut of 6,000 board feet per acre every 10 years was considered feasible in this stand, which contained 21,300 board feet per acre. This cut would remove less than 30 per cent of the total volume, and would take most of the trees 24 inches and larger in diameter together with defective and other undesirable trees which should be removed for cultural purposes. Enough trees of various sizes were present in the stand to assure at least five cuts of 6,000 board feet per acre each, if fire protection and good management were practiced. Reproduction coming in during this period should supply enough new trees to sustain this cut indefinitely. With a stumpage price of $8 per M board feet for the large, high-quality timber cut in such a program, the periodic income would be $48, or an average of $4.80 per acre per year.

Yield of second-growth red gum: Second-growth red gum in fully stocked unmanaged stands in Southern bottomlands has been found to yield 20,460 board feet (Scribner) per acre at 80 years on medium or average sites, and 35,940 board feet per acre at 80 years on the best sites.[5] These yields indicate average annual growth per acre of 256 and 449 board feet, respectively, counting only trees 13 inches and larger in diameter. At $6 per M board feet for stumpage for the entire stand, these rates of growth represent average gross annual income of $1.54 and $2.69 per acre. Average net annual growth to 45 merchantable cubic feet (inside bark to a four-inch top) on medium sites between ages of 20 and 80 years. It is difficult to compare these growth and yield figures with those for similar "normal" stands of Southern pines because of differences in products and in diameter and utilization limits. However, growth and yield in cubic volume to four inches is approximately the same for loblolly pine and red gum when each is on an average site, whereas the usual saw-timber yields of red gum are definitely lower than those of loblolly pine because of poorer utilization.

Second-growth ash originating from sprouts. One of the most valuable bottomland species, ash reproduces well from sprouts. Fire is especially damaging to young ash. (Photograph by Clement Mesavage, U. S. Forest Service.)

Yield of second-growth cottonwood: Of all bottomland hardwoods, cottonwood grows the fastest and yields the greatest volumes per acre per year. According to measurements made in average, natural, fully stocked, even-aged stands of cottonwood in the Mississippi Valley, a total yield of approximately 42 cords per acre can be obtained at the age of 16 years.[6] This is an average annual yield per acre of 2.6 cords. At a value of $1 per cord this represents a gross annual income of $2.60 per acre. The greatest average annual production in board feet was found to occur at age 35 with a stand per acre of 29,400 board feet (Scribner), representing an average annual yield per acre of 840 board feet. At a value of $6 per M board feet for stumpage this represents an annual gross income of $5.04 per acre.

Yield of second-growth tupelo: Tupelo is ramarkably fast-growing when one considers the poor sites on which it occurs. According to a preliminary study,[7] "the yield of tupelo and of the four chief species of Southern pine show that tupelo, although badly outstripped in early growth by all of the pine except longleaf, in later years exceeds or practically equals all except loblolly." Average fully stocked 50-year-old stands (the oldest studied) were found to contain 62.6 cords per acre, indicating an average growth of 1¼ cords per year up to this age. The rate of growth between 20 and 50 years in fully stocked stands, however, was at the rate of 1-2/3 cords per acre per year. At $1 per cord this represents an average gross income of $1.67 per acre per year. Board-feet yields were not measured.

Conclusion

Although the growth and yield figures cited in this paper are sketchy and far from complete, they indicate that management in bottomland hardwoods has a promising future. The data presented are based on stands grown without management. If management in bottomland hardwoods results in greatly increasing yields and incomes, and in reducing costs, as it has in pine, the future of our bottomland hardwoods and of the bottomland hardwood industry in the South is secure. Detailed facts and much of the "know-how" of management remain to be determined.

[4]Putnam, J. A. An interpretation of the grade and volume figures of semi-permanent yield plots in second-growth red gum. Unpublished report, Southern Forest Expt. Sta. 1932.

[5]Winters, R. K., and Osborne, J. G. Growth and yield of second-growth red gum in fully stocked stands on alluvial lands in the South. U. S. Forest Service, Southern Forest Expt. Sta. Occasional Paper 54. 1935.

Overcup oak and bitter pecan mixed with hackberry, green ash, and bottomland red oak on a very low, poor site. This stand was logged eight years ago but only the best trees were cut. Growth rate and quality are relatively poor. (Photograph by U. S. Forest Service.)

[6]Williamson, A. W. Cottonwood in the Mississippi Valley. U. S. Dept. Agr. Bul. 24. 1913.

[7]Hadley, E. W. A preliminary study of the growth and yield of second-growth tupelo gum in the Atchafalaya basin of southern Louisiana. Lumber Trade Jour. 90 (10): 17-18, illus. 1926.

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