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Wetland Silvicultural Systems

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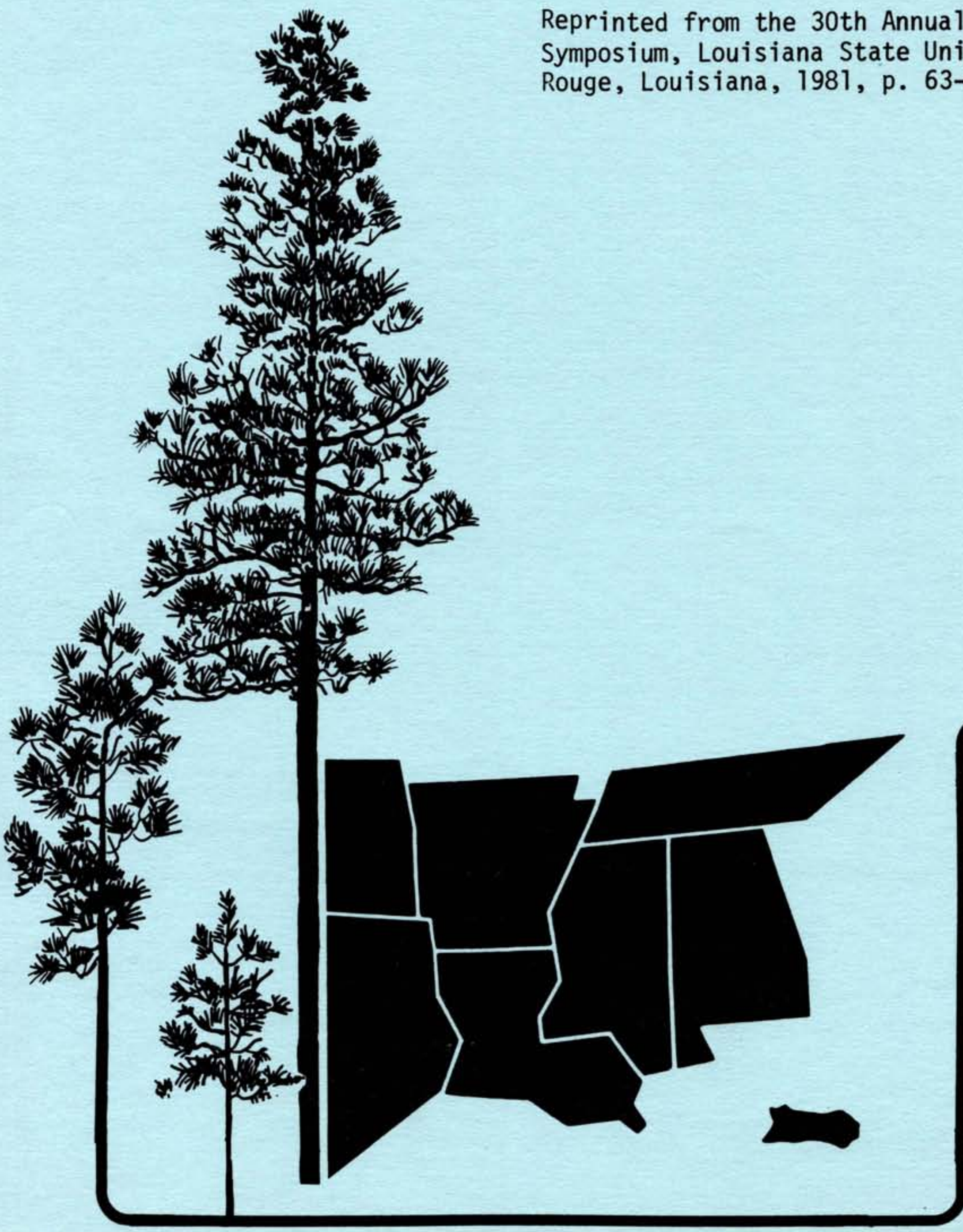

Southern Forest Experiment Station

Errata for

WETLAND SILVICULTURAL SYSTEMS

by Robert L. Johnson

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Page 66, table 2, 6th species listed under "Do not favor on either site" should be "Cherrybark oak."

Page 67, 2nd paragraph, 3rd & 4th sentences, should read: "On a good site, crop trees should average about 5 to 6 feet of height growth and 0.6 to 0.8 inch of diameter growth annually for the first 15 years. Height growth then slows, but diameter growth may continue at nearly the same rate."

Page 73, 1st paragraph, 5th line, last word: Should be "epicormic."

Page 77, Literature Cited: This citation (cited on page 71) was omitted, "JOHNSON, R. L., and J. S. McKNIGHT. 1969. Benefits from thinning black willow. USDA For. Serv. Res. Note SO-89, 6 p."

WETLAND SILVICULTURAL SYSTEMS

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Many forests of the lowlands and swamps of the Midsouth are occasionally to frequently inundated. Such forests are common along the Mississippi, White, Red, Mobile, Tombigbee, and Alabama Rivers, and in coastal swamps such as the Atchafalaya Basin.

Site-Species Relationships

Lowland forests are comprised of many different species growing in a variety of soils. Species groupings (not conventional SAF types) were described by Putnam et al. (1960) and later by Hodges and Switzer (1979). Both essentially recognize eight species groups and associated physiographic positions in major stream valleys as listed:

Species group	Physiographic site
1. Cottonwood	New land
2. Elm--sycamore--pecan--sugarberry	High front or ridge
3. Sweetgum--water oaks	First bottom ridge
4. Red oaks--white oaks--mixed species	Second bottom ridge
5. Black willow	New land
6. Overcup oak--water hickory	Slough or low flat
7. Elm--ash--sugarberry	Flat
8. Cypress--water tupelo	Swamp

Frequently, but not always, species groupings 1 through 4 are found on relatively well-drained, medium-textured soils, whereas groupings 5 through 8 are often indicative of poorly-drained, fine-textured soils.

Soil series is one of the most important variables related to species occurrence and development. Broadfoot (1976) describes 40 Midsouth soils that support hardwoods and lists the species found on each. He also offers a site index range for each species. I have used the upper end of his site index range in computing the values in table 1, which are based on 21 soils common to lowland areas. Species listed are only the ones of commercial importance or that frequently occur in natural stands; many other commercial species occasionally occur.

Two of the more common soils found in lowlands of the Midsouth are Commerce silt loam and Sharkey clay. Commerce averages 20 percent sand, 43 percent silt, and 37 percent clay; Sharkey is 11 percent sand, 24 percent silt, and 65 percent clay (Broadfoot 1976). Average pH is 6.9 for Commerce and 5.9 for Sharkey. Permanent wilting point is 19 percent moisture by volume for Commerce and 30 percent for Sharkey.

Commerce occurs on high, well-drained fronts adjacent to water courses. It will flood periodically but is usually one of the last lowland soils to be inundated and one of the first to dry. Conversely, Sharkey is found on low, poorly-drained, slackwater areas subject to almost annual flooding for 4 or 5 months in the winter and spring.

Many of the same commercial species are found on these very different soils (table 2), but only four occur frequently and should be favored in management on both sites (Broadfoot 1976).

As a general rule, once established, trees grow better on Commerce (table 2). Based on plantations of the same age on both sites, cottonwood, sweetgum, and sycamore may produce nearly twice the volume during the first 10 to 15 years on Commerce. High pH limits some, but not all oaks. Cherrybark and Nuttall oaks usually cannot adjust to the high pH in Commerce and will not develop there even if other trees and herbaceous plants are controlled, whereas plantings of Shumard oak have survived and grown well.

Depth to the permanent water table and timing, frequency, and duration of flooding are other important variables to the establishment, survival, and development of hardwoods. Some species, such as cypress and tupelo, can tolerate extended flooding, whereas others, such as cherrybark oak, cannot. Well- and poorly-drained sites are usually reflected by the species represented.

Man's attempts at drainage and his harvesting practices complicate species occurrence and site evaluation. He tends to harvest certain species and sizes of trees. Sometimes his efforts improve the forest, but all too often he reduces productivity by cutting trees that would enhance stand development. The end result has often been a lowland forest cleared for agriculture.

Stand Development

Even-aged Species Groups

Some of the species associations already mentioned--cottonwood, black willow, overcup oak--water hickory, and cypress--tupelo--naturally grow in even-aged stands. These stands develop as follows:

Table 1. Species occurrence and associated site indices based on 21 common lowland soils (Broadfoot 1976).

Species	Frequent occurrence	Maximum site index[1/] Average	Maximum site index[1/] Range
	Number of soils[2/]	Feet	Feet
Sweetgum	19	108	95-120
Elms	16	84	70- 90
Green ash	13	91	80-100
Water oak	13	102	95-110
Willow oak	13	104	90-110
Cherrybark oak	10	110	90-120
Sugarberry	10	92	85-100
Hickories	8	91	75- 95
Nuttall oak	7	103	95-110
Water hickory	5	83	75- 90
Cottonwood	5	118	105-125
Overcup oak	4	88	85- 95
Honeylocust	3	83	75- 90
Pecan	3	107	90-115
Sycamore	3	125	120-130
Black tupelo	2	90	90
Swamp tupelo	1	90	90
Red maple	1	90	90
River birch	1	90	90

1/ Cottonwood values are based on 30 years; other species on 50 years.

2/ Out of 21 described by Broadfoot.

Table 2. Species to favor or not favor in management on Sharkey clay and Commerce silt loam with associated site indices (Broadfoot 1976).

	Species	Commerce	Sharkey
		------- Feet 1/	-------
Favor on both sites	Cottonwood	125 2/	105
	Green ash	95	95 2/
	Sweetgum	120 2/	100 2/
Favor on Sharkey	Nuttall oak	110	100 2/
	Water oak	105	100 2/
	Willow oak	105	105 2/
Favor on Commerce	Baldcypress	110	95
	Black willow	90	90
	Pecan	115 2/	90
	Red & silver maples	90	85
	Sugarberry	100 2/	85 2/
Do not favor on either site	American elm	95 2/	85 2/
	Black locust	-- 4/	-- 4/
	Black tupelo	-- 3/	80
	Black walnut	95	-- 3/
	Boxelder	-- 2/,4/	-- 4/
	Cherrybark	110	95
	Hickories	80	80
	Honeylocust	95	80
	Laurel oak	-- 4/	85
	Overcup oak	-- 3/	85 2/
	Persimmon	85	85
	Sassafras	90	90
	Shumard oak	110	-- 3/
	Swamp chestnut oak	95	90
	Water hickory	-- 3/	85 2/
	Water tupelo	80	80
	Yellow-poplar	100	-- 3/

1/ In 30 years for cottonwood; 50 years for other species.

2/ Occurs frequently; others occur occasionally.

3/ Normally does not occur naturally.

4/ Site index unknown.

Cottonwood.--From a recent survey of natural, unthinned cottonwood stands (Johnson and Burkhardt 1976), stocking in the 22-inch diameter stand as estimated by Putnam et al. (1960) (table 3) is fairly accurate. In the 1976 survey, one 32-year-old stand had 45 free-to-grow trees that averaged 22.9 inches dbh. There were another 15 trees/acre in a subordinate position. Total sawtimber volume was 22,995 board feet/acre (Doyle) for this stand of about 30 percent more volume than Putnam observed in his study, even when he included volumes from thinnings. It may be that Putnam estimated about two logs/tree, while large trees in the sampled stand averaged 138 feet tall and 128 square feet of basal area.

From the seedling stage, natural cottonwood stands grow rapidly and natural thinning begins almost immediately. At each stage of development, the better trees are above their neighbors. On a good site, crop trees should average about 5 to 6 feet of height growth and 0.6 to 0.8 inch of diameter growth may continue at nearly the same rate. Cottonwood will continue growing well for at least 75 years, but most stands are harvested by age 50. Mean annual increment (MAI) peaks at about 250 cubic feet/acre between ages 15 and 20 in unthinned cottonwood stands (Williamson 1913).

Black willow.--Black willow normally occurs on fine-textured soil. Its early growth is second only to cottonwood. After 20 years, total height of dominant black willows is nearly that of cottonwood. Eventually, cottonwood will grow to be 30 or more feet taller than black willow.

MAI probably peaks in about 20 years in an unthinned stand at 200 cubic feet/acre. Natural mortality is high in black willow and trees seldom remain vigorous beyond age 35. Yield figures presented in table 3 would probably be low for black willow if thinnings are as frequent as recommended.

Overcup oak--water hickory.--Information presented in table 3 is probably applicable to this type. It is one of the slowest growing lowland types as indicated by Broadfoot's (1976) site index figures in table 1.

Cypress--water tupelo.--Putnam et al. (1960) presents a separate set of figures for this type (not shown) because of the extremely high stocking levels. Basal areas of 250 to 350 square feet/acre are not uncommon. Correspondingly, volumes of 6,000+ cubic feet/acre exist (McGarity 1977). Growth in unmanaged stands may average 75 to 100 cubic feet annually to 70 years.

Williston et al. (1980) in a recent publication reported that after 100 years cypress crop trees were 21.1 inches dbh and 119 feet tall with 81 feet of limb-free bole. Basal area in unthinned stands was 303 square feet/acre; number of trees was 190. There were 70,068 board feet/acre (Int. ¼).

Table 3. Hypothetical stocking and estimated yields for even-aged hardwood stand (Putnam et al. 1960)[1].

Average dbh	Average trees			Cumulative yields		
	Total	Leave	Cut	Sawtimber	Poletimber	Topwood
Inches	---------- No. ----------			Bd. ft. (Doyle)	Cords	Cords
2	2,120	475	1,645	--	--	--
6	475	202	273	--	16.1	--
10	202	112	90	--	28.8	--
14	112	71	41	5,196	18.8	6.8
18	71	49	22	10,623	18.8	12.7
22	49	36	13	16,404	18.8	18.2

1/ Condensed from table 7, P. 80-81.

Uneven-aged Species Groups

The other four species groups mentioned here--elm--sycamore--pecan--sugarberry, sweetgum--water oaks, red oaks--white oaks--mixed species, and elm--ash--sugarberry--occur later in the succession on sites subject to less severe flooding. They tend to be more diverse in species, and due largely to past cutting practices are either uneven-aged or even-aged in small groups.

Putnam et al. (1960) offers guidelines for stocking and yields of uneven-aged stands (table 4). Note, however, that at the beginning of a cutting cycle, base volume is 5,287 board feet/acre (Doyle). Few uneven-aged lowland hardwood forests have that much volume. Thus, the first task is building the stand. Early treatments might best be directed toward removing cull and low vigor trees and for providing growing spaces for reproduction and residuals. One guide for diameter distribution in a many-aged stand is the "q" factor. This is simply the quotient between numbers of trees in successive diameter classes. Quotients ranging between 1.3 and 2.0 (for 2-inch dbh classes) have all been recommended (Marquis 1975).

Understocked, uneven-aged stands are common in the lowlands and provide a difficult challenge to the forest manager. Such stands usually are a hodge-podge of species and sizes in almost an infinite number of combinations. In the following simplified example, variables to consider in handling these conditions are discussed.

Assuming a stand has 49 trees averaging 10 inches dbh, according to Putnam's guide for even-aged stands (table 3), full stocking will not be reached until trees average 22 inches dbh. Should the stand be harvested and begun again or should it be carried to full stocking? If we decide to continue, it will take about 35 years to reach our diameter goal--if the trees average about 0.35 inch annual diameter growth. This is an average growth rate for free-to-grow trees of the species we are likely to encounter. At 22 inches dbh, Putnam estimates a total volume of 14,699 board feet/acre (Doyle) and 6½ cords in the tops. There would have been no thinnings in this stand. Conversely, if we decide to start over, our immediate harvest from the 49 trees would be about 8 cords, and we should produce another 29 cords (thinnings plus residual) in 35 years assuming a fully stocked new stand where crop trees are back to 10 inches dbh. What would we rather produce--sawtimber or pulpwood?

This kind of reasoning could be carried beyond 35 years, but it would only complicate an already hazy picture. For example, our growth projections for the 49 trees may be considerably less than normal for the species and site. Trees that have only partial crowns or that have been stagnated may never recover and reach the diameter growth of trees that have always been in a dominant or codominant position. Sawlog merchantability may also be well below normal. Flat-topped or forked trees with only one merchantable log will likely not increase merchantable sawtimber height. There are grade and species considerations.

Table 4. Hypothetical stocking and diameter distribution for well-managed uneven-aged southern hardwoods on average or better sites (Putnam et al. 1960)[1].

Dbh	After cutting; beginning of new cycle			End of cycle; ready for cutting		
	Trees	Basal area	Volume	Trees	Basal area	Volume
Inches	No.	Sq. ft.	Cords	No.	Sq. ft.	Cords
2	26.0	0.58	--	48.0	1.06	--
4	17.2	1.50	0.2	30.0	2.61	0.4
6	10.5	2.07	.4	15.8	3.10	.6
8	8.2	2.86	.6	12.2	4.27	.9
10	7.0	3.82	.8	9.0	4.92	1.2
12	6.5	5.10	1.3	6.6	5.18	1.3
Total	75.4	15.93	3.3	121.6	21.14	4.4
			Bd. ft.			Bd. ft.
14	6.0	6.41	312	6.0	6.41	312
16	5.3	7.40	503	5.7	7.96	541
18	4.3	7.60	632	5.6	9.90	823
20	3.2	6.98	688	5.3	11.56	1,139
22	2.3	6.07	678	4.3	11.35	1,268
24	1.6	5.03	524	3.2	10.06	1,248
26	1.1	4.06	561	2.3	8.48	1,170
28	.8	3.42	524	1.6	6.84	1,048
30	.45	2.21	369	1.1	5.40	902
32	.27	1.51	272	.8	4.47	804
34	.11	.69	139	.45	2.83	547
36	.04	.28	57	.27	1.91	392
38	.02	.16	28	.11	.95	191
40				.04	.35	76
42				.02	.19	37
Total	25.49	51.82	5,287	36.80[2]	88.66	10,498
All trees	100.89	67.75	--	158.40	109.80	--

[1] Condensed from table 6, p. 78.

[2] Total taken from table 6, p. 78.

Potential grade 3 and grade 2 logs are 50 percent and 75 percent as valuable as grade 1 logs (Forest Products Laboratory 1953). Weak, widely spaced trees will branch along the bole and there will be degrade. If the 49 trees are sugarberry instead of green ash, they are presently only about 60 percent to 70 percent as valuable per cubic foot.

Thinning

Although the trend is changing, there have been few commercial thinnings in pulpwood-size stands and practically no precommercial thinnings. Historically, thinnings have started when trees reach sawtimber size, about 14 inches dbh.

Putnam et al. (1960) provides hypothetical stocking and yield guidelines for even-aged stands beginning when trees average only 2 inches dbh (table 3). Volumes removed during thinnings are not shown separately but are included in the cumulative yields. They also give diameter growth rates by species for trees free-to-grow in unmanaged stands. With this information, we can estimate stand age at each thinning within the various species groups and total age to 22 inches dbh (table 5). Note that our estimates show a cottonwood stand reaching 22 inches dbh in one-third the time required for a stand of overcup oak--water hickory. Ages and yields are likely conservative for well-managed stands.

Findings thus far in both natural and planted stands provide some guidelines to thinning. Larger trees with the best crowns should be favored and thinning should begin early. For good diameter growth, most species require a minimum live crown to total height ratio of 40 percent. Trees with less crown are usually in a subordinate position, so thinning is from below. Advantages to frequent, light thinnings as compared to infrequent, heavy thinnings are fuller site utilization and less chance of epicormic branching on the boles of crop trees. Epicormic branches are particularly prone to develop on sweetgum of all sizes. An obvious disadvantage to frequent thinnings is greater chance for logging damage to crop trees.

Proper thinning will allow for utilization of trees that would otherwise die and will distribute nearly the same total growth among fewer, selected crop trees. One guide for thinning cottonwood is to create space in feet between crowns no greater than half the diameter in inches (Obye 1958). A rule suggested for black willow is to provide a tree spacing in feet that is 1.75 times the average tree diameter in inches (Johnson and McKnight 1969). After thinning, basal areas/acre of 70 for sweetgum (Johnson 1968) and 100 for cypress (Williston et al. 1980) have been recommended.

Regeneration Systems

Types

Five systems are recognized for lowland hardwood forests. A brief discussion of each follows:

Table 5. Estimated stand age by dbh class, basal area, and species group for leave trees.

Average dbh	Basal area	Species: Cotton-wood	Black willow	Overcup oak--water hickory	Cypress--water tupelo
Inches	Sq.ft./acre	------ Years ------			
2	14	3	4	14	10
6	47	9	12	30	23
10	71	15	20	48	39
14	85	21	27	66	53
18	95	25	34	84	66
22	102	32	41	98	79

<u>Single-tree selection</u>.--Over the years, there have been many who have expressed problems related to this system. Stubbs (1964) summarized most complaints after his trials in coastal plain bottomland hardwoods around Charleston, S.C. He recognized five weaknesses: (1) Damage to reserve sawtimber trees during logging is high, (2) epicomic branches on the boles of reserve trees are numerous and degrading, (3) only 2.3 percent increment was measured on residual 75-year-old growing stock trees, (4) damage to sapling size reproduction was high and there was an increasing number of more tolerant, less valuable tree species, and (5) management costs are high. Conversely, McKnight (1967) considers the system to have the following advantages: (1) Allows maximum flexibility for natural site-species variation, (2) permits more control over reproduction from natural sources, (3) favors growing stock wherever it may occur, (4) allows adjustment to changing markets by permitting frequent harvests of high-value trees, and (5) allows for harvest of the forest while also providing maximum range of stand conditions for recreation, game, and site protection.

<u>Group selection</u>.--This is a system of small or patch clearcuts. It has some of the advantages of clearcutting and disadvantages of single-tree selection.

<u>Seed tree</u>.--This system is applicable only to regeneration of light-seeded species. Although it has worked well with yellow-poplar on some sites, the seed tree system is generally not recommended for species and sites of the lowlands. Clearcutting will usually give the same results, but not always.

<u>Shelterwood</u>.--This should normally be used in dense old-growth stands where there is no advanced reproduction. In time it will favor establishment of new trees but not necessarily of the same species that are in the overstory. Until the overstory has been completely removed, a shelterwood has several of the disadvantages of single-tree selection.

<u>Clearcut</u>.--The main advantage here is ample sunlight that favors growth and development of moderate to intolerant species which are usually more desirable commercially. The system can fail if there is not advanced reproduction, stump and/or root sprouting from cut trees, and/or a crop of new seedlings. It may also require the removal of good growing stock trees and is not aesthetically pleasing to some.

<u>Even-aged Stands</u>

Groups that occur naturally in even-aged stands are either pioneers or are particularly suited for the environment in which they grow. In general, regardless of the regeneration system used, stands of pioneer species are followed by other species whereas stands of sub-climax species reproduce to the same. These trends are generally indicated in table 6 with further explanations as follows:

<u>Cottonwood and black willow</u>.--Neither species will reproduce naturally. Site preparation combined with clearcutting has sometimes

Table 6. Expected regeneration following harvest cutting systems in different species groups (McKnight and Johnson 1980)[1].

Species groups	Silvicultural systems	Species usually favored
Cottonwood	Seed tree with site preparation	Cottonwood
	Clearcut	Sycamore, pecan, ash, boxelder
Black willow	Seed tree with site preparation	Black willow
	Clearcut	Sugarberry, green ash, cypress, American elm, overcup oak, water hickory, Nuttall oak, privet
Cypress--water tupelo	Group selection	Cypress, tupelo, and sometimes green ash, overcup oak, water hickory, sweetbay
	Clearcut	Cypress, tupelo, and sometimes green ash, overcup oak, water hickory, or elm, maple, buttonbush, sweetbay
Elm--sycamore--pecan--sugarberry	Group selection	Mixed hardwoods--sweetgum, water oaks, sycamore, pecan, sugarberry, green ash
	Clearcut	Same as above
Sweetgum--water oaks	Group selection	Sweetgum, water oaks, green ash
	Clearcut	Heavy to sweetgum, but water oaks and green ash also
	Shelterwood	Water oaks, sweetgum, green ash
Overcup oak--water hickory	Group selection	Overcup oak, water hickory
	Shelterwood	Overcup oak, water hickory, Nuttall oak, green ash
Elm--ash--sugarberry	Clearcut	Elm, ash, sugarberry, Nuttall and willow oak, swamp dogwood, deciduous holly
	Group selection	Elm, ash, sugarberry, Nuttall and willow oaks
Red oaks--white oaks--mixed species	Shelterwood	Red oaks, white oaks, water oaks, hickory, ash, American hornbeam, eastern hophornbeam, sweetgum
	Group selection	Same as above

[1] Condensed from table 3, p. 37.

proven successful for regenerating cottonwood (Johnson 1965) and would likely work for willow, but surface soil moisture of the prepared seedbed is a critical factor.

Stands of both species allow filtered sunlight to reach the forest floor and thus permit invasion by other species. Green ash, pecan, sycamore, sugarberry, and sweetgum establish under cottonwood and will develop under any harvest system that provides ample sunlight. Single-tree selection will favor the more tolerant sugarberry and boxelder. When boxelder dominates the midstory, it should be brought back to ground level after harvest so that better species can compete. Ground disturbance will favor boxelder as well as more desirable light-seeded species such as sycamore.

Black willow stands are usually followed by sugarberry or green ash that become established in the understory; periodic overflow and sedimentation favor the establishment of both species. However, harvest without advanced reproduction is risky.

<u>Overcup oak--water hickory</u>.--Water is usually a critical factor in regenerating this group. Whatever regeneration system is selected, reproduction is likely to favor overcup oak and water hickory unless drainage is improved. Good seedling stands of overcup oak regularly establish in the understory--unless there is very dense shade. A light shelterwood will keep established seedlings alive, but full release is necessary to keep them growing well. Seedlings of most other species cannot tolerate the water associated with the sites where this species group commonly occurs. During dry cycles, green ash, Nuttall oak, and sugarberry are common invaders but are not likely to persist. Water hickory will reproduce by seed but is not common in the understory. Most water hickory reproduction will be as sprouts from the stumps of cut trees. Although the system employed is usually not critical to the species regenerated, openings of 2 acres or larger result in better reproduction growth than smaller openings.

<u>Cypress--water tupelo</u>.--Some cypress--tupelo reproduction usually follows any regeneration system since other species cannot tolerate the water. A danger with this group, however, is the possibility of no reproduction of commercial species after harvest. Advanced reproduction is usually sparse and new seedlings will not establish in standing water. A dry cycle which may occur only once in 30 to 50 years appears necessary for widespread regeneration and usually for harvest. Seedlings can start in July or August from seeds up to 30 months old. New seedlings are killed when covered with water during the growing season. The larger seedlings become, the longer they can tolerate complete submergence during the growing season. Once trees are tall enough to have a portion of their tops above the water, they will survive and develop. Stumps from cypress 40 to 60 years old and 10 to 14 inches dbh may sprout if cut in fall or winter (Williston et al. 1980), but such sprouting may be undependable.

Sprouts of water tupelo are of questionable value in regeneration. Work in the Southeast has reported good development from sprouts (Hook et al. 1967), but results from a study in the Atchafalaya Basin have not been encouraging.[1/] Stumps in the latter test produced sprouts, but they died within 6 years. Flooding depth and duration at harvest time may be the key difference.

Uneven-aged Stands

Uneven-aged species groups occur later in the succession and are characterized by a wider diversity of species. Therefore, the opportunities to change species composition by stand manipulation is greater provided substantial overstory still exists. There are still fairly narrow bounds, however. The new stand will almost always be a combination of species that are in the overstory and those already established in the understory, unless seeds are brought in from an overflow of a nearby water source. Advanced reproduction (understory trees 2.0+ feet tall) is usually more important than seeds or sprouts from overstory species because the understory reflects a successional adjustment.

The forester's opportunities for regeneration are to harvest so as to favor less rather than more tolerant species. This means openings of 2 or more acres within 150 feet of light-seeded seed trees and a seedbed relatively clear of grass and herbaceous plants. Although intolerant species can begin in openings as small as 1/20th acre, they cannot long persist without additional sunlight. Neither will species long survive on unsuitable sites. They will eventually be overtopped by more site-suitable species.

Selection of a regeneration system in the uneven-aged stands referred to in this paper depends on how discriminating the manager is in terms of species. It also depends on whether he favors storage of large trees or fast development of reproduction. If more tolerant species and slower reproduction growth are acceptable, the single-tree selection system is workable, but it requires considerable expertise by the forest manager.

Group selection, seed tree, and clearcut will usually give similar results. In deteriorated stands, all may have to be combined with site preparation. A method in current use by some is to mechanically shear all uncut trees at or near ground level. Sprouts are adequate to make the system generally successful even when new seedlings are sparse.

[1/] Kennedy, Harvey E., Jr. Coppice regeneration in water tupelo--does it work? (Manuscript in preparation by U.S. Dep. Agric. For. Serv., South. For. Exp. Stn., New Orleans, La.)

Since most uneven-aged stands are really several stands of varying size and species, guidelines given in table 6 can be used for general predictions. However, simple guidelines that accurately predict regeneration over a broad range of sites, stand conditions, and treatments have yet to be developed.

Refinements

Silviculture in lowland hardwood forests will become more intensive; economics will provide the incentive. There will be several degrees of intensity depending on site productivity and treatment opportunities. In some stands we will do nothing, but the decision should be based on knowledge and not "pot luck."

Research has a long way to go in providing knowledge needed by the practicing forester to make decisions in the field. Conversely, many practicing foresters are not using research information already available.

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DISCUSSION

Question: Steve Faulkner

In regard to the baldcypress coppice regeneration that dies after six to eight years, what causes this death?

Dr. Johnson:

The only thing we can attribute it to is the duration of flooding and the depth of the water. Apparently in the Atchafalaya Basin, coppice has not been a very successful method of reproduction. On the other side of it, in the southeast apparently this does not happen with the same species where water levels may not be as high and the duration of flooding may not be as long. So that may be one of the keys.

Question: Jack Moran

What kind of competition control was used in the green ash plantation you discussed, if any?

Dr. Johnson:

In all plantations we establish in Stoneville to date, we do intensive site preparation, then we plant the trees and disc. The treatment is very expensive for the plantation I showed, perhaps $250 per acre.

Question: Anonymous

We are involved a lot with small landowners. Could you give us any information on crop returns? In other words, what could a small landowner afford to do at this point in time in regards to the extent of his silvicultural practices?

Dr. Johnson:

I don't see how a landowner could afford to go into this intensive site preparation where we actually site prepare, plant and cultivate. Direct seeding is a very inexpensive treatment, and there is definite promise in that. I can't give you any exact dollar figures on what a man can invest.