SOUTHERN FOREST EXPERIMENT STATION

1973

U.S. FOREST SERVICE RESEARCH NOTE

SO-168

Forest Service, U. S. Dept. of Agriculture

T-10210 FEDERAL BLDG. 701 LOYOLA AVENUE NEW ORLEANS, LA. 70113

RAISED WATER TABLES AFFECT SOUTHERN HARDWOOD GROWTH

W. M. Broadfoot[1]

SOUTHERN FOREST EXPERIMENT STATION

In natural stands near Demopolis Lock and Dam Reservoir in Alabama, the average growth in tree radius increased about 50 percent in the 5 years after the water table was raised from an indefinite depth to within reach of the tree roots. In natural stands near the Jim Woodruff Reservoir in Florida, radial growth of trees also increased markedly after the water table was raised, but only when no sediment was deposited around the trees.

Additional keywords: Tree growth, sedimentation, water impoundment.

Water that is impounded by the many dams in the South partially saturates tree-root zones nearby. The effects of these raised water tables on established forest trees and seedlings have not been reported. Yet such information is needed to fully assess the desirability of building some dams.

This paper reports the influences of raised water tables on mature hardwoods of various species that normally grow along water courses.

METHODS AND MATERIALS

Effects of raised water tables on mature trees were observed around two reservoirs of nearly constant level—the Demopolis Lock and Dam, Demopolis, Alabama, and the Jim Woodruff Reservoir near Marianna, Florida. Hardwoods adjacent to the reservoirs were selected for measurement of radial growth 5 years after water impoundment was completed.

Two increment cores were taken at right angles to each other from representative dominant or codominant trees. Average radial growth was recorded for two 5-year periods before impoundment and for the 5-year period after the water table had been raised. At each location where trees were observed, depth to capillary moisture and depth to water table were measured in auger holes. Moisture levels were measured late in the season when the soil was dry.

At the Demopolis Lock and Dam, observations were made in one general soil area and water table condition near the confluence of the Tombigbee and Black Warrior Rivers. Average values from each of several hardwood species

[1] W. M. Broadfoot, now retired, was Principal Soil Scientist at the Southern Hardwoods Laboratory. The Laboratory is maintained at Stoneville, Miss., by the Southern Forest Experiment Station, USDA Forest Service, in cooperation with the Mississippi Agricultural and Forestry Experiment Station and the Southern Hardwood Forest Research Group.

were obtained, even though the number of trees representing some species was small. Newly established trees were tallied around the edges of the water, where the timber had been cut and the soil was saturated by the raised water table.

At several spots along both sides of the Jim Woodruff Reservoir trees were measured and soil and water conditions were described. No statistical analysis was made.

RESULTS AND DISCUSSION

Demopolis

Demopolis Lock and Dam was filled after the 1955 growing season. A drought in 1952 through 1956 made special handling of growth data necessary. Since rainfall was several inches below normal in each of these growing seasons, 2 dry years were separated from each of the 5-year periods before (1953, 1954) and after (1955, 1956) water impoundment (table 1).

Growth of all species except white oak increased considerably when additional moisture was made available by raising the water table. In the area where trees were measured, the water table averaged 46 inches from the soil surface, and capillary moisture extended to an average of 15 inches below the ground surface. If it is assumed that the majority of tree roots occupy the surface 4 feet of this loamy soil, then capillary moisture extends about 30 inches into the root zone.

Radial growth in the 2 dry years after impoundment was 48 percent faster (weighted average) than in 2 dry years before impoundment. If only years of normal rainfall are compared, the increase was 48 percent above that immediately prior to impoundment, and 20 percent above that in 1945-49 when the stand was 10 years younger. The 20-percent increase is impressive in that stand growth tends to decrease with age.

Some flat areas around the Demopolis Reservoir that were just above the constant pool level had been cleared of all vegetation before impoundment. These areas became swampy, and 5 years later they were thickly covered with young green ash, which averaged about 15 feet in height. Where the cleared areas were high enough above pool level so that the soil was unsaturated, young trees consisted principally of sweetgum, sycamore, and red oaks. All species, including some black willow in the swampy areas, were vigorous and appeared to be developing very rapidly. The constant supply of moisture in the growing season was probably responsible for the rapid growth.

Woodruff

Soil and water table conditions were highly variable around and adjacent to the Jim Woodruff Reservoir. Although it was designed to be a constant-level pool, there was considerable evidence of high water and flooding, especially in the upper portion of the reservoir. Timber response during the 5 years after the pool level

Table 1.—*Effect of raised water table on radial growth of hardwoods near Demopolis Lock and Dam. Average depth to capillary moisture was 15 inches, and to raised water table 46 inches*

Species	Radial growth before impoundment				Radial growth after impoundment					
	1945-1949	1950-1952	1953-1954	5-yr total	1955-1956	Increase over 1953-1954	1957-1959	5-yr total	Increase over 1945-1949	Increase over 1950-1954
	In					*Percent*	*In*		*Percent*	
Green ash	0.94	0.55	0.32	0.87	0.67	109	1.02	1.71	82	96
Cherrybark oak	1.18	.63	.39	1.02	.47	20	.86	1.35	14	32
Swamp chestnut oak	.75	.39	.24	.63	.35	46	.41	.78	4	24
Water oak	1.06	.59	.35	.94	.52	48	.69	1.22	15	30
White oak	.39	.32	.20	.52	.28	40	.24	.53	36	2
Willow oak	1.10	.51	.32	.83	.52	62	.98	1.51	37	82
Sweetgum	.98	.43	.20	.63	.32	60	.53	.86	−12	36
Sycamore	.79	.20	.20	.39	.35	75	.61	.98	24	149
Weighted average, all species	1.06	.53	.33	.86	.49	48	.78	1.27	20	48

was reached in 1957 was observed at 10 locations. Since conditions and responses varied by locations, table 2 gives soil and water-table conditions and radial growth of various species for each location. Radial growth of dominant or codominant trees during the 5 years before and after impoundment are compared.

At location 1, where the water table was raised to 18 inches from the surface, radial growth of longleaf pine increased by 113 percent after impoundment. The turkey oak nearby was dead, but radial growth had increased until death. The year of death was indefinite, but it did occur after water was raised into the root zone. The tree sampled was not suppressed by the young open stand of longleaf pine. Apparently, the turkey oak was dependent on its deeper roots for sustenance in the deep sandy soil, and these roots were smothered by the raised water table. Longleaf pine is adapted to both deep sandy soils and shallower, wet, and poorly aerated soils such as Leon, Plummer, and Portsmouth.

Locations 2 and 3 were similar in that the water table was deeper than 48 inches and capillary moisture above the water table came only slightly into the lower root zone. Hardwood growth was increased considerably and longleaf pine growth somewhat less by impoundment.

Table 2.—*Reaction of various forest species to raised water tables and sedimentation near the Jim Woodruff Reservoir*

Soil-site condition and description	Species	Five-year radial growth		
		1952-56 (before impoundment)	1957-61 (after impoundment)	Change
		In	*In*	*Percent*
1. Sandy loam soil, gentle slope, 45 feet from edge of water. Capillary water 0 inch, water table 12 inches under longleaf pine I, rest 18 inches	Longleaf pine I	0.98	1.35	38
	Longleaf pine	.90	1.92	113
	Turkey oak (dead)	.37	.53	43
2. Sandy loam surface over red sandy clay subsoil, on 5- to 10-foot ridge, about 100 feet from edge of reservoir. Capillary water 36 inches, water table >48 inches	Sweetgum	.57	.98	72
	Southern red oak	.45	1.10	144
	Water oak	.94	1.76	87
	Longleaf pine	.82	.94	15
3. Sandy loam over red sandy clay loam, open pasture area, 5-foot ridge, about 60 feet from reservoir. Capillary water 40 inches, water table >48 inches	Longleaf pine	.57	.73	28
	Sweetgum	.53	.98	85
	Water oak	.61	1.18	93
4. Grayish-brown loamy sand, 5- to 10-foot bank adjacent to reservoir. Capillary water 30 inches, water table >48 inches	Yellow-poplar	.82	1.31	60
	Winged elm	.37	.37	0
	River birch	.57	.82	44
5. Same as 4 except irregular depths of sand deposited around trees. Capillary water 36 inches, water table >48 inches	Sweetgum	.37	.45	22
	Loblolly pine	.65	.65	0
	Water oak	.65	.61	−6
	Water oak	.37	.53	43
	Pignut hickory (alive)	.08	0	−100
	Yellow-poplar	.45	.37	−18
	Shumard oak	.65	.37	43
6. Clay loam to silty clay loam soil, blue (gleyed) at 3 feet, flat, adjacent to water's edge. Capillary water 30 inches, water table 48 inches	Sweetgum	1.39	1.96	41
	Green ash	.53	.65	23
	Sycamore	.61	.61	0
7. Same as 6 except blue clay at 24-inch depth. Capillary water 18 inches, water table 36 inches	Sweetgum	.94	1.02	9
	Green ash	.53	.73	38
	Sycamore	.94	.94	0
8. Same area as 6 and 7 except in shallow slough back from lake bank, some recent sand deposits, water marks on trees at 5 feet. Capillary water 0 inch, water table 12 inches	Green ash	.78	.65	−16
	Sugarberry	1.10	.61	−44
	Sycamore	1.39	1.47	6
	Sweetgum	1.35	.94	−30
9. Loamy sand bank, 10 to 15 feet above lake water level, 150 feet from water's edge (control). Capillary water >48 inches, water table unknown	Cherrybark oak	1.96	1.96	0
	Sycamore	1.59	1.55	−2
	Yellow-poplar	1.18	1.39	18
	Sweetgum	.90	.61	−32
	Sugarberry	1.14	.94	−18
	Cherrybark oak	2.16	2.24	4
	Water oak	1.55	1.35	−13
10. East bank of Chattahoochee, loamy sand soil, recent sand deposits among trees. Blue clay loam at about 40-inch depth. Capillary water 30 inches, water table 40 inches	Cottonwood	1.35	2.08	54
	Sugarberry	.61	.41	−33

At location 4, part of the area was covered to irregular depths by recent sand and silt deposits. Where there was no sedimentation, yellow-poplar and river birch growth was improved by raising the water table; that of winged elm was not. The sand deposit, which averaged about 6 inches around the trees at location 5, was too irregular to measure around each separate tree. Generally, stand growth was decreasing, and the sand deposit appeared to be the cause.

The influence of recent sand deposits was also observed at location 8. The only species that was not affected was sycamore. The lack of growth response by sycamore was surprising, since a larger increase was observed for this species near Demopolis Lock and Dam. The reason for the different reaction was not discovered at the time the observations were recorded. Because sycamore reproduces well from cuttings, growth would not be expected to be decreased by the porous sand deposits. Personal observations on site requirements of sycamore made in the last decade indicate that poorest growth is on clay soils, and on such soils this species has shallow root systems. If these indications are correct, it follows that sycamore roots were unaffected at locations 6 and 7 because both of these have clayey soils in which capillary moisture supply was not as near the root zone as at location 8 or at Demopolis, where the soil was loam.

Trees at location 9 on a 10- to 15-foot-deep loamy sand front were not appreciably affected by impoundment. This plot was chosen as a control to compare growth of various species for the two periods without the influence of the water table. Even though 1952-56 had below-normal rainfall, there was no significant increase in growth during 1957-61 when rainfall was normal. On this site, therefore, the rainfall deficit of the preimpoundment period was not sufficient to restrict radial growth below that made when soil moisture is normal.

Radial growth of eastern cottonwood at location 10 increased 54 percent after the water table was raised to 40 inches from the surface. This species, like sycamore, can tolerate considerable sediment deposits, and is not as sensitive to clay content or poor aeration. A portion of this site had been cleared, and an excellent young stand of cottonwood, sycamore, black willow, and green ash seeded on sandy deposits. After 5 years, height ranged from 10 feet for the green ash up to 50 feet for the cottonwood.

In general, tree radial growth around the Jim Woodruff Reservoir increased markedly only where no recent sediment was present around the trees. Growth of most trees along the reservoir near where the Chattahoochee River enters was retarded by sand deposits.

No such deposits were formed where the Tombigbee and Black Warrior Rivers enter the Demopolis pool. The Chattahoochee River is straighter and faster than the Tombigbee or Black Warrior. During winter and spring rains, its water carries considerable sand and silt. When the floodwater hits the pool, the sudden slowdown probably causes rapid "backwater" rises and overflows. Sediment is dropped before the water returns to the normal banks of the reservoir. The backwater rise is negligible near the dam, but high-water marks on the trees indicate that overflow is normally about 3 to 6 feet in the upper part of the reservoir. Recent sand deposits seem to be in proportion to flood depth.