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Long-Term Artificial Annual Flooding Reduces Nuttall Oak Bole Growth

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SUMMARY

Nuttall oak (Quercus *nuttallii* Palmer) bole volume growth is significantly reduced by long-term artificial annual flooding of thinned stands, Regardless of size, trees growing in a green-tree reservoir grew significantly less in cubic-foot volume than trees in a nearby nonflooded area during the 6-year study period. Trees subject to heavy thinning grew significantly faster than those lightly thinned in the nonflooded area, but thinning intensity was not significant in the green-tree reservoir. This indicates a general decline in tree vigor caused by artificial annual flooding for the prior 17 years. Mortality for 6 years in the flooded and nonflooded areas has been 17 and 0 percent, respectively.

Additional keywords: *Quercus nuttallii*, thinning, green-tree reservoir.

INTRODUCTION

Green-tree reservoirs are artificial water impoundments created in living bottomland hardwood stands to enhance winter feeding areas for migrating waterfowl. The impoundments are flooded in the late fall after the growing season and drained in the early spring before growth commences.

Benefits to tree growth from annual water impoundments have been cited. A 50-percent increase in radial dbh growth was reported by Broadfoot (1967) after timber stands were flooded from February to July over a 4-year period. Raised water tables through artificial flooding also increased tree radius growth by 50 percent over a 5-year period after impoundment (Broadfoot 1973).

A correctly managed green-tree reservoir should increase the quantity of mast (acorns) produced and improve tree growth (Rudolph and Hunter 1964). Pin oak *(Quercus palustris* Muenchh.) acorn production was increased after 4 years in Missouri (Minckler and McDermott 1960). But, after an additional 10 years of study in the same area, based on averages over the 14 years, flooding had reduced the production of mature acorns about 25 percent (from 97,000 to 73,000/ac). Because the percent that was insect infested was less in the flooded areas (16 percent) than on the normal areas (33 percent), the number of sound acorns was approximately the same between the two areas (65,000 on the normal vs. 61,150/ac. on the flooded area) (McQuilkin and Musbach 1977). Nuttall oak (Q. *nuttallii* Palmer) acorn production for 5 years in a 15-year-old green-tree reservoir was about half that of an unflooded control area (Francis 1983). Based on a small sample, Newling (1981) reported no significant difference in rate of growth for Nuttall oak in a green-tree reservoir and unflooded reference areas, and variable results for other species.

This paper reports the effects on Nuttall oak volume growth of long-term flooding in a green-tree reservoir.

METHODS

The study areas are on the Delta National Forest, near Rolling Fork, MS, in mostly pure, even-aged Nuttall oak stands that averaged 50 to 60 years old. Two locations were selected, one in the green-tree reservoir (GTR) of the Sunflower Waterfowl Project, and one in a nearby area not subject to artificial flooding (nonflooded area-NA).

The GTR, flooded annually since 1958, is flooded during the first 2 weeks of October with drainage beginning about February 15. However, due to poor drainage and frequent overflows from the adjacent Sunflower River, drainage is often not complete until mid-June.

Except for annual water impoundment in the GTR, both areas are similar in site and stand conditions. Soils at both locations are associations of Sharkey and Alligator, which are level to nearly level, poorly drained, slackwater clays.

At each location, three dominant/codominant Nuttall oak trees were selected from each of four dbh classes in each of three blocks. This provided 36 test trees per location, a total of 72 trees. The four dbh classes were small (8.5 to 11.5 in dbh), medium (14.5 to 17.5 in dbh), large (20.5 to 23.5 in dbh), and extra large (26.5 to 29.5 in dbh).

Thinning treatments imposed in each block were control (no thinning), moderate (all trees adjacent to the test tree were removed to allow a 15-foot minimum clearance around the crown), and heavy (all adjacent trees removed to allow a 30-foot minimum clearance around the crown). Thinning treatments were randomly assigned to trees of each size class in each block. The study area was thinned in the late summer of 1974 and the study was installed 1 year later in the 1975-76 dormant season.

The test trees were measured prior to the 1976 growing season and at the end of the 1981 growing season, thus recording 6 years' growth. Bole circumference was measured at heights of 4.5, 9, 17, and 25 feet. Upper bole measurements were obtained using Swedish tree climbing ladders. Cubic-foot bole volumes were estimated by Smalian's formula (Husch et al. 1972) for the 20.5-foot interval between 4.5 and 25 feet. Periodic volume growth is the difference between the final and initial measurements.

RESULTS

Volume Growth

During the 6-year growth period, 6 trees died in the GTR while one in the NA was severely wind damaged. Average bole volume growth in the GTR of 5.6 cubic feet was significantly (α = 0.05) less than the 6.6 cubic feet in the NA. Volume growth increased significantly with tree size in both flooded and nonflooded areas (table 1). In the GTR large and extra-large trees added significantly more volume than the small and medium trees. In the NA each successively larger tree size produced significantly more wood except in the large tree category.

Both thinning treatments significantly increased bole growth in the nonflooded area (table 2). Trees in the heavier thinned plots (30-foot) grew significantly more volume than those subject to light (15-foot) thinning, -with respective growth means of 8.6 and 7.2 cubic feet. The trees that were thinned had approximately doubled the volume growth of the control trees. Thinned but unflooded volume growth averaged 7.9 cubic feet for the two treatments compared to 4.2 for the control. Although thinning in the GTR also increased growth, the increase was not statistically significant.

Table l.-Mean B-year *bole volume growth by free size c/asses on flooded and unflooded areas*

Size class	Treatment area	
	Flooded	Nonflooded
	···· *cubic feet per tree*	
Small	3.2a[1]	4.2a
Medium	5.4a	6.1 b
Large	6.6b	6.9b
Extra-large	7.8b	9.3c

[1]Means within columns followed by the same letter are not significantly different (a = 0.05).

Table *2.-Mean 6-year bole volume growth by thinning treatment on flooded and unflooded areas*

Thinning Treatment	Treatment area	
	Flooded	Nonflooded
	······ *cubic feet per tree*	
Control	4.1a[1]	4.2a
15-foot radius	6.0a	7.2b
30-foot radius	6.4a	8.6c

[1]Means within columns followed by the same letter are not significantly different (α = 0.05).

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DISCUSSION

The continuous annual flooding has had a small, though statistically significant, negative effect on bole volume growth over the 6-year growth period. Trees in the GTR averaged 5.6 cubic feet of growth for the period compared to 6.6 cubic feet in the NA.

Trees in the GTR did not significantly respond to thinning treatment as expected, but the trees in the NA did. This indicates an overall deterioration in tree vigor in the GTR, resulting in the inability to respond to thinning regardless of tree size.

As expected, small trees had less volume growth than big trees but had the highest percent growth.

Trees in the NA responded to the thinning treatments for all size trees. The heavier thinned trees grew faster than those receiving a moderate thinning.

Although significant growth differences exist between the two areas, the growth magnitudes are small. But the death of six trees in the GTR in 6 years and the lack of thinning response indicate the GTR trees are deteriorating due to the annual artificial flooding.

LITERATURE CITED

Broadfoot, W. M. Shallow-water impoundment increases soil moisture and growth of hardwoods. Soil Sci. Soc. Am. J. 31: 562-564; 1967.

Broadfoot, W. M. Raised water tables affect southern hardwood growth. Res. Note SO-168, New Orleans, LA; U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1973. 4 p.

Francis, John K. Acorn production and tree growth of Nuttall oak in a green-tree reservoir. Res. Note SO-289, New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1983. 3 p.

Husch, Bertrom; Miller, Charles I.; Beers, Thomas W. Forest mensuration. 2d ed. New York: Ronald Press; 1972. 410 p.

McQuilkin, R. A.; Musbach, R. A. Pin oak acorn production on green tree reservoirs in southeastern Missouri. J. Wildl. Manage. 41: 218-225; 1977.

Minckler, L. S.; McDermott, R. E. Pin oak acorn production and regeneration as affected by stand density, structure, and flooding. Missouri Agricultural Experiment Station Res. Bull. 750. Columbia, MO: University of Missouri, 1960. 21 p.

Newling, Charles J. Ecological investigation of a green tree reservoir in the Delta National Forest, Mississippi. Waterways Experiment Station Misc. Pap. EL-81-5. Vicksburg, MS: U.S. Army Engineers Waterways Experiment Station, 1981. 67 p.

Rudolph, R. R.; Hunter, C. G. Green trees and greenheads. In: Linduska, J. P., ed. Waterfowl tomorrow. Washington, DC: U.S. Dep. Interior; 1964: 611-618.