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Acorn Production and Tree Growth of Nuttall Oak in a Green-Tree Reservoir

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SUMMARY

Green-tree reservoirs, created by flooding live timber stands, provide resting places and food for wintering waterfowl. The effects of winter flooding in terms of acorn production and growth of Nuttall oaks were studied in a reservoir which had been flooded annually for 15 years and in a nearby unflooded site. The study, which lasted for 5 years, included four tree sizes and three thinning treatments. Acorn production was about half as great in the winter-flooded site as in the control area. Large trees were better mast producers than small trees within the same stand. Thinning had no effect on mast production, but significantly affected diameter growth.' Diameter growth was about the same in flooded and nonflooded areas. Eleven percent of the flooded trees died, while none of the nonflooded trees died.

Additional keywords: Quercus *nuttallii* Palmer, winter flooding, mast.

Green-tree reservoirs are created by artificially flooding live timber stands during the fall and winter. Many have been built in the South as habitat for wintering waterfowl and to increase hunting opportunities. In recent years, green-tree reservoirs have become a convenient means of mitigating the impact of waterfowl habitat destruction by large water projects.

Minckler (1960) showed on increase in pin oak *(Quercus palustris* Muenchh.) acorn production associated with winter flooding in a green-tree reservoir. However, McQuilkin and Musbach (1977) monitored the same area for an additional 14 years and concluded that the production of acorns did not vary significantly between flooded and nonflooded areas. They found that acorn production increased with tree size and stocking. Broadfoot (1967) cited a 50-percent increase in radial growth of timber in stands that were flooded from February to July over a 4-year period. Filer (1975) reported that the, kinds of mycorrhizal fungi present were not altered by winter and spring flooding but the concentration of individuals was reduced. Much remains unknown about the benefits and liabilities of fall, winter, and spring flooding. The results of a study of mast production and growth of Nuttall oak *(Quercus nuttallii* Palmer) in a single, but not atypical, green-tree reservoir are given in this paper.

PROCEDURE

A site within the green-tree reservoir of the Sunflower Waterfowl Project, near Rolling Fork, Mississippi, was compared with a nearby site outside the reservoir. The soils of both areas are in the Sharkey series (Vertic Haplaquepts). The timber stands are dominated by Nuttall oak, green ash, and overcup oak. Understories of the two areas are similar.

Annual flooding of the green-tree reservoir begins each fall between the 1st and 15th of October. Drainage starts about February 15, but sometimes is not complete until mid-June due to poor internal drainage and overflows from the Sunflower River.

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In wet springs, when the Sunflower River overflows, the control area is also flooded, but the water leaves sooner than from the reservoir. Annual flooding of the green-tree reservoir began in 1959 and continues until the present. Events in years 16 (1975) through 20 (1979) were monitored during this study.

Both areas were divided into three blocks. In each block, 12 trees were chosen, 3 from each of the following size classes: small (8.5 to 11.5 in or 22 to 29 cm dbh), medium (14.5 to 17.5 in or 37 to 44 cm dbh), large (20.5 to 23.5 in or 52 to 60 cm dbh), and extra large (26.5 to 29.5 in or 67 to 75 cm dbh). Three thinning treatments were imposed: no thinning, moderate (adjacent trees were removed to create a minimum 15 ft or 4.6 m of crown clearance), and heavy (30-ft or 9.1-m minimum crown clearance). Thinning was conducted in the late summer previous to year 16. The result was that each block contained all of the size and thinning combinations.

At the beginning of the experiment, and again 5 years later, study trees were measured for dbh and crown area (vertical projection to ground surface). The average crown radius used to calculate crown area was obtained by measuring distances from tree center to points directly below the edge of the crown in eight cardinal directions.

Acorns were collected in four traps underneath each tree. A trap consisted of a post set in the ground supporting a pair of wire screen-protected bushel baskets. The traps were located at random intervals along the main axis of the crown. Acorns were retrieved from the traps at about P-week intervals during seedfall. Seedfall continued from October through January, the peak being sometime in December. The collected acorns were separated into sound and unsound seed and dried for 24 hours at 70° C (158° F) and weighed. “Unsound” was defined as being hollow or having more than half of the seed eaten by insects. The number of unsound acorns was so small that it was not analyzed statistically. Eighty-two percent of this unsound seed came from the nonflooded area.

The results were evaluated using analysis of variance with $p=0.95$. Due to the lack of replication of the flooding treatment, it was impossible to test the significance of flooding. However, the two areas were compared with a test equivalent to the t-test using replications within the area. Tree size and thinning were evaluated by the usual F-tests. The means of significant main effects were compared by Duncan’s New Multiple Range test.

RESULTS AND DISCUSSION

Acorns were produced and collected in years 1, 4, and 5. Weather-related failures of the acorn crop in both flooded and nonflooded areas occurred in years 2 and 3. Means shown hereafter are total acorns produced divided by 5 to obtain average annual production.

Dry weight of acorns produced per square foot of crown, dry weight per tree, and acorns per tree were significantly affected by area. Acorns per square foot of crown for the two areas were not significantly different. Means for the above are presented in table 1. The means of each significantly different measure of acorn productivity for the nonflooded area were about twice as large as those of the flooded area. Although the soils and stands of the areas appear quite similar, it is impossible to say with certainty that differences are due to flooding treatments and not to unknown environmental variation.

Tree size significantly affected all measurements of acorn productivity (table 2). Acorn production of the smallest tree size was always inferior to the other three sizes. These smallest trees were mostly of intermediate crown class at the beginning of the experiment. Even those released by thinning had not gained sufficient vigor during the 5-year period to facilitate acorn production per crown area comparable to the larger trees. In the number- and weight-per-square-foot data there was no difference between the three largest sizes. Dry weight of acorns per tree of the largest size was greater than the other sizes; the largest size tree produced a greater number of acorns per tree than the two

Table 1.—*Mean annual acorn production and growth made by Nuttall oaks on nonflooded and flooded areas over a 5-year period*

Item	Nonflooded	Flooded
Dry weight (g) of acorn/ft² of crown	1.11a[1]	0.64b
Number of acorns/ft² of crown	0.44a	0.29a
Dry weight (g) of acorns/tree	2232a	933b
Number of acorns/tree	956a	422b
Increase in diameter (in)	1.35a	1.43a
Increase in crown area (ft²)	906a	357b

[1]Means within rows followed by the same letter are not significantly different ($\alpha = 0.05$).

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Table 2.—*Mean annual acorn production and increase in crown area ot tour sizes of Nuttall oaks*

Item	Tree size			
	Small	Medium	Large	Extra large
Acorns/ft^2	0.14b[1]	0.40a	0.44a	0.46a
Dry weight (g/ft^2)	0.32b	1.08a	1.03a	1.08a
Acorns/tree	104c	638b	790ab	1225a
Dry weight (g/tree)	229c	1535b	1576b	2990a
Increase in crown area (ft^2)	242b	628ab	576ab	1080a

[1]Means within rows followed by the same letter are not significantly dlfferent ($\alpha = 0.05$).

smallest sizes. In contrast to tree size, thinning had no effect on acorn productivity. Probably not enough time had elapsed for a response to occur. No significant interaction between area, size, or thinning occurred.

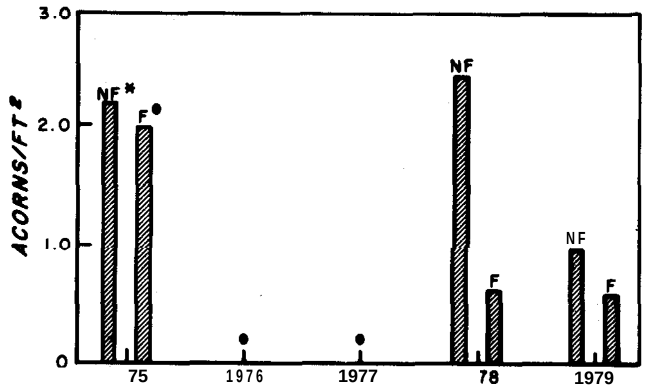
Diameter growth was not significantly affected either by area or tree size, but it was significantly affected by thinning.

Increase in crown area was significantly affected by area and tree size, but not by thinning. The larger trees made greater gains in crown area. Trees on the nonflooded site increased Rheir crown area more than those on the flooded site. Although mean crown area increased on the flooded site, several individual trees lost crown area. An observed dieback of twigs and branches may have been the cause;

During the 5 years of the study, four measurement trees died in the green-tree reservoir. None died on the nonflooded site. The trees that died were located in a portion of the green-tree reservoir that did not drain well. The loss of these trees was responsible for a minor portion of the difference in mast production associated with flooding in the last 2 years of the study (fig. 1).

Overall, the flooded area produced much less mast than the nonflooded area; also, less increase in crown area and greater mortality were noted. Thinning had no significant effect on acorn production but increased diameter growth. The small trees were poor acorn producers in both areas, even after release from competitors.

It is probable that reduced vigor of oaks in the flooded area resulted from inadequately aerated soil. Soils dry enough to allow the infusion of air are necessary for root regeneration. Flooding only



✱ NONFLOODED AREA

● FLOODED AREA

● NO COUNTS WERE DONE IN 1976 OR 1977

Figure 1.—*Nuttall oak acorn production per square toot of crown area on flooded and nontiooded sites over a 5-year period.*

every second or third year might assure the high tree vigor desirable in a green-tree reservoir. Delaying flooding as long as possible in the fall is suggested by Broadfoot's (1967) successful flooding of a natural stand beginning each year in February. Timely and effective withdrawal of water in the spring might also improve growing season soil aeration. Once the requirements of Nuttall oak are understood, it should be possible to provide waterfowl habitat without sacrificing either mast or timber production.

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