SUGGESTIONS FOR THE MANAGEMENT OF OAK FORESTS FOR MAST PRODUCTION

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The great value of acorns as food for waterfowl, turkeys, quails, squirrels, and many other forms of wildlife is well known. Yet little is known of the problem of how best to manage an oak forest to get maximum mast production. A knowledge of the relation of productivity to such factors as size, age, stand density, and other growing conditions of the timber is requisite to proper management.

With this in view, a study was made to determine the relation of acorn yield to the bole diameter and growth rate in the cherrybark oak *(Quercus falcata pagodaefolia)* on Kentucky Woodlands National Wildlife Refuge in 1948 and 1949. This species was selected for study because it is a heavy and consistent acorn producer and is one of the commonest and most widely distributed of the bottomland oaks in Southeastern United States.

METHODS AND MATERIALS

Seventy dominant and co-dominant forest trees, ranging in size from twelve inches to 40 inches dbh, were selected. All of these trees were outwardly sound and all were thrifty except the very large over-aged trees. Increment borings were made and the radial growth for the last ten years was determined for each tree. The dbh for each tree was measured. Seven diameter classes were used. Table 1 shows the size range of the diameter classes and the number of trees from which collections were made each year. Two trees which were used in 1948 were lost in 1949 because of a right-of-way clearing and one tree, not used in 1948, was added in 1949. All of the remaining 68 trees were used both years.

Table 1. Diameter classes, number of trees used each year, and average radial growth in last 10 years.

	Number of trees						
Class	12 [a]	14	18	22	26	30	32.5
Range	11.8-13.3 [a]	13.8-15.3	16.5-19.5	20.5-23.5	24.5-27.5	28.5-31.5	32.5 up
1948	5	10	17	12	13	8	5
1949	5	10	18	10	13	8	5
Avg. growth	1.8	1.7	1.7	1.5	1.7	2.1	1.3

[a] Diameter in inches.

A modification of the method of sampling of Downs and McQuilkin (1944) was used. The acorn traps were simply shallow boxes 0.25 milacre inside area. They were made of old weather boarding and other 1" × 6" or 1" × 8" rough lumber. The bottoms were made of 1" thick boards of various widths. Small spaces were left between the bottom boards to allow rain to drain through and to allow for swelling in wet weather. The spaces, of course, were not wide enough to allow acorns or parts of acorns to pass through. The tops of the traps were of 1 inch mesh chicken wire.

One trap was used at each tree and this was placed under a representative part of the crown about midway between the bole and the periphery of the crown. It is believed that those acorns collected from a trap situated in this way, are a fair sample of the yield of ¼ milacre of crown area, aside from those which might be carried away by birds or rodents before falling. A cast-off one quart motor oil can was placed under each corner of the trap to make it less vulnerable to rodent depredations and to keep the floor off the moist ground.

RESULTS

There was considerable difference in the yield of individual trees of the same size, growth rate and apparent growing conditions, which probably indicates that genetic differences are a significant factor. For example, one tree of 25 inches dbh and 2.0 inch ten year radial growth had an average per trap yield of 233 acorns, while another tree of similar size and growth rate had an average per trap yield of 31 acorns.

In most cases, a tree which produced heavily one year was a heavy producer both years. Likewise, light producers and medium producers showed consistency in yield. However, in some cases, individual trees showed considerable variation from one year to the next. For example, one tree produced 146 acorns per trap the first year and only 15 acorns per trap the next year. Another tree produced 23 acorns per trap the first year and 77 acorns per trap the second year, although the first year was a much better mast year for most trees.

The accompanying Fig. 1 shows graphically the average yield per trap in each diameter class for each year. As will be seen, the smaller trees, which usually are the younger ones, are light producers. As the trees increase in size, the yield increases until they become quite large and then the yield declines. Downs and McQuilkin found similar patterns in the scarlet oak and the white oak. In 1949 the greatest yield was in the 30 inch class, while in 1948 the peak yield fell in the 26 inch class, but the trends are much alike both years.

The growth rates of the trees in this study, as shown in Table 1 suggest a parallel between growth and yield except that the younger trees show a high growth rate and a low yield. Upon eliminating those trees of less than 20 inches dbh, and breaking down the yield of the remaining 38 trees according to growth rate, the relation of yield to growth is apparent, as shown in Table 2.

APPLICATIONS

If, as suggested by the data of this study, acorn yield in mature trees is directly related to radial growth, it would follow that that type of management which would accelerate growth of the forest in general would result in an increase in mast, provided that the stand was not thinned beyond the point necessary to attain this accelerated growth.

Apparently it is the vigor, as exemplified by radial growth rate, rather than the size of the tree that is important in attaining a heavy acorn yield. This probably will account for the characteristic heavy yields of meadow type trees. Being free of competition and living under ideal growing conditions, they have a rapid growth rate and are heavy mast producers even until they are very large trees.

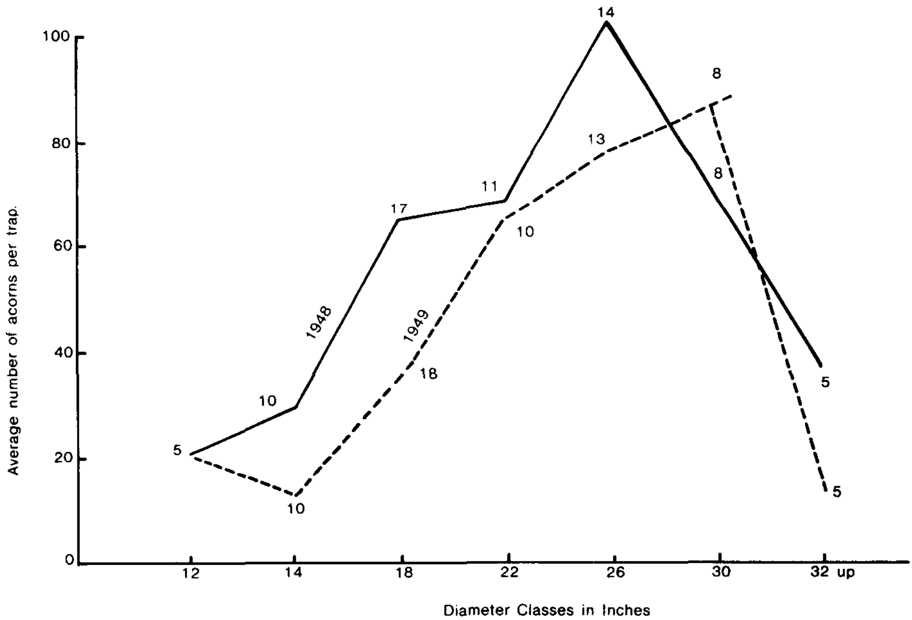

Fig. 1. Cherrybark oak yield by diameter breast high. Number of trees in each class shown on curve.

Table 2. Yield according to growth rate in trees larger than 20 inches d.b.h.

	Inches radial growth in last 10 years					
	0-0.5	0.6-1.0	1.1-1.5	1.6-2.0	2.1-2.5	2.6-3.0
Number of trees	1	4	9	14	7	3
Average number of acorns produced per ¼ milacre	5.0	71.3	73.3	76.9	77.2	82.3

From the standpoint of individual production, the meadow type tree is the ideal. However, trees so spaced as to be true meadow type trees would be too scattered for a maximum mast yield, to say nothing of timber yield or of desirable forest conditions. The question in making thinnings is where is the point of diminishing returns? How nearly can we eliminate competition between individual trees and still not waste space? Assuming that the meadow type tree is the standard which we should approach, measurements were made on 33 meadow type oaks of several species to learn the potential crown development of trees of various bole sizes. These findings are shown in Table 3. Judging from these limited measurements, the indications are that the crown diameter is, roughly, twice as many feet as the bole diameter is inches. Assuming that this is the potential width of an oak's crown, thinnings should be made in such a way as to

Table 3. Showing the average diameter of crowns of meadow type oaks according to diameter class.

Bole Diameter Class in Inches	Average Crown Diameter	Number of Trees
8	20	1
10	22	2
12		
14	26	1
16	34	1
18	36	6
20	39	3
22	47	1
24	47	3
26	49	4
28	47	2
30	58	1
32	63	1
34	68	1
36	65	1
38	70	1
40	76	1
42	80	2

allow crown development to approach this. The foresters have a rule of thumb for making hardwood thinnings. In trees less than 10 inches, the dbh in inches plus one, in trees between 10 and 17 inches, the dbh in inches plus two, and in trees more than 17 inches, the dbh in inches plus three is converted to feet and that much is allowed for crown radial development. This is fairly heavy thinning and a forest, where thinnings of this kind are made in short cutting cycles, should be a continuously rapid growing one.

The following suggestions are offered for the management of a hardwood forest to bring about an increase in mast. In harvesting, the trees should be considered individually. Oaks should be favored and thrifty, well formed trees should be left uncut regardless of how large they are. Trees should be removed only when they are ill-formed, unthrifty, or defective, or are competing unduly with more desirable trees. Thinnings should be heavy enough to allow for nearly full crown development. Cutting cycles should be as short as is practical in order to maintain an even growth of the forest and to avoid drastic canopy openings which would result in over-extensive brushy areas. Such practices are not incompatible with economic considerations. Bole length is sacrificed but bole diameter is gained, and many foresters favor this type of management because of the higher value of large logs.

In time, this kind of management should result in an all-aged fast growing forest of large crowned short boled trees with small scattered patches of undergrowth. Such a forest with its high yield of mast and its good cover conditions should be favorable for most forms of forest wildlife.

LITERATURE CITED

Downs, Albert A., and William E. McQuilkin. 1944. Seed production of southern Appalachian Oaks. J. of Forestry. 42: 913-920.