SOUTHERN FOREST EXPERIMENT STATION

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SITE INDEX CURVES FOR RED AND WHITE OAKS IN THE BOSTON MOUNTAINS OF ARKANSAS

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Site index curves for white oak and red oaks (northern red and black oaks) derived from stem analysis data collected in the Boston Mountains of northern Arkansas differ from each other and from previously published upland oak curves.

Harmonized site index curves developed for the entire commercial range of oak *(6)* have long been the standard reference for estimating site index of both red and white oak stands in the Boston Mountains of northern Arkansas, despite the demonstrated superiority of locally derived curves for northern red oak in the Lake States *(2)* and for oak in the Southeast *(5)*. This note presents two sets of curves for the Boston Mountains, one for white oak *(Quercus alba* L.), and one for red oaks—northern red oak *(Q. rubra* L.) and black oak *(Q. velutina* Lam.).

METHODS

Standard methods of stem analysis and computation *(1,3,4,7)* were followed in constructing the curves. Stems of 278 dominant and codominant trees were analyzed; 136 were white oak and 142 were red or black oak. Each oak group was represented by a wide range of site indexes, and stand ages ranged from 50 to 108 (tables 1 and 2). All sectioned trees were located in even-aged, well-stocked stands that contained no evidence of cutting, grazing, or severe burning.

Each tree was sectioned at 0.5 foot, at 4.5 feet, and at intervals of 4 to 12 feet up to the growing tip of the tree.[2] Total height was recorded for each tree, and annual rings were counted at each of the sectioned points.

The ring counts at the cross-sections were converted to tree ages at these points. Heights and ages were then plotted for individual trees and inspected for indications of early suppression or top breakage. Trees showing any such evidence were rejected. Individual tree curves for northern red oak and black oak were similar, and the decision was made to derive a single set of curves for pooled red and black oak data.

Data for the two species groups (white and red oaks) were then stratified by 10-foot site

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[2] Some 8- and 12-foot saw logs were cut from 16 white oak and 22 red and black oak sample trees.

index classes (at age 50). Each 10-foot site index class was represented by a minimum of 18 sample trees. The fewest observations were recorded for the highest and lowest site classes in each species group (tables 1 and 2). Age distribution varied widely for most site index classes, but the majority of sample trees were between 50 and 59 years old. The relatively few sample trees older than 70 years were fairly evenly distributed among site index classes.

Table 1.—*Distribution of sample white oaks by age and site index classes*

Total age (years)	Site index class				Total
	35-44	45-54	55-64	65-74	
	Number of trees				
50-59	5	37	23	12	77
60-69	9	14	9	4	36
70-79	2	2	2	2	8
80-89	2	3	4	2	11
90-99	...	1	1	1	3
100+	...	1	...	...	...
Total	18	58	39	21	136

Table 2.—*Distribution of sample red oaks*[1] *by age and site index classes*

Total age (years)	Site index class				Total
	45-54	55-64	65-74	75-84	
	Number of trees				
50-59	19	43	20	14	96
60-69	2	4	2	2	10
70-79	2	3	4	4	13
80-89	2	2	3	2	9
90-99	1	2	2	2	7
100+	2	3	2	...	7
Total	28	57	33	24	142

[1] Includes both northern red oak and black oak.

The individual height/age curves were next combined to form one average height/age curve for each 10-foot site index class. These composite curves were fairly uniform and indicated no obvious polymorphic tendencies.

Growth patterns in second-growth stands were not sigmoid. Instead, initial growth rates were rapid and did not slow for 30 to 40 years. This pattern is probably characteristic of trees developing from seedling sprouts rather than from true seedlings.

EQUATIONS

Various mathematical models were tested for expressing the observed height/age relationship. Logarithmic functions such as log height $= a + b\ (1/age)$ produced curves that were too flat. Curves based on the relationship height $= \sqrt{age}$ adequately represented height growth beyond age 50 but over-estimated height at younger ages. The relationship height $= (age)^{0.75}$ produced curves that were adequate for younger trees but overestimated heights beyond age 50.

The conditioned polynomial, height $= b_1\ (age)^{-2} + b_2\ (age)^{-1} + b_3\ (age)^{-0.5} + b_4\ (age)^{0.5}\ b_5\ (age) + b_6\ (age)^2$, was fitted stepwise to all stem analysis data for each species, with the following satisfactory results:

Red oaks

$$\text{Height} = 1.60443\ (age) - 0.00759\ (age)^2 + 0.45558\ (age)^{0.5}\ R^2 = 0.98$$

White oak

$$\text{Height} = 1.24692\ (age) - 0.00543\ (age)^2 + 0.77468\ (age)^{0.5}\ R^2 = 0.98$$

Inserting the condition that height at age 50 is site index (SI) and solving for height in terms of site index and age provided equations for generating the site index curves (figs. 1 and 2):

Red oaks

$$\text{Height} = 0.02\ (SI)\ (age) + 0.31507\ (age) - 0.00759\ (age)^2 + 0.45558\ (age)^{0.5}$$

White oak

$$\text{Height} = 0.02\ (SI)\ (age) + 0.1619\ (age) - 0.00543\ (age)^2 + 0.77468\ (age)^{0.5}$$

The two sets of curves derived from these models fit the observed data very closely for all ages and sites.

Growth patterns for white oak and red oaks were essentially similar up to about age 50, with white oak growing slightly slower than the red oaks. Thereafter, however, white oak maintained a relatively rapid growth rate up to and beyond 80 years of age. Red oak height growth declined sooner and more rapidly. For example, if red oak and white oak are the same height at age 50, the white oak is likely to be

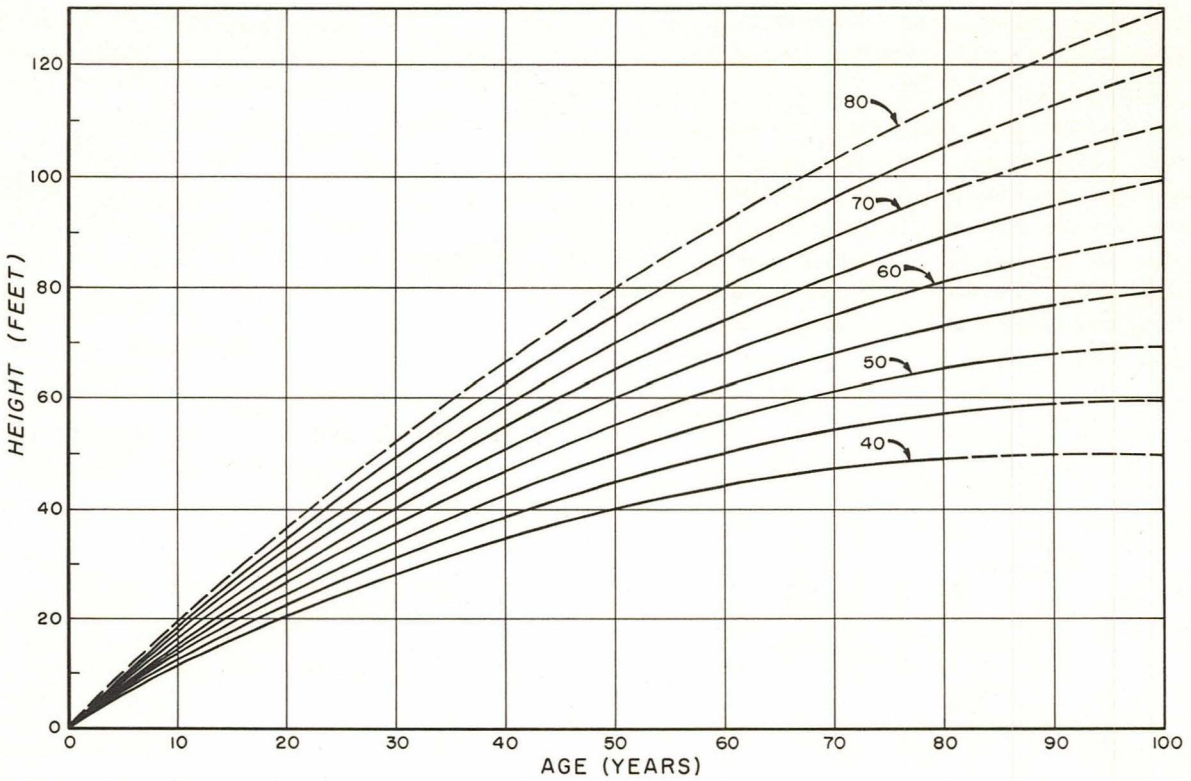

Figure 1.—*White oak site index curves for the Boston Mountains. Dashed lines indicate extrapolation.*

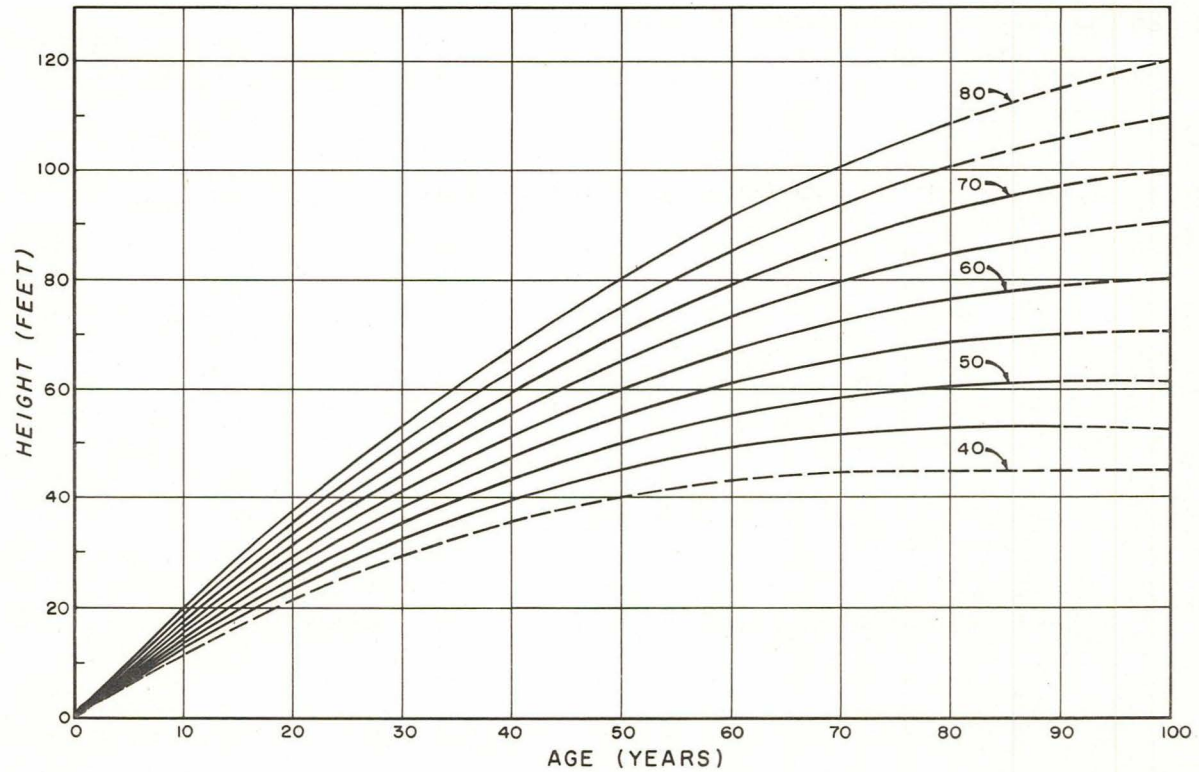

Figure 2.—*Red oak site index curves for the Boston Mountains. Dashed lines indicate extrapolation.*

nearly 5 feet taller at age 80 and may be as much as 10 feet taller than red oak at age 100.

The curves for red oaks and white oak agree fairly closely with Schnur's *(6)* upland oak curves in early years, especially on the medium sites (figs. 3 and 4). On poor sites, early growth is somewhat more rapid than predicted by the old curves; on good sites the opposite is true. After age 50, white oak on poor sites grows about as shown in the upland oak curves, but on better sites the new and old curves differ considerably. At 80 years on a site with an index of 70, white oak is likely to be 10 feet taller than indicated by Schnur's curves.

The differences in growth patterns between the new and old curves are sufficient to recommend the locally derived curves for determining site index of both red and white oaks in the Boston Mountains of northern Arkansas.

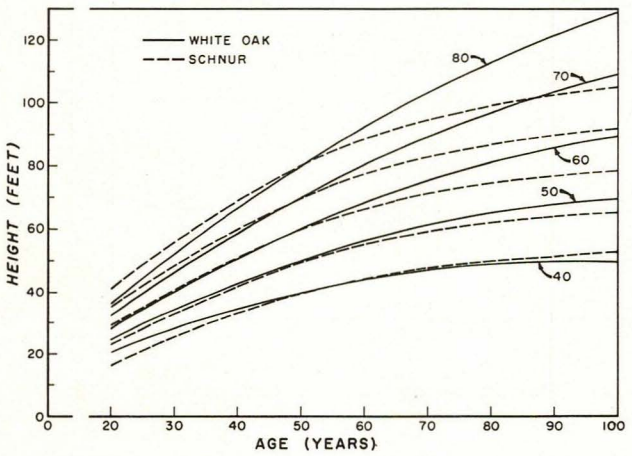

Figure 3.—*White oak curves for Boston Mountains compared with Schnur's curves* (6).

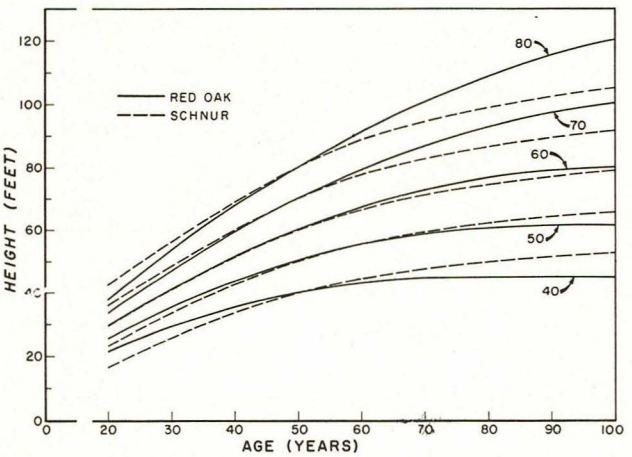

Figure 4.—*Red oak curves for the Boston Mountains compared with Schnur's curves* (6).

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