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Polymorphic Site Index Curves for Natural Sweetgum in Alabama

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Polymorphic Site Index Curves For Natural Sweetgum In Alabama

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INTRODUCTION

ALTHOUGH hardwood species account for 59 percent of the timber volume in the South, they have received little attention from forest managers (1). Most of the forest management effort has been devoted to pine. Recently the pulp and paper industries have increased their consumption of hardwood species and they, together with the hardwood lumber industry, have become concerned with the decreasing supply of desirable hardwoods. Consequently, increased attention should be given hardwood management procedures in Alabama.

The potential production of hardwoods is high. The fastest growing trees in North America are represented among southern hardwood species. The increasing demand being placed upon forest land for uses other than timber production, together with a sustained demand for forest products, indicates that foresters in the future will be required to know the potential of each site for a particular tree species. The increased use of fast-growing tree species, such as sweetgum, appears likely.

Sweetgum, also called Redgum (*Liquidambar styraciflua* L.) is widely distributed in Alabama and grows on a variety of sites. However, pure stands are usually found only on better sites. The U.S. Forest Service estimates that there are 920 million cubic feet of sweetgum in Alabama (4). This is the greatest volume for any commercial hardwood species in the State.

Tree site index was first defined in 1824 and has been used extensively since that time in both Europe and the United States.

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The use of good tree site index curves is the most direct method and probably the best tool for evaluating stand productivity (5). Three publications of past years have been concerned with tree site index of sweetgum (2, 9, 10). However, only one of these projects used sweetgum plots in Alabama and these were apparently restricted to one large alluvial bottomland (10).

The site index curves presented in this paper are polymorphic in form, which means that the curve shape may differ from site to site to fit the actual trend of height growth (8). The curves used for past site index information were usually harmonized. Use of the harmonized curve technique assumes that the effect of differences in site on height growth are relatively the same at all ages and the growth curve on a good site has the same shape as that on a poor site. Neither of these assumptions seems likely to be true. The polymorphic curve technique is based on stem analysis, and each curve is developed from data obtained from a given site. Therefore, this technique avoids the most serious pitfalls of the harmonized curve technique.

DATA COLLECTION

Fifty stands of natural sweetgum were located within Alabama by extensive exploration during 1971 and 1972. Figure 1 shows the approximate location of each stand. All of these stands had closed canopies, were even-aged, and ranged in age from 6 to 50 years. Stand basal area ranged from 25 square feet to 200 square feet

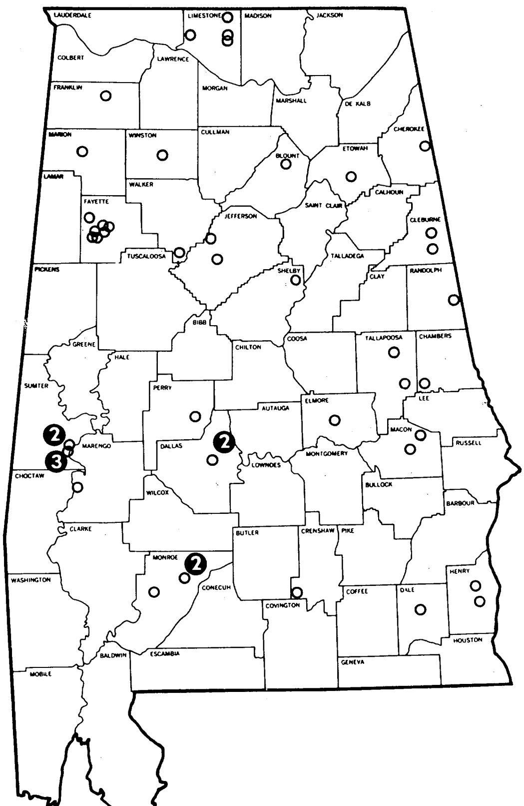

FIG. 1. Approximate location of sweetgum stands in Alabama used to develop tree site index.

per acre. At least 80 percent of the trees in each stand were sweetgum. Topographic positions ranged from bottoms to hillsides. Approximately 45 of the stands could be positively identified as having originated on old fields, and any of the others may have been of similar origin. Stands in which more than 20 percent of the trees had multiple stems or top die-back were not chosen.

At each stand, the first two dominants encountered within the stand were selected as sample trees and felled. Felled trees were sectioned at 4.0-foot intervals beginning at the top of a 0.5-foot stump. A disc was cut from the base of each 4.0-foot section and a ring count made after staining. This ring count was then converted to tree age at a point within each section. It is obvious that each year's growth would not occur in 4-foot multiples. Therefore, a formula proposed by Lenhart was used to predict the point within each 4-foot section at which height growth had ceased for the appropriate year (6). The only other measurement made was total tree height.

ANALYSIS OF DATA

The age and height estimates obtained from stem analysis were used for fitting growth models described by Richards (7) and modified by Graney and Burkhart (3).

The form of Richards' equation is:

$$H = a_1 \left[1 - \exp(-a_2 \text{ Age})\right]^{a_3} \qquad \{1\}$$

where H is height at a given age and a_1, a_2, and a_3 describe ultimate tree height, rate of tree height growth, and initial pattern of height growth respectively.

Graney and Burkhart postulated that height could be expressed as a function of both age and site index, rather than being a function of age alone. This led to their development of the five parameter model:

$$H = \{a_0 + a_1 SI\} \{1 - \exp[-(a_2 + a_3 SI) \text{ Age}]\}^{a_4} \qquad \{2\}$$

where SI is site index or observed height at index age. This equation expresses height as a function of site index (observed height at index age) and age. These authors noted that the main advantage of this model is that only one equation is required for the generation of the polymorphic height-age curves.

Using 25 years as the base age, a modification of Graney and Burkhart's model (Equation 2) was developed and subsequent testing found this model to describe the data satisfactorily. The new model added an additional parameter as follows:

$$H = \{a_0 + a_1 SI\}\{1 - \exp[-(a_2 + a_3\,SI)\,Age]\}^{a_4 + a_5 SI} \qquad \{3\}$$

After fitting this model to the data the following equation was produced:

$$H = \{71.0 + 0.485\,SI\}\{1 - \exp[-(-0.0297 + 0.00110\,SI)\,Age]\}^{0.163 + 0.0135\,SI} \qquad \{4\}$$

where H is total height (feet) at a given age, SI is height at a given age, and age is observed age of tree.

The site index curves in Figure 2 were generated from equation {4}[1]. These curves are based on a 25-year index age since all field data were collected from trees of age 50 years or less.

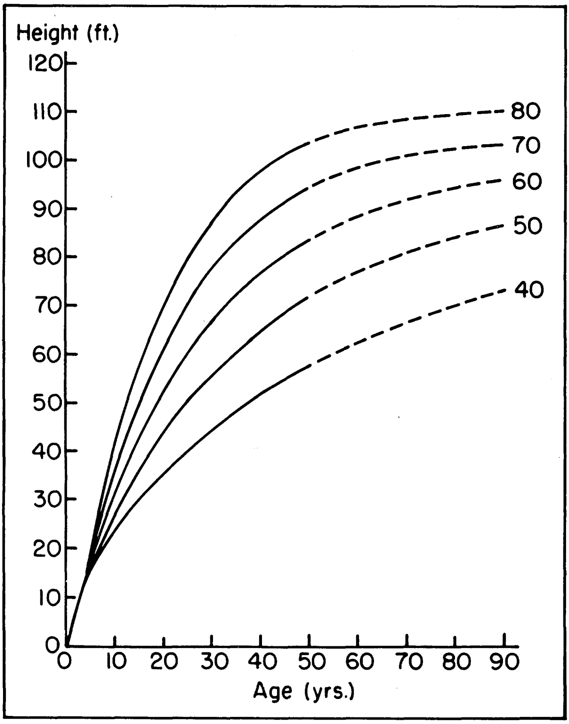

FIG. 2. Polymorphic Site Index Curves (Base age of 25 years) for Sweetgum in Alabama.

[1] Predicted heights were adjusted slightly to make curves pass through site index at age 25 years.

USE OF SITE INDEX CURVES

In order to determine average site index for a sweetgum stand in Alabama, measure total age and total height of at least two dominant trees in the stand. If the stand exceeds 5 acres in size or appears to vary in site index, then treat each 5 acres or each differing area as a new stand and measure another two dominants. The measurement trees should appear always to have been dominant and should not have suffered any obvious top damage. Use the site index curves of Figure 2 and estimate the site index value for each tree. The average site index of the measurement trees will be a satisfactory estimate of average site index for the stand.

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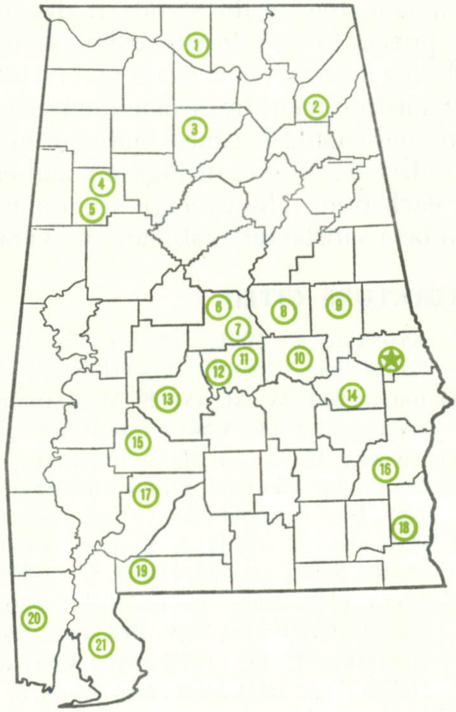

Research Unit Identification

Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
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8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
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11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.