SOUTHERN FOREST EXPERIMENT STATION

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SITE INDEX TABLE FOR SHORTLEAF PINE IN THE BOSTON MOUNTAINS OF ARKANSAS

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A field guide is presented for estimating shortleaf pine site index from aspect, slope shape, elevation, and degree of oak and hickory competition. The table predicted site index within 5 feet on 74 of 90 plots.

Land managers in the mountains of Arkansas need to evaluate the potential of sites for pine growth. Much of the forest there has been so badly abused by high-grading, indiscriminate grazing, and periodic wildfires that existing trees seldom reflect potential site quality, and many thousands of acres have been cleared of forest growth. Heretofore, selection among land management alternatives has been based on incomplete and sometimes inaccurate information concerning the most practical economic use of the land.

This note presents a table for estimating potential shortleaf pine site index in the Boston Mountains from easily ascertainable information on aspect, elevation, slope shape, and degree of oak and hickory competition. In a test of the table's accuracy, site index at 50 years was predicted within 5 feet on 74 of 90 sample plots.

METHODS

One hundred and two plots in a five county area were selected to represent the range of site conditions of shortleaf pine in the Boston Mountains. Colluvial soils (Allen and Holston series) were represented by 37 plots, residual soils of sandstone origin (Hartsells, Linker, and Mountainburg series) by 42 plots, and residual soils of shale origin (Enders series) by 23 plots.

Study plots were confined to even-aged 30-to 75-year-old stands of shortleaf pine and pine-hardwood mixtures. Each plot contained 3 to 5 or more dominant and codominant trees grouped as closely as possible to insure uniform soil condition. Pits were dug to bedrock or to a minimum depth of 50 inches, within the limits of each plot. All soil profiles were classified by soil scientists in the Soil Conservation Service. Soil samples were removed from each horizon for subsequent laboratory determinations of particle-size distribution, loss-on-ignition percent (a rough estimate of organic matter content), pH, and moisture contents at 1/3 and 15 atmospheres. Topographic features such as aspect, slope position, slope shape, slope steepness, total length of slope, distance from top of slope, and elevation were also recorded for each plot. Tree age was determined by adding 4 to the number of annual rings at breast height.

DATA ANALYSIS

Some 28 individual and combined soil and topographic variables were screened by regression. Age of the sample trees was not included as an independent variable. Screening revealed 11 variables that were correlated with site index in similar ways in each of the three soil groupings. Differences between residual soils of sandstone and shale origin were minor, and these series were lumped together. Finally analyses were computed for residual soils, colluvial soils, and all soils.

Equations were developed from each regression analysis and the equation of best fit for each soil group was selected.[1]

On confirmatory plots deviations between measured and predicted site index were small and the all-soils equation performed almost as well as separate equation for residual soils and colluvial soils. Accordingly, the equation for all soils was selected for field application:

Shortleaf pine S.I. = 65.6 + 2.12 (aspect) + 2.42 (slope shape) — 4.09 (elevation in thousands of feet) — 0.80 (percent loss-on-ignition). $R^2 = 0.58$. Standard error of estimate $Sy{\cdot}x = 3.31$.

FIELD APPLICATION

Definitions of the independent variables included in the equation are:

Aspect.—Degrees azimuth from true north coded for analysis. In general, N to NE exposures have the highest positive effect on site quality while S and SW exposures have negative effect. However plots with no aspect, i. e., essentially flat, have the highest site quality (all other factors being equal).

Slope shape.—The general configuration of the slope in the immediate vicinity of the plot. Either (1) *Convex,* where the general area tends to have a rounded surface sloping away from the plot proper; (2) *Linear,* neither rounded nor cup shaped; or (3) *Concave,* cup-shaped, where the general area tends to drain inward toward the plot. Site index increased as slope shape changed from convex through linear to the water receiving and retaining concave.

Elevation.—Elevation above sea level, determined from USGS maps and interpolated to the nearest 50 feet, where possible. In the analysis elevation was negatively correlated with shortleaf pine site index. That is, the higher the elevation the poorer the site was, if all other variables remained constant.

Loss-on-ignition.—This variable, which produced the highest correlation with site index, was determined by exposing soil samples from the A_1 horizon to temperatures of 650°C., and assuming that the percent loss reflected organic matter content. Such measurements are not practical in the field. Accordingly, an independent investigation was initiated to find some easily identifiable factor which was closely correlated with percent loss-on-ignition. After many trials, we found that the number of oak and hickory stems and sprout clumps within 40 feet of the plot center could be placed in frequency classes that were closely correlated with loss-on-ignition values. These frequency classes essentially reflect prior land use and presence or absence of hardwoods during the life of the stand.

Table 1 presents predicted site index for plots falling into six aspect groupings, eight elevation classes, three slope shapes, and four groupings of competing oak and hickory stems and sprout clumps. This table was constructed by semigraphical extrapolation of the regression equation.

This table was developed by holding all but a single variable constant in the equation and computing site indexes for various levels of the fluctuating variable. When this step was complete for each component of the equation, the data were plotted and values from the plottings were incorporated into the table to overcome rounding errors.

Site indexes were estimated with this table on 90 additional plots that had not been included in the analysis or involved in the development of the table. Estimates on 82 percent of these plots were within 5 feet of the

[1] Graney, D. L., and Ferguson, E. R. Site-quality relationships for shortleaf pine in the Boston Mountains of Arkansas. Forest Sci. 17: 16-22. 1971.

Table 1.—*Predicted shortleaf pine site index (height in feet at age 50) in the Boston Mountains by elevation, aspect, slope shape, and competition level*

Elevation (feet above sea level)	Slope shape	Aspect (azimuth)																							
		None—flat				0-75° 346-360°				76-105° 316-345°				106-135° 286-315°				136-165° 256-285°				166-255°			
		Competition level[1]																							
		0-29	30-59	60-89	90+	0-29	30-59	60-89	90+	0-29	30-59	60-89	90+	0-29	30-59	60-89	90+	0-29	30-59	60-89	90+	0-29	30-59	60-89	90+
700	Concave	74	71	68	65	73	70	67	64	72	69	66	63	71	68	65	62	70	67	64	61	69	66	63	60
to	Level	72	69	66	63	71	68	65	62	70	67	64	61	69	66	63	60	68	65	62	59	67	64	61	58
900	Convex	70	67	64	61	69	66	63	60	68	65	62	59	67	64	61	58	66	63	60	57	65	62	59	56
901	Concave	73	70	67	64	72	69	66	63	71	68	65	62	70	67	64	61	69	66	63	60	68	65	62	59
to	Level	71	68	65	62	70	67	64	61	69	66	63	60	68	65	62	59	67	64	61	58	66	63	60	57
1100	Convex	69	66	63	60	68	65	62	59	67	64	61	58	66	63	60	57	65	62	59	56	64	61	58	55
1101	Concave	72	69	66	63	71	68	65	62	70	67	64	61	69	66	63	60	68	65	62	59	67	64	61	58
to	Level	70	67	64	61	69	66	63	60	68	65	62	59	67	64	61	58	66	63	60	57	65	62	59	56
1300	Convex	68	65	62	59	67	64	61	58	66	63	60	57	65	62	59	56	64	61	58	55	63	60	57	54
1301	Concave	71	68	65	62	70	67	64	61	69	66	63	60	68	65	62	59	67	64	61	58	66	63	60	57
to	Level	69	66	63	60	68	65	62	59	67	64	61	58	66	63	60	57	65	62	59	56	64	61	58	55
1500	Convex	67	64	61	58	66	63	60	57	55	62	59	56	64	61	58	55	63	60	57	54	62	59	56	53
1501	Concave	70	67	64	61	69	66	63	60	68	65	62	59	67	64	61	58	66	63	60	57	65	62	59	56
to	Level	68	65	62	59	67	64	61	58	66	63	60	57	65	62	59	56	64	61	58	55	63	60	57	54
1700	Convex	66	63	60	57	65	62	59	56	64	61	58	55	63	60	57	54	62	59	56	53	61	58	55	52
1701	Concave	69	66	63	60	68	65	62	59	67	64	61	58	66	63	60	57	65	62	59	56	64	61	58	55
to	Level	67	64	61	58	66	63	60	57	65	62	59	56	64	61	58	55	63	60	57	54	62	59	56	53
1900	Convex	65	62	59	56	64	61	58	55	63	60	57	54	62	59	56	53	61	58	55	52	60	57	54	51
1901	Concave	68	65	62	59	67	64	61	58	66	63	60	57	65	62	59	56	64	61	58	55	63	60	57	54
to	Level	66	63	60	57	65	62	59	56	64	61	58	55	63	60	57	54	62	59	56	53	61	58	55	52
2100	Convex	64	61	58	55	63	60	57	54	62	59	56	53	61	58	55	52	60	57	54	51	59	56	53	50
2101	Concave	67	64	61	58	66	63	60	57	65	62	59	56	64	61	58	55	63	60	57	54	62	59	56	53
to	Level	65	62	59	56	64	61	58	55	63	60	57	54	62	59	56	53	61	58	55	52	60	57	54	51
2300	Convex	63	60	57	54	62	59	56	53	61	50	55	52	60	57	54	51	59	56	53	50	58	55	52	49

[1] Number of oak and hickory stems and sprout clumps within 40 feet of plot center.

actual site index at age 50 calculated from Coile and Schumacher's tables.[2]

In the Boston Mountain province we think the table will permit land managers to efficiently and effectively determine shortleaf pine growth potential. It should aid in selection of plantable sites and areas on which to concentrate intensive management practices.

[2] Coile, T. S., and Schumacher, F. X. Site index of young stands of loblolly and shortleaf pines in the Piedmont Plateau region. J. For. 51: 432-435. 1953.