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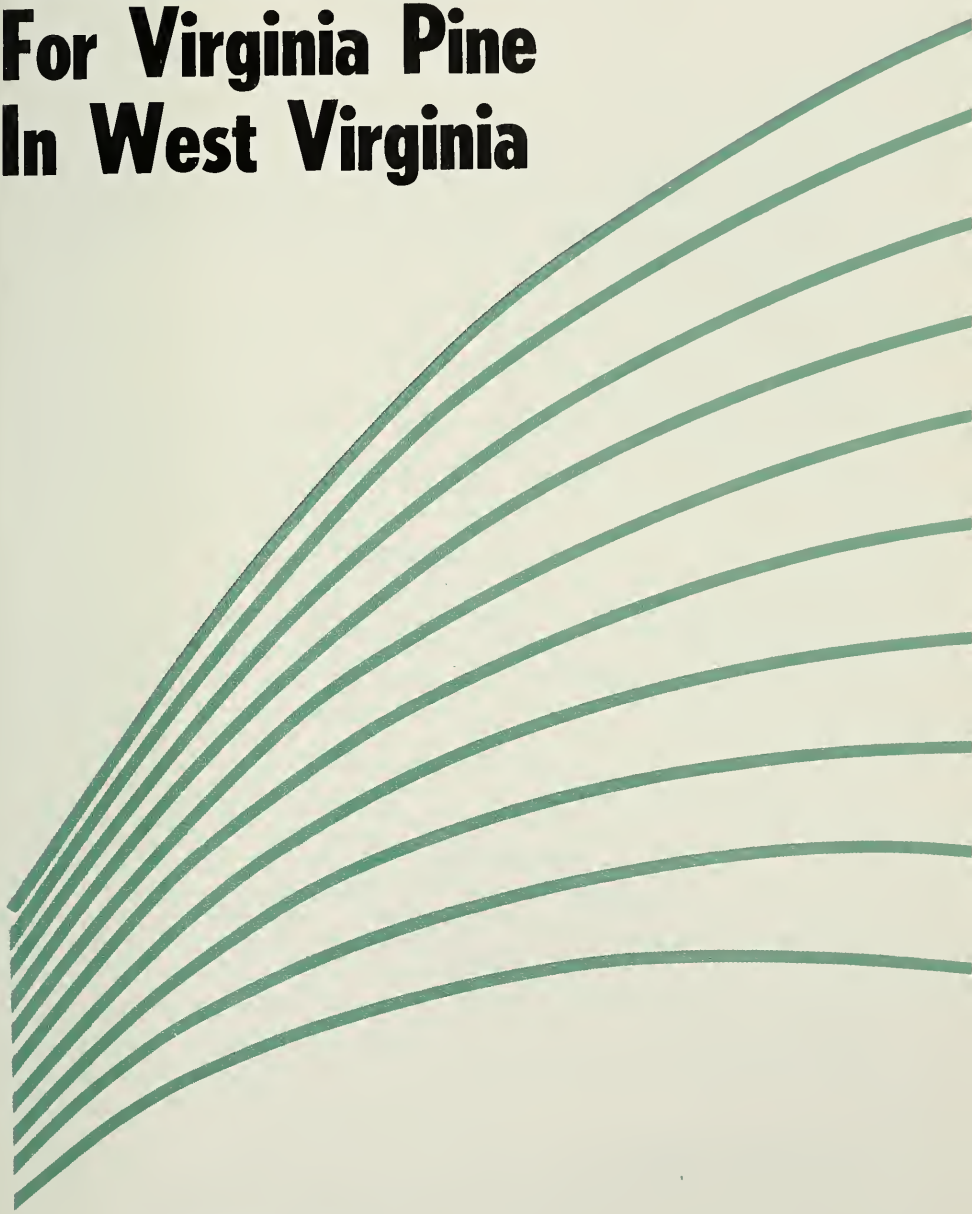

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Site Index Curves for Virginia Pine in West Virginia

D. L. Kulow, D. W. Sowers, and H. H. Heesch

Since the Second World War, the value of Virginia pine (*Pinus virginiana* Mill.) has increased because of its good pulping qualities and the demand for pulpwood (Carvell, 1966). The natural range of the species covers a considerable portion of West Virginia, Maryland, and Pennsylvania (Snow, 1960). West Virginia alone contains more than thirteen million cubic feet of the pine (Ferguson, 1964), and is presently serving as a source of wood for several mills. At the present time, growth, yield, and volume tables, as well as site index curves, are based upon data collected in the southern portion of the species' range (Chaiken, et al., 1959; Nelson, et al., 1961; and Slocum, et al., 1953). Chaiken suggested that these tools are not entirely applicable to the northern range of Virginia pine. A preliminary study in the eastern part of the State supported this suggestion.

Methods

Nine hundred and twenty-two dominant and codominant trees were measured in ten counties of West Virginia, and in two counties in both Maryland and Pennsylvania.[1] Tree heights were plotted over age, and a regression curve of the form:

$$\text{Log (tree height)} = a + b\,(\text{age})^{-1}$$

was fitted to the data. The "a" and "b" are the regression constant and coefficient respectively. Following regression, this became:

$$(1)\quad \text{Log (tree height)} = 4.3834 - 16.4987\,(\text{age})^{-1}$$

This accounts for 99.7 percent of the variation in the data and is used for the guide curve in Figure 1a.

To test the homogenity of the dispersion of the individual sample points about this regression curve, the coefficient of variation for each age class was computed and this parameter was then plotted over age in Figure 1b and a regression of the form:

[1]Calhoun, Grant, Hampshire, Hardy, Mason, Morgan, Pleasants, Ritchie, Wirt and Wood counties in West Virginia; Allegany and Washington counties in Maryland; and Bedford and Fulton counties in Pennsylvania.

$$\text{Coefficient of Variation } (\%) = a + b\,(\text{age}) + c\,(\text{age})^2$$

was fitted to the data. The second degree term was not significant and the equation became:

$$(2) \quad CV\,(\%) = 11.37 + .0898\,(\text{age})$$

This equation accounts for 97.9 percent of the variation. Therefore, the dispersal of the individual sample units about the regression curve of Equation 1 increases as age increases, so the guide curve must be adjusted with the coefficient of variation to form the set of index curves (Bruce, et al., 1950). The formula for this adjustment is:

$$H = \left[\frac{(SI_i / h_{50}) - 1}{CV_{50}}\right] (CV_a)\,(h_a) + h_a$$

Where: H = the height in feet of the i^{th} site index curve at the a^{th} age, or total tree height in feet,

SI_i = the numerical value of the i^{th} site index curve at any age,

$SI_i = H$, when age is 50 years,

h_{50} = the height of the guide curve in feet at age 50. (From Formula 1),

CV_{50} = the coefficient of variation expressed as a decimal at age 50 (From Formula 2),

h_a = the height of the guide curve at the a^{th} age (From Formula 1),

CV_a = the coefficient of variation decimal at the a^{th} age (From Formula 2).

Solving for site index, the formula becomes:

$$SI_i = \left[\frac{CV_{50}\ \ h_{50}}{CV_a}\right] \left[(H / h_a) - 1\right] + h_{50}$$

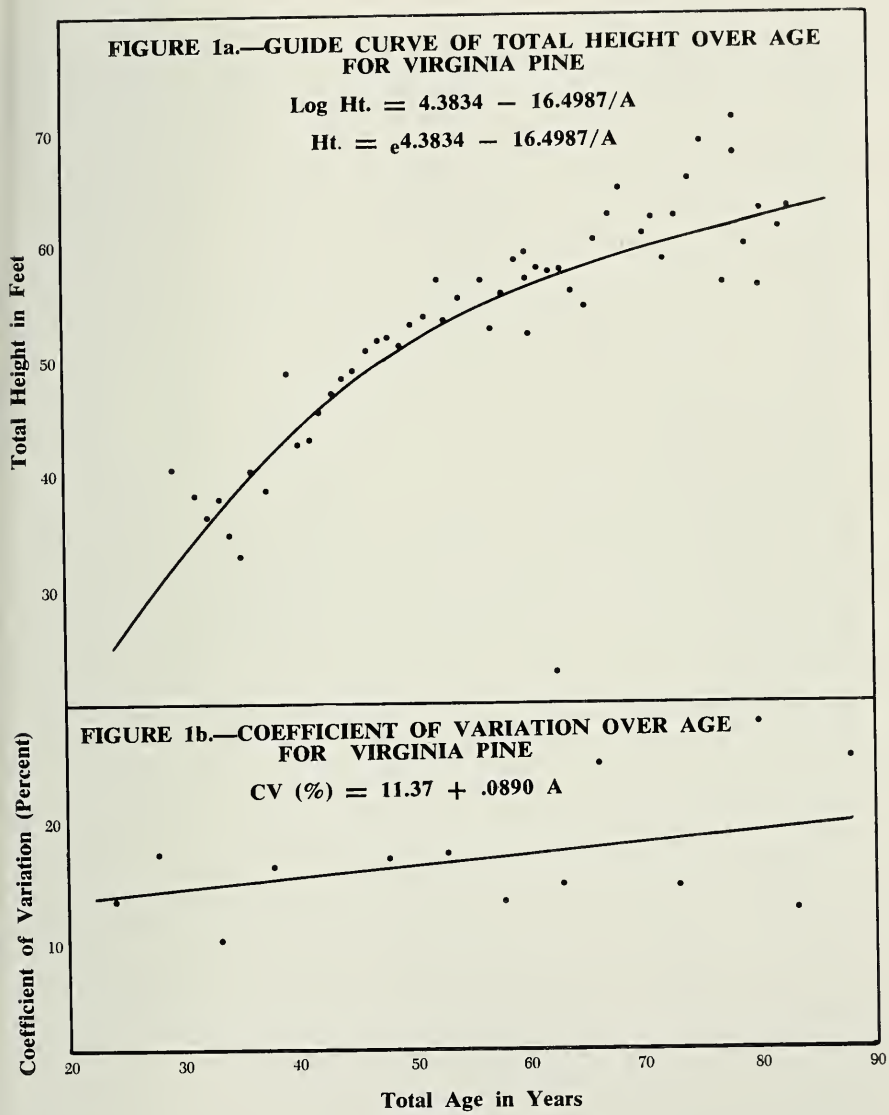
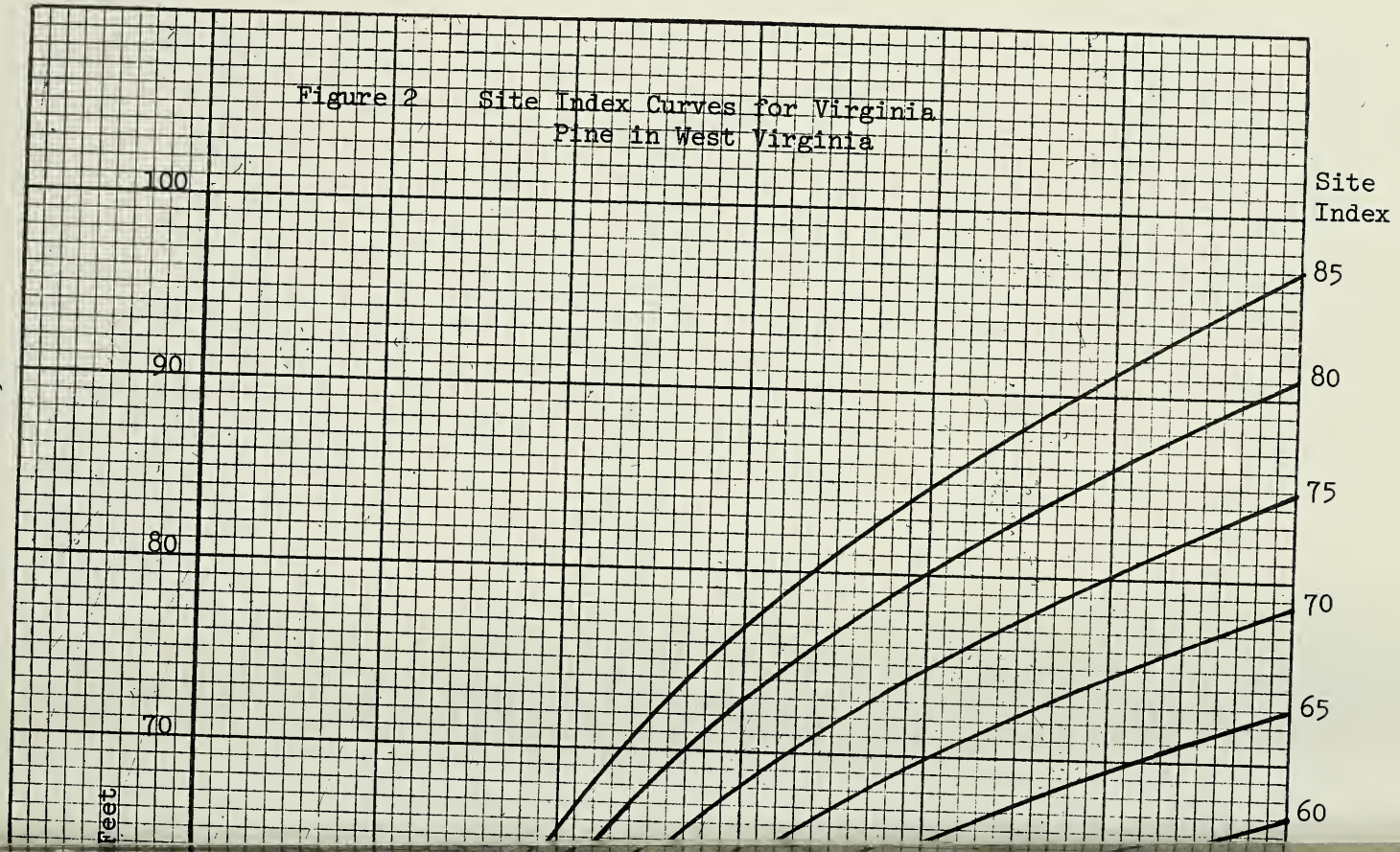
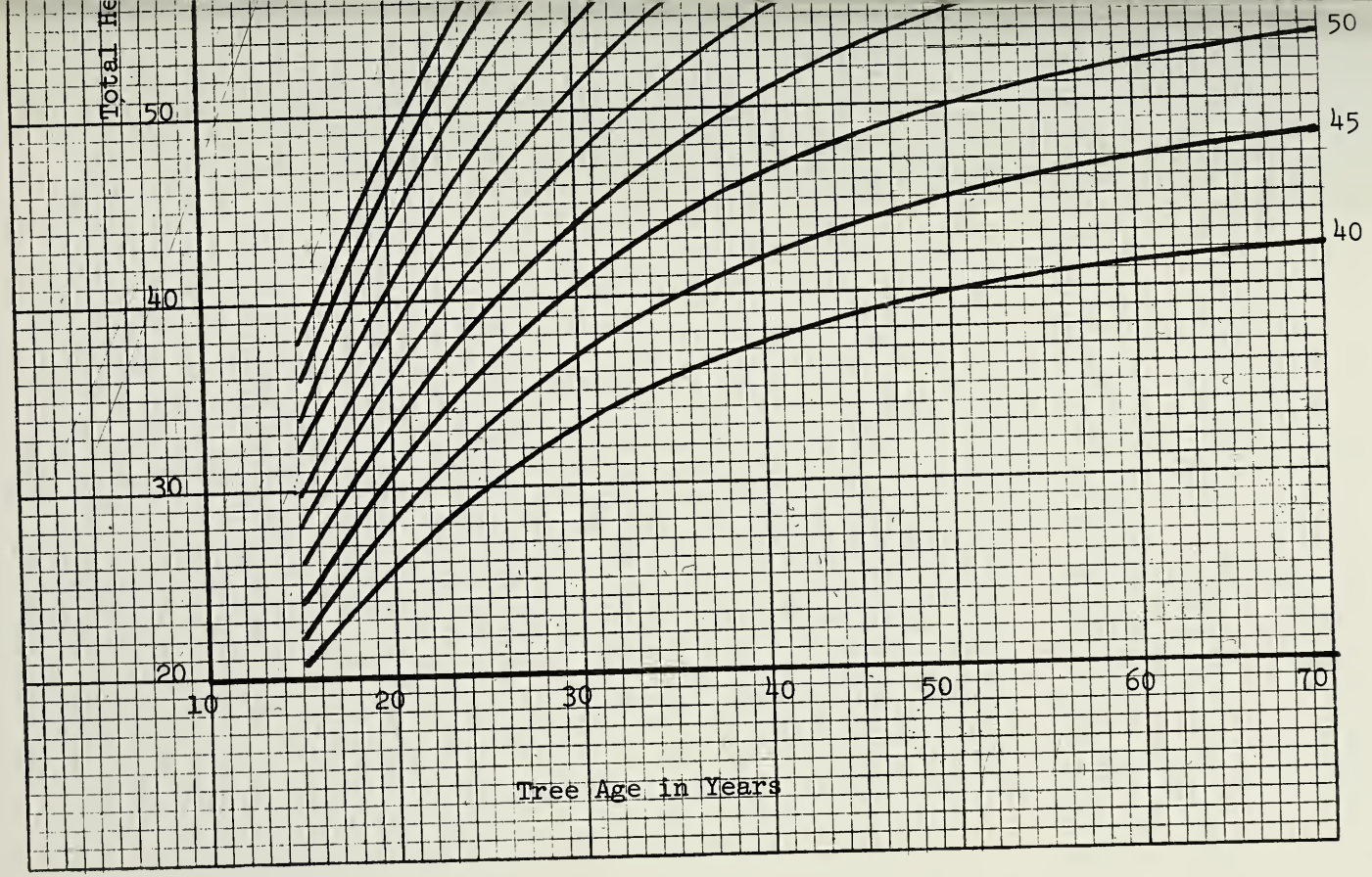


FIGURE 1a.—GUIDE CURVE OF TOTAL HEIGHT OVER AGE FOR VIRGINIA PINE
Log Ht. = 4.3834 − 16.4987/A
Ht. = e4.3834 − 16.4987/A
Total Height in Feet
70
60
50
40
30
FIGURE 1b.—COEFFICIENT OF VARIATION OVER AGE FOR VIRGINIA PINE
CV (%) = 11.37 + .0890 A
Coefficient of Variation (Percent)
20
10
20
30
40
50
60
70
80
90
Total Age in Years

Figure 2 Site Index Curves for Virginia Pine in West Virginia




Total He
50
40
30
20
10
20
30
40
50
60
70
Tree Age in Years
50
45
40

From Formula 1:

$h_{50} = 57.6$ feet

and $h_a = {}_e(4.38 - 16.50/A)$ Where e is the base of the Napierian logarithm and A is the tree's age

From Formula 2:

$CV_{50} = 15.86$ percent

and $CV_a = 11.37 - .0898\ (A)$ where A = the tree's age

By substitution:

$$(3)\quad SI_i = \left[\frac{10{,}173.1}{126.6 + A}\right]\left[He^{-(4.38 + 16.50/A)} - 1\right] + 57.6$$

Results

A range of tree heights (H) and tree ages (A) was selected and applied to Formula 3. The resulting points were drawn into the curves of Figure 2. To test these curves against those now in use, a sample of five trees was selected randomly from each age class in the original data. The site index for these trees was computed for Formula 3 and read from the tables of Chaiken, et al., (1959) and Slocum, et al., (1953). The values were compared by Chi-squared test on a limit of four feet at the ninety-five percent level of accuracy. The difference between these curves and the older curves is very significant (Table 1.) However, if we assume that the effective range (i.e. the range in ages where most site index values are applicable) is from 30 years to 60 years, then a Chi-square value of 42.27 is needed for significance on 29 degrees of freedom. The difference between these curves and Southeastern curves is still significant with a Chi-squared value of 95.43. A comparison with the Durham County, North Carolina, curves shows no significant difference (Chi-square = 13.70).

Table 1.—Chi-Squared Test Between the Site Index Curves of Figure 1 and the Southeastern Curves[1] and the Durham Co. Curves[2]

Age in Years	Height in Feet	Fig. 1 SI	Southeastern Ex. Sta. SI (%)	Durham Co. North Carolina SI (%)	Age in Years	Height in Feet	Fig. 1 SI	Southeastern Ex. Sta. SI (%)	Durham Co. North Carolina SI (%)
21	39	63	71	80	47	71	73	73	75
22	42	66	73	82	47	44	45	45	46
23	39	58	65	70	47	52	53	53	54
24	39	56	63	69	47	48	48	49	50
25	31	42	49	55	48	67	68	68	70
26	48	67	72	80	52	67	67	66	66
26	37	49	56	45	53	69	68	68	68
26	42	57	63	70	53	63	62	62	62
27	53	73	77	85	53	51	50	50	49
28	54	73	76	84	54	54	53	53	52
33	44	52	55	59	56	66	64	64	64
34	53	63	65	70	57	71	68	68	67
34	50	58	62	65	58	67	64	65	63
34	46	54	57	60	59	63	60	61	59
35	54	63	65	70	60	72	68	69	67
38	57	64	65	69	61	75	70	72	69
39	64	72	72	76	62	60	57	57	55
39	65	72	73	77	62	64	60	61	57
39	68	76	77	82	63	66	62	63	60
39	49	54	55	58	65	64	59	60	58
43	61	65	65	68	67	72	66	68	65
43	48	51	52	52	70	54	50	51	48
43	46	47	49	50	71	55	51	51	49
44	74	78	78	80	79	90	77	83	73
44	44	46	47	47	88	73	62	66	62
					Chi-Squared[3]			146°°	503°°

[1] Chaiken, et al., (1959)
[2] Slocum, et al., (1953)
[3] $o^{-2} = (4)^2 / (1.96)^2$
°° very significant difference

Summary

Site index curves constructed for the northern portion of the range of Virginia pine are significantly different from those in the central and southern part of the range. This represents a refinement to the site evaluation procedure for the species, but does not imply that former management plans are in error. Until growth and yield tables can be constructed for this area, new management procedures should be based upon the site index values from Figure 2 and the yield values from the southern area.

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