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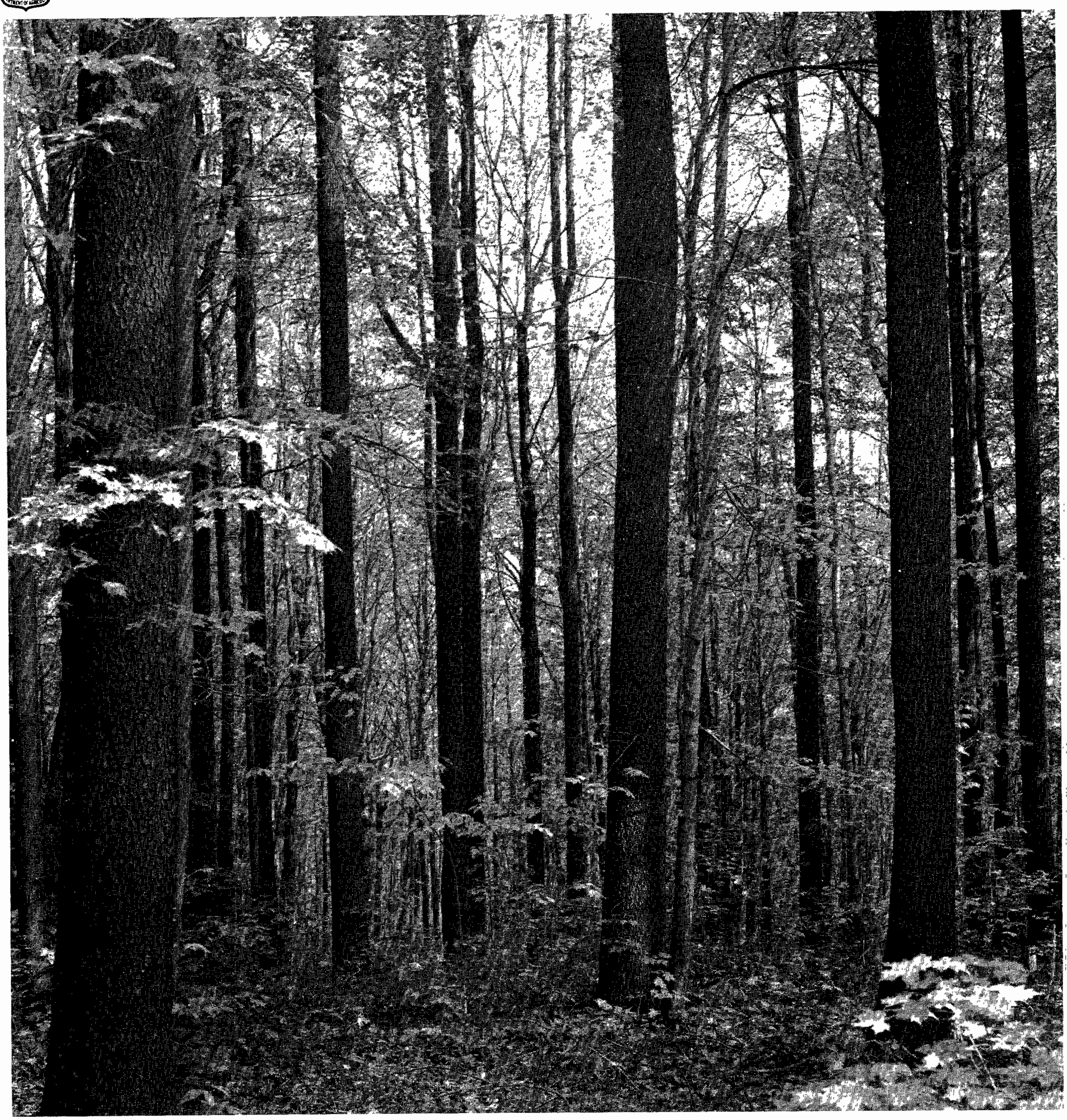
Black Cherry Site Index Curves for the Allegheny Plateau

L. R. Auchmoody
C. O. Rexrode



The Authors

L. R. Auchmoody is a principal soil scientist at the Northeastern Forest Experiment Station's Forestry Sciences Laboratory at Warren, Pennsylvania. Before his retirement, C. O. Rexrode was a research forest entomologist at the Northeastern Station's Forestry Sciences Laboratory at Delaware, Ohio.

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Abstract

Black cherry site index curves were developed for the Allegheny Plateau in northwestern Pennsylvania. They show for this region that height rises less sharply prior to the index age and is maintained for a longer period thereafter than described by existing curves. An equation to predict site index from height and age is furnished to allow the use of these curves in computer processing. For field use, a table of site indexes by 2-foot heights and 2-year ages is provided.

Introduction

For many years the only available site index curves for black cherry (*Prunus serotina* Ehrh.) were those developed in 1937 by S. E. Defler,[1] and later published by the USDA Forest Service (Hampf 1965). These were harmonized curves made from height and age measurements taken in 38 stands growing in south-central New York and northwestern Pennsylvania. These curves have been used extensively.

More recently, a second set of black cherry site index curves was developed for the northern Lake States region (Carmean 1978). These are polymorphic curves made from stem analyses of 126 trees located on 42 plots. These curves generally agree with the Defler curves below the index age, but show considerable departure above. Since the entire data set used to develop the Carmean curves came from the extreme northwestern commercial range of black cherry, it may not be strictly applicable to other geographic regions that differ in climate, soils, and in black cherry growth rates.

Black cherry is one of the most important and most valuable eastern hardwoods. It is found in commercial quantities and attains its best growth and development on the Allegheny Plateau of western Pennsylvania and New York and southward throughout the Allegheny Mountains. Yet the accuracy with which existing site index curves describe black cherry height/age relationships within this region remains undetermined. Therefore, the purpose of this study was to construct a set of black cherry site index curves applicable to sites on the Allegheny Plateau of western Pennsylvania and New York, and to compare these curves with those that already exist.

[1]Defler, Sam E. Black cherry characteristics, germination, growth, and yield. Unpublished M.S. thesis. New York State College of Forestry; 1937.

Procedures

Six fully stocked Allegheny hardwood stands were selected for sampling. The sampled stands were even-aged second growth, about 70 years old, free from cutting, and located on the Allegheny Plateau in northwestern Pennsylvania. These stands originated after heavy clearcutting early in the century, and now contain 30 to 50 percent black cherry in admixture with white ash (*Fraxinus americana* L.), red maple (*Acer rubrum* L.), sugar maple (*Acer saccharum* Marsh.), and beech (*Faqus grandifolia* Ehrh.). The prevailing cool and moist climate of the area is characterized by a 120-day frost-free period and 44 inches of well-distributed precipitation, and is typical of conditions where black cherry attains its best development.

The six sites included soils that ranged in drainage from well drained to somewhat poorly drained, and in soil texture from loam to silty clay loam. All were residual soils, having developed in place from the underlaying parent material. The effective rooting depth was generally less than 3 feet, being limited by a fragipan, perched water table, or compact stony layers above bedrock. Soils included the Cookport, Clymer, Hazelton, and Wharton series, which are representative and important forest soils in the region. Only the very wettest and most poorly drained soils where black cherry is seldom found and grows poorly were not sampled.

A total of 39 sample trees growing within the six areas were felled and dissected. All trees were dominants or codominants that had no serious stem deformities, and they showed no evidence of suppression or disease. Site index at age 50 of the sampled trees ranged from 56 to 82 feet.

Felled trees were sectioned at 5-foot intervals for their entire length. At each dissection point, the height above ground was recorded and a 1-inch-thick disk removed for age determinations in the laboratory.

Height and age data were adjusted to compensate for dissections not coinciding with the maximum height attained for a particular age, and for differences in the number of years required for seedlings to reach breast height. Because actual tree heights usually are greater than heights of the dissection points, heights were adjusted upward by adding half of the average annual height growth to the height of each dissection point (Carmean 1972). To avoid variation in the time required for stands to reach 4.5 feet, a constant 4 years were added to age at breast height to obtain total age.

The site index curves were constructed by a technique similar to one described by McQuilkin (1974). First, regressions of the form $Y = a + bX - cX^2$ were fitted to the adjusted height (Y) and age (X) of each sample tree. All regressions were significant ($P \leq .01$) and had R^2 exceeding 0.99. From these regressions, the actual site index (height at age 50) and the corresponding heights attained at 10, 20, 30, 40, 50, 60, 70, and 80 years were obtained for each of the 39 trees. Next, these data were used to develop linear regressions with site index as the dependent variable and height as the independent variable for each of the eight age classes. These regressions were then used to determine the tree heights at 10-year age intervals that predicted site indexes of 40, 50, 60, 70, 80, 90, and 100. Finally, these heights and ages were used to plot each of the 10-foot site index curves from 40 to 100. The ability of these curves to describe height/age relationships was checked by comparing heights obtained from the curves with the actual heights attained by the original 39 trees, but no evaluation was made with an independent sample.

Results

The black cherry site index curves derived in this study are given in Figure 1. They show substantially different height/age patterns than described in the original curves by Defler[1] and by the curves developed for the Lake States by Carmean (1978). In both sets of existing curves, height rises sharply before the index age and then falls off quickly after the age of 50 years. By contrast, second-growth cherry in northwestern Pennsylvania has slower early growth and more sustained height growth after the index age. These differences in curve form mean that using the other curves locally will result in lower than actual site indexes for stands between the ages of 20 and 50 years, and higher than actual site indexes in stands older than 50 years. These deviations are large, underestimating by as much as 15 to 16 site index points in very young stands (age 20) to overestimates of 10 to 15 site index points at age 80 (Table 1).

The new curves appear to closely track black cherry height/age patterns in this area, as evidenced by small mean departures between the original 39 sample trees and the composite site index curves (Table 2). Though the accuracy of the curves has not been verified with independent data, we nevertheless believe that the curves can be used with confidence since the sample trees used for their development and the sites upon which the sample trees grew were highly representative of the region.

To enable the use of the curves with electronic data processing, an equation was developed to predict site index from height and age. The equation is:

$$\text{Site Index} = 71.558 + 1.437(\text{height}) - 2.353(\text{age}) + 0.016(\text{age}^2) - 0.007(\text{height} \times \text{age})$$

Each of the four variables are significant ($P \leq .01$). The equation has an R^2 of 0.993 and a standard error of estimate equal to 1.78 feet.

Table 1.—Comparative site indexes at several heights and ages using the present curves, Defler's curves, and Carmean's curves (deviations from present curves in parentheses)

Height (feet)	Age 20			Age 30			Age 40			Age 60			Age 70			Age 80		
	Present curves	Defler	Carmean	Present curves	Defler	Carmean	Present curves	Defler	Carmean	Present curves	Defler	Carmean	Present curves	Defler	Carmean	Present curves	Defler	Carmean
20	55	—[a]	39(−16)															
30	70	55(−15)	59(−11)	52	40(−12)	44(−8)												
40	84	73(−11)	76(−8)	65	56(−9)	57(−8)	51	46(−5)	47(−4)									
50	100	91(−9)	—	78	70(−8)	69(−9)	62	57(−5)	58(−4)	42	46(+4)	44(+2)						
60				90	83(−7)	80(−10)	73	68(−5)	68(−5)	50	55(+5)	54(+4)	44	51(+7)	48(+4)	40	48(+8)	44(+4)
70				102	98(−4)	—	84	80(−4)	78(−6)	59	64(+5)	64(+5)	52	60(+8)	58(+6)	47	57(+10)	54(+7)
80							94	91(−3)	—	69	73(+4)	74(+5)	60	68(+8)	69(+9)	55	65(+10)	65(+10)
90										78	82(+4)	—	70	77(+7)	81(+11)	63	73(+10)	78(+15)
100										88	91(+3)	—	79	85(+6)	—	73	81(+8)	—
110										97	100(+3)	—	88	94(+6)	—	82	89(+7)	—
120													98	102(+4)	—	92	98(+6)	—

[a]Site indexes are beyond those given by the height/age curves.

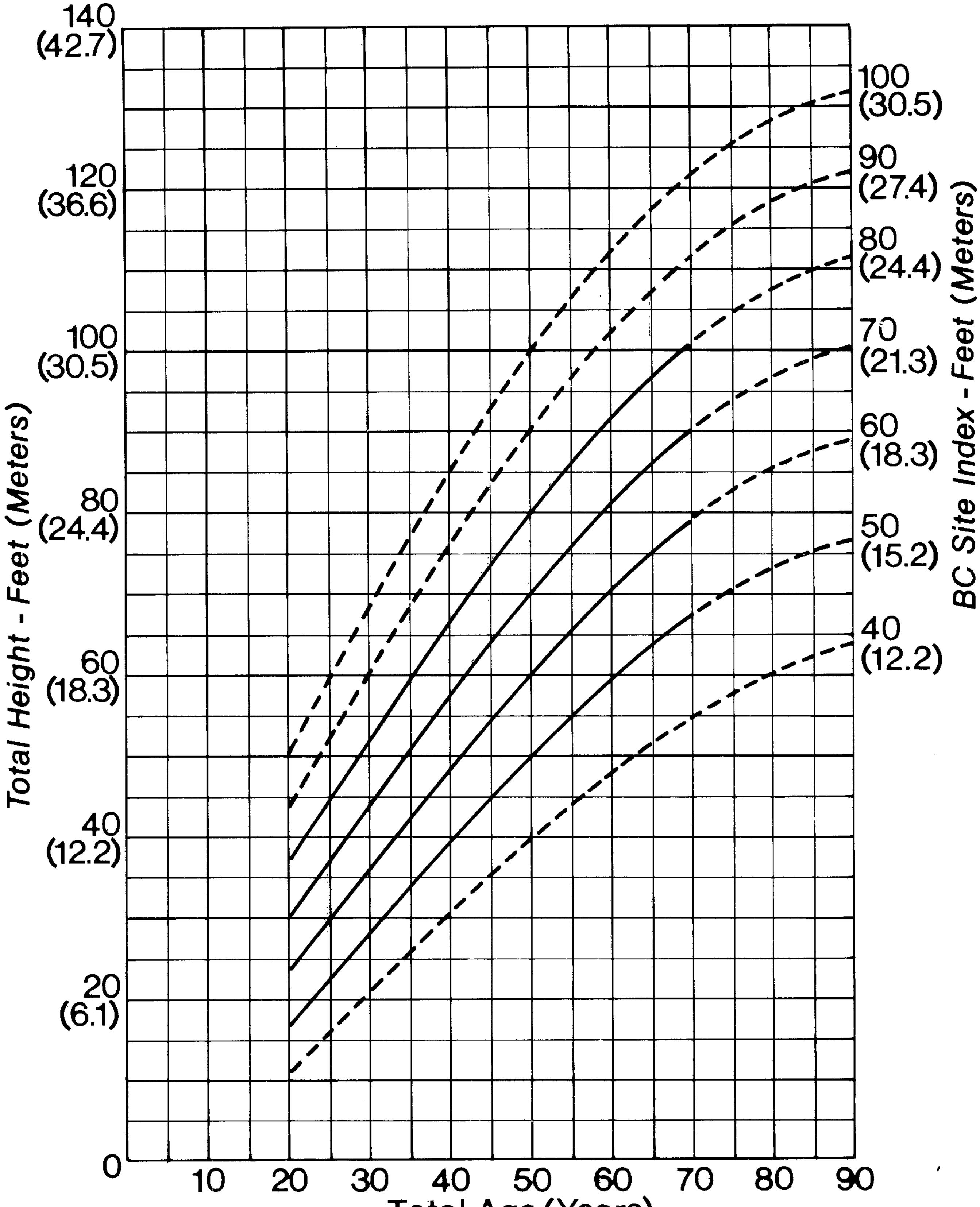

Figure 1.—Black cherry site index curves for the Allegheny Plateau. Four years should be added to breast-height age to obtain total age. Dashed lines are beyond observed data.

Table 2.—Departure of the new site index curves from actual height/age patterns of the 39 sample trees (site index curve height + actual height)

Age	Mean departure	Maximum negative departure	Maximum positive departure
		Feet	
20	−0.3	−3	+4
30	+0.1	−2	+4
40	+0.2	−1	+3
50	0	0	0
60	−0.4	−4	+2
70	−1.2	−9	+4

To simplify the use of the site index curves in the field, and to eliminate the need for interpolating between the 10-foot site classes shown in Figure 1, the equation was used to produce a table of site indexes by 2-foot heights and 2-year age classes (Table 3). The table can be used in lieu of the curves by simply picking out the site index that corresponds to the appropriate height and stand age.

Tabular values computed with the equation and given in Table 3 are similar but not identical to those obtained directly from the curves (Fig. 1). For example, at the index age of 50, tabular site indexes are about 2 feet less than those from the curves at site index 50 and below, and are about 2 feet higher than indicated by the curves at site index 90 and above. Nevertheless, nearly all values in the table are within ± 2 feet of the site indexes obtained directly from the curves. This is sufficient for field use.

Discussion

The curves developed in this study apply to stands that have not been damaged by major ice and glaze storms, and to those which have remained relatively well stocked throughout their life. Measurements from stands where extensive stem breakage has occurred, such as that associated with the glaze storms of 1936 and 1950 (Hough 1959), will result in abnormally low site indexes. Many stands on the Allegheny Plateau have experienced this type of stem breakage, so care must be exercised in selecting sites that are free of such disturbance.

Low estimates of site index also are likely if the present curves are applied to stands that are sparsely stocked, such as orchard stands and those that may have existed many years at less than 40 to 50 percent relative density. This will occur simply because black cherry requires strong lateral competition to develop straight boles and to maintain normal rates of height growth.

Finally, the best estimates of site index will be obtained if breast height age plus 4 years is used as a measure of total age rather than the actual age since stand establishment. This will minimize the effect of variables, such as deer browsing, that are not site related but that have a major impact on early height growth. The use of actual age, such as that determined from stand records or low stumps, will result in lower than actual site indexes where it has taken more than 4 years for the stand to reach breast height.

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Table 3.—Black cherry site index estimates by 2-foot heights and 2-year ages.

Stand age (years)	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
20	52	54	57	59	62	65	67	70	72	75	78	80	83	85	88	91	93	96	98	101																												
22	48	51	53	56	58	61	63	66	69	71	74	76	79	81	84	87	89	92	94	97	99																											
24	45	47	50	52	55	57	60	62	65	67	70	73	75	78	80	83	85	88	90	93	95	98	100																									
26	41	44	46	49	51	54	56	59	61	64	66	69	71	74	76	79	81	84	86	89	91	94	96	99																								
28	38	41	43	46	48	51	53	55	58	60	63	65	68	70	73	75	78	80	83	85	88	90	93	95	98																							
30		38	40	42	45	47	50	52	55	57	60	62	64	67	69	72	74	77	79	82	84	86	89	91	94	96	99																					
32			37	39	42	44	47	49	52	54	56	59	61	64	66	68	71	73	76	78	81	83	85	88	90	93	95	97	100																			
34				37	39	41	44	46	48	51	53	56	58	60	63	65	68	70	72	75	77	80	82	84	87	89	92	94	96	101																		
36						39	41	43	46	48	50	53	55	57	60	62	64	67	69	72	74	76	79	81	83	86	88	90	93	95	98	100																
38							38	40	43	45	47	50	52	54	57	59	61	64	66	68	71	73	75	78	80	82	85	87	89	92	94	96	99															
40								38	40	42	45	47	49	52	54	56	59	61	63	66	68	70	72	75	77	79	82	84	86	89	91	93	95	98														
42									38	40	42	45	47	49	51	54	56	58	60	63	65	67	70	72	74	76	79	81	83	85	88	90	92	95	97	99												
44										38	40	42	44	47	49	51	53	56	58	60	62	65	67	69	71	74	76	78	80	82	85	87	89	91	94	96	98	100										
46											37	40	42	44	46	49	51	53	55	57	60	62	64	66	69	71	73	75	77	80	82	84	86	89	91	93	95	97	100									
48												37	40	42	44	46	48	51	53	55	57	59	62	64	66	68	70	73	75	77	79	81	83	86	88	90	92	94	97	99								
50													38	40	42	44	46	48	51	53	55	57	59	61	64	66	68	70	72	74	77	79	81	83	85	87	89	92	94	96	98	100						
52														38	40	42	44	46	48	51	53	55	57	59	61	63	65	68	70	72	74	76	78	80	83	85	87	89	91	93	95	97	100					
54															38	40	42	44	46	48	51	53	55	57	59	61	63	65	67	70	72	74	76	78	80	82	84	86	88	91	93	95	97	99				
56																38	40	42	45	47	49	51	53	55	57	59	61	63	65	67	69	71	74	76	78	80	82	84	86	88	90	92	94	96	98			
58																37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	76	78	80	82	84	86	88	90	92	94	96	98		
60																	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	82	84	86	88	90	92	94	96	98	100
62																		38	40	42	44	46	48	50	52	54	56	58	60	62	64	65	67	69	71	73	75	77	79	81	83	85	87	89	91	93	95	97
64																			38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	77	79	81	83	85	87	89	91	93	95
66																				39	41	43	45	47	49	51	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	81	83	85	87	89	91	93
68																					40	42	44	45	47	49	51	53	55	57	59	61	63	64	66	68	70	72	74	76	78	80	82	84	85	87	89	91
70																						41	42	44	46	48	50	52	54	56	57	59	61	63	65	67	69	71	72	74	76	78	80	82	84	86	87	89
72																							41	43	45	47	49	51	53	54	56	58	60	62	64	65	67	69	71	73	75	77	78	80	82	84	86	88
74																								42	44	46	48	50	52	53	55	57	59	61	62	64	66	68	70	72	73	75	77	79	81	82	84	86
76																									43	45	47	49	51	52	54	56	58	60	61	63	65	67	69	70	72	74	76	78	79	81	83	85
78																										45	46	48	50	52	53	55	57	59	60	62	64	66	68	69	71	73	75	76	78	80	82	83
80																											46	48	49	51	53	54	56	58	60	61	63	65	67	68	70	72	74	75	77	79	81	82
82																												47	49	50	52	54	56	57	59	61	62	64	66	68	69	71	73	74	76	78	80	81
84																												47	48	50	52	53	55	57	58	60	62	64	65	67	69	70	72	74	75	77	79	80
86																													48	50	51	53	55	56	58	60	61	63	65	66	68	70	71	73	75	76	78	80
88																													48	50	51	53	55	56	58	59	61	63	64	66	68	69	71	72	74	76	77	79
90																													48	50	51	53	54	56	58	59	61	62	64	66	67	69	70	72	74	75	77	78

Auchmoody, L. R.; Rexrode, C. O. **Black cherry site index curves for the Allegheny Plateau.** Res. Pap. NE-549. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 5 p.

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Keywords: *Prunus serotina;* site index curves; height growth

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