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by H. Clay Smith

Height of Tallest Saplings in 10-year-old Appalachian Hardwood Clearcuts

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6816 MARKET STREET, UPPER DARBY, PA. 19082

The Author

H. CLAY SMITH is a research forester at the Northeastern Forest Experiment Station's laboratory at Parsons, West Virginia. He received a B.S. degree from West Virginia University, an M.S. degree from Purdue University, and attended the State University of New York College of Forestry at Syracuse. He has been working for the U.S. Forest Service in timber-management research since 1962.

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ABSTRACT

Stem characteristics, mainly height, of the tallest hardwood saplings in 10-year-old circular clearcut openings were evaluated for several Appalachian hardwoods in West Virginia. Heights of the tallest saplings were not influenced by cardinal directions on two oak sites. Saplings were taller near the center of 150-, 200-, and 250-foot openings than saplings in the center of the 50- and 100-foot openings. Saplings in the larger openings (150- to 250-foot) were significantly taller near the opening center compared to the tallest saplings along the border of the same size openings. For small openings (100-foot or less), the border effect was present throughout the openings.

Height of Tallest Saplings in 10-year-old Appalachian Hardwood Clearcuts

WE HAVE INFORMATION from a West Virginia study that may be helpful in answering questions about the effect of size of clearcut openings on the heights of dominant-codominant hardwood reproduction.

Generally, hardwood reproduction near the borders of clearcut openings is not as tall as that in the center of the openings *(Smith 1963)*. However, Tryon and Trimble *(1969)* reported that the height of dominant-codominant Appalachian hardwood reproduction in 14-year-old 1/4- and 1/2-acre openings did not differ, and stems including the intolerants were capable of growing well in openings as small as 1/4-acre for at least 15 years. Minckler and Woerheide *(1965)* evaluated hardwood reproduction in the Central States and reported that the north and central portions of 10-year-old clearcut openings had taller trees. However, Trimble and Tryon *(1969)* reported no difference in height of dominant-codominant stems for any cardinal direction quadrant.

For upland hardwoods in the Central States, opening size did not affect reproduction growth 2 years after cutting *(Sander and Clark 1971)*. They reported an edge or border effect on all circular openings (1/8- to 5-acres). However, Clark and Watt *(1971)* noted that the smaller openings, less than 1/2-acre in size, had a much greater percentage of area that was influenced by the border. They indicated that the width of the border effect was likely to be greater than 10 feet and less than 30 feet.

To provide additional information about height of reproduction, we evaluated several characteristics, mainly height, of the tallest saplings in 10-year-old Appalachian hardwood clearcut openings.

STUDY AREA

The study was made on the Fernow Experimental Forest near Parsons, West Virginia. Data were collected on two oak sites—site index 60 and site index 75. The area had been heavily cut to remove the best trees in 1905 to 1910. Average annual rainfall for this locale usually varies from 55 to 60 inches. Soils are largely Calvin and DeKalb channery silt loams averaging 30 inches depth to bedrock.

All stands were unmanaged and well stocked at the time the study began in 1965. These stands were dominated by sugar maple, yellow-poplar, red oak, black cherry, basswood, beech, and sweet birch trees on the better sites. On the fair sites, chestnut oak, red oak, red maple, sweet birch, black gum, sassafras, and sourwood were dominant. On the better sites, the heights of dominant-codominant border trees averaged about 90 feet, on the fair sites about 65 feet. Most of the sawtimber-size trees were second growth, 55 to 60 years old; however, there were some old residuals from the early logging in 1905 to 1910.

METHODS

For the study we used circular clearcut openings 50, 100, 150, 200, and 250 feet in diameter on the good sites and 50, 150, and 250 feet in diameter on the fair sites. There were three replications of each opening size. The 50-foot openings involved the removal of two or three sawtimber-size trees, resembling an individual-tree selection or group-selection cutting practice. The 250-foot openings were more than 1 acre in size and provided the effect of a clearcut.

Circular plot diameter	*Acres*	*Number of openings*	
		Good site	*Fair site*
(feet)		*SI 75*	*SI 60*
50	0.045	3	3
100	.180	3	0
150	.406	3	3
200	.721	3	0
250	1.127	3	3

All trees 5 inches diameter breast height (dbh) and larger were cut. Stems 1.0 to 4.9 inches dbh were basal-sprayed, using 2,4,5-T at 16 pounds acid equivalent per 100 gallons (ahg) mixed with diesel oil. Also, all cut stumps were sprayed with this herbicide mixture. This herbicide treatment was used to reduce sprouting.

For sampling purposes, radial transects in the four cardinal directions were used in selecting study stems. Successive 25-foot long, 4-foot wide sampling plots were established along the transects. Thus, a 50-foot diameter opening had one 25-foot sample plot per cardinal direction or four sample plots per opening. A 250-foot diameter opening had five 25-foot sampling plots per cardinal direction or 20 sample plots per opening. The 25-foot sample plots started at the opening center (sample plot 1) and progressed toward the opening border (fig. 1).

Data analyses and comparisons were made on the heights of the tallest sapling in 10-year-old clearcuts.

The tallest dominant-codominant sapling was selected within each 25-foot sample plot regardless of species. Occasionally a sapling adjacent to the sample plot was selected because it was dominating saplings on the sample plot. Data recorded for the tallest sapling were: species, dbh, total height, crown class, and potential for a sawlog crop tree. Aspect, slope position, and slope percent were variable among the openings, and we did not have sufficient information to analyze these data. Data were subjected to analysis of variance techniques and tested for significant differences at the 5-percent level.

RESULTS

Sapling Heights

Cardinal directions.—Statistical analyses indicated that the height of tallest saplings did not differ significantly by direction for the good or fair sites.

Sapling heights by opening size.—The tallest saplings ranged in height from an average of about 17 feet to more than 29 feet on the good sites and about 16 to 32 feet on the fair sites. We found significant differences in sapling heights among the various opening sizes (table 1). Saplings in the center of 50- and 100-foot openings on the good sites were significantly shorter than saplings growing in the center of 150-, 200-, and 250-foot openings.

A similar result was found on the fair sites: saplings in the center of 50-foot openings were

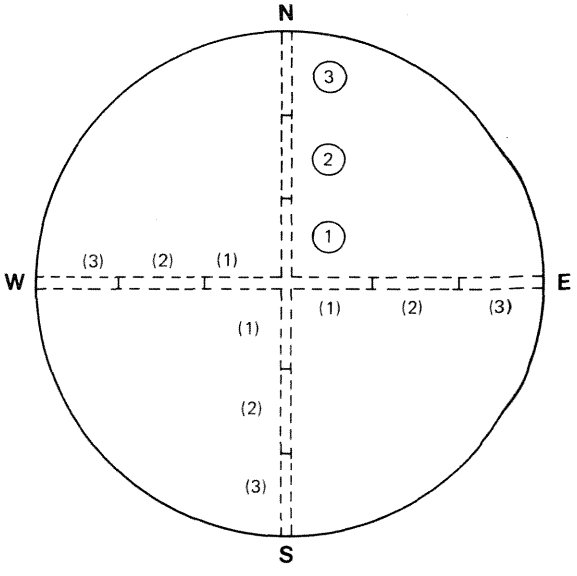

Figure 1.—Schematic of sampling scheme for a 100-foot-diameter opening. Numbers 1, 2, 3 show sample plots.

Table 1.—*Sapling height analyses, in feet*

25-foot sample plots	Opening size							
	Good site					Fair site		
	50	100	150	200	250	50	150	250
AVERAGE HEIGHT TALLEST SAPLINGS BY 25-FOOT PLOTS FOR EACH OPENING SIZE AND SITE CLASS								
1 (center)	16.7a[1]	19.2a	25.5b	27.2b	26.5b	16.2a	30.1b	30.9b
2	—	20.9a	23.5ac	26.1bc	29.5b	—	30.8a	30.2a
3	—	—	20.7a	25.0b	29.3b	—	24.6a	32.2b
4	—	—	—	25.4a	28.4a	—	—	29.6
5 (border)	—	—	—	—	21.0	—	—	24.4
AVERAGE SAPLING HEIGHTS ALONG THE BORDER OF EACH SIZE OPENING								
	16.7a	20.9b	20.7b	25.4b	21.0b	16.2a	24.6a	24.4a

[1]For each site, means in same row identified by the same letter are not significantly different.

significantly shorter than saplings in the center of the 150- and 250-foot openings. These results indicate a border effect, as the saplings in the center of the 50- and 100-foot openings were influenced by the opening perimeter.

We compared the heights of saplings along the borders of the different size openings. For the good sites, tallest saplings in the 50-foot openings were significantly shorter than the tallest saplings along the borders of 100- to 250-foot openings (17 versus 21 feet plus). A similar trend was observed on the fair site, but the data were not quite significant (table 1).

Also, saplings on both the good and fair sites were significantly taller (5 to 6 feet) near the opening centers than along the borders of 150- and 250-foot openings. Saplings in the 200-foot openings were also taller near the opening centers than along the borders, but the difference was not significant. However, the saplings along the borders of 100-foot openings on the good sites were slightly taller than those established near the opening centers, indicating that the border effect is present throughout the smaller openings (table 2).

Table 2.—*Average sapling heights for plot center versus border within same size opening, in feet*

Opening size (feet)	Good site[1]		Fair site	
	Plot center	Border edge	Plot center	Border edge
50	16.7	—	15.8	—
100	19.2a	20.9a	—	—
150	25.5a	20.7b	30.1a	24.6b
200	27.2a	25.4a	—	—
250	26.5a	21.0b	30.9a	24.4b

[1]For each site, means in same row identified by the same letter are not significantly different.

Additional Tallest Tree Characteristics

For the good sites, after 10 years, about 81 percent of the tallest saplings were seedling-origin stems, and this was expected because a herbicide treatment was used to reduce sprouting. However, only about 60 percent of the stems on the fair site were of seedling origin.

Stem diameters (dbh) averaged between 2.0 and 2.7 inches for the tallest saplings in 100- to 250-foot openings. The tallest saplings in the 50-foot openings ranged from 1.2 to 1.5 inches dbh (table 3). For both the good and fair sites, about 90 percent of the tallest saplings were potential sawlog crop trees. Species such as American chestnut, striped maple, and pin cherry were not considered as potential crop trees.

On the good sites, in the 50-, 100-, and 150-foot openings, sugar maple saplings were the tallest stems on about 50 percent of these sample plots. For the 200- and 250-foot openings, black locust and pin cherry accounted for about 45 percent of the tallest saplings. On the fair sites, American chestnut, red maple, sassafras, and pin cherry were frequently the tallest saplings. Several of these taller saplings averaged 25 feet tall and were at least 2.5 inches dbh—pin cherry, black locust, yellow-poplar, and Fraser magnolia on the good sites; and Fraser magnolia, pin cherry, American chestnut, and red maple on the fair sites.

Table 3.—*Stem characteristics for tallest saplings within each size opening by site class—excluding American chestnut, striped maple, and pin cherry*

Opening size (feet)	Height		Dbh		Potential crop trees
	Seedling origin	Sprout origin	Seedling origin	Sprout origin	
	Feet	*Feet*	*Inches*	*Inches*	*Pct.*
			GOOD SITE		
50	17.1 (6) [a]	14.6 (1)	1.2	1.3	75 (5)
100	19.9 (14)	16.9 (3)	1.6	1.3	100 (17)
150	23.2 (25)	22.3 (5)	2.0	1.9	96 (29)
200	25.6 (35)	27.8 (11)	2.2	2.7	95 (44)
250	27.0 (48)	29.1 (9)	2.6	3.2	86 (49)
			FAIR SITE		
50	15.6 (8)	17.4 (4)	1.2	1.2	100 (12)
150	26.4 (11)	26.6 (23)	2.5	2.9	85 (29)
250	29.4 (44)	29.8 (16)	2.7	2.9	85 (51)

[a] Figures in parentheses indicate number of samples.

We also examined the height and dbh of the same species for a variety of opening sizes. On the good site, the heights of sugar maple saplings ranged from about 18 to 24 feet for all openings. The average dbh for sugar maple saplings was erratic, 1.4 to 2.0 for the smaller openings and 1.6 for the largest openings. Of course, the number of sugar maple saplings sampled was much higher in the smaller openings than in the larger openings, as expected.

The height growth of the tallest yellow-poplar and black cherry saplings was strongly influenced by opening size. Height averaged 17 feet or less in 100-foot openings and about 28 feet in 250-foot openings. Average dbh for yellow-poplar ranged from about 2.5 for the 100-foot openings to 3.3 inches for the 250-foot openings. Black cherry averaged 2.6 inches dbh for the 250-foot openings.

On the fair sites, red maple averaged about 20 feet in height and 1.6 inches dbh for the 50-foot openings to about 30 feet and at least 3 inches dbh for the 250-foot openings. Similarly, the height of sassafras saplings ranged from about 15 feet in height and 1.1 inch dbh on 50-foot openings to 24 feet and about 2 inches dbh on the 150- and 250-foot openings.

Pin cherry averaged at least 30 feet tall and nearly 3.0 inches dbh regardless of opening size or site.

SUMMARY AND DISCUSSION

A summary of the information on heights of the tallest saplings in 10-year-old clearcut circular openings ranging from 50 to 250 feet in diameter:

- Tallest sapling heights were not influenced by cardinal direction.
- For the good site, saplings in the center of 50- and 100-foot openings were significantly shorter than saplings in the 150-, 200-, and 250-foot openings. Also saplings in the 50-foot openings on the fair site were significantly shorter than those on the 150- and 250-foot openings.
- For the good site, saplings were significantly shorter along the border of 50-foot openings as compared to 100-, 150-, 200- or 250-foot openings. A similar trend was evident on the fair site, but the data were not significant. Within each size opening, saplings near the center of the openings were taller than those along the opening border with one exception—the 100-foot opening on the good site.

Individual sapling characteristics indicated that about 80 and 60 percent of these tallest saplings were of seedling origin on the good and fair sites respectively. Nearly all study stems were in the codominant and dominant crown classes, and about 90 percent of the com-

mercial species (excluding pin cherry, American chestnut, and striped maple) were potential crop trees for sawlog production.

Sugar maple was the most numerous species on the good site, occurring as the tallest tree in about 50 percent of the sample plots on the 50-, 100-, and 150-foot openings. We suspect that these taller sugar maples were advance reproduction responding to the release. On the fair sites, red maple, sassafras, and unblighted American chestnut were the most abundant tall trees on 50- and 150-foot clearcut openings. For the larger openings on both sites, pin cherry, black locust, Fraser magnolia, sweet birch, and sassafras were the tallest; however, many of the pin cherry and American chestnut will soon die.

Comparing similar species in different size openings indicated that for sugar maple on the good site, the average height ranged from about 18 to 24 feet. For yellow-poplar and black cherry, height growth increased as opening size increased, averaging 17 feet or less in 100-foot openings to about 28 feet in the 250-foot openings.

Similarly, on the fair site red maple averaged 20 feet in 50-foot openings and 30 feet in 150- and 250-foot openings. Sassafras ranged from 15 feet in the 50-foot openings to 24 feet in the 150- and 250-foot openings.

Diameter (dbh) comparisons were similar in that, as the opening size increased, the dbh increased. Sugar maple was the exception. Sugar maple ranged in size from 1.4 to 2.0 inches dbh; yellow-poplar stems averaged 2.5 inches dbh for the 100-foot openings to 3.3 inches for the 250-foot openings, while black cherry averaged 2.6 inches dbh in 10 years for the 250-foot openings. Red maple averaged 1.6 inches dbh in the 50-foot openings to more than 3 inches dbh for the 250-foot openings. Sassafras ranged from 1.1 inches dbh in the 50-foot openings to about 2 inches dbh on the 150- and 250-foot openings.

Measurements of the tallest saplings in 25-foot-radius plots showed that openings of 150-foot diameter and larger (0.4 acre plus) had the taller dominant-codominant saplings when compared to the 50- and 100-foot diameter openings. Also, a greater variety of individual species was evident in the larger openings. The shading effect from trees along the opening borders, is less for saplings growing near the center of the larger openings compared to the smaller openings *(Sander and Clark 1971)*. This would strongly influence heights of the faster-growing, light-requiring saplings established near the center of the larger openings.

For good and fair oak sites, the expected height and dbh for the tallest dominant-codominant saplings in 10-year-old clearcut openings 150 feet in diameter or larger should be 25 to 30 feet tall and 2.5 to 3.0 inches dbh. This information provides silviculturists with an estimate of the potential growth of Appalachian hardwood saplings in a relatively free-to-grow crown position where the saplings have not received any cultural treatments.

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APPENDIX

Common and scientific names of species referred to in this study:

Basswood	*Tilia americana* L.
Beech, American	*Fagus grandifolia* Ehrh.
Birch, sweet	*Betula lenta* L.
Cherry, black	*Prunus serotina* Ehrh.
Cherry, pin	*Prunus pensylvanica* L.f.
Chestnut, American	*Castanea dentata* (Marsh.) Borkh.
Gum, black	*Nyssa sylvatica* Marsh.
Locust, black	*Robinia pseudoacacia* L.
Magnolia, Fraser	*Magnolia fraseri* Walt.
Maple, red	*Acer rubrum* L.
Maple, striped	*Acer pensylvanicum* L.
Maple, sugar	*Acer saccharum* Marsh.
Oak, chestnut	*Quercus prinus* L.
Oak, northern red	*Quercus rubra* L.
Sassafras	*Sassafras albidum* (Nutt.) Nees.
Sourwood	*Oxydendrum arboreum* (L.) DC.
Yellow-poplar	*Liriodendron tulipifera* L.