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# Percent Crown Cover Tables for Applying the Shelterwood System in New England

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## Abstract

Provides tables for estimating residual percent crown cover, using a 10-factor prism, of three species groups: (1) sugar and red maples, yellow and paper birches; (2) white ash, white pine, red spruce, balsam fir, and hemlock; and (3) beech.

The shelterwood system is recommended for regenerating both hardwood and softwood species in the Lake States (Tubbs 1977). This system is used in New England for spruce-fir (Frank and Bjorkbom 1973) as well as other species. In certain areas, wildlife managers use shelterwood cuts to maintain softwood deer yards.

The shelterwood system may use three types of cuttings: (1) a preparatory cutting prepares for reproduction; (2) a seed cutting results in the establishment of reproduction; and (3) a removal cutting frees the established reproduction.

The first two types of cuttings usually are specified in terms of the residual percent crown cover to leave after the cutting (Godman and Tubbs 1973). However, in spruce-fir, only 30 to 50 percent reduction in basal area is feasible at any one time—regardless of residual percent crown cover—due to the risk of wind damage. The residual trees may be different sizes and species with varying crown/dbh relationships; so it is not easy to estimate residual crown cover from total basal area estimates.

Based on available equations that relate crown diameter to tree dbh by species, tables are presented for estimating residual percent crown cover using a 10-factor prism. Crown diameter

equations were available for dominant forest-grown trees of sugar maple, red maple, beech, yellow birch, and paper birch (Leak 1983); red spruce, balsam fir, and white ash;<sup>1</sup> and white pine (Philbrick 1971). Using these equations, we

<sup>1</sup>Solomon, D. S.; Brann, T.; Schnell, J. Crown-height-diameter relationships for commercial tree species in New England. (Manuscript in preparation, Northeastern Forest Experiment Station, Orono, Maine.)

estimated the average crown diameter per dbh class for each species. Crown area per tree was determined by assuming a circular crown shape. We multiplied by the appropriate per acre conversion factors to determine crown area per acre for each tree counted on 10-factor prism plot. We divided by 435.60 to convert crown area to percent crown cover.

Species were combined into group with similar percent crown covers per counted tree (Table 1). Within a group, the range in crown cover among species is fairly wide for saplings and poles. However, the range narrows to 2 to 3 percent for sawtimber-sized trees—the size of trees commonly left in the overstory following shelterwood preparatory and seed cuttings.

**Table 1.—Mean and range<sup>a</sup> in percent crown cover per tree counted by a 10-factor prism, by species groups**

Dbh (in)	Sugar and red maples, yellow birch, paper birch		White ash, white pine, red spruce, balsam fir, and hemlock <sup>b</sup>		Beech
	Mean	Range	Mean	Range	Mean
2	59.4	30.3–75.0	31.8	19.0–46.3	52.5
4	28.5	21.1–34.6	14.9	11.5–19.2	29.5
6	20.5	17.9–24.0	10.7	8.6–12.8	23.4
8	16.9	15.6–19.0	8.9	7.2–10.1	20.5
10	14.8	13.9–16.0	7.9	6.5–8.6	18.9
12	13.3	12.8–13.9	7.5	6.0–7.9	17.9
14	12.2	11.8–12.8	6.8	5.7–7.3	17.2
16	11.4	11.0–12.0	6.5	5.4–7.1	16.6
18	10.7	10.0–11.3	6.3	5.2–7.0	16.3
20	10.1	9.0–10.7	6.1	5.1–6.8	15.9
22	9.6	8.2–10.5	5.9	5.0–6.8	15.6
24	9.1	7.4–10.2	5.8	4.9–6.7	15.4
26	8.7	6.7–10.0	5.7	4.8–6.6	15.2

<sup>a</sup>Range among species in the group in percent crown cover.

<sup>b</sup>No data on hemlock; but, we believe it belongs in this species group.

For each species group, tables were constructed to show cumulative percent crown cover for each tree counted on a 10-factor plot (Tables 2, 3, and 4). For example, if a 10-factor prism count picked up two 18-inch sugar maples, two 14-inch white ashes, and a 16-inch beech, the percent crown cover would be  $21 + 14 + 17 = 52$ .

The tables extend only to about 100 percent crown cover because higher percentages are not used in defining shelterwood harvests. With small stems and softwood species, a significant amount of basal area can be removed from a stand before the crown cover drops below 100 percent.

In marking a shelterwood cut, repeated prism tallies of the residual trees can be made to see whether the marking is close to the desired percent crown cover. Alternatively, the tables can be used to estimate the appropriate residual basal area that should be left to attain a certain percent crown cover. For

example, in a beech stand where the overstory trees average about 18 inches dbh, approximately 40 square feet (tree count of 4) of such trees will provide about 65 percent crown cover. Even small residual trees that are not in the regeneration size classes should be considered in estimating residual crown cover. As the tables indicate, small trees contribute a disproportionate share to percent crown cover.

Certain shortcuts might be followed in using the tables. In Table 2, note that basal area per acre (tree count  $\times$  10) is quite close to percent crown cover for trees larger than about 14 inches dbh. In Tables 2, 3, and 4, percent crown cover does not change very much for trees larger than 14 to 16 inches. Therefore, tree size might not need to be measured on large trees; an average percent crown cover figure might be used for each large tree counted per species group. Crown cover is not an exact measure because it ignores differences among species in the amount of light transmitted through the

crown. Thus, shortcuts and approximations are warranted in using these tables.

Data for hemlock in New England were not available. But we believe that hemlock is similar to the relatively narrow-crowned species in Table 3. Oak crowns apparently are a little wider (slightly higher percentages) than maple-birch crowns (Table 2).

The data in this paper are from dominant forest-grown trees. If suppressed, intermediate, or crowded codominant trees are left as residuals, the tables will tend to overestimate the residual percent crown cover. We believe that the data apply fairly well throughout New England. In other regions, a few dominant forest-grown trees should be measured to check our basic regressions.

With experience, a marker should be able to acquire the ability to mark to a certain residual percent crown cover with only an occasional check against these tables.

**Table 2.—Cumulative percent crown cover for sugar and red maples, yellow and paper birches, 10-factor prism**

Dbh (inches)	Tree count												
	1	2	3	4	5	6	7	8	9	10	11	12	
2	59	119											
4	28	57	85	114									
6	21	41	62	82	103								
8	17	34	51	68	84	101							
10	15	30	44	59	74	89	103						
12	13	27	40	53	67	80	93	106					
14	12	24	37	49	61	73	86	98	110				
16	11	23	34	45	57	68	80	91	102				
18	11	21	32	43	54	64	75	86	96	107			
20	10	20	30	40	50	60	70	80	91	101			
22	10	19	29	38	48	57	67	76	86	96	105		
24	9	18	27	36	45	54	64	73	82	91	100	109	
26	9	17	26	35	43	52	61	69	78	87	95	104	

**Table 3.—Cumulative percent crown cover for white ash, white pine, red spruce, balsam fir, and hemlock, 10-factor prism**

Dbh (inches)	Tree count																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2	32	64	95	127														
4	15	30	45	60	74	89	104											
6	11	21	32	43	54	64	75	86	96	107								
8	9	18	27	36	44	53	62	71	80	89	98	107						
10	8	16	24	32	40	47	55	63	71	79	87	95	103					
12	8	15	22	30	38	45	52	60	68	75	82	90	98	105				
14	7	14	20	27	34	41	48	54	61	68	75	82	88	95	102			
16	6	13	20	26	32	39	46	52	58	65	72	78	84	91	98	104		
18	6	13	19	25	32	38	44	50	57	63	69	76	82	88	94	101	107	
20	6	12	18	24	30	37	43	49	55	61	67	73	79	85	92	98	104	110
22	6	12	18	24	30	35	41	47	53	59	65	71	77	83	88	94	100	106
24	6	12	17	23	29	35	41	46	52	58	64	70	75	81	87	93	100	104
26	6	11	17	23	28	34	40	46	51	57	63	68	74	80	86	91	97	103

**Table 4.—Cumulative percent crown cover for beech, 10-factor prism**

Dbh (inches)	Tree count						
	1	2	3	4	5	6	7
2	52	105					
4	30	59	89	118			
6	23	47	70	93	117		
8	21	41	62	82	103		
10	19	38	57	76	95	114	
12	18	36	54	72	90	107	
14	17	34	51	69	86	103	
16	17	33	50	67	83	100	
18	16	33	49	65	81	98	114
20	16	32	48	64	80	95	111
22	16	31	47	63	78	94	110
24	15	31	46	62	77	93	108
26	15	30	46	61	76	91	107

## Literature Cited

- Frank, R. M.; J. C. Bjorkbom. **A silvicultural guide for spruce-fir in the Northeast.** Gen. Tech. Rep. NE-6: Upper Darby, PA: U. S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1973. 29 p.
- Godman, R. M.; C. H. Tubbs. **Establishing even-age northern hardwood regeneration by the shelterwood method—a preliminary guide.** Res. Pap. NC-99: St. Paul, MN: U. S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1973. 9 p.
- Leak, W. B. **Stocking, growth and habitat relations in New Hampshire hardwoods.** Res. Pap. NE-523: Broomall, PA: U. S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1983. 11 p.
- Philbrick, J. S. **A stocking guide for eastern white pine silviculture in northern New Hampshire.** Durham, NH: University of New Hampshire; 1971. 59 p. M.S. Thesis.
- Tubbs, C. H. **Manager's handbook for northern hardwoods in the North Central States.** Gen. Tech. Rep. NC-99: St. Paul, MN: U. S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1977. 29 p.

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