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DIAMETER INCREASE IN SECOND-GROWTH APPALACHIAN HARDWOOD STANDS — A COMPARISON OF SPECIES

Abstract.—A study of growth at d.b.h. among eight hardwood species after partial cutting in second-growth stands. Red oak grew fastest, followed in order by yellow-poplar, sugar maple, basswood, black cherry, white ash, beech, and chestnut oak.

Many second-growth Appalachian hardwood stands between 40 and 60 years old are being placed under management. The first operation in most of these stands is a conditioning cut. Before the cut is made, the timber marker has to choose which trees to leave for additional growth and development. So he needs to know the relative growth rates to be expected for the different species. This report provides such information for eight Appalachian hardwood species in middle-aged, previously unmanaged stands.

Study Area and Methods

Data for these comparisons were drawn from 10 compartments on the Fernow Experimental Forest near Parsons, W. Va. The second-growth stands on these areas were initially between 45 and 55 years old and all contained some residual stems from the previous commercial harvest cut. Each stand received a conditioning cut that was either an individual tree-selection cut (seven compartments) or a diameter-limit cut in which all trees over 17.0 inches d.b.h. were removed (three compartments). Most of the old residuals were removed in this first conditioning cut. Basal area after the cut ranged from 52 to 80 square feet per acre in trees over 5.0 inches d.b.h.

The 10 compartments ranged in size from 12 to 60 acres. Site indexes based on oak *(Schnur 1937, Trimble and Weitzman 1956)* ranged from 59 to 84.

Species composition on the better sites included yellow-poplar (*Liriodendron tulipifera* L.), northern red oak (*Quercus rubra* L.) black cherry (*Prunus serotina* Ehrh.), white ash (*Fraxinus americana* L.), basswood (*Tilia americana L.*), hickory (*Carya* sp.), sugar maple (*Acer saccharum* Marsh.), and a scattering of other species. On the poorer sites upland oaks, red maple (*Acer rubrum* L.), black gum (*Nyssa sylvatica* March.), sassafras (*Sassafras albidum* (Nutt.) Nees), and sourwood (*Oxydendrum arboreum* (L.) DC.) predominated.

We studied d.b.h. change, by species, of trees that were in the 13-to-21-inch diameter classes immediately after cutting. The few trees larger than 21 inches were excluded because they were old dominant residuals whose growth rates were not representative of second-growth stands. Trees below 13 inches were excluded because a large portion of them were sub-dominant trees even after the stand was cut, and their growth rates were influenced more by competition than by inherent species capacity. Moreover, many of these smaller stems would be removed in an intermediate cut under an even-aged system. The limitation of the study to trees between 13 and 21 inches was an attempt to work only with the "crop-tree" stand; that is trees in the upper intermediate, codominant, and dominant crown classes that were—after the stand was cut—essentially free to grow.

We computed average d.b.h. for each species on each of the 10 compartments immediately after cutting and again at the end of the measurement period, which ranged from 5 to 12 years.

Direct comparisons of average growth rates among species were not appropriate because site quality and stand density differed among the areas. Instead, comparisons were made by expressing d.b.h. growth of each species on each compartment as a percent of the red oak growth on that compartment. Red oak was chosen as the yardstick because it was the only species occurring in adequate numbers on all 10 compartments. The possibility that growth proportions between red oak and other species might not actually be similar on all study sites was accepted as an unavoidable risk.

Comparisons for a species were made only on compartments where there were 30 or more trees in the 13-to-21-inch group after cutting. No tabular entries were made for a species that was compared on fewer than three compartments.

Table 1.—Relative growth rates of the species studied

Species	Percent of red oak d.b.h. growth		Areas where species were compared	Total comparison trees
	Average	Range		
	Percent	*Percent*	*No.*	*No.*
Red oak	100	100-100	10	1,476
Yellow-poplar	85	75-100	6	819
Sugar maple	69	57-78	4	385
Basswood	62	47-81	4	333
Black cherry	58	39-81	6	607
White ash	57	34-94	3	191
Beech	46	38-59	3	221
Chestnut oak	45	41-52	3	162

Results

Of the species compared, red oak grew the fastest in d.b.h. after partial cutting (table 1). Yellow-poplar was a close second and had an average d.b.h. growth rate that was 85 percent that of red oak. This ranking agrees with that of another recently reported study *(Trimble 1967)*. Other species, in decreasing order of growth rate, were sugar maple, basswood, black cherry, white ash, beech (*Fagus grandifolia* Ehrh.), and chestnut oak (*Quercus prinus* L.). There were not enough hickory stems between 13 and 21 inches to meet the minimum-number standards set up for comparison.

Table 2.—Theoretical 10-year d.b.h. growth rates after cutting
(In inches)

Species	Site index 80			Site index 70		
	Average	High	Low	Average	High	Low
Red oak	3.2	—	—	2.4	—	—
Yellow-poplar	2.7	3.2	2.4	2.0	2.4	1.8
Sugar maple	2.2	2.5	1.8	1.7	1.9	1.4
Basswood	2.0	2.6	1.5	1.5	1.9	1.1
Black cherry	1.9	2.6	1.2	1.4+	1.9	.9
White ash	1.8	3.0	1.1	1.4—	2.3	.8
Beech	1.5	1.9	1.2	1.1+	1.4	.9
Chestnut oak	1.4	1.7	1.3	1.1—	1.2	1.0

However, computations made with lesser numbers on five compartments indicated a hickory d.b.h. growth that was 48 percent of red oak growth. This ranks hickory with beech and chestnut oak.

Actual 10-year d.b.h. growth for red oak after cutting in this and other studies has been between about 2.8 and 3.5 inches on site index 80, and between about 2.0 and 2.8 inches on site index 70. Using 3.2 and 2.4 inches as an approximation for site indexes 80 and 70 respectively, we have computed theoretical growth rates for the other species (table 2).

Discussion

These relative d.b.h. growth rates provide one basis for determining which species to favor in partial cuttings. However, these averages mask some important differences among species. For example, vigorous basswood, black cherry, or white ash of dominant crown positions are generally considered to grow faster than sugar maple in the same positions. And yet sugar maples of all types respond strongly to release *(Zillgitt 1950),* whereas the less vigorous stems of the other three species often appear to respond poorly to release *(Trimble 1967, U. S. Forest Service 1965).*

These characteristics may be inferred from the data in table 2, in which the growth rate of basswood, black cherry, and white ash in the "high" column is greater than that of sugar maple, even though the average rate of sugar maple growth is higher than that of the other three species. Vigorous yellow-poplar apparently do as well as vigorous red oak *(Holcomb and Bickford 1952, Trimble 1960)* even though they do not do as well on the average or perhaps do not respond as well to release at this age *(Trimble 1967).*

With these results and inferences we can rate the potential future growth of the various species:

- First preference in selecting trees to leave after a partial cutting should be given to red oak and yellow-poplar. Dominant vigorous individuals of these two species should be rated about equally, but red oak should be favored over yellow-poplar among individuals of lower vigor or dominance class.

- Second preference should be given to sugar maple, basswood, black cherry, and white ash. Dominant vigorous individuals of the latter three species should be favored over sugar maple, but sugar maple should be favored over the other three species among individuals of lower vigor or dominance class.

- Beech, chestnut oak, and hickory should be be retained only when suitable individuals of the other species are not available. Although important differences in growth among these three species were not shown here, other studies indicate that chestnut oak responds well to release on fair sites (Trimble 1967) and that it generally grows faster than beech (Campbell 1955). Another study (Trimble 1960) indicates that it may be a faster grower relative to red oak than the data in table 2 show. It probably should be favored over beech and hickory.

These recommendations are based solely on relative d.b.h. growth rates and do not consider other important criteria like relative species values, merchantable height growth, markets, and owner's objectives.

— GEORGE R. TRIMBLE, JR.
Project Leader, Timber and Watershed Laboratory
Northeastern Forest Experiment Station
Forest Service, U. S. Dep. of Agriculture
Parsons, W. Va.

Literature Cited

Campbell, Robert A.
1955. TREE GRADES AND ECONOMIC MATURITY FOR SOME APPALACHIAN HARDWOODS. SE. Forest Exp. Sta., Sta. Paper 53. 22 pp.. Athens, Ga.

Holcomb, Carl J., and C. Allen Bickford.
1952. GROWTH OF YELLOW-POPLAR AND ASSOCIATED SPECIES IN WEST VIRGINIA AS A GUIDE TO SELECTIVE CUTTING. NE. Forest Exp. Sta., Sta. Paper 52. 28 pp., Upper Darby, Pa.

Schnur, G. Luther.
1937. YIELD, STAND, AND VOLUME TABLES FOR EVEN-AGED UPLAND OAK FORESTS. U. S. Dep. Agr. Tech Bull. 560. 88 pp., illus.

Trimble, George R., Jr.
1960. RELATIVE DIAMETER GROWTH RATES OF FIVE UPLAND OAKS IN WEST VIRGINIA. J. Forestry. 58: 111-115, illus.

Trimble, George R., Jr.
1967. GROWTH OF APPALACHIAN HARDWOODS AS AFFECTED BY SITE AND RESIDUAL STAND DENSITY. U. S. Forest Serv. Res. Paper NE-98, In press. NE. Forest Exp. Sta., Upper Darby, Pa.

Trimble, G. R., Jr., and Sidney Weitzman.
1956. SITE INDEX STUDIES OF UPLAND OAK IN THE NORTHERN APPALACHIANS. Forest Sci. 2: 162-173, illus.

United States Forest Service.
1965. SILVICS OF FOREST TREES OF THE UNITED STATES. Agr. Handbook No. 271, 761 pp., illus.

Zillgitt, W. M.
1951. CONVERTING MATURE NORTHERN HARDWOODS STANDS TO SUSTAINED YIELD. J. Forestry 49: 494-497.

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