EST SERVICE RESEARCH NOTE NE-275
1979

Northeastern Forest Experiment Station

FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE, 370 REED ROAD, BROOMALL, PA. 19008

TREE GRADE DISTRIBUTION IN ALLEGHENY HARDWOODS

—RICHARD L. ERNST
Research Forester

—DAVID A. MARQUIS
Principal Research Silviculturist
Northeastern Forest Experiment Station
Warren, Pennsylvania

Abstract. Estimates of the distribution of tree grades by diameter class were developed for six hardwood species on the Allegheny Plateau. These estimates can be used to calculate present and projected stand values when actual tree grade measurements are not available.

INTRODUCTION

From information developed as part of a series of financial maturity studies in northeastern hardwoods it is possible to calculate the value of a stand if one has data on the numbers of trees by species, diameter at breast height (dbh), merchantable height, and tree grade. (DeBald and Mendel 1976a; Mendel et al.; DeBald and Mendel 1976b; Grisez and Mendel 1972). Unfortunately, information on tree grade often is not included in data collected during stand inventories, or in data developed from yield tables or stand growth simulators.

However, if tree grade, which is an indicator of suitability for various wood products, can be correlated with size class for each species, estimates of stand quality and value can be made for typical stands where specific tree grade data is unavailable. We collected data to develop empirical tree grade distributions by dbh and species for typical cherry-maple stands on the Allegheny Plateau.

METHODS

Empirical grade distributions were derived from summaries of data on species, diameter, and tree grade. Two sources were used: timber sale cruise data from the four districts on the Allegheny National Forest, and data from complete inventories of seven sample stands.

The timber sale data consisted of information on species, dbh, and tree grade for about 12,500 trees, all of which were grade 3 or better; trees that were not at least grade 3 were not recorded. These data were from systematic samples of trees to be included in clearcutting sales over a 3-year period. We used grading rules described by Hanks (1971).

Because the first data set included only trees that were grade 3 or better, we used a second set so that we could calculate the probability of a tree of a given species and diameter being at least grade 3. This second data set was collected from complete inventories of seven additional cherry-maple stands. A total of 3,650 trees greater than 10 inches in dbh were recorded by species and dbh, and each tree was classified as grade 3 and better or less than grade 3. Thus, the two data sets provided a means of calculating—for each diameter class and species—the probability of a tree being grade 1 or 2 or 3.

Each of these probabilities were plotted separately as a function of diameter for each species. Species with similar distributions were grouped. These groups were: (1) black cherry and yellow-poplar; (2) sugar maple and red maple, (3) beech and birch.

Three regression equations were developed for each species group. Each equation related diameter to: (1) The proportion of trees grade 3 and better: (2) The proportion of grade 3 and better trees that were grade 1: and (3) The proportion of grade 3 and better trees that were grade 3. The proportion of grade 3 and better trees that were grade 2 was obtained by subtracting the values for equations 2 and 3 from equation 1.

Predicted values derived from these equations were tabulated and plotted for each species group.

RESULTS

The regression statistics for tree grade distribution and the diameter range over which these equations are valid are shown in Tables 1-3. The lower limit is the minimum dbh requirement for a particular grade. The upper

Table 1.—Regression statistics for dependent variable of percent of trees grade 3 or better.

Species	Regression Equation	R^2	Range in Diameter
			inches
Black cherry and yellow-poplar	$135.5 - 806.5D^{-1}$	73	10-22
Sugar maple and red maple	$140.9 - 1083.5D^{-1}$	84	10.22
Beech and birch	$111.9 - 980.2D^{-1}$	87	10-22

Table 2.—Regression statistics for dependent variable of percent of grade 3 or better trees in grade 1.

Species	Regression Equation	R^2	Range in Diameter
			inches
Black cherry and yellow-poplar	$127.8 - 839.7D^{-1}$	65	16-26
Sugar maple and red maple	$157.8 - 1777D^{-1}$	77	16-26
Beech and birch	$178.4 - 2408.3D^{-1}$	84	16-26

Table 3.—Regression statistics for the dependent variable of percent of grade 3 or better trees in grade 3.

Species	Regression Equation	R^2	Range in Diameter
			inches
Black cherry and yellow-poplar	$-17.4 + 431.6D^{-1}$	62	13-23
Sugar maple and red maple	$-31.8 + 755.9D^{-1}$	64	13-22
Beech and birch	$-42.5 + 896.6D^{-1}$	32	13-20

limit represents the upper limits of the data. Extrapolating beyond this upper limit gives unreasonable results; predictions beyond the upper limit are made by assuming the same value as that at the upper diameter limit.

Tree grade is dependent on two major factors: tree size (diameter), and the presence of grade stoppers such as limbs, knots, decay, sweep, and crook. Tree size alone is a major determinant of grade—a large percentage of the trees qualify for the next higher grade as soon as they reach the minimum diameter. For example, more than 60 percent of the black cherry and yellow-poplar trees that we examined qualified for grades 1, 2, or 3 when they reached the minimum diameter for those grades. This effect of diameter thresholds used in defining grade is evident in Figures 1 to 3.

However, species differed considerably in the extent to which diameter alone determines grade. Only 15 to 25 percent of the beech and birch qualified for the next higher grade when they reached the minimum diameter. Thus, grade stoppers are more common in the latter species and more often limit grade after minimum diameter has been attained.

The importance of grade stoppers in beech and birch also is evident in data for trees of large size—well beyond minimum diameter for grade 1 and at or near economic maturity. For example, less than half of the 23-inch beech and birch qualified for grade 1; but more than 90 percent of the black cherry and yellow-poplar qualified at that size.

The numbers of grade stoppers in individual stands may vary widely due to factors such as density, snow bending, ice breakage, insect or disease attack, and site conditions. So the grade distributions reported here represent average values that one might expect in typical stands—and the values may be in considerable error for an individual stand. Thus, these estimates of grade distribution are not intended to replace tree grading but are to be used as a management planning tool.

These data were collected, and will apply most accurately, in second-growth cherry-

Figure 1—Grade distribution for black cherry/yellow-poplar group.

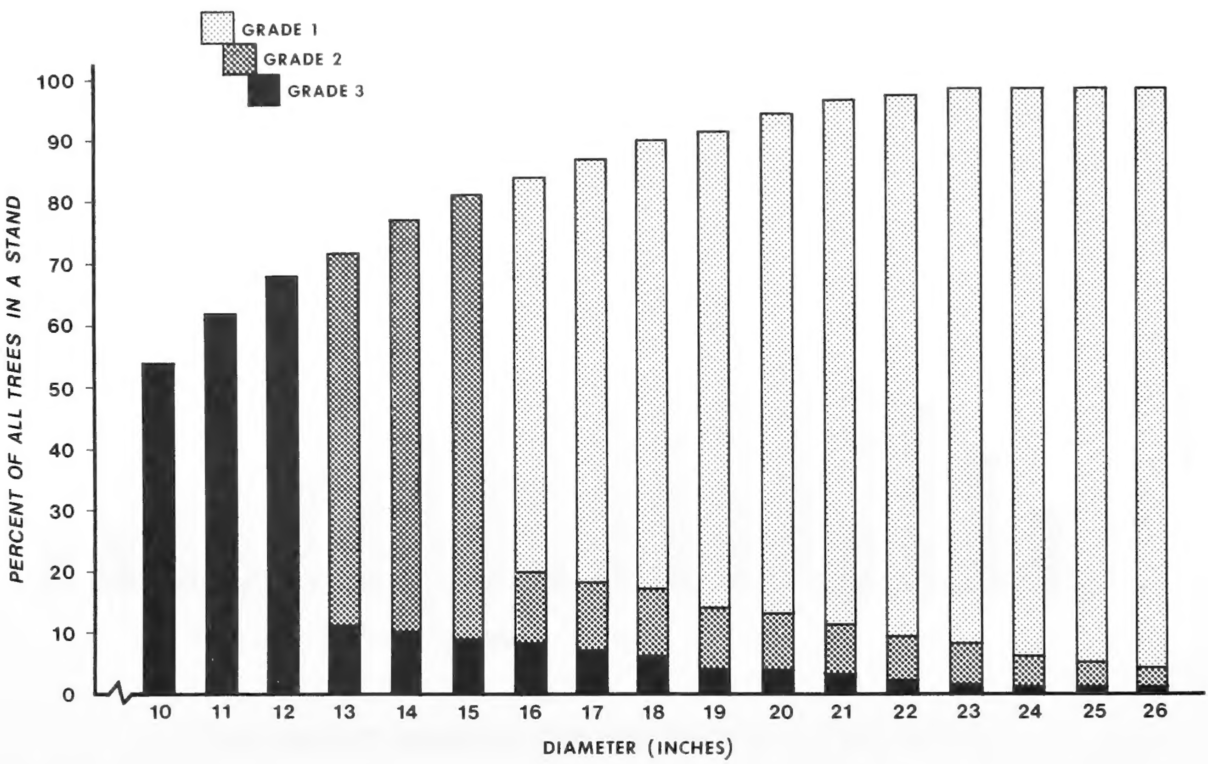


Figure 2—Grade distribution for red maple/sugar maple group.

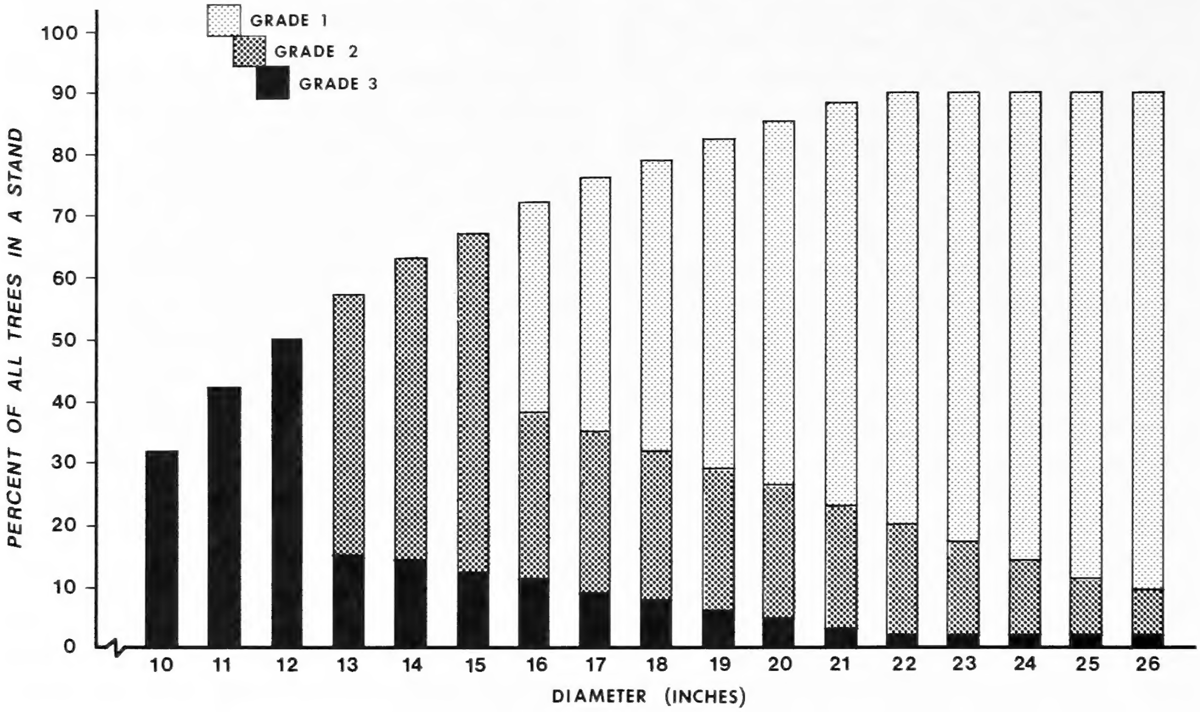
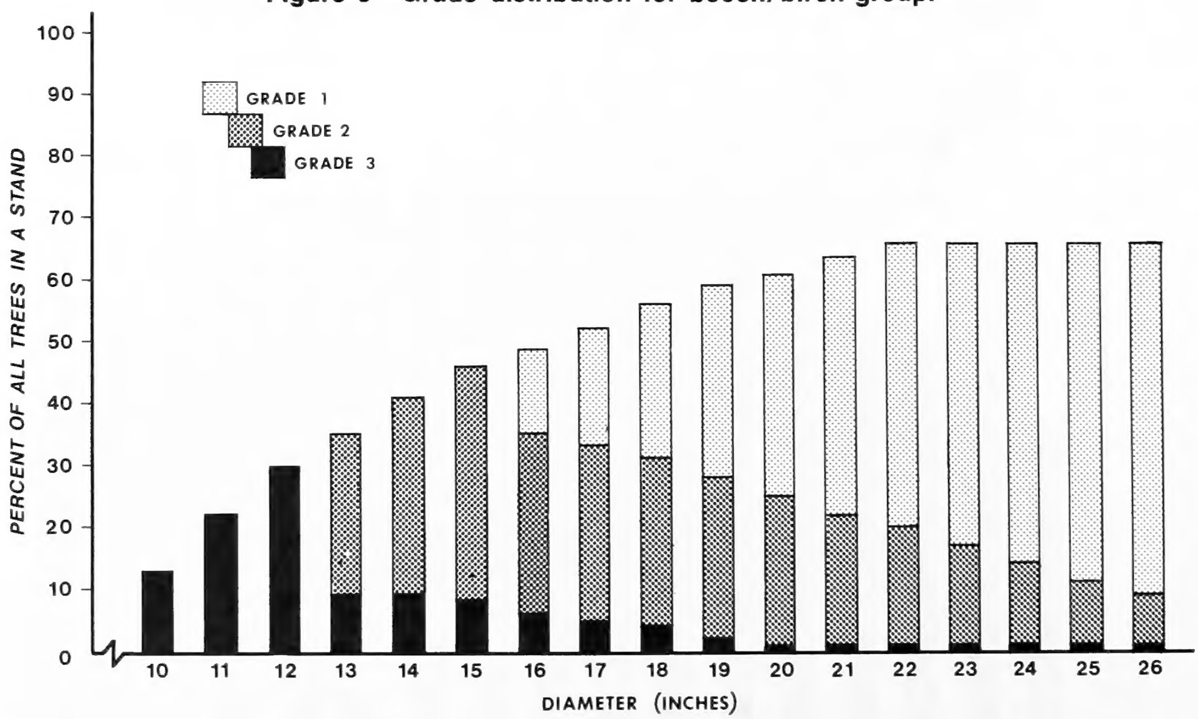


Figure 3—Grade distribution for beech/birch group.



maple stands on the Allegheny Plateau of northwestern Pennsylvania—stands that were uncut or had been thinned one time. Grade distribution is likely to be substantially different in stands that have been under intensive management over a long period, or that have been high-graded.

Despite these limitations, the data are useful for estimating stand value for typical stands where specific grade information is lacking. They can be used to estimate the financial maturity of typical stands or to evaluate short-term value changes that might be expected from several cutting strategies in typical stands.

Stand values may be calculated from stand table data by proportioning the trees in each species-dbh class into grades. Tree value conversion standards (Mendel et al. 1976) can then be applied to derive a value for the entire stand.

LITERATURE CITED

DeBald, Paul S., Joseph J. Mendel.
1976a. **An individual-tree approach to making stand evaluations.** USDA For. Serv. Res. Pap. NE-336. 13 p.

DeBald, Paul S., Joseph J. Mendel.
1976b. **Composite volume and value tables for hardwood pulpwood.** USDA For. Serv. Res. Pap. NE-338. 43 p.

Grisez, Ted J., Joseph J. Mendel.
1972. **The rate of value increase for black cherry, red maple and white ash.** USDA For. Serv. Res. Pap. NE-321. 26 p.

Hanks, Leland F.
1971. **Interim hardwood tree grades for factory lumber.** USDA For. Serv. Res. Pap. NE-199. 29 p.

Hanks, Leland F.
1976. **Hardwood tree grades for factory lumber.** USDA For. Serv. Res. Pap. NE-33. 81 p.

Mendel, Joseph J., Paul S. DeBald, and Martin E. Dale.
1976. **Tree value conversion standards for hardwood sawtimber.** USDA For. Serv. Res. Pap. NE-337. 74 p.

☆U.S. GOVERNMENT PRINTING OFFICE: 1979—603-011/20

MANUSCRIPT RECEIVED FOR PUBLICATION 22 JANUARY 1979