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TREE GRADES, YIELDS AND VALUES FOR SOME APPALACHIAN HARDWOODS

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by

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INTRODUCTION

Foresters have long recognized the need for a better method of appraising standing timber in terms of quality as well as volume of lumber that trees may be expected to produce. Because the range in price between high-grade lumber and low-grade lumber is extremely wide, a stand of high-quality timber is much more valuable than a low-quality stand. In spite of this, estimating methods commonly used today give little consideration to quality.

Because of the extreme variability in timber and the lack of a workable procedure, the practice of grading logs and standing timber has lagged far behind the grading of most other commodities. Some progress has been made in the development of standard rules for grading hardwood logs, but not until recently in the Southeast, and then only on an experimental basis, have trees been graded according to their lumber quality.

To the forester, timber buyer, owner and manager alike, a reliable system of tree grades, supported by corresponding lumber values, would be especially useful in determining:

1. The choice of species and sizes of trees to cut or leave.
2. The tree's highest market value, e.g., veneer or lumber.
3. The best financial rotation.
4. Timber values for sale or exchange.

This paper describes a system of tree grading that is intended to separate Appalachian hardwood trees into appropriate value classes.

1/ Forester, Southern Appalachian Branch, Southeastern Forest Experiment Station.

The paper provides estimates of lumber-grade yields for trees of various sizes and grades, and outlines short-cut methods of estimating stand and tree values.

Past Work

Tree grades and classifications have been developed along two somewhat separate lines. The first, exemplified by the tree classification system in Ponderosa pine, was based upon the silvicultural characteristics of vigor and risk; other systems have included both silvicultural characteristics and utilization value, and still others are based only on utilization value.

Stratification of trees into value classes eliminates the necessity of grading each log in the tree. This initial step provides a key to tree value, which is the end result desired for appraisal and many other management purposes. A combination value and silvicultural vigor and risk system of tree grading was first used by the U. S. Forest Service in the Lake States region in the early '40's.[2/] The value grades of this system were based on the quality of the butt log. The successful pioneering done on the butt-log basis in the Lake States encouraged the author to try a similar approach in the Southern Appalachians.

Basis for Appalachian Hardwood Tree Grades

The Appalachian hardwood tree grades here presented, like the Lake States tree grades, are based solely upon grade of the butt log. The specifications used in classifying butt logs for tree grading are given in table 1. On the basis of these specifications, the tree grades are as follows:

Grade A--tree with a select butt log

Grade B--tree with a grade 1 butt log

Grade C--tree with a grade 2 or grade 3 butt log

2/ Goetzen, C. B., Parton, W. W., Stott, C. B., and Stone, J. H. Suggested hardwood tree class standards for farm foresters. U. S. Forest Service, Region 9. Milwaukee. 1943. (Multilithed, 34 pp.)

This system takes advantage of the recognized tendency for the upper logs in a tree to be of lower grade than those next below them. When the upper logs were graded by the Bent Creek[3/] log-grading system from which the above butt log requirements were derived, it was found that there was an orderly decline in log grades up the tree. For example, a select butt log is usually topped by a grade 1 log, a grade 1 log by a grade 2, and a grade 2 butt log is usually topped by a grade 3 log. The consistency of this 1, 2, 3 order of log occurrence is demonstrated in table 2, for 205 trees. The particular value of this system is that it permitted the use of lumber-grade yield data by log grades in building up grade yield and value data for the tree grades. The tests reported on page 13 show that, as a result of this system, grading of the trees by the butt log alone provided a reasonably good estimate of tree value, when compared with the value obtained by grading each log in the tree.

The differences in tree values in the lower butt log grades are relatively small compared with those of the upper grades. For example, there is little to be gained economically in separating trees containing grade 2 butt logs from those with grade 3 butt logs, because the tree value differences are less than five dollars per thousand board feet. Thus, grade 2 or 3 butt logs are combined to form tree grade C. Efforts in refinement might better be spent on the higher brackets of the value scale in separating veneer-quality trees from those of sawlog grade. While this method of tree grading is sometimes less accurate than grading each log in the tree, it is acceptably accurate and at the same time is much simpler to use. Through it, the chore of grading is reduced to a workable basis.

Since the tree grade is based on the quality of the butt log, the appraiser must examine this log closely. Usually the first consideration is that of size. There is no point in considering the number or size of clear sections in the butt log if the tree is smaller than 18" d.b.h.

3/ The Bent Creek Experimental Forest, near Asheville, N. C., is a field laboratory of the Southern Appalachian Branch of the Southeastern Forest Experiment Station.

Table 1.--Appalachian hardwood tree grade specifications

Tree Grade	Min. d.b.h.	Butt log specifications[1]			
		Log grade[2]	Min. clear lgth.-total	Maximum sections[3]	Max. def. allowed
	Inches		Feet	Number	Percent
A	20	Select	12	[4]1	10
A	30	Select	14	[4]2	25
B	18	No. 1	13	[5]3	25
C		Any tree with a No. 2 or No. 3 butt log.			

1/ Normally the first 16 feet above the stump. This log may be extended to allow for jump butts--up to 6 feet in length. Any jump butt exceeding this length will be considered a part of the butt log, and the log or tree graded accordingly.

2/ Grade based on poorest of 3 best faces. A face is one quarter of the log's circumference.

3/ A section is the clear length between two successive defects or the distance between a defect and the end of a log on any one face.

4/ Each section must have at least 7 ft. clear. Thus a centered knot or other similar defect is permissible in this grade.

5/ Each section need have only 5 ft. between defects in this grade.

because such a log automatically falls in class C. If the d.b.h. exceeds this minimum size and the butt log has two or more clear faces, [4]/ or contains clear sections five feet or longer, then further consideration is warranted. After surface characteristics and size requirements have been satisfied, there still remains the final limiting factor of defect allowance.

4/ A face is one quarter of the log's circumference. A clear face is one containing no specified defects, such as knots, bumps, cracks, scars (over 1/5 the log diameter at that point) or other defects which might reduce the quality of lumber.

Table 2.--Actual distribution of log grades by log position in the tree[1/]

Grade of butt log	Basis	Second log				Third log			Fourth log		Fifth log	Sixth log
		Select	No.1	No.2	No.3	No.1	No.2	No.3	No.2	No.3	No. 3	No. 3
	No. trees	Distribution by number of logs										
Select	2/ 78	13	54	11	0	9	41	21	3	33	3	1
No. 1	3/ 52	0	4	45	3	0	5	38	0	9	1	
No. 2	4/ 75	0	0	9	66	0	0	46	0	5	1	
Totals	205	13	58	65	69	9	46	105	3	47	5	1
		Distribution by percentage of logs										
Select	2/ 78	17	69	14	0	13	58	29	8	92	100	100
No. 1	3/ 52	0	8	86	6	0	12	88	0	100	100	
No. 2	4/ 75	0	0	12	88	0	0	100	0	100	100	

1/ These data are based on a log-by-log tally of 205 trees. The sample tree data were collected within a radius of 35 miles of Asheville, N. C. Tree diameters ranged from 16 to 42 inches.

2/ According to the hypothesis all 78 trees should have No. 1 second logs, No. 2 third logs, and No. 3 upper logs.

3/ According to the hypothesis all 52 trees should have No. 2 second logs, and No. 3 upper logs.

4/ According to the hypothesis all 75 trees should have No. 3 second logs and upper logs.

Experience is the best guide for estimating defect, which includes such items as rot, sweep, crook, etc. Considerable assistance can be obtained by a careful study of a recent publication on log and tree defects.[5/] If the stump section is so defective that it will or should be butted after felling, a jump butt up to 6 feet long may be deducted mentally when grading the butt log. Defective logs exceeding allowable limits for the grade are reduced one grade; they are not further degraded because of defect.

Figures 1 and 2 illustrate tree grades A, B, and C in yellow-poplar.

In actual practice tree grading is much easier than reading of the specifications makes it appear. With a few hours' practice and conscientious attention to specifications, almost any timber estimator can grade trees satisfactorily.

TREE YIELDS

Estimating Lumber Yield by Tree Grade

The first step in developing the system was to collect a sizeable backlog of information on log-grade yields of graded lumber. Then the method for obtaining the tree yields and values necessary to apply or test the system consisted of constructing hypothetical tree yields and converting these yields to their equivalent dollar value. The tables of lumber yield by tree grade (appendix tables A-1 through A-7) were constructed by assembling log-grade yields into hypothetical trees of average taper, on the assumption that upper log quality decreased progressively with upper log position.

5/ Lockard, C. R., Putnam, J. A., and Carpenter, R. D. Log defects in southern hardwoods. Agriculture Handbook No. 4, U. S. Dept. Agr., Forest Service. June 1950.

Figure 1.--View of graded yellow-poplar trees

Figure 2.--Opposite view of same three graded yellow-poplar trees. Tree A is 30 inches d.b.h. and is clear on three faces; tree B is 18 inches d.b.h. and clear on two faces with 7-foot cuttings on the third, but is too small to make grade A at present; tree C is 14 inches d.b.h. and is too small and too knotty to be anything better than grade C.

Beginning then, with graded logs and their lumber yields, mountain hardwood tree grade yields were based upon the previously mentioned tendency of upper logs to be of successively lower grade than those next below them. Although the hypothesis of progressive, orderly decline in grade is not inviolate, there is good evidence that upper logs do approach those grades which progressive decline would indicate. Furthermore, as shown on page 13, the computed values of some 200 sample trees representing the natural occurrence of graded logs did not differ significantly from the hypothetical values.

For each tree grade, diameter class, and log length of each species shown in tables A-1 through A-7, lumber yields were computed for each log and then combined to produce synthesized tree yields. Percentage yields of lumber for the various log grades and sizes needed were obtained from grade-yield studies of some 1,700 hardwood logs. The respective tabular percentage figures were then multiplied by the volume of the appropriate-size log to arrive at the board-foot contents by lumber grade. Totals by lumber grade for the whole tree were first added and then these volumes were converted to percentage yields for the tree, as shown in tables A-1 through A-7.

Translating Lumber Yields to Tree Value

Although lumber-grade yields for different tree grades are informative and useful for some purposes, they are cumbersome for direct use in appraising timber. Total dollar value of the lumber in the tree is more useful, but it fluctuates with each change in the market value of lumber. Fortunately, a single index of the lumber quality of a tree is available, using a 100-point scale in which an index of 100 represents an ideal tree containing nothing but FAS lumber.

In deriving this "Quality Index," Herrick[6/] started with the

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6/ Herrick, A. M. Grade yields and overrun from Indiana hardwood sawlogs. Purdue University Bul. No. 516. April 1946.

observation that when prices for hardwood lumber change, the prices for the different grades tend to change in the same ratio. Taking the price of FAS as unity, the prices for the lower grades of lumber for a given species can then be expressed as a decimal part of the value of FAS. The percentage of a particular grade of lumber in a tree, multiplied by the decimal ratio of the price of that grade to the price of FAS, will show the contribution of that grade to the total value of the tree. The sum of these contributions for all grades of lumber indicated the relative value of the tree per thousand board feet on the 100-point scale of Quality Index, hereafter referred to as Q. I. For example, the formula for Q. I. for the oaks and several other hardwoods is 1(%FAS) + .95(% Selects) + .65(% 1C) + .40(% 2C & S.W.) + .20(% 3C). The dollar value of the log or tree is then obtained simply by multiplying the Q. I. by the current value of FAS for the species, and dividing by 100.

Q. I. values, like form class, vary somewhat between species, but the variation is surprisingly small. In fact, it is less than the seasonal or annual variation within a species caused by variation in price ratios. For example, white oak, yellow-poplar and basswood showed slightly different price ratios from year to year during the last three years, yet the average price ratio for each during this period fits the general formula very well. The other species tested showed relatively consistent price ratios for the three years. Because of the consistency of lumber-grade price ratios, and therefore of Q. I. values, regardless of species, over a base period (1937-1950), it was decided to use a general formula rather than separate ones for each species. This combined formula gave dollar values within plus or minus 3 percent of those computed, when the yield of each lumber grade for a given species and tree grade was multiplied by its respective price. This small value difference is less than the expected error in grade-yield estimate. The complete general formula reads Q. I. = 1(%FAS) + .95 (% Selects) + .85(% Saps) + .65(% 1C) + .45(% 2A) + .30(% 2B) + .40 (% 2C & S.W.) + .35(% 3A) + .15(% 3B) + .20(3C). In solving the formula, only the applicable grades are used for any one species. Among some 15

or 16 hardwoods studied, only 2 were so different that the basis for Q. I. determination needed changing to achieve greater value accuracy. These species were buckeye and hickory. For buckeye the 1C grade should be multiplied by .7 and the 2C grade by .5 instead of the customary .65 and .40. For hickory, 1C grade should be multiplied by .6 and 2C by .35. After the Q. I. value is once computed and plotted over diameter for each tree grade, it will remain valid over a long period of time--until subsequent grade-yield studies reveal differences in grade yields or until a basic change in grade-value relationships occurs. The latter situation is not apt to occur soon, judging from Herrick's studies of prices obtained before and during O.P.A. and from ours since.

Q. I. values were computed from the percentage of lumber grade yields shown in tables A-1 through A-7. Grade yields for some of the oaks include timbers as well as boards. These yields were combined with 3A lumber in computing tree yields and values. These values were then plotted and smooth curves were drawn. The values shown in table 3 were read from these curves.

All values used in computing Q. I. are based on one-inch lumber, since nearly all of the lumber cut in the southern Appalachians is of this thickness.

Multiplying the Q. I. by the appropriate FAS price and dividing by 100 provides the data for curves of lumber prices by species, tree grade, and size such as are shown in figure 3. From such price curves we can determine species groupings. Those shown in table 4 are based on prevailing prices as of July 1, 1950.

Lumber values for 2-log, 25-inch trees representing hardwoods average $119 per M.b.f. for grade A trees, $98 for grade B trees and $83 for grade C trees. If these dollar values are corrected to a 100-point scale, with grade A trees at the top, then grade B trees average 82 and grade C trees average 70--providing a very satisfactory stratification of tree values. These value differences are conservative from the buyer's standpoint, since woods-run grade A trees will be considerably larger than average grade C trees, and the value differences shown above will be accentuated.

Table 3.--Condensed tree yields for some Appalachian hardwoods[1/]
(In Quality Index numbers)

Species	D.b.h. (Inches)	Tree Grade A				Tree Grade B				Tree Grade C			
		1 log	2 logs	3 logs	4 logs	1 log	2 logs	3 logs	4 logs	1 log	2 logs	3 logs	4 logs
White ash	20	76	70	68		67	64	62		64	60	57	
	25	80	75	73		73	69	66		66	62	59	
	30	83	79	76		78	72	68		68	63	61	
Basswood	20	72	67	63		66	61	56		56	51	51	
	25	76	72	69		71	64	59		58	53	52	
	30	80	77	73		74	67	61		59	55	53	
Beech--avg.[2/]		62	--	--		48	--	--		35	--	--	
Black birch	20	--	--	--		58	54	--		49	45	--	
	25	--	--	--		61	56	--		51	46	--	
	30	--	--	--		63	57	--		52	47	--	
Buckeye	20	61	52	50		58	51	47		53	49	45	
	25	68	60	52		64	56	49		57	53	46	
	30	75	66	53		69	61	51		61	56	47	
	35	80	69	--		72	--	--		--	--	--	
Cherry--avg.[3/]		70	--	--		55	--	--		42	--	--	
Hickory--avg.		--	--	--		51	47	--		42	39	--	
Hard maple	20	70	68	63		67	62	58		56	51	50	
	25	75	73	68		72	65	62		60	54	52	
	30	80	77	72		76	69	64		63	56	53	
Red maple	20	77	68	--		66	58	--		49	46	--	
	25	78	71	--		69	60	--		51	47	--	
	30	79	73	--		71	62	--		52	48	--	
Black oak	20	60	58	56		50	48	46		44	40	39	
	25	66	63	58		54	52	48		45	42	41	
	30	71	67	62		57	54	49		46	43	42	
	35	75	70	--		59	--	--		--	--	--	
Scarlet oak	20	52	51	48		49	48	44		44	44	39	
	25	58	56	52		54	52	46		45	45	41	
	30	62	60	56		58	54	48		46	46	42	
	35	65	62	--		--	--	--		--	--	--	
Northern red oak	20	66	62	57		58	51	49		47	45	44	
	25	70	66	62		63	56	53		52	48	46	
	30	72	70	64		67	61	56		56	50	48	
	35	74	72	66		68	63	58		58	51	50	
Chestnut oak	20	46	43	42		43	39	38		35	35	35	
	25	51	47	45		43	40	39		37	36	36	
	30	55	51	47		44	41	40		39	37	37	
	35	58	52	48		45	42	40		40	38	37	
White oak	20	54	52	49		52	47	44		44	38	36	
	25	63	59	55		56	50	46		46	40	38	
	30	71	65	60		59	53	48		47	41	39	
	35	75	69	63		62	55	49		--	41	40	
Yellow-poplar	20		58	56	55		54	51	50		48	47	46
	25		60	58	57		55	52	51		49	48	48
	30		62	60	58		56	53	52		50	49	49
	35		63	61	59		56	54	53		51	50	50

1/ Quality Index (Q.I.), values were computed from base formula: Q.I. = Sum of grade yield percents weighted by relative dollar values. These Q.I. values were then plotted over d.b.h. and curved. See text for explanation of use.

2/ Beech Data from U. S. Forest Products Laboratory, "Sawlog Grades for Hardwoods—Central States Studies." Report No. D 1699 Nov. 1947.

3/ Cherry data from Northeastern Forest Experiment Station, "Lumber Values From Graded Logs—Black Cherry and Oak —," by G. E. Doverspike and J. C. Rettie, Nov. 1949.

Table 4.--Lumber values[1/] for 2-log trees 25 inches d.b.h.

Grade A trees

High	Medium	Low
$120 +	$100 - 120	$100 -
Hard maple	White oak	Scarlet oak
Basswood	Black oak	Chestnut oak
	Northern red oak	Buckeye
	Yellow-poplar	
	Ash	
	Soft maple	

Grade B trees

$110 +	$ 90 - 110	$ 90 -
Hard maple	Ash	Black oak
Black birch	Yellow-poplar	Chestnut oak
Basswood	Northern red oak	Buckeye
	White oak	
	Red maple	
	Scarlet oak	

Grade C trees

$ 90 +	$ 70 - 90	$ 70 -
Hard maple	Northern red oak	Chestnut oak
Ash	White oak	Buckeye
Black birch	Scarlet oak	
Basswood	Red maple	
Yellow-poplar	Black oak	

1/ Per M.b.f., air-dry lumber, based on prices shown in "Hardwood Market Report" for July 1, 1950.

Tests of Quality Index Estimates

Recently some 200 trees representing 10 of 13 commercially important hardwood species were graded log by log. These trees ranged from 16 to 42 inches d.b.h. and from 1-1/2 to 5-1/2 sixteen-foot logs in length. A few of the smallest and a few of the largest trees were discarded because they exceeded the range of existing Q. I. curves. Of the remaining 199 trees, 77 were grade A, 57 were grade B, and 65 were Grade C. Q. I. values were computed for each tree based on the observed log grade and proportionate volume of each log. These computed values were then compared with the estimated values based on grading only the butt log and assuming an orderly decline in grade of the upper logs. Within each tree grade, species with similar Q. I. values based on observed log grades were grouped, and somewhat different species combinations were sometimes used in the different grades. Thus, basswood was combined with hard maple in grade A trees, but with soft maple and red oak in grade B. This was necessary because of the few trees available in some species and grades.

The small sample of trees within species, diameters, merchantable length, and tree grade, necessitated considerable grouping of data. Further refinements must be deferred until considerably more data are available. Deviations of the estimated from the actual values, as presented in table 5, show small mean differences. Only in grade A white oak did the mean deviation exceed two Q. I. units. This deviation amounts to some two percent of the dollar value for this species. The maximum differences for individual trees did not exceed 7 Q. I. units, and occurred in grade A hard maple and grade C scarlet oak. These differences represent, respectively, 9 and 16 percent of dollar value. An approximation of the error of estimate indicates that mean indices for the combination of species commonly occurring in sales of mountain hardwoods can be predicted within two Q. I. units.

Table 5.--Estimated vs. actual Quality Index for sample trees[1/]

Tree grade	Species	No. trees	Mean estimated Q.I.	Mean actual Q.I.	Mean deviation from estimate
C	Hard maple	7	51.1	52.1	+ 1.0
	Red maple	6	45.3	46.5	+ 1.2
	Yellow-poplar	5	46.4	46.8	+ .4
	Northern red oak	4	44.8	45.5	+ .7
	Black oak	9	38.9	40.3	+ 1.4
	Scarlet oak	19	41.4	40.2	- 1.2
	Chestnut oak	3	39.0	37.0	- 2.0
	White oak	12	37.5	38.8	+ 1.3
B	Hard maple	13	61.5	61.6	+ .1
	Basswood	3	57.0	57.7	+ .7
	Red maple	4	55.5	56.5	+ 1.0
	Yellow-poplar	4	50.0	51.2	+ 1.2
	Northern red oak	3	56.7	58.3	+ 1.6
	Black oak	12	47.8	48.8	+ 1.0
	Scarlet oak	10	48.5	47.8	- .7
	White oak	5	49.0	48.4	- .6
	Chestnut oak	3	39.3	39.3	- 0.0
A	Hard maple	14	67.9	66.1	- 1.8
	Basswood	6	65.2	64.8	- .4
	Buckeye	3	55.0	57.3	+ 2.3
	Red maple	2	63.0	61.5	- 1.5
	Yellow-poplar	11	57.3	58.0	+ .7
	Black oak	13	59.8	61.1	+ 1.3
	Northern red oak	6	61.2	61.8	+ .6
	Chestnut oak	11	46.4	46.8	+ .4
	White oak	6	59.3	57.0	- 2.3
	Scarlet oak	5	54.6	53.6	- 1.0

1/ Estimated Q. I. is based on grading the butt log only, and assuming a regular decline of log grades in upper logs. Actual Q. I. is based on the grade of each log in the tree, and the lumber-grade yields for a log of that size and grade.

APPLICATION OF TREE GRADES

One of the principal reasons for knowing the relative value of the various species, and especially of sizes and grades within species is to help the forest manager in determining which trees to cut or leave. Although the present tree-grading system does not include such silvicultural factors as vigor, growth rate, or risk, these elements must be given appropriate consideration in making cut-and-leave determinations. We plan to incorporate some or all of these items into the system in the future, since it is the combination of volume and quality increment on which the final choice should be based. Meanwhile, foresters and other timber managers are in a better position to choose between species because of the factual data presented here. As an example, in marking we might have to choose a leave-tree among yellow-poplar, buckeye, basswood, white or northern red oak, all of grade A quality, and 20 inches d.b.h. A glance at figure 3 shows that basswood is the most valuable and buckeye the least. But if there is a choice between red or white oak or yellow-poplar, note the rapid rise in value of the white oak curve beyond 25 inches. Consequently, if the leave-trees are to remain for twenty years more, and if growth rates are similar, then the white oak would be the best choice to leave. The subject of financial maturity will be discussed later in a separate publication.

In figure 4 the relationship between grade yield and dollar value of lumber per tree is graphically illustrated for several species. Here it can be seen at a glance that species differences are large, even for grade A and B trees. Figures 3 and 4 show that there is a greater difference in value between the most valuable species (hard maple) and the least valuable (buckeye) than there is between the tree grades for the same species, d.b.h., and log length. Consequently, species remains the most important criterion of tree value; grade and size are the next most important variables. For such species as yellow-poplar and red maple, size is of less importance than grade from the lumber-value standpoint, as illustrated in figure 3. For other species, such as white oak in particular, size is of paramount importance.

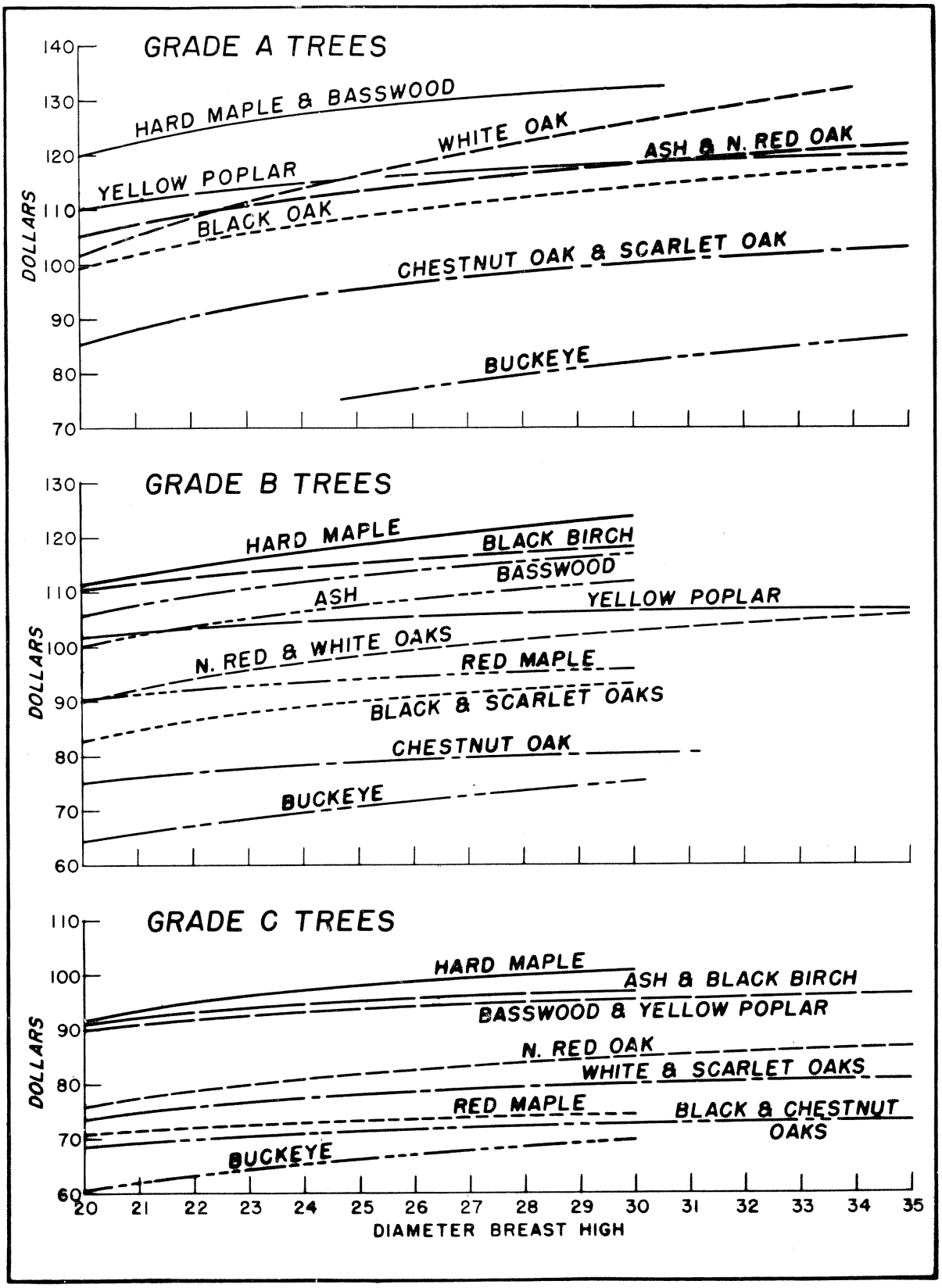

Figure 3.--Lumber value per thousand board feet, for 2-log trees. Lumber prices are from "The Hardwood Market Report" of July 1, 1950.

An increase of one log in merchantable height or an increase of one grade in quality will greatly steepen any new value curves similar to those shown in figure 3. Hence it should not be assumed that, because a species has a flat curve of unit value over diameter in one grade, all trees of that grade should be cut as soon as they reach a size which will offset the cost of production and manufacture. Only in those cases in which no appreciable increase in quality or volume is expected before the next cut is it wise to cut to the minimum size, and then only if the silvicultural requirements of spacing and species composition have been met. In general, value curves do not flatten until the trees have reached the following diameters: 30 inches for grade A, 25 inches for grade B, and 20 to 25 inches for grade C. Furthermore, production costs are relatively low at these diameters. Thus, net returns would be better than for smaller trees. Supplemental studies have shown that only very low rates of interest can be earned on trees over 30 inches in diameter when held for lumber production. Further study is needed for other products such as veneer.

In computing average lumber values for appraisal purposes, the average tree diameter and merchantable height for each grade within the species is first determined. Then the appropriate Q. I. value is determined from table 3 for each tree grade and species by interpolation or curving. Next the unit value is obtained by applying the current price of FAS to the Q. I. value. The next step is to multiply the respective values per M.b.f. by the volume in that tree grade, and then determine the weighted lumber value for all tree grades for that species. Any desired species combinations can then be made, and weighted averages can readily be computed.

An example of the value of tree grading in timber appraisal work comes from a recent sale of approximately 1-1/2 million feet of mostly high-quality trees. These trees appraised one-third more when graded than when appraised at the usual average value. Actual bids supported the grade-appraised price.

Using the foregoing system and the data provided in this paper, with local adjustments where necessary, it is believed that one familiar with timber cruising and appraisal methods can considerably increase the accuracy of his appraisal of the value of a tree or a stand.

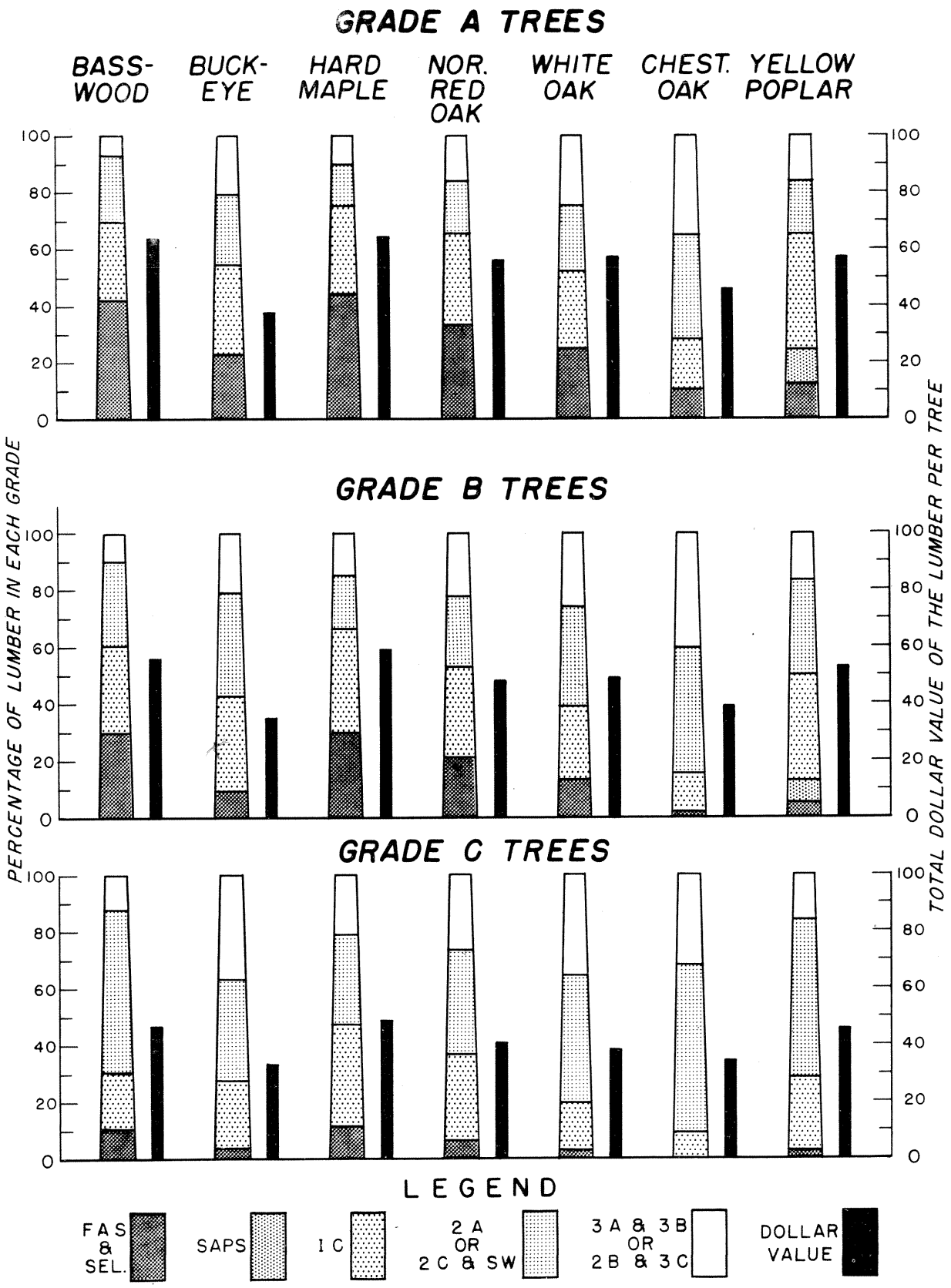

Figure 4.--Tree yields and values for selected species, 2-log, 25-inch d.b.h. trees. All values are on the per-tree basis.

APPENDIX

Contents — Table Number

Lumber yields for trees by tree grade and size

Table A-1.--Lumber yields for trees by tree grade and size
(In percent)

Tree grade	D.b.h. (Inches)	White ash							Basswood							
		FAS	SEL	1C	2C	3C	1C & Btr.	Curved Q.I.	FAS	SEL	1C	2C	3A	3B	1C & Btr.	Curved Q.I.
1-LOG TREES																
A	20	40	13	29	11	7	82	76	25	14	39	18	4	-	78	72
	25	44	15	27	9	5	86	80	37	12	33	14	4	-	82	76
	30	48	16	25	7	4	89	83	46	11	29	10	4	-	86	80
B	20	25	8	40	16	11	73	67	16	16	32	24	10	2	64	66
	25	32	11	38	12	7	81	73	22	18	30	22	8	-	70	71
	30	39	13	35	8	5	87	78	25	20	29	21	5	-	74	74
C	20	18	6	43	27	6	67	64	8	10	29	40	12	1	47	56
	25	20	6	47	25	2	73	66	10	10	30	40	10	-	50	58
	30	20	6	51	23	-	77	68	11	9	31	40	9	-	51	59
2-LOG TREES																
A	20	32	10	33	15	10	75	70	19	15	37	21	7	1	71	67
	25	38	12	32	11	7	82	75	29	14	32	18	7	-	75	72
	30	42	14	31	8	5	87	79	36	15	29	15	5	-	80	77
B	20	21	7	40	21	10	68	64	12	13	30	31	12	2	55	61
	25	26	9	41	18	6	76	69	17	14	30	30	9	-	61	64
	30	30	10	41	16	3	81	72	18	15	30	30	7	-	63	67
C	20	16	5	39	28	12	60	60	4	6	28	46	15	1	38	51
	25	17	6	41	23	13	64	62	6	5	30	47	12	-	41	53
	30	18	6	44	18	14	68	63	6	5	31	47	11	-	42	55
3-LOG TREES																
A	20	28	9	35	18	10	72	68	14	14	34	26	10	2	62	63
	25	32	11	35	15	7	78	73	24	13	31	24	8	-	68	69
	30	36	12	35	13	4	83	76	29	13	29	22	7	-	71	72
B	20	19	6	38	25	12	63	62	9	10	28	37	14	2	47	56
	25	23	8	39	20	10	70	66	12	10	29	37	11	1	51	59
	30	26	9	40	16	9	75	68	13	11	30	37	9	-	54	61
C	20	15	5	37	30	13	57	57	3	4	27	49	16	1	34	51
	25	16	6	39	23	16	61	59	4	4	29	49	13	1	37	52
	30	17	6	42	17	18	65	61	4	4	31	50	11	-	39	53

Table A-2.--Lumber yields for trees by tree grade and size
(In percent)

Tree grade	D.b.h. (Inches)	Black birch								Buckeye							
		FAS	SEL	1C	2C	3A	3B	1C & btr.	Curved Q.I.	FAS	SEL	1C	2C	3A	3B	1C & btr.	Curved Q.I.
1-LOG TREES																	
A	20									10	6	36	32	10	6	52	56
	25									24	6	33	18	10	9	63	63
	30									36	5	33	10	9	7	74	70
	35									46	5	33	6	6	4	84	75
B	20	10	9	41	22	9	9	60	58	6	2	26	38	19	9	34	47
	25	12	11	40	22	9	6	63	61	11	4	36	33	7	9	50	55
	30	14	11	40	22	9	4	65	63	14	6	45	29	3	3	65	62
C	20	3	4	34	29	19	11	41	49	2	1	26	44	18	9	29	45
	25	3	5	35	30	19	8	43	51	2	1	30	43	18	6	33	46
2-LOG TREES																	
A	20									9	4	29	34	19	5	42	54
	25									18	5	32	25	11	9	55	60
	30									25	5	37	19	7	7	67	66
	35									35	6	39	16	5	2	80	70
B	20	7	6	37	25	13	12	50	54	4	2	24	41	19	10	30	47
	25	8	8	38	25	14	7	54	56	7	3	33	37	12	8	43	52
	30	9	8	38	25	14	6	55	57	9	4	40	35	9	3	53	56
C	20	2	2	27	36	21	12	31	45	2	1	19	47	14	17	22	42
	25	2	3	30	37	21	7	35	56	4	-	24	36	16	20	28	43
3-LOG TREES																	
A	20									5	3	24	43	15	10	32	49
	25									14	3	27	29	11	16	44	54
	30									20	4	32	18	9	17	56	57
B	20									3	1	21	46	15	14	25	44
	25									6	2	28	38	12	14	36	48
	30									8	3	35	30	11	13	46	51
C	20									2	-	17	51	11	19	19	40
	25									4	-	21	37	15	23	25	41

Table A-3.--Lumber yields for trees by tree grade and size
(In percent)

Hickory							
Tree grade	D.b.h. (Inches)	FAS	1C	2C	3C	1C & btr.	Curved Q.I.
1-LOG TREES							
B	20	17	43	18	22	60	51
	25	19	29	35	17	48	52
C	20	7	15	56	22	22	41
	25	9	15	56	20	24	44
2-LOG TREES							
B	20	12	31	34	23	43	46
	25	14	23	44	19	37	49
C	20	4	12	61	23	16	38
	25	5	13	61	21	18	41

Table A-5.--Lumber yields for trees by tree grade and size
(In percent)

Tree grade	D.b.h. (Inches)	Black oak									Scarlet oak							
		FAS	SEL	1C	SW & 2C	Tbrs.	3A	3B	1C & btr.	Curved Q.I.	FAS	SEL	1C	SW & 2C	3A	3B	1C & btr.	Curved Q.I.
1-LOG TREES																		
A	20	24	7	30	21	6	9	3	61	60	12	6	30	22	10	20	48	52
	25	33	7	29	16	6	6	3	69	66	19	6	30	20	9	16	55	57
	30	42	7	28	10	6	4	3	77	71	24	7	29	18	9	13	60	62
	35	48	7	28	5	6	3	3	83	75	28	8	28	16	9	11	64	65
B	20	16	9	22	19	10	8	16	47	50	9	9	30	25	11	16	48	49
	25	19	9	25	16	10	7	14	53	54	14	7	30	25	12	12	51	56
	30	22	8	28	14	10	6	12	58	57	18	5	29	24	14	10	52	59
	35	24	7	31	13	10	5	12	62	59								
C	20	5	2	23	33	-	25	10	30	44	5	2	23	33	25	12	30	44
	25	5	2	25	33	-	25	10	32	45	5	2	25	33	25	10	32	45
	30	5	2	26	33	-	24	10	33	46	5	2	25	33	25	10	33	46
2-LOG TREES																		
A	20	19	8	26	21	8	9	9	53	58	9	8	30	24	11	18	47	52
	25	26	8	26	17	8	7	8	60	63	16	7	30	22	10	15	53	57
	30	33	7	27	12	8	5	8	67	67	21	6	29	21	11	12	56	61
	35	36	7	29	9	8	4	7	72	70	24	6	28	20	11	11	58	62
B	20	11	5	22	25	6	16	15	38	48	7	5	27	28	18	15	39	50
	25	13	6	25	23	6	15	12	44	52	10	5	27	29	18	11	42	53
	30	14	5	27	23	6	14	11	46	54	12	4	27	28	19	10	43	55
C	20	3	1	17	36	-	28	15	21	40	3	1	17	36	28	15	21	44
	25	3	1	19	38	-	27	12	23	42	3	1	19	38	27	12	23	45
	30	3	1	20	38	-	26	12	24	43	3	1	20	38	26	12	24	46
3-LOG TREES																		
A	20	14	7	24	24	6	14	11	45	56	7	6	27	26	16	18	40	48
	25	21	6	25	21	6	12	9	52	58	13	6	28	25	14	14	47	52
	30	25	6	26	18	6	11	8	57	62	16	5	28	24	15	12	49	56
B	20	8	4	18	29	4	20	17	30	46	5	4	22	31	21	17	31	44
	25	9	4	21	29	4	19	14	34	48	7	4	23	32	21	13	34	46
	30	11	4	23	28	4	18	12	38	49	9	2	23	32	21	13	34	48
C	20	2	1	14	38	-	29	16	17	39	2	1	14	38	29	16	17	39
	25	2	1	16	39	-	28	14	19	41	2	1	16	39	28	14	19	41
	30	2	1	18	40	-	27	13	21	42	2	1	18	40	27	13	21	42

Table A-4.--Lumber yields for trees by tree grade and size
(In percent)

Tree grade	D.b.h. (Inches)	Hard maple								Soft maple							
		FAS	SEL	1C	2C	3A	3B	1C & btr.	Curved Q.I.	FAS	SEL	1C	2C	3A	3B	1C & btr.	Curved Q.I.
1-LOG TREES																	
A	20	25	18	29	12	8	8	72	70	36	21	24	19	-	-	81	77
	25	31	18	31	11	5	3	80	75	42	20	13	21	4	-	75	78
	30	37	18	32	12	1	-	87	80	47	18	8	13	14	-	73	79
B	20	20	17	33	15	12	3	70	67	24	7	33	25	10	1	64	66
	25	28	15	33	13	10	1	76	72	27	6	37	22	8	-	70	69
	30	34	15	34	11	7	1	83	76	28	6	41	19	6	-	75	71
C	20	6	8	39	28	15	4	53	56	2	6	30	41	18	3	38	49
	25	10	8	40	25	14	3	58	60	3	6	32	41	16	2	41	51
	30	12	10	41	22	13	2	63	63	4	6	33	41	15	1	43	52
2-LOG TREES																	
A	20	21	19	30	13	10	7	70	68	28	8	31	24	7	2	67	68
	25	28	17	32	13	7	3	77	73	32	9	31	18	8	2	72	71
	30	34	16	33	12	5	-	83	77	35	8	32	15	8	2	75	73
B	20	13	13	35	22	13	4	61	62	14	6	32	32	13	3	52	58
	25	19	12	36	19	12	2	67	65	16	6	34	31	12	1	56	60
	30	24	11	37	17	10	1	72	69	17	5	38	28	11	1	60	62
C	20	4	5	35	33	19	4	44	51	1	4	25	46	21	3	30	46
	25	6	5	37	31	18	3	48	54	2	3	26	47	20	2	31	47
	30	7	6	38	29	19	1	51	56	2	3	28	46	20	1	33	48
3-LOG TREES																	
A	20	15	16	33	18	11	7	64	63								
	25	22	15	34	16	10	3	71	68								
	30	28	14	35	15	7	1	77	72								
B	20	10	10	33	26	17	4	53	58								
	25	14	9	35	24	16	2	58	62								
	30	17	9	36	22	14	2	62	64								
C	20	3	4	33	35	20	5	40	50								
	25	5	4	35	33	20	3	44	52								
	30	5	5	37	31	20	2	47	53								

Table A-6.--Lumber yields for trees by tree grade and size
(In percent)

Tree grade	D.b.h. (Inches)	Northern red oak								Chestnut oak								
		FAS	SEL	1C	SW & 2C	3A	3B	1C & btr.	Curved Q.I.	FAS	SEL	1C	SW & 2C	Tbrs.	3A	3B	1C & btr.	Curved Q.I.
1-LOG TREES																		
A	20	21	12	36	20	11	-	69	66	6	7	14	25	15	14	19	27	46
	25	27	11	34	18	9	1	72	70	10	6	19	30	15	11	9	35	51
	30	33	10	31	16	7	3	74	72	13	5	23	35	15	7	2	41	53
	35	37	10	29	14	6	4	76	74	16	4	26	38	15	1		46	58
B	20	13	12	30	21	14	10	55	58	4	1	17	43	17	11	7	22	43
	25	21	11	30	19	11	8	62	63	4	1	17	43	17	11	7	22	43
	30	25	11	29	19	10	6	65	67	4	1	17	43	17	11	7	22	44
	35	27	11	28	19	10	5	66	68	4	1	17	43	17	11	7	22	45
C	20	3	4	30	33	14	16	47	47	-	-	8	58	-	14	20	8	35
	25	6	5	34	31	13	11	45	52	-	-	11	58	-	14	17	11	37
	30	7	5	38	31	12	7	50	56	-	-	12	60	-	14	14	12	39
	35	8	6	41	30	10	5	55	58	-	-							
2-LOG TREES																		
A	20	15	12	34	21	13	5	61	62	5	4	15	33	16	13	14	24	43
	25	23	11	32	19	10	5	66	66	7	4	18	36	16	11	8	29	47
	30	29	11	30	17	8	5	70	70	9	3	20	39	16	9	4	32	51
	35	32	10	29	16	8	5	71	72	10	3	22	40	16	6	3	35	52
B	20	7	8	30	26	14	15	45	51	2	-	13	43	17	12	13	15	49
	25	15	7	31	25	12	10	53	56	2	-	14	43	17	12	12	16	40
	30	17	8	32	25	11	7	57	61	2	-	15	43	17	12	11	17	41
	35	18	9	33	24	11	5	60	63	2	1	15	43	17	12	10	18	42
C	20	1	2	27	39	18	13	30	45	-	-	6	58	-	16	20	6	36
	25	3	3	31	37	17	9	37	48	-	-	9	59	-	15	17	9	36
	30	4	3	34	37	16	6	41	50	-	-	9	61	-	15	15	9	37
	35	4	3	36	37	15	5	43	51	-	-	10	61	-	15	14	10	38
3-LOG TREES																		
A	20	11	10	32	24	14	9	53	57	4	3	12	39	12	13	17	19	44
	25	18	9	31	23	11	8	58	62	5	3	16	41	12	12	11	24	46
	30	23	9	31	21	10	6	63	64	6	2	18	44	12	10	8	26	47
	35	25	9	31	20	9	6	65	66	8	2	19	45	12	8	6	29	48
B	20	5	6	26	32	17	14	37	49	2	-	10	36	22	14	16	12	38
	25	10	6	29	31	15	9	45	53	2	-	11	40	19	14	14	13	39
	30	12	6	31	30	14	7	49	56	2	-	12	41	19	14	12	14	40
	35	13	7	32	30	13	5	52	58	2	-	13	41	19	13	12	15	40
C	20	1	2	24	41	19	13	27	44	-	-	5	57	-	17	21	5	35
	25	2	2	29	40	18	9	33	46	-	-	7	59	-	16	18	7	36
	30	3	2	32	39	18	6	37	48	-	-	8	61	-	16	15	8	37
	35	3	2	34	39	17	5	39	50	-	-	9	61	-	15	15	9	37

Table A-7.--Lumber yields for trees by tree grade and size
(In percent)

Tree grade	D.b.h. (Inches)	White oak									Yellow-poplar								
		FAS	SEL	1C	2C	Tbrs.	3A	3B	1C & btr.	Curved Q.I.	FAS	SEL	SAP	1C	2A	2B	3C	1C & btr.	Curved Q.I.
		1-LOG TREES									4-LOG TREES								
A	20	13	9	26	18	5	14	15	48	54	1	6	8	34	34	14	3	49	55
	25	24	9	27	18	5	9	8	60	63	3	5	8	35	32	13	4	51	57
	30	33	9	30	16	5	5	3	72	71	4	5	8	37	28	14	4	54	58
	35	39	9	32	12	5	3	-	80	75	5	5	8	38	26	15	3	56	59
B	20	9	6	24	32	4	14	11	39	52	1	2	5	28	42	19	3	36	50
	25	14	5	29	25	3	13	11	48	56	1	2	6	29	42	17	3	38	51
	30	18	5	33	18	2	13	11	56	59	1	2	6	30	41	17	3	39	52
	35	20	5	37	14	-	13	11	62	62	1	2	6	31	41	17	2	40	53
C	20	1	2	23	45	-	14	15	26	44	-	(2)		20	54	21	3	22	46
	25	2	3	26	45	-	12	12	31	46	-	(3)		21	56	17	3	24	48
	30	2	3	28	46	-	10	11	33	47	-	(4)		23	56	15	2	27	49
											-	(4)		23	57	14	2	27	50
		2-LOG TREES																	
A	20	10	8	24	26	5	14	13	42	53	2	10	11	42	24	8	3	65	58
	25	18	8	27	23	4	11	9	53	59	4	9	12	42	18	11	4	67	60
	30	25	7	30	18	4	9	7	62	64	6	9	11	43	12	14	5	69	62
	35	30	7	33	14	3	8	5	70	69	8	8	10	45	7	18	4	71	63
B	20	5	4	22	40	-	15	14	31	47	1	4	7	37	35	14	2	49	54
	25	8	4	27	35	-	14	12	39	50	2	4	7	37	33	14	3	50	55
	30	11	4	30	32	-	12	11	45	53	2	4	8	39	30	14	3	53	56
	35	12	4	33	29	-	11	11	49	55	2	4	7	40	29	16	2	53	56
C	20	-	1	16	46	-	17	20	17	38	-	(2)		24	54	17	3	26	48
	25	1	2	17	46	-	16	18	20	40	-	(3)		26	55	14	2	29	49
	30	1	2	19	46	-	15	17	22	41	-	(4)		27	56	12	1	31	50
	35	1	2	20	46	-	14	17	23	41	1	(4)		28	55	11	1	33	51
		3-LOG TREES																	
A	20	8	6	21	31	3	16	15	35	49	1	7	9	38	31	11	3	55	56
	25	14	6	26	28	3	12	11	46	55	3	6	9	39	27	12	4	57	58
	30	19	6	29	25	3	10	8	54	60	5	6	9	41	22	13	4	61	60
	35	22	6	32	22	2	9	7	60	63	6	6	9	43	19	14	3	64	61
B	20	4	3	17	42	-	16	18	24	44	1	3	6	31	40	17	2	41	51
	25	6	3	22	39	-	15	15	31	46	1	3	6	31	40	16	3	41	52
	30	8	3	24	36	-	14	15	35	48	1	3	6	33	38	16	3	43	53
	35	9	3	26	34	-	13	15	38	49	1	3	6	34	37	17	2	44	54
C	20	-	1	13	46	-	17	23	14	36	-	(2)		21	55	19	3	23	47
	25	1	1	15	46	-	17	20	17	38	-	(4)		22	56	16	2	26	48
	30	1	1	16	47	-	16	19	18	39	-	(4)		24	56	14	2	28	49
	35	1	1	17	46	-	16	19	19	40	-	(4)		25	56	13	2	29	50