Adjusting Quality Index Log Values to Represent Local and Regional Commercial Sawlog Product Values

by

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INTRODUCTION

A SAWMILL operator should be able to accurately predict the expected product volume and value of a log prior to purchase and processing if he is to manage his enterprise efficiently. Considerable methodology and procedure have been developed to assist him in this prediction. Many systems of log grades for hardwood species have been established which segregate the logs into groups based on estimated yields and gross value.

The quality-index (Q.I.) concept (Herrick 1946)[1] provides a method for determining log product values. It is based on hardwood lumber-grade yields and prices, and makes the computation of log values relatively easy.

All of these aids use lumber-grade yields to predict log product values. In other words, the value of a hardwood log is computed on the assumption that the log is sawed into 4/4 lumber, in an adequate mill, by a sawyer skilled in cutting standard graded hardwood lumber.

A number of problems are immediately perceived by the sawmill operator who is a potential user of these aids.

He asks, "What is the relationship between my mill and this so-called adequate mill? How does the skill of my sawyer compare with the skill of this mythical sawyer? What is the relationship between the log-grade yield patterns used by these aids and those of my mill, especially when I may saw some timbers, ties and other products rather than all factory grade 4/4 lumber?"

These are relevant questions which signal the fact that it is necessary to bridge this credibility gap if more operators are to successfully employ some of the old aids as well as new developments which are forthcoming.

A series of research papers have been and are being prepared which use the Q.I. concept as a base for log and tree valuation.

[1] Names and/or dates in parenthesis refer to Literature Cited, p. 15.

Therefore, the primary purpose of this paper is not only to report the results of a comparative analysis as to how well the Q.I. method predicts log product values when compared to commercial sawmill log output values, but also to develop a methodology which will facilitate the comparison and provide the adjustments needed by the sawmill operator.

The commercial sawlog values as derived in an independent study of seven sawmills in southeastern Ohio and eastern Kentucky were compared with Q.I. values developed for an analysis of log and tree valuation. (Whittaker and McCauley 1966). Six different species were compared: red oak, black oak, scarlet oak, white oak, chestnut oak, and yellow-poplar.

QUALITY INDEX - WHAT IT IS AND WHAT IT DOES

The quality-index (Q.I.) concept as developed by Herrick and refined by other researchers, was employed in this analysis to put log grades on a lumber value basis. Essentially, the Q.I. is a single number, a percentage that expresses the volume and value of a log in terms of different grades of 4/4 lumber. In formula form it appears as (Herrick 1946):

$$\text{Q.I.} = (\%\ \text{FAS} \times \text{PR}_{\text{FAS}}) + (\%\ \text{SEL} \times \text{PR}_{\text{SEL}}) + (\%\ \text{No. 1 Common} \times \text{PR}_{\text{No 1C}}) + \ldots\ldots\ldots\ldots (\%\ \text{3A Common} \times \text{PR}_{\text{No 3AC}})$$

wherein

% FAS—means the percentage of the volume of the lumber sawed from a log in First and Seconds lumber grade.

PR_{FAS}—means the standard price relative for FAS lumber.

Two sets of data were used to develop a Q.I.: (1) lumber-grade yields by log grade, log diameter, and species and (2) lumber-price relatives, i.e., lumber-price ratios with 4/4 No. 1 Common as the base grade. Prices were derived from regional price reports and averaged for a period of five years.

In this analysis, U.S. Forest Service hardwood log grades for

standard factory lumber, F_1, F_2, F_3 grades, and construction and local use classes were used (Ostrander et al. 1965).

Lumber-grade yield estimates were obtained from the Forest Products Laboratory publication *Hardwood log grades for standard lumber* (Vaughn, Walling, McDonald, and Bulgrin 1966). The erratic nature of the basic data, especially in the larger diameter classes, made it necessary to hand-curve the yield data to make it useful for developing the Q.I.'s.

Lumber price relatives used here were developed from the *Hardwood Market Report* (Lemsky 1962-1966) for the base period 1962-1966.

Prices were averaged over the five year period and the ratios, i.e., the average price of the various grades relative to the average price of No. 1 Common lumber, were determined. The price relatives (P.R.) for No. 1 Common are always 1.00, whereas the P.R.'s for hardwood lumber grades FAS and SEL are above 1.00 and the P.R.'s for No. 2 Common, No. 3A and 3B Common are below 1.00 (table 1).

Table 1.—*Lumber price relatives by grade and species*[1]

Species	Lumber grade							
	FAS	SEL	SAPS	No. 1C	No. 2C or 2AC	No. 2BC	No. 3AC	No. 3BC
Red oak	1.74	1.65	—	1.00	0.67	—	0.59	0.40
Black oak	1.74	1.65	—	1.00	0.67	—	0.59	0.40
Scarlet oak	1.74	1.65	—	1.00	0.67	—	0.59	0.40
White oak	1.90	1.81	—	1.00	0.68	—	0.59	0.40
Chestnut oak	1.90	1.81	—	1.00	0.68	—	0.59	0.40
Yellow-poplar	1.45	1.38	1.31	1.00	0.69	0.47	0.25	0.25

[1] Based on 1962-66 prices from the *Hardwood Market Report* for Appalachian hardwoods, f.o.b. mills, Johnson City, Tennessee area with 4/4 thickness, plain-sawed No. 1 Common grade as the reference grade.

Once the lumber-grade yields and the price relatives are obtained, it is possible to calculate the Q.I.'s. For example, given a 16-inch diameter chestnut oak, log grade F_1, with lumber-grade yields of 15.2 percent FAS, 11.5 percent SEL, 30.5 percent No. 1C,

23.5 percent No. 2C, 6.5 percent No. 3A and 12.8 percent No. 3B and the price relatives as shown in Table 1 for chestnut oak, the Q.I. calculation appears as:

$$\begin{aligned} \text{Q.I.} = {} & (.152 \times 1.90) + (.115 \times 1.81) + \\ & (.305 \times 1.00) + (.235 \times 0.68) + \\ & (.065 \times 0.59) + (.128 \times 0.40) \\ \text{Q.I.} = {} & 1.051 \end{aligned}$$

Log Q.I.'s were computed for each species and diameter for log grades F_1, F_2, and F_3 (Appendix, tables 7 to 12). For log classes below these grades, lumber-grade yields were not available and an arbitrary quality index of 0.400 was used. This arbitrary Q.I. was used because Trimble and Mendel found, in the absence of data on lumber-grade yields, a Q.I. of 0.400 was representative for this quality of logs regardless of species (Trimble and Mendel 1969).

DEVELOPMENT OF Q.I. LOG VALUES

The usefulness of log-quality indexes is well demonstrated when it is necessary to determine log values. All that is needed are the Q.I.'s for a given species, grade and diameter of log (Appendix), and the current No. 1 Common lumber price. For this study the average 1962 *Hardwood Market Report* prices for 4/4 No. 1 Common plain sawn lumber for each species was used. This year was selected in order to compare Q.I. values with actual values received by the study mills during this year. The average *Hardwood Market Report* prices were:

Red oak Black oak Scarlet oak	$105/M bd. ft.
White oak Chestnut oak	$110/M bd. ft.
Yellow-poplar	$130/M bd. ft.

Assume we wish to determine the lumber-product value of the

previously used sample log, i.e., the 16-inch diameter chestnut oak grade F_1, whose log quality index was calculated as 1.051. All that is necessary is to multiply the Q.I. (1.051) times the 1962 price of No. 1 Common lumber ($110/M bd. ft.). Thus the Q.I. lumber value for this log would be (1.051 × $110/M) = $115.61/M bd. ft.

DEVELOPMENT OF COMMERCIAL SAWLOG VALUES

The commercial sawlog product values used in this analysis were developed from the previously mentioned study of seven sawmills located in southeastern Ohio and eastern Kentucky. At these mills red oak, black oak, scarlet oak, chestnut oak, white oak, and yellow-poplar logs were graded according to the specifications for U.S. Forest Service Factory Grades F_1, F_2, and F_3, construction and local use classes, and cull logs (table 2). Cull logs are those logs not meeting the specifications for the above grades and classes.

Table 2. —*Distribution of sawlogs used in analysis, by species and log grade or class*

Species	Log Grade No. 1	Log Grade No. 2	Log Grade No. 3	Construction and local use	Cull logs	Total
Red oak	19	20	9	2	5	55
Black oak	28	63	59	27	30	207
Scarlet oak	31	29	55	40	48	203
White oak	9	25	39	14	22	109
Chestnut oak	34	64	58	3	18	177
Yellow-poplar	82	206	258	147	158	851
Total	203	407	478	233	281	1,602

Each log was numbered and sawed into products following the regular sawing methods of the sawmill. This provided a representative estimate of sawlog product yields from regional com-

mercial operations. Only lumber, timbers and similar products were included as sawlog product yield. The log products such as sawdust, chips, and slabs were excluded.

After a log was cut, all boards were graded by a qualified NHLA lumber inspector and the volume determined for each of the boards and other cut products. The value of each of these products from the log was determined by multiplying its volume by the price received by the study mill, f.o.b. mill. The sum of these values gave the commercial product value of the sawlog. Because of the limited data for some species and diameter classes, the log-product values for construction and local use log classes were combined.

HOW THE COMPARATIVE ANALYSIS WAS MADE

Ratios were used to measure and compare the independently developed sawmill log-product values with the Q.I. log-product

Table 3.—*Quality Index-commercial sawmill log product value ratios for* scarlet oak, Log Grade No. 1, by diameter class

Log d.i.b. (in.)	No. logs	Sawmill log product volume (bd. ft.)	Sawmill log product value (dollars)	Quality index	Q.I. log value[1] ($/M bd. ft.)	Q.I. log value (dollars)	Ratio sawmill/Q.I. log values
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
13	7	665	67.70	.964	101.22	67.31	1.006
14	3	293	30.53	.985	103.42	30.30	1.008
15	5	589	61.50	1.003	105.32	62.03	0.991
16	5	630	71.30	1.023	107.41	67.67	1.054
17	2	317	37.60	1.043	109.52	34.72	1.083
18	2	373	36.80	1.063	111.61	41.63	0.884
20	4	942	108.82	1.102	115.71	109.00	0.998
22	1	186	17.20	1.138	119.49	22.23	0.774
23	2	447	33.30	1.153	121.07	54.12	0.615
Total	31	4,442	464.75	—	—	489.00	0.950

[1] Value derived by multiplying Q. I. by No. 1 Common lumber price.

values. Quality index and commercial sawlog product values were determined for each log to develop the value ratios, as presented in table 3 for log grade No. 1 scarlet oak.

The following methods were used in calculating these values:

a. Columns 1, 2, 3 and 4 show the log diameter class, number of logs, volume of log products, and total log product value derived from the sawmill study of scarlet oak, grade No. 1 sawlogs that were sawn and sold.

b. Column 5 is the quality index for scarlet oak, log grade 1 by diameter class as derived from table 9 in the Appendix.

c. Column 6, Q.I. log value/M bd. ft., was computed by multiplying the average 1962 *Hardwood Market Report* price for No. 1 Common plain sawn scarlet oak lumber by the Q.I. (column 5). For example, to determine the Q.I. log-product value/M bd. ft. for 13-inch logs, the Q.I. was multipled by the 1962 price of No. 1 Common scarlet oak lumber ($.964 \times \$105.00 = \$101.22$).

d. To determine the Q.I. log value of the sawmill study sawlogs, the sawmill log-product volume (column 3) was multiplied by the Q.I. unit value (column 6). For the 13-inch class this was $.665 \times \$101.22 = \$67.31$ and was recorded in column 7.

e. The ratio of commerical sawmill/Q.I. log-product values (column 8) was computed by dividing the sawmill log-product value (column 4) by the Q.I. log value (column 7). For 13-inch logs this was $\$67.70/\$67.31 = 1.006$. Expressed in percent, the commercial sawmill log value of logs in this class was 0.6 percent greater than the computed quality index value for the same log diameter class. A value ratio, as in the 15-inch class, of 0.991 means that the commercial sawmill log-product values were below that computed by the quality index method by 0.9 percent.

Likewise, a value ratio of 1.000 would mean there was no difference in the commercial sawmill and computed quality index values for that group of logs. Value ratios, for each species by log grade and diameter class, are shown in the Appendix, tables 13-18.

It should be stressed that ratios of commercial sawlog and Q.I. sawlog values not only differ from mill to mill, but will change

as the price relationships change between lumber and other products. These ratios should be checked periodically to determine whether they reflect current prices and mill sawing methods. Such checking could be accomplished by using a small sample of logs to determine the consistency of the ratios.

Results of Analysis

For all species analyzed in log grade No. 1 and No. 2 the commercial sawlog product values on the average were respectively 4.9 percent less and 7.3 percent greater than those predicted by the quality index for the same logs (table 4).

Table 4.—*Ratio of commercial sawlog and quality index sawlog product values, by species and Forest Service log grades and classes*

Species	Log Grade No. 1	Log Grade No. 2	Log Grade No. 3	Construction and local use	Cull logs	Construction, local use, and cull logs
Red oak	.966	1.227	1.317	1.531	1.810	1.711
Black oak	.884	1.163	1.151	1.670	1.392	1.534
Scarlet oak	.950	1.068	1.153	1.537	1.451	1.485
White oak	.766	1.056	1.057	1.338	1.400	1.371
Chestnut oak	1.012	1.293	1.233	1.847	1.724	1.745
Yellow-poplar	.956	.991	1.085	1.518	1.487	1.504
All species ave.	.951	1.073	1.119	1.533	1.483	1.507

There are two generalizations of significance concerning grade No. 1 and No. 2 logs: (1) sawmill operators in the region studied tend to saw logs into products whose value is within 10 percent, plus or minus, of that predicted by the quality index, (2) the quality-index method based on 4/4 grade lumber prices was a reliable tool to predict grade No. 1 and No. 2 log-product values in 1962.

The product value ratios of table 4 for log grades below grade

No. 2 indicate that sawmill operators convert their logs into (1) products of greater value than the grade lumber market would return and/or (2) obtained greater yields in the higher lumber grades than that obtained in the studies used for developing the quality index, or (3) sold their grade lumber in markets paying higher prices than quoted in the Hardwood Market Report. For example, grade No. 3 log-product values at commercial sawmills are almost 12 percent greater than the quality index predicted and for the lower log classes—construction, local use and culls—about 50 percent greater than the Q.I. predicted product value. Thus, if the Q.I. method based on 4/4 grade lumber yields and prices is used, adjustments must be made on a local basis to compensate for under-valuation of some log grades and classes by the Q.I. method.

The differences between Q.I. values and actual sawmill log product values were rather consistent throughout all species for most log grades. Also, the results indicate that size class (log diameter) does not significantly influence the value ratio. There was no consistent trend for any species from higher to lower or lower to higher values as size class changed. Statistical tests were also made to determine the adequacy of the sample log data. It was found that for accurate estimates of the value ratios, 4 to 8 sample logs for each diameter class and log quality class are required to maintain the standard error at the 5 percent level.

VALUE ADJUSTMENTS

We have indicated that the value differences found in the analysis are primarily related to different product yields or differences in product value in excess of that reported in the Hardwood Market Report.

Recovery in the higher lumber grades was a cause for value differences for some species and log grades or classes. Table 5 shows that one of the sawmills in the study recovered 20 percent more No. 1 Common and better lumber than the curved recovery data indicated for chestnut oak log grade No. 2.

Table 5.—*Comparison of computed Q.I. and actual sawmill log product values for chestnut oak, Log Grade No. 2, at a commercial sawmill*

Log d.i.b. (in.)	No. logs	Log volume (bd. ft.)	C.S. log value[1] $	Q.I. log value[2] $	Percent yield No. 1C & btr.		Percent value No. 1C & btr.		Percent yield 2C & below		Percent value 2C & below		Percent value other products		Percent yield other products	
					C.S.	Q.I.	C.S.	Q.I.	C.S.	Q.I.	C.S.	Q.I.	C.S.	Q.I.	C.S.	Q.I.
11	10	587	56.77	43.58	35	22	46	35	22	78	20	65	43	—	34	—
12	9	476	77.29	35.50	26	22	45	36	28	78	21	64	46	—	34	—
13	6	501	47.06	37.64	27	23	38	36	17	77	15	64	56	—	47	—
14	5	439	50.29	33.18	50	23	66	37	14	77	10	63	36	—	24	—
16	9	1,078	120.13	83.01	50	24	64	38	19	76	14	62	31	—	22	—
17	4	363	40.23	28.23	56	24	69	39	24	76	18	61	20	—	13	—
18	1	167	20.29	13.32	64	26	76	49	13	74	9	51	23	—	15	—
Average (percent)			—	—	43	23	56	37	20	77	16	63	37	—	28	—

[1] C.S.—Commercial sawmill A log product value
[2] Q.I.—Quality Index product value

The cause for the lower Q.I. values is related to the basic recovery data used in computing the Q.I. log values for this species. Using the Q.I. method, table 5 shows the average percent No. 2 Common and lower lumber grades recovered was 77 percent of the total yield and 63 percent of the total product value. On the other hand, commercial sawmill operations show only 20 percent of the yield and 16 percent of the value in these grades. The remaining yield and value at this commercial sawmill was in other products such as blocking, skids, barn timbers, bridge timbers, etc. This is characteristic of sawmill operations in the Ohio-Kentucky area.

These mills generally saw the low quality portion of a log (especially in the oak species) and the entire log in lower quality classes into products other than grade lumber. These products provide a greater return than grade lumber and are more readily marketable. Table 4 shows that for the chestnut oak this product differentiation starts in grade No. 3 logs and increases as the log quality is reduced.

Inasmuch as multi-product standards have not been developed, the above recovery and value differences point out the need for value adjustments when using the Q.I. method. Log evaluators must be alert to species and product mix variation by locality and region and make Q.I. value adjustments accordingly. Although we have emphasized the need for adjusting Q.I. log values, we must at the same time recognize that when the objective product mix is heavy to grade lumber, value adjustments may be unnecessary.

Table 6 shows that the Q.I. estimate of product yield and value for yellow-poplar, log grade No. 2 was consistent with that received by commercial sawmill operations. In this case, only six percent of the yield, representing four percent of the value, was processed into products other than grade lumber by the sawmills studied.

Published log yield data for log classes by lumber grade for logs not meeting F_1, F_2, F_3 standards is not available. As indicated earlier an arbitrary Q.I. of .400 was selected for these log classes. It is apparent from the analysis that the Q.I. must be adjusted

Table 6.—*Comparison of computed Q.I. and actual commercial sawmill log values for yellow-poplar, Log Grade No. 2*

Log d.i.b. (in.)	No. logs	Log volume (bd. ft.)	C.S. log value[1] $	Q.I. log value[2] $	Percent yield No. 1C & btr.		Percent value No. 1C & btr.		Percent yield 2C & below		Percent value 2C & below		Percent yield other products		Percent value other products	
					C.S.	Q.I.	C.S.	Q.I.	C.S.	Q.I.	C.S.	Q.I.	C.S.	Q.I.	C.S.	Q.I.
11	25	1,609	150.67	155.62	37	42	46	59	55	58	49	41	8	—	5	—
13	25	1,969	200.31	193.51	41	42	50	60	50	58	44	40	9	—	6	—
12	40	2,576	243.58	251.50	46	43	55	60	49	57	42	40	5	—	3	—
14	25	2,185	222.17	217.30	45	44	58	61	51	56	39	39	4	—	3	—
15	24	2,337	229.09	235.45	38	46	48	62	55	54	48	38	7	—	4	—
16	18	2,194	228.63	224.18	51	47	61	64	45	53	36	36	4	—	3	—
17	14	1,794	184.65	185.64	55	49	67	65	42	51	31	35	3	—	2	—
18	10	1,306	119.73	136.67	57	50	63	65	39	50	35	35	4	—	2	—
19	10	1,577	159.85	166.26	58	51	66	66	38	49	32	34	4	—	2	—
20	4	573	65.77	60.86	67	52	78	67	31	48	20	33	2	—	2	—
21	1	152	13.99	16.26	57	53	58	68	43	47	42	32	—	—	—	—
22	6	1,130	109.88	121.93	63	54	72	69	25	46	20	31	12	—	8	—
23	2	379	63.05	41.24	87	55	94	70	8	45	14	30	5	—	2	—
24	2	521	53.57	57.10	78	56	84	71	20	44	15	29	2	—	1	—
Average (percent)			—	—	50	49	60	63	44	51	36	37	6	—	4	—

[1] C.S.—*Commercial sawmill.*
[2] Q.I.—Quality Index.

upward for these lower quality classes. Table 4 shows that the value difference was rather consistent for the lower log quality classes, regardless of species. This would indicate that a Q.I., based on 4/4 grade lumber recovery and values, should be adjusted upward for these log quality classes.

Until more realistic lumber recovery data becomes available for computing the Q.I. log values, an adjustment of 40-50 percent upward would appear to be valid for construction, local use, and cull logs.

Adjusting Q.I. Log Values

This report contains all the necessary information for finding the estimated product value of a log for a mill that has processing procedures and price relationships similar to the mills used in this study. The only outside information needed is a reliable No. 1 Common lumber price. For example, assume a buyer wants to know the value of products he can expect to saw from a 13-inch diameter, 14-foot long scarlet oak grade No. 3 log when the current selling price of 4/4 No. 1 Common red oak lumber is $130/M bd. ft. The volume of this log is 100 board feet (Int. 1/4-inch rule), and its Q.I. value given in table 9, Appendix is .620. Substituting these values in the Q.I. log-product value formula:

$$\text{Q.I. log-product value} = \frac{(\text{Q.I.}) \times (\text{No. 1 Common lumber price}) \times (\text{bd. ft. volume of log})}{1000}$$

$$= (.620) \times (\$130) \times (.100)$$

$$= \$8.06$$

This $8.06 is what he can expect to receive from this log if it is sawn into 4/4 grade lumber. However, usually such a low quality log is sawn into grade lumber and other products. This requires an adjustment in the Q.I. log-product value if it is to represent the value of the various products which can be sawn from this log. The adjustment is made by substituting the log value ratio (Appendix, table 15) of this log (1.344) in the formula:

$$\begin{aligned}\text{Adjusted Q.I. log-product value} &= (\text{Q.I. log-product value}) \\ &\quad \times (\text{log value ratio}) \\ &= (\$8.06) \times (1.344) \\ &= \$10.83\end{aligned}$$

The buyer can expect to receive $10.83 from the products sawn from this 13-inch, 14-foot scarlet oak grade No. 3 log.

CONCLUSIONS

This analysis shows that the quality-index method of log valuation will provide a consistent estimate of log-product values when grade lumber is produced. However, where sawmill practices and product mix objectives are other than producing grade lumber, adjustments in log-product value estimates must be made. These adjustments have been found to be of greater consequence in the lower quality logs (log grade No. 3 and below), which mill operators generally process into products of higher value than low-grade lumber.

Because of the differences in recovery it is recommended that when regional or national lumber grade yields for a given species are used to determine log values by the Q.I. method, local adjustments should be made to bring values more closely in line with reality. The methods outlined here can be used to develop adjustment ratios for regions and mills outside the area studied. Samples of more than four logs for each species-log grade cell need to be studied to give reliable results.

The methods and analysis used here can serve as a guide for adjusting log values; however, the real need is a multi-product grading system. With such a system, Q.I.'s could be developed for all product grades and eliminate the need for adjusting the Q.I. values.

LITERATURE CITED

Herrick, Allyn M.
1946. GRADE YIELDS AND OVERRUN FROM INDIANA HARDWOOD SAWLOGS. Purdue Univ. Agr. Exp. Sta. Bull. 516, 60 pp., illus.

Herrick, Allyn M.
1956. THE QUALITY INDEX IN HARDWOOD SAWTIMBER MANAGEMENT. Purdue Univ. Agr. Exp. Sta. Bull. 632, 26 pp., illus.

Lemsky, Abe.
1962-66. HARDWOOD MARKET REPORT. Memphis, Tenn.

Ostrander, M. D. and others.
1965. A GUIDE TO HARDWOOD LOG GRADING (REVISED). U.S.D.A. Forest Serv. NE. Forest Exp. Sta., 50 pp., illus.

Trimble, George R., Jr. and Joseph J. Mendel.
1969. THE RATE OF VALUE INCREASE FOR NORTHERN RED OAK, WHITE OAK, AND CHESTNUT OAK. U.S.D.A. Forest Serv. Res. Paper NE-129, 29 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.

Vaughn, C. L., Walling, A. C., McDonald, K. A., and E. H. Bulgrin.
1966. HARDWOOD LOG GRADES FOR STANDARD LUMBER. U. S. Forest Serv. Res. Paper, FPL-63, 52 pp., illus. Forest Prod. Lab., Madison, Wisc.

Whittaker, James C., and Orris D. McCauley.
1966. COSTS AND RETURNS FOR HARDWOOD LUMBER PRODUCTION IN THE APPALACHIAN REGION OF KENTUCKY AND OHIO. U. S. Forest Serv. Res. Paper NE-55, 10 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.

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APPENDIX

Table 7.—*Log-quality index for red oak by log grade or class and size class*[1]

Log d.i.b. inches	Quality index			
	Log Grade No. 1	Log Grade No. 2	Log Grade No. 3	Construction, local use, and cull classes
8	—	—	.437	.400
9	—	—	.437	.400
10	—	.694	.439	.400
11	—	.702	.442	.400
12	—	.714	.445	.400
13	0.992	.731	.447	.400
14	1.080	.748	.448	.400
15	1.118	.766	.454	.400
16	1.147	.773	.462	.400
17	1.160	.773	.474	.400
18	1.165	.776	.493	.400
19	1.165	.778	.514	.400
20	1.165	.782	.543	.400
21	1.165	.784	.572	.400
22	1.166	.787	.606	.400
23	1.169	.792	.645	.400
24	1.172	.799	.686	.400
25	1.175	—	.729	.400
26	1.184	—	—	.400
27	1.195	—	—	.400
28	1.209	—	—	.400
29	1.223	—	—	.400
30	1.237	—	—	.400

[1] By hand-curving lumber grade yield data from Res. Paper FPL-63 and 1962-1966 lumber prices from *Hardwood Market Report.*

Table 8.—*Log-quality index for black oak by log grade or class and size class*[1]

Log d.i.b. inches	Quality index			
	Log Grade No. 1	Log Grade No. 2	Log Grade No. 3	Construction, local use, and cull classes
8	—	—	.501	.400
9	—	—	.521	.400
10	—	.687	.539	.400
11	—	.690	.557	.400
12	—	.692	.575	.400
13	1.043	.695	.593	.400
14	1.051	.704	.612	.400
15	1.065	.713	.629	.400
16	1.079	.724	.646	.400
17	1.098	.733	.663	.400
18	1.118	.747	.678	.400
19	1.140	.762	.697	.400
20	1.159	.780	.714	.400
21	1.184	.799	—	.400
22	1.205	.819[2]	—	.400
23	1.230	.840[2]	—	.400
24	1.256	.862[2]	—	.400
25	1.280	.885[2]	—	.400
26	1.304	.904[2]	—	.400
27	1.329	.929[2]	—	.400

[1] By hand-curving lumber grade yield data from Res. Paper FPL-63 and 1962-1966 lumber prices from *Hardwood Market Report.*

[2] Extrapolated from curved indexes. Yield data for Q. I. development not available.

Table 9.—*Log-quality index for scarlet oak by log grade or class and size class*[1]

Log d.i.b. inches	Quality index			
	Log Grade No. 1	Log Grade No. 2	Log Grade No. 3	Construction, local use, and cull classes
8	—	—	.523	.400
9	—	—	.539	.400
10	—	—	.557	.400
11	—	.771	.578	.400
12	—	.775	.598	.400
13	.964	.782	.620	.400
14	.985	.794	.641	.400
15	1.003	.806	.659	.400
16	1.023	.818	.679	.400
17	1.043	.831	.695	.400
18	1.063	.845	.711	.400
19	1.081	.860	.727	.400
20	1.102	.874	.743	.400
21	1.119	.888	.759[2]	.400
22	1.138	.902	—	.400
23	1.153	.915	—	.400

[1] By hand-curving lumber grade yield data from Res. Paper FPL-63 and 1962-1966 lumber prices from *Hardwood Market Report.*

[2] Extrapolated from curved indexes. Yield data for Q. I. development not available.

Table 10.—*Log-quality index for white oak by log grade or class and size class*[1]

Log d.i.b. inches	Quality index			
	Log Grade No. 1	Log Grade No. 2	Log Grade No. 3	Construction, local use, and cull classes
8	—	—	.518	.400
9	—	—	.531	.400
10	—	.709	.543	.400
11	—	.730	.558	.400
12	—	.746	.572	.400
13	1.039	.764	.586	.400
14	1.096	.783	.600	.400
15	1.145	.803	.613	.400
16	1.187	.820	.629	.400
17	1.228	.841	.650	.400
18	1.255	.857	.675	.400
19	1.277	.872	.702	.400
20	1.289	.887	.726	.400
21	1.310	.906	.753	.400
22	1.336	.925	.783	.400
23	1.365	.945	.809	.400
24	1.402	.968	.844	.400
25	1.442	.991	.872	.400
26	—	1.017	.900	.400
27	—	1.043	—	.400
28	—	1.084	—	.400

[1] By hand-curving lumber grade yield data from Res. Paper FPL-63 and 1962-1966 lumber prices from *Hardwood Market Report.*

Table 11.—*Log-quality index for chestnut oak by log grade or class and size class*[1]

Log d.i.b. inches	Quality index			
	Log Grade No. 1	Log Grade No. 2	Log Grade No. 3	Construction, local use, and cull classes
8	—	—	.521	.400
9	—	—	.545	.400
10	—	.671	.563	.400
11	—	.675	.581	.400
12	—	.678	.594	.400
13	1.033	.683	.599	.400
14	1.037	.687	.601	.400
15	1.045	.693	.602	.400
16	1.051	.700	.603	.400
17	1.059	.707	.604	.400
18	1.065	.725	.605	.400
19	1.069	.743	.605	.400
20	1.078	.760	.606	.400
21	1.085	.782	.608	.400
22	1.091	.790	.609	.400
23	—	.797	.612	.400
24	—	.806	.616	.400
25	—	.820	.622	.400
26	—	.824	.626	.400
27	—	.833	.632	.400
28	—	.843	.638	.400
29	—	.857	—	.400
30	—	.862	—	.400
31	—	.870	—	.400

[1] By hand-curving lumber grade yield data from Res. Paper FPL-63 and 1962-1966 lumber prices from *Hardwood Market Report.*

Table 12.—*Log-quality index for yellow-poplar by log grade or class and size class*[1]

Log d.i.b. inches	Quality index			
	Log Grade No. 1	Log Grade No. 2	Log Grade No. 3	Construction, local use, and cull classes
8	—	—	.524	.400
9	—	—	.539	.400
10	—	.743	.553	.400
11	—	.744	.568	.400
12	—	.751	.583	.400
13	.895	.756	.600	.400
14	.915	.765	.615	.400
15	.933	.775	.630	.400
16	.947	.786	.645	.400
17	.963	.796	.659	.400
18	.977	.805	.672	.400
19	.991	.811	.688	.400
20	1.001	.817	.703[2]	.400
21	1.014	.823	.718[2]	.400
22	1.024	.830	.733[2]	.400
23	1.033	.837	.748[2]	.400
24	1.045	.843	.763[2]	.400
25	1.055	.850	—	.400
26	1.063	—	—	.400
27	1.071	—	—	.400
28	1.075	—	—	.400
29	1.078	—	—	.400
30	1.079	—	—	.400

[1] By hand-curving lumber grade yield data from Res. Paper FPL-63 and 1962-1966 lumber prices from *Hardwood Market Report.*

[2] Extrapolated from curved indexes. Yield data for Q. I. development not available.

Table 13.—*Ratio of commercial sawlog and Q. I. sawlog values for red oak*

Log d.i.b. inches	Log Grade No. 1		Log Grade No. 2		Log Grade No. 3		Construction and local use logs		Cull logs		Construction, local use, and cull classes	
	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio
10					1	1.086	—	—	—	—	—	—
11			1	1.115	—	—	—	—	—	—	—	—
12			4	1.332	1	1.724	—	—	1	2.200	1	2.200
13	2	1.028	2	1.572	1	1.153	—	—	1	1.894	1	1.894
14	2	1.029	2	1.058	—	—	1	1.533	2	1.518	3	1.516
15	1	0.577	1	1.249	—	—	—	—	1	2.241	1	2.241
16	2	1.075	1	1.420	—	—	1	1.519	—	—	1	1.519
17	1	0.983	2	1.345	2	1.351	—	—	—	—	—	—
18	3	1.053	1	0.815	2	1.534	—	—	—	—	—	—
19	3	0.988	4	1.264	—	—	—	—	—	—	—	—
20	2	1.085	1	1.103	—	—	—	—	—	—	—	—
21	1	1.187	—	—	—	—	—	—	—	—	—	—
22	1	0.854	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	2	1.220	—	—	—	—	—	—
25	—	—	1	1.099	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	—	—	—	—
30	1	0.609	—	—	—	—	—	—	—	—	—	—
Total	19		20		9		2		5		7	
Log grade ratio		0.966		1.227		1.317		1.531		1.810		1.711

Table 14.—*Ratio of commercial sawlog and Q. I. sawlog values for black oak*

Log d.i.b. inches	Log Grade No. 1		Log Grade No. 2		Log Grade No. 3		Construction and local use logs		Cull logs		Construction, local use, and cull classes	
	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio
6									1	1.786	1	1.786
7									2	1.609	2	1.609
8					—	—	—	—	—	—	—	—
9					3	1.141	4	1.379	3	1.469	7	1.424
10					4	1.116	7	1.657	5	1.383	12	1.561
11			6	0.939	10	1.245	2	1.224	6	1.241	8	1.238
12			12	1.019	12	1.083	2	1.835	2	1.189	4	1.519
13	3	0.850	15	1.143	8	1.065	6	1.553	4	1.360	10	1.474
14	6	0.844	8	1.102	8	0.999	1	1.470	1	1.189	2	1.343
15	6	0.911	6	1.196	6	1.310	1	1.456	2	1.609	3	1.563
16	5	0.853	6	1.332	4	1.174	1	1.856	2	1.596	3	1.659
17	5	0.926	3	1.137	2	1.202	1	1.337	2	1.221	3	1.254
18	1	0.908	4	1.377	—	—	1	2.130	—	—	1	2.130
19	1	0.904	1	1.337	1	1.128	—	—	—	—	—	—
20	—	—	—	—	1	1.381	—	—	—	—	—	—
21	—	—	1	1.378	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	1	2.248	—	—	1	2.248
23	1	0.857	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	1	0.898	—	—	—	—	—	—	—	—
Total	28		63		59		27		30		57	
Log grade ratio		0.884		1.163		1.151		1.670		1.392		1.534

Table 15.—*Ratio of commercial sawlog and Q. I. sawlog values for scarlet oak*

Log d.i.b. inches	Log Grade No. 1		Log Grade No. 2		Log Grade No. 3		Construction and local use logs		Cull logs		Construction, local use, and cull classes	
	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio
8					—	—	—	—	4	1.533	4	1.533
9					1	1.336	—	—	4	1.588	4	1.588
10					2	1.561	6	1.668	7	1.446	13	1.561
11			1	0.958	2	1.019	10	1.514	4	1.581	14	1.538
12			4	1.060	12	1.105	6	1.593	11	1.426	17	1.481
13	7	1.006	4	1.134	8	1.344	8	1.570	7	1.457	15	1.526
14	3	1.008	6	1.127	8	1.159	6	1.491	1	1.494	7	1.492
15	5	0.991	4	1.117	2	1.074	1	1.405	4	1.377	5	1.385
16	5	1.054	3	1.199	7	1.159	3	1.392	2	1.246	5	1.335
17	2	1.083	3	1.065	5	1.064	—	—	2	1.407	2	1.407
18	2	0.884	—	—	5	1.069	—	—	1	1.481	1	1.481
19	—	—	—	—	2	1.069	—	—	—	—	—	—
20	4	0.998	1	1.292	—	—	—	—	1	1.371	1	1.371
21	—	—	1	1.088	1	1.465	—	—	—	—	—	—
22	1	0.774	1	0.528	—	—	—	—	—	—	—	—
23	2	0.615	1	0.964	—	—	—	—	—	—	—	—
Total	31		29		55		40		48		88	
Log grade ratio		0.950		1.068		1.153		1.537		1.451		1.485

Table 16.—*Ratio of commercial sawlog and Q. I. sawlog values for white oak*

Log d.i.b. inches	Log Grade No. 1		Log Grade No. 2		Log Grade No. 3		Construction and local use logs		Cull logs		Construction, local use, and cull classes	
	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio
7									1	1.082	1	1.082
8					2	1.136	1	1.133	2	1.446	3	1.333
9					3	1.267	1	1.287	4	1.450	5	1.426
10					3	1.263	2	1.073	3	1.246	5	1.172
11			2	0.819	10	1.098	4	1.210	6	1.384	10	1.315
12			7	1.035	6	1.091	3	1.550	1	1.137	4	1.455
13	3	0.811	2	0.862	6	1.003	1	1.227	3	1.336	4	1.307
14	3	0.695	8	0.927	3	1.190	—	—	—	—	—	—
15	1	0.500	3	1.136	3	0.884	2	1.413	1	2.099	3	1.631
16	—	—	—	—	1	1.243	—	—	1	1.137	1	1.137
17	—	—	1	1.444	—	—	—	—	—	—	—	—
18	2	0.868	2	1.316	1	0.776	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	1	0.883	—	—	—	—	—	—
Total	9		25		39		14		22		36	
Log grade ratio		0.766		1.056		1.057		1.338		1.400		1.371

Table 17.—*Ratio of commercial sawlog and Q. I. sawlog values for chestnut oak*

Log d.i.b. inches	Log Grade No. 1		Log Grade No. 2		Log Grade No. 3		Construction and local use logs		Cull logs		Construction, local use, and cull classes	
	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio
8					3	1.354	—	—	2	1.671	2	1.671
9					7	1.389	—	—	7	1.692	7	1.692
10					13	1.238	2	1.683	1	1.591	3	1.658
11			14	1.240	8	1.255	—	—	4	1.535	4	1.535
12			14	1.244	6	1.204	1	2.119	2	1.515	3	1.706
13	9	1.081	10	1.189	5	1.104	—	—	—	—	—	—
14	6	1.019	9	1.204	6	1.290	—	—	—	—	—	—
15	6	1.046	1	0.881	1	1.670	—	—	1	1.161	1	1.161
16	4	1.001	9	1.443	3	1.246	—	—	—	—	—	—
17	6	0.963	4	1.421	2	1.184	—	—	—	—	—	—
18	—	—	1	1.522	2	1.460	—	—	1	2.899	1	2.899
19	3	0.904	1	1.677	2	1.011	—	—	—	—	—	—
20	—	—	1	1.144	—	—	—	—	—	—	—	—
Total	34		64		58		3		18		21	
Log grade ratio		1.012		1.293		1.233		1.847		1.724		1.745

Table 18.—*Ratio of commercial sawlog and Q. I. sawlog values for yellow-poplar*

Log d.i.b. inches	Log Grade No. 1		Log Grade No. 2		Log Grade No. 3		Construction and local use logs		Cull logs		Construction, local use, and cull classes	
	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio	No. logs	Ratio
5									2	1.477	2	1.477
6									13	1.471	13	1.471
7									30	1.439	30	1.439
8					6	1.230	16	1.474	18	1.371	34	1.413
9					12	1.121	27	1.432	24	1.440	51	1.432
10					47	1.156	37	1.483	23	1.449	60	1.468
11			25	0.968	39	1.059	28	1.536	9	1.409	37	1.514
12			40	0.969	44	1.141	19	1.556	14	1.492	33	1.531
13	7	0.897	25	1.035	29	1.068	7	1.558	10	1.629	17	1.591
14	13	0.956	25	1.022	23	1.116	4	1.759	8	1.596	12	1.661
15	11	0.984	24	0.973	19	1.155	6	1.425	2	1.110	8	1.349
16	13	0.952	18	1.020	12	1.147	2	1.640	1	1.350	3	1.525
17	12	0.880	14	0.995	8	1.005	1	1.380	3	1.719	4	1.644
18	12	1.060	10	0.876	4	1.067	—	—	1	2.031	1	2.031
19	5	1.027	10	0.961	2	1.029	—	—	—	—	—	—
20	3	1.144	4	1.081	3	0.856	—	—	—	—	—	—
21	2	0.842	1	0.860	2	0.679	—	—	—	—	—	—
22	3	0.715	6	0.901	6	1.057	—	—	—	—	—	—
23	1	0.783	2	1.529	1	0.851	—	—	—	—	—	—
24	—	—	2	0.938	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	1	0.862	—	—	—	—	—	—
Total	82		206		258		147		158		305	
Log grade ratio		0.956		0.991		1.085		1.518		1.487		1.504

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