Lumber Grade Yields For Sub-Factory Class RED OAK LOGS

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U. S. FOREST SERVICE RESEARCH PAPER NE-114
1968
NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE
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RED OAK LOGS

INTRODUCTION

A RECENT study made at Carbondale, Ill., showed that sawing large sub-factory class red oak[1] sawlogs into grade lumber can be profitable. Sub-factory logs are those that will not meet the Forest Service minimum specifications for factory-lumber logs and are generally considered to be, at the best, marginal in quality.

The most recent report of the timber situation in the United States indicates that the ". . . declining quality of timber resources represents a major problem for wood-using industries," but that "projected timber demands to the year 2000 could be met with more intensive forest management and utilization." (*8*)

[1] Red oak, in this report, includes northern red oak (*Quercus rubra* L.), black oak (*Quercus velutina* Lam.), and scarlet oak (*Quercus coccinea* Muenchh.).

What is the quality of our hardwood resource, and how much volume are we talking about? The report (8) summarizes the quality of our eastern hardwood sawtimber resource as follows:

Grade	*Percent*
No. 1 factory-lumber logs (7)	11
No. 2 factory-lumber logs (7)	18
No. 3 factory-lumber logs (7)	48
Tie-and-timber logs	23
	100

The portion of the sawtimber resource in tie-and-timber logs constitutes a volume of 99 billion board feet, but this number does not include the additional billions of board feet in local-use logs. It seems reasonable that the combined volume of sub-factory class sawtimber (tie-and-timber logs and local-use logs) totals at least 150 billion board feet.

If we are to meet the increasing demand for lumber through more intensive forest management and increased utilization, we must find ways to economically process the low-grade segment of our sawtimber resource. We now have little or no information about the conversion value of sub-factory class sawlogs. The study reported here is the first step in determining the value of the sub-factory class of red oak sawlogs. If we assume similar red oak yields for any particular area of operation, the results reported should enable a sawmill operator to determine the marginal log for his particular operation if he knows his costs for converting these logs into factory-grade lumber.

WHAT ARE SUB-FACTORY CLASS SAWLOGS?

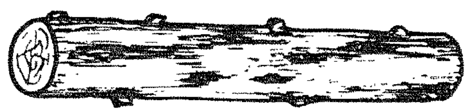
Hardwood sawlogs are most frequently segregated on the basis of use classes. Thus, logs meeting the factory class requirements are basically intended to be converted into lumber that later will be remanufactured into smaller defect-free pieces for end uses such as furniture or flooring, for which clear pieces are required.

The sub-factory group of sawlogs can be subdivided further into two classes—the construction class and the local-use class.

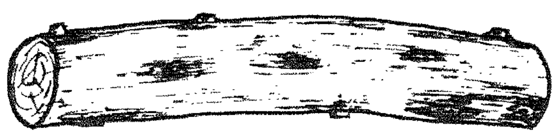
Descriptions of these two classes of logs from *A Guide to Hardwood Log Grading* (6) are given in the Appendix. The specifications for construction-class logs are listed in table 1, and examples are illustrated in figure 1. Specifications for local-use logs are listed in table 2, and examples are illustrated in figure 2.

Conversion of logs of these low quality classes into 4/4 lumber is not uncommon, especially in areas where strong markets exist for flooring and pallets. Thus the primary objective of this study was to determine the grade yield of 4/4 standard factory lumber (5) that can be expected from sub-factory class red oak sawlogs,

HARDWOOD CONSTRUCTION LOGS



A 10-foot log 18 inches in diameter at the small end. The cuttings on at least two of the four faces are not equal to the minimum required for factory grade 3. Although it has numerous knots, none has a knot collar exceeding 1/3 of the log diameter at the point where it occurs. The log contains no rot, shake, or splits, and it is straight.



A 12-foot log, 22 inches in diameter at the small end. The cuttings on at least two of the four faces are not equal to the minimum required for a factory grade 3. The numerous knots are small and, although the log is sweepy, the actual sweep does not exceed 1/4 of the diameter of the small end of the log. There is no rot, shake, or split.

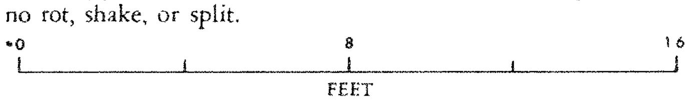
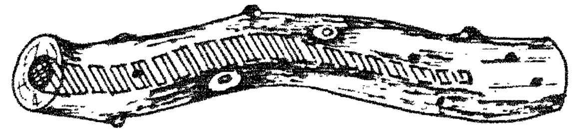
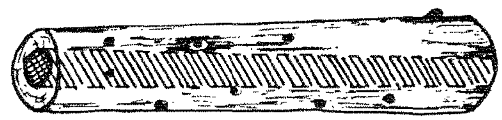


Figure 1.—Examples of hardwood construction class logs.

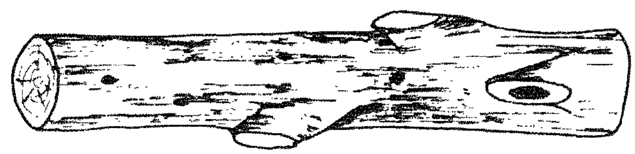
LOCAL-USE CLASS



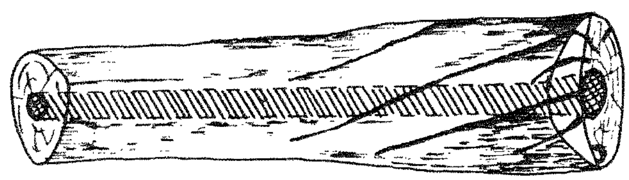
A 14-foot log 16 inches in diameter at the small end. It does not have minimum cuttings required for a factory log. It is too crooked and unsound to meet construction specifications. Sweep and rot deductions are less than 67 percent.



A 12-foot log 18 inches in diameter at the small end. It does not have the cuttings required for a factory log. It has no large knots and no sweep, but it has an unsound heart for which scale deductions will be less than 67 percent.



A 16-foot log 18 inches in diameter at the small end. It does not have the cuttings required for a factory log. Although it is sound, several knots are too large for the construction class.



A 16-foot log 20 inches in diameter at the small end. It does not have the cuttings required for a factory grade 3 log because of the deep spiral seams. It will not qualify as a construction log because of unsound heart.

Figure 2.—Examples of local-use class logs.

Table 1.—*Forest Service standard specifications*[1] *for construction logs*

Position in tree		Butt & upper
Diameter, small end		8 inches +
Length, without trim		8 feet
Clear cuttings		No requirements.
Sweep allowance, absolute		¼ diameter small end for each 8 feet of length.
Sound surface defects	Single knots	Any number, if no one knot has an average collar diameter in excess of ⅓ of log diameter at point of occurrence.
	Whorled knots	Any number if sum of collar diameters does not exceed ⅓ of log diameter at point of occurrence.
	Holes	Any number provided none has a diameter over ⅓ of log diameter at point of occurrence, and none extends over 3 inches into included timber.[2]
Unsound surface defects		Same requirements as for sound defects if they extend into included timber.[2] No limit if they do not.
End defects	Sound	No requirements.
	Unsound	None permitted except one shake not more than ⅓ the width of contained tie or timber and one split not over 5 inches long.

[1] These specifications are minimum for the class. If, from a group of logs, factory logs are selected first, thus leaving only non-factory logs from which to select construction logs, then the quality range of the construction logs so selected is limited, and the class may be considered a grade. If selection for construction logs is given first priority, then it may be necessary to subdivide the class into grades.

[2] Included timber is always square, and dimension is judged from small end.

Table 2.—*Suggested specifications for hardwood local-use logs*

Position in tree	Butt & upper
Diameter, small end	8 inches +
Length, without trim	8 feet +
Sweep allowance, absolute	½ diameter of small end
Total scale deduction allowed	50 to 67 percent
Clear cuttings	No requirements
Surface defects, sound and unsound	Only requirement is that diameter of knots, holes, rot, etc., shall not exceed ½ diameter of log at point of occurrence.
Sound end defects	No requirements

and to develop average lumber yield percentages by lumber grade and log diameter. Subsequent studies will be made to determine log values when multiple products such as side lumber, ties, and timbers are produced.

THE STUDY

The study was conducted at the Kaskaskia Experimental Forest in Illinois during two consecutive logging seasons. In both years we took data on red oak logs that were below grade 3 and had a net log scale of 50 percent or more of the gross log-scale volume.

The 235 study logs were placed on rollways and washed to insure that no defects (*4*) were hidden by dirt. Detailed end diagrams and surface diagrams were made of all defect indicators according to standard practices (*1*). Scaling deductions for rot, sweep, and crook were determined and recorded, using the procedure outlined by Grosenbaugh (*2*).

The study logs were sawed at the Kaskaskia Experimental Forest sawmill. Sawing methods were determined by the number of grade faces[2] on the log.

Logs with no factory-grade faces were placed on the carriage so the major defects were located along the edges of the sawing faces. The faces were sawed until the lumber grade dropped below 3A Common, or below the lumber grade obtainable from an adjacent face; the log was then turned 90 degrees, and the next face was sawed as the first. Sawing was continued until the log was completely converted into 4/4 lumber.

Logs with one factory-grade face were placed on the carriage with the grade face against the knees. The opposite face was sawed until the grade dropped below 3A Common, or below the lumber grade obtainable from an adjacent face; the log was then turned 180 degrees, and the grade face was sawed as the first. Next the log was turned 90 degrees, and the third face was sawed as above. Finally, the log was turned 180 degrees, and the fourth face was sawed until the conversion of the log was completed.

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[2] A grade face is a section one-fourth the surface of the log as divided lengthwise that will meet the specifications for a factory-grade sawlog face.

The sawing methods for logs with two factory-grade faces depending on whether the logs had opposite grade faces or adjacent grade faces.

If the log had opposite grade faces, one of the grade faces first was sawed until the grade dropped below 3A Common, or below the lumber grade obtainable from an adjacent face; then the log was turned 180 degrees, and the second grade face was sawed as the first. The log was then turned 90 degrees, and the third face was sawed as above; finally the log was turned 180 degrees, and the fourth face was sawed until the conversion was completed.

Logs with adjacent grade faces were placed on the carriage with one of the grade faces against the knees, and the first poor face was slabbed to provide a bearing surface. The log was then turned 90 degrees, and the second poor face was slabbed as the first. The log was then turned 90 degrees, and the first grade face was sawed until the grade dropped below 3A Common, or below the grade obtainable from an adjacent face when the second grade face was sawed as the first.

The sawing order by faces was indicated on both ends of the logs before they were placed on the carriage. The lumber produced was edged, ripped, and trimmed to obtain the best grade lumber, and efforts were made to minimize volume loss.

After each board was edged, it was numbered with the log number from which it was cut and with consecutive board numbers. If a board was ripped or crosscut, each portion was given the same log and board number. This numbering enabled us to identify individual boards in both green and dry grading and to record both green and air-dry yields for individual logs.

All the lumber produced in the study was graded by a competent lumber grader. The following National Hardwood Lumber Association grades were recognized: First and Seconds, Selects, Number 1 Common, Number 2 Common, Number 3A Common, and Number 3B Common. The length, width, surface measure, and grade were tallied by log- and board-number.

After the lumber was green-graded, it was stacked, and the lumber piles were roofed during the drying period. After the lumber had reached an approximate moisture content of 20 percent, it was regraded by the same grader.

ANALYSIS OF DATA

The data were combined for analysis. Table 3 shows the actual air-dry lumber grade-yield percentages by log diameter and by lumber grade for all study logs.

Curved lumber grade-yields by log diameter were developed by a least squares fit of the data, using a procedure reported by Jensen (*3*). This curving procedure has been used previously in log- and tree-grade analyses, and it was found to be appropriate. Table 4 shows the curved lumber grade-yield percentages by log diameter and lumber grade for the study logs.

Statistical evaluation of the differences among the three species of red oak was not attempted because of the small number of logs. Differences of practical importance did not occur in the data at hand.

Table 3.—Actual dry lumber yields by grade for sub-factory class[1] red oak[2] sav

Diameter	Logs	Lumber grade-yield						Vol lum tal
		FAS	Sel	1C	2C	3A	3B	
Inches	*No.*			*Percent*				*Boar*
9	6	—	—	—	—	7.1	92.9	1
10	21	—	—	2.7	11.4	17.9	68.0	7
11	36	—	—	3.0	9.4	22.7	64.9	1,6
12	45	—	0.4	3.5	11.7	22.4	62.0	2,1
13	37	—	.2	6.0	18.4	26.7	48.7	2,4
14	28	0.3	1.5	7.6	17.6	28.2	44.8	1,9
15	30	.2	.2	12.0	22.0	30.6	35.0	2,4
16	16	.4	1.2	9.1	22.6	28.7	38.0	1,5
17	9	—	1.7	19.1	32.5	23.8	22.9	8
18	3	—	.9	24.2	30.1	31.1	13.7	3
19	4	1.4	1.6	11.1	22.2	30.8	32.9	4
Average		0.2	0.6	7.9	17.9	26.1	47.3	

[1] Includes only construction class and local-use class sawlogs.
[2] Includes black oak, northern red oak, and scarlet oak.

Table 4.—*Curved dry lumber yields by grade for sub-factory class*[1] *red oak*[2] *sawlogs*

Diameter	Lumber grade					
	FAS	Sel	1C	2C	3A	3B
Inches			*Percent*			
9	—	—	2	5	8	85
10	—	—	3	8	16	73
11	—	1	3	11	21	64
12	—	1	4	14	24	57
13	—	1	6	16	27	50
14	—	1	8	19	28	44
15	—	1	10	21	30	38
16	—	1	12	24	30	33
17	1	1	14	25	30	29
18	1	1	15	27	30	26
19	1	1	17	28	30	23

[1] Includes only construction class and local-use class sawlogs.

[2] Includes black oak, northern red oak, and scarlet oak.

By combining the data from logs of each species of red oak we were able to compare the value of construction logs with the value of local-use logs. There was no significant difference in value between the two classes of sawlogs.

APPLICATION

If he knows his costs a sawmill operator can use table 4 to determine the marginal sawlog for his particular situation. A hypothetical example will serve to illustrate the procedure.

Problem:

. A mill operator has production costs, including the cost of logs, sawing, lumber grading, drying and overhead as shown in table 5. What is the marginal or break-even log that can be sawed under this cost situation when the following prices for air-dry lumber are received?

	Price per thousand board feet
FAS	$200
Sel	$180
1C	$135
2C	$ 85
3A	$ 75
3B	$ 35

Solution:

Multiply the lumber yield percentages (table 4) by their respective selling prices for each log diameter class to determine the average lumber value per thousand board feet:

Example: 17-inch logs:

FAS: .01 x $200 = $ 2.00
Sel: .01 x $180 = $ 1.80
1C: .14 x $135 = $18.90
2C: .25 x $ 85 = $21.25
3A: .30 x $ 75 = $22.50
3B: .29 x $ 35 = $10.15

Lumber value per thousand board feet for 17-inch logs = $76.60.

Table 5.—*Log lumber values and log-processing costs*

Diameter (inches)	Average lumber value per thousand board feet	Average variable costs per thousand board feet[1]
9	$42.70	$72.50
10	48.40	71.25
11	53.35	70.00
12	57.05	69.00
13	61.25	68.25
14	65.15	67.60
15	68.95	67.00
16	72.45	66.25
17	76.60	65.70
18	78.60	65.00
19	81.10	64.50

[1] Costs in this example from: Keppler, William E. and Thomas P. Fetters. LOGS—THE CRITICAL MILL INPUT. N. Logger 16(3): 22-24. 1967.

The average lumber values per thousand board feet for the logs is shown in table 5.

The marginal log for the sawmill in this example falls between 14 and 15 inches in diameter (the point at which the value of the lumber from the log is equal to the cost of producing the lumber). Logs 15 inches in diameter or larger will, on the average, yield a profit to this mill owner. On the other hand, this owner should reject logs less than 15 inches in diameter because the value of the lumber produced from these logs does not equal the cost of producing it.

A person wishing to apply these data to his own particular operation must substitute his own costs for those used in the example, and must also use his own lumber selling prices to determine his log value.

DISCUSSION

It is not known if these data will apply to sub-factory class sawlogs of other species, but it is very likely that the yields from other oaks would not differ materially from the yields presented in this paper because of the relatively low values involved. A sample of approximately 50 logs should be sufficient to compare other oak yields to the red oak yields if an operator wishes to make this test.

It is possible that conversion of all or some of these logs into products other than 4/4 lumber would yield higher returns. For example, if a sawyer cuts the No. 2 Common and Better Portion of the log into 4/4 factory lumber and converts the remainder of the log into structural items, the returns might be higher than they would be if only factory lumber were produced. A mill operator will be able to make this decision based on prices he receives for products other than factory lumber.

■

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APPENDIX

Construction Class Sawlogs

This class includes logs suitable for sawing into ties and timbers and other items to be used, more or less intact, for structural or weight-bearing purposes. Grade specifications are contained in the construction-lumber section of the National Haıdwood Lumber Association rules; the tie specifications of the American Railway Association; and the standard specifications for structural wool joists and planks, beams and stringers, and posts and timbers of the American Society for Testing Materials.

In general, these specifications are designed to insure the strength of a piece. In the usual run of logs suitable for this use, the position and condition of the heart are especially important factors. Knots and other defects that would impair the strength of the product are limited to sizes that hold impairment within acceptable limits.

Although factory-lumber grades allow for progressively more defects from the high grades to the low grades, construction specifications are rigid throughout with regard to the inclusion of weakening imperfections. This results in long requirements different from those for factory-lumber use. For example, a factory log with a rotten, shaky interior, and with large but widely spaced individual defects, may produce enough high-grade boards so that a high average quality of yield can be obtained. Yet such a log would be practically worthless as a construction log.

Local-Use Class

In general, local-use logs are those that are suitable for products not usually covered by any standard specifications. High strength, great durability, or fine appearance are not required in these products. These logs are generally sold in local or restricted markets for use in secondary farm buildings, crating, mine ties, and industrial blocking. Whereas the products of the other two classes are usually sold over a wide area and through a variety of marketing channels, local-use materials are generally sold directly to the user by the producer. This often makes the handling of local-use logs rather profitable.