Characteristics of FACTORY-GRADE HARDWOOD LOGS Delivered to Appalachian Sawmills

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U.S.D.A. FOREST SERVICE RESEARCH PAPER NE-166
1970

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE
RICHARD D. LANE, DIRECTOR

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UNTIL NOW, INFORMATION about the characteristics of sawlogs delivered to Appalachian sawmills has been generally unavailable. We know what the standing timber is like, from forest-survey data. But this paper covers a different spectrum: the frequency distributions—by size, grade, volume, and species group—of factory-grade logs actually harvested and delivered to the mills. These data were compiled from records of thousands of logs measured during studies of logging and milling economics at 15 Appalachian sawmills.

From requests received at the USDA Forest Service's Forest Products Marketing Laboratory, we know that some lumbermen can use data on hardwood sawlog use to determine the portion of certain species that are big enough for different-size timbers. Other operators can use the data as a basis for selecting equipment size or to appraise their sawing practices and to improve efficiency. Foresters can use the data to compare the quantity and grade of the harvest with the records of standing timber in

survey data. Researchers may find the data helpful when they need a foreknowledge of sample size in order to plan a study.

APPLICABILITY OF DATA

The graphs in this paper illustrate how the diameters, lengths, grades, and volumes of factory-grade hardwood sawlogs are distributed for the various Appalachian species sampled. Although these graphs are based on numbers of logs, the increments on the vertical axes of all graphs are in percent—not numbers of logs. This does not change general graphic shapes, and it does allow a direct comparison between species by eliminating the variation due to sample size.

Although the frequency distributions can be a valuable working tool, they have limitations that must be considered. First, the distributions represent factory-grade logs only. Construction grade, local-use, and cull logs were omitted, for they accounted for less than 2 percent of the logs sampled. Second, none of the graphs will precisely represent the logs received at any individual mill. Nor will the data necessarily apply to a small sample of logs received over a short period of time. However, even though there may be substantial deviations in any particular size and quality class, the general trends should be representative of long-term factory-grade log receipts.

The following factors will help you to evaluate the significance and applicability of the frequency distributions:

- 4,386 logs were measured.
- Species were recorded in nine groups: red oak, white oak, chestnut oak, beech, birch, maple, ash-basswood, poplar-cucumber, and miscellaneous. The red-oak group included red, scarlet, and black oaks; the birch group included yellow and black birch; the maple group included red and sugar maples; and the miscellaneous group contained mainly hickory and black cherry.
- Logs were measured at 15 sawmills scattered through five states: North Carolina, Virginia, West Virginia, Massachusetts and Vermont.

- Only 17 percent of the sample was taken in New England; most of the logs were sampled in West Virginia. The logs sampled in New England had slightly less volume than logs of similar species sampled in the southern Appalachians.
- 48 percent of the logs were delivered to circular sawmills, and the rest were delivered to band mills. The logs delivered to circular mills were similar in size and grade to those delivered to band mills.

DIAMETER AND GRADE DISTRIBUTIONS

The logs were concentrated heavily in the smaller diameters (figs. 1 to 9). For most species, the graphed frequency distributions rise rapidly in the lower diameters, peak at 12 to 14 inches, decline sharply at 17 or 20 inches, and then trail off gradually. Except for chestnut oak and beech, two-thirds of the logs had scaling diameters of less than 16 inches.

The tables accompanying the graphs show the distribution of logs among the three factory grades established by the USDA Forest Service.[1] For most species, high-quality grade-1 logs made up less than 20 percent of the total. Conversely, one-third or more of the logs of most species were grade 3. Most of the logs in most species were grade 2 logs having potential lumber yields of 30 to 60 percent in grades 1 Common and Better.[2]

Log quality was closely linked to scaling diameter. For most species, most logs 11 inches in diameter and smaller were grade 3. Most of the logs between 12 and 16 inches in diameter were grade 2. And for most species, most logs 17 inches in diameter and larger were grade 1.

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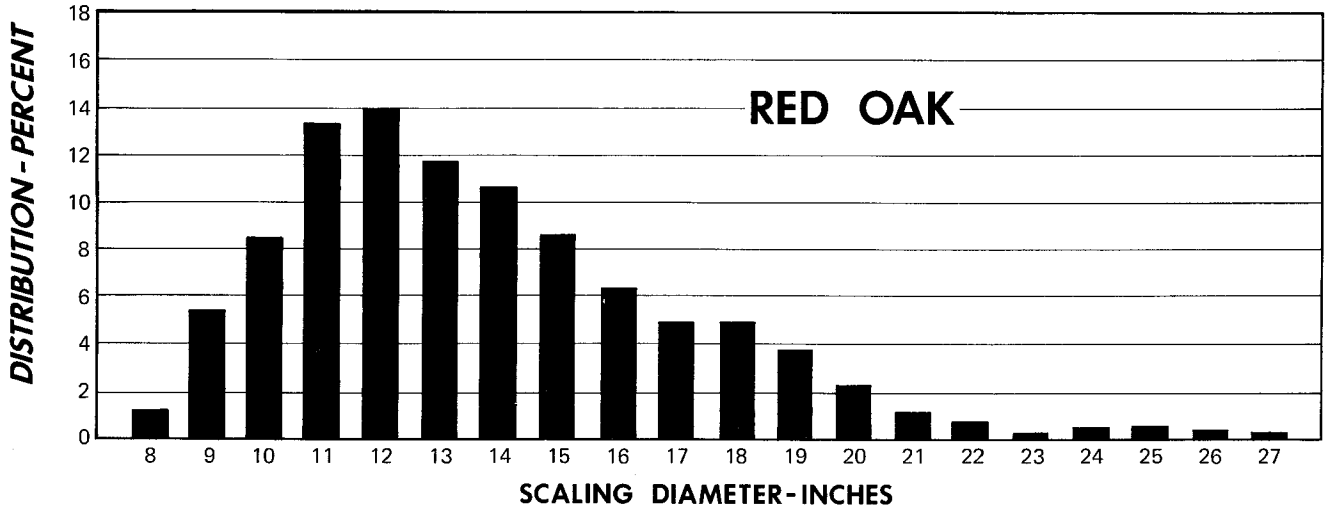
[1] Ostrander, M. D., and others. A GUIDE TO HARDWOOD LOG GRADING (REVISED). USDA Forest Serv. NE. Forest Exp. Sta., 50 pp., illus. Upper Darby, Pa. 1965.

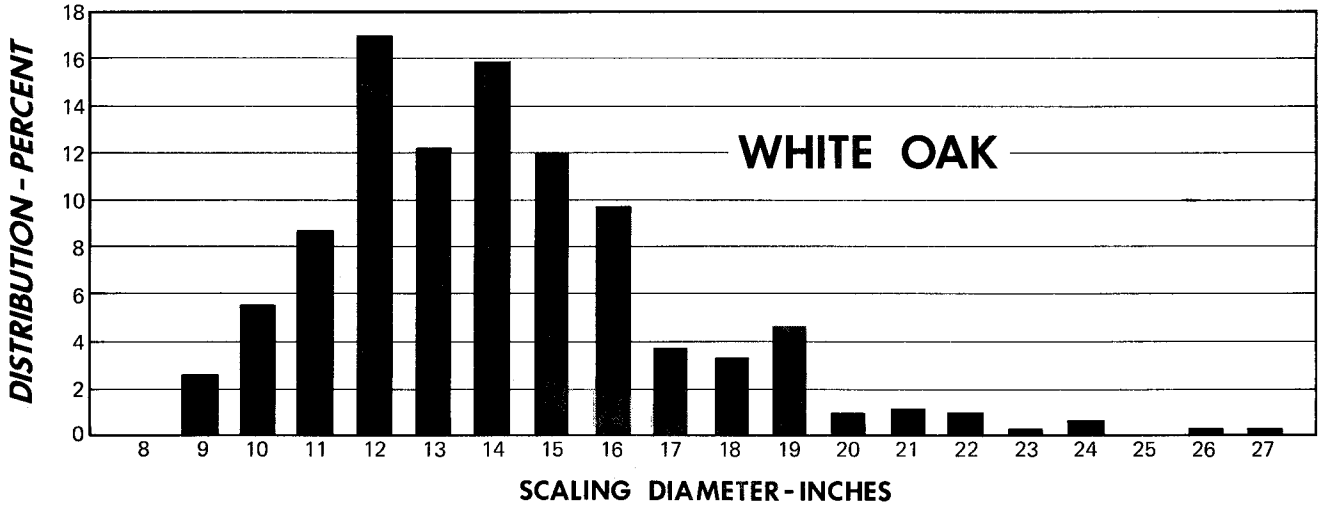
[2] Vaughan, C. L., A. C. Wollin, K. A. McDonald, and E. H. Bulgrin. HARDWOOD LOG GRADES FOR STANDARD LUMBER. USDA Forest Serv. Res. Paper FPL-63, 52 pp., illus. Forest Prod. Lab., Madison, Wis. 1966.

Figure 1.—Distribution of factory-grade sawlogs among diameter classes and log grades (958-log sample).



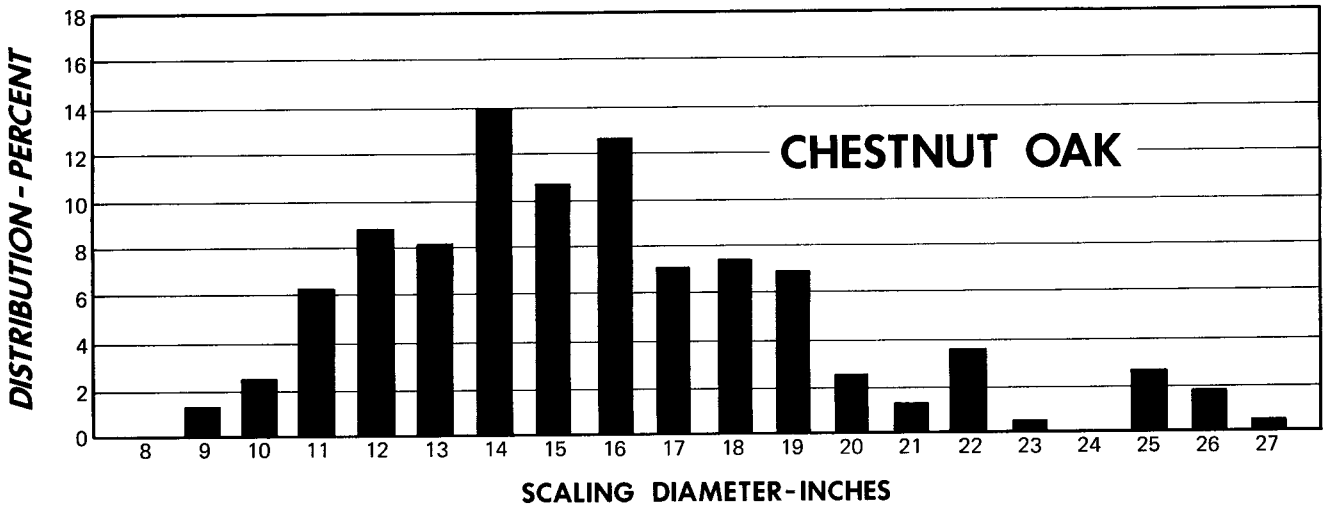
	LOG-GRADE DISTRIBUTION-PERCENT																				TOTAL
GRADE 1	—	—	—	—	—	3.6	2.1	2.9	2.5	1.9	2.6	2.3	1.1	0.7	0.3	0.2	0.3	0.2	0.4	0.1	21.2
GRADE 2	—	—	1.3	6.6	10.0	4.9	6.2	3.5	2.5	2.1	1.5	1.0	1.0	.3	0	0	.2	.1	0	.2	41.4
GRADE 3	1.3	5.4	7.1	6.8	4.0	3.3	2.3	2.3	1.3	.9	.8	.5	.1	.2	.5	.1	.1	.4	0	0	37.4
TOTAL	1.3	5.4	8.4	13.4	14.0	11.8	10.6	8.7	6.3	4.9	4.9	3.8	2.2	1.2	0.8	0.3	0.6	0.7	0.4	0.3	100.0

Figure 2.—Distribution of factory-grade sawlogs among diameter classes and log grades (343-log sample).



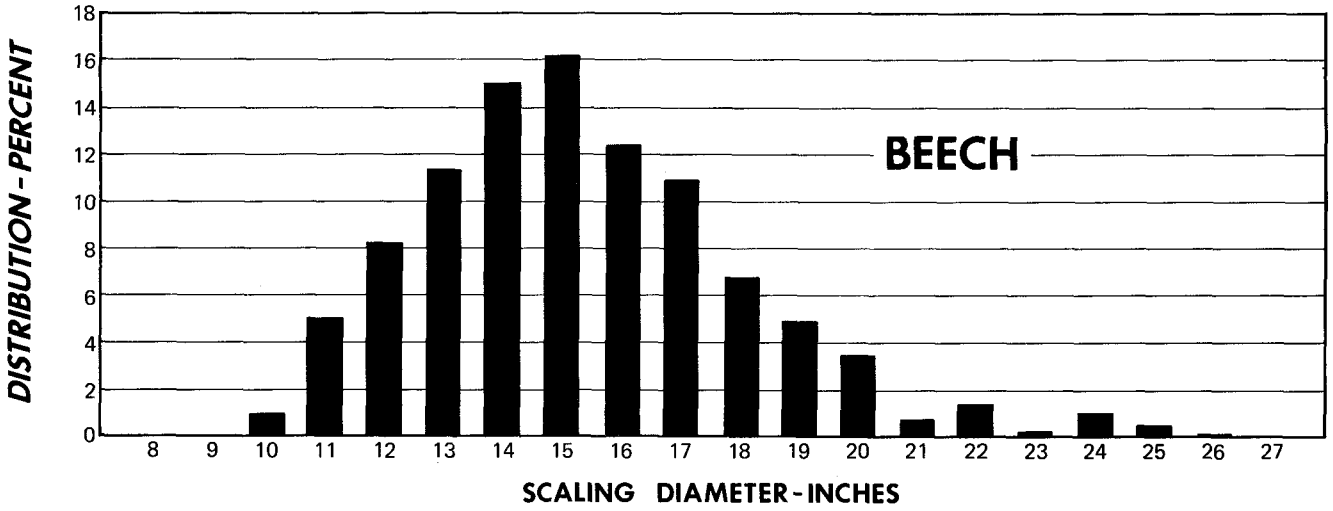
	LOG-GRADE DISTRIBUTION-PERCENT																				TOTAL
GRADE 1	—	—	—	—	—	2.7	2.6	3.2	2.0	1.2	1.5	1.7	0.6	0.3	0.9	0	0.6	0	0	0	17.3
GRADE 2	—	—	2.1	2.6	7.2	4.3	5.5	4.2	4.9	1.9	.9	1.7	.3	.6	0	0	0	0	0.3	0	36.6
GRADE 3	0	2.6	3.5	6.1	9.8	5.2	7.8	4.6	2.9	.6	.9	1.2	0	0.3	0	0.4	0	0	0	0.3	46.1
TOTAL	0	2.6	5.6	8.7	17.0	12.2	15.9	12.0	9.8	3.7	3.3	4.6	0.9	1.2	0.9	0.4	0.6	0	0.3	0.3	100.0

Figure 3.—Distribution of factory-grade sawlogs among diameter classes and log grades (158-log sample).



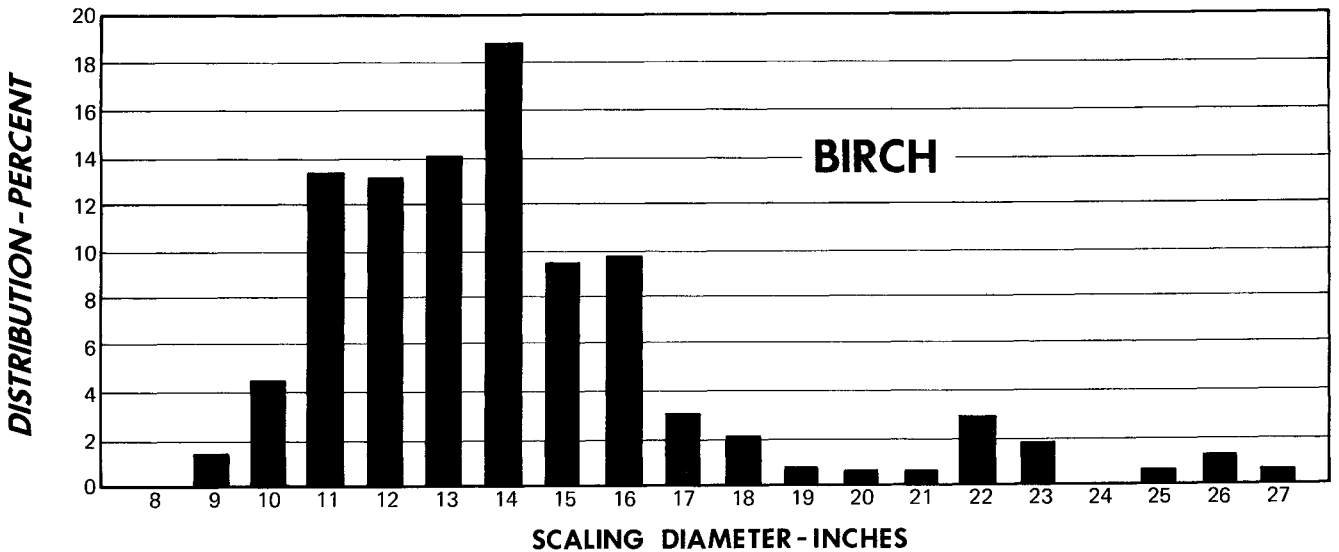
	LOG-GRADE DISTRIBUTION-PERCENT																				TOTAL
GRADE 1	—	—	—	—	—	0	1.3	0.6	3.2	3.8	3.2	5.7	1.9	1.3	1.9	0	0	1.3	0.6	0.6	25.4
GRADE 2	—	—	0	2.5	5.7	5.7	8.9	6.3	7.0	1.9	3.2	.6	.6	0	1.9	0.6	0	1.3	1.3	0	47.5
GRADE 3	0	1.3	2.5	3.8	3.2	2.5	3.8	3.8	2.4	1.9	1.3	.6	0	0	0	0	0	0	0	0	27.1
TOTAL	0	1.3	2.5	6.3	8.9	8.2	14.0	10.7	12.6	7.6	7.7	6.9	2.5	1.3	3.8	0.6	0	2.6	1.9	0.6	100.0

Figure 4.—Distribution of factory-grade sawlogs among diameter classes and log grades (346-log sample).



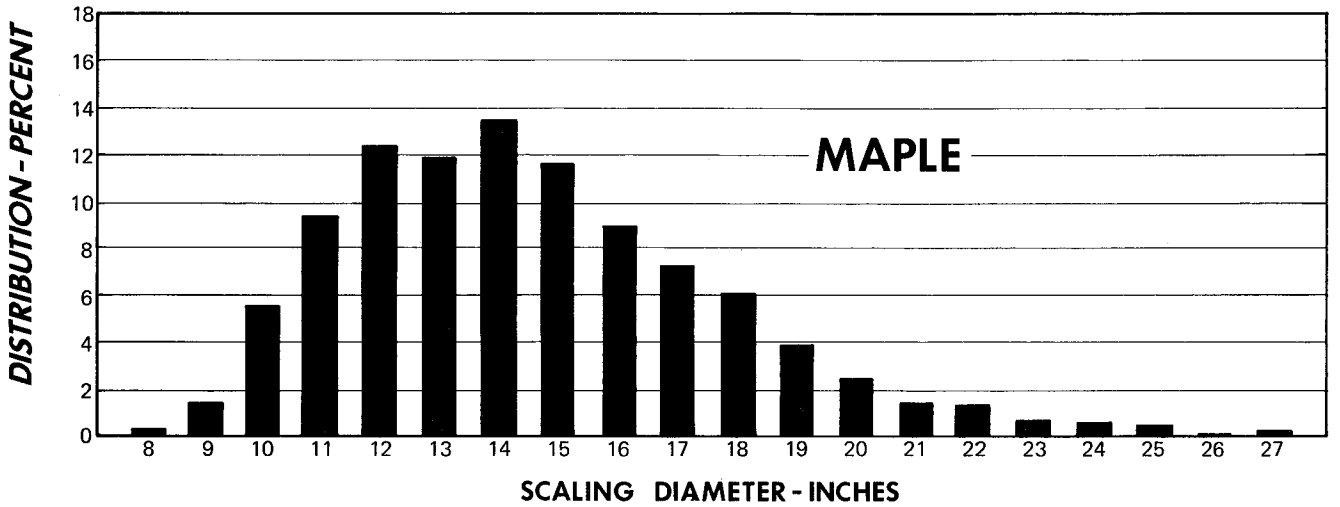
	LOG-GRADE DISTRIBUTION - PERCENT																				TOTAL
GRADE 1	--	--	--	--	--	2.6	1.2	2.9	2.9	2.6	1.2	1.7	1.4	0	0.6	0	0.6	0.6	0	0	18.3
GRADE 2	--	--	0	1.4	3.6	5.2	7.8	7.2	4.9	6.4	2.6	2.3	1.4	0.9	.6	0.3	.6	0	0	0	45.2
GRADE 3	0	0	1.2	3.6	4.6	3.5	6.1	6.1	4.6	2.0	2.9	.9	.6	0	.3	0	0	0	0.1	0	36.5
TOTAL	0	0	1.2	5.0	8.2	11.3	15.1	16.2	12.4	11.0	6.7	4.9	3.4	0.9	1.5	0.3	1.2	0.6	0.1	0	100.0

Figure 5.—Distribution of factory-grade sawlogs among diameter classes and log grades (135-log sample.)



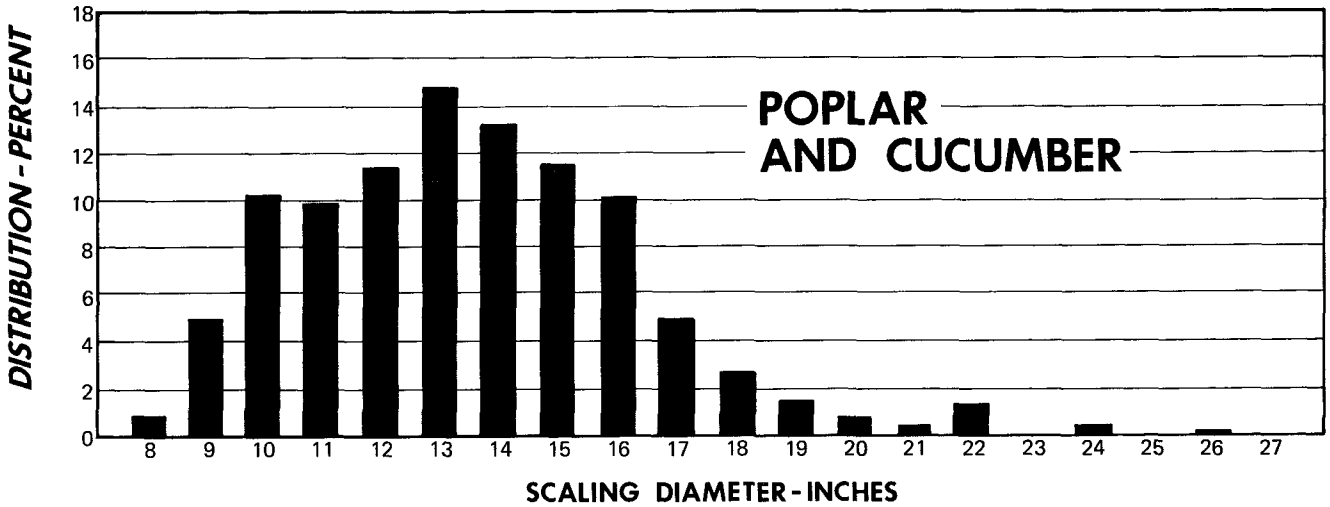
	LOG-GRADE DISTRIBUTION-PERCENT																				TOTAL
GRADE 1	—	—	—	—	—	3.0	5.2	1.5	3.7	2.4	0.7	0	0	0	1.5	0.9	0	0	0.7	0	19.6
GRADE 2	—	—	0	6.7	5.9	8.1	9.6	7.4	4.4	.7	1.5	0.9	0.7	.7	.7	0	0	0.7	.7	0.7	49.4
GRADE 3	0	1.5	4.4	6.7	7.4	3.0	4.0	.7	1.7	0	0	0	0	0	.7	.9	0	0	0	0	31.0
TOTAL	0	1.5	4.4	13.4	13.3	14.1	18.8	9.6	9.8	3.1	2.2	0.9	0.7	0.7	2.9	1.8	0	0.7	1.4	0.7	100.0

Figure 6.—Distribution of factory-grade sawlogs among diameter classes and log grades (1,170-log sample).



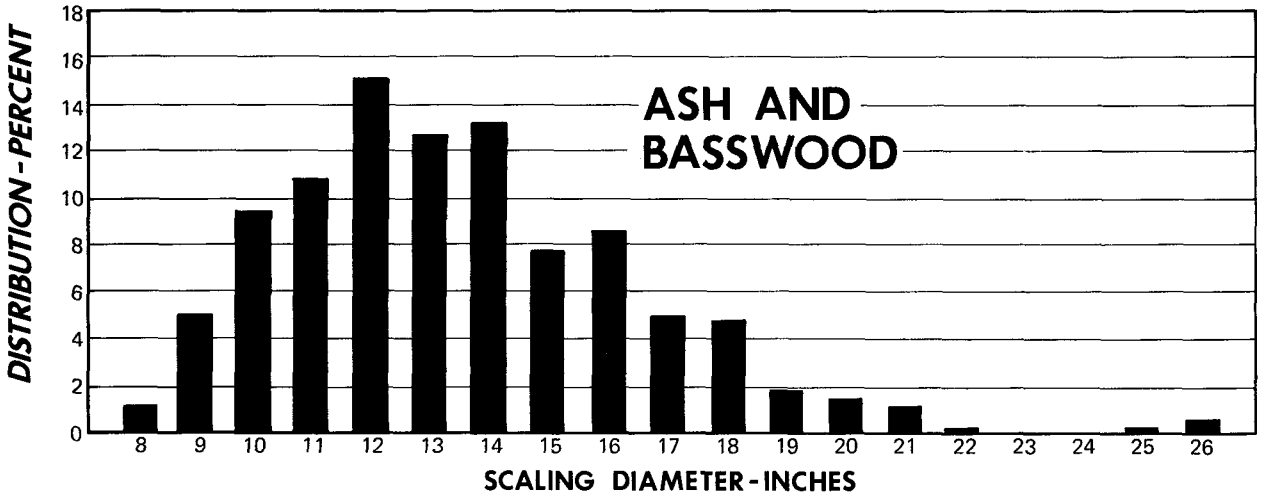
	LOG-GRADE DISTRIBUTION - PERCENT																				TOTAL
GRADE 1	—	—	—	—	—	1.4	1.6	2.4	2.4	1.7	1.9	1.7	0.8	0.8	0.6	0.4	0.3	0.1	0	0.1	16.2
GRADE 2	—	—	0.1	4.8	6.8	6.1	7.3	5.8	4.0	3.5	2.2	1.4	1.5	.4	.5	.1	.2	.1	0.1	.1	45.0
GRADE 3	0.3	1.4	5.6	4.7	5.6	4.4	4.6	3.5	2.6	2.1	2.0	.8	.3	.2	.2	.2	.1	.2	0	0	38.8
TOTAL	0.3	1.4	5.7	9.5	12.4	11.9	13.5	11.7	9.0	7.3	6.1	3.9	2.6	1.4	1.3	0.7	0.6	0.4	0.1	0.2	100.0

Figure 7.—Distribution of factory-grade sawlogs among diameter classes and log grades (427-log sample).



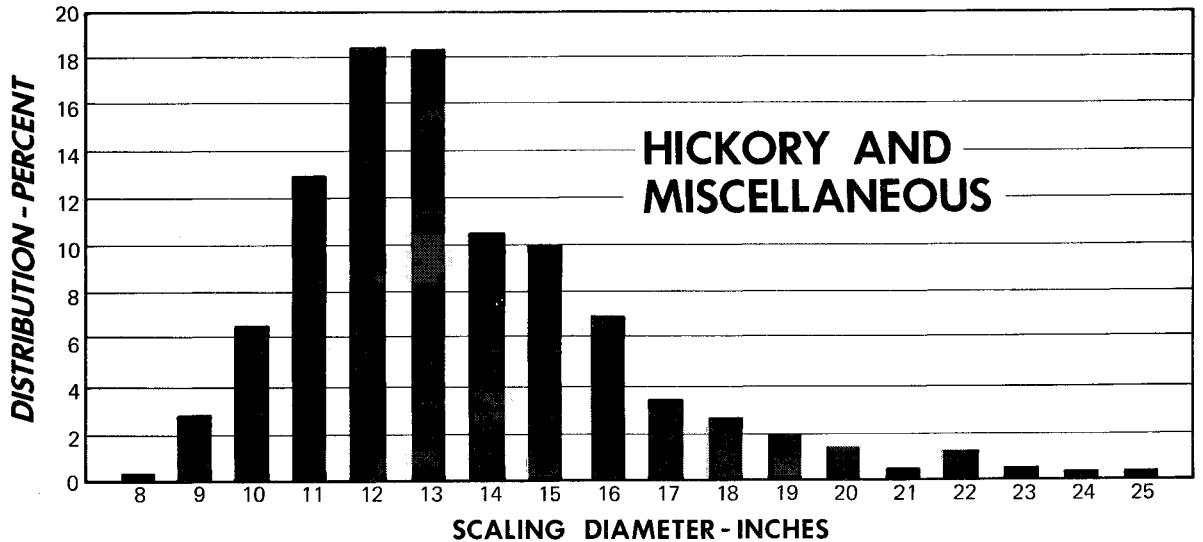
	LOG-GRADE DISTRIBUTION-PERCENT																			TOTAL
GRADE 1	--	--	--	--	--	1.6	3.3	2.6	6.8	2.1	1.4	.7	.4	.2	.7	0	0.4	0	0.2	0 20.4
GRADE 2	--	--	0	4.9	6.8	8.4	8.4	6.8	3.0	1.9	1.4	.9	.2	.2	0	0	0	0	0	0 42.9
GRADE 3	0.9	4.9	10.3	4.9	4.7	4.9	1.6	2.3	.4	.9	0	0	.2	0	.7	0	0	0	0	0 36.7
TOTAL	0.9	4.9	10.3	9.8	11.5	14.9	13.3	11.7	10.2	4.9	2.8	1.6	0.8	0.4	1.4	0	0.4	0	0.2	0 100.0

Figure 8.—Distribution of factory-grade sawlogs among diameter classes and log grades (315-log sample).



	LOG-GRADE DISTRIBUTION-PERCENT																			TOTAL
GRADE 1	--	--	--	--	1.9	4.1	3.2	2.5	3.2	2.5	3.2	1.6	1.3	1.3	0.3	0	0	0.3	0.3	25.7
GRADE 2	--	--	0.9	7.0	9.2	5.1	7.6	4.4	3.8	1.9	1.3	0	.3	0	0	0	0	0	.3	41.8
GRADE 3	1.3	5.1	8.6	3.8	4.1	3.5	2.5	.8	1.6	.6	.3	.3	0	0	0	0	0	0	0	32.5
TOTAL	1.3	5.1	9.5	10.8	15.2	12.7	13.3	7.7	8.6	5.0	4.8	1.9	1.6	1.3	0.3	0	0	0.3	0.6	100.0

Figure 9.—Distribution of factory-grade sawlogs among diameter classes and log grades (534-log sample).



	LOG - GRADE DISTRIBUTION - PERCENT																		TOTAL
GRADE 1	—	—	—	—	—	3.5	2.2	3.4	1.9	1.5	0.6	0.9	0.6	0.2	0.9	0.4	0.2	0.2	16.5
GRADE 2	—	—	0.6	6.4	9.6	8.4	5.4	4.9	2.8	1.3	1.3	.4	.7	.4	.2	0	.2	.2	42.8
GRADE 3	0.4	2.8	6.0	6.7	8.8	6.4	3.0	1.7	2.2	.7	.7	.7	.2	0	.2	.2	0	0	40.7
TOTAL	0.4	2.8	6.6	13.1	18.4	18.3	10.6	10.0	6.9	3.5	2.6	2.0	1.5	0.6	1.3	0.6	0.4	0.4	100.0

LOG-LENGTH DISTRIBUTIONS

The distributions of log lengths were similar among most of the nine species groups that were sampled (figs. 10, 11, and 12). The percentage of logs cut to different lengths increased progressively as lengths increased from 8 feet to 12 feet. Except for the poplar-cucumber log group, more logs were cut to 12-foot lengths than to any of the other lengths. The straight bole characteristics of poplar and cucumber may account for the predominance of 16-foot logs cut from these species.

Except for the oak log groups, there were noticeably fewer 14-foot logs than 12- and 16-foot logs. Evidently buckers have learned that logs that are straight enough for 14-foot lengths can usually be extended to 16 feet without noticeable scaling penalty. Furthermore, logging contractors favor 16-foot logs because of greater trucking efficiency. Sawmill operators also prefer 16-foot logs to 14-foot logs if the longer logs are reasonably straight. So the production of fewer 14-foot logs may be more a matter of economics and policy than a function of stem shape.

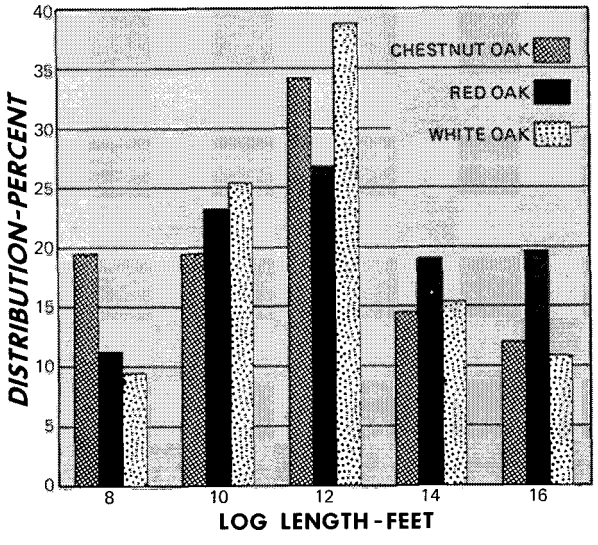
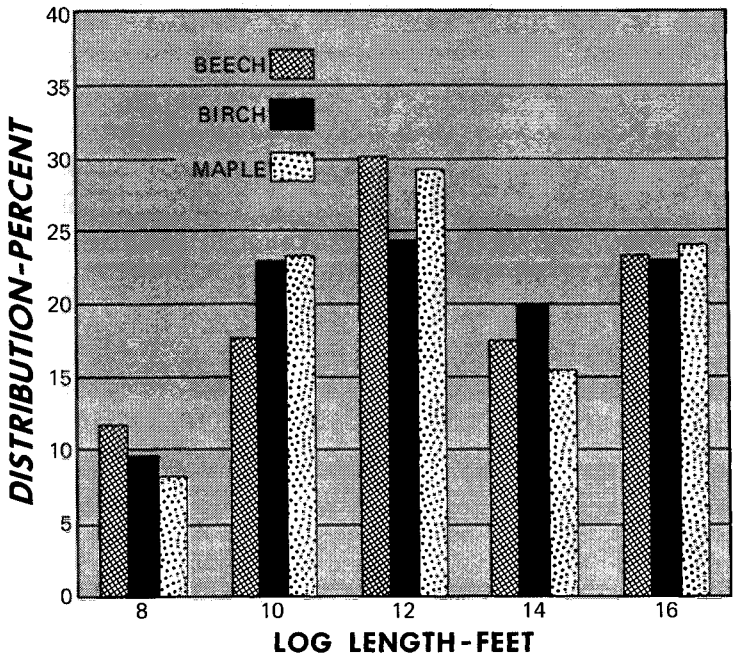


Figure 10. — Distribution (by percent of total for each species) of sawlog lengths observed at sample mills.

Figure 11.—Distribution (by percent of total for each species) of sawlog lengths observed at sample mills.



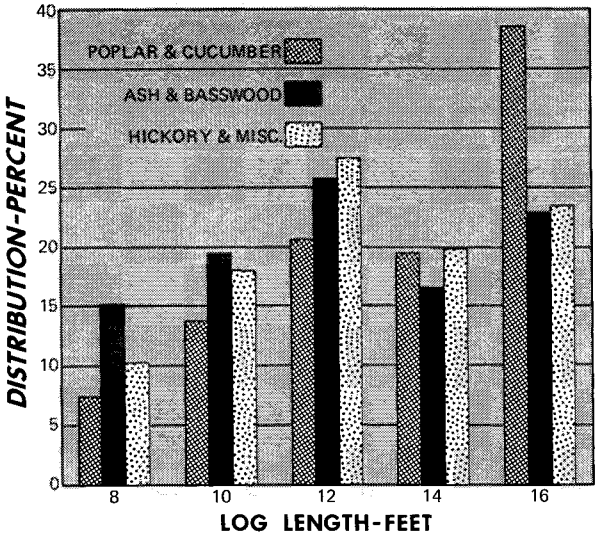


Figure 12. — Distribution (by percent of total for each species) of sawlog lengths observed at sample mills.

LOG-VOLUME DISTRIBUTIONS

Curves showing the proportionate number of logs by volume classes (figs. 13, 14, and 15) may be more useful than the frequency distributions by diameters and lengths, because volume is a function of both of these elements. The volume classes used to develop these curves were: 20 board feet or less, 21 to 40, 41 to 60, 61 to 80, 81 to 100, 101 to 150, 151 to 200, 201 to 250, 251 to 300, 301 to 400, and over 400 board feet.

The cumulative curves provide: (1) the gross log scale representing a specified portion of a species sample and (2) the portion of the total species sample above or below a selected log scale. For example, the index lines linked to the red-oak curve (fig. 13) show that 50 percent of the logs had a gross scale less than 60 board feet, Doyle. Index lines linked to the chestnut-oak curve (fig. 13) show that logs scaling 150 board feet or less accounted for about 75 percent of the total sample in this species.

Figure 13.—Relationship between individual log scale and the cumulative percent of the total number of logs sampled for each species.

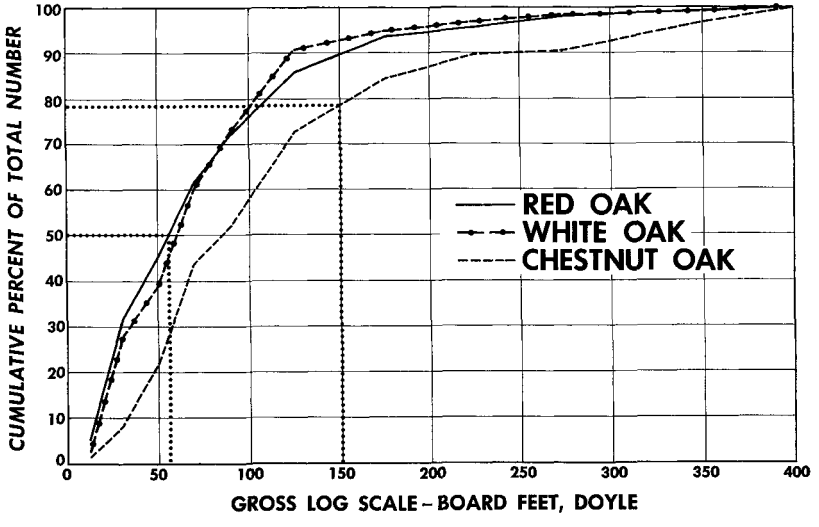


Figure 14.—Relationship between individual log scale and the cumulative percent of the total number of logs sampled for each species.

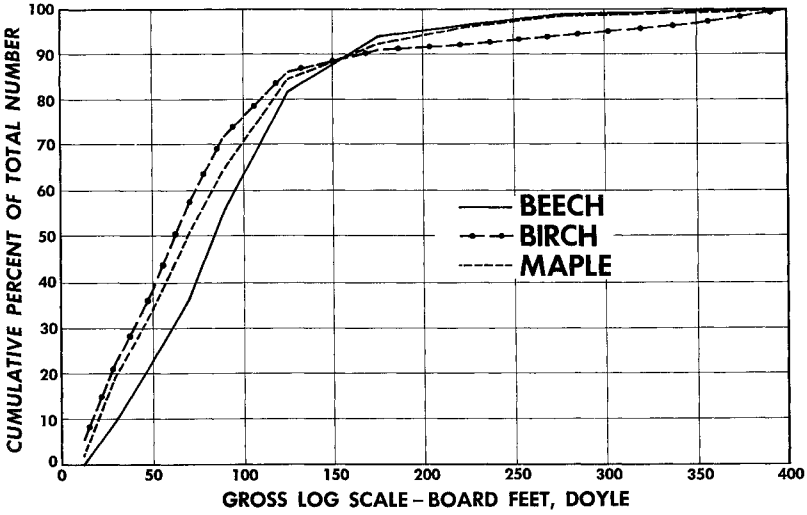
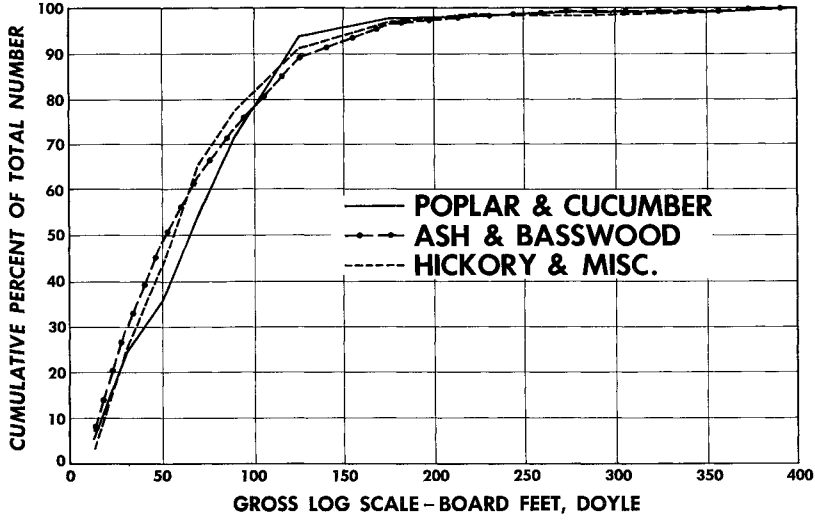


Figure 15.—Relationship between individual log scale and the cumulative percent of the total number of logs sampled for each species.



In skewed distributions like those shown in this paper, median volume is a more reliable measure of the midpoint than average log volume. Median volumes describes that point in the cumulative curve where there are as many logs with a larger volume as there are with a smaller volume. Mill operators should use the median for a measure of production efficiency rather than use the average. Median volumes (board feet, Doyle) for the log samples used in this study are as follows:

Species group	*Median log volume*
Red oak	70
White oak	70
Chestnut oak	95
Beech	95
Birch	70
Maple	80
Ash-basswood	65
Poplar-cucumber	75
Miscellaneous	65

RECOMMENDATIONS

The size, grade, and volume frequencies presented in this paper show general trends only—not exact profiles of the sawlog distributions that can be expected at any sawmill. For the greatest precision, we urge sawmill operators to develop their own frequency distributions. Scale-book records can be plotted to give a good picture of raw material inputs.

■

THE FOREST SERVICE of the U. S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.