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Veneer Recovery of Douglas-Fir From the Coast and Cascade Ranges of Oregon and Washington

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Abstract

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This report summarizes the results of veneer recovery studies at a plywood plant in Oregon and one in Washington. Both mills peeled and clipped to maximize volume and veneer grade recovery, but because they had different objectives and techniques, both volume and grade recovery differed between the two mills. Results for veneer blocks and for woods-length logs are reported for individual mills and compared. Recovery information is presented by log grade and diameter for veneer volume, veneer grade, veneer value, and log value. Combined veneer recovery from the two mills is compared to recovery from sawmills and to the combined recovery from veneer studies conducted in the late 1960s.

Keywords: Douglas-fir, *Pseudotsuga menziesii*, veneer recovery, plywood, plywood yield, Oregon, Washington.

Summary

This report summarizes the results of veneer recovery studies at a mill in Oregon and one in Washington. Both mills produced a wide range of high-grade plywoods and peeled and clipped to maximize recovery of grade. Objectives and techniques were different between the two mills so recovery was in most cases also different.

Volume recovery from peeler blocks was slightly higher at the Oregon mill. For small blocks, the recovery was much higher because a 4-foot core lathe was far better at making veneer from small-diameter logs than was the conventional 8-foot lathe used at the Washington mill. For larger blocks, the Oregon mill recovered slightly more volume at their 8-foot lathe because they saved "utility" grade veneer that was not saved at the Washington mill. Shrinkage and layup losses differed between the mills to the extent that dry finished panel recovery was nearly equal for larger logs.

For woods-length logs the comparisons are less distinct. The Oregon study recovered more volume, particularly from the smaller logs. Grade yield was higher for large logs at the Oregon study, but overall values were very similar between the two studies. We believe the differences were due to mill options rather than differences in the resource. Overall value varied by log grade and diameter for both mills, but the mills seemed to get to nearly identical ends via different routes.

No difference could be detected between old-growth and young-growth logs, but there was a large difference between the value recovered by peeling and sawing of similar logs. This difference was strongly related to log diameter. The increase in recovery in this study compared to veneer studies done in the 1960s was dramatic, amounting to roughly 15 percent of block volume and ranging from 20 to nearly a 50-percent increase in veneer volume.

Contents

Introduction

Coast Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *menziesii*) is one of the most important raw material resources in the United States. About 35 percent of the Douglas-fir timber produced in the coast region of Oregon and Washington is used to produce plywood. Production is in excess of 8 billion square feet (3/8-inch basis) annually and represents more than a third of the structural panel production in the United States (Warren 1986). Douglas-fir plywood is used for sheathing, floor deck and underlayment, siding, roofing, and other construction uses. It also has industrial uses such as boat building, signs, furniture, fixtures, paneling, cabinets and other structural and nonstructural uses. Overall, more than 30 grades of plywood are being made in several thicknesses.

The last comprehensive veneer recovery reports on coast Douglas-fir were published in 1973 and included data from recovery studies conducted in the 1960s (Fahey 1974, Lane and others 1973, Woodfin 1974). Since the previous studies were run, product standards, mill equipment, and the size and quality of the resource have changed. Second-growth timber has become more important, and most of the oldest, decadent old growth has been cut; therefore, updated information is needed by land managers, timber appraisers, and mill owners.

The Timber Quality Research project at the Pacific Northwest Research Station, with the help of other public agencies and the forest products industry, recently completed an extensive study of Douglas-fir in western Oregon and Washington. The study obtained yields of lumber and veneer from over 700 trees selected from typical commercial sawtimber stands throughout the Coast Range and west side of the Cascade Range in Oregon and Washington. Because of the distances involved in hauling sample trees to cooperating mills, the study was divided into two parts. The first part was completed in Oregon in 1981 and the second part was completed in Washington in 1983. Each part included three mills (two sawmills and a veneer plant) and sampled trees throughout the range of coast Douglas-fir within each State. The lumber recovery information was prepared as a separate report (Willits and Fahey 1988).

The primary objective of this report is to present updated veneer recovery information for Douglas-fir. Block volume recovery will be presented by block diameter with all measurements in cubic feet. Woods-length log information will be reported to provide estimates of recovery of veneer volume, grade, and value by log diameter and log grade for both Scribner and cubic scales. A secondary objective is to compare volume and value recovery between old-growth and young-growth logs.

Methods

Cooperating Mills

The two plywood mills cooperating in this study were selected because both produced sanded plywood in several grades and thicknesses. Both mills had 8-foot lathes that normally processed logs down to 10 inches in diameter at the small end, used a wide range of veneer grades, and clipped green veneer to maximize grade recovery. The Oregon mill also had a 4-foot core lathe capable of processing smaller diameter logs, which allowed a slightly smaller tree to be included in the sample.

Sample

The range of coast Douglas-fir extends from northern California to British Columbia and from sea level to elevations above 5,000 feet. The geographical area of these studies was from the crest of the Cascade Range to the Pacific coast from the California-Oregon border north to the Mount Baker-Snoqualmie National Forest. To assure adequate sampling of the geographic diversity, both States were arbitrarily divided into subregions. Western Oregon was divided into three: southwest Oregon, the Coast Range, and the Cascade Range. Western Washington had four subregions: the east and west sides of the Olympic Peninsula, and the Cascade Range north and south of Mount Rainier. Twenty-three areas were sampled from six National Forests and five Bureau of Land Management Districts in Oregon and 22 areas were sampled from three National Forests in Washington (fig. 1).

Sampling procedure was designed to select a sample that was representative of the variation in the resource, not the average size and quality of timber or the average log mix used by a mill in a normal production run.

Both old-growth and young-growth trees were included in the sample. Young-growth trees were defined as those less than 100 years old (Lane and others 1973). This coincides with an estimate by the Old Growth Definition Task Group (1986) of young-growth forests maturing at 90 to 110 years. The old-growth trees came from both mature and old-growth forests. The sample for old-growth timber was stratified by d.b.h. (diameter at breast height), quality, and defect. The d.b.h. ranged from 12 to 50 inches and was stratified into 4-inch classes. Quality was defined by the four-grade system (Lane and Woodfin 1977) applied to the first 16 feet of the tree. Defect was defined for stratification as the presence or absence of obvious defect indicators such as conks, defective scars and burls, or old breaks within the merchantable stem. The young-growth sample was stratified only by d.b.h., because the young trees are a fairly uniform grade and major defects are rare.

After the sample was selected, trees were randomly selected within each diameter and grade class for processing at veneer mills. In the Washington study, about one-fourth of the trees greater than 18 inches d.b.h. went to the veneer plant. From the Oregon sample, 30 percent of all trees were designated for the veneer plant. Because of the core lathe, no lower diameter limit was applied. Trees designated for veneer mills were marked before logging so that the logs would be bucked into veneer lengths.

Felling and Bucking

The trees were felled according to normal industry practices and bucked into the lengths preferred by each mill. Trees for the mill in Washington were cut into veneer block length (8 feet plus trim) multiples to an approximate minimum top diameter of 10 inches. Logs intended for the mill in Oregon were cut into veneer block multiples to about 11 inches (small-end diameter); smaller diameter logs were cut into 4-foot multiples for the core lathe. A few logs were bucked to nonpreferred lengths for both mills because of normal breakage due to falling and hauling. Logs were tagged to identify tree number, log, and block position in the tree. Logs that would not ordinarily have been peeled at either mill, due to small diameter or low grade, were included in the sample at both mills.

Figure 1—Approximate location of the 45 areas sample trees were selected from.

Log Scaling and Grading

After all the logs were removed from the woods, they were scaled "as presented" by U.S. Department of the Interior, Bureau of Land Management, USDA Forest Service, and industry check scalers. Both Scribner (Northwest Log Rules Advisory Group 1980) and cubic[1] scales were taken. The logs were graded using the seven-grade system (Northwest Log Rules Advisory Group 1980). No grade No. 1 Sawmill logs were found. Table 1 shows the number of woods-length logs by diameter and grade for each mill.

Table 2 shows the number of blocks by diameter for each lathe. Block length was measured to the nearest whole inch and block diameters were measured (small diameter and at a right angle) to the nearest one-tenth of an inch on both ends before the block was peeled.

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[1] National Cubic Measurement Committee. 1978. The draft cubic log scaling handbook. Washington, DC: U.S. Department of Agriculture, Forest Service. Unpublished administrative report.

Table 1—Log distribution by log grade and diameter

Diameter range	Oregon study				Washington study			
	Peelers		Saw logs		Peelers		Saw logs	
	1 & 2	3 & Spec.	No.2	No.3	1 & 2	3 & Spec.	No.2	No.3
Inches								
6-8				28				5
9-11				47				16
12-14			12	31			21	28
15-17			40	5			54	1
18-20		4	26	6		7	43	1
21-23		10	15	3		9	24	2
24-26		6	9	4		11	12	0
27-29		5	10	1		11	9	0
30-32	0	5	6	0	1	10	2	0
33-35	1	5	5	0	3	6	6	0
36+	4	2	4	0	2	4	1	0

Table 2—Number of blocks by diameter and lathe

Diameter range	Lathe		
	Oregon		
	4 foot	8 foot	Washington
Inches			
6-8	47		2
9-11	201	1	20
12	158	59	106
15	4	148	180
18		138	174
21		121	160
24		91	122
27		63	93
30		56	58
33		48	49
36		19	43
39+		18	11
Total	410	764	1018

Peeling

The two mills where the studies were conducted had slightly different objectives, so their methods were not identical. The mill in Oregon produces a wide range of exterior and interior sanded panels. It usually peels for 1/10-inch veneer on the 8-foot lathe and peels for core veneer of several different thicknesses on a 4-foot core lathe. The mill in Washington generally produces medium- and high-density overlays. It operates one 8-foot and one 10-foot lathe, normally peels most of the veneer one-eighth of an inch thick, and develops 4-foot core veneer by cutting 8-foot veneer in half or buying special thicknesses.

At the Oregon mill, all logs were barked, bucked into 103-inch blocks, and conditioned in a hot water spray for periods designed to increase the temperature to 125 °F at the block core. Blocks smaller than 12 inches in diameter were rebucked into 51-inch blocks and peeled on the core lathe to produce nominal 7/32-inch-thick by 4-foot-long veneer. The core lathe produced only 4-foot-long veneer in half sheet and random widths. The clipper was set to clip half sheets (27 inches wide) with random-width strip developed only from clipping out defects (for example, knots, holes, splits, or bark pockets) larger than those permitted in D grade veneer. Blocks larger than 12 inches were peeled into nominal 1/10-inch-thick by 8-foot-long veneer. The clipper was programmed to clip first for A grade veneer if the width was 12 inches or greater and second for full sheets. The operator overrode the clipper-scanner and clipped all half sheets when the veneer was of very low grade.

At the Washington mill, preparations were similar, except that blocks larger than 20 inches in diameter were not conditioned, and all veneer was peeled nominal one-eighth of an inch thick by 8 feet long. The scanner at the clipper was programmed similarly to the one at the Oregon mill, except that first priority was full sheets of either A or B grade. In addition, this mill did not save Utility grade veneer, thereby resulting in slightly lower overall recovery.

All the veneer from each block was sprayed with dye so that its identity could be maintained through the veneer dryer (Lane 1971). After clipping, the veneer was sorted by relative moisture content (heartwood or sapwood) and by size (full sheets, half sheets, random-width 8-foot sheets, or random-width 4-foot sheets) for drying. Green veneer was stacked by hand, except full sheets and half-sheets were machine stacked at the Washington mill and half sheets were machine stacked at the core lathe. The dry veneer was graded under the supervision of a Timber Engineering Company quality supervisor in the Oregon mill using Product Standard 1-74 (American Plywood Association [APA] 1974) and at the Washington mill under the supervision of an APA quality supervisor using Product Standard 1-83 (APA 1983). The small adjustment in grade B veneer involved in this change should have little affect on relative grade recovery. Utility grade veneer, not in the APA standard but frequently saved as a mill grade, also was tallied in this study. Utility grade veneer has firm white speck rot and larger defects or larger knotholes than D grade veneer.

Measurements and Calculations

The diameter of each peeler core was measured to the nearest one-tenth of an inch, and maximum and minimum diameters were recorded at a point about 2 feet from the end. Veneer was tallied by counting the number of full sheets and half sheets and by measuring the width of each piece of strip veneer for each veneer grade for each block peeled.

Table 3—Nominal and actual sizes of veneer produced during the study

Lathe	Veneer condition	Thickness	Length: Full sheets	Length: Core stocks	Width: Full sheets	Width: Half sheets	Random strip
		Inches	*Feet*	*Feet*	*Inches*	*Inches*	
Oregon mill:							
8 foot	Nominal	1/10	8	4	54	27	NA
	Green	0.103	101	50.5	53.0	27.3	As measured
	Dry	.098	101	50.5	50.4	25.6	As measured
	Finished panel	.098	96	48	48	24	0.92*dry[a]
4 foot	Nominal	3/16	—	4	—	27	NA
	Green	.224	—	50.5	—	27.3	As measured
	Dry	.216	—	50.5	—	25.6	As measured
	Finished panel	.216	—	48	—	24	.92*dry
Washington mill:							
8 foot	Nominal	1/8	8	4	54	27	NA
	Green	.128	101	50.5	53.5	26.2	dry/.95[b]
	Dry	.122	101	50.5	50.8	24.9	As measured
	Finished panel	.122	96	48	48	24	.92*dry[a]

[a] Factors from layup loss study (Fahey 1987).
[b] Factor from shrinkage of a full sheet.

Veneer dimensions were estimated from a sample measured continuously during the study. Veneer thickness was measured to the nearest one-thousandth of an inch. Width of full sheets was measured to the nearest one-tenth of an inch both before and after drying. Half-sheet width was measured to the nearest one-tenth of an inch before drying. Random-width strip was measured to the nearest whole inch after drying. Rate of shrinkage to be applied to half sheet and random-width strip was calculated from the full-sheet measurements. Thickness shrinkage was calculated from the green and dry thickness measurements. Table 3 shows the nominal and actual sizes of veneer produced during the study.

Volume and grade information was compiled by using computer programs (Woodfin and Mei 1967) designed for this purpose. Veneer volume is expressed in two ways: green volume and dry finished panel volume. Green volume was calculated by using the tally taken after drying and the measurements taken before drying: green volume therefore may be slightly low as a result of sheets lost in drying. Green volume of random-width strip is found by dividing the dry volume by the ratio of dry to green width. Finished panel volume is calculated by using the tally taken after drying and the measurements from a finished panel of plywood (96 by 48 inches). Finished panel volume is also called dry trimmed veneer volume and is the green volume minus losses from shrinkage, trimming to panel size, and laying up plywood from veneers. The loss in random-width strip from the volume of dry veneer to volume of finished panels is based on a strip-loss study conducted at three plywood plants (Fahey 1987).

Pricing

The prices used in this report are green veneer prices from Random Lengths (1982) converted to a 3/8-inch basis. Prices were calculated using the ratio of full sheet, half sheets, and strip from the Oregon study. These prices, although several years old, reflect the normal ratio of values; AB is slightly more than double the price of CD veneer, and Utility veneer is about 80 percent of the price of CD veneer.

The prices used to prepare this report and to analyze the data are as follows:

Veneer grade	Dollars per thousand square feet, 3/8-inch basis
AB	202
CD	92
Utility	74

Availability of Data

Prices are used only for illustration of relative trends. Anyone wanting to do a detailed analysis or to develop economic factors for log allocation models should contact the authors. A file containing data for woods-length logs with Scribner and cubic scales, log grade, and veneer recovery by grade, length, width, and thickness is available on request.

Analysis

The objectives of this paper are to provide estimates of the recovery of veneer volume for veneer blocks and estimates of volume, grade, and relative value from logs. A secondary objective is to compare the recovery of young growth to old growth. Analysis techniques used to meet these objectives are described in the following section.

Standard regression techniques were used, and the best model form for each dependent variable was chosen. Model forms that are logically related to the measure in question were tested, and only terms with significant F-values were used. The coefficient of determination (R^2) and standard error of the estimate were the criteria for choosing among models. Model forms tested were picked from among equations known to be effective (Bruce 1970, Fahey 1984):

$$\begin{aligned} \text{Volume or value} &= b_0 + b_1 D, \\ &= b_0 + b_1/D, \\ &= b_0 + b_2/D^2, \\ &= b_0 + b_1 D + b_2/D, \\ &= b_0 + b_1 D + b_2/D^2, \\ &= b_0 + b_2/D + b_3/D^2, \text{ and} \\ &= b_0 + b_1 D + b_2/D + b_3/D^2, \end{aligned}$$

where: b_0, b_1, b_2, b_3 are regression coefficients, and
D is small-end diameter.

Separate regression equations were estimated for each mill and log grade, and covariance analysis or analysis of variance was used to test for differences among mills or among log grades. All tests were done at the 0.05 probability level.

Recovery From Veneer Blocks

Recovery at each of the three lathes was modeled independently by using the model form best describing the relation among the mills with coefficients estimated individually for each lathe. Dependent variables were percentage of block volume recovered as green veneer, finished panels, peeler cores, and chippable residues. Small-end diameter was the independent variable. Analysis of covariance was used to test for differences among lathes. In addition, the relation between block diameter and percentage of volume recovered as full sheets and half sheets was tested to determine if there was a change in veneer sheet distribution related to block size.

Recovery From Woods-Length Logs

Most decisions about logs are based on the log length as brought from the woods; therefore much of our analysis was based on woods-length logs.

Volume—Recovery of veneer volume can be expressed in two ways: recovery ratio and cubic recovery percent (CR%). Because there is no reason for volume recovery to differ with log grade, log grades were not used in the analysis of volume. Differences in block recovery, because of the core lathe, indicated that recovery of small logs would differ between the mills, so no statistical comparison tests were done.

Value—Value can be expressed in three ways: $/MVT (dollars per thousand square feet, 3/8-inch basis of veneer), $/CCF (dollars per hundred cubic feet of log scale), and $/MNLS (dollars per thousand board feet of net log scale). Veneer value was expected to differ by log grade and diameter; therefore, regression equations were estimated for each log grade. Because $/MVT is the average value of the veneer produced, it does not include bias due to defect estimation and is the best indicator of the inherent quality of the wood. It was used to determine if the log grades separated the logs into distinct value classes. Value by log grade was first tested between mills: if there was no difference between mills for a given log grade, then the grade was tested for a difference with other grades. Standard F-tests or analysis of variance tests were used to compare regressions for the following log grades: No. 3 Peeler and Special Peeler combined vs. No. 2 Sawmill, and No. 2 Sawmill vs. No. 3 Sawmill for each mill. There were only 11 No. 1 Peeler and No. 2 Peeler logs at both mills so they were combined for all analyses. Results for long logs will be presented separately for each mill only if differences between the mills were significant at the 0.05 probability level.

Volume by grade—The intent of the analysis of the volume by veneer grade was to show general trends in the data and relation between log grades and veneer grade recovery. Because the percentage of volume in each veneer grade group can differ by log diameter, regression equations were estimated for each veneer grade group. Percentage of volume in a grade group was the dependent variable, and diameter and transformations thereof were the independent variables. A set of regression equations (one for each veneer grade group) was estimated for each log grade so that they total 100 percent. Regressions were estimated for C, and for D and Utility veneer combined. The default grade, AB veneer, was used to force the percentages to total 100.

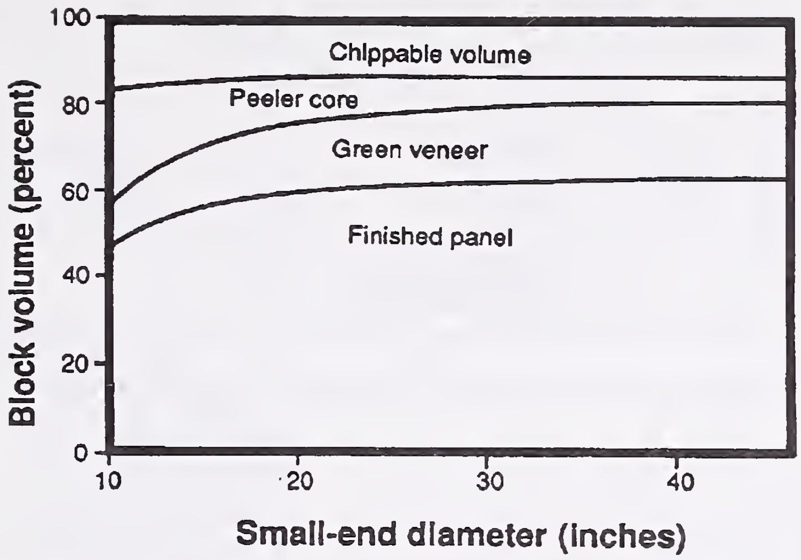

Figure 2—Cumulative percentage of dry finished panel, green veneer, peeler core, and chippable volume by block diameter from the 8-foot lathe at the Oregon mill. Regression equations and related statistics are given in table 6.

Old Growth vs. Young Growth

Cubic recovery percent was estimated for both old-growth and young-growth logs for each mill. Value recovery ($/MVT, $/CCF) was based on No. 2 Sawmill logs only; it was the sole grade for which there were comparable samples. These regressions were compared by using covariance analysis.

Results and Discussion

Recovery From Veneer Blocks

The volume recovered from veneer blocks is a relatively simple measure used to monitor what proportion of the volume sent to a mill is being used for veneer and what by-products are being produced. As displayed in figure 2, the proportion of wood recovered as products differed by diameter; the figure is a representation of the materials balance at the 8-foot lathe in the Oregon mill. Higher percentages of green veneer and of finished panel volume were recovered from large blocks than from smaller blocks. Conversely a higher proportion of the volume of small blocks was left as core or converted to chips. The rate of change in proportions of block volume is rapid for small-diameter blocks, and hardly changes in blocks larger than 20 inches.

Volume recovery also differed between the two mills (fig. 3A). For blocks of the same size, recovery of green veneer volume was highest for the core lathe and lowest for the Washington mill. The three lathes used in this study were different for several reasons. The 4-foot core lathe at the Oregon mill peeled down to a 3-inch core diameter, the 8-foot lathe at the same facility peeled down to a 5-1/4-inch core, and the 8-foot lathe in Washington peeled down to a 6-inch core. In the Oregon study, all blocks were conditioned; only those blocks less than 20 inches in diameter were conditioned at the Washington mill.

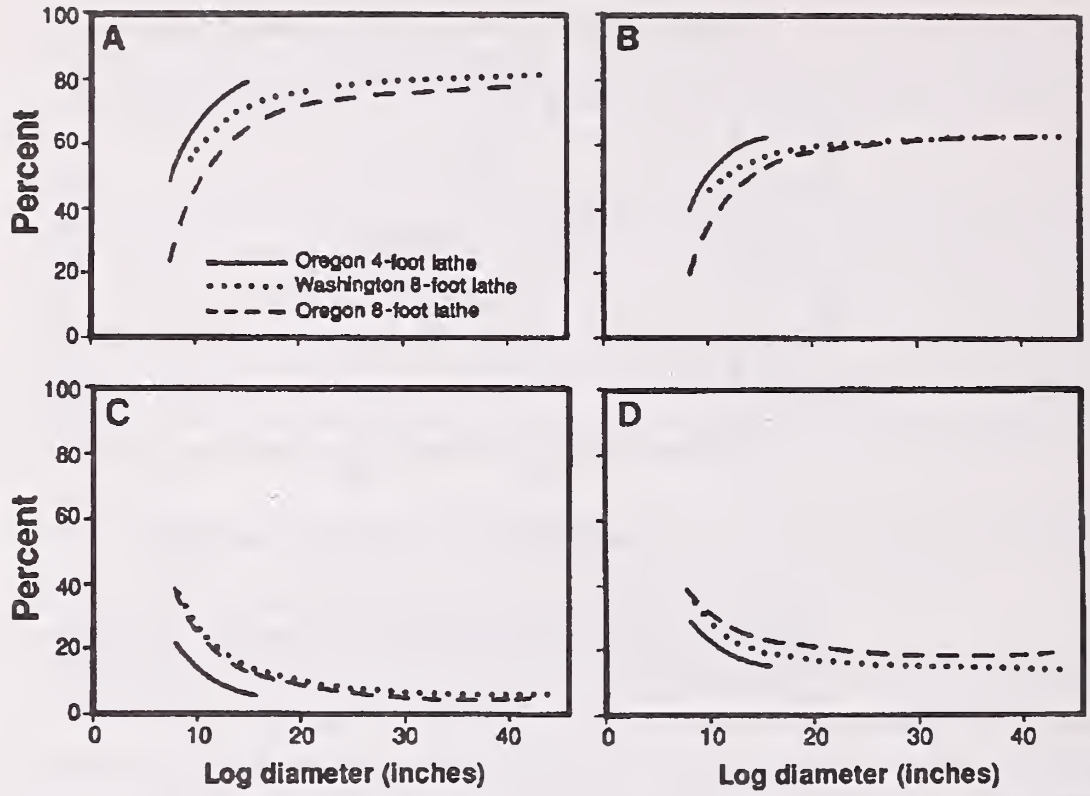

Figure 3—Predicted recovery of green veneer, finished panel volume, peeler core, and chippable residues from individual veneer blocks for each lathe by block diameter. Regression equations and related statistics are given in table 6. (**A**) Percentage of block volume recovered as green veneer increases rapidly as block diameter increases, above 14 inches in diameter, the rate of increase slows. (**B**) Percentage of block volume recoverable as dry finished panels is less than for green veneer because of shrinkage, layup losses, and panel trim. (**C**) The minimum peeler core is a fixed volume. When it is expressed as a percentage of total block volume it decreases as diameter increases. (**D**) Chippable volume is determined by subtracting green veneer and peeler core volumes from block volume. Chippable volume develops during block roundup and from clipping out veneer that does not meet grade.

Recovery of finished panels was closer between the mills than was the recovery of green veneer. The Oregon mill had a higher green recovery rate (fig. 3B) because more Utility grade veneer (table 4) was saved that would have been chipped at the Washington mill. Recovery of finished panel was nearly equal at large diameters because the Oregon mill produced more half sheets and strip, with more lost in layup than was lost from the high ratio of full sheets produced in Washington. Veneer recovery at the 8-foot lathe at the Oregon mill was poorly correlated with block diameter. This is because small blocks were peeled at the 4-foot core lathe, and recovery from blocks larger than 12 inches is not affected by diameter to the same degree as is recovery from small blocks.

Peeler core volume was lowest at the 4-foot core lathe because of the small core size (fig. 3C). Although the target core size was different between the two 8-foot lathes, no significant difference was detected in the proportion of volume in the core. At both 8-foot lathes, defective cores were chipped and sound cores were used to manufacture Stud grade lumber. At the 4-foot core lathe, all cores were chipped and could be included with the chippable volume.

Table 4—Average veneer grade recovery by log grade and mill

Mill and log grade	Number of logs	Veneer grade			
		AB	C	D	Util
		Percent			
Oregon mill:					
No. 1 Peeler and No. 2 Peeler	5	71.8	17.4	7.0	3.8
No. 3 Peeler and Special Peeler	37	56.6	34.0	5.6	3.8
No. 2 Sawmill	127	28.9	50.0	16.4	4.7
No. 3 Sawmill	125	5.9	60.8	25.3	8.0
Washington mill:					
No. 1 Peeler and No. 2 Peeler	6	63.7	30.1	6.2	—
No. 3 Peeler and Special Peeler	58	53.4	36.3	10.2	.1
No. 2 Sawmill	172	31.7	42.4	25.3	.6
No. 3 Sawmill	53	18.7	50.0	31.3	—

Chippable volume was calculated by subtracting green veneer and core volume from the block volume. No account was kept of which cores were chipped and which were manufactured into studs. Actual volume chipped was higher than shown at the core lathe because all the peeler cores were chipped (fig. 3D). They are reported separately to allow the user to adjust estimates to fit any particular set of markets and circumstances.

Regression analysis was used to test for increased percentage of full sheets or half sheets with increased block diameter. Although we expected this type of relation, these studies indicated that it does not exist. Distribution of defects that can be removed by clipping is apparently the predominant cause of variation in recovery of full sheets and half sheets, and diameter of the block has little or no effect.

The three plants were quite different in total production of various widths of veneer (table 5). The 4-foot core lathe produced only half sheets and strip. Although the two 8-foot lathes produced nearly the same amount of total strip, the Washington mill put much more emphasis on recovering full sheets than did the Oregon mill.

Recovery From Woods-Length Logs

Log purchases and log allocations to mills are usually made on the basis of woods-length logs. Woods-length logs contain anywhere from two to as many as eight veneer blocks, so variation is less than for individual blocks because of the averaging effect.

Table 5—Average recovery of veneer by length, width, and lathe

Lathe	Veneer length	Full sheets	Half sheets	Random strip
	Feet		*Percent*	
Oregon mill:				
4-foot	4	—	82.7	17.3
8-foot	4	—	—	5.9
	8	37.5	35.3	21.3
Washington mill:				
8-foot	4	—	—	2.7
	8	53.2	18.9	25.2

Recovery factor is the more variable of the estimates of veneer recovery because Scribner scale, on which it is based, generally underestimates log volume by not recognizing log taper and typically overestimates the effect of defect on recovery.

Figure 4 shows the recovery factors for woods-length logs. Recovery factors were relatively high for small-diameter logs from both samples because of idiosyncrasies in the scaling system. Recovery from the Oregon study was higher than for the Washington study for several reasons: the Oregon mill peeled to a slightly smaller core diameter than the Washington mill did, the core lathe is more efficient for small-diameter logs or blocks, the Oregon mill conditioned all logs while the mill in Washington conditioned only the smaller logs, and the Oregon mill saved more Utility grade veneer. Because the results were so different and were the result of processing differences at the mill, no statistical analysis was run to test for differences.

Cubic recovery percent differed by log diameter at both mills (fig. 5). As with the recovery factor, the Oregon mill had a higher CR% in the smaller diameter logs because the core lathe was more efficient in peeling blocks from small-diameter logs. This advantage decreased as log diameter increased until there was little practical difference for logs larger than 14 inches on the small end. The CR% from logs less than 10 inches in diameter at the Washington mill was particularly low because logs of this size had at least one block and possibly more that were not peeled, so that no veneer could be recovered.

Volume by grade—There were differences in recovery of the several grades of veneer from the two samples. It is not possible to say what part of the difference was due to resource and what part was due to differences in mill practices. We think that the differences were caused mostly by the types of plywood produced by each mill and that the practices at each mill affected grade recovery. These practices should be evaluated before any attempt is made to use this information to estimate veneer grade recovery.

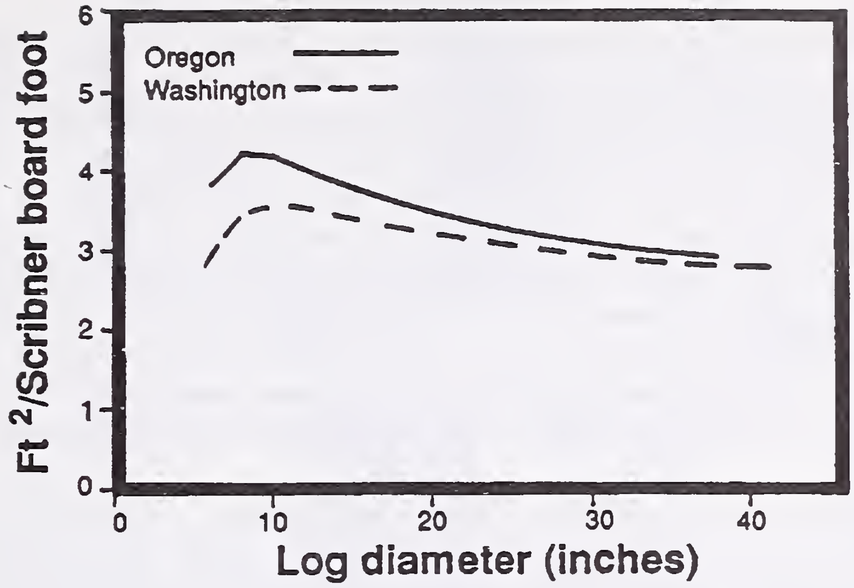

Figure 4—Recovery ratio, square feet (3/8-inch basis) of plywood per Scribner board foot of log scale, varies by log diameter and mill because of Scribner scale and milling practices. The large difference in small-diameter logs is due to the efficiency of the core lathe at the Oregon mill in recovering veneer from small blocks. Regression equations and related statistics are given in table 6.

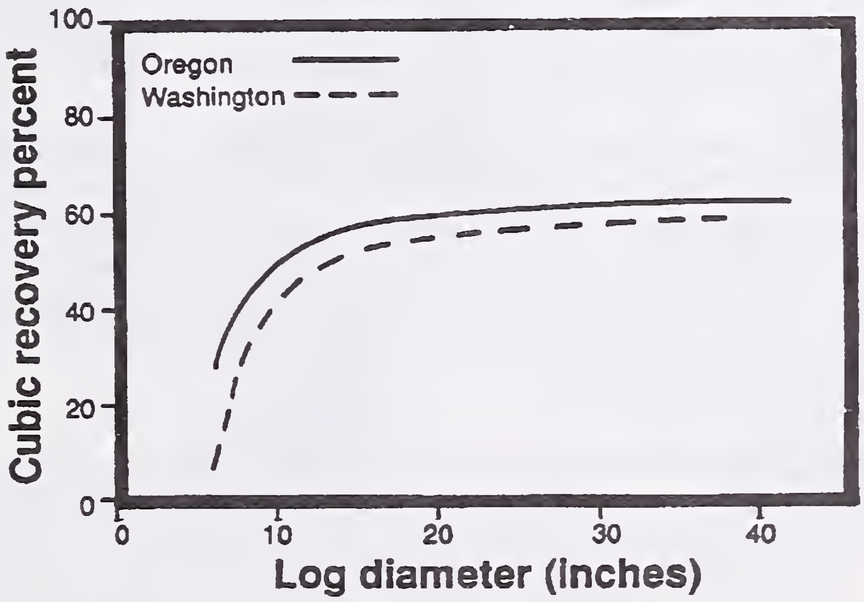

Figure 5—Cubic recovery percent, the volume of plywood in cubic feet expresses as a percentage of the volume of the log in cubic feet, by log diameter. As with recovery ratios, there is a big difference in recovery of small-diameter logs. The difference is due to the use of the core lathe for small blocks. Regression equations and related statistics are given in table 6.

The Washington mill produces a line of medium- and high-density overlays for a few specialized markets. The goal is to maximize the recovery of AB full sheets, and the mill accepts more grade B veneer if it can keep full-width sheets. Appearance qualities are less critical because they cover much of their face veneer with resin-impregnated paper.

The Oregon mill produces a much more general line of sanded veneer and has less market for plywood using B grade veneer faces. This mill puts more emphasis in recovering A grade veneer at the expense of both full sheets and total volume of AB grade veneer. The same sheet that was clipped into a full sheet of B grade veneer in the Washington mill would have been clipped into two or more pieces in the Oregon mill; part was A grade veneer and part was either B or C grade veneer. Another difference in grade recovery occurred from using the core lathe on small-diameter logs. Recovery in these short blocks is usually about 85 percent C grade veneer because it is easy to isolate and clip out defects in short veneer (Fahey 1978, Snellgrove and Ernst 1983). Because this veneer is used only for plywood core (3 ply) or crossbands (5 or 7 ply), no effort is made to clip for veneer higher than C grade.

For this analysis, D and Utility grade veneer were combined and C grade veneer was reported separately. Although C and D grade veneer are priced the same and Utility is priced lower, grade was reported in this way because of the uses of the different grades. Plywood graded for exterior uses requires C or better grades in all plies. Use of D grade veneer is limited to Sheathing and Interior grades of plywood. Utility grade veneer has larger defects (usually patches of firm white speck rot) or may have larger knotholes than allowed in D grade veneer for outer plies of plywood. Oversized holes are sometimes allowed in D grade veneer used in the center of plywood that is five or more plies thick, and veneer with excessive white speck may be used for mill-certified panels. The Oregon mill produced about 4 percent Utility veneer, but the Washington mill produced less than 1 percent Utility.

Log grade is useful in predicting the grades of veneer that can be recovered (table 4). At both mills, the percentage of AB veneer increased as log grade increased, but other grades of veneer declined. Log grade and diameter were important in predicting the grade of veneer recovered (fig. 6). Generally, the percentage of AB veneer tended to increase with log diameter as does the percentage of volume in D and Utility veneer grade. There is a concomitant decrease in the percentage recovered as C veneer grade.

Log diameter was important for predicting the percentage of AB veneer grades at one mill but was less so at the other. This difference largely was attributable to the conditioning of the larger blocks at the Oregon mill. Grantham and Atherton (1959) show that heating veneer blocks before peeling increases the recovery of A grade veneer. Any comparisons of grade recovery are not valid because the mills objectives and equipment were different and the logs were not matched samples. There were so few No. 1 Peeler and No. 2 Peeler logs at either mill that both samples were pooled to assemble a sample large enough for estimating a regression.

Veneer value—Average value of veneer ($/MVT) is based on the grades recovered and the prices applied to those grades. Although the grouping of grades and the prices used in this report do not lend to fine discrimination in values, the value is an index of inherent wood quality. The veneer grades represent a more or less continuous change in wood quality, but the prices represent large discrete changes in value. Average values are useful indices of quality, only because logs produce a mixture of grades.

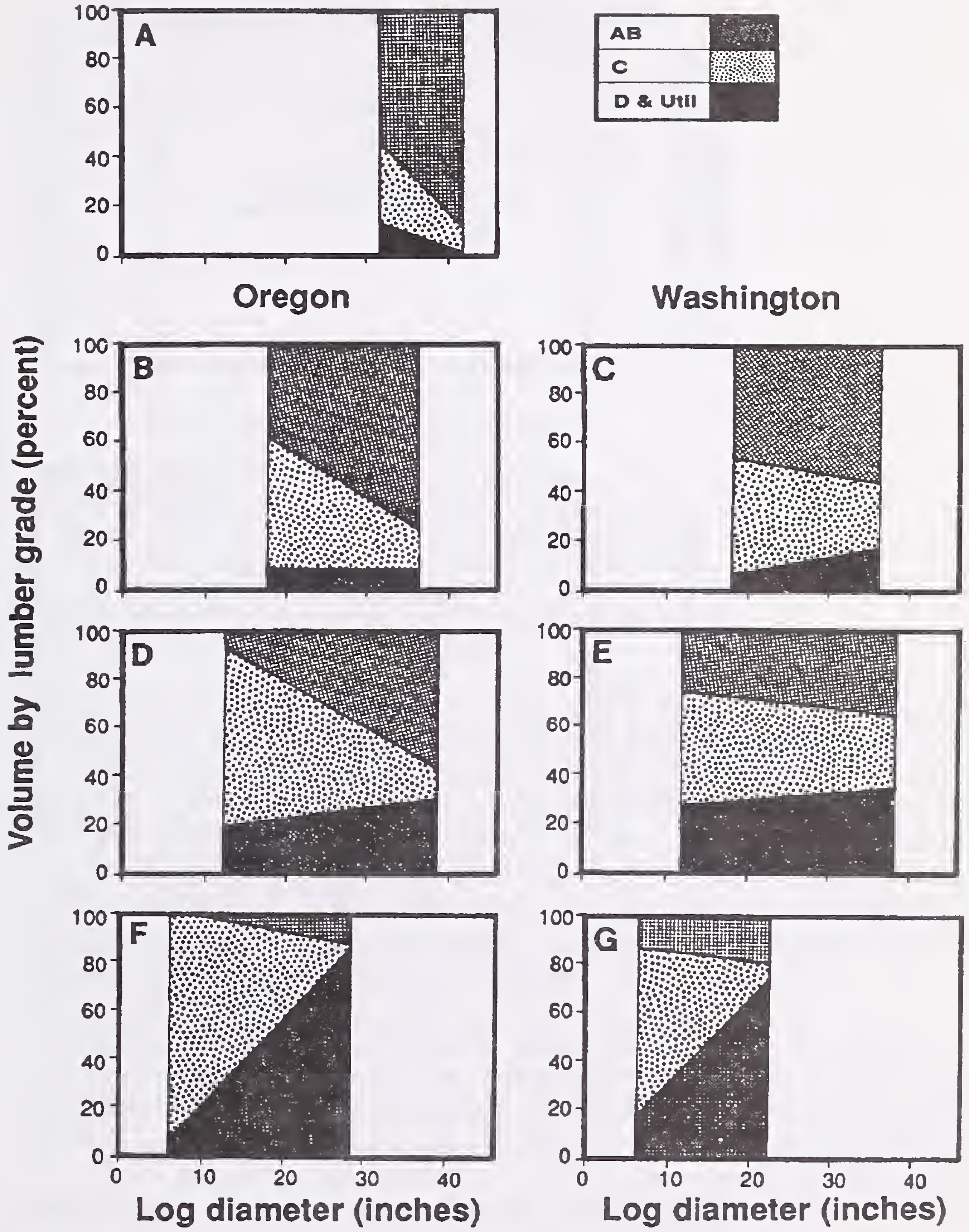

Figure 6—Percentage of total recovery in each grade of veneer by log grade, by mill, and by log diameter. **A.** No. 1 Peeler and No. 2 Peeler logs from both mills were combined because there were not enough logs to estimate each mill separately. A and B grade veneer increased with log diameter with a reduction in both C and D and Utility grade groups. **B.** and **C.** No. 3 Peeler and Special Peeler logs had similar patterns. Both the A and B grade group and the D and Utility grade group increased with log diameter but the percentage of C grade decreased. The pattern was much more pronounced at the Oregon mill than at the Washington mill. **D.** and **E.** No. 2 Sawmill logs had a dramatic increase in AB veneer at the Oregon mill and a fairly constant amount of each of the grades of veneer produced across the diameter range at the Washington mill. **F.** and **G.** No. 3 Sawmill logs had a dramatic increase in D and Utility as diameter increased for both mills. All logs smaller than 12 inches on the small end are No. 3 Sawmill; but of the logs 12 inches and larger, only the roughest logs are No. 3 Sawmill. The apparent differences between the mills are emphasized by the increased recovery of C and D grade veneer for small-diameter logs at the core lathe.

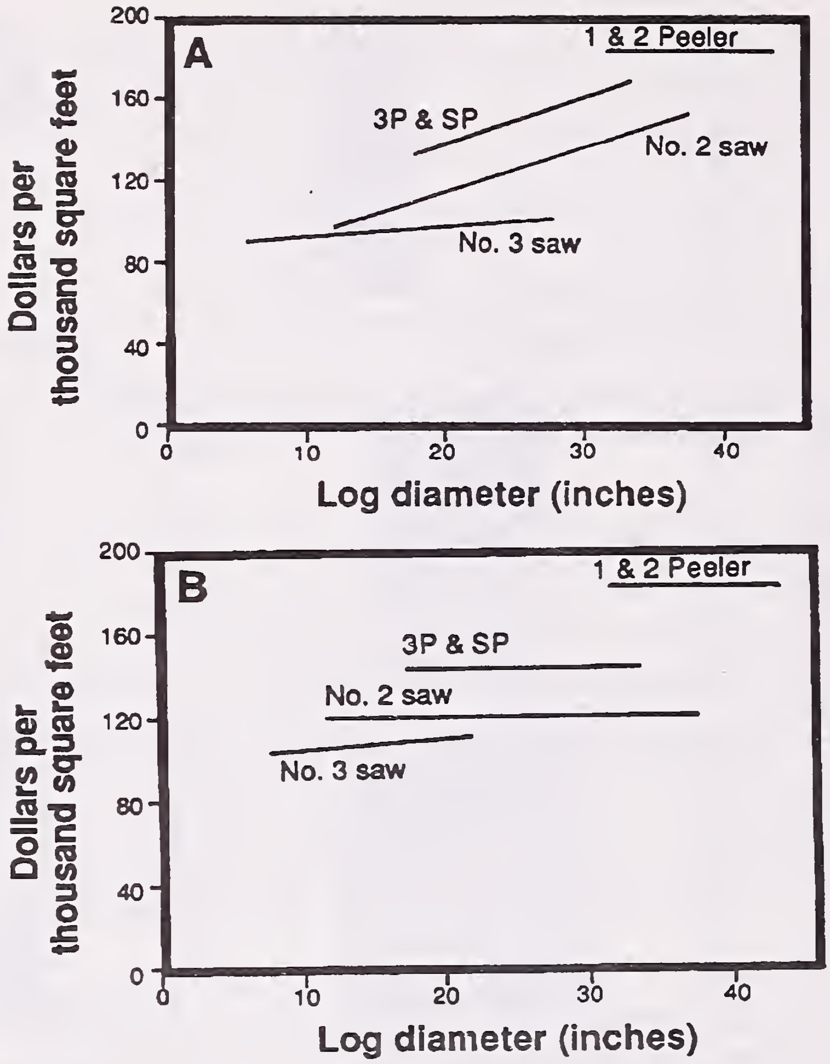

Figure 7—Dollars per thousand veneer tally by log grade, diameter, and mill. The No. 1 Peeler and No. 2 Peeler grade logs are for both mills combined. Regression equations and related statistics are given in table 7. **A.** At the Oregon mill, there was a relation between log diameter and value of veneer for all log grades except the No. 1 Peeler and No. 2 Peeler, which was too small a sample to test. **B.** At the Washington mill, only No. 3 Sawmill logs had value related to log diameter. They were of higher value than at the Oregon mill, but the slope of the line was not different.

The value of veneer recovered from the study logs differed by log grade and between mills (fig. 7). The relation between diameter and average veneer value also differed by log grade. The logs graded No. 1 Peeler and No. 2 Peeler (samples combined) yielded the most valuable veneer, and the No. 3 Sawmill logs yielded the least valuable.

Logs increased in value as diameter increased only if the percentage of AB veneer increased. Even though the percentage of AB veneer from No. 2 Sawmill and No. 3 Peeler and Special Peeler logs did increase with log diameter at the Washington mill (fig. 6), the change in value was not statistically significant. The same two grades of logs had significant increases in average veneer value at the Oregon mill. No. 3 Sawmill logs produced consistently higher grade veneer in the Washington sample. Average veneer price for small-diameter logs at the Oregon mill was held down by the 100-percent grade C and D veneer produced at the 4-foot lathe.

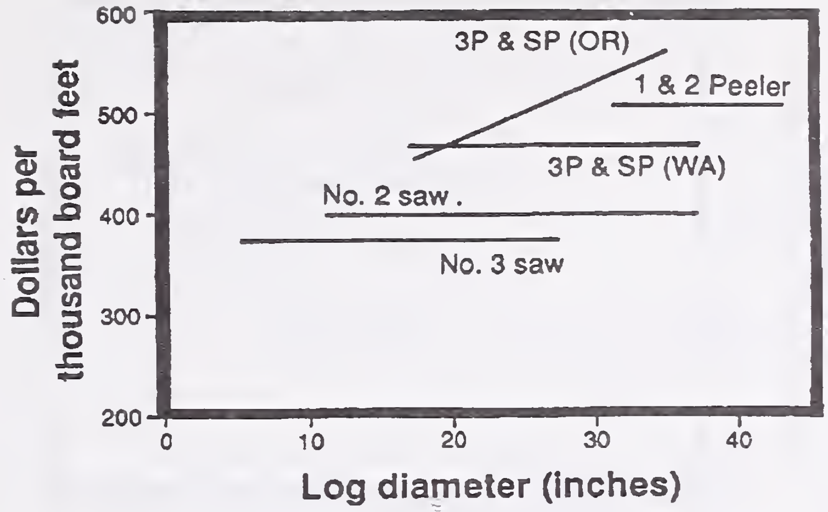

Figure 8—Dollars per thousand net log scale by log grade, diameter, and mill. Differences between the two mills were not significant except for the No. 3 Peeler and Special Peeler grade logs. The processing techniques at the Oregon mill produced higher grade veneer out of the larger logs, but the processing at the Washington mill produced a constant value of veneer regardless of diameter. Regression equations and related statistics are given in table 7.

Differences in veneer value were found among all log grades, but there were not enough grade No. 1 Peeler and No. 2 Peeler logs to test for significance. Based on the grade recovery, the two mills get about the same average veneer values for each log grade, but the Oregon sample is more dependent on log diameter than is the Washington sample. This difference between the mills may be caused by differences in milling practices, resource characteristics, or simply by the prices we used in this report. Tests showed statistically significant differences between the mills; however, possible sources of variation cannot be segregated, and results therefore are reported separately (fig. 7A and B.) with no attempt to combine samples.

Log value—Dollars per thousand net log scale ($/MNLS) is the value of veneer divided by the net Scribner scale of the log. It reflects both the quality of veneer and the scalers estimate of net log volume. Possible sources of variation in this estimate included resource base, milling differences, prices, and the idiosyncrasies of the scaling system. It is, however, the basis for buying and selling logs. Figure 8 displays the average value for the various log grades by diameter class for the combined samples.

The differences in value are caused by two factors: the variation in volume recovery associated with log diameter, and the variation in veneer grade recovery associated with both log grade and log diameter. The sample of No. 1 Peeler and No. 2 Peeler logs was so small that they should be viewed as having little predictive value, and the figure displays only an average value for this grade group. The value of No. 3 Peeler and Special Peeler logs showed a marked slope in the Oregon study, but the Washington study showed no slope. No relation was found between the log value and diameter for No. 2 Sawmill and No. 3 Sawmill logs, and no difference was found between the mills.

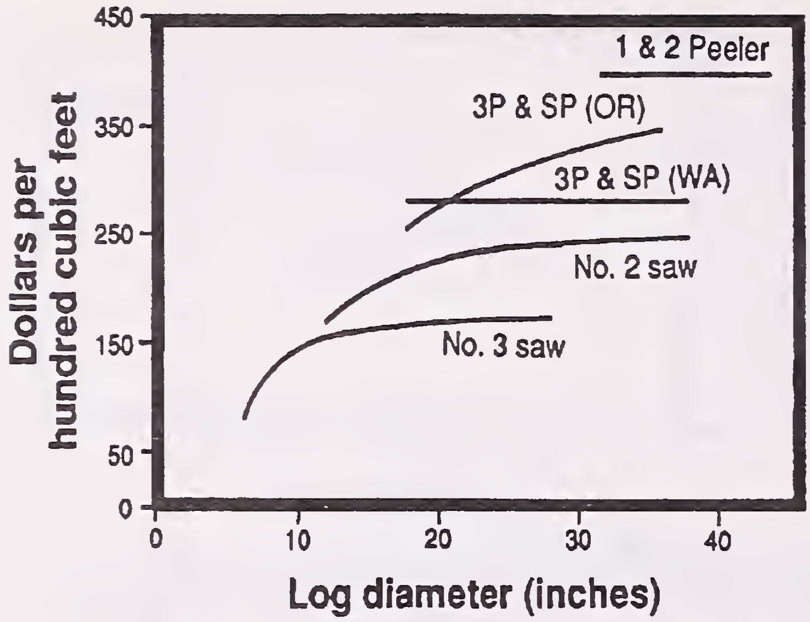

Figure 9—Dollars per hundred cubic feet by log grade, diameter, and mill. Differences between the two mills were not significant except for the No. 3 Peeler and Special Peeler grade logs. The Oregon mill was affected by diameter more than the Washington mill was. Regression equations and related statistics are given in table 7.

Value per hundred cubic feet ($/CCF) is the value of all the veneer recovered from a log divided by the log volume in cubic-foot scale. This scale accounts for log taper and has deductions for defects that are closely related to product loss. There is less variation in $/CCF than in $/MNLS because less error is associated with log scaling. The estimated value is affected by the change in volume recovery with diameter and also with the change in grade of veneer that is associated with both log grade and log diameter. As shown in figure 9, $/CCF differs by log diameter and among log grades. As with the $/MNLS, there are too few samples in the No. 1 Peeler and No. 2 Peeler grades to predict whether they really are different from logs of the No. 3 Peeler grade. The log grades were effective in segregating the logs by value, and there was a difference between mills only for the combined No. 3 Peeler and Special Peeler logs.

No. 3 Peeler and Special Peeler logs displayed a difference in value between mills that was significant in $/MVT, $/MNLS and $/CCF. Although the program at the clipper was expected to yield more A grade veneer strip at the Oregon mill, this increase would not account for a difference of this magnitude. These were high-grade logs capable of producing high-quality veneer; the Oregon mill steamed all blocks, but only those smaller than 20 inches were steamed at the Washington mill. Previous work (Grantham and Atherton 1959) shows that conditioning the block before peeling also increases the recovery of A grade veneer. These are not matched samples, and no legitimate conclusions can be drawn from the result, but there is reason to believe that much of the increased value was produced by steaming the blocks from these larger logs. The Washington mill has increased its capacity to steam blocks since the study and now steams all blocks that they peel.

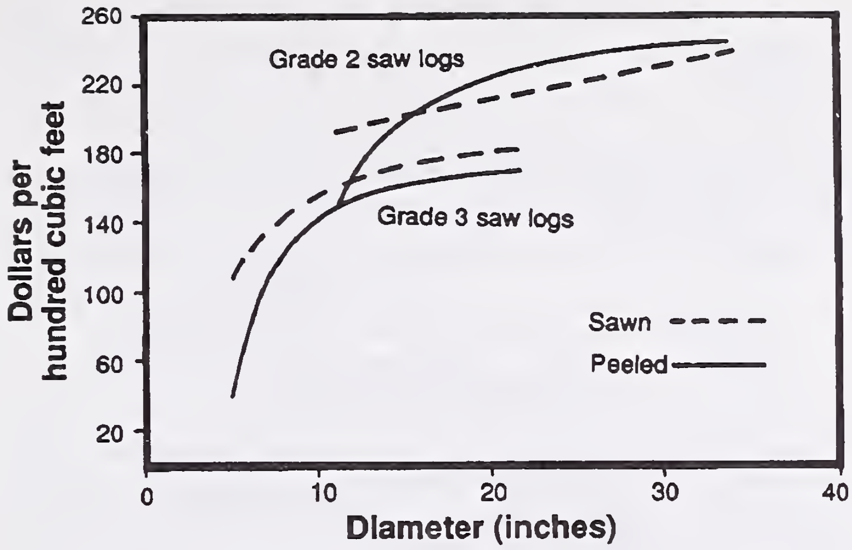

Figure 10—Dollars per hundred cubic foot of log for peeled and sawn logs by small diameter. The point of the figure is how closely veneer value recovery is tied to log diameter, whereas lumber value is less dependent on log size. The absolute level of these curves are not precise; prices are based on different points in time and the costs of production are not included.

Old Growth vs. Young Growth

An analysis to determine if a difference could be found between young growth and old growth was done for both mills combined and for each individual mill. No differences were found between old-growth and young-growth grade 2 saw logs in volume or value recovery. The young-growth sample contained few peeler grade logs, and the grade 3 saw logs were predominantly grade 3 because they were less than 12 inches in small-end diameter.

Lumber vs. Veneer

There is a very strong indication that small-diameter logs, (less than about 12 inches) should not be peeled into veneer. Figure 10 shows a comparison of $/CCF for No. 2 Sawmill and No. 3 Sawmill logs when sawn (Willits and Fahey 1988) and when peeled. Although $/CCF reflects both the product grade and volume recovery, both manufacturing costs and by-product values are omitted from these estimates of value. The point of figure 10 is not the relative level of the curves but the shape of them. Veneer recovery is much more sensitive to log diameter than is lumber recovery. A small-diameter 4-foot core lathe can lower this limit somewhat, but Douglas-fir is a very expensive resource to use for core veneer.

Comparison to Earlier Studies

A series of 10 veneer recovery studies run throughout the Douglas-fir region of Oregon, Washington, and California (Woodfin 1974) was used to compare differences over time. These studies, completed between 1963 and 1967, were compiled differently than the current studies. Utility grade veneer was not included in recovery but was reported separately; a more critical difference was that recovery was reported on the basis of dry untrimmed veneer. Because the information was reported so completely, we were able to reconstruct volume, including Utility grade veneer, and using dry loss factors developed at the same time (Woodfin 1973), convert it to the basis used in this study.

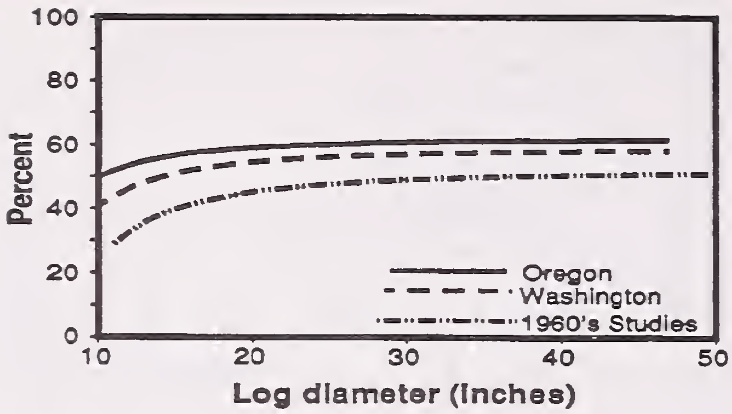

Figure 11—Comparison of 1980s studies with the 1960s veneer recovery study (Woodfin 1974). The difference is due to small incremental gains in all processes and technologies used in manufacturing plywood.

Our studies show much higher recovery than the earlier ones (fig. 11). Use of the core lathe for small-diameter blocks at one of the two mills is the only obvious change in technology. The difference between the recent studies and the 1960s studies, which included nearly 7 percent Utility grade, represent a major change in recovery.

There is no single reason for the change, but there was a series of small incremental changes in all processes. Improved bucking of logs into peeler blocks has resulted in closer trim allowances and less bucking waste. Block conditioning is used more; in the 1960s only 3 of the 10 mills conditioned blocks for peeling. Larger chucks required that larger core diameters be left at the lathe, and knife control and nosebars were primitive when compared to those in use in the 1980s. The scanning clipper had not been developed, and scanners that could clip veneer to within one-fourth of an inch of a defect were not developed until the 1970s. In the 1960s, green sheets had to be slightly larger, and much of the strip was narrower than necessary because of imprecise clipper controls. All these factors contributed to lower recovery of green veneer 20 years ago.

At the dryer, larger sheets shrink more than small ones, and there were more losses due to drying and handling with the older dryers. Finally, the layup and strip loss study completed during the 1960s showed that 16.1 percent of volume is lost from dry veneer to finished panel (Woodfin 1973); a comparable study in the 1980s showed only a 12.1-percent loss (Fahey 1987).

The changes in recovery over 20 years were impressive; however, neither mill used power backup rolls or rotary clippers during our study. Power backup rolls decrease spinouts and result in fewer oversized cores and therefore more green veneer going to the clipper. Rotary clippers have the potential to clip more precisely and do not have the damming action of the guillotine clipper, which frequently breaks the leading edge of the veneer ribbon. As a result, the green width of full sheets and half sheets can be reduced. The 1980s studies were completed before the development of improved adhesives. These adhesives make it feasible to dry to 6- to 8-percent moisture-content rather than to dry to the 3-percent moisture content of the past.

Higher moisture content veneer reduces shrinkage and handling losses. Because there is less shrinkage, green full sheets and half sheets can be clipped narrower than they are currently, while shrinkage and trim allowances are maintained.

If the best of existing technology were implemented, we estimate that recovery of green veneer could be increased by an additional 3 or 4 percent and recovery of finished panel by an estimated 6 to 8 percent for logs similar to those used in our study.

Conclusions

This report summarizes the results of veneer recovery studies at two veneer mills, one in western Oregon and one in western Washington. The combined recovery from the two mills approximate "average" conversion of logs to veneer for sanded plywood mills in the region. Douglas-fir veneer is manufactured into many products ranging from 1/4-inch interior panels to structural roofing panels more than 1 inch thick. Grade requirements differ from the D and Utility veneer used to back interior hardwood paneling to the all A and B grade veneer required in marine grades of plywood. Although this makes Douglas-fir plywood recovery impossible to characterize, it is relatively easy to do so for dry veneer. This leaves the decisions up to the user of the data as to which plywood panels they will construct.

Recovery of veneer volume is a reflection of log size and of the milling equipment and techniques used by the mill. The difference between high and low recovery is a matter of small incremental gains. How blocks are centered for chucking, the size of peeler core, and whether or not the blocks were conditioned before peeling affect the volume of the ribbon of green veneer. Clipping programs, the precision and accuracy of the scanner in locating and trimming defects, determine what part of the ribbon will become green veneer and what will be chipped (Funck and Sheffield 1985). The margin allowed for shrinkage and trim on full sheets or half sheets, and the minimum size of strip that will be clipped and saved affect the volume going to the dryer. Dryer losses are affected by how the veneer is dried and handled, but there is a major change in volume due to shrinkage (Wangaard 1950) at all plants. Finally, volume is lost in patching and preparing dry veneer, in laying up the finished panels, and in trimming them. Both mills were superior to earlier veneer recovery studies (Lane and others 1973, Woodfin 1973), and although each tended to have minor relative areas of advantage, there was little overall difference between the mills other than the 4-foot core lathe.

Data were analyzed individually for each mill. Statistical analysis was used to determine that volume recovery for blocks differed with diameter and was different for each mill, and woods-length log recovery differed by mill. Differences in the response to log diameter by veneer grade and dollar values could conceivably result from variation in the resource or in the way that the two mills treated blocks or clipped veneer sheets from the ribbon of veneer produced. We think that most differences were due to individual mill practices. Although the core lathe increased recovery for small-diameter logs, it produced nothing but low-priced veneer. Steaming of blocks larger than 20 inches in diameter seemingly increased the proportion of high-grade veneer from larger blocks at the Oregon mill.

The grading system was effective at separating logs into classes of similar value. Insofar as they could be tested, the values of the various grades of logs were different whether $/MVT, $/MNLS, or $/CCF was the dependent variable. In most cases, it was not possible to detect a difference between mills for logs of similar grade. In the few instances where differences were detected, they were related to mill equipment and procedures rather than to any inherent difference in the resource. An analysis to determine if a difference could be found between old-growth and young growth was done for both mills combined and on each individual mill. Old-growth had a greater range in diameter and more high-grade logs than young growth, but no differences were found between old-growth and young-growth logs of the same grade and diameter.

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Appendix

Table 6—Equations and statistics for estimates of volume recovery for veneer blocks and for woods-length logs

Location and variable for estimate is provided	Equation	R^2	Sy.x
	Mill-length blocks		
Washington mill, 8-foot lathe:[a]			
Green veneer	$78.93 - 3554/D^2$	0.227	15.05
Dry veneer	$64.30 - 2918/D^2$	.229	12.25
Core	$3.31 + 2252/D^2$	.438	5.89
Chippable	$17.76 + 1301/D^2$	.049	13.09
Oregon mill, 8-foot lathe:[a, b]			
Green veneer	$81.82 - 2631/D^2$	.070	15.17
Dry veneer	$63.59 - 1789/D^2$	.051	12.36
Core	$4.28 + 2300/D^2$	.130	9.42
Chippable	$13.89 + 334/D^2$	.135	14.02
Oregon mill, 4-foot lathe:[a]			
Green veneer	$88.46 - 2574/D^2$	.298	17.46
Dry veneer	$70.52 - 2009/D^2$	.266	14.91
Core	$1.14 + 1331/D^2$	.315	8.76
Chippable	$10.41 + 1238/D^2$	.002	11.51
	Woods-length logs		
Recovery ratio:[c]			
Washington	$2.14 + 28.01/D - 140.3/D^2$	.051	27.86
Oregon	$1.97 + 38.24/D - 164.0/D^2$	.145	25.92
Cubic recovery percent:[d]			
Washington	$59.2 - 1854/D^2$	.229	24.80
Oregon	$62.2 - 1242/D^2$	.444	18.39

[a] Equation and statistics for figure 3.
[b] Equation and statistics for figure 2.
[c] Equation and statistics for figure 4.
[d] Equation and statistics for figure 5.

Table 7—Equations and statistics for average veneer and log value for woods-length logs by log grade and mill

Log grade	Mill	Equation or average and 95-percent confidence interval	R^2	Sy.x
		Dollars per thousand square feet veneer[a]		
No. 1 Peeler and No. 2 Peeler	Both	184 ± 5		
No. 3 Peeler and Special Peeler	Washington	147 ± 3		
	Oregon	94 + 2.23	.371	10.60
No. 2 Sawmill	Washington	123 ± 2		
	Oregon	72 + 2.14 D	.464	12.83
No. 3 Sawmill	Washington	103 + 0.47 D	.265	11.97
	Oregon	89 + 0.47 D	.265	11.97
		Dollars per thousand net log scale[b]		
No. 1 Peeler and No. 2 Peeler	Both	506 ± 21		
No. 3 Peeler and Special Peeler	Washington	466 ± 14		
	Oregon	344 + 6.04	.218	12.63
No. 2 Sawmill	Both	399 ± 7		
No. 3 Sawmill	Both	373 ± 10		
		Dollars per hundred cubic feet net log scale[c]		
No. 1 Peeler and No. 2 Peeler	Both	398 ± 14		
No. 3 Peeler and Special Peeler	Washington	281 ± 9		
	Oregon	$435 - 3192/D$	.275	14.22
No. 2 Sawmill	Both	$255 - 12794/D^2$	.097	30.17
No. 3 Sawmill	Both	$176 - 3385/D^2$	.230	32.65

[a] Equations and statistics for figure 7.
[b] Equations and statistics for figure 8.
[c] Equations and statistics for figure 9.

Glossary

Core veneer—Four-foot long pieces of veneer used for center ply on three-ply panels or for cross bands on five-ply or thicker panels. A 4-foot lathe is called a core lathe because it produces only core veneer.

Cubic recovery percent (CR%)—The cubic feet of veneer produced from a cubic foot of log input. Log volume is expressed as a percentage of the product (net) cubic scale. Cubic recovery percent can be based on finished panel-sized veneer or untrimmed green veneer.

Dollars per hundred cubic feet of log scale ($/CCF)—The total value of the veneer produced from a log divided by the cubic scale of the log. Cubic scale volume in this paper is product (net).

Dollars per thousand square feet veneer tally ($/MVT)—The average value of the veneer produced, based on the veneer volume and the pricing structure used in this paper.

Dollars per thousand net log scale ($/MNLS)—The total value of the veneer produced from a log divided by the net Scribner scale of the log.

Finished panel volume—The veneer volume calculated by using the tally taken after drying and the measurements from a finished panel of plywood (96 by 48 inches). Finished panel volume is also called dry trimmed veneer volume and is essentially the green volume minus shrinkage, trim, and layup losses.

Peeler core—The center of a veneer block that is left after peeling. It is slightly larger than the chuck used to turn the block.

Recovery ratio—The square feet (3/8-inch basis) of veneer recovered from a board foot of Scribner net log scale. In this report, recovery ratio is based on the recovery of finished panel volume.

Fahey, Thomas D.; Willits, Susan A. 1991. Veneer recovery of Douglas-fir from the Coast and Cascade Ranges of Oregon and Washington. Res. Pap. PNW-RP-439. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 26 p.

This report summarizes the results of veneer recovery studies at a plywood plant in Oregon and one in Washington. Both mills peeled and clipped to maximize volume and veneer grade recovery, but because they had different objectives and techniques, both volume and grade recovery differed between the two mills. Results for veneer blocks and for woods-length logs are reported for individual mills and compared. Recovery information is presented by log grade and diameter for veneer volume, veneer grade, veneer value, and log value. Combined veneer recovery from the two mills is compared to recovery from sawmills and to the combined recovery from veneer studies conducted in the late 1960s.

Keywords: Douglas-fir, *Pseudotsuga menziesii*, veneer recovery, plywood, plywood yield, Oregon, Washington.

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