United States
Department of
Agriculture

Forest Service

Pacific Northwest
Forest and Range
Experiment Station

Research Paper
PNW-299
October 1982

Western Hemlock as a Veneer Resource

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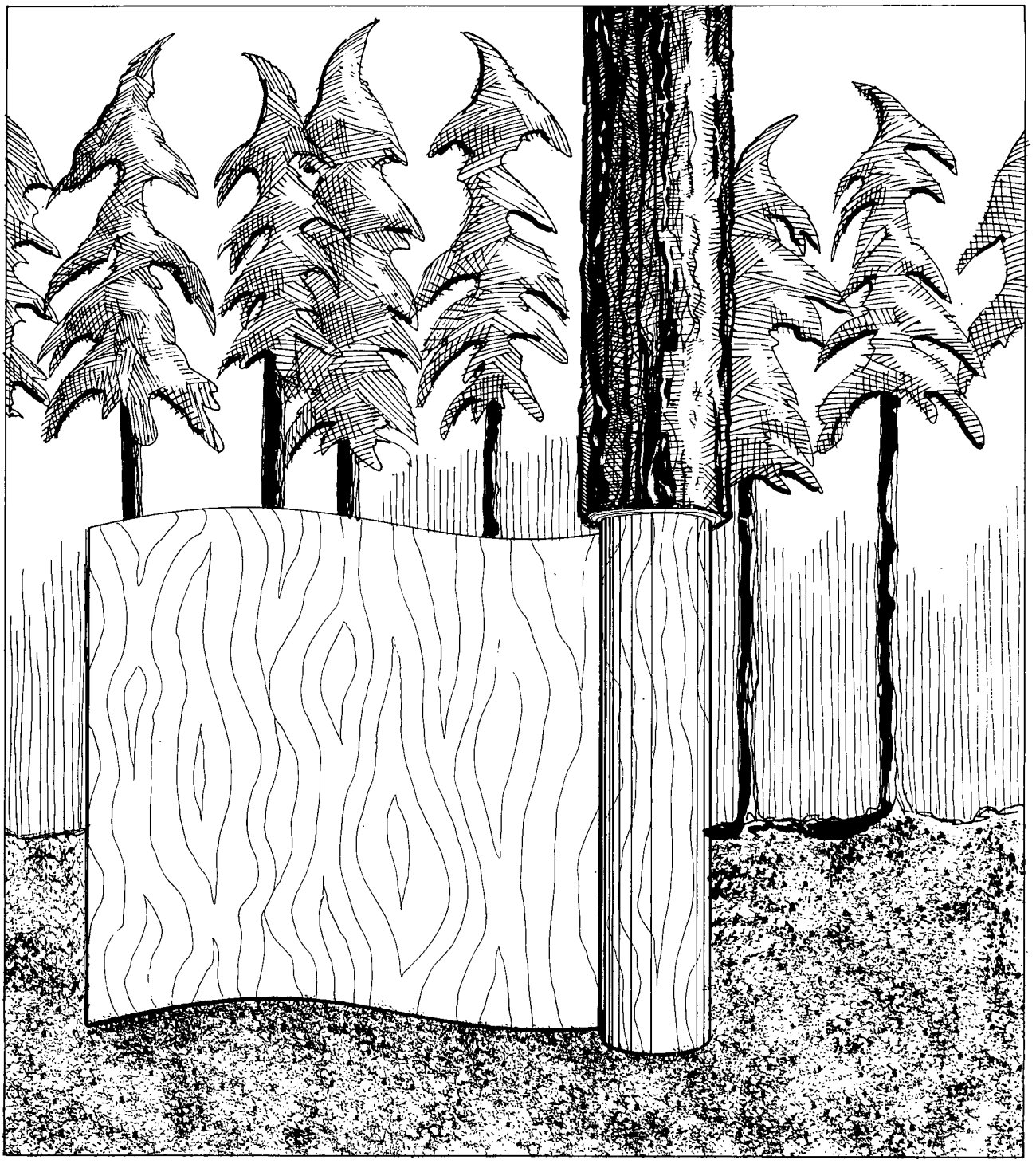

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Abstract

Fahey, Thomas D.; Woodfin, Richard O., Jr. Western hemlock as a veneer resource. Res. Pap. PNW-299. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1982. 24 p.

Presents recovery of veneer grade and volume from western hemlock from Oregon and Washington. Veneer grade recovery varied by grade and size of logs. Veneer volume recovered was about 45 percent of the cubic volume of the log and varied somewhat with log diameter.

Keywords: Veneer yield, veneer recovery, western hemlock, *Tsuga heterophylla*.

Summary

This paper reports on a study of veneer grade yield from western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) trees from 38 plots in northwestern Washington and west-central Oregon. Veneer was peeled from blocks bucked from 391 long logs (167 trees). There was no significant difference in veneer recovery volumes between areas. Yields are shown for three nominal thicknesses of veneer (3/16-, 1/6-, and 1/8-inch) from logs ranging in diameter from 11 to 45 inches. About 45 percent of log volume was recovered as dry untrimmed veneer. Veneer grade recovered varied with the grade of log. For grade 3 saw logs, 66 percent of the veneer recovered was grade D. Grade 2 saw logs produced 47 percent grade D veneer. The highest grade logs, Peeler and No. 1 saw logs, produced only about 22 percent grade D veneer, with more than 40 percent in grades B patch and better. Results are applicable to production decisions, log allocation studies, and stand valuation decisions (by industry and land managers) for the range of timber size and quality sampled.

Contents

Introduction

Western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) comprises about 25 percent of the total commercial softwood sawtimber inventory in Alaska, Oregon, and Washington—about 240 billion board feet.

This paper presents combined veneer grade and veneer volume recovery information from research conducted at two mills to evaluate yield for western hemlock over its range in Oregon and Washington. The species is not a major raw material for veneer but is well accepted for construction plywood and inner plies and is beginning to be used more widely. Lutz (1971) reported peeling characteristics but included no information on product yield.

The recovery of veneer by grade from small diameter hemlock logs peeled on a 4-foot core lathe has been described by Fahey (1978).

Reports of veneer recovery for other species are available for comparison (Woodfin 1974, Woodfin and Pong 1974, Fahey 1974), as is a report on western hemlock lumber (Woodfin and Snellgrove 1976).

The primary objective of this research is to develop veneer grade and volume recovery by size and grade of western hemlock logs. This paper includes tables of veneer grade recovery by size and grade of log and by volume of products recovered during processing.

Yields presented will provide the mill manager with estimates of veneer grade recovery for making or adjusting log allocations between processing centers. In addition, this paper contains information required by resource managers to establish diameter and log grade values based on peeling western hemlock.

Methods

Sample Selection

Timber for the studies came from the Olympic Peninsula of Washington State and from the central Cascade Range and the Coast Ranges of Oregon. Figure 1 shows the approximate location of sample areas.

The trees were selected from 38 sample areas picked to represent the size and quality of commercial western hemlock west of the Cascade Range. Diameter at breast height (d.b.h.) of sample trees ranged from about 13 to 58 inches. Trees with d.b.h. larger than 60 inches were excluded because they are so rare that a representative sample could not be selected. Trees smaller than 12-inch d.b.h. were not selected because they would not provide a chuckable veneer bolt.

The trees were distributed over a range of quality by applying log grades for coast Douglas-fir (Lane et al. 1973) to the first 16 feet of the tree bole with a 2-foot stump and trim allowance. Grades were applied without regard to visible defect. Sample trees showing no visible defect were selected as well as those with obvious defects. Basal wounds or scars, *Echinodontium tinctorium* conks, older stem breaks, frost cracks, and seams were considered defect indicators for sample stratification. The existing log grades for western hemlock were not used in stratifying the sample because they are excessively restrictive in defining surface characteristics.[1/]

[1/] Log grade descriptions for hemlock, silver and white fir. Form R-6 2440-19E (3/1/63), 14 p. USDA For. Serv. Pacific Northwest Region, Portland, Oreg.

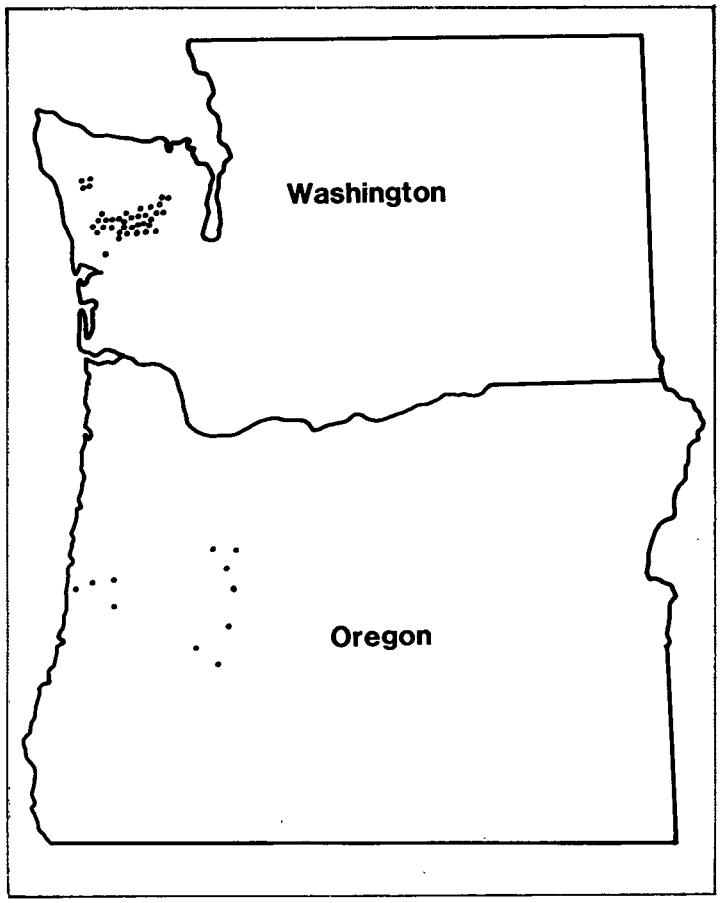

Figure 1.—Approximate location of sample areas.

Harvesting and Processing

Trees selected for the study were felled and bucked into long (woods length) logs suitable for rebucking as peeler blocks. Each log and subsequent bucked block was identified by tree number and position in the tree so yield could be related to quality and size of the piece.

Logs were transported to a cooperating veneer mill where they were scaled according to USDA Forest Service methods for timber from the west side of the Cascade Range.[2/] They were then graded according to the USDA Forest Service Region 6 log grade description for hemlock (see footnote 1).

The study logs were bucked into block lengths of 102 inches at one mill and 103 inches at the other, and all suitable blocks were peeled according to each mill's practice. Neither mill used a temperature conditioning period before peeling the blocks.

The veneer was marked for identification under production conditions at the lathe. This permits veneer volume and grade yields to be measured for each block.

[2/] USDA Forest Service R-6 Supplement to National Forest Log Scaling Handbook for West-Side Log Scaling. April 1969.

Both mills in this study had 8-foot lathes and clipped green veneer for grade recovery. Green veneer was sorted by half sheets, strips of random widths, and 4-foot core stock ("fishtails" [3]). Neither mill produced full sheets (4 x 8 feet) from hemlock.

At one plant, all blocks were peeled into nominal 1/6-inch veneer. At the other plant, blocks having potentially high grade veneer were peeled into 1/8-inch veneer; lower quality blocks were peeled into 3/16-inch veneer. This tabulation shows veneer target sizes recorded at each mill by condition:

Veneer	Rough green	Rough dry
	Inches	
Nominal thickness:		
1/8-inch	0.139	0.127
3/16-inch	.218	.205
1/6-inch	—	.171
Width:		
Half sheets	26	25
Length:		
8 feet	101	101
4 feet	51	51

The thickness of the nominal 3/16-inch veneer is a problem that will be addressed in "Application of Results." Mill personnel referred to this particular peel as 3/16 inch. The dry thickness was 1/5-inch plus and the green thickness was 7/32 inch.

Actual dry thickness was used in calculating volume, but in this paper we will refer to it as 3/16 inch. The veneer was dried and then graded by or under the supervision of quality supervisors from the American Plywood Association (APA) or Timber Engineering Company (TECO).

Compilation of Data

Veneer yields are based on the grade and tally of all veneer—individual, dry, untrimmed pieces as they come from the dryer. Veneer losses in dry veneer handling and plywood production have been reported (Woodfin 1973). Information on western hemlock in that article is based on veneer from the Washington sample.

The amount of dry, untrimmed veneer recovered from each peeled block was determined by a count of half sheets and by measurement of the actual width of each 8-foot random strip and each fishtail. The average untrimmed width of half sheets plus the total width of strips and the average thickness of dry veneer were used to calculate yield. A computer program (Woodfin and Mei 1967) was used to compile the data.

[3] Fishtails are 4-foot long pieces of veneer produced when the blocks are reduced to a uniform cylinder.

Veneer volumes presented in this paper and plywood production figures reported by industry are in terms of square feet of veneer (or plywood) converted to the common base of 3/8-inch thickness. A yield of square feet of nominal 1/6-inch veneer (actual thickness 0.171 dry) is divided by the factor 0.375 to convert to the 3/8-inch basis. Similar factors are used for other veneer thicknesses. Nominal rather than actual thickness is commonly used by industry. We use actual thickness because there are differences among mills, or within the same mill at different times, in the actual thickness of nominal veneers.

Cubic volumes were computed for each log or block and for the total yield of usable veneer, peeler core, reject grade veneer, and the residual components of the log. Cubic volumes of individual peeler blocks were summed to obtain the volume of the long log. The cubic-foot volume of blocks was computed by the formula:

Cubic-foot volume=$0.001818L(D^2_S+D_SD_L+D^2_L)$
(Grosenbaugh 1963);

where 0.001818 is a constant,
L is the actual length in feet,
D_S is the average small-end diameter in inches, and
D_L is the average large-end diameter in inches.

An estimate of the volume of residue was obtained by subtracting the dry veneer and peeler core volumes from the cubic-foot log volume. The residue total includes spur trim, roundup loss, green veneer lost at the clipper, and veneer shrinkage.

Model Selection and Analysis

Data from both studies were analyzed for two purpose: (1) to determine the model that best predicts volume recovery and (2) to test for differences in recovery between the two studies.

In choosing the model, these relationships were tested:

$y=b_0+b_1D$;

$y=b_0+b_1D+b_2D^2$;

$y=b_0+b_11/D+b_21/D^2$;

where: y=cubic feet of veneer, and
d=small end diameter (inches).

The best model—$y=b_0b_1(1/D)+b_2(1/D^2)$—was selected, based on the sum of squares explained by regression and F value. Covariance analysis using this model showed no difference between the two studies in either slopes or adjusted means, and the samples were combined.

Analysis of veneer grade recovery assumed that veneer grade would vary by log grade. The models used for volume were tested for veneer grade, and the appropriate model was selected by use of the sum of squares explained by regression and F value.

Results and Discussion

The 391 long logs in these studies had an average scaling diameter of 22 inches (range, 11 to 45 inches). All logs were at least one-third sound as determined by the scaler. Table 1 summarizes the sample characteristics and recovery by log grade.

The geographic range of western hemlock suggests a variation in timber quality and for potential product recovery. This was tested with covariance analysis, and no significant difference was detected. The two studies reported here are combined as a single sample from western Oregon and Washington.

Table 1—Summary of woods-length western hemlock logs peeled in the study, by log grade

Log grade	Number of logs	Average log diameter	Average scale		Defect	Veneer recovery ratio[1/]
			Gross	Net		
		Inches	- Board feet -		Percent	
Peeler	8	29.9	1,254	1,065	15	2.60
No. 1	10	33.6	1,760	1,497	15	2.45
No. 2	285	23.0	779	678	13	2.45
No. 3	88	18.6	435	344	21	1.69
All grades	391	22.4	736	632	14	2.36

[1/] Square feet (3/8-inch basis) per board foot of net log scale. Veneer measurements are actual dry, untrimmed sizes.

Recovery by Veneer Grade and Item

Veneer grade recovery varies by both log grade and log diameter; average veneer grade for each grade of log is in table 2. The recovery by grade, item, and veneer thickness for each log grade and for the total study is in appendix tables 4 through 8. The production by item was about 70 percent half sheets, 25 percent 8-foot strips, and 5 percent 4-foot strips for all log grades, except grade 3 which had more strips in both lengths. This percentage distribution of strips and fishtails is common to other veneer studies (Fahey 1974, Woodfin 1974). Note the increase in D grade veneer between the Peeler grade logs, 22.8 percent (table 4), and the No. 3 grade logs, 66.0 percent (table 7). Of equal importance is the fact that this trend holds for each veneer thickness peeled.

Recovery of veneer grades by log size and log grade may be more useful than averages to managers. Figure 2 shows the veneer grade plotted over log diameter by log grade.

Veneer grade by individual log grade and diameter class is in appendix tables 14-18. We suggest using figure 2 to estimate grade rather than these tables for any log grade and diameter group having less than 20 logs. These curves were developed by using covariance analysis of Peeler grade and grade 1 combined, grade 2, and grade 3 logs.

Table 2—Average veneer recovery from woods-length western hemlock logs, by log grade

Log grade	Log sample	Veneer volume, 3/8-inch basis	Veneer grade					
			A	A patch	B	B patch	C	D
	Number	Square feet	Percent					
Peeler	8	22,103	0.5	6.0	23.3	18.0	29.4	22.8
No. 1	10	36,684	.1	1.0	23.2	18.1	36.0	21.6
No. 2	285	474,105	.2	1.0	5.2	11.5	35.5	46.6
No. 3	88	51,087	0	.2	2.7	5.3	25.8	66.0
All grades	391	583,979	.2	1.1	6.8	11.7	34.4	45.8

For high grade logs, there was no relationship between diameter and recovery of veneer grade. For grade 2 saw logs, the percentage of D grade veneer stayed constant over the range of diameters, but the percentage of grade C veneer decreased. Percentage of B and Better increased with log size. For grade 3 saw logs, all groupings of veneer grade varied with log diameter. The percentage recovered as grade B and Better and grade D veneer increased, whereas the percentage in grade C declined.

The total variation in recovery by veneer grade is very high. Variation in groupings of veneer grade explained by grading and regression is:

Source of variation	D	C and D	B and Better
		Percent	
Regression only	9.6	44.7	44.7
Log grading only	54.0	39.7	39.7
Grading and regression	65.6	63.5	63.5

The interpretation of this tabulation and figure 2 is that the percentage of grade D veneer is strongly related to log grade, but not to diameter. Grade C and the B and Better veneer are related to both log grade and size. The variation in percentage of C and D is identical to the variation in B and Better because one grade grouping is the reciprocal of the other.

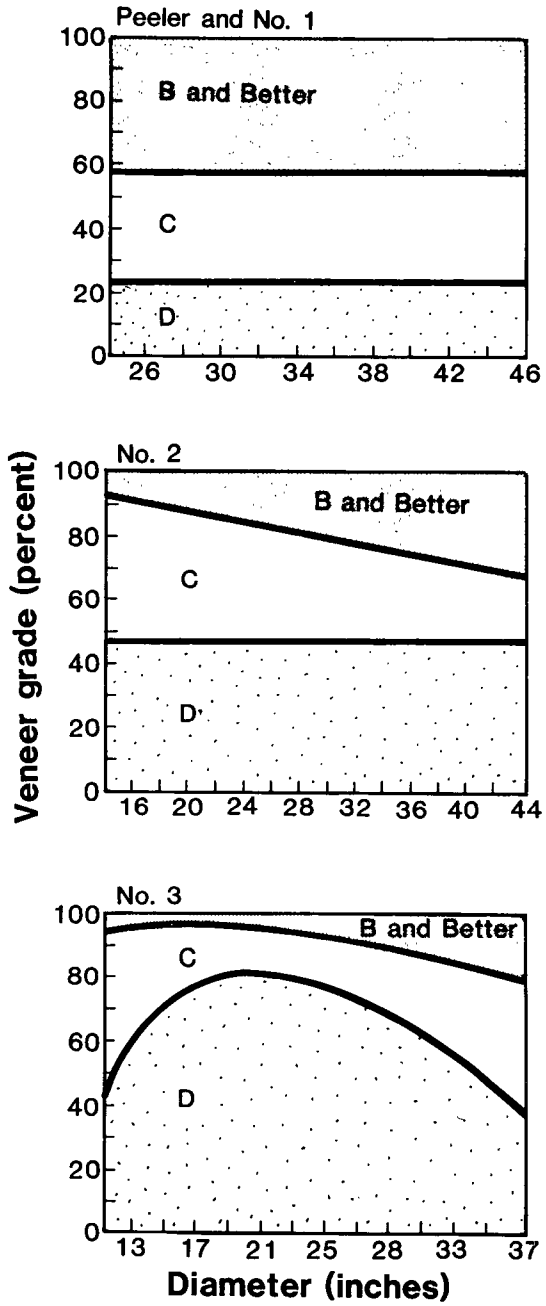

Figure 2.—Combined recovery of veneer grade by diameter for log grades Peeler and No. 1, No. 2, and No. 3.

Volume Recovery

The usual term for reporting results of veneer recovery is the veneer recovery ratio or square feet of veneer (3/8-inch basis) divided by net log scale. Veneer recovery ratio by log grade and for all log grades combined is presented in table 1. Recovery ratio by log grade and diameter class is in appendix tables 9-13. The overall average for all log grades was 2.36 square feet of 3/8-inch veneer per board foot of net log scale. Variation was so great in relation to Scribner volume that we chose not to present curved recovery by diameter for Scribner scale.

The log cubic volume and cubic feet of veneer, below grade veneer, core, and residue by log grade and diameter class are presented in detail in appendix tables 9-13. Average cubic recovery by log grade and for all grades combined is in table 3.

Table 3—Summary of cubic recovery of dry veneer as a percent of log cubic volume, by log grade

Log grade	Graded veneer	Below grade veneer	Core	Residual value[1/]
		Percent		
Peeler	50.9	2.2	18.3	28.6
No. 1	48.2	1.4	20.9	29.5
No. 2	47.2	3.7	16.4	32.7
No. 3	26.6	5.9	21.4	46.2
All grades	44.4	3.8	17.5	34.3

[1/] Includes block roundup, spur trim, and clipper loss which are chippable volume; also includes shrinkage from green to dry veneer.

The difference in recovery between grades was not tested because of the small sample of Peeler and No. 1 log grades and a major difference in diameter distribution between grade 2 and 3 logs. (All logs 13 inches or less are grade 3 regardless of their quality characteristics.)

There is a relationship between log diameter and percentage of cubic volume recovered as graded veneer (fig. 3). The correlation between diameter and percent recovery explains only 4 percent of the total variation. It provides a better estimator of log recovery than the mean, but only slightly better. Above 14 inches there is little increase in recovery as diameter increases. This is contrary to normal expectation but is a pattern that has repeatedly occurred (Fahey 1974, Woodfin 1974, Woodfin and Pong 1974).

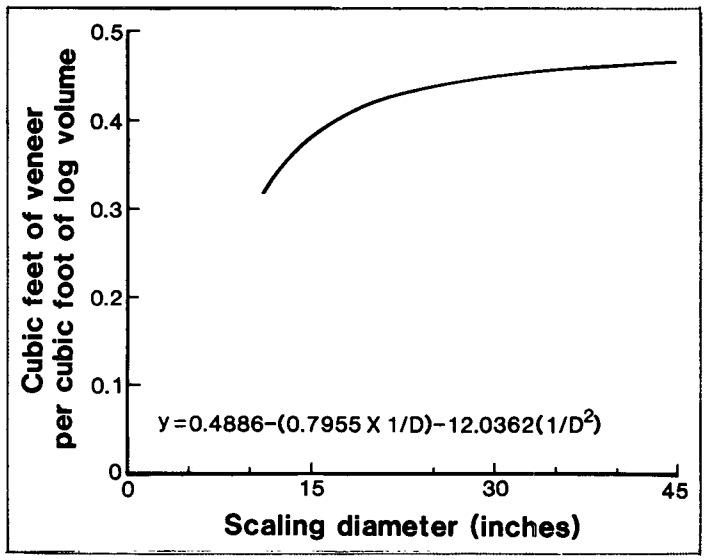

Figure 3.—Veneer recovery ratio—cubic feet of veneer volume per cubic foot of log volume by log diameter of western hemlock.

Application of Results

Results from this study can be used to estimate veneer recovery from western hemlock, or in conjunction with the lumber recovery data[4/] from the same locations, to develop log allocation models.

Information in this report is compiled on a square-foot, 3/8-inch basis and is computed on the actual dimensions of dry veneer. Conversion to finished panels is relatively simple. A panel layup study done with the Washington portion of this study (Woodfin 1973) showed that 14 percent of veneer volume was lost during stringing, reclip, patching, layup, and panel trim.

Industry often calculates square feet of green veneer on a nominal basis. There are several ways to convert the figures in the report to nominal sizes.[5/]

Cubic Volume

The actual volume of logs can be accounted for by using cubic volumes as a starting point. The breakdown by components for 100 cubic feet of log volume is shown in figure 4. The volume of finished panel is estimated to be 37.3 cubic feet, with a total of 45.2 cubic feet green volume (core, roundup, spur trim, and clipper loss) available for chips. In addition, 10.9 cubic feet of dry material (panel trim and below grade veneer) is available for fuel or particle board. Shrinkage is 6.6 cubic feet for dried wood. The 37.3 cubic feet of trimmed panel can be used to estimate the square foot (3/8-inch) panel volume.

[4/] Unpublished data on file at Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

[5/] Details for calculating conversions are available at the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

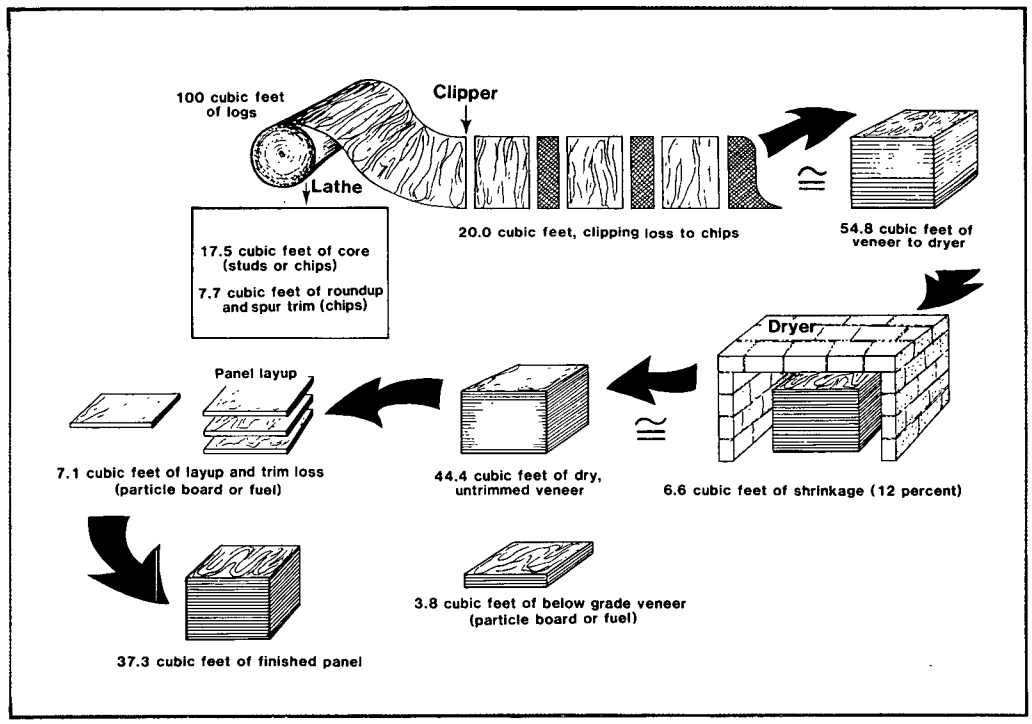

Figure 4.—Distribution of log volume.

The calculations are:

Veneer volume of 583,979 square feet (3/8-inch basis) divided by log volume of 41,777 cubic feet equals 13.98 times 0.84 recovery times 100 cubic feet equals 1,174 square feet of plywood (3/8-inch basis) per 100 cubic feet of log volume.

Cubic volumes by log grade and diameter are shown in appendix tables 9-13, but shrinkage is included in residue. Dividing the dry veneer volume plus the below-grade volume by 0.88 gives the volume of green veneer. Multiplying green veneer volume by 0.12 gives the volume of shrinkage. This should be subtracted from the reported residue to get an estimate of the true chippable volume.

Veneer recovery by log size can be estimated from the regression line or the equation in figure 3. Veneer recovery ratio for 17-inch logs was about 0.40 cubic foot of veneer per cubic foot of gross log volume.[6/] One cubic foot of veneer is equal to 32 square feet on a 3/8-inch basis. Yield is 32x0.40=12.8 square feet per cubic foot of a 17-inch log. Panel layup and trim losses would reduce this volume.

Metric Conversions

1 inch = 2.54 centimeters
1 foot = 0.3048 meter
1 square foot = 0.0929 square meter
1 cubic foot = 0.02832 cubic meter

6/ From the regression model the value is calculated as:
$y=0.4886-(0.7955x1/17)-12.0362(1/17^2)=0.4002$ or 40 percent.

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Appendix

Table 4—Distribution of veneer grade and item by thickness, Peeler grade western hemlock logs

Size of veneer item	Veneer grade						Total veneer volume	
	A	A patch	B	B patch	C	D		
	Percent						Square feet, 3/8-inch basis	Percent
Half sheets:								
1/8-inch	1.5	16.7	13.6	22.7	33.7	11.8	5,555	
1/6-inch	0	2.8	29.4	18.1	23.9	25.7	9,735	
3/16-inch	0	0	0	0	0	0	0	
Total							15,290	69.2
Random width, 8-foot:								
1/8-inch	0	0	.9	30.6	59.0	9.5	588	
1/6-inch	.6	1.8	25.7	12.4	29.8	29.7	5,805	
3/16-inch	0	0	0	0	0	0	0	
Total							6,393	28.9
Random width, 4-foot:								
1/8-inch	0	0	9.3	14.3	49.0	27.4	420	
1/6-inch	0	0	0	0	0	0	0	
3/16-inch	0	0	0	0	0	0	0	
Total							420	1.9
Total or average	.5	6.0	23.3	18.0	29.4	22.8	22,103	100.0

Table 5—Distribution of veneer grade and item by thickness, grade 1 western hemlock logs

Size of veneer item	Veneer grade						Total veneer volume	
	A	A patch	B	B patch	C	D		
	Percent						Square feet, 3/8-inch basis	Percent
Half sheets:								
1/8-inch	0.8	7.6	18.9	12.7	49.2	10.8	4,478	
1/6-inch	0	.1	31.9	14.3	31.3	22.4	18,919	
3/16-inch	0	0	0	75.1	23.4	1.5	3,279	
Total							26,676	72.6
Random width, 8-foot:								
1/8-inch	0	0	6.4	11.2	68.1	14.3	1,642	
1/6-inch	.1	.1	19.8	5.4	39.1	35.5	7,587	
3/16-inch	0	0	0	72.9	17.2	9.9	343	
Total							9,572	26.1
Random width, 4-foot:								
1/8-inch	0	0	2.2	22.6	43.1	32.1	371	
1/6-inch	0	0	0	0	0	0	0	
3/16-inch	0	0	0	0	0	100.0	65	
Total							436	1.2
Total or average	.1	1.0	23.2	18.1	36.0	21.6	36,684	100.0

Table 6—Distribution of veneer grade and item by thickness, grade 2 western hemlock logs

Size of veneer item	Veneer grade						Total veneer volume	
	A	A patch	B	B patch	C	D		
	Percent						Square feet, 3/8-inch basis	Percent
Half sheets:								
1/8-inch	0.6	3.4	3.9	15.7	34.5	41.9	118,589	
1/6-inch	1/	.3	5.8	11.3	31.0	51.6	173,222	
3/16-inch	0	0	.9	16.6	37.6	44.9	36,972	
Total							328,783	69.4
Random width, 8-foot:								
1/8-inch	1/	.2	8.8	6.3	55.4	29.3	37,605	
1/6-inch	.1	.1	8.1	4.4	32.3	55.0	61,350	
3/16-inch	0	0	.5	16.2	39.5	43.0	24,499	
Total							123,454	26.0
Random width, 4-foot:								
1/8-inch	0	0	7.8	10.0	40.2	42.0	14,487	
1/6-inch	0	0	0	0	0	0	0	
3/16-inch	0	0	0	0	48.8	51.2	7,381	
Total							21,868	4.6
Total or average	.2	1.0	5.2	11.5	35.5	46.6	474,105	100.0

1/ Less than 0.05.

Table 7—Distribution of veneer grade and item by thickness, grade 3 western hemlock logs

Size of veneer item	Veneer grade						Total veneer volume	
	A	A patch	B	B patch	C	D		
	Percent						Square feet, 3/8-inch basis	Percent
Half sheets:								
1/8-inch	0	1.0	0.6	3.9	25.0	69.5	1,879	
1/6-inch	0	.5	2.5	6.1	23.6	67.3	19,421	
3/16-inch	0	0	3.6	7.0	13.1	76.3	6,887	
Total							28,187	55.2
Random width, 8-foot:								
1/8-inch	0	0	10.6	0	54.0	35.4	814	
1/6-inch	0	0	4.9	1.9	27.9	65.3	10,357	
3/16-inch	0	0	.8	9.6	29.1	60.5	7,941	
Total							19,112	37.4
Random width, 4-foot:								
1/8-inch	0	0	1.5	3.6	49.6	45.3	662	
1/6-inch	0	0	0	0	0	0	0	
3/16-inch	0	0	0	0	39.9	60.1	3,126	
Total							3,788	7.4
Total or average	0	.2	2.7	5.3	25.8	66.0	51,087	100.0

Table 8—Distribution of veneer grade and item by thickness, all log grades of western hemlock logs

Size of veneer item	Veneer grade						Total veneer volume	
	A	A patch	B	B patch	C	D		
	Percent						Square feet, 3/8-inch basis	Percent
Half sheets:								
1/8-inch	0.7	4.1	4.8	15.7	34.8	39.9	130,501	
1/6-inch	0	.4	8.8	11.4	30.1	49.3	221,297	
3/16-inch	0	0	1.3	19.2	33.0	46.5	47,138	
Total							398,936	68.3
Random width, 8-foot:								
1/8-inch	1/	.1	8.7	6.8	55.9	28.5	40,649	
1/6-inch	.1	.2	9.9	4.7	32.3	52.8	85.099	
3/16-inch	0	0	.6	15.2	36.8	47.4	32,783	
Total							158,531	27.2
Random width, 4-foot:								
1/8-inch	0	0	7.4	10.1	40.9	41.6	15,940	
1/6-inch	0	0	0	0	0	0	0	
3/16-inch	0	0	0	0	45.9	54.1	10,572	
Total							26,512	4.5
Total or average	.2	1.1	6.8	11.7	34.4	45.8	583,979	100.0

Table 9—Log scale, veneer recovery, and cubic volume by scaling diameter, Peeler grade western hemlock logs

Log scaling diameter	Number of logs	Scale[1]		Veneer recovery		Cubic volume					
		Gross	Net	Volume	Recovery ratio	Log	Veneer	Veneer recovery	Below grade veneer	Core	Residue[2]
Inches		- Board feet -		Square feet		- Cubic feet -		Percent	- - - -	Cubic feet	- - - - -
26	1	820	690	1,277	1.85	105.88	41.17	38.9	--	19.46	45.25
27	1	1,160	1,160	3,144	2.71	163.41	101.22	61.9	0.47	13.43	48.29
28	2	2,480	2,330	5,057	2.17	336.02	162.75	48.4	5.20	47.94	120.13
29	0	--	--	--	--	--	--	--	--	--	--
30	0	--	--	--	--	--	--	--	--	--	--
31	2	3,020	2,460	6,450	2.62	434.16	203.61	46.9	9.11	109.22	112.22
32	0	--	--	--	--	--	--	--	--	--	--
33	1	1,670	1,180	3,859	3.27	222.75	124.24	55.8	.20	52.46	45.85
34	0	--	--	--	--	--	--	--	--	--	--
35	1	880	690	2,316	3.36	123.93	72.44	58.4	16.20	11.22	24.07
Total or average	8	10,030	8,510	22,103	2.60	1,386.15	705.43	50.9	31.18	253.73	395.81

[1] USDA Forest Service R-6 Supplement to National Forest Log Scaling Handbook for West-Side Log Scaling. April 1969.

[2] Includes shrinkage.

Table 10—Log scale, veneer recovery, and cubic volume by scaling diameter, grade 1 western hemlock logs

Log scaling diameter	Number of logs	Scale[1]		Veneer recovery		Cubic volume					
		Gross	Net	Volume	Recovery ratio	Log	Veneer	Veneer recovery	Below grade veneer	Core	Residue[2]
Inches		- Board feet -		Square feet		- Cubic feet -		Percent	- - - - Cubic feet - - - - -		
26	1	1,060	980	3,687	3.76	151.40	115.24	76.1	2.98	13.40	19.78
27	0	--	--	--	--	--	--	--	--	--	--
28	1	1,240	1,130	3,529	3.12	170.00	110.27	64.9	9.48	14.22	36.03
29	1	1,290	890	1,886	2.12	177.01	60.70	34.3	.56	53.52	62.23
30	0	--	--	--	--	--	--	--	--	--	--
31	2	3,020	2,840	5,730	2.02	423.91	184.37	43.5	.85	75.38	163.31
32	0	--	--	--	--	--	--	--	--	--	--
33	0	--	--	--	--	--	--	--	--	--	--
34	0	--	--	--	--	--	--	--	--	--	--
35	2	3,720	3,420	10,039	2.94	543.70	323.11	59.4	2.50	56.79	161.30
36	0	--	--	--	--	--	--	--	--	--	--
37	1	1,670	1,300	2,962	2.28	219.51	92.54	42.2	15.33	25.74	85.90
38	0	--	--	--	--	--	--	--	--	--	--
39	1	2,380	2,060	6,746	3.27	350.23	217.11	62.0	.93	52.30	79.89
40	0	--	--	--	--	--	--	--	--	--	--
41	0	--	--	--	--	--	--	--	--	--	--
42	0	--	--	--	--	--	--	--	--	--	--
43	0	--	--	--	--	--	--	--	--	--	--
44	0	--	--	--	--	--	--	--	--	--	--
45	1	3,220	2,350	2,105	.90	392.61	67.82	17.3	.11	215.70	108.98
Total or average	10	17,600	14,970	36,684	2.45	2,428.37	1,171.16	48.2	32.74	507.05	717.42

[1] USDA Forest Service R-6 Supplement to National Forest Log Scaling Handbook for West-Side Log Scaling. April 1969.

[2] Includes shrinkage.

Table 11—Log scale, veneer recovery, and cubic volume by scaling diameter, grade 2 western hemlock logs

Log scaling diameter	Number of logs	Scale[1]		Veneer recovery		Cubic volume					
		Gross	Net	Volume	Recovery ratio	Log	Veneer	Veneer recovery	Below grade veneer	Core	Residue[2]
Inches		- Board feet -		Square feet		- - Cubic feet - -		Percent	- - - - Cubic feet - - - - -		
14	22	4,180	3,830	10,474	2.73	869.97	335.61	38.6	16.64	209.25	308.47
15	22	6,030	5,470	14,923	2.73	1,141.59	477.61	41.8	17.40	277.13	369.45
16	25	7,570	7,210	17,193	2.38	1,300.27	553.10	42.5	21.87	258.27	467.03
17	19	6,370	5,990	15,783	2.63	1,085.94	502.75	46.3	42.14	210.46	330.59
18	15	5,860	5,560	14,208	2.56	961.84	452.83	47.1	32.81	190.42	285.78
19	20	8,700	8,280	22,315	2.70	1,423.69	710.13	49.9	31.52	273.68	408.36
20	19	10,110	9,030	22,139	2.45	1,620.33	702.97	43.4	51.67	308.40	557.29
21	10	6,190	5,700	15,426	2.71	960.21	495.76	51.6	6.36	123.33	334.76
22	11	7,510	6,550	15,927	2.43	1,163.35	502.91	43.2	50.70	351.70	358.04
23	13	9,430	8,640	22,432	2.60	1,415.87	714.36	50.4	47.03	269.08	385.40
24	14	11,170	9,910	23,645	2.39	1,623.96	752.95	46.4	42.99	264.40	563.62
25	8	8,140	7,260	15,077	2.08	1,112.74	480.51	43.2	39.66	233.29	359.28
26	5	5,060	4,630	12,590	2.72	761.03	400.63	52.6	35.24	100.27	224.89
27	5	5,800	5,270	15,169	2.88	838.76	482.53	57.5	32.98	102.78	220.47
28	9	9,580	8,630	19,149	2.22	1,287.73	607.23	47.2	74.33	171.15	435.02
29	9	10,710	8,940	22,857	2.56	1,497.28	721.12	48.2	97.44	183.90	494.82
30	5	6,260	5,170	12,210	2.36	808.60	387.10	47.9	27.59	105.74	288.17
31	4	5,240	4,480	10,140	2.26	740.76	322.93	43.6	19.67	111.13	287.03
32	6	8,280	6,670	14,418	2.16	1,033.11	451.35	43.7	45.62	164.71	371.43
33	7	11,730	9,900	25,050	2.53	1,664.69	798.26	48.0	32.01	265.11	569.31
34	10	15,400	13,120	33,989	2.59	2,264.20	1,078.55	47.6	80.80	295.33	309.52
35	3	5,140	4,080	8,641	2.12	641.55	270.06	42.1	38.51	120.29	212.69
36	3	5,480	4,720	10,187	2.16	811.02	321.74	39.7	42.50	107.88	338.90
37	2	3,860	3,150	7,473	2.37	442.27	233.52	52.8	11.38	32.68	164.69
38	6	10,300	8,430	21,690	2.57	1,258.12	677.80	53.9	89.81	168.60	321.91
39	2	4,200	3,210	10,018	3.12	678.46	318.30	46.9	12.80	134.00	213.36
40	5	11,000	8,400	13,008	1.55	826.39	411.00	49.7	39.79	120.97	254.63
41	0	--	--	--	--	--	--	--	--	--	--
42	3	6,540	5,750	15,922	2.77	856.72	497.64	58.1	65.02	82.13	211.93
43	2	3,670	3,230	7,101	2.20	468.34	221.95	47.4	26.81	56.77	162.81
44	1	2,410	2,100	4,951	2.36	311.56	154.73	49.7	15.60	41.44	99.79
Total or average	285	221,920	193,310	474,105	2.45	31,870.35	15,037.93	47.2	1,188.69	5,234.29	10,409.44

[1] Forest Service R-6 Supplement to National Forest Log Scaling Handbook for West-Side Log Scaling. April 1969.

[2] Includes shrinkage.

Table 12—Log scale, veneer recovery, and cubic volume by scaling diameter, grade 3 western hemlock logs

Log scaling diameter	Number of logs	Scale[1]		Veneer recovery		Cubic volume					
		Gross	Net	Volume	Recovery ratio	Log	Veneer	Veneer recovery	Below grade veneer	Core	Residue[2]
Inches		- Board feet -		Square feet		- - Cubic feet - -		Percent	- - - - Cubic feet - - - - -		
11	1	120	70	147	2.10	36.57	4.72	12.9	2.31	8.84	20.70
12	6	880	810	1,981	2.45	180.72	63.47	35.1	1.36	51.67	64.22
13	20	2,930	2,740	7,122	2.60	587.68	229.29	39.0	2.87	151.00	204.52
14	6	950	890	1,938	2.18	208.78	62.34	29.8	5.81	49.94	90.69
15	4	680	520	805	1.55	122.03	25.90	21.2	.37	48.78	46.98
16	6	1,700	1,300	2,448	1.88	356.26	77.60	21.8	35.78	75.94	166.94
17	6	1,560	1,340	1,753	1.31	252.73	56.21	22.2	6.52	79.81	110.19
18	8	2,830	2,490	3,842	1.54	536.39	122.64	22.9	43.68	127.16	242.91
19	1	510	370	335	.91	66.81	10.47	15.7	4.04	8.36	43.94
20	3	1,330	1,030	1,785	1.73	192.33	57.47	29.9	2.20	64.07	68.59
21	4	1,750	1,080	2,202	2.04	321.63	68.90	21.4	17.68	76.44	158.61
22	1	350	300	598	1.99	57.09	18.65	32.7	5.37	8.87	24.20
23	3	1,600	1,230	1,117	.91	226.04	35.14	15.5	18.79	49.73	122.38
24	3	1,770	1,330	1,943	1.46	262.62	62.17	23.7	26.50	53.77	120.18
25	2	1,960	1,360	1,305	.96	208.86	41.90	20.1	4.66	36.21	126.09
26	3	2,680	1,720	2,233	1.30	380.17	70.81	18.6	13.82	114.11	181.43
27	1	680	450	255	.57	78.49	8.24	10.5	.85	15.78	53.62
28	2	2,480	2,100	3,862	1.84	391.60	117.33	30.0	4.24	55.82	214.21
29	0	--	--	--	--	--	--	--	--	--	--
30	2	2,390	1,860	2,633	1.42	369.34	82.38	22.3	43.15	37.83	205.98
31	0	--	--	--	--	--	--	--	--	--	--
32	1	1,560	1,510	2,103	1.39	229.55	65.72	28.6	42.92	20.52	100.39
33	1	1,270	660	1,953	2.96	192.17	61.01	31.7	20.84	17.90	92.42
34	1	850	650	240	.37	64.35	7.48	11.6	6.29	16.74	33.84
35	0	--	--	--	--	--	--	--	--	--	--
36	3	5,420	4,430	8,487	1.92	770.23	268.19	34.8	47.68	132.37	321.99
Total or average	88	38,250	30,240	51,087	1.69	6,092.44	1,618.03	26.6	357.73	1,301.66	2,815.02

[1] USDA Forest Service R-6 Supplement to National Forest Log Scaling Handbook for West-Side Log Scaling. April 1969.

[2] Includes shrinkage.

Table 13—Log scale, veneer recovery, and cubic volume by scaling diameter for all log grades, western hemlock logs

Log scaling diameter	Number of logs	Scale[1]		Veneer recovery		Cubic volume					
		Gross	Net	Volume	Recovery ratio	Log	Veneer	Veneer recovery	Below grade veneer	Core	Residue[2]
Inches		- Board feet -		Square feet		- - Cubic feet - - -		Percent	- - - - -	Cubic feet	- - - - -
11	1	120	70	147	2.10	36.57	4.72	12.9	2.31	8.84	20.70
12	6	880	810	1,981	2.45	180.72	63.47	35.1	1.36	51.67	64.22
13	20	2,930	2,740	7,122	2.60	587.68	229.29	39.0	2.87	151.00	204.52
14	28	5,130	4,720	12,412	2.63	1,078.75	397.95	36.9	22.45	259.19	399.16
15	26	6,710	5,990	15,728	2.63	1,263.62	503.51	39.8	17.77	325.91	416.43
16	31	9,270	8,510	19,641	2.31	1,656.53	630.70	38.1	57.65	334.21	633.97
17	25	7,930	7,330	17,536	2.39	1,338.67	558.96	41.8	48.66	290.27	440.78
18	23	8,690	8,050	18,050	2.24	1,498.23	575.47	38.4	76.49	317.58	528.69
19	21	9,210	8,650	22,560	2.62	1,490.50	720.60	48.3	35.56	282.04	452.30
20	22	11,440	10,060	23,924	2.38	1,812.66	760.44	42.0	53.87	372.47	625.88
21	14	7,940	6,780	17,628	2.60	1,281.84	564.66	44.0	24.04	199.77	493.37
22	12	7,860	6,850	16,525	2.41	1,220.44	521.56	42.7	56.07	260.57	382.24
23	16	11,030	9,870	23,549	2.39	1,641.91	749.50	45.6	65.82	318.81	507.78
24	17	12,940	11,240	25,588	2.28	1,886.58	815.12	43.2	69.49	318.17	683.80
25	10	10,100	8,620	16,382	1.90	1,321.60	522.41	39.5	44.32	269.50	485.37
26	10	9,620	8,020	19,787	2.47	1,398.48	627.85	44.9	52.04	247.24	471.35
27	7	7,640	6,880	18,568	2.70	1,080.66	591.99	54.8	34.30	131.99	322.38
28	14	15,780	14,190	31,597	2.23	2,185.35	997.58	45.6	93.25	289.13	805.39
29	10	12,000	9,830	24,743	2.52	1,674.29	781.82	46.7	98.00	237.42	557.05
30	7	8,650	7,030	14,843	2.11	1,177.94	469.48	39.8	70.74	143.57	494.15
31	8	11,280	9,780	22,320	2.28	1,598.83	710.91	44.4	29.63	295.73	562.56
32	7	9,840	8,180	16,521	2.02	1,262.66	517.07	41.0	88.54	185.23	471.82
33	9	14,670	11,740	30,862	2.63	2,079.61	983.51	47.3	53.05	335.47	707.58
34	11	16,250	13,770	34,229	2.49	2,328.55	1,086.03	46.6	87.09	312.07	843.36
35	6	9,740	8.190	20,996	2.56	1,309.18	665.61	50.8	57.21	188.30	398.06
36	6	10,900	9,150	18,674	2.04	1,581.25	589.93	37.3	90.18	240.25	660.89
37	3	5,530	4,450	10,435	2.34	661.78	326.06	49.3	26.71	58.42	250.59
38	6	10,300	8,430	21,690	2.57	1,258.12	677.80	53.9	89.81	168.60	321.91
39	3	6,580	5,270	16,764	3.18	1,028.69	535.41	52.0	13.73	186.30	293.25
40	5	11,000	8,400	13,008	1.55	826.39	411.00	49.7	39.79	120.97	254.63
41	0	--	--	--	--	--	--	--	--	--	--
42	3	6,540	5,750	15,922	2.77	856.72	497.64	58.1	65.02	82.13	211.93
43	2	3,670	3,230	7,101	2.20	468.34	221.95	47.4	26.81	56.77	162.81
44	1	2,410	2,100	4,951	2.36	311.56	154.73	49.7	15.60	41.44	99.79
45	1	3,220	2,350	2,105	.90	392.61	67.82	17.3	.11	215.70	108.98
Total or average	391	287,800	247,030	583,979	2.36	41,777.31	18,532.55	44.4	1,610.34	7,296.73	14,337.69

[1]/USDA Forest Service R-6 Supplement to National Forest Log Scaling Handbook for West-Side Log Scaling. April 1969.

[2]/Includes shrinkage.

Table 14—Recovery of veneer grade by scaling diameter, Peeler grade western hemlock logs

Log scaling diameter	Number of logs	Veneer volume, 3/8-inch basis	Veneer grade					
			A	A patch	B	B patch	C	D
Inches		Square feet	Percent					
26	1	1,277	0	0	20.0	13.9	24.9	41.2
27	1	3,144	0	2.1	23.0	20.5	18.0	36.4
28	2	5,057	.5	1.3	39.0	13.4	21.8	24.0
29	0	--	--	--	--	--	--	--
30	0	--	--	--	--	--	--	--
31	2	6,450	1.3	15.0	17.0	30.5	19.5	16.7
32	0	--	--	--	--	--	--	--
33	1	3,859	.3	5.4	27.7	10.7	42.0	13.9
34	0	--	--	--	--	--	--	--
35	1	2,316	0	0	1.7	4.4	70.3	23.6
Total or average	8	22,103	.5	6.0	23.3	18.0	29.4	22.8

Table 15—Recovery of veneer grade by scaling diameter, grade 1 western hemlock logs

Log scaling diameter	Number of logs	Veneer volume, 3/8-inch basis	Veneer grade					
			A	A patch	B	B patch	C	D
Inches		Square feet	Percent					
26	1	3,687	0	0	0	73.6	22.4	4.0
27	0	--	--	--	--	--	--	--
28	1	3,529	0	4.4	20.5	7.2	62.5	5.4
29	1	1,886	0	.4	5.3	2.7	55.5	36.1
30	0	--	--	--	--	--	--	--
31	2	5,730	0	0	17.8	8.9	43.4	29.9
32	0	--	--	--	--	--	--	--
33	0	--	--	--	--	--	--	--
34	0	--	--	--	--	--	--	--
35	2	10,039	0	.1	21.4	11.8	41.2	25.5
36	0	--						
37	1	2,962	1.2	6.3	8.0	19.6	43.1	21.8
38	0	--						
39	1	6,746	.1	.1	45.8	17.1	12.6	24.3
40	0	--	--	--	--	--	--	--
41	0	--	--	--	--	--	--	--
42	0	--	--	--	--	--	--	--
43	0	--	--	--	--	--	--	--
44	0	--	--	--	--	--	--	--
45	1	2,105	0	0	55.7	10.0	17.7	16.6
Total or average	10	36,684	.1	1.0	23.2	18.1	36.0	21.6

Table 16—Recovery of veneer grade by scaling diameter, grade 2 western hemlock logs

Log scaling diameter	Number of logs	Veneer volume, 3/8-inch basis	Veneer grade					
			A	A patch	B	B patch	C	D
Inches		Square feet	Percent					
14	22	10,474	0	0	1.7	6.9	45.9	45.5
15	22	14,923	.1	.2	3.7	6.4	42.1	47.5
16	25	17,193	0	0	.9	6.0	35.4	57.7
17	19	15,783	0	0	1.0	10.5	39.0	49.5
18	15	14,208	0	.3	2.4	7.3	53.1	36.9
19	20	22,315	0	.5	2.8	6.2	48.8	41.7
20	19	22,139	.1	.6	4.1	4.6	48.7	41.9
21	10	15,426	0	0	6.5	7.6	40.6	45.3
22	11	15,927	0	.9	5.3	7.6	40.5	45.7
23	13	22,432	0	.4	3.8	15.3	36.5	44.0
24	14	23,645	0	0	4.1	8.0	35.5	52.4
25	8	15,077	.1	.2	9.9	11.1	37.7	41.0
26	5	12,590	.2	4.1	8.3	14.1	24.8	48.5
27	5	15,169	0	2.0	5.2	12.3	37.6	42.9
28	9	19,149	.2	.8	5.7	12.2	25.8	55.3
29	9	22,857	0	.1	6.2	5.6	39.0	49.1
30	5	12,210	0	.3	5.6	9.8	29.3	55.0
31	4	10,140	0	.3	5.8	15.0	24.7	54.2
32	6	14,418	.2	4.3	5.0	17.8	23.0	49.7
33	7	25,050	.1	.7	5.7	10.4	21.7	61.4
34	10	33,989	.3	1.0	11.0	13.3	23.6	50.8
35	3	8,641	0	0	1.0	10.4	53.8	34.8
36	3	10,187	.3	1.2	8.6	15.5	31.0	43.4
37	2	7,473	1.3	2.6	6.8	17.4	36.2	35.7
38	6	21,690	1.4	3.1	4.5	16.2	31.9	42.9
39	2	10,018	0	0	5.0	19.1	15.1	60.8
40	5	13,008	.1	.4	7.5	21.2	34.0	36.8
41	0	--	--	--	--	--	--	--
42	3	15,922	.5	4.0	3.9	23.9	38.9	28.8
43	2	7,101	.5	2.8	5.5	17.2	49.5	24.5
44	1	4,951	0	2.4	2.9	17.8	45.9	31.0
Total or average	285	474,105	.2	1.0	5.2	11.5	35.5	46.6

Table 17—Recovery of veneer grade by scaling diameter, grade 3 western hemlock logs

Log scaling diameter	Number of logs	Veneer volume, 3/8-inch basis	Veneer grade					
			A	A patch	B	B patch	C	D
Inches		Square feet	Percent					
11	1	147	0	0	0	0	0	100.0
12	6	1,981	0	0	0	4.1	58.4	37.5
13	20	7,122	0	0	.4	5.3	42.5	51.8
14	6	1,938	0	0	.2	0	11.9	87.9
15	4	805	0	0	0	0	14.2	85.8
16	6	2,448	0	0	1.6	2.2	17.4	78.8
17	6	1,753	0	0	.9	1.0	27.3	70.8
18	8	3,842	0	0	.4	3.0	12.6	84.0
19	1	335	0	0	0	3.6	52.2	44.2
20	3	1,785	0	0	.6	4.5	11.2	83.7
21	4	2,202	0	0	0	1.7	14.7	83.6
22	1	598	0	0	0	.5	29.6	69.9
23	3	1,117	0	0	7.2	1.3	25.9	65.6
24	3	1,943	0	0	1.2	5.8	15.8	77.2
25	2	1,305	0	0	.9	2.4	9.0	87.7
26	3	2,233	0	0	10.8	.4	15.3	73.5
27	1	255	0	0	35.3	9.4	11.8	43.5
28	2	3,862	0	0	2.3	2.9	21.6	73.2
29	0	--	--	--	--	--	--	--
30	2	2,633	0	0	.4	7.3	24.5	67.8
31	0	--	--	--	--	--	--	--
32	1	2,103	0	0	.4	1.8	20.8	77.0
33	1	1,953	0	0	6.5	17.5	20.2	55.8
34	1	240	0	0	6.7	2.9	52.9	37.5
35	0	--	--	--	--	--	--	--
36	3	8,487	0	1.5	7.0	12.4	33.5	45.6
Total or average	88	51,087	0	.2	2.7	5.3	25.8	66.0

Table 18—Recovery of veneer grade by scaling diameter, all grades of western hemlock logs

Log scaling diameter	Number of logs	Veneer volume, 3/8-inch basis	Veneer grade					
			A	A patch	B	B patch	C	D
Inches		Square feet	Percent					
8	0	--						
9	0	--						
10	0	--						
11	1	147	0	0	0	0	0	100.0
12	6	1,981	0	0	0	4.1	58.4	37.5
13	20	7,122	0	0	0.4	5.3	42.5	51.8
14	28	12,412	0	0	1.5	5.8	40.5	52.2
15	26	15,728	.1	.2	3.5	6.1	40.6	49.5
16	31	19,641	0	0	1.0	5.5	33.2	60.3
17	25	17,536	0	0	1.0	9.5	37.8	51.7
18	23	18,050	0	.2	1.9	6.4	44.5	47.0
19	21	22,650	0	.5	2.8	6.2	48.7	41.8
20	22	23,924	.1	.6	3.9	4.6	45.8	45.0
21	14	17,628	0	0	5.7	6.9	37.3	50.1
22	12	16,525	0	.9	5.1	7.4	40.1	46.5
23	16	23,549	0	.3	3.9	14.6	36.0	45.2
24	17	25,588	0	0	3.9	7.8	34.0	54.3
25	10	16,382	.1	.2	9.2	10.4	35.5	44.6
26	10	19,787	.1	2.6	7.8	23.6	23.3	42.6
27	7	18,568	0	2.0	8.6	13.7	33.9	41.8
28	14	31,597	.2	1.2	12.2	10.7	28.8	46.9
29	10	24,743	0	.2	6.2	5.4	40.1	48.1
30	7	14,843	0	.2	4.7	9.4	28.4	57.3
31	8	22,320	.4	4.5	12.1	17.9	28.0	37.1
32	7	16,521	.2	3.7	4.4	15.8	22.7	53.2
33	9	30,862	.1	1.3	8.5	10.9	24.1	55.1
34	11	34,229	.3	1.0	10.9	13.2	23.8	50.8
35	6	20,996	0	0	10.9	10.4	49.5	29.2
36	6	18,674	.2	1.3	7.9	14.1	32.1	44.4
37	3	10,435	1.3	3.7	7.1	18.1	38.1	31.7
38	6	21,690	1.4	3.1	4.5	16.2	31.9	42.9
39	3	16,764	0	0	21.5	18.3	14.1	46.1
40	5	13,008	.1	.4	7.5	21.2	34.0	36.8
41	0	--	--	--	--	--	--	--
42	3	15,922	.5	4.0	3.9	23.9	38.9	28.8
43	2	7,101	.5	2.8	5.5	17.2	49.5	24.5
44	1	4,951	0	2.4	2.9	17.8	45.9	31.0
45	1	2,105	0	0	55.7	10.0	17.7	16.6
Total or average	391	583,979	.2	1.1	6.8	11.7	34.4	45.8

Fahey, Thomas D.; Woodfin, Richard O., Jr. Western hemlock as a veneer resource. Res. Pap. PNW-299. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1982. 24 p.

Presents recovery of veneer grade and volume from western hemlock from Oregon and Washington. Veneer grade recovery varied by grade and size of logs. Veneer volume recovered was about 45 percent of the cubic volume of the log and varied somewhat with log diameter.

Keywords: Veneer yield, veneer recovery, western hemlock, *Tsuga heterophylla*.

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