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Lumber Recovery From Douglas-fir Thinnings at a Bandmill and Two Chipping Canters

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INTRODUCTION

Commercial thinning of young Douglas-fir stands is a rapidly increasing portion of the total timber harvested in the Pacific Northwest. New logging and sawmilling equipment and increasing demand for forest products have combined to make operations in younger and smaller stands commercially feasible. Very little information is available on lumber grade recovery, overrun, or chip recovery from this portion of the resource.

In 1968 Region 6 of the National Forest System in cooperation with the Pacific Northwest Forest and Range Experiment Station, the Bureau of Land Management, and three mills initiated a series of lumber recovery studies on thinning materials from Douglas-fir stands. The material was processed between January and April 1970 through a conventional bandmill, a 10-inch-maximum cant-size square-canting chipper (Beaver) with resaw, and a 12-inch-center-cant profiling chipper with double arbor circular saws for cant breakdown (Chip-N-Saw Model 1242-60).[1/]

The information on lumber and chip recovery will be useful to mill operators and timber managers in predicting product yields of logs from similar stands and in evaluating different production methods as logs of this type are used more.

[1] *Mention of companies or products does not constitute endorsement by the U.S. Department of Agriculture.*

STUDY PROCEDURES

TIMBER SAMPLING AREAS

The samples were taken from well-stocked Douglas-fir stands less than 100 years old (table 1) located on the Mount Hood National Forest in Oregon. The sample trees were selected to improve growing conditions for the thriftier trees, to salvage incipient or existing mortality, or to improve stand spacing. The material processed at the Chip-N-Saw and at the bandmill was from the same stand, with only a road separating the two areas. The material processed at the Beaver was from two widely separated stands.

Because the bandmill had no effective diameter limit, some larger trees were included in the sample (tables 1 and 2).

LOG SCALING AND GRADING

The woods-length logs were scaled and graded in the mill yard by a U.S. Forest Service check scaler. Scaling was according to uniform scaling bureau rules for west side,[2/] with logs up to 40 feet in length being scaled as one piece. Logs were graded according to rules for Douglas-fir logs in the standing tree.[3/] Defects not visible on the log surface were not considered in grading.

[2] *Official log scaling and grading rules. Revised as needed.*

[3] *Log grade descriptions for Douglas-fir. Form R6-2440-19D (March 1965). Unpublished material on file at U.S. Forest Serv., Region 6, Portland, Oreg.*

Table 1.--Stand characteristics of sampling areas

Characteristic	Clackamas County		Hood River County	
	Beaver	Beaver	Chip-N-Saw	Bandmill
Stand age (years)	55	85	65	65
Site class	III	III	III	III
Basal area/acre (square feet)	225	215	200	200
Basal area cut/acre (square feet)	41	45	43	43
Average d.b.h. (inches)	9.5	10.0	10.0	10.6
D.b.h. range (inches)	7-14	7-16	6-15	7-18
Log scaling defect (percent)	1	1	4	3

Table 2.--Log input by diameter class as a percent of net Scribner scale and gross cubic volumes

Diameter (inches)	Beaver			Chip-N-Saw			Bandmill		
	Number	Scribner	Cubic	Number	Scribner	Cubic	Number	Scribner	Cubic
	Percent								
4	46	2.35	2.71	28	1.65	1.75	75	5.22	5.88
5	285	14.28	18.22	244	20.39	29.52	214	16.70	23.55
6	199	19.55	16.91	101	17.83	15.11	68	11.29	9.61
7	161	20.88	20.00	63	13.96	12.39	66	14.36	12.74
8	137	21.75	22.91	74	21.48	19.79	66	17.31	16.77
9	62	12.41	12.32	32	12.69	11.54	31	10.56	10.10
10	32	7.82	6.15	17	8.17	6.74	18	7.83	6.79
11	4	.96	.78	6	3.83	3.16	10	5.49	4.84
12	0	--	--	0	--	--	13	7.56	6.59
13	0	--	--	0	--	--	6	3.68	3.13
Total	926	100.0	100.0	565	100.0	100.0	567	100.0	100.0

CUBIC MEASUREMENTS

Cubic measurements were made on sawmill length, bucked and barked logs. The cubic volume of a wood length log was determined by adding the cubic volume of the mill length segments, with diameters recorded to the nearest inch. The cubic volume of the segments was determined by Smalian's formula. No deductions were made from gross cubic volume measurements. Cubic volumes of lumber were calculated by computer, based on sample measurements of actual rough green lumber width and thickness and on nominal lumber lengths.

PROCESSING AND INDIVIDUAL MILL SETUP

In the woods each mill length log was given a number identifying the tree and the log position in the tree. At the mill, lumber was identified with the mill length and scaling length log and tree from which it came.

The bandmill had a debarker, band headrig for primary breakdown, reciprocating gangsaw, two edgers, a vertical band resaw, and gang trim saw. Grading and tallying of boards was done on the green chain. Due to very difficult conditions in the mill, several errors were made in assigning log sequential numbers to some or all of the boards from several logs. Recovery by log or by diameter class cannot be accurately given. However, total log scale in and total lumber recovery out can be compared with the other two studies.

The equipment with the Beaver included a debarker, vertical band resaw with recycling chains, an edger, and a 24-foot gang trim saw. Grading and tallying were done on the green chain.

The output from the Chip-N-Saw was put into the production flow from a conventional mill which was sawing other lumber also. The edger and trim saw were inside the main mill. Grading and tallying were done on the chain from the canter to the main mill. Because of plant layout there was more pencil trim and rip[4/] at this mill than at the other two, but because of the soundness of the material, less than 10 percent of the total pieces were either trimmed or ripped.

CHIP RECOVERY

At all three mills, an empty chip bin or car was provided. All study chips were put in one shipment. The weight and moisture content of the chips were determined in the standard manner by the chip purchaser, and the total number of ovendry tons was determined from the shipment or car number. At the Chip-N-Saw, material pencil trimmed or ripped was excluded from the lumber tally. Since actual trimming or ripping was done at the main mill, these chips were not included in the reported chip recovery. The actual chip recovery would be very little higher than reported here. Pencil trim and rip at the other two mills would be insignificant.

LUMBER GRADING

All lumber was graded in the rough green condition by inspectors from the West Coast Lumber Inspection Bureau or Pacific Lumber Inspection Bureau. Each piece was given its anticipated surfaced

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[4] *Reduction in length or width marked by the grader when he assumed such remanufacture would be done beyond the point at which he was grading.*

green grade.[5] Pencil trim and rip, or both, were also designated by the grade inspector. Pencil trim was used to upgrade a board only when it could reasonably be assumed that the same decision would be made at the planer chain.

LUMBER TALLY

Lumber was tallied by Forest Service crews working immediately after the grader. Each board was tallied by width, thickness, length, grade, and the identification number of the log from which it came. Pencil trim and rip were deducted from the actual length and width as the boards were tallied.

RESULTS AND CONCLUSIONS

The results are listed in a series of tables (tables 3-6). Table 3 is the lumber recovery by lumber grade and dimension item for each of the study mills. Table 4 is the recovery by lumber grade for each log diameter class for the Beaver and Chip-N-Saw, and the totals for the bandmill. Table 5 is the total value and volume, recovery per unit volume, and value per unit volume by diameter class for the Beaver and Chip-N-Saw and totals for the bandmill. Table 6 summarizes information from the other tables and includes chip recovery.

The tables are set up to allow the user to supply any set of grade, item, or chip prices to recompute values. The values assigned to various grades and items can produce wide variations in total and unit values.

Diameter limits expressed in the grading rules caused all logs at both the Beaver and the Chip-N-Saw to be graded Number 3 Sawmill. There were 19 logs at the bandmill large enough to be graded Number 2 Sawmill. Since individual log recovery was not obtained at the bandmill, there was no analysis by grade. This refinement is probably not necessary since, other than diameter, there were no external differences between grade 2 and grade 3 logs.

Among the three mills, there were some obvious differences in the volume and grade of lumber items produced, as well as in the volume of chips per unit of log input.

These differences bear out the common assumption that a bandmill will produce more overrun and less chips than a chipping type headrig. It is also commonly held that most of the increase in overrun at a bandmill will be in the form of 1-inch lumber. The bandmill overrun was 168 percent compared with 138 percent for the Beaver. Of this difference only 16 percent could be attributed to differences in 1-inch lumber production. Of the bandmill's 29-percent difference from the Chip-N-Saw, only 6 percent was attributable to 1-inch boards. Evidently the versatility of the bandmill increases recovery of more than just 1-inch boards.

The ability to vary production by lumber size was very limited on the Chip-N-Saw. The bandmill was virtually unlimited but heavily weighted toward 2-inch dimension by the gang saw. The Beaver, except for the initial 10- by 10-inch cant size, was limited only by resaw capacity. A large majority of the

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[5] *West Coast Lumber Inspection Bureau. Number 15, Standard grading and dressing rules for Douglas fir west coast hemlock, Sitka spruce, western red cedar lumber. Rev. Feb. 15, 1968. Portland, Oreg.*

Table 3.--Percent of total production by grade, dimension, and mill

Dimension (inches)	Select Structural	Construction	Standard	Utility	Economy	Total
			Percent			
Beaver:						
1 x 4	--	[1/]0.54	0.04	0.05	0.02	0.65
1 x 6	--	[2/].33	.03	[2/].05	.04	.45
2 x 3	--	1.10	.38	.16	.04	1.68
2 x 4	5.16	17.58	4.65	1.85	.38	29.62
2 x 6	4.32	7.92	2.84	.72	.46	16.26
2 x 8	1.13	1.38	.70	.03	--	3.24
2 x 10	--	.05	--	--	--	.05
4 x 4	3.09	41.50	2.97	.49	--	48.05
Total	13.70	70.40	11.61	3.35	.94	100.00
Chip-N-Saw:						
1 x 4	3.53	3.07	0.56	0.47	0.21	7.84
1 x 6	.02	[3/].20	.12	.12	[3/].28	.74
2 x 4	13.17	20.28	5.32	3.55	1.65	43.97
2 x 6	11.47	15.19	2.49	1.80	.82	31.77
2 x 8	5.59	6.63	.48	.28	.24	13.22
2 x 10	.83	1.14	.42	.07	--	2.46
Total	34.61	46.51	9.39	6.29	3.20	100.00
Bandmill:						
1 x 3	0.01	0.47	0.12	0.05	0.01	0.66
1 x 4	.37	6.22	1.56	.79	.29	9.23
1 x 6	.01	.37	.09	.05	--	.52
1 x 8	--	[4/].05	.02	--	--	[4/].07
2 x 3	.03	.37	.03	.02	--	.45
2 x 4	2.82	20.35	4.27	1.67	.62	29.73
2 x 6	1.86	19.78	7.70	2.11	.26	31.71
2 x 8	.91	11.50	5.75	1.05	--	19.21
2 x 10	.45	3.90	2.31	.54	--	7.20
2 x 12	.07	.53	.12	--	--	.72
3" & thicker, 4" & wider	.04	.30	.15	--	.01	.50
Total	6.57	63.84	22.12	6.28	1.19	100.00

[1/] Includes 0.01 percent 1 x 3.

[2/] Includes 0.05 percent 1 x 8.

[3/] Includes 0.01 percent 1 x 8.

[4/] Includes 0.02 percent 1 x 10.

Table 4.--Lumber grade recovery as a percent of lumber tally volume by diameter class and mill

Diameter (inches)	Number of logs	Select Structural	Construction	Standard	Utility	Economy
			Percent			
Beaver:						
4	46	7.6	73.2	11.3	4.6	3.3
5	285	10.0	75.6	10.7	3.2	.5
6	199	8.1	78.0	8.8	3.4	1.7
7	161	13.1	69.3	13.7	3.1	.8
8	137	16.1	66.7	12.4	3.8	1.0
9	62	22.7	63.7	11.0	1.9	.7
10	32	16.1	65.0	14.5	4.2	.2
11	4	21.8	52.5	7.5	18.2	--
Total	926	13.7	70.4	11.6	3.4	.9
Chip-N-Saw:						
4	28	13.2	30.7	23.2	23.8	9.1
5	244	27.8	50.6	11.2	6.8	3.6
6	101	34.1	47.5	9.6	5.9	2.9
7	63	34.0	47.8	8.4	7.8	2.0
8	74	44.6	43.7	5.7	3.9	2.1
9	32	36.5	46.8	7.8	5.7	3.2
10	17	38.7	43.4	9.4	3.7	4.8
11	6	38.7	35.2	12.3	9.3	4.5
Total	565	34.6	46.5	9.4	6.3	3.2
Bandmill, Total	567	6.6	63.8	22.1	6.3	1.2

Table 5.--Lumber recovery and value per unit volume by log diameter class for three mills

Diameter (inches)	Scribner		Lumber tally		Cubic volume			Ratio of board-foot lumber tally to cubic log volume	Value[1/]			
	Gross board feet	Net board feet	Total board feet	As percent of net scale	Gross volume logs	Volume of lumber	Percent recovered as lumber		Total	Dollars/MBF lumber tally	Dollars/MBF net log scale	Dollars/M cu.ft. gross log volume
Beaver:												
4	830	830	1,315	158	248.9	110.8	45	5.28	130.26	99.06	156.94	523.34
5	5,080	5,040	9,303	185	1,672.9	790.3	47	5.56	943.14	101.38	187.13	563.78
6	7,010	6,900	7,987	116	1,553.4	682.9	44	5.14	802.93	100.53	116.37	516.89
7	7,500	7,370	9,291	126	1,836.7	791.7	43	5.06	940.44	101.22	127.60	512.03
8	7,770	7,680	10,885	142	2,103.8	926.5	44	5.17	1,097.53	100.83	142.91	521.69
9	4,470	4,380	6,155	141	1,131.9	524.5	46	5.44	626.15	101.73	142.96	553.18
10	2,770	2,760	3,301	120	564.5	281.2	50	5.85	334.06	101.20	121.04	591.78
11[2/]	340	340	362	106	71.7	31.0	43	5.05	34.79	96.11	102.32	485.22
Total	35,770	35,300	48,599	138	9,183.8	4,138.9	45	5.29	4,909.30	101.02	139.07	534.56
Chip-N-Saw:												
4	410	380	736	194	98.6	59.0	60	7.46	64.89	88.17	170.77	735.96
5	4,850	4,690	9,646	206	1,661.9	773.1	47	5.80	945.69	98.04	201.64	569.04
6	4,420	4,100	4,301	105	850.9	344.9	41	5.05	424.85	98.78	103.62	499.29
7	3,330	3,210	3,516	110	697.4	284.0	36	5.04	347.03	98.70	108.11	497.61
8	5,060	4,940	6,335	128	1,113.8	515.1	46	5.60	634.07	100.09	128.35	569.29
9	3,030	2,920	4,035	138	649.8	327.3	50	6.21	398.29	98.71	136.40	612.94
10	1,900	1,880	2,262	120	379.3	184.0	48	5.96	222.65	98.43	118.43	587.00
11	920	880	1,115	127	177.7	90.7	51	6.27	107.63	96.53	122.31	605.68
Total	23,920	23,000	31,946	139	5,629.4	2,578.1	46	5.67	3,145.10	98.45	136.74	558.69
Bandmill, Total	26,820	26,050	43,754	168	6,381.4	3,227.5	51	6.86	4,365.33	99.77	167.76	684.07

[1/] Lumber prices used are: Standard & Better, $102.89; Utility, $65.62; Economy, $38.65.

[2/] Maximum capacity, 10-inch by 10-inch cant.

Table 6.--Summary of three processing alternatives

Characteristic	Beaver	Chip-N-Saw	Bandmill
Average weighted scaling diameter	6.6	6.4	6.6
Percent defect	1	4	3
Percent Select Structural[1/]	13.7	34.6	6.6
Percent Construction[1/]	70.4	46.5	63.8
Percent Standard[1/]	11.6	9.4	22.1
Percent Utility[1/]	3.4	6.3	6.3
Percent Economy[1/]	.9	3.2	1.2
Overrun percent	38	39	68
Percent cubic recovered as lumber	45	46	51
$/MBF lumber tally[2/]	101.02	98.45	99.77
$/MBF net log scale[3/]	139.07	136.74	167.76
$/M cubic feet	534.56	558.69	684.07
Chip recovery, dry tons[4/]	77.63	[5/]35.80	25.48
Dry tons/M net log scale	2.20	1.56	.98
Dry tons/M cubic feet of logs	8.453	6.360	3.993

1/ West Coast Lumber Inspection Bureau. No. 15, Standard grading and dressing rules for Douglas fir, west coast hemlock, Sitka spruce, western red cedar lumber. Rev. Feb. 15, 1968. Portland, Oreg.

2/ Lumber prices used are: Standard & Better, $102.89; Utility, $65.62; Economy, $38.65.

3/ Official log scaling and grading rules. Revised as needed.

4/ 1 dry ton equals 2,000 pounds of ovendry chips.

5/ Does not include chips from trimming or edging done in the main sawmill (estimated maximum 0.30 dry ton).

4x4's produced at the Beaver were produced by resawing larger cants.

Although the variation in lumber *grades* is partly a function of the items produced, it seems to be largely due to variations in sawing and trimming decisions. There was little variation in knot size among trees from the different samples. The difference in the percent of utility was largely due to mismanufacture and defects not trimmed; economy lumber was apparently related to the difference in percent of scaling defect among the mills. This relationship occurs in most lumber recovery studies.

One reason for the high percentage of Select Structural lumber from the Chip-N-Saw was the production of lumber with very little wane. Under the provisions of standard grading and dressing rules for Douglas-fir[6] and given a limited variation in knot size, wane would be the most important single factor in degrading lumber from Select Structural to Construction or Standard grade.

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[6] *See footnote 5.*

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Trees cut in thinning a Douglas-fir stand were processed into lumber by three alternative methods: a square cant chipper, a profiled cant chipper, and a bandmill. Results reported include lumber recovery by grade and dimension, recovery factors for long log Scribner and cubic volume, and total chip recovery.

Keywords: Lumber, recovery ratios, thinning (trees), sawmill equipment.

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The mission of the PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION is to provide the knowledge, technology, and alternatives for present and future protection, management, and use of forest, range, and related environments.

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