Log-Gang and Scrag Mills' *Sawing Efficiency*

By **J.R. Pfeiffer**

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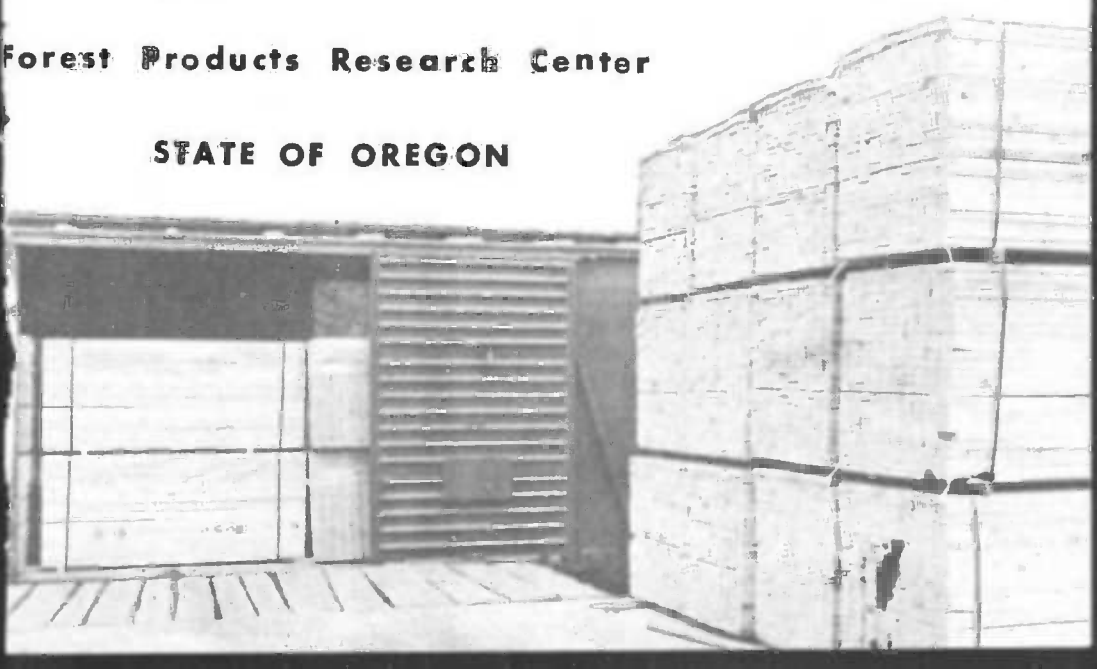

Forest Products Research Center

. . . Its Purpose

Fully utilize the resource by:

- developing more by-products from mill and logging residues to use the material burned or left in the woods.
- expanding markets for forest products through advanced treatments, improved drying, and new designs.
- directing the prospective user's attention to available wood and bark supplies, and to species as yet not fully utilized.
- creating new jobs and additional dollar returns by suggesting an increased variety of saleable products. New products and growing values can offset rising costs.

Further the interests of forestry and forest products industries within the State.

. . . Its Program

- Accelerated air drying of lumber with fans, to lower shipping costs.
- Kiln schedules for thick Douglas fir lumber, to speed drying.
- Bevel siding from common lumber, to increase sales.
- End gluing of dimension lumber, to utilize shorts.
- Effect of spacing and end distance on strength of bolted joints.
- Production and bleaching of high-yield pulps from Douglas fir mill residues.
- Strength of wood and wood structures.
- Douglas fir wood and bark lignin and bark extractives for full recovery.
- Ammoniated wood and bark as improved soil amendments.
- Service tests of treated and untreated wood products.
- Floor tile from wood and bark residues.

CONTENTS

SUMMARY

Overrun was not greatly different at the 3 scrag and 3 log-gang mills studied. Bucking long logs to 8-foot lengths offset heavy kerf at scrag mills.

Resawing to 1- by 4-inch and 2- by 3-inch stock had pronounced effect on increasing overrun.

Productivity ranged from 3,000+ to over 6,000 board feet a day for each man. Scrag mills with double pairs of saws had highest rates of the 6 mills.

With any of the 6 mills when sawing material from thinnings, the chief problem is likely to be log supply.

Log-Gang and Scrag Mills' Sawing Efficiency

by

J. R. Pfeiffer

Much interest has been generated during the past few years in sawmills designed to saw small logs efficiently. Anticipating increased interest in utilization of small logs, such as those that will result from thinnings or improvement cuttings, the Forest Products Research Center undertook a study of scrag and log-gang mills. Other mill types were considered for the study, but for one or more reasons they were not included. While some circular and band mills are fast, with or without a cant gang saw, they were not included since they cut larger logs than would be obtained from thinnings. Other mill types were not included because of the limited number in operation.

PROCEDURES AND PRACTICES

Study periods

The study was conducted at 3 scrag and 3 log-gang mills sawing small-diameter logs. The study was made to include about 8 hours' operating time at each mill, but, to obtain as nearly average operating conditions as possible, each mill was studied for only 2 hours' operating time a day. Total study time included 2 morning and 2 afternoon study periods at each mill.

At 4 mills, nearly every log sawed during the 2-hour test periods was taken as a study log. Because of high production rate at scrag mills 1 and 2, only alternate logs were studied.

Lumber identification

Full-length logs were scaled and given a number, and the entire area of one end of each log was marked with a colored crayon on entering the mill. Two colors were applied alternately to distinguish between lumber recovery from odd- and from even-numbered logs. One end of each 8-foot portion of the full-length logs, in the scrag mills, was given the same color as the full-length log. After sawing on the headrig and edging, lumber from the gang mills was marked across the face of each piece so it could be tallied properly on the green chain after trimming. Lumber from scrag mills was tallied before trimming.

Test material

A total of 2,696 Douglas fir logs, ranging from 5 to 18 inches in diameter at small ends, were included in the study. Log lengths were from 8 feet (in a few logs) to 32 feet for 5 mills, but ranged above 32 feet at one mill. Average log diameter and log length for each study mill are shown in Table 1.

Mill descriptions

Scrag mills. The scrag mills had circular cutoff saws to cut logs into 8-foot lengths as they entered the mill.

Scrag mills 1 and 2 had 4-saw headrigs. Two of the 4 saws were set to cut a 4-inch cant from the center of the log, and the other 2 saws were adjustable to cut either 2- or 4-inch cants on both sides of the center cant. Scrag mill 3 had 2 adjustable main saws and 4 stationary top saws located above and slightly behind the 2 adjustable saws. The top saws were set at 4-inch intervals to allow them to cut logs larger than 17-inch diameter.

All 3 scrag mills had wide western-style edgers; saws on one side of the arbor were set for 2-inch cuts, and saws on the other side for 4-inch cuts.

Other equipment at each scrag mill included a circular resaw for making 2- by 3-inch and 1- by 4-inch lumber. Scrag mill 2 had automatic stacking equipment rather than a green chain. Here, most of the lumber was stickered and later stacked for air drying prior to shipment. An automatic unstacker also was used by this mill in the planing operation before shipment. The other 2 scrag mills planed and shipped unseasoned lumber.

Log-gang mills. Two of the log-gang mills had 24-inch headrigs, and the third mill had a 36-inch headrig. All gang mills had conventional western edgers. The 24-inch mills (1 and 3) trimmed with a gang trimmer; mill 2 had a single cross-cut trim saw operated by one man. Only mill 3 had a resaw; it was used to recover 2- by 3-inch and 1- by 4-inch lumber from slabs and edgings. At none of the log-gang mills was lumber stacked for drying.

Sawing practices

Both scrag and log-gang mills were sawing principally dimension lumber. Lumber produced by the scrag mills was from 1- by 4-inch to

Table 1. Sizes and Numbers of Logs Cut and Studied.

Mill	Type	Average log size		Study time	Logs sawed	Logs studied
		Small-end diameter	*Length			
		Inches	Feet	Hr: min		
Log-gang mills						
1	Heaps 24-inch	11.4	18.5	7:58	398	387
2	Superior 24-inch	11.9	15.3	7:43	273	242
3	Wierhand 36-inch	10.0	19.7	7:15	409	378
Scrag mills						
1	"Shop Built"	8.8	12.7	8:02	1,834	847
2	Keystone	8.5	20.0	8:00	1,076	522
3	Salem Pole Mill	10.3	32.1	7:29	387	320

* For scrag mills, represents average of full-length logs before bucking to 8-foot lengths.

2- by 4-inch material, from 5 1/2 to 8 feet long. Lumber from log-gang mills was from 1 to 3 inches thick, from 3 to 12 inches wide, and from 8 to 28 feet long. At log gang 3, material was saved as short as 6 feet. Greatest volume production was 2-inch dimension lumber in all mills.

Nominal two-inch dimension lumber at all mills was sawed full 1 3/4 inches thick. Saw kerf for the log-gang mills was 3/16-inch and for the scrag mills, 3/8-inch.

Only a small amount of lumber at any mill was re-edged after it left the main mill, but most lumber was retrimmed after planing.

Handling practices

Logs. Logs for all mills were purchased both by log scale and by the cord. Bundled logs occasionally were purchased at two mills.

Each mill had a pond from which logs were moved to a log haul and conveyed into the mill. Seldom was any bucking done in the pond. Logs for the gang-saw mills were sawed full length, but logs were bucked into 8-foot lengths for the scrag mills.

Lumber. Lumber from the three gang mills and scrag mills 1 and 3 was piled in unit packages as it came off the green chain and was taken directly to the planer with a lumber carrier or lift truck. At scrag mill 2, lumber was stickered and piled for air drying in unit packages prior to being surfaced and shipped.

Most of the lumber from each mill was sold as Standard and Better dimension. The lower grades were sold separately.

RESULTS

Production rates

Total daily production and production per man day at each mill, plus other pertinent data, are shown in Table 2. Total daily production for log-gang mills ranged from about 25 to 45 M fbm (feet board measure). Production per man-day, a better measure of comparison, ranged from 3,000 to 4,250 fbm in the log-gang mills. Total daily production for scrag mills ranged from about 46 to 85 M fbm, and production per man-day ranged from 4,220 to 6,370 fbm.

Although the scrag mills achieved the highest production per man-day, all six mills achieved high production rates with small logs. Nearly one-fourth of all logs sawed were less than 8 inches in diameter; more than three-fourths of all logs sawed were less than 12 inches in diameter. Despite this small log size, all mills obtained production rates of 3 M fbm or more per man-day; four mills obtained production of more than 4 M fbm per man-day and two scrag mills exceeded 6 M fbm per man-day.

Lumber recovery

Lumber recovery was determined at the green chain and did not take into account losses that could occur in surfacing, retrimming or re-edging. It was reasoned that losses from the above causes would not affect a comparison of mills studied.

Overrun. A total of 99,879 fbm of rough-green lumber was produced from 74,062 fbm of logs (gross scale, Scribner Decimal C) at the 3 gang mills during the test periods. Overrun on gross log scale thus averaged 34.8 per cent.

A total of 142,455 fbm of rough-green lumber was produced from 99,965 fbm of logs at the 3 scrag mills during the test periods. Overrun on gross log scale thus averaged 42.5 per cent.

Comparison of average overrun obtained at the 3 log-gang mills with that obtained at the 3 scrag mills is by itself misleading, for it does not reveal the wide variation obtained at individual mills. The study revealed that overrun was markedly affected by two important factors, namely:

- Rebucking logs after scaling--
  At the scrag mills, all logs were cut to 8-foot lengths before sawing; at the gang mills, all logs were sawed in the 8-to-32-foot lengths scaled.

- Resawing--
  At 2 scrag mills and one gang mill where 1- by 4-inch and 2- by 3-inch stock was resawed, overruns obtained ranged from 42.5 to 49.6 per cent. At the one scrag mill and 2 gang mills where resaws were not operating, overruns obtained ranged from 21.8 to 35.6 per cent.

Average overrun obtained at each mill is shown in Table 2, while overruns obtained from each log-diameter class at each of the six mills are shown in Tables 3 to 8. Wide variation from one diameter class to another is immediately apparent. Also apparent from a comparison of Tables 3 to 8 is the variation between mills of the same type. It is revealed graphically in Figure 1 that variation in overrun between individual mills was greater than the difference in average overrun for the two mill types.

Lumber recovery in cubic volume. Average lumber recovery at the two types of mills also may be compared on the basis of cubic volume recovered. This has been done for all 16- to 20-foot logs sawed at three gang and two scrag mills, and results were tabulated in Table 9. When data of Table 9 are presented graphically in Figure 2, it is revealed that recoveries were roughly equivalent at each mill type--as represented by the mills studied.

Lumber recovery by grade. Lumber output was not graded during the study. Instead, five of the mills furnished information on grades shipped and average mill-realization price for a period of six months or longer. This information, summarized in Table 10, revealed that differences in grade recovery and sales realization were not greatly different for the two mill types. One mill was unable to furnish data because its output was sold with lumber from its band mill.

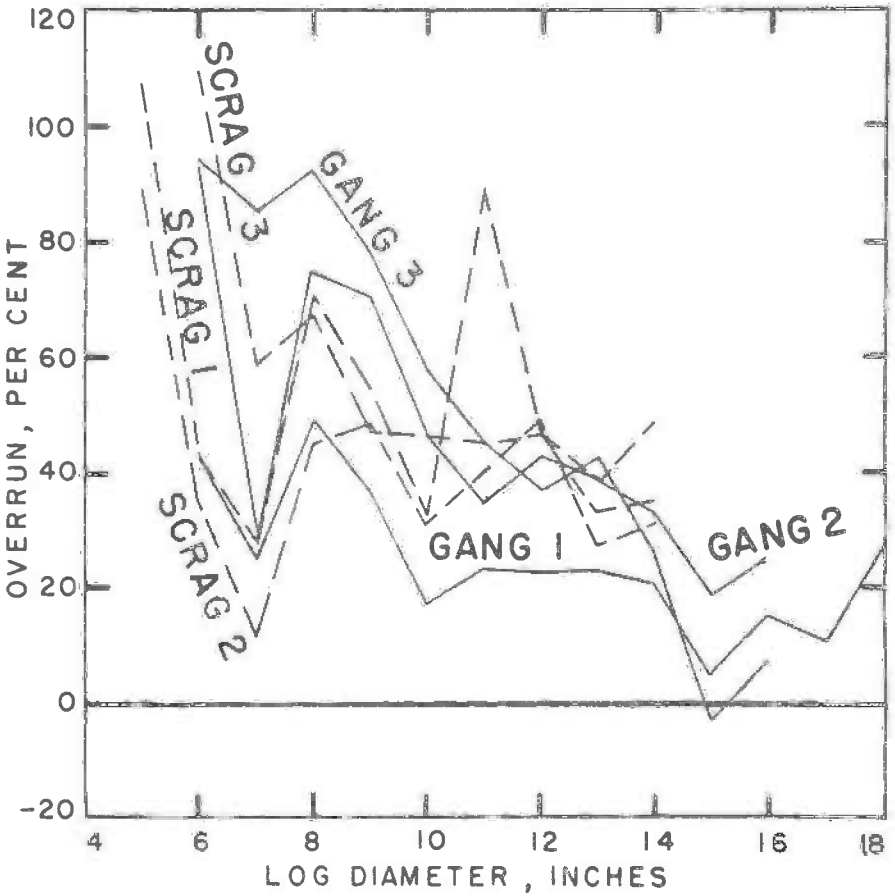

Figure 1. Overrun by Log Diameter, Based on Scribner Decimal C Gross Log Scale, at 3 Log-Gang and 3 Scrag Mills.

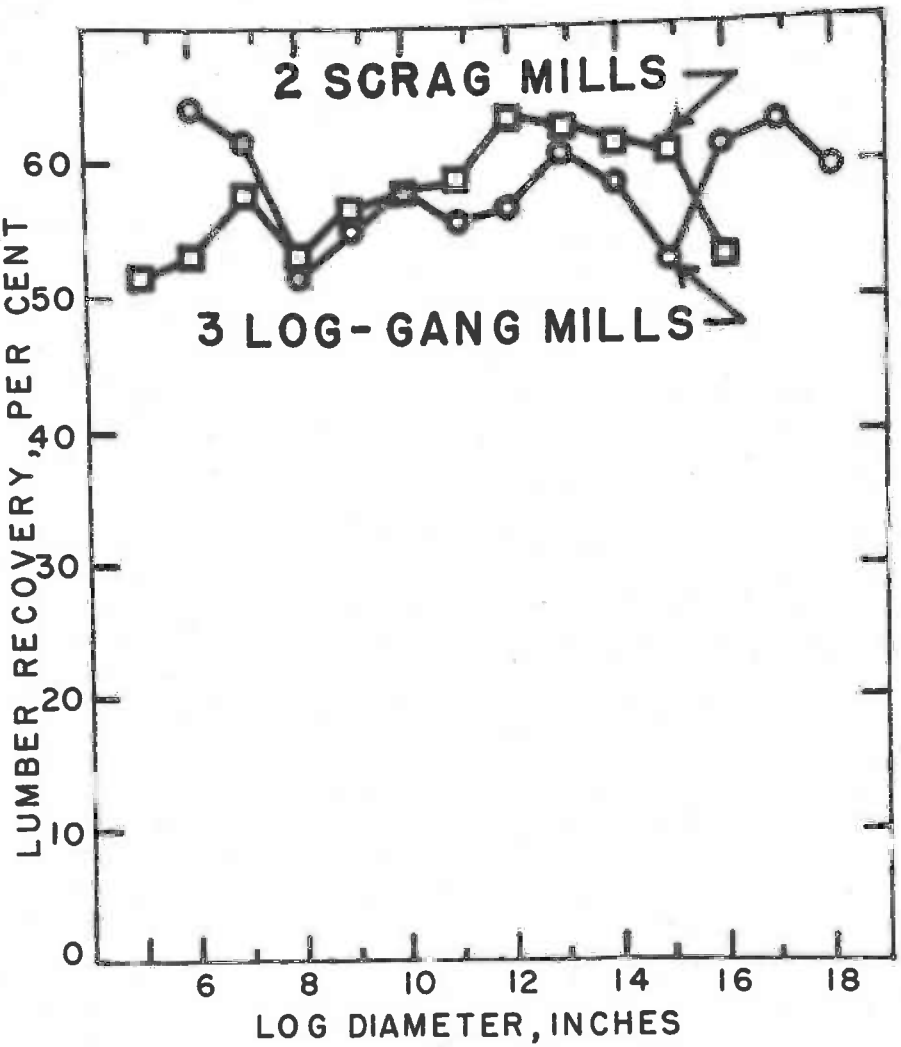

Figure 2. Relationship of Nominal Rough-Green Lumber Volume to Volume of Logs 16-20 Feet Long at 3 Log-Gang and 2 Scrag Mills.

DISCUSSION OF RESULTS

A surprising result of the study was that gang mills, equipped with 3/16-inch saws, did not give consistently higher overrun than did scrag mills fitted with 3/8-inch saws. Results of this study showed that the practice of rebucking 16- to 32-foot logs into 8-foot lengths before sawing, as was done at all three scrag mills but not at the gang mills, offset volume lost through heavy kerf.

The importance of resawing 1- by 4-inch and 2- by 3-inch stock at both gang and scrag mills is well illustrated by the study. In fact, this practice proved to have the most pronounced effect on overrun.

Major advantage of the scrag mill was its high productivity per man-day. The one scrag mill having adjustable saws in front, backed by 4 stationary top saws, had about the same production per man as the most productive gang mill, but the two scrag mills equipped with double pairs of saws had production rates almost 50 per cent greater than that of the gang mills.

High production rate of the scrag mills studied was obtained without loss in overrun (as compared with the gang mills studied) due to the practices of rebucking logs before sawing, and of resawing slabs. Furthermore, average sales value of lumber produced in the two mill types was not greatly different.

Gang mills did possess advantages which offset their lower production rate. For example,

- Gang mills, as operated in this study, could produce a variety of widths, thicknesses, and lengths, thus offering an advantage in a competitive market.
- Gang mills with narrow saws potentially permitted increased recovery from a given log volume.
- Gang mills were easier to supply with logs than were the scrag mills. Scrag mills had high capacity on small logs, but were not always able to obtain logs rapidly enough to maintain their productive rate continuously.

In conclusion, both mill types were suited to producing lumber from small logs. All mills achieved high production rates despite the fact that more than three-fourths of the logs sawed were less than 12 inches in diameter. Therefore, in adapting either mill type to sawing material resulting from thinnings or improvement cuttings, the chief problem is likely to be that of keeping the mill supplied with logs.

Table 2. Lumber Thickness and Recovery, Overrun, and Production for Each Mill Studied.

Mill	Logs studied	Gross log scale	Lumber tally	Saw kerf	Lumber thickness	Over-run*	Men per shift	Production**	
								Daily	Per man-day
		M fbm	M fbm	In.	In.	%		M fbm	M fbm
Log-gang mills									
1	387	29.6	36.1	3/16	1 3/4+	21.8	11	33.0	3.00
2	242	18.5	25.1	3/16	1 3/4+	35.6	6	25.5	4.25
3	378	26.3	39.0	3/16	1 3/4+	49.3	12	44.6	3.72
Scrag mills									
1	847	29.6	44.3	3/8	1 3/4+	49.6	14	84.7	6.05
2	522	29.1	39.3	3/8	1 3/4+	35.3	11	70.0	6.37
3	320	41.3	58.8	3/8	1 3/4+	42.5	11	46.4	4.22

* Overrun was based only on logs studied.

** Production was estimated from volume of all logs cut during study periods, disregarding down time and rest periods.

Table 3. Log Length, Log Scale, Lumber Recovery, and Overrun by Diameter Classes for Log-gang Mill 1.

Small diameter	Avg log length	Gross scale	Lumber tally	Over-run	Logs
In.	Feet	Fbm	Fbm	%	Basis
5	22.0	10	32	220.0	1
6	18.4	330	471	42.7	15
7	18.2	1,750	2,180	24.6	55
8	19.6	1,510	2,261	49.7	45
9	18.4	2,030	2,771	36.5	47
10	17.4	3,470	4,045	16.6	56
11	18.3	2,500	3,071	22.8	32
12	18.1	3,610	4,416	22.3	40
13	19.0	3,130	3,838	22.6	27
14	18.4	3,240	3,893	20.2	25
15	18.7	3,010	3,168	5.2	18
16	17.7	2,660	3,074	15.6	15
17	18.8	1,070	1,179	10.2	5
18	19.0	1,310	1,677	28.0	6
All diameters		29,630	36,076	21.8	387

Table 4. Log Length, Log Scale, Lumber Recovery, and Overrun by Diameter Classes for Log-gang Mill 2.

Small diameter	Avg log length	Gross scale	Lumber tally	Over-run	Logs
In.	Feet	Fbm	Fbm	%	Basis
6	16.3	130	251	93.1	7
7	16.6	280	360	28.6	10
8	16.2	350	610	74.3	13
9	15.9	1,010	1,721	70.4	28
10	16.1	1,620	2,376	46.7	31
11	16.7	1,840	2,478	34.7	27
12	15.5	2,480	3,475	42.4	32
13	14.4	2,200	3,058	39.0	26
14	14.0	2,450	3,253	33.3	24
15	14.1	2,760	3,281	18.4	22
16	14.0	2,165	2,718	25.5	15
17	15.0	1,040	1,324	27.3	6
18	12.0	160	169	5.6	1
All diameters		18,485	25,074	35.6	242

Table 5. Log Length, Log Scale, Lumber Recovery, and Overrun by Diameter Classes for Log-gang Mill 3.

Small diameter	Avg log length	Gross scale	Lumber tally	Over-run	Logs
In.	Feet	Fbm	Fbm	%	Basis
5	14.0	10	18	80.0	1
6	19.7	490	952	94.3	21
7	18.2	1,010	1,878	85.9	33
8	19.8	2,147	4,132	92.4	62
9	19.2	3,000	5,353	78.4	69
10	19.7	3,980	6,289	58.0	58
11	19.5	2,970	4,331	45.8	37
12	19.3	3,260	4,477	37.3	34
13	20.6	3,600	5,152	43.1	29
14	19.3	2,040	2,578	26.4	15
15	17.8	1,420	1,377	-3.0	9
16	19.3	1,160	1,247	7.5	6
17	19.0	650	722	11.1	3
18	16.0	210	223	6.2	1
All diameters		25,947	38,729	49.3	378

Table 6. Log Length, Log Scale, Lumber Recovery, and Overrun by Diameter Classes for Scrag Mill 1.

Small diameter	Avg log length	Gross scale	Lumber tally	Over-run	Logs
In.	Feet	Fbm	Fbm	%	Basis
5	13.3	220	455	106.8	27
6	12.4	1,430	1,712	43.3	83
7	13.1	3,430	4,379	27.7	134
8	13.3	3,915	6,683	70.7	172
9	13.9	4,990	7,704	54.4	144
10	14.2	5,850	7,776	32.9	110
11	12.5	3,320	6,303	89.8	84
12	12.3	2,880	4,221	46.6	47
13	12.4	2,000	2,771	38.6	26
14	12.2	1,350	2,012	49.0	17
15	8.0	140	155	10.7	2
17	8.0	90	118	31.1	1
All diameters		29,615	44,289	49.6	847

Table 7. Log Length, Log Scale, Lumber Recovery, and Overrun by Diameter Classes for Scrag Mill 2.

Small diameter	Avg log length	Gross scale	Lumber tally	Over-run	Logs
In.	Feet	Fbm	Fbm	%	Basis
5	16.0	170	321	88.8	17
6	17.9	1,970	2,653	34.7	84
7	20.0	3,690	4,112	11.4	100
8	18.9	3,420	4,980	45.6	94
9	21.4	4,450	6,602	48.4	78
10	21.0	4,780	6,241	30.6	60
11	22.1	2,830	3,975	40.5	30
12	21.4	2,350	3,522	49.9	22
13	20.5	2,020	2,582	27.8	16
14	24.0	1,700	2,242	31.9	10
15	20.0	700	886	26.6	4
16	18.0	720	929	29.0	4
17	12.0	270	289	7.0	3
All diameters		29,070	39,334	35.3	522

Table 8. Log Length, Log Scale, Lumber Recovery, and Overrun by Diameter Classes for Scrag Mill 3.

Small diameter	Avg log length	Gross scale	Lumber tally	Over-run	Logs
In.	Feet	Fbm	Fbm	%	Basis
5	47.0	40	166	315.0	2
6	34.9	350	733	109.4	7
7	31.4	1,740	2,762	58.7	31
8	31.5	2,750	4,616	67.9	42
9	31.9	4,400	6,493	47.6	49
10	33.1	5,180	7,572	46.2	42
11	32.7	7,920	11,523	45.5	55
12	29.7	4,740	6,972	47.1	32
13	32.8	5,520	7,374	33.6	28
14	32.5	3,490	4,733	35.6	15
15	30.0	2,130	2,565	20.4	8
16	32.0	1,280	1,518	18.6	4
17	30.0	1,730	1,777	2.7	5
All diameters		41,270	58,804	42.5	320

Table 9. Cubic Volume of Logs Sawed and Rough-green Lumber Recovered at Three Gang and Two Scrag Mills. (16- to 20-foot logs only)

Small diameter	Logs	Log scale	Lumber tally	Log volume*	Lumber volume**	Recovery
In.	Basis	Fbm	Fbm	Cu ft	Cu ft	Per cent
Log-gang mills						
6	27	540	964	124.4	79.6	64.0
7	28	840	1,270	172.4	105.9	61.4
8	29	870	1,464	229.0	122.0	53.3
9	30	1,200	1,932	293.3	161.1	54.9
10	30	1,890	2,444	349.7	202.8	57.9
11	30	2,220	2,834	427.6	236.2	55.2
12	30	2,590	3,227	477.7	268.9	56.3
13	27	2,940	3,718	513.1	309.9	60.4
14	23	2,790	3,475	498.3	289.5	58.1
15	21	3,320	3,209	508.1	267.4	52.6
16	17	3,180	3,668	501.1	305.7	61.0
17	4	850	983	130.7	81.9	62.7
18	1	210	223	31.5	18.6	59.0
Scrag mills+						
5	18	180	347	56.5	29.0	51.3
6	20	400	545	85.4	45.3	53.0
7	169	5,070	5,648	816.4	470.6	57.6
8	165	5,950	7,390	1166.9	615.9	52.8
9	20	800	1,181	174.4	98.5	56.5
10	20	1,200	1,464	211.2	122.0	57.8
11	20	1,400	1,767	251.2	147.3	58.6
12	20	1,600	2,238	295.0	186.4	63.2
13	18	1,800	2,306	307.8	192.4	62.5
14	10	1,100	1,441	196.3	120.1	61.2
15	3	420	487	67.0	40.6	60.5
16	3	480	605	28.3	14.9	52.7

* Based on Sorenson Log Rule (Taper assumed, 1 inch in 10 feet).

** Based on nominal lumber dimensions (Board feet/12).

+ Logs from only two scrag mills were included, since only a few logs in this length were sawed at the third mill.

Table 10. Recovery of Dimension Lumber and Average Mill Price of All Lumber Sold for Three Log-Gang and Three Scrag Mills.

Mill	Dimension-lumber grade recovery			Mill price, 1955
	Standard & Better	Utility	Economy	
	Per cent	Per cent	Per cent	Dollars per M fbm
Log-gang mills				
1	96	3	1	72.07
2	86	12	2	65.00
3	83	15	2	---*
Scrag mills				
1	85	10	5	65.00
2	86	12	2	65.00
3	91	8	1	57.75

* Mill price unavailable, as lumber was sold along with lumber sawed with a band mill.