An Analysis of the Differences among Log Scaling Methods and Actual Log Volume

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Abstract

Log rules estimate the volume of green lumber that can be expected to result from the sawing of a log. As such, this ability to reliably predict lumber recovery forms the foundation of log sales and purchase. The more efficient a sawmill, the less the scaling methods reflect the actual volume recovery and the greater the overrun factor. Using high-resolution scanned log data and the RAYSAW hardwood log sawing simulator, we compared recovery results for a 32-log sample with data from other mills and examined the overrun factors for common log scaling methods. With the sample logs, we saw underruns as low as –31.9 percent and overruns as high as 159.4 percent depending on log rule and log characteristics. Given the measurement accuracy of laser profiling systems and computing speed, it is relatively easy to determine log volume and recovery both quickly and with heretofore unknown accuracy. The log rules commonly in use today were all developed over 100 years ago: Doyle in 1825, Scribner in 1846, and International ¼-Inch in 1906. Both the logs from the forest and processing methods and equipment in the mills have changed since then. As such, the log rules are not as relevant to modern mills and today's timber supply as they once were. Given modern developments in laser measurement systems, mill operators have much better tools available to access log supply.

Log rules estimate the volume of green lumber that can be expected to result from sawing a log. As such, this ability to reliably predict lumber recovery forms the foundation of log sales and purchase. There are three common geometric-based methods of scaling hardwood logs: Doyle, Scribner, and International ¼-Inch (Freese 1973, Bond 2011). The Doyle rule estimates lumber recovery based on log diameter, length, residue, and saw kerf. However, slab and edging volume is overestimated for smaller logs and underestimated for larger logs. Thus, Doyle heavily favors the log buyer, as it underestimates log volumes for the majority of logs (those under 28 in.). Scribner is fairer to the seller, but the buyer should still be able to produce 10 to 20 percent more lumber than credited by the Scribner rule (Mattoon et al. 1958). International ¼-Inch has always been fairer to the seller than Doyle or Scribner, as it gives volumes closer to what can be sawn using good methods (Mattoon et al. 1958). However, any scaling method is subject to the accuracy of the measurements made.

Hardwood logs must be graded to assess the quality of the log and the potential value of the lumber to be sawn. One drawback to grading is that it requires more time from and skill on the part of the log scaling personnel. One study found that grading logs to Forest Service log grades (Rast et al. 1973) required about 3 minutes more per thousand board feet (BF) than simply scaling logs (Church 1966). The additional information of log grade allows the buyer to determine the board footage by grade and lumber value that can likely be sawn from the log (Hanks et al. 1980). The Forest Service grade recovery yields are based on International ¼-Inch scale volumes and provide a conservative recovery volume and value estimate. However, there is much room for improvement with regard to estimating grade recovery, especially when considering recovery improvements due to modern sawmill equipment and methods.

Laser scanning systems are installed in many hardwood mills and can scan a log in just a few seconds. These systems accurately measure log dimensions to the nearest 0.01 inch or better. As a result, laser scanning creates a detailed profile of the log, which can be digitally sawn using the RAYSAW (Thomas 2013) hardwood log sawing simulator. In addition, RAYSAW grades logs to Forest

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Service factory log grades. Combined with scale volumes, this allows potential grade recovery yields to be roughly estimated. In this study, we compared volumes from three scaling methods with volumes sawn from the scanned representations for a sample of red oak (*Quercus rubra*) and white oak (*Quercus alba*) logs. A range of log sizes and grades were used to make comparisons as broad and applicable as possible.

The lumber recovery factor (LRF) is a gauge of a sawmill's efficiency and is calculated by dividing the cubic foot volume of the logs processed by the nominal board footage of the lumber sawn (Steele 1984). A study by Lin et al. (2011) examined the LRFs of small Appalachian hardwood sawmills and found that they ranged from 6.2 to 7.1 depending on log diameter and species. Similarly, 35 hardwood sawmills involved in the Sawmill Improvement Program reported LRF values between 5.0 and 7.5 (Wade et al. 1992). By definition, LRF depends only on the accuracy of the measurement, and it truly reflects efficiency of the mill. Further, using LRF and the volume of a log as determined using Smalian's or Huber's volume equations (Haygreen and Bowyer 1996) would allow lumber recovery to be estimated for the mill.

Methods

The logs in this study came from trees that met the minimum size requirements of being able to produce two or more logs of 8 feet and longer with a minimum scaling diameter of 8 inches. For each sample site, logs were randomly selected from the entire population that met these requirements. Sixty-six white oak trees were selected from three sites in West Virginia and bucked into 249 logs. In addition, 32 red oak trees were selected from an additional site in West Virginia and bucked into 140 logs. The trees were bucked by experienced logging crews to maximize log grade and minimize sweep. To determine quality, the location, type, and size of all log surface defects were recorded. Based on log size and defect data, each log was computer graded to Forest Service log grades (Rast et al. 1973). From the total sample population of 369 logs, 20 white oak and 12 red oak logs were selected. These logs were selected to represent a diverse range of log diameters, lengths, and grades.

Table 1 lists the length, diameter, taper, sweep, and grade of each log in the study. The log number column identifies the name and location of the log. Logs with an A after the number are first-story logs, those with a B are second-story logs, and so on. Of the 32 logs, seven were graded as

Table 1.—Species, grade, and size specifications of sample logs.

		Outside bark				Average			
Log no.	Length (in.)	Large-end diam. (in.)	Small-end diam. (in.)	Sweep (in.)	Eccentricity	Taper per foot (in.)	Scaling diam. (in.)	Scaling length (ft)	Forest Service log grade
F-12C	125.5	18.6	17.5	1.91	0.50	0.11	16	10	Factory 3
F-36A	174.7	26.8	23.8	2.12	0.65	0.22	22	14	Factory 1
F-15B	193.8	11.6	10.5	2.71	0.37	0.07	9	16	Factory 3
GC-39C	100.3	14.2	12.5	0.85	0.40	0.21	11	8	Factory 2
GC-20C	132.9	14.0	12.3	1.72	0.39	0.17	11	10	Factory 3
FA-12B	150.6	15.1	13.7	3.83	0.12	0.12	13	12	Factory 3
FA-12A	143.1	22.9	15.6	1.38	0.28	0.73	14	10	Factory 2
FA-6B	194.9	19.7	17.3	3.02	0.48	0.15	16	16	Factory 1
F-11B	198.4	13.2	12.1	0.93	0.32	0.07	11	16	Factory 2
F-18C	207.3	14.1	9.8	3.61	0.43	0.27	9	16	Factory 3
GC-31A	207.9	16.3	12.9	1.32	0.37	0.21	12	16	Factory 2
GC-28A	149.3	17.9	13.6	1.84	0.35	0.36	12	12	Factory 2
GC-23C	107.7	11.4	10.5	1.26	0.33	0.11	9	8	Factory 3
GC-38C	153.9	11.3	10.2	1.83	0.40	0.09	9	12	Factory 3
F-13A	198.3	21.6	15.5	1.16	0.40	0.38	14	16	Factory 2
F-31C	125.8	18.9	17.1	2.14	0.34	0.17	16	10	Factory 3
FA-11C	132.0	19.1	18.3	1.83	0.36	0.08	17	10	Factory 3
FA-7A	195.1	24.0	18.6	2.11	0.41	0.34	17	16	Factory 1
FA-9A	144.3	24.6	19.1	2.68	0.49	0.45	18	12	Factory 1
FA-11B	119.2	19.5	18.3	1.13	0.40	0.15	17	8	Factory 3
27C	187.1	19.5	19.0	0.59	0.47	0.03	18	14	Construction
32A	126.3	21.5	18.7	1.01	0.51	0.28	17	10	Factory 1
8D	125.7	17.8	16.6	1.40	0.43	0.12	15	10	Construction
28B	125.9	14.2	13.2	0.92	0.47	0.09	12	10	Factory 3
9C	156.8	10.2	8.4	3.14	0.43	0.15	7	12	Construction
29D	126.3	15.8	13.5	2.38	0.51	0.23	12	10	Factory 3
11C	158.2	14.4	13.2	2.92	0.45	0.10	12	12	Factory 3
15A	152.1	18.8	14.4	2.21	0.34	0.37	13	12	Factory 1
15B	104.7	14.1	13.2	0.96	0.41	0.12	12	8	Construction
17A	126.1	21.2	17.8	1.15	0.40	0.33	17	10	Factory 1
17B	126.8	17.7	17.3	0.50	0.48	0.03	16	10	Factory 2
17C	126.4	17.2	16.9	0.73	0.36	0.03	16	10	Factory 3
Average	149.9	17.4	15.0	1.8	0.4	0.2	13.8	11.8	

Factory 1, and another seven were graded as Factory 2. Factory 3 logs were the largest group, containing 14 logs, and the remaining four logs were construction grade (Table 1). The scaling diameter is the small-end diameter measured inside the bark. The laser scanning system measures all diameters outside the bark. To determine the scaling diameter, we estimated bark thickness and subtracted twice the thickness from the small-end diameter (Thomas and Bennett 2014a). The taper measurement is the average amount the diameter decreases each foot along the log's length in inches. Sweep is measured as the distance to the log surface from a line stretched between the log ends at the point where a maximal arc is formed (Fig. 1).

Each log was scanned using a high-resolution laser scanner developed specifically for accurate measurement of logs and detection and characterization of surface defects (Thomas and Thomas 2011). The scanner is composed of three industrial laser scan heads designed for the wood processing industry. The scanners are stationed at 120-degree intervals on a circle with a diameter of approximately 8 feet. This allows the three scan heads to collect a complete surface scan. Figure 2 shows a rendered image of a scanned red oak log (Log 27C) where defects and bark texture are easily visible. The log is supported by V-stands every 5 feet at the center of the circle of scanners. These can be seen in Figure 2 as jagged bumps at the ends and center of the log image. The laser imagery is composed of a series of scan lines around the log circumference every 1/16 inch. Resolution between points within each scan line varies depending on the size of the log but is typically around ⅛ inch. All points are measured to the nearest 0.001 inch. Using laser data, the diameter, length, and cubic foot volume of each log were determined using the method developed by Thomas and Bennett (2014b). Using the laser data to calculate volume gives accurate volume estimates comparable to those performed using an immersion tank.

RAYSAW (Thomas 2013) was used to grade the logs to Forest Service log grades and scale the logs using Doyle, Scribner, and International ¼-Inch scaling rules (Freese 1973). Table 2 lists the estimated lumber recovery volumes for each scaling method and log. Using RAYSAW, sawing patterns were created that maximized recovery and

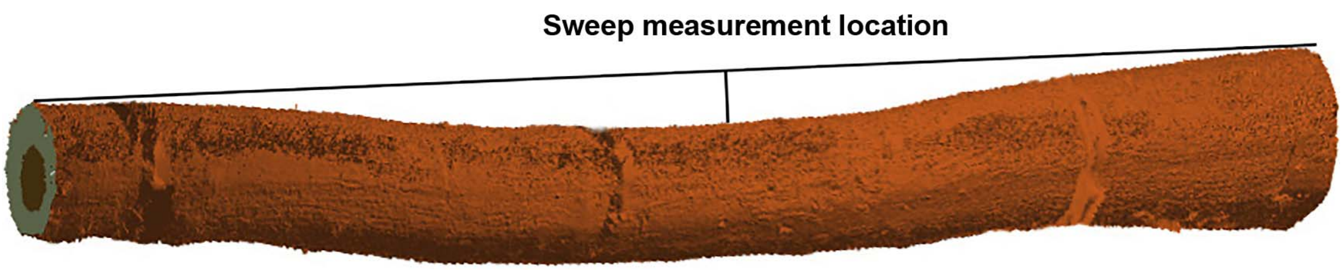

Figure 1.—Illustration of sweep measurement on a log. (Color version is available online.)

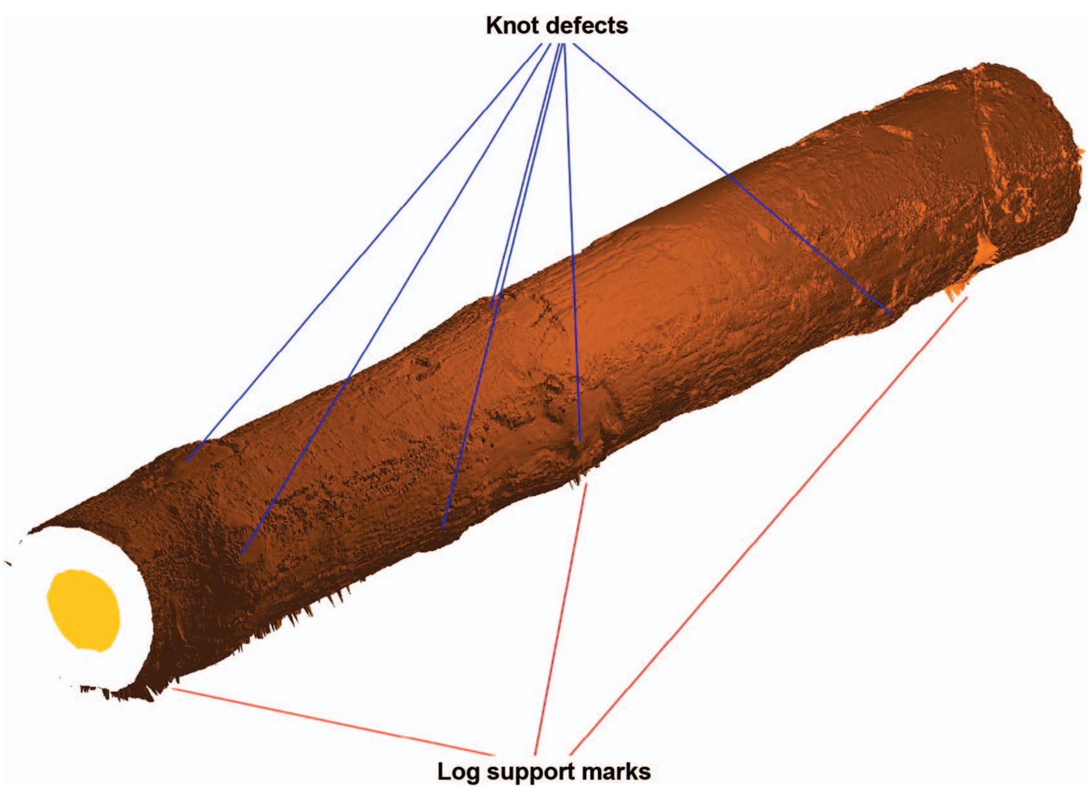

Figure 2.—High-resolution laser scan image of a sample red oak log (Log 27C). (Color version is available online.)

Table 2.—Scale and sawn estimated lumber recovery volumes.[a]

	Volume (bdft)			Sawn volume (bdft)			Underrun/overrun (%)		
Log no.	Doyle	Scribner	International 1/4-Inch	Lumber	Cant	Total	Doyle	Scribner	International 1/4-Inch
F-12C				104.8	20.0	124.8			
F-36A	253	266	278	341.9	28.0	369.9	46.3	39.1	33.2
F-15B	36	50	65	30.3	21.3	51.7	43.5	3.3	−20.1
GC-39C	25	35	36	25.7	16.0	41.7	70.2	19.2	16.0
GC-20C	31	45	46	35.4	14.7	50.1	63.6	11.3	8.0
FA-12B	75	86	98	50.5	16.0	66.5	−11.3	−22.7	−31.9
FA-12A	63	72	80	85.0	22.0	107.0	71.2	48.6	33.6
FA-6B	144	159	181	158.7	32.0	190.7	32.4	19.9	5.6
F-11B	49	65	80	72.7	21.3	94.0	91.8	44.6	17.5
F-18C	25	40	51	51.9	0.0	51.9	107.5	29.7	2.0
GC-31A	64	79	97	94.4	34.0	128.4	100.6	62.5	32.5
GC-28A	61	73	83	64.3	24.0	88.3	45.3	20.9	6.5
GC-23C	13	21	22	16.4	16.0	32.4	159.4	54.4	46.0
GC-38C	19	30	36	19.0	16.0	35.0	86.7	16.7	−1.9
F-13A	100	114	136	158.7	32.0	190.7	90.7	67.3	40.7
F-31C	90	99	108	105.4	20.0	125.4	39.4	26.7	16.6
FA-11C	90	99	108	85.6	22.0	107.6	19.6	8.7	0.1
FA-7A	144	159	181	203.0	32.0	235.0	63.2	47.8	30.2
FA-9A	147	160	169	226.0	24.0	250.0	70.0	56.2	48.1
FA-11B	72	83	84	107.3	18.0	125.3	74.0	50.9	48.6
27C	172	187	200	195.6	30.0	225.6	31.6	20.7	12.6
32A	106	116	123	142.3	20.0	162.3	53.7	39.9	32.2
8D	90	99	108	81.9	20.0	101.9	13.2	2.9	−5.3
28B	40	49	57	45.6	20.0	65.6	64.1	33.9	15.9
9C	12	24	27	26.0	0.0	26.0	116.7	8.3	−3.2
29D	40	49	60	47.3	20.0	67.3	68.2	37.3	12.2
11C	48	59	69	56.9	26.0	82.9	72.7	40.5	19.6
15A	61	73	83	87.0	24.0	111.0	82.7	52.1	33.9
15B	32	39	44	44.8	16.0	60.8	90.1	56.0	38.2
17A	90	99	108	123.5	20.0	143.5	59.5	45.0	33.5
17B	90	99	108	105.0	20.0	125.0	38.9	26.3	16.2
17C	90	99	108	94.0	20.0	114.0	26.6	15.1	6.0
Total	2,474	2,843	3,152			3,752			
Overrun	1,278	909	601						
Average							62.5	31.0	17.0

[a] bdft = board feet.

minimized residue given the diameter, eccentricity, and defects of each log. The log was then digitally sawn using the RAYSAW simulator and the volumes of the resulting boards tallied. Figure 3 is a screenshot of the RAYSAW user interface. RAYSAW operates by presenting the user with an end view of the log with the predicted internal defects and a surface view of the log divided into four faces. The user can roll and position the log to obtain the best opening face, then click in the end view to draw the sawing pattern. The advantage of digitally sawing the log is the ability to correct mistakes that would reduce recovery. For example, if we discovered that a sawing pattern would result in too wide or too narrow an opening face, we could reposition the pattern or add a board to correct the problem. With the exception of Logs F-18C and 9C, all logs were sawn to either a 4 by 4-inch or a 6 by 4-inch cant. Table 3 lists the opening face widths of each log. The average widths of the first, second, third, and fourth faces sawn were 6.96, 6.52, 6.21, and 5.65 inches, respectively. The overall average opening face width was 6.35 inches.

All logs were sawn to produce 4/4 boards when dried, a commonly sold lumber thickness (National Hardwood Lumber Association 2015). Additionally, a sawing variation allowance of 0.1 inch was added to the thickness to simulate movement of the bandsaw blade along the saw line. Although this allowance is greater than typically accounted for, it provides a conservative estimate of log recovery. A green allowance of 0.125 inch was added to the board thickness and on each edge of the board. The kerf size used in the simulations was 0.1875 inch. Thus, for every 4/4 board, a 1.4125-inch-thick section of the log was expended.

Results and Discussion

Table 2 lists the Doyle, Scribner, and International ¼-Inch scaled volumes of the 32 sample logs. Examining the total scaled volume for each of the scaling methods, we see that the Doyle-scaled volume is 678 BF less than the International ¼-Inch volume and 369 BF less than the Scribner volume. Given that the Doyle rule underestimates volumes for most logs (those under 28 in. in diameter), these scale differences should be expected. Scribner was closer to International ¼-Inch volumes, with a difference of 309 BF. However, the Doyle log rule was created in 1825 and the Scribner rule in 1846. International ¼-Inch, created in 1906, is the newest commonly used log scale. Both timber supply and mills have changed significantly since these log rules

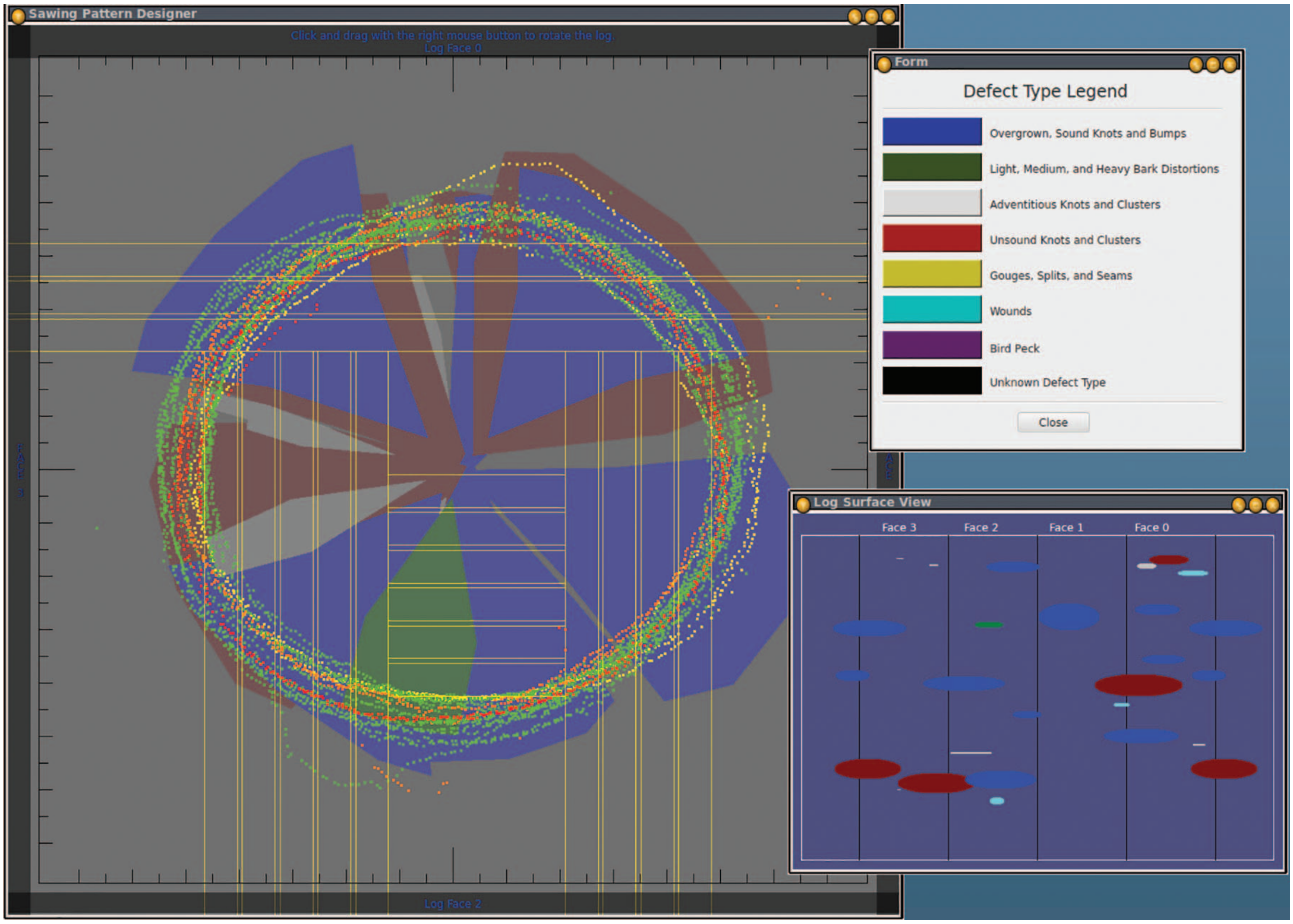

Figure 3.—Sample sawing pattern as used for Log 27C. (Color version is available online.)

Table 3.—Cant dimensions and opening face widths of the study logs.

		Opening face widths (in.)			
Log no.	Cant size (in.)	1	2	3	4
F-12C	6 × 4	6.75	7.75	6.50	6.00
F-36A	6 × 4	7.75	7.75	6.50	6.00
F-15B	4 × 4	6.50	4.25	4.75	4.00
GC-39C	6 × 4	7.00	7.25	6.00	6.00
GC-20C	4 × 4	6.25	5.50	6.00	4.00
FA-12B	4 × 4	6.75	6.75	5.50	4.00
FA-12A	6 × 4	6.25	6.25	6.00	6.00
FA-6B	6 × 4	5.00	6.00	6.00	6.00
F-11B	6 × 4	6.50	6.50	6.00	5.50
F-18C	None	6.25	7.00	—	—
GC-31A	6 × 4	8.25	7.00	6.00	6.00
GC-28A	6 × 4	6.75	6.00	6.25	6.00
GC-23C	4 × 4	6.50	5.50	5.00	4.00
GC-38C	4 × 4	5.75	4.75	4.50	4.00
F-13A	6 × 4	8.75	7.25	6.00	6.00
F-31C	6 × 4	9.50	6.75	6.25	6.00
FA-11C	6 × 4	7.75	6.00	6.00	6.00
FA-7A	6 × 4	8.25	8.00	7.00	6.00
FA-9A	6 × 4	8.50	7.25	6.75	6.00
FA-11B	6 × 4	6.50	6.75	6.00	6.00
27C	6 × 4	6.25	6.50	7.00	6.00
32A	6 × 4	9.00	7.75	9.00	6.00

were created. Even 60 years ago, the average sawyer was expected to best Scribner volumes by 10 to 20 percent (Mattoon et al. 1958).

Underrun/overrun

RAYSAW-simulated sawn volume of each log is reported in Table 2. As most logs were sawn into lumber and cants, volumes for each are listed separately, along with the total for all sawn volume. The total sawn volume for all 32 logs

Table 3.—Continued.

		Opening face widths (in.)			
Log no.	Cant size (in.)	1	2	3	4
8D	6 × 4	6.25	6.25	6.75	6.00
28B	4 × 4	7.25	6.00	6.25	6.00
9C	None	5.00	6.25	—	—
29D	4 × 4	7.50	6.50	6.25	6.00
11C	4 × 4	6.00	5.25	6.00	6.00
15A	4 × 4	6.25	7.00	6.00	6.00
15B	6 × 4	6.50	8.25	6.00	6.00
17A	6 × 4	8.50	6.00	5.75	6.00
17B	6 × 4	6.75	6.25	7.50	6.00
17C	6 × 4	6.00	6.25	6.75	6.00
Average opening face width		6.96	6.52	6.21	5.65
Overall opening face average width					6.35

was 3,752 BF. The rightmost columns of Table 2 report the underrun or overrun percentage for each log as well as an overall average. Underrun or overrun is calculated as

$$\text{Overrun or Underrun} = \frac{\text{Total sawn volume}}{\text{Scale volume}} - 1$$

This allows underrun, a failure to meet the scaled volume, to be represented as a negative percentage. Overrun is then the percentage by which the total sawn volume exceeded the scaled volume.

The average overrun for the Doyle scale was 62.5 percent, which represents a total of 1,278 BF (Table 2). Overrun ranged from 13.2 to 159.4 percent. The underestimation of volume by the Doyle scale is evident on Logs GC-23C, 9C, and F-18C, with overruns of 159.4, 116.7, and 107.5 percent, respectively. Underrun occurred only on one log, FA-12B. Here, the underrun of –11.3 percent (8.5 BF) was caused by significant sweep (3.83 in. on a 13-in. log; Table 1). An end view of Log FA-12B is shown in Figure 4. The red dotted circle describes the first 18 inches at the large end of the log, orange the middle, and yellow the last 18 inches. Examining Figure 4, you can see that the large and small ends are aligned, but the middle is out of alignment by nearly 4 inches. This degree of sweep greatly reduces the volume of lumber that can be sawn from a log. As an example, compare the swept profile in Figure 4 with that of the straight log shown in Figure 3.

The average overrun for the Scribner scale was 31.0 percent, which represents 909 BF more than estimated (Table 2). As with the Doyle scale, the only log that had an underrun was the significantly swept log, FA-12B (Table 1; Fig. 4). The largest overrun occurred on Log F-13A, which was 14 inches in diameter and 16 feet in length. Log F-13A had a taper of 0.38 inch, which is approximately twice the sample average of 0.20 inch. Given the taper, extra board footage was to be cut within the taper area, yielding a substantial overrun. A total of seven logs yielded overruns greater than 50 percent.

As expected, the average overrun for the International ¼-Inch scale was lower, at 17.0 percent, giving an extra 601 BF (Table 2). A total of five logs did not make the scale, with a total underrun of 52.9 BF. The highest underrun (31.5 BF) was encountered with Log FA-12B, which accounted for 60 percent of the total underrun volume. The greatest observed overrun was 48.6 percent (Table 2) with Log FA-11B. This log was bucked 8 inches too short to make a 10-foot log; thus, it was scaled back to 8 feet. The lumber sawn was then scaled to 9 feet, accounting for much of the overrun. This was also the case with Log FA-12A, which was cut at 143 inches and then scaled back to 10 feet.

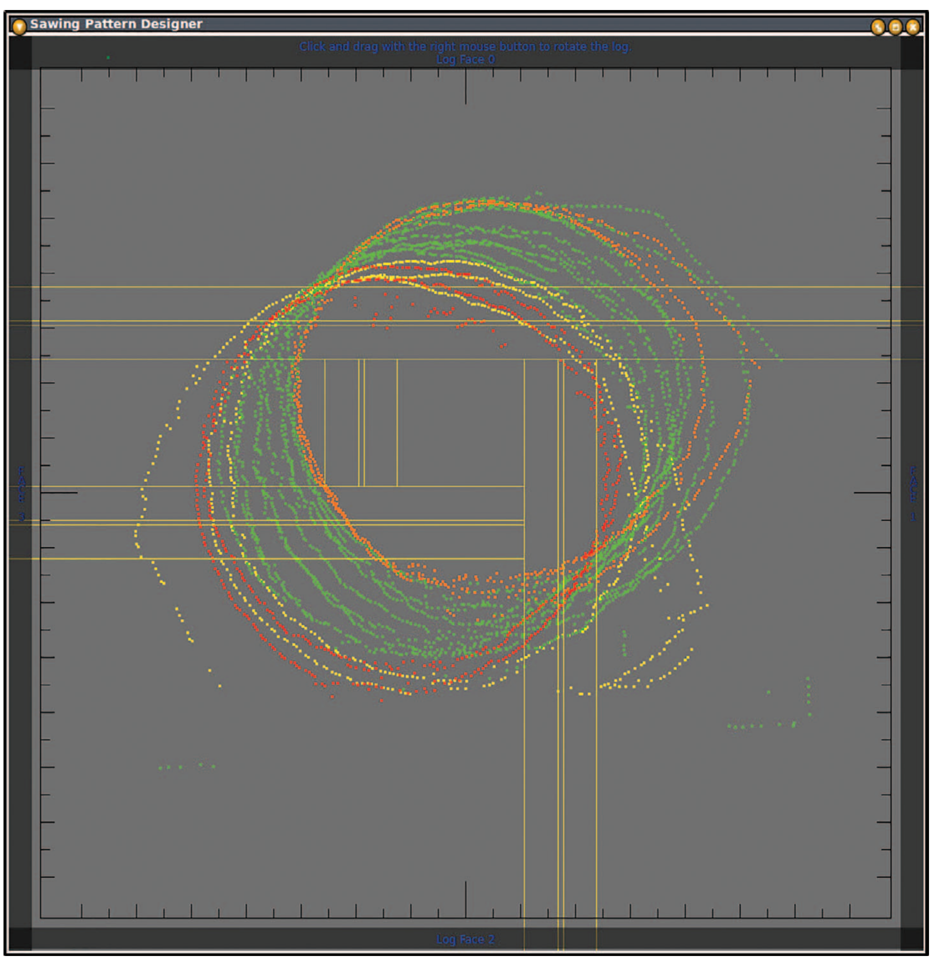

Figure 4.—Sawing pattern end view of Log FA-12B, exhibiting a high degree of sweep. (Color version is available online.)

Overall, a total of 12 logs had overruns of greater than 25 percent.

Lumber recovery factor

When examining the LRFs for this study, one must remember that the log volumes are based on laser measurements, as opposed to Smalian's or Huber's volume estimates (Thomas and Bennett 2014a). Debarked log volume is calculated by estimating the bark thickness using the equations developed for use with laser-scanned logs (Thomas and Bennett 2014b). These methods model the changes in bark thickness along the length of the log and allow the bark to be digitally removed. This permits both the volume of the debarked log and the volume of the bark to be accurately calculated.

The resulting lumber measurements, dimensions, and volumes are based on the laser measurement system. Thus, the calculated LRFs are more precise than those normally encountered in sawmills. In addition, the sawing was performed using a simulator that displayed the log surface with external defects as well as predicted internal defect positions and sizes (Fig. 2). Thus, we were able to optimize the sawing solution to maximize recovery as described earlier.

Using log and sawn volumes as calculated by RAYSAW, we were able to determine the LRF for each log as well as an overall average (Table 4). The average net LRF for RAYSAW and the logs processed in this study was 7.1. LRFs by log ranged from a low of 3.5 for a small Factory 3 grade log (F-18C) to a high of 9.1 for a large Factory 1 grade log (F-36A). Comparing the average LRF using RAYSAW to the LRFs observed by other studies (Wade et al. 1992, Lin et al. 2011), the volume recovery of RAYSAW appears consistent with that from an efficient mill.

Table 4.—Lumber recovery factors for each log and overall.[a]

Log no.	Debarked volume (ft^3)	Total (bdft)	Lumber recovery factor (bdft/ft^3)	Forest Service log grade
F-12C	18.7	124.8	6.7	Factory 3
F-36A	40.5	369.9	9.1	Factory 1
F-15B	9.4	51.7	5.5	Factory 3
GC-39C	6.8	41.7	6.1	Factory 2
GC-20C	8.3	50.1	6.1	Factory 3
FA-12B	14.2	66.5	4.7	Factory 3
FA-12A	17.2	107.0	6.2	Factory 2
FA-6B	29.4	190.7	6.5	Factory 1
F-11B	13.0	94.0	7.2	Factory 2
F-18C	14.9	51.9	3.5	Factory 3
GC-31A	17.2	128.4	7.5	Factory 2
GC-28A	13.2	88.3	6.7	Factory 2
GC-23C	5.2	32.4	6.2	Factory 3
GC-38C	6.6	35.0	5.3	Factory 3
F-13A	22.9	190.7	8.3	Factory 2
F-31C	18.7	125.4	6.7	Factory 3
FA-11C	18.0	107.6	6.0	Factory 3
FA-7A	31.8	235.0	7.4	Factory 1
FA-9A	29.9	250.0	8.4	Factory 1
FA-11B	18.1	125.3	6.9	Factory 3
27C	30.1	225.6	7.5	Construction
32A	21.1	162.3	7.7	Factory 1
8D	14.1	101.9	7.2	Construction
28B	9.7	65.6	6.8	Factory 3
9C	5.4	26.0	4.8	Construction
29D	11.2	67.3	6.0	Factory 3
11C	11.9	82.9	6.9	Factory 3
15A	15.1	111.0	7.3	Factory 1
15B	8.3	60.8	7.3	Construction
17A	18.7	143.5	7.7	Factory 1
17B	15.7	125.0	7.9	Factory 2
17C	16.1	114.0	7.1	Factory 3
Overall average			7.1	
Factory 1 log average			7.7	
Factory 2 log average			7.1	
Factory 3 log average			6.0	
Construction log average			6.7	

[a] bdft = board feet.

Summary and Conclusions

In this study, we determined that the average overrun per log across all log grades and diameters was 17 percent for International ¼-Inch scale volumes. This equates to approximately 19 BF per log on average. Further, the average overruns for the Doyle and Scribner scales were 62.5 and 31 percent, respectively. Examining the LRFs for the simulated mill, we see that the simulated mill's LRF is what we would expect from a well-run, efficient mill. Thus, the overrun figures shown here are close to what should be expected in an actual, well-run mill (Lin et al. 2011).

All commonly used hardwood log scales are more than a century old. Many changes have occurred to both timber supply and sawmills since the rules were written. Even 60 years ago, the average sawyer was expected to best the volume predicted using these rules by a significant percentage. Technological improvements such as laser scanning head-rig systems have made possible accurate opening face cuts and taper adjustments. Improved sawing mechanics have provided sawmills with smaller kerf sizes and decreased sawing variation allowances. The end result is that today's mills are much more efficient than those of the past. Thus, the scale volumes that set the bar for past sawyers are not necessarily the volumes that should be expected from today's hardwood sawmills.

The use of antiquated log rules as a basis of trade is not an accurate or fair practice. A revised scaling method, such as one based on Smalian's or Huber's volume equations, could provide a fair, accurate approach. Lumber recovery could then be easily predicted through multiplying log volume by the average LRF. Given the accuracy and increasing prevalence of laser scanning systems, the ability to determine log volumes to a high degree of precision is becoming more common.

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