Trends in Lumber Processing in the Western United States. Part II: Overrun and Lumber Recovery Factors

Charles E. Keegan III
Todd A. Morgan
Keith A. Blatner
Jean M. Daniels

Abstract

This article describes trends in three measures of lumber recovery for sawmills in the western United States: lumber overrun (LO), lumber recovery factor (LRF), and cubic lumber recovery (CLR). All states and regions showed increased LO during the last three decades. Oregon and Montana had the highest LO at 107 and 100 percent, respectively. Alaska had the lowest LO at 31 percent, followed by the Four Corners Region (i.e., Arizona, Colorado, New Mexico, and Utah). Because sawmills in the western United States use the Scribner Log Rule (SLR) as the unit of log input, higher LO is not a clear indication that mills are using improved sawing technology and techniques. At best, LO is an imprecise measure of production efficiency.

Better measures of lumber output per unit input include LRF and CLR. These measures are substantially better than LO because they are based on the cubic volume of solid wood fiber in a log, thus eliminating a number of the problems associated with the SLR. Oregon, followed by Washington, had the highest LRF (8.67 and 8.43 board feet lumber tally per cubic foot of logs, respectively) and the highest CLR (52% and 50%, respectively). Alaska had the lowest LRF and CLR. Changes in LRF and CLR suggest that sawmills in the western United States have used improved sawing technology and techniques to increase the volume of lumber recovered even as log sizes have decreased.

Estimates of lumber recovery per unit volume of timber processed are critical to analyses of long-term forest policy, forestland investment strategies, and timber management. Inaccurate information on the relationship between timber input and lumber output can lead to erroneous projections related to the volume of timber needed to fill future demand, impacts on forest inventories, and future prices for lumber, timber, and timberland. Changes in milling infrastructure have improved lumber recovery rates across the western United States, but these changes are poorly documented and slow to be adopted in industry analyses. This article reports trends in three measures of lumber recovery for western sawmills: lumber overrun (LO), lumber recovery factor (LRF), and cubic lumber recovery (CLR).

LO is the amount of lumber actually recovered in excess of the amount predicted by the log scale, expressed as a percentage of the log scale. Although LO is the most commonly quoted measure of lumber recovery/efficiency, it is of limited usefulness. In the western United States, LO is primarily a reflection of the characteristics of the Scribner Log Rule (SLR) rather than an indicator of conversion efficiency. The SLR was not designed to estimate the volume of wood fiber in logs, but rather to estimate the volume of lumber that could be sawn from a log (Fonseca 2005). Calculated LO is heavily influenced by assumptions related to lumber sizes and grades and sawing technology

The authors are, respectively, Retired Research Professor (Charles.Keegan@business.umt.edu) and Research Assistant Professor and Director of Forest Industry Research (Todd.Morgan@business.umt.edu), Bureau of Business and Economic Research, Univ. of Montana, Missoula; Professor and Chair, Dept. of Natural Resource Sci., Washington State Univ., Pullman (blatner@wsu.edu); and Research Forester, USDA Forest Serv., Pacific Northwest Research Sta., Portland, Oregon (jdaniels@fs.fed.us). This paper was received for publication in September 2009. Article no. 10679.
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Forest Prod. J. 60(2):140–143.

used to estimate lumber production (Spelter 2004). These assumptions often do not reflect the technology currently used or actual lumber sizes and grade. Further, two variants of the SLR are commonly applied in the western United States—Eastside and Westside scales (Fonseca 2005). These two scales provide different estimates of board foot Scribner and underestimate the volume of wood fiber as log diameter decreases to a different degree (Briggs 1994, Spelter 2004). The vagaries of the SLR as a measure of log input make LO a flawed measure of changes in lumber recovery and milling efficiency over time.

Two other measures of lumber output per unit input, LRF and CLR, offer substantially better measures than LO. LRF is the board feet lumber tally of lumber produced per cubic foot volume of logs processed. CLR is the cubic volume of lumber manufactured per cubic volume of logs processed. The LRF and CLR are better expressions of conversion efficiency than LO because log input is measured in terms of net cubic log scale, eliminating a number of the problems associated with the SLR.

Methods

The states included in this analysis were Alaska, Arizona, California, Colorado, Idaho, Montana, New Mexico, Oregon, Utah, Washington, and Wyoming. Because of the limited number of mills in Arizona, Colorado, New Mexico, and Utah these states are reported together as the Four Corners Region. LO, LRF, and CLR were calculated using published mill censuses or other available data sources (see Appendix in Keegan et al. 2010). To calculate LO, the volume of lumber produced (expressed in board feet lumber tally) in excess of the Scribner log scale volume processed was divided by the Scribner volume of logs and expressed as a percentage. The Scribner volume was divided by board foot per cubic foot (BF/CF) ratios to express log volumes in cubic feet. Lumber production was then divided by the cubic log volume to estimate LRF. The state level cubic foot volume of lumber, prior to drying, was then divided by the cubic feet of logs processed by sawmills to yield the CLR.

Results are presented for four time periods: the 1970s, 1980s, 1990s, and 2000 through 2006. With the exception of Colorado in the 1990s and Wyoming in the 1980s and 1990s, at least one mill census or other data source was available to calculate the BF/CF ratio in each state. See Keegan et al. (2010), which includes a more detailed discussion of data sources and the approach used to estimate BF/CF ratios.

Results

Lumber overrun

All states and regions showed increased LO through time (Table 1). Oregon and Montana had the largest increases, with LO in both states increasing from 30 percent in the 1970s to 107 and 100 percent, respectively, in the 2000s. Overrun calculations imply that by the end of the study period, mills in those states were producing more volume of lumber than they received as logs, demonstrating the limited utility of LO calculations. Alaska showed almost no improvement in LO, increasing from 21 to 27 percent. The Four Corners Region began with the lowest LO but improved modestly over time.

The use of the SLR Westside variant leads to a higher LO because of its tendency to yield a lower scaled volume than the Eastside variant for a given set of logs. Among the three states (Alaska, Oregon, and Washington) that use primarily the Westside SLR, Oregon consistently had the highest LO. Montana had the highest LO for states based on the Eastside variant. The states that exhibited increasing LO also exhibited a trend of using smaller logs (Keegan et al. 2010).

Lumber recovery factor

As with LO, all states and regions showed increased LRF from the 1970s to 2006 (Table 2). LRF in Oregon, Washington, and Idaho rose the most over the multidecade period, increasing by 23, 18, and 17 percent, respectively. Most recently, Oregon, followed by Washington, had the highest LRF in the western United States at 8.67 and 8.36 board feet lumber tally per cubic foot of logs processed from 2000 through 2006. At 6.72 and 7.25, Alaska and Wyoming had the lowest LRF values; LRF in these states improved by only 5 to 7 percent over the entire 36-year period.

Cubic lumber recovery

All states and regions showed increased CLR over the last three decades, and improvements were similar to gains in

Table 1.—LO, percentage of board feet lumber tally in excess of Scribner log input volume divided by Scribner log input volume.[a]

Region/state	Scale	1970s (%)	1980s (%)	1990s (%)	2000–2006 (%)
Four Corners[b]	Eastside	12	19	34	31
Northern Rockies	Eastside				
Idaho		34	36	54	86
Montana		30	52	77	100
Wyoming		20	NA[c]	NA	55
Pacific Coast	Eastside				
California		19	34	53	61
Pacific Coast	Westside				
Alaska		21	20	18	27
Oregon		30	53	83	107
Washington		29	41	69	90

[a] During recent years in Oregon and Washington, approximately 80 percent of the volume of sawlogs used was processed in areas using the Westside SLR. In the 1970s and 1980s, the percentage was only slightly lower at approximately 77 percent. Virtually all sawlogs processed in Alaska used the Westside SLR.
[b] Arizona, Colorado, New Mexico, and Utah.
[c] NA = not available.

Table 2.—LRF, board feet lumber tally per cubic foot of bole wood processed.

Region/state	Scale	1970s	1980s	1990s	2000–2006	% increase[a]
Four Corners[b]	Eastside	6.56	6.45	6.78	7.50	14
Northern Rockies	Eastside					
Idaho		6.66	6.66	7.44	7.81	17
Montana		6.79	6.79	6.96	7.40	9
Wyoming		6.92	NA[c]	N/A	7.25	5
Pacific Coast	Eastside					
California		7.17	7.16	7.76	8.12	13
Pacific Coast	Westside					
Alaska		6.29	6.22	5.98	6.72	7
Oregon		7.04	7.91	8.19	8.67	23
Washington		7.11	7.74	7.50	8.36	18

[a] Percent increase column represents the total increase between the first (1970s) and last (2000 through 2006) periods.
[b] Arizona, Colorado, New Mexico, and Utah.
[c] NA = not available.

overrun and LRF. Oregon and Washington led again. With CLR values of 0.52 and 0.50 cubic feet of green finished lumber per cubic foot of bole wood processed, they had the highest CLR from 2000 through 2006 (Table 3). Oregon and Washington also showed the largest increases in CLR, increasing 24 and 16 percent, respectively, from the 1970s to 2006. Alaska, Montana, and Wyoming showed the smallest increases in CLR, with each state increasing less than 10 percent. Alaska ended up with the lowest CLR at 39 cubic feet of green finished lumber per cubic foot of bole wood processed.

Discussion

Measures of the volume of lumber produced per unit of log input can be influenced by a range of factors in addition to log scale. These factors include technology, log size, lumber size, lumber grade, and market conditions for lumber and residue—particularly coarse residue.

Market conditions for lumber and mill residue and changes in lumber size and grade produced over time have had a modest influence on trends in recovery (Keegan et al. 1998). As lumber markets decline, sawmills tend to favor production of coarse or chippable residue over sawing marginal lower-valued lumber grades—the opposite happens when lumber markets are strong. An increase in the proportion of the log recovered as chips leads to a decrease in volume of lumber, sawdust, and shavings produced. Year-to-year variation in lumber recovery resulting from market response to cyclic demand for lumber is not generally factored into long-term trends.

Lumber size and grade also had some minor influence on changes in recovery over time because the cubic volume of a nominal board foot varies based on the mix of lumber products sawn. Wider lumber has more cubic feet of solid wood per thousand board feet (MBF) than narrow lumber. For example, 1 MBF lumber tally of dry, finished 2 by 4s has approximately 54.8 cubic feet of solid wood, whereas 1 MBF of dry, finished 2 by 6s has approximately 57.3 cubic feet, and 1 MBF of 2 by 12s has approximately 58.6 cubic feet (Hartman et al. 1976).

Available data do not allow a precise profile of lumber sizes produced by state. In this analysis the same cubic volumes of lumber, 56.5 cubic feet of solid wood per MBF lumber tally and 3.5 cubic feet per MBF of shrinkage from finished green lumber to finished dry lumber, were assumed for all states and all time periods. The simplifying assumption of no differences among states only affected recovery calculations to a small degree. The use of a single cubic volume for lumber slightly overstates past lumber recovery factors, understates the historic percentage of the log recovered in lumber, and understates the relative lumber recovery of states processing larger logs. As demonstrated

Table 3.—CLR, cubic feet of green finished lumber per cubic foot of bole wood processed.

Region/state	1970s	1980s	1990s	2000–2006	% increase[a]
Four Corners[b]	0.40	0.41	0.41	0.46	15
Northern Rockies					
Idaho	0.40	0.43	0.45	0.46	15
Montana	0.41	0.41	0.42	0.44	7
Wyoming	0.42	NA[c]	NA	0.44	5
Pacific Coast					
Alaska	0.36	0.36	0.37	0.39	8
California	0.42	0.43	0.43	0.48	14
Oregon	0.42	0.48	0.49	0.52	24
Washington	0.43	0.45	0.51	0.50	16

[a] Percent increase column represents the total increase between the first (1970s) and last (2000 through 2006) periods.
[b] Arizona, Colorado, New Mexico, and Utah.
[c] NA = not available.

earlier, this is because larger sized lumber has higher cubic volume per MBF lumber tally.

The differences in lumber recovery due to the production of larger sized lumber are small (<2%) and do not materially affect the among-state or within-state comparisons of lumber recovery through time. For example, an adjustment for a mix of larger lumber during the 1970s in Oregon only changed the statewide LRF from 7.04 to 6.94 and the CLR from 42 to 43 cubic feet of green finished lumber per cubic foot of bole wood. Adjustments for a mix of larger lumber sizes in other states would have similarly minimal impacts.

Two opposing forces have perhaps had the strongest influence on changes in recovery at western sawmills over the last several decades—technology and log size. All states and regions within the western United States have shown increased LO, LRF, and CLR since the 1970s. At the same time there has been a move to processing smaller logs throughout most of the region (Keegan et al. 2010). Owing to the weakness of the SLR as a measure of log input, higher LO is not a clear indication that western sawmills are using improved sawing technology and techniques. Because the SLR inconsistently underestimates log volume as log size decreases it is not possible to identify the proportion of increased LO that is attributable solely to the SLR.

Because LRF and CLR use a consistent measure of log input (i.e., cubic feet), they overcome the limitations of LO by eliminating the measurement distortions of the SLR. Hence, the change in LRF and CLR offer a clear indication that western sawmills have made improvements in production efficiency, increasing the volume of lumber recovery over time even as log size has decreased. These improvements include

- log size (diameter and length) sensing capabilities linked to computers to determine the optimum sawing pattern to recover either the greatest volume or greatest value from each log,
- curve sawing technology to increase recovery from logs with sweep and crook,
- improved sawing accuracies to reduce the amount of size variation in sawn lumber, increase solid wood recovery, and allow rough green lumber sizes to be produced closer to desired finished sizes,
- thinner kerf saws to reduce the proportion of the log that becomes sawdust, and
- edging and trim optimization, better quality saws, and improved drying techniques, all of which reduce lumber loss.

Conclusions

This article presents data that clearly demonstrate increased lumber recovery per unit of timber processed throughout much of the western United States at a time when log sizes used by sawmills have been decreasing. These data are also strong evidence that the improved sawmill technologies and techniques used in western sawmills over the past several decades are responsible for substantially improved lumber recovery. Subsequent analyses will need to further examine the changes in percent use of sawlogs as lumber and the mill residue components to explain more fully the proportionate influences of improved technology versus declining log size. Nevertheless, the data presented provide important insights into recovery trends that are critical underlying assumptions in analyses of timber markets over time.

Acknowledgment

This report was partially funded by the USDA Forest Service Pacific Northwest Research Station Joint Venture Agreement PNW-07-JV-11261975-343.

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