

# LORCAT:

## An Easy-To-Use Hardwood Log Recovery Analysis Tool

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**E**d Thomas of the US Forest Service and Urs Buehlmann with Virginia Tech have developed an easy-to-use tool—LORCAT—designed to examine hardwood log recovery. The following article contains highlights from the paper created by Thomas and Buehlmann as well as Q&A from a discussion between NHLA and the developers.

Numerous factors influence product recovery and efficiency in hardwood sawmills. Some factors relate to the geometric and quality characteristics of the logs processed; others to processing details such as kerf size, sawing variation, or sawing strategy. Also, the geometric dimensions and the type of products sawn impact recovery yield. Examining and developing an understanding of the inter-relationships among these numerous interdependent factors is the key to maximizing yield and profit for every sawmill operation.

Lumber recovery is affected by factors relating to log features (species, diameter, length, taper, and grade), sawmill parameters (kerf width and sawing variation), and recovery goals (sawing strategy, green and kiln dry-dressed lumber size) (Steele 1984, Lin et al. 2011). These factors, due to variances in log resource, processing parameters, and recovery goals, are rarely consistent from mill to mill (Steele 1984).

Given the importance of all these factors and their interrelated interaction on mill profitability, numerous sawmill simulation tools to help sawmill managers explore the impact of these settings on mill operations have been created. However, these analysis tools typically require extensive mill data and possibly specialized training to accomplish even minor analyses. The newly developed Log Recovery Analysis Tool (LORCAT) was designed to avoid the complexities of past tools by being straightforward to set-up and use with easily understood results.

**Q: What is LORCAT and how did it come to be?**

**Answer Thomas & Buehlmann:**

LORCAT (Log Recovery Analysis Tool) is a sawmill analysis tool designed and developed to enable mill personnel and researchers to examine the impact and relationships among various factors that influence hardwood mill recovery. LORCAT is a spreadsheet-based

tool that was developed for use with the Microsoft Excel® or Libre-Office® spreadsheet applications, which most users are familiar with.

LORCAT is the result of a question from a large sawmill that wanted to estimate recovery for a 7/8-inch target thickness. An existing simulation program was not suitable for the analysis. So, we created what was at the time a very simple spreadsheet to examine that question. Afterwards we realized that the spreadsheet could be expanded to handle many more types of questions and analyses, bringing LORCAT into existence.

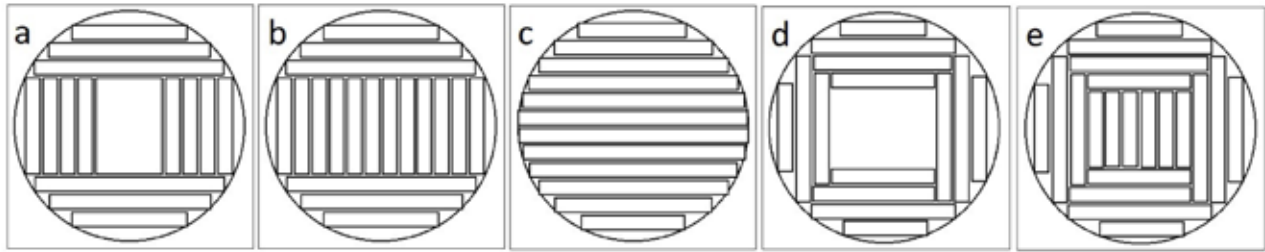
**Q: You say LORCAT avoids the complexities of past tools, in what way?**

**Answer Thomas & Buehlmann:**

Past tools (such as Solve or PROYIELD) require a large amount of data input to be able to function, some even require users to complete training for their use. LORCAT minimizes the need for data input by relying on historic information collected by the US Forest Service about log yield and grade recovery. With LORCAT, we worked hard to reduce the data required to the minimum. We also kept parts of the analysis independent, allowing users to use only selected features of the tool. For example, if users don't want to use the profit/loss feature of the tool, they don't have to enter their price and cost data and can just use the yield and recovery portion of the tool. Also, we kept the results simple and used a format that is easy to follow.

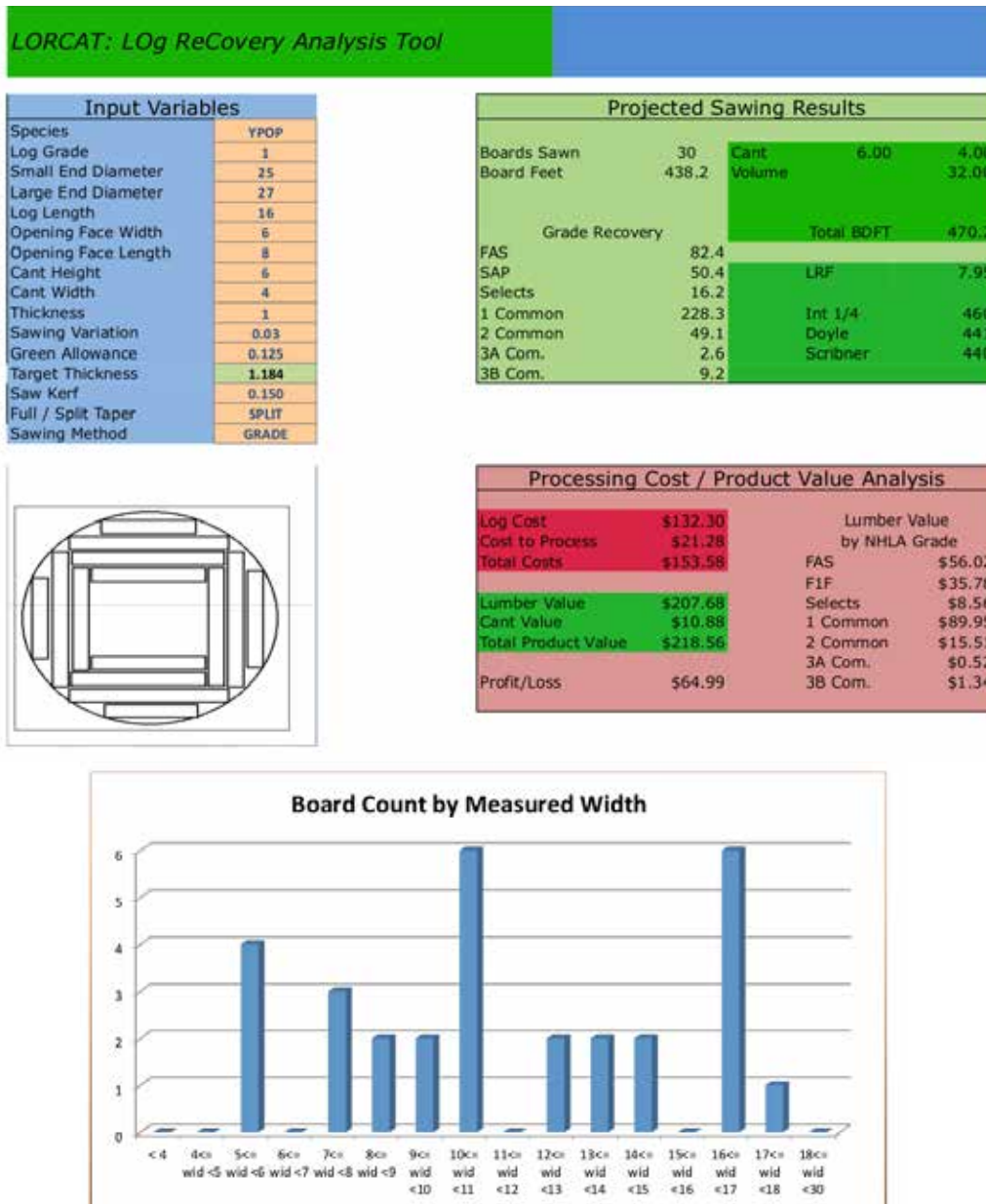
**About the Tool**

LORCAT simulates the sawing of logs using one of five common sawing methods. The first method simulates sawing logs to a cant with a specified size (e.g., 6 in x 4 in; Figure 1a). The second method simulates using a gang-resaw to saw the cant produced from sawing the first two faces into lumber (Figure 1b). The third method simulates the European method of live or fitch sawing where the log is sawn through-and-through (Figure 1c). The fourth and fifth sawing options emulate grade sawing where the log is rotated, and lumber is sawn from the best face. The grade sawing methods can saw to a cant (Figure 1d) or simulate a gang-resaw to saw the cant



**Figure 1.** a. Slab sawing to a specified cant size; b. Slab sawing to specified cant thickness then completing sawing using a gang-resaw; c. live sawing; d. Grade sawing to a specified cant size; b. Grade sawing to specified cant thickness then completing sawing using a gang-resaw.

**Figure 2.** LORCAT: Log Recovery and Analysis Tool main window.



into lumber (Figure 1e). Users can select the method and all sawing parameters to suit their operation or their analysis needs.

For all sawing methods, users can choose either split-taper or full-taper sawing (Malcolm 1961). In split-taper sawing, the taper of the log is split between opposite faces and the log is sawn parallel to its central axis (Hallock et al. 1978). This sawing method has the potential to produce shorter boards if the amount of taper is large enough yet increase recovery of lumber. Full-taper sawing saws the log parallel to the outside faces of the log (Hallock et al. 1978). Thus, the grain will be parallel to the board surface in the resulting boards, making lumber sawn stronger in general than split-taper sawn lumber.

### Using the Tool

LORCAT is an easy-to-use, spreadsheet-based analysis tool that requires minimal data input from the user. The main user interface of LORCAT is shown in Figure 2.

The light blue box in the upper left corner of the screen controls the analysis. Here you enter the specifics of the log being sawn as well as the lumber, cant and sawing parameters. The cells shaded light maroon indicate cells where you can enter/change data. The generic sawing pattern displayed in the lower left corner labeled “Sawing Pattern” shows a symbolic representation of the sawing pattern used given the current setup specified in the “Input Variables”

section above. For example, entering zero into “Cant Height” and “Cant Width” in the “Input Variables” of LORCAT, will change the symbolic picture from “Sawing to a specified cant size (Figure 1a)” to “live sawing (Figure 1c).” Sawing results are displayed in the green box in the upper right corner labeled “Projected Sawing Results.” It reports the expected volumes of the resulting lumber and cant, and the expected grade mix of the lumber produced according to NHLA lumber grading rules. The red box in the lower right corner labeled “Processing Cost / Product Value Analysis,” reports the profitability of the sawing operation. The lumber values, log and processing costs are all based on user entered costs in the “Costs” and “Operation Costs” worksheets accessible in the tabs at the bottom of the spreadsheet. Suppose that users want to analyze the results from sawing multiple logs. In that case, they need to activate the “Batch Sawing” worksheet by clicking on this tab, which allows users to generate samples consisting of hundreds of logs.

green allowance, sawing variance, taper setting, and sawing method. Enter a series of diameters, grades, and species, and LORCAT will project the profit or loss of each. Once your costs are setup, the break-even log analysis could be done in just few minutes. Further, when your market prices or costs change, your analysis is easy to revisit.

**Q: Will this program provide the break-even log values by species, grade, and diameter?**

**Q: Will this program help a company decide what to cut from the logs that will be the most profitable? i.e 4/4 or 8/4, cant size?**

**Answer Thomas & Buehlmann:**

Yes, it is an easy analysis to setup. The first step would be to enter your current costs for logs, market prices for lumber, and your operating costs. Next, specify the opening face size, cant size, thickness,

**Answer Thomas & Buehlmann:**

Yes. It would be an analysis similar to determining the break-even log discussed above. Except you would need to set up a random sample of log sizes that approximates the log sizes that you normally process. Then you would let LORCAT run each of the target size/cant size combinations, results of which can easily be saved in LORCAT. Afterwards, you can easily compare total recovery and profit, finding the best solution for your mill.

**An Example**

As a bandsaw owner, you might wonder if you should invest in thinner kerf blades or not? You can use LORCAT to conduct a series of simulations to examine the yield implications of four band mill kerf

Batch Sawing Input Variables																			
Processing Setup					Log Size Distribution Setup														
Lumber Thickness	1.00	Number of Samples	50	Mean Small End Diameter	18.00	Small End Diameter Std Deviation	5.00	Mean Taper	3.00	Taper Std Deviation	1.00	Log Length	12	Log Grade	2	Species	YPOP	SED Under 8" Protection	YES
Opening Face Width	6.00	Log Length	12	Log Grade	2	Species	YPOP	SED Range	8 to 28	LED Range	9 to 33	Taper Range	1 to 5						
Opening Face Length	8.00	Small End Diameter	18.00	Small End Diameter Std Deviation	5.00	Mean Taper	3.00	Taper Std Deviation	1.00	Log Length	12	Log Grade	2	Species	YPOP	SED Under 8" Protection	YES		
Cant Height	6	Log Length	12	Log Grade	2	Species	YPOP	SED Range	8 to 28	LED Range	9 to 33	Taper Range	1 to 5						
Cant Width	3.5	Log Length	12	Log Grade	2	Species	YPOP	SED Range	8 to 28	LED Range	9 to 33	Taper Range	1 to 5						
Green Allowance	0.125	Log Length	12	Log Grade	2	Species	YPOP	SED Range	8 to 28	LED Range	9 to 33	Taper Range	1 to 5						
Sawing Variation	0.03	Log Length	12	Log Grade	2	Species	YPOP	SED Range	8 to 28	LED Range	9 to 33	Taper Range	1 to 5						
Target Thickness	1.184	Log Length	12	Log Grade	2	Species	YPOP	SED Range	8 to 28	LED Range	9 to 33	Taper Range	1 to 5						
Kerf Thickness	0.135	Log Length	12	Log Grade	2	Species	YPOP	SED Range	8 to 28	LED Range	9 to 33	Taper Range	1 to 5						
Sawing Method	GRADE	Log Length	12	Log Grade	2	Species	YPOP	SED Range	8 to 28	LED Range	9 to 33	Taper Range	1 to 5						
Split or Full Taper?	SPLIT	Log Length	12	Log Grade	2	Species	YPOP	SED Range	8 to 28	LED Range	9 to 33	Taper Range	1 to 5						

Small End Diameter	Large End Diameter	Log Length	Log Grade	Species	Opening Face Width	Opening Face Length	Sawing Method	Split or Full Taper	Cant Height	Cant Width	Lumber Thickness	Green Allowance	Sawing Variation	Kerf Thickness
15.877	19.179	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
11.164	13.971	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
12.385	13.588	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
20.253	22.963	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
15.559	18.638	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
15.592	18.158	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
11.548	14.589	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
19.058	20.809	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
15.427	18.698	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
17.330	19.985	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
14.345	18.998	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
14.948	18.131	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
22.577	26.445	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
11.383	13.471	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
8.374	10.266	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
11.264	14.146	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
23.467	26.632	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
16.003	18.427	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
22.846	25.910	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
11.567	14.235	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
21.654	24.352	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
22.357	25.769	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
24.307	26.633	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
20.442	24.352	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135
15.112	18.816	12	2	YPOP	6	8	GRADE	SPLIT	6	3.5	1	0.125	0.03	0.135

thicknesses available: 0.125, 0.111, 0.096, and 0.084-inch. After you have downloaded and opened LORCAT on your computer (no installation necessary as LORCAT consists of a spreadsheet file), you assemble a sample of 200, 12-foot-long logs with a total volume of 4,220 ft<sup>3</sup>. The International 1/4-inch scale volume (USDA Forest Service 2006) for those 200 logs was 26,070 board feet (bdft) and the Doyle scale volume (Cassens 2011) was 21,605 bdft. You decide to use a minimum opening face (minimum size of first board removed from a log face) of 6-inches wide and 6 feet long. You also decide that if the taper is 1 inch or greater, split-taper sawing is to be used. Also, you set the simulation up so that the sawing process simulates sawing the logs to produce a 6-inch cant that then is sawn into 6-inch wide boards (Figure 1b). You set the target thickness to 1-inch plus a green thickness allowance of 0.125-inch plus sawing variation of 0.022-inch. The details and the results of the first simulation run for band kerf thickness of 0.125-inch of your scenario analysis is shown in Figure 3.

Results from your scenario analysis are shown in Table 1. Lumber recovery increased from 28,887 bdft when the kerf is 0.125 inches, to 30,113 bdft when the kerf is 0.084 inches, an increase of approximately 4 percent. In the example, each reduction in kerf resulted in an approximate increase of 400 bdft, with a total overall improvement of 1,226 bdft between the widest and the thinnest kerf. Sixty-nine

percent of the total improvement, 850 bdft, was realized with the 0.096-inch thick kerf. You now must estimate if the additional costs from using a thinner kerf are less than the additional profit resulting from the extra yield obtained. Realize that being able to tailor the log size distribution as well as the cost information to your specific operation, will give you the most meaningful results.

**Table 1.** LORCAT analysis and scale results for a sample of 200, 12-ft-long logs having an average small-end diameter of 16 inches and variable amounts of taper.

Kerf	Lumber Recovery Factor	Recovery	Doyle Overrun	Int 1/4-inch Overrun
(inches)		(bdft)	(percent)	(percent)
0.125	6.845	28,887	33.70%	10.80%
0.111	6.946	29,311	35.70%	12.40%
0.096	7.047	29,737	37.60%	14.10%
0.084	7.136	30,113	39.40%	15.50%

**Q: If a company doesn't purchase logs based on Forest Service Log Grades, will this spreadsheet be of use to them?**

**Answer Thomas & Buehlmann:**

Yes. In general, most hardwood log grading systems used in the industry are simplifications of the USFS log grading rules. I would recommend that anyone unsure what FS log grades correspond or approximate the grades they are using, that they take a look at the FS log grading rules. The University of Tennessee has a publication that is a good summary of the FS grading rules and it can be found at: <https://extension.tennessee.edu/publications/Documents/PB1772.pdf>

**Q: Where can a company access this program?**

**LORCAT can be downloaded from either of these web sites:**

<https://www.woodproducts.sbio.vt.edu/lorcat/>

<https://www.nrs.fs.fed.us/tools/lorcat/>

There are two versions of LORCAT available on these two web sites. One is for Microsoft Excel. The other is for LibreOffice Calc, a free, open-source alternative to Microsoft Excel. Download the version you want to use, open the file, and start analyzing your operation. If your computer has Microsoft Excel or LibreOffice Calc already installed (most business computers have either program already installed), no installation or any other computer manipulation is needed to work with LORCAT.

**Q: What should a company do if they experience problems or have questions about LORCAT?**

Please contact Ed Thomas (304.431.2324, [ralph.thomas@usda.gov](mailto:ralph.thomas@usda.gov)) or Urs Buehlmann (540.231.9759, [buehlmann@gmail.com](mailto:buehlmann@gmail.com)) for free support.

