Lumber Values From Beetle-Killed Lodgepole Pine

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Abstract

The study of lodgepole pine attacked by mountain pine beetles (*Dendroctonus ponderosae* Hopk.) in the East Kootenay region of British Columbia, Canada, shows that positive conversion returns for lumber manufacture can be obtained unless trees have started to shed their bark and develop severe checking. Quality classes were derived using tree foliage characteristics as well as bark characteristics for trees dead many years. Trees with green and red foliage yielded similar values per 100 cubic feet of logs with positive conversion returns. Trees with no foliage but tight bark also yielded positive returns, but at a lower level. For trees sloughing bark the returns were negative.

THE MOUNTAIN PINE BEETLE (*Dendroctonus ponderosae* Hopk.) is stated to be the most serious enemy of mature pines in western Canada (4). The volume of mature lodgepole pine (*Pinus contorta* var *latifolia* Engelm.) killed by this beetle is estimated at 1.3 million cubic feet per year in British Columbia for the past 20 years (2, 4).

The mountain pine beetle is native to western North America and attacks western white (*P. monticola* Dougl.) and ponderosa (*P. ponderosa* Laws.) pines in addition to lodgepole pine, but because of the larger volumes and wider distribution of lodgepole relative to the other pines in British Columbia, this species is the most seriously affected.

Although a fair volume of literature has developed over the years on the mountain pine beetle (3), there is very little on the subject of lumber values from beetle-attacked trees. This is rather surprising, since the determination of product values from attacked trees should be an important ingredient in establishing control and salvage strategies to attain maximum values from affected timber.

One study of 62 southern pine trees (5) reported that, in beetle-infested loblolly (*Pinus taeda* L.) and shortleaf (*Pinus echinata* Mill.) pines approximately 12 months after the foliage had faded, the lumber recovery factor (LRF) was 5.8 compared with 6.7 for unaffected control trees. It was also found that No. 1 and No. 2 lumber-grade yield dropped from an average of 94 percent in control trees to 73 percent and 54 percent from beetle-attacked butt and top logs, respectively. In a study of dead western white pine, killed apparently by a combination of white pine blister rust and mountain pine beetle attack (6), it was found that tree values decreased as time-since-death increased. Material from trees dead for 2 years was worth 72 percent of live material; trees dead for 3 to 6 years were worth 44 percent and trees dead longer were worth 29 percent of live trees. However the logs recovered in that study were cut into 4/4- and 5/4-inch boards in which beetle-induced blue stain is a degrading factor. In 8/4-inch and thicker structural lumber blue stain is not a degrading factor.

Levi and Dietrich (1) conducted a survey of buyers of pine in North Carolina. Fifty percent of the pole, piling, and post buyers would not purchase beetle-killed trees. Only 5 percent of pulpwood buyers refused to accept dead trees. From 10 to 22 percent of groups of lumber, railroad-tie, and reconstituted-wood-products manufacturers refused to accept beetle-killed timber. A survey of this nature indicates the need to determine the stage at which it is no longer feasible to economically utilize attacked timber for various products and also the need to have a practical field method for estimating the probable wood quality of standing beetle-killed timber.

In the spring of 1977, the Western Forest Products Laboratory of the Canadian Forestry Service conducted a study of lumber-grade yields from dead lodgepole pine attacked by the mountain pine beetle. The study was requested by Crestbrook Forest Industries

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Ltd. of Cranbrook, British Columbia (which has cutting rights in an area severely attacked by the beetles) and by the British Columbia Forest Service (BCFS), which is responsible for management of the forest resource in British Columbia. In addition to assessing lumber values from attacked trees, a further study objective was to relate lumber quality to the appearance of standing trees.

Materials and Methods

Sample Selection

Sample trees were selected in the Elk Creek drainage of the East Kootenay region of British Columbia as stands in this area had been heavily attacked by mountain pine beetles. Four distinct classes of trees were sampled; classes related to tree appearance which, in turn, was a reflection of time since beetle attack.

1) *Green top.* — These are trees which still have green foliage and obvious signs of beetle attack, such as exit holes and/or pitch extrusions from beetle holes. These trees are probably in the 1-year-since-attack class, although there were indications that some trees may have been attacked 2 years in a row, but had overcome the initial attack.

Because blue stain is not a degrading factor in structural grades of lumber graded under National Lumber Grading Authority rules, this category served as a control. These trees would normally develop yellow foliage in the spring following the summer of attack.

2) *Red top.* — These trees have red foliage. This normally develops the second year after attack, but again it was apparent on close examination that some of the "red tops" had been dead for more than 2 years, but the needles persisted.

3) *Gray tight bark.* — Trees in this class have no foliage remaining but have tight bark; probably dead for 4 or more years.

4) *Gray loose bark.* — These are trees with no foliage and with loose or sloughing bark, with obvious wood checking, and apparently dead longer than those with *gray tight bark.*

It is difficult for anyone not informed as to the life cycle and habits of the beetles to say exactly when the initial attack took place. There probably is a range of years since attack in each of the above four categories. However, as the objective was to develop a practical means of identifying tree quality, it was thought best to sample what appeared to be obvious quality classes based on standing tree appearance.

It was intended to sample 100 trees in each of two broad groups—based on diameter at breast height (DBH)—for each quality class, but availability constraints resulted in the final sample numbers shown in Table 1.

Mill Study

Logs were scaled by a BCFS scaler under the rules of the Firmwood and Lumber Cubic scales. The former is the official scale in British Columbia, allowing deductions only for rot and lack of wood. The Lumber Cubic scale, no longer in official use in British Columbia, but used in parts of the United States, also permits deductions for log defects prejudicial to lumber yields, such as severe checks, shake, sweep, and crook.

Logs were processed through the Crestbrook Forest Industries Ltd. sawmill at Canal Flats, British Columbia. Lumber from the eight groups was identified using different colors of paint. A rough-green tally was taken at the green chain where the lumber was pulled and stripped for air-drying.

After 6 weeks air-drying under ideal conditions of temperature and wind, the lumber was dressed in batches and graded at the planer chain, by certificated graders, using NLGA 1970 rules for structural lumber.

Results

Lumber Recovery Factors

LRFs are shown in Table 1. The differences between those for the Firmwood and those for the Lumber Cubic scales are an indication of the volumes deducted in the Lumber Cubic which were deemed to affect lumber yields. The largest deductions were in *gray loose bark* and were almost entirely for severe checking.

Although there were differences in log top-diameter distributions within each DBH class for each quality group, these were not sufficient to cause substantial differences in LRF between groups within DBH classes. BCFS LRFs used in timber appraisals for lodgepole pine are shown in parentheses in Table 1. As these BCFS LRFs are highly dependent on log top diameter, the sampling is considered unbiased as far as the influence of top-diameter distributions on LRFs is concerned.

TABLE 1. — *Tree sample numbers and lumber recovery factors.*

Tree DBH class (in.)	No. of trees	Lumber recovery factors (fbm/ft.³)	
		Firmwood	Lumber Cubic
		GREEN TOP	
5.1-11.0	100	4.58(5.14)[1]	4.66
11.1+	100	6.01(5.53)	6.13
	Avg.	5.71(5.45)	5.82
		RED TOP	
5.1-11.0	110	4.75(5.14)	4.86
11.1+	135	5.94(5.52)	6.10
	Avg.	5.59(5.43)	5.73
		GRAY TIGHT BARK	
5.1-11.0	104	5.52(5.21)	5.66
11.1+	82	5.20(5.53)	5.69
	Avg.	5.31(5.42)	5.69
		GRAY LOOSE BARK	
5.1-11.0	133	4.86(5.22)	6.85
11.1+	89	5.26(5.52)	6.75
	Avg.	5.10(5.40)	6.79

[1]( ) These LRFs are the result of applying decay, waste and breakage factors for lodgepole pine in Zone 6 of BC to BCFS LRFs for sound logs.

LRFs actually obtained for the smaller DBH groups were quite variable and did not follow a preconceived concept of diminishing recovery with diminishing tree quality. Also, we have no convincing argument as to why the LRF for the smaller DBHs in the *gray tight bark* group was considerably greater (5.5) than the others for small DBH trees.

LRFs for the larger DBH groups were more as expected, diminishing as tree quality deteriorated. Because of the heavy contribution of the larger DBH groups to total volume, group average LRFs also diminished as tree quality deteriorated.

It is of interest to note that, for the better quality trees, the LRF obtained by the company in this study was superior to that applied by the BCFS; in the poorer quality trees the reverse was the case. However, on the overall average the company LRF for study trees was 5.45 which compares closely to the 5.43 which would be used by the BCFS in stumpage appraisal calculations for sound, green timber.

Lumber Grade Yields

Lumber grade yields (Table 2) are for 2-inch lumber, which comprised 98 percent of total lumber volume. Because there was so little 1-inch lumber, it was not dressed or given a final grade. The grade-yield pattern was fairly similar for the three most recently attacked quality groups, but then deteriorated considerably in the worst quality group—the *gray loose bark* group. The weighted average was only 14 percent No. 1 lumber compared with over 30 percent for the other groups, and 30 percent No. 3 lumber compared with from 11 to 17 percent for the others.

The reason for the higher percentage of inferior grades of lumber from the trees that had been dead longest was the severe checking prevalent in this category.

Log Product Values

Log product values are shown in Table 3 based on the Firmwood scale and in Table 4 based on the Lumber Cubic scale. Based on Firmwood scale, log values diminished as tree quality deteriorated, but only by 1 percent from *green* to *red top*, by 6 percent from *green* to *gray tight bark*, and by 11 percent from *green* to *gray loose bark*.

Because LRFs were greater under Lumber Cubic scale, log values are also greater per hundred cubic

TABLE 2. — *Lumber grade yields.*

Tree DBH class (in.)	Lumber grades			
	No. 1	No. 2	No. 3	Econ.
	GREEN TOP			
5.1-11.0	47[a]	35	12	6
11.1 +	33	52	10	5
Avg.	35	49	11	5
	RED TOP			
5.1-11.0	42	44	10	4
11.1 +	34	47	16	3
Avg.	36	46	14	4
	GRAY TIGHT BARK			
5.1-11.0	40	41	14	5
11.1 +	27	47	19	7
Avg.	31	46	17	6
	GRAY LOOSE BARK			
5.1-11.0	13	55	25	7
11.1 +	14	45	33	8
Avg.	14	49	30	7

[a]Numbers indicate yield percentage.

TABLE 3. — *Log product values*[1] *based on firmwood scale.*

Tree DBH class (in.)	LRF	Lumber values		Chip yields odt/Ccf[4] logs	Chip values $/Ccf logs	Total value $/Ccf logs
		$/M[2] lbr.	$/Ccf[3] logs			
		GREEN TOP				
5.1-11.0	4.58	144	66	.67	20	86
11.1 +	6.01	146	88	.52	16	104
Avg.	5.71	146	83	.55	17	100
		RED TOP				
5.1-11.0	4.75	147	70	.65	20	90
11.1 +	5.94	146	87	.53	16	103
Avg.	5.59	146	82	.57	17	99
		GRAY TIGHT BARK				
5.1-11.0	5.52	145	80	.58	17	97
11.1 +	5.20	141	73	.61	18	91
Avg.	5.31	143	76	.60	18	94
		GRAY LOOSE BARK				
5.1-11.0	4.86	139	68	.64	19	87
11.1 +	5.26	135	71	.60	18	89
Avg.	5.10	137	70	.62	19	89

[1]Basis:
(a) Lumber values from Madison's Canadian Lbr. Reporter May 27, 1977.
No. 2 & Btr. $155/M f.o.b. mill
No. 3 $123
Econ. $ 40
(b) Chip yields based on species density of 25.5 pounds per cubic foot
(c) Chip values at $30/odt f.o.b. mill
[2]Dollars per thousand board feet
[3]Dollars per hundred cubic feet log volume
[4]Ovendry tons per hundred cubic feet

TABLE 4. — *Log product values*[1] *based on lumber cubic scale.*

Tree DBH class (in.)	LRF	Lumber values		Chip yields odt/Ccf logs	Chip values $/Ccf logs	Total value $/Ccf logs
		$/M lbr.	$/Ccf logs			
		GREEN TOP				
5.1-11.0	4.66	144	67	.66	20	87
11.1 +	6.13	146	89	.51	15	104
Avg.	5.82	146	85	.54	16	101
		RED TOP				
5.1-11.0	4.86	147	71	.64	19	90
11.1 +	6.10	146	89	.51	15	104
Avg.	5.73	146	84	.55	16	100
		GRAY TIGHT BARK				
5.1-11.0	5.66	145	82	.56	17	99
11.1 +	5.69	141	80	.56	17	97
Avg.	5.69	143	81	.56	17	98
		GRAY LOOSE BARK				
5.1-11.0	6.85	139	94	.45	13	107
11.1 +	6.75	135	92	.47	14	106
Avg.	6.79	137	93	.46	14	107

[1]Basis as in Table 3.

TABLE 5. — *Operating costs and net values related to tree quality.*

Tree quality class	Avg. operating costs $/Ccf logs — Firmwood scale	Avg. operating costs $/Ccf logs — Lumber Cubic scale	Avg. net values $/Ccf logs — Firmwood scale	Avg. net values $/Ccf logs — Lumber Cubic scale
Green top	90	92	10	9
Red top	90	92	9	8
Gray tight bark	90	96	4	2
Gray loose bark	90	120	–1	–13

TABLE 6. — *Chip characteristics.*[1]

Tree quality group	Screen size 2 in.	1-1/4 in.	7/8 in.	5/8 in.	3/8 in.	1/4 in.	Pan	Percent bark	Percent MC[2]
	Percent retained								
Green top	2.8	15.0	26.6	23.3	22.8	6.2	3.3	0.6	32.4
Red top	0.2	11.2	25.6	24.6	26.8	8.2	3.4	0.5	23.1
Gray tight bark	1.2	8.3	21.7	22.8	30.6	10.7	4.7	0.5	13.9
Gray loose bark	0.6	8.2	20.8	26.5	30.2	8.4	5.3	0.5	14.6

[1]Data from Crestbrook Forest Industries Ltd.
[2]Original weight basis.

feet. Comparing Table 3 with Table 4, the difference is slight in the first two quality groups, but increases on average by $4 per hundred cubic feet in *gray tight bark* and by $18 per hundred cubic feet in *gray loose bark*, the latter which, as a result, becomes the highest value group under Lumber Cubic scale.

Thus, despite *gray loose bark* having the poorest lumber quality, the deductions allowed under Lumber Cubic scale were sufficient to more than compensate, resulting in this category having the highest LRF and value per cunit of logs when scaled under Lumber Cubic scale rules.

Typical BCFS logging and milling cost allowances for lodgepole pine in the study area are about $45 per hundred cubic feet of logs for each operation, for a total of $90 per hundred cubic feet. This is based on the Firmwood scale. Costs would therefore be greater if the Lumber Cubic scale was used.

Operating costs and net values, which are the differences between product values and operating costs, are shown in Table 5 for the average of each quality group. These net values indicate positive returns for all quality groups except *gray loose bark.*

Chip Characteristics

Chip characteristics are shown in Table 6. There was a slight increase in fines with deteriorating tree quality. Moisture content did drop significantly, however, from 32.4 percent in *green top* to about 14 percent in both *gray* classes.

Summary and Conclusions

This study indicates that LRFs based on the Firmwood scale diminish as tree quality deteriorates. The difference between the top two quality classes, *green top* and *red top*, was fairly insignificant at 2 percent, but increased to 7 percent between *green top* and *gray tight bark* and to 11 percent between *green top* and *gray loose bark.*

Based on the Lumber Cubic scale, the poorest quality group (*gray loose bark*) had the highest LRFs. This was because of the large, probably excessive, deductions made for the severe checks in trees of this quality group.

As is usual, the smaller trees on the whole yielded less lumber per cubic foot, but yielded a higher percentage of No. 1 grade of lumber, presumably because of smaller knots. However, because of the lower LRFs and the practice of marketing No. 2 and Better lumber as an item, the net result was that the larger trees on the average had a greater value per cubic foot. Thus, although the larger trees are more heavily infested, it appears to be of no importance to relative lumber values.

Net values for the *green top* and *red top* classes were similar at between $8 and $10 per hundred cubic feet of logs. Those for the third quality class were $5 to $6 less, but still positive; while those for the poorest quality group, *gray loose bark*, were negative.

The study shows that positive net values can be obtained from beetle-attacked lodgepole pine until the stage where the trees are dead with loose bark and severe checks.

As long as the bark remains tight, lumber values sufficient to give positive net values are possible. However, to ensure positive values, it appears that attacked trees should be harvested prior to the stage of complete foliage loss.

Literature Cited

1. Levi, M. P., and R. L. Dietrich. 1976. Utilization of southern pine beetle-killed timber. Forest Prod. J. 26(4):42-48.
2. Safranyik, L., D. M. Shrimpton, and H. S. Whitney. 1976. Mountain pine beetle workshops—planning and execution. Can. Forestry Serv., Pac. Forest Res. Cent., Victoria, B.C., BC-P-15. 41 p.
3. ———, ———, and ———. 1975. Mountain pine beetle bibliography. Canadian Forestry Serv., Pac. Forest Res. Cent., Victoria, B.C., Rep. BC-X-126. 69 pp.
4. ———, ———, and ———. 1974. Management of lodgepole pine to reduce losses from the mountain pine beetle. Canadian Forestry Serv., Pac. Forest Res. Cent., Victoria, B.C., Forestry Tech. Rep. 1. 24 pp.
5. Sinclair, S. A., G. Ifju, and H. J. Heikkenen. 1977. Bug boards. Southern Lumberman 234(2900):9-10.
6. Snellgrove, T. A. 1977. White pine yields decrease as time since death increases. Forest Ind. 104(4):26-28.