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Lumber Value Loss Associated with Tapping Sugar Maples for Sap Production

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Abstract

Tapping sugar maples for sap production yields an annual income, but there is a loss in timber quality if the tree is cut for factory lumber products. We estimate an average loss per tree of \$2.87 based on a sample of 90 trees in Vermont that were formerly tapped.

ODC 852.19 : 892.68 : 176.1 *Acer saccharum* Marsh.

Tapping of sugar maple for sap production damages the wood in the vicinity of the tapholes. This damage has been characterized, and the tree's response to this kind of wounding has been studied (Walters and Shigo 1978). Although tapping for sap production yields an annual income, there is a loss in timber quality if the tree is cut for factory lumber products. We have developed a method to estimate the value of this quality lost.

Methods

Data used in this analysis were collected in 1975 for the purpose of comparing lumber-grade yield distributions from logs cut from sugar maple used for sap production with yields from forest-grown sugar maples as reported by Vaughan and his coworkers (1966).

Four former sugarbushes were selected in northwestern Vermont on the basis of the owner's willingness to cut. A sugarbush may be defined as part of a stand of mature hardwood forest where most other trees have been cut and the maples have been thinned sufficiently to allow trees to develop a good crown growth (Willits and Hills 1976). The smallest scale recognized for commercial maple syrup production is 500 taps, which may cover an area of 5 to 7 acres (Willits and Hills 1976).

Merchantable trees in the four sugarbushes were selected for cutting: sugarbush 1—17 trees, sugarbush 2—19 trees, sugarbush 3—12 trees, and sugarbush 4—42 trees. They were scanned with a portable metal detector from stump height to about 10 to 12 feet above ground level. Trees that contained no detectable metal (overgrown spouts) were cut using local cutting practices and skidded to a landing. Ninety trees were cut and bucked for grade, and the logs were graded according to USDA Forest Service log grades (Rast et al. 1973).

The logs were transported to a local sawmill where the butt logs were again electronically scanned for overgrown metal. All logs were sawed into lumber and timbers; each piece was marked with the number of the parent log so individ-

ual trees could be reconstructed for analysis. The lumber was graded according to National Hardwood Lumber Association inspection rules using a double grading technique. The first grading ignored the holes and stain caused by tapping; then, the lumber was regraded recognizing these defects. These grade-yield differences comprise the basic data for this analysis.

The mill tally of board-foot volumes by lumber-grade—Firsts and Seconds, Selects, No. 1 Common, No. 2 Common, No. 3A and No. 3B Common and Timbers—was determined for each tree. Each tree had two sets of volume data: one showed volume by lumber grade ignoring taphole damage, and the other recognized taphole damage.

In computing tree value, we modified the quality index system developed by Herrick (1946). Quality index is a number that expresses the relative value of a tree as a function of the amount and value of the different grades of 4/4 lumber that can be sawed from it. Values were applied by the use of price relatives (PR) (Herrick 1956), which were derived from the 1975 to 1980 *Hardwood Market Report*. Prices for each lumber grade were averaged for the 5-year base period (mid-1975 to mid-1980) and expressed as a proportion of the average price for No. 1 Com-

mon Lumber (Table 1). The tree value formula is:

$$\text{Tree value} = [(FAS \times PR_{FAS}) + (\text{Sel} \times PR_{\text{Sel}}) + \dots + (\text{Timbers} \times PR_{\text{Timbers}})] \times \text{Price/Bf}$$

Where:

FAS is the total volume of lumber sawed from the tree that would grade Firsts and Seconds.

PR_{FAS} is the price relative for FAS lumber.

Price/Bf is the current price of No. 1 Common 4/4 hard maple lumber in dollars per board foot.

Table 1.—Price relatives for hard maple lumber and timbers^a

Lumber grade	Price relative ^b
Firsts and seconds	1.32
Selects	1.24
No. 1 Common	1.00
No. 2 Common	.66
No. 3A Common	.58
No. 3B Common	.45
Timbers	.50

^a Northern Hardwoods (F.O.B. Mills—Wausau, Wisconsin Area) hard maple 4/4 lumber and hardwood hearts from 1975–80 *Hardwood Market Report*.

^b Prices for all grades expressed as proportion of price for No. 1 Common lumber.

Two estimates of tree value were made for each tree: one ignored tapholes and associated stain; the other recognized tapholes and stain as defects. The second estimate subtracted from the first is the tree value loss in dollars attributable to tapping for sap production.

Dollar values in this report are based on the current value of \$274 per thousand board feet for No. 1 Common 4/4 hard maple lumber. These dollar values can be easily adjusted to reflect a current lumber price (C) by multiplying all values by $C \div 274$. When there is a major shift in the relative prices among grades, it is necessary to recompute values using the tree value formula.

Results and Discussion

Of the 90 trees in the analysis, 37 had factory grade-1 butt logs, 39 had grade-2, and 14 had grade-3. Each tree grade was assumed to be equivalent to its butt-log grade. The average volume from the mill tally was 247.6 board feet, and average lumber value was \$57.94 for trees not tapped, and \$54.99 for those tapped. Table 2 shows mean dbh, merchantable height, and butt-log grade by sugarbush.

Table 3 shows the mean value loss per tree. Mean value loss ranged from \$.68 per tree in sugarbush 2 to \$4.39 in sugarbush 3. The loss values were plotted to test for "outliers" and the need to transform the data. The tests were negative, so stepwise multiple regression was run on tree-value loss to see what variables in the study might be useful for predicting tree-value loss.

Dbh, merchantable height, their squares, square roots, and all

Table 2.—Mean dbh, merchantable height, butt-log grade, by sugarbush

Sugarbush	Dbh		Merchantable height		Butt-log grade	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
	----- Inches -----		----- Feet -----			
1	16.86	2.68	27.52	7.81	1.47	0.62
2	16.12	1.39	28.35	5.94	1.58	0.69
3	15.35	1.63	25.32	6.08	1.83	0.72
4	16.65	2.99	34.05	10.70	1.90	0.73
All sugarbushes	16.40	2.52	30.45	9.36	1.74	0.71

Table 3.—Mean value loss per tree and standard deviation within sugarbush

Sugarbush	Tree value ^a loss	Standard deviation
	----- Dollars -----	
1	2.75	1.87
2	0.68	0.61
3	4.39	1.66
4	3.64	2.91
All sugarbushes	2.87	2.38

^a Based on \$274/Mbf for No. 1 Common 4/4 hard maple lumber.

possible products of the dbh, merchantable height measurements were candidate predictor variables. Dbh was the only variable entered into the regression. However, the added precision with which sugarbush loss could be predicted with dbh was too small to justify any cost for collecting dbh data.

Mean and Variance of Value Loss

With no relationship between the tree value loss and measured tree characteristics, mean value loss per tree seems to be the best estimate of loss based on these data. Analysis of the between-bush and within-bush variance indicates significant inequality of variances between sugarbushes. Therefore, the simple mean of the four sugarbush means, \$2.87, is the appropriate estimate of loss per tree, $\hat{V}$.

The value loss in a sugarbush can be estimated by $\hat{L} = \hat{V}\hat{N}$, where N is an estimate of the number of merchantable sugar maples in the stand. The variance of $\hat{V}$ can be estimated by $\text{Var}(\hat{V}) = 3.770/\hat{N} + 1.897$ and the $\text{Var}(\hat{L}) = \hat{N}^2 \text{Var}(\hat{V}) + \hat{V}^2 \text{Var}(\hat{N})$.

Then:

$$\hat{L} = \hat{V}\hat{N}, \text{ with } \hat{V} = 2.87 \quad [1]$$

$$\text{Var}(\hat{L}) = 3.770 \hat{N} + 1.897 \hat{N}^2 + \hat{V}^2 \text{Var}(\hat{N}) \quad [2]$$

If the number of trees in the stand is known, rather than estimated, $\text{Var}(\hat{N}) = 0$.

The differences between bushes resulted in the lack of precision with which the value loss can be predicted. However, the value loss—less than 5 percent of the overall mean tree value—is relatively small.

Untested variables may account for the large differences between stands. For example, sugarbush 2 may have been atypical because it seemed to have been tapped for only 3 years. One-third of the trees in this bush had no change in value after double grading. A more realistic estimate of value loss can be made by deleting the mean for bush 2. The estimate of variance

however would retain the mean square error for bush 2. The new mean value loss, $\hat{V}$, would be \$3.59 per tree instead of \$2.87, with variance estimated using equation [2].

Estimates of factory-lumber value loss would be useful for stands of mature sugar maple being considered for conversion to sap production. This estimate is not a substitute for the thorough investment evaluation that should be done in deciding the potential for converting a maple stand to sap production. Factory-lumber value loss is just one of the components in this analysis. The loss also can be used as one component in a user fee if the stand is to be operated by another party.

Application

Theoretical Example

We estimated the timber-value loss of a forest stand of mature sugar maple, 12.5 acres in area, in northern Vermont. Early in its history, the stand was operated for sap production, but had not been tapped for at least 15 years and so, was similar in history and composition to the sampled bushes. Field data were collected with slight modification of the procedure outlined by Lancaster and his coworkers (1974). Ten prism points were systematically laid out, and a 10-factor prism was used to select sample trees.

The information needed to evaluate the loss due to tapping is an estimate of the number of sugar maple in the 12-inch diameter class and above in grade 3 or above,¹ and a measure of sampling error. However, the sampled trees were tallied by dbh class to estimate the potential number of taps available. Below-grade sugar maple meeting

the minimum diameter requirement were also tallied by diameter class only for purposes of estimating the total number of taps available. A poor-quality timber tree is usually adequate for sap production and sometimes is an excellent sugar producer.

There were an estimated 686.25 trees with a variance of 2,861.46. Value loss expected from tapping this stand can be predicted by applying the tree value loss from Table 3. The result is obtained by multiplying the estimate of trees, $\hat{N} = 686.25$, times value loss per tree, $\hat{V} = \$2.87$, which equals $\$1,970 \pm \959 ($\pm$ one standard deviation). If the more conservative estimate of \$3.59 is used for loss per tree, the value loss for the stand is $\$2,464 \pm \965 .

Example Stand Characteristics

The basal area of the stand in merchantable sugar maple in the 12-inch diameter class and above is 77 square feet; the mean stand diameter is 15.7 inches. The following schedule for tapping intensity was used:

Dbh class (inches)	Taps
12-14	1
16-18	2
20-24	3
26 and greater	4

The potential number of taps is 88.3 per acre. If cull trees are included, there are 95.1 taps per acre. The gross volume² of sawtimber is 7,826 board feet per acre. This is broken down by quality as 750 board feet per acre in grade-1 trees, 2,549 board feet in grade-2 trees, and 4,527 board feet in grade-3 trees.

Related Issues

The decision to convert a stand to maple sap production is a long-term management commitment. Timber production becomes a

¹ The USDA Forest Service tree grades (Hanks 1976) are based on the USDA Forest Service log grades (Rast et al. 1973). The guide for hardwood tree grading used by Forest Service markers in Region 9 specifies minimum dbh based on Form Class 80.

² Volumes were estimated using a board-foot volume equation for sugar maple (Scott 1979).

subordinate goal because management for sap production requires (1) lower stocking to encourage wider and deeper crowns and (2) longer rotations because a tree continues to be a good sap producer long after it has passed the age of financial maturity as a timber tree, about 100 to 120 years.

To apply this evaluation, a potential sugarbush must be defined the same way we defined a sugarbush in the study. It should be a contiguous stand of mature sugar maple with minimal stocking for commercial production. Stands that do not qualify within the larger maple stand should be removed from the analysis. Maple stands that are not contiguous should be evaluated independently.

It is important to note that this evaluation of value loss included sawing the tapped zone into factory lumber. If, as has been done in the past, the butt log is cut above the tapped zone (jump-butt cutting), our estimate of value loss would be inappropriate. To ensure that the butt log is acceptable to the mill, use only plastic spouts for sap collection and use only aluminum nails to hold the pipeline in place at stress points.

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