MULTIMARKET COMPETITION FOR YELLOW POPLAR TREES IN EASTERN KENTUCKY

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ABSTRACT.—Merchandising of tree stems can greatly increase profits for timber stands. In eastern Kentucky, the sawtimber, plywood peeler, and fiberstrand markets currently utilize yellow poplar trees. An economic analysis showed some general trends for the yellow poplar market in eastern Kentucky. Markets were found to be highly diameter-specific and each market out-competed the others within a specific range of diameters. However, an increase in the price of one market greatly affected the dominance range of the other markets. This analysis also showed that merchandising of yellow poplar stands provided an increase of 29.2 percent in delivered mill price over the next best single market option.

INTRODUCTION

Timber stand and tree merchandising determines the economic returns and profitability of a timber stand containing tree species utilized by multiple markets (Greber and Smith 1986; Sibal et al. 1984). Proper merchandising can maximize economic returns from a stand. In eastern Kentucky, yellow poplar (*Liriodendron tulipifera*) is currently being utilized by sawtimber, plywood peeler, and fiberstrand (also know as engineered wood product or laminated strand lumber) markets. The fiberstrand and plywood peeler markets are both new to Kentucky and have projected demands of 37 thousand board feet (MBF) and 600,000 tons of yellow poplar, respectively (Lowe 1995).[2] The recent establishment of these yellow poplar consumers in 1988, along with the demand for sawtimber, allows for the possibility of maximizing harvest profits through the merchandising of yellow poplar stands.

The objective of merchandising a timber stand is to determine the proper allocation of tree stems to product markets to maximize economic returns. Optimum merchandising is based largely on market conditions and product specifications (Greber and Smith 1986). The goal of this research is to provide insight on the current market state of yellow poplar in eastern Kentucky to better facilitate yellow poplar timber stand and individual tree merchandising.

METHODS

To accurately provide market trends for yellow poplar trees, analysis was completed by 1-inch (in.) diameter classes. The analysis used cubic-foot (ft^3)volume equations for individual yellow poplar trees provided by Hilpp (1997) (Table 1). The authors calculated ft^3 volumes by diameter class for each product class (sawtimber, plywood peeler, and fiberstrand). Tree grades used for these equations are those of Hanks (1976). An average tree grade per diameter class was found for yellow poplar trees in Kentucky (Table 2) with the use of the U.S. Forest Service's Forest Inventory and Analysis Database (Hansen et. al 1992). Listed in Table 2, the authors used this value for the tree-grade variable in the volume equations. Because many purchase sawtimber and plywood peeler logs by volumes attained from inside bark scaling diameters, inside bark volume equations were used for these products. However, fiberstrand material is purchased by weight with the bark attached to the stem. Therefore, the authors used the outside bark volume equation for fiberstrand.

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[2] Lowe, Larry. 1995. Roundwood consumption in and around Kentucky. Unpublished memo. Frankfort, KY: Kentucky Division of Forestry.

Table 1.—Coefficient values for ft^3 volume equations for individual yellow poplar trees for sawtimber, plywood peeler, and fiberstrand product markets (Hilpp 1997)

Product class	Intercept	d.b.h.	d.b.h.^{2}	Tree Grade[a]
Sawtimber[b]	47.73568	-4.20819	0.30533	-8.67475
Plywood peeler[b]	18.13984	0.00000	0.13898	-7.39586
Fiberstrand[c]	19.93393	0.00000	0.24460	-6.76835

d.b.h. = diameter breast height

[a] Below grade trees (USFS grades 4 and 5) are given a value of 4.
[b] Volumes are inside bark.
[c] Volumes are outside bark.

To provide volumetric units consistent with prices obtained for sawtimber and plywood peeler, the authors converted ft^3 units into Doyle board-foot units. Table 2 lists an average ratio of International ¼ in. board-foot to ft^3 volume for each diameter class, which was calculated from Beck (1964). Next, the authors used linear regression to form an equation that would predict the ratio of Doyle board-foot volume to International ¼ in. board-foot volume by diameter class. The resulting equation had a coefficient of determination, or r^2 value, of 0.9875. Table 2 lists the predicted ratios made by this linear regression. With the use of these conversions, Doyle board-foot units were estimated.

Table 2.—Values by diameter class for average tree grade, average ratio of International ¼ in. board-foot volume to ft^3 volume, and predicted ratio of International ¼ in. board-foot volume to Doyle board-foot volume used in this analysis

D-class	Avg. Tree Grade	Ratio Int'l.	Ratio Doyle-Int'l[a]
		cubic feet	
11	3.352466	4.416667	0.470272
12	3.283253	4.510833	0.524194
13	3.039486	4.672857	0.574082
14	2.957698	4.763571	0.619936
15	2.961372	4.898462	0.661756
16	2.669524	4.986154	0.699542
17	2.510498	5.073846	0.733294
18	2.253076	5.241667	0.763012
19	2.324828	5.338462	0.788696
20	2.335356	5.425455	0.810346
21	1.967782	5.537778	0.827962
22	2.246447	5.611111	0.841544
23	2.503691	5.697500	0.851092

[a] Result of linear regression: RATIO = -0.389114 + 0.100313*DBH + -0.002017*DBH2

Fiberstrand raw material is purchased by tonnage. Therefore, it was necessary to convert ft^3 volume to tons for this product. The authors used a conversion reported in TimberMart South (1996). This publication provides a conversion of 5,800 pounds per standard cord (128 ft^3) which equated to 0.02265625 ft^3/ton for hardwood pulpwood. The authors estimated tonnage units with this conversion.

To examine the effects of price fluctuation and difference in values by log grade, different levels of delivered raw material prices were used. Three levels of sawtimber prices—$350, $225, and $125 per MBF for grades 1, 2, and 3, respectively—reflected the three merchantable sawlog grades because purchase prices for sawlogs increase with increases in log grade. Reported price lists do not exist for Kentucky (Lowe 1997),[3] so the authors used average delivered log prices in east Tennessee. They assumed that the east Tennessee reported price list reflected east Kentucky prices because of similar topography, stand development, and market demand.

Hilpp (1997) found that 71.09 percent of yellow poplar plywood peeler logs were of medium grade. To facilitate this analysis, the authors assumed that yellow poplar plywood peeler logs are all of consistent medium grade—arguably the advantage of the plywood peeler market. Therefore, they used only one price, $240/MBF, to determine plywood peeler value.

Two prices were used to determine the value of fiberstrand trees, $17/ton and $25/ton. These prices show the effects of a range in purchase price due to market fluctuation, a predicted increase in unit purchase price, and/or variable radius or distance-dependent purchase pricing.

A key aspect of this analysis is that the multimarket comparisons are on a tree-by-tree basis. The volumes and dollar values listed are those for all the merchantable logs within that tree, i.e., total tree volume and value. To simplify the analysis, the authors did not separate into logs and merchandize them as such. The values listed by diameter class assume that the logs within each tree are of uniform grade (reflected by the graded prices) for sawtimber and plywood peeler. Merchandising is done among trees in this analysis, not among logs within trees.

RESULTS

Table 3 lists estimated Doyle sawtimber and plywood peeler board-foot volumes and fiberstrand tonnage values. Table 4 records values for each tree by diameter class, product class, and associated unit price. A theoretical range of sawtimber prices is identified in Table 4 as the “likely” price range. The authors assumed that these prices best reflected market prices by diameter class for sawtimber trees given the average tree grade listed in Table 4. The price range for fiberstrand, as reflected by two price levels, demonstrates how a change in unit price affects the competitiveness of the “grade-free” fiberstrand market with the sawtimber and plywood peeler markets.

[3] Lowe, Larry. 1997. Log price reporting. Unpublished memo. Frankfort, KY: Kentucky Division of Forestry.

Table 3.—Predicted individual tree sawtimber and plywood peeler board-foot volumes and fiberstrand tonnage

D-class	Sawtimber.	Plywood peeler.	Fiberstrand
	- - - - - - - - - *board feet* - - - - - - - -		*tons*
11	19.33	21.11	0.6081
12	30.09	32.80	0.7462
13	48.99	51.37	0.9221
14	67.95	69.41	1.0843
15	89.54	89.17	1.2444
16	123.52	118.51	1.4609
17	158.72	147.85	1.6682
18	205.45	186.00	1.9016
19	243.52	215.23	2.0957
20	287.73	248.23	2.3102
21	352.79	297.46	2.5938
22	394.04	324.83	2.7893
23	440.05	354.68	2.9993

Table 4.—Dollar values of yellow poplar trees by diameter class for three product markets and associated unit price levels[a]

D-class	Average Tree Grade	Grade 3 Swtmbr. $125	Grade 2 Swtmbr. $225	Grade 1 Swtmbr. $350	Med.Gr. Plywood $240	Low-end Fbrstrd. $17/ton	Hi-end Fbrstrd. $25/ton
11	3.3525	2.24	4.35	6.77	5.07	**10.34**[b]	15.20*[c]
12	3.2833	3.76	6.77	10.53	7.87	**12.68**	18.65*
13	3.0395	6.12	11.02	17.15	12.33	**15.68**	23.05*
14	2.9577	8.49	15.29	23.78	16.66	**18.43**	27.11*
15	2.9614	11.19	20.15	31.34	**21.40**	21.15	31.11*
16	2.6695	15.44	27.79	43.23	**28.44**	24.84	36.52*
17	2.5105	19.84	**35.71**	55.55	35.48	28.36	41.71*
18	2.2531	25.68	46.23	**71.91***	44.64	32.33	47.54
19	2.3248	30.44	54.79	**85.23***	51.65	35.63	52.39
20	2.3354	35.97	64.74	**100.71***	59.57	39.27	57.75
21	1.9678	44.10	79.38	**123.48***	71.39	44.09	64.84
22	2.2464	49.26	88.66	**137.91***	77.96	47.42	69.73
23	2.5037	55.01	99.01	**154.02***	85.12	50.99	74.98

Swtmbr = sawtimber; Med. Gr. = medium grade; Fbrstrd. = fiberstrand

[a] Shading represents the assumed "unlikely" range of sawtimber prices for diameter classes considering the average tree grade.

[b] Values in bold indicate the highest value in a diameter class when comparing the "likely" range for sawtimber, medium grade plywood peeler, and fiberstrand at $17/ton.

[c] An * indicates the highest value in a diameter class when comparing the "likely" range for sawtimber, medium grade plywood peeler, and fiberstrand at $25/ton.

This analysis makes two separate comparisons. The first comparison examines the sawtimber market in the "likely" price range, the plywood peeler market at a constant price of $240/MBF, and the fiberstrand market at $17/ton. The second comparison differs only by using the $25/ton price for fiberstrand. Bold type and asterisks note the highest price values per diameter class for the first and second comparisons, respectively.

The first comparison shows that each product market can out-compete the other markets within a certain diameter range. For diameter classes 11 through 14, highest values for individual trees are obtained through the fiberstrand market. The plywood peeler market provides the highest value for individual trees within the 15- and 16-in. diameter range. This market also nearly out-competes the sawtimber market grade 2 price within the 17-in. diameter class. The sawtimber market provides the highest values for trees falling within the diameter classes of 18 in. or greater.

The second comparison eliminates the plywood peeler market from the other competitive markets. When the fiberstrand unit price increases, this product provides the highest value in the 17-in. diameter class as well as the 18-inch diameter class when compared to grade 2 sawtimber prices. Above 18 in. in diameter, the sawtimber market continues to provide the highest individual tree value.

DISCUSSION

This analysis shows the importance of competitive pricing for yellow poplar markets. When fiberstrand prices are low ($17/ton), all three markets establish a diameter range in which they can out-compete the others. However, with the increase in the unit price for one market (in this case the fiberstrand market unit price increases to $25/ton), the dominance range of each product market is affected. As demonstrated by the second comparison, the dominance range of the plywood peeler market was completely eliminated.

It is also interesting to note the competitiveness of the plywood peeler and fiberstrand markets with the sawtimber market at different grade prices. At grade 3 sawtimber prices, the plywood peeler market completely dominates the sawtimber market. Even at $17/ton prices for fiberstrand, the sawtimber price values only remain higher at diameters of 21 in. or greater. It therefore seems practical that grade 3 yellow poplar trees would receive higher dollar values used for either the fiberstrand or plywood peeler market. This trend provides evidence for the hypothesis that the plywood peeler market's primary advantage is that plywood peeler logs consistently receive medium grade and therefore can always out-compete the low grade sawtimber market.

At the other extreme, grade 1 sawtimber prices, the plywood peeler market is entirely out-competed. The fiberstrand market's dominance range extends only into the lowest diameter classes. At $17/ton and $25/ton, the dominance range for the fiberstrand market extends only to the 12- and 14-in. diameter classes, respectively. These ranges provide evidence that high quality grade 1 trees and/or logs always achieve higher prices in the sawtimber market except at the very lowest range of diameters.

To demonstrate the economic implications of merchandising, an example of a harvest scenario is provided . The diameter distribution for an acre of yellow poplar (Table 5) was taken from McGee and Della-Bianca (1967). The stand selected has a site index of, is 50 years old, and has 131 square feet of basal area. The value per acre presented in Table 6 assumes the acre is to be harvested entirely for each of the three product classes or be merchandised. Merchandising in this example allots all of the trees in each diameter class to the highest value market for that diameter class (those values in bold in Table 4). In this example, the figure of $17/ton is used for fiberstrand price and the “likely” range is used for sawtimber price. An increase of 29 percent for the value of an acre is attained by merchandising over the next best option in this example, sawtimber.

Table 5.—Diameter distribution for an acre of yellow poplar with site index 100, age 50, and basal area of 131 square feet per acre (McGee and Della-Bianca 1967)

Diameter Class	11	12	13	14	15	16	17	18	19	20
Number of trees	14	13	13	12	11	10	9	7	5	1

Table 6.—Dollar values for an acre of yellow poplar harvested entirely for each of three product markets and the value of the same acre harvested using merchandising. Values are delivered to mill prices.

	Sawtimber only	Plywood peeler only	Fiberstrand only	Merchandising
Value/Acre	$2016.81	$2002.92	$1914.62	$2606.02

These dollar values are delivered to mill prices and do not reflect transportation or sorting costs. Also, the volumes listed by diameter class are individual tree volumes, which is not separated into graded logs. It is unlikely that an entire tree would receive grade 1 sawtimber prices for all the logs within that tree. Therefore, the range of prices listed for the three grades of sawtimber for each diameter class must be viewed to show the range of values for a tree of a given diameter. However, this analysis does provide evidence of market trends for yellow poplar in eastern Kentucky. This evidence supports the following general trends: (1) plywood peeler markets out-compete low-grade sawtimber markets, (2) high-quality logs achieve higher value in the sawtimber market except in the lowest diameter classes, (3) the fiberstrand market out-competes all markets (even grade 1 sawtimber) in the lowest diameter classes, and (4) an increase in the unit price by one market disrupts the diameter range at which all markets out-compete one another.

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