Impact of Timber Sale Characteristics on Harvesting Costs

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ABSTRACT

Large changes have taken place in the forest industry in the past decade with record high and low home construction levels, the dissolution of vertically integrated forest products companies, and record high fuel costs. All of these shifts have impacted the timber harvesting workforce. We gathered data on timber sales from across the southeastern United States from 2000 through 2011 to examine what changes had occurred in harvest tract characteristics. Among the trends observed were an increase in average tract acreage and substantial increases in partial harvesting. These data were then used to model harvesting costs in the Auburn Harvesting Analyze, in an effort to determine what trends existed. Little long-term impact to harvesting costs could be attributed to timber sale characteristics.

Keywords: Harvest volumes, acreage, logging

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**Introduction**

Across much of the country, forestland ownership patterns have shifted dramatically. Lands previously owned by vertically integrated forest products companies have been divested, typically to land management organizations seeking to provide competitive financial returns to company shareholders. Fragmentation and parcelization are viewed as significant long-term threats to the sustainability of the forest industry (Sampson and DeCoster 2000). As the size of ownerships decrease, contiguous stretches of similar forest conditions are feared to become increasingly less common. While this can have substantial ecological implications, it has potentially detrimental economic implications as well. The average size of a harvested tract has a direct impact on the cost to cut and haul timber (Greene et al. 1997). Twenty acres is viewed by many logging contractors as a threshold of financial viability (Moldenhauer and Bolding 2009). With the level of mechanization and the production potential of most contractors operating in the southern US, tracts of less than twenty acres do not typically afford enough production to dilute the costs of moving the crew onsite. While acreage is often used as an indicator of minimum operable tract size, total and per acre volume are important cost drivers for harvesting operations (Greene et al. 1997).

We undertook a project to determine what changes have occurred in the characteristics of harvested tracts since 2000 and what impact they may have had on harvesting costs over the same timeframe.

**Methods**

Individual timber sale data from across the South were compiled from Timber-Mart South for each quarter from January 1, 2000 through December 31, 2011. Data from eleven states were included (AL, AR, FL, GA, LA, MS, NC, SC, TN, TX, VA), though not all states had timber sale data in every quarter. Timber sale characteristics included sale date, acreage, state, total volume, total sale price, and harvest type, but many timber sale records excluded data in one or more of these categories. Timber-Mart South’s primary focus is timber prices rather than harvest tract information, thus many of the reporters share only product prices and volumes, with no way to tie this information to a specific harvested tract (Harris et al. 2012). The data were processed using SAS 9.2 to provide a single record for each of the 18,006 individual sales. All product volumes were converted to tons using 2.7 cords/ton, 7.5 MBF (Scribner board rule)/ton, 8 MBF (Doyle Board Rule)/ton, and 6.23 MBF (International ¼ Board Rule)/ton. Individual product volumes were then combined into a total volume per timber sale.

Sales records were analyzed by quarter to provide South-wide average harvest characteristics. The data were split for this analysis into clearcuts and partial harvests, with salvage sales removed from the analysis. Four-quarter moving averages were
generated to clarify trends in the data. Medians were generated for quarterly measures of central tendency as means were greatly influenced by large outliers in a significant percentage of the quarters examined. Kolmogorov-Smirnoff tests for normality in the data also verified that more robust estimators were needed than arithmetic means.

The Auburn Harvest Analyzer was adapted to accept inputs of quadratic mean diameter, tract acreage, and volume per acre as variables (Tufts et al. 1985). A standard feller-buncher, two skidder, one knuckleboom loader system was used to estimate harvesting costs for crews typical in the Southeastern U.S. (Baker and Greene 2008). All model parameters were held constant except for those values calculated from quarterly sales data. The common inputs by machine are listed in Table 1. Additional assumptions include labor rate of $16.00/SMH, labor fringe expenses of 40% of the base rate of pay, combined interest, insurance, and taxes of 10% of average annual investment, lubrication costs 37% of fuel expense, and off-road diesel costs of $3.00 per gallon.

Table 1. Machine rate cost assumptions by machine.

<table>
<thead>
<tr>
<th>Machine</th>
<th>Purchase Price</th>
<th>Salvage Value</th>
<th>Economic Life (yrs)</th>
<th>Availability (%SMH)</th>
<th>Fuel (gal/PMH)</th>
<th>Maintenance &amp; Repair (% Depreciation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feller-buncher</td>
<td>$205,000</td>
<td>20%</td>
<td>4</td>
<td>85%</td>
<td>8.14</td>
<td>100%</td>
</tr>
<tr>
<td>Skidder</td>
<td>$225,000</td>
<td>25%</td>
<td>5</td>
<td>85%</td>
<td>7.77</td>
<td>90%</td>
</tr>
<tr>
<td>Loader</td>
<td>$190,000</td>
<td>30%</td>
<td>5</td>
<td>85%</td>
<td>6.29</td>
<td>90%</td>
</tr>
</tbody>
</table>

An array of quadratic mean diameters, tract acreages, and volumes per acre were used to examine the sensitivity of the modeled costs to these three input variables. Quarterly median acreage and volume per acre values from both clearcuts and partial harvests were used to calculate harvesting cost changes for an average logging system based on the changes in observed tract characteristics. To differentiate the average tree size impacts of clearcuts versus partial harvests, quadratic mean diameters of 9 and 7.5 inches were modeled for each harvest type respectively.

Results

The data included a large number of records which excluded information necessary for the analysis. When only sale records including acreage were retained, the dataset included 12,436 individual timber sales, whereas 8,675 records included both volumes and acreages. The distribution of sales records including at least acreage amongst the eleven states is shown in Figure 1. While Georgia had the greatest percentage of records, every state except Tennessee had over 600 sales records in the dataset.
Clearcutting as a percentage of all sales fluctuated within a narrow range while the median sale acreage increased in 2005, but has not varied widely since (Table 2). Median total tons harvested remained relatively stable throughout the period. Abnormally low volumes in 2004 are likely a result of very low reporting of harvest volumes in all four quarters of that year. The proportion of clearcutting and partial cutting as a percentage of total harvested acres has varied over the past nine years in the South, despite the relatively small fluctuations in the proportion of total sales (Figure 2). When observing total acres cut, partial harvests have been performed on more acres each quarter for almost the entire period. Partial harvests have been performed on 59.5% of the reported harvested acreage since 2000, compared to 40.5% for clearcutting. This balance has shifted more heavily towards partial harvests in recent years, averaging 70.1% partial harvesting and 29.9% clearcutting in 2011.

Figure 1. Percentage of total timber sale records with acreage reported from 2000 – 2011, by state.
Table 2. Summary of timber sale data by year based on Timber-Mart South data for the Southern states.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Sales</th>
<th>Median Acreage</th>
<th>Median Total Tons</th>
<th>Median Tons/Acre</th>
<th>Clearcut (% of all sales)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1096</td>
<td>75</td>
<td>2499</td>
<td>36.3</td>
<td>53</td>
</tr>
<tr>
<td>2001</td>
<td>969</td>
<td>78</td>
<td>4150</td>
<td>53.8</td>
<td>58</td>
</tr>
<tr>
<td>2002</td>
<td>1054</td>
<td>78</td>
<td>4683</td>
<td>62.1</td>
<td>56</td>
</tr>
<tr>
<td>2003</td>
<td>1031</td>
<td>81</td>
<td>5482</td>
<td>54.7</td>
<td>54</td>
</tr>
<tr>
<td>2004</td>
<td>1056</td>
<td>78</td>
<td>2900</td>
<td>38.1</td>
<td>57</td>
</tr>
<tr>
<td>2005</td>
<td>1480</td>
<td>99</td>
<td>3841</td>
<td>42.2</td>
<td>49</td>
</tr>
<tr>
<td>2006</td>
<td>880</td>
<td>92</td>
<td>4604</td>
<td>45.8</td>
<td>46</td>
</tr>
<tr>
<td>2007</td>
<td>1112</td>
<td>99</td>
<td>4221</td>
<td>42.9</td>
<td>46</td>
</tr>
<tr>
<td>2008</td>
<td>859</td>
<td>102</td>
<td>4500</td>
<td>40.0</td>
<td>43</td>
</tr>
<tr>
<td>2009</td>
<td>1089</td>
<td>99</td>
<td>5134</td>
<td>49.4</td>
<td>50</td>
</tr>
<tr>
<td>2010</td>
<td>866</td>
<td>95</td>
<td>5340</td>
<td>52.3</td>
<td>51</td>
</tr>
<tr>
<td>2011</td>
<td>851</td>
<td>100</td>
<td>4505</td>
<td>43.5</td>
<td>42</td>
</tr>
<tr>
<td>Total or Mean</td>
<td>12343</td>
<td>90</td>
<td>4007</td>
<td>47.4</td>
<td>51</td>
</tr>
</tbody>
</table>
Figure 2. Relative proportion of total acres harvested in clearcut and partial cutting by quarter from January 2000 through December 2010. Four quarter moving averages are shown by lines.

The median acreage of tracts harvested during this time period fluctuated from quarter to quarter, but showed a slightly increasing trend over the entire timeframe (Figure 3). The four-quarter moving average for median clearcut size was around 85 acres at the end of 2011 and median partial harvest size around 120 acres. For a given quarter, median harvest size varied between 80 and 140 acres for partial harvests and between 50 and 100 acres for clearcuts.
Figure 3. Median clearcut and partial cut acreage in the Southeastern US between 2000 and 2010. Four quarter moving averages are shown by lines.

Total volume harvested per tract fluctuated more than other measures over the period studied, but trends were not apparent over the entire timeframe (Figure 4). Through 2003 and 2004, a distinct peak is seen where total tract volume was higher for clearcuts. Median partial harvest volume ranged between 1300 tons and 4500 tons for a given quarter. Median clearcut harvest volume ranged between 2500 tons and 8000 tons. Both of these ranges are extremely wide considering they are median values for a quarter.

Despite the observed variation in total harvest volume, four-quarter moving averages of median per acre harvest volume remained comparatively stable (Figure 5). Partial harvest volumes per acre have stayed close to 30 tons since 2000, only once approaching 40 tons per acre and twice decreasing beneath 25 tons per acre. Excluding the first quarter of 2008, which is believed to be an anomalous value resulting from low reporting volumes, per acre clearcut volumes have fluctuated between roughly 50 and 80 tons, dipping below 50 tons on only one other occasion.
Figure 4. Median and four-quarter moving average total harvest volume per tract in tons for clearcuts and partial harvests from fourth quarter 2000 through fourth quarter 2010.
Figure 5. Median and four-quarter moving average tons harvested per acre for clearcuts and partial harvests from fourth quarter 2000 through fourth quarter 2010.

We used the observed ranges in harvested tract data using the Auburn Harvesting Analyzer to determine the sensitivity of the cut and load cost per ton to each variable of interest. When harvested acreages, quadratic mean diameters, or tons per acre were at low values, per ton logging costs increased rapidly (Figure 6). As the values of these variables each increased, per ton costs declined. Beyond some point, production reached a practical maximum in the given set of stand conditions, and costs decreased at a gradual rate as variable costs and tract fixed costs (e.g. road construction costs) per ton decreased incrementally.
Figure 6. Modeled impact of changes in tons per acre harvested, quadratic mean diameter, and acreage on per ton cut and load rate.

When the average tract characteristics from the sales data were used in the cost model, few trends were apparent in the data with regards to cost impacts over the period studied (Figure 7). The higher rate for partial cuts was a result of a smaller average tree size and fewer tons harvested per acre. The implication appeared to be that shifts in the characteristics of harvested tracts have not yet had a large impact on average harvesting costs across the Southeast. While quarterly fluctuations have been high at times, the long-term average has not shifted appreciably. Other researchers have found substantial cost increases for harvesting contractors over the same timeframe (e.g. Stuart et al. 2008). These data suggest that harvesting cost increases would be driven by shifts in component costs (e.g. labor, fuel, etc.), as reported by Stuart, et al. (2008), more so than changes in tract characteristics.
Figure 7. Quarterly changes in modeled cut and load rates based on average harvest tract characteristics from the 4th quarter 2000 through 4th quarter 2008.

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Literature Cited


