Pitfalls of Interpreting Hardwood Inventory Statistics

by

William G. Luppold and William H. McWilliams

Abstract

Forest inventory statistics have been increasingly used to justify greater utilization of the eastern hardwood resource and/or to evaluate the sustainability of expanding demand for hardwood roundwood and sawtimber. This paper examines statistics compiled by the USDA Forest Inventory and Analysis (FIA) units and demonstrates how they can be misinterpreted. For example, the total fiber supply can be underestimated when cull trees are excluded from estimates of growing stock and sawtimber. Also, the improper use of annualized growth and removal data can result in a distorted representation of sustainable harvest levels. Those who use FIA statistics on a regular basis should have a complete understanding of their underlying definitions to avoid drawing erroneous conclusions.

INTRODUCTION

Forest inventory statistics developed by the USDA Forest Service Forest Inventory and Analysis (FIA) units are used by a variety of customers. In recent years this information has become available over the Internet, allowing almost anyone with a modem easy access. This ease of access occurs at a time when numerous issues related to hardwood utilization are the subject of intense debate. The combination of easy access and divisive hardwood utilization issues makes it critical that persons who use inventory information understand the meaning of these statistics prior to drawing conclusions concerning resource sustainability.

The objective of this paper is to present two points concerning resource statistics that should be of interest to persons examining hardwood resource statistics. The first is what the term "growing stock" actually encompasses. The second is to explain the meaning and interpretation of "annualized estimates of growth and removal." Before examining these subjects, a brief review of the accounting procedures associated with measuring sawtimber and growing stock needs to be presented.

THE ACCOUNTING OF SAWTIMBER AND GROWING STOCK

The FIA definition of "growing stock" includes trees of commercial species that are at least 5.0-inches in diameter at breast height (dbh) and have the potential to develop into sawtimber. Hardwood trees are considered sawtimber if they are at least 11.0-inches dbh and contain at least one 12-foot sawlog or two noncontiguous 8-foot logs. In addition, one-third of the sawlog portion must be free from defect, such as rot or poor form. In assigning volumes to growing stock trees, cull portions of the merchantable bole or sawlog are deducted-hence the term "net volume." Trees not considered as growing stock include "rough" and "rotten" trees. Rough trees do not contain a sawlog or potential sawlog primarily due to sound cull, e.g., limbiness or sweep. Rotten trees do not contain a sawlog or potential sawlog primarily due to unsound cull portions.

Gross growth of growing stock and sawtimber volume is the sum of ingrowth, growth on mortality, growth on removals, accretion, and cull increment/decrement. Growing-stock ingrowth includes the volume of trees that have grown to the 5-inch merchantable threshold since the previous measurement. Similarly, hardwood sawtimberingrowth occurs when trees less than 11 inches dbh cross the threshold to sawtimber size. Accretion is the increase in volume of trees already in the growing-stock or sawtimber inventory. Cull increment/decrement represents the net difference between the volume of trees entering and departing cull-tree status. For inventories conducted over the last decade, the volume of trees previously classified as cull trees that are subsequently reclassified as growing stock (cull decrement) has far outweighed the volume of trees that become cull (cull increment). This reclassification has resulted from a gradual change in the interpretation of the definition for growing stock. Net growth of growing stock and sawtimber is defined as gross growth minus mortality. Mortality includes the volume of trees that died since the previous measurement. However, there are subtle differences in mortality estimates between FIA units.

The FIA unit at the Northeastern Research Station (NE) estimates mortality volume using tree
measurements from prior inventories. There is no attempt to account for growth that occurred between the previous measurement and the actual time of death. In measuring growth on mortality, FIA units at the North Central (NC) and Southern (SO) Stations record estimated time of death, allowing a volume estimate at the time of death.

Net change in growing stock and sawtimber volume is equal to net growth minus timber removals. Timber removals are estimated by accounting for all trees harvested since the previous inventory. Another form of timber removal is associated with timberlands that shift to other land uses. The volume of trees on land that changes use classification is included in the estimate of timber removal. As with mortality, the NE FIA unit does not attempt to compute growth on removals, while the NC and SO units estimate growth prior to removal.

Average annual growth and removal are estimated by dividing total net growth or removals since the prior survey by the elapsed time between measurements. Such estimates represent the period between successive inventories rather than a given year.

Problems can arise in interpreting FIA statistics if users take the narrow view that growing-stock inventories are fully representative of forest resources. This will result in underestimates of timber availability, particularly if the intent is to examine total fiber. The volume of cull trees should be considered as part of the overall fiber resource. Pennsylvania’s most recent inventory included nearly a million cubic feet of cull-tree volume (Aleerich 1993). Missouri’s last inventory showed a high proportion of hardwood cull trees -- 45 percent of sawtimber-size hardwood trees reported as cull (Hahn and Spencer 1991).

The percentage of cull trees also changes by tree diameter (Table 1). In West Virginia, the percentage of cull hardwoods decreases as diameter increases, then it reaches a low point and then increases again. The high percentage of cull trees in the largest diameter classes likely represents a build-up of "wolf trees" that have been passed over repeatedly by loggers. This increase following a decrease in percent cull is common in most eastern states. A major exception is Missouri where percent cull increases across the range of diameters.

Table 1.-- Percent of trees classified as cull by diameter class in West Virginia and Missouri in 1989

<table>
<thead>
<tr>
<th>Diameter class (inches)</th>
<th>Cull trees in West Virginia</th>
<th>Cull trees in Missouri</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 to 6.9</td>
<td>15.5</td>
<td>35.5</td>
</tr>
<tr>
<td>7 to 8.9</td>
<td>10.4</td>
<td>37.7</td>
</tr>
<tr>
<td>9 to 10.9</td>
<td>6.4</td>
<td>39.0</td>
</tr>
<tr>
<td>11 to 12.9</td>
<td>7.9</td>
<td>41.1</td>
</tr>
<tr>
<td>13 to 14.9</td>
<td>6.9</td>
<td>41.8</td>
</tr>
<tr>
<td>15 to 16.9</td>
<td>11.6</td>
<td>44.7</td>
</tr>
<tr>
<td>17 to 18.9</td>
<td>11.8</td>
<td>49.6</td>
</tr>
<tr>
<td>19 to 20.9</td>
<td>13.7</td>
<td>55.8</td>
</tr>
<tr>
<td>21 to 28.9</td>
<td>17.7</td>
<td>63.2</td>
</tr>
<tr>
<td>Over 29</td>
<td>34.3</td>
<td>66.7</td>
</tr>
</tbody>
</table>

1 From DiGiovanni 1990 and Hahn and Spencer 1991

The reclassification of cull trees as growing stock can influence estimates of net growth. West Virginia's 1989 inventory reported cull decrement that was 12 percent of the net growth of growing stock compared to 16 percent for ingrowth (DiGiovanni 1990). Also cull decrement can vary considerably by species. In West Virginia, cull decrement was 20 percent of the net growth for other white oaks (mostly chestnut oak) but only 3 percent of the net growth of yellow-poplar.

It should be noted that annual estimates are only averages for the period between inventories. Although they do not necessarily reflect current conditions, they often are interpreted as such. This can lead to misinterpretation because growth, removals, and mortality vary over time. Growth changes as levels of accretion and ingrowth fluctuate. In recent decades, eastern hardwood forests have matured gradually. Ingrowth to sawtimber has been especially high as hardwood trees have grown to the 11.0-inch threshold. In the future, the level of ingrowth may decline as a greater percentage of the growing stock exceeds 11 inches.

Since the relationship between growth and removals often is used to gauge resource sustainability, it is important that these estimates be interpreted accurately. The tendency of the NE FIA unit to underestimate net growth by not computing for growth on mortality and removals should be considered when analyzing these data. Users of survey data also should be aware that future increases...
TABLE 2.-- Estimates of hardwood sawtimber removals and sawtimber production for West Virginia.

<table>
<thead>
<tr>
<th>Survey period</th>
<th>Average annual sawtimber removals</th>
<th>Reporting year</th>
<th>Estimated sawtimber production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-74</td>
<td>405.3</td>
<td>1965</td>
<td>470.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1974</td>
<td>446.4</td>
</tr>
<tr>
<td>1975-89</td>
<td>411.4</td>
<td>1987</td>
<td>556.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1994</td>
<td>794.4</td>
</tr>
</tbody>
</table>


in sawtimber inventory may be more moderate than in the past.

It also is important to understand the relationship between periodic averages and trends in annual removal. In regions where timber removals are increasing, FIA removals likely will be lower than single-year estimates of timber production for years toward the end of the period, so it is critical that average annual estimates be extrapolated correctly when estimating future demand.

Table 2 compares FIA’s estimates of average sawtimber removals for 1961 to 1974 and 1975 to 1989 (Bones 1978, DiGiovanni 1990) with estimates of timber product output (TPO) for West Virginia for 1965, 1974, 1987, and 1994 (Bones and Glover 1977, Widmann and Murriner 1990, Widmann et al. 1998). Estimated production of sawtimber reported in the TPO studies are higher than estimated average removals. The reason for this is that FIA’s sawtimber removals are for the sawlog portion of hardwoods at least 11 inches in diameter. The annual surveys can include removals of sawtimber volume in trees less than 11 inches, cull trees, and non sawlog portions. The considerable increase in sawtimber removals that occurred in West Virginia during the late 1980’s also is shown in Table 1. We can assume that the margin between FIA’s average estimate for 1975 to 1989 and annual removals for latter years has continued to expand.

A final consideration when interpreting FIA statistics for timber availability is that these data must be tempered with information from other sources. Actual availability of timber depends on other factors e.g., owner attitudes, accessibility constraints, and operability limits. For example, a recent final consideration when interpreting FIA statistics for timber availability is that these studies of owner characteristics in West Virginia reported that 36 percent of private forest-land owners, who controlled 10 percent of the forest land, indicated they would not harvest timber during the next decade (Birch 1996).

IMPLICATIONS AND CONCLUSIONS
Depending on the type of roundwood product and the state it is grown in, direct interpretation of FIA statistics in the analysis of changes in demand may underestimate or overestimate resource availability. In Missouri an analysis of the impact of increased pulp chip production does not take into consideration the great amount of cull timber suitable for chip production, the impact of the state’s mills on the sawtimber and growing-stock resources might be overstated. Likewise, if an analysis of northern red oak sawtimber harvested in West Virginia fails to recognize that future growth volumes of this species may come from accretion rather than ingrowth, long term supplies of red oak might be overestimated.

Estimates of annualized growth and removal that are taken out of context could create the false impression that new industry can be supported. Over the last 20 years, much of the increase in growing-stock volume is the result of accretion while most of the increases in sawtimber are the result of ingrowth. Cull decrement also has been a source of increased growing stock of volumes in some states. As the resource ages, increased sawtimber volume will be from accretion and decreased volumes will be from ingrowth, thus slowing net growth.
The growth in sawmill size is an indicator that industries in hardwood producing states have adjusted to this increase; in turn, production and mill size have increased (Luppold 1996, Luppold and Dempsey 1989, Luppold and Dempsey 1994). Encouraging industrial expansion at a time when sawtimber production is increasing while ingrowth may be decreasing could affect sustainability. This does not mean that eastern forests cannot sustain additional demand but that one must be careful when analyzing the impact of potential new demands.

LITERATURE CITED


