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West Virginia Harvest and Utilization Study, 2008

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Abstract

Thirty active harvesting operations were part of a harvest and utilization study conducted in West Virginia in 2008. Data were collected on roundwood product and residue yields obtained from trees of different sizes, species, and qualities. This study was modeled after studies conducted on a regular and frequent basis by the Forest Inventory and Analysis unit in the Southern Research Station. Of the total volume harvested during this study, 88 percent was utilized and 12 percent was considered unutilized. Of the hardwood logging residue measured, 56 percent was from non-growing-stock sections of the trees—e.g., tops, limbs, and stumps. The other 44 percent was unutilized growing-stock sections including upper stems and saw log-sized material. When the harvest utilization factors estimated in this study are applied to Forest Inventory and Analysis estimates of total harvest volume for West Virginia in 2008, a statewide hardwood logging residue estimate of 35.5 million cubic feet is obtained.

Cover Photos

Logging operations on national forests. Clockwise from top left, U.S. Forest Service employee Neal Bennett bucking a log with a chain saw on Allegheny National Forest, 2005; felled tree showing stump with stump pull, Jefferson National Forest, 2007; log loader, Jefferson National Forest, 2007; logged area with harvest residue, Jefferson National Forest, 2007. Photos by Jan Wiedenbeck, U.S. Forest Service.

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INTRODUCTION

Estimates of forest resource utilization have become increasingly important in West Virginia. These estimates are typically the first data source sought by parties interested in developing new forest products enterprises, especially those dealing with bioenergy. The U.S. Forest Service has been tracking this information in the Southern Region for some time, but very little new information is available for other areas in the United States. Information provided by the U.S. Forest Service related to the forest and timber resources in West Virginia comes from three primary areas: (1) forest inventory plots, which quantify change by growth, mortality, and removals; (2) mill surveys, which estimate the level of resources being consumed by primary wood products facilities (sawmills, pulpmills, engineered product mills, etc.); and (3) logging utilization research, which is used to quantify the amount of harvested roundwood delivered to market versus the amount that is left in the woods.

This bulletin details the findings of a 2008 harvest and utilization study in West Virginia. The objective of this project was to investigate roundwood utilization rates on timber harvests in West Virginia.

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METHODS

To quantify roundwood utilization in West Virginia, 30 active timber harvests were sampled during the summer and early fall of 2008. The harvest sites to be sampled were obtained from West Virginia Division of Forestry logging notification forms. In West Virginia, the notification of timber harvesting is mandated under the 1992 Logging Sediment Control Act (Grushecky et al. 2006). To reduce variability due to species composition, harvest type, and terrain, harvests were stratified based on the three U.S. Forest Service Forest Inventory and Analysis (FIA) units (Alderman and Luppold 2005). About 20 harvests from each of the FIA units were randomly selected from the overall harvest population. A greater number of delineated sites were needed due to harvest completions, permission problems, and size constraints, which limited the feasibility of completing sampling on some of the harvest sites. Ultimately, 30 sites were sampled during the study period but despite our best efforts, the distribution of sampling sites among regions was not even, with the southern region's sample being smaller than that of the other two regions (Fig. 1).

The sampling methodologies used at each site were patterned after the techniques used by the U.S. Forest Service Southern Research Station (Bentley and Johnson 2009) and data collection field crews received in-woods training by both Bentley and Johnson. It should be noted that

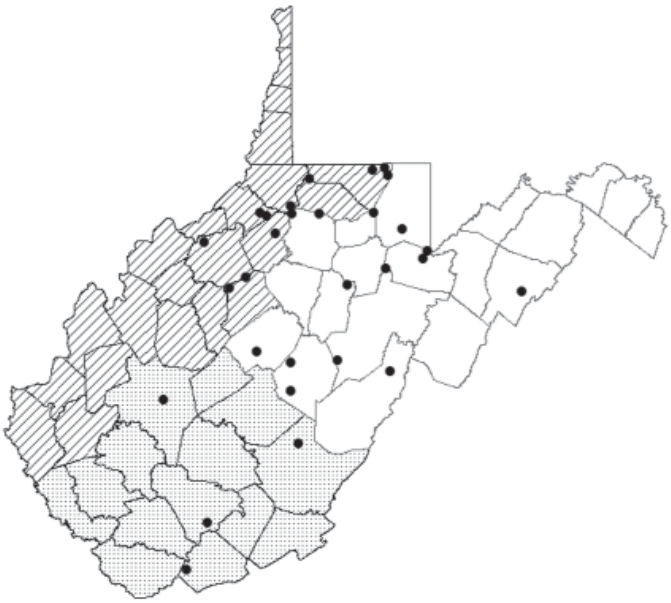

Figure 1.—Harvest operations, West Virginia, 2008. Three FIA units are depicted through shading.

in utilization studies conducted by the former North Central Research Station, when residual trees located proximal to sample trees were killed by the felling of the sample trees, the residual trees killed were tallied as logging residue. Using the Southern Research Station's methodology, only trees scheduled for harvest were included in the utilization tally in this study. Therefore, the collateral damage component of logging residue/loss is not captured here. The goal for each of the 30 sites was to sample 30 felled trees for utilization. Because of weather, equipment, and/or personnel issues, 30 trees were not sampled on all sites. Utilization information was collected when the tree was felled and subsequently merchandised in the woods as well as when the tree was bucked and prepared for market at the landing.

Once an active harvest site was chosen, field crews met with the logging supervisor before data collection commenced. The following information was recorded at each site:

- Global position system (GPS) coordinates of landing
- Type and specification of all product markets (saw logs to 10-inch top, veneer logs to 14-inch top, pulpwood to 3-inch top, etc.)
- Number of active loggers on each site
- Number of truckloads leaving site each day
- Location of all product markets
- Forester involvement (timber was/was not marked and sold by a forester)
- Type of logger (contractor, independent, company)
- Harvest type ("fully mechanized" in which a mechanical harvester, grapple skidder, and bucking saw are used or "not fully mechanized")
- Equipment specifications

The field crew then noted the current location of harvesting within the tract and the general direction of harvest progression. With this information, the field crew members could be positioned a safe distance from harvesting while the logging crew could fell several trees in a given area. Once the trees were felled, the field crew collected the following data **for each tree** (Fig. 2; numbers refer to items in diagram):

1. Species
2. Stump height
3. Stump diameter
4. Diameter at 12-inch stump height
5. Diameter at breast height (d.b.h.), measured at 4.5 feet above ground
6. Diameter at 16-foot log
7. Diameter and distance to topping point (end of utilization determined by logger) in woods
8. Diameter and distance to saw log top for sawtimber-size trees (7 inches for softwoods and 9 inches for hardwoods)
9. Diameter and distance to 4 inches top of main stem
10. Cull information (%)
11. Large and small end diameters and length for each portion of the felled tree remaining as long as they met a 4-inch diameter and 8-inch length minimum
12. Utilization (binary) of each measured piece
13. Product class of tree (saw log, peeler, pulpwood, etc., based on type of product obtained from the butt log)

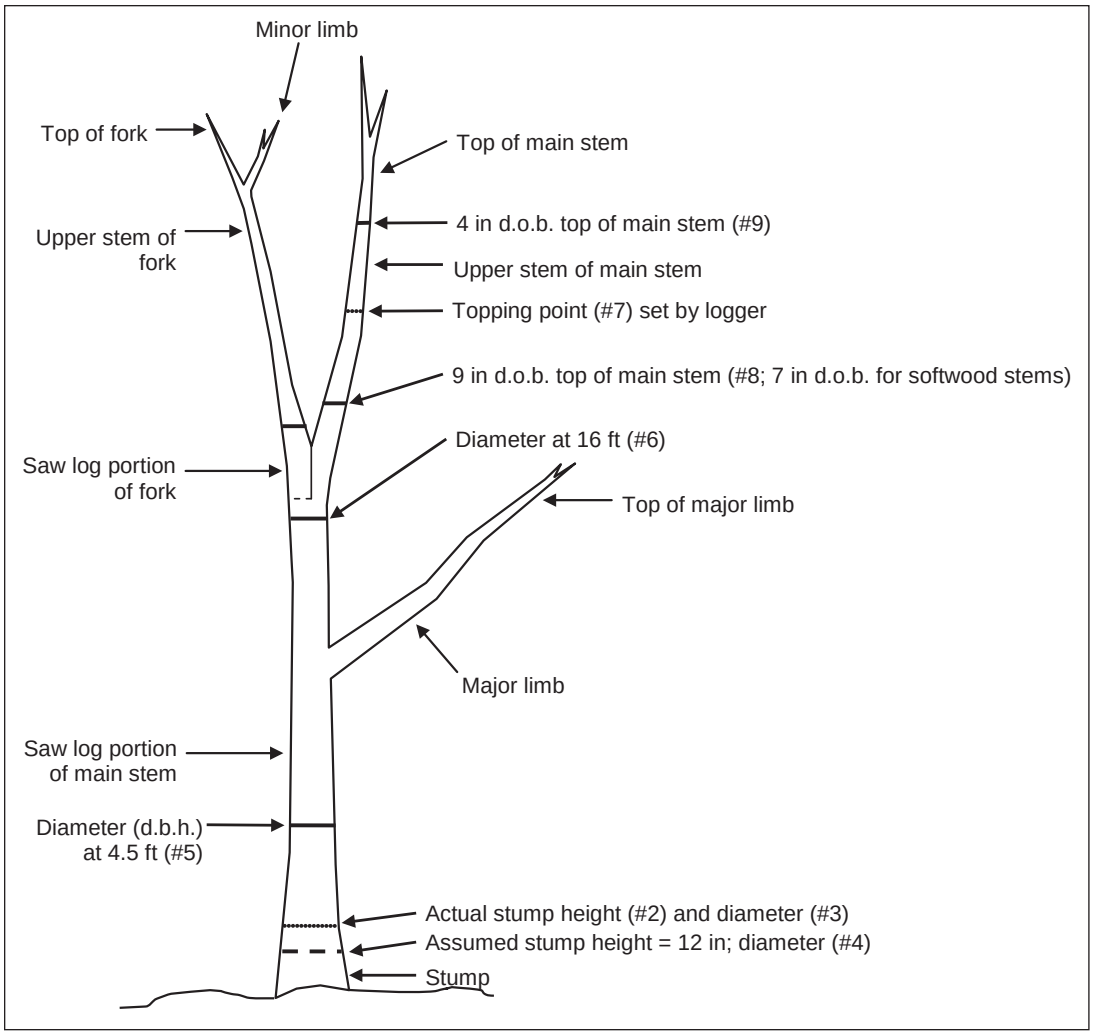

Figure 2.—Stem sections and measurement locations taken on trees after felling. The numbers in parentheses correspond to the numbers on the list of types of data collected by the field crew.

With these data, a number of useful metrics were calculated, including growing- and non-growing-stock volume as well as percent under- and overutilization. Growing-stock volume, as defined by FIA merchantability standards, is the volume in the main stem of a 5.0-inch d.b.h. or larger tree from a 1-foot stump to a 4-inch top minus deductions for cull. Volume merchandised outside of these parameters is considered non-growing-stock volume. All volume in: 1) the 1-foot stump; 2) the main tree stem above the 4-inch top to the growing tip of the tree; and 3) in all limbs 4 inches and larger and at least 5 feet long are considered non-growing stock according to FIA definition (Bentley and Johnson 2009).

Typically, trees are not cut at a height above the ground of exactly 1 foot, nor are they cut off at exactly a 4-inch diameter top. Trees cut above a 1-foot stump and below a 4-inch top would be considered underutilized, and that volume not utilized would be considered growing-stock residue. On the other hand, by FIA standards, trees cut below a 1-foot stump and above a 4-inch top are considered 100 percent utilized, and those portions below and above are considered overutilization. A myriad of combinations actually occur on active harvest operations. The aggregated volume from measured trees provides the overutilization and underutilization factors that can be applied to statewide inventory results for an estimate of growing-stock and non-growing-stock logging residues (Bentley and Johnson 2009). The top of the saw log portion of sawtimber size trees of each stem (7 inches in softwoods and 9 inches in hardwoods) also was recorded so that both saw log and upper stem portions of the growing-stock section could be determined.

HIGHLIGHTS

Characteristics of Harvested Trees in West Virginia in 2008

Research results provide reliable estimates of the species mix, tree size (as defined by average d.b.h. and bole length to merchantable tops), product markets, and overall utilization rates on current harvest sites in West Virginia. In this study, 816 trees were sampled at 30 harvest sites. Yellow-poplar was the most commonly sampled tree, followed by red maple and red oak. Black walnut, in comparison, represented only 0.1 percent of the sample (Table 1).

To aid in data interpretation, individual species were grouped by species group based on physical attributes and forest products markets (Table 2). The yellow-poplar species group was most prevalent, followed by the white oak, soft maple, and red oak species groups. The cherry and soft-hardwood species groups were least prevalent, representing only 3.4 and 2.0 percent of the samples, respectively.

The average d.b.h. of trees sampled in 2008 in West Virginia was 16.9 inches (± 4.5 inches). On average, the red oak species group had the largest d.b.h. at 18.9 inches, followed by the hard maple (18.3 inches), and cherry species groups (18.1 inches) (Table 3). Stumps, by FIA standards, are measured from the ground to the top of the stump on the uphill side of the bole. In certain circumstances, loggers try to maximize the volume harvested by cutting trees as close to the ground as possible. However, in species that tend to have substantial butt flare, such as red oak, short stumps can

Table 1.—Trees sampled on 30 active timber harvests in West Virginia by species and percent of total in 2008

Species Common name	Scientific name	Number	Percent
Yellow-poplar	*Liriodendron tulipifera*	208	25.5
Red maple	*Acer rubrum*	114	14.0
Black/red oak	*Quercus velutina* Quercus rubra	78	9.5
Chestnut oak	*Quercus prinus*	76	9.3
White oak	*Quercus alba*	73	8.9
Sugar maple	*Acer saccharum*	52	6.4
Eastern white pine	*Pinus strobus*	39	4.8
Hickory spp.	*Carya* spp.	39	4.8
American beech	*Fagus grandifolia*	34	4.1
Black cherry	*Prunus serotina*	28	3.4
Eastern hemlock	*Tsuga canadensis*	17	2.1
White ash	Fraxinus americana	16	2.0
Cucumber	*Magnolia acuminata*	9	1.1
Black birch	*Betula lenta*	7	0.9
Black locust	*Robinia pseudoacacia*	5	0.6
American basswood	*Tilia americana*	4	0.5
Black gum	*Nyssa sylvatica*	4	0.5
Sassafras	*Sassafras albidum*	4	0.5
Bigtooth aspen	*Populous grandidentata*	3	0.4
Paper birch	*Betula papyrifera*	3	0.4
Pine spp.	*Pinus* spp.	2	0.2
Black walnut	*Juglans nigra*	1	0.1
Total trees sampled		816	100

cause problems as the logs are processed up the supply chain. The average stump height for all species was 9.8 inches (± 7 inches). On average, the white oak species group had the highest stumps at 11 inches (± 10.1 inches). The softwood and hickory species groups had the lowest average stump diameter measured at 7.3 inches. The overall average stump diameter was 20.6 inches (± 5.6 inches). The red oak species group had the largest average stump diameter, followed by the white oak and hard maple species groups. The soft-maple species group had the smallest average stump diameter (Table 3).

The merchantable bole length is the distance between a 1-foot stump and a 4-inch top (diameter outside bark or d.o.b.). For hardwood trees, bole length can be influenced as much by tree growth form as it can be by product market. For the trees sampled in this study, the average bole length to a 9-inch d.o.b. saw log top (the minimum top diameter for a hardwood saw log) was 49.8 feet (±24.2 feet). Yellow-poplar had the highest average bole length to a 9-inch top, followed by the red and white oak species groups. The average bole length to at least a 4-inch merchantable top was 69.4 feet (±4.5 feet). Again, yellow-poplar stems had the largest bole length to a 4-inch top followed by the red oak and soft hardwoods species groups. The mixed hardwoods species group had the shortest overall length to a 9-inch and 4-inch top (Table 4).

The end of utilization, or bucking point, represents the diameter at which the loggers severed the main stem from the top in the woods before transport to the landing. The average bucking diameter for all of the stems measured was 9.4 inches (±3.9 inches). The red oak species group had the largest diameter at the end of utilization at 11.5 inches, followed by hard maple at 11.3 inches. The softwood group had the smallest diameter at the end of utilization point at 5.9 inches (Table 5).

Table 2.—Trees sampled on 30 active timber harvest in West Virginia by species group and percent of total, 2008

Species group[a]	Number	Percent
Yellow-poplar	208	25.5
White oak	149	18.2
Soft maple	114	14.0
Red oak	78	9.5
Mixed hardwoods	74	9.1
Softwoods	58	7.1
Hard maple	52	6.4
Hickory spp.	39	4.8
Cherry	28	3.4
Soft hardwoods	16	2.0
Total trees samples	816	

[a] Definition of species groups: yellow-poplar includes only yellow-poplar; white oak includes white and chestnut oak; soft maple includes only red maple; red oak includes red and black oaks; mixed hardwoods includes American beech, white ash, black birch, black locust, black gum, sassafras, paper birch, and black walnut; softwoods includes hemlock and various members of the *Pinus* genera; hard maple includes only sugar maple; hickory spp. includes all hickories; cherry includes only black cherry; and soft hardwoods includes cucumber, American basswood, and bigtooth aspen.

Table 3.—Average diameter at breast height (d.b.h.), stump height, and stump diameter of trees sampled on 30 active timber harvests in West Virginia, 2008 (standard deviation in parentheses). Bold font is used to highlight the largest and smallest averages for each attribute.

Species group	D.b.h. (inches)	Stump height (inches)	Stump diameter (inches)
Cherry	18.1 (±2.9)	9.7 (±2.2)	20.9 (±4.7)
Hickory spp.	15.6 (±3.0)	**7.3** (±5.7)	20.8 (±4.1)
Hard maple	18.3 (±4.5)	10.7 (±5.0)	21.8 (±6.3)
Mixed hardwoods	15.4 (±3.5)	10.4 (±5.5)	18.4 (±4.1)
Softwoods	15.1 (±5.5)	**7.3** (±4.5)	18.8 (±7.0)
Red oak	**18.9** (±4.1)	9.8 (±7.3)	**24.7** (±5.8)
Soft hardwoods	16.7 (±3.3)	10.6 (±5.1)	19.5 (±4.8)
Soft maple	**14.8** (±4.1)	9.1 (±3.3)	**17.4** (±4.9)
White oak	17.7 (±5.0)	**11.0** (±10.1)	22.0 (±4.8)
Yellow-poplar	17.5 (±4.2)	10.0 (±7.6)	20.8 (±5.5)

Table 4.—Average bole lengths to a 9-inch saw log top and 4-inch merchantable top by species group, of trees sampled on 30 active timber harvests in West Virginia, 2008 (standard deviation in parentheses). Bold font is used to highlight the largest and smallest averages for each attribute.

Species group	Bole length to 9 inch saw log top (feet)	Bole length to 4 inch merchantable top (feet)
Cherry	49.7 (±11.2)	65.9 (±11.4)
Hickory spp.	46.2 (±13.6)	69.1 (±10.6)
Hard maple	48.8 (±15.3)	68.2 (±13.6)
Mixed hardwoods	**37.6** (±15.9)	**57.3** (±15.1)
Softwoods	41.4 (±27.3)	64.6 (±21.1)
Red oak	53.7 (±15.5)	74.4 (±13.8)
Soft hardwoods	50.9 (±16.2)	69.4 (±13.8)
Soft maple	38.7 (±15.4)	58.6 (±13.9)
White oak	51.8 (±39.8)	68.7 (±12.3)
Yellow-poplar	**60.3** (±16.0)	**80.3** (±15.1)

Table 5.—Average end-of-utilization diameter (standard deviation) by species group of trees sampled on 30 active timber harvests in West Virginia, 2008. Bold font is used to highlight the largest and smallest averages.

Species group	End of utilization diameter (inches)
Cherry	9.4 (±3.2)
Hickory spp.	9.4 (±3.3)
Hard maple	11.3 (±4.6)
Mixed hardwoods	8.7 (±3.3)
Softwoods	**5.9** (±3.3)
Red oak	**11.5** (±3.9)
Soft hardwoods	10.7 (±2.6)
Soft maple	8.3 (±3.4)
White oak	10.2 (±4.3)
Yellow-poplar	9.4 (±3.6)

Of the 816 harvested trees sampled for utilization in this study, only 58 were softwoods (7.1 percent). Softwoods composed 6.4 percent of the harvested tree volume (Table A2) and 7.0 percent of the utilized volume. The softwood proportion of the tree sample in this study is similar to that noted in Widmann et al. (2007) based on 2000 forest inventory data with only 6 percent of West Virginia's sawtimber resource in softwood species. The softwood component of the utilized roundwood volume captured in this study was, however, 4 percent higher than the proportional softwood volume of industrial roundwood processed by primary processors in the state in 2007 (Piva and Cook 2011).

Due to the small size of the softwood sample, "saw logs" was the only class for which utilization factors could be independently evaluated. For hardwoods, three product classes are evaluated: saw logs, peelers (for veneer), and pulpwood (Table 6). In distinguishing these product classes, logs that were being sold to a scragg sawmill and those to be manufactured into posts and rails were included in the saw log category.

As expected, the average d.b.h. of hardwood trees classified as saw log trees was larger than that of peeler trees which was larger than that of pulpwood trees (Table 6). The actual or residual stump height of peeler

Table 6.—Average diameter at breast height (d.b.h.), stump height, and bole length to 4-inch top, by species group and product, of trees sampled on 30 active timber harvests in West Virginia, 2008

	Saw logs			Peelers			Pulpwood		
Species group	Average d.b.h. (inches)	Average stump height (inches)	Average bole length (feet)	Average d.b.h. (inches)	Average stump height (inches)	Average bole length (feet)	Average d.b.h. (inches)	Average stump height (inches)	Average bole length (feet)
Hardwood	18.1	10.2	71.8	16	8.2	79.8	13.3	9.9	55.9
	n=538 trees			n=65 trees			n=137 trees		
Softwood[a]	15.8	7.8	66.3	--	--	--	--	--	--
	n=56 trees								

[a] Total number of trees shown does not sum to 816 because softwood peeler and pulpwood logs are not included in these calculations due to insufficient sample sizes.

trees was slightly lower than that of pulpwood and saw log trees (Table 6). Peeler logs in West Virginia are yellow-poplar—a species that grows very straight and has minimal butt flare, thus is more easily felled with a low stump than are trees with form irregularities. The average bole length of the trees classed as peeler trees was longer than the bole length measured for saw log trees, which was longer than the bole length of pulpwood trees. Again, the straight form of yellow-poplar peeler logs leads to longer, unbranched bole sections for this product class.

Total Removals

A total of 73,478 cubic feet was sampled during this project. About 66,160 cubic feet (90 percent) was considered growing-stock volume (volume of tree found in main stem from 1-foot stump to 4.0-inch top diameter d.o.b.). Of the total volume harvested, 88 percent was utilized and 12 percent was considered unutilized (Fig. 3).

Of the 12 percent of the harvested tree volume that was unutilized, 55 percent was non-growing stock and 45 percent was considered growing-stock volume (Fig. 3). Of the unutilized growing-stock volume, 53 percent met saw log specifications (making up 24 percent of the total unutilized volume) and 47 percent were upper stems (21 percent of total unutilized volume) (Fig. 3). Of the unutilized non-growing-stock volume, 95 percent was found in tops with the remaining 5 percent (2 percent of total unutilized volume) in stumps. When considering only growing-stock volume, or the volume in the main stem between a 1-foot stump and 4-inch top, 94 percent of the harvested volume was utilized (Fig. 4). These relationships are further detailed in tables found in the Appendix.

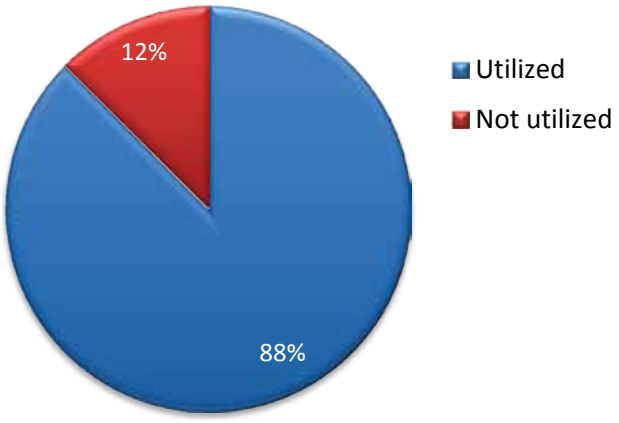

Figure 3.—Disposition of total harvest volume, West Virginia, 2008. Total volume of all trees was 73,500 ft^3. For hardwood species, the volume utilization was 87 percent while for softwoods it was 96 percent.

Hardwood Removals

Since the hardwood volume (71,198 cubic feet) for the West Virginia utilization study was 93 percent of the total sample volume, the utilization percentages for the hardwood component are very similar to the overall percentages. As noted in Figure 2, 87 percent of the hardwood volume harvested as part of this study was utilized leaving 13 percent of the harvested volume as logging residue. Of the 63,608 cubic feet of hardwood growing stock volume, 93.5 percent was utilized. Of the 9,214 cubic feet of hardwood logging residue measured at these 30 harvest operations, 56 percent was from non-growing stock sections of the trees—e.g., tops, limbs, and stumps. The other 44 percent was unutilized growing stock sections including upper stems and saw log sized material. By comparison, Bentley and Johnson

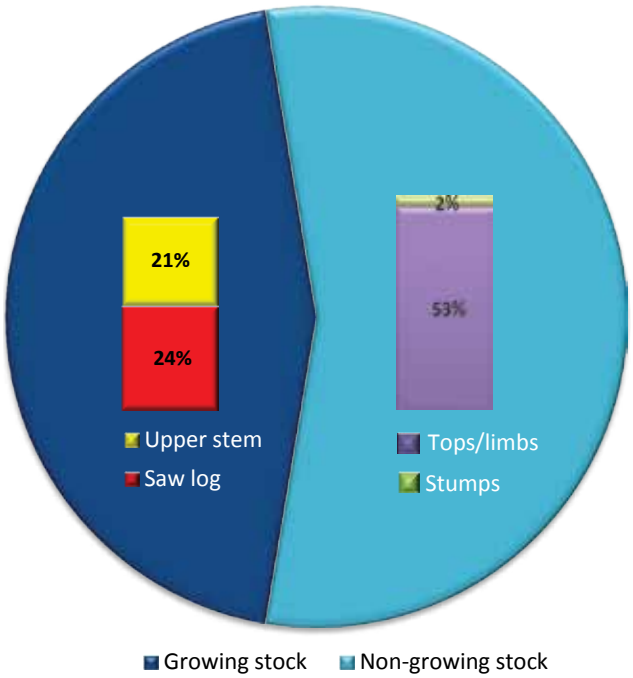

Figure 4.—Unutilized volume (residue) in growing- and non-growing-stock segments of harvested trees, West Virginia, 2008.

Table 7.—Comparison of factors for estimating total tree volumes and growing-stock volumes that must be harvested to produce a unit (e.g., 1,000 ft^3) of green roundwood product and a factor for estimating the amount of harvest residue generated for each unit of roundwood produced. Bold font is used to highlight the factors obtained in this study for West Virginia.

Reference study	Roundwood delivered to primary processor	Total tree volume removal factor	Growing stock removal factor	Harvest residue factor
		ALL SPECIES		
Virginia 2007[a]	1.0	1.22	1.04	0.22
North Carolina 2007[b]	1.0	1.22	1.05	0.22
West Virginia 2008[c]	**1.0**	**1.14**	**1.03**	**0.14**
Michigan 1998[d]	1.0	1.28	0.94	0.28
Minnesota 1975-1976[e]	1.0	1.19	0.96	0.19
		HARDWOODS		
Virginia 2007[a]	1.0	1.27	1.06	0.27
North Carolina 2007[b]	1.0	1.31	1.10	0.31
West Virginia 2008[c]	**1.0**	**1.15**	**1.03**	**0.15**
Michigan 1998[d]	1.0	1.26	0.93	0.26
Minnesota 1975-1976[e]	1.0	1.22	0.95	0.22

[a]Bentley and Johnson 2009
[b]Bentley and Johnson 2010
[c]This study…factors are based on calculations using numbers from Table A1.
[d]Haugen and Weatherspoon 2003
[e]Blyth and Smith 1979

(2009, 2010) determined that 68 percent and 61 percent, respectively, of the woody harvest residue left in harvest operations in Virginia and North Carolina in 2007 was from non-growing stock sources. Similar to the North Carolina 2007 results, the proportionally higher growing-stock component of harvest residues found in this study for West Virginia is attributable to a greater volume of saw log material that was not utilized (54 percent saw logs and 46 percent tops and limbs).

For West Virginia in 2008, FIA reports that annual hardwood removals of all live trees was 334 million cubic feet of which 282 million cubic feet (84 percent) was growing stock removals (U.S. Forest Service 2013). Using FIA's EVALIDator tool (U.S. Forest Service 2013) we can estimate that 81.76 percent of total hardwood removals of live trees were harvest removals (as opposed to trees killed but not utilized and trees associated with land-use reclassifications). The statewide estimate of hardwood logging residues for 2008 is obtained by multiplying 334 million cubic feet by the harvest removal factor from EVALIDator and then by this study's hardwood residue factor of 0.13 (unutilized portion of harvested hardwood trees) (Fig. 2). This approach provides an estimate of 35.5 million cubic feet of hardwood logging residue for West Virginia in 2008.

Removal Factors for West Virginia, 2008

Tables A1 through A7 in the Appendix provide utilization volumes and percentages by wood type, source, and species group. Utilization factors calculated from these numbers can be used to predict the amount of woody material of different types that will need to be harvested to obtain 1,000 cubic feet of product (before shrinkage). These factors can be applied to timber products output data that is collected periodically for different states to estimate harvest-based removals from forest inventory, or to estimate the amount of harvest residue generated. Table 7 shows two utilization factors derived from this study (bold font) alongside those from other studies in the eastern region. By using data from other tables found in the Appendix, more specific utilization factors for various species, products (saw logs vs. peelers vs. pulpwood), and tree classes (sawtimber vs. poletimber) can be calculated.

Table 7 should be interpreted as follows:

- For every unit (e.g., cubic foot) of green roundwood delivered to a primary processor, multiply by the total tree volume removal factor to determine total tree volume required to produce that unit of roundwood product.
- For every unit of green roundwood delivered to a primary processor, the amount of growing stock that is removed to obtain the roundwood product is estimated by multiplying by the growing stock removal factor.
- For every unit of green roundwood delivered to a primary processor, the amount of residue generated in producing that roundwood product is estimated by multiplying by the residue generation factor.

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GLOSSARY[1]

Growing-stock removals. The growing-stock volume removed from poletimber and sawtimber trees in the timberland inventory. (Note: Includes volume removed for roundwood products, logging residues, and other removals.)

Growing-stock trees. Living trees of commercial species classified as sawtimber, poletimber, saplings, and seedlings. Growing-stock trees must contain at least one 12-foot or two 8-foot logs in the saw-log portion, currently or potentially (if too small to qualify). The log(s) must meet dimension and merchantability standards and have, currently or potentially, one-third of the gross board-foot volume in sound wood.

Growing-stock volume. The cubic-foot volume of sound wood in growing-stock trees at least 5.0 inches d.b.h. from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem.

Hardwoods. Dicotyledonous trees, usually broadleaf and deciduous.

> *Soft hardwoods.* Hardwood species with an average specific gravity of 0.50 or less, such as gums, yellow-poplar, cottonwoods, red maple, basswoods, and willows.
>
> *Hard hardwoods.* Hardwood species with an average specific gravity greater than 0.50, such as oaks, hard maples, hickories, and beech.

Log. A primary forest product harvested in long, primarily 8-, 12-, and 16-foot lengths.

Logging residues. The unused portion(s) of live trees cut or destroyed during logging operations.

Merchantable portion (bole length). That portion of live trees 5.0 inches d.b.h. and larger between a 1-foot stump and a minimum 4.0-inch top d.o.b. on the central stem. That portion of primary forks from the point of occurrence to a minimum 4.0-inch top d.o.b. is included.

Merchantable volume. Solid-wood volume in the merchantable portion of live trees.

Non-growing-stock sources. The net volume removed from the non-growing-stock portions of poletimber and sawtimber trees (stumps, tops, limbs, cull sections of central stem) and from any portion of a rough, rotten, sapling, dead, or nonforest tree.

Other removals. The growing-stock volume of trees removed from the inventory by cultural operations such as timber stand improvement, land clearing, and other changes in land use, resulting in the removal of the trees from timberland.

Peeler log. A roundwood product either rotary cut, sliced, stamped, or sawn into a variety of veneer products such as plywood, finished panels, veneer sheets, or sheathing. Also called veneer log.

Posts, poles, and pilings. Roundwood products milled (cut or peeled) into standard sizes (lengths and circumferences) to be put in the ground to provide vertical and lateral support in buildings, foundations, utility lines, and fences. May also include nonindustrial (unmilled) products.

Poletimber-size trees. Softwoods 5.0 to 8.9 inches d.b.h. and hardwoods 5.0 to 10.9 inches d.b.h.

Pulpwood. A roundwood product that will be reduced to individual wood fibers by chemical or mechanical means. The fibers are used to make a broad generic group of pulp products that includes paper products, as well as chipboard, fiberboard, insulating board, and paperboard.

Rotten trees. Live trees of commercial species not containing at least one 12-foot saw log, or two noncontiguous saw logs, each 8 feet or longer, now or prospectively, primarily because of rot or missing sections, and with less than one-third of the gross board-foot tree volume in sound material.

[1] This glossary was provided to us for use by James W. Bentley, U.S. Department of Agriculture Forest Service, Southern Research Station, Knoxville, TN.

Roundwood (roundwood logs). Logs, bolts, or other round sections cut from trees for industrial manufacture or consumer uses.

Roundwood products. Any primary product, such as lumber, poles, pilings, pulp, or fuelwood that is produced from roundwood.

Salvable dead trees. Standing or downed dead trees that were formerly growing stock and considered merchantable. Trees must be at least 5.0 inches d.b.h. to qualify.

Saw log. A roundwood product, usually 8 feet in length or longer, processed into a variety of sawn products such as lumber, cants, pallets, railroad ties, and timbers.

Saw log portion. The part of the bole of sawtimber trees between a 1-foot stump and the saw log top.

Saw log top. The point on the bole of sawtimber trees above which a conventional saw log cannot be produced. The minimum saw log top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Sawtimber size trees. Softwoods 9.0 inches d.b.h. and larger and hardwoods 11.0 inches d.b.h. and larger.

Sawtimber volume. Growingstock volume in the saw log portion of sawtimber-sized trees in board feet (International ¼-inch rule).

Softwoods. Coniferous trees, usually evergreen, having leaves that are needles or scalelike.

Timberland. Forest land capable of producing 20 cubic feet of industrial wood per acre per year and not withdrawn from timber utilization.

Timber products. Roundwood products and byproducts.

Timber products output. The total volume of roundwood products from all sources plus the volume of byproducts recovered from mill residues (equals roundwood product drain).

Timber removals. The total volume of trees removed from the timberland inventory by harvesting, cultural operations such as stand improvement, land clearing, or changes in land use. (Note: Includes roundwood products, logging residues, and other removals.)

Tree. Woody plant having one erect perennial stem or trunk at least 3 inches d.b.h., a more or less definitely formed crown of foliage, and a height of at least 13 feet (at maturity).

Upper-stem portion. The part of the main stem of sawtimber trees above the saw-log top and the minimum top diameter of 4.0 inches outside bark, or to the point where the main stem breaks into limbs.

Utilization studies. Studies conducted on active logging operations to develop factors for merchantable portions of trees left in the woods (logging residues), logging damage, and utilization of the unmerchantable portion of growing-stock trees and non-growing-stock trees.

APPENDIX

Index of Tables

Table A1.—Harvest and utilization volume by source and volume type, West Virginia, 2008

Source	Total tree volume	Growing stock					Non-growing stock				
		Total growing stock volume	Saw log		Upper stem		Total non-growing stock volume	Stumps		Tops/limbs	
			Utilized	Not utilized	Utilized	Not utilized		Utilized	Not utilized	Utilized	Not utilized
	cubic feet										
Sawtimber	72,207	64,950	58,681	2,219	2,221	1,829	7,257	526	234	1,680	4,817
Poletimber	1,271	1,210	694	2	460	54	61	19	3	26	13
Total	73,478	66,160	59,375	2,221	2,681	1,883	7,318	545	237	1,706	4,830

Table A2.—Harvest and utilization volume by species group and volume type, West Virginia, 2008

Species group	Total tree volume	Growing stock					Non-growing stock				
		Total growing stock volume	Saw log		Upper stem		Total non-growing stock volume	Stumps		Tops/limbs	
			Utilized	Not utilized	Utilized	Not utilized		Utilized	Not utilized	Utilized	Not utilized
	cubic feet										
Cherry	2,536	2,252	2,087	52	72	42	284	13	-	117	152
Hickory	3,148	2,786	2,496	106	104	81	362	41	8	93	220
Sugar maple	5,389	4,470	4,177	126	87	81	919	23	9	218	670
Mixed hardwood	4,468	3,922	3,344	185	227	165	545	30	20	139	356
Red oak	9,453	8,531	7,782	404	119	229	921	64	29	105	725
Soft hardwood	1,124	1,030	868	96	10	56	94	6	6	-	82
Soft maple	6,780	5,932	5,189	131	382	228	848	48	3	323	472
White oak	14,390	12,515	11,329	479	397	312	1,875	125	100	261	1,393
Yellow-poplar	21,511	20,185	18,200	591	799	595	1,326	149	57	381	737
Total hardwoods[a]	68,796	61,622	55,472	2,169	2,195	1,789	7,174	498	231	1,637	4,808
Pine	4,682	4,538	3,903	52	486	94	144	47	6	69	22
Total	73,478	66,160	59,375	2,221	2,681	1,883	7,318	545	237	1,706	4,830

[a] Individual species volumes may not add to total hardwood volumes due to rounding.

Table A3.—Harvest and utilization volume by product and volume type, West Virginia, 2008. Data includes sawtimber and poletimber trees.

Product	Total tree volume	Growing stock					Non-growing stock				
		Total growing stock volume	Saw log		Upper stem		Total non-growing stock volume	Stumps		Tops/limbs	
			Utilized	Not utilized	Utilized	Not utilized		Utilized	Not utilized	Utilized	Not utilized
	cubic feet										
Saw log	53,074	47,395	43,193	1,699	1,245	1,257	53,074	380	176	1,079	4,045
Peeler	5,649	5,380	4,699	237	219	225	5,649	44	5	53	168
Pulpwood	14,755	13,385	11,483	286	1,217	400	14,755	121	56	575	618
Total	73,478	66,160	59,375	2,222	2,681	1,882	73,478	545	237	1,707	4,831

Table A4.—Overutilization and underutilization of growing stock by product, as a percent of total product, West Virginia, 2008. Data includes sawtimber and poletimber trees.

Product	Growing stock utilized/total volume utilized	Non-growing stock utilized/ total volume utilized	Growing stock utilized/total growing stock volume	Growing stock not utilized/total growing stock volume	Saw log utilized/ total saw log volume	Saw log not utilized/total saw log volume	Cull utilized/ total saw log volume
	percent						
Saw log	96.8	3.2	93.8	6.2	96.2	3.8	0.5
Peeler	98.1	1.9	91.4	8.6	95.2	4.8	0.1
Pulpwood	94.8	5.2	94.9	5.1	97.6	2.4	1.2
All products	96.5	3.5	93.8	6.2	96.4	3.6	0.6

Table A5.—Harvest and utilization volume by product and volume type, West Virginia, 2008. Data includes sawtimber trees.

Product	Total tree volume	Growing Stock					Non-growing stock				
			Saw log		Upper stem			Stumps		Tops/limbs	
		Total	Utilized	Not utilized	Utilized	Not utilized	Total	Utilized	Not utilized	Utilized	Not utilized
	cubic feet										
Saw log	52,771	47,111	43,027	1,698	1,153	1,234	5,659	374	175	1,070	4,040
Peeler	5,613	5,345	4,679	237	209	221	268	44	4	53	168
Pulpwood	13,823	12,494	10,976	284	859	375	1,330	108	55	557	610
Total	72,207	64,950	58,682	2,219	2,221	1,830	7,257	526	234	1,680	4,818

Table A6.—Volume of hardwood growing stock by product and utilization, West Virginia, 2008. Data includes sawtimber trees.

Product	Growing Stock			Saw log portion of growing stock[a]				Non-growing stock utilized (C)	Total Volume (gs+ngs)[b] Utilized (A)+(C)
	Total (A)+(B)	Utilized (A)	Not utilized (B)	Total	Utilized	Not utilized	Cull utilized		
	cubic feet								
Saw log	47,111	44,180	2,932	45,625	43,027	1,698	216	1,444	45,625
Peeler	5,345	4,887	458	4,984	4,679	237	5	97	4,984
Pulpwood	12,494	11,835	659	12,500	10,976	284	130	665	12,500
Total	64,950	60,902	4,049	63,109	58,682	2,219	351	2,206	63,109

[a] Saw log portions of growing stock obtained from sawtimber trees.
[b] gs=growing stock, ngs=non-growing stock

Table A7.—Overutilization and underutilization of hardwood growing stock by product for sawtimber trees, as a percent of total product, West Virginia, 2008

Product	Growing stock utilized/total volume utilized	Non-growing stock utilized/ total volume utilized	Growing stock utilized/total growing stock volume	Growing stock not utilized/total growing stock volume	Saw log utilized/ total saw log volume	Cull utilized/ total saw log volume	Saw log not utilized/total saw log volume
	percent						
Saw log	96.8	3.2	93.8	6.2	96.2	0.5	3.8
Peeler	98.1	1.9	91.4	8.6	95.2	0.1	4.8
Pulpwood	94.7	5.3	94.7	5.3	97.5	1.2	2.5
All products	96.5	3.5	93.8	6.2	96.4	0.6	3.6

Wiedenbeck, Jan; Grushecky, Shawn. 2014. **West Virginia harvest and utilization study, 2008.** Resour. Bull. NRS-87. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 16 p.

Thirty active harvesting operations were part of a harvest and utilization study conducted in West Virginia in 2008. Data were collected on roundwood product and residue yields obtained from trees of different sizes, species, and qualities. This study was modeled after studies conducted on a regular and frequent basis by the Forest Inventory and Analysis unit in the Southern Research Station. Of the total volume harvested during this study, 88 percent was utilized and 12 percent was considered unutilized. Of the hardwood logging residue measured, 56 percent was from non-growing-stock sections of the trees—e.g., tops, limbs, and stumps. The other 44 percent was unutilized growing-stock sections including upper stems and saw log-sized material. When the harvest utilization factors estimated in this study are applied to Forest Inventory and Analysis estimates of total harvest volume for West Virginia in 2008, a statewide hardwood logging residue estimate of 35.5 million cubic feet is obtained.

KEY WORDS: residue, logging, removal factors, overutilization, underutilization

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