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Montana Logging Utilization, 2002

Todd A. Morgan
Timothy P. Spoelma
Charles E. Keegan
Alfred L. Chase
Michael T. Thompson

Bureau of Business and Economic Research, University of Montana-Missoula
Forest Inventory and Analysis, Rocky Mountain Research Station

Abstract

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A study of logging utilization in Montana during 2002 provided logging and product utilization data for sawlog and veneer log harvests in Montana. Results of the study indicate a shift toward greater utilization of smaller diameter material, as 78 percent of the harvested volume in Montana during 2002 came from trees less than 17 inches diameter at breast height. The portion of inventory volume utilized is also increasing, as indicated by decreasing removals factors for growing stock (1.081 cubic feet removed from inventory per cubic foot delivered to the mill) and sawtimber trees (0.961 cubic feet removed per cubic foot delivered to the mill). The study also provided factors for converting volumes to and from Scribner and International ¼-inch rule log scales, as well as to and from cubic foot volumes.

Key words: growing-stock removals, logging residue, sawtimber removals, timber harvest, timber products output, utilization factors

Authors

Todd A. Morgan, Timothy P. Spoelma, and **Alfred L. Chase** are Research Foresters, and **Charles E. Keegan III** is the Director of Forest Industry Research, Bureau of Business and Economic Research, University of Montana-Missoula, MT 59812.

Michael T. Thompson is a Forester, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Forestry Sciences Laboratory, 507 25th Street, Ogden, UT 84401.

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Introduction

Forest planners and managers have a continuing need for information about the timber resource. This need combined with the general public's ever-increasing interest in the effects of timber harvesting make up-to-date data on the forests and how they are changing an essential element of well-informed forest management decisions. Information on the condition and changes in Montana's timber resource comes from three main sources: (1) strategic level inventory, which quantifies existing conditions and changes due to land exchanges, timber harvest, mortality, and growth; (2) mill surveys, which quantify the volume of timber products harvested and delivered to primary wood products facilities; and (3) logging utilization studies, which characterize harvest operations and quantify the volume that is cut or otherwise killed and left in the forest during the harvesting of timber.

Substantial changes in Montana's wood products industry over the past two decades—changes in volume and ownership source of harvest, harvesting and milling techniques, and numbers and types of mills operating—have necessitated a new logging utilization study to better reflect the effects of contemporary timber harvesting on forest inventory. Prior logging utilization studies for Montana were conducted in 1965 and 1988 (McLain 1992; Wilson and others 1970). Information provided by logging utilization studies includes not only volumes of growing stock left in the forest as logging residue from logging operations and proportions of harvested material coming from growing stock and other sources, but also the diameter distribution of current tree harvest and descriptions of harvesting techniques and equipment used by Montana loggers.

In 2002, the Bureau of Business and Economic Research (BBER) at The University of Montana–Missoula undertook a study of logging utilization in Montana in cooperation with the Interior West Forest Inventory and Analysis (IWFIA) Program of the USFS Rocky Mountain Research Station. The overall goal of this study was to acquire and analyze logging and product utilization data for sawlog and veneer log harvests in Montana. The specific objectives toward this end were to:

1. Characterize Montana's timber harvest by tree size.
2. Characterize harvest operations.
3. Provide removals factors to convert volumes received by primary wood processors into estimates of total removals from growing stock, including the volume of residue remaining in the forest following harvest.
4. Provide log scale conversion factors to convert board foot Scribner volume removals to cubic feet and the International Board Foot Rule.
5. Estimate product removals from growing stock stems, salvable dead trees, other growing stock sources, and noninventory sources.

Methods

Site Stratification and Selection

Conducting a comprehensive logging utilization study in Montana presents numerous logistic challenges. There are nearly 22.3 million acres of forestland spread over more than 145,000 square miles, annual harvest volumes of approximately 200 million cubic feet, and an 11-month logging season. Ideally, all logging operations expected to occur in Montana during the year of analysis would be listed and stratified by important variables, then a random sample of appropriate size from each stratum would be selected. Given the nature of the timber harvesting and processing business it is not possible to establish far in advance precisely when, where, and how logging will take place. For example, weather often causes managers to postpone or accelerate logging operations, or changing markets may lead to a substantial shift in the kind and quantity of timber demanded by mills. For this study, expert opinion of timber harvest professionals and published timber harvest accounts were employed to develop an appropriate statewide logging site sampling design. Felled trees were to be measured at 30 to 35 representative active logging operations with 25 to 30 randomly selected trees at each site. This logging utilization methodology has been used successfully in the USDA Forest Service Southern Region since the late 1980s (Johnson and Bentley 2002). These numbers of sites and measurement trees were thought to capture most of the variation among sites and among harvested trees within a site.

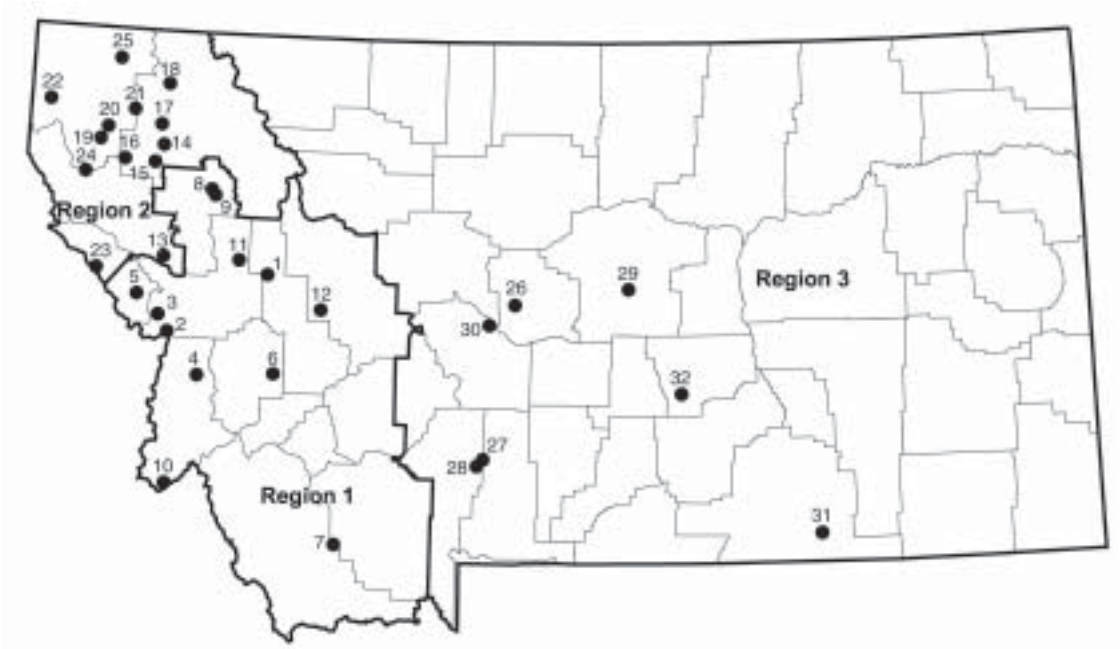
Harvesting operations in Montana were stratified according to relevant characteristics of annual harvest volumes, keeping the targeted number of logging sites in mind. Keegan and others (2001) summarize the volume of Montana's annual timber harvest in various ways, including by product type, ownership, and county. This background information allowed for the volume-based stratification of potential logging sites by (1) type of material harvested, (2) yarding/skidding method, (3) landowner, and (4) geographic location.

Approximately 869 million board feet, Scribner, were harvested in 1998; green (live) timber accounted for nearly 90 percent (Keegan and others 2001). Because salvage logging operations, which harvest dead timber, typically account for such a small proportion of annual harvest, and because salvage operations do not usually have a major impact on growing-stock inventory, all logging utilization measurements were conducted on green sales. Sawlogs and veneer logs accounted for 94 percent of the 1998 harvest and historically account for over 90 percent of all timber harvested in Montana (Keegan and others 2001). Therefore, this logging utilization study focused solely on operations where sawlogs or veneer logs were the primary product. The majority of the volume in other products was assumed to come as secondary or tertiary products from saw/veneer log harvests, or in sufficiently small volume as to have little impact on inventory removals.

Discussions with land managers, mill operators, and loggers provided researchers with an approximation of the harvest volume that is ground-skidded (75 percent) versus cable-yarded (25 percent). Therefore, the statewide number of logging operations to be visited was constrained according to this 3:1 ratio. It should be noted that a higher proportion of harvesting operations requiring the use of cable yarding occur in western (west of the Continental Divide) versus eastern Montana.

Keegan and others (2001) report that about 44 percent of Montana's timber harvest in 1998 came from industrial ownership, 27 percent from nonindustrial private, 22 percent from National Forests, 5 percent from other public ownerships, and less than 3 percent from Indian trust lands. Thus, the next level of stratification approximated these ownership proportions at the Statewide level. Again, because of differences in the geographic distribution of logging operations by landowner, these proportions were not necessarily maintained in each of the individual geographic regions.

Because of the unpredictable nature of logging operations, this logging utilization study was designed as a series of censuses of every green saw/veneer log harvesting operation active in a given region of the State during a time period, with an eye toward targeting (according to stratification) the total number of operations of a given skidding/yarding method or ownership.



1 Monture Creek—Ovando
2 Mill Creek
3 Wagon Mountain
4 Burnt Fork—Stevensville
5 Cyr Flat—Fish Creek
6 Maxville
7 Sweetwater—Dillon
8 Swan River CTL
9 Swan River Tree
10 West Fork Bitterroot—Painted Rocks
11 Arch-Inez—Seeley Lake
12 Baldy 8—Lincoln
13 Dixon SW
14 Jackson Draw
15 Kessler View
16 Leo's Lament—Bar Z Mountain
17 Rhodes Draw
18 Chicken-Werner
19 McKillop Creek
20 Wolf Mountain—Cow Creek Spur
21 Fairview—Brush Creek
22 Whitetail
23 Little Joe
24 Vermillion River
25 Virginia Tepee
26 Dry Wolf
27 Olson Creek Tractor
28 Olson Creek Line
29 Flat Top—Lewistown
30 Adams Creek
31 Kid Creek—Lodge Grass
32 Goulding Creek—Roundup

Figure 1—Montana Logging Utilization Study System 2002.

Montana was divided into three geographic regions for this study (fig. 1). The first region visited included Beaverhead, Deer Lodge, Jefferson, Granite, Lake, Lewis and Clark, Madison, Missoula, Powell, Ravalli, and Silver Bow Counties, as well as the southern portion of Mineral County. The second region included the northern portion of Mineral County along with Flathead, Lincoln, and Sanders Counties. The third region included forestlands in all remaining counties in Montana. Twelve sites were located in the first region, and all were measured during July; the 13 sites in the second region were measured during August; and the seven sites in the third region were completed during September and early October 2002.

Data Collection

Two to three weeks in advance of the field crew working in a region, mills known to receive timber from that region were contacted and asked to provide a list of ownerships and specific sites from which they planned to receive timber. The landowners were then contacted to get permission for the researchers to access their lands. The logging contractors were typically contacted a few days in advance, and a time was arranged for field crews to visit and measure trees on the site(s).

At the harvesting operation sites, loggers provided information regarding the tree species, products being merchandised, and preferred and acceptable lengths to be sent to the receiving mill(s). Researchers recorded this information and the date, county, ownership, felling method, yarding method, length of material being yarded, log merchandising location and method, operator, equipment in use, and receiving mill(s).

For utilization analysis, it was necessary for the field crew to track and measure all components of a tree's main stem after felling. Each measurement tree, therefore, had to be alive prior to harvest, at least 5.0 inches diameter at breast height (d.b.h.), and completely intact or have all of its parts available for measurement. Trees meeting these requirements were found lying throughout the sale area or accumulated in piles for skidding, depending on the operator and equipment being used. Trees were selected independent of species, diameter, or form. In cases where accumulating harvesting heads were used, it was assumed that placement of trees within a pile was random, and researchers typically selected two or three trees from a pile that could be measured safely and precisely.

For each measurement tree, a unique identification number was assigned, and species, d.b.h., tree class, primary product, bole length, and percent cubic cull were recorded. Diameter and section length measurements were taken at the cut stump height, at 1 foot above ground level (uphill side of the tree), at breast height (4.5 feet above ground on uphill side), at the 7-inch diameter outside bark (d.o.b.) point, at the 4-inch d.o.b. point, and at the end-of-utilization point. Diameter and section length measurements were also taken on intervals corresponding to the lengths and sizes specified by the receiving mill. Thus, for each section, lower and upper d.o.b. and length were recorded. The percent cubic cull in each section was also recorded, and each section was identified as utilized (sent to the mill) or un-utilized (left on-site).

Data Analysis

Data analysis was performed by personnel trained in the use of "UT_1," a computer program developed by researchers at the Southern Research Station to aid the processing of logging utilization data. Tree data were entered, checked, and processed site-by-site and then combined into a master data file for the State. The master data file was processed to develop State-level factors for total removals from growing stock, sawtimber removals, and logging residues. Data were then recombined by size class, ownership, felling method, yarding/skidding method, and so forth, to enable researchers to develop board foot to cubic foot conversion factors and to examine differences in logging utilization by various harvesting criteria. Results presented in this report are from analyses of the State-level and size-class data.

Results

Characteristics of Harvest Operations

Thirty-two logging operations in Montana were visited with felled-trees measured between July 8 and October 2, 2002. These operations were distributed throughout eastern and western Montana (fig. 1). Harvesting operations occurred in five general ownership groups—Federal, State, Indian trust, industrial private, and non-industrial private—in 17 counties (table 1), and were representative of forest types and commercial tree species in Montana.

Logging operations included hand- and mechanical-felling methods, ground skidding and cable yarding systems, tree-length and merchandised-length skidding/yarding, and hand and mechanical merchandising (table 2). Mechanical felling methods included the use of accumulating heads such as a feller buncher, as well as cut-to-length harvester heads. Ground-based skidding included the use of skidders or dozers, which may have either a grapple or a winch with chokers, as well as forwarding systems where material is piled on a bunk that is either attached directly to or transported by a tractor before being unloaded at the landing. Mechanical merchandising methods include the use of equipment such as stroke (slide-boom) delimbers, cut-to-length harvester heads, or other mechanized merchandising equipment (for example, Hahn Harvester).

Table 1—Number of logging operations by county and ownership group—Montana, 2002.

County	National Forest	State	Indian Trust	Industrial	Non-industrial private	Total
Big Horn			1			1
Fergus					1	1
Flathead		1		4		5
Gallatin				2		2
Granite	1					1
Judith Basin	1					1
Lake		2				2
Lewis & Clark	1					1
Lincoln	2			3		5
Madison					1	1
Meagher	1					1
Mineral	2					2
Missoula	1			2		3
Musselshell					1	1
Powell					1	1
Ravalli	1				1	2
Sanders			1	1		2
Total	**10**	**3**	**2**	**12**	**5**	**32**

Table 2—Characterization of logging operations by ownership, felling method, yarding method, material length yarded, merchandising location, and merchandising method—Montana, 2002.

		Ownership		Felling		Yarding		Material length		Merchandising location		Merchandising method	
		Public	Private	Hand	Mech.	Ground	Cable	Tree-length	Merch. length	In-woods	Landing	Hand	Mech.
Ownership	Public	13											
	Private	--	19										
Felling	Hand	5	6	11									
	Mechanical	8	13	--	21								
Yarding	Ground	9	16	4	21	25							
	Cable	4	3	7	0	--	7						
Material length	Tree-length	11	16	7	20	23	4	27					
	Merch. length	2	3	4	1	2	3	--	5				
Merchandising location	In-woods	2	2	3	1	1	3	0	4	4			
	Landing	11	17	8	20	24	4	27	1	--	28		
Merchandising method	Hand	3	5	8	0	4	4	4	4	3	5	8	
	Mechanical	10	14	3	21	21	3	23	1	1	23	--	24

Table 3—Distribution of harvested material and logging residue by tree diameter class—Montana, 2002.

Tree diameter class	% harvested trees	% harvested volume (cubic foot basis)	% logging residue volume (cubic foot basis)
6”	9.0%	1.7%	2.5%
8”	24.8%	10.1%	5.1%
10”	22.5%	15.6%	16.6%
12”	17.6%	18.4%	17.4%
14”	10.9%	15.7%	18.1%
16”	8.6%	16.6%	18.6%
18”	3.4%	9.1%	9.7%
20”	1.8%	6.2%	5.4%
22”	0.8%	2.9%	2.1%
24”+	0.6%	3.8%	4.4%
All trees	**100.0%**	**100.0%**	**100.0%**

Characteristics of Harvested Trees

Improvements in milling technology and changes in timber inventory have increased the proportionate use of smaller diameter trees and decreased the use of larger trees as borne out by repeated logging utilization studies. In 1988, less than 50 percent of harvested volume came from trees smaller than 17 inches d.b.h. (McLain 1992). Results of the 2002 logging utilization study indicate that 78 percent of harvest volume came from trees smaller than 17 inches d.b.h., and about 50 percent came from trees less than 13 inches d.b.h. (table 3). Trees with d.b.h. greater than 23 inches accounted for over 18 percent of harvest volume in 1988, but less than 4 percent in 2002. Logging residue (growing-stock volume cut or killed but not delivered to a mill), like utilized volume, tended to come from the small to intermediate sized trees, with nearly 80 percent of residue volume resulting from the cutting of trees smaller than 17 inches d.b.h. (table 3).

Removals Factors for Montana, 2002

Removals factors quantify the amount of growing stock and sawtimber volume that FIA categorizes as removals. These factors incorporate the FIA definitions (see “Definitions” section of this report) of growing stock and sawtimber volume and generate FIA removal estimates from the amount of tree volume delivered to a mill. In addition, removals factors produce categories of wood fiber utilized during harvesting operations. Removals factors are presented per cubic foot of green timber delivered to mills, thus allowing expansion of mill receipts to net impact on inventory volume.

In 2002, every 1,000 cubic feet of green timber harvested in Montana and delivered to mills resulted in 1,081 cubic feet being removed from growing-stock inventory (table 4). Of the 1,081 cubic feet removed from growing-stock inventory, 989 cubic feet was a growing-stock product (between a 1-foot

Table 4—Growing stock removals factors for each cubic foot of green material delivered to mills—Montana.

	Cubic feet		
	1965	**1988**	**2002**
Timber delivered to mills	1.000	1.000	1.000
Nongrowing-stock product delivered to mills	<.005	<.005	0.011
Growing stock product delivered to mills	0.997	0.999	0.989
Logging residue	0.163	0.122	0.092
Removals from growing stock (cubic)	1.160	1.121	1.081

stumps and tops—stumps cut shorter than 1.0 foot, and tops smaller than 4.0 inches in diameter).

Removals factors from 1965 (Wilson and others 1970) and 1988 (McLain 1992) indicate that the volume of logging residue created per cubic foot of timber harvested in Montana has decreased nearly 44 percent over the past four decades, and almost 25 percent since 1988. Likewise, the volume of "overutilized" stumps and tops has more than doubled in the same period.

It is important to note that logging residue includes inventory material that is not only unutilized during the processing of a tree into logs, but residue also includes growing-stock material knocked over or otherwise killed as a direct result of harvesting. No losses of the latter type were identified on the logging sites visited in 2002.

Removals factors can also be determined for the sawlog portion of the sawtimber volume (material to a 7-inch top for trees greater than or equal to 9 inches diameter at breast height). Figure 2 illustrates the difference between growing-stock volume and sawtimber volume. Removals factors for sawtimber volume are shown in table 5. Once again, factors from 1965 (Wilson and others 1970) and 1988 (McLain 1992) are provided for comparison.

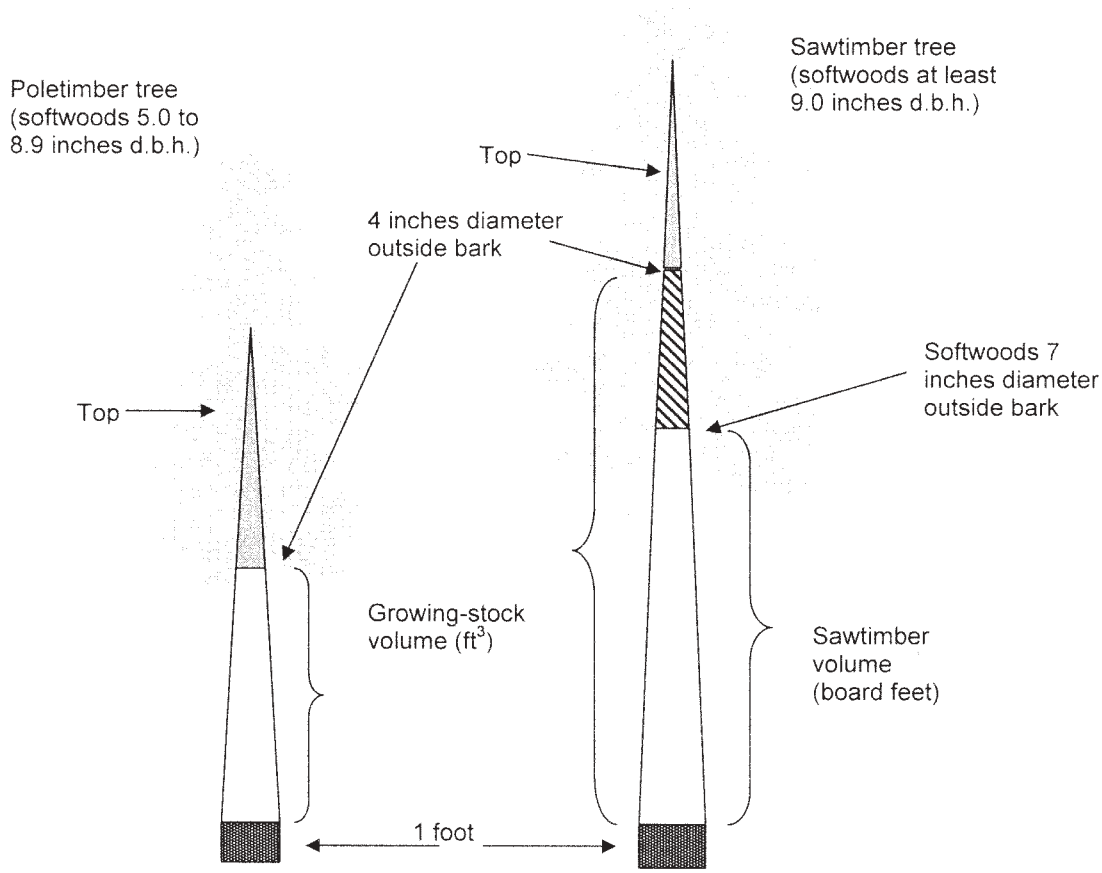


Figure 2—Stem sections of poletimber and sawtimber trees. Growing-stock volume comprises volume in poletimber and sawtimber trees that qualify as growing stock. Sawtimber volume is the volume contained in the sawlog portion of sawtimber trees. Nongrowing-stock volume is shaded. Roundwood products from the nongrowing-stock volume portion of tree stems are nongrowing-stock product volume. Board-foot volume from poletimber trees or from sections of sawtimber trees above the 7-inch top (cross-hatched) is also nongrowing-stock product volume.

The factors in table 5 show that for every 1,000 cubic feet of green timber delivered to the mills from sawtimber trees, 961 cubic feet were removed from sawtimber inventory. Of the 961 cubic feet, 944 cubic feet went to mills, and 17 cubic feet of remained in the forest as logging residue. Of every 1,000 cubic feet delivered to mills, 56 cubic feet came from nonsawtimber volume.

Results in tables 4 and 5 clearly illustrate three things. First, growing-stock and sawtimber removals decreased for each cubic foot of volume delivered to the mill when compared to historic levels. Second, the amount of nongrowing stock volume (stump material and material above the top diameter as defined for growing-stock) reaching the mill increased, indicating greater utilization of each tree that is felled. And third, the amount of logging residue, or unutilized growing-stock volume, per unit of mill-delivered material decreased.

Timber Removals by Product Type

Removals factors described in tables 4 and 5 in combination with data on timber product utilization volume and appropriate board foot cubic foot conversion factors enable the characterization of the impact of harvest for various products on Montana's timber inventory, and the source of timber (growing stock, dead trees) harvested in Montana and used to produce various products. Using quarterly surveys of Montana's industry done by the Bureau of Business and Economic Research (FIDACS 2002) and the most recent account of timber harvest for various products (Keegan and others 2001), total timber harvest and use by product were estimated in cubic feet. The sawlog and veneer log portion of the harvest was converted to board feet Scribner and International ¼-inch rule based on the log and tree dimensions established in this logging utilization study (table 6). For other timber products, data from Keegan and others (2001) were used to convert cubic to board feet.

Table 5—Sawtimber removals factors for each cubic foot of green material delivered to mills—Montana.

	Cubic feet		
	1965	**1988**	**2002**
Timber delivered to mills	1.000	1.000	1.000
Nonsawtimber product delivered to mills	0.018	0.049	0.056
Sawtimber product delivered to mills	0.982	0.951	0.944
Logging residue	0.074	0.035	0.017
Removals from sawtimber-size trees	1.056	0.986	0.961

Table 6—Net saw and veneer log volume conversion factors for Montana, 2002.

1 cubic foot	=	4.79	board feet (Scribner rule)
1 cubic foot	=	5.38	board feet (International 1/4-inch rule)
1 board foot (Scribner rule)	=	1.12	board feet (International 1/4-inch rule)

Table 7—Industrial timber removals by product—Montana, 2002.

Products and additional removals	Product volume delivered to mills: Total	From live trees	From salvable dead trees	Other sources	Nongrowing stock product volume	Growing stock volume
			Thousand cubic feet			
Saw/veneer logs	145,627	130,413	15,214	-	1,435	128,978
Pulpwood	8,321	6,916	1,405	-	76	6,840
House logs	2,317	406	1,912	-	4	401
Other industrial	4,370	3,894	476	-	43	3,851
Cedar products	99	50	50	-	1	49
Total	160,735	141,678	19,057	-	1,558	140,119
Logging residue	-	-	-	-	-	12,891
Total	160,735	141,678	19,057	-	1,558	153,010
						Sawtimber removals
			Thousand board feet (Scribner rule)			
Saw/veneer logs	697,554	624,677	72,877	-	34,982	589,695
Pulpwood	27,460	22,822	4,638	-	1,278	21,544
House logs	11,587	2,028	9,559	-	114	1,914
Other industrial	4,370	3,894	476	-	218	3,676
Cedar products	496	248	248	-	14	234
Total	741,467	653,669	87,798	-	36,605	617,064
Logging residue	-	-	-	-	-	10,490
Total	741,467	653,669	87,798	-	36,605	627,554
			Thousand board feet (International 1/4-inch rule)			
Saw/veneer logs	781,260	699,638	81,622	-	39,180	660,458
Pulpwood	30,755	25,561	5,195	-	1,431	24,129
House logs	12,977	2,271	10,706	-	127	2,144
Other industrial	4,894	4,361	533	-	244	4,117
Cedar products	556	278	278	-	16	262
Total	830,443	732,109	98,334	-	40,998	691,111
Logging residue	-	-	-	-	-	11,749
Total	830,443	732,109	98,334	-	40,998	702,860

Results indicate that 161 million cubic feet (MMCF) of timber were harvested and delivered to mills in 2002, but only 140 MMCF of that represented a growing-stock removal that was delivered to mills (table 7). More than 19 MMCF of the volume delivered to mills was dead timber and therefore not part of growing stock inventory, with another 1.6 MMCF from nongrowing stock product volume.

Summary

The Montana logging utilization study illustrates several important points. Logging technology has improved over time. For every tree that is felled, more volume delivered to mills is coming from the nongrowing-stock portion of tree stumps and tops. Higher proportions of harvested material are coming from smaller diameter trees than in the past, and the quantity of wood waste left on harvested sites is decreasing. These findings indicate that the wood-using industry continues to strive for more efficient technology that minimizes waste and better utilizes harvested volume.

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Definitions

Forest Inventory and Analysis (FIA) Definitions

Diameter at breast height (d.b.h.): Tree diameter in inches outside bark at breast height (4.5 feet aboveground) on uphill side. All timber species are measured at d.b.h.

Diameter at root collar (d.r.c.): Tree diameter in inches outside bark at root collar or at the point nearest the ground line (whichever is higher). For multistemmed trees, d.r.c. is calculated from an equation that incorporates the individual stem measurements. All woodland species are measured at d.r.c.

Growing-stock inventory: The population volume estimate in cubic feet of live growing-stock trees 5.0 inches d.b.h. and larger.

Growing-stock removals: The growing stock volume in cubic feet removed as the result of harvesting activity. Consists of growing-stock logging residue and growing stock product volume.

Growing-stock trees: A live timber species tree that qualifies as a sound (growing stock) tree class (see tree class).

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 diameter outside bark (d.o.b.) of the central stem.

Inventory volume: The population volume estimate of live trees 5.0 inches d.b.h. and larger. Refers to estimates of live, growing stock, and sawtimber inventory.

Live inventory: The population volume estimate in cubic feet of all live trees 5.0 inches d.b.h. and larger.

Live tree: All living trees 5.0 inches d.b.h. and larger. Includes all tree classes and both timber and wood land species.

Live-tree removals: The live tree volume in cubic feet removed as the result of harvesting activity. Consists of logging residue and product volume.

Merchantable portion: For timber species 5.0 inches d.b.h. and larger, the portion of the tree bole from a 1-foot stump to a 4.0-inch d.o.b. top.

Nongrowing-stock volume: The cubic-foot volume of wood in trees 5.0 inches d.b.h. and larger that do not meet the standards for growing stock (see tree class) or that volume in trees above a 4.0-inch d.o.b. or below a 1-foot stump height.

Nonsawtimber volume: The cubic-foot or board foot volume in trees that do not meet the size

requirements (less than 9.0 inches d.b.h. for softwoods or less than 11.0 inches for hardwoods) or standards (see tree class) for sawtimber trees. Also refers to that volume above a sawlog top or below a 1-foot stump (see sawlog portion).

Poletimber tree: A timber species softwood 5.0 to 8.9 inches d.b.h. and a timber species hardwood 5.0 to 10.9 inches d.b.h. A woodland species 5.0 to 8.9 inches d.r.c. (single stem measurement or computed multistem measurement).

Sawtimber inventory: The population volume estimate in board feet of live growing-stock softwoods 9.0 inches d.b.h. and larger and hardwoods 11.0 inches d.b.h. and larger.

Sawlog portion: The part of the bole of sawtimber trees between a 1-foot stump and the sawlog top.

Sawtimber removals: The growing stock volume in board feet removed as the result of harvesting activity. Consists of logging residue and product volume.

Sawlog top: The point on the bole of timber species sawtimber trees above which a conventional sawlog cannot be produced. The minimum sawlog top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Sawtimber tree: A timber species softwood 9.0 inches d.b.h. and larger and a timber species hardwood 11.0 inches and larger classified as a sound tree (see tree class). A woodland species 9.0 inches d.r.c. and larger (single stem measurement or computed multistem measurement.

Sawtimber volume: Growing-stock volume in the sawlog portion of sawtimber trees in board feet.

Timber species: Tree species traditionally used for industrial wood products. These include all species of conifers, western juniper except pinyon pine and juniper. Hardwoods included are aspen, box elder, cottonwood, paper birch, hackberry, green ash, Bur oak, and Chinkapin oak. All timber species are measured at d.b.h. (See diameter at breast height, d.b.h.).

Tree class: A classification system (below) for live or dead trees based on a tree's physical characteristics.

- **Live trees** are classified for tree class as follows; timber species are classified as either a sound tree (also referred to as a growing-stock tree), rough tree, or rotten tree:

  Sound tree (Growing-stock tree): A live timber species, 5.0 inches d.b.h. or larger, with less than two-thirds (67 percent) of the merchantable volume cull and containing at least one solid 8-foot section, now or prospectively, reasonable free of form defect, on the merchantable portion of the tree. Also included in this category are live timber species sapling (1.0 to 4.9 inches d.b.h.) if it is expected to develop into a sound live tree, 5.0 inches d.b.h. or larger, with good form and vigor.

  Rough tree: A live timber species, 5.0 inches d.b.h. and larger, with two-thirds (67 percent) or more of the merchantable volume cull, and more than half of this cull is due to sound wood dead loss, or severe form-defect volume loss (such as severe sweep, crook, forks). Also included in this category are live timber species sapling (1.0 to 4.9 inches d.b.h.) that is not expected to develop into a sound live tree 5.0 inches d.b.h. or larger due to defect, or a timber species (5.0 inches d.b.h. and larger) that does not now, or prospectively, have at least one solid 8-foot section, reasonably free of form defect, on the merchantable portion.

  Rotten tree: A live timber species, 5.0 inches d.b.h. and larger, with two-thirds (67 percent) or more of the merchantable volume cull, and more than half of this cull is due to rotten and/or missing material.

- **Dead trees** (timber or woodland species) are classified for tree class as follows:

  Salvable dead tree: A standing dead tree or a down dead tree, 1.0 inch d.b.h/d.r.c. or larger,

that has a minimum of one-third of the original merchantable volume sound. See "downed tree" and "standing tree."

Nonsalvable dead tree: A standing dead tree or a down dead tree, 1.0 inch d.b.h./d.r.c. or larger, that has less minimum of one-third of the original merchantable volume sound. See "downed tree" and "standing tree."

Woodland species: Tree species that are not usually converted into industrial wood products. Common uses of woodland trees are fuelwood, fencepost, and Christmas trees. These species include pinion, juniper (except western juniper), mesquite, locust, mountain-mahogany, Rocky Mountain maple, big tooth maple, desert ironwood, and oaks (except Bur oak and Chinkapin oak). Due to the variability in form, woodland species diameter measurements are usually measured at root collar.

Timber Products Output and Utilization Study Definitions

Growing-stock product volume: The growing stock volume contained in timber products such as sawlogs, posts, poles, pulpwood, fuel wood, and house logs.

Logging residue: The unused or nonutilized growing-stock or sawtimber volume of trees cut or killed by logging and left at the logging site.

Nongrowing-stock product volume: The cubic-foot volume contained in timber products such as sawlogs, posts, poles, pulpwood, fuel wood, and house logs that came from the upper stems (beyond the 4 inches d.o.b.) or below the 1-foot stump portion of growing-stock trees; the cubic volume contained in timber products that came from rough trees; the cubic foot volume that came from trees less than 5.0 inches d.b.h.; the board-foot volume in timber products that came from the upper stems (beyond the 7 inches d.o.b. for softwoods or 9 inches d.o.b. for hardwoods) and below the 1-foot stump of sawtimber trees; the board-foot volume in timber products that came from softwood trees less than 9.0 inches d.b.h. and hardwood trees less than 11.0 inches d.b.h.; the board-foot volume in timber products that came from rough trees (see tree class).

Over/under-utilization: A term used to describe the amount of nongrowing-stock volume in relation to growing-stock product volume. Overutilization refers to a positive amount of nongrowing-stock volume, whereas underutilization refers to a negative amount of nongrowing-stock volume (stumps cut higher than 1.0 feet or tops larger than 4.0 inches d.o.b.).

Product volume: The cubic-foot or board-foot volume in timber products such as sawlogs, posts, poles, pulpwood, fuelwood, and house logs. Product volume comprises volume from salvable dead trees, live trees, other sources, nongrowing-stock volume, and growing stock volume.

Roundwood: Logs, bolts, or other round sections cut from trees for industrial or consumer use.

Roundwood product: Any primary product such as lumber, poles, pilings, pulp, or fuel wood that is produced from roundwood.

Sawtimber product volume: The sawtimber volume in timber products.

Sawtimber removals: The growing stock volume in board feet removed as the result of harvesting activity. Consists of logging residue and product volume.

RMRS
ROCKY MOUNTAIN RESEARCH STATION

The Rocky Mountain Research Station develops scientific information and technology to improve management, protection, and use of the forests and rangelands. Research is designed to meet the needs of National Forest managers, Federal and State agencies, public and private organizations, academic institutions, industry, and individuals.

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