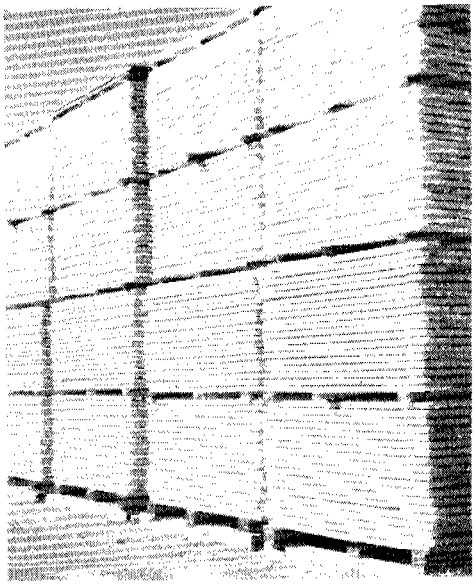
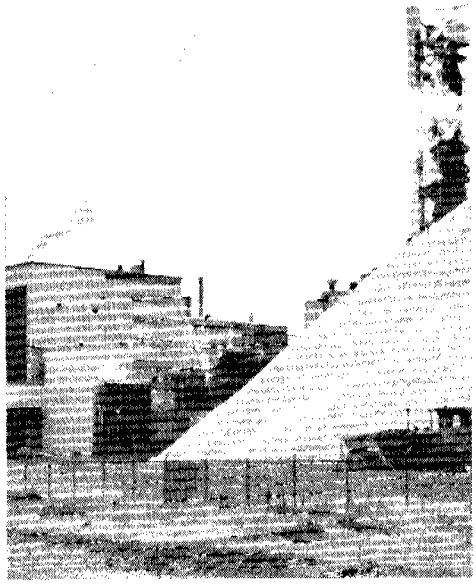
HARVESTING AND UTILIZATION OPPORTUNITIES FOR FOREST RESIDUES in the northern rocky mountains





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RESIDUE CHARACTERISTICS IN THE NORTHERN ROCKY MOUNTAINS

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ABSTRACT

In the northern Rocky Mountains, 350-450 million cubic feet (9.9 to 12.7 million m^3) of logging residue is generated each year. This residue consists of dead standing and down trees, green unmerchantable trees, broken pieces and the tops and branches of those trees removed in logging. Up to 60 percent of the residue material is technologically suitable for wood products, but condition, size and product potential vary among forest types. Other factors which influence residue utilization are level of harvest, trends in wood processing, industrial uses and economic conditions.

KEYWORDS: forest residue, logging residue, utilization

INTRODUCTION

During the past 5 years, the Forest Residues Utilization research unit has made an extensive study of forest and logging residues in the principal forest types of Montana, Idaho and Wyoming. The purposes of this study were to develop wood biomass data as a baseline for evaluating impacts of alternative residue treatments and to estimate the utilization potential of forest residues. Over 3,000 samples were taken at various research sites and in undisturbed stands in National Forests throughout the area.

Residues were measured using standard fixed or variable plot techniques for standing trees and the planar intercept (line transect) method for down material (Brown 1974). Characteristics such as piece size and condition were determined by measurement or estimation. The principal forest types included in these studies were lodgepole, larch, grand fir, spruce-alpine fir and Douglas-fir. Most timber harvest and residue management problems occur in mature and overmature forests of these types.

This paper summarizes residue characteristics that affect harvest and utilization potentials. The characteristics of woody material were reported earlier (Benson and Schlieter 1980a).

CHARACTERISTICS OF FOREST RESIDUES

Old-growth conifer forests typically contain a sizable volume of material--such as dead, cull, rotten and undersize stems--not normally suited for sawlogs or veneer logs. Because disease, insects, bad weather and fire suppression occur neither regularly nor evenly throughout stands, the amount and condition of residues vary widely. One stand, because of reasonably good spacing, may have escaped serious disease or insect problems and have very little residue. The trees in another stand in the same forest type may have experienced extensive crowding and fire suppression that produced many small defective stems; similarly, stands that have suffered heavy rot or insect mortality may have more residue than merchantable material. The data that follow should be interpreted as averages for each type.

Volume and Condition

When considering utilization of residue material, the volume per acre and the condition of residues are of key importance. Furthermore, even if no utilization is planned, the physical presence of residues affects the costs both of logging and of subsequent activities such as fuel management and regeneration.

The volume of all wood 3 inches diameter (7.6 cm) and larger on our study sites is shown in table 1. Forest inventory and sale cruise data normally present smaller volumes because they tend not to include all the types of material reported here.

Table 1.--Volume of wood in mature stands, in residue study areas, by component.[1]

	FOREST TYPE					
	Lodgepole	Larch	Douglas-fir Moist site	Douglas-fir Dry site	Grand fir	Spruce-Alpine fir[2]
	ft^3/acre					
Green Trees						
Merchantable log	2225	3401	2546	1658	4283	2000
Cull	119	222	334	52	564	391
Top	457	132	105	75	208	300
Small stems	244	663	527	300	156	380
Sub total	3045	4418	3512	2085	5211	3071
(m^3/ha)	(213)	(309)	(246)	(146)	(364)	(215)
Standing Dead						
No defect	436	86	180	0	24	153
Sound defect[3]	291	30	49	78		
Solid rot	139	493	36	22	256	68
Crumbly rot	0	302	55	0		
Sub total	866	911	320	100	280	221
(m^3/ha)	(61)	(64)	(22)	(7)	(20)	(15)
Down						
No defect	356	108	267	43	281	455
Sound defect[3]	310	66	52	19	7	43
Solid rot[4]	213	124	137	181	309	106
Crumbly rot[4]	233	1196	398	527	1903	262
Sub total	1112	1494	854	770	2500	866
(m^3/ha)	(78)	(104)	(60)	(54)	(175)	(61)
TOTAL, ft^3/a	5023	6823	4686	2955	7991	4158
(m^3/ha)	(351)	(477)	(328)	(207)	(559)	(291)

[1]Top volumes and stem volumes for small trees were compiled from recently published formulae based on species, d.b.h., and height (Faurot 1977).

[2]Breakdown of totals into component is estimated.

[3]Sound defect includes crook, sweep, fork, splits and drying checks that prevent use for solid wood products but not for fibers.

[4]Solid rot includes pieces with rot that can be handled in logging; crumbly rot is material that will not hold together in logging.

Total stand volumes ranged from about 3,000 ft^3/a on dry Douglas-fir sites to nearly 8,000 ft^3/a on grand fir sites. In most forest types about half the total volume consisted of green merchantable logs (fig. 1), and the condition of other standing residue material varied. In lodgepole pine and spruce-alpine fir, much of the residue was sound dead material. These forest types occur at high elevations with dry, cool conditions that do not favor rapid decay. On the other hand, in grand fir and western larch (which favor moister, warmer sites) rotten dead material predominated. Cull green material with rot also was substantial in moister forest types.

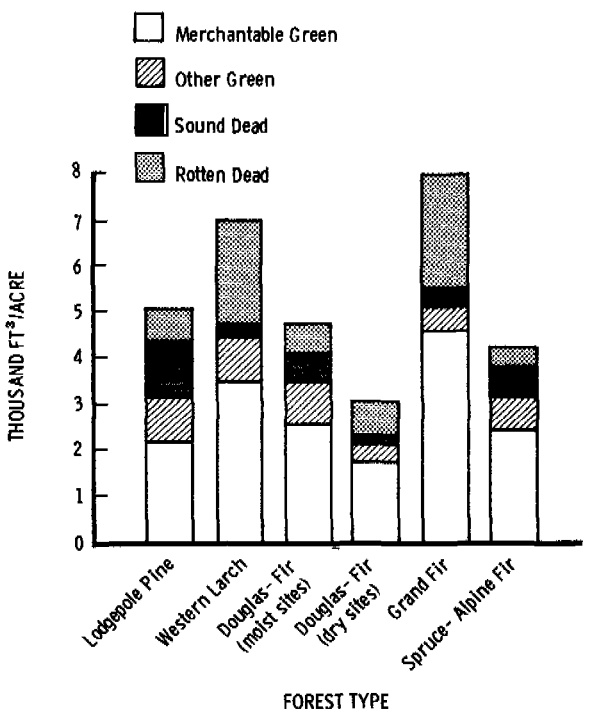

Figure 1.--Volume of wood 3 inches (7.6 cm) and larger in diameter in principal forest types.

The condition of down material appears to be related to decay conditions. In grand fir and larch most of the down material was crumbly rot that could not be removed from the site with conventional logging equipment. In lodgepole and spruce-alpine fir about three-fourths of the material was sound or had only limited defects that would not preclude harvesting (fig. 2).

Figure 2.--Most of the dead and down material in lodgepole stands is suited for product utilization.

Size and Number of Residue Pieces

Because utilization potentials and the costs of harvesting both relate to the number and size of the residue pieces involved, these characteristics were measured in detail for some of our samples.

In lodgepole pine and Douglas-fir sites representing a range of residue conditions, we estimated the following distribution of residue piece sizes:

Condition, diameter, length	Percentage of harvestable residue	
	Lodgepole pine	Douglas-fir
Sound, 6"+, 18'+	43	53
Sound, 6"+, 9' to 18 '	8	9
Sound, 3" to 6", 9'+	29	19
Sound, all diameter, less than 9'	5	9
Solid rot all diameters and lengths	15	10

(Source: Outlook for Utilization of Forest Residues, Northern Rocky Mountain Area, Unpublished Report, USFS Forestry Sciences Laboratory, Missoula)

These estimates indicate that about half the volume of usable residue material was in fairly large pieces or whole trees. Pieces greater than 6 inches in diameter by 18 feet in length averaged 15 ft^3 per piece. In most cases, small green and standing dead trees were intact and of full length; down material was often broken, however, which meant more pieces with smaller volumes. There was also considerable variation among forest types in the number and size of sound, usable, down pieces. Lodgepole pine averaged 127 sound down pieces per acre; western larch 65; and dry Douglas-fir sites 18.

When all sound standing and down material is taken into account, there are potentially 500-800 pieces per acre (1235-1975/ha) in a typical lodgepole pine stand and 200-400 pieces/a (495-990/ha) in Douglas fir (estimates were derived from Benson and Strong 1977; Benson and Keck[1]; Benson and Schlieter 1980a). About 200 stems per acre (495/ha) in lodgepole stands, and 100-150/a (245-370/ha) in Douglas-fir stands, are merchantable green trees. The remainder are residue pieces--300-500 pieces per acre (740-1235/ha) in lodgepole, and 100-250 (245-615/ha) in Douglas-fir.

Product Potential

Potential products were estimated for several forest types. The number of product pieces that could be recovered from each standing or down dead piece was determined, beginning with the product of highest value (table 2). In lodgepole pine over 350 product pieces per acre (865/ha) were recoverable; in Douglas-fir about 70 (170/ha), and in larch about 40 (100/ha).

Specifications for these products vary from one location to another but the size requirements used in the study were typical. Dead material of certain species is not currently used for some of the products listed in table 2. In the larch and Douglas-fir types, for example, only a few pieces are suited for solid wood products, and most have defects that prevent use for anything except pulp wood.

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[1]Benson, Robert E., and Kenneth Keck. 1979. Forest residues on the Targee National Forest. Mimeo. Rept. Forestry Sciences Laboratory, Drawer G, Missoula.

Table 2.--Number of potential products from standing and down dead pieces, selected forest types.

Product and type piece[1]	Lodgepole pine	Western larch	Douglas-fir moist sites
	- - - - - - - - - - - -	pieces/acre	- - - - - - - - - - - - -
Houselogs			
standing	9 (22)	1 (2)	2 (5)
down	13 (32)		
Sawlogs			
standing	21 (52)	3 (7)	7 (17)
down	20 (49)		
Corral rails			
standing	43 (106)	3 (7)	5 (12)
down	46 (114)		
Posts			
standing	36 (89)	1 (2)	2 (5)
down	44 (109)		
Pulp bolts			
standing	51 (126)	30 (74)	57 (141)
down	75 (185)		

[1]Minimum specifications used were as follow:

Houselogs-- 9 inches diameter, 8 feet long; no crook, sweep, rot, or checks that would preclude use as houselogs;
Sawlogs-- 6 inches diameter, 8 feet long, 1/3 sound;
Corral rails-- 3 inches diameter, 10 feet long; reasonably straight, no rot or major checks;
Posts-- 3 inches diameter, 7 feet long; no crook, rot or major checks;
Pulp bolts-- 3 inches diameter, 8 feet long; sound enough to hold together in yarding.

LOGGING RESIDUES

The amount and characteristics of residue material that actually remains after logging may or may not be closely related to predictions based on pre-harvest conditions. Often residue material becomes broken in the logging operation so the post-harvest potential is reduced.

In one study of 33 cutting units, between 1,800-2,600 ft^3/acre (126-182 m^3/ha) remained in units that received conventional utilization; only about 20 percent of this material was over 9 feet (2.7 m) long. In unlogged stands, however, about 80 percent of the residue material was over 9 feet (2.7 m) long, which indicated much of the residue potential was lost due to breakage in logging. On the other

hand, where removal of all pieces over 9 feet (2.7 m) long was required in utilization specifications, only about 15 percent of the total preharvest volume remained as residues. This suggests that when logging is intended to remove residue material it can be done without excessive breakage.

In our study about half the volume remaining after conventional utilization was green material. With close and intermediate residue utilization levels, virtually all the green material was removed, with only the unsound or broken small pieces of dead material remaining.

In another study, six timber sale units logged to conventional sawlog standards had from 1,800 ft^3/acre to over 3,800 ft^3/acre (126 m^3 to 266 m^3/ha) of residue remaining. Two of these units were relogged to recover pulpwood and any other products that could be made. This resulted in a 44 percent reduction of residues in one area and a 59 percent reduction in the other (Chase 1979).

In typical mature or overmature stands, where about half the total volume is residue material, the proper combination of utilization standards and logging could remove most of this material for utilization (fig. 3). Based on our case studies, it appears that close utilization at the time of initial sawlog removal recovers more of the material than relogging. This, however, would depend on stand conditions and other factors not considered in these study areas.

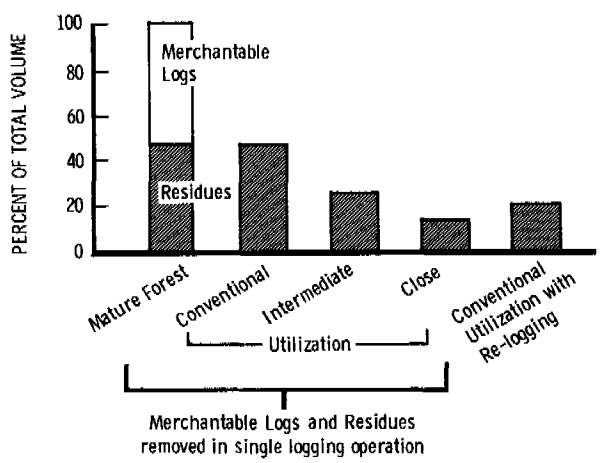

Figure 3.--Proportion of residue material in mature stands remaining under alternative utilization practices.

FACTORS INFLUENCING POTENTIAL UTILIZATION

Other papers in this proceedings examine the potential for residue utilization from both technical and economic perspectives. The total potential in terms of wood volume and use depends on three general factors: level of harvest, trends in utilization standards, and large scale uses.

Level of Harvest

Currently about 465 million ft^3 (13.1 million m^3) of residues are generated annually in the northern Rocky Mountains. About 355 million ft^3 (10 million m^3) of these residues accumulate in the six major forest types discussed in this summary. The level of harvest is projected to remain at present levels for the next decade or so, which means that if residues are removed at the time of regular harvest there is potentially available 0.3 to 0.4 billion ft^3 (8.5 million m^3 to 11.3 million m^3) of additional material.

If, as has been speculated, land use designation or restrictions on logging reduce the level of harvest, the volume of residues would be reduced accordingly. On the other hand, two potential sources of residues not included are: (1) material from thinning in young stands, which could add a modest amount, but is generally considered to be costly as fiber at this time; and (2) extensive salvage of dead or high risk trees. There are options to salvage log or prelog dead or high risk trees over large areas. This would essentially be the same as taking out all the residues in a short period of time rather than a continuing smaller annual volume removed along with the regular harvest. Two major problems would need to be solved: first, financing the extensive road system needed to reach scattered dead or high risk trees in a short time period; and second, providing equipment to successfully and economically remove these trees without adverse impacts on the remaining forest system.

Trends in Utilization

There has been a continuing trend toward greater utilization of wood fiber from any given logging unit because of increased demands for wood and improved methods of utilizing material formerly left as residue. When our studies began more than 6 years ago, we defined residue as material not meeting usual sawlog or veneer log specifications. Since then, material we originally classed as residue has been utilized to a greater degree. This has not been quantified in our studies, but several examples will illustrate the situation.

In western Wyoming and southeastern Idaho several mills were forced to adapt to using dead lodgepole pine. Bark beetle epidemics had almost eliminated green sawtimber.

A relatively new industry which produces house logs and log homes has been established in western Montana. Dead lodgepole is preferred, and often the value of this one-time residue is higher than that of green trees.

Throughout the western states, areas near forested land have seen a dramatic increase in the use of wood as a home heating fuel. In one area of southeastern Idaho it is estimated that from 25 to 40 percent of the total wood removed is for home heating fuel.

These trends indicate that a substantial portion of the region's 350 to 400 million ft^3 (10 to 11.3 million m^3) of residue material is already being utilized. The "residue" base actually shrinks, as mechantability standards are redefined.

Large Scale Use

The harvesting of northern Rocky Mountain timber for lumber and veneer production creates a seemingly inexhaustible supply of residue that has potential value. During the past few years important, but incremental, changes in residue utilization have occurred. In contrast to these small improvements, major increases in residue removal through industrial use appear possible. These possibilities include the expanded use of forest residues for pulp or fiber, as surplus sawmill and veneer mill residues decline; harvesting of forest residues for chemicals and wood alcohol; manufacture of densified fuel pellets for home or industrial use; and large scale use of all fiber material--wood, straw, whatever--for energy production.

If such large scale uses develop, guidelines will be needed to aid the land manager in determining the kinds and amounts of residue that should be left on an area to protect and enhance the forest ecosystem.

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