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Logging Residue in the Pacific Northwest: Characteristics Affecting Utilization

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Abstract

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Information on the characteristics of logging residue in Idaho, Washington, and Oregon is presented. Tables show volume by diameter and length, number of pieces per acre, percent of residue that is sound, distribution by slope and distance to road, and average proportion of bark. Results are shown for 19 strata (harvest method by geographic area and owner).

Keywords: Residue measurements, slash utilization, Pacific Northwest.

Summary

Interest in logging residue as a source of wood for producing energy has increased significantly in the past decade. The pulp and board industry is examining residue materials as a source of wood fiber for expanding productive capacity. The focus of investigations of logging residue has now moved from broad assessments of regional or national potential to the quantity and characteristics of residue at particular locations. These site-specific analyses require analytical data not provided by existing sources, which are also largely outdated.

This report presents information on the characteristics of residue materials in Idaho, Washington, and Oregon. The objective of the study was to provide quantitative data on characteristics that affect the potential utilization of residue for energy or other products. Specific characteristics for which data are provided are:

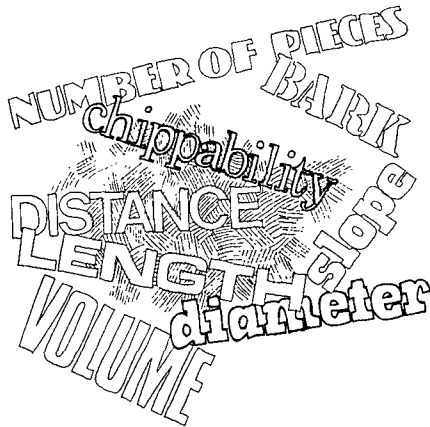
1. Gross volume of logging residue by diameter and length, in cubic feet per acre.
2. Number of pieces of residue per acre, by diameter and length.
3. Volume of residue by percent of sound material, in cubic feet per acre.
4. Average percentage of bark on residue pieces by diameter.
5. Accessibility of residue, by slope and distance to road.

The study involved measurement of residue on 518 areas cut over since January 1, 1979. The samples were allocated among 19 strata defined by geographic area, ownership, and harvest method.

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Background



Logging residue¹ is increasingly being considered as a major source of wood for augmenting energy supplies. This development extends beyond the use of mill residue which is gradually becoming part of the energy base through cogeneration (see "Glossary"). A great deal of attention during the past decade has been focused on regional or national assessments of quantities of logging residue (Bergvall et al. 1978, Grantham et al. 1974). These and other studies have addressed the issue of whether there is a sufficient quantity of logging residue to have a significant impact on energy supplies. The force behind these assessments has been determination of management activities, public laws, grants, or tax incentives aimed at encouraging use of wood residue for energy or other products.

¹See "Glossary" for definition of terms used in this report.

Also having an effect on the current and future availability of residue is the general tightening of timber supplies. The forest products industry, particularly the pulp and board sector, is examining alternative sources of wood fiber to augment expected shortages of mill residue. Underutilized sources, such as logging residue, are being carefully examined by these industries. Even today, faced with reduced supplies of mill residue, the pulp and board industries are using some logging residue to maintain the flow of raw material to their mills.

The prospect of these new or expanded markets has changed the focus of analysis of logging residue. What had been a concern about regional or national quantities of residue has become a need for specific information about residue on defined areas. New questions are being asked with increasing frequency by land managers, energy producers, planners, and forest product firms. These questions concern size, quality, number of pieces, topography, and dispersion.

As site-specific analysis became a reality, so did awareness of weaknesses in existing data on logging residue. Much of the needed information was either outdated or not provided by the existing sources (Howard 1973). Two basic needs became evident. First, new and more flexible data concerning residue volume were needed. Second, crucial questions about costs, equipment, handling, and transportation required more detail about the characteristics of logging residue. Various aspects of residue quantities are addressed by Howard (1981).

The purpose of this report is to describe the characteristics of wood residue that affect utilization:

1. Gross volume (see "Glossary") of logging residue by diameter and length, in cubic feet per acre.
2. Number of pieces of residue per acre, by diameter and length.
3. Volume of residue by percent sound (chippable; see "Glossary") in cubic feet per acre.
4. Average percent of bark on residue pieces by diameter.
5. Accessibility of residue on a cutover area (see "Glossary"), by slope and distance to road.

Only item 5 includes residue occurring in large YUM (see "Glossary") piles. The other characteristics, however, are based on line transect measurements and relate only to scattered residue and small piles. Lack of information about piled residue is not a significant problem for three reasons. First, it is already concentrated, almost always near an access road, and cost and equipment needed to yard it are not a concern. Second, because material in piles tends to be larger, it is not as difficult to handle as material scattered over the cutover areas. Third, residue in large piles represents only a small proportion of average stratum volumes.

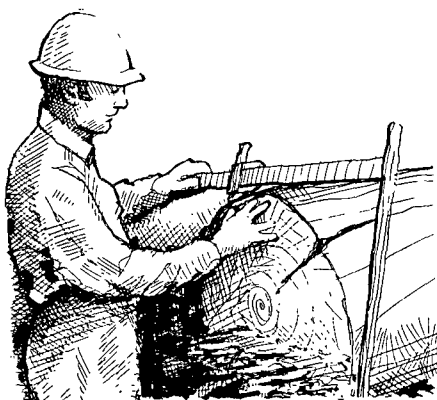
The above kinds of information are displayed for 19 strata (see "Glossary") for Idaho, Oregon, and Washington.

Three levels of stratification were used in selecting samples: (1) geographic area, (2) owner class, and (3) harvest method. Logging residue was measured on 518 areas cut over since January 1, 1979. The number of samples for strata in which sampling occurred is shown below:

<u>Area</u>	<u>Owner</u>	<u>Harvest method</u>		
		<u>Clearcut</u>	<u>Partial cut</u>	<u>All methods</u>
Idaho	National Forest	25	25	—
	Other public	—	—	25
	Private	—	—	25
Western Oregon	National Forest	20	²	—
	Other public	19	25	—
	Private	29	26	—
Eastern Oregon	Public	—	—	35
	Private	—	—	35
Western Washington	National Forest	20	²	—
	Other public	35	9	—
	Private	30	25	—
Eastern Washington	Public	—	—	35
	Private	—	—	35
Douglas-fir region	National Forest	—	40	—

² Partial cuts were combined into the Douglas-fir region because of an inadequate sample population in western Washington.

Procedure



Sample size and allocation were determined so as to yield estimates of average residue volume by stratum to a desired level of precision. For a detailed description of the sample selection process, see Howard (1981). The aspects of study design relevant to this report are summarized below.

Sample selection was made by identifying all cutover areas by stratum, then randomly selecting the desired number of samples from this population by one of two procedures: Where lists of all areas harvested since January 1, 1979, were available by owner, areas to be sampled were randomly selected from the lists. For other owners, sample units were randomly selected from lists of only the cutover areas that met study criteria. The latter procedure was used primarily for public landowners.

All cutover areas selected had to meet five criteria:

1. Logging was completed after January 1, 1979, and before field examination.
2. The cutover area was 5 acres or larger.
3. Harvesting on the area was not done for fire salvage purposes.
4. None of the residue was burned before field examination.
5. None of the residue was removed for firewood or other purposes before field examination.

These criteria were established to insure that estimates of residue would represent normal harvesting situations.

More sample units than needed were selected. The extra units served as alternates to replace areas that failed to meet study criteria on field examination. Alternate sample units for each stratum were used in the order in which they were selected.

The logging residue scattered throughout each cutover area was estimated by the line intersect method (Pickford and Hazard 1978, Howard and Ward 1972). All residue 3.01 or more inches in diameter (d.i.b.; see "Glossary") and 1.0 foot long or longer were measured. Pieces that were rotten to the point of losing their original form were excluded from the study. The sample design consisted of 200-foot line transects located at 30 points on a systematic grid. To reduce bias, both the initial starting point and the base line for the grid system were randomly selected. To reduce piece orientation bias (Howard and Ward 1972), each of the 30 line transects were randomly oriented along 45° azimuths.

Measurements were made on all residue pieces defined above. These measurements provided the basis for computing gross and net volume (see "Glossary") of logging residue.

The technique used to estimate volume did not allow for characterizing the residue; this information was obtained from subsamples of pieces measured for volume. A subsample consisted of the first two pieces of residue on each of the 200-foot line transects, resulting in a maximum of 60 pieces for each cutover area. Where residue volume was very low, fewer than 60 pieces were measured. This design yielded a subsample of 15 to 20 percent of the total number of pieces measured for volume. Measurements recorded for each piece were:

1. Small end diameter (d.i.b.), to the nearest inch.
2. Large end diameter (d.i.b.), to the nearest inch.
3. Length to the nearest foot.
4. Percent bark, to the nearest 10 percent.

The volume of each piece was computed by the Smalian formula:

$$V = 0.005454 \left[\frac{D^2 + d^2}{2} \right] \cdot L;$$

where: D = large end diameter (inches) inside bark;
d = small end diameter (inches) inside bark; and
L = piece length.

For each cutover area, volume of each piece was summarized by diameter and length class. A proportion was developed to relate the subsample volume to the total volume from the line transect. This proportion was then used to adjust the subsample volume in each diameter-length class to reflect the estimated residue volume for the area. Averages for strata were obtained by weighting the volume for each cutover area by the total harvest volume for that area.

To obtain number of pieces per acre by diameter and length class, the adjusted volume for each class was divided by the average piece volume for the class. Results for each stratum were determined by weighting volume for each cutover area by its total harvest volume.

Average percent of bark was determined by summarizing by diameter class the bark data collected for each cutover area. Averages for each stratum were obtained by weighting the values for individual cutover areas by total harvest volume.

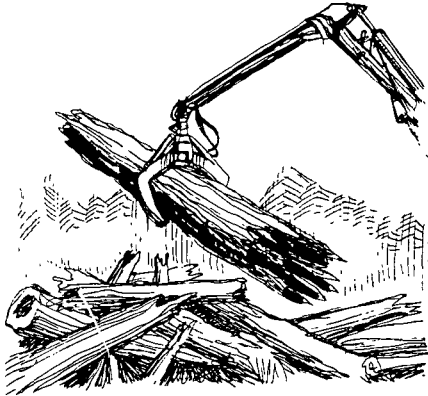
After the transects were measured, all residue, including piles, was ocularly placed in one of six accessibility categories. Categories used were:

Slope: 0-35 percent
36 percent or more

Distance to road: 0- 500 feet
501-1,000 feet
1,001 feet or more

Roads are defined as roadbeds capable of handling log trucks and other necessary equipment. In tractor-logged areas, especially those with flat terrain, acceptable roads were frequently of lesser quality than those on steeper slopes.

Results



This section presents and discusses study results. The focus will be primarily on interpretation of the data. Comparison and significance of the various figures will not be stressed because of the different uses for these data.

Tables 1 through 4 show only residue scattered throughout cutover areas and exclude residue in large piles. Table 5 pertains to all qualifying residue, including piles. To assist in expanding interpretation of the data in table 5 to volume estimates, tables 8 and 9 in the appendix give average gross and net residue (including piles) volume by stratum.

Volume by Diameter and Length Classes

Table 1 gives distribution of gross volume (wood only) per acre of logging residue for each of the study strata. Quantities are expressed in gross volume for two reasons. First, data were collected in such a way that the net volume of each piece of the subsample could not be computed. A net volume table could only be derived by proportioning each cell of the gross volume table to the average net volume for the same stratum. This, however, would introduce a bias because larger pieces of residue tend to be more defective than smaller pieces. Second, gross volume represents the material that must be handled, whether for product recovery or residue reduction. Even if

product recovery is the major consideration, gross volume is the carrier of net usable content. The exception would be residue with too much defect to have value for products. For evaluation, table 2 can be used to estimate the proportion of the residue below or above any acceptable chipable content.

The data in table 1 can be used to determine the volume of residue for specified limits of utilization. For example, assume that only residue greater than 20 inches in diameter and 16 feet in length is being considered for recovery for a particular product. Assume further that clearcuts on National Forest lands in western Washington are the only source of this residue. From the data in table 1, it is possible to determine how much residue larger than these set limits is available. This is shown in the following tabulation:

Western Washington, National Forest clearcuts

Small-end diameter	Length (feet)			
	1.0-7.9	8.0-15.9	16.0-31.9	32.0+
<i>(Cubic feet per acre)</i>				
3.1- 7.9				
8.0-11.9				
12.0-15.9				
16.0-19.9			286	245
20.0-23.9			311	90
24.0-27.9			164	41
28.0-35.9			27	—
36.0+			136	—

The sum of these figures is 1,300 cubic feet per acre, representing 38 percent of the average volume for the stratum.

In addition to the volume in the calculation above, residue in piles might be considered as having product value. Pile volume can be estimated by taking the difference between the gross volume shown in table 1 and table 8 in the appendix. Additional analysis would be needed to determine the usable proportion of the pile volume.

Land managers usually set utilization standards for logging operations. These standards determine the volume of residue that will be scattered or piled throughout a cutover area. Efforts to reduce residue volumes can be affected by lowering the utilization standards. Since lower standards will cause the logging operation to incur additional costs, it is important to know how much residue is involved. The impact of changing utilization limits can be determined from table 1, and from table 6 in the appendix. The format of the two tables is the same, but table 6 gives smaller diameter and length classes for residue less than 8 inches in diameter and 8 feet long. These data can also be used to determine residue availability under different cost assumptions.

Table 1—Gross volume (wood) of logging residue by area, owner class, and harvest method, and diameter and length classes¹

Owner class and harvest method	Small-end diameter	Length (feet)				
		1.0-7.9	8.0-15.9	16.0-31.9	32.0 +	Total
	<i>Inches</i>	<i>----- Cubic feet per acre -----</i>				
IDAHO						
National Forest: Clearcut	3.1- 7.9	50	112	231	397	790
	8.0-11.9	17	49	134	202	402
	12.0-15.9	13	53	145	108	319
	16.0-19.9	5	28	119	220	372
	20.0-23.9	2	—	52	20	74
	24.0-27.9	2	14	138	161	315
	28.0-35.9	7	—	27	174	208
	36.0 +	8	—	30	—	38
Total		104	256	876	1,282	2,518
Partial cut	3.1- 7.9	30	112	237	367	746
	8.0-11.9	19	61	160	175	415
	12.0-15.9	13	53	128	266	460
	16.0-19.9	8	29	45	131	213
	20.0-23.9	2	14	23	130	169
	24.0-27.9	—	7	—	96	103
	28.0-35.9	—	—	40	—	40
	36.0 +	10	—	—	—	10
Total		82	276	633	1,165	2,156
Other public (all methods)	3.1- 7.9	17	54	130	226	427
	8.0-11.9	9	49	91	233	382
	12.0-15.9	8	37	103	184	332
	16.0-19.9	5	14	42	181	242
	20.0-23.9	1	3	15	33	52
	24.0-27.9	2	12	18	50	82
	28.0-35.9	2	7	31	17	57
	36.0 +	—	—	—	—	—
Total		44	176	430	924	1,574
Private (all methods)	3.1- 7.9	24	83	171	219	497
	8.0-11.9	9	43	73	81	206
	12.0-15.9	10	22	66	72	170
	16.0-19.9	4	14	37	26	81
	20.0-23.9	1	11	43	—	55
	24.0-27.9	2	4	—	26	32
	28.0-35.9	—	—	—	42	42
	36.0 +	—	—	—	—	—
Total		50	177	390	466	1,083

See footnotes at end of table.

Table 1—Gross volume (wood) of logging residue by area, owner class, and harvest method, and diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				
		1.0-7.9	8.0-15.9	16.0-31.9	32.0 +	Total
	<i>Inches</i>	<i>Cubic feet per acre</i>				
WESTERN OREGON						
National Forest: Clearcut	3.1- 7.9	60	122	235	130	547
	8.0-11.9	66	118	112	32	328
	12.0-15.9	91	194	132	233	650
	16.0-19.9	54	94	140	134	422
	20.0-23.9	37	77	215	70	399
	24.0-27.9	14	98	237	46	395
	28.0-35.9	26	46	98	174	344
	36.0 +	16	—	128	—	144
Total		364	749	1,297	819	3,229
Partial cut ²	3.1- 7.9	18	49	91	74	232
	8.0-11.9	15	41	75	93	224
	12.0-15.9	19	49	89	104	261
	16.0-19.9	11	45	90	167	313
	20.0-23.9	3	18	102	180	303
	24.0-27.9	2	27	83	105	217
	28.0-35.9	6	13	108	118	245
	36.0 +	—	27	28	105	160
Total		74	269	666	946	1,955
Other public: Clearcut	3.1- 7.9	41	154	275	243	713
	8.0-11.9	38	119	178	130	465
	12.0-15.9	39	91	217	303	650
	16.0-19.9	18	79	129	136	362
	20.0-23.9	11	44	86	52	193
	24.0-27.9	—	49	24	168	241
	28.0-35.9	6	67	92	77	242
	36.0 +	—	30	298	133	461
Total		153	633	1,299	1,242	3,327
Partial cut	3.1- 7.9	15	53	115	135	318
	8.0-11.9	14	28	53	81	176
	12.0-15.9	11	28	59	105	203
	16.0-19.9	7	28	68	114	217
	20.0-23.9	3	13	43	87	146
	24.0-27.9	3	20	25	115	163
	28.0-35.9	4	6	46	101	157
	36.0 +	—	9	19	100	128
Total		57	185	428	838	1,508

See footnotes at end of table.

Table 1—Gross volume (wood) of logging residue by area, owner class, and harvest method, and diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-7.9	8.0-15.9	16.0-31.9	32.0 +	
	<i>Inches</i>	<i>----- Cubic feet per acre -----</i>				
WESTERN OREGON (continued)						
Private:						
Clearcut	3.1- 7.9	31	77	161	151	420
	8.0-11.9	27	76	103	41	247
	12.0-15.9	28	61	126	146	361
	16.0-19.9	28	99	141	140	408
	20.0-23.9	3	66	124	75	268
	24.0-27.9	9	48	157	136	350
	28.0-35.9	5	32	137	81	255
	36.0 +	25	15	269	158	467
Total		156	474	1,218	928	2,776
Partial cut	3.1- 7.9	20	57	114	93	284
	8.0-11.9	10	31	71	50	162
	12.0-15.9	12	46	86	154	298
	16.0-19.9	9	49	81	114	253
	20.0-23.9	2	23	59	127	211
	24.0-27.9	7	22	96	185	310
	28.0-35.9	4	28	109	167	308
	36.0 +	—	27	31	203	261
Total		64	283	647	1,093	2,087
WESTERN WASHINGTON						
National Forest:						
Clearcut	3.1- 7.9	58	174	236	54	522
	8.0-11.9	67	174	102	24	367
	12.0-15.9	69	194	158	145	566
	16.0-19.9	44	224	286	245	799
	20.0-23.9	60	69	311	90	530
	24.0-27.9	16	70	164	41	291
	28.0-35.9	32	56	27	—	115
	36.0 +	—	63	136	—	199
Total		346	1,024	1,420	599	3,389
Partial cut ²	3.1- 7.9	18	49	91	74	232
	8.0-11.9	15	41	75	93	224
	12.0-15.9	19	49	89	104	261
	16.0-19.9	11	45	90	167	313
	20.0-23.9	3	18	102	180	303
	24.0-27.9	2	27	83	105	217
	28.0-35.9	6	13	108	118	245
	36.0 +	—	27	28	105	160
Total		74	269	666	946	1,955

See footnotes at end of table.

Table 1—Gross volume (wood) of logging residue by area, owner class, and harvest method, and diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-7.9	8.0-15.9	16.0-31.9	32.0 +	
	<i>Inches</i>	<i>----- Cubic feet per acre -----</i>				
WESTERN WASHINGTON (continued)						
Other public:						
Clearcut	3.1- 7.9	46	125	221	105	497
	8.0-11.9	38	119	128	29	314
	12.0-15.9	29	59	80	59	227
	16.0-19.9	32	108	115	57	312
	20.0-23.9	22	72	94	97	285
	24.0-27.9	5	83	150	120	358
	28.0-35.9	15	85	164	71	335
	36.0 +	5	79	202	198	484
Total		192	730	1,154	736	2,812
Partial cut	3.1- 7.9	22	67	170	147	406
	8.0-11.9	9	21	85	11	126
	12.0-15.9	13	13	30	34	90
	16.0-19.9	2	7	41	146	196
	20.0-23.9	—	17	18	—	35
	24.0-27.9	—	12	—	68	80
	28.0-35.9	—	63	74	88	225
	36.0 +	—	34	109	—	143
Total		46	234	527	494	1,301
Private:						
Clearcut	3.1- 7.9	47	142	238	60	487
	8.0-11.9	35	105	130	49	319
	12.0-15.9	34	73	87	90	284
	16.0-19.9	11	32	89	71	203
	20.0-23.9	7	23	31	79	140
	24.0-27.9	18	37	39	—	94
	28.0-35.9	7	32	75	—	114
	36.0 +	—	35	121	111	267
Total		159	479	810	460	1,908
Partial cut	3.1- 7.9	26	89	203	271	589
	8.0-11.9	13	87	64	28	192
	12.0-15.9	5	30	53	23	111
	16.0-19.9	6	28	86	31	151
	20.0-23.9	4	12	50	17	83
	24.0-27.9	4	—	12	22	38
	28.0-35.9	—	—	33	—	33
	36.0 +	—	—	97	59	156
Total		58	246	598	451	1,353

See footnotes at end of table.

Table 1—Gross volume (wood) of logging residue by area, owner class, and harvest method, and diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				
		1.0-7.9	8.0-15.9	16.0-31.9	32.0 +	Total
	<i>Inches</i>	<i>----- Cubic feet per acre -----</i>				
		EASTERN OREGON				
Public (all methods)	3.1- 7.9	11	30	48	115	204
	8.0-11.9	6	17	24	89	136
	12.0-15.9	6	18	47	125	196
	16.0-19.9	2	8	26	41	77
	20.0-23.9	2	11	28	3	44
	24.0-27.9	2	5	17	66	90
	28.0-35.9	1	9	40	39	89
	36.0 +	—	2	—	—	2
Total		30	100	230	478	838
Private (all methods)	3.1- 7.9	17	54	72	104	247
	8.0-11.9	7	14	28	60	109
	12.0-15.9	4	11	20	70	105
	16.0-19.9	3	11	27	90	131
	20.0-23.9	—	4	21	—	25
	24.0-27.9	1	5	5	27	38
	28.0-35.9	—	—	—	59	59
	36.0 +	1	3	—	—	4
Total		33	102	173	410	718
		EASTERN WASHINGTON				
Public (all methods)	3.1- 7.9	16	48	66	106	236
	8.0-11.9	10	24	43	82	159
	12.0-15.9	4	17	59	72	152
	16.0-19.9	4	6	52	54	116
	20.0-23.9	1	4	11	26	42
	24.0-27.9	—	5	5	50	60
	28.0-35.9	1	8	6	28	43
	36.0 +	—	—	16	—	16
Total		36	112	258	418	824
Private (all methods)	3.1- 7.9	11	36	85	70	202
	8.0-11.9	6	17	30	40	93
	12.0-15.9	5	6	17	18	46
	16.0-19.9	2	7	29	30	68
	20.0-23.9	2	4	13	9	28
	24.0-27.9	1	2	10	17	30
	28.0-35.9	2	6	9	8	25
	36.0 +	—	—	—	—	—
Total		29	78	193	192	492

¹ Does not include residue in large piles.

² Average of partial cut areas in western Oregon and western Washington; these strata were combined because of an inadequate sample population in western Washington.

Table 2—Gross and net volume (wood) of logging residue by area, owner class, harvest method, and chippable material¹

		Chippable material (percent)							
Owner class and harvest method	Volume	0	1-20	21-40	41-60	61-80	81-99	100	Total
----- Cubic feet per acre -----									
IDAHO									
National Forest: Clearcut	Gross	209	537	303	225	202	385	657	2,518
	Net	0	54	91	112	142	346	657	1,402
Partial cut	Gross	106	321	268	285	314	379	483	2,156
	Net	0	32	80	143	220	341	483	1,299
Other public (all methods)	Gross	89	224	231	196	230	262	342	1,574
	Net	0	22	70	98	161	236	342	929
Private (all methods)	Gross	108	161	117	95	108	170	324	1,083
	Net	0	16	35	48	75	153	324	651
WESTERN OREGON									
National Forest: Clearcut	Gross	283	619	384	420	298	346	879	3,229
	Net	0	62	115	210	209	311	879	1,786
Partial cut ²	Gross	200	340	219	203	218	316	459	1,955
	Net	0	34	66	101	153	285	459	1,098
Other public: Clearcut	Gross	221	649	380	311	344	297	1,125	3,327
	Net	0	65	114	156	241	266	1,125	1,967

See footnotes at end of table.

Table 2—Gross and net volume (wood) of logging residue by area, owner class, harvest method, and chippable material¹ (continued)

Owner class and harvest method		Volume	Chippable material (percent)						
			0	1-20	21-40	41-60	61-80	81-99	100
<i>Cubic feet per acre</i>									
WESTERN OREGON (continued)									
Other public (continued):									
Partial cut	Gross	102	266	206	152	147	148	487	1,508
	Net	0	27	62	76	103	132	487	887
Private:									
Clearcut	Gross	300	522	340	248	216	257	893	2,776
	Net	0	0	52	103	151	231	893	1,554
Partial cut	Gross	108	473	243	309	201	207	546	2,087
	Net	0	47	74	154	140	186	546	1,147
WESTERN WASHINGTON									
National Forest:									
Clearcut	Gross	173	887	440	333	313	397	846	3,389
	Net	0	89	132	166	219	358	846	1,810
Partial cut ²	Gross	200	340	219	203	218	316	459	1,955
	Net	0	34	66	101	153	285	459	1,098
Other public:									
Clearcut	Gross	172	549	335	295	337	296	828	2,812
	Net	0	55	100	147	236	266	828	1,632

See footnotes at end of table.

Table 2—Gross and net volume (wood) of logging residue by area, owner class, harvest method, and chippable material¹ (continued)

Owner class and harvest method	Volume	Chippable material (percent)							Total
		0	1-20	21-40	41-60	61-80	81-99	100	
----- Cubic feet per acre -----									
WESTERN WASHINGTON (continued)									
Other public (continued):									
Partial cut	Gross	86	395	140	123	90	95	372	1,301
	Net	0	39	43	61	63	86	372	664
Private:									
Clearcut	Gross	263	389	212	188	154	236	466	1,908
	Net	0	39	63	94	108	213	466	983
Partial cut	Gross	56	323	154	183	145	142	350	1,353
	Net	0	32	46	91	102	129	350	750
EASTERN OREGON									
Public	Gross	136	217	87	68	77	62	191	838
(all methods)	Net	0	22	26	34	53	56	191	382
Private	Gross	76	134	84	89	65	54	216	718
(all methods)	Net	0	13	25	44	46	49	216	393
EASTERN WASHINGTON									
Public	Gross	62	115	112	130	83	111	211	824
(all methods)	Net	0	11	34	65	58	100	211	479
Private	Gross	43	77	60	55	63	55	139	492
(all methods)	Net	0	8	17	28	44	49	139	285

¹ Does not include residue in large piles.

² Average of partial cut areas in western Oregon and western Washington; these strata were combined because of an inadequate sample population in western Washington.

Number of Pieces Per Acre

As the focus on logging residue becomes site specific, the cost of retrieving residue material is a critical factor in making decisions about removing it. Because the characteristics of residue vary greatly, the cost of removing it must be correlated with the size and number of pieces so that decisionmakers can use available data on cost. Table 3 gives information needed for analyses of costs of handling, such as yarding.

Table 3—Logging residue by area, owner class, harvest method, and diameter and length classes¹

Owner class and harvest method	Small-end diameter	Length (feet)				
		1.0-7.9	8.0-15.9	16.0-31.9	32.0 +	Total
	<i>Inches</i>	<i>Number of pieces per acre</i>				
		IDAHO				
National Forest: Clearcut	3.1- 7.9	71.6	71.0	59.7	26.6	228.9
	8.0-11.9	8.0	8.6	8.8	5.2	30.6
	12.0-15.9	3.3	4.2	5.4	1.8	14.7
	16.0-19.9	.6	1.2	2.5	1.4	5.7
	20.0-23.9	.2	—	.8	.2	1.2
	24.0-27.9	.2	.4	1.4	.4	2.4
	28.0-35.9	.2	—	.2	.6	1.0
	36.0 +	.2	—	.2	—	.4
Total		84.3	85.4	79.0	36.2	284.9
Partial cut	3.1- 7.9	56.7	67.1	60.0	22.2	206.0
	8.0-11.9	9.7	10.4	11.3	5.4	36.8
	12.0-15.9	3.6	4.9	4.7	4.2	17.4
	16.0-19.9	1.0	1.5	1.0	1.5	5.0
	20.0-23.9	.2	.6	.4	1.0	2.2
	24.0-27.9	—	.2	—	.6	.8
	28.0-35.9	—	—	.4	—	.4
	36.0 +	.2	—	—	—	.2
Total		71.4	84.7	77.8	34.9	268.8
Other public (all methods)	3.1- 7.9	31.2	34.3	31.3	15.5	112.3
	8.0-11.9	3.8	7.9	6.9	5.7	24.3
	12.0-15.9	2.2	3.0	4.0	2.3	11.5
	16.0-19.9	.8	.8	.8	1.3	3.7
	20.0-23.9	.2	.2	.4	.4	1.2
	24.0-27.9	.3	.4	.3	.4	1.4
	28.0-35.9	.2	.2	.3	.2	.9
	36.0 +	—	—	—	—	—
Total		38.7	46.8	44.0	25.8	155.3
Private (all methods)	3.1- 7.9	41.9	52.5	46.6	18.3	159.3
	8.0-11.9	4.6	7.4	5.2	2.2	19.4
	12.0-15.9	2.3	1.7	2.8	.8	7.6
	16.0-19.9	.7	.7	1.1	.2	2.7
	20.0-23.9	.2	.4	.7	—	1.3
	24.0-27.9	.2	.2	—	.2	.6
	28.0-35.9	—	—	—	.3	.3
	36.0 +	—	—	—	—	—
Total		49.9	62.9	56.4	22.0	191.2

See footnotes at end of table.

Table 3—Logging residue by area, owner class, harvest method, and diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				
		1.0-7.9	8.0-15.9	16.0-31.9	32.0+	Total
	<i>Inches</i>	<i>Number of pieces per acre</i>				
WESTERN OREGON						
National Forest: Clearcut	3.1- 7.9	97.7	72.0	58.7	18.3	246.7
	8.0-11.9	28.4	20.9	9.2	1.0	59.5
	12.0-15.9	21.9	16.3	6.2	3.0	47.4
	16.0-19.9	7.2	4.9	3.6	1.7	17.4
	20.0-23.9	3.0	3.3	3.3	.7	10.3
	24.0-27.9	1.0	2.3	2.7	.4	6.4
	28.0-35.9	1.4	.7	.7	.7	3.5
	36.0+	.4	—	.7	—	1.1
Total		161.0	120.4	85.1	25.8	392.3
Partial cut ²	3.1- 7.9	28.6	27.5	21.4	5.3	82.8
	8.0-11.9	6.9	6.2	5.4	1.9	20.4
	12.0-15.9	4.7	4.1	3.3	1.5	13.6
	16.0-19.9	1.6	2.3	2.1	1.6	7.6
	20.0-23.9	.4	.7	1.5	1.2	3.8
	24.0-27.9	.2	.7	1.0	.7	2.6
	28.0-35.9	.3	.2	.8	.4	1.7
	36.0+	—	.3	.2	.2	.7
Total		42.7	42.0	35.7	12.8	133.2
Other public: Clearcut	3.1- 7.9	74.8	97.4	69.6	23.0	264.8
	8.0-11.9	18.2	19.1	13.0	3.6	53.9
	12.0-15.9	9.1	8.1	7.8	3.6	28.6
	16.0-19.9	2.3	4.6	2.6	1.0	10.5
	20.0-23.9	1.0	1.3	1.7	.4	4.4
	24.0-27.9	—	1.0	.4	1.3	2.7
	28.0-35.9	.4	1.3	.7	.4	2.8
	36.0+	—	.4	1.4	.4	2.2
Total		105.8	133.2	97.2	33.7	369.9
Partial cut	3.1- 7.9	29.0	36.3	30.8	9.8	105.9
	8.0-11.9	7.4	5.2	4.0	2.1	18.7
	12.0-15.9	2.3	2.9	2.3	1.7	9.2
	16.0-19.9	.9	1.4	1.7	1.0	5.0
	20.0-23.9	.3	.5	.7	.7	2.2
	24.0-27.9	.1	.5	.3	.6	1.5
	28.0-35.9	.2	.1	.3	.4	1.0
	36.0+	—	.1	.1	.3	.5
Total		40.2	47.0	40.2	16.6	144.0

See footnotes at end of table.

Table 3—Logging residue by area, owner class, harvest method, and diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-7.9	8.0-15.9	16.0-31.9	32.0 +	
	<i>Inches</i>	<i>Number of pieces per acre</i>				
WESTERN OREGON (continued)						
Private:						
Clearcut	3.1- 7.9	48.0	47.4	40.2	12.4	148.0
	8.0-11.9	12.8	13.3	7.8	1.5	35.4
	12.0-15.9	6.0	5.8	5.4	2.3	19.5
	16.0-19.9	3.3	4.7	3.6	1.6	13.2
	20.0-23.9	.3	2.3	1.9	.7	5.2
	24.0-27.9	.7	1.2	1.8	.7	4.4
	28.0-35.9	.2	.6	1.2	.3	2.3
	36.0 +	.7	.2	1.1	.4	2.4
Total		72.0	75.5	63.0	19.9	230.4
Partial cut	3.1- 7.9	36.6	40.2	32.1	9.5	118.4
	8.0-11.9	4.8	5.2	5.2	1.5	16.7
	12.0-15.9	2.7	4.1	3.8	1.4	12.0
	16.0-19.9	1.2	2.4	1.9	1.2	6.7
	20.0-23.9	.4	.8	.9	1.1	3.2
	24.0-27.9	.6	.6	1.0	1.1	3.3
	28.0-35.9	.2	.6	1.0	.7	2.5
	36.0 +	—	.4	.2	.4	1.0
Total		46.5	54.3	46.1	16.9	163.8
WESTERN WASHINGTON						
National Forest:						
Clearcut	3.1- 7.9	88.9	86.9	54.4	5.3	235.5
	8.0-11.9	31.6	28.3	8.2	1.0	69.1
	12.0-15.9	14.7	15.7	6.6	2.3	39.3
	16.0-19.9	5.9	11.4	6.6	2.3	26.2
	20.0-23.9	4.6	2.3	4.6	1.0	12.5
	24.0-27.9	1.0	1.7	1.7	.4	4.8
	28.0-35.9	1.4	1.4	.4	—	3.2
	36.0 +	—	.7	.7	—	1.4
Total		148.1	148.4	83.2	12.3	392.0
Partial cut ²	3.1- 7.9	28.6	27.5	21.4	5.3	82.8
	8.0-11.9	6.9	6.2	5.4	1.9	20.4
	12.0-15.9	4.7	4.1	3.3	1.5	13.6
	16.0-19.9	1.6	2.3	2.1	1.6	7.6
	20.0-23.9	.4	.7	1.5	1.2	3.8
	24.0-27.9	.2	.7	1.0	.7	2.6
	28.0-35.9	.3	.2	.8	.4	1.7
	36.0 +	—	.3	.2	.2	.7
Total		42.7	42.0	35.7	12.8	133.2

See footnotes at end of table.

Table 3—Logging residue by area, owner class, harvest method, and diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-7.9	8.0-15.9	16.0-31.9	32.0+	
	<i>Inches</i>	<i>Number of pieces per acre</i>				
WESTERN WASHINGTON (continued)						
Other public: Clearcut	3.1- 7.9	82.9	81.1	62.4	14.3	240.7
	8.0-11.9	17.4	19.8	10.5	1.2	48.9
	12.0-15.9	7.4	5.7	3.9	1.0	18.0
	16.0-19.9	4.4	5.7	2.8	.9	13.8
	20.0-23.9	2.2	2.5	1.5	.7	6.9
	24.0-27.9	.5	1.8	1.7	.5	4.5
	28.0-35.9	.5	1.4	1.2	.4	3.5
	36.0+	.2	.7	1.0	.4	2.3
Total		115.5	118.7	85.0	19.4	338.6
Partial cut	3.1- 7.9	50.0	55.2	55.6	18.1	178.9
	8.0-11.9	3.4	3.4	5.7	.4	12.9
	12.0-15.9	2.3	.8	1.2	.8	5.1
	16.0-19.9	.4	.4	.8	1.2	2.8
	20.0-23.9	—	.4	.4	—	.8
	24.0-27.9	—	.4	—	.4	.8
	28.0-35.9	—	.8	.4	.4	1.6
	36.0+	—	.4	.4	—	.8
Total		56.1	61.8	64.5	21.3	203.7
Private: Clearcut	3.1- 7.9	77.7	80.1	62.7	7.2	227.7
	8.0-11.9	16.6	17.9	10.1	1.8	46.4
	12.0-15.9	8.2	6.5	3.6	1.8	20.1
	16.0-19.9	1.6	1.6	2.3	.7	6.2
	20.0-23.9	.6	.7	.6	.7	2.6
	24.0-27.9	1.3	.9	.6	—	2.8
	28.0-35.9	.2	.4	.6	—	1.2
	36.0+	—	.2	.4	.2	.8
Total		106.2	108.3	80.9	12.4	307.8
Partial cut	3.1- 7.9	49.5	68.6	68.6	27.6	214.3
	8.0-11.9	5.9	5.3	5.3	.9	17.4
	12.0-15.9	1.4	2.5	2.0	.5	6.4
	16.0-19.9	.9	1.4	2.2	.4	4.9
	20.0-23.9	.4	.4	.9	.2	1.9
	24.0-27.9	.2	—	.2	.2	.6
	28.0-35.9	—	—	.2	—	.2
	36.0+	—	—	.4	.2	.6
Total		58.3	78.2	79.8	30.0	246.3

See footnotes at end of table.

Table 3—Logging residue by area, owner class, harvest method, and diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				
		1.0-7.9	8.0-15.9	16.0-31.9	32.0 +	Total
	<i>Inches</i>	<i>Number of pieces per acre</i>				
EASTERN OREGON						
Public (all methods)	3.1- 7.9	19.9	17.2	9.8	4.7	51.6
	8.0-11.9	2.2	2.6	1.5	.9	7.2
	12.0-15.9	1.1	1.4	1.5	1.3	5.3
	16.0-19.9	.4	.4	.6	.4	1.8
	20.0-23.9	.2	.4	.4	.1	1.1
	24.0-27.9	.2	.1	.2	.3	.8
	28.0-35.9	.1	.2	.3	.1	.7
	36.0 +	—	.1	—	—	.1
Total		24.1	22.4	14.3	7.8	68.6
Private (all methods)	3.1- 7.9	31.4	31.0	17.7	5.3	85.4
	8.0-11.9	3.2	2.1	1.8	.7	7.8
	12.0-15.9	1.0	.9	.8	.9	3.6
	16.0-19.9	.4	.5	.6	.4	1.9
	20.0-23.9	—	.1	.3	—	.4
	24.0-27.9	.1	.1	.1	.1	.4
	28.0-35.9	—	—	—	.2	.2
	36.0 +	.1	.1	—	—	.2
Total		36.2	34.8	21.3	7.6	99.9
EASTERN WASHINGTON						
Public (all methods)	3.1- 7.9	27.2	26.7	16.3	6.4	76.6
	8.0-11.9	4.3	3.9	3.0	2.0	13.2
	12.0-15.9	1.0	1.5	2.1	1.2	5.8
	16.0-19.9	.5	.3	1.2	.6	2.6
	20.0-23.9	.1	.1	.2	.2	.6
	24.0-27.9	—	.1	.1	.3	.5
	28.0-35.9	.1	.2	.1	.2	.6
	36.0 +	—	—	.1	—	.1
Total		33.2	32.8	23.1	10.9	100.0
Private (all methods)	3.1- 7.9	19.2	22.3	16.8	4.7	63.0
	8.0-11.9	2.2	2.7	2.1	1.0	8.0
	12.0-15.9	1.0	.4	.7	.4	2.5
	16.0-19.9	.4	.3	.7	.4	1.8
	20.0-23.9	.2	.2	.3	.1	.8
	24.0-27.9	.1	.1	.2	.2	.6
	28.0-35.9	.2	.1	.1	.1	.5
	36.0 +	—	—	—	—	—
Total		23.3	26.1	20.9	6.9	77.2

¹ Does not include residue in large piles.

² Average of partial cut areas in western Oregon and western Washington; these strata were combined because of an inadequate sample population in western Washington.

Since these data are averages, portions of pieces appear in the tabulations. Several pieces of a certain diameter or length class may be found on one area and none on another, especially pieces in the larger size classes. What is important, however, is whether there are few or many pieces of a given size. It is significant, for example, that on private lands in Idaho there are almost 162 pieces per acre that are less than 8 inches in diameter, but less than 1 piece per acre over 24 inches.

For the entire study area, 75 percent of all pieces are less than 8 inches in diameter, excluding those in large piles. To provide more detail for analyzing the cost of handling these smaller pieces, table 7 in the appendix shows number of pieces per acre for diameter classes from 3.1 to 7.9 inches and length classes from 1.0 to 7.9 feet. This table is similar in format to table 6.

The data from tables 1 and 3 can be used to estimate the average volume per piece of residue. This is accomplished by dividing the volume in a specific diameter and length class from table 1 by the number of pieces in the same size class in table 3. For example, for other public lands in Idaho, table 1 shows 226 cubic feet per acre for pieces less than 8 inches in diameter and longer than 31.9 feet. Table 3 indicates that for the same size class there are 15.5 pieces per acre. Thus, the average volume per piece is 14.6 cubic feet. Tables 6 and 7 can be similarly used to determine average volume for pieces of residue less than 8 inches in diameter and 8 feet long.

Percent Chippable

Use of logging residue for a given product is usually associated with physical characteristics of the material. A key factor is freedom from physical defects. The nature and amount of acceptable defect depend on the type of product. Checking and splitting, for example, make wood unsuitable for sawn products but have no effect on the quality of chips. Likewise, decay beyond very early stages may prohibit use for pulp but not necessarily for energy. At some point, degradation in quality will make wood unsuitable for any use except enhancement of soil.

The quality standard for this study was based on physical characteristics. Specifically, any residue material that can be handled with existing equipment and will produce usable chips is considered sound wood. This allows for decay up to the point that chips begin to disintegrate. The net volume referred to includes only the portion of the residue that meets this standard.

Assessments of the cost and returns of converting residue to a particular product require that the acceptable level of defect be defined. Material below this level is rejected as having too little usable content relative to the cost of handling and processing and the value of the resulting product. The data in table 2 can be used to make this type of evaluation. Gross and net volume, excluding large piles, are given for seven classes of material of varying chippable content.

The following is an example of how to interpret the data in table 2. Other public land in Idaho shows a gross volume of residue of 230 cubic feet per acre in the 61 to 80 percent class of chippable material and a net volume of 161 cubic feet per acre. Thus, 230 cubic feet would have to be processed to recover 161 cubic feet of usable wood fiber.

Net volume is not synonymous with recovery for solid wood products. Defects, such as cracks, splits, and early stages of decay, greatly reduce the usability of residue for these products. Therefore, the data in table 2 cannot be used to make precise assessments of the potential for producing solid wood products.

Average Percentage of Bark

Bark is not an acceptable raw material in the production of some wood products. Most pulp processes accept little or no bark in their furnish. The bark collected is generally used for hog fuel because it has energy value greater than wood.

Because logging residue is being considered as a potential source of wood by some industries, it is important to know the amount of bark that persists on residue materials. This information can be used to determine the proportion of bark that might be included if the residue is chipped. The proportion of bark can also help determine equipment needed for debarking residue.

Table 4 shows average percent bark by diameter classes. Residue volumes given in this report do not include bark. These data can be obtained from a related report (Howard 1981).

Table 4—Average amount of bark on logging residue by area, owner class, harvest method, and diameter class¹

Owner class and harvest method	Small-end diameter	Bark	Owner class and harvest method	Small-end diameter	Bark
	<i>Inches</i>	<i>Percent</i>		<i>Inches</i>	<i>Percent</i>
IDAHO					
National Forest: Clearcut	3.1- 7.9	55	National Forest: Partial cut	3.1- 7.9	53
	8.0-11.9	38		8.0-11.9	30
	12.0-15.9	44		12.0-15.9	27
	16.0-19.9	47		16.0-19.9	27
	20.0-23.9	63		20.0-23.9	38
	24.0-27.9	60		24.0-27.9	18
	28.0-35.9	76		28.0-35.9	0
	36 +	20		36 +	100
Average		52	Average		48
Other public (all methods)	3.1- 7.9	53	Private (all methods)	3.1- 7.9	59
	8.0-11.9	24		8.0-22.9	35
	12.0-15.9	28		12.0-15.9	38
	16.0-19.9	38		16.0-19.9	23
	20.0-23.9	37		20.0-23.9	30
	24.0-27.9	29		24.0-27.9	60
	28.0-35.9	16		28.0-35.9	45
	36 +	0		36 +	0
Average		46	Average		55
WESTERN OREGON					
National Forest: Clearcut	3.1- 7.9	68	National Forest: Partial cut ²	3.1- 7.9	56
	8.0-11.9	44		8.0-11.9	35
	12.0-15.9	33		12.0-15.9	37
	16.0-19.9	30		16.0-19.9	25
	20.0-23.9	32		20.0-23.9	33
	24.0-27.9	43		24.0-27.9	34
	28.0-35.9	30		28.0-35.9	23
	36 +	27		36 +	46
Average		57	Average		48
Other public: Clearcut	3.1- 7.9	69	Other public: Partial cut	3.1- 7.9	65
	8.0-11.9	45		8.0-11.9	42
	12.0-15.9	38		12.0-15.9	41
	16.0-19.9	27		16.0-19.9	27
	20.0-23.9	18		20.0-23.9	22
	24.0-27.9	28		24.0-27.9	9
	28.0-35.9	23		28.0-35.9	39
	36 +	0		36 +	31
Average		60	Average		58

See footnotes at end of table.

Table 4—Average amount of bark on logging residue by area, owner class, harvest method, and diameter class¹ (continued)

Owner class and harvest method	Small-end diameter	Bark	Owner class and harvest method	Small-end diameter	Bark
	<i>Inches</i>	<i>Percent</i>		<i>Inches</i>	<i>Percent</i>
WESTERN OREGON (continued)					
Private:			Private:		
Clearcut	3.1- 7.9	63	Partial cut	3.1- 7.9	59
	8.0-11.9	45		8.0-11.9	37
	12.0-15.9	31		12.0-15.9	22
	16.0-19.9	30		16.0-19.9	29
	20.0-23.9	20		20.0-23.9	19
	24.0-27.9	10		24.0-27.9	15
	28.0-35.9	18		28.0-35.9	22
	36 +	9		36 +	31
Average		53	Average		50
WESTERN WASHINGTON					
National Forest:			National Forest:		
Clearcut	3.1- 7.9	56	Partial cut ²	3.1- 7.9	56
	8.0-11.9	45		8.0-11.9	35
	12.0-15.9	31		12.0-15.9	37
	16.0-19.9	21		16.0-19.9	25
	20.0-23.9	33		20.0-23.9	33
	24.0-27.9	47		24.0-27.9	34
	28.0-35.9	31		28.0-35.9	23
	36 +	48		36 +	46
Average		48	Average		48
Other public:			Other public:		
Clearcut	3.1- 7.9	62	Partial cut	3.1- 7.9	66
	8.0-11.9	40		8.0-11.9	33
	12.0-15.9	38		12.0-15.9	6
	16.0-19.9	27		16.0-19.9	14
	20.0-23.9	23		20.0-23.9	0
	24.0-27.9	16		24.0-27.9	5
	28.0-35.9	16		28.0-35.9	20
	36 +	21		36 +	0
Average		54	Average		60
Private:			Private:		
Clearcut	3.1- 7.9	64	Partial cut	3.1- 7.9	72
	8.0-11.9	40		8.0-11.9	43
	12.0-15.9	36		12.0-15.9	20
	16.0-19.9	31		16.0-19.9	21
	20.0-23.9	30		20.0-23.9	4
	24.0-27.9	8		24.0-27.9	0
	28.0-35.9	12		28.0-35.9	0
	36 +	0		36 +	0
Average		57	Average		67

See footnotes at end of table.

Table 4—Average amount of bark on logging residue by area, owner class, harvest method, and diameter class¹ (continued)

Owner class and harvest method	Small-end diameter	Bark	Owner class and harvest method	Small-end diameter	Bark
	<i>Inches</i>	<i>Percent</i>		<i>Inches</i>	<i>Percent</i>
EASTERN OREGON					
Public (all methods)	3.1- 7.9	57	Private (all methods)	3.1- 7.9	61
	8.0-11.9	35		8.0-11.9	24
	12.0-15.9	28		12.0-15.9	42
	16.0-19.9	49		16.0-19.9	29
	20.0-23.9	25		20.0-23.9	24
	24.0-27.9	31		24.0-27.9	3
	28.0-35.9	18		28.0-35.9	3
	36 +	<u>0</u>		36 +	<u>0</u>
Average		51	Average		57
EASTERN WASHINGTON					
Public (all methods)	3.1- 7.9	61	Private (all methods)	3.1- 7.9	65
	8.0-11.9	34		8.0-11.9	34
	12.0-15.9	25		12.0-15.9	43
	16.0-19.9	29		16.0-19.9	37
	20.0-23.9	37		20.0-23.9	54
	24.0-27.9	40		24.0-27.9	5
	28.0-35.9	46		28.0-35.9	30
	36 +	<u>0</u>		36 +	<u>0</u>
Average		54	Average		60

¹ Does not include residue in large piles.

² Average of partial cut areas in western Oregon and western Washington; these strata were combined because of an inadequate sample population in western Washington.

Loss of bark has two major causes. The first is related to natural mortality of trees. Bark begins to loosen and slough off a few years after death of a tree. This progresses until all the bark has fallen off. Trees and logs at all stages of this process are found after logging. Damage to trees during logging is the other reason for loss of bark. Felling and handling contribute to loss of bark on a given piece. The combination of these losses, plus some minor ones, contributes to figures in table 4 showing bark well below 100 percent for all diameter classes.

Residue Accessibility

Accessibility of logging residue is important, particularly in terms of handling

equipment. Two factors that affect the type of equipment used to retrieve residue are slope and distance to the nearest road. The slope factor determines whether ground-based or cable systems are required to yard the residue. Generally, relogging cannot bear the cost of new road construction, and roads that were built during the initial logging operation are the roads that must be used for recovery activities. Equipment limitations, such as maximum yarding distance, are therefore determined by distance to the nearest existing road.

The distribution of logging residue by slope and distance to the nearest road is shown in table 5, which includes piles.

Table 5—Distribution of logging residue by area, owner class, harvest method, and slope and distance to road classes¹

Owner and harvest method	Slope (percent)	Distance to road (feet)			Total
		0-500	501-1,000	1,001 +	
----- Percent -----					
IDAHO					
National Forest: Clearcut	0-35	33.5	12.4	2	45.9
	36 +	44.6	9.5	—	54.1
Total		78.1	21.9	2	100.0
Partial cut	0-35	35.3	4.2	.3	39.8
	36 +	37.6	11.4	11.2	60.2
Total		72.9	15.6	11.5	100.0
Other public (all methods)	0-35	43.1	13.6	.9	57.6
	36 +	27.0	13.9	1.5	42.4
Total		70.1	27.5	2.4	100.0
Private (all methods)	0-35	64.2	6.8	.6	71.6
	36 +	21.9	5.6	.9	28.4
Total		86.1	12.4	1.5	100.0
WESTERN OREGON					
National Forest: Clearcut	0-35	14.3	13.5	6.7	34.5
	36 +	33.4	21.5	10.6	65.5
Total		47.7	35.0	17.3	100.0

See footnotes at end of table.

Table 5—Distribution of logging residue by area, owner class, harvest method, and slope and distance to road classes¹ (continued)

Owner and harvest method	Slope (percent)	Distance to road (feet)			
		0-500	501-1,000	1,001 +	Total
<i>Percent</i>					
WESTERN OREGON (continued)					
National Forest (continued):					
Partial cut ³	0-35	72.2	11.0	—	83.2
	36 +	11.5	4.5	.8	16.8
Total		83.7	15.5	0.8	100.0
Other public:					
Clearcut	0-35	14.1	5.4	4.4	23.9
	36 +	55.5	17.7	2.9	76.1
Total		69.6	23.1	7.3	100.0
Partial cut	0-35	38.5	7.8	1.3	47.6
	36 +	35.4	15.8	1.2	52.4
Total		73.9	23.6	2.5	100.0
Private:					
Clearcut	0-35	43.9	5.2	.5	49.6
	36 +	40.5	8.2	1.7	50.4
Total		84.4	13.4	2.2	100.0
Partial cut	0-35	71.2	10.0	—	81.2
	36 +	13.3	5.5	—	18.8
Total		84.5	15.5	—	100.0

See footnotes at end of table.

Table 5—Distribution of logging residue by area, owner class, harvest method, and slope and distance to road classes¹ (continued)

Owner and harvest method	Slope (percent)	Distance to road (feet)			
		0-500	501-1,000	1,001 +	Total
-----Percent-----					
WESTERN WASHINGTON					
National Forest:					
Clearcut	0-35	30.5	6.0	—	36.5
	36 +	39.8	23.0	.7	63.5
Total		70.3	29.0	.7	100.0
Partial cut ³	0-35	72.2	11.0	—	83.2
	36 +	11.5	4.5	.8	16.8
Total		83.7	15.5	.8	100.0
Other public:					
Clearcut	0-35	43.2	1.5	—	44.7
	36 +	32.1	22.2	1.0	55.3
Total		75.3	23.7	1.0	100.0
Partial cut	0-35	85.7	5.0	—	90.7
	36 +	8.8	.5	—	9.3
Total		94.5	5.5	—	100.0
Private:					
Clearcut	0-35	30.2	10.0	.1	40.3
	36 +	41.1	18.6	—	59.7
Total		71.3	28.6	.1	100.0

See footnotes at end of table.

Table 5—Distribution of logging residue by area, owner class, harvest method, and slope and distance to road classes¹ (continued)

Owner and harvest method	Slope (percent)	Distance to road (feet)			
		0-500	501-1,000	1,001 +	Total
<i>Percent</i>					
WESTERN WASHINGTON (continued)					
Private (continued):					
Partial cut	0-35	67.8	24.1	4.7	96.6
	36 +	3.2	.2	—	3.4
Total		71.0	24.3	4.7	100.0
EASTERN OREGON					
Public	0-35	49.1	27.6	9.8	86.5
(all methods)	36 +	4.3	5.9	3.3	13.5
Total		53.4	33.5	13.1	100.0
Private	0-35	58.0	22.1	5.8	85.9
(all methods)	36 +	10.6	3.4	.1	14.1
Total		68.6	25.5	5.9	100.0
EASTERN WASHINGTON					
Public	0-35	36.8	15.1	2.1	54.0
(all methods)	36 +	28.9	12.4	4.7	46.0
Total		65.7	27.5	6.8	100.0
Private	0-35	38.7	17.8	6.1	62.6
(all methods)	36 +	26.7	9.8	.9	37.4
Total		65.4	27.6	7.0	100.0

¹ Includes residue in large piles, which are almost always adjacent to a road and thus part of the 0-500 column.

² Less than 0.05 percent.

³ Average of partial cut areas in western Oregon and western Washington; these strata were combined because of an inadequate sample population in western Washington.

Precision of Study Data

This study was designed to provide information on characteristics of logging residue through a sample of pieces that were measured for volume. The design resulted in 15 to 20 percent of these pieces being sampled for a given stratum. These data on characteristics were not subjected to conventional statistical analysis and should be viewed as indicative of the distribution of residue over various classifications, rather than precise estimates of the volume in given size classes.

Because the probability of sampling a piece of residue is proportional to its length, the sampling scheme used in this study results in a bias in the data on length. The estimates overstate the volume in longer pieces and understate the volume in shorter pieces. The magnitude of this bias is unknown.

The sample data for each table in this report have been adjusted to represent the average residue volume for each stratum. The precision of these average volumes has been determined in a separate report (Howard 1981). Shown below is the statistical information associated with the average gross volume (wood only) for each stratum. A detailed analysis of these averages can be found in the above report.

Statistical information for determination of precision, by stratum

Stratum	Sample size	Average volume per unit	Standard error of the mean
	(Number)	(Cubic feet)	
Idaho:			
National Forest—			
Clearcut	25	77,706.2	21,281.6
Partial cut	25	108,385.8	44,964.9
Other public (all methods)	25	269,928.0	48,622.1
Private (all methods)	25	109,896.2	21,636.3
Western Oregon:			
National Forest—			
Clearcut	20	76,787.2	12,891.3
Other public—			
Clearcut	19	110,847.4	28,339.6
Partial cut	25	81,016.6	13,639.2
Private—			
Clearcut	29	158,310.7	15,076.0
Partial cut	26	161,054.0	33,595.3
Western Washington:			
National Forest—			
Clearcut	20	124,137.6	13,323.4
Other public—			
Clearcut	35	211,295.1	34,055.4
Partial cut	9	95,283.9	33,185.4
Private—			
Clearcut	30	145,432.6	30,124.5
Partial cut	25	96,580.2	37,140.4
Eastern Oregon:			
Public (all methods)	35	114,844.1	18,269.9
Private (all methods)	35	122,087.2	23,089.0
Eastern Washington:			
Public (all methods)	35	119,488.9	20,283.3
Private (all methods)	35	55,955.7	7,938.3
Douglas-fir region:			
National Forest—			
Partial cut	40	118,711.4	16,997.0

Metric Equivalents

1 inch = 2.54 centimeters
1 foot = 30.48 centimeters
1 mile = 1.609 kilometers
1 acre = 2.47 hectares
1 cubic foot = 0.283 cubic meter (stere)
1 pound = 0.454 kilogram
1 ton = 0.907 metric ton
1 British thermal unit (Btu) = 1 055.87
joules

Literature Cited



Bergvall, John A.; Bullington, Darryl C.;
Gee, Loren; and Koss, William. Wood
waste for energy study. Inventory
assessment and economic analysis.
Olympia, WA: State Wash. Dep. Nat.
Resour.; 1978.

Grantham, John B.; Estep, Eldon M.;
Pierovich, John M., and others. Energy
and raw material potentials of wood
residue in the Pacific Coast States:
a summary of a preliminary feasibility
investigation. USDA For. Serv. Gen. Tech.
Rep. PNW-18. Portland, OR: Pac.
Northwest For. and Range Exp. Stn.;
1974.

Howard, James O.; Logging residue in
Washington, Oregon, and California:
volume and characteristics. USDA For.
Serv. Resour. Bull. PNW-44. Portland, OR:
Pac. Northwest For. and Range Exp.
Stn.; 1973.

Howard, James O. Ratios for estimating
logging residue in the Pacific North-
west. USDA For. Serv. Res. Pap.
PNW-288. Portland, OR: Pac. Northwest
For. and Range Exp. Stn.; 1981.

Howard, James O.; Ward, Franklin R.
Measurement of logging residue: alter-
native application of the line intersect
method. USDA For. Serv. Res. Note
PNW-183. Portland, OR: Pac. Northwest
For. and Range Exp. Stn.; 1972.

Pickford, Stewart G.; Hazard, John W.
Simulation studies on line intersect
sampling of forest residue. For. Sci.
24(4): 469-483; 1978.

Appendix

Glossary¹

Clearcut A harvest method in which all, or nearly all, of the trees in a stand of timber are cut in one operation.

Cogeneration The concurrent production of two or more forms of energy from one basic conversion process; for example, steam and electricity from one boiler system.

Cutover area Synonymous with sample unit or sample area; the area encompassing a single harvest operation (example: a clearcut).

Diameter Diameter of residue pieces measured inside the bark (d.i.b.) at the point residue intersects a line transect.

Harvest volume Net scaled volume of timber removed from a cutover area during harvesting, expressed in thousand board feet (log scale) per acre (MBF/AC).

Line transect A vertical sampling plane with no width, along which all intersecting residue pieces are measured.

Logging residue

General: All down and dead woody material existing on an area after timber harvest is completed.

Specific: All logging residue (as defined above) 3.01 inches and larger in diameter inside bark (d.i.b.) and 1.0 foot long and longer, including limbs, slabs, splinters, and bark.

¹ Terms and abbreviations are defined as they are used in this report.

MBF 1,000 board feet of logs, a measurement of the quantity of timber harvested.

Owner class

Other public: Lands owned by the public or managed by a public agency, excluding National Forest lands.

Public: Lands owned by the public or managed by a public agency.

Private: Lands owned by private individuals, forest industries, or other corporations.

Partial cut A harvest method in which portions of a stand of timber are cut during a number of entries over time; precommercial thinning operations are not included.

Ponderosa pine region Area of Oregon and Washington east of the Cascade Range.

Residue volume

Gross: Volume of a piece of residue measured only by its external dimensions; includes rot, cracks, and missing parts.

Net: The usable portion of a piece of residue; for this report usability is based on physical chippability of the material.

Chippable: Condition of residue being sound enough to be physically handled and capable of producing usable chips; includes residue exhibiting early stages of wet or dry rot.

Stratum A category of timber harvest area defined for this study by geographic area, ownership class, and harvest method.

Table 6—Gross volume (wood) of logging residue by area, owner class, harvest method, and log diameter and length classes¹

Owner class and harvest method	Small-end diameter	Length (feet)				
		1.0-3.9	4.0-5.9	6.0-7.9	8.0 +	Total
	<i>Inches</i>	<i>-----Cubic feet per acre-----</i>				
		IDAHO				
National Forest: Clearcut	3.1- 3.9	1	3	4	295	303
	4.0- 4.9	2	4	4	162	172
	5.0- 5.9	1	2	2	63	68
	6.0- 6.9	2	16	4	153	175
	7.0- 7.9	1	2	2	67	72
	8.0-11.9	2	7	8	385	402
	12.0-15.9	2	5	6	306	319
	16.0 +	2	5	17	983	1,007
Total		13	44	47	2,414	2,518
Partial cut	3.1- 3.9	1	2	4	246	253
	4.0- 4.9	2	3	3	143	151
	5.0- 5.9	—	1	2	122	125
	6.0- 6.9	2	3	3	125	133
	7.0- 7.9	1	1	2	80	84
	8.0-11.9	3	8	8	396	415
	12.0-15.9	3	4	6	447	460
	16.0 +	1	5	14	515	535
Total		13	27	42	2,074	2,156
Other public (all methods)	3.1- 3.9	—	1	2	141	144
	4.0- 4.9	1	2	2	79	84
	5.0- 5.9	—	1	1	34	36
	6.0- 6.9	1	2	2	105	110
	7.0- 7.9	—	1	1	51	53
	8.0-11.9	1	2	6	373	382
	12.0-15.9	1	5	2	324	332
	16.0 +	5	3	2	423	433
Total		9	17	18	1,530	1,574
Private (all methods)	3.1- 3.9	1	2	2	213	218
	4.0- 4.9	1	2	3	93	99
	5.0- 5.9	1	1	2	53	57
	6.0- 6.9	1	2	3	70	76
	7.0- 7.9	1	1	1	44	47
	8.0-11.9	2	3	4	197	206
	12.0-15.9	2	2	6	160	170
	16.0 +	1	6	—	203	210
Total		10	19	21	1,033	1,083

See footnotes at end of table.

Table 6—Gross volume (wood) of logging residue by area, owner class, harvest method, and log diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0 +	
	<i>Inches</i>	<i>Cubic feet per acre</i>				
WESTERN OREGON						
National Forest: Clearcut	3.1- 3.9	1	3	6	201	211
	4.0- 4.9	4	7	7	83	101
	5.0- 5.9	—	3	2	53	58
	6.0- 6.9	3	11	11	108	133
	7.0- 7.9	—	1	1	42	44
	8.0-11.9	9	26	31	262	328
	12.0-15.9	16	36	35	563	650
	16.0 +	19	47	85	1,553	1,704
Total		52	134	178	2,865	3,229
Partial cut ²	3.1- 3.9	—	1	3	81	85
	4.0- 4.9	1	1	2	40	44
	5.0- 5.9	—	1	—	25	26
	6.0- 6.9	1	3	3	42	49
	7.0- 7.9	—	1	1	26	28
	8.0-11.9	2	6	7	209	224
	12.0-15.9	3	6	10	242	261
	16.0 +	3	11	8	1,216	1,238
Total		10	30	34	1,881	1,955
Other public: Clearcut	3.1- 3.9	1	2	4	246	253
	4.0- 4.9	3	5	4	178	190
	5.0- 5.9	—	2	2	63	67
	6.0- 6.9	4	6	4	147	161
	7.0- 7.9	—	2	2	38	42
	8.0-11.9	5	12	21	427	465
	12.0-15.9	8	13	18	611	650
	16.0 +	6	16	13	1,464	1,499
Total		27	58	68	3,174	3,327
Partial cut	3.1- 3.9	1	1	2	153	157
	4.0- 4.9	1	2	2	70	75
	5.0- 5.9	—	1	1	22	24
	6.0- 6.9	—	2	1	43	46
	7.0- 7.9	—	1	—	15	16
	8.0-11.9	2	7	5	162	176
	12.0-15.9	1	4	6	192	203
	16.0 +	1	9	7	794	811
Total		6	27	24	1,451	1,508

See footnotes at end of table.

Table 6—Gross volume (wood) of logging residue by area, owner class, harvest method, and log diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0 +	
	<i>Inches</i>	<i>Cubic feet per acre</i>				
WESTERN OREGON (continued)						
Private:						
Clearcut	3.1- 3.9	—	2	2	129	133
	4.0- 4.9	2	3	4	89	98
	5.0- 5.9	—	1	3	44	48
	6.0- 6.9	1	4	7	101	113
	7.0- 7.9	—	1	1	26	28
	8.0-11.9	4	11	12	220	247
	12.0-15.9	3	9	16	333	361
	16.0 +	5	27	38	1,678	1,748
Total		15	58	83	2,620	2,776
Partial cut	3.1- 3.9	—	2	3	110	115
	4.0- 4.9	1	2	3	55	61
	5.0- 5.9	—	1	1	31	33
	6.0- 6.9	1	3	2	51	57
	7.0- 7.9	—	—	1	17	18
	8.0-11.9	1	4	5	152	162
	12.0-15.9	1	4	7	286	298
	16.0 +	6	2	14	1,321	1,343
Total		10	18	36	2,023	2,087
WESTERN WASHINGTON						
National Forest:						
Clearcut	3.1- 3.9	1	5	5	137	148
	4.0- 4.9	3	5	5	97	110
	5.0- 5.9	—	3	3	48	54
	6.0- 6.9	4	7	10	110	131
	7.0- 7.9	—	3	4	72	79
	8.0-11.9	10	20	37	300	367
	12.0-15.9	6	31	32	497	566
	16.0 +	15	54	83	1,782	1,934
Total		39	128	179	3,043	3,389
Partial cut ²	3.1- 3.9	—	1	3	81	85
	4.0- 4.9	1	1	2	40	44
	5.0- 5.9	—	1	—	25	26
	6.0- 6.9	1	3	3	42	49
	7.0- 7.9	—	1	1	26	28
	8.0-11.9	2	6	7	209	224
	12.0-15.9	3	6	10	242	261
	16.0 +	3	11	8	1,216	1,238
Total		10	30	34	1,881	1,955

See footnotes at end of table.

Table 6—Gross volume (wood) of logging residue by area, owner class, harvest method, and log diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0+	
	<i>Inches</i>	<i>Cubic feet per acre</i>				
WESTERN WASHINGTON (continued)						
Other public: Clearcut	3.1- 3.9	1	3	5	171	180
	4.0- 4.9	2	5	7	99	113
	5.0- 5.9	—	2	3	53	58
	6.0- 6.9	3	6	8	87	104
	7.0- 7.9	—	—	1	41	42
	8.0-11.9	4	13	21	276	314
	12.0-15.9	4	17	8	198	227
	16.0+	9	34	36	1,695	1,774
Total		23	80	89	2,620	2,812
Partial cut	3.1- 3.9	1	2	3	227	233
	4.0- 4.9	2	3	4	64	73
	5.0- 5.9	—	1	1	36	38
	6.0- 6.9	—	2	2	41	45
	7.0- 7.9	—	—	1	16	17
	8.0-11.9	—	5	4	117	126
	12.0-15.9	—	3	10	77	90
	16.0+	—	2	—	677	679
Total		3	18	25	1,255	1,301
Private: Clearcut	3.1- 3.9	1	3	4	141	149
	4.0- 4.9	2	6	5	106	119
	5.0- 5.9	—	2	4	47	53
	6.0- 6.9	1	9	8	101	119
	7.0- 7.9	—	1	1	45	47
	8.0-11.9	6	14	15	284	319
	12.0-15.9	6	12	16	250	284
	16.0+	4	14	25	775	818
Total		20	61	78	1,749	1,908
Partial cut	3.1- 3.9	—	2	4	282	288
	4.0- 4.9	1	4	3	127	135
	5.0- 5.9	—	1	2	66	69
	6.0- 6.9	2	3	3	49	57
	7.0- 7.9	—	—	1	41	42
	8.0-11.9	1	5	7	179	192
	12.0-15.9	1	4	—	106	111
	16.0+	1	6	7	445	459
Total		6	25	27	1,295	1,353

See footnotes at end of table.

Table 6—Gross volume (wood) of logging residue by area, owner class, harvest method, and log diameter and length classes¹ (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0 +	
	<i>Inches</i>	<i>Cubic feet per acre</i>				
EASTERN OREGON						
Public (all methods)	3.1- 3.9	1	2	2	96	101
	4.0- 4.9	—	1	1	28	30
	5.0- 5.9	—	—	1	27	28
	6.0- 6.9	1	1	1	27	30
	7.0- 7.9	—	—	—	15	15
	8.0-11.9	1	2	3	130	136
	12.0-15.9	—	2	4	190	196
	16.0 +	1	5	1	295	302
Total		4	13	13	808	838
Private (all methods)	3.1- 3.9	1	2	3	103	109
	4.0- 4.9	1	1	2	43	47
	5.0- 5.9	—	1	1	23	25
	6.0- 6.9	1	1	2	39	43
	7.0- 7.9	—	—	1	22	23
	8.0-11.9	1	2	4	102	109
	12.0-15.9	1	2	1	101	105
	16.0 +	2	2	1	252	257
Total		7	11	15	685	718
EASTERN WASHINGTON						
Public (all methods)	3.1- 3.9	1	1	2	84	88
	4.0- 4.9	—	2	2	51	55
	5.0- 5.9	—	1	1	25	27
	6.0- 6.9	1	1	2	47	51
	7.0- 7.9	—	1	1	14	16
	8.0-11.9	2	3	5	149	159
	12.0-15.9	1	1	2	148	152
	16.0 +	2	2	2	270	276
Total		7	12	17	788	824
Private (all methods)	3.1- 3.9	—	1	2	87	90
	4.0- 4.9	—	1	2	40	43
	5.0- 5.9	—	1	1	22	24
	6.0- 6.9	—	1	1	26	28
	7.0- 7.9	—	—	1	16	17
	8.0-11.9	1	2	3	87	93
	12.0-15.9	1	2	2	41	46
	16.0 +	2	3	2	144	151
Total		4	11	14	463	492

¹ Does not include residue in large piles.

² Average of partial cut areas in western Oregon and western Washington; these strata were combined because of an inadequate sample population in western Washington.

Table 7—Logging residue by area, owner class, harvest method, and diameter and length classes^{1 2}

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0 +	
	<i>Inches</i>	<i>Number of pieces per acre</i>				
		IDAHO				
National Forest: Clearcut	3.1- 3.9	5.2	10.5	9.9	87.2	112.8
	4.0- 4.9	10.7	8.2	7.3	35.7	61.9
	5.0- 5.9	1.8	2.5	1.6	12.4	18.3
	6.0- 6.9	4.0	5.2	2.9	14.7	26.8
	7.0- 7.9	1.0	1.0	.6	7.5	10.1
	8.0-11.9	2.1	3.1	2.9	22.4	30.5
	12.0-15.9	1.2	1.2	1.0	11.2	14.6
	16.0 +	.2	.6	.6	9.0	10.4
Total		26.2	32.3	26.8	200.1	285.4
Partial cut	3.1- 3.9	4.2	8.3	10.0	76.7	99.2
	4.0- 4.9	7.4	6.3	5.9	30.5	50.1
	5.0- 5.9	.8	1.8	1.5	16.6	20.7
	6.0- 6.9	3.8	2.7	2.0	17.5	26.0
	7.0- 7.9	.9	.9	.9	7.9	10.6
	8.0-11.9	3.6	3.8	2.4	27.0	36.8
	12.0-15.9	1.7	1.1	.9	13.6	17.3
	16.0 +	.2	.6	.6	6.6	8.0
Total		22.6	25.5	24.2	196.4	268.7
Other public (all methods)	3.1- 3.9	2.7	5.2	5.8	41.6	55.3
	4.0- 4.9	3.7	3.5	2.8	16.7	26.7
	5.0- 5.9	.4	.8	1.2	7.4	9.8
	6.0- 6.9	1.7	1.7	1.2	10.7	15.3
	7.0- 7.9	—	.7	.7	4.9	6.3
	8.0-11.9	1.0	1.3	1.7	20.4	24.4
	12.0-15.9	.7	1.2	.5	9.1	11.5
	16.0 +	.6	.5	.3	4.7	6.1
Total		10.8	14.9	14.2	115.5	155.4
Private (all methods)	3.1- 3.9	4.4	6.9	5.5	70.5	87.3
	4.0- 4.9	6.0	4.6	4.0	21.9	36.5
	5.0- 5.9	.4	1.3	1.8	9.7	13.2
	6.0- 6.9	2.6	1.8	2.3	11.2	17.9
	7.0- 7.9	.2	—	.7	4.2	5.1
	8.0-11.9	1.8	1.6	1.3	14.8	19.5
	12.0-15.9	.7	.6	1.2	5.2	7.7
	16.0 +	.2	.8	—	3.3	4.3
Total		16.3	17.6	16.8	140.8	191.5

See footnotes at end of table.

Table 7—Logging residue by area, owner class, harvest method, and diameter and length classes^{1 2} (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0 +	
	<i>Inches</i>	<i>Number of pieces per acre</i>				
WESTERN OREGON						
National Forest: Clearcut	3.1- 3.9	2.7	9.8	12.1	78.2	102.8
	4.0- 4.9	17.0	14.1	8.5	30.7	70.3
	5.0- 5.9	.4	4.0	1.7	12.4	18.5
	6.0- 6.9	6.6	13.1	6.9	19.3	45.9
	7.0- 7.9	.4	1.0	.4	8.5	10.3
	8.0-11.9	7.2	11.8	9.5	31.0	59.5
	12.0-15.9	7.2	8.8	5.9	25.5	47.4
	16.0 +	3.6	4.3	4.9	25.1	37.9
Total		45.1	66.9	49.9	230.7	392.6
Partial cut ³	3.1- 3.9	1.9	3.0	5.0	29.2	39.1
	4.0- 4.9	3.3	3.1	2.7	10.0	19.1
	5.0- 5.9	.3	.8	.4	4.7	6.2
	6.0- 6.9	2.6	3.2	1.7	7.4	14.9
	7.0- 7.9	.2	.7	.7	2.9	4.5
	8.0-11.9	2.1	2.7	2.2	13.4	20.4
	12.0-15.9	1.5	1.4	1.9	8.8	13.6
	16.0 +	.7	1.1	.6	13.2	15.6
Total		12.6	16.0	15.2	89.6	133.4
Other public: Clearcut	3.1- 3.9	3.9	7.8	7.8	91.6	111.1
	4.0- 4.9	13.0	12.7	6.2	49.9	81.8
	5.0- 5.9	—	3.3	1.7	16.9	21.9
	6.0- 6.9	7.2	6.5	2.6	25.9	42.2
	7.0- 7.9	.7	1.0	1.0	5.9	8.6
	8.0-11.9	5.5	6.2	6.5	35.6	53.8
	12.0-15.9	3.3	3.0	3.0	19.5	28.8
	16.0 +	1.0	1.7	1.0	18.2	21.9
Total		34.6	42.2	29.8	263.5	370.1
Partial cut	3.1- 3.9	3.6	4.1	5.2	44.8	57.7
	4.0- 4.9	3.6	3.4	2.6	16.9	26.5
	5.0- 5.9	.4	.7	.9	5.6	7.6
	6.0- 6.9	1.1	2.1	1.1	7.9	12.2
	7.0- 7.9	.1	.5	.1	1.8	2.5
	8.0-11.9	2.3	3.3	1.9	11.1	18.6
	12.0-15.9	.5	1.0	.9	6.8	9.2
	16.0 +	.4	.7	.4	8.3	9.8
Total		12.	15.8	13.1	103.2	144.1

See footnotes at end of table.

Table 7—Logging residue by area, owner class, harvest method, and diameter and length classes^{1 2} (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0 +	
	<i>Inches</i>	<i>Number of pieces per acre</i>				
WESTERN OREGON (continued)						
Private:						
Clearcut	3.1- 3.9	2.6	4.9	4.9	49.4	61.8
	4.0- 4.9	6.4	6.6	5.3	23.2	41.5
	5.0- 5.9	.7	1.1	2.4	7.9	12.1
	6.0- 6.9	2.6	4.8	4.8	15.5	27.7
	7.0- 7.9	.3	.8	.4	3.7	5.2
	8.0-11.9	3.3	5.4	4.1	22.6	35.4
	12.0-15.9	1.5	2.2	2.4	13.5	19.6
	16.0+	.7	2.2	2.3	21.6	26.8
Total		18.1	28.0	26.6	157.4	230.1
Partial cut	3.1- 3.9	1.9	4.8	6.6	51.8	65.1
	4.0- 4.9	3.8	5.0	3.8	13.9	26.5
	5.0- 5.9	.7	1.9	1.4	6.5	10.5
	6.0- 6.9	1.9	2.7	1.5	7.3	13.4
	7.0- 7.9	.5	.4	.4	2.4	3.7
	8.0-11.9	1.1	1.8	2.0	11.9	16.8
	12.0-15.9	.6	1.0	1.2	9.2	12.0
	16.0+	1.1	.4	.8	13.3	15.6
Total		11.6	18.0	17.7	116.3	163.6
WESTERN WASHINGTON						
National Forest:						
Clearcut	3.1- 3.9	5.6	12.4	7.9	64.8	90.7
	4.0- 4.9	11.8	9.8	7.5	33.6	62.7
	5.0- 5.9	.4	4.3	2.0	12.7	19.4
	6.0- 6.9	8.5	7.5	7.5	25.1	48.6
	7.0- 7.9	.4	2.0	2.0	10.5	14.9
	8.0-11.9	10.1	10.1	11.4	37.5	69.1
	12.0-15.9	2.3	7.2	5.3	24.4	39.2
	16.0+	2.7	4.9	5.3	34.5	47.4
Total		41.8	58.2	48.9	243.1	392.0
Partial cut ³	3.1- 3.9	1.9	3.0	5.0	29.2	39.1
	4.0- 4.9	3.3	3.1	2.7	10.0	19.1
	5.0- 5.9	.3	.8	.4	4.7	6.2
	6.0- 6.9	2.6	3.2	1.7	7.4	14.9
	7.0- 7.9	.2	.7	.7	2.9	4.5
	8.0-11.9	2.1	2.7	2.2	13.4	20.4
	12.0-15.9	1.5	1.4	1.9	8.8	13.6
	16.0+	.7	1.1	.6	13.2	15.6
Total		12.6	16.0	15.2	89.6	133.4

See footnotes at end of table.

Table 7—Logging residue by area, owner class, harvest method, and diameter and length classes^{1 2} (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				Total
		1.0-3.9	4.0-5.9	6.0-7.9	8.0+	
	<i>Inches</i>	<i>Number of pieces per acre</i>				
WESTERN WASHINGTON (continued)						
Other public: Clearcut	3.1- 3.9	3.6	10.5	11.6	76.0	101.7
	4.0- 4.9	11.1	11.3	10.1	41.1	73.6
	5.0- 5.9	.9	2.8	2.9	15.6	22.2
	6.0- 6.9	4.9	7.4	5.7	18.3	36.3
	7.0- 7.9	—	.4	.5	6.9	7.8
	8.0-11.9	4.1	6.6	6.8	31.3	48.8
	12.0-15.9	1.8	4.4	1.3	10.5	18.0
	16.0+	2.0	3.3	2.5	22.2	30.0
Total		28.4	46.7	41.4	221.9	338.4
Partial cut	3.1- 3.9	6.1	7.6	7.9	84.1	105.7
	4.0- 4.9	8.3	6.8	6.1	26.7	47.9
	5.0- 5.9	.4	1.6	.4	7.6	10.0
	6.0- 6.9	1.2	1.9	1.9	8.3	13.3
	7.0- 7.9	—	—	.4	2.3	2.7
	8.0-11.9	.4	1.6	1.6	9.4	13.0
	12.0-15.9	—	.8	1.6	2.7	5.1
	16.0+	—	.4	—	6.1	6.5
Total		16.4	20.7	19.9	147.2	204.2
Private: Clearcut	3.1- 3.9	3.6	9.8	9.1	65.9	88.4
	4.0- 4.9	9.9	13.0	7.5	39.5	69.9
	5.0- 5.9	1.1	2.6	3.5	13.2	20.4
	6.0- 6.9	3.3	8.1	5.3	21.8	38.5
	7.0- 7.9	.4	.7	.6	9.6	11.3
	8.0-11.9	4.8	6.9	5.0	29.7	46.4
	12.0-15.9	2.4	2.9	2.9	11.8	20.0
	16.0+	.7	1.6	1.2	9.2	12.7
Total		26.2	45.6	35.1	200.7	307.6
Partial cut	3.1- 3.9	2.2	6.7	8.9	102.6	120.4
	4.0- 4.9	4.3	9.0	5.1	36.1	54.5
	5.0- 5.9	.9	1.4	1.5	13.6	17.4
	6.0- 6.9	3.6	3.5	2.0	8.4	17.5
	7.0- 7.9	.5	.2	.4	4.3	5.4
	8.0-11.9	1.0	2.5	2.5	11.3	17.3
	12.0-15.9	.4	1.0	.0	4.9	6.3
	16.0+	.2	.7	.5	6.1	7.5
Total		13.1	25.0	20.9	187.3	246.3

See footnotes at end of table.

Table 7—Logging residue by area, owner class, harvest method, and diameter and length classes^{1 2} (continued)

Owner class and harvest method	Small-end diameter	Length (feet)				
		1.0-3.9	4.0-5.9	6.0-7.9	8.0+	Total
	<i>Inches</i>	<i>Number of pieces per acre</i>				
EASTERN OREGON						
Public (all methods)	3.1- 3.9	3.4	3.3	3.6	19.0	29.3
	4.0- 4.9	1.7	2.0	1.4	6.0	11.1
	5.0- 5.9	.8	.7	.5	2.0	4.0
	6.0- 6.9	1.0	.7	.8	2.9	5.4
	7.0- 7.9	.2	.4	.2	1.9	2.7
	8.0-11.9	.6	.9	.9	5.0	7.4
	12.0-15.9	.3	.4	.6	4.1	5.4
	16.0+	.3	.3	.2	3.0	3.8
Total		8.3	8.7	8.2	43.9	69.1
Private (all methods)	3.1- 3.9	4.2	5.6	6.1	33.2	49.1
	4.0- 4.9	3.4	2.5	3.1	10.3	19.3
	5.0- 5.9	.6	1.2	.7	3.5	6.0
	6.0- 6.9	.9	1.4	1.3	4.9	8.5
	7.0- 7.9	.4	.3	.3	2.2	3.2
	8.0-11.9	1.3	.9	1.2	4.5	3.5
	12.0-15.9	.4	.4	.2	2.5	7.9
	16.0+	.2	.2	.1	2.2	2.7
Total		11.4	12.5	13.0	63.3	100.2
EASTERN WASHINGTON						
Public (all methods)	3.1- 3.9	3.2	4.3	4.8	25.6	37.9
	4.0- 4.9	1.9	3.3	3.2	11.2	19.6
	5.0- 5.9	.6	.9	.7	4.5	6.7
	6.0- 6.9	1.2	1.6	1.1	6.5	10.4
	7.0- 7.9	.2	.5	.4	1.9	3.0
	8.0-11.9	1.2	1.4	1.8	8.7	13.1
	12.0-15.9	.4	.4	.3	4.7	5.8
	16.0+	.2	.2	.2	3.3	3.9
Total		8.9	12.6	12.5	66.4	100.4
Private (all methods)	3.1- 3.9	2.3	3.2	3.8	25.1	34.4
	4.0- 4.9	1.7	2.0	2.4	9.0	15.1
	5.0- 5.9	.4	.7	1.1	4.2	6.4
	6.0- 6.9	.5	.7	.5	3.7	5.4
	7.0- 7.9	.2	.2	.2	1.9	2.5
	8.0-11.9	.5	.8	1.1	5.7	8.1
	12.0-15.9	.3	.4	.4	1.4	2.5
	16.0+	.2	.3	.2	2.1	2.8
Total		6.1	8.3	9.7	53.1	77.2

¹ Does not include residue in large piles.

² Totals may not agree with totals in table 3 because of rounding.

³ Average of partial cut areas in western Oregon and western Washington, these strata were combined because of an inadequate sample population in western Washington.

Table 8—Average gross volume¹ (wood only), of logging residue by area, owner class, and harvest method

Area and owner class	Harvest method	
	Clearcut	Partial cut
<i>Cubic feet per acre</i>		
Idaho:		
National Forest	3,098	2,215
Other public	—	² 1,586
Private	—	² 1,101
Western Oregon:		
National Forest	3,375	³ 2,020
Other public	3,402	1,542
Private	2,806	2,092
Western Washington:		
National Forest	3,598	³ 2,020
Other public	2,856	1,301
Private	1,944	1,355
Eastern Oregon:		
Public	—	² 838
Private	—	² 720
Eastern Washington:		
Public	—	² 850
Private	—	² 508

¹ Includes volume of residue in large piles.

² Samples selected randomly from all areas harvested since January 1, 1979; a large majority of samples were from partial cut areas, the predominant practice in this stratum.

³ Average of partial cut areas in western Oregon and western Washington; these strata were combined because of an inadequate sample population in western Washington.

Table 9—Average net volume¹ (wood only), of logging residue by area, owner class, and harvest method

Area and owner class	Harvest method	
	Clearcut	Partial cut
<i>Cubic feet per acre</i>		
Idaho:		
National Forest	1,716	1,331
Other public	—	² 935
Private	—	² 661
Western Oregon:		
National Forest	1,865	³ 1,133
Other public	2,008	905
Private	1,570	1,150
Western Washington:		
National Forest	1,923	³ 1,133
Other public	1,656	664
Private	1,002	751
Eastern Oregon:		
Public	—	² 383
Private	—	² 394
Eastern Washington:		
Public	—	² 493
Private	—	² 294

¹ Includes volume of residue in large piles.

² Samples selected randomly from all areas harvested since January 1, 1979; a large majority of samples were from partial cut areas, the predominant practice in this stratum.

³ Average of partial cut areas in western Oregon and western Washington; these strata were combined because of an inadequate sample population in western Washington.

Abstract

Howard, James O. Logging residue in the Pacific Northwest: Characteristics affecting utilization. USDA For. Serv. Res. Pap. PNW-289, 41 p. Portland, OR: Pac. Northwest For. and Range Exp. Stn.; 1981.

Information on the characteristics of logging residue in Idaho, Washington, and Oregon is presented. Tables show volume by diameter and length, number of pieces per acre, percent of residue that is sound, distribution by slope and distance to road, and average proportion of bark. Results are shown for 19 strata (harvest method by geographic area and owner).

Keywords: Residue measurements, slash utilization, Pacific Northwest.

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