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logging residue

IN



volume and characteristics

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ABSTRACT

This report makes available data on the volume and characteristics of logging residue resulting from 1969 logging operations in Oregon, Washington, and California.

The results indicate highest volumes of logging residue are found in the Douglas-fir region of western Oregon and western Washington. Average gross volume of residue in this region ranged from 4,548 cubic feet per acre on National Forest land to 1,491 cubic feet per acre on private land; net volume averaged 3,127 and 1,328 cubic feet per acre, respectively. Total net volume for all owners in this region was estimated to be about 460 million cubic feet for 1969. The lowest average volume of logging residue was found in the ponderosa pine region of eastern Oregon and eastern Washington--gross averaged between 350 and 400 cubic feet per acre for all owners. In California, gross volume averaged 1,905 cubic feet per acre for private lands and 1,460 cubic feet per acre for National Forests.

Additional information is provided concerning the average and total volume of residue by diameter class, length class, soundness, and type of material.

KEYWORDS: Slash, logging, wood waste, Oregon, Washington, California.

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INTRODUCTION

Large quantities of wood residue are a byproduct of logging activities. Traditionally, these logging residues have been considered a fire hazard, an impediment to reforestation and young-growth management, and an eyesore. Their disposal has been economically and environmentally costly. In recent years, interest has been shown in the potential of logging residues with the objective of extending the Nation's wood supply and solving, at least in part, the disposal problems.

Whether one is interested in fire hazard reduction, disposal costs, or utilization possibilities, information is needed on the amount and characteristics of the residue. In general, lack of this type of data has hampered intensive probes into the crucial problems associated with the use or disposal of logging residues.

This report makes available regional data on the volume and characteristics of logging residues resulting from 1969 logging operations. The study was conducted on

clearcut operations in western Oregon and western Washington,^{1/} and all types of logging operations in eastern Oregon and eastern Washington,^{2/} and California. Because of the uniqueness of these three regions, they were sampled separately and are discussed separately.

In general, logging residue is defined as all material left on or near the ground after a logging operation. In this report, logging residue^{3/} is that portion of the material that is at least 4 inches in diameter and 4 feet in length excluding stumps and old, punky logs that are rotten to the point of losing their cylindrical form. Throughout the text, reference to net and gross volume excludes limbwood, which is reported in tables 14 and 15.

^{1/} Hereafter referred to as the Douglas-fir region.

^{2/} Hereafter referred to as the ponderosa pine region.

^{3/} Technical terms used in this text are listed in "Definitions."

DOUGLAS-FIR REGION

VOLUME PER ACRE WAS HIGHEST ON NATIONAL FOREST LANDS

Of the three areas included in this 1969 study, the highest average volumes of logging residue were found on Douglas-fir region clearcuts. Within this region, the highest average net volume, 3,127 cubic feet per acre, occurred on National Forest lands. Private lands have the lowest average net volume, with only 1,328 cubic feet per acre. The average net volume for other public ownerships is 2,025 cubic feet per acre.

Although many factors contribute to the higher volumes of residue on National Forest land, two of the more important are: (1) A higher proportion of the log harvest on the National Forests comes from old-growth timber with higher proportion of defect, which yields more residue per acre than young-growth timber. Data from this study indicate the average age of the stands clearcut on the National Forest samples was 260 years. The average age of the samples on private lands was only 140 years. (2) Private companies operating on their own lands receive all benefits from residue reduction efforts, such as hazard reduction, site preparation, and increased mobility for second-growth management. These benefits accrue to these submarginal logs, thus making their removal economically more feasible. However, on public lands the operator receives only the product conversion value of the timber, thereby resulting in a larger marginal log and a greater volume of residue.

RESIDUE ON PUBLIC LANDS WAS LARGER THAN ON PRIVATE LANDS

The residue measured on public

lands in 1969 averaged larger than on private lands. Shown below is average net volume for two classifications:

	Percent of net volume 28 inches in diam- eter and larger	Percent of net volume 20 feet in length and longer
Public	32	40
Private	20	26

The primary factor contributing to the greater proportion of larger material on public lands is the higher average age of the timber. It is this larger diameter material, associated with old-growth stands, that presents the greatest problems of mobility related to intensive management.

In terms of residue material greater than 28 inches in diameter *and* 20 feet in length, the public lands have a substantially greater volume. Residue in this category averages 527 and 316 cubic feet per acre net volume on the National Forests and other public lands, respectively. These higher average volumes represent a greater opportunity for utilization than the 20 cubic feet per acre on private lands.

LARGER SHARE OF RESIDUE ON PUBLIC LANDS CAME FROM DEAD TREES

The net volume of residue at the time of logging in 1969 attributable to dead trees or logs was estimated at 630 cubic feet per acre on public lands. On private lands, this type of residue accounts for only 36 cubic feet per acre. These figures do not represent the total contribution of dead trees, since some of the preharvest dead material may be removed during logging operations. Thus these

figures underestimate the volume of dead material prior to logging.

**OLDER STANDS YIELDED
MORE RESIDUE WITH
LESS SOUND WOOD**

As indicated by the following tabulation, the greater volumes of logging residue are associated with a higher average stand age. Also, the residue that is created, or already existing, contains a higher proportion of cull, or rotten, wood.

<u>Age of stand harvested</u> (years)	<u>Average gross volume</u> (cubic feet per acre)	<u>Average defect of residue</u> (percent)
< 101	1,236	12
101-200	1,948	18
201-300	3,915	26
301+	5,812	31

The high degree of rot associated with old-growth stands is clearly indicated by these data.

**HIGHEST VOLUMES IN THE
PRIVATE SECTOR WERE
FROM CEDAR STANDS**

The net volume of residue on two sample units in privately owned cedar stands averaged 3,400 cubic feet per acre in 1969. This was over 2.5 times greater than the average for the private sector as a whole. The characteristics of the residue on these cedar stands differed substantially from that found on the other forest types. For example, in the private sector the net volume of residue greater than 36 inches in diameter was 175 cubic feet per acre. This same size class of residue on the two cedar tracts averaged 668 cubic feet per acre. Likewise, the net volume of

slabs and splinters for the entire sector was 162 cubic feet per acre, but for the cedar tracts alone the average was 663 cubic feet per acre. Excluding the two cedar sample units from the private sector would have the effect of reducing the average net volume of logging residue 14 percent, to 1,148 cubic feet per acre.

There are three major factors which help explain the greater volume of residue associated with harvesting of cedar stands. They are: (1) the general decadent condition of the old-growth stands, where dead and cull trees are prevalent, (2) the tendency of cedar to split or shatter during the felling operation, and (3) the poor market for low quality logs, due particularly to the lack of demand for cedar chips.

**VOLUME OF UTILITY LOGS
WAS HIGHEST ON NATIONAL
FOREST CLEARCUTS**

Utility logs, commonly called chip logs, represent the lowest log grade currently recognized. As economic conditions change, it will be this type of log that will present the best opportunities for increasing utilization. For the National Forest sample in 1969, about 1,795 cubic feet per acre, 57 percent of the net volume, was utility log material. For other public and private sectors, 56 and 47 percent of the average net volume, respectively, met the definition for a utility log. Improved markets for chips and lower grade lumber, together with improved handling systems, would result in increased utilization of this material with a subsequent reduction of residue disposal problems.

TOTAL NET VOLUME OF
RESIDUE FROM CLEARCUTS
AMOUNTED TO 460 MILLION
CUBIC FEET

The total net volume of logging residue on Douglas-fir region clearcuts was estimated at 460 million cubic feet for 1969. This is about 79 percent of the total gross volume of logging residue. The total net figure is equivalent to about 50 percent of the raw material consumption of Oregon's and Washington's pulp and board industries.^{4/}

^{4/} John A. Bergvall and Donald R. Gedney. *Washington mill survey, wood consumption and mill characteristics*, 1968. *State Wash. Dep. Nat. Resour. and Pac. Northwest Forest & Range Exp. Stn.*, 119 p., illus., 1970.

Eugene R. Manock, Grover A. Choate, and Donald R. Gedney. *Oregon timber industries, 1968, wood consumption and mill characteristics*. *State Oreg. Dep. For. and Pac. Northwest Forest & Range Exp. Stn.*, 117 p., illus. [n.d.]

This residue volume represents the amount created by 1969 clearcut operations; of course, this volume eventually decreases due to slash burning, relogging, and decay. Consequently, the current volume of 1969 residue will be appreciably smaller, reducing both the disposal problem and the raw material potential. It must be kept in mind that, for the most part, this material had a negative market value at the time of logging. Only as technology and economic conditions change or new timber sale policies are formulated will this residue find its way to the marketplace.

PONDEROSA PINE REGION



PONDEROSA PINE REGION

LOWEST AVERAGE VOLUMES OCCURRED IN THE PONDEROSA PINE REGION

The average per-acre volume of residue in the ponderosa pine region was the lowest of the three regions of the 1969 study. Private lands with 396 and 352 cubic feet per acre, gross and net, averaged only slightly higher than the 356 and 291 cubic feet per acre on the National Forests. These volumes are not surprising in light of the low per-acre harvest volumes and the partial cut harvesting methods used.

FULL TREES OR TOPS CONSTITUTED OVER ONE-HALF OF THE NET VOLUME

As the 1969 data in table 15 show, 48 million cubic feet or 56 percent of the total net volume of residue in the ponderosa pine region was in the form of full trees or tops. This proportion far exceeds that of the other regions. This material consisted primarily of poletimber-size trees that were cut during harvesting operations to decrease competition for better trees and limby tops of older trees. Limby tops are quite common in overmature pine stands.

RESIDUE WAS SMALLER THAN IN THE DOUGLAS-FIR REGION

Data from this 1969 study indicate that about 56 percent of the net volume was comprised of pieces less than 12 inches in diameter. This compares with only 33 percent for the Douglas-fir region. Only 14 percent of the residue exceeded

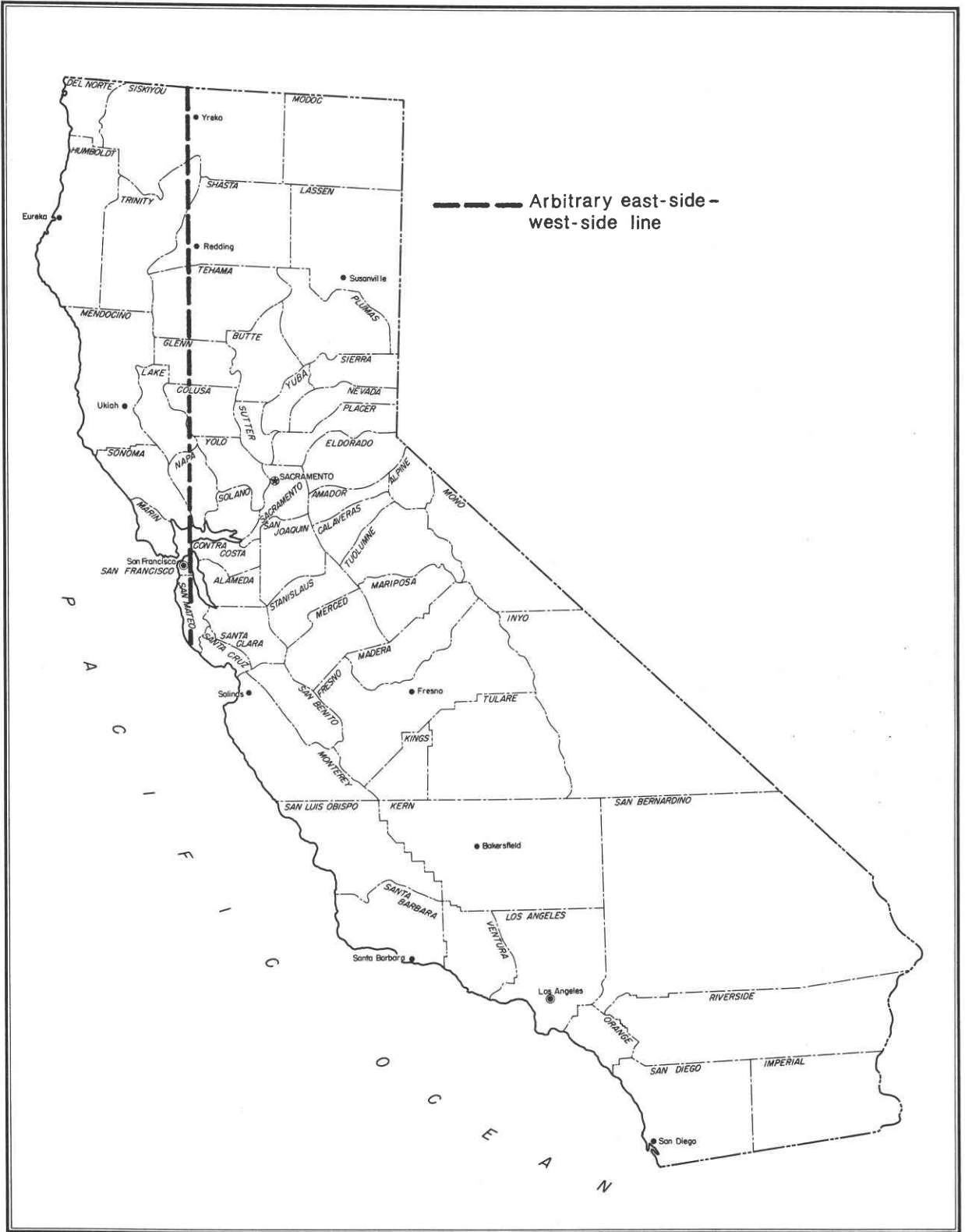
28 inches in diameter in this region, but in the Douglas-fir region 24 percent was greater than 28 inches. Three factors play an important part in creating this high proportion of smaller size residue. These are: (1) smaller average diameter of trees in this region, (2) a generally poor market for small logs, although this has been changing somewhat in the past few years with the installation of chipping saws by a few mills in the area, and (3) cutting of small, nonsalable suppressed trees to reduce competition in the remaining stand.

TOTAL NET VOLUME OF RESIDUE WAS LESS THAN 87 MILLION CUBIC FEET

The total net volume of residue from 1969 logging in the ponderosa pine region was estimated to be about 87 million cubic feet. This was less than one-fifth the total for the Douglas-fir region but was dispersed over a land area almost twice as large. Gross volume in this area was 103.6 million cubic feet.

With the low per-acre volumes, wide geographic dispersion, and poor chip markets, little opportunity exists for relogging in this region. Recent interest in small-log processing equipment should increase utilization and help reduce residue problems for some areas. The highest volumes of residue occur along the Cascades in the transitional timber types. This area, closest to the chip market of western Oregon, should show the greatest change in utilization in the future.

CALIFORNIA



CALIFORNIA

Due to the relatively small sample, geographic stratification within ownership classes was not feasible from a statistical standpoint. Thus, the volume estimates by owner groups for California reflect both the high volume stands along the coast and the low volume interior stands and are not comparable to the same owner groups in the other areas. Data from this 1969 study indicate subsequent studies of residue should be designed for sampling by both geographic area and ownership class.

LOGGING IN EAST-SIDE TYPES RESULTS IN LOWER PER-ACRE RESIDUE VOLUMES

An arbitrary poststratification of the 1969 sample units into east-side and west-side conditions indicated a substantial difference in residue development between the two areas. The sample units in the west side, or coastal area, averaged about 2,755 cubic feet per acre net volume. The east-side, or interior, units averaged only 400 cubic feet per acre. Those results are not surprising in light of the differences between the pine-fir stands of the east side and the redwood-Douglas-fir stands of the west side and the different harvesting systems used.

PRIVATE LANDS HAVE A GREATER VOLUME OF RESIDUE THAN THE NATIONAL FORESTS

The average net volume of residue on private lands was 1,370 cubic feet per acre in 1969, but the National Forests averaged 1,168 cubic feet per acre. The geographic pattern of ownership helps explain this situation. Over 50 percent

of the State's timber harvest comes from the heavily forested coastal area, where a much larger proportion of the land is in private ownership compared with National Forest ownership. Thus, the random selection of sample units on the basis of volume harvested has the effect of weighting the private sector toward the coastal area. Also, most of the coastal redwood is in private ownership. These two factors combined would lead to the expectation of more residue on private lands than on National Forest lands for the statewide sample.

RESIDUE IN CALIFORNIA WAS LARGER THAN IN THE DOUGLAS-FIR REGION

In 1969, the logging residue measured in California was larger on the average than that sampled in the Douglas-fir region of Oregon and Washington. The study data indicate that 47 percent of the net volume in California was in pieces 28 inches in diameter or larger, and 76 percent was at least 20 feet long or longer. In the Douglas-fir region, only 24 and 32 percent, respectively, of the net volume is in these two size classes. A major influence on the greater volume of larger material in California is the redwood-Douglas-fir stands of the coastal area where large, low quality logs are common. This type of material can present a serious problem in terms of mobility of men and equipment related to intensive management.

OVER 38 PERCENT OF THE NET VOLUME WAS FROM DEAD TREES

For the State as a whole, over 38 percent of the net volume of residue in 1969 was from trees dead at the time of

logging. In the private sector, residue from dead trees accounted for 586 cubic feet per acre, or 43 percent of the average net volume. The average on the National Forests was lower, with 375 cubic feet per acre originating from dead trees. These figures are much higher than those for the Douglas-fir region where only 15 percent of the net volume came from dead trees. As mentioned earlier, these figures underestimate the volume of dead material before the logging operation.

PRIVATE SECTOR HAS A LARGE VOLUME OF LIMBWOOD

As table 14 indicates, the average volume of limbwood over 4 inches in diameter on private lands was 188 cubic feet per acre in 1969. This is equivalent to 14 percent of the average net volume of residue. This compares with just over 1 percent for the Douglas-fir region. The large volume of limbwood on private lands was characteristic of the redwood type, where limbs in excess of 20 inches in diameter are common. On National Forests in California, the volume of limbwood was equivalent to 3 percent of the net volume.

TOTAL NET VOLUME OF RESIDUE FOR ALL OWNERS WAS 321 MILLION CUBIC FEET

The total net volume of logging residue in California was estimated to be 321 million cubic feet in 1969, about 75 percent of the total gross volume.

The total net volume is equivalent to about 1.9 times the wood consumed by the State's pulp and board industries in 1968.^{5/} However, unfavorable factors such as wide geographic dispersion, low per-acre volume in some areas, and abundance of mill residues inhibit utilization of logging residue. In the past decade, the timber industry has discovered the existence of valuable clear wood in redwood logs with large epicormic branches. Many of these logs left during the early logging operations will be removed during subsequent logging of the residual stand.

As was the case in the Douglas-fir region, much of the estimated total residue for 1969 is nonexistent today because of decay, burning, and relogging.

^{5/} B. R. Barrette, D. R. Gedney, and D. D. Oswald. *California timber industries - 1968 - mill characteristics and wood supply*. State Calif. Div. For., 117 p., illus. [n.d.]

APPENDIX

SCOPE AND PROCEDURE OF STUDY

This study, conducted during 1969-70, involved 76 sample units in Oregon, Washington, and California. The National Forests of western Washington were sampled during the summer of 1969, the remainder of the areas during 1970. Three ownership classes were recognized: National Forest, other public (all lands owned or managed by public agencies other than U. S. Forest Service), and all private owners. The study involved only clearcut operations in the Douglas-fir region of western Oregon and western Washington. In the ponderosa pine region of eastern Oregon and eastern Washington and in California, all types of logging operations were sampled.

For each of the study areas, the sample was allocated to each ownership class in proportion to the annual log harvest attributed to the class. Within each ownership class, the sample was randomly selected from available records of cutover areas. The final allocation of sample units is shown below:

	<u>National Forest</u>	<u>Other public</u>	<u>Private</u>
Douglas-fir region	22	8	24
Ponderosa pine region	5	<u>6/1</u>	4
California	6	--	6

^{6/} Included with National Forest for tabulation and discussion.

The survey was conducted using the line intersect method introduced in New Zealand.^{7/} This method requires recording only the diameter of residue material intersected by a sampling line of no width. The sum of the square of these diameters and the total length of sampling line is translated into an estimate of the per-acre volume of residue.

For this study, a sample unit consisted of 30 chains of line transect located in each of the randomly selected cutover areas. To insure a degree of randomness and to improve the distribution over the sample area, the direction of the sampling line was changed every 5 chains, as shown in figure 1.

No attempt was made to integrate criteria related to form, minimum length of sound wood, or log grade.

Table 1 shows the sampling error by ownership class for each geographic area. These figures represent the weighted sampling errors for the mean residue volumes at the 68-percent probability level.

^{7/} W. G. Warren and P. F. Olsen. A line intersect technique for assessing logging waste. *Forest Sci.* 10: 267-276, illus., 1964.

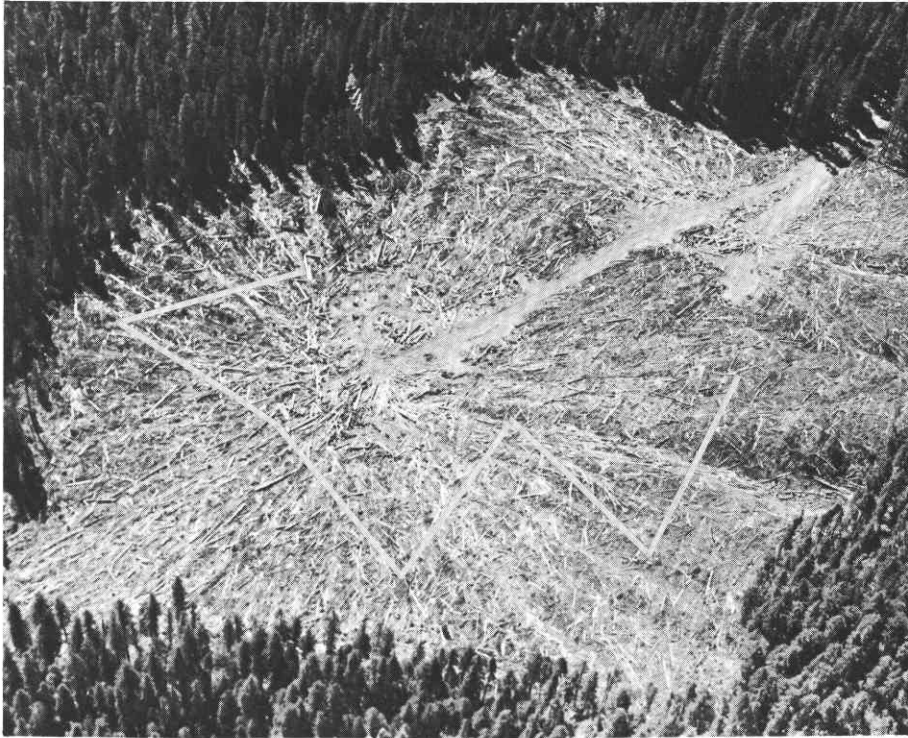


Figure 1.—Example of layout of 30-chain line transect, with random direction change every 5 chains.

TABLE 1.--AVERAGE VOLUME AND SAMPLING ERROR, BY OWNERSHIP CLASS AND GEOGRAPHIC AREA

Geographic area	National Forest		Other public		Private	
	Average volume (net)	Sampling error ^{1/}	Average volume (net)	Sampling error ^{1/}	Average volume (net)	Sampling error ^{1/}
	<i>Cubic feet per acre</i>	<i>Percent</i>	<i>Cubic feet per acre</i>	<i>Percent</i>	<i>Cubic feet per acre</i>	<i>Percent</i>
Douglas-fir region	3,127	±17.4	2,025	±21.3	1,328	±17.4
Ponderosa pine region	^{2/} 291	±56.4	--	--	352	±25.8
California	1,168	±46.2	--	--	1,370	±58.8

^{1/} These figures represent the weighted sampling errors expressed as a percent of the average (at the 68-percent probability level).

^{2/} Includes one sample unit on Indian land in eastern Washington.

DEFINITIONS

Logging residue:	All material at least 4 inches in diameter and 4 feet long left on the ground after a logging operation; excluded are upright stumps and punky logs rotten to the point of losing cylindrical form.
Live residue	Residue from trees killed during, or as a result of, logging.
Dead residue	Residue from trees, or parts of trees, that were dead before logging occurred.
Volume:	
Gross	Total cubic volume of a piece of residue by diameter and length.
Net	The portion of a piece of residue capable of producing a sound pulp chip, with a 10-percent minimum; does not include rotten, shattered, or missing parts.
Class of residue:	
Bucked log	A log that had one or both ends severed by sawing but was left as residue because of length, form, quality, lost log, etc.
Breakage	A log broken on both ends as a result of the felling operation; differs from a bucked log in that neither end was cut off during bucking.
Slab or splinter	A fragmented portion of a log or tree that has minimum dimensions of 4 inches by 5 inches and is at least 4 feet long.
Long butt	A bucked-out segment of the tree adjacent to the stump, left because of poor form or quality.
Full tree or top	A tree, or portion of a tree, with the limbs and top still connected, usually left because of size, form, or excessive limbiness.
Limbwood	A limb separated from the tree by breakage or sawing that is at least 4 inches in diameter and at least 4 feet long.

Residue diameter:

Log or limb

By the line transect method, the diameter is taken at the point of intersection of the sample line; the diameter is the midpoint diameter for a particular classification, such as length class.

Slab or splinter

The circular diameter corresponding to the area of the rectangle as measured by width and depth of the material.

Barkable:

Capable of being barked by a mechanical barker.

Nonbarkable:

Not capable of being barked by a mechanical barker; some of the residue in this class could be barked by a hydraulic barker.

Line transect:

A sample line of no width, i. e., a vertical plane, traversing the cutover area, used to sample residue volume.

Sample unit:

A 30-chain segment of line transect; for this study, line direction was randomly changed every 5 chains.

Utility log:

Defined by the log scaling and grading bureaus as a log that has a usable chip content of at least 50 percent of its gross volume, a minimum diameter of 6 inches, and a minimum length of 12 feet.

TABLE 2.--AVERAGE NET AND GROSS VOLUME OF LOGGING RESIDUE, BY OWNERSHIP, DIAMETER, AND LENGTH CLASSES, DOUGLAS-FIR REGION, 1969

Ownership and diameter classes (inches)	Average, all classes		Length class (feet)							
			4.0-7.9		8.0-11.9		12.0-19.9		20.0+	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
-----Cubic feet per acre-----										
National Forest:										
4.0- 7.9	244	225	41	35	46	42	77	71	80	77
8.0-11.9	553	493	79	64	117	102	172	157	185	170
12.0-15.9	648	511	99	64	151	132	214	179	184	136
16.0-19.9	472	327	46	29	122	77	144	109	160	112
20.0-23.9	423	282	72	48	63	43	160	107	128	84
24.0-27.9	420	254	75	55	65	39	114	72	166	88
28.0-35.9	942	541	106	57	103	60	274	169	459	255
36.0+	656	350	85	27	45	18	93	33	433	272
Slabs	190	144	48	36	46	30	83	68	13	10
Total	4,548	3,127	651	415	758	543	1,331	965	1,808	1,204
Other public:										
4.0- 7.9	222	202	37	31	52	45	57	54	76	72
8.0-11.9	375	330	47	38	73	58	115	101	140	133
12.0-15.9	263	219	17	11	77	59	85	71	84	78
16.0-19.9	274	218	41	33	43	38	86	75	104	72
20.0-23.9	231	173	40	30	50	42	51	42	90	59
24.0-27.9	141	71	14	13	28	15	44	22	55	21
28.0-35.9	485	345	61	42	80	52	162	146	182	105
36.0+	441	317	30	27	44	17	69	62	298	211
Slabs	215	150	59	43	64	43	27	21	65	43
Total	2,647	2,025	346	268	511	369	696	594	1,094	794
Private:										
4.0- 7.9	182	178	52	50	39	38	48	47	43	43
8.0-11.9	324	309	62	58	61	58	108	103	93	90
12.0-15.9	214	199	31	29	35	30	82	79	66	61
16.0-19.9	144	128	19	19	25	22	57	50	43	37
20.0-23.9	98	84	17	15	27	20	27	23	27	26
24.0-27.9	43	36	5	4	5	4	9	7	24	21
28.0-35.9	79	57	14	11	24	19	29	22	12	5
36.0+	212	175	41	38	40	35	105	87	26	15
Slabs	195	162	55	46	52	42	62	51	26	23
Total	1,491	1,328	296	270	308	268	527	469	360	321

TABLE 3.--AVERAGE NET AND GROSS VOLUME OF LOGGING RESIDUE,
BY OWNERSHIP, DIAMETER, AND LENGTH CLASSES,
PONDEROSA PINE REGION, 1969

Ownership and diameter classes (inches)	Average, all classes		Length class (feet)							
			4.0-7.9		8.0-11.9		12.0-19.9		20.0+	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
-----Cubic feet per acre-----										
National Forest: ^{1/}										
4.0- 7.9	70	66	8	6	9	9	32	31	21	20
8.0-11.9	104	101	7	7	12	12	44	42	41	40
12.0-15.9	34	27	12	9	11	10	9	6	2	2
16.0-19.9	49	29	28	19	4	3	0	0	17	7
20.0-23.9	6	2	0	0	0	0	6	2	0	0
24.0-27.9	16	8	0	0	0	0	0	0	16	8
28.0-35.9	58	46	0	0	0	0	0	0	58	46
36.0+	18	11	0	0	0	0	0	0	18	11
Slabs	1	1	1	1	0	0	0	0	0	0
Total	356	291	56	42	36	34	91	81	173	134
Private:										
4.0- 7.9	99	98	19	19	19	19	37	37	24	23
8.0-11.9	78	72	13	13	21	21	19	18	25	20
12.0-15.9	54	52	0	0	5	4	29	28	20	20
16.0-19.9	67	59	20	18	0	0	23	22	24	19
20.0-23.9	59	41	29	15	0	0	0	0	30	26
24.0-27.9	0	0	0	0	0	0	0	0	0	0
28.0-35.9	17	11	0	0	0	0	0	0	17	11
36.0+	0	0	0	0	0	0	0	0	0	0
Slabs	22	19	17	14	5	5	0	0	0	0
Total	396	352	98	79	50	49	108	105	140	119

^{1/} Includes one sample unit on Indian land in eastern Washington.

TABLE 4.--AVERAGE NET AND GROSS VOLUME OF LOGGING RESIDUE,
BY OWNERSHIP, DIAMETER, AND LENGTH CLASSES,
CALIFORNIA, 1969

Ownership and diameter classes (inches)	Average, all classes		Length class (feet)							
			4.0-7.9		8.0-11.9		12.0-19.9		20.0+	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
-----Cubic feet per acre-----										
National Forest:										
4.0- 7.9	121	114	31	27	17	16	18	17	55	54
8.0-11.9	238	214	32	24	32	29	44	39	130	122
12.0-15.9	97	85	15	15	5	2	21	20	56	48
16.0-19.9	144	101	19	18	36	14	8	1	81	68
20.0-23.9	144	98	15	11	13	8	13	13	103	66
24.0-27.9	121	58	0	1	57	32	0	0	64	25
28.0-35.9	306	243	53	38	25	25	0	0	228	180
36.0+	228	197	0	0	0	0	0	0	228	197
Slabs	61	58	26	24	4	4	6	5	25	25
Total	1,460	1,168	191	158	189	130	110	95	970	785
Private:										
4.0- 7.9	69	64	11	9	14	13	13	12	31	30
8.0-11.9	115	106	31	27	8	6	35	32	41	41
12.0-15.9	179	152	34	20	15	10	35	31	95	91
16.0-19.9	78	57	18	9	18	12	0	0	42	36
20.0-23.9	112	95	0	0	13	13	0	0	99	82
24.0-27.9	90	63	0	0	0	0	18	18	72	45
28.0-35.9	178	105	0	0	0	0	25	22	153	83
36.0+	999	669	45	23	0	0	0	0	954	646
Slabs	85	59	4	0	22	4	0	0	59	55
Total	1,905	1,370	143	88	90	58	126	115	1,546	1,109

TABLE 5.--TOTAL NET VOLUME OF LOGGING RESIDUE, BY OWNERSHIP, DIAMETER, AND LENGTH CLASSES, DOUGLAS-FIR REGION, 1969

Ownership and diameter classes (inches)	Total, all classes	Length class (feet)			
		4.0-7.9	8.0-11.9	12.0-19.9	20.0+
----- <i>Thousand cubic feet</i> -----					
National Forest:					
4.0- 7.9	10,241	1,623	1,899	3,230	3,489
8.0-11.9	22,292	2,878	4,622	7,128	7,664
12.0-15.9	23,092	2,901	5,937	8,051	6,203
16.0-19.9	14,795	1,283	3,518	4,970	5,024
20.0-23.9	12,800	2,131	1,973	4,898	3,798
24.0-27.9	11,514	2,504	1,739	3,206	4,065
28.0-35.9	24,527	2,592	2,690	7,666	11,579
36.0+	15,838	1,219	833	1,470	12,316
Slabs	6,511	1,663	1,335	3,064	449
Total	141,610	18,794	24,546	43,683	54,587
Other public:					
4.0- 7.9	10,134	1,550	2,243	2,717	3,624
8.0-11.9	16,502	1,863	2,914	5,040	6,685
12.0-15.9	10,977	602	2,891	3,557	3,927
16.0-19.9	10,890	1,614	1,932	3,761	3,583
20.0-23.9	8,681	1,506	2,098	2,085	2,992
24.0-27.9	3,512	648	745	1,081	1,038
28.0-35.9	17,282	2,073	2,621	7,356	5,232
36.0+	15,829	1,325	879	3,094	10,531
Slabs	7,459	2,133	2,111	1,058	2,157
Total	101,266	13,314	18,434	29,749	39,769
Private:					
4.0- 7.9	28,985	8,202	6,023	7,740	7,020
8.0-11.9	50,607	9,430	9,514	16,754	14,909
12.0-15.9	32,525	4,778	4,859	12,795	10,093
16.0-19.9	20,861	3,202	3,572	8,231	5,856
20.0-23.9	13,704	2,405	3,367	3,698	4,234
24.0-27.9	5,884	577	622	1,211	3,474
28.0-35.9	9,439	1,746	3,142	3,752	799
36.0+	28,681	6,171	5,872	14,239	2,399
Slabs	26,600	7,512	7,024	8,279	3,785
Total	217,286	44,023	43,995	76,699	52,569

TABLE 6.--TOTAL NET VOLUME OF LOGGING RESIDUE, BY OWNERSHIP, DIAMETER, AND LENGTH CLASSES, PONDEROSA PINE REGION, 1969

Ownership and diameter classes (inches)	Total, all classes	Length class (feet)			
		4.0-7.9	8.0-11.9	12.0-19.9	20.0+
-----Thousand cubic feet-----					
National Forest: ^{1/}					
4.0- 7.9	13,539	1,231	1,846	6,359	4,103
8.0-11.9	20,718	1,436	2,462	8,615	8,205
12.0-15.9	5,538	1,846	2,051	1,231	410
16.0-19.9	5,949	3,898	615	0	1,436
20.0-23.9	410	0	0	410	0
24.0-27.9	1,641	0	0	0	1,641
28.0-35.9	9,436	0	0	0	9,436
36.0+	2,256	0	0	0	2,256
Slabs	205	205	0	0	0
Total	59,692	8,616	6,974	16,615	27,487
Private:					
4.0- 7.9	7,558	1,465	1,465	2,854	1,774
8.0-11.9	5,554	1,003	1,620	1,388	1,543
12.0-15.9	4,011	0	308	2,160	1,543
16.0-19.9	4,550	1,388	0	1,697	1,465
20.0-23.9	3,162	1,157	0	0	2,005
24.0-27.9	0	0	0	0	0
28.0-35.9	848	0	0	0	848
36.0+	0	0	0	0	0
Slabs	1,466	1,080	386	0	0
Total	27,149	6,093	3,779	8,099	9,178

^{1/} Primarily National Forest but also includes some land owned or administered by other public agencies.

TABLE 7.--TOTAL NET VOLUME OF LOGGING RESIDUE, BY OWNERSHIP, DIAMETER, AND LENGTH CLASSES, CALIFORNIA, 1969

Ownership and diameter classes (inches)	Total, all classes	Length class (feet)			
		4.0-7.9	8.0-11.9	12.0-19.9	20.0+
-----Thousand cubic feet-----					
National Forest: ^{1/}					
4.0- 7.9	12,456	2,959	1,726	1,923	5,848
8.0-11.9	23,296	2,649	3,114	4,254	13,279
12.0-15.9	9,284	1,655	197	2,177	5,255
16.0-19.9	11,024	1,983	1,517	88	7,436
20.0-23.9	10,709	1,158	957	1,368	7,226
24.0-27.9	6,292	0	3,519	0	2,773
28.0-35.9	26,332	4,149	2,680	0	19,503
36.0+	21,412	0	0	0	21,412
Slabs	6,352	2,631	418	552	2,751
Total	127,157	17,184	14,128	10,362	85,483
Private:					
4.0- 7.9	9,083	1,233	1,843	1,748	4,259
8.0-11.9	15,002	3,890	911	4,435	5,766
12.0-15.9	21,383	2,764	1,379	4,370	12,870
16.0-19.9	8,031	1,290	1,753	0	4,988
20.0-23.9	13,512	0	1,780	0	11,732
24.0-27.9	8,969	0	0	2,563	6,406
28.0-35.9	14,913	0	0	3,139	11,774
36.0+	94,673	3,212	0	0	91,461
Slabs	8,388	50	544	0	7,794
Total	193,954	12,439	8,210	16,255	157,050

^{1/} Primarily National Forest but also includes some land owned or administered by other public agencies.

TABLE 8.--AVERAGE NET VOLUME OF LOGGING RESIDUE, BY OWNERSHIP,
DIAMETER, AND PERCENT CHIPPABLE CLASSES,
DOUGLAS-FIR REGION, 1969

Ownership and diameter classes (inches)	Average, all classes	Percent chippable class				
		1-20	21-40	41-60	61-80	81+
-----Cubic feet per acre-----						
National Forest:						
4.0- 7.9	225	0	1	6	17	201
8.0-11.9	493	0	2	11	62	418
12.0-15.9	511	0	11	31	116	353
16.0-19.9	327	6	6	40	50	225
20.0-23.9	282	5	12	41	86	138
24.0-27.9	254	1	1	30	95	127
28.0+	891	10	142	99	302	338
Slabs	144	0	3	9	54	78
Total	3,127	22	178	267	782	1,878
Other public:						
4.0- 7.9	202	0	3	5	26	168
8.0-11.9	330	1	3	18	38	270
12.0-15.9	219	0	2	26	41	150
16.0-19.9	218	0	4	19	83	112
20.0-23.9	173	0	13	40	49	71
24.0-27.9	71	2	5	8	33	23
28.0+	662	0	35	90	208	329
Slabs	150	0	14	31	70	35
Total	2,025	3	79	237	548	1,158
Private:						
4.0- 7.9	178	0	0	1	13	164
8.0-11.9	309	0	1	8	40	260
12.0-15.9	199	0	9	5	40	145
16.0-19.9	128	0	6	13	32	77
20.0-23.9	84	1	3	6	28	46
24.0-27.9	36	0	3	3	8	22
28.0+	232	2	14	41	29	146
Slabs	162	3	5	28	46	80
Total	1,328	6	41	105	236	940

TABLE 9.--AVERAGE NET VOLUME OF LOGGING RESIDUE, BY OWNERSHIP,
DIAMETER, AND PERCENT CHIPPABLE CLASSES,
PONDEROSA PINE REGION, 1969

Ownership and diameter classes (inches)	Average, all classes	Percent chippable class				
		1-20	21-40	41-60	61-80	81+
-----Cubic feet per acre-----						
National Forest: ^{1/}						
4.0- 7.9	66	0	0	2	1	63
8.0-11.9	101	2	0	5	3	91
12.0-15.9	27	0	0	6	8	13
16.0-19.9	29	1	0	3	22	3
20.0-23.9	2	0	2	0	0	0
24.0-27.9	8	0	0	0	0	8
28.0+	57	0	0	20	12	25
Slabs	1	0	0	0	1	0
Total	291	3	2	36	47	203
Private:						
4.0- 7.9	98	0	1	0	4	93
8.0-11.9	72	0	0	3	2	67
12.0-15.9	52	0	0	8	11	33
16.0-19.9	59	0	0	18	7	34
20.0-23.9	41	0	0	15	26	0
24.0-27.9	0	0	0	0	0	0
28.0+	11	0	11	0	0	0
Slabs	19	0	0	7	3	9
Total	352	0	12	51	53	236

^{1/} Includes one sample unit on Indian land in eastern Washington.

TABLE 10.--AVERAGE NET VOLUME OF LOGGING RESIDUE, BY OWNERSHIP,
DIAMETER, AND PERCENT CHIPPABLE CLASSES,
CALIFORNIA, 1969

Ownership and diameter classes (inches)	Average, all classes	Percent chippable class				
		1-20	21-40	41-60	61-80	81+
-----Cubic feet per acre-----						
National Forest:						
4.0- 7.9	114	0	1	3	3	107
8.0-11.9	214	1	6	12	22	173
12.0-15.9	85	0	0	10	10	65
16.0-19.9	101	1	1	23	7	69
20.0-23.9	98	0	5	15	47	31
24.0-27.9	58	0	0	41	17	0
28.0+	440	0	20	62	159	199
Slabs	58	0	0	0	5	53
Total	1,168	2	33	166	270	697
Private:						
4.0- 7.9	64	0	0	3	3	58
8.0-11.9	106	1	0	7	2	96
12.0-15.9	152	2	0	2	28	120
16.0-19.9	57	0	6	5	8	38
20.0-23.9	95	0	0	19	22	54
24.0-27.9	63	2	0	13	13	35
28.0+	774	0	126	277	296	75
Slabs	59	0	0	0	17	42
Total	1,370	5	132	326	389	518

TABLE 11.--TOTAL NET VOLUME OF LOGGING RESIDUE, BY OWNERSHIP,
DIAMETER, AND PERCENT CHIPPABLE CLASSES,
DOUGLAS-FIR REGION, 1969

Ownership and diameter classes (inches)	Total, all classes	Percent chippable class				
		1-20	21-40	41-60	61-80	81+
----- <i>Thousand cubic feet</i> -----						
National Forest:						
4.0- 7.9	10,241	0	46	278	788	9,129
8.0-11.9	22,292	0	102	508	2,793	18,889
12.0-15.9	23,092	0	506	1,415	5,255	15,916
16.0-19.9	14,795	250	292	1,792	2,250	10,211
20.0-23.9	12,800	243	527	1,863	3,889	6,278
24.0-27.9	11,514	44	44	1,378	4,312	5,736
28.0+	40,365	432	6,425	4,485	13,669	15,354
Slabs	6,511	0	136	407	2,441	3,527
Total	141,610	969	8,078	12,126	35,397	85,040
Other public:						
4.0- 7.9	10,134	0	92	217	1,299	8,526
8.0-11.9	16,502	50	122	942	1,928	13,460
12.0-15.9	10,977	0	98	1,290	2,101	7,488
16.0-19.9	10,890	0	238	939	4,147	5,566
20.0-23.9	8,681	0	632	1,993	2,494	3,562
24.0-27.9	3,512	131	262	393	1,573	1,153
28.0+	33,111	0	1,807	4,521	10,376	16,407
Slabs	7,459	0	698	1,568	3,478	1,715
Total	101,266	181	3,949	11,863	27,396	57,877
Private:						
4.0- 7.9	28,985	0	21	238	2,185	26,541
8.0-11.9	50,607	0	57	1,195	6,713	42,642
12.0-15.9	32,525	0	1,364	885	6,664	23,612
16.0-19.9	20,861	0	989	2,100	5,062	12,710
20.0-23.9	13,704	254	463	908	4,633	7,446
24.0-27.9	5,884	0	454	423	1,199	3,808
28.0+	38,120	309	2,477	6,774	4,697	23,863
Slabs	26,600	430	811	4,565	7,606	13,188
Total	217,286	993	6,636	17,088	38,759	153,810

TABLE 12.--TOTAL NET VOLUME OF LOGGING RESIDUE, BY OWNERSHIP,
DIAMETER, AND PERCENT CHIPPABLE CLASSES,
PONDEROSA PINE REGION, 1969

Ownership and diameter classes (inches)	Total, all classes	Percent chippable class				
		1-20	21-40	41-60	61-80	81+
-----Thousand cubic feet-----						
National Forest: ^{1/}						
4.0- 7.9	13,539	0	0	410	205	12,924
8.0-11.9	20,718	410	0	1,026	615	18,667
12.0-15.9	5,538	0	0	1,231	1,641	2,666
16.0-19.9	5,949	205	0	615	4,514	615
20.0-23.9	410	0	410	0	0	0
24.0-27.9	1,641	0	0	0	0	1,641
28.0+	11,692	0	0	4,103	2,461	5,128
Slabs	205	0	0	0	205	0
Total	59,692	615	410	7,385	9,641	41,641
Private:						
4.0- 7.9	7,558	0	77	0	308	7,173
8.0-11.9	5,554	0	0	232	154	5,168
12.0-15.9	4,011	0	0	617	849	2,545
16.0-19.9	4,550	0	0	1,388	540	2,622
20.0-23.9	3,162	0	0	1,157	2,005	0
24.0-27.9	0	0	0	0	0	0
28.0+	848	0	848	0	0	0
Slabs	1,466	0	0	540	231	695
Total	27,149	0	925	3,934	4,087	18,203

^{1/} Primarily National Forest but also includes some land owned or administered by other public agencies.

TABLE 13.--TOTAL NET VOLUME OF LOGGING RESIDUE, BY OWNERSHIP,
DIAMETER, AND PERCENT CHIPPABLE CLASSES,
CALIFORNIA, 1969

Ownership and diameter classes (inches)	Total, all classes	Percent chippable class				
		1-20	21-40	41-60	61-80	81+
-----Thousand cubic feet-----						
National Forest: ^{1/}						
4.0- 7.9	12,456	16	120	305	316	11,699
8.0-11.9	23,296	78	677	1,279	2,368	18,894
12.0-15.9	9,284	0	0	1,072	1,078	7,134
16.0-19.9	11,024	88	88	2,473	788	7,587
20.0-23.9	10,709	0	547	1,641	5,124	3,397
24.0-27.9	6,292	0	0	4,443	1,849	0
28.0+	47,744	0	2,144	6,828	17,273	21,499
Slabs	6,352	0	0	0	585	5,767
Total	127,157	182	3,576	18,041	29,381	75,977
Private:						
4.0- 7.9	9,083	46	0	402	367	8,268
8.0-11.9	15,002	85	0	929	356	13,632
12.0-15.9	21,383	262	0	320	3,920	16,881
16.0-19.9	8,031	0	888	720	1,139	5,284
20.0-23.9	13,512	0	0	2,716	3,146	7,650
24.0-27.9	8,969	256	0	1,794	1,794	5,125
28.0+	109,586	0	17,767	39,231	41,918	10,670
Slabs	8,388	50	0	0	2,447	5,891
Total	193,954	699	18,655	46,112	55,087	73,401

^{1/} Primarily National Forest but also includes some land owned or administered by other public agencies.

TABLE 14.--AVERAGE NET VOLUME OF LOGGING RESIDUE, BY AREA, OWNERSHIP CLASS, AND TYPE OF MATERIAL,^{1/} 1969

Area and ownership class	Average, all classes	Roundwood				Slabs and splinters
		Bucked log	Breakage	Full tree or top	Limbwood	
-----Cubic feet per acre-----						
Douglas-fir region:						
National Forest	<u>2/</u> 3,153	1,674	1,014	284	37	144
Other public	2,054	977	542	357	29	149
Private	1,344	192	632	342	16	162
Ponderosa pine region:						
National Forest ^{3/}	312	70	57	163	21	1
Private	376	30	110	193	24	19
California:						
National Forest	1,205	401	80	629	37	58
Private	1,558	141	314	856	188	59

^{1/} See "Definitions."

^{2/} Will not balance with other tables when limbwood is subtracted, because limbwood in the western Washington sample could not be separated.

^{3/} Includes one sample unit on Indian land in eastern Washington.

TABLE 15.--TOTAL NET VOLUME OF LOGGING RESIDUE, BY AREA, OWNERSHIP CLASS, AND TYPE OF MATERIAL,^{1/} 1969

Area and ownership class	Average, all classes	Roundwood				Slabs and splinters
		Bucked log	Breakage	Full tree or top	Limbwood	
-----Thousand cubic feet-----						
Douglas-fir region:						
National Forest	<u>2/</u> 142,761	75,747	45,898	12,842	1,775	6,499
Other public	102,706	48,833	27,100	17,874	1,440	7,459
Private	219,845	31,375	103,405	55,906	2,559	26,600
Ponderosa pine region:						
National Forest ^{3/}	64,000	14,359	11,692	33,436	4,308	205
Private	29,000	2,314	8,484	14,886	1,851	1,465
California:						
National Forest ^{3/}	131,165	43,589	8,700	68,516	4,008	6,352
Private	220,630	19,977	44,500	121,089	26,676	8,388

^{1/} See "Definitions."

^{2/} Will not balance with other tables when limbwood is subtracted, because limbwood in the western Washington sample could not be separated.

^{3/} Primarily National Forest but also includes some land owned or administered by other public agencies.

TABLE 16.--AVERAGE GROSS AND NET VOLUME OF LIVE AND DEAD, BARKABLE AND NONBARKABLE LOGGING RESIDUE,
BY AREA AND OWNERSHIP CLASS, 1969

Area and ownership class	Average, live and dead		Live						Dead					
			Average, all live		Barkable		Nonbarkable		Average, all dead		Barkable		Nonbarkable	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
-----Cubic feet per acre-----														
Douglas-fir region:														
National Forest	4,548	3,127	3,303	2,512	2,614	2,115	689	397	1,245	615	869	551	376	64
Other public	2,647	2,025	1,552	1,383	1,250	1,151	302	232	1,095	642	835	521	260	121
Private	1,491	1,328	1,412	1,267	1,159	1,054	253	213	79	61	44	36	35	25
Ponderosa pine region:														
National Forest ^{1/}	356	291	184	178	162	161	22	17	172	113	123	95	49	18
Private	396	352	386	342	319	278	67	64	10	10	9	9	1	1
California:														
National Forest	1,460	1,168	865	793	818	746	47	47	595	375	594	375	1	0
Private	1,905	1,370	1,141	784	1,123	768	18	16	764	586	754	584	10	2

^{1/} Includes one sample unit on Indian land in eastern Washington.

TABLE 17.--TOTAL NET VOLUME OF LIVE AND DEAD, BARKABLE AND NONBARKABLE LOGGING RESIDUE, BY AREA AND OWNERSHIP CLASS, 1969

Area and ownership class	Total, live and dead	Live			Dead		
		Total	Barkable	Nonbarkable	Total	Barkable	Nonbarkable
----- <i>Thousand cubic feet</i> -----							
Douglas-fir region:							
National Forest	141,610	113,759	95,780	17,979	27,851	24,953	2,898
Other public	101,266	69,161	57,559	11,602	32,105	26,054	6,051
Private	217,286	207,305	172,454	34,851	9,981	5,890	4,091
Ponderosa pine region:							
National Forest ^{1/}	59,692	36,513	33,026	3,487	23,179	19,487	3,692
Private	27,149	26,378	21,442	4,936	771	694	77
California:							
National Forest ^{1/}	127,157	86,332	81,215	5,117	40,825	40,825	0
Private	193,954	110,993	108,728	2,265	82,961	82,678	283

^{1/} Primarily National Forest but also includes some land owned or administered by other public agencies.

TABLE 18.--TOTAL GROSS VOLUME OF LIVE AND DEAD, BARKABLE AND NONBARKABLE LOGGING RESIDUE, BY AREA AND OWNERSHIP CLASS, 1969

Area and ownership class	Total, live and dead	Live			Dead		
		Total	Barkable	Nonbarkable	Total	Barkable	Nonbarkable
----- <i>Thousand cubic feet</i> -----							
Douglas-fir region:							
National Forest	205,184	149,004	117,919	31,085	56,180	39,211	16,969
Other public	132,388	77,619	62,514	15,105	54,769	41,768	13,001
Private	243,983	231,052	189,648	41,404	12,931	7,197	5,734
Ponderosa pine region:							
National Forest ^{1/}	73,026	37,747	33,234	4,513	35,279	25,231	10,048
Private	30,543	29,774	24,606	5,168	769	693	76
California:							
National Forest ^{1/}	158,790	94,083	88,970	5,113	64,707	64,596	111
Private	269,607	161,467	158,933	2,534	108,140	106,711	1,429

^{1/} Primarily National Forest but also includes some land owned or administered by other public agencies.

TABLE 19.--AVERAGE NET VOLUME OF LOGGING RESIDUE, BY AREA, OWNERSHIP CLASS, AND DISTANCE TO LANDING, 1969

Area and ownership class	Average, all classes	Distance to landing (feet)					
		0-200	201-400	401-600	601-800	801-1,000	1,001+
-----Cubic feet per acre-----							
Douglas-fir region:							
National Forest	3,127	962	504	918	603	140	0
Other public	2,025	1,002	546	134	167	143	33
Private	1,328	1,007	185	115	21	0	0
Ponderosa pine region:							
National Forest ^{1/}	291	188	87	12	2	2	0
Private	352	352	0	0	0	0	0
California:							
National Forest	1,168	513	200	241	89	125	0
Private	1,370	495	831	44	0	0	0

^{1/} Includes one sample unit on Indian land in eastern Washington.

TABLE 20.--TOTAL NET VOLUME OF LOGGING RESIDUE, BY AREA, OWNERSHIP CLASS, AND DISTANCE TO LANDING, 1969

Area and ownership class	Total, all classes	Distance to landing (feet)					
		0-200	201-400	401-600	601-800	801-1,000	1,001+
-----Thousand cubic feet-----							
Douglas-fir region:							
National Forest	141,610	43,504	22,859	41,614	27,320	6,313	0
Other public	101,266	50,015	27,332	6,670	8,383	7,156	1,710
Private	217,286	164,682	30,361	18,871	3,372	0	0
Ponderosa pine region:							
National Forest ^{1/}	59,692	38,564	17,846	2,462	410	410	0
Private	27,149	27,149	0	0	0	0	0
California:							
National Forest ^{1/}	127,157	55,830	21,770	26,253	9,731	13,573	0
Private	193,954	70,086	117,714	6,154	0	0	0

^{1/} Primarily National Forest but also includes some land owned or administered by other public agencies.

☆ G.P.O.: 1973 797-404/84

Howard, James O.

1973. Logging residue in Washington, Oregon, and California--volume and characteristics. USDA Forest Serv. Resour. Bull. PNW-44, 26 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Information is presented on the per-acre and total volume of logging residue by ownership, diameter class, length class, soundness, and type of material for 1969 in Oregon, Washington, and California.

KEYWORDS: Slash, logging, wood waste, Oregon, Washington, California.

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