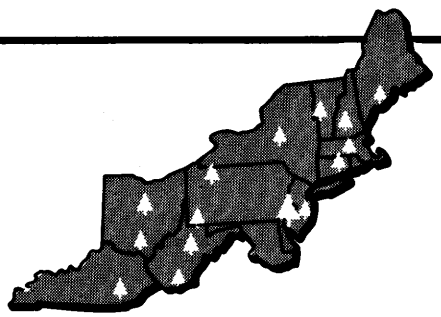
USDA FOREST SERVICE RESEARCH NOTE NE-227

1976

Northeastern Forest Experiment Station



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A LOGGING RESIDUE "YIELD" TABLE FOR APPALACHIAN HARDWOODS

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Abstract.—An equation for predicting logging-residue volume per acre for Appalachian hardwoods was developed from data collected on 20 timber sales in national forests in West Virginia and Virginia. The independent variables of type-of-cut, products removed, basal area per acre, and stand age explained 95 percent of the variation in residue volume per acre. A "yield" table was then prepared to show probable residue volumes for four cutting practices, and various levels of basal area and stand age.

Keywords: Logging residue, slash, tables (data)

Today's forester manages forest land for a variety of multiple-use benefits. He is, therefore, concerned with many aspects of resource production that have only recently become public issues. Because of this new awareness, pressures have developed that now affect nearly every decision the forester makes.

One aspect now receiving greater attention is management to minimize logging residues. In the past, residue was called slash. When accumulations were judged excessive in streams, along roads, for regeneration, or as fire hazards, the slash was usually disposed of by mechanical or other means. Recently, however, the esthetic impact of slash has gained importance; disposal practices now considered wasteful or as sources of air pollution by many people have been sharply curtailed. Consequently, the forester must now consider alternatives that so far are rather poorly defined.

If the forester is to design timber-production activities that will minimize logging residues, he must be able to forecast the results of his actions before they are taken. He needs a reliable method for predicting the amount of logging residue for various cutting practices and under different stand conditions. The method should be simple and, if possible, based on information that is usually known before a harvest cut is made.

Such a method is now available for Appalachian hardwoods. Data collected for a recent study of logging residue in the Monongahela National Forest in West Virginia and the Jefferson National Forest in Virginia were used to develop a very simple prediction equation. The equation was then used to prepare a "yield" table

that permits the forester to readily estimate logging-residue volumes for several harvesting alternatives and a range of stand conditions.

Methods and Procedures

Data were obtained from 20 harvest sites, 11 on the Monongahela National Forest and 9 on the Jefferson National Forest. On 4 of the sites improvement cuts were made; selection cuts were made on 4 sites; 5 were clearcut for removal of sawlogs only; and 7 were clearcut for removal of other products such as pulpwood and mine props, or sawlogs and other products. All of the sampled areas were logged in 1974 or earlier, and in the conventional manner—ground-skidding and hauling of roundwood to the mill. Logging-residue volumes in gross cubic feet per acre (with and without bark) were estimated by using the line-intersect technique for each area *(Bailey 1970, Martin 1975, 1976)*.

Only those residue pieces with a small-end diameter outside bark (dob) of 4.0 inches or more *and* a length of 4.0 feet or more were included in the sample. Our residue estimates include all down material from the current logging operation, plus all trees felled during postharvest timber-stand improvement (sale-area betterment with K-V funds). Standing trees (alive or dead) were not considered logging residue and were excluded. Although defect was not directly estimated, only pieces that were at least 50 percent sound were measured. Sweep, crook, or other defects that did not reduce the content of solid wood fiber were ignored in estimating soundness.

Additional information for each site was obtained from sale records maintained at the appropriate ranger district offices. The records included a description of the type of cut, the products and volumes removed, basal area per acre before harvest, stand age, and site index. These items were then used as independent variables in a multiple-regression analysis to determine their usefulness as predictors of logging-residue volume per acre (the dependent variable).

Predicting Residue Volumes

After a variety of models were examined, the following equation was selected as the best for predicting residue volumes because of its simplicity and good statistical qualities:

$$V = -302.36011 - 20.14233UA + 242.82202UB + 1781.67993UC + 3.02592BA + 3.40529A$$

($R^2 = .953$; $S_{y.x} = 212.2$ cubic feet)

Where:

V = Gross logging-residue volume (including bark) in pieces 4.0 inches or more in diameter at the small end, and 4.0 feet or more in length (in cubic feet per acre)

UA-UC = Dummy variables that represent four types of harvest cut - utilization options:

	UA=	UB=	UC=
(1) Improvement cuts	1	0	0
(2) Selection cuts	0	1	0
(3) Clearcuts where only sawlogs are removed	0	0	1
(4) Clearcuts where other products or sawlogs and other products are removed	0	0	0

BA = Total stand basal area (square feet per acre)

A = Stand age (years)

This equation was then used to prepare the guidelines shown in table 1. To convert these figures to volume of wood only, simply deduct 18 percent (the average bark volume found in my study). Also, an approximate weight estimate can be obtained by multiplying the values by average weight per cubic foot. Conversion to board feet would not be too reliable since logging residues contain many small diameter pieces.

Thus, to forecast residue accumulations before logging activities begin, all that the forester needs is an estimate of basal area per acre and stand age, and a knowledge of how the harvest will be conducted. With this information he can consult table 1 and quickly estimate the probable residue volume when the harvest has been completed.

Discussion

The logging residue "yield" table should be considered only as a first step. Even though the statistical quality was high, the sample size was rather small. Therefore additional sampling

Table 1.—*Gross volume of logging residue (including bark)*[a] *expected for Appalachian hardwoods for various stand densities, ages, and harvesting practices*

Stand age (years)	Basal area per acre (sq. ft.)									
	50	60	70	80	90	100	110	120	130	140
	Cubic feet per acre									
	IMPROVEMENT CUT									
60	33	63	94	124	154	184	215	245	275	305
80	101	131	162	192	222	253	283	313	343	374
100	169	200	230	260	290	321	351	381	411	442
120	237	268	298	328	358	389	419	449	480	510
	SELECTION CUT									
60	296	326	357	387	417	447	478	508	538	568
80	364	394	425	455	485	515	546	576	606	637
100	432	463	493	523	553	584	614	644	674	705
120	500	531	561	591	621	652	682	712	742	773
	CLEARCUT (SAWLOGS ONLY)									
60	1,835	1,865	1,895	1,926	1,956	1,986	2,016	2,047	2,077	2,107
80	1,903	1,933	1,964	1,994	2,024	2,054	2,085	2,115	2,145	2,175
100	1,971	2,001	2,032	2,062	2,092	2,122	2,153	2,183	2,213	2,243
120	2,039	2,070	2,100	2,130	2,160	2,191	2,221	2,251	2,281	2,312
	CLEARCUT (OTHER)									
60	53	84	114	144	174	205	235	265	295	326
80	121	152	182	212	242	273	303	333	363	394
100	189	220	250	280	311	341	371	401	432	462
120	258	288	318	348	379	409	439	469	500	530

[a] Pieces 4.0 inches or more at small-end diameter, and 4.0 feet or more in length; at least 50 percent sound.

might improve precision and also detect real differences that the present sample has not shown.

For example, we may find a significant difference between cover types; with additional data from a greater range of sites, we may find that site index or volume removed per acre or both are useful predictors. Also, we may be able to expand the breakdown of cutting practices to include, for example, subdivisions of selection and improvement cuts by products removed.

Of course, being able to predict logging-residue volumes does not solve the problem of what to do with the material. However, these forecasts can be valuable in solving this problem when they are complemented with professional judgment and other information.

Since logging residues affect esthetics, regeneration, wildlife habitat, erosion, and on some sites, soil nutrients and fire fuel buildup, it is important to know the impact of different management systems and harvesting methods on residue accumulations. For example, if the forester can predict differences in residue volumes for even-age versus uneven-age management, or for sawlog removal versus whole- tree utilization, he will be in a better position to decide which system or harvesting method to use.

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MANUSCRIPT RECEIVED FOR PUBLICATION 6 APRIL 1976.

☆U.S. GOVERNMENT PRINTING OFFICE: 1977—704-176:503