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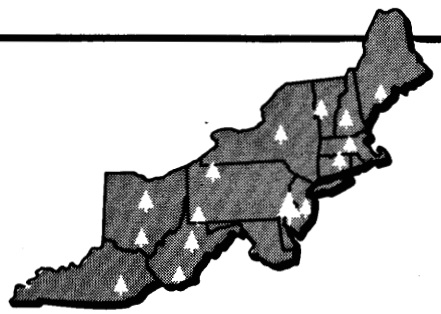

FOREST SERVICE, U.S. DEPT. OF AGRICULTURE, 6816 MARKET STREET, UPPER DARBY, PA. 19082

REST: A COMPUTER SYSTEM FOR ESTIMATING LOGGING RESIDUE BY USING THE LINE-INTERSECT METHOD

by A. JEFF MARTIN

Associate Market Analyst
Forest Products Marketing Laboratory
Princeton, Va.

Abstract.—A computer program was designed to accept logging-residue measurements obtained by line-intersect sampling and transform them into summaries useful for the land manager. The features of the program, along with inputs and outputs, are briefly described, with a note on machine compatibility.

KEYWORDS: Logging residue, computer program.

The forester and the land manager who are concerned with improving the utilization of wood fiber produced by a forest want to know how much is left behind after a logger has harvested a forest stand. One way to estimate logging residues is by means of the line-intersect method.

Logging residues include the unwanted, generally unutilized woody material in the forest that originates from the activities of timber harvesting. Of course the line-intersect method can also be used for other forest residues, such as those resulting from natural processes or other activities of man.

The line-intersect method for sampling logging residues is well documented *(Bailey 1970a, 1970b, Bailey and Lefebure 1971; Howard and Ward 1972; Van Wagner 1968; and Warren and Olsen 1964)*. Briefly, the method requires that a sample line be established on the cutover area and that the diameters of all logging residues that cross the line are measured at the point of intersection.

Sample lines may be continuous or segmented, and they may be oriented either systematically (using a grid network) or randomly. Volume in cubic feet per acre is estimated by using a very simple formula after diameters have been converted into cross-sectional areas. Weight may also be estimated if specific gravity is known. If desired, information about lengths, end diam-

eters, defects, etc. may be determined by subsampling a portion of the sample line.

Line-intersect sampling is highly recommended for several reasons:

1. For the same level of accuracy in volume estimation, the line-intersect method requires only one-fourth to one-half the time needed for fixed-area plots.
2. There is no problem with pieces overlapping a boundary as there is with fixed-area plots.
3. When the line-intersect method is used, there is no difficulty in determining what has or has not been tallied, because measuring proceeds systematically along the sample line.

However, less attention has focused on a general system for compiling a useful picture of residue conditions for a particular area. Bailey does describe some of the techniques needed in such a system, but all the details are not combined in a step-by-step manner.

The REST System

The REST (Residue ESTimation) system described in this note is one approach for putting residue information into a format that will be useful to industry, resource analysts, and resource planners. REST incorporates the methods developed by Bailey, along with some additional measures for assigning the residue volumes (or weights) to the appropriate diameter and length classes. This information can be subdivided further by species or species groups and by type (sawable or chippable only, straight or crooked, etc.).

Although this sounds like a straightforward procedure, the computations are lengthy because of the assumptions on which the line-intersect method is based. By using the line-intersect sampling scheme, we are saying that a satisfactory volume (or weight) estimate is possible when only the diameter at point of intersection is measured. When a total per-acre figure is our goal, we have no problem. However, when we subsample the residue and attempt to group the data by length class, we run into difficulty because the probability of intersecting a piece is proportional to its length.

Bailey resolved this by what he calls a five-step rectification procedure. The computations involved are incorporated into REST along with provisions for assigning the pieces to the proper diameter classes. REST is primarily the result of taking what has been developed by others and organizing a systematic means of translating field data into a workable description of residue conditions.

The steps in the REST system have been programmed in FORTRAN IV for use with an IBM System/370 computer. However, the aim in programming was to achieve generality so that REST could be used with most computer facilities (fewer than 45,000 bytes of core storage are needed). Flexibility was another programming goal, so that REST should fill the need of users in any timber-growing region.

Features of REST

Virtually any approach to field measurements with the line-intersect method is compatible with REST. Sample lines (sampling units) may be referenced to a grid system and oriented unidirectionally, randomly, or paired at right angles to each other. Another possibility is to use a continuous line with a random change in direction after a predetermined number of feet or chains have been measured. The REST system is set up so that information collected from a subsample of the sampling units can be used easily for developing a conversion ratio — to adjust cross-section area at the point of intersection to correspond with the mean of piece end areas and to adjust for defective wood *(Bailey 1970b)*—and for developing length and diameter distributions etc.

The user will have to decide on appropriate procedures. However, REST is designed to handle the summarization for any field layout and for any intensity of subsampling (from 0 to 100 percent). Other specific features are:

1. Use of the conversion ratio (as recommended by Bailey) is optional.

2. An estimate of the residue weight (in tons) can be obtained if an appropriate specific gravity is supplied.
3. The length of each sampling unit is selected by the user.
4. Diameter and length classes to be used in the output tables and the minimum diameter and length limits are set by the user.
5. Per-acre figures can be adjusted for the effects of slope if so desired.

Inputs

1. Title card
2. Control card:
   a. Tables to be printed.
   b. Diameter-class width.
   c. Length-class width.
   d. Data-printing code.
   e. Conversion-ratio use code.
3. Parameter card:
   a. Minimum diameter limit used when sampling.
   b. Minimum length limit used when sampling.
   c. Slope—optional.
   d. Length of each sampling unit.
   e. Number of sampling units.
   f. Number of sampling units that were subsampled.
   g. Specific gravity—optional.
4. Data cards:
   a. Species code.
   b. Diameter at the point of intersection. For pieces in the subsample, any or all of the following items may be obtained.
      Both end diameters.
      Length.
      Defect.
      Classification code—assigned by the user.

Outputs

1. A complete listing of the data cards — optional.
2. A summary of the sample data, showing average volume (and weight if desired) per acre, the input parameters, average diameters, average length, etc.
3. A set of nine tables, showing the data summarized by diameter and length classes. In addition to the final volume and weight summaries, there are tables showing the number of pieces and volume in the subsample as well as tables showing the intermediate steps used in obtaining the final summaries. The user has the option of printing all, none or any combination of these tables.

Discussion

Sampling logging residues with the line-intersect technique is a means of establishing what has already happened. However, with sufficient sample data, collected on past operations, timber managers may be able to predict residue conditions on future timber sales. And resource analysts could use line-intersect sampling to monitor the residue situation over time so that future assessments of changing utilization patterns can be made readily.

The REST system could be useful because it was developed to help these people convert basic data, with a minimum of effort and no intermediate computations, to useful secondary information.

Program Availability

Complete documentation of the REST system is available upon request from the USDA Forest Products Marketing Laboratory at Princeton, West Virginia 24740. The user's guide contains the program source listing, input instructions and forms, and examples of the printed output.

Literature Cited

Bailey, G. R.
1970a. A SIMPLIFIED METHOD OF SAMPLING LOGGING RESIDUE. For. Chron. 46(4) : 289-294, illus.

Bailey, G. R.
1970b. SPEEDIER ESTIMATES OF LOGGING RESIDUE. For. Ind. 90(12) : 32-33, 35.

Bailey, G. R., and E. L. Lefebure.
1971. ESTIMATING VOLUME DISTRIBUTIONS OF LOGGING RESIDUE FROM INTERSECT-SAMPLED DATA. Can. For. Serv. Bimon. Res. Note 27(1) : 4-5.

Howard, James O., and F. R. Ward.
1972. MEASUREMENT OF LOGGING RESIDUE—ALTERNATIVE APPLICATIONS OF THE LINE INTERSECT METHOD. USDA For. Serv. Res. Note PNW-183. 8 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

Van Wagner, C. E.
1968. THE LINE INTERSECT METHOD IN FOREST FUEL SAMPLING. For. Sci. 14(1) : 20-26, illus.

Warren, W. G., and P. F. Olsen.
1964. A LINE INTERSECT TECHNIQUE FOR ASSESSING LOGGING WASTE. For. Sci. 10(3) : 267-276, illus.

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