STX

TIMBER ESTIMATING WITH 3P SAMPLING AND DENDROMETRY

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

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STX

TIMBER ESTIMATING

WITH

3P

SAMPLING AND DENDROMETRY

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INTRODUCTION

The STX system is a revolutionary method for estimating the volume and quality of standing timber. The system is based on use of the STX computer program. STX methods are more accurate, more efficient, more flexible, and more consistent than earlier methods. The system uses sampling and measuring techniques that have become feasible only since the advent of high-speed binary computers.

The simplest use of STX is for estimating volumes segregated into grade or quality classes. Options provide for translating grade or quality class volumes into various products and estimated values, based on mill studies.

The STX system has been tested and applied for sales of a number of timber types throughout the United States. Since its invention and introduction in 1963 by L. R. Grosenbaugh,[1] the system has been a subject of interest among foresters. Thus, there has been a demand for a guide for use of the system and for comparing its results with those obtained by other methods. This handbook is intended to fill the need for such a guide.

STX (5–1–67) is programmed for use when it is feasible to enumerate each tree in the population being measured. A companion program—beyond the scope of this handbook—has been developed to adapt the procedures for area-sampling of large tracts, or stands composed of numerous small trees.

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[1] L. R. Grosenbaugh. STX-Fortran-4 program for estimates of tree populations from 3P sample-tree measurements. U.S. Forest Service Research Paper PSW-13. Pacific Southwest Forest and Range Experiment Station, 1967.

WHAT'S DIFFERENT ABOUT STX?

The STX system differs from conventional timber estimating systems in several ways:

(1) STX uses 3P sampling, a method in which the *probability* that a tree will be selected as a sample is *proportional* to a *prediction* of volume or value made for each tree in the population being sampled; it thereby favors the selection of large or valuable trees. Rapid ocular estimates of tree volume or value are used to reduce the number of sample trees needed to obtain estimates with a given degree of accuracy. The nature of these estimates and why they are more efficient than conventional sampling methods are discussed later under "3P sampling."

(2) STX provides for use of optical dendrometers to measure out-of-reach stem dimensions on standing trees (or direct measurements on felled or wind-thrown trees); this eliminates the chance for bias that occurs with conventional systems.

(3) STX estimates are expressed by a trio of measurements (cubic-foot volume, square feet of log surface area, and linear feet of log length) that are more descriptive than single units of measurement, such as board feet, cords, or pounds. This trio of measurements can be converted directly to estimates of potential for producing primary products (such as lumber and plywood) or secondary products (such as chips produced from slabs, edgings, and peeler-bolt cores). Conversions to dollar values of any products can similarly be made.

(4) This trio of measurements are additive without regard to log size. This permits aggregating contents of similar stem sections in several quality-defect classes so that estimates may be adjusted to reflect differences between stands. Conventional solutions to this problem require a massive job of sorting (by log-sizes within quality classes) to achieve the same objective because single units of measure are nonlinear with respect to product outturn.

THE STX SYSTEM

Field tally

The predicted volume is listed on a tally sheet for each tree as it is marked for cutting or is otherwise encountered in the population being sampled. Each prediction is then paired with a random number in a list generated for that particular sampling job. When the random number equals or is less than the prediction with which it is paired, the tree qualifies as a 3P sample to be marked for conventional measurement or for measurement with a dendrometer. The list of random numbers can be generated so that approximately any desired number of trees will qualify as samples. The field tally consists of a list of predictions for all trees and measurement data for those that qualify as samples.

Sample blow-up

The procedure used to expand the sample information to a total estimate consists of aggregating the predicted volumes of the samples, comparing with the individual predicted volume of each measured tree, and adjusting accordingly the measured volume of each tree. Each sample tree is expanded individually, then totaled for the population estimate. The blow-up factor for any given sample tree, called frequency (i.e., the number of trees in the population represented by that tree), is obtained by dividing the sum of the predictions of all trees by the product of the total number of samples and the prediction for that particular sample tree. For example, if predictions for a 10,000-tree timber sale total 1,200,000 bd. ft., 125 trees are drawn as 3P samples, and predicted volume for one of the samples is 150 bd. ft., the frequency for that particular tree is computed to be:

$$F = \frac{1{,}200{,}000}{125 \times 150} = 64.0$$

If the actual scaled volume of the sample tree was found to be 175.2 bd. ft. (International ¼ in. log rule), its contribution to the total estimate is 175.2 x 64.0 = 11,213 bd. ft.

When tree content is expressed in cubic volume, surface area, and length—as it is by the STX program—the expansion is made similarly, but volume, surface area, and length are each multiplied by the frequency factor. Thus, if the program showed that the sample tree with $F = 64$ contained 27.1 cu. ft., 103.6 sq. ft., and 32.0 linear ft., the contribution of the sample tree to the total estimate would be 64 x 27.1 = 1734.4 cu. ft., 64 x 103.6 = 6630.4 sq. ft., and 64 v 32.0 = 2048.0 linear ft. Other samples are expanded in similar manner and summed for totals of cubic volume, surface area, and length. These totals are then converted to estimated product units. For example, assuming that Int. ¼ bd. ft., gross volume = 9.1236 cu. ft. — .70846 sq. ft. + .04222 linear ft., the expanded contribution of the sample tree is computed to be:

$$\begin{aligned} & 9.1236 \times 1734.4 \\ - \; & .70846 \times 6630.4 \\ + \; & .04222 \times 2048.0 = 11{,}213 \text{ bd. ft. Int. } 1/4 \end{aligned}$$

Similar equations for converting cubic volume, surface area, and length are available, or can be derived from mill-scale studies, to show expanded volumes in other units of measure, such as dry or green lumber tally, dollar value of products, weight and value of chips produced, green weight of logs, etc.

Accommodating differences in quality and defect

In STX procedure, the coefficients are not prepared for the entire tree contents as shown in the example above, because to do so would give the same volume to defective material as to sound, and the same value to low-quality as to high-quality material. Instead, the formulas include a trio of coefficients for each of 11 quality-defect classes. A conversion formula may therefore contain as many as 33 coefficients, rather than 3 as shown for the illustrative Int. ¼ equation.

The procedure used to account for differences in value and yield resulting from differences in grade and defect is as follows:

(1) Sample trees are divided ocularly into segments according to the 11 quality-defect classes.

(2) Program computations of cubic volume, surface area, and length are made for each segment and expanded by the computed tree frequency.

(3) The expanded segment estimates are subtotaled by species and grade-defect classes.

(4) The sums in each category are converted to estimates in other units of measure, as desired.

Data processing

The STX program is operational at a number of computer centers that serve processing sections of each of the Forest Service regions. Only two data card forms—a tree card and a dendrometer card—are needed; both are punched from an STX tally sheet. The tally sheets are sent to the regional center with data statements for five control cards that must precede each set of data cards to be separately processed.

The control cards offer a wide selection of outputs, both in print and on cards, if the program is compiled with appropriate constants. Controls discussed herein are those required for appraisal data, but suggestions are also made for alternative objectives.

Output reports include (1) preliminary report of tree counts and predictions, (2) stem dimensions and computations for individual sample trees, (3) summary reports of expanded estimates and sampling error, (4) tabulations of expanded estimates of volume, surface area, and length by grade-defect classes, and (5) conversions of class subtotals to other units of measure. In addition, processing statistics and error messages signal input flaws and suspicious data.

Output reports contain far more information on dimensions, contents, and quality of sample trees than was previously available; this feature should appeal to prospective timber purchasers. By simple substitution of conversion constants, bidders can also use the program to estimate product yields and returns for their particular operations.

PREPARATION FOR STX ESTIMATES

These input items are required for the STX system to estimate volume and value for tree-measurement timber sales:

Planning

During sale area reconnaissance:

(1) Estimate:

- (a) Total sale volume
- (b) Total number of trees
- (c) Volume of the largest tree.

(2) Decide on:

- (a) Sampling accuracy objectives
- (b) Species or species groups
- (c) Products on which appraisal will be based
- (d) Measurement units needed by purchasers and for management planning and business records
- (e) Identification of size classes
- (f) Subareas, such as payment units or any other, for which separate volume or value information will be needed.

(3) Calculate the number of sample trees needed for the total estimate.

(4) Obtain a computer-generated list of random integers for selecting 3P sample trees so as to approximate the desired number of samples.

Field work

(1) Prepare a short work plan to show organization of field work; necessary equipment, tools, and aids; methods of making volume predictions; and specifications for dendrometry.

(2) Provide cruiser training to develop estimating skills.
(3) Arrange for check dendrometry.

Data processing (field level)

(1) Prepare data statements for STX control cards.
(2) Check card listings.
(3) Debug program output as required.

Data processing (processing center)

(1) Punch and verify data cards.
(2) Arrange for machine processing, as required.
(3) Furnish coefficients for converting volume, surface, and length to estimates of product yield and value.

3P SAMPLING

Determining number of sample trees

Equations used in conventional random sampling are applicable to 3P sampling. For large populations

$$N = \left(\frac{CV \text{ in percent}}{\text{sampling error in percent}}\right)^2$$

where N = estimated number of samples and CV = the coefficient of variation of the ratio of measured-tree gross volume to predicted-tree gross volume. Thus, 100 sample trees are needed for a ± 2% accuracy if CV is ± 20%.

How 3P samples differ from conventional samples

The difference in meaning of CV distinguishes 3P sampling from conventional random sampling. In conventional sampling CV refers to the dispersion of individual tree volumes around the *average volume per tree.* In 3P sampling CV refers to the dispersion of the ratios of (measured volume/predicted volume) for individual trees around the *average of these ratios.*

With conventional sampling, the estimator is at the mercy of volume dispersion as it happens to exist. The range in tree volumes is usually wide and—even with stratification by diameter classes—he cannot reduce CV much below ± 35%. For an estimate with a sampling error of ± 2%, he therefore needs at least $(35/2)^2 =$ 307 sample trees. With 3P sampling, by contrast, CV depends on the estimator's skill in holding as constant as he can the ratio of measured gross volume to predicted gross volume. Beginners may be expected to achieve a CV of ± 25%; this drops the number of samples to 156. Trained cruisers can readily attain a CV of ± 15%, which reduces the required number to 56 sample trees instead of 307 for a 2% sampling error.

Sampling efficiency with 3P also increases because probability of sample selection increases with tree size, while the cost of dendrometry increases very little as tree size increases. In an east Texas pilot sale, for example, trees ranged from 20 to 1600 bd. ft. per tree; frequency of samples in the smallest size group was 1 in about 90, whereas for the largest group, the probability of sample selection was 1 in about 6. Consequently, the average volume of 3P samples is likely to be disproportionately greater than that of the average tree.

Accuracy of the estimate is not affected by prediction bias. A cruiser who is erratic in his predictions but who averages out "on the button" will cause greater error in the final estimate than will a cruiser who is severely but more uniformly biased one way or the other.

It is important to keep the ratios as uniform as possible. This is more difficult with small than with large trees. In the east Texas pilot sale, for example, CV increased from ± 12.4% for the largest tree sizes to ± 20.9% for the smallest. A factor in this disparity of CV among size classes is complacency in making predictions for small trees since so few are found to qualify. Although the odds for sample selection are against the small trees, small sample trees contribute as much to the total volume estimate as large trees. Thus, for the east Texas sale, a sample tree with a measured volume of 23 bd. ft. had a frequency of 240.878, thereby contributing 23 x 240.878 = 5540 bd. ft. to the estimate. For the same sale, a sample with measured volume of 1146 bd. ft. had a frequency of only 4.866, thereby contributing 5576 bd. ft. In computation of *CV* the ratio (measured/predicted) for a small tree similarly counts just as much as the ratio for a large tree.

Basis for making predictions

Predictions are made directly in terms of gross volume and may be weighted by relative value. Normally, it is sufficient to use volume tables based on diameter and height for the species being appraised, but form class tables are preferable when they are available. *Predictions should not be reduced for breakage and cull.*

Training estimators

A group of conveniently located trees should be measured with a dendrometer and used as a practice range. At first, volume estimates should be made with table lookup, based on estimates of diameter and other parameters, such as height and form class, required by the volume table. As soon as the operation becomes familiar, measurements should be preceded by a quick guess of volume, however "wild," based on a visual impression of tree size without recourse to measurements or tables. In this manner, and with practice, only a modicum of skill appears to be needed to make acceptable predictions (both in speed and consistency) by cruisers having some aptitude for the work.

Estimators who base their impressions of tree volume on practice with form class volume tables generally acquire a better knack for making consistent predictions than those trained with diameter-height tables or tables based solely on diameter.

Computing *CV* of predictions

As will be shown later, sampling error for an STX cruise appears in the computer output and *CV* may be derived by multiplying the sampling error in percent by the square root of the number of 3P samples. Thus, *CV* is ± 20% if sampling error is ± 2.0% with 100 3P sample trees. For practice sessions, however, *CV* must be calculated with whatever facilities are available. A convenient formula for this is:

$$CV = 100 \sqrt{\left(\frac{N}{N-1}\right)\left(\frac{N \Sigma X^2}{(\Sigma X)^2} - 1\right)}$$

where $CV =$ coefficient of variation in percent
$N =$ the number of samples
$X =$ (measured volume/prediction).

For example, if 3 sample trees have prediction ratios, respectively, of 1.440, 1.032, and 1.291

$$CV = 100 \sqrt{\left(\frac{3}{3-1}\right)\left(\frac{3 \quad (1.440^2 + 1.032^2 + 1.291^2)}{(1.440 + 1.032 + 1.291)^2} - 1\right)}$$

$$= \pm 16.4\%.$$

Identifying sample trees in the field

Since a list of the trees in a sale area or a map showing their locations is rarely available in advance, the identification of qualifying sample trees and determination of their locations present practical and statistical problems. The object is to select, without bias, one sample tree *for each accumulation of predictions* that totals to

$$\frac{\text{sum of all predictions}}{\text{designed number of sample trees.}}$$

For example, for a sale of 1,000,000 bd. ft. where sample design calls for 100 sample trees, one sample must be drawn for any accumulation that totals to 1,000,000/100 = 10,000 bd. ft. This problem of sample selection is solved by use of either of two computer programs. One is called THRP,[2] the other is adapted to a wider variety of computers and is called RN3P, both prepared by Grosen-

[2] L. R. Grosenbaugh. Three-pee sampling theory and program THRP. U.S. Forest Service Research Paper PSW-21. Pacific Southwest Forest and Range Experiment Station, 1965.

baugh. These computer programs furnish lists of positive random integers and nulls fitted to any particular sale or sampling job. After predictions of volume are made, they are compared with successive numbers in the lists. A tree qualifies as a sample when the random number is equal to or less than the prediction with which it is paired. Trees paired with nulls are nonsamples.

The theory developed for this selection system is complex, but its application is very simple. The estimator does not need to keep track of the accumulated predictions and his tally may proceed in any order.

Obtaining a list of random integers

A list of random numbers and nulls must be obtained for each sale and requires some advance information about the sale area, based on data that is usually available from field reconnaissance and diagnostic tallies made for compartment prescriptions. Two control cards are needed to obtain computer outputs of random integers:

For either THRP or RN3P, the first control card is left blank in Columns 1–4, full identification of the sale area is shown in Columns 5–64, and a brief coded identification of the sale area is shown in Columns 73–76 (same as will be used in program STX later).

For THRP, the second control card contains:

Column	
1–4	Blank
5–16	L = any 12-digit identification number that lacks eights or nines, different for each sale
18–22	LIM = total number of trees to be included in the 3P estimate of volumes.* This number should be a multiple of 500
24–27	K = volume of the largest tree that is to be included by the 3P estimate [3]

[3] All trees larger than K are sure-to-be-measured trees; their volumes will be automatically added to the sample estimate based on the 3P-measured trees.

29–33 *KZ* = total volume to be 3P-estimated divided by the number of 3P sample trees that are desired

For RN3P, the second control card contains the same information arranged as follows:

Column	
1	Blank
2–10	Any positive integer (0 through 999999999), different for each sale
14–20	*LIM* (as for THRP above)
24–30	*K* (as for THRP above)
34–40	*KZ* (as for THRP above)

Figure 1 shows how data sheets are prepared for punching the control cards that are needed. Note that a job-end card punched 9999 in Columns 1–4 must follow the last card of each pair of control cards.

Some 3P design considerations

The value of *LIM* is not critical. Overestimates or underestimates do not affect the 3P estimate. Always try to overestimate the total number of trees. Excess random numbers are cheap and are much cheaper than another list. If an additional list is needed, change the number shown as *L* in Columns 5–16 to provide a different set of random numbers.

Overestimates or underestimates of *KZ* will affect the number of samples that will be drawn, resulting in more or less accuracy than planned. The volume estimate, however, will not be biased.

Setting the value of *K* may need consideration in some situations because occurrence of trees larger than the value of *K* will require the estimator to either (1) reduce the prediction to *K*, a decision that will increase the *CV* of his predictions, or (2) place the tree in a sure-to-be-measured category, separate from the population being 3P-sampled, and thus increase expense of sample tree measurement and subsequent computations.

In general, the value of *K* can be set high enough to

```
1    THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL                    TEST   1
2 192348613       500       120       660                               TEST   2
3 9999
```

Figure 1.—Program statements for obtaining a RN3P output of random numbers.

rule out the occurrence of numerous trees with a prediction higher than K. For some estimates, however, it may be advantageous to set K low enough so that a stratum of the largest and most valuable trees is measured 100%.

When species vary considerably in value, weighting the predictions by relative value will give high-value species a better chance of being picked as samples. This is advisable if the high-value species form a minor component of the stand.

Take, for example, a stand composed of 25,000 bd. ft. of a high-value species (HIVA) and 90,000 bd. ft. of a low-value species (LOVA). If HIVA is worth three times the MBF value of LOVA, the volume estimate, weighted by the relative value, is (3 x 25,000) + (1 x 90,000) = 165,000. Assume also that the largest HIVA tree has 400 bd. ft. (unweighted) and the largest LOVA tree has 1000 bd. ft. and that both species combined include fewer than 500 trees. To obtain an appropriate list of random numbers for drawing a sample of 25 trees assuming we wish a sampling error of 5% and estimating the CV to be 25% $((25/5)^2)$, parameters for the second data card needed by THRP or RN3P will include:

$LIM = 500$
$K = 3 \times 400 = 1200$
$KZ = 165{,}000/25 = 6600$

Program statements needed for punching an RN3P parameter card are shown by figure 1. Values of K and KZ are in tens of bd. ft. Figure 2 shows the RN3P output of random numbers, also in tens of bd. ft. The figure -99999 indicates a null, automatically a nonsample, unless it is paired with a sure-to-be-measured tree.

With this design the number of LOVA samples that can be expected is 90,000/6600 = 14, and the number of HIVA is 75,000/6600 = 11.

Preparing random numbers for field use

For convenient field reference with a method that pre-

```
THREE-PEE SAMPLE-TREE MEASUREMENT AND APPRAISAL                    PAGE    1
L=   192348613, LIM=     500, K=     120, KZ=     660                   TEST

     91 -99999     60 -99999 -99999    103      2     77 -99999 -99999
 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999 -99999     95 -99999 -99999    119      9     69
 -99999 -99999 -99999 -99999 -99999     59 -99999 -99999 -99999 -99999
 -99999 -99999 -99999     56     74 -99999 -99999 -99999 -99999     27
 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999 -99999     65      6 -99999 -99999 -99999 -99999
     40 -99999     93 -99999     84 -99999 -99999 -99999 -99999 -99999
 -99999      5     50 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999 -99999    101 -99999 -99999     21 -99999 -99999 -99999 -99999
 -99999 -99999     73 -99999 -99999 -99999 -99999 -99999 -99999     31
 -99999     19    106 -99999    109 -99999    101 -99999 -99999    103
     38 -99999 -99999 -99999 -99999 -99999     47 -99999 -99999     51
 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999     50 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999    108 -99999 -99999 -99999    120 -99999    100
     31 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999     65 -99999 -99999 -99999 -99999 -99999 -99999 -99999     87
 -99999 -99999 -99999 -99999     72 -99999 -99999 -99999 -99999     49
 -99999 -99999      5    108 -99999 -99999     95     41 -99999 -99999
 -99999 -99999 -99999 -99999     51 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999 -99999     24 -99999 -99999     44 -99999     73
 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999 -99999     14 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999 -99999     47 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999     72 -99999 -99999 -99999 -99999     85 -99999
 -99999    110 -99999     26 -99999     51 -99999 -99999 -99999 -99999
 -99999 -99999     35 -99999 -99999 -99999 -99999 -99999 -99999 -99999
     21 -99999     28 -99999     74 -99999 -99999 -99999 -99999     76
 -99999      4 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999 -99999     28 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999 -99999 -99999 -99999     20 -99999     48 -99999
     68     32     61 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999 -99999 -99999 -99999     82 -99999 -99999 -99999
 -99999 -99999 -99999 -99999 -99999     44     52 -99999 -99999 -99999
 -99999 -99999 -99999 -99999 -99999      1    117 -99999     47 -99999
 -99999 -99999 -99999 -99999 -99999      4 -99999 -99999 -99999    120
 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999
 -99999 -99999 -99999 -99999     40 -99999 -99999 -99999 -99999     76
    118 -99999 -99999    111 -99999 -99999    111 -99999      5 -99999
      6 -99999 -99999 -99999     54 -99999 -99999    116 -99999 -99999
 -99999 -99999 -99999 -99999 -99999     23 -99999 -99999     27     51
 -99999 -99999 -99999 -99999 -99999 -99999     52 -99999 -99999      1
 -99999 -99999 -99999 -99999 -99999 -99999 -99999     29     77 -99999
 -99999 -99999 -99999     18    113 -99999 -99999 -99999 -99999 -99999
 -99999      4 -99999 -99999 -99999 -99999 -99999    111 -99999    102
    119 -99999     75 -99999 -99999 -99999 -99999 -99999      3 -99999
 -99999 -99999 -99999 -99999     65 -99999 -99999 -99999     18 -99999
 -99999 -99999     69     14      9 -99999 -99999 -99999 -99999     16
 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999 -99999
                                                                          6107
   TEST   TEST   TEST   TEST   TEST   TEST   TEST   TEST   TEST   TEST     106

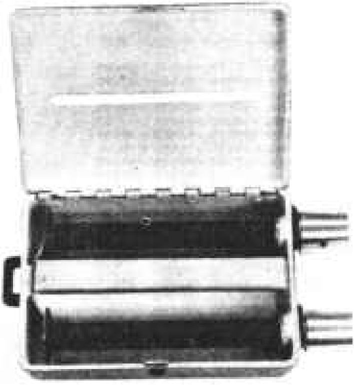
THREE-PEE SAMPLE-TREE MEASUREMENT AND APPRAISAL                    PAGE    2
L=   192348613, LIM=     500, K=     120, KZ=     660                   TEST

TEST       KSUM        =        6107,  NK       =     106,  NKZ=      500
EXPECTED   NK*(K+1)/2=          6413,  NKZ*K/KZ=       90,  LIM=      500
```

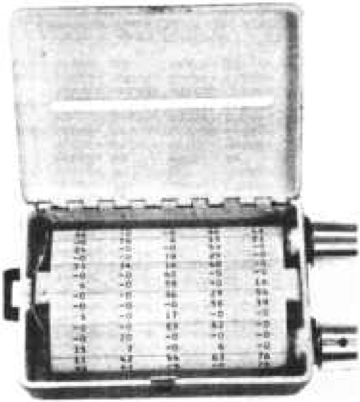
Figure 2.—RN3P output of random numbers.

vents bias by premature disclosure of random integers, the lists of random numbers are slit, joined into strips, and loaded into a special dispenser.[4] Figure 3 shows the details of strip preparation, using an output from program THRP, which shows nulls as –0 instead of –99999.

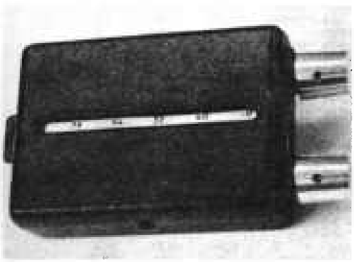
[4] C. Mesavage. Random integer dispenser. U.S. Forest Service Research Note SO–49. Southern Forest Experiment Station, 1967.



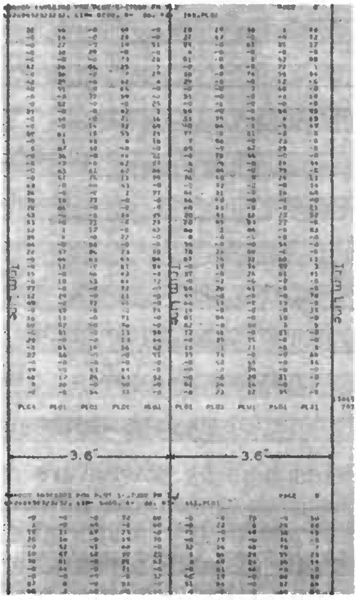
The random integer dispenser ready for loading with tape.



With tape on spools.



Cover closed, instrument ready for use.



Trimming specifications for preparation of a printout tape.

Figure 3.—Preparing random numbers for field use.

FIELD WORK

Organization of field work

Field work consists of listing predictions of volume for each tree and measurement of trees that qualify as samples or as sure-to-be-measured trees. Experience indicates that work should be organized to fit the conditions, changing in some cases on the same job, depending on density of stocking, terrain, and size of the field crew.

When stocking is dense and maneuverability is restricted, a tallyman can efficiently keep the records for a crew of estimators and inform the estimators which trees qualify as samples. If trees are large, sample trees occur frequently and it may pay to have one or more dendrometerists keep up with sample tree measurements as the crew progresses.

When stocking is not dense, it is usually better to have each estimator keep his own tally and map the location of sample trees for later dendrometry. String stripping may facilitate such a two-stage procedure. The following discussion assumes this type of work organization.

Equipment

Tools and supplies needed for STX estimating include:

(1) An aluminum letter-size sheet holder with a random integer dispenser attached to the front cover; the dispenser is loaded with the tape of random numbers generated for that sale

(2) A supply of STX tally sheets as shown in figure 4

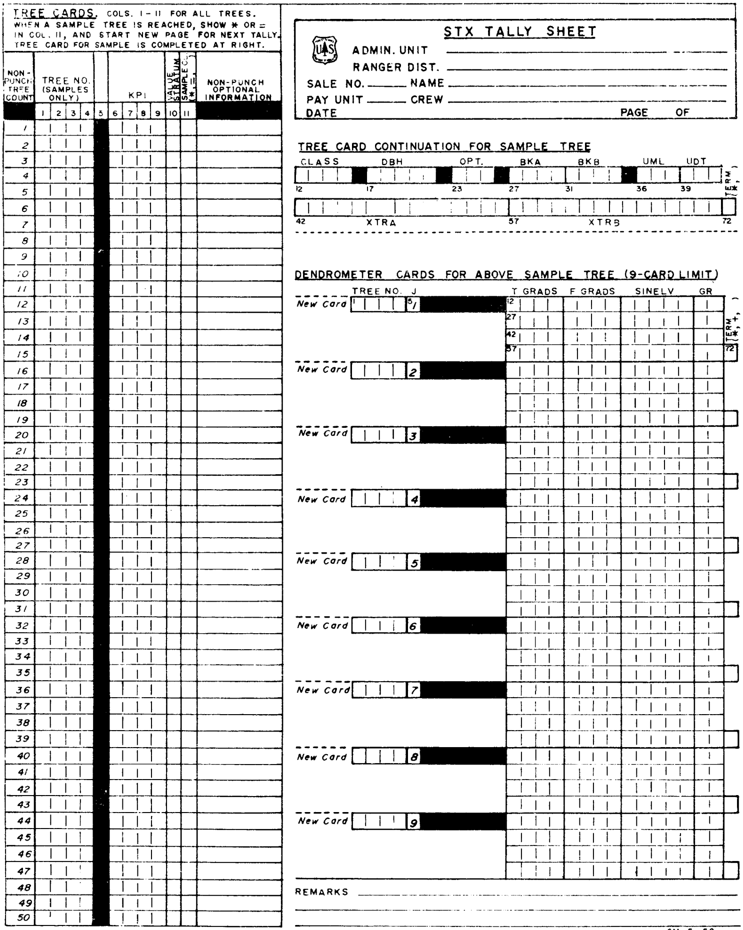
(3) Volume tables needed to help make volume predictions

(4) Diameter and distance tapes

(5) Clinometer

(6) Map of the sale area

(7) Plastic flagging, bark shaver, and tree-marking keel or tree labels.



TREE CARDS. COLS. 1 - 11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1 2 3 4	5	KPI 6 7 8 9	VALUE STRATUM 10	SAMPLE C. (* =) 11	NON-PUNCH OPTIONAL INFORMATION
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
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16						
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43						
44						
45						
46						
47						
48						
49						
50						

STX TALLY SHEET

ADMIN. UNIT

RANGER DIST.

SALE NO. ____ NAME

PAY UNIT ____ CREW

DATE PAGE OF

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS DBH OPT. BKA BKB UML UDT (TERM *, =)

12 17 23 27 31 36 39

42 XTRA 57 XTRB 72

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

TREE NO. J T GRADS F GRADS SINELV GR (TERM +, *, =)

New Card 1 5 /1 12 27 42 57 72

New Card 2

New Card 3

New Card 4

New Card 5

New Card 6

New Card 7

New Card 8

New Card 9

REMARKS

CM 6-68

Figure 4.—STX tally sheet.

Procedure for making predictions and designating sample trees

Estimators make predictions of volume as trees are encountered. (Stems of trees that fork below breast height should be considered as separate trees.) The predictions must correspond with the units on which the random numbers are based. For example, since HIVA was weighted 3X in the 3P design previously discussed, each prediction for HIVA in that sale is multiplied by three before it is recorded on the tally sheet, and since the random numbers were generated in tens of bd. ft., predictions for both HIVA and LOVA must be in tens of bd. ft. When relative value differs in this manner, each stratum is coded numerically (1 through 9) and the code for each tree is shown in Column 10 of the tally sheet. When there is only one stratum, the 1 need not be shown.

Each prediction is recorded as it is made in Columns 6–9 of the tally sheet (in the field headed KPI), and it is then compared with the current random number to see if the tree qualifies as a sample. To prevent selection bias, the next number of a given column is rotated into view *after* the prediction has been recorded. A tree paired with a positive random number qualifies as a 3P sample when the random number is equal to or less than the prediction. It is a nonsample if paired with a null, unless it qualifies as a sure-to-be-measured tree because the prediction is greater than the value of K. For example, in the design shown in figure 1, $K = 120$. Any tree with a prediction of 121 or greater is a sure-to-be measured tree. When a "sure" tree is encountered, the random number dispenser is advanced as for any other tree.

A tree number is assigned only to sample trees. If more than one estimator is employed, a temporary number incorporating the estimator's initials is recorded in the remarks section at the bottom of the tally sheet. The dendrometerist records a permanent number later.

Sample trees are flagged distinctively, and their locations are plotted on the sale-area map. Listing of additional predictions on the tally sheet ceases when a sample tree is recorded. A new tally sheet is started for the next tree.

Appendix C shows how tally sheets were prepared for the first 18 of 33 sample trees measured for a hypothetical population of 386 trees. Note that the tree predictions were merely listed (under KPI and value stratum) until a tree qualified as a sample. Each prediction was paired successively with the list of random numbers shown in figure 2. (The associated random numbers on the sample tally sheets are listed in the non-punch column only as a convenient reference for the reader. Do not record them in the field.) The rest of the tally sheet is filled in by the dendrometerist.

General procedure for measuring sample trees

Equipment. Tools and supplies required for dentrometry include:

(1) Optical dendrometer

(2) Slide rule for multiplication and division or, for Barr and Stroud dendrometer,[5] a Barr and Stroud calculator [6]

(3) STX reference manual

(4) STX tally sheets (in aluminum sheet holder) showing predictions made by the estimators

(5) Diameter tape

(6) Bark gauge, carpenter brace with 1-in. bit, and Starrett No. 237 depth gauge with No. 611N rule; these items are for bark measurement

[5] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

[6] C. Mesavage. Revised calculator for Barr and Stroud dendrometers. U.S. Forest Service Research Note SO-84. Southern Forest Experiment Station, 1968.

(7) Telescoping pole, extendable to 13 ft.

(8) Hand level or clinometer (for level sightings)

(9) Small hand axe, bark scribe, tree identification tags, marking keel, and plastic flagging tape

(10) Distance tape, range pole, and tree calipers; these items, not carried in the field, are used for checks of dendrometer.

The dendrometerist finds the sample trees and assigns each a permanent sequential number, marking it on the tree (for field identification) and in Columns 1–4 of the tally sheet. He then obtains and records stem measurements, beginning with the stump, at breast height and at points above that divide the tree into segments that are uniform as to taper, quality, and defect. Quality and defect of each segment, including stump to breast height, are classified ocularly, based on surface indications. Tree measurements are terminated at a designated top.

Although a dendrometerist can work alone, an assistant is generally advisable. The assistant keeps notes, clears lines of sight, obtains measurements as required at the tree, and performs related work.

Recording tree measurements

The tally sheet is designed to facilitate field entries, editing, and punching of data that relate to the tree as a whole (on a tree card) and that relate to stem measurements made along the bole (on as many as nine dendrometer cards per tree).

To assure successful processing of data, entries on the tally sheet must follow explicitly the recording directions discussed below:

Tally sheet (data for tree card):

Column	*Entry on tally sheet*
1–4	This field shows the tree number (for sample trees only).
5	Blank.
6–9	This field shows the volume predictions (for all trees).

Column	*Entry on tally sheet*
10	This field shows the value stratum for each tree by means of a one-character code (1 through 9). Strata are coded when trees differ in relative value, or when, for groups having the same value, calculations of sampling error are desired for separate strata. This is discussed further in the section on program outputs.
11	This field is left blank until a tree qualifies for measurement. An asterisk (*) is entered for 3P samples; an equal sign (=) is entered for "sure" samples.
12–15	This field (labeled CLASS) shows how trees are classified. For timber sales, this field is normally used to identify species with a four-character abbreviation, such as DFIR. Sometimes, it is desirable to defer the entry for CLASS until the field work has been completed. If alternative classifications are being considered, these may be entered in the nonpunch column.
16	This field is not normally used. However, it may be used for blind labeling, i.e., the program will ignore the character, but it may be useful in hand sorting.
17–21	This field (labeled DBH) shows the tape or caliper measurement of the d.b.h.o.b. to 0.1 in. The decimal point need not be entered since its position is implied as 0.1 by the program, but use of an explicit decimal point makes the entry easier to read.
23	The fields 23–25 are labeled OPT. Field 23 codes the mode of measurement as follows: 0—Barr and Stroud FP–12 (or earlier model) dendrometer 1—Barr and Stroud FP–15 dendrometer (SINELV is coded)

Column *Entry on tally sheet*

23 (*Cont.*)

2—Direct measurements on felled or climbed trees or those provided by direct-reading dendrometers

3—Modified Zeiss Teletop dendrometer.

As explained further below, tape measurements of stump diameter and d.b.h. can be combined with dendrometer measurements of upper-stem diameters. In such cases, the mode of measurement is coded to indicate the type of dendrometer used on the upper stem.

24 Column 24 codes machine procedure for reducing outside-bark measurements of stem diameters to wood diameters, as follows:

0 or 1 d.i.b./d.o.b. at any point on the stem is assumed equal to (d.b.h.i.b./d.b.h.o.b.).

2 d.i.b./d.o.b. is projected hyperbolically. d.i.b./d.o.b. is made to increase above breast height and decrease below breast height, i.e., relative bark thickness is programmed to decrease up the stem.

3 d.i.b./d.o.b. is projected hyperbolically. d.i.b./d.o.b. is made to decrease above breast height and increase below breast height, i.e., relative bark thickness is programmed to increase up the stem.

25 Column 25 codes method for obtaining computer estimates when unseen but usable material occurs above the last measured section. (The code is ignored unless –999 is recorded as the last F GRADS, explained further below.)

1 This is a computer projection, based on diameter at stump and at least

Column	*Entry on tally sheet*	
25 (*Entry 1 Cont.*)		
		three sets of measurements above the stump (preferably above breast height), that requires entries under UDT (Columns 39–41) or under both UDT and UML (Columns 36–38). UDT is (desired minimum top d.o.b./d.b.h.o.b.). UML is guessed or measured length of top section.
	2	Computed from estimated taper rate (recorded under UDT in inch per foot.) and length (entered under UML). UDT may be guessed or obtained from taper tables. UML may be guessed or measured with clinometer.
26	Blank.	
27–34	These fields (labeled BKA and BKB) are used for recording single bark thickness to 0.1 in. If only one measurement (or average of several measurements) is made, it is entered under BKA (without decimal point). A second measurement (or average) is entered under BKB. When an entry is made only under BKA, the program doubles it. If BKB is also shown, the program adds the measurements. If no entries of bark thickness are recorded, the program assumes that d.b.h.i.b./d.b.h.o.b. is .90 (a parameter that can easily be changed in the program), and the mode of correction is guided by the option coded in Column 24. If a fictitious negative bark thickness (like –009) is entered under BKA, no correction for bark is made. In this manner, outside-bark volumes may be computed from d.o.b. meaurements, or inside-bark volumes may be computed from d.i.b. measurements.	
35	Blank.	

Column	*Entry on tally sheet*
36–38	This field (labeled as UML) is for recording length of unseen section above the last measured section. The current format implies this is in whole feet. A value for UML must be shown if Column 25 is coded 2, otherwise it would imply that last section is of zero length. UML is optional if Column 25 is coded 1.
39–41	This field is labeled UDT. If Column 25 is coded 1, and F GRADS of –999 is recorded after the last set of measurements, the program will compute top d.o.b. as (UDT x d.b.h.o.b.). To obtain a projection to 50% of d.b.h., for example, UDT is recorded as 500. The decimal point is implied and need not be recorded. If a length is shown under UML, the projection will terminate at this length or at (UDT x d.b.h.), whichever comes first. If UDT is omitted, the program assumes a value of .45. This figure may easily be changed to any other constant, if desired. If Column 25 is coded 2, and F GRADS of –999 is entered after the last set of measurements, the unseen section will be computed as a conic frustrum having the length entered under UML, and a taper rate, in *inches per foot,* as entered (without decimal point) under UDT.
42–71	These fields are reserved for future use (when point sampling, etc., are employed).
72	This field is normally blank, but see comments below on tally of cull trees.

Tally sheet (data for dendrometer cards):

Stem measurements are made, beginning with the stump, and are recorded in the fields labeled **T GRADS, F**

GRADS, and SINELV. Four sets of measurements may be recorded on each of up to nine dendrometer cards. An asterisk is entered in Column 72 of the last set of dendrometer measurements to show that the next measurements are for a new tree. Computer interpretation of these data depends on the mode of measurement coded for Column 23 of the tree card.

The tally sheets in Appendix C illustrate most, if not all, tree-measurement options available with the STX program. Leading zeros should not be entered unless an implied decimal point precedes the first zero, such as 01 for .01.

Modes of tree measurement

Any method of tree measurement can be accommodated by the STX computer program, and the method may be changed from tree to tree on the same job.

Barr and Stroud dendrometers. See tally sheets for sample trees nos. 1 and 2, Appendix C. Drum calibrations of T and F GRADS are read to 0.1 grad and entered without a decimal point. Thus a reading of 45.2 is entered as 452. Sine of the vertical angle, read from the clinometer of model FP12, is similarly entered without the decimal point, but the sign must be shown. Thus, angles with sines of + .252 and – .135 are entered as +2520 and –1350, respectively. Clinometer scales of model FP15 are graduated in terms (1 + sine). Angles having sines of +.252 and –.135 appear as 1.252 and .865 on the FP15 clinometer and are entered as 12520 and 8650, respectively. The micrometer may be interpolated to show an additional decimal place, if desired. For example, an interpolated reading might show the sine coded as 1.2525, and be entered as 12525. (Column 23 of the tree card is coded 0 for model FP12 or earlier models, and 1 for model FP15.)

To measure total height, T GRADS and SINELV are sighted to a terminal leaf, when possible, and F GRADS is entered 0.1 grad greater than T GRADS. This is illustrated by sample tree no. 16. When it is not possible to read T GRADS, both T and F GRADS are recorded as –999, and SINELV is the only actual measurement recorded.

Modified Zeiss Teletop. See tally sheet for sample tree no. 5. The T GRADS field is used for recording slant distance to 0.1 ft. and F GRADS for recording stem diameters to 0.1 in. The decimal point is not entered in either case. Vertical angle, read to 0.1 degree in terms of (100 + degrees), is entered with decimal point in the SINELV field. (Column 23 of the tree card is coded 3.)

To include total height, T GRADS and SINELV to a terminal leaf are determined when possible, and F GRADS is entered as 1.

Direct measurements on felled or climbed trees. See sample tree no. 3. The T GRADS field is left blank. Diameters measured with tape or caliper are entered, to 0.1 in., in the F GRADS field. The decimal point is not entered. Height in ft. (to 0.1 ft. *above the last measured diameter*) is entered in the SINELV field with decimal point. (Column 23 of the tree card is coded 2.)

Other dendrometers. Readings from dendrometers not specifically programmed for STX are first converted into direct measurements, as illustrated by sample tree no. 3. (Column 23 of the tree card is coded 2.)

Procedures when lines of sight are obscured

Several procedures are available to facilitate measurements or to estimate stem diameters when lines of sight (LOS) are obscured:

LOS to stump and breast height are obscured. See sample tree no. 6. Actual measurements at stump and breast height may be recorded as the first two F GRADS if the initial T GRADS is shown as –999. The second T GRADS is left blank. The first SINELV is recorded as the distance *upwards from stump* to breast height, and the second SINELV is distance *upwards from breast height* to the point of first dendrometer measurements. Diameters recorded as the first two F GRADS are measured to 0.1 in. and may be recorded without decimal point, and distance upwards is measured to 0.1 ft., recorded with decimal point. Mode of measurement coded in Column 23 of the tree card identifies the dendrometer used for the upper-stem measurements.

LOS to merchantable top is obscured. When unseen but usable material occurs above the last measured section, contents of the section can be estimated by a convex-conic-concave projection based on lower measurements (if at least three sets of measurements in addition to stump are recorded) or by a conic projection based on estimated length and taper of the unseen section. For either type of projection, –999 is recorded as the final F GRADS to signal the presence of unseen material.

Sample tree no. 7 shows the field record for a tree in which top diameter was extrapolated to a minimum d.o.b. of UDT x d.b.h.o.b., in this case .425 x 22.8 = 9.7 in. Sample tree no. 8 shows the field record for a tree that was extrapolated to a minimum d.o.b. of .500 x 27.1 = 13.6 in. for a distance (recorded in UML) of 14 ft. Note that for both trees Column 25 (tree card) was coded 1 to indicate that top d.o.b. equals UDT x DBH.

For sample tree no. 9 the uppermost section was projected as a conic frustrum by coding Column 25 (tree card) as 2 and furnishing estimates of .300 in. of taper per ft. (recorded as UDT) for a length of 22 ft. (recorded as UML).

LOS to terminal tip is obscured. When it is feasible to measure SINELV to include total height but impossible to measure T GRADS to a terminal leaf, a computer projection is activated by recording –999 as the last T GRADS, –999 as the last F GRADS, and SINELV. This is illustrated by sample tree no. 17 for a Barr and Stroud dendrometer. The same procedure is used for the modified Zeiss Teletop.

Other special recording procedures

Moving instrument location. The location of the dendrometer may be changed as needed for better visibility of stem sections. When the move is on the same contour, measurements and data recording are continued as though a move had not been made. See sample tree no. 10.

If a move is to a higher or lower instrument location, a + sign is posted in Column 72 of the dendrometer card to indicate that the next measurements will be from a new location, but for the same tree. See sample tree no. 11. The first set of measurements from the new location are for the same stem section last measured at the previous location. A new dendrometer card is started for each move made in this manner. An asterisk is entered in Column 72 of the last dendrometer card used.

The symbols ++ are entered under GR for the stump (explained further below) to show that the instrument was moved on or off the contour.

If LOS to top is obscured from last instrument location, at least three sets of measurements in addition to bottom section and final F GRADS of -999 are needed to activate computer projection when Column 25 of the tree card is code 0 or 1.

Measuring forked trees. As shown by sample tree no. 15, measurements of the single stem below a fork are made as usual, and a + sign is entered in Column 72 of the dendrometer card to show that the next set of measurements will be from the base of a prong. The measurements (at base of the prong) are entered as the first set on the next dendrometer card. This procedure is repeated for every prong, each terminating with a + in Column 72. The tallest prong is left until last and terminated by an asterisk in Column 72 of the last dendrometer card.

If LOS to top of any prong is obscured, at least three sets of measurements in addition to base and final F GRADS of -999 are needed for computer projection by method 0 or 1 in Column 25. This projection can be made for any prong, but, if made for more than one, the same UDT and UML will apply.

Defining merchantable sawtimber length

Sawtimber is utilized to some minimum diameter that produces a log of marketable size, consistent with the cost of log making and product recovery. Validity of coefficients for converting estimates of volume in standing trees to estimates of net product yields and value depends in part on unambiguous definition of the point of cutoff. Recommendations for specifying merchantable length in several common situations are as follows:

(1) When average tree is small and stems taper uniformly, a condition prevalent for many northern and some western conifers, dendrometry may be terminated at a fixed diameter of 6 or 8 in., depending on species and product. In such cases the stem may be scanned with a dendrometer that has been preset for the desired minimum diameter. If branches obscure the LOS, tree contents above the last measured section can be estimated by computer extrapolation if at least three sets of measurements above the stump have been recorded. Column 25 of OPT is coded 1, UDT is shown as (min. d.o.b./d.b.h.o.b.), and UML is estimated. Final F GRADS is shown as –999 to activate the unseen option. (With Barr and Stroud dendrometers, F GRADS preset at 64.5 displaces 8–in. diameter at any distance.)

(2) When average tree is relatively large and stem taper is uniform despite occurrence of limbs, minimum diameter frequently tends toward a fixed relationship with d.b.h., a condition prevalent with most western conifers with tip terminals. In such cases the dendrometer may be preset for scanning the stem to a diameter equivalent to some fixed percentage of d.b.h. If LOS is obscured, the desired ratio of minimum d.o.b. to d.b.h.o.b. is shown as UDT. Maximum length may optionally be shown as UML. (If desired UDT is .45, it need not be recorded since a blank UDT is implied to be .45.) Final F GRADS must be shown as –999 to activate the unseen option.

(3) When the uniformity of upper-stem taper is broken up by relatively large branches (a condition prevalent for southern conifers, large hardwoods, and some western conifers, such as ponderosa pine), merchant-

ability may be limited by excessive taper: taper is excessive when an increase in the length of the top log results in reduced log scale. When the stem is visible, the point beyond which taper is excessive is easily ascertained ocularly by an experienced dendrometerist or by trial and error based on dendrometer measurements at several points.[7]

When LOS are obscured, computer projections are best based on an estimate of top-log taper, recorded in in. per ft. under UDT, and an estimate of length, recorded in whole ft. under UML. Table 1 shows average upper-log taper, in in. per ft., for southern conifers and eastern hardwoods.

Classifying grade and defect of stem segments

Two columns, labeled GR on the tally sheet, are used for two-character coding of segment quality and volume losses caused by defect. The program is limited to 11 classes of segment for each of up to nine tree classes. Nine quality-defect classes are used, as follows:

Quality classes

- *A* Segment contains no indication of knots or limbs
- *B* Segment has overgrown knots
- *C* Segment has limbs, green or dead

Defect classes

- *A* Segment is sound
- *B* Segment has sound cull (crook or sweep)
- *C* Segment has or is suspected to have rotten cull

For example, an *AA* segment is clear and sound.

Other definitions of class may be used if desired, but they must be relatively unambiguous, and the criteria must have promise of good correlation with grade and yield. Segment lengths may be of any length if taper is uniform.

Cull sections occurring anywhere *below* the designated

[7] C. Mesavage. Definition of merchantable sawtimber height. Journal of Forestry 63:30–32, 1965.

Table 1.—*Taper per foot in 16-ft. logs, by d.b.h. and log position, eastern hardwoods and southern pines*

	2 Logs	3 Logs		4 Logs			5 Logs				6 Logs				
d.b.h.	2d	2d	3d	2d	3d	4th	2d	3d	4th	5th	2d	3d	4th	5th	6th
10	.09	.08	.09												
12	.10	.08	.09	.07	.09	.12									
14	.11	.09	.10	.08	.09	.12									
16	.12	.09	.11	.08	.10	.13									
18	.12	.10	.11	.08	.11	.14									
20	.13	.11	.12	.09	.11	.15	.07	.10	.14	.18					
22	.14	.11	.12	.09	.12	.16	.07	.11	.14	.18					
24	.14	.11	.13	.09	.14	.16	.07	.11	.15	.19					
26	.15	.12	.14	.09	.14	.17	.07	.12	.16	.20					
28	.16	.12	.15	.10	.15	.18	.08	.12	.16	.21	.06	.09	.13	.20	.28
30	.16	.12	.16	.11	.16	.19	.08	.12	.17	.22	.06	.09	.13	.20	.28
32	.17	.12	.17	.11	.16	.19	.08	.13	.18	.23	.06	.09	.13	.20	.29
34	.18	.13	.17	.11	.16	.20	.08	.13	.19	.24	.06	.09	.14	.21	.29
36	.18	.13	.18	.11	.16	.21	.08	.14	.19	.24	.07	.09	.14	.21	.31
38	.18	.13	.18	.12	.16	.21	.08	.14	.19	.24	.07	.09	.14	.21	.32
40	.18	.14	.18	.12	.17	.21	.09	.14	.20	.25	.08	.09	.15	.22	.33

top, including jump butts, are classed as *XX*. Jump butts should not be omitted.

The 11th category is a class identified in the program as *UU* that may be used to classify material such as pulpwood above the sawlog top, or in small trees. When it is desirable to include the entire stem of sound timber from stump to tip, material above the merchantable pulpwood top may be classed *XX*. See sample tree no. 18.

Tally of cull trees

Cull trees are normally not tallied. They may be tallied if they are assigned to a separate stratum. Each cull must have prediction of at least 1 (fictitious or constant) and the prediction may not be omitted from the tally unless the tree has been classed as sure-to-be-measured. Culls that qualify as 3P samples or sure-to-be-measured must have a tree card containing stratum, sample category, KPI, species, and DBH.

If individual cull tree detail is desired in the printout, the tree card must be followed by a dendrometer card with a 1 punched in Columns 5, 19, 34, and an asterisk punched in Column 72. A sample tree number is not assigned to cull trees.

If no cull tree detail is desired on printout, the dendrometer card may be omitted. Instead, an asterisk is punched in Column 72 of the tree card. Although no tree detail will appear in the printout, its frequency, basal area, and KPI are accumulated and are included in stratum and grand totals.

Some suggestions for dendrometry

Checking dendrometers. Dendrometers should be checked frequently and adjusted when necessary. With Barr and Stroud dendrometers, T GRADS at 100 ft. should be 50.77. F GRADS at this distance for diameters of 2 and 24 in. should be 54.45 and 87.86, respectively.

Sources of error. Some of the more frequent sources of error in diameter measurement include (1) LOS not square across a section, (2) lines of coincidence not in the center of the viewing field, (3) imperfect alignment of coincidence lines.

When stems are numerous, special care is needed to avoid inadvertent sightings to background stems. T GRADS should increase as elevation angle departs from a level shot and decrease as a level shot is approached. F GRADS normally, but do not necessarily, decrease up a stem. Measurements should avoid bumps and swells.

Measuring procedures. Since actual measurements of bark thickness and d.b.h. are normally required, it saves time to measure d.o.b. at stumb as well as at breast height and to record the two diameters as the first two F GRADS, even when dendrometer LOS are clear. A light measuring pole, extendable to 13 ft., is a useful accessory for measuring distance upwards from stump to breast height and from breast height to the first point of dendrometer measurement. Dendrometer measurements may begin at breast height if this section is visible, thus showing two measurements of d.b.h. (one recording tape measurement as the second F GRADS, the second based on dendrometer measurements recorded as the third T GRADS and F GRADS). The second SINELV in this case will show distance upwards to be 0.0.

If diameters are actually measured at stump and breast height, the rest of the tree can often be measured from one instrument vantage point. Experience dictates when a new vantage point should be sought as an alternative to clearing LOS from a single location.

Options for computer estimates of "unseen" upper stem sections apply only to the topmost segment of a tree. Whenever feasible, the instrument should be moved to a new location to reduce length of unseen portion.

When a dendrometer location is changed to a different elevation, it is necessary to begin new measurements by repeating shots to the section that was last measured from the previous location. It is usually difficult to see the previous section from a new location, and hence it is better to locate a new vantage point on the same elevation so that measurements can be continued as though no move had been made. Picking a new location on the same contour is facilitated by using the dendrometer for level sightings to new locations or by using a hand level to check the contour by shooting back at the dendrometer from new locations.

Bark options. To establish the proper option for any species, measurements of bark and d.o.b. should be made at stump, at breast height, and as high as can be reached for at least 10 sample trees. D.i.b./d.o.b. should be computed and averaged at each level. Bark option is 0 or 1 if d.i.b./d.o.b. for the three levels is constant, 2 if it increases with height, and 3 if it decreases with height. Studies have shown that code 2 should be entered in Column 24 as the bark option for southern pines.[8]

Measuring bark. Sizable errors in bark thickness can go undetected if bark is not measured properly.[9] Recommended procedures are as follows:

(1) *Reducing ambiguity.* Ambiguity in measurements can be practically eliminated by measuring radially from the wood surface to the contour of a diameter tape wrapped tautly around the section. In this procedure bark thickness is regarded as the difference in diameters of two concentric circles, one defined by the tape as the bark surface, the other by the interior wood surface. The radial distance from wood to tape may be measured even where the tape crosses a bark fissure. However, measurements should be made well to either side of swells or bark ridges that cause the tape to kink.

(2) *Reducing sampling error.* Bark thickness may vary considerably around a stem on the same cross section. The following guide is suggested for keeping sampling error

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[8] C. Mesavage. Converting dendrometer estimates of outside-bark stem diameters to wood diameters on major southern pines. U.S. Forest Service Research Note SO-93. Southern Forest Experiment Station, 1969.

[9] C. Mesavage. Measuring bark thickness. Journal of Forestry 67:753–754, 1969.

in bounds with a minimum number of measurements: Start with one pair. If one measurement of the pair is 30 percent or more greater than the other, measure a second pair and average the four readings. Bark thickness should be measured "wood to tape" even when o.b. diameters are taken with calipers.

(3) *Increasing accuracy.* Considerable experience is needed to operate the bark punch so that the chisel reaches the wood but goes no further. When bark is soft or thin the position of the mark made by the chisel can be checked by exposing the wood surface with a tree scribe. When bark is thick or tough it is advisable to bore into it with a light carpenter's brace and a 1-in. auger bit, instead of using a chisel. The brace may be turned rapidly most of the way, then slowed to the minimum torque needed to drive the bit into the bark. When the wood is reached, the brace will usually stall. Bark thickness is then measured from wood to tape. For bark thicker than 2.5 in. (the limit for available bark-measuring gauges), a Starrett No. 237 depth gauge with No. 611N rule is a convenient substitute. Residual bark fibers left after boring should be scraped from the surface of the wood before measuring.

DATA PROCESSING

Data preparation and general procedure

The steps needed to prepare the data and to select, obtain, debug, and interpret the output include the following:

(1) Check the tally sheets for omissions and errors. Careful editing of tally sheets is required because blanks in some fields are not necessarily omissions that will cause processing to cease, or produce incorrect results. For example, blanks in Columns 10, 24, and 25 on the tree card are interpreted as code 1. If bark measurements are omitted, the ratio d.i.b./d.o.b. will be assumed by the program to be .90 (or as programmed). The program ignores a blank UML if Column 25 is punched as code 1 or left blank but will abort if Column 25 is punched as

code 2. Processing will continue if final F GRADS are shown as −999, even when UDT and Column 25 have inadvertently been left blank, because Column 25 will be assumed to be code 1 and UDT will be assumed to be .45 (or as programmed).

(One way to avoid omissions is to check with a zero every column that is purposely left blank, except for value stratum and sampling category. A dash should not be used instead of a zero because it might be interpreted as a minus sign.)

Common errors or omissions are as follows:

- — Sampling category not shown for sample trees in Column 11
- — Sample tree number omitted on tree or dendrometer card
- — d.b.h. omitted in Columns 17–21
- — Bark measurement omitted
- — UDT omitted though final F GRADS is shown as −999, and vice versa
- — Grade-defect class not shown for unseen topmost section
- — Terminating asterisk omitted on last dendrometer card
- — Illogical progressions of T and F GRADS (not necessarily incorrect)
- — −999 not shown as first T GRADS when tape measurements are made at stump and breast height

(2) If the population is not divided into two or more strata, count and add the predictions for all trees, including measured trees (both sure and 3P) and predicted-only trees.

(3) Decide on tree class codings for Columns 12–15 if this decision was deferred. For timber sales, tree class is normally used to code species or species-groups. Not more than nine tree classes should be recorded if the data are later to be converted to estimates of products or product values.

(4) Prepare data statements for five STX control

cards (explained below) and send the statement sheet with tally sheets to the data processing center.

(5) Check and correct (if necessary) data card listings and program outputs sent back from the data processing center.

Program control cards

Program statements for five control cards are illustrated by figure 5. The required control cards are as follows:

Card no.	*Columns*	*Entry*
1	5–68	Name of sale, area, or job
	73–76	Job identifier (same as used for THRP or RN3P)
	80	Card number
2	5–16	Initials of user and input date
	17–43	Copy the instrument parameters shown in Columns 17–43 of figure 5, if at least one tree was measured with any model of Barr and Stroud dendrometer. Otherwise, these columns may be left blank.

Card no.	*Columns*	*Entry*
	45	Total number of value strata coded in Column 10 of tally sheet
	46–50	*KZ* (same as for THRP or RN3P)
	51–55	*K* (same as for THRP or RN3P)
	66–71	Job options (explained below)
	73–76	Job identifier
	80	Card number
3		Nine 8-column fields, beginning with Columns 1–8, for total tree count in each stratum. Card is left blank if tree cards are punched for nonsamples as well as samples.
	73–76	Job identifier
	80	Card number

DATA LISTING FOR 80 COLUMN PUNCHED CARD

```
    THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL                     TEST   1
    CM 03-16-70  08000 01964673-11905 1565B 2 660  120           223022 TEST   2
     234    152                                                         TEST   3
    9034   6933                                                         TEST   4
       1      3                                                         TEST   5
```

Figure 5.—Program statements for STX control cards.

Card no.	*Columns*	*Entry*
4		Nine 8-column fields, beginning with Columns 1–8, for aggregate predictions in each value stratum. Card is left blank if tree cards are punched for nonsamples as well as samples.
	73–76	Job identifier
	80	Card number
5		Nine 8-column fields, beginning with Columns 1–8, for relative value within each value stratum. Card is left blank unless strata differ in value per unit of volume.
	73–76	Job identifier
	80	Card number

Job options

Job options, coded in Columns 66–71 of the second control card are as follows:

Column	*Entry on tally sheet*	
First (Column 66)	0 or 1	Input cards must be punched for all trees (including nonmeasured trees assigned predictions only), but third and fourth control cards are left blank.
	2	Input cards must be punched only for measured trees, but aggregate number of trees and aggregate predictions for each stratum (including sure-to-be-measured trees, 3P measured trees, and 3P predicted-only trees) must be punched on the third and fourth control cards.

Column	*Entry on tally sheet*	
Second (Column 67)	0 or 1	Processing will cease after the program has calculated and printed a preliminary report. (See page 1 of Appendix A.)
	2	Processing will continue beyond the preliminary report if no fatal errors occur.
Third (Column 68)	0 or 1	No individual tree detail will be printed.
	2	Individual tree detail will be printed. (See page 2 of Appendix B.)
	3	Individual tree and tree-segment detail will be printed. (See pages 2–9 of Appendix A.)
Fourth (Column 69)	0 or 1	No detail cards will be punched as part of output.
	2	Tree detail cards will be punched as part of output. (See page 40, PSW–13.[10])
	3	Tree-segment detail cards will be punched as part of output. (See page 42, PSW–13.[10])
Fifth (Column 70)	0 or 1	No log and tree detail will be written on tape for later grade-yield and realization processing.
	2	Log and tree detail will be written on tape and will be processed if no fatal errors have occurred, but subtotals only will be tabulated in printout. (See page 13 of Appendix A.)
	3 or 3+	Same as 2 above, but sorted individual log detail will also be printed. (See page 44, PSW–13.[10])

[10] L. R. Grosenbaugh. STX-Fortran-4 program for estimates of tree populations for 3P sample-tree measurements. U.S. Forest Service Research Paper PSW–13. Pacific Southwest Forest and Range Experiment Station, 1967.

Column	*Entry on tally sheet*	
Sixth (Column 71)	0	No further processing.
	1–9	Not more than this indicated number of sets of conversion coefficients will be searched to convert subtotals to product outturn and realization values. (See page 14 of Appendix A and page 7 of Appendix B.)

Card punching

Tree and dendrometer cards are punched directly from the tally sheets. The four-character job identifier (punched in Columns 73–76 on the control cards) should be punched in Columns 77–80 of each tree and dendrometer card. A two-character (or one-character) label may precede this to identify pay units, if desired, using Columns 75–76 for two characters and Column 76 for one character.

Column 66 of the second control card indicates whether tree cards are to be punched for all trees or for sample trees only.

Tree cards for nonsamples (if they are to be punched) must contain the following items recorded on the tally sheet:

Column	*Entry*
6–9	KPI
10	Value stratum (implied as one stratum if blank)
75–76 or 76	Pay unit number
77–80	Job identifier

Tree cards for measured trees (3P sample or sure-to-be-measured) must contain the following items recorded on the tally sheet:

Column	*Entry*
1–4	Sample tree number

Column	*Entry*
6–9	KPI (if *all* trees are sure-to-be-measured, KPI need not be estimated or shown)
10	Value stratum (blank is implied as one stratum)
11	Sampling category (*, =, or blank)
12–15	CLASS
17–21	DBH
23–25	OPT (blank is not necessarily a field omission; it will = 1 except blank Column 23 = 0)
27–34	BKA or BKA and BKB (blank = .1 d.b.h.)
36–38	UML (blank is considered 0)
39–41	UDT (blank = .45)
75–76 or 76	Pay unit number
77–80	Job identifier

A tree card for a sample tree must be followed by one or more dendrometer cards with entries as follows:

Column	*Entry*
1–4	Sample tree number
5	Card number within-tree (first dendrometer card = 1, etc.)
6–11	Blank
12–26	First set of stem measurements
27–41	Second set of stem measurements
42–56	Third set of stem measurements
57–71	Fourth set of stem measurements
72	Blank or + implies next card is a dendrometer card for the same tree. * implies next card is a tree card for the next tree.
75–76 or 76	Pay unit number
77–80	Job identifier

In addition to the above data cards, cards 9 through 14 of subroutine BLD may have to be repunched to show appropriate constants as follows:

Card no. of subroutine BLD	*Entry*
9	The positive or negative number following MRE should be the logical number of the system input tape, the integer following MPR should be the logical number of the system output tape, and the integer following MPU should be the logical number of the system punch tape. Integers following JW and JX should be logical numbers for system binary scratch tapes.
10 and 11	These columns label the manufactured units or values into which volume, surface, and length are to be converted for error computations.
12	The conversion coefficients corresponding to BORD, SLAB, and CLFT on BLD card 12 convert cu. ft. of volume, sq. ft. of surface, and ft. of length to arbitrary units. The program was initially supplied for conversion to Int. ¼ (with trim allowance) but these may be replaced by other units such as cu. ft. if KPI's are made in cu. ft., etc.
13	Numbers and characters on BLD card 13 ensure that character code assumed by program logic is identical with that of the user.
14	The decimal fraction following RDE is the ratio of d.i.b./d.o.b. at breast height that will be assumed if no bark measurements are recorded for a particular tree. RDE supplied with initial program was .90.

Card no. of subroutine BLD	*Entry*
14 (*Cont.*)	The decimal fraction following UDTRO is the assumed ratio of d.o.b. of unseen top to d.b.h. or the assumed taper in in. per ft. UDT supplied with initial program was .45.
	The decimal numbers following QUAN and DENO are asymptotic bark parameters for hyperbolic extrapolation of d.i.b./d.o.b. ratios above and below breast height. QUAN and DENO supplied with initial program are 1 and 2, respectively, for bark option code 2. Initial program also contains a modification (FORTRAN function FFB3) to accommodate bark option code 3, in which QUAN and DENO are 9 and 10, respectively.

Cards are also needed to insert conversion coefficients into the program and to label certain special outputs (explained later).

Finally, certain system cards are needed to monitor the program.

Card listings

Figure 6 shows a listing of cards as they are arrayed for processing. The control cards in this list should be checked against the program statements. Figures 7 and 8 show separate lists for tree and dendrometer cards, respectively. These listings should be checked against the tally sheets.

PROGRAM OUTPUTS

Processing by the STX program is organized in four major sections (subroutines ST11, ST22, ST33, and ST44) that allow a wide choice of printed outputs. (Card

```
THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL                                  TEST    1
CM  03-16-70 08000 01964673-11905 15658 2  660  120                       223022 TEST    2
 234     152                                                                     TEST    3
9034    6933                                                                     TEST    4
   1       3                                                                     TEST    5
1   842*HIVA  17.0 020   10   6                                                  TEST
11        445 943+0140   443 831+0560AA 444 805+1140AA 451 764+2890AA TEST
12        474 715+5250CA 484 707+5890CA                                         *TEST
2   752*HIVA  15.8 120   10  14                                                  TEST
21        384 91509210   380 846 9940AA 387 82811920AA 397 77613720BA TEST
22        415 74714630BA 436 72515800CA 469 64616960CA                          *TEST
3   992*HIVA  17.7 220    9   7                                                  TEST
31            205  0.0       177  4.0AA      162  8.0AA      148 14.6AA TEST
32            136 14.0BB     132  9.5CA      103 20.0CA                         *TEST
4  1382=HIVA  21.0 200 -009                                                      TEST
41            216  0.0       196  4.0AA      185  8.0AA      167 16.8AB TEST
42            169  6.7CA     153 15.9CA      136 10.9CA                         *TEST
5   251*LOVA  15.6 320    6  10                                                  TEST
51        676 190 96.6   675 156 99.7AA 680 144106.8AA 727 136121.5AA TEST
52        810 110133.5BA 908  84140.9CA                                         *TEST
6  1451=LOVA  34.5 120   18  16                                                  TEST
61       -999 386  4.0       345  8.0AA 470105810920AA 478 98912520BB TEST
62        492 94213980BA 501 88414850CA 508 83515510CB                          *TEST
7   571*LOVA  22.8 121   18   6    425                                           TEST
71       -999 285  4.0       228  8.0AA 443 87811090BA 450 84613150CA TEST
72        472 79415120CA    -999     CA                                         *TEST
```

```
8     881*LOVA  27.1 121    11  15  14500                                          TEST
81        -999 301  4.0         271  8.0AA 413102711230AC 441 92214090CA TEST
82         470 86015840CA 475 80516730CA    -999      CA                          *TEST
9    1091*LOVA  32.4 122    15  19  22300                                          TEST
91        -999 404  4.0         324  8.0AA 426110711280AA 441 99414110BA TEST
92         479 86715810CB    -999       CA                                        *TEST
10   1211=LOVA  32.0 120    19  17                                                 TEST
101       -999 362  4.0++       320  8.0AA 489 96110890AA 495 90812110AA TEST
102        514 87512720BA 504 85313950CA 515 80915020CB 526 73515970CA*TEST
11   1091*LOVA  31.3 120    15  15                                                 TEST
111       -999 375  4.0++       313  8.0AA 442102911010BA                         +TEST
112        465 99910950   482 91013400CA                                          +TEST
113        464 93313770   480 85415350CA 493 77116110CA                           *TEST
12   1031*LOVA  28.9 112    14      10170                                          TEST
121       -999 338  4.0         289  8.0AA 399111311350BA 418104713790BA TEST
122        448 91715900CA 459 85716760CA    -999      CA                          *TEST
13    331*LOVA  18.8 130     8  10                                                 TEST
131       -999 243  4.0         188  8.0AA 430 86311270AA 447 81113340BA TEST
132        457 75614890CA 473 72315760CA                                          *TEST
14   1322=HIVA  21.9                                                               TEST
141        4141105-0510   413 919-0040AA 418 888+1990AA 432 831+3830CA TEST
142        462 761+5620CA 475 700+6340CA                                          *TEST
15    692*HIVA  16.8 120     8  12                                                 TEST
151       -999 197  4.0         168  8.0AA 360 85211350AA 374 80712970BA+TEST
152        374 80212980   413 73715020CA                                          +TEST
153        375 80512960   416 73815130CA 424 69816540CA                           *TEST
```

Figure 6.—Listing of control, tree, and dendrometer cards in processing order.

```
16    212*HIVA  11.1 120    8   4                                                      TEST
161        -999 132  3.5        111  8.5AA 367 71110890CA 389 69413500CA TEST
162         423 64615440CA 468 46916300XX                                             *TEST
17    331*LOVA  19.0 120                                                               TEST
171        -999 218  3.5        190  8.5AA 350 91011570CA 385 84114240CA TEST
172         425 72516110CA-999-99917500XX                                             *TEST
18   1172*HIVA  20.1 120   11  11                                                      TEST
181        -999 244  3.5        201  8.5AA 400 91111260AA 417 83913460CA TEST
182         446 75815270CA 475 69716320CA 484 66217030UU-999-99917460XX*TEST
19    692*HIVA  19.5 120   14  16                                                      TEST
191        -999 235  3.5        195  8.5AA 314 90910680CA 347 80513850CA TEST
192         396 67215780CA 415 65516240UU 435 43617380XX                              *TEST
20    302*HIVA  13.4 120   10   8                                                      TEST
201        -999 166  3.5        134  8.5AA 328 77411670AA 359 73114020CA TEST
202         396 66115690CA                                                            *TEST
21    542*HIVA  17.0 120   10  10                                                      TEST
211        -999 211  3.5        170  8.5AA 354 86111460CA 381 80314100CA TEST
212         426 67216220CA                                                            *TEST
22    512*HIVA  16.0 122   10   8  10190                                               TEST
221        -999 186  3.5        160  8.5AA 340 85511660CA 383 77714390CA TEST
222              -999     CB                                                          *TEST
23    452*HIVA  17.7 120   12  10                                                      TEST
231        -999 226  3.5        177  8.5AA 413 81611520AA 433 76214410CB TEST
232         457 72015750CB 472 68916530CB                                             *TEST
24    242*HIVA  15.2 120   14  10                                                      TEST
241        -999 184  3.5        152  8.5AA 192 81111340CA 226 81012990CB*TEST
```

```
 25   272*HIVA  11.8 120    8   6                                                    TEST
 251      -999 158  3.5        118  8.5AA 281 76211590CA 305 69013430CA*TEST
 26   692*HIVA  17.4 120   10  10                                                    TEST
 261      -999 201  3.5        174  8.5AA 419 81710830AA 427 78012580CA TEST
 262       445 73714420CA 457 72115400CB                                            *TEST
 27   511*LOVA  23.1 120   12   8                                                    TEST
 271      -999 276  3.5        231  8.5AA 383 98511510AA 419 88015120CA TEST
 272       443 81116220CA                                                           *TEST
 28   512*HIVA  15.8 122   12  10  10100                                             TEST
 281      -999 207  3.5        158  8.5AA 279 83611690AA 327 77414600AA TEST
 282       356 74515810CA    -999     CA                                            *TEST
 29   842*HIVA  18.3 120   14  10                                                    TEST
 291      -999 244  3.5        18311230AA 417 77114080CA 451 71616080CA*TEST
 30  1022*HIVA  19.0 122   12  10  14100                                             TEST
 301      -999 245  3.5        190  8.5AC 356 91011740AA 374 86613430AA TEST
 302       405 82015110CA    -999     CA                                            *TEST
 31  1211=LOVA  31.0 122   18  14  10150                                             TEST
 311      -999 385  3.5        310  8.5AA 419103811150AA 431 97713360CA TEST
 312       454 89315160CA    -999     CA                                            *TEST
 32   572*HIVA  15.8 122    8  12  10100                                             TEST
 321      -999 202  3.5        158  8.5AA 316 82511460AA 347 75014320CA TEST
 322       383 72715750CA    -999     CA                                            *TEST
 33   651*LOVA  27.4 122   15  11  16130                                             TEST
 331      -999 303  3.5        274  8.5AA 387106111350CA 406 97014150CA TEST
 332           -999     CA                                                          *TEST
9999
9999
```

Figure 6.—Continued

1	842*HIVA	17.0	020	10	6		TEST
2	752*HIVA	15.8	120	10	14		TEST
3	992*HIVA	17.7	220	9	7		TEST
4	1382=HIVA	21.0	200	-009			TEST
5	251*LOVA	15.6	320	6	10		TEST
6	1451=LOVA	34.5	120	18	16		TEST
7	571*LOVA	22.8	121	18	6	425	TEST
8	881*LOVA	27.1	121	11	15	14500	TEST
9	1091*LOVA	32.4	122	15	19	22300	TEST
10	1211=LOVA	32.0	120	19	17		TEST
11	1091*LOVA	31.3	120	15	15		TEST
12	1031*LOVA	28.9	112	14		10170	TEST
13	331*LOVA	18.8	130	8	10		TEST
14	1322=HIVA	21.9					TEST
15	692*HIVA	16.8	120	8	12		TEST
16	212*HIVA	11.1	120	8	4		TEST
17	331*LOVA	19.0	120				TEST
18	1172*HIVA	20.1	120	11	11		TEST

19	692*HIVA	19.5	120	14	16		TEST
20	302*HIVA	13.4	120	10	8		TEST
21	542*HIVA	17.0	120	10	10		TEST
22	512*HIVA	16.0	122	10	8	10190	TEST
23	452*HIVA	17.7	120	12	10		TEST
24	242*HIVA	15.2	120	14	10		TEST
25	272*HIVA	11.8	120	8	6		TEST
26	692*HIVA	17.4	120	10	10		TEST
27	511*LOVA	23.1	120	12	8		TEST
28	512*HIVA	15.8	122	12	10	10100	TEST
29	842*HIVA	18.3	120	14	10		TEST
30	1022*HIVA	19.0	122	12	10	14100	TEST
31	1211=LOVA	31.0	122	18	14	10150	TEST
32	572*HIVA	15.8	122	8	12	10100	TEST
33	651*LOVA	27.4	122	15	11	16130	TEST

Figure 7.—Listing of tree cards only.

```
 11         445 943+0140   443 831+0560AA 444 805+1140AA 451 764+2890AA TEST
 12         474 715+5250CA 484 707+5890CA                               *TEST
 21         384 91509210   380 846 9940AA 387 82811920AA 397 77613720BA TEST
 22         415 74714630BA 436 72515800CA 469 64616960CA                *TEST
 31             205  0.0       177  4.0AA     162  8.0AA     148 14.6AA TEST
 32             136 14.0BB     132  9.5CA     103 20.0CA                *TEST
 41             216  0.0       196  4.0AA     185  8.0AA     167 16.8AB TEST
 42             169  6.7CA     153 15.9CA     136 10.9CA                *TEST
 51         676 190 96.6   675 156 99.7AA 680 144106.8AA 727 136121.5AA TEST
 52         810 110133.5BA 908  84140.9CA                               *TEST
 61        -999 386  4.0       345  8.0AA 470105810920AA 478 98912520BB TEST
 62         492 94213980BA 501 88414850CA 508 83515510CB                *TEST
 71        -999 285  4.0       228  8.0AA 443 87811090BA 450 84613150CA TEST
 72         472 79415120CA    -999     CA                               *TEST
 81        -999 301  4.0       271  8.0AA 413102711230AC 441 92214090CA TEST
 82         470 86015840CA 475 80516730CA    -999     CA                *TEST
 91        -999 404  4.0       324  8.0AA 426110711280AA 441 99414110BA TEST
 92         479 86715810CB    -999     CA                               *TEST
101        -999 362  4.0++     320  8.0AA 489 96110890AA 495 90812110AA TEST
102         514 87512720BA 504 85313950CA 515 80915020CB 526 73515970CA*TEST
111        -999 375  4.0++     313  8.0AA 442102911010BA                +TEST
112         465 99910950   482 91013400CA                               +TEST
113         464 93313770   480 85415350CA 493 77116110CA                *TEST
121        -999 338  4.0       289  8.0AA 399111311350BA 418104713790BA TEST
```

```
122       448 91715900CA 459 85716760CA    -999     CA               *TEST
131      -999 243  4.0       188  8.0AA 430 86311270AA 447 81113340BA TEST
132       457 75614890CA 473 72315760CA                              *TEST
141       4141105-0510   413 919-0040AA 418 888+1990AA 432 831+3830CA TEST
142       462 761+5620CA 475 700+6340CA                              *TEST
151      -999 197  4.0       168  8.0AA 360 85211350AA 374 80712970BA+TEST
152       374 80212960   413 73715020CA                              +TEST
153       375 80512960   416 73815130CA 424 69816540CA               *TEST
161      -999 132  3.5       111  8.5AA 367 71110890CA 389 69413500CA TEST
162       423 64615440CA 468 46916300XX                              *TEST
171      -999 218  3.5       190  8.5AA 350 91011570CA 385 84114240CA TEST
172       425 72516110CA-999-99917500XX                              *TEST
181      -999 244  3.5       201  8.5AA 400 91111260AA 417 83913460CA TEST
182       446 75815270CA 475 69716320CA 484 66217030UU-999-99917460XX*TEST
191      -999 235  3.5       195  8.5AA 314 90910680CA 347 80513850CA TEST
192       396 67215780CA 415 65516240UU 435 43617380XX               *TEST
201      -999 166  3.5       134  8.5AA 328 77411670AA 359 73114020CA TEST
202       396 66115690CA                                             *TEST
211      -999 211  3.5       170  8.5AA 354 86111460CA 381 80314100CA TEST
212       426 67216220CA                                             *TEST
221      -999 186  3.5       160  8.5AA 340 85511660CA 383 77714390CA TEST
222          -999     CB                                             *TEST
231      -999 226  3.5       177  8.5AA 413 81611520AA 433 76214410CB TEST
232       457 72015750CB 472 68916530CB                              *TEST
```

Figure 8.—Listing of dendrometer cards only.

```
241        -999 184   3.5         152   8.5AA 192 81111340CA 226 81012990CB*TEST
251        -999 158   3.5         118   8.5AA 281 76211590CA 305 69013430CA*TEST
261        -999 201   3.5         174   8.5AA 419 81710830AA 427 78012580CA TEST
262         445 73714420CA 457 72115400CB                                  *TEST
271        -999 276   3.5         231   8.5AA 383 98511510AA 419 88015120CA TEST
272         443 81116220CA                                                 *TEST
281        -999 207   3.5         158   8.5AA 279 83611690AA 327 77414600AA TEST
282         356 74515810CA       -999       CA                             *TEST
291        -999 244   3.5         18311230AA 417 77114080CA 451 71616080CA*TEST
301        -999 245   3.5         190   8.5AC 356 91011740AA 374 86613430AA TEST
302         405 82015110CA       -999       CA                             *TEST
311        -999 385   3.5         310   8.5AA 419103811150AA 431 97713360CA TEST
312         454 89315160CA       -999       CA                             *TEST
321        -999 202   3.5         158   8.5AA 316 82511460AA 347 75014320CA TEST
322         383 72715750CA       -999       CA                             *TEST
331        -999 303   3.5         274   8.5AA 387106111350CA 406 97014150CA TEST
332             -999       CA                                              *TEST
```

Figure 8.—Continued

outputs for individual trees or tree-segments may also be obtained.) The sections are activated by job options (coded on control card no. 2) that enable the user to terminate processing according to the availability of input data, or to achieve partial STX objectives. Printed reports include the following:

(1) *Preliminary report of counts and aggregate predictions.* This always appears as page 1 of the computer output (p. 78–79 of Appendix A). The report is produced when subroutine ST11 has been able to complete its processing of tree cards without encountering a fatal error. The report can be obtained in advance of dendrometry if desired, once the sample trees have been selected, if NE is changed to EQ on cards 108 and 111 of ST11. The report shows, for each statum and total, the observed number of trees and aggregate predictions, compares number and aggregate predictions of observed sample trees with expected values, and shows the standard errors of expected values. The table enables the user to check input-totals of number of sample trees and aggregate predictions and supplies machine-totals for each stratum (when input includes tree cards for each tree). The computer-comparison of observed and expected values alert the user to possible irregularities in field procedures. ST11 also copies sample tree data onto tape for later processing.

If ST11 is unable to complete processing, it flags input errors by special printouts, as will be explained later, and it will not print a preliminary report. STX processing ceases after the preliminary report is produced, unless the second job option is punched as code 2.

(2) *Detailed "log" and tree report.* This report, shown on pages 80–94 of Appendix A, is printed when the second job option is punched as code 2 and third job option is punched as code 3, if no fatal flaws have been detected by ST11. The report shows volume, surface area, and length between consecutively arrayed diameters. It also

shows the raw dendrometer readings and computed slant distance to the top of each tree-segment. Raw SINELV readings obtained with a FP15 dendrometer are reduced by 1 before printing because the inclinometer is read as sine + 1. Those obtained with a modified Zeiss Teletop are similarly reduced by 100 degrees because the inclinometer is read as degrees + 100. Thus, an FP15 reading of SINELV of 1.0920 is printed as .0920, and a Teletop reading of 99.7 is printed as —.3000.

A tree summary line is also printed below the detail shown for tree-segments. If the third job option is punched as code 2, the printed report will list only this summary line information for each sample tree, as shown on pages 104–105 of Appendix B. The summary lines, read from left to right, include the following information:

- — Tree identifying number
- — Totals for volume, surface, and length
- — Tree d.b.h. in inches
- — Frequency represented by the tree
- — Prediction (KPI)
- — Double-bark thickness in inches (0. or —0 signals that no bark measurement was recorded)
- — Asterisk following bark thickness indicates that the tree was forked, or that the instrument was moved two or more times to a new contour
- — Trio of figures indicating mode of tree measurement, bark option selected, and option governing unseen length, the latter signaled by an asterisk if unseen length actually occurred
- — Tree classification
- — Value stratum

(3) *Summary report for the tree population.* This is shown on pages 95–98 of Appendix A. Summary printouts are furnished by ST33 when the second job option is punched 2 and no fatal flaws have been detected by either ST11 or ST22. Separate summaries are produced for each stratum as well as for the whole. Sampling error

is computed for each stratum. For the combined strata, sampling error is computed both for volume and for volume weighted by relative value. The summary lists expanded estimates of tree frequency, basal area, length, surface area, and cubic volume, by sampling category. It also shows input aggregates of predictions, number of sample trees, and the number of measured tree-segments. Basal area includes only trees for which d.b.h. was recorded in Columns 17–21 of the tree card.

Sampling error is calculated in terms of the International ¼ in. log rule, but this unit of measure may easily be changed to another if desired by repunching BLD cards 10, 11, and 12.

(4) *Summary report for data processing statistics.* The summary report for the tree population is followed by a page, always numbered zero, that shows data processing statistics, checks, error counts, and a list of trees with suspicious input data. These are discussed more fully later. This summary report occurs on page 99 of Appendix A.

When program outputs are made free of error, this summary page can be removed without disturbing the page sequence of the STX report.

The values shown in the last two lines of the page zero summary should be checked. Unless the aggregate predictions agree exactly with the sample estimates, all sample-based estimates must be rejected. Machine error, failure to draw at least one sample from a nonempty stratum, or the occurrence of some fatal flaw flagged by a diagnostic message is usually responsible when this check indicates a faulty estimate.

(5) *Grade-yield and realization reports.* If the second and fifth job options are punched 2 or greater, subroutine PREP and SORT rearray tree and tree-segment data, and subroutine PROD will print class subtotals or complete tree-segment data. Subtotals are printed, as shown on page 100 of Appendix A, if code 2 is punched as the fifth job option, and tree-segment data, as shown on pages

44–45 of PSW–13,[11] are printed if code 3 is punched as the fifth job option. Present versions of ST44 and supporting subroutines can subtotal up to 99 tree and tree-segment classes.

If the sixth job option is punched (1 through 9), as will be explained more fully later, ST44 also will convert the class subtotals of volume, surface, and length into other units of volume and value and print the results in a table as shown on page 101 of Appendix A. Present versions of ST44 can convert up to nine species with 11 tree-segment classes into six end-products. The sixth job option must be punched with the number of tree classes recognized in the class subtotals, and the program must be modified by data statements (explained later) that introduce appropriate conversion coefficients.

The last line of the second grade-yield and realization report (page 101 of Appendix A) shows "volume (cu. ft. i.b.) paired with yield coefficients." The volume shown here must agree with that of the first grade-yield and realization report (page 100 of Appendix A). Disagreement indicates that some volume was not matched with conversion coefficients and has been omitted from product yield and value.

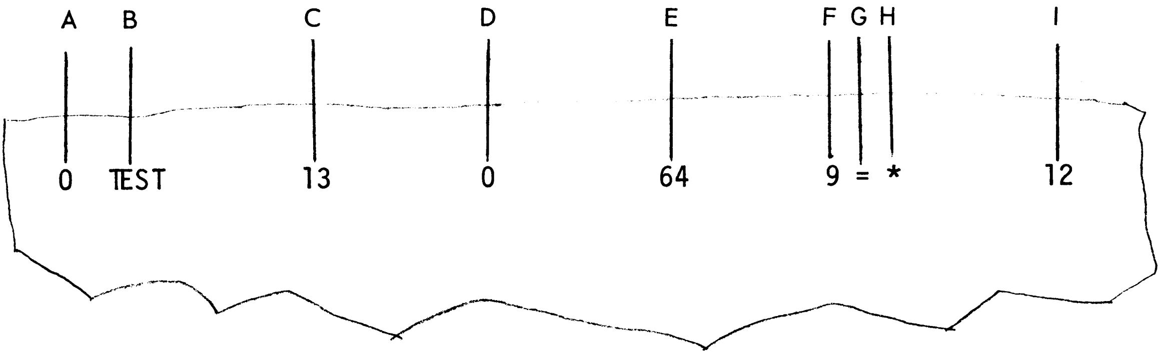
(6) *Card outputs.* The program supplies card outputs showing tree detail if code 2 is punched as the fourth job option and supplies cards showing tree-segment detail if code 3 is punched as the fourth job option. Facsimiles of tree and log card outputs are shown on pages 40–45 of PSW–13.[11]

Diagnostics and errors

The STX program prints out diagnostic or error messages at three stages of processing:

(1) A message is printed, as shown by figure 9, if an

[11] L. R. Grosenbaugh. STX-Fortran-4 program for estimates of tree populations from 3P sample-tree measurements. U.S. Forest Service Research Paper PSW–13. Pacific Southwest Forest and Range Experiment Station, 1967.



A O unless special error recovery procedure is available
B Brief job identifier
C Tree number stored most recently
D Card number within tree
E Prediction for tree
F Value stratum
G Sampling class (=, *,)
H Terminal symbol (, +, *)
I Previous tree number

Figure 9.—Information printout for error encountered by subroutine ST11.

error is encountered by ST11 in processing data. No output reports will be produced if an error is detected by ST11. The message signals the following errors:

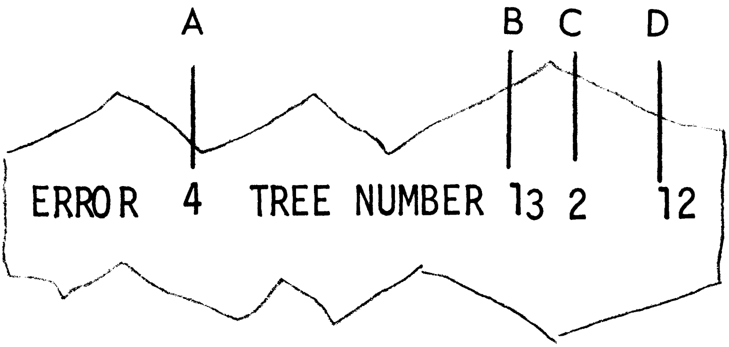
- — A within-tree card sequence number that is negative
- — A negative stratum number or one exceeding the number of strata specified on the job control card
- — A sample-tree prediction that is blank, zero, negative, or larger than the maximum (L) specified on the job control card

The locations in the printed message (fig. 9) from left to right include:

- — Ordinarily contain zero
- — Four-character job identifier
- — Current tree number
- — Within-tree card sequence number
- — Prediction for tree
- — Sampling category
- — Terminal symbol

  (Sampling category symbols include =, *, or blank to imply, respectively, sure samples, 3P samples, and nonsamples. Terminal symbols include *, +, or blank to imply, respectively, last card of a given tree, last card prior to forking or establishment of a new reference elevation, and a nonterminal card continued normally on a following card.)
- — Tree number read previous to the one that is currently stored. If current and previous tree numbers are the same, it is likely that both represent the previous number, and that the tree card for the current tree contains an illegal character or reflects some system irregularity.

(2) If ST11 encounters no errors and if a 2 or larger number has been punched as the second job option on the second control card, processing of individual trees by ST22 is started. A different error message is printed if certain errors are encountered by ST22, as shown by figure 10. The first location in the message is a numerical code for the particular error, the next is the tree num-



A Error code
B Tree number
C Card number within tree
D Previous tree number

Figure 10.—Error message printed for errors encountered by subroutine ST22.

ber, then within-tree dendrometer card sequence number, and last the number of the tree previously processed. Error codes in ST22 are as follows:

1. Implies negative diameter arising from faulty unseen length projection.
2. Implies machine error in failing to branch properly on +, *, or blank or failure to copy these correctly from input tape.
3. Implies negative length due to faulty dendrometry (progressing from top to stump, etc.), faulty punching, or faulty unseen length projection. Downward progression must be repunched in upward progression.
4. Implies disarranged data deck or faulty punching. Failure to punch terminal asterisk can cause this, as can variation in tree number (caused by faulty punching) during single within-tree card sequence. The most common cause is failure of within-tree card sequence to be in arithmetic progression with unit interval starting with zero.

5. Implies earlier machine error (in ST11) to detect faulty data with stratum number larger than maximum specified on second control card.
6. Implies machine error in failing to branch properly on sure-to-be-measured tree or in earlier failing to detect faulty data with sample tree having blank, zero, or negative prediction larger than value specified as K.
7. Implies inadequate number of measured diameters for computations (must be at least four when Column 25 of the tree card is punched 0 or 1, at least one if Column 25 is punched with code 2, and at least two without any projection at all).

(3) After printing any of these seven error messages, ST22 will continue to process and print individual tree data. Further summarization or processing is suppressed (after 25 error messages or misarrayed cards), but ST33 produces a summary printout for data processing statistics, page number of which is always zero. This printout, page zero shown on page 99 of Appendix A, contains two messages, one showing the number of input flaws that blocked processing and a second identifying, by tree number, sample trees containing suspicious data. Input data and outputs for these trees should be closely examined. Reasons for suspicion are lack of recorded d.b.h. (the program uses the second set of dendrometer measurements as a substitute but omits the tree from summaries of basal area), a population frequency of one or less for a 3P sample tree (no sample drawn without replacement can represent less than itself; a tree with $F=1$ should be a sure-to-be-measured tree), or an upper d.o.b. more than one-half in. larger than its next lower d.o.b.

The amounts of input and processing done before encountering fatal flaws are helpful in verifying that the same number of tree cards were read by ST11 and ST22 and that later processing was completed for all measured trees.

A check may also be made on page zero of the summary of the actual number of trees in the population (aggregate number of trees input) compared with the number estimated from the sample. A difference of more than three times the standard error of estimated number indicates that there may be errors in procedure, recording, or transcription.

Function of value strata compared with tree class

To a limited extent, some of the same information can be obtained for tree classes as for value strata, tending to confuse the distinction between these two means of dividing a population. The important thing to remember is that sample "blow-up" and error calculations are kept separate by value strata, whereas tree class is used to allow separate tabulations of volume, surface area, and length for conversion to estimates of product outturn or realization values.

Value strata. If trees are not placed in value strata, i.e., Column 10 of the tree card is blank, the program infers that only one stratum exists. Tree frequency (the "blow-up" factor) and sampling error are computed separately by strata if strata are coded, otherwise these computations are based on a single stratum. Sampling error is set as zero unless at least two sample trees are drawn from a stratum.

Tree class. Just as trees can be separated into value strata without designating tree class, trees may be separated into tree classes without designating stratum. By exercising the fifth job option, subtotals of volume, surface area, and length can be produced for each tree class, as shown on page 100 of Appendix A. The totals for all tree classes must agree with the totals shown for all strata i.e., the totals shown on page 100 of Appendix A must agree with those on pages 97–98. The subtotals listed on page 100 may then be converted to other product estimates as shown on page 101 of Appendix A.

Trees are normally not coded by strata unless they differ in relative value because estimates of sampling error are usually desired only for the totals. There are other situations, however, in which sampling error by strata may be of interest. For example, trees may be coded by strata to indicate stocking within stands classified according to type, age class, pay unit, etc. Similarly, if more than one estimator made predictions for the tree tally, each man's work can be identified as a stratum to facilitate checks of performance. In any case, the summary reports account for the stocking in each stratum and show the sampling error.

When estimates of sampling error are not required, tree class may be used to obtain the same summaries with two added advantages: (1) subtotals for up to 99 tree classes can be obtained if quality-defect class is left blank, compared with a program capacity of only nine strata, and (2) estimates for tree classes can be converted to products and values by exercising the sixth job option if appropriate conversion coefficients are put into the program.

PROGRAM COMPUTATIONS

When a Barr and Stroud dendrometer is used to obtain sample tree measurements, the computer converts readings of T GRADS to distance in ft. and those of T GRADS with F GRADS to diameter in inches. Theory and equations used are discussed by Grosenbaugh in Forest Science Monograph No. 4.[12]

Heights above and below horizontal are calculated by multiplying slant distance by the sine of the vertical angle. Length of a tree segment is determined by subtracting height to the bottom of a segment from height to the top of the segment.

Cubic volume and surface areas are calculated on the assumption that each tree segment is a conic frustrum.

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[12] L. R. Grosenbaugh. Optical dendrometers for out-of-reach diameters: a conspectus and some new theory. Forest Science Monograph 4, 1963.

Diameters are reduced for bark thickness by multiplying outside-bark diameter by a ratio of d.i.b./d.o.b. If bark is measured at breast height, this ratio is d.b.h.i.b./d.b.h.o.b., modified as directed by the option punched in Column 24 of the tree card.

Assuming d.o.b. is 10.0 in., and d.b.h.i.b./d.b.h.o.b. is 20.0/22.0, d.i.b. is computed as follows:

Code 0 or 1

$$\text{d.i.b.} = \text{d.o.b.}\ \frac{\text{d.b.h.i.b.}}{\text{d.b.h.o.b.}}$$

$$= 10.0 \times \frac{20.0}{22.0} = 9.1 \text{ in.}$$

Code 2

$$\text{d.i.b.} = \text{d.o.b.} \times (1.0 - (1.0\text{–d.b.h.i.b./d.b.h.o.b.})\ (\text{QUAN}/(\text{DEMO} = \text{d.o.b./d.b.h.o.b.})))$$

$$= 10.0 \times (1.0 - (1.0 - .909)\ (1/(2.0\text{–}10.0\ /22.0)))$$

$$= 10.0 \times (1.0 - (.091)\ (1/1.545))$$

$$= 10.0 \times (1.0 - .0589) = 9.4 \text{ in.}$$

Code 3

$$\text{d.i.b.} = \text{d.o.b.} \times (\text{d.b.h.i.b./d.b.h.o.b.})\ (\text{QUAN}/\ (\text{DENO} - \text{d.o.b./d.b.h.o.b.}))$$

$$= 10.0 \times (.9096)\ (9/(10.0 - 10.0/22.0))$$

$$= 10.0 \times (.9096)\ (.94285)$$

$$= 8.6 \text{ in.}$$

If bark is not measured, d.i.b./d.o.b. at any point on the stem is assumed to be .90, a value that is easily changed in the program. If a negative bark thickness is recorded, no reduction for bark will be made, allowing computations of volume including bark or excluding bark, when diameters have been measured i.b. as on felled trees.

Tree frequency is computed separately for trees in each stratum, or for all trees combined if they are not classified by stratum, as follows:

$$F = \frac{KPI \text{ for all trees (less sure } KPI)}{\text{No. of samples multiplied by } KPI}$$

Thus, tree no. 1, shown on pages 80–81 of Appendix A to have a prediction of 84 in stratum 2, has a frequency of 6663/(18 x 84) = 4.407. The sum of the predictions (6663) and the number of 3P samples (18) are shown by the stratum 2 summary report on page 96 of Appendix A.

Field calculations

Rapid field checks of diameters, distances, and heights measured with Barr and Stroud dendrometers can be obtained by use of scales designed for this purpose.[13] A calculator is made by pasting the scales, available from the Southern Forest Experiment Station, to the rails and center bar of a double-face slide rule. The C and D scales of the slide rule are not covered and remain available for use in multiplication and division.

Appendix D shows the sine, cosine, and tangent equivalents of angles, by degrees and tenths, that may be used in trigonometric solutions for unknowns, such as the following:

(a) *To determine height above or below horizontal:* Multiply slant distance by sine of vertical angle or multiply horizontal distance by the tangent.

(b) *To determine horizontal distance:* Multiply slant distance by the cosine.

(c) *To set off height intercepts of equal length:* Find the difference in tangents of vertical angles to stump and top of desired segment-length. Add the amount of this tangent difference successively for each height increment. Preset the clinometer for the corresponding angles. For Barr and Stroud dendrometers, convert each tangent to the sine equivalent before setting the clinometer.

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[13] C. Mesavage. Revised calculator for Barr and Stroud dendrometers. U.S. Forest Service Research Note SO–84. Southern Forest Experiment Station, 1968.

CONVERSION COEFFICIENTS

General procedure for obtaining and applying conversion coefficients

Coefficients used to convert volume, surface area, and length to product outturn and value are derived from whole-tree data by fitting multivariate regressions. Once the data are available, the coefficients are easily obtained by a computer program called REX.[14] Data for the regressions are collected from mill-scale studies in a marketing zone for each species-group or tree class to be converted. Separate studies are not required for each STX sale. The general procedure is not unlike that now used in mill-scale studies, but there are some differences, as follows:

(1) Trees selected for the studies should contain the entire range of quality-defect classes that normally occur for the tree class. At least 34 sample trees must be input if the range includes all 11 grade-defect classes. These selected trees must be weighted for REX by the reciprocal of the dendrometered utilizable volume for each tree. If they are drawn by a 3P subsample the weights in REX are the frequency represented by each tree.

(2) Each tree is dendrometered, or felled and measured, using the procedure previously explained for measuring sample trees. In filling out the STX tally sheet, Columns 6–9 are left blank if no prediction is required and Column 10 is left blank because all trees are in one stratum. Tree number must be shown, and Column 11 must show = as the sampling category. The remainder of the tally sheet is recorded as required to show the tree and stem measurements that are made and the grade-defect class of each tree segment. The entry for CLASS (in Columns 12–15) depends on how STX processing is to be

[14] L. R. Grosenbaugh. REX-Fortran-4 system for combinatorial screening or conventional analysis of multivariate regressions. U.S. Forest Service Research Paper PSW–44. Pacific Southwest Forest and Range Experiment Station, 1967.

organized: The object of STX processing is to ascertain volume, surface area, and length, summarized *for each tree* by grade-defect class, that will be used as input data for the regression analysis. If CLASS is left blank, or used merely to label the group of trees, job options 123000 (in Columns 66–71 of the second control card) will produce a report showing log and tree detail, as illustrated on pages 80–94 of Appendix A. Volume surface area and length may then be hand summarized to show totals by grade-defect class for each tree.

An alternative way that will eliminate hand summarization is to group the trees into lots of nine, the first containing trees 1–9, the second, trees 10–18, etc. CLASS is then coded so that the first column (Column 12) is numbered from 1 to 9 in each lot. The lots are stacked so that separate STX reports will be produced for each lot by the same machine run. If the job options are coded 123020, the report for each lot will show, in addition to the log and tree report, a tabulation (see page 100 of Appendix A) of volume, surface area, and length summarized for each tree by grade-defect class.

(3) The sample trees are milled into products. Every log and bolt should be labeled so that total yield and value of each product may be ascertained separately for each tree. These whole-tree totals of yields and values are then related to dendrometered quantities by grade defect class of volume, surface area, and length to the actual utilized top. Should "jump butting" be a common practice, then a further adjustment can be made to reflect the beginning point of basal utilization. Since there are 11 grade-defect classes, the regression will be based on 33 independent variables. Zeros are entered as quantities for volume, surface area, and length in grade-defect classes that are not present in a given tree. The actual conversion coefficients are processed by the REX program. (The mechanics of the REX program are beyond the scope of this handbook.)

(4) The conversion coefficients are assembled in matrices, one for each CLASS to be processed by the STX

program, by appropriate data statements that are put into subroutine ST44 of the STX program and by alterations of format cards in subroutine PROD. Figure 11 shows the cards in PROD and ST44 that were altered to obtain the STX output shown on page 101 of Appendix A. Up to six end-products can be accommodated by each matrix of coefficients.

When more than six end-products are required, the data must be run again with a new set of coefficients. Appendix B illustrates a rerun of the same data used for Appendix A except that conversion coefficients were inserted for a new set of end-products. The job options specified on the second control card were coded as 222022. Since the third job option was made 2 instead of 3, the log and tree report (pages 104–105 of Appendix B) shows only the summary lines for each sample tree. The matrices inserted to obtain the conversions to a new set of end-products are shown as figure 12.

Labels used for the ST44 matrices must correspond with codes used for CLASS and GR on the tally sheet and be entered in appropriate collating sequence. Thus, the matrix for HIVA precedes that for LOVA. Note also (on cards 26–27 and 68–69 of figures 11 and 12) that the second element of the matrix name or matrix subscript is changed to ascend numerically, thus, for HIVA it is 1, for LOVA it is 2, etc.

Each card for the matrix contains data statements for two sets of coefficients. Thus, card 28 corresponds with the format to show that coefficients for converting GR *AA* to rough log weight are 41.41222 cu. ft. volume + 5.542556 sq. ft. + 0 and for converting GR *AA* to chipweight are 16.75876 cu. ft. − 8.526190 sq. ft. + 19.34555 ft. Similarly, card 29 shows log volume as 1.0 cu. ft. + 0 sq. ft. + 0 ft. and log surface as 0 cu. ft. + 1.0 sq. ft. + 0 ft. Card 30 shows log length as 0 cu. ft. + 0 sq. ft. + 1.0 ft. and Doyle scale (without bark) as 6.920394 cu. ft. − .6664733 sq. ft. + 0 ft. Subsequent cards show sets of coefficients for GR *AB*, ascending alphabetically to *XX*.

```
@NW   FOR,*  PROD
-30,34
    70FORMAT (1H1,16A4,1X,A4,2X,4HPAGE,I4/1X,3A4,F7.3,F11.8,2F8.4,I3,    C046 30
     1F8.0,I5,1X,I9,1X,I6 /23X,34HGRADE-YIELD AND REALIZATION REPORT/    C046 31
     210X,13HROUGH LOG WT.,2X,12HINC.WT.CHIPS,4X,10HLOG VOLUME,3X,11HLOGC046 32
     3 SURFACE,3X,10HLOG LENGTH,2X,13HDOYLE(NO BK.)/1X,8HCLAS GR ,2(4X,1C046 33
     40HGREEN LBS.),5X,9HCU.FT.IB.,5X,9HSQ.FT.IB.,4X,10HLINEAL FT.,4X,10C046 34
     5HNET BD.FT./1X,92(1H=))                                            C046 34A
@NW   FOR,*  ST44
-26,109
      DATA LC(  1,  1)/4HHIVA/                                           ST44  26
     0DATA LC(  2,  1)/2HAA/,P1AA/                                       ST44  27
     1 41.41222,+5.542556,       0., 16.75876,-8.526190, 19.34555,       ST44  28
     2 1.0,3*0.,+1.0, 0.0,                                               ST44  29
     3 2*0.,1.0, 6.920394,-.6664733,       0./                           ST44  30
     0DATA LC( 21,  1)/2HAB/,P1AB/                                       ST44  31
     1 69.34406,-2.224934,       0., 8.062943,-4.176948, 19.34555,       ST44  32
     2 1.0,3*0.,+1.0, 0.0,                                               ST44  33
     3 2*0.,1.0, 5.062638,-.5987217,       0./                           ST44  34
     0DATA LC( 40,  1)/2HAC/,P1AC/                                       ST44  35
     1 69.34406,-2.224934,       0., 8.062943,-4.176948, 19.34555,       ST44  36
     2 1.0,3*0.,+1.0, 0.0,                                               ST44  37
     3 2*0.,1.0, 5.062638,-.5987217,       0./                           ST44  38
     0DATA LC( 59,  1)/2HBA/,P1BA/                                       ST44  39
```

```
1 66.85595,-.1748965,        0., 16.75876,-8.526190, 19.34555,         ST44  40
2 1.0,3*0.,+1.0, 0.0,                                                  ST44  41
3 2*0.,1.0, 9.770582,-1.573353,        0./                             ST44  42
0DATA LC( 78, 1)/2HBB/,P1BB/                                           ST44  43
1 100.8519,-2.838336,        0., 8.062943,-4.176948, 19.34555,         ST44  44
2 1.0,3*0.,+1.0, 0.0,                                                  ST44  45
3 2*0.,1.0, 7.020523,-.7513185,        0./                             ST44  46
0DATA LC( 97, 1)/2HBC/,P1BC/                                           ST44  47
1 100.8519,-2.838336,        0., 8.062943,-4.176948, 19.34555,         ST44  48
2 1.0,3*0.,+1.0, 0.0,                                                  ST44  49
3 2*0.,1.0, 7.020523,-.7513185,        0./                             ST44  50
0DATA LC(116, 1)/2HCA/,P1CA/                                           ST44  51
1 62.41423, .6513477,        0., 14.67044,-7.287123, 16.11837,         ST44  52
2 .8753894,     3*0.,+.8546752,        0.,                             ST44  53
3     2*0., .8331825, 8.101184,-1.114157,        0./                   ST44  54
0DATA LC(135, 1)/2HCB/,P1CB/                                           ST44  55
1 82.45383,-3.376700,        0., 7.059423,-3.591807, 16.34471,         ST44  56
2 .8755393,     3*0.,+.8599118,        0.,                             ST44  57
3     2*0., .8448821, 7.676051,-.9324310,        0./                   ST44  58
0DATA LC(154, 1)/2HCC/,P1CC/                                           ST44  59
1 82.45383,-3.376700,        0., 7.059423,-3.591807, 16.34471,         ST44  60
2 .8755393,     3*0.,+.8599118,        0.,                             ST44  61
3     2*0., .8448821, 7.676051,-.9324310,        0./                   ST44  62
```

Figure 11.—Data statements inserted in subroutines PROD and ST44 for conversion to end products (first stack).

```
      DATA LC(173, 1)/2HUU/,P1UU/18*0./                                ST44  63
      DATA LC(192, 1)/2HXX/,P1XX/18*0./                                ST44  67
      DATA LC(  1, 2)/4HLOVA/                                          ST44  68
     0DATA LC(  2, 2)/2HAA/,P2AA/                                      ST44  69
     1 41.41222,+5.542556,       0., 16.75876,-8.526190, 19.34555,     ST44  70
     2 1.0,3*0.,+1.0, 0.0,                                             ST44  71
     3 2*0.,1.0, 6.920394,-.6664733,       0./                         ST44  72
     0DATA LC( 21, 2)/2HAB/,P2AB/                                      ST44  73
     1 69.34406,-2.224934,       0., 8.062943,-4.176948, 19.34555,     ST44  74
     2 1.0,3*0.,+1.0, 0.0,                                             ST44  75
     3 2*0.,1.0, 5.062638,-.5987217,       0./                         ST44  76
     0DATA LC( 40, 2)/2HAC/,P2AC/                                      ST44  77
     1 69.34406,-2.224934,       0., 8.062943,-4.176948, 19.34555,     ST44  78
     2 1.0,3*0.,+1.0, 0.0,                                             ST44  79
     3 2*0.,1.0, 5.062638,-.5987217,       0./                         ST44  80
     0DATA LC( 59, 2)/2HBA/,P2BA/                                      ST44  81
     1 66.85595,-.1748965,       0., 16.75876,-8.526190, 19.34555,     ST44  82
     2 1.0,3*0.,+1.0, 0.0,                                             ST44  83
     3 2*0.,1.0, 9.770582,-1.573353,       0./                         ST44  84
     0DATA LC( 78, 2)/2HBB/,P2BB/                                      ST44  85
     1 100.8519,-2.838336,       0., 8.062943,-4.176948, 19.34555,     ST44  86
```

```
2 1.0,3*0.,+1.0, 0.0,                                              ST44  87
3 2*0.,1.0, 7.020523,-.7513185,        0./                         ST44  88
0DATA LC( 97, 2)/2HBC/,P2BC/                                       ST44  89
1 100.8519,-2.838336,        0., 8.062943,-4.176948, 19.34555,     ST44  90
2 1.0,3*0.,+1.0, 0.0,                                              ST44  91
3 2*0.,1.0, 7.020523,-.7513185,        0./                         ST44  92
0DATA LC(116, 2)/2HCA/,P2CA/                                       ST44  93
1 62.41423, .6513477,        0., 14.67044,-7.287123, 16.11837,     ST44  94
2 .8753894,      3*0.,+.8546752,       0.,                         ST44  95
3      2*0., .8331825, 8.101184,-1.114157,       0./               ST44  96
0DATA LC(135, 2)/2HCB/,P2CB/                                       ST44  97
1 82.45383,-3.376700,        0., 7.059423,-3.591807, 16.34471,     ST44  98
2 .8755393,      3*0.,+.8599118,       0.,                         ST44  99
3      2*0., .8448821, 7.676051,-.9324310,       0./               ST44 100
0DATA LC(154, 2)/2HCC/,P2CC/                                       ST44 101
1 82.45383,-3.376700,        0., 7.059423,-3.591807, 16.34471,     ST44 102
2 .8755393,      3*0.,+.8599118,       0.,                         ST44 103
3      2*0., .8448821, 7.676051,-.9324310,       0./               ST44 104
 DATA LC(173, 2)/2HUU/,P2UU/18*0./                                 ST44 105
 DATA LC(192, 2)/2HXX/,P2XX/18*0./                                 ST44 109
```

Figure 11.—Continued

```
@NW   FOR,*  PROD
-30,34
     70FORMAT (1H1,16A4,1X,A4,2X,4HPAGE,I4/1X,3A4,F7.3,F11.8,2F8.4,I3,   C046 30
      1F8.0,I5,1X,I9,1X,I6 /23X,34HGRADE-YIELD AND REALIZATION REPORT/   C046 31
      214X,8HSCRIBNER,3X,12HINT. 1/4 IN.,2X,12HLUMBER TALLY,3X,11HLBR. F.C046 32
      30.B.,2X,12HADD.WT.CHIPS,2X,12HCHIPS F.O.B./1X,8HCLAS GR ,3(4X,10HNC046 33
      4ET BD.FT.),2X,12HDOLLAR VALUE,2X, 12HOVENDRY LBS.,2X,12HDOLLAR VALC046 34
      5UE/1X,92(1H=))                                                    C046 34A
@NW   FOR,*  ST44
-26,109
       DATA LC(  1, 1)/4HHIVA/                                           ST44  26
      0DATA LC(  2, 1)/2HAA/,P1AA/                                       ST44  27
      1 5.682587,+.0395142,        0., 5.561980,+.2654460,       0.,     ST44  28
      2 7.453517,-.3888483,        0., 3.149913,-.3917946,       0.,     ST44  29
      3 8.425655,-4.375114, 9.460729, .0567816,-.0294845, .0637571/      ST44  30
      0DATA LC( 21, 1)/2HAB/,P1AB/                                       ST44  31
      1 4.856914,-.2071593,        0., 5.377562,-.2922441,       0.,     ST44  32
      2 15.12255,-3.185063,        0.,12.198771,-3.504285,       0.,     ST44  33
      3 3.475934,-1.957713, 9.460729, .0234248,-.0131933, .0637571/      ST44  34
      0DATA LC( 40, 1)/2HAC/,P1AC/                                       ST44  35
      1 4.856914,-.2071593,        0., 5.377562,-.2922441,       0.,     ST44  36
      2 15.12255,-3.185063,        0.,12.198771,-3.504285,       0.,     ST44  37
      3 3.475934,-1.957713, 9.460729, .0234248,-.0131933, .0637571/      ST44  38
      0DATA LC( 59, 1)/2HBA/,P1BA/                                       ST44  39
```

```
1 9.394628,-1.090034,        0., 9.777942,-1.027430,        0.,      ST44  40
2 7.107180,-.4317826,        0.,1.5488091,-.0874188,        0.,      ST44  41
3 8.425655,-4.375114, 9.460729, .0567816,-.0294845, .0637571/        ST44  42
0DATA LC( 78, 1)/2HBB/,P1BB/                                         ST44  43
1 7.734848,-.5313729,        0., 7.061453,-.2500347,        0.,      ST44  44
2 9.313595,-1.356407,        0., .3011685,+.0817320,        0.,      ST44  45
3 3.475934,-1.957713, 9.460729, .0234248,-.0131933, .0637571/        ST44  46
0DATA LC( 97, 1)/2HBC/,P1BC/                                         ST44  47
1 7.734848,-.5313729,        0., 7.061453,-.2500347,        0.,      ST44  48
2 9.313595,-1.356407,        0., .3011685,+.0817320,        0.,      ST44  49
3 3.475934,-1.957713, 9.460729, .0234248,-.0131933, .0637571/        ST44  50
0DATA LC(116, 1)/2HCA/,P1CA/                                         ST44  51
1 8.019529,-.7753361,        0., 7.921466,-.5774056,        0.,      ST44  52
2 5.690870,-.2410233,        0.,1.1640645,-.0103419,        0.,      ST44  53
3 7.375729,-3.739302, 7.882514, .0497060,-.0251996, .0531213/        ST44  54
0DATA LC(135, 1)/2HCB/,P1CB/                                         ST44  55
1 8.294018,-.7891706,        0., 8.186456,-.5942404,        0.,      ST44  56
2 8.135322,-1.012106,        0.,2.2109610,-.2854149,        0.,      ST44  57
3 3.043317,-1.683461, 7.993200, .0205093,-.0113451, .0538672/        ST44  58
0DATA LC(154, 1)/2HCC/,P1CC/                                         ST44  59
1 8.294018,-.7891706,        0., 8.186456,-.5942404,        0.,      ST44  60
2 8.135322,-1.012106,        0.,2.2109610,-.2854149,        0.,      ST44  61
3 3.043317,-1.683461, 7.993200, .0205093,-.0113451, .0538672/        ST44  62
```

Figure 12.—Data statements inserted in subroutines PROD and ST44 for conversion to end products (second stack)

```
 DATA LC(173, 1)/2HUU/,P1UU/18*0./                                       ST44  63
 DATA LC(192, 1)/2HXX/,P1XX/18*0./                                       ST44  67
 DATA LC(  1, 2)/4HLOVA/                                                 ST44  68
0DATA LC(  2, 2)/2HAA/,P2AA/                                             ST44  69
1 5.682587,+.0395142,       0., 5.561980,+.2654460,       0.,            ST44  70
2 7.453517,-.3888483,       0., 1.049971,-.1305982,       0.,            ST44  71
3 8.425655,-4.375114, 9.460729, .0567816,-.0294845, .0637571/            ST44  72
0DATA LC( 21, 2)/2HAB/,P2AB/                                             ST44  73
1 4.856914,-.2071593,       0., 5.377562,-.2922441,       0.,            ST44  74
2 15.12255,-3.185063,       0., 4.066257,-1.168095,       0.,            ST44  75
3 3.475934,-1.957713, 9.460729, .0234248,-.0131933, .0637571/            ST44  76
0DATA LC( 40, 2)/2HAC/,P2AC/                                             ST44  77
1 4.856914,-.2071593,       0., 5.377562,-.2922441,       0.,            ST44  78
2 15.12255,-3.185063,       0., 4.066257,-1.168095,       0.,            ST44  79
3 3.475934,-1.957713, 9.460729, .0234248,-.0131933, .0637571/            ST44  80
0DATA LC( 59, 2)/2HBA/,P2BA/                                             ST44  81
1 9.394628,-1.090034,       0., 9.777942,-1.027430,       0.,            ST44  82
2 7.107180,-.4317826,       0., .5162697,-.0291396,       0.,            ST44  83
3 8.425655,-4.375114, 9.460729, .0567816,-.0294845, .0637571/            ST44  84
0DATA LC( 78, 2)/2HBB/,P2BB/                                             ST44  85
```

```
1 7.734848,-.5313729,        0., 7.061453,-.2500347,        0.,         ST44  86
2 9.313595,-1.356407,        0., .1003895,+.0272440,        0.,         ST44  87
3 3.475934,-1.957713, 9.460729, .0234248,-.0131933, .0637571/          ST44  88
0DATA LC( 97, 2)/2HBC/,P2BC/                                           ST44  89
1 7.734848,-.5313729,        0., 7.061453,-.2500347,        0.,         ST44  90
2 9.313595,-1.356407,        0., .1003895,+.0272440,        0.,         ST44  91
3 3.475934,-1.957713, 9.460729, .0234248,-.0131933, .0637571/          ST44  92
0DATA LC(116, 2)/2HCA/,P2CA/                                           ST44  93
1 8.019529,-.7753361,        0., 7.921466,-.5774056,        0.,         ST44  94
2 5.690870,-.2410233,        0., .3880215,-.0034473,        0.,         ST44  95
3 7.375729,-3.739302, 7.882514, .0497060,-.0251996, .0531213/          ST44  96
0DATA LC(135, 2)/2HCB/,P2CB/                                           ST44  97
1 8.294018,-.7891706,        0., 8.186456,-.5942404,        0.,         ST44  98
2 8.135322,-1.012106,        0., .7369870,-.0951383,        0.,         ST44  99
3 3.043317,-1.683461, 7.993200, .0205093,-.0113451, .0538672/          ST44 100
0DATA LC(154, 2)/2HCC/,P2CC/                                           ST44 101
1 8.294018,-.7891706,        0., 8.186456,-.5942404,        0.,         ST44 102
2 8.135322,-1.012106,        0., .7369870,-.0951383,        0.,         ST44 103
3 3.043317,-1.683461, 7.993200, .0205093,-.0113451, .0538672/          ST44 104
 DATA LC(173, 2)/2HUU/,P2UU/18*0./                                     ST44 105
 DATA LC(192, 2)/2HXX/,P2XX/18*0./                                     ST44 109
```

Figure 12.—Continued

APPENDIX A.—Computer output—preliminary report, detailed log and tree report, and summary reports

```
THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL                    TEST  PAGE   1
CM  03-16-70  8.000  .01964673 -1.1905  1.5658  2    660.  120          0 223022
              PRELIMINARY REPORT--COUNTS AND AGGREGATE PREDICTIONS
================================================================================

         STRATUM 1                                   TREE COUNTS    PREDICTIONS
--------------------------------------------------------------------------------
             SURE-TO-BE MEASURED  TREES(=1)             3              387
             THREE-PEE  MEASURED  TREES(*2)            10              673
             THREE-PEE  PREDICTED TREES( 3)           221             7974
--------------------------------------------------------------------------------
                              ALL TREES(1,2,3)        234             9034
--------------------------------------------------------------------------------
                    ALL MEASURED  TREES(1,2)           13             1060
                    ALL THREE-PEE TREES(2,3)          231             8647
                  EXPECTED VALUES   FOR (*2)           13.102          635.570
                  EXP. VAL. ST. ERRORS (*2)             3.484          169.015
         STRATUM 2                                   TREE COUNTS    PREDICTIONS
--------------------------------------------------------------------------------
             SURE-TO-BE MEASURED  TREES(=1)             2              270
```

THREE-PEE MEASURED TREES(*2)	18	1128
THREE-PEE PREDICTED TREES(3)	132	5535
ALL TREES(1,2,3)	152	6933
ALL MEASURED TREES(1,2)	20	1398
ALL THREE-PEE TREES(2,3)	150	6663
EXPECTED VALUES FOR (*2)	10.095	571.770
EXP. VAL. ST. ERRORS (*2)	3.038	172.059

TOTALS FOR ALL 2 STRATA	TREE COUNTS	PREDICTIONS
SURE-TO-BE MEASURED TREES(=1)	5	657
THREE-PEE MEASURED TREES(*2)	28	1801
THREE-PEE PREDICTED TREES(3)	353	13509
ALL TREES(1,2,3)	386	15967
ALL MEASURED TREES(1,2)	33	2458
ALL THREE-PEE TREES(2,3)	381	15310
EXPECTED VALUES FOR (*2)	23.197	1207.341
EXP. VAL. ST. ERRORS (*2)	4.623	241.185

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 2

CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 660. 120 0 223022

DETAILED LOG AND/OR TREE REPORT

TREE/ NO./	VOLUME / CU.FT. /	SURFACE / SQ.FT. /	LENGTH / FEET /	D.I.B. / INCHES /	LOG/ CODE/	RANGE/ FEET/	TGRADS	FGRADS	SINELV
	5.0	22.4	7.9	10.7	CA	86.8	48.4	70.7	.5890
	16.6	67.6	21.9	10.9	CA	82.2	47.4	71.5	.5250
	13.1	46.5	13.1	12.7	AA	73.7	45.1	76.4	.2890
	5.0	16.2	4.2	14.3	AA	71.5	44.4	80.5	.1140
	5.0	13.6	3.0	15.4	AA	71.2	44.3	83.1	.0560
	.0	.0	.0	19.6		71.8	44.5	94.3	.0140
1	44.7	166.2	50.1	17.0=D,F=		4.407,	84,	1.6	021 HIVA 2
	6.6	35.9	15.7	7.2	CA	80.2	46.9	64.6	.6960
	6.3	28.9	10.6	10.2	CA	69.1	43.6	72.5	.5800
	4.9	21.0	7.2	10.7	BA	63.8	41.5	74.7	.4630
	9.1	35.7	11.2	11.5	BA	60.0	39.7	77.6	.3720
	10.9	39.7	11.5	13.0	AA	58.1	38.7	82.8	.1920
	4.7	15.8	4.2	13.4	AA	56.9	38.0	84.6	-.0060
	.0	.0	.0	15.2		57.6	38.4	91.5	-.0790
2	42.5	177.0	60.4	15.8=D,F=		4.936,	75,	2.4	121 HIVA 2
	13.1	57.3	20.0	9.6	CA	.0	.0	10.3	20.0000
	8.0	30.9	9.5	12.2	CA	.0	.0	13.2	9.5000

	13.2	48.1	14.0	12.6	BB	.0	.0	13.6	14.0000
	16.2	54.5	14.6	13.7	AA	.0	.0	14.8	14.6000
	10.5	32.4	8.0	14.9	AA	.0	.0	16.2	8.0000
	6.5	18.0	4.0	16.1	AA	.0	.0	17.7	4.0000
	.0	.0	.0	18.3		.0	.0	20.5	.0000
3	67.4	241.2	70.1	17.7=D,F=		3.739,	99,	1.6	221 HIVA 2
	12.4	41.2	10.9	13.6	CA	.0	.0	13.6	10.9000
	22.5	67.0	15.9	15.3	CA	.0	.0	15.3	15.9000
	10.3	29.5	6.7	16.9	CA	.0	.0	16.9	6.7000
	28.4	77.4	16.8	16.7	AB	.0	.0	16.7	16.8000
	15.8	39.9	8.0	18.5	AA	.0	.0	18.5	8.0000
	9.3	21.6	4.0	19.6	AA	.0	.0	19.6	4.0000
	.0	.0	.0	21.6		.0	.0	21.6	.0000
4	98.8	276.6	62.3	21.0=D,F=		1.000,	138,	-1.8	211 HIVA 2
	6.5	34.6	14.7	7.8	CA	90.8	90.8	8.4	40.9000
	12.5	53.2	18.1	10.1	BA	81.0	81.0	11.0	33.5000
	16.4	61.8	18.6	12.4	AA	72.7	72.7	13.6	21.5000
	8.4	29.7	8.4	13.0	AA	68.0	68.0	14.4	6.8000
	4.6	14.6	3.7	14.0	AA	67.5	67.5	15.6	-.3000
	.0	.0	.0	16.5		67.6	67.6	19.0	-3.4000
5	48.4	193.9	63.5	15.6=D,F=		34.588,	25,	1.6	321 LOVA 1

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 3
CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 660. 120 0 223022

DETAILED LOG AND/OR TREE REPORT

TREE/ NO./	VOLUME CU.FT.	SURFACE SQ.FT.	LENGTH FEET	D.I.B. INCHES	LOG/ CODE/	RANGE/ FEET/	TGRADS	FGRADS	SINELV
	20.5	47.5	8.8	19.4	CB	100.4	50.8	83.5	.5510
	30.7	63.2	10.4	21.9	CA	95.9	50.1	88.4	.4850
	52.1	99.0	15.0	24.6	BA	90.8	49.2	94.2	.3980
	55.9	98.2	13.8	25.9	BB	84.0	47.8	98.9	.2520
	39.0	62.6	8.0	28.7	AA	80.6	47.0	105.8	.0920
	23.3	34.2	4.0	31.1	AA	.0	.0	34.5	8.0000
	.0	.0	.0	34.3		.0	-99.9	38.6	4.0000
6	221.5	404.9	59.9	34.5=D,F=		1.000,	145,	3.4 121	LOVA 1
	36.7	141.5	44.5	9.0	CA	.0	.0	-99.9	.0000
	24.7	76.0	18.6	14.8	CA	81.4	47.2	79.4	.5120
	24.2	68.4	15.3	16.4	CA	73.3	45.0	84.6	.3150
	15.8	39.8	8.0	17.6	BA	71.2	44.3	87.8	.1090
	11.0	23.5	4.0	20.4	AA	.0	.0	22.8	8.0000

	.0	.0	.0	24.5		.0	-99.9	28.5	4.0000
7	112.4	349.1	90.4	22.8=D,F=		15.170,	57,	2.4	121*LOVA 1
	3.9	14.9	3.5	12.7	CA	.0	.0	-99.9	.0000
	13.5	38.2	8.6	15.7	CA	82.7	47.5	80.5	.6730
	36.1	90.8	18.2	18.3	CA	80.6	47.0	86.0	.5840
	52.3	117.6	21.1	19.8	CA	70.6	44.1	92.2	.4090
	24.4	49.6	8.0	22.8	AC	63.4	41.3	102.7	.1230
	14.4	26.9	4.0	24.5	AA	.0	.0	27.1	8.0000
	.0	.0	.0	26.9		.0	-99.9	30.1	4.0000
8	144.7	338.0	63.3	27.1=D,F=		9.826,	88,	2.6	121*LOVA 1
	31.9	93.4	22.0	13.2	CA	.0	.0	-99.9	.0000
	49.1	111.0	20.1	19.2	CB	84.4	47.9	86.7	.5810
	70.0	134.2	20.5	23.1	BA	70.6	44.1	99.4	.4110
	34.1	58.6	8.0	26.9	AA	66.5	42.6	110.7	.1280
	22.2	33.4	4.0	29.0	AA	.0	.0	32.4	8.0000
	.0	.0	.0	34.8		.0	-99.9	40.4	4.0000
9	207.4	430.6	74.5	32.4=D,F=		7.933,	109,	3.4	122*LOVA 1

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 4
CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 660. 120 0 223022

DETAILED LOG AND/OR TREE REPORT

TREE/ NO./	VOLUME / CU.FT. /	SURFACE / SQ.FT. /	LENGTH / FEET /	D.I.B. / INCHES /	LOG/ CODE/	RANGE/ FEET/	TGRADS	FGRADS	SINELV
	21.1	63.6	15.3	13.6	CA	114.2	52.6	73.5	.5970
	28.0	70.8	14.2	18.0	CB	105.3	51.5	80.9	.5020
	24.7	56.2	10.2	20.0	CA	97.8	50.4	85.3	.3950
	24.4	52.3	8.9	22.2	BA	104.6	51.4	87.5	.2720
	35.5	71.8	11.6	22.5	AA	92.4	49.5	90.8	.2110
	31.1	55.9	8.0	24.9	AA	89.2	48.9	96.1	.0890
	19.6	31.4	4.0	28.4	AA	.0	.0	32.0	8.0000
	.0	.0	.0	31.5	++	.0	-99.9	36.2	4.0000
10	184.4	401.9	72.3	32.0=D,F=		1.000,	121,	3.6 121	LOVA 1
	15.8	45.3	10.4	14.6	CA	91.3	49.3	77.1	.6110
	35.6	84.3	15.9	18.7	CA	84.9	48.0	85.4	.5350
	.0	.0	.0	21.8		78.2	46.4	93.3	.3770
	65.7	133.7	21.7	21.9	CA	85.8	48.2	91.0	.3400
	.0	.0	.0	25.2		78.6	46.5	99.9	.0950
	30.9	55.7	8.0	24.9	BA	70.9	44.2	102.9	.1010

	20.5	32.1	4.0	28.3	AA	.0	.0	31.3	8.0000
	.0	.0	.0	33.0	++	.0	-99.9	37.5	4.0000
11	168.5	351.2	60.0	31.3=D,F=		7.933,	109,	3.0*121	LOVA 1
	14.7	43.0	10.0	15.7	CA	.0	.0	-99.9	.0000
	16.2	42.1	8.8	17.2	CA	76.4	45.9	85.7	.6760
	47.4	104.7	18.4	19.6	CA	72.7	44.8	91.7	.5900
	53.7	104.8	16.3	23.8	BA	64.5	41.8	104.7	.3790
	28.9	53.9	8.0	25.4	BA	60.4	39.9	111.3	.1350
	17.5	29.6	4.0	26.1	AA	.0	.0	28.9	8.0000
	.0	.0	.0	30.5		.0	-99.9	33.8	4.0000
12	178.4	378.1	65.5	28.9=D,F=		8.395,	103,	2.8	112*LOVA 1
	7.0	29.7	10.1	10.6	CA	81.8	47.3	72.3	.5760
	12.0	44.0	12.8	11.9	CA	75.7	45.7	75.6	.4890
	19.9	62.4	15.6	14.3	BA	72.4	44.7	81.1	.3340
	12.1	34.8	8.0	16.2	AA	67.5	43.0	86.3	.1270
	8.7	20.8	4.0	17.0	AA	.0	.0	18.8	8.0000
	.0	.0	.0	22.7		.0	-99.9	24.3	4.0000
13	59.6	191.7	50.6	18.8=D,F=		26.203,	33,	1.8	131 LOVA 1

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 5
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DETAILED LOG AND/OR TREE REPORT

TREE/ NO./	VOLUME CU.FT.	SURFACE SQ.FT.	LENGTH FEET	D.I.B. INCHES	LOG/ CODE/	RANGE/ FEET/	TGRADS	FGRADS	SINELV
	6.1	26.0	8.9	9.8	CA	82.7	47.5	70.0	.6340
	18.0	62.8	17.5	12.5	CA	77.5	46.2	76.1	.5620
	18.2	55.0	13.2	14.9	CA	68.0	43.2	83.1	.3830
	21.7	59.8	13.1	16.9	AA	64.5	41.8	88.8	.1990
	7.9	17.2	3.0	18.0	AA	63.4	41.3	91.9	-.0040
	.0	.0	.0	25.9		63.6	41.4	110.5	-.0510
14	72.0	220.8	55.7	21.9=D,F=		1.000,	132,	.0 011	HIVA 2
	5.7	27.2	10.3	9.4	CA	66.0	42.4	69.8	.6540
	12.1	49.7	16.2	10.8	CA	64.0	41.6	73.8	.5130
	.0	.0	.0	12.6		56.1	37.5	80.5	.2960
	11.1	46.0	15.1	10.7	CA	63.4	41.3	73.7	.5020
	.0	.0	.0	12.5		55.9	37.4	80.2	.2980
	8.9	32.4	9.3	12.6	BA	55.9	37.4	80.7	.2970
	9.0	30.0	8.0	13.8	AA	53.8	36.0	85.2	.1350

	5.5	16.6	4.0	14.8	AA	.0	.0	16.8	8.0000
	.0	.0	.0	16.9		.0	-99.9	19.7	4.0000
15	52.4	201.9	63.0	16.8=D,F=		5.365,	69,	2.0*121	HIVA 2
	1.4	14.1	14.5	.0	XX	79.8	46.8	46.9	.6300
	5.5	32.5	15.3	7.4	CA	65.7	42.3	64.6	.5440
	7.0	37.1	15.6	8.9	CA	58.5	38.9	69.4	.3500
	4.3	21.4	8.5	9.3	CA	54.8	36.7	71.1	.0890
	2.2	9.8	3.5	9.9	AA	.0	.0	11.1	8.5000
	.0	.0	.0	11.4		.0	-99.9	13.2	3.5000
16	20.4	114.8	57.4	11.1=D,F=		17.627,	21,	1.2 121	HIVA 2
	3.9	26.6	19.0	.1	XX	.0	-99.9	-99.9	.7500
	13.7	52.1	16.0	10.6	CA	66.2	42.5	72.5	.6110
	20.4	64.5	16.3	14.3	CA	57.8	38.5	84.1	.4240
	12.7	36.8	8.5	16.0	CA	52.4	35.0	91.0	.1570
	6.3	16.7	3.5	17.1	AA	.0	.0	19.0	8.5000
	.0	.0	.0	19.2		.0	-99.9	21.8	3.5000
17	57.0	196.7	63.2	19.0=D,F=		26.203,	33,	.0 121	LOVA 1

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 6
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DETAILED LOG AND/OR TREE REPORT

TREE/ NO./	VOLUME / CU.FT. /	SURFACE / SQ.FT. /	LENGTH / FEET /	D.I.B. / INCHES /	LOG/ CODE/	RANGE/ FEET/	TGRADS	FGRADS	SINELV
	1.0	8.9	8.1	.1	XX	.0	-99.9	-99.9	.7460
	4.0	20.9	8.7	8.3	UU	86.8	48.4	66.2	.7030
	9.7	41.5	14.3	10.0	CA	82.7	47.5	69.7	.6320
	15.9	56.1	15.7	12.3	CA	72.1	44.6	75.8	.5270
	20.5	61.3	14.6	14.9	CA	64.3	41.7	83.9	.3460
	14.2	39.0	8.5	17.1	AA	60.6	40.0	91.1	.1260
	7.2	17.8	3.5	17.9	AA	.0	.0	20.1	8.5000
	.0	.0	.0	21.0		.0	-99.9	24.4	3.5000
18	72.6	245.5	73.5	20.1=D,F=		3.164,	117,	2.2 121	HIVA 2
	1.2	10.9	11.0	.0	XX	68.8	43.5	43.6	.7380
	1.8	10.8	5.2	7.6	UU	63.8	41.5	65.5	.6240
	8.1	38.3	14.5	8.1	CA	59.8	39.6	67.2	.5780
	16.1	58.1	16.8	12.0	CA	52.0	34.7	80.5	.3850
	11.2	34.5	8.5	14.5	CA	48.2	31.4	90.9	.0680
	6.0	16.2	3.5	16.5	AA	.0	.0	19.5	8.5000
	.0	.0	.0	19.0		.0	-99.9	23.5	3.5000

19	44.3	168.8	59.5	19.5=D,F=		5.365,	69,	3.0	121 HIVA 2
	5.2	28.6	12.5	7.8	CA	59.8	39.6	66.1	.5690
	7.6	35.6	13.3	9.8	CA	53.7	35.9	73.1	.4020
	5.8	24.9	8.5	10.7	AA	49.7	32.8	77.4	.1670
	3.1	11.6	3.5	11.6	AA	.0	.0	13.4	8.5000
	.0	.0	.0	13.7		.0	-99.9	16.6	3.5000
20	21.7	100.6	37.7	13.4=D,F=		12.339,	30,	1.8	121 HIVA 2
	11.0	49.4	17.9	8.4	CA	66.5	42.6	67.2	.6220
	15.3	54.8	15.7	12.6	CA	57.1	38.1	80.3	.4100
	9.8	32.3	8.5	14.1	CA	53.0	35.4	86.1	.1460
	5.2	15.0	3.5	15.0	AA	.0	.0	17.0	8.5000
	.0	.0	.0	17.8		.0	-99.9	21.1	3.5000
21	41.2	151.5	45.6	17.0=D,F=		6.855,	54,	2.0	121 HIVA 2
	6.6	28.8	10.0	10.2	CB	.0	.0	-99.9	.0000
	14.8	55.7	16.7	11.8	CA	57.4	38.3	77.7	.4390
	9.0	31.0	8.5	13.7	CA	51.1	34.0	85.5	.1660
	4.4	13.9	3.5	14.2	AA	.0	.0	16.0	8.5000
	.0	.0	.0	16.1		.0	-99.9	18.6	3.5000
22	34.8	129.4	38.7	16.0=D,F=		7.258,	51,	1.8	122*HIVA 2

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 7
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DETAILED LOG AND/OR TREE REPORT

TREE/ NO./	VOLUME CU.FT. /	SURFACE SQ.FT. /	LENGTH FEET /	D.I.B. INCHES /	LOG/ CODE/	RANGE/ FEET/	TGRADS	FGRADS	SINELV
	5.3	25.2	9.6	9.4	CB	81.4	47.2	68.9	.6530
	9.3	39.6	13.4	10.6	CB	75.7	45.7	72.0	.5750
	18.3	68.6	20.5	12.0	CB	68.3	43.3	76.2	.4410
	9.8	32.4	8.5	13.6	AA	63.4	41.3	81.6	.1520
	5.6	15.7	3.5	15.5	AA	.0	.0	17.7	8.5000
	.0	.0	.0	18.7		.0	-99.9	22.6	3.5000
23	48.3	181.5	55.5	17.7=D,F=		8.226,	45,	2.2 121	HIVA 2
	4.5	20.1	7.1	10.9	CB	41.5	22.6	81.0	.2990
	6.5	26.2	8.5	10.8	CA	39.8	19.2	81.1	.1340
	3.6	12.6	3.5	12.8	AA	.0	.0	15.2	8.5000
	.0	.0	.0	14.7		.0	-99.9	18.4	3.5000
24	14.6	58.9	19.1	15.2=D,F=		15.424,	24,	2.4 121	HIVA 2

	4.3	22.0	9.0	8.4	CA	47.3	30.5	69.0	.3430
	4.9	22.9	8.5	10.2	CA	45.2	28.1	76.2	.1590
	2.6	10.7	3.5	10.4	AA	.0	.0	11.8	8.5000
	.0	.0	.0	13.0		.0	-99.9	15.8	3.5000
25	11.8	55.6	21.0	11.8=D,F=		13.710,	27,	1.4	121 HIVA 2
	6.0	26.3	9.2	10.7	CB	75.7	45.7	72.1	.5400
	11.3	45.3	14.5	11.2	CA	71.8	44.5	73.7	.4420
	11.4	41.1	11.8	12.6	CA	66.7	42.7	78.0	.2580
	10.0	32.6	8.5	13.9	AA	64.7	41.9	81.7	.0830
	5.1	15.0	3.5	15.4	AA	.0	.0	17.4	8.5000
	.0	.0	.0	17.4		.0	-99.9	20.1	3.5000
26	43.7	160.3	47.5	17.4=D,F=		5.365,	69,	2.0	121 HIVA 2
	15.5	46.5	11.1	14.9	CA	71.2	44.3	81.1	.6220
	45.8	118.6	24.5	17.1	CA	64.7	41.9	88.0	.5120
	19.5	45.6	8.5	19.9	AA	57.4	38.3	98.5	.1510
	10.0	21.0	3.5	21.1	AA	.0	.0	23.1	8.5000
	.0	.0	.0	24.6		.0	-99.9	27.6	3.5000
27	90.8	231.7	47.6	23.1=D,F=		16.955,	51,	2.0	121 LOVA 1

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 8
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DETAILED LOG AND/OR TREE REPORT

TREE/ NO./	VOLUME / CU.FT. /	SURFACE / SQ.FT. /	LENGTH / FEET /	D.I.B. / INCHES /	LOG/ CODE/	RANGE/ FEET/	TGRADS	FGRADS	SINELV
	5.3	25.7	10.0	9.4	CA	.0	.0	-99.9	.0000
	4.9	22.4	8.1	10.2	CA	53.2	35.6	74.5	.5810
	10.9	45.7	15.2	10.9	AA	49.6	32.7	77.4	.4600
	7.7	28.6	8.5	12.1	AA	45.1	27.9	83.6	.1690
	4.3	13.8	3.5	13.6	AA	.0	.0	15.8	8.5000
	.0	.0	.0	16.5		.0	-99.9	20.7	3.5000
28	33.1	136.2	45.3	15.8=D,F=		7.258,	51,	2.2	122*HIVA 2
	12.6	54.2	18.6	10.3	CA	73.7	45.1	71.6	.6080
	1.2	4.1	1.1	12.0	CA	64.3	41.7	77.1	.4080
	6.0	16.3	3.5	15.9	AA	.0	.0	18.3	1.1230
	.0	.0	.0	19.6		.0	-99.9	24.4	3.5000
29	19.8	74.5	23.2	18.3=D,F=		4.407,	84,	2.4	121 HIVA 2
	13.3	48.4	14.0	12.6	CA	.0	.0	-99.9	.0000
	13.7	46.0	12.3	13.8	CA	61.6	40.5	82.0	.5110

	12.7	39.7	9.9	14.8	AA	55.9	37.4	86.6	.3430
	12.3	36.3	8.5	15.8	AA	53.2	35.6	91.0	.1740
	6.7	17.1	3.5	16.8	AC	.0	.0	19.0	8.5000
	.0	.0	.0	20.5		.0	-99.9	24.5	3.5000
30	58.6	187.4	48.2	19.0=D,F=		3.629,	102,	2.2	122*HIVA 2
	18.6	48.3	10.0	17.8	CA	.0	.0	-99.9	.0000
	36.0	84.3	15.8	19.1	CA	74.7	45.4	89.3	.5160
	43.1	91.1	15.3	21.8	CA	67.8	43.1	97.7	.3360
	30.8	57.3	8.5	23.7	AA	64.7	41.9	103.8	.1150
	17.8	28.0	3.5	27.8	AA	.0	.0	31.0	8.5000
	.0	.0	.0	33.3		.0	-99.9	38.5	3.5000
31	146.3	309.0	53.1	31.0=D,F=		1.000,	121,	3.2	122*LOVA 1
	5.0	25.0	10.0	9.1	CA	.0	.0	-99.9	.0000
	6.0	28.2	10.5	10.0	CA	57.4	38.3	72.7	.5750
	10.9	45.9	15.4	10.4	CA	52.0	34.7	75.0	.4320
	7.9	29.1	8.5	12.3	AA	48.4	31.6	82.5	.1460
	4.4	14.0	3.5	13.8	AA	.0	.0	15.8	8.5000
	.0	.0	.0	16.7		.0	-99.9	20.2	3.5000
32	34.2	142.1	48.0	15.8=D,F=		6.494,	57,	2.0	122*HIVA 2

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 9

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DETAILED LOG AND/OR TREE REPORT

TREE/ NO./	VOLUME / CU.FT. /	SURFACE / SQ.FT. /	LENGTH / FEET /	D.I.B. / INCHES /	LOG/ CODE/	RANGE/ FEET/	TGRADS	FGRADS	SINELV
	32.8	81.2	16.0	18.5	CA	.0	.0	-99.9	.0000
	45.4	100.7	17.8	20.3	CA	61.8	40.6	97.0	.4150
	26.4	53.1	8.5	22.9	CA	58.1	38.7	106.1	.1350
	12.9	23.8	3.5	24.8	AA	.0	.0	27.4	8.5000
	.0	.0	.0	27.1		.0	-99.9	30.3	3.5000
33	117.5	258.8	45.8	27.4=D,F=		13.303,	65,	2.6	122*LOVA 1

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SUMMARY REPORT--SURE-TO-BE MEASURED TREES PLUS EXPANDED 3P SAMPLES

STRATUM 1

SAMPLE VARIABLES	SURE-TO-BE MEASURED AGGREGATIONS	3P-EXPANDED SAMPLE ESTIMATES	TOTAL SAMPLE ESTIMATES PLUS SURE
TREES(FREQUENCY)	3.000	166.510	169.510
PREDICTIONS(KPI)	387.	8647.	9034.
B.A.(SQ.FT.O.B.)	17.3	460.3	477.6
LENGTH(FT.)	185.2	10202.5	10387.7
SURFACE(SQ.FT.IB.)	1115.7	42251.1	43366.8
VOLUME(CU.FT.I.B.)	552.2	15437.1	15989.3
REL.VAL.PER MF.UNIT	1.00	1.00	1.00
GROSS MF.UNITS	4177.4	109296.1	113473.5
ST.ERROR(PCT.)	-----	2.3	2.2

COMPONENT ITEMS	(1=) NUMBER	(2*) NUMBER	(1,2) NUMBER
MEASURED TREES	3	10	13
MEASURED LOGS	18	50	68

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 11
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SUMMARY REPORT--SURE-TO-BE MEASURED TREES PLUS EXPANDED 3P SAMPLES

STRATUM 2--------------2--------------2--------------2

SAMPLE VARIABLES	SURE-TO-BE MEASURED AGGREGATIONS	3P-EXPANDED SAMPLE ESTIMATES	TOTAL SAMPLE ESTIMATES PLUS SURE
TREES(FREQUENCY)	2.000	135.566	137.566
PREDICTIONS(KPI)	270.	6663.	6933.
B.A.(SQ.FT.O.B.)	5.0	178.0	183.0
LENGTH(FT.)	118.0	5953.2	6071.1
SURFACE(SQ.FT.IB.)	497.4	17459.8	17957.2
VOLUME(CU.FT.I.B.)	170.8	4351.4	4522.2
REL.VAL.PER MF.UNIT	3.00	3.00	3.00
GROSS MF.UNITS	1188.3	27076.8	28265.1
ST.ERROR(PCT.)	-----	6.3	6.1

COMPONENT ITEMS	(1=) NUMBER	(2*) NUMBER	(1,2) NUMBER
MEASURED TREES	2	18	20
MEASURED LOGS	11	87	98

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 12
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SUMMARY REPORT--SURE-TO-BE MEASURED TREES PLUS EXPANDED 3P SAMPLES

TOTALS ALL 2 STRATA**

SAMPLE VARIABLES	SURE-TO-BE MEASURED AGGREGATIONS	3P-EXPANDED SAMPLE ESTIMATES	TOTAL SAMPLE ESTIMATES PLUS SURE
TREES(FREQUENCY)	5.000	302.075	307.075
PREDICTIONS(KPI)	657.	15310.	15967.
B.A.(SQ.FT.O.B.)	22.3	638.2	660.6
LENGTH(FT.)	303.2	16155.6	16458.8
SURFACE(SQ.FT.IB.)	1613.1	59710.9	61324.0
VOLUME(CU.FT.I.B.)	723.0	19788.5	20511.5
REL.VAL.PER MF.UNIT	1.44	1.40	1.40
GROSS MF.UNITS	5365.7	136372.8	141738.6
ST.ERROR(PCT.)	-----	2.2	2.2
GROSS WTD.MF.UNITS	7742.32	190526.36	198268.69
ST.ERROR(PCT.)	-----	3.0	2.9

COMPONENT ITEMS	(1=) NUMBER	(2*) NUMBER	(1,2) NUMBER
MEASURED TREES	5	28	33
MEASURED LOGS	29	137	166

MF.UNITS= BD. FT. (INT. 1/4-IN.) ,AFTER ALLOWANCE FOR TRIM OF .3 FT. PER 16 FT
=(.89560000+01)*(CU.FT.)+(-.69540000+00)*(SQ.FT.)+(.41450000-01)*(FT.)

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THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL                  TEST  PAGE    0
CM  03-16-70  8.000  .01964673 -1.1905  1.5658  2    660.  120          0 223022
       SUMMARY REPORT--SURE-TO-BE MEASURED TREES PLUS EXPANDED 3P SAMPLES
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DATA PROCESSING BLOCKED BY    0 INPUT FLAWS.
SAMPLE ESTIMATES INVOLVE    0 SUSPICIOUS ITEMS NUMBERED
              0
INPUT READ BEFORE FLAW,IF ANY---
    CARDS WITH TREE PREDICTIONS ONLY           (FIRST)                       353
    CARDS WITH MEASURED TREE INFO              (FIRST)                        33
    ----------------------------------------------------------------------------
    CARDS WITH MEASURED TREE INFO              (SECOND)                       33
    CARDS WITH ADDITIONAL DENDROMETER INFO     (SECOND)                       65

PROCESSING DONE BEFORE FLAW,IF ANY---
    NUMBER OF MEASURED TREES PROCESSED                                        33
    NUMBER OF MEASURED LOGS PROCESSED                                        166
    TREE CARDS PUNCHED OR WRITTEN                                              0
    LOG CARDS PUNCHED OR WRITTEN                                               0
    LABEL ON CARD OUTPUT                                                    TEST

CHECK OF INPUT AGGREGATES WITH EXPANDED 3P SAMPLE
    AGGREGATE NUMBER OF TREES INPUT(1+2+3)                            386
    SAMPLE ESTIMATE(EXPANDED 2)+NO.SURE(1)                            307.075
    STANDARD ERROR OF ESTIMATED NUMBER                                 34.741
    ----------------------------------------------------------------------------
    AGGREGATE PREDICTIONS(KPI) INPUT(1+2+3)                         15967
    SAMPLE ESTIMATE(EXPANDED 2)+KPI SURE(1)                         15967.
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THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 13

CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 660. 120 0 223022

GRADE-YIELD AND REALIZATION REPORT

CLAS GR	CU.FT.IB.VOL.	SQ.FT.IB.SURF.	LIN.FT.LENGTH	FREQUENCY	COUNT
HIVA AA	1413.16	4741.18	1297.49	219.89	36
HIVA AB	28.41	77.41	16.80	1.00	1
HIVA AC	24.19	62.03	12.70	3.63	1
HIVA BA	117.02	453.95	140.87	15.24	3
HIVA BB	49.22	179.89	52.35	3.74	1
HIVA CA	2412.93	10227.29	3565.71	290.13	45
HIVA CB	420.43	1756.70	588.84	52.72	6
HIVA UU	22.08	123.98	55.81	8.53	2
HIVA XX	34.76	334.74	340.57	26.16	3
LOVA AA	3658.45	9204.35	2024.48	293.78	22
LOVA AC	240.17	486.98	78.61	9.83	1
LOVA BA	2762.70	7067.49	1608.91	110.62	9
LOVA BB	55.90	98.24	13.75	1.00	1
LOVA CA	8731.25	24812.55	5982.58	387.15	31
LOVA CB	437.78	999.20	182.10	9.93	3
LOVA XX	103.05	698.00	497.24	26.20	1
TOTALS	20511.50	61323.97	16458.79	1459.54	166

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 14

CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 660. 120 0 223022

GRADE-YIELD AND REALIZATION REPORT

CLAS GR	ROUGH LOG WT. GREEN LBS.	INC.WT.CHIPS GREEN LBS.	LOG VOLUME CU.FT.IB.	LOG SURFACE SQ.FT.IB.	LOG LENGTH LINEAL FT.	DOYLE(NO BK.) NET BD.FT.
HIVA AA	84800.22	8359.26	1413.16	4741.18	1297.49	6619.74
HIVA AB	1797.70	230.72	28.41	77.41	16.80	97.47
HIVA AC	1539.09	181.63	24.19	62.03	12.70	85.30
HIVA BA	7744.36	815.85	117.02	453.95	140.87	429.16
HIVA BB	4453.15	658.15	49.22	179.89	52.35	210.38
HIVA CA	157262.94	18344.62	2112.26	8741.01	2970.88	8152.81
HIVA CB	28733.95	6282.63	368.10	1510.61	497.50	1589.22
HIVA UU	.00	.00	.00	.00	.00	.00
HIVA XX	.00	.00	.00	.00	.00	.00
SUBTOT	286331.40	34872.86	4112.35	15766.07	4988.59	17184.09
LOVA AA	202520.34	21997.72	3658.45	9204.35	2024.48	19183.49
LOVA AC	15570.71	1423.12	240.17	486.98	78.61	924.32
LOVA BA	183466.69	17165.90	2762.70	7067.49	1608.91	15873.50
LOVA BB	5359.22	306.41	55.90	98.24	13.75	318.67
LOVA CA	561115.75	43708.62	7643.24	21206.67	4984.58	43088.37
LOVA CB	32722.87	2478.00	383.30	859.22	153.86	2428.76
LOVA XX	.00	.00	.00	.00	.00	.00
SUBTOT	1000755.57	87079.77	14743.76	38922.95	8864.19	81817.11
TOTALS	1287086.95	121952.62	18856.11	54689.03	13852.77	99001.20

VOLUME (CU.FT.IB.) PAIRED WITH YIELD COEFFICIENTS= 20511.51

APPENDIX B.—Computer output—preliminary report, detailed log and tree report, and summary reports (same as Appendix A summaries, but using a different set of conversion coefficients)

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THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL                      TEST   PAGE    1
CM   03-16-70   8.000   .01964673 -1.1905  1.5658  2    660.  120           0 222022
           PRELIMINARY REPORT--COUNTS AND AGGREGATE PREDICTIONS
=================================================================================

       STRATUM 1                                    TREE COUNTS    PREDICTIONS
---------------------------------------------------------------------------------
              SURE-TO-BE MEASURED  TREES(=1)            3               387
              THREE-PEE  MEASURED  TREES(*2)           10               673
              THREE-PEE  PREDICTED TREES( 3)          221              7974
---------------------------------------------------------------------------------
                               ALL TREES(1,2,3)       234              9034
---------------------------------------------------------------------------------
                      ALL MEASURED  TREES(1,2)         13              1060
                      ALL THREE-PEE TREES(2,3)        231              8647
                    EXPECTED VALUES  FOR (*2)          13.102           635.570
                    EXP. VAL. ST. ERRORS (*2)           3.484           169.015
       STRATUM 2                                    TREE COUNTS    PREDICTIONS
---------------------------------------------------------------------------------
              SURE-TO-BE MEASURED  TREES(=1)            2               270
              THREE-PEE  MEASURED  TREES(*2)           18              1128
```

THREE-PEE PREDICTED TREES(3)	132	5535
ALL TREES(1,2,3)	152	6933
ALL MEASURED TREES(1,2)	20	1398
ALL THREE-PEE TREES(2,3)	150	6663
EXPECTED VALUES FOR (*2)	10.095	571.770
EXP. VAL. ST. ERRORS (*2)	3.038	172.059

TOTALS FOR ALL 2 STRATA	TREE COUNTS	PREDICTIONS
SURE-TO-BE MEASURED TREES(=1)	5	657
THREE-PEE MEASURED TREES(*2)	28	1801
THREE-PEE PREDICTED TREES(3)	353	13509
ALL TREES(1,2,3)	386	15967
ALL MEASURED TREES(1,2)	33	2458
ALL THREE-PEE TREES(2,3)	381	15310
EXPECTED VALUES FOR (*2)	23.197	1207.341
EXP. VAL. ST. ERRORS (*2)	4.623	241.185

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 2
CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 660. 120 0 222022

DETAILED LOG AND/OR TREE REPORT

TREE/ NO./	VOLUME / CU.FT. /	SURFACE / SQ.FT. /	LENGTH / FEET /	D.B.H. / INCHES /			
1	44.7	166.2	50.1	17.0=D,F=	4.407,	84,	1.6 021 HIVA 2
2	42.5	177.0	60.4	15.8=D,F=	4.936,	75,	2.4 121 HIVA 2
3	67.4	241.2	70.1	17.7=D,F=	3.739,	99,	1.6 221 HIVA 2
4	98.8	276.6	62.3	21.0=D,F=	1.000,	138,	-1.8 211 HIVA 2
5	48.4	193.9	63.5	15.6=D,F=	34.588,	25,	1.6 321 LOVA 1
6	221.5	404.9	59.9	34.5=D,F=	1.000,	145,	3.4 121 LOVA 1
7	112.4	349.1	90.4	22.8=D,F=	15.170,	57,	2.4 121*LOVA 1
8	144.7	338.0	63.3	27.1=D,F=	9.826,	88,	2.6 121*LOVA 1
9	207.4	430.6	74.5	32.4=D,F=	7.933,	109,	3.4 122*LOVA 1
10	184.4	401.9	72.3	32.0=D,F=	1.000,	121,	3.6 121 LOVA 1
11	168.5	351.2	60.0	31.3=D,F=	7.933,	109,	3.0*121 LOVA 1
12	178.4	378.1	65.5	28.9=D,F=	8.395,	103,	2.8 112*LOVA 1
13	59.6	191.7	50.6	18.8=D,F=	26.203,	33,	1.8 131 LOVA 1

14	72.0	220.8	55.7	21.9=D,F=	1.000,	132,	.0 011 HIVA 2
15	52.4	201.9	63.0	16.8=D,F=	5.365,	69,	2.0*121 HIVA 2
16	20.4	114.8	57.4	11.1=D,F=	17.627,	21,	1.2 121 HIVA 2
17	57.0	196.7	63.2	19.0=D,F=	26.203,	33,	.0 121 LOVA 1
18	72.6	245.5	73.5	20.1=D,F=	3.164,	117,	2.2 121 HIVA 2
19	44.3	168.8	59.5	19.5=D,F=	5.365,	69,	3.0 121 HIVA 2
20	21.7	100.6	37.7	13.4=D,F=	12.339,	30,	1.8 121 HIVA 2
21	41.2	151.5	45.6	17.0=D,F=	6.855,	54,	2.0 121 HIVA 2
22	34.8	129.4	38.7	16.0=D,F=	7.258,	51,	1.8 122*HIVA 2
23	48.3	181.5	55.5	17.7=D,F=	8.226,	45,	2.2 121 HIVA 2
24	14.6	58.9	19.1	15.2=D,F=	15.424,	24,	2.4 121 HIVA 2
25	11.8	55.6	21.0	11.8=D,F=	13.710,	27,	1.4 121 HIVA 2
26	43.7	160.3	47.5	17.4=D,F=	5.365,	69,	2.0 121 HIVA 2
27	90.8	231.7	47.6	23.1=D,F=	16.955,	51,	2.0 121 LOVA 1
28	33.1	136.2	45.3	15.8=D,F=	7.258,	51,	2.2 122*HIVA 2
29	19.8	74.5	23.2	18.3=D,F=	4.407,	84,	2.4 121 HIVA 2
30	58.6	187.4	48.2	19.0=D,F=	3.629,	102,	2.2 122*HIVA 2
31	146.3	309.0	53.1	31.0=D,F=	1.000,	121,	3.2 122*LOVA 1
32	34.2	142.1	48.0	15.8=D,F=	6.494,	57,	2.0 122*HIVA 2
33	117.5	258.8	45.8	27.4=D,F=	13.303,	65,	2.6 122*LOVA 1

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THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL                    TEST  PAGE   3
CM  03-16-70  8.000  .01964673 -1.1905  1.5658  2   660.  120          0 222022
       SUMMARY REPORT--SURE-TO-BE MEASURED TREES PLUS EXPANDED 3P SAMPLES
===============================================================================
```

STRATUM 1	SURE-TO-BE MEASURED AGGREGATIONS	3P-EXPANDED SAMPLE ESTIMATES	TOTAL SAMPLE ESTIMATES PLUS SURE
SAMPLE VARIABLES			
TREES(FREQUENCY)	3.000	166.510	169.510
PREDICTIONS(KPI)	387.	8647.	9034.
B.A.(SQ.FT.O.B.)	17.3	460.3	477.6
LENGTH(FT.)	185.2	10202.5	10387.7
SURFACE(SQ.FT.IB.)	1115.7	42251.1	43366.8
VOLUME(CU.FT.I.B.)	552.2	15437.1	15989.3
REL.VAL.PER MF.UNIT	1.00	1.00	1.00
GROSS MF.UNITS	4177.4	109296.1	113473.5
ST.ERROR(PCT.)	-----	2.3	2.2

COMPONENT ITEMS	(1=) NUMBER	(2*) NUMBER	(1,2) NUMBER
MEASURED TREES	3	10	13
MEASURED LOGS	18	50	68

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 4
CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 660. 120 0 222022

SUMMARY REPORT--SURE-TO-BE MEASURED TREES PLUS EXPANDED 3P SAMPLES

STRATUM 2--------------2--------------2--------------2

SAMPLE VARIABLES	SURE-TO-BE MEASURED AGGREGATIONS	3P-EXPANDED SAMPLE ESTIMATES	TOTAL SAMPLE ESTIMATES PLUS SURE
TREES(FREQUENCY)	2.000	135.566	137.566
PREDICTIONS(KPI)	270.	6663.	6933.
B.A.(SQ.FT.O.B.)	5.0	178.0	183.0
LENGTH(FT.)	118.0	5953.2	6071.1
SURFACE(SQ.FT.IB.)	497.4	17459.8	17957.2
VOLUME(CU.FT.I.B.)	170.8	4351.4	4522.2
REL.VAL.PER MF.UNIT	3.00	3.00	3.00
GROSS MF.UNITS	1188.3	27076.8	28265.1
ST.ERROR(PCT.)	-----	6.3	6.1

COMPONENT ITEMS	(1=) NUMBER	(2*) NUMBER	(1,2) NUMBER
MEASURED TREES	2	18	20
MEASURED LOGS	11	87	98

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 5
CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 660. 120 0 222022
SUMMARY REPORT--SURE-TO-BE MEASURED TREES PLUS EXPANDED 3P SAMPLES

TOTALS ALL 2 STRATA**

SAMPLE VARIABLES	SURE-TO-BE MEASURED AGGREGATIONS	3P-EXPANDED SAMPLE ESTIMATES	TOTAL SAMPLE ESTIMATES PLUS SURE
TREES(FREQUENCY)	5.000	302.075	307.075
PREDICTIONS(KPI)	657.	15310.	15967.
B.A.(SQ.FT.O.B.)	22.3	638.2	660.6
LENGTH(FT.)	303.2	16155.6	16458.8
SURFACE(SQ.FT.IB.)	1613.1	59710.9	61324.0
VOLUME(CU.FT.I.B.)	723.0	19788.5	20511.5
REL.VAL.PER MF.UNIT	1.44	1.40	1.40
GROSS MF.UNITS	5365.7	136372.8	141738.6
ST.ERROR(PCT.)	-----	2.2	2.2
GROSS WTD.MF.UNITS	7742.32	190526.36	198268.69
ST.ERROR(PCT.)	-----	3.0	2.9

COMPONENT ITEMS	(1=) NUMBER	(2*) NUMBER	(1,2) NUMBER
MEASURED TREES	5	28	33
MEASURED LOGS	29	137	166

MF.UNITS= BD. FT. (INT. 1/4-IN.) ,AFTER ALLOWANCE FOR TRIM OF .3 FT. PER 16 FT
=(.89560000+01)*(CU.FT.)+(-.69540000+00)*(SQ.FT.)+(.41450000-01)*(FT.)

```
THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL                     TEST  PAGE   0
CM  03-16-70  8.000  .01964673 -1.1905  1.5658  2    660.  120          0 222022
       SUMMARY REPORT--SURE-TO-BE MEASURED TREES PLUS EXPANDED 3P SAMPLES
================================================================================


DATA PROCESSING BLOCKED BY   0 INPUT FLAWS.
SAMPLE ESTIMATES INVOLVE   0 SUSPICIOUS ITEMS NUMBERED
             0
INPUT READ BEFORE FLAW,IF ANY---
    CARDS WITH TREE PREDICTIONS ONLY         (FIRST)                         353
    CARDS WITH MEASURED TREE INFO            (FIRST)                          33
    ----------------------------------------------------------------------------
    CARDS WITH MEASURED TREE INFO            (SECOND)                         33
    CARDS WITH ADDITIONAL DENDROMETER INFO   (SECOND)                         65

PROCESSING DONE BEFORE FLAW,IF ANY---
    NUMBER OF MEASURED TREES PROCESSED                                        33
    NUMBER OF MEASURED LOGS PROCESSED                                        166
    TREE CARDS PUNCHED OR WRITTEN                                              0
    LOG CARDS PUNCHED OR WRITTEN                                               0
    LABEL ON CARD OUTPUT                                                    TEST

CHECK OF INPUT AGGREGATES WITH EXPANDED 3P SAMPLE
    AGGREGATE NUMBER OF TREES INPUT(1+2+3)                              386
    SAMPLE ESTIMATE(EXPANDED 2)+NO.SURE(1)                              307.075
    STANDARD ERROR OF ESTIMATED NUMBER                                   34.741
    ----------------------------------------------------------------------------
    AGGREGATE PREDICTIONS(KPI) INPUT(1+2+3)                           15967
    SAMPLE ESTIMATE(EXPANDED 2)+KPI SURE(1)                           15967.
================================================================================
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THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL TEST PAGE 6
CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 650. 120 0 222022

GRADE-YIELD AND REALIZATION REPORT

CLAS GR	CU.FT.IB.VOL.	SQ.FT.IB.SURF.	LIN.FT.LENGTH	FREQUENCY	COUNT
HIVA AA	1413.16	4741.18	1297.49	219.89	36
HIVA AB	28.41	77.41	16.80	1.00	1
HIVA AC	24.19	62.03	12.70	3.63	1
HIVA BA	117.02	453.95	140.87	15.24	3
HIVA BB	49.22	179.89	52.35	3.74	1
HIVA CA	2412.93	10227.29	3565.71	290.13	45
HIVA CB	420.43	1756.70	588.84	52.72	6
HIVA UU	22.08	123.98	55.81	8.53	2
HIVA XX	34.76	334.74	340.57	26.16	3
LOVA AA	3658.45	9204.35	2024.48	293.78	22
LOVA AC	240.17	486.98	78.61	9.83	1
LOVA BA	2762.70	7067.49	1608.91	110.62	9
LOVA BB	55.90	98.24	13.75	1.00	1
LOVA CA	8731.25	24812.55	5982.58	387.15	31
LOVA CB	437.78	999.20	182.10	9.93	3
LOVA XX	103.05	698.00	497.24	26.20	1
TOTALS	20511.50	61323.97	16458.79	1459.54	166

THREE-PEE SAMPLE TREE MEASUREMENT AND APPRAISAL   TEST PAGE 7

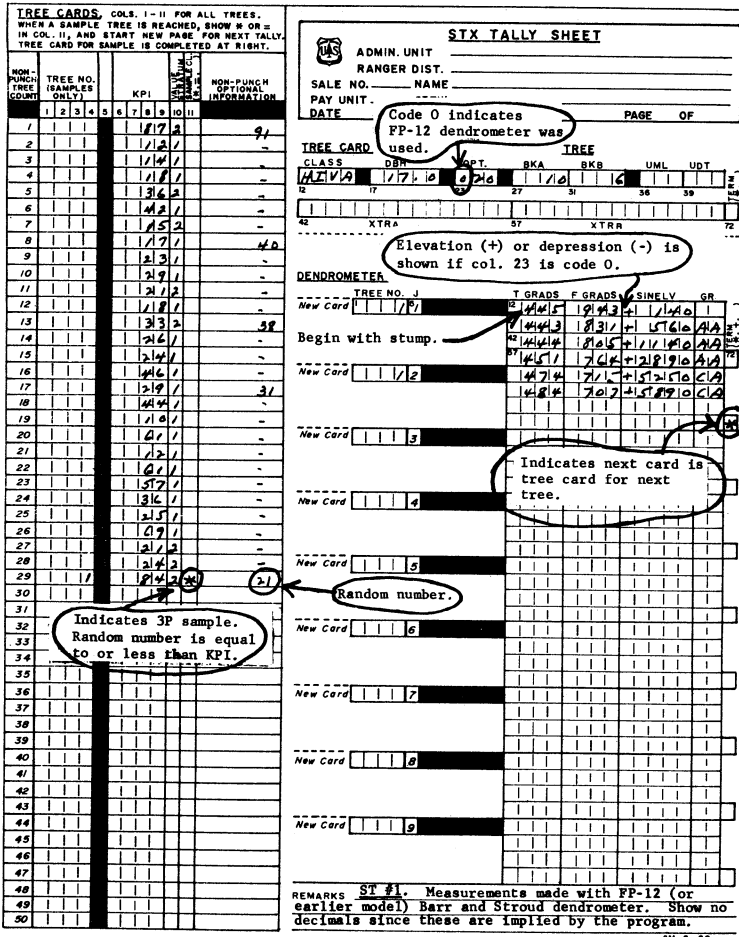
CM 03-16-70 8.000 .01964673 -1.1905 1.5658 2 660. 120   0 222022

GRADE-YIELD AND REALIZATION REPORT

CLAS GR	SCRIBNER NET BD.FT.	INT. 1/4 IN. NET BD.FT.	LUMBER TALLY NET BD.FT.	LBR. F.O.B. DOLLAR VALUE	ADD.WT.CHIPS OVENDRY LBS.	CHIPS F.O.B. DOLLAR VALUE
HIVA AA	8217.73	9118.48	8689.40	2593.76	3438.79	23.17
HIVA AB	121.94	130.14	183.05	75.28	106.14	.72
HIVA AC	104.62	111.93	168.17	77.66	82.80	.56
HIVA BA	604.57	677.85	635.70	141.56	332.62	2.24
HIVA BB	285.11	302.57	214.40	29.53	314.15	2.12
HIVA CA	11421.00	13208.68	11266.68	2703.04	7660.93	51.63
HIVA CB	2100.69	2397.90	1642.34	428.16	3028.86	20.41
HIVA UU	.00	.00	.00	.00	.00	.00
HIVA XX	.00	.00	.00	.00	.00	.00
SUBTOT	22855.66	25947.55	22799.74	6048.99	14964.29	100.85
LOVA AA	21153.19	22791.51	23689.26	2639.20	9707.81	65.42
LOVA AC	1065.59	1149.20	2080.90	407.75	625.15	4.21
LOVA BA	18250.71	19752.14	16583.37	1220.35	7577.94	51.07
LOVA BB	380.21	370.20	387.42	8.29	132.08	.89
LOVA CA	50782.44	54837.38	43708.00	3302.38	18775.49	126.53
LOVA CB	2842.44	2990.12	2550.21	227.58	1105.79	7.45
LOVA XX	.00	.00	.00	.00	.00	.00
SUBTOT	94474.57	101890.56	88999.14	7805.54	37924.25	255.58
TOTALS	117330.23	127838.12	111798.88	13854.53	52888.54	356.42

VOLUME (CU.FT.IB.) PAIRED WITH YIELD COEFFICIENTS= 20511.51

APPENDIX C.—Examples of field tally sheets
(see text pages 22–26)



TREE CARDS. COLS. 1 - 11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*) 11	NON-PUNCH OPTIONAL INFORMATION
1			25	1		-
2			8	1		-
3			49	1		68
4			9	2		-
5			28	1		-
6			6	1		-
7			49	1		-
8			9	2		-
9			39	1		-
10			99	2		-
11			614	1		118
12	2		75	2	*	6
13						
14						
15						
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49						
50						

STX TALLY SHEET

ADMIN. UNIT ____
RANGER DIST. ____
SALE NO. ____
PAY UNIT ____
DATE ____ PAGE ____ OF ____

Code 1 indicates FP-15 dendrometer was used.

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	D.T. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM (*)
H IV A	15.8	1 26	10	14			

XTRA (42)	XTRB (57–72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO.	J	T GRADS	F GRADS	SINELV	GR
New Card	2	1	384	915	9210	
			380	946	9940	AA
			387	828	11920	AA
			397	776	13720	BA
New Card	2	2	415	745	14630	BA
			436	725	14800	CA
			469	646	16960	CA
						*
New Card		3				
New Card		4				
New Card		5				
New Card		6				
New Card		7				
New Card		8				
New Card		9				

REMARKS ST #2 FP-15 Barr and Stroud dendrometer measurements. Column 23 is code 1.

CM 6-68

TREE CARDS, COLS. 1 - 11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*, =) 11	NON-PUNCH OPTIONAL INFORMATION
1			63	2		-
2			25	1		-
3			57	2		-
4			61	1		-
5			36	1		-
6			36	2		119
7			99	1		-
8			56	1		-
9			61	1		-
10			19	1		-
11			53	1		-
12			61	1		-
13			69	1		-
14			99	2		-
15			93	2		-
16			39	2		-
17			63	2		-
18	3		99	2	*	5
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
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30						
31						
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37						
38						
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40						
41						
42						
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47						
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49						
50						

STX TALLY SHEET

ADMIN. UNIT

RANGER DIST.

SALE NO.

PAY UNIT

DATE

PAGE OF

Code 2 indicates direct reading dendrometer or taped measurements

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OR (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM (*, =)
HIVA	17.7	226	9	7			

XTRA (42)	XTRB (57)	72

Measured diameter to 0.1 inches. Do not record the decimal point.

DENDROMETER

	TREE NO.	J	T GRADS	F GRADS	SINELV	GR	TERM (*, +, =)
New Card	3	1	12	265	10.0		
			27	177	14.0	AA	
			42	162	18.0	AA	
			57	148	14.6	AA	72
New Card	3	2		136	14.0	BB	
				132	19.5	CA	
				103	20.0	CA	
							*
New Card		3					
New Card		4					
New Card		5					
New Card		6					
New Card		7					
New Card		8					
New Card		9					

Measured segment length, to 0.1 feet. Show decimal point.

REMARKS ST #3. Recording tape measurements, or direct-reading dendrometers. The TGRADS column is left blank. Col. 23 is code 2.

CM 6-68

TREE CARDS, COLS. 1-11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*, =) 11	NON-PUNCH OPTIONAL INFORMATION
1	14		1318	2	=	—
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
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14						
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Indicates 'sure-to-be' measured sample tree.

STX TALLY SHEET

ADMIN. UNIT ____________

RANGER DIST. ____________

SALE NO. ____________

PAY UNIT ____________

DATE ____________ PAGE ___ OF ___

Negative bark thickness. No reduction for bark will be computed.

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM (*,)
4IVA	21.0	200	-009				

XTRA (42)	XTRB (57)	(72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO.	J	T GRADS	F GRADS	SINELV	GR	TERM (*,+)
New Card	14	1		216	0.10		
				196	4.0	AA	
				185	8.10	AA	
				167	16.18	AB	
New Card	14	2		169	6.17	CA	
				153	15.9	CA	
				136	10.9	CA	
							*
New Card		3					
New Card		4					
New Card		5					
New Card		6					
New Card		7					
New Card		8					
New Card		9					

REMARKS ST #4. A negative bark thickness (actual or fictitious) is recorded in cols. 27-30 when no reduction for bark is to be computed.

CM 6-68

TREE CARDS, COLS. 1 - 11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*, =) 11	NON-PUNCH OPTIONAL INFORMATION
1			12	1		–
2	5		215	1	*	19
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
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STX TALLY SHEET

ADMIN. UNIT

RANGER DIST.

SALE NO

PAY UNIT

DATE

PAGE OF

Code 3 indicates modified Zeiss Teletop Dendrometer

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OBS (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM. (* =)
L0VA	15.6	320	6	10			

XTRA (42)	XTRB (57–72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO. J	T GRADS	F GRADS	SINELV	GR
New Card	51	676	190	96.6	
		675	156	91.7	AA
		680	144	106.8	AA
		727	136	121.5	AA
New Card	52	810	110	133.5	BA
		908	84	140.9	CA
New Card	3				
New Card	4				
New Card	5				
New Card	6				
New Card	7				
New Card	8				
New Card	9				

TGRADS is slant distance to 0.1 feet.
FGRADS is diameter to 0.1 inches.
SINELV is (Degrees + 100) to 0.1°.

REMARKS ST #5. Recording Modified Zeiss Teletop measurements. Decimal point is implied for T and F GRADS, but must be explicit for SINELV. Col. 23 is code 3.

CM 6-68

TREE CARDS. COLS. 1 – 11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*, =) 11	NON-PUNCH OPTIONAL INFORMATION
1			121	2		–
2			125	1		–
3			128	1		50
4			124	1		–
5			99	2		–
6			8	1		65
7			39	1		–
8			108	1		–
9	6		145	1	=	–
10						
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12						
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STX TALLY SHEET

ADMIN. UNIT ______

RANGER DIST. ______

SALE NO. ______ NAME ______

PAY UNIT ______ CREW ______

DATE ______ PAGE ___ OF ___

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)
L4VA	34.5	120	18	16		

XTRA (42)	XTRA (57)

DENDROMETER CARDS FOR ABOVE SAMPLE

	TREE NO. J	T GRADS	F GRADS	SINELV	GR
New Card	6 1	-999	386	4.6	
			345	8.0	AA
		470	1058	1092.0	AA
		478	989	1257.0	BB
New Card	6 2	492	942	1397.0	BA
		501	884	1485.0	CA
		548	835	1551.0	CB
New Card	3				
New Card	4				
New Card	5				
New Card	6				
New Card	7				
New Card	8				
New Card	9				

Distance upwards to next section, in feet and tenths

1st TGRADS is -999
2d TGRADS is blank
FGRADS are meas. dia.

Dendrometer measurements begin at third segment.

REMARKS ST #6. Combining tape and dendrometer measurements when lines of sight to stump and DBH are obscured.

CM 5-88

TREE CARDS, COLS. 1-11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*,=) 11	NON-PUNCH OPTIONAL INFORMATION
1			314	1		-
2			1108	1		-
3			144	1		-
4			128	1		-
5			168	1		-
6			119	1		110
7			419	1		-
8			449	1		-
9	7		57	1	*	4
10						
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STX TALLY SHEET

ADMIN. UNIT ____

RANGER DIST. ____

SALE NO. ____ NAME ____

PAY U... ____

DAT... ____ OF

> If col. 25 is code 0 or 1, UDT must be (top d.o.b./DBHOB). Do not record decimal. UML may be blank.

TREE ...

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT	TERM (*,+)
2 0 V A	22.8	121	18	6		425	

XTRA (42)	XTRB (57–72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

> Tape meas. as shown, or dendrometer meas.

	TREE NO. J	T GRADS	F GRADS	SINELV	GR
New Card	7 1	-999	285	14.0	
			228	81.0	AA
		443	878	11090	BA
		450	846	13150	CA
New Card	7 2	472	794	15120	CA
			-999		CA
New Card	3				
New Card	4				
New Card	5				
New Card	6				
New Card	7				
New Card	8				
New Card	9				

> Show final FGRADS as -999. If col. 25 is 0 or 1, at least three sets of measurements above stump are required.

REMARKS ST #7. When top section is obscured, top d.o.b. may be extrapolated from lower measurements. Procedure is governed by code recorded in col. 25.

CM 6-68

TREE CARDS, COLS. 1 - 11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1 2 3 4	5	KPI 6 7 8 9	VALUE STRATUM 10	SAMPLE CL. 11	NON-PUNCH OPTIONAL INFORMATION
1			61	1		-
2			118	1		-
3	8		88	1	*	32
4						
5						
6						
7						
8						
9						
10						
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STX TALLY SHEET

ADMIN. UNIT ______
RANGER DIST. ______
SALE NO. ______ NAME ______
PAY UNIT - ______
DATE ______ PAGE ___ OF ___

UML is estimated length of unseen top section in whole feet.

TREE CARD

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML	UDT (39)
L0VA	27.1	121	11	15	14	500

XTRA (42) ______ XTRB (57) ______ (72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

New Card – TREE NO. J	T GRADS	F GRADS	SINELV	GR
8 1	-999	361	4.6	
		271	8.6	AA
	413	1627	11236	AC
	441	922	14090	CA
8 2	470	860	15840	CA
	475	[illegible]	16730	CA
		-999		CA
				*
3				
4				
5				
6				
7				
8				
9				

-999 F Grad indicates presence of unseen Top

REMARKS ST #8. If column 25 is code 0 or 1, unseen top d.o.b. is extrapolated to (UDT x DBHOB) or for length shown as UML, whichever comes first.

CM 6-68

TREE CARDS. COLS 1 - 11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE (=, *) 11	NON-PUNCH OPTIONAL INFORMATION
1			65	1		-
2			51	2		-
3			19	1		-
4			7	1		-
5			85	1		-
6			49	1		-
7			88	1		-
8			7	1		-
9			49	1		-
10			93	2		-
11			21	1		-
12			69	1		-
13	9		109	1	*	4
14						
15						
16						
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STX TALLY SHEET

ADMIN. UNIT

RANGER DIST.

SALE NO. ______ NAME

PAY UNIT

DATE

If col. 25 is code 2, UDT is taper in inches per foot, to .000", and UML is length of unseen section in whole feet.

TREE CARD C

CLASS (12)	DBH (17)	OPT (23)	BKA (27)	BKB (31)	UML	UDT (39)
L0VA	32.4	122	15	19	22	3.66

XTRA (42) XTRB (57–72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO.	J	T GRADS	F GRADS	SINELV	GR
New Card	9	1	-999	404	4.6	
				324	8.10	AA
			426	1107	11286	AA
			441	994	1410	BA
New Card	9	2	479	867	15810	CB
				-999		CA
						*
New Card		3				
New Card		4				
New Card		5				
New Card		6				
New Card		7				
New Card		8				
New Card		9				

TERM (+, *, -)

REMARKS ST #9. If col. 25 is code 2, both UML and UDT are required. At least one measured section, preferably but not necessarily above DBH, should be recorded.

CM 6-68

TREE CARDS, COLS. 1-11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1	2	3	4	5	KPI 6	7	8	9	VALUE STRATUM 10	SAMPLE CL. (*, =) 11	NON-PUNCH OPTIONAL INFORMATION
1								1	9	1		–
2								7	8	1		–
3							1	2	1	1	=	–
4												
5												
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STX TALLY SHEET

ADMIN. UNIT ______

RANGER DIST. ______

SALE NO. ______ NAME ______

PAY UNIT ______ CREW ______

DATE PAGE OF

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM (*,)
L0VA	32.0	120	19	17			

XTRA (42)	XTRB (57)	(72)

Always record signal (++) here to indicate instrument was moved one or more times.

DENDROMETER

	TREE NO.	T GRADS	F GRADS	SINELV	GR	
New Card	101	(12) -999	362	4.10	++	
		(27)	320	81.0	AA	TERM (+, *,)
		(42) 489	961	10890	AA	
		(57) 495	968	121110	AA	(72)
New Card	102	514	875	127210	BA	
		504	853	139510	CA	
		515	809	150210	CB	
		526	735	159710	CA	*
New Card	3					
New Card	4					
New Card	5					
New Card	6					
New Card	7					
New Card	8					
New Card	9					

REMARKS ST #10. Instrument may be moved for better visibility. If move is on the same contour, recording proceeds as though instrument was not moved.

CM 6-68

TREE CARDS, COLS. 1 - 11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*, =) 11	NON-PUNCH OPTIONAL INFORMATION
1			44	1		-
2			34	1		60
3			61	1		-
4			46	1		-
5			64	1		-
6			80	1		-
7			36	1		-
8			25	1		-
9			53	1		93
10	11		109	1	*	50
11						
12						
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STX TALLY SHEET

ADMIN. UNIT ______
RANGER DIST. ______
SALE NO. ______ NAME ______
PAY UNIT ______ CREW ______
DATE PAGE OF

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM (+, *)
L6VA	31.3	120	15	15			

XTRA (42)	XTRB (57–72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO.	J	T GRADS	F GRADS	SINELV	SR	TERM (+, *)
New Card	11	1	999	375	4.0	H+	
				213	8.0	AA	
			4442	1029	11010	BA	
							+
New Card	11	2	465	999	10950		
			482	910	13400	CA	
							+
New Card	11	3	464	933	13770		
			480	854	15350	CA	
			493	771	16110	CA	
							*
New Card		4					
New Card		5					
New Card		6					
New Card		7					
New Card		8					
New Card		9					

Same section from new and previous locations.

Terminate card with (+) if move to new contour is made. Terminate last card with (*).

REMARKS ST #11. If move is to a new contour, terminate dendrometer card with (+), and start new card. 1st shots at new setup are to same diameter last measured.

CM 6-68

TREE CARDS, COLS. 1-11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*,=) 11	NON-PUNCH OPTIONAL INFORMATION
1			85	1		101
2	12		1013	1	*	73
3						
4						
5						
6						
7						
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11						
12						
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STX TALLY SHEET

ADMIN. UNIT

RANGER DIST.

SALE NO.

PAY UNIT

DATE

OF

Single Bark Measurement is recorded as BKA. Two bark measurements as BKA and BKB

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM (*,)
L0VA	28.9	12	14		10	70	

XTRA (42)	XTRB (57)	(72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO.	J	T GRADS	F GRADS	SINELV	GR	TERM (*,+)
New Card	12	1	-999	338	4.0		
				289	8.0	AA	
			399	113	1350	BA	
			418	047	3790	BA	
New Card	12	2	448	917	5900	CA	
			459	857	6760	CA	
				-999		CA	
							*
New Card		3					
New Card		4					
New Card		5					
New Card		6					
New Card		7					
New Card		8					
New Card		9					

REMARKS ST #12. If only one single bark is measured, it is recorded BKA. Program doubles it. If two barks are recorded as BKA and BKB, program adds them.

CM 6-68

TREE CARDS. COLS. 1–11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1–4	5	KPI 6–9	VALUE STRATUM 10	SAMPLE CL. (*,=) 11	NON-PUNCH OPTIONAL INFORMATION
1			46	1		
2			106	1		
3			40	1		
4			25	1		
5			30	2		
6			36	1		
7			13	1		
8			48	2		
9	13		33	1	*	
10						
11						
12						
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STX TALLY SHEET

ADMIN. UNIT ______

RANGER DIST. ______

SALE NO. ______ NAME ______

PAY UNIT ______

DATE ______ PAGE ___ OF ___

(Bark option.)

TREE CARD CO[...] LE TREE

CLASS (12)	DBH (17)	OPT (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM
L4VA	18.8	130	8	10			

XTRA (42)	XTRB (57–72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO. J	T GRADS	F GRADS	SINELV	GR
New Card	13 1	999	243	4.0	
			188	8.0	AA
		430	863	11270	AA
		447	811	13340	BA
New Card	13 2	457	756	14890	CA
		473	723	15760	CA
New Card	3				
New Card	4				
New Card	5				
New Card	6				
New Card	7				
New Card	8				
New Card	9				

REMARKS ST #13. Col. 24 under OPT codes the method to be used for reducing outside-bark stem diameters to wood diameters.

CM 6-68

TREE CARDS, COLS. 1-11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*,=) 11	NON-PUNCH OPTIONAL INFORMATION
1			24	1		-
2			25	1		-
3			45	2		-
4			43	1		-
5			39	1		-
6			14	1		-
7			99	2		-
8			23	1		35
9			23	1		28
10			31	1		-
11			39	1		-
12			44	1		-
13			12	2		61
14			43	1		-
15	14		132	2	=	-
16						
17						
18						
19						
20						
21						
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23						
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STX TALLY SHEET

ADMIN. UNIT

RANGER DIST.

SALE NO.

PAY UNIT

DATE

PAGE OF

When Col. 24 and BKA and BKB are blank DIB/DOB = .90

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM (*,)
HIVA	21.9						

XTRA (42)	XTRB (57)	(72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO.	J	T GRADS	F GRADS	SINELV	GR
New Card	14	1	414	1105	-0510	1
			413	919	-0040	AA
			418	888	+1990	AA
			432	831	+3836	CA
New Card	14	2	462	761	+5620	CA
			475	706	+6340	CA
New Card		3				
New Card		4				
New Card		5				
New Card		6				
New Card		7				
New Card		8				
New Card		9				

REMARKS ST #14. If col. 24 under OPT is blank, and no bark thickness is recorded, program assumes Dib/Dob is .90. This value is easily changed if desired.

CM 6-68

TREE CARDS. COLS. 1 - 11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*, =) 11	NON-PUNCH OPTIONAL INFORMATION
1			272	2		–
2			44	1		–
3			46	1		–
4			65	1		–
5			76	1		–
6			12	1		–
7			40	1		–
8			12	1		–
9			28	1		–
10			44	1		–
11			39	1		–
12			49	1		75
13			28	1		–
14			41	1		–
15			44	1		–
16			33	1		–
17			49	1		–
18			48	2		–
19			51	2		56
20			24	2		–
21			19	1		–
22			23	1		–
23	15		69	2	*	69
24						
25						
26						
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STX TALLY SHEET

ADMIN. UNIT ______

RANGER DIST. ______

SALE NO. ______ NAME ______

PAY UNIT ______ CREW ______

DATE PAGE OF

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM (+, *)
4IVA	16.8	120	8	12			

XTRA (42)	XTRB (57)	72

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO. J	T GRADS	F GRADS	SINELV	GR	TERM (+, *)
New Card	15 1	999	197	4.10		
			168	8.10	AA	
		360	852	11350	AA	
		374	807	12970	BA	+
New Card	15 2	374	802	12980		
		413	737	15620	CA	
						+
New Card	15 3	375	805	12960		
		416	738	15130	CA	
		424	498	16540	CA	
						*
New Card	4					
New Card	5					
New Card	6					
New Card	7					
New Card	8					

Sections terminated with + indicate fork

ST #15. Trees forked above breast height are measured by terminating the single stem section with (+) sign. Each prong except the last is also terminated with a (+) sign. The tallest prong is left till last and is terminated with an (*) to indicate that next card is for a new tree. Measurements for each prong begin at base of prong.

CM 6-68

TREE CARDS, COLS. 1-11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*, =) 11	NON-PUNCH OPTIONAL INFORMATION
1			45	2		-
2			316	1		-
3			39	1		-
4			9	2		-
5			25	1		-
6			39	1		-
7			33	1		-
8			46	1		108
9			51	1		-
10			36	1		-
11			15	1		-
12			25	1		108
13			15	2		-
14			84	2		-
15			44	1		-
16			15	1		-
17			49	1		-
18			64	1		72
19	16		21	2	*	18
20						
21						
22						
23						
24						
25						
26						
27						
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STX TALLY SHEET

ADMIN. UNIT ____
RANGER DIST. ____
SALE NO. ____ NAME ____
PAY UNIT ____ CREW ____
DATE ____ PAGE ____ OF ____

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM (*, =)
HIVA	11.1	120	8	4			

XTRA (42)	XTRB (57)	(72)

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO.	J	T GRADS	F GRADS	SINELV	GR.
New Card	16	1	999	132	31.5	
				111	81.5	AA
			367	711	10890	CA
			389	694	13500	CA
New Card	16	2	423	446	15440	CA
			468	469	16306	XX
New Card		3				
New Card		4				
New Card		5				
New Card		6				
New Card		7				
New Card		8				
New Card		9				

Dendrometry is terminated at total height when tip TGRADS + 0.1 = FGRADS

REMARKS ST #16. To terminate dendrometry at total height, measure TGRADS to terminal leaf (if feasible), and SINELV. Make FGRADS = (TGRADS + 0.1) as shown above.

CM 6-68

TREE CARDS, COLS. 1-11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*, =) 11	NON-PUNCH OPTIONAL INFORMATION
1			19	1		26
2			57	2		-
3			53	1		-
4			31	1		-
5			25	1		-
6			36	2		-
7			12	1		-
8			17	1		-
9			44	1		-
10			40	1		-
11			65	1		-
12			39	1		-
13			9	1		-
14			39	1		111
15			33	1		-
16			52	1		-
17			43	1		-
18			12	1		-
19			26	1		-
20			33	1		-
21			51	2		-
22	17		33	1	*	14
23						
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STX TALLY SHEET

ADMIN. UNIT ______
RANGER DIST. ______
SALE NO. ______ NAME ______
PAY UNIT ______ CREW ______
DATE   PAGE   OF

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)	TERM.
LØVA	19.0	20					

XTRA (42) ______ XTRB (57-72) ______

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO.	J	T GRADS	F GRADS	SINELV	GR
New Card	17	1	-999	218	3.5	
				190	18.5	AA
			356	910	11576	CA
			385	841	14246	CA
New Card	17	2	425	725	16110	CA
			-999	-999	17500	XX
New Card		3				
New Card		4				
New Card		5				
New Card		6				
New Card		7				
New Card		8				
New Card		9				

Computer projection when tip TGRADS not feasible

REMARKS ST #17. If TGRADS to tip are not feasible, measure approx. SINELV at total height. Record both TGRADS and FGRADS as -999 to obtain a computer projection

CM 6-68

TREE CARDS, COLS. 1-11 FOR ALL TREES. WHEN A SAMPLE TREE IS REACHED, SHOW * OR = IN COL. 11, AND START NEW PAGE FOR NEXT TALLY. TREE CARD FOR SAMPLE IS COMPLETED AT RIGHT.

NON-PUNCH TREE COUNT	TREE NO. (SAMPLES ONLY) 1-4	5	KPI 6-9	VALUE STRATUM 10	SAMPLE CL. (*,=) 11	NON-PUNCH OPTIONAL INFORMATION
1			33	1		–
2			28	1		–
3			69	2		–
4			36	2		95
5			30	2		–
6	18		117	2	*	74
7						
8						
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STX TALLY SHEET

ADMIN. UNIT ____________
RANGER DIST. ____________
SALE NO. ______ NAME ____________
PAY UNIT ______ CREW ____________
DATE ____________ PAGE ___ OF ___

TREE CARD CONTINUATION FOR SAMPLE TREE

CLASS (12)	DBH (17)	OPT. (23)	BKA (27)	BKB (31)	UML (36)	UDT (39)
4IVA	20.1	120	11	11		

XTRA (42) ____ (57) ____

Code classifies stem segment below

DENDROMETER CARDS FOR ABOVE SAMPLE TREE (9-CARD LIMIT)

	TREE NO. J	T GRADS	F GRADS	SINELV	GR.
New Card	18 1	–999	1244	3.5	
			1201	18.5	AA
		4400	[illegible]	11260	AA
		4417	839	13460	CA
New Card	18 2	4446	758	15270	CA
		4475	697	16320	CA
		4484	662	17030	UU
		–999	–999	17460	XX
New Card	3				
New Card	4				
New Card	5				
New Card	6				
New Card	7				
New Card	8				
New Card	9				

REMARKS ST #18. A one or two-letter class code may be entered to describe segment below each measurement. Thus, first AA describes first 3.5 feet of this stem.

CM 6-68

APPENDIX D.—Tables of trigonometric functions[15]

Natural Sines, Cosines and Tangents

0°–14.9°

Degs.	Function	0.0°	0.1°	0.2°	0.3°	0.4°	0.5°	0.6°	0.7°	0.8°	0.9°
0	sin	0.0000	0.0017	0.0035	0.0052	0.0070	0.0087	0.0105	0.0122	0.0140	0.0157
	cos	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9999	0.9999	0.9999
	tan	0.0000	0.0017	0.0035	0.0052	0.0070	0.0087	0.0105	0.0122	0.0140	0.0157
1	sin	0.0175	0.0192	0.0209	0.0227	0.0244	0.0262	0.0279	0.0297	0.0314	0.0332
	cos	0.9998	0.9998	0.9998	0.9997	0.9997	0.9997	0.9996	0.9996	0.9995	0.9995
	tan	0.0175	0.0192	0.0209	0.0227	0.0244	0.0262	0.0279	0.0297	0.0314	0.0332
2	sin	0.0349	0.0366	0.0384	0.0401	0.0419	0.0436	0.0454	0.0471	0.0488	0.0506
	cos	0.9994	0.9993	0.9993	0.9992	0.9991	0.9990	0.9990	0.9989	0.9988	0.9987
	tan	0.0349	0.0367	0.0384	0.0402	0.0419	0.0437	0.0454	0.0472	0.0489	0.0507
3	sin	0.0523	0.0541	0.0558	0.0576	0.0593	0.0610	0.0628	0.0645	0.0663	0.0680
	cos	0.9986	0.9985	0.9984	0.9983	0.9982	0.9981	0.9980	0.9979	0.9978	0.9977
	tan	0.0524	0.0542	0.0559	0.0577	0.0594	0.0612	0.0629	0.0647	0.0664	0.0682
4	sin	0.0698	0.0715	0.0732	0.0750	0.0767	0.0785	0.0802	0.0819	0.0837	0.0854
	cos	0.9976	0.9974	0.9973	0.9972	0.9971	0.9969	0.9968	0.9966	0.9965	0.9963
	tan	0.0699	0.0717	0.0734	0.0752	0.0769	0.0787	0.0805	0.0822	0.0840	0.0857
5	sin	0.0872	0.0889	0.0906	0.0924	0.0941	0.0958	0.0976	0.0993	0.1011	0.1028
	cos	0.9962	0.9960	0.9959	0.9957	0.9956	0.9954	0.9952	0.9951	0.9949	0.9947
	tan	0.0875	0.0892	0.0910	0.0928	0.0945	0.0963	0.0981	0.0998	0.1016	0.1033
6	sin	0.1045	0.1063	0.1080	0.1097	0.1115	0.1132	0.1149	0.1167	0.1184	0.1201
	cos	0.9945	0.9943	0.9942	0.9940	0.9938	0.9936	0.9934	0.9932	0.9930	0.9928
	tan	0.1051	0.1069	0.1086	0.1104	0.1122	0.1139	0.1157	0.1175	0.1192	0.1210
7	sin	0.1219	0.1236	0.1253	0.1271	0.1288	0.1305	0.1323	0.1340	0.1357	0.1374
	cos	0.9925	0.9923	0.9921	0.9919	0.9917	0.9914	0.9912	0.9910	0.9907	0.9905
	tan	0.1228	0.1246	0.1263	0.1281	0.1299	0.1317	0.1334	0.1352	0.1370	0.1388
8	sin	0.1392	0.1409	0.1426	0.1444	0.1461	0.1478	0.1495	0.1513	0.1530	0.1547
	cos	0.9903	0.9900	0.9898	0.9895	0.9893	0.9890	0.9888	0.9885	0.9882	0.9880
	tan	0.1405	0.1423	0.1441	0.1459	0.1477	0.1495	0.1512	0.1530	0.1548	0.1566
9	sin	0.1564	0.1582	0.1599	0.1616	0.1633	0.1650	0.1668	0.1685	0.1702	0.1719
	cos	0.9877	0.9874	0.9871	0.9869	0.9866	0.9863	0.9860	0.9857	0.9854	0.9851
	tan	0.1584	0.1602	0.1620	0.1638	0.1655	0.1673	0.1691	0.1709	0.1727	0.1745
10	sin	0.1736	0.1754	0.1771	0.1788	0.1805	0.1822	0.1840	0.1857	0.1874	0.1891
	cos	0.9848	0.9845	0.9842	0.9839	0.9836	0.9833	0.9829	0.9826	0.9823	0.9820
	tan	0.1763	0.1781	0.1799	0.1817	0.1835	0.1853	0.1871	0.1890	0.1908	0.1926
11	sin	0.1908	0.1925	0.1942	0.1959	0.1977	0.1994	0.2011	0.2028	0.2045	0.2062
	cos	0.9816	0.9813	0.9810	0.9806	0.9803	0.9799	0.9796	0.9792	0.9789	0.9785
	tan	0.1944	0.1962	0.1980	0.1998	0.2016	0.2035	0.2053	0.2071	0.2089	0.2107
12	sin	0.2079	0.2096	0.2113	0.2130	0.2147	0.2164	0.2181	0.2198	0.2215	0.2232
	cos	0.9781	0.9778	0.9774	0.9770	0.9767	0.9763	0.9759	0.9755	0.9751	0.9748
	tan	0.2126	0.2144	0.2162	0.2180	0.2199	0.2217	0.2235	0.2254	0.2272	0.2290
13	sin	0.2250	0.2267	0.2284	0.2300	0.2318	0.2334	0.2351	0.2368	0.2385	0.2402
	cos	0.9744	0.9740	0.9736	0.9732	0.9728	0.9724	0.9720	0.9715	0.9711	0.9707
	tan	0.2309	0.2327	0.2345	0.2364	0.2382	0.2401	0.2419	0.2438	0.2456	0.2475
14	sin	0.2419	0.2436	0.2453	0.2470	0.2487	0.2504	0.2521	0.2538	0.2554	0.2571
	cos	0.9703	0.9699	0.9694	0.9690	0.9686	0.9681	0.9677	0.9673	0.9668	0.9664
	tan	0.2493	0.2512	0.2530	0.2549	0.2568	0.2586	0.2605	0.2623	0.2642	0.2661
Degs.	Function	0′	6′	12′	18′	24′	30′	36′	42′	48′	54′

Degs.	Function	0.0°	0.1°	0.2°	0.3°	0.4°	0.5°	0.6°	0.7°	0.8°	0.9°
15	sin	0.2588	0.2605	0.2622	0.2639	0.2656	0.2672	0.2689	0.2706	0.2723	0.2740
	cos	0.9659	0.9655	0.9650	0.9646	0.9641	0.9636	0.9632	0.9627	0.9622	0.9617
	tan	0.2679	0.2698	0.2717	0.2736	0.2754	0.2773	0.2792	0.2811	0.2830	0.2849
16	sin	0.2756	0.2773	0.2790	0.2807	0.2823	0.2840	0.2857	0.2874	0.2890	0.2907
	cos	0.9613	0.9608	0.9603	0.9598	0.9593	0.9588	0.9583	0.9578	0.9573	0.9568
	tan	0.2867	0.2886	0.2905	0.2924	0.2943	0.2962	0.2981	0.3000	0.3019	0.3038
17	sin	0.2924	0.2940	0.2957	0.2974	0.2990	0.3007	0.3024	0.3040	0.3057	0.3074
	cos	0.9563	0.9558	0.9553	0.9548	0.9542	0.9537	0.9532	0.9527	0.9521	0.9516
	tan	0.3057	0.3076	0.3096	0.3115	0.3134	0.3153	0.3172	0.3191	0.3211	0.3230
18	sin	0.3090	0.3107	0.3123	0.3140	0.3156	0.3173	0.3190	0.3206	0.3223	0.3239
	cos	0.9511	0.9505	0.9500	0.9494	0.9489	0.9483	0.9478	0.9472	0.9466	0.9461
	tan	0.3249	0.3269	0.3288	0.3307	0.3327	0.3346	0.3365	0.3385	0.3404	0.3424
19	sin	0.3256	0.3272	0.3289	0.3305	0.3322	0.3338	0.3355	0.3371	0.3387	0.3404
	cos	0.9455	0.9449	0.9444	0.9438	0.9432	0.9426	0.9421	0.9415	0.9409	0.9403
	tan	0.3443	0.3463	0.3482	0.3502	0.3522	0.3541	0.3561	0.3581	0.3600	0.3620
20	sin	0.3420	0.3437	0.3453	0.3469	0.3486	0.3502	0.3518	0.3535	0.3551	0.3567
	cos	0.9397	0.9391	0.9385	0.9379	0.9373	0.9367	0.9361	0.9354	0.9348	0.9342
	tan	0.3640	0.3659	0.3679	0.3699	0.3719	0.3739	0.3759	0.3779	0.3799	0.3819
21	sin	0.3584	0.3600	0.3616	0.3633	0.3649	0.3665	0.3681	0.3697	0.3714	0.3730
	cos	0.9336	0.9330	0.9323	0.9317	0.9311	0.9304	0.9298	0.9291	0.9285	0.9278
	tan	0.3839	0.3859	0.3879	0.3899	0.3919	0.3939	0.3959	0.3979	0.4000	0.4020
22	sin	0.3746	0.3762	0.3778	0.3795	0.3811	0.3827	0.3843	0.3859	0.3875	0.3891
	cos	0.9272	0.9265	0.9259	0.9252	0.9245	0.9239	0.9232	0.9225	0.9219	0.9212
	tan	0.4040	0.4061	0.4081	0.4101	0.4122	0.4142	0.4163	0.4183	0.4204	0.4224
23	sin	0.3907	0.3923	0.3939	0.3955	0.3971	0.3987	0.4003	0.4019	0.4035	0.4051
	cos	0.9205	0.9198	0.9191	0.9184	0.9178	0.9171	0.9164	0.9157	0.9150	0.9143
	tan	0.4245	0.4265	0.4286	0.4307	0.4327	0.4348	0.4369	0.4390	0.4411	0.4431
24	sin	0.4067	0.4083	0.4099	0.4115	0.4131	0.4147	0.4163	0.4179	0.4195	0.4210
	cos	0.9135	0.9128	0.9121	0.9114	0.9107	0.9100	0.9092	0.9085	0.9078	0.9070
	tan	0.4452	0.4473	0.4494	0.4515	0.4536	0.4557	0.4578	0.4599	0.4621	0.4642
25	sin	0.4226	0.4242	0.4258	0.4274	0.4289	0.4305	0.4321	0.4337	0.4352	0.4368
	cos	0.9063	0.9056	0.9048	0.9041	0.9033	0.9026	0.9018	0.9011	0.9003	0.8996
	tan	0.4663	0.4684	0.4706	0.4727	0.4748	0.4770	0.4791	0.4813	0.4834	0.4856
26	sin	0.4384	0.4399	0.4415	0.4431	0.4446	0.4462	0.4478	0.4493	0.4509	0.4524
	cos	0.8988	0.8980	0.8973	0.8965	0.8957	0.8949	0.8942	0.8934	0.8926	0.8918
	tan	0.4877	0.4899	0.4921	0.4942	0.4964	0.4986	0.5008	0.5029	0.5051	0.5073
27	sin	0.4540	0.4555	0.4571	0.4586	0.4602	0.4617	0.4633	0.4648	0.4664	0.4679
	cos	0.8910	0.8902	0.8894	0.8886	0.8878	0.8870	0.8862	0.8854	0.8846	0.8838
	tan	0.5095	0.5117	0.5139	0.5161	0.5184	0.5206	0.5228	0.5250	0.5272	0.5295
28	sin	0.4695	0.4710	0.4726	0.4741	0.4756	0.4772	0.4787	0.4802	0.4818	0.4833
	cos	0.8829	0.8821	0.8813	0.8805	0.8796	0.8788	0.8780	0.8771	0.8763	0.8755
	tan	0.5317	0.5340	0.5362	0.5384	0.5407	0.5430	0.5452	0.5475	0.5498	0.5520
29	sin	0.4848	0.4863	0.4879	0.4894	0.4909	0.4924	0.4939	0.4955	0.4970	0.4985
	cos	0.8746	0.8738	0.8729	0.8721	0.8712	0.8704	0.8695	0.8686	0.8678	0.8669
	tan	0.5543	0.5566	0.5589	0.5612	0.5635	0.5658	0.5681	0.5704	0.5727	0.5750
Degs.	Function	0′	6′	12′	18′	24′	30′	36′	42′	48′	54′

[15] From Hudson and Lipka. A manual of mathematics. New York, John Wiley and Sons, 1917.

Degs.	Function	0.0°	0.1°	0.2°	0.3°	0.4°	0.5°	0.6°	0.7°	0.8°	0.9°
30	sin	0.5000	0.5015	0.5030	0.5045	0.5060	0.5075	0.5090	0.5105	0.5120	0.5135
	cos	0.8660	0.8652	0.8643	0.8634	0.8625	0.8616	0.8607	0.8599	0.8590	0.8581
	tan	0.5774	0.5797	0.5820	0.5844	0.5867	0.5890	0.5914	0.5938	0.5961	0.5985
31	sin	0.5150	0.5165	0.5184	0.5195	0.5210	0.5225	0.5240	0.5255	0.5270	0.5284
	cos	0.8572	0.8563	0.8550	0.8545	0.8536	0.8526	0.8517	0.8508	0.8499	0.8490
	tan	0.6009	0.6032	0.6056	0.6080	0.6104	0.6128	0.6152	0.6176	0.6200	0.6224
32	sin	0.5299	0.5314	0.5329	0.5344	0.5358	0.5373	0.5388	0.5402	0.5417	0.5432
	cos	0.8480	0.8471	0.8462	0.8453	0.8143	0.8434	0.8425	0.8415	0.8406	0.8396
	tan	0.6249	0.6273	0.6297	0.6322	0.6346	0.6371	0.6395	0.6420	0.6445	0.6469
33	sin	0.5446	0.5461	0.5476	0.5490	0.5505	0.5519	0.5534	0.5548	0.5563	0.5577
	cos	0.8387	0.8377	0.8368	0.8358	0.8348	0.8339	0.8329	0.8320	0.8310	0.8300
	tan	0.6494	0.6519	0.6544	0.6569	0.6594	0.6619	0.6644	0.6669	0.6694	0.6720
34	sin	0.5592	0.5606	0.5621	0.5635	0.5650	0.5664	0.5678	0.5693	0.5707	0.5721
	cos	0.8290	0.8281	0.8271	0.8261	0.8251	0.8241	0.8231	0.8221	0.8211	0.8202
	tan	0.6745	0.6771	0.6796	0.6822	0.6847	0.6873	0.6899	0.6924	0.6950	0.6976
35	sin	0.5736	0.5750	0.5764	0.5779	0.5793	0.5807	0.5821	0.5835	0.5850	0.5864
	cos	0.8192	0.8181	0.8171	0.8161	0.8151	0.8141	0.8131	0.8121	0.8111	0.8100
	tan	0.7002	0.7028	0.7054	0.7080	0.7107	0.7133	0.7159	0.7186	0.7212	0.7239
36	sin	0.5878	0.5892	0.5906	0.5920	0.5934	0.5948	0.5962	0.5976	0.5990	0.6004
	cos	0.8090	0.8080	0.8070	0.8059	0.8049	0.8039	0.8028	0.8018	0.8007	0.7997
	tan	0.7265	0.7292	0.7319	0.7346	0.7373	0.7400	0.7427	0.7454	0.7481	0.7508
37	sin	0.6018	0.6032	0.6046	0.6060	0.6074	0.6088	0.6101	0.6115	0.6129	0.6143
	cos	0.7986	0.7976	0.7965	0.7955	0.7944	0.7934	0.7923	0.7912	0.7902	0.7891
	tan	0.7536	0.7563	0.7590	0.7618	0.7646	0.7673	0.7701	0.7729	0.7757	0.7785
38	sin	0.6157	0.6170	0.6184	0.6198	0.6211	0.6225	0.6239	0.6252	0.6266	0.6280
	cos	0.7880	0.7869	0.7859	0.7848	0.7837	0.7826	0.7815	0.7804	0.7793	0.7782
	tan	0.7813	0.7841	0.7869	0.7898	0.7926	0.7954	0.7983	0.8012	0.8040	0.8069
39	sin	0.6293	0.6307	0.6320	0.6334	0.6347	0.6361	0.6374	0.6388	0.6401	0.6414
	cos	0.7771	0.7760	0.7749	0.7738	0.7727	0.7716	0.7705	0.7694	0.7683	0.7672
	tan	0.8098	0.8127	0.8156	0.8185	0.8214	0.8243	0.8273	0.8302	0.8332	0.8361
40	sin	0.6428	0.6441	0.6455	0.6468	0.6481	0.6494	0.6508	0.6521	0.6534	0.6547
	cos	0.7660	0.7649	0.7633	0.7627	0.7615	0.7604	0.7593	0.7581	0.7570	0.7559
	tan	0.8391	0.8421	0.8451	0.8481	0.8511	0.8541	0.8571	0.8601	0.8632	0.8662
41	sin	0.6561	0.6574	0.6587	0.6600	0.6613	0.6626	0.6639	0.6652	0.6665	0.6678
	cos	0.7547	0.7536	0.7524	0.7513	0.7501	0.7490	0.7478	0.7466	0.7455	0.7443
	tan	0.8693	0.8724	0.8754	0.8785	0.8816	0.8847	0.8878	0.8910	0.8941	0.8972
42	sin	0.6691	0.6704	0.6717	0.6730	0.6743	0.6756	0.6769	0.6782	0.6794	0.6807
	cos	0.7431	0.7420	0.7408	0.7396	0.7385	0.7373	0.7361	0.7349	0.7337	0.7325
	tan	0.9004	0.9036	0.9067	0.9099	0.9131	0.9163	0.9195	0.9228	0.9260	0.9293
43	sin	0.6820	0.6833	0.6845	0.6858	0.6871	0.6884	0.6896	0.6909	0.6921	0.6934
	cos	0.7314	0.7302	0.7290	0.7278	0.7266	0.7254	0.7242	0.7230	0.7218	0.7206
	tan	0.9325	0.9358	0.9391	0.9424	0.9457	0.9490	0.9523	0.9556	0.9590	0.9623
44	sin	0.6947	0.6959	0.6972	0.6984	0.6997	0.7009	0.7022	0.7034	0.7046	0.7059
	cos	0.7193	0.7181	0.7169	0.7157	0.7145	0.7133	0.7120	0.7108	0.7096	0.7083
	tan	0.9657	0.9691	0.9725	0.9759	0.9793	0.9827	0.9861	0.9896	0.9930	0.9965
Degs.	Function	0′	6′	12′	18′	24′	30′	36′	42′	48′	54′

Natural Sines, Cosines and Tangents

45°–59.9°

Degs.	Function	0.0°	0.1°	0.2°	0.3°	0.4°	0.5°	0.6°	0.7°	0.8°	0.9°
45	sin	0.7071	0.7083	0.7096	0.7108	0.7120	0.7133	0.7145	0.7157	0.7169	0.7181
	cos	0.7071	0.7059	0.7046	0.7034	0.7022	0.7009	0.6997	0.6984	0.6972	0.6959
	tan	1.0000	1.0035	1.0070	1.0105	1.0141	1.0176	1.0212	1.0247	1.0283	1.0319
46	sin	0.7193	0.7206	0.7218	0.7230	0.7242	0.7254	0.7266	0.7278	0.7290	0.7302
	cos	0.6947	0.6934	0.6921	0.6909	0.6896	0.6884	0.6871	0.6858	0.6845	0.6833
	tan	1.0355	1.0392	1.0428	1.0464	1.0501	1.0538	1.0575	1.0612	1.0649	1.0686
47	sin	0.7314	0.7325	0.7337	0.7349	0.7361	0.7373	0.7385	0.7396	0.7408	0.7420
	cos	0.6820	0.6807	0.6794	0.6782	0.6769	0.6756	0.6743	0.6730	0.6717	0.6704
	tan	1.0724	1.0761	1.0799	1.0837	1.0875	1.0913	1.0951	1.0990	1.1028	1.1067
48	sin	0.7431	0.7443	0.7455	0.7466	0.7478	0.7490	0.7501	0.7513	0.7524	0.7536
	cos	0.6691	0.6678	0.6665	0.6652	0.6639	0.6626	0.6613	0.6600	0.6587	0.6574
	tan	1.1106	1.1145	1.1184	1.1224	1.1263	1.1303	1.1343	1.1383	1.1423	1.1463
49	sin	0.7547	0.7559	0.7570	0.7581	0.7593	0.7604	0.7615	0.7627	0.7638	0.7649
	cos	0.6561	0.6547	0.6534	0.6521	0.6508	0.6494	0.6481	0.6468	0.6455	0.6441
	tan	1.1504	1.1544	1.1585	1.1626	1.1667	1.1708	1.1750	1.1792	1.1833	1.1875
50	sin	0.7660	0.7672	0.7683	0.7694	0.7705	0.7716	0.7727	0.7738	0.7749	0.7760
	cos	0.6428	0.6414	0.6401	0.6388	0.6374	0.6361	0.6347	0.6334	0.6320	0.6307
	tan	1.1918	1.1960	1.2002	1.2045	1.2088	1.2131	1.2174	1.2218	1.2261	1.2305
51	sin	0.7771	0.7782	0.7793	0.7804	0.7815	0.7826	0.7837	0.7848	0.7859	0.7869
	cos	0.6293	0.6280	0.6266	0.6252	0.6239	0.6225	0.6211	0.6198	0.6184	0.6170
	tan	1.2349	1.2393	1.2437	1.2482	1.2527	1.2572	1.2617	1.2662	1.2708	1.2753
52	sin	0.7880	0.7891	0.7902	0.7912	0.7923	0.7934	0.7944	0.7955	0.7965	0.7976
	cos	0.6157	0.6143	0.6129	0.6115	0.6101	0.6088	0.6074	0.6060	0.6046	0.6032
	tan	1.2799	1.2846	1.2892	1.2938	1.2985	1.3032	1.3079	1.3127	1.3175	1.3222
53	sin	0.7986	0.7997	0.8007	0.8018	0.8028	0.8039	0.8049	0.8059	0.8070	0.8080
	cos	0.6018	0.6004	0.5990	0.5976	0.5962	0.5948	0.5934	0.5920	0.5906	0.5892
	tan	1.3270	1.3319	1.3367	1.3416	1.3465	1.3514	1.3564	1.3613	1.3663	1.3713
54	sin	0.8090	0.8100	0.8111	0.8121	0.8131	0.8141	0.8151	0.8161	0.8171	0.8181
	cos	0.5878	0.5864	0.5850	0.5835	0.5821	0.5807	0.5793	0.5779	0.5764	0.5750
	tan	1.3764	1.3814	1.3865	1.3916	1.3968	1.4019	1.4071	1.4124	1.4176	1.4229
55	sin	0.8192	0.8202	0.8211	0.8221	0.8231	0.8241	0.8251	0.8261	0.8271	0.8281
	cos	0.5736	0.5721	0.5707	0.5693	0.5678	0.5664	0.5650	0.5635	0.5621	0.5606
	tan	1.4281	1.4335	1.4388	1.4442	1.4496	1.4550	1.4605	1.4659	1.4715	1.4770
56	sin	0.8290	0.8300	0.8310	0.8320	0.8329	0.8339	0.8348	0.8358	0.8368	0.8377
	cos	0.5592	0.5577	0.5563	0.5548	0.5534	0.5519	0.5505	0.5490	0.5476	0.5461
	tan	1.4826	1.4882	1.4938	1.4994	1.5051	1.5108	1.5166	1.5224	1.5282	1.5340
57	sin	0.8387	0.8396	0.8406	0.8415	0.8425	0.8434	0.8443	0.8453	0.8462	0.8471
	cos	0.5446	0.5432	0.5417	0.5402	0.5388	0.5373	0.5358	0.5344	0.5329	0.5314
	tan	1.5399	1.5458	1.5517	1.5577	1.5637	1.5697	1.5757	1.5818	1.5880	1.5941
58	sin	0.8480	0.8490	0.8499	0.8508	0.8517	0.8526	0.8536	0.8545	0.8554	0.8563
	cos	0.5299	0.5284	0.5270	0.5255	0.5240	0.5225	0.5210	0.5195	0.5180	0.5165
	tan	1.6003	1.6066	1.6128	1.6191	1.6255	1.6319	1.6383	1.6447	1.6512	1.6577
59	sin	0.8572	0.8581	0.8590	0.8599	0.8607	0.8616	0.8625	0.8634	0.8643	0.8652
	cos	0.5150	0.5135	0.5120	0.5105	0.5090	0.5075	0.5060	0.5045	0.5030	0.5015
	tan	1.6643	1.6709	1.6775	1.6842	1.6909	1.6977	1.7045	1.7113	1.7182	1.7251
Degs.	Function	0′	6′	12′	18′	24′	30′	36′	42′	48′	54′

Degs.	Function	0.0°	0.1°	0.2°	0.3°	0.4°	0.5°	0.6°	0.7°	0.8°	0.9°
60	sin	0.8660	0.8669	0.8678	0.8686	0.8695	0.8704	0.8712	0.8721	0.8729	0.8738
	cos	0.5000	0.4985	0.4970	0.4955	0.4939	0.4924	0.4909	0.4894	0.4879	0.4863
	tan	1.7321	1.7391	1.7461	1.7532	1.7603	1.7675	1.7747	1.7820	1.7893	1.7966
61	sin	0.8746	0.8755	0.8763	0.8771	0.8780	0.8788	0.8796	0.8805	0.8813	0.8821
	cos	0.4848	0.4833	0.4818	0.4802	0.4787	0.4772	0.4756	0.4741	0.4726	0.4710
	tan	1.8040	1.8115	1.8190	1.8265	1.8341	1.8418	1.8495	1.8572	1.8650	1.8728
62	sin	0.8829	0.8838	0.8846	0.8854	0.8862	0.8870	0.8878	0.8886	0.8894	0.8902
	cos	0.4695	0.4679	0.4664	0.4648	0.4633	0.4617	0.4602	0.4586	0.4571	0.4555
	tan	1.8807	1.8887	1.8967	1.9047	1.9128	1.9210	1.9292	1.9375	1.9458	1.9542
63	sin	0.8910	0.8918	0.8926	0.8934	0.8942	0.8949	0.8957	0.8965	0.8973	0.8980
	cos	0.4540	0.4524	0.4509	0.4493	0.4478	0.4462	0.4446	0.4431	0.4415	0.4399
	tan	1.9626	1.9711	1.9797	1.9883	1.9970	2.0057	2.0145	2.0233	2.0323	2.0413
64	sin	0.8988	0.8996	0.9003	0.9011	0.9018	0.9026	0.9033	0.9041	0.9048	0.9056
	cos	0.4384	0.4368	0.4352	0.4337	0.4321	0.4305	0.4289	0.4274	0.4258	0.4242
	tan	2.0503	2.0594	2.0686	2.0778	2.0872	2.0965	2.1060	2.1155	2.1251	2.1348
65	sin	0.9063	0.9070	0.9078	0.9085	0.9092	0.9100	0.9107	0.9114	0.9121	0.9128
	cos	0.4226	0.4210	0.4195	0.4179	0.4163	0.4147	0.4131	0.4115	0.4099	0.4083
	tan	2.1445	2.1543	2.1642	2.1742	2.1842	2.1943	2.2045	2.2148	2.2251	2.2355
66	sin	0.9135	0.9143	0.9150	0.9157	0.9164	0.9171	0.9178	0.9184	0.9191	0.9198
	cos	0.4067	0.4051	0.4035	0.4019	0.4003	0.3987	0.3971	0.3955	0.3939	0.3923
	tan	2.2460	2.2566	2.2673	2.2781	2.2889	2.2998	2.3109	2.3220	2.3332	2.3445
67	sin	0.9205	0.9212	0.9219	0.9225	0.9232	0.9239	0.9245	0.9252	0.9259	0.9265
	cos	0.3907	0.3891	0.3875	0.3859	0.3843	0.3827	0.3811	0.3795	0.3778	0.3762
	tan	2.3559	2.3673	2.3789	2.3906	2.4023	2.4142	2.4262	2.4383	2.4504	2.4627
68	sin	0.9272	0.9278	0.9285	0.9291	0.9298	0.9304	0.9311	0.9317	0.9323	0.9330
	cos	0.3746	0.3730	0.3714	0.3697	0.3681	0.3665	0.3649	0.3633	0.3616	0.3600
	tan	2.4751	2.4876	2.5002	2.5129	2.5257	2.5386	2.5517	2.5649	2.5782	2.5916
69	sin	0.9336	0.9342	0.9348	0.9354	0.9361	0.9367	0.9373	0.9379	0.9385	0.9391
	cos	0.3584	0.3567	0.3551	0.3535	0.3518	0.3502	0.3486	0.3469	0.3453	0.3437
	tan	2.6051	2.6187	2.6325	2.6464	2.6605	2.6746	2.6889	2.7034	2.7179	2.7326
70	sin	0.9397	0.9403	0.9409	0.9415	0.9421	0.9426	0.9432	0.9438	0.9444	0.9449
	cos	0.3420	0.3404	0.3387	0.3371	0.3355	0.3338	0.3322	0.3305	0.3289	0.3272
	tan	2.7475	2.7625	2.7776	2.7929	2.8083	2.8239	2.8397	2.8556	2.8716	2.8878
71	sin	0.9455	0.9461	0.9466	0.9472	0.9478	0.9483	0.9489	0.9494	0.9500	0.9505
	cos	0.3256	0.3239	0.3223	0.3206	0.3190	0.3173	0.3156	0.3140	0.3123	0.3107
	tan	2.9042	2.9208	2.9375	2.9544	2.9714	2.9887	3.0061	3.0237	3.0415	3.0595
72	sin	0.9511	0.9516	0.9521	0.9527	0.9532	0.9537	0.9542	0.9548	0.9553	0.9558
	cos	0.3090	0.3074	0.3057	0.3040	0.3024	0.3007	0.2990	0.2974	0.2957	0.2940
	tan	3.0777	3.0961	3.1146	3.1334	3.1524	3.1716	3.1910	3.2106	3.2305	3.2506
73	sin	0.9563	0.9568	0.9573	0.9578	0.9583	0.9588	0.9593	0.9598	0.9603	0.9608
	cos	0.2924	0.2907	0.2890	0.2874	0.2857	0.2840	0.2823	0.2807	0.2790	0.2773
	tan	3.2709	3.2914	3.3122	3.3332	3.3544	3.3759	3.3977	3.4197	3.4420	3.4646
74	sin	0.9613	0.9617	0.9622	0.9627	0.9632	0.9636	0.9641	0.9646	0.9650	0.9655
	cos	0.2756	0.2740	0.2723	0.2706	0.2689	0.2672	0.2656	0.2639	0.2622	0.2605
	tan	3.4874	3.5105	3.5339	3.5576	3.5816	3.6059	3.6305	3.6554	3.6806	3.7062
Degs.	Function	0′	6′	12′	18′	24′	30′	36′	42′	48′	54′

Degs.	Function	0.0°	0.1°	0.2°	0.3°	0.4°	0.5°	0.6°	0.7°	0.8°	0.9°
75	sin	0.9659	0.9664	0.9668	0.9673	0.9677	0.9681	0.9686	0.9690	0.9694	0.9699
	cos	0.2588	0.2571	0.2554	0.2538	0.2521	0.2504	0.2487	0.2470	0.2453	0.2436
	tan	3.7321	3.7583	3.7848	3.8118	3.8391	3.8667	3.8947	3.9232	3.9520	3.9812
76	sin	0.9703	0.9707	0.9711	0.9715	0.9720	0.9724	0.9728	0.9732	0.9736	0.9740
	cos	0.2419	0.2402	0.2385	0.2368	0.2351	0.2334	0.2317	0.2300	0.2284	0.2267
	tan	4.0108	4.0408	4.0713	4.1022	4.1335	4.1653	4.1976	4.2303	4.2635	4.2972
77	sin	0.9744	0.9748	0.9751	0.9755	0.9759	0.9763	0.9767	0.9770	0.9774	0.9778
	cos	0.2250	0.2232	0.2215	0.2198	0.2181	0.2164	0.2147	0.2130	0.2113	0.2096
	tan	4.3315	4.3662	4.4015	4.4374	4.4737	4.5107	4.5483	4.5864	4.6252	4.6646
78	sin	0.9781	0.9785	0.9789	0.9792	0.9796	0.9799	0.9803	0.9806	0.9810	0.9813
	cos	0.2079	0.2062	0.2045	0.2028	0.2011	0.1994	0.1977	0.1959	0.1942	0.1925
	tan	4.7046	4.7453	4.7867	4.8288	4.8716	4.9152	4.9594	5.0045	5.0504	5.0970
79	sin	0.9816	0.9820	0.9823	0.9826	0.9829	0.9833	0.9836	0.9839	0.9842	0.9845
	cos	0.1908	0.1891	0.1874	0.1857	0.1840	0.1822	0.1805	0.1788	0.1771	0.1754
	tan	5.1446	5.1929	5.2422	5.2924	5.3435	5.3955	5.4486	5.5026	5.5578	5.6140
80	sin	0.9848	0.9851	0.9854	0.9857	0.9860	0.9863	0.9866	0.9869	0.9871	0.9874
	cos	0.1736	0.1719	0.1702	0.1685	0.1668	0.1650	0.1633	0.1616	0.1599	0.1582
	tan	5.6713	5.7297	5.7894	5.8502	5.9124	5.9758	6.0405	6.1066	6.1742	6.2432
81	sin	0.9877	0.9880	0.9882	0.9885	0.9888	0.9890	0.9893	0.9895	0.9898	0.9900
	cos	0.1564	0.1547	0.1530	0.1513	0.1495	0.1478	0.1461	0.1444	0.1426	0.1409
	tan	6.3138	6.3859	6.4596	6.5350	6.6122	6.6912	6.7720	6.8548	6.9395	7.0264
82	sin	0.9903	0.9905	0.9907	0.9910	0.9912	0.9914	0.9917	0.9919	0.9921	0.9923
	cos	0.1392	0.1374	0.1357	0.1340	0.1323	0.1305	0.1288	0.1271	0.1253	0.1236
	tan	7.1154	7.2066	7.3002	7.3962	7.4947	7.5958	7.6996	7.8062	7.9158	8.0285
83	sin	0.9925	0.9928	0.9930	0.9932	0.9934	0.9936	0.9938	0.9940	0.9942	0.9943
	cos	0.1219	0.1201	0.1184	0.1167	0.1149	0.1132	0.1115	0.1097	0.1080	0.1063
	tan	8.1443	8.2636	8.3863	8.5126	8.6427	8.7769	8.9152	9.0579	9.2052	9.3572
84	sin	0.9945	0.9947	0.9949	0.9951	0.9952	0.9954	0.9956	0.9957	0.9959	0.9960
	cos	0.1045	0.1028	0.1011	0.0993	0.0976	0.0958	0.0941	0.0924	0.0906	0.0889
	tan	9.5144	9.6768	9.8448	10.02	10.20	10.39	10.58	10.78	10.99	11.20
85	sin	0.9962	0.9963	0.9965	0.9966	0.9968	0.9969	0.9971	0.9972	0.9973	0.9974
	cos	0.0872	0.0854	0.0837	0.0819	0.0802	0.0785	0.0767	0.0750	0.0732	0.0715
	tan	11.43	11.66	11.91	12.16	12.43	12.71	13.00	13.30	13.62	13.95
86	sin	0.9976	0.9977	0.9978	0.9979	0.9980	0.9981	0.9982	0.9983	0.9984	0.9985
	cos	0.0698	0.0680	0.0663	0.0645	0.0628	0.0610	0.0593	0.0576	0.0558	0.0541
	tan	14.30	14.67	15.06	15.46	15.89	16.35	16.83	17.34	17.89	18.46
87	sin	0.9986	0.9987	0.9988	0.9989	0.9990	0.9990	0.9991	0.9992	0.9993	0.9993
	cos	0.0523	0.0506	0.0488	0.0471	0.0454	0.0436	0.0419	0.0401	0.0384	0.0366
	tan	19.08	19.74	20.45	21.20	22.02	22.90	23.86	24.90	26.03	27.27
88	sin	0.9994	0.9995	0.9995	0.9996	0.9996	0.9997	0.9997	0.9997	0.9998	0.9998
	cos	0.0349	0.0332	0.0314	0.0297	0.0279	0.0262	0.0244	0.0227	0.0209	0.0192
	tan	28.64	30.14	31.82	33.69	35.80	38.19	40.92	44.07	47.74	52.08
89	sin	0.9998	0.9999	0.9999	0.9999	0.9999	1.000	1.000	1.000	1.000	1.000
	cos	0.0175	0.0157	0.0140	0.0122	0.0105	0.0087	0.0070	0.0052	0.0035	0.0017
	tan	57.29	63.66	71.62	81.85	95.49	114.6	143.2	191.0	286.5	573.0
Degs.	**Function**	0′	6′	12′	18′	24′	30′	36′	42′	48′	54′