Some Methods of Estimating the Volume of Timber in Woods and Plantations

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General Principles

All methods of estimating the cubic contents of woods and plantations have as their basic principle an accurate count of all the trees and an accurate measurement of one or more sample trees. The numerous recognised "Methods" vary only in the way the sample trees are selected.

Explanation of Terms

Sample Plot.—When the area is too large for a total count, a plot which is representative of the whole is demarcated and is referred to as the Sample Plot.

Quarter-Girth Volume.—The volume of round timber is calculated from measurements of girth and length. In a uniformly tapering stem the girth is taken at mid-length; in an irregular stem it is taken at the middle point of each regular section. The quarter of the girth in inches is squared, divided by 144 and multiplied by the length of the stem or section in feet. The result is the volume in cubic feet.

Basal Area.—Trees may be conveniently classified according to their quarter girths at breast height, 4′ 3″ above ground level. This quarter girth is presumed to be the same as that at the base of the tree. It is squared, divided by 144, and is spoken of as the Basal Area of the tree in square feet. The total basal area of a group of trees is the sum of the basal areas of the individual trees, and the mean basal area is this sum divided by the number of trees in the group. The mean basal area tree is that tree with a quarter girth corresponding to the mean basal area, i.e., multiply the M.B.A. by 144 and extract the square root.

Forest mensuration tables may be used to find the B.A. of any Q.G. and vice versa.

The Sample Plot

The area of the sample plot depends on the nature of the crop and the purpose for which the estimation of volume is needed. In an even-aged, fully or regularly stocked stand of even growth, 1/10 acre will usually be enough for management statistics. In an irregular or unevenly grown stand, or for purposes of purchase or sale, a larger area would be desirable. The larger the plot the greater the accuracy, and the size depends on the degree of accuracy needed and the time and assistance at the disposal of the estimator. For many reasons a strip 1 chain wide is convenient. It may be 1, 2, 3, 4, 5 or more chains in length, giving areas of 1/10, 1/5, 3/10, 2/5 and 1/2 acre respectively (10 sq. chains=1 acre).

The enumerator and his assistant first walk through the entire wood before picking on a representative area for the plot or strip. A base line 1 chain long is marked with a stake at each end, and two sides lines 1 chain long are laid off at right angles and marked with stakes. These four stakes enclose 1 square chain=1/10 acre. The strip is extended as desired by continuing the side lines to 2 or more chains, with a stake at each chain length. The boundaries should be marked by lightly blazing the marginal trees or in some other way.

On a hillside it is usual to run the strip up hill. When the trees are in lines it is well to run the strip diagonally across the rows to avoid a large number of stems actually on the boundary line and therefore not wholly growing on the plot. In girthing or counting every second such tree is omitted.

Girthing the Stems

The assistant measures the girth of each tree at 4′ 3″, using a quarter-girth tape from which the quarter of the girth can be read directly, and as he proceeds marks each tree with a scribe or knife. The enumerator enters the quarter girths in appropriately headed columns in his notebook by means of strokes or dots for each tree.

It is important that the tape should be placed horizontally around the stem. The Q.G. is read to the nearest ¼ inch below.

Working Up the Figures

When all the stems on the plot have been girthed and booked, a form headed as follows is drawn up:

Q.G. Class	B.A.	No. of Stems	B.A. of Class	No. in Group	B.A. of Group	Mean B.A.	Q.G. Sample
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

These columns are filled-in in this way:

(a) The range of quarter girths which occur, e.g., 4″, 4¼″, 4½″ . . . . . 10″.

(b) The corresponding basal area, e.g., 4″ Q.G. gives 4×4 divided by $144 = 1/9 = .1111$ sq. feet basal area. Can be found by tables.

(c) No. of stems in each class; found by summarising the ¼″ classes in the notebook.

(d) Basal area of class; is found by multiplying (b) by (c), e.g., in 4″ Q.G. class the basal area is .1111 and if number of stems is 10 the B.A. of class is 1.111 sq. feet.

The next step depends on the method to be adopted in the selection of sample trees.

Selection of Sample Trees

The methods to be described presume that the basal areas of the trees in the sample plot are directly proportional to their volumes and that the mean basal area tree of a group, found arithmetically by dividing the total basal area of the group by the number of trees in it, is the mean volume tree of that group.

Arithmetical Mean Sample Tree Method

The sample plot is treated as one group, and its total basal area is divided by the total number of stems to get the mean basal area tree for the plot.

The form is filled in this way:

Column (e)—The total of column (c) is entered.
" (f) " " " " (d) " "
" (g)—The mean basal area is found by dividing (f) by (e).
" (h)—The quarter girth corresponding to the mean basal area is entered. This is the Q.G. of the Sample Tree.

Urich's Method

In this method the trees in adjacent girth classes are put in groups, each with the same number of trees, and the sample tree is calculated for each group.

The number of groups is first decided and the total number of trees, column (c), is divided by this to get the number of trees which will be put in each group. Any remainder can go in a group by themselves or be added to the last group. The first group is formed by entering in column (e) the number of trees in it and adding up the class basal areas, column (d), until the basal area of this number of trees is reached. This area is entered in column (f). It often happens that the final Q.G. class dealt with must be split in order to get the correct number for the group, and in such cases only the basal area of the trees actually taken for the group are included. The trees remaining and the balance of the basal area go to the next group. The mean basal area of the group is found by dividing the group basal area, column (f) by the number of trees in the group, column (e), and this quotient is entered in column (g). The corresponding quarter girth goes in column (h) and is the quarter girth of the Sample Tree of the first group.

This procedure is repeated for each group into which the stems on the plot have been divided.

Hartig's Method

This is another "group" method and is considered to be better than Urich's. The trees in adjacent girth classes are placed in groups each of which contains an equal basal area. The procedure followed is, first, to decide on the number of groups and then to divide the total basal area, column (d), by this figure. The quotient is entered in column (f). The class basal area, column (d), is added up until the group basal area figure is reached and the number of stems, column (c), needed to reach that area is the number in the first group and is entered in column (e). It may be necessary to split up the final class basal area to get the correct group area, and in such cases the balance of the area and the trees remaining over in the corresponding classes, are carried forward to the next group. The mean basal area of the group is found in the usual way by dividing the group basal area, column (f), by the number of trees in the group, column (e), and it is entered in column (g). The corresponding quarter girth goes in column (h). It is the quarter girth of the Sample Tree of the first group.

The other groups are dealt with in the same way. It usually happens that there is a remainder of basal area when all the groups have been formed. This may be treated as a group basal area in itself or added to the last group.

Measuring the Sample Trees

A second form is drawn up with headings as follows:

No. in Group (i)	Q.G. Sample (j)	Length Sample (k)	Mid Q.G. Sample (l)	Mid S.A. Sample (m)	Vol. Sample (n)	Vol. Group (o)

Column (i) is the same as column (e) on other form and gives number of stems in each group.

Column (j) is also taken from the other form, column (h), and shows the quarter girth of the Sample Tree of the group.

The next step is to find trees with these quarter girths at breast height. These trees may be in the plot or in the surrounding plantation, and it is convenient to select trees about to be cut down as thinnings. One or more stems may be measured for each sample and an average found.

The best way to get an accurate volume is to fell the trees and measure the length and the mid-length quarter girth on the ground. If felling is not permissible, volume may be estimated by height measuring instruments and form factors, or by climbing to mid-height.

The length of each sample goes in column (k) opposite the group to which it belongs. The quarter girth at mid-length goes in column (l) and the corresponding sectional area in the next column, (m). The sectional area is found in the same way as the basal area. The volume of the sample is got by multiplying this sectional area by the length. It is entered in column (n). When there is more than one sample tree for a group, the average volume is calculated.

Total Volume of Groups

The volume of the group is the volume of the average sample tree multiplied by the number of trees in the group. It goes in column (o).

Total Volume of Plot

The sum of the group volumes, column (o), is the volume of the sample plot.

Volume of Whole Wood

The volume estimated for the sample plot is brought to volume on one acre, and from this the volume contained in the whole area of the wood or plantations is calculated.