

# MENSURATION

## CALU FACTSHEET

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ESTIMATING TIMBER VOLUMES



### INTRODUCTION

**Mensuration** simply means measuring things: it is a term widely used in the commercial forestry. The science of mensuration, in relation to trees, has developed largely from studying even aged, regularly spaced plantations. In these stands, the amount (volume) of timber that is useful in an industrial context (e.g. for use in construction) is the primary interest. This means that volume estimates usually only consider material with a diameter of more than 7cm; and often only consider the main stem of the tree.

Many non-commercial broadleaved woodlands have never been surveyed. In cases where surveys have been conducted, the objective has often been something other than timber volume assessment (e.g. wildlife surveys).

The increased interest in bringing woodlands into production means there is a need to evaluate the volume of standing timber, and also predict future potential yields. Periodic volume inventories allow woodland owners to understand the productivity of their sites. This is essential to determining the “sustainable cut” that can be taken from a given stand of trees. If more timber is being cut each year than is being produced by growth, at some point in time, there will be no more timber to harvest.

This factsheet outlines the established mensuration techniques in use today.

### INVENTORY AND TARIFFING

Forest **inventory** is, essentially, analogous to a stock take in business terms. The standing trees are the stock. As volume is the main measure of sale for timber and wood, a woodland or forest inventory usually aims to estimate the volume of timber in an area. The most accurate way to do this would be to fell the timber and assess its volume by displacement – e.g. by putting the wood into a vessel of water and measuring the volume of water displaced. This is neither practical nor useful as it would destroy the growing resource.

For high value stands of trees which are nearly ready for harvest, a procedure known as “**tariffing**” can be used. This process involves counting all of the trees, measuring the diameter at breast height of a proportion of the trees; felling a sub-sample of these trees and calculating their volume. These data are then tabulated to show the relationship between diameter at breast height (dbh) and volume for that particular stand.

For low volume stands of trees, the process of tariffing could outweigh the value of the timber. In these circumstances an “**abbreviated tariffing**” procedure might be used. With this system, the number of trees is estimated (by extrapolating from small sample areas); fewer trees have their diameter at breast height measured; and rather than felling and measuring the trees to estimate volume, charts that relate volume to dbh are used. This method is often the most appropriate for complex stands of mixed species and mixed ages of trees.

A further simplification would be to use what is known as the “**inventory**” method. This relies on more assumptions than the abbreviated tariffing procedure, but requires less work



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on the part of the surveyor. For the purposes of inventory, relationships between the basal area of wood per hectare and the consequent volume of wood per hectare are assumed.

As mentioned above, the problem with these methods is that they focus on wood of more than 7cm in diameter. In addition, they have not really been developed for under managed, unevenly aged and mixed species woodlands.

When trying to evaluate the volume of wood in an unevenly aged, unevenly spaced broadleaved woodland, particularly if the volume estimate is required for fuel wood, a different approach may be required.

In the 1980s, the Forestry Commission conducted research into the total volume of above ground wood in a range of broadleaved species. They found that the amount of wood in the branches of broadleaved trees (particularly ash, beech and oak) is considerable. If this branch wood is taken into account when evaluating the annual volume growth increments of the trees, their yield class is actually comparable to many commercial coniferous species grown in the UK. For anybody considering utilising woodlands for fuel wood, this is important.

As a result of this research, **total volume tables**, based on the average diameter at breast height for stands of broadleaved trees were developed. These tables remain the main tool for estimating volume in broadleaved woodlands. They are available at:

<http://forestry.oxfordjournals.org/cgi/reprint/61/3/193.pdf>

#### DEFINITIONS AND TERMINOLOGY:

Forest mensuration and inventory have a whole language of their own. Some of the key terms used are explained below. It is important when discussing measurements to make sure that a precise definition is used to avoid confusion and under- or over-estimations.

- **Diameter at breast height (dbh)** – the diameter of a tree 1.3m above ground height.
- **Basal area** – for a single tree, this is the area of its main stem at breast height. In practice, the stem is assumed to be circular for this calculation and the area is derived from the diameter using the formula: basal area in m<sup>2</sup> = (3.142 x dbh<sup>2</sup>) ÷ 40,000. The divisor of 40,000 is used as the diameter will have been measured in centimetres rather than metres (and therefore needs to be divided by 10,000 to convert cm<sup>2</sup> to m<sup>2</sup>), and the diameter rather than radius has been used in the equation, meaning the result needs to be divided by four (the standard equation for the area of a circle is  $\pi r^2$ ).
- **Basal area per hectare** – the sum of the basal areas of all the trees on a hectare of land.
- **Timber height** – the vertical distance from the base of the tree to the highest point on the main stem where the diameter is 7cm or larger.
- **Total height** – the vertical distance from the base of a tree to its tip.
- **Top height** – the arithmetic mean total height of the 100 trees with largest diameter at breast height per hectare.
- **Form height** – is the ratio of a tree's volume to its basal area
- **Timber volume** – the volume of timber which has an underbark diameter greater than a given value, often either 10cm or 7cm, but this is dependent on the market requirement.
- **Total volume** – the total volume of timber/wood in a tree including branches, non-straight sections etc. This can be either an under- or over-bark volume.
- **Stem volume** – the volume of timber in the main stem, or sometimes in major branches greater than a certain diameter.
- **Crownwood volume** – the timber/wood that is not classified as stem timber: the crown of the tree.

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