20

Measuring trees and logs

SUMMARY

Simple instruments and methods are described for measuring the dimensions and some important characteristics of single forest trees and groups of trees (stands) and of logs of both regular and irregular shape. Ways of using these measurements to derive estimates of quantity (volume, weight, etc.) are discussed.

Introduction

One of the many reasons discussed in Chapter 1 for growing trees on farms is the production of wood for sale as sawlogs, firewood or pulpwood. Using a few simple instruments and methods, a farmer can take measurements sufficient to check the growth of his or her tree crop or to estimate the quantity and value of the timber. These measurements may involve trees standing singly or in groups, felled trees cut into logs, or irregular material for use as firewood.

Measurement of standing trees

Single trees

In forestry, the two most useful and widely measured dimensions of a standing tree are the diameter and height of its stem. These dimensions can be used to estimate the volume of stem wood (see below).

TREE DIAMETER

By international agreement, stem diameter is measured over bark at breast height (DBHOB), this being 1.3 m above ground level in Australia and many other countries (though at 1.4 m in North America, New Zealand, South Africa and many countries in Asia). If a tree is on sloping ground, the measurement is made at 1.3 m above the ground on the uphill side.

DBHOB is measured using either a steel or fibre-glass diameter tape or a caliper (Figure 20.1). Diameter tapes are usually graduated in centimetres and millimetres on one side for reading girth and in π (pi) units on the reverse side for reading diameter. Most calipers are graduated on both sides in centimetres and millimetres. Calipers made of metal, for example aluminium or steel, are most suitable and are fairly readily obtained.

Because tree stems are rarely truly circular in cross-section, the average of two measurements is required if calipers are used, and these measurements should be taken at right angles to each other. With both the tape and caliper, it is important that measurements be made at right angles to the longitudinal axis of the stem.

Should the position on a stem at which a measurement of diameter is required fall on a bulge, branch whorl or damaged section, it is necessary to average the results of two measurements taken at the same distance above and below the desired position and beyond the influence of the bulge, etc.

Despite the fact that tree cross-sections are rarely truly circular, they are usually assumed to be circular in estimating the cross-sectional area

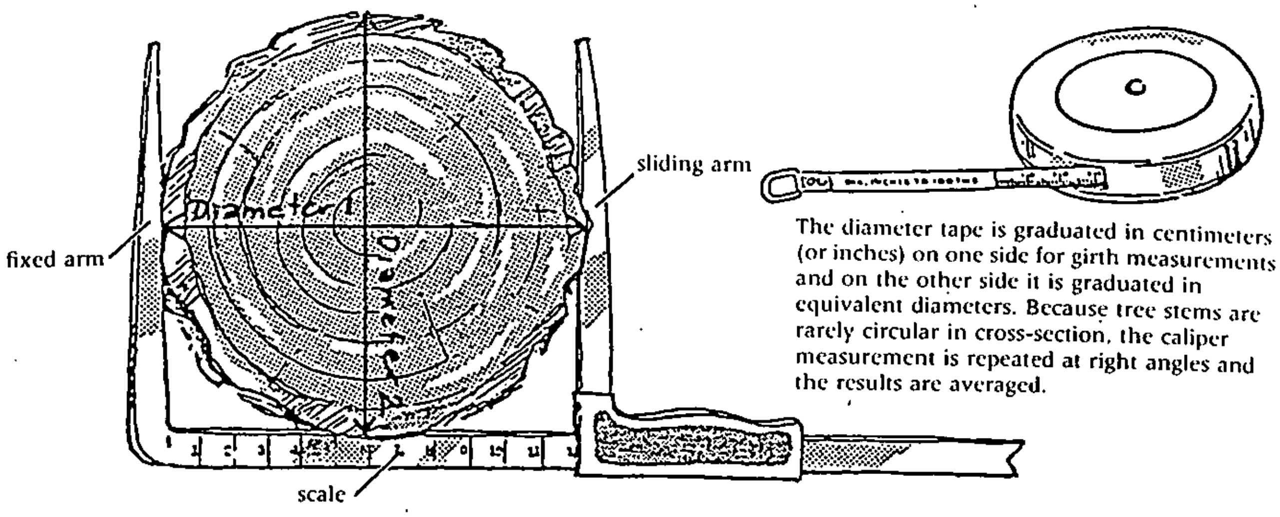


Figure 20.1 Diameter tape and caliper

of a stem from its diameter (D) using the formula, area = $\pi D^2/4$. This value can be obtained from prepared tables such as those of the Forestry and Timber Bureau (see 'Further reading'), an extract of which is given in Table 20.1. It can also be derived using a pocket calculator by entering the diameter in centimetres, squaring it, and multiplying the result either by $\pi/40\,000$ or by 0.000 078 5398. The display gives the sectional area in square metres.

Commonly in Australia, the diameter of a tree or log is expressed in centimetres and millimetres and the equivalent cross-sectional area is expressed in square metres and decimals. By international agreement, the sectional area of a tree stem at breast height is given the special name 'basal area'.

TREE HEIGHT

In coniferous and young broadleaved trees, the main stem extends in an unbroken line from ground level to the tree tip. In such trees, farmers and foresters usually measure the tree's height, i.e. the total length of the stem above ground. For mature broadleaved trees, it is usual to measure the height to the top of the useful log. This often corresponds with the height where the main crown begins.

There is a variety of instruments and methods by which tree height or log length in the standing tree can be obtained. For a quick, rough estimate, obtain a 3 m long stick and stand it vertically at the base of the tree. Move back from the tree to a distance approximately equal to its height and, using as a guide the height of the 3 m stick, estimate by eye how many times taller the tree is, and hence derive the height of the tree.

Several instruments measuring angles of elevation and depression are available, which can be used to estimate tree height to within ± 2.5% (i.e. to within ½ m of true height if the height of the tree approximates 20 m), e.g. the Abney level, Blume Leiss height measurer, Haga altimeter and Suunto clinometer (Figure 20.2). Each of these

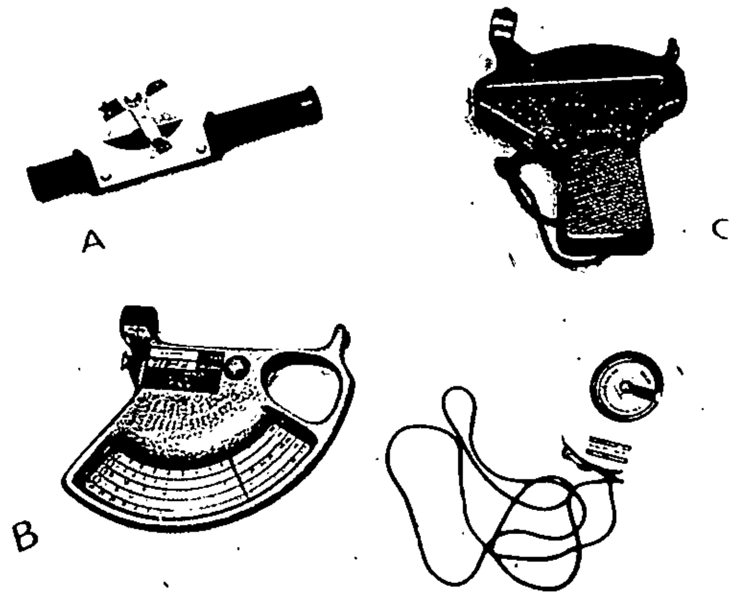


Figure 20.2 Height measuring instruments: a) Abney level; b) Blume Leiss height measurer; c) Haga altimeter; d) Suunto clinometer

instruments, particularly the Abney and Suunto, would also be useful to the farmer for purposes other than measuring height, e.g. measuring slopes and laying out levels in soil conservation work. Of the four instruments, the Suunto clinometer is the cheapest to buy and the most compact; the Abney level is the least robust and requires

Table 20.1 Converting diameter in centimetres to sectional area in square metres

	Diameter in centimetres					
	0.0	*0.2*	*0.4*	*0.6*	*0.8*	
10	0.00785	0.00817	0.00849	0.00882	0.00916	10
11	0.00950	0.00985	0.01021	0.01057	0.01094	11
12	0.01131	0.01169	0.01208	0.01227	0.01287	12
13	0.01327	0.01368	0.01410	0.01453	0.01496	13
14	0.01539	0.01584	0.01629	0.01674	0.01720	14
15	0.01767	0.01815	0.01863	0.01911	0.01961	15
16	0.02011	0.02061	0.02112	0.02164	0.02217	16
17	0.02270	0.02324	0.02378	0.02433	0.02488	17
18	0.02545	0.02602	0.02659	0.02717	0.02776	18
19	0.02835	0.02895	0.02956	0.03017	0.03079	19
20	0.03142	0.03205	0.03269	0.03333	0.03398	20
21	0.03464	0.03530	0.03597	0.03664	0.03733	21
22	0.03801	0.03871	0.03941	0.04011	0.04083	22
23	0.04155	0.04227	0.04301	0.04374	0.04449	23
24	0.04524	0.04600	0.04676	0.04753	0.04831	24
25	0.04909	0.04988	0.05067	0.05147	0.05228	25
26	0.05309	0.05391	0.05474	0.05557	0.05641	26
27	0.05726	0.05811	0.05896	0.05983	0.06070	27
28	0.06158	0.06246	0.06335	0.06424	0.06514	28
29	0.06605	0.06697	0.06789	0.06881	0.06975	29
30	0.07069	0.07163	0.07258	0.07354	0.07451	30
31	0.07548	0.07645	0.07744	0.07843	0.07942	31
32	0.08042	0.08143	0.08245	0.08347	0.08450	32
33	0.08553	0.08657	0.08762	0.08867	0.08973	33
34	0.09079	0.09186	0.09294	0.09402	0.09511	34
35	0.09621	0.09731	0.09842	0.09954	0.10066	35
36	0.10179	0.10292	0.10406	0.10521	0.10636	36
37	0.10752	0.10869	0.10986	0.11104	0.11222	37
38	0.11341	0.11461	0.11581	0.11702	0.11824	38
39	0.11946	0.12069	0.12192	0.12316	0.12441	39
40	0.12566	0.12692	0.12819	0.12946	0.13074	40
41	0.13203	0.13332	0.13461	0.13592	0.13723	41
42	0.13854	0.13987	0.14120	0.14253	0.14387	42
43	0.14522	0.14657	0.14793	0.14930	0.15067	43
44	0.15205	0.15344	0.15483	0.15623	0.15763	44
45	0.15904	0.16046	0.16188	0.16331	0.16475	45
46	0.16619	0.16764	0.16909	0.17055	0.17202	46
47	0.17349	0.17497	0.17646	0.17795	0.17945	47
48	0.18096	0.18247	0.18398	0.18551	0.18704	48
49	0.18857	0.19012	0.19167	0.19322	0.19478	49
50	0.19635	0.19792	0.19950	0.20109	0.20268	50

regular checking to ensure it is properly adjusted*; the Haga altimeter and the Blume Leiss height measurer are the simplest and quickest to use for height measurement but are awkward to use in setting levels. Several methods of measuring height are possible with these instruments, and they are described below.

Method 1 This requires an instrument with a degree scale, e.g. the Abney level or Suunto clinometer. The observer stands at a position where the head is above the level of the base of the tree and both the tree top and base can be clearly seen. This position can be any distance from the tree

* Adjusting the Abney level: check that the line of sight and the axis of the bubble tube are parallel. The bubble tube is held by two capstan screws, which may get out of adjustment. An effective way to test and adjust the instrument is as follows. Select two firm positions such as the tops of fence posts, say about 10 to 20 m apart (no particular distance is essential nor does it have to be measured) and sight from each to the other with the instrument, reading the angle of observation with the bubble at the centre of run. If the two readings are zero, or one is an elevation and the other a depression of the same angular value, then the instrument is in collimation and needs no adjustment. If, however, the two readings differ, their arithmetic average is the correct angular difference in elevation. A sight is then taken from one point to the other, with this average angular difference clamped on the instrument as an elevation or depression as appropriate, and the bubble tube is moved up or down at one end by its capstan screw until the bubble is at the centre of run for that sight. The reverse reading is then taken as a check to ensure the adjustment has been carried out correctly. Apart from this check specific to the Abney level, all height-measuring instruments should be checked regularly against some known height to ensure they are reading correctly.

but a distance roughly equal to the height of the tree is best for several reasons. Using a 20–40 m long tape measure (Figure 20.3), the horizontal distance to the middle of the tree (not to that part of the tree nearest to the observer) is measured along the line OC (see Figure 20.4). Then the angle of elevation to the top of the tree is measured by sighting to A, i.e. the angle AOC, and the angle of depression to the base of the tree is measured by sighting to B, i.e. the angle BOC. The lengths of AC and CB are then given by multiplying OC by the tangents of the angles AOC and BOC respectively, and the height of the tree AB is given by adding AC to CB.

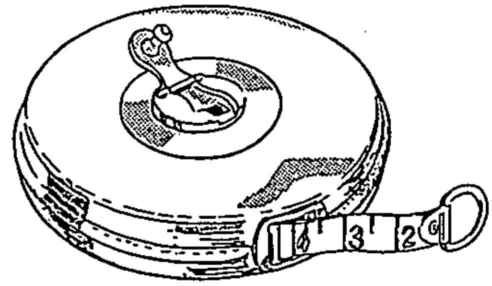


Figure 20.3 Linear tape (30 m long)

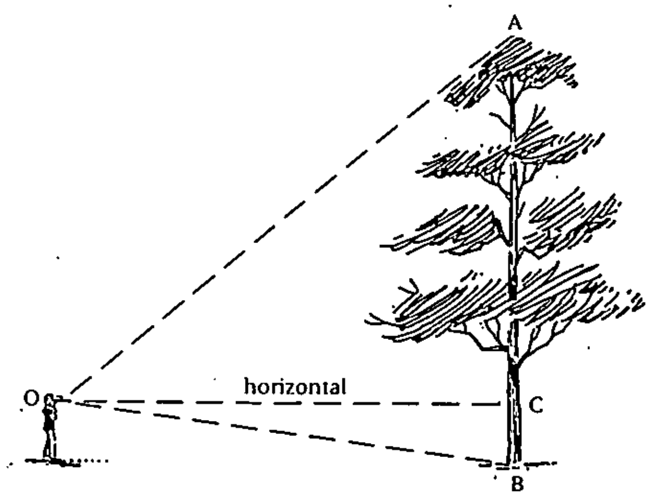


Figure 20.4 Measuring tree height

The values of the tangents of angles most likely to be needed for tree-height measurement are given in Table 20.2. For other values, either a standard set of trigonometric tables or a scientific calculator should be used.

Method 2 This method uses an instrument with a percentage (%) scale, e.g. the engineering Abney level or the Suunto clinometer. The observer stands at a position as in Method 1 and measures OC as described above but, instead of reading the angles of elevation and depression to the top and base of the tree respectively, the height of A above horizontal and that of B below horizontal are read on the % scale of the instrument (both readings are expressed as a percentage of the horizontal distance OC). The height of the tree AB is then given by multiplying OC by the sum of the two percentage readings. For example, if OC is 30 m, AC is read as +82%, an elevation, and CB as −8%, a depression, then: AB = 30 (82% + 8%) = 27 m.

Table 20.2 Tangents of angles of elevation and depression

Angle (deg.)	*Tan*	*Angle (deg.)*	*Tan*	*Angle (deg.)*	*Tan*
1	.017	21	.384	41	.869
2	.035	22	.404	42	.900
3	.052	23	.424	43	.933
4	.070	24	.445	44	.966
5	.087	25	.466	45	1.000
6	.105	26	.488	46	1.036
7	.123	27	.510	47	1.072
8	.141	28	.532	48	1.111
9	.158	29	.554	49	1.150
10	.176	30	.577	50	1.192
11	.194	31	.601	51	1.235
12	.213	32	.625	52	1.280
13	.231	33	.649	53	1.327
14	.249	34	.675	54	1.376
15	.268	35	.700	55	1.428
16	.287	36	.727	56	1.483
17	.306	37	.754	57	1.540
18	.325	38	.781	58	1.600
19	.344	39	.810	59	1.664
20	.364	40	.839	60	1.732

Method 3 This method involves use of either a Haga altimeter or a Blume Leiss height measurer. Both instruments have four direct-reading scales, each of which is used for a specified horizontal distance from the tree. Having set out the chosen horizontal distance, which should approximate the height of the tree, the observer reads AC and CB in metres from the appropriate scale of the instrument and derives the height of the tree AB by adding the two readings. This method, which is the quickest to apply, is widely used by foresters.

Compensating for lean In all the foregoing, it has been assumed that the tree is vertical. Many trees lean and any method that assumes the tree is vertical often gives an error, which may be positive or negative, large or small. If a tree is leaning (and it is wise to assume every tree is leaning until proven otherwise), the top of the tree should be projected vertically on to the ground below by sighting it through a plumb line held by hand some distance from the tree, at two places — one preferably in the plane of the lean and the other in a plane at right angles to it. (A practical plumb line can be made using a stone and a 1 m length of string.) The observer then assumes that the tip of the tree projected onto the ground is the base of the tree and measures the height from the tip to its projection on the ground using any of the methods described above. Unless the angle of lean is more than 10 degrees — and this is a severe lean — the height measured will be very close to the true length of the stem.

In all methods, it is necessary to ensure that the eye of the observer is above the level of the tree's base. (If it is not, appropriate allowances will need to be made. These are not explained here.)

BARK THICKNESS

Bark thickness can be measured using a bark gauge or, more simply, a hammer and nail.

The Swedish bark gauge (Figure 20.5), used internationally, is a steel rod about 15 cm long with one end in the form of a gouge chisel and the other a handle. The central portion of the steel rod is graduated in appropriate units, for example centimetres and millimetres, and along it slides a metal sleeve, the bottom of which carries a flange. The chisel is forced by hand through the bark to the junction of the bark and wood. The sleeve is moved until the flange is against the tree. The upper end of the sleeve, by its position on the graduated scale, then indicates the depth of penetration of the chisel end and thus the thickness of the bark. Two or four measurements of bark thickness, evenly spaced around the circumference of the stem, are made and the underbark diameter is calculated by subtracting twice the average bark thickness from the overbark diameter.

Bark thickness can also be measured quite reliably using a hammer, a nail of known length (10 cm is usually adequate), and a good ruler. Tap the nail gently into the tree until the resistance of the wood is felt. With the nail still in the tree, measure the length of the protruding section and, by subtraction from the known length, determine the bark thickness.

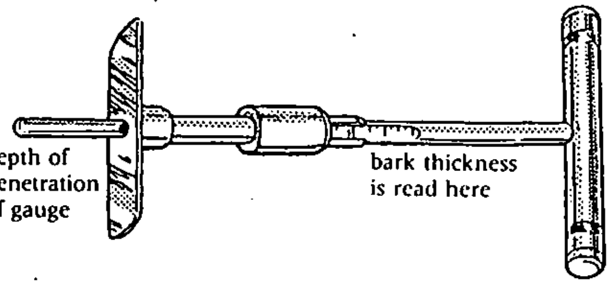


Figure 20.5 The Swedish bark gauge

In measuring bark thickness using any form of bark gauge, you assume the gauge will penetrate the bark — no more, no less. The reliability of this measurement depends on how soft the bark is compared with the wood, and the skill and experience of the measurer.

TREE VOLUME

Measuring the volume of a standing tree directly is usually too laborious for a farmer. The most convenient alternative is to obtain the tree volume indirectly by reference to prepared 'tree-volume tables'. These tables are compiled by forest authorities for a single tree species or a group of species that have a similar rate of taper along the stem. (The trunk of a tree tapers, i.e. it decreases in diameter from the base upwards. There is no simple measurement that describes taper adequately.) These tables commonly require the diameter at breast height (DBHOB) and the height of the tree, or the height to the top of the log that it is estimated would be cut from the tree. For most conifers, it is usually total height of the tree because the top of the tree is readily identified and because the various diameter limits to which logs are taken, for example, 15, 10 or 7 cm underbark at the small end, are well related to the total height of the tree. For most broadleaved tree species, it is usually the height from ground level to the top of the log that is measured because the top of the tree is not readily identified and because the height to which logs are taken may bear no relationship to the total height of the tree. Usually an allowance is made in the table for a stump of standard height. If a tree has to be cut higher than this standard because of defect due to fire, termite attack, etc., then a further allowance is made.

If a suitable tree-volume table is not available (from the forest authorities), the farmer may need to engage a forest consultant.

A rough estimate of the stem volume (to a top diameter limit of 10 cm under bark (DUB)) of a standing tree of radiata pine (or any tree of similar stem form) can be obtained by applying the formula:

$$\text{stem volume (m}^3) = D^2 \times H \times 0.000026$$

where D is DBHOB in centimetres and H is total height in metres. For example, if D = 51.5 cm and H = 36 m, then:

$$\text{stem volume} = 51.5^2 \times 36 \times 0.000026 = 2.5 \text{ m}^3$$

Group of trees

For the purpose of this discussion, we shall call a group of trees a forest stand. This could be a farm woodlot, a forest plot, or a section of an extensive area of forest. Information about a forest stand likely to be useful to the farmer includes stocking, height of dominant trees, the distribution of trees by diameter class, stand basal area and stand volume. Some of this information can be obtained by the farmer without much effort but, for other information, the farmer should seek advice from a forest authority or a forest consultant.

STOCKING

Stocking is expressed as either the total number of trees in the stand or the number per hectare. It can be determined simply in small forest stands by counting every tree. For larger stands, some form of sampling is required. For example, in a forest plantation with regular boundaries and trees planted in rows, it is possible to estimate the total stocking by counting all trees in each fifth or tenth row, and multiplying the total count by 5 or 10. Estimating stocking in other types of forest can be done by locating evenly throughout the stand a number of temporary plots of known area, e.g. circular plots (Table 20.3), counting the number of trees on each plot and applying the formula:

$$\text{stocking (total number of trees)} = \frac{\text{area of stand} \times \text{total count in all plots}}{\text{number of plots} \times \text{plot area}}$$

For example, suppose a farmer lays out five circular plots each of radius (horizontal) 17.84 m (i.e. area = 0.1 ha — see Table 20.3) in a forest stand of area 5.6 ha and makes counts of 37, 46, 33, 36 and 50 trees. Then the estimated stocking of the forest stand

$$= \frac{5.6 \times (37 + 46 + 33 + 36 + 50)}{5 \times 0.1} = 2262 \text{ trees}$$

Table 20.3 Areas of circular plots of given radius*

Radius (metres)	*Area (hectares)*
3.99	0.005
4.89	0.0075
5.64	0.01
6.91	0.015
7.98	0.02
8.92	0.025
12.62	0.05
15.45	0.075
17.84	0.1
19.95	0.125
21.85	0.15
23.60	0.175
25.23	0.2

* Note that when establishing a circular forest plot, the linear tape used to set out the radius must be held horizontally.

HEIGHT OF DOMINANT TREES

Several essentially synonymous terms are used in Australia to describe the height of the dominant trees in a forest stand, e.g. top height, predominant height and mean dominant height. All may be defined as the average height of the tallest 40–75 trees per hectare in coniferous plantations (the actual number varying between state forest authorities) and the tallest 25–30 trees per hectare in native eucalypt forest.

Knowledge of the height of dominant trees in a coniferous stand can be useful because if the farmer also has information on stocking and stand basal area, a quick, indirect means of determining stand volume may be available through the local forest office. Let us suppose a farmer lives in a district where there are extensive coniferous plantations and where top height is defined as the average height of the tallest 40 trees per hectare. Suppose also the farmer has a small plantation of the same coniferous species. To estimate the top height of this plantation, the farmer should locate evenly within it a number of temporary plots, e.g. circular plots of radius 8.92 m, i.e. one-fortieth of a hectare (Table 20.3), and measure on each the height of the tallest tree, which can be selected by eye. Top height of the stand is the average height of the trees so measured.

DISTRIBUTION OF TREES BY DIAMETER CLASS

An effective way of describing a stand of trees quantitatively is through the classification of individual trees by species, by diameter over bark at breast height, and height. When the trees of a stand are measured and tallied by diameter class, such as <14, 15–19, 20–24 and 25–29 cm, the classification so formed is called a stand table. The relative number of trees in the various size classes indicates the structure of the stand, which must be known for silvicultural practices to be applied effectively. The stand table is usually expressed on a per hectare basis.

STAND BASAL AREA

The sum of the basal areas of all trees of a stand on a per hectare basis is known as stand basal area. The stand basal area may (depending on each situation) show that the site could support more trees, or that the trees are competing too strongly, to their mutual disadvantage. The thinning of a stand should be guided accordingly.

The basal area of a stand can be obtained by measuring the DBHOB of every tree in the stand (or a sample of it), calculating the basal area of each tree (or reading it from a table), adding these basal areas, and dividing by the area of the stand (or the sample) in hectares. Should a stand table be available, stand basal area can be determined by multiplying the basal area of the midpoint of each diameter class by the number of trees in the class and then summing the products.

There is an easier and quicker method of determining stand basal area, called the angle count method, which is useful when deciding on a thinning regime or checking the growth of a forest. The method is less useful when information on tree size is required as well, e.g. when timber is being offered for sale. Details of the method are given in Appendix 20.1.

STAND VOLUME

The volume of trees in a forest stand is of interest as an indication of how well the stand is developing and as a measure of its value for sale. If the stand is small, it may be practicable to estimate the volume of every tree using an appropriate tree-volume table as discussed earlier. For larger stands, several methods of estimating volume are available but they are too involved for present discussion and the advice of a forest authority or a consultant forester should be sought. However, if the stand is planted pine and estimates of stand basal area over bark in square metres (G) and stand top height in metres (H) are available, then a *rough* estimate of the saleable volume of wood underbark in cubic metres is given by the formula:

$$\text{stand volume} = G \times H \times 0.3$$

Measurement of felled trees or logs

The farmer may want to estimate the volume of a log, cut from a tree and lying on the ground, for sale purposes. To do this, the length of the log is multiplied by either the area underbark of the cross-section at the middle of the log, or by the average cross-sectional area underbark of the two ends of the log.* If the sectional area underbark is in square metres and the length in metres, the volume of the log will be in cubic metres. Suppose, for example, the following diameter measurements are recorded on a log 6.0 m long:

small-end diameter underbark = 36 cm
large-end diameter underbark = 48 cm
centre diameter underbark = 43 cm

The corresponding sectional areas underbark, read from tables or calculated, are:

$$\begin{aligned}\text{small end} &= 0.102\ \text{m}^2\\ \text{large end} &= 0.181\ \text{m}^2\\ \text{centre} &= 0.145\ \text{m}^2\end{aligned}$$

Log volume underbark is then given either by:

$$\frac{(0.102 + 0.181)}{2} \times 6.0 = 0.85\ \text{m}^3$$

or, as is more usual, by: $0.145 \times 6.0 = 0.87\ \text{m}^3$

The difference between the two results, assuming all diameter measurements were made correctly, is because the log does not conform exactly to the solid shape assumed in the formulae.

For butt logs with flared large ends, it is prudent to derive volume from length and mid-diameter underbark to avoid serious overestimates in the volume. The mid-diameter can be obtained by removing a complete ring of bark or, if a caliper is used to measure diameter, by removing pieces of bark so that the caliper arms can be placed flush against the wood surface.

Log volume tables, which give the volume in cubic metres of logs of various lengths and diameters, are available (see reference to Forestry and Timber Bureau, 1973, in 'Further reading'). These tables are usually based on log mid-diameter because less error is involved if the log shape departs from the assumed shape.

The farmer should be aware of certain terms and conventions used when measuring logs for sale as veneer logs or sawlogs. For example, log volume may be expressed as gross volume overbark, gross volume underbark, or net volume underbark. The last is more meaningful for sale purposes as it makes allowance for cross-cutting and defects in the log.

Measurement of log diameter is usually made to the nearest centimetre and measurement of length usually includes an overcut allowance of about 8 cm. This allowance compensates for inaccurate cross-cutting and subsequent docking or trimming in the mill. Thus, if log lengths desired by the miller range from 2.4 to 6.0 m in increments of 30 cm, the logs should be cut to lengths of 2.48, 2.78, ... 6.08 m, but volume should be based on lengths of 2.4, 2.7, ... 6.0 m. Similarly, allowances must be made at the time of log measurement for defects in the log. The most common defect in hardwood logs is pipe, which is a longitudinal cavity extending along the centre of the log. Allowance for pipe is usually determined assuming the shape of the cross-section of the pipe is square with side equal to pipe diameter. A common practice in making the allowance is to

* It is preferable, and usually more accurate, to derive volume from the underbark cross-section of a log at its mid-length, but sometimes removing the bark at mid-length is difficult or the middle of a log is inaccessible, e.g., stacked logs or the log is very heavy and embedded in the ground.

measure the pipe diameter at each end of the log and average the two diameters to the nearest centimetre above. Thus, for our previous example, if we assume a pipe diameter of 8 cm at the small end and 15 cm the large end, the volume allowance to make is determined as follows:

average pipe diameter $= (8 + 15)/2 = 12$ cm (to the nearest cm above)
log length $= 6.0$ m
pipe volume $= 0.12^2 \times 6.0 = 0.09\ m^3$

The net volume of the log underbark will then be either $0.85 - 0.09 = 0.76\ m^3$ or $0.87 - 0.09 = 0.78\ m^3$ depending on whether the underbark diameter of the log was measured at both ends or at mid-length only.

Measurement of firewood and pulpwood

Firewood

The amount of heat obtainable from the combustion of fuelwood depends mainly on the weight of wood substance burnt (irrespective of tree species) and on the moisture content of the wood. It is therefore logical to sell fuelwood on the basis of air-dry weight, not by volume (whether true volume or stacked volume). Dense, undecayed wood may contain several times as much wood substance, and fuel value, as partly decayed light wood of the same volume and moisture content. Green timber may contain more water than wood substance, and the moisture content may vary widely. Furthermore, not only is the water worthless as a fuel, but a great deal of heat is wasted in evaporating the water, and is thus not available for heating.

In the past, quantity of firewood was frequently assessed on a stack basis by filling a space of known volume with the wood material. However, the reliability of the volume estimate was seriously affected by the shape, size, arrangement and compaction of the pieces in the stack. Today, much firewood is sold by the truckload, utility load or trailer load. If a docket giving the weight of wood delivered is not handed to the purchaser, this method of sale is equally unsatisfactory (and mostly illegal) as no objective measure is available of the quantity of wood purchased.

Weighing can be done rapidly and accurately, but it has some limitations, e.g. a weighing device (truck scales, weighbridge, etc.) must be accessible, and allowance must be made for moisture content. Fully air-dried timber in Australia has a moisture content of about 10–15% of oven-dry weight. With air-dry timber, variations in moisture content are of no practical importance. A farmer may find that a particular truck, stacked in a particular way with a particular type of air-dry firewood, regularly holds 8–10 t. Given this information, such a truckload could reasonably be sold as a 9 t quantity without being weighed each time (unless this infringes a local ordinance).

In the absence of scales, the farmer may wish to make a tentative estimate of the weight of firewood in logs of known volume. He can do this if he knows the density of the wood.

The density of most air-dry Australian timbers ranges from about 0.5–1.3 t/m³. The density of young radiata pine is about 0.5 and that of mature radiata pine, cypress pine (*Callitris* spp.) and banksia is about 0.6. Light eucalypts (ashes, blue gums, peppermints, stringybarks) have a density of about 0.8, sheoak (*Casuarina* spp.) about 0.9 and heavy eucalypts (bloodwoods, boxes, grey gums, ironbarks, mallees, red gums) about 1.0. The density of wattles (*Acacia* spp.) ranges from about 0.5 (black wattle) to 1.3 (yarran).

The density of green timber is much more uniform, and averages about 1.1 or 1.2 t/m³ for all species mentioned above with the exception of cypress pine, which is about 0.9. Wood with a density greater than 1.0 does not float on water, of course.

Usually, the actual volume of the firewood is not known, but the volume of stacked firewood is easily measured. As a very rough guide: 1 t of solid air-dry eucalypt wood tightly packed in unsplit firewood lengths occupies a stacked volume of about 2 m³. In most parts of Australia, however, sale of firewood on a stack basis is no longer legal — the farmer should check the local ordinance.

Pulpwood

Much the same comments apply to pulpwood as for firewood, i.e. the most logical basis for sale is weight but, with pulpwood, sale is usually by weight of green timber. Again, however, if the timber is regular in length and shape, and of known density, sale by stacked volume can be justified.

Methods using specialised equipment are available for sampling pulpwood for moisture content. These enable green weight to be converted to oven-dry weight.

Acknowledgements

This chapter revises and expands Chapter 21, 'Tree and timber measurement', written by Dr L.T. Carron for the 1968 edition of *Growing Trees on Australian Farms*. Criticism of the manuscript by Dr Carron and Messrs C.J. Borough, K.W. Cremer and K.W. Groves is gratefully acknowledged.

Further reading

Forestry and Timber Bureau (1973). *Metric Log Volume Tables*. Aust. Gov. Publ. Service, Canberra.

Forestry and Timber Bureau (1975). *Tables for Foresters*. Aust. Gov. Publ. Service, Canberra.

APPENDIX 20.1

Determining stand basal area by angle-count sampling

The angle-method involves an observer standing at each of a number of sampling points in representative parts of the stand and counting those trees that, in a complete 360 degree sweep of inspection about the selected point, have a diameter at breast height that appears wider than a certain angle of view. The stand basal area about the point is given by the product of the number of trees counted and a factor that depends on the size of the angle of view.

The method is particularly practical under certain circumstances. It can be done very quickly (usually taking 5–10 minutes per sweep). It does not require any measurement of area of sampling units and can be carried out with various kinds of instruments, which include, in the simplest case, the observer's thumb, a stick held at arm's length, or a piece of plastic or other semi-rigid material held at a fixed distance from the eye. However, a number of qualifications, limitations, and other requirements are involved. The farmer could not expect to achieve precise estimates of stand basal area using the method without a considerable amount of practice and, perhaps, some specialist advice. Nevertheless, if the procedures described below are followed, an acceptable estimate (within about 10% of true) of stand basal area about a point should be possible:

1 Take a flat sheet of plastic, tin, cardboard or other semi-rigid material and, with a sharp instrument, cut from it a rectangular strip exactly 1.6 cm wide and about 5 cm long. Nail or glue one end of the long axis of the strip at right angles to the end of a timber rod exactly 40 cm long. This serves as the angle gauge (Figure A20.1a). By holding the free end of the rod to the base of the eye and sighting along the rod, an angle of 2° 17′ 26″ is generated by the 1.6 cm width of strip. This is equivalent to an angle gauge factor of 4 square metres per hectare.

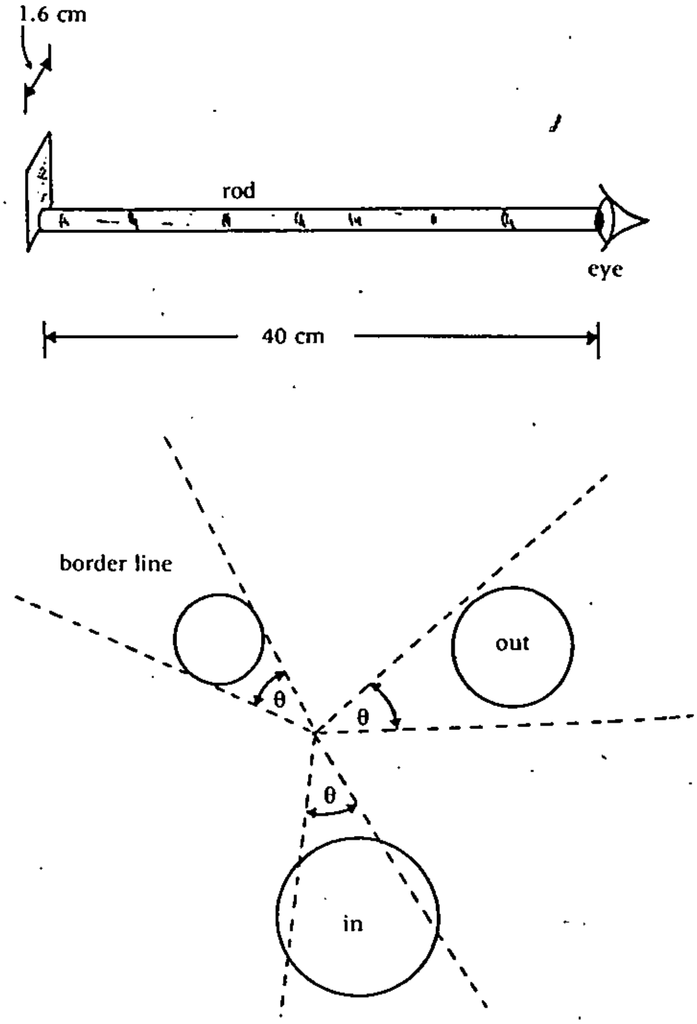


Figure A20.1 a) Home-made angle gauge (see text); b) angle count sweeping

2 Stand at a selected point in the forest and, during a full 360° sweep about the point, record the number of trees that appear larger at breast height than the 1.6 cm width of the plastic strip and the number that appear to exactly match the width (Figure A20.1b). The former are

called 'in' trees (each tree counts one) and the latter are called 'borderline' trees (each counts one-half, i.e. 0.5). Trees that appear to be narrower at breast height than the width of the plastic strip are ignored. Suppose in a particular sweep, ten trees are counted 'in' and one tree is classed as 'borderline'. Then the estimate of stand basal area about the point is given by: $[(10 \times 1) + (1 \times 0.5)] \times 4 = 42$ m^2/ha.

3 Observe the following precautions when making a sweep:

- Ensure that the vertex of the angle generated by the angle gauge is at the eye of the observer. The observer should stand directly over the angle count point, which should be temporarily marked on the ground.
- Since basal area of a tree is defined as its sectional area at breast height, i.e. 1.3 m above ground, the observer must sight to this point. There is no need to mark this point on most trees as most will be clearly 'in' or 'out'. But on a small proportion of trees, the decision whether a tree is 'in', 'out', or 'borderline' will be difficult to make. In these cases, the breast-high point must be marked tem-porarily — place a stick cut to a length of 1.3 m against the tree and sight to the top of the stick.
- If a tree is leaning at an angle to the line of sight from the observer, align the long axis of the plastic strip parallel to the long axis of the tree before making a decision on the tree.
- Should one tree be obscured by another, move sideways to a position from which the hidden tree is fully visible but keep the distance from the observer to the tree unchanged. Make the decision and then return to the angle-count point before proceeding to assess the next tree.
- Be on the alert for dead or useless trees, which normally would be excluded from assessment.
- Ensure that no tree is missed. Remember that each missed 'in' tree represents an error equivalent to 4 m^2/ha with our particular angle gauge. It would be wise for the farmer to repeat the sweep until the results are confirmed.
- Correction should be made to the estimate of stand basal area if the slope of the ground exceeds 10°. Correction is based on measurement of the maximum slope across the area swept, i.e. the area within about 10 m of the angle-count point. Corrections to apply for various angles of slope are given in Table A20.1. Suppose, for example, the estimate of stand basal area by angle counting is 36 m^2/ha and the slope is measured as 16°; then the corrected estimate is $36 \times 1.040 = 37.44$, i.e. 37 m^2/ha.
- Beginners to angle counting invariably record too many 'borderline' trees, mainly because too little time and care is taken in making the decision when the decision is 'close'. A good 'rule of thumb' guide is that approximately one in ten trees will be a legitimate borderline.

Table A20.1 Corrections for slope when using the angle-count method to estimate stand basal area

Slope (degrees)	*Correction*	*Slope (degrees)*	*Correction*
10	1.015	22	1.079
12	1.022	24	1.095
14	1.031	26	1.113
16	1.040	28	1.133
18	1.051	30	1.155
20	1.064	32	1.179

INKATA PRESS PROPRIETARY LIMITED
MELBOURNE AND SYDNEY

Published 1990

National Library of Australia card number
and ISBN 0 909605 65 3

National Library of Australia
Cataloguing-in-Publication data:

Trees for rural Australia.

Bibliography.
Includes index.
ISBN 0 909605 65 3.

1. Trees — Australia. 2. Tree planting —
Australia. I. Cremer, K. W. (Kurt W.).

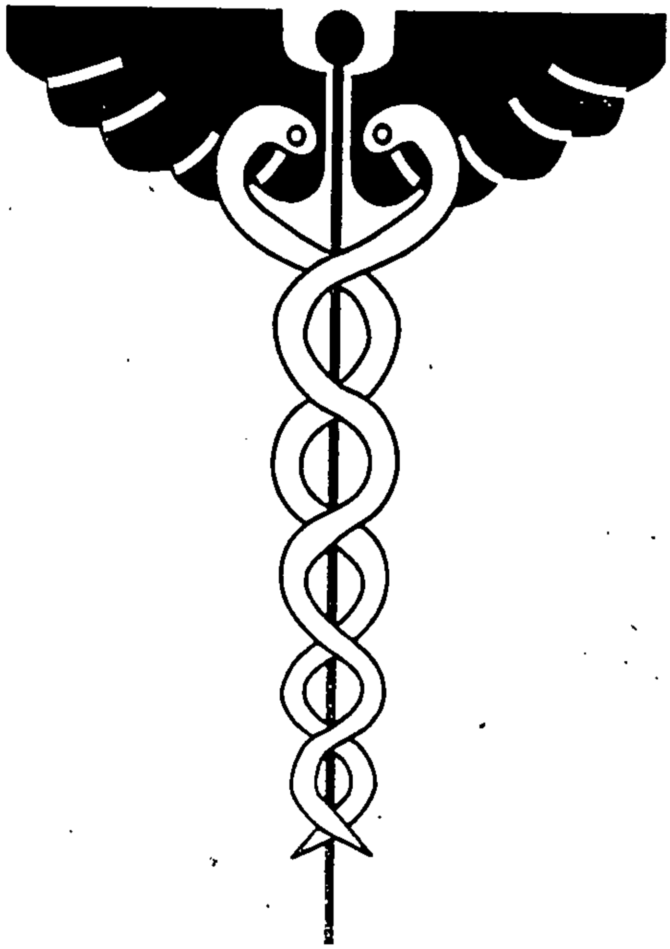
635.9770994

Designed by Pauline McClenahan
Edited by Marjorie Pressley
Typeset in 9pt Meridien and Leawood Book by Setrite Typesetters
Printed through Bookbuilders

GEORGIA

NORTHERN REGION NATIVE FOREST MARVL MANUAL

FIELD PROCEDURES



Developed by Northern Region Inventory Unit 1996

INDEX

1. INTRODUCTION

This manual has been written as a guide for the measurement of MARVL-based inventory plots in the native forests of Northern Region. It is intended to supplement, not replace formal face-to-face training. The manual describes field procedures for measuring both bound and angle gauge primary plots as well as secondary angle gauge plots.

While attempting to give an explanation of correct procedures for most aspects of MARVL plot measurement it cannot be expected to cover all possible situations encountered in the field. If, having read the relevant part of this manual, you are still unsure about any aspect of plot measurement you should contact your supervising forester or Scott Arnold (066) 528900 or (066) 534810 (a.h.), radio call sign 1453.

2. MARVL INVENTORY EQUIPMENT CHECKLIST

Map of area to be inventoried, with plot location information

Hip chain

Hip chain cotton (keep a good supply)

Compass

Clino

Vertex Hypsometer (and spare batteries)

30 or 50 metre tape

Spray paint (keep a good supply)

Diameter tape

Basal Area Optic Prism (or Relaskop)

Proformas (keep a good supply)

Booking board

Pencil & eraser (including spare leads)

Spare folders for storing finished plot sheets

Set of field notes

Calculator (or slope correction tables)

3. LOCATING PLOT POINTS

The plot location information provided by the supervising forester describes how to locate a road-side take off point (T.O.P.) for each plot. Using a hip-chain (**not** the trip meter in the vehicle, unless you have checked it's accuracy) locate the T.O.P. Mark the T.O.P., along with the plot number, on a tree or other easily visible spot.

From the plot location notes read off the bearing and distance to the plot you intend to measure. Check that you have all necessary equipment before leaving the vehicle. Use hip-chain and compass to locate plot point.

The plot should be established exactly where the hip-chain and compass bearing take you. If the plot point is in some way "different" to the general area, feel free to make note of this in the comments section of the proforma. **THE PLOT SHOULD <u>NOT</u> BE MOVED FROM THIS SPOT UNLESS YOU ARE <u>SURE</u> YOU ARE IN THE WRONG PLACE.** (Note: you can make an allowance of 50-100 metres for survey error during the course of locating the plot point, especially if there is a long traverse to get to the plot point.)

Mark the centre of the plot with a small dot of paint or a cross on the ground. The plot number should be painted on the tree nearest to the plot point.

4. INVENTORY DESIGN

4.1 Primary and Secondary Plots

All inventories are based on Primary Plots. Primary Plots are plots where detailed information about individual trees is collected, for example; diameter and height. Primary plots can be either bound plots or angle gauge plots (see Section 4.2 "Bound Plots and Angle Gauge Plots" below for more detail).

Some inventories may have two types of plots, the mandatory Primary Plots <u>and</u> some Secondary Plots. The Secondary Plots are <u>always</u> angle gauge plots and, unlike the Primary Plots, the only information which is collected is the tally of "in" trees.

4.2 Bound Plots and Angle Gauge Plots

There are two types of plots which can be used by MARVL, they are <u>bound</u> (fixed area) plots, and <u>angle gauge</u> plots. The main difference between bound plots and angle gauge plots is that with bound plots the plot size (ie: it's **boundary**) determines which trees are "in" and "out", whereas with an angle gauge plot the angle generated by the gauge is used to pick "in" or "out" trees.

5. SETTING OUT PLOTS

5.1 Bound Plots

Bound plots in Northern Region are circular, 0.1 hectare plots. The plot point mark on the ground is the centre of the plot and the horizontal radius of the plot is 17.84 metres.

Slope Correction

The first thing to be done in establishing a bound plot is to measure, and allow for, the slope of the plot. The slope of the plot must be measured in order to make sure that the area occupied by the plot is always 0.1ha. On slopes greater than 5^0 the correct radius of the plot should be looked up on the "MARVL Bound Plot Slope Correction Table" (page 13).

Plot slope is determined by measuring the slope of the steepest part of the plot as well as the slope in the opposite direction. The two readings are averaged to get plot slope. Where a plot falls on the cap of a ridge measure the slope angle down either side of the ridge. Similarly if the plot falls in a gully you measure the slope up either side. Remember, when taking slope readings you should take readings to a point at the same height as your eye, not to ground level.

Marking Plot Boundary

Having measured the average slope of the plot and looked up the new radius, the next thing to do is set out the plot boundary. This is best done using the Vertex[§] to lay out a circle surrounding the plot point.

One person should hold the transponder 1.3 metres directly above the plot point while another person sweeps around the plot perimeter measuring the distance of all trees which appear close to the plot radius. The hypsometer should be held at the middle of the side of the tree at 1.3 metres when measuring distances. While most trees will be clearly in or out, any which are within 20 centimetres of the plot radius will need to be checked exactly using a tape measure.

In this case, one person should hold the end of the 30 or 50 metre tape directly above the plot point marked on the ground while another person holds the other end of the tape at the middle of the side of the tree at 1.3 metres. At all times the tape should be held tight, straight (no bending around trees, branches, etc) and parallel to the ground.

If the middle of the side of the tree at 1.3 metres above the ground is closer to the plot point than the plot radius (or exactly equal to it), then the tree is in, otherwise the tree is out. Please take care when checking "close" trees because one tree in or out of a plot can make a difference of several hundred cubic metres!!

[§] For details on use of the Vertex see "Vertex Hypsometer User Notes", your supervising forester will be able to give you a copy.

Which Trees Are In?

Once the boundary of the plot has been determined, all trees with a diameter at breast height (1.3 metres) greater than 100 millimetres are recorded. No palms or ferns should be included. No trees which have a DBHob less than 100 millimetres are included.

For details on measuring and assessing the "in" trees, refer to Section 6 "Measuring Trees", on page 6 and Section 7 "Assessing Trees" on page 10.

5.2 Angle Gauge Plots

Angle gauge devices come in a variety of designs, they all do the same thing but by different means. This manual describes the use of an optic prism, but a trained operator could substitute a Relaskop or a steel angle count gauge.

The Principle

The idea of angle gauge plots is to use an angle generated by the optic prism to select "in" trees. Any tree which appears wider than the angle generated by the prism is "in" and should count as one in the tally of "in" trees for the plot. From the Angle Gauge Plot Diagrams on page 5 it is obvious that trees of any size may be "in" and that the critical distance from the plot point where a tree becomes border-line varies according to the diameter of the tree.

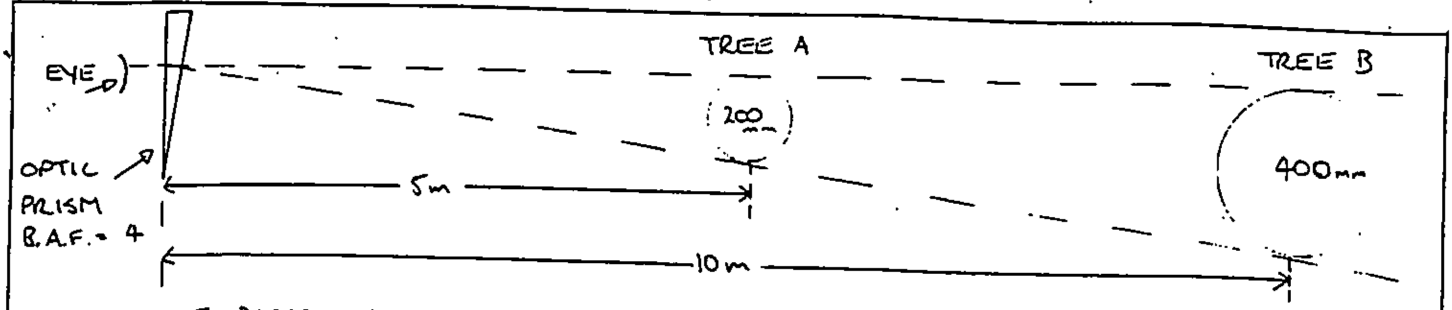
The plot is measured by placing the optic prism (not your eye) directly over the plot point and comparing the width of each tree at 1.3 metres with the angle generated by the optic prism. A full 360 degree turn is done and all "in" trees are recorded on the proforma. If you are using a Relaskop for your angle gauge then the instrument should be held over the plot point, but if you are using a steel angle count gauge then your eye should stay over the plot point.

Borderline Trees

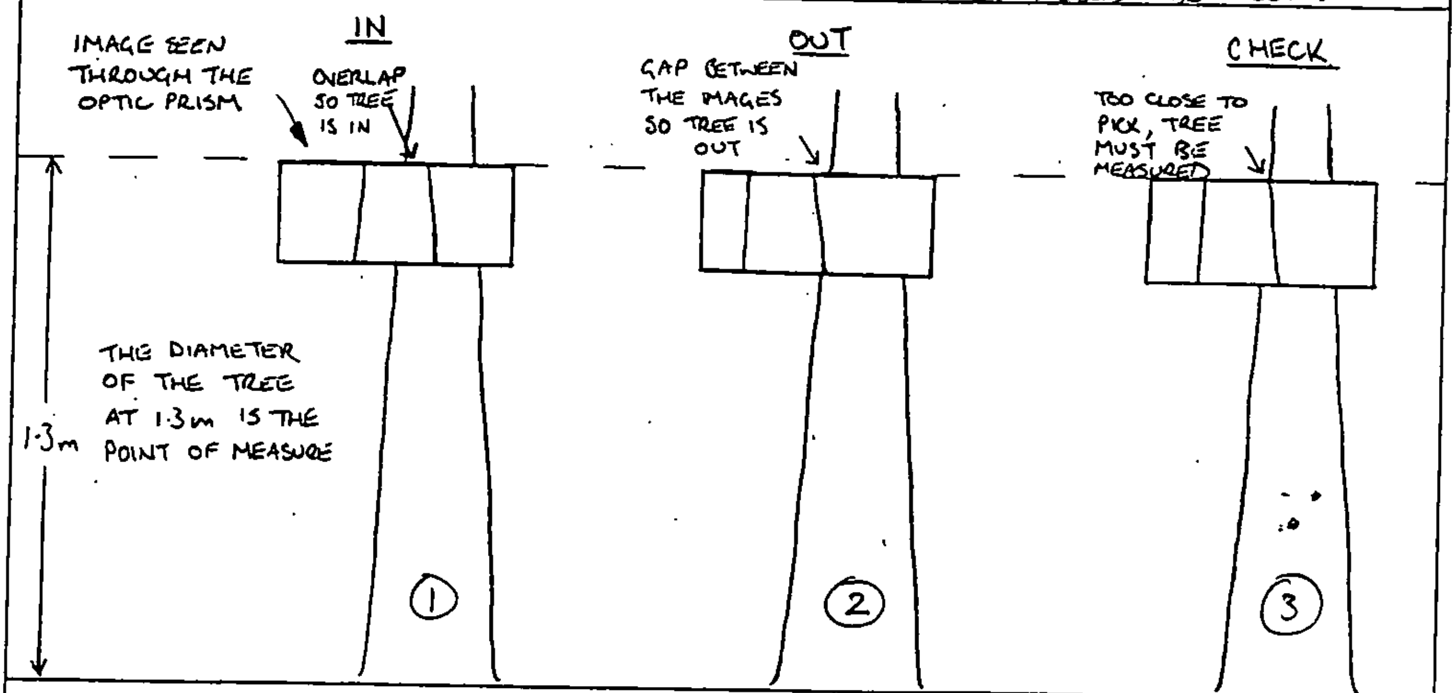
Some trees will appear to be almost exactly the same width as the angle generated by the optic prism. Where this happens the tree must be checked. This is done by measuring the distance to the middle of the side of the tree at 1.3 metres and the DBHob of the tree. It is vital that the distance measured is the horizontal distance from the plot point to the middle of the side of the tree. If there is too much slope to allow the tape to be held horizontal for this measurement, then hold the tape parallel to the ground, measure the distance and the slope to the tree and convert the slope distance to horizontal using the "Individual Tree Slope Correction Table" on page 17.

The DBHob is looked up on the "Limiting Horizontal Distances..." table (pages 15 and 16) with the correct B.A.F. (B.A.F. stands for "Basal Area Factor") and the corresponding distance is compared to the measured distance to the tree. If the measured distance to the tree is less than the distance on the table then the tree is "in", if the measured distance is greater than the distance on the table then the tree is "out".

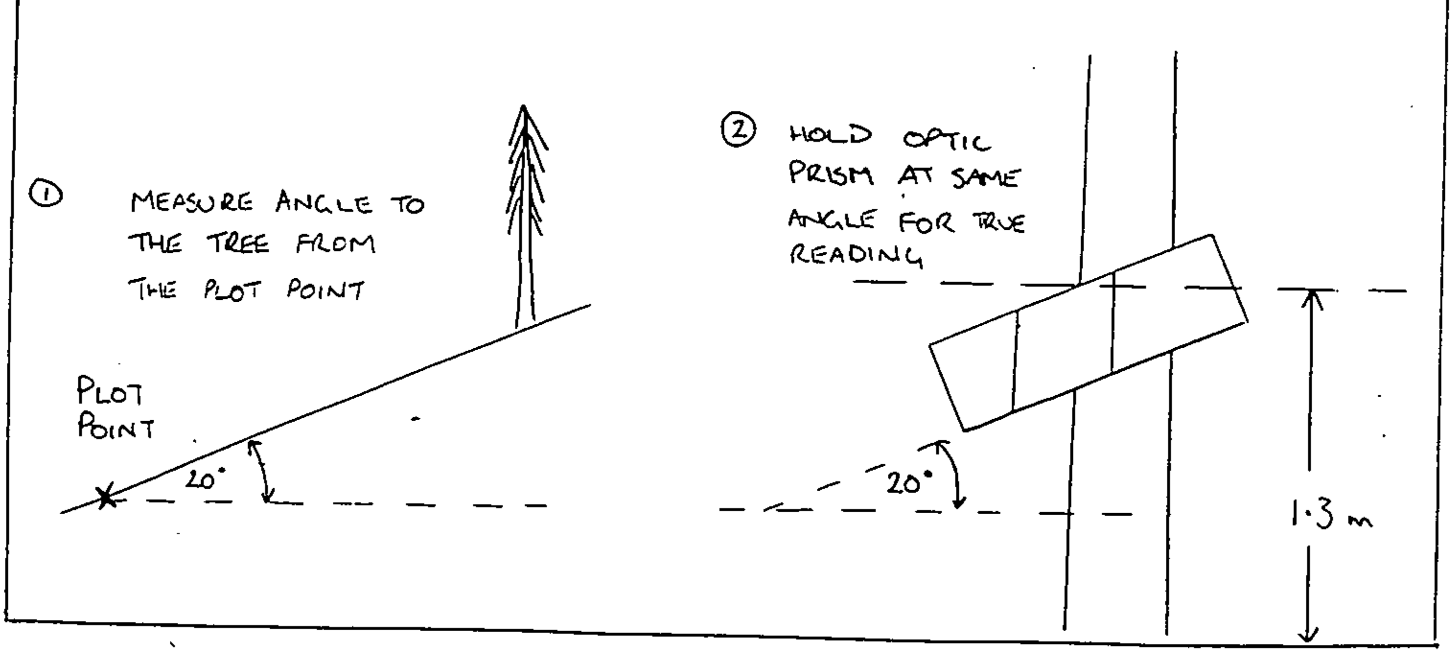
FIG. 1: ANGLE GAUGE PLOT DIAGRAMS



TO DETERMINE IF A TREE IS "IN" OR "OUT" THE DBHob OF THE TREE IS COMPARED WITH THE ANGLE GENERATED BY THE OPTIC PRISM. IF THE TREE IS LARGER THAN THE ANGLE IT IS "IN", IF THE TREE IS SMALLER IT IS "OUT". THE CRITICAL, OR LIMITING DISTANCE WHERE A TREE CHANGES BETWEEN "IN" AND "OUT" VARIES WITH THE SIZE OF THE TREE. THE B.A.F. IS A FIXED RATIO BETWEEN DISTANCE TO THE TREE AND IT'S DBHob. TREE B IS TWICE AS LARGE AS TREE A SO IT'S LIMITING DISTANCE IS TWICE AS FAR AS FOR TREE A. BOTH TREES ARE AT TRUE BORDERLINE SO IF EITHER TREE WERE ANY CLOSER THEY WOULD BE "IN", AND ANY FURTHER AWAY THEY WOULD BE "OUT".



SLOPE CORRECTION



If, on the rare chance, the two distances are exactly the same the tree is a true borderline tree. When this occurs in a **Primary Plot** (ie: one where each "in" tree is measured and assessed) then the first occurrence should be included as normal, the second occurrence should be treated as "out", and so on. Try to make sure you can remember how the last true borderline tree was treated so the alternate " one in, one out" pattern will work. This "one-in-one-out" method is not the normal method for dealing with borderline trees, we have to use this method until the developers of the MARVL computer software build in a facility to accept "half trees" in Primary Plots. All occurrences should be counted as a **half** on the tally for that plot if you are installing a **Secondary Plot**.

Slope Correction

There are two stages of slope correction for angle gauge plots. The first involves the initial "sweep" around the plot point. When assessing trees on a slope the optic prism should be held on the same angle as the slope between the plot point and the tree in question. See Angle Gauge Plot Diagrams on page 5. Relaskop users should not do this as the Relaskop barrel will perform this slope correction for you. Simply release the brake so the barrel rotates freely, aim at the 1.3 metre point on the tree, allow the barrel to settle and then apply the brake. Then compare the band width with the tree width as usual.

The second form of slope correction is used when a tree is so close to the limiting distance that it is not possible to determine if the tree is "in" or "out" just from the optic prism (or Relaskop). When this occurs the tree must be checked as described in the "**Borderline Trees**" section above.

Which Trees Are In?

All trees seen as "in" by the angle gauge count as one on the tally for that plot. Merchantable and non-merchantable species are treated in exactly the same way in Angle Gauge plots.

True borderline trees count as half on the plot tally when installing Secondary Plots. In Primary Plots every second true borderline tree is "out" and every alternate true borderline tree is "in" and should be described as usual.

For details on measuring and assessing the "in" trees, refer to Section 6 "Measuring Trees", below and Section 7 "Assessing Trees on page 10.

6. MEASURING TREES

NOTE: The following section on measuring trees, and section 7: "Assessing Trees", are only applicable to Primary Plots. The only information recorded for Secondary Plots is the tally of "in" trees.

6.1 Diameter (DBHob)

Measuring Point

Tree diameter obviously changes as you move along the stem of a tree. In general the tree will get thinner as you move towards the tip but there are also changes in diameter caused by limb swellings, damaged points, etc. So for any one tree there are countless diameters you could measure (if you were keen!).

What we need is a consistent diameter measurement point so if two different people measure the same tree we should get the same answer. That consistent measuring point is called "DBHob", standing for Diameter at Breast Height over bark.

There is a set of rules which define DBHob and how to measure it. The rules are:

1. Breast Height is 1.3 metres above ground level measured along the stem. Where the tree is on a slope, 1.3m is measured on the uphill side of the tree. Where the tree is on a lean, 1.3m is measured on the underside of the lean.

2. Trees which fork above 1.3m are considered to be one tree, but if the two leaders are separate at 1.3m each leader is treated as a separate tree.

3. Where a swelling occurs at 1.3m, two points, unaffected by swellings or limbs, equal distances above and below 1.3m should be selected so two unaffected measurements are then averaged to give an estimate of DBHob.

The measurer should paint the point(s) on the tree where the diameter measurement(s) have been made.

Tape & Placement

The tape should be placed around the tree perpendicular (that is, at right angles) to the axis of the stem at 1.3m. If there is lichen or loose bark at 1.3m they should be gently cleared so as not to remove any firm bark from the tree.

On larger trees care should be taken to ensure the tape does not "get the droops" around the back of the tree. The tape should always go directly around the stem at the point of measurement.

Taking Readings

All diameter measure measurements should be measured, called and booked in millimetres. Where a part millimetre occurs always round down.

Multiple Leaders

Trees which fork above 1.3m are considered to be a single tree. Trees which have physically separated below 1.3m are considered to be two (or possibly three) different trees.

In situations where a tree forks right at 1.3m and the 1.3m point is swollen as a result of the fork, the tree should be treated as two separate trees with the diameters measured at the lowest point where the new leaders have assumed a normal shape.

In all instances where a forked tree gets recorded as two or more trees the section of the tree below the fork should be described as waste.

6.2 Height

Once the Vertex has been calibrated it is ready for use. See Vertex User notes for more detail on the Vertex hypsometer.

All "in" trees of commercial species are to be measured for total height. Turn the transponder on and place it at the middle of the side of the tree at 1.3m. The person with the hypsometer should place themselves about as far away from the tree as the tree is tall and in a position where they can see both the transponder and the top of the tree.

Turn the hypsometer on and aim the little red dot at the transponder, hold the orange button down until the red dot disappears, then release the orange button. The red dot should now be flashing, aim the flashing dot at the top of the tree and hold the orange button down until the dot disappears again.

In the lower left-hand corner of the display screen, just above the printing "Height 1" the height of the tree is shown. If you are unsure of the height given, then "re-shoot" to the point on the tree and compare the reading for "Height 2" with your first reading.

The main thing to keep in mind when heighting eucalypts is the shape of the tree crown. The diagram on page 9 illustrate what can go wrong when a height reading is taken to the front of the tree crown instead of to the top of the crown.

Observed Site Height

Observed site height is one of the fields to be filled in on the top section of the proforma. What we mean by "observed site height" is the maximum height trees could possibly reach in the area within and surrounding the plot. In other words, "what height would an undisturbed stand of trees reach?".

The procedure for collecting this bit of information varies according to the nature of the trees which are actually **in** the plot. In most cases the plot will probably contain at least one tree which is representative of this "maximum" height. In these situations all you need to do is see where the total height of that tree fits in the "Site HT" index (the little box in the bottom left-hand corner of the proforma) and write the corresponding number in the "Obs. Site Ht:" field.

If there are taller trees outside the plot (especially if the plot is in a patch of young regeneration or some other type of "gap") then the tallest of those trees should be measured for total height and that figure used to determine the plot's site height.

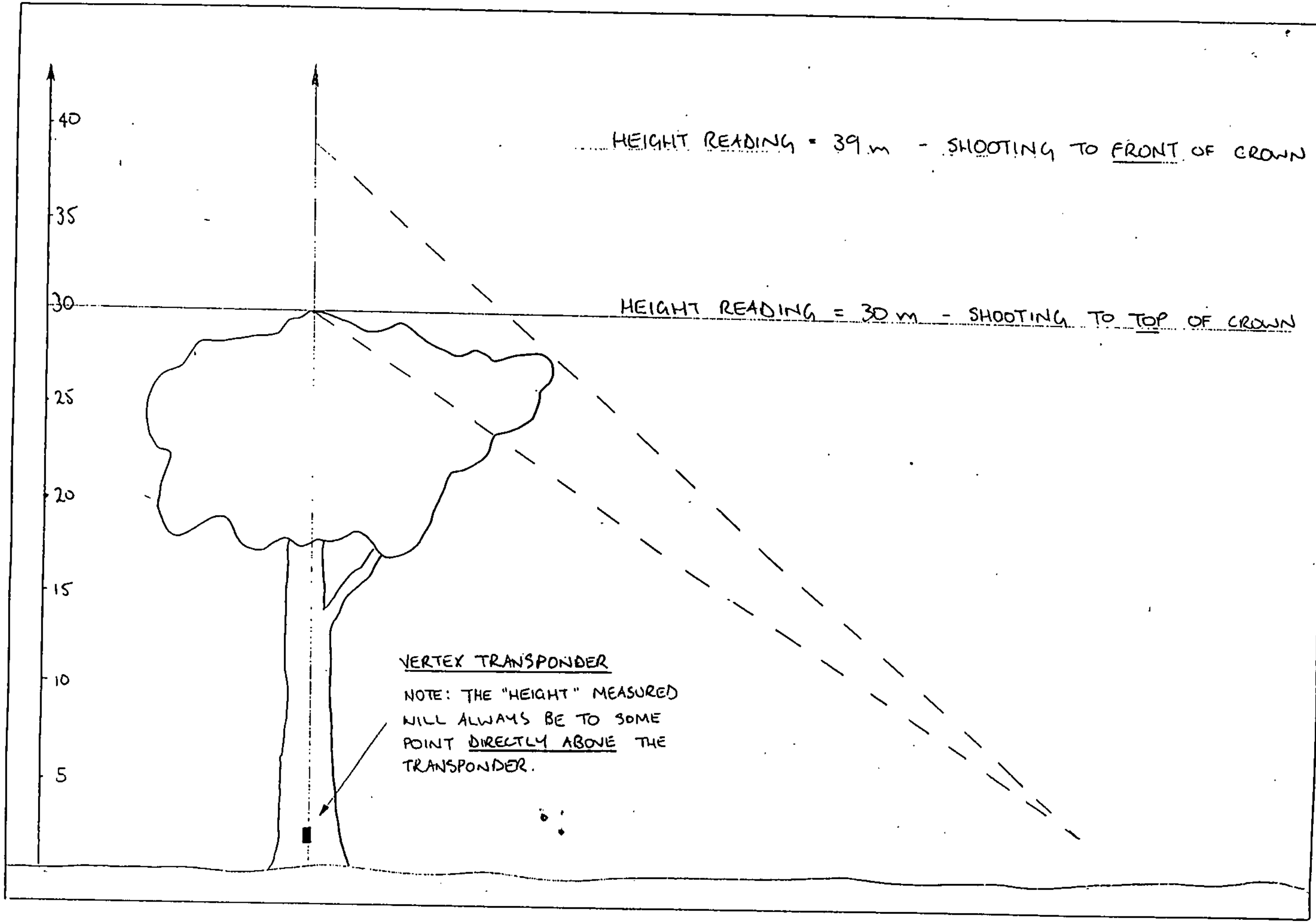


FIG. 2: CORRECT METHOD FOR HEIGHTING EUCALYPTS

7. ASSESSING TREES

7.1 Crown Condition

Each tree in the plot is assessed for it's Crown Condition. The definitions of the Crown Condition classes are the same as for State Forest's P.G.P. system:

1 = Good, leafy vigorous crown
2 = Fair
3 = Poor - senescent, diseased or damaged

7.2 Dominance Class

Each tree in the plot is assessed for it's Dominance Class. The definitions of the Dominance Classes are the same as for State Forest's P.G.P. system:

1 = Dominant - trees with crowns extending above the general canopy, receiving full light from above & partly from the sides
2 = Co-dominant - crown forms part of the general canopy, receives full light from above and little from the sides
3 = Sub-dominant - shorter than 1 & 2, crown extends into general canopy, receives a little light from above but none from the sides
4 = Suppressed - crown entirely below canopy, receives no direct light from above or sides

7.3 Habitat Status

Each tree in the plot must be assessed for it's habitat status. Our definition of a "habitat tree" is the same as the Section 120 Licence conditions, ie: a hollow bearing tree.

All trees in the plot which meet this condition must have a "H" placed in the Habitat Status column for that tree, regardless of how many trees in the plot have already been given a "H". **Do not** attempt to record only enough "habitat trees" to meet a certain stocking rate (eg: 5 habitat trees per hectare), book **all** trees which meet the definition.

7.4 Logging Impediment

"Logging Impediment" is supposed to describe any "environmental" reason (other than Habitat Status) why a tree would not be available for harvesting during a routine harvesting operation. The sorts of things we mean here are slopes greater than 30°, water-course prescriptions and wildlife prescriptions.

Where a plot falls in, or near, a creek and some, or all, of the trees in the plot would be in a filter/protection strip of some sort, you should apply a 10 metre exclusion zone along the bank of the creek. All trees within that 10 metre exclusion zone are given "E" for their Logging Impediment. The only exception to this "rule" is any situation where you are **certain** that some more serious prescription would apply, eg: a 20 metre exclusion zone surrounding a major creek with large pools of still water. Whenever the normal 10 metre "rule" is over-ridden, you should make a note of this in the comments section of the plot sheet.

Where a tree meets any of the many and various wildlife prescriptions (eg: has koala scats under it, or a "V-notch", or a Powerful Owl roost tree) then that tree should be given "E" for Logging Impediment and a note should be made in the comment section specifying which tree number and which of these wildlife prescriptions applies (eg: "Tree 5 has V-notch").

7.5 Stem Deterioration Point

Stem Deterioration Point (SDP) is a recently developed term meant to indicate crown break and allow objective classification for the end of the main stem. It will be critical to the application of height growth functions to ensure that future bole height predictions are not over-estimated.

The emphasis is on the physical characteristics of the stem and crown, for instance a relatively young spar which maintains a conical apical growing point is unlikely to have a Stem Deterioration Point. However an older mature stem which "breaks-up" into permanent branches in the upper crown, and has no recognisable leader or main stem, will have an obvious Stem Deterioration Point. As tree height growth is initiated from the top of the tree, it is important that such a point is recorded so that no further stem height growth would be assumed for the tree.

This information is recorded by assessing the stem to the SDP and coding the remaining height to the top of the tree with the "T" MARVL description code. Otherwise a tree without a SDP should be coded to the top with the last MARVL description code. While generally older trees will tend to have more obvious SDP's, this characteristic can be present on even the smallest sapling, especially in the instance of suppressed advance growth which have suffered crown damage.

It should be born in mind however that as this code effectively "kills" stem height growth beyond that point for future predictions. Therefore it should be carefully assessed, and for younger trees only used when the assessor is confident that the stem is not capable of "straightening out" if released.

7.6 Tree Descriptions

The way trees in MARVL plots are described depends on what type of inventory is being done. In Northern Region there are two types of inventories:

1. Planning Scale Inventories are inventories where plots are distributed over a large area (such as a Management Area or a whole District).
2. Operational Inventories are inventories where plots are only put in compartments which are scheduled to be harvested in the near future.

Make sure you use the right method for the type of inventory you are doing. The "Dictionary" code box in the bottom right hand corner of the proforma is different for the two inventory types. For Planning Scale Inventories the choices are based on high and low quality wood, where for Operational Inventories the choices are based on product types (compulsory, poles, salvage etc).

All tree descriptions must be booked in a cumulative way. By this we mean that if a tree has a five metre waste ("W") section at the stump, then ten metres of high quality ("A") material, then ten metres of low quality material ("B") up to the crown base (Stem Deterioration Point) and a top height ("T") of 40 metres, the tree description should look like this:

Tree No.	Spp Code	DBH (mm)	Harvesting Status	Crown Cond	Domin Class	Habitat Status	MARVL Tree Description
1	BBT	750	A	2	1		W5 A15 B25 T40
2	NCO	148	E	3	4		W10

Trees of non-commercial species (NCO) should be given a tree description of waste ("W") to the top height of the tree as in the example above.

If a section of a tree borders between two codes always describe the section as being the poorer of the two choices. This rule applies to both Planning Scale Inventories and Operational Inventories.

Viewing each tree from several angles definitely helps the assessor to pick up all the key features of the tree. Except in the case of very simple trees, all trees should be assessed from more than one perspective.

Planning Scale Inventories

Trees in these plots are assessed for wood quality characteristics - not products. The assessor should not attempt to break the tree up into "logs" according to current specifications. In general each tree should be viewed overall and then assessed for wood quality on "sectional" basis.

An important point to note is that **stem size** makes no difference to **wood quality**. A section of stem which is only 20 centimetres in diameter but is straight and seemingly defect free should be described as being high quality.

Each tree's description will start with a section of waste (coded as "W") which represents both the stump height of the tree and any additional "butting" of the first log which may be necessary.

If the tree is entirely unmerchantable then the waste section should continue up to the top height of the tree.

For trees which contain some potentially merchantable material (including pulp) then the merchantable sections should be measured for length with the Vertex and given the appropriate quality code ("A", "B" or "P"). This process continues right the way up the stem from the stump to the "stem deterioration point". From the "stem deterioration point" to the top of the tree crown should be given the code "T". If sections of waste occur between the merchantable sections then they should be included in the tree description in the same way as for merchantable sections.

All of the wood quality codes can be used more than once in any tree, and there is no reason why you cannot revert to a higher quality code once a section of low quality or waste has been described.

Operational Inventories

The main objective of Operational Inventories is to provide an estimate of the likely yield of wood by product type from compartments which will soon be logged. In order to do this the wood quality codes used to describe the trees relate almost exactly to current product definitions.

Each product type has it's own code which is applied in pretty much the same way as the high and low quality codes are used in Planning Scale Inventories. (Note: Not all Districts sell all types of products, but for completeness sake they are all listed in the Dictionary).

The main difference between Planning Scale and Operational Inventories is that because we are trying to get an idea of actual volumes of each product, it is O.K. for the assessor to try to break the tree up into products. Minimum length and diameter specifications which apply to each product type should be used to help the assessor to make the tree descriptions as realistic as possible.

8. APPENDIX

MARVL Bound Plot Slope Correction Table

Average Slope	Plot Radius (m)
0	17.84
1	17.84
2	17.85
3	17.85
4	17.86
5	17.88
6	17.89
7	17.91
8	17.93
9	17.95
10	17.98
11	18.01
12	18.04
13	18.07
14	18.11
15	18.15
16	18.20
17	18.24
18	18.29
19	18.35
20	18.40
21	18.46
22	18.53
23	18.60
24	18.67
25	18.74
26	18.82
27	18.90
28	18.99
29	19.08
30	19.17
31	19.27
32	19.37
33	19.48
34	19.59
35	19.71
36	19.84
37	19.96
38	20.10
39	20.24
40	20.38
41	20.54
42	20.70
43	20.96
44	21.04
45	21.22

LIMITING HORIZONTAL DISTANCES FOR B.A.F. = 2

DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance
1	0.35	31	10.96	61	21.57	91	32.17	121	42.78	151	53.39	181	63.99
2	0.71	32	11.31	62	21.92	92	32.53	122	43.13	152	53.74	182	64.35
3	1.06	33	11.67	63	22.27	93	32.88	123	43.49	153	54.09	183	64.70
4	1.41	34	12.02	64	22.63	94	33.23	124	43.84	154	54.45	184	65.05
5	1.77	35	12.37	65	22.98	95	33.59	125	44.19	155	54.80	185	65.41
6	2.12	36	12.73	66	23.33	96	33.94	126	44.55	156	55.15	186	65.76
7	2.47	37	13.08	67	23.69	97	34.29	127	44.90	157	55.51	187	66.11
8	2.83	38	13.44	68	24.04	98	34.65	128	45.25	158	55.86	188	66.47
9	3.18	39	13.79	69	24.40	99	35.00	129	45.61	159	56.21	189	66.82
10	3.54	40	14.14	70	24.75	100	35.36	130	45.96	160	56.57	190	67.18
11	3.89	41	14.50	71	25.10	101	35.71	131	46.32	161	56.92	191	67.53
12	4.24	42	14.85	72	25.46	102	36.06	132	46.67	162	57.28	192	67.88
13	4.60	43	15.20	73	25.81	103	36.42	133	47.02	163	57.63	193	68.24
14	4.95	44	15.56	74	26.16	104	36.77	134	47.38	164	57.98	194	68.59
15	5.30	45	15.91	75	26.52	105	37.12	135	47.73	165	58.34	195	68.94
16	5.66	46	16.26	76	26.87	106	37.48	136	48.08	166	58.69	196	69.30
17	6.01	47	16.62	77	27.22	107	37.83	137	48.44	167	59.04	197	69.65
18	6.36	48	16.97	78	27.58	108	38.18	138	48.79	168	59.40	198	70.00
19	6.72	49	17.32	79	27.93	109	38.54	139	49.14	169	59.75	199	70.36
20	7.07	50	17.68	80	28.28	110	38.89	140	49.50	170	60.10	200	70.71
21	7.42	51	18.03	81	28.64	111	39.24	141	49.85	171	60.46	201	71.06
22	7.78	52	18.38	82	28.99	112	39.60	142	50.20	172	60.81	202	71.42
23	8.13	53	18.74	83	29.34	113	39.95	143	50.56	173	61.16	203	71.77
24	8.49	54	19.09	84	29.70	114	40.31	144	50.91	174	61.52	204	72.12
25	8.84	55	19.45	85	30.05	115	40.66	145	51.27	175	61.87	205	72.48
26	9.19	56	19.80	86	30.41	116	41.01	146	51.62	176	62.23	206	72.83
27	9.55	57	20.15	87	30.76	117	41.37	147	51.97	177	62.58	207	73.19
28	9.90	58	20.51	88	31.11	118	41.72	148	52.33	178	62.93	208	73.54
29	10.25	59	20.86	89	31.47	119	42.07	149	52.68	179	63.29	209	73.89
30	10.61	60	21.21	90	31.82	120	42.43	150	53.03	180	63.64	210	74.25

LIMITING HORIZONTAL DISTANCES FOR B.A.F. = 4

DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance	DBHob (cm)	Horizontal Distance
1	0.25	31	7.75	61	15.25	91	22.75	121	30.25	151	37.75	181	45.25
2	0.50	32	8.00	62	15.50	92	23.00	122	30.50	152	38.00	182	45.50
3	0.75	33	8.25	63	15.75	93	23.25	123	30.75	153	38.25	183	45.75
4	1.00	34	8.50	64	16.00	94	23.50	124	31.00	154	38.50	184	46.00
5	1.25	35	8.75	65	16.25	95	23.75	125	31.25	155	38.75	185	46.25
6	1.50	36	9.00	66	16.50	96	24.00	126	31.50	156	39.00	186	46.50
7	1.75	37	9.25	67	16.75	97	24.25	127	31.75	157	39.25	187	46.75
8	2.00	38	9.50	68	17.00	98	24.50	128	32.00	158	39.50	188	47.00
9	2.25	39	9.75	69	17.25	99	24.75	129	32.25	159	39.75	189	47.25
10	2.50	40	10.00	70	17.50	100	25.00	130	32.50	160	40.00	190	47.50
11	2.75	41	10.25	71	17.75	101	25.25	131	32.75	161	40.25	191	47.75
12	3.00	42	10.50	72	18.00	102	25.50	132	33.00	162	40.50	192	48.00
13	3.25	43	10.75	73	18.25	103	25.75	133	33.25	163	40.75	193	48.25
14	3.50	44	11.00	74	18.50	104	26.00	134	33.50	164	41.00	194	48.50
15	3.75	45	11.25	75	18.75	105	26.25	135	33.75	165	41.25	195	48.75
16	4.00	46	11.50	76	19.00	106	26.50	136	34.00	166	41.50	196	49.00
17	4.25	47	11.75	77	19.25	107	26.75	137	34.25	167	41.75	197	49.25
18	4.50	48	12.00	78	19.50	108	27.00	138	34.50	168	42.00	198	49.50
19	4.75	49	12.25	79	19.75	109	27.25	139	34.75	169	42.25	199	49.75
20	5.00	50	12.50	80	20.00	110	27.50	140	35.00	170	42.50	200	50.00
21	5.25	51	12.75	81	20.25	111	27.75	141	35.25	171	42.75	201	50.25
22	5.50	52	13.00	82	20.50	112	28.00	142	35.50	172	43.00	202	50.50
23	5.75	53	13.25	83	20.75	113	28.25	143	35.75	173	43.25	203	50.75
24	6.00	54	13.50	84	21.00	114	28.50	144	36.00	174	43.50	204	51.00
25	6.25	55	13.75	85	21.25	115	28.75	145	36.25	175	43.75	205	51.25
26	6.50	56	14.00	86	21.50	116	29.00	146	36.50	176	44.00	206	51.50
27	6.75	57	14.25	87	21.75	117	29.25	147	36.75	177	44.25	207	51.75
28	7.00	58	14.50	88	22.00	118	29.50	148	37.00	178	44.50	208	52.00
29	7.25	59	14.75	89	22.25	119	29.75	149	37.25	179	44.75	209	52.25
30	7.50	60	15.00	90	22.50	120	30.00	150	37.50	180	45.00	210	52.50

Individual Tree Slope Correction Table

(For use in Angle Gauge Plots only)

SLOPE	MEASURED SLOPE DISTANCE (to be converted to horizontal distance)																															
	1 cm	2 cm	3 cm	4 cm	5 cm	6 cm	7 cm	8 cm	9 cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	1 m	2 m	3 m	4 m	5 m	6 m	7 m	8 m	9 m	10 m	20 m	30 m	40 m	50 m
5	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.99	2.99	3.98	4.98	5.98	6.97	7.97	8.97	9.96	19.92	29.89	39.85	49.81
6	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.99	1.99	2.98	3.98	4.97	5.97	6.96	7.96	8.95	9.95	19.89	29.84	39.78	49.73
7	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.30	0.40	0.50	0.60	0.69	0.79	0.89	0.99	1.99	2.98	3.97	4.96	5.96	6.95	7.94	8.93	9.93	19.85	29.78	39.70	49.63
8	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.30	0.40	0.60	0.59	0.69	0.79	0.89	0.99	1.98	2.97	3.96	4.95	5.94	6.93	7.92	8.91	9.90	19.81	29.71	39.61	49.51
9	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.30	0.40	0.49	0.59	0.69	0.79	0.89	0.99	1.98	2.96	3.95	4.94	5.93	6.91	7.90	8.89	9.88	19.75	29.63	39.51	49.38
10	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.30	0.39	0.49	0.59	0.69	0.79	0.89	0.98	1.97	2.95	3.94	4.92	5.91	6.89	7.88	8.86	9.85	19.70	29.54	39.39	49.24
11	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.29	0.39	0.49	0.59	0.69	0.79	0.88	0.98	1.96	2.94	3.93	4.91	5.89	6.87	7.85	8.83	9.82	19.63	29.45	39.27	49.08
12	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.29	0.39	0.49	0.59	0.68	0.78	0.88	0.98	1.96	2.93	3.91	4.89	5.87	6.85	7.83	8.80	9.78	19.56	29.34	39.13	48.91
13	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.19	0.29	0.39	0.49	0.58	0.68	0.78	0.88	0.97	1.95	2.92	3.90	4.87	5.85	6.82	7.79	8.77	9.74	19.49	29.23	38.97	48.72
14	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.19	0.29	0.39	0.49	0.58	0.68	0.78	0.87	0.97	1.94	2.91	3.88	4.85	5.82	6.79	7.76	8.73	9.70	19.41	29.11	38.81	48.51
15	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.19	0.29	0.39	0.48	0.58	0.68	0.77	0.87	0.97	1.93	2.90	3.86	4.83	5.80	6.76	7.73	8.69	9.66	19.32	28.98	38.64	48.30
16	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.19	0.29	0.38	0.48	0.58	0.67	0.77	0.87	0.96	1.92	2.88	3.85	4.81	5.77	6.73	7.69	8.65	9.61	19.23	28.84	38.45	48.06
17	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.19	0.29	0.38	0.48	0.57	0.67	0.77	0.86	0.96	1.91	2.87	3.83	4.78	5.74	6.69	7.65	8.61	9.56	19.13	28.69	38.25	47.82
18	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.95	1.90	2.85	3.80	4.76	5.71	6.66	7.61	8.56	9.51	19.02	28.53	38.04	47.55
19	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.09	0.19	0.28	0.38	0.47	0.57	0.66	0.76	0.85	0.95	1.89	2.84	3.78	4.73	5.67	6.62	7.56	8.51	9.46	18.91	28.37	37.82	47.28
20	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.09	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.88	2.82	3.76	4.70	5.64	6.58	7.52	8.46	9.40	18.79	28.19	37.59	46.98
21	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.09	0.19	0.28	0.37	0.47	0.56	0.65	0.75	0.84	0.93	1.87	2.80	3.73	4.67	5.60	6.54	7.47	8.40	9.34	18.67	28.01	37.34	46.68
22	0.01	0.02	0.03	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.19	0.28	0.37	0.46	0.56	0.65	0.74	0.83	0.93	1.85	2.78	3.71	4.64	5.56	6.49	7.42	8.34	9.27	18.54	27.82	37.09	46.36
23	0.01	0.02	0.03	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.18	0.28	0.37	0.46	0.55	0.64	0.74	0.83	0.92	1.84	2.76	3.68	4.60	5.52	6.44	7.36	8.28	9.21	18.41	27.62	36.82	46.03
24	0.01	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.08	0.09	0.18	0.27	0.37	0.46	0.55	0.64	0.73	0.82	0.91	1.83	2.74	3.65	4.57	5.48	6.39	7.31	8.22	9.14	18.27	27.41	36.54	45.68
25	0.01	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.08	0.09	0.18	0.27	0.36	0.45	0.54	0.63	0.73	0.82	0.91	1.81	2.72	3.63	4.53	5.44	6.34	7.25	8.16	9.06	18.13	27.19	36.25	45.32
26	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.18	0.27	0.36	0.45	0.54	0.63	0.72	0.81	0.90	1.80	2.70	3.60	4.49	5.39	6.29	7.19	8.09	8.99	17.98	26.96	35.95	44.94
27	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.18	0.27	0.36	0.45	0.53	0.62	0.71	0.80	0.89	1.78	2.67	3.56	4.46	5.35	6.24	7.13	8.02	8.91	17.82	26.73	35.64	44.55
28	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.18	0.26	0.35	0.44	0.53	0.62	0.71	0.79	0.88	1.77	2.65	3.53	4.41	5.30	6.18	7.06	7.95	8.83	17.66	26.49	35.32	44.15
29	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.17	0.26	0.35	0.44	0.52	0.61	0.70	0.79	0.87	1.75	2.62	3.50	4.37	5.25	6.12	7.00	7.87	8.75	17.49	26.24	34.98	43.73
30	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.17	0.26	0.35	0.43	0.52	0.61	0.69	0.78	0.87	1.73	2.60	3.46	4.33	5.20	6.06	6.93	7.79	8.66	17.32	25.98	34.64	43.30
31	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.17	0.26	0.34	0.43	0.51	0.60	0.69	0.77	0.86	1.71	2.57	3.43	4.29	5.14	6.00	6.86	7.71	8.57	17.14	25.72	34.29	42.86
32	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.17	0.25	0.34	0.42	0.51	0.59	0.68	0.76	0.85	1.70	2.54	3.39	4.24	5.09	5.94	6.78	7.63	8.48	16.96	25.44	33.92	42.40
33	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.17	0.25	0.34	0.42	0.50	0.59	0.67	0.75	0.84	1.68	2.52	3.35	4.19	5.03	5.87	6.71	7.55	8.39	16.77	25.16	33.55	41.93
34	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.17	0.25	0.33	0.41	0.50	0.58	0.66	0.75	0.83	1.66	2.49	3.32	4.15	4.97	5.80	6.63	7.46	8.29	16.58	24.87	33.16	41.45
35	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.16	0.25	0.33	0.41	0.49	0.57	0.66	0.74	0.82	1.64	2.46	3.28	4.10	4.91	5.73	6.55	7.37	8.19	16.38	24.57	32.77	40.96
36	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.06	0.07	0.08	0.16	0.24	0.32	0.40	0.49	0.57	0.65	0.73	0.81	1.62	2.43	3.24	4.05	4.85	5.66	6.47	7.28	8.09	16.18	24.27	32.36	40.45
37	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.06	0.07	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80	1.60	2.40	3.19	3.99	4.79	5.59	6.39	7.19	7.99	15.97	23.96	31.95	39.93
38	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.06	0.07	0.08	0.16	0.24	0.32	0.39	0.47	0.55	0.63	0.71	0.79	1.58	2.36	3.15	3.94	4.73	5.52	6.30	7.09	7.88	15.76	23.64	31.52	39.40
39	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.08	0.16	0.23	0.31	0.39	0.47	0.54	0.62	0.70	0.78	1.55	2.33	3.11	3.89	4.66	5.44	6.22	6.99	7.77	15.54	23.31	31.09	38.86
40	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.08	0.15	0.23	0.31	0.38	0.46	0.54	0.61	0.69	0.77	1.53	2.30	3.06	3.83	4.60	5.36	6.13	6.89	7.66	15.32	22.98	30.64	38.30
41	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.08	0.15	0.23	0.30	0.38	0.45	0.53	0.60	0.68	0.75	1.51	2.26	3.02	3.77	4.53	5.28	6.04	6.79	7.55	15.09	22.64	30.19	37.74
42	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.07	0.15	0.22	0.30	0.37	0.45	0.52	0.59	0.67	0.74	1.49	2.23	2.97	3.72	4.46	5.20	5.95	6.69	7.43	14.86	22.29	29.73	37.16
43	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.07	0.15	0.22	0.29	0.37	0.44	0.51	0.59	0.66	0.73	1.46	2.19	2.93	3.66	4.39	5.12	5.85	6.58	7.31	14.63	21.94	29.25	36.57
44	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.14	0.22	0.29	0.36	0.43	0.50	0.58	0.65	0.72	1.44	2.16	2.88	3.60	4.32	5.04	5.75	6.47	7.19	14.39	21.58	28.77	35.97
45	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.14	0.21	0.28	0.35	0.42	0.49	0.57	0.64	0.71	1.41	2.12	2.83	3.54	4.24	4.95	5.66	6.36	7.07	14.14	21.21	28.28	35.36

ASB	Eucalyptus agglomerata	Blueleaved Stringybark
BBT	Eucalyptus pilularis	Blackbutt
BBX	Lophostemon confertus	Brush Box
BLW	Eucalyptus spp.	Bloodwood group
BSA	Eucalyptus stellulata	Black Sallee
CBK	Eucalyptus rubida	Candlebark
CBX	Eucalyptus bosistoana	Coast grey Box
DSB	Eucalyptus cameronii	Diehard Stringybark
DWG	Eucalyptus dunnii	White Gum
EPM	Eucalyptus nova-anglica	New England Peppermint
ESB	Eucalyptus calignosa	New England Stringybark
EUC	Eucalyptus spp.	Eucalyptus spp.
FAS	Eucalyptus fastigata	Brown barrel
FLG	Eucalyptus grandis	Flooded Gum
FRG	Eucalyptus tereticornis	Forest red Gum
GBX	Eucalyptus moluccana	Grey Box
GIB	Eucalyptus siderophloia	Grey Ironbark
GYG	Eucalyptus propinqua	Grey Gum
HPP	Araucaria cuninghamii	Hoop Pine
IBK	Eucalyptus spp.	Ironbark group
MAG	Eucalyptus viminalis	Manna Gum
MDG	Eucalyptus globulus ssp maidenii	Maidens Gum
MKG	Eucalyptus cypellocarpa	Monkey Gum
MMT	Eucalyptus obliqua	Messmate
MTG	Eucalyptus dalrympleena	Mountain Gum
NCE	Eucalyptus spp.	Non-commercial Eucalypt spp.
NCO	Non-commercial other	Non-commercial other
NEB	Eucalyptus andrewsii spp. campanulata	New England Blackbutt
NIB	Eucalyptus crabra	Narrowleaved Ironbark
NPM	Eucalyptus radiata	Narrowleaved Peppermint
OAK	Oak group	Oak group
OCE	Eucalyptus spp.	Other commercial Eucalypt spp.
PPM	Eucalyptus spp.	Peppermint group
PYR	Eucalyptus pyrocarpa	Largefruited Blackbutt
RAP	Angophora floribunda	Roughbarked Apple
RIB	Eucalyptus sideroxylon	Red Ironbark
RLG	Eucalyptus deanii	Roundleaved Gum
RMY	Eucalyptus resinifera	Red Mahoghany
RPM	Eucalyptus elata	River Peppermint
RSB	Eucalyptus macrorhyncha	Red Stringybark
SAP	Angophora costata	Smoothbarked Apple
SBG	Eucalyptus saligna	Blue Gum
SBK	Eucalyptus spp.	Stringybark group
SBX	Eucalyptus rummeryi	Steel box
SCG	Eucalyptus haemastoma	Scribbly Gum
SHG	Eucalyptus nitens	Shinning Gum
SMY	Eucalyptus robusta	Swamp Mahoghany
SNG	Eucalyptus pauciflora	Snow Gum
SPG	Eucalyptus maculata	Spotted Gum
SSB	Eucalyptus laevopinea	Silvertop Stringybark
TRP	Syncarpia glomulifera	Turpentine
TWD	Eucalyptus microcorys	Tallowwood
WAT	Acacia spp.	Wattle group
WBX	Eucalyptus albens	White Box
WMY	Eucalyptus acmenioides or	Mahoghany, white (group)
WSB	Eucalyptus globoidea	White Stringybark
YSB	Eucalyptus muelleriana	Yellow Stringybark

Urbenville Management Area
Stratification Report

Date: 10/31/96
Time: 10:28 AM

Volume Stratification Summary						
Vol Strata Id	Description	Net Area	No. Plots Required	Record Count	Proportion Required	No. Plots Selected
0	Not Available	-	0			
1	0 - 7 m3/ha CURHIEUC	5,749	25	286	9%	25
2	7.1 - 12 m3/ha CURHIEUC	2,361	25	114	22%	25
3	12.1 - 19 m3/ha CURHIEUC	2,009	25	99	25%	25
4	19.1 m3/ha + CURHIEUC	939	25	49	51%	25
Total		**11,058**	**100**	**548**		**100**

Overall Strategic Inventory Summary	
Sampling Area:	**Urbenville MA**
Availability Scenario Used:	**Scenario 11**
Net Area of Resource:	**11,058**
Total No. of Plots:	**140**
Sampling Intensity:	**1.3%**

Structural Stratification Summary											
Availability	Yield Association	Size Distribution	Strata Identifier	Net Area	No. Plots Required	Record Count	No. of Plots in Vol Strata	Extra Plots Required	Extra Propn Reqd	No. Plots Selected	Done Successfully
1	5	2	1	32	2	2	1	1	50%	1	Y
1	5	4	2	1,007	15	43	5	10	23%	10	Y
1	5	5	3	340	10	25	5	5	20%	5	Y
1	5	6	4	2,742	15	146	32	0	0%	0	Y
1	6	2	5	104	4	5	2	2	40%	2	Y
1	6	4	6	1,336	15	57	9	6	11%	6	Y
1	6	5	7	1,352	15	61	6	9	15%	9	Y
1	6	6	8	2,660	15	128	27	0	0%	0	Y
1	8	5	9	771	10	42	9	1	2%	1	Y
1	9	6	10	716	10	39	4	6	15%	6	Y
1	9	4	9								
1	9	5	9								
1	13	4	9								
1	Other		99								
0			0								
Totals				**11,058**	**111**	**548**	**100**	**40**		**40**	**10**

Northern Region Hardwood Inventory Proforma
Planning Scale Inventory

District		*Plot No.*		*Date:*	
MA		*Stratum*		*Crew:*	
SF name		*BAF/ Plot Size*		*Obs. Site Ht:*	
Cpt. No.		*Slope*		*AMG*	

Tree No.	Spp Code	Dbh (mm)	Tree Description	Crown Cond.	Domin. Class	Habitat Status	Logging Imped.

Comments:

Site HT:	Logging Impediment:	Crown:	Dominance:	Habitat:	Dictionary:
1= 50+	A = No impediment	1 = Good	1 = Dominant	H = Habitat	A = High Qual.
2= 40 - 50 m	E = Environmental imped.	2 = Fair	2 = Co-dominant		B = Low Qual.
3= 30 - 40 m		3 = Poor	3 = Sub-dominant		P = Pulp
4= 20 - 30 m			4 = Suppressed		W = Waste
5= < 20m					T = Top ht

REVIEW OF QUOTA SAWLOG RESOURCES IN THE URBENVILLE MANAGEMENT AREA

Dailan Pugh 2/2/97

State Forests have been conducting a Rapid Operational Inventory to identify the volumes of sawlogs remaining in select compartments outside the IDFA in a variety of management areas. This was due for completion by the 20/1/97, though only the results for the Urbenville MA have been provided at this time. While I have previously used volume estimates in harvesting plans to validate State Forests' Wood Resources Study, this new inventory should provide a more reliable basis for validation.

In the Urbenville MA the Rapid Operational Inventory (ROI) was undertaken at greater intensity, with 10 plots per compartment being utilised. These plots were established within the net loggable area along transects through the compartment. At each plot the Marketing Foremen assessed the Basal Area Factor, counting all trees over 30 cm dbh, then subjectively decided which were suitable for removal as either small sawlogs or quota sawlogs (accounting for retention of habitat trees, growers etc.).

The results for Urbenville confirm my previous assessments which found that the Wood Resources Study (WRS) is grossly over-estimating volumes of quota sawlogs and that there appears to be little statistical relationship between the WRS and other estimates. For the 32 compartments assessed in the Urbenville MA, the ROI gives total volumes of quota sawlogs which are only 62% of the WRS estimates. This comparison includes 9 compartments which were assigned 0 volumes in the WRS, with these removed the ROI quota volumes only represent 46% of the WRS quota volumes.

There are now over four comparable estimates of quota volumes in the Urbenville MA for these 32 compartments (see Table 1), none of which appear to be related to the others. This raises significant questions about State Forests' resource assessment methodologies. While it is too early to assess the accuracy of the ROI (though being based on actual field data it is hoped that it will approximate reality) it is evident that their previous assessment methodologies have failed.

In the Urbenville MA the 1995 commitments to industry were 34,600 cu. m. of quota sawlogs, the WRS estimated that without the protection of any forest the sustainable yield was 18,500 cu. m. of quota sawlogs. The ROI data suggest that without any further protection of forests less than 12,000 cu. m. of quota sawlogs may be sustainable. Yet the NSW Government has committed 17,300 cu. m. of sawlogs per. annum. to the industry for up to 10 years while also identifying the majority of the State Forests in Urbenville as likely to be required for a Comprehensive, Adequate and Representative (CAR) reserve system.

Dailan 2/2/97

URBENVILLE MA, COMPARTMENTS OUTSIDE THE CCO

			FAMIS Inventory (1985)		Wood Resources Study (1996)		Re-revised District estimate (1996)		Rapid Operational Inventory (1997)		
State Forest	Cmpt.	Net Area	FAMIS Quota Volume 1985 (cum)	Quota removed since 1985	WRS Harvestable Volume 1996 (cum)	WRS Quota Volume (using filter factor of 91%)	Quota Sawlogs (quota cum)	Smalls	Quota	Small sawlogs	Rapid Op. In. quota as % of WRS quota
1 Koreelah	34	210	3957	4189	1971	1794	0	0	997	494	56
2 Beaury	71(/2)	210	4203		1074	977	2000	0	939	722	96
	90	109	1924		1461	1330	940	0	230	61	17
	91	79	1146		0	0	0	0	92	205	
	101	63	2000	1005	395	359	0	0	73	0	20
	102	157	3435	2511	1537	1399	0	0	218	0	16
	103	207	4377	3368	1429	1300	0	0	359	0	28
120 Bald Kno	36	20	582			0			351	20	
	37	25	606			0			203	26	
	38	121	1816	41	1148	1045			1171	323	112
	40	130	2037		1940	1765			439	639	25
	41	164	2298		1736	1580			551	1782	35
	66	174	5253		3625	3299	2290	210	750	554	23
	69	69	1797		738	672	770	120	212	277	32
121 Donaldso	42	184	3381		3024	2752	1400	50	139	353	5
	44	76	1446		1052	957	500	25	416	144	43
	47	160	2530		2138	1946	1500	120	159	534	8
	60	139	1809		1192	1085	1000	50	640	513	59
	61	93	1605	1461	1683	1532	0	0	443	0	29
394 Yabbra	139	253	4807	2561	1735	1579	1090	100	2073	377	131
	142	154	3225	2273	0	0	0	0	607	514	
	143	137	2698	3579	0	0	0	0	385	83	
	144	14	2265	547	87	79	0	0	661	418	835
	148	138	2069	2507	0	0	0	0	1138	297	
	149	221	5864	3360	1096	997	0	0	776	32	78
	150	230	3197		1693	1541	1500	50	921	0	60
	157	156	3038		902	821	1170	0	1243	450	151
	158	123	2598		1953	1777	1150	0	900	444	51
	174	168	566		0	0	250	25	179	57	
541 Edinburg	127	196	2881	3523	1100	1001	0	0	270	0	27
	128	226	4053	7547	0	0	0	0	1290	448	
542 Mt. Linde	283	193	2483		0	0	1000	0	609	365	
TOTALS						31585	16560		19434		62

1995
Prineville Commit 34,600
WRS sus yield 18,500 100%

518,500
×62
37000
111000
1,147,000