

# 5 GROUND-MEASUREMENT METHODS

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## 5.1 Selection of ground samples

As described in Section 2.5, a 10 per cent second phase ground sample was chosen to provide a satisfactory sampling error, considering the size of the area, the sample size, and the likely types of management enquiry. Every fifth plot on alternate flight lines was selected to obtain a uniform distribution of ground samples.

Plot position maps were overlaid onto the Department's coloured 1:50 000 scale operational plans to identify the relevant plots. Smaller areas of other land-uses such as recreation or conservation areas, plantations and private property are excluded from selection.

Similarly, areas of imminent logging or mining are excluded, but are programmed for reassessment after the operations are complete. If a plot could not be located in the field, then the next stereopair along the flight line was used as a replacement.

## 5.2 Locating ground samples

An index of second phase ground plots is provided to the ground crews, together with the Australian Map Grid coordinates for each plot and the corresponding large scale 70 mm stereopair. In addition a map of the photo points, produced via the intergraph system at 1:25 000 scale and overlaid onto the Department's Topographic series (Fig. 23), is provided to show detailed information on tracks and other features to assist in field navigation to each plot.

These maps are the initial means of navigating to the vicinity of each sample plot - usually to the nearest road or track feature that can be used as a reference point. Distances and bearings to each plot are scaled off the map and measured by rally-type trip meters, where appropriate, or hip-chain and compass.

The Trimble GPS receiver from the photography operations was also mounted on vehicles and used in areas with few reference points and poor map detail for new tracks. Hand-held GPS units were also used. This equipment was only useful in the latter stages of the field program when the satellite constellation was almost complete, providing better signals for ground reception in forest areas.

Once the assessment crew has navigated to the approximate location of each plot, it then examines the photographs stereoscopically to identify the precise location of the plot on the ground using features such as individual tree shape and size, stag-headed trees, logs, understorey plants. The plot centre is defined as the centre of the relevant photo overlap. The transparencies are viewed using an Abrams

2X/4X lens stereoscope and a white translucent sheet of perspex to provide diffuse natural back lighting (Fig. 25).

Experienced assessors generally locate the sample point within ten minutes, although the task is more difficult in some forest types with dense featureless canopies. If a plot cannot be found it is substituted by the next along the flight line. Where featureless forest types are likely to be extensive, with few tracks for referencing, as in the higher quality southern forests, an additional tracking camera is also used to provide an overview of the area. This camera has a wide-angle lens and gives stereoscopic images centred on the sample points to show a larger area of forest to assist the ground navigation.

## 5.3 Ground measurements

### 5.3.1 Choice of measurement variables

Since the ground samples are the second phase of the inventory, their purpose is twofold. Firstly, they are used to correct any errors in the first phase photo-estimation of volume and species composition and secondly, they provide additional information on timber quality and dimensions to facilitate partitioning of gross volume estimates into quality and size classes.

To satisfy the first requirement, it is necessary to record the trees by species and to measure appropriate dimensions for calculating volumes. A volume relationship requiring measurements of the stem diameter and height at crown break together with diameter at breast height (d.b.h.o.b.) of 1.3 m and bark thickness (b.t.) is used. The point of crown break used in this function has to be described explicitly to cater for wide variation in branching habits (Appendix I).

The above measurements also provide the data for analysing piece sizes, an important consideration in conjunction with quality data for determining types of products.

The methods used for wood-quality assessments are very different from the routine assessment procedures and are described in Section 5.4. Because of time constraints these measurements are restricted to bole wood, but it is recognized that a separate, additional inventory of crown wood will be required at a later stage when demand for this resource increases.

The major species (Appendix 111) are measured down to 15 cm d.b.h.o.b; all other species are measured down to 25 cm. The minimum of 15 cm diameter over bark equates approximately to 10 cm under bark, which is likely to be the lower limit for most products.

Other attributes recorded include silvicultural class : e.g. old-growth/regrowth; condition: standing/fallen, live/dead; and status, which describes the general size and quality class of each tree. Additional factors cover assessments of forest health, damage owing to fire, insect, disease, and regeneration stocking.

### 5.3.2 Ground measurement procedures

Circular 0.125 ha full plots of 20 m radius and 0.03 ha subplots of 10 m radius are laid out and marked as the first stage of measurement. Circular plots were selected to minimize difficulties in matching the photo and ground plot boundaries.

Trees less than 25 cm d.b.h.o.b. are measured only on the smaller subplot because of their greater numbers. Similarly, measurement of small logs and species of little commercial potential are restricted to the subplot. Other adjustments to further improve efficiency involve eliminating measurements and quality assessments on some classes of trees, such as trees of small diameter, trees of very poor form, and large trees with a high proportion of defects.

Lower bole diameters are measured with a steel tape, bark thickness with either an ice-pick or needle-syringe type gauge. Heights and upper stem diameters are measured using a Spiegel Relascope.

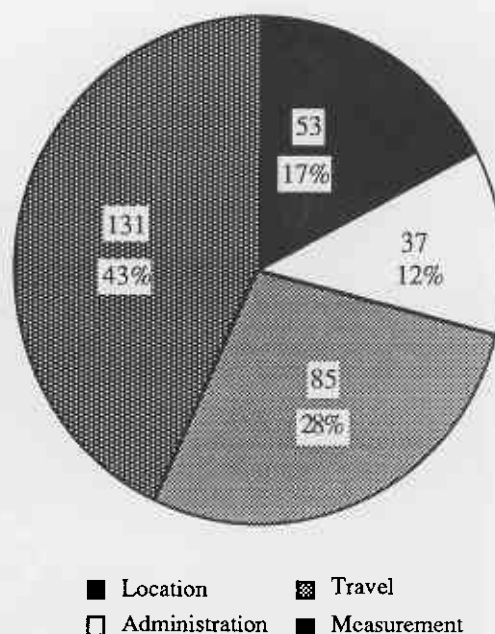
The major plot measurement procedure relates to the assessment and description of timber quality in each log, live and dead tree. This step is time-consuming because every defect and wood type along each bole is categorized according to type and size (circumference or cross-sectional area), with the bottom and top heights of each affected section being recorded.

To make the resource data more versatile, some abnormalities not normally regarded as defects are recorded, such as wild grain and eccentricity, as they may become significant in the future when specifications could be revised.

Observations on forest damage and regeneration stocking require a relatively small part of the plot measurement time, which in total varies from 0.5-1.0 days (including travel) depending on the number of trees, their size and condition (Fig. 35). Details of the plot measurement specifications are given in Appendix II.

### 5.3.3 Recording methods

Most of the early recording was onto special paper sheets that can be used in light rain, but the method is inefficient because it requires subsequent entry and validation for computer analysis. Consequently, portable computers have been investigated for direct recording. Husky Hunter computers were available in the Department and have been programmed for direct field recording with much of



**Figure 35**

Time allocation for ground plot establishment (minutes and percentages) for a sample of ground plots during the early stages of the program. Times and proportions are affected markedly by forest conditions and the assessor's experience. This trial included two plots that could not be found, despite considerable searching.

the validation carried out as the data is entered (Fig. 36), but other machines are being evaluated.

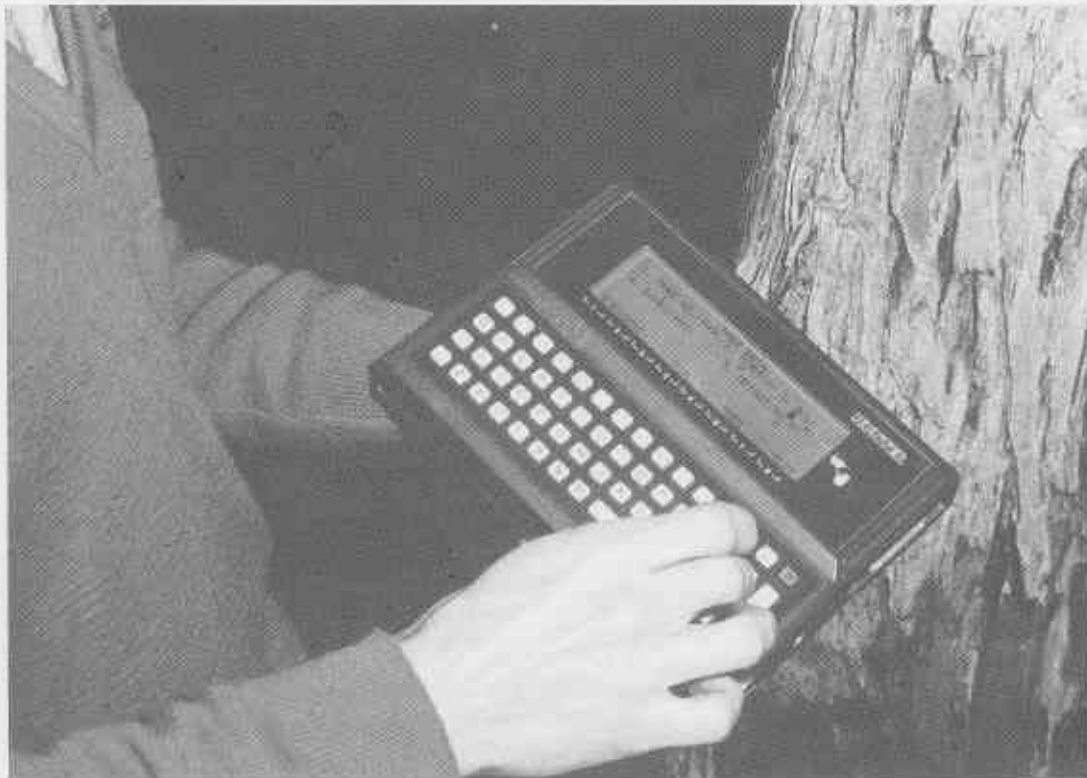
Using the Husky Hunters, the assessor keys in the records for each plot and may accumulate data on a few plots before downloading it to the main computer system. It is then given a final validation check for errors that are difficult to detect with the Husky system. Any corrections are made by the assessment crews to help them improve their recording procedures.

## 5.4 Quality assessment

Describing quality characteristics, including defects and attributes, rather than assessing trees for specific products, is a relatively new approach that is being employed because specific *product* requirements are subject to rapid change in today's wood utilization industry. It is an approach designed to allow for changes in the types or amounts of specific defects permissible in each product, as well as the possibility of new products coming onto the market in future years.

The system requires the description of a range of wood qualities (see Appendix IV) and their magnitude (See Appendix V) that can then be analysed according to product-specifications by computer modelling techniques. Figure 37 shows a simplified flow diagram of the sorting process.

For sawn products, the modelling process rebuilds the tree to look at interactions and the relative positions of positive



**Figure 36**

The Husky Hunter portable computer in use in the field..

and negative characteristics. For bulk products, such as chipwood and charcoal, the modelling process simply considers the usable cross-sectional areas required for a log to qualify.

In the actual assessment of quality there are basically three types of features; surface features that can be described easily, internal conditions such as rot or termite attack, and shape. Assessment of some surface features is very straightforward and only requires a description of the proportion of the circumference and the length that is affected, plus the quadrant. Other features, however, such as overgrowths or borer holes, have associated internal defects that are hidden. The internal defects are dealt with in the sorting process by including a conservative allowance for them in the specifications for the product .

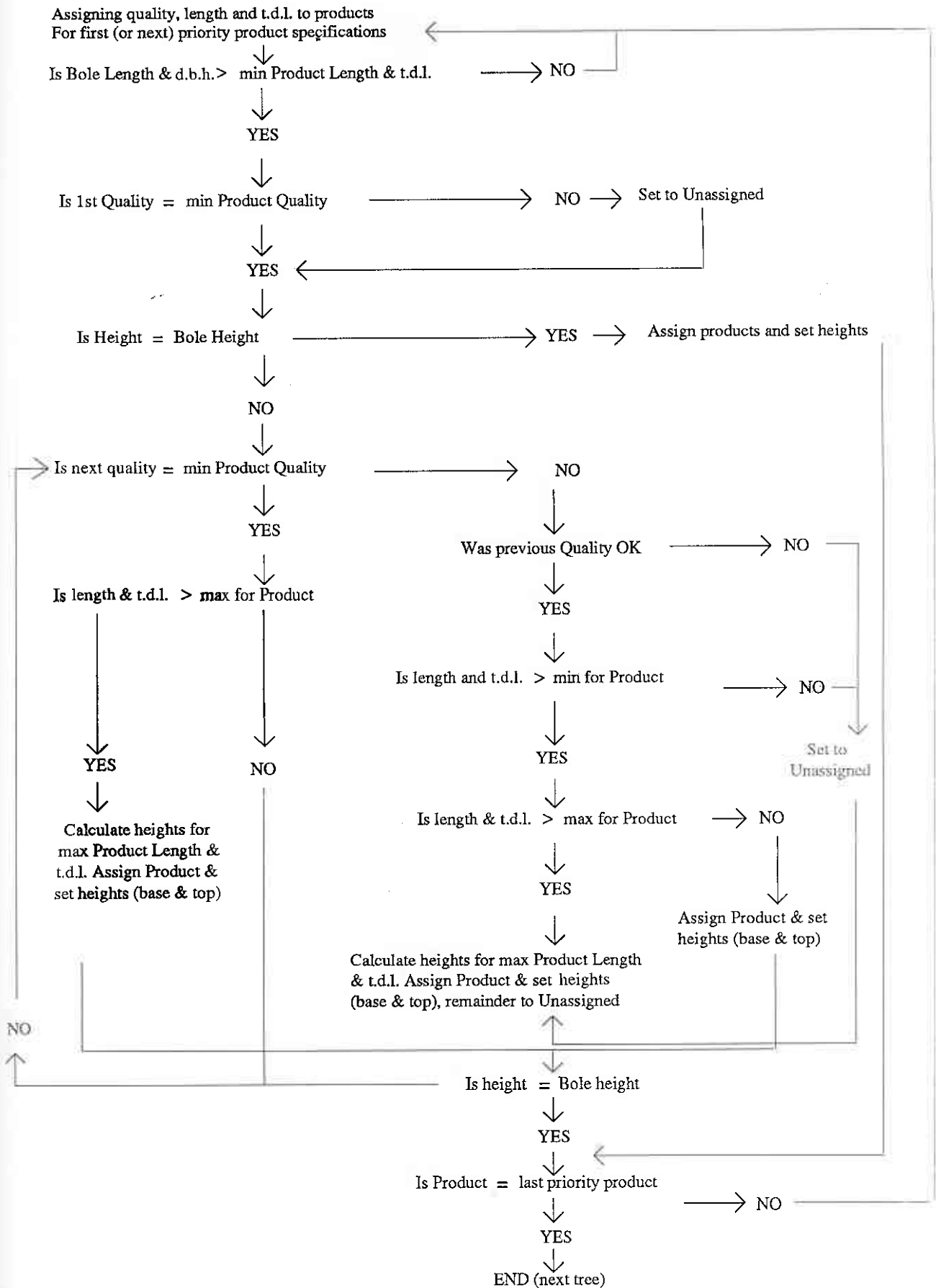
Sawing trials are being conducted to try to develop a stronger correlation between external indications and their internal expression (Fig. 38). These form part of a wider program aimed at developing better understanding of relationships between utilization potential and basic resource availability and quality.

## 5.5 Product types

Products are defined very loosely as the aim was to design a flexible system that would allow for the calculation of product types to meet various specifications. A table of permitted features, and conditional features, together with their limits, formed the basis for programming the sorting of different product qualities (Table 5).

If the values of conditional features change, then the limits are also changed in the software. If the conditional or permissible features change, the software can again be changed to add or delete from the list and the sorting becomes more or less complicated as a result. The aim is to develop the sorting process so that the product specifications become part of the input, thereby providing planners with a means for evaluating resource availability in relation to tighter or looser specifications.

Part of the product specification has to include priorities for sorting. For example, a high quality log would be suitable for many uses but it can only be used once and the priorities can markedly alter the yields for specific products.



**Figure 37**

Quality Sorting Program. The figure represents a simplified flow diagram of the quality sorting program to determine products and calculate piece-size diameters and lengths.

**Table 5**  
Current specifications used in product sorting - sawlogs.

<b>Sawlogs</b>	First Grade A1, A2		Second Grade B1, B2							
<b>Codes</b>	Short E		Small J							
<b>Tree Description</b>	(See Appendix II)									
<b>Acceptable</b>	Status	Form	Silviculture	Condition	Species					
	1,2	0-2	1-6	1,4	1-4					
<b>Size</b>	A1	A2	B1	B2	E	J				
<b>t.d.l.u.b. (cm)</b>										
Min	25	25	25	25	25	15				
Max	999	999	999	999	999	25				
<b>Length (m)</b>										
Min	3.0	2.1	3.0	2.1	0.75	2.1				
Max	999	3.0	999	3.0	2.1	999				
<b>Qualities</b>	(See Appendix II)									
<b>Acceptable</b>	CW, CU, IL, LM, L, EM, E, F, X									
<b>Unacceptable</b>	Q, IP, DP, DM, HP, HM									
<b>Non-Millable</b>	HB, HU, H, BU, B, O, SH, T, R									
<b>Min. % Millable</b>	A1	A2	B1	B2	E	J				
	50	50	30	30	50	95				
<b>Conditional (Maximum)</b>										
	Wind	Dryside Multiple	Overgrowth Multiple	Checks	Branch Multiple	Branch Unsuitable Multiple	Circularity	Gum	Gum Multiple	Bend/ Multiple
A	14	2	2	5	2	1	35	30	3	8
B	14	3	2	5	2	2	35	30	3	8
E	14	2	2	5	2	1	35	30	3	8
J	14	1	0	0	1	0	10	10	1	0
<b>Multiple Sweep* and Kink (max) (*Single Sweep and Kink - special cases where deviation calculated)</b>										
	t.d.l. (max)	A	B	E	J					
	300	1.5	1.5	1.5	1.0					
	500	5.0	5.0	5.0	1.0					
	—	7.5	7.5	7.5	1.0					



**Figure 38**

Correlating external log characteristics and internal defects. Sawing trials were carried out at CALM's Wood Utilization Research Centre at Harvey, W.A., to correlate external characteristics and internal defects.

At this stage the sorting programs are intended to handle six grades of sawlogs, plus chipwood and charcoal logs, but they are to be expanded to include roundwood products such as poles and fencing materials.

## **5.6 Validation procedures**

Validation of ground plot data is performed by processing the data with software written specifically for the project. Data collected on portable computers is subjected to basic checking in the field to ensure that all fields are entered with relevant symbols and that all related fields are matched.

The main validation program continues running after an error is discovered to find related errors so that the data can be corrected in a single editing session. Data are again validated after this editing to ensure that none of the errors was missed and that no new errors have been introduced. Supervisors and assessors are involved in the validation process to give direct feed-back on any misconceptions, bad habits or tardiness.

Not all validation messages indicate real errors, as there are often warnings that a value exceeds the expected range and should be checked. In the interests of efficiency, symbols are used to highlight error types. For example, if a tree-record is in error then it is printed on one line with the appropriate symbol printed below it in a relevant record-field.