The Grimes Assessment
As used for determining the Leaf Area of Jarrah Trees

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Major portions of this text are direct transcriptions from Grimes (1978). The figures of Grimes (1978) can be used as a general guide with this text. However, Crown Density diagrams of Grimes (1978) are not quite right for jarrah. The scales described are used to determine the leaf area of individual jarrah trees. This leaf area measurement technique is described in *Crown Assessments Improve Regressions Estimates of Leaf Area in Jarrah Trees* (Whitford 1991).

CROWN SIZE

Crown size considers the depth, width and shape and varies with stem diameter and species. It is a comparison to an idealized crown proportion and development. The perfect jarrah pole crown is egg shaped in outline and round in plan (score 5). This idealized crown shape breaks down with pile and larger sized trees. In such trees the 5 crown becomes either wider or deeper than the egg shaped pole crown. The width and depth of the crown is considered in proportion to the trunk diameter and to a lesser extent the tree height. Size should be considered from two views at right angles, or from directly beneath the crown and also at a distance where the crown can be seen clearly. This scale describes forest trees and does not apply to isolated trees in cleared areas; eg., trees remaining in cleared farm paddocks.

5 points The crown is wide, deep and roughly circular in plan, without any obvious faults.

4 points The crown has easily observed but slight faults, such as lopsidedness or is partly undeveloped.

3 points Obvious deficiencies in size and/or shape are present. The crown is considered to be satisfactory. The typical pole crown in the northern jarrah forest is a score 3.0.

2 points Small, poorly shaped crowns that are considered unsatisfactory.

1 point Useless crowns, very small and ungainly.

CROWN DENSITY

Crown density is a measure of the density of leaves within the crown outline. The density and distribution of the foliage clumps determines the score. Crown density has a maximum score of nine points, but for simplicity it can be considered in five stages with interpolation between the stages, ie. scores 1, 3, 5, 7, 9. I prefer to define all the levels and consequently I have expanded Grimes' scale to include definitions for scores 2, 4, 6 and 8.

Light levels affect the density score. Assessors should be aware that reduced lighting gives the impression of increased density, while bright sunlight reflects off the leaf surface and gives the impression of reduced density. A clear sky at mid morning or afternoon gives the correct impression.

Grimes adds 2 points for crowns that are heavy in seed. This is not done in jarrah as we are assessing for leaf area. Grimes assessed for vigour.

Some of Grimes' clump descriptions are referenced to a density grid standard of 10% interval random density grids. Any standard would work. I used Forest Survey Aid no. 3 from the Forestry and Timber Bureau (dated Dec. 1950), (see Fig. 1.). When a standard is used, a typical leaf clump should be examined against a background of sky.

Grimes' drawings of leaf density are not correct for jarrah. The 9 point tree would be given an 8 in jarrah and the 7 point tree given a 6.5. The 5 point tree fits the description of "above average density unevenly distributed". In jarrah the typical score 5 tree has "average density with a reasonable distribution". The 3 point tree fits the "sparse and poorly spread" description.

9 points Very dense leaf clumps with even distribution of clumps over the crown. Very little light penetrating the leaf clumps. Evenly distributed clumps are clumps that meet or almost meet to fill in the crown outline, when the crown is viewed as being 2-dimensional. In jarrah, the leaves in a very dense clump cannot hang freely because they are so tightly packed. Consequently the leaves are bent by their contact with other leaves and the midrib or leaf face is excessively curved. Leaves layer on top of one another. Leaves inside the clumps are heavily shaded. These characteristics are used to identify very dense clumps. This score occurs in crowns that have regenerated after total crown scorch.

8 points Dense leaf clumps well distributed or very dense clumps unevenly distributed. Well distributed clumps are clumps that are consistently spread throughout the crown but do not meet to form the continuous and solid crown of evenly distributed clumps.

7 points Dense leaf clumps distributed unevenly over the crown. You cannot see through a dense leaf clump when it is viewed in isolation against a clear sky background, ie. a dense leaf clump has 100% visual density on when compared to the density scale. Uneven clumps are discontinuous.

6 points Clumps are above average density and are well distributed.

5 points Clumps of average density with reasonable distribution or dense clumps very unevenly spread or above average density unevenly distributed. Average density clumps are 70% visual density when compared to the density scale. Clumps with a reasonable distribution are more widely separated than clumps that are well distributed.

4 points Average density clumps poorly spread or sparse clumps well spread. The typical jarrah crown is score 4.

3 points Clumps are sparse and poorly spread, or very sparse and well spread. Sparse clumps are between 30% and 40% visual density.

2 points Clumps are sparse and very poorly spread, or very sparse and poorly spread.

1 point Very few leaves anywhere in the crown.

FRUITING

The fruiting or seeding score considers the amount of fruit and/or flowers carried by the tree. Seeding should be assessed unaided and with binoculars as variations in tree height and leaf density can affect the interpretation. The crown should be viewed from beneath and from a distance. Flowering alone never produces a score of 4 or above because it does not cause loss of leaves.

6 points Extreme Seeding. The tree is almost defoliated yet it carries a large seed crop **throughout** the crown. Large clusters of seed exist throughout the crown with few associated leaves (Crown Density less than 2). The tree stands out, as it appears unhealthy in its lack of leaves and overall brown colour, yet vigorous in the extent of the seed crop it carries. Such trees only occur in a seeding year. (eg. Tree GD and the tree near Banksiadale rd. shown in photographs LA1/1 and LA1/2 of the authors standard set. Contact author.)

5 points Heavily Seeding. Seed capsules are immediately obvious and are noticeably affecting the leaf carrying capacity of the entire crown. Clusters of fruit may exist without associated leaves in **parts** of the crown, (Usually the upper portion) or the entire crown is peppered with capsules. A red-brown tinge to the crown. A Heavily seeding tree has a Crown Density that is average or lower, ie. 4 or less.

4 points Seeding +. Fruit is noticeable with **some** obvious reduction in leaf carrying capacity due to seeding.

3 points Seeding -. Fruit noticeable and numerous but only a slight reduction in leaf carrying capacity or, fruit is noticeable but not numerous with an obviously associated leaf loss.

2 points Light Seeding. Some fruit visible **with close inspection,** but not affecting leaf area. A light sprinkling of fruit.

1 point Not Seeding. Fruit not evident.

CROWN DIMENSIONS

When the Grimes crown assessments are used to estimate leaf area they must be combined with a measurement of underbark diameter, crown width or crown depth.

Underbark diameter

Underbark diameter is measured at breast height (1.3 metres) with a diameter tape. The tape should not be stretched tightly or read while it is loose around the tree. The tape should be firm. The tape should be positioned to avoid bumps or irregularities in the bark or stem. Avoid unrepresentative diameters caused by scars or other irregularities by positioning the tape slightly lower or higher on the stem. Where trees are fire-scarred at the base and the scar extends up to or just below breast height, the tree should not be measured for diameter. Assessors should inspect the stem at breast height for fire scars that have been over grown with bark.

Bark depth should be measured at four points equally spaced around the stem. Crevices in the bark should be avoided. Similarly, unrepresentative lumps or thicknesses in the bark should be avoided. Excessive or light pressure on the bark gauge should not be used. The pressure on the gauge should be sufficient to penetrate the bark but not continue into or dent the sapwood.

Crown depth

The measurement of crown dimensions to estimate leaf area developed from the notion of mentally enclosing the crown in a box and determining the dimensions of this box. The box was intended to efficiently and closely enclose the crown and comprise a volume that was representative of, and correlated with, the crown volume. Hence when determining these dimensions, leaf clumps separate or protruding from the main crown volume should only influence the dimensions of the box if they contain a significant proportion of the total leaf volume (ie., 5%

or more) Atypically sparse leaf clumps at the crown extremes should not be considered as part of the crown volume.

When measuring crown depth in jarrah the top of the crown is usually rounded and well defined. Occasionally small leaf clumps protrude above the rounded top of the crown. These clumps should be ignored (unless they are large or dense) and the highest point of the rounded top taken as the top of the crown.

Difficulties more often occur in defining the base of the crown. Only the mass of leaves should be considered in defining the crown base and branch structures should be ignored. The main crown is defined as the outline of the leafy crown that is made up of contiguous or evenly separated leaf clumps. Leaf clumps below the main crown are ignored if they are clearly sparser or smaller than the clumps that make up the main crown (ie. they contain less than 5% of the total leaf area). They are ignored because they contribute little to the leaf area of the tree and if considered would create a false impression of the crown volume.

Beneath the main crown, large leaf clumps and clumps with a density that is typical of the main crown, sometimes occur separate from the main crown. These **are** considered when defining the crown base. If these leaf clumps are separated from the main crown by a distance that is greater than the distance between similar clumps within the main crown, the clump is visually repositioned to form part of the main crown. (see Fig. 2). The crown depth is then measured.

Crown Width

Crowns are rarely circular in plan; elliptical plan shapes, with one dimension greater than all others, are more common. As only one crown width is measured, a representative or average dimension must be selected. The dimension that is measured must not lie along the major or minor axis of the ellipse.

The crown width is measured by locating the two opposite edges of the crown on the ground with a plumb line and measuring between these two points.

The edge should not be moved out to include small leaf clumps. The edge point selected should be representative of the main crown volume.

In dense stands the crown edges can be difficult to see. By inspecting the crown from below, representative dimensions and clear lines of site can be selected.

References

Grimes, R.F. (1978). Crown assessment of natural spotted gum ironbark forest. *Department of Forestry, Queensland, Technical paper* no.7, pp. 1-16.

Whitford, K.W. (1991). Crown assessments improve regression estimates of leaf area in jarrah trees (Eucalyptus marginata). *Australian Journal of Botany.* 39, 535 - 44

Fig. 1. The density scale standard used to establish the clump density levels. Single representative clumps on the edge of the crown should be selected for assessment. These clumps should be viewed against a background of clear sky. Any similar percentage density scale could be used.

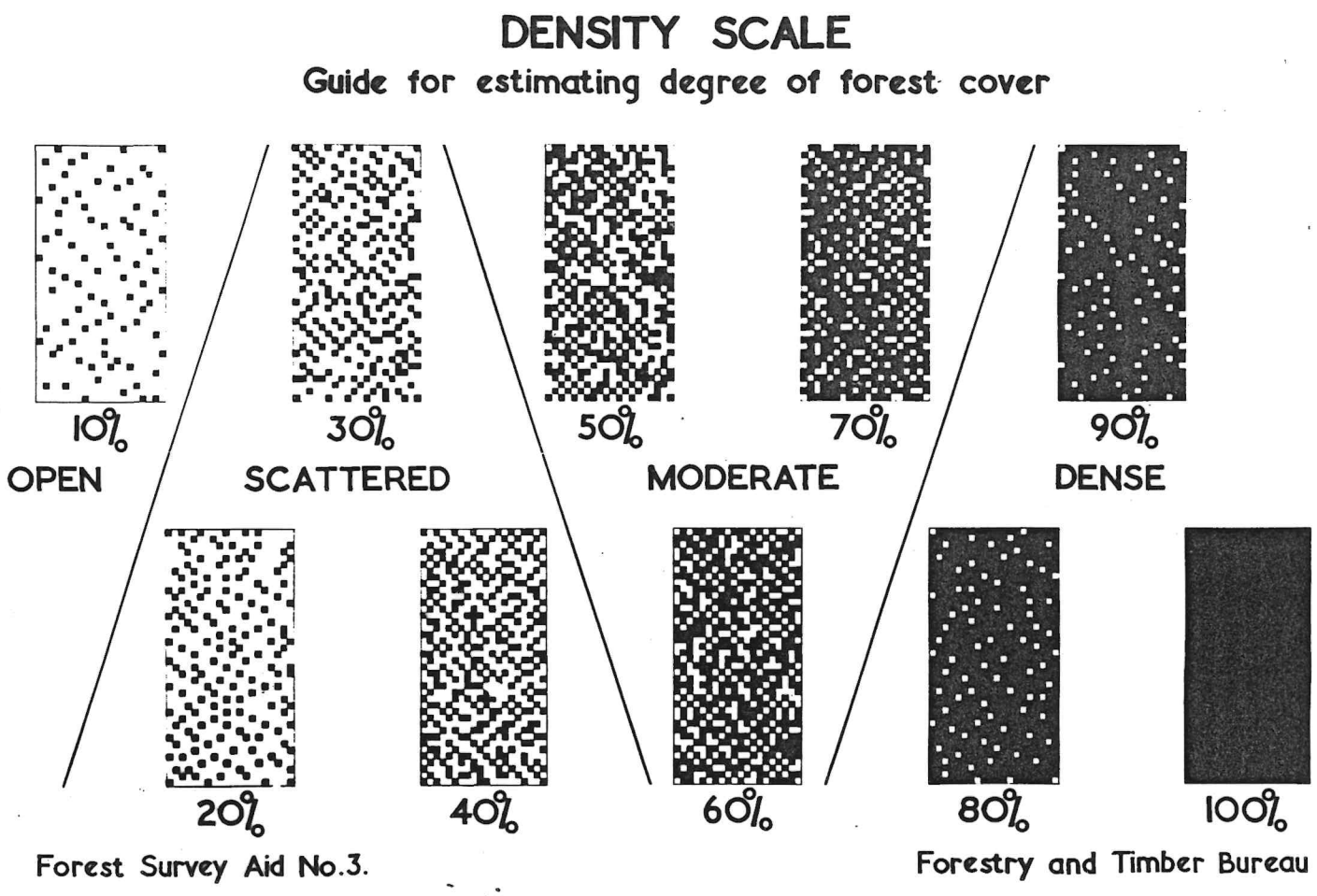
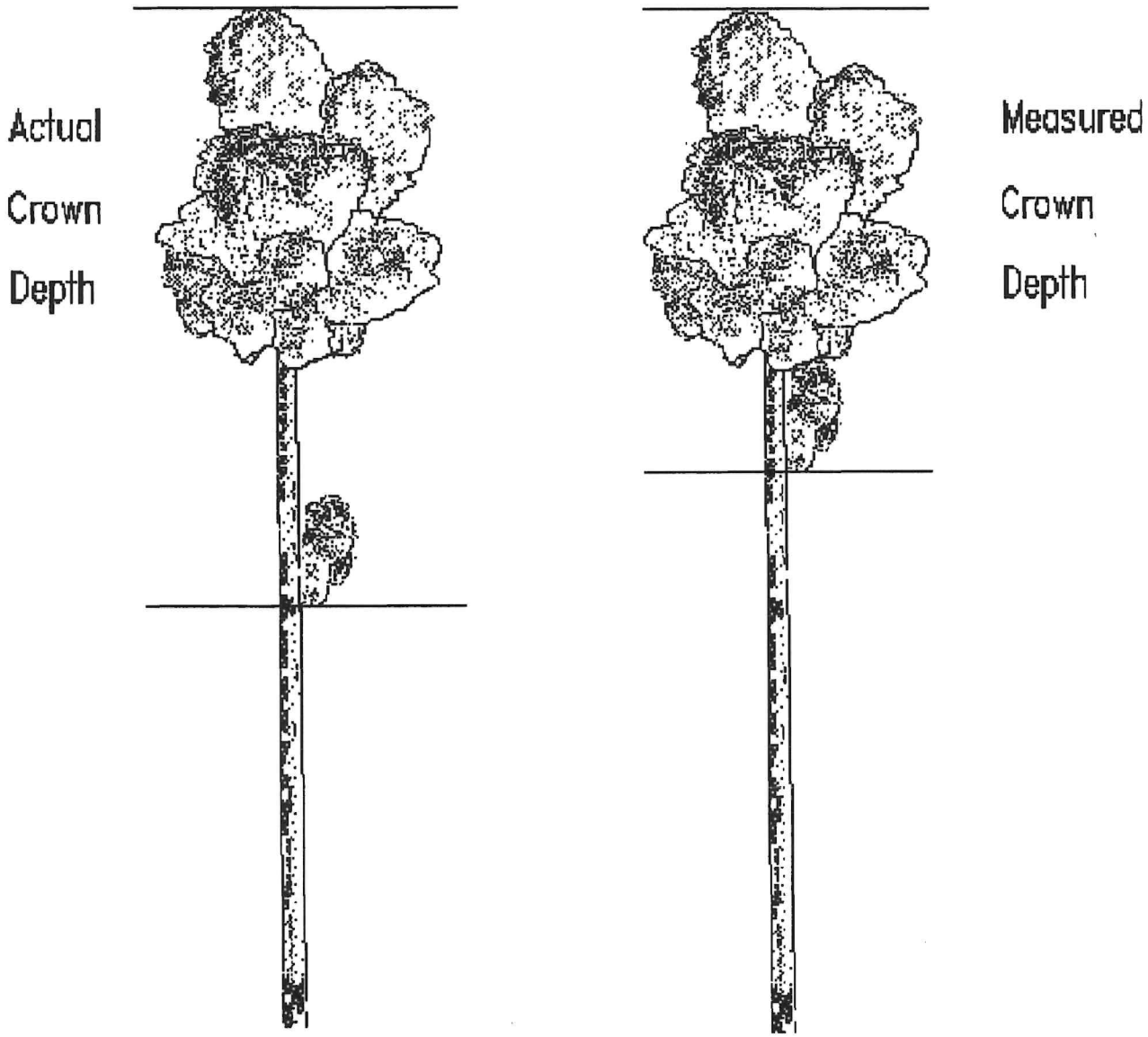


Fig. 2. The measurement of crown depth allows for large leaf clumps isolated beneath the main crown volume.



LE 704

The Grimes Assessment as used for determining the Leaf Area of Jarrah Trees

CROWN POSITION

Crown Position is the position of the tree crown relative to adjacent crowns, and has a maximum score of five points.

5 points	All the crown is open without any competition from above or the side. The tree is in a dominant position with unrestricted sunlight.
4 points	The upper surface is exposed and all or part of the sides may be in competition with adjacent crowns. There is no restriction to vertical crown growth. The tree is in a co-dominant position.
3 points	Only part of the upper crown is exposed, and the stem has mostly side light. The crown does have competition in part from above from the side. The tree is subdominant.
2 points	None of the upper surface is exposed, and only part of the side of the crown is free. The tree is growing completely under the crown of a dominating stem in a partly suppressed position.
1 point	The crown has no direct access to light either from above or from the side and is in a completely suppressed position.

CROWN SIZE

Crown Size considers the depth, width and shape and varies with diameter and species. It is a comparison to an idealized crown proportion. The perfect jarrah pole crown is egg shaped in outline and round in plan (score 5). This idealized crown shape breaks down with pile and larger sized trees. In such trees the 5 canopy becomes either wider or deeper than the egg shaped pole canopy The width and depth of the crown is considered in proportion to the trunk diameter and to a lesser extent the tree height. Size should be considered from 2 views at right angles or, from beneath and at a distance where the canopy can be seen clearly.

5 points	The crown is wide, deep and roughly circular in plan, without any obvious faults.
4 points	The crown has easily observed but slight faults, such as lop sidedness or is partly undeveloped.
3 points	Obvious deficiencies in size and/or shape are present. The crown is considered to be satisfactory.
2 points	Small, poorly shaped crowns that are considered unsatisfactory.
1 point	Useless crowns, very small and ungainly.

CROWN DENSITY

Crown density is a measure of the density of leaves within the canopy outline. The density and distribution of the foliage clumps determines the level. Crown density has a maximum score of nine points, but for simplicity it can be considered in five stages with interpolation between the stages ie. scores 1, 3, 5, 7, 9. The light level effects the interpretation of the density class. Reduced lighting gives the impression of increased density, while bright light reflects off the leaf surface and gives the impression of reduced leaf area. A clear sky at mid morning or afternoon gives the correct impression.

9 points	Very dense leaf clumps with even distribution of clumps over the crown. Very little light penetrating the leaf clumps.(Evenly spread clumps are clumps that almost meet to fill in the crown outline when the crown is viewed as being 1-dimensional.)
8 points	Dense leaf clumps well distributed or very dense clumps unevenly distributed. (Well distributed clumps are clumps that are consistantly spread throughout the canopy but do not meet to form the solid canopy of evenly spread clumps.)
7 points	Dense leaf clumps distributed unevenly over the crown.(You cannot see through a dense leaf clump.)
6 points	Above average density well distributed.
5 points	Clumps of average density with reasonable distribution or dense clumps very unevenly spread. (Average density clumps are 70% density when compared to the density scale.)
4 points	Average density clumps poorly spread or sparse clumps well spread.
3 points	Clumps are sparse and poorly spread or very sparse well spread.
1 point	Very few leaves anywhere in the crown.

SEEDING

The seeding score considers the amount of fruit carried by the tree. Seeding should be assessed using binoculars as variations in tree height and leaf density can affect the interpretation. The canopy should be viewed from beneath and from a distance.

6 points	Extreme, the tree is almost defoliated yet it carries a large seed crop **throughout** the canopy. Large clusters of seed exist throughout the canopy with few associated leaves. The tree stands out, as it appears unhealthy in its lack of leaves and overall brown color, yet vigorous in the extent of the seed crop it carries. (eg. Tree GD and the tree near Banksiadale rd. shown in photo's LA1/1 and LA1/2.)
5 points	Heavily Seeding. Seed capsules are immediately obvious and are noticeably affecting the leaf carrying capacity of the entire canopy. (Clusters of fruit may exist without associated leaves in **parts** of the canopy, (Usually the upper portion.) or the entire canopy is peppered with capsules. A Heavily seeding tree has a leaf density that is average or lower.
4 points	Seeding + Seed is noticeable with **some** obvious reduction in leaf carrying capacity due to seeding.
3 points	Seeding - Seed noticeable and numerous but only a slight reduction in leaf carrying capacity or, seed is noticeable but not numerous with an obviously associated leaf loss.
2 points	Light Seeding. Some Seed visible **with close inspection**, but not affecting leaf area.
1 point	Not Seeding. Seed not evident.

LE 704

CANOPY DIMENSION

The measurement of canopy dimensions developed from a specific concept devised to measure leaf area. The historical background to the development of this technique is relevant.

Initially we attempted to relate tree leaf area to sapwood area and stem diameter. Such relationships had been successfull in conifers. We found that, in jarrah, these relationships were affected by the seeding cycle and possibly site variables. In Jarrah, the fruits carried in the later stages of seeding cause leaf fall in the adjacent branchlets. This may simply be caused by the impact of the fruit during winding periods. This leaf fall can produce a considerable reduction in leaf area in those trees that are heavily seeding.

In the process of collecting this initial data we also observed the wide variety of canopy shapes and sizes that could be found on stems of similar diameters. We concluded that attempting to measure leaf area indirectly via stem diameter or sapwood area was inappropriate. As leaf area was obviously affected by both canopy size and the leaf density within the canopy outline, it was concluded that these variables should be measured.

Two measuring techniques were proposed. The first method viewed the canopy as a volume that could be determined by defining the canopys occupation of an imagined cube. This cube was visualized so that the sides were in close contact with the extremities of the canopy. The dimensions of the cube were measured and the percentage canopy occupation of this cube determined using a graticule. The leaf density of this defined volume was then determined by comparison to a density standard.

In practice it was found that canopies sometimes adopted irregular shapes. Often small parcels of leaves existed seperatly from the main canopy volume. This main volume was sometimes not clearly definable, because the extremities of this volume consisted of leaf clumps of reduced density. To define the canopy in terms of these outermost clumps, that were not representative of the larger canopy, was inconsistent with the measurement concept. In such cases it was decided to attempt a best approximation of the canopy dimensions by only measuring to the extremes of clumps that were typical of the entire canopy. This situation was most often found when measuring the canopy depth.

Canopy width measurements were also affected by another complexity. It was decided to measure only one width as this measurement was time consuming. Again canopy irregularities can seriously affect the value determined in this measurement. Canopies are rarely circular in plan. Elipsoidal plan shapes are most common. Clearly there is scope for considerable variation when measuring only one width of an ellipsoidal shape. For this measurement to be of any value, care must be taken to ensure that this width does not lie along the major or minor axis of the ellipse. This requirement is made more difficult in dense stands where few clear views of the canopy are available. In spite of the inaccuracies that can occur in this measurement, it does make a significant contribution to describing leaf area and is a worthwhile measurement.

This practise of measuring representative canopy dimensions was continued in the second method. This second method is based on subjective assessments of canopy size and leaf density but makes use of the dimensions determined in the first method.