# Standard Operating Procedure 13
# Measuring a Large Tree Plot

## Overview

This SOP describes the tasks required to establish, mark out and measure/assess attributes associated with a Large Tree Plot. The SOP includes details about how to mark out a slope adjusted Large Tree Plot, divide it into quadrants and record individual tree attributes (such as tree species, diameter at breast height, height, crown class) and forest stand attributes such as canopy cover. This SOP also describes how to record information in a *Large Tree Plot Form*. A filled form example is shown in Appendix 13.1.

## Glossary of definitions

**Assessable Crown:** Range from lowest to highest branch of a tree bearing live foliage

**Basal Area:** The sum of the cross-sectional areas measured at breast height of the trees in a given stand (or plot). Usually expressed as square metres per hectare ($m^2$/ha).

**Blaze:** Permanent tree scar (mark) made using an axe, to strip away enough wood/bark without killing the tree.

**Breast height:** 1.3 m above ground level for measuring tree diameter.

**Butt:** Base of a tree or the large end of a log.

**Canopy:** The uppermost (highest) foliage layer in a forest. This will most often comprise *Eucalyptus* species but, depending on forest type and growth stage, may comprise other genera such as *Acacia*, *Nothofagus*, *Callitris*, *Allocasuarina* or even shrub species.

**Canopy Closure:** The degree to which the crowns of adjacent trees block sunlight or obscure the view of the sky.

**Clinometer:** Instrument for determining angles of inclination or slope and measuring tree heights.

**Coarse Woody Debris (CWD):** Dead woody material substantially detached from the parent tree and in contact with the ground, and which is ≥ 10 cm in diameter in both of two perpendicular directions (hence comprises large branches and logs). It does not include cut or uprooted trees that have been "hung up" on other trees: these will be considered as tree stems.

**Crown:** The totality of branches, twigs and leaves extending from the main trunk or stem of a tree.

**Crown Class:** A class that describes the position of a tree crown in relation to the general canopy of the forest stand and the crowns of adjacent trees.

**Crown Clumping:** The structure of foliage relating to its evenness of spread over a trees crown.

**Crown Density:** An estimate of the amount of light able to penetrate the crown of a tree.

**Crown Openness:** The fraction of sky that can be seen through the crown of an individual tree of a given species.

**Crown Position:** Estimate of the growing conditions and openness of a trees location in a forest stand.

**Dead Tree:** A tree with no live green foliage above 1.3m.

**Decomposition:** The process of decay.

**Defoliation:** Loss of foliage from a single or group of trees due to either biotic causes (for example: insects, pathogens) or abiotic causes (for example: nutritional deficiencies, fire).

**Diameter at Breast Height (DBH)**: Diameter at Breast Height: the stem diameter of a tree measured at breast height. For the purpose of ground plot measurement, diameter at breast height implies diameter measured outside or over bark (dob). On sloping ground breast height is measured on the uphill side of the tree.

**Dieback:** Decline in tree health caused by either single or a range of factors covering drought, salinity, fire, insect pest and pathogen outbreaks.

**Discolouration:** Change in leaf colour from its naturally occurring pigments.

**Disturbance:** A change in average environmental conditions that causes a pronounced change.

**Dominance Category:** A scheme of categorization that determines whether a tree is either dominant (crown extending above the general forest canopy level), co-dominant (crown at the general canopy level) or suppressed (crown entirely below the general level of the canopy).

**Epicormic Shoots:** Shoots emerging from dormant buds along a branch or trunk of a tree usually in response to stress factors such as fire, drought, physical injury.

**Field Form**: A data collection form for recording measurements and other information. This form may be in one of three formats: Hardcopy paper form; MS Excel form, or MS Access Database.

**Foliage:** All the leaves of a tree.

**Forked Tree:** A tree which contains a point where the main leader of the tree splits. As a guide, both forks are distinctive leaders, not branches. The smaller fork should be at least 50% the diameter of the larger fork. See Appendix 13.9 for an illustration of what constitutes a forked tree.

**Height Tree:** A tree (one of up to eight trees) selected on a Large Tree Plot for the purpose of height measurement and canopy health assessment. Height Trees must be live, standing trees.

**Hypsometer:** A class of instrument used to measure tree heights from the ground using geometric principles.

The observer takes a sighting to the top and the base of the tree from a known distance. Modern hypsometers use laser technology (sometimes in combination with ultrasonic technology) to measure height, distance and angle. Similar term: laser rangefinder.

**Large Tree Plot (LTP)**: ~0.04 ha circular plot within which detailed tree data and information is collected. The Centre of the LTP is exactly coincident with the *Sample Point Location* and the Sample Point Location Stake *if* the Stake is NOT off-set from the Sample Point Location.

**Large Tree Plot Form**: Field form used for recording LTP establishment and measurement data and information.

**Level of decay:** One of three stages of decay that will influence, over time, how much wood or carbon remains within a piece of CWD, or in a stump:

1) **Sound.** Intact with little evidence of decay (essentially hard, solid wood). Logs generally circular in cross section, and can support their own weight. Leaves, twigs and branches may still be present, and bark is generally intact.

2) **Moderate stage of decay**. Some sections may be pulled away by hand. Bark has generally become detached, and any branches have mostly fallen off. Logs still largely circular in cross section, but hollows are developing at ends and where branches have detached. Stumps beginning to hollow out at top. In wet forests, moss may exceed 50% cover on the wood.

3) **Advanced stage of decay**. Mostly rotten and hollow, and although the outer 'shell' may sometimes appear solid the inner material is able to be crumbled in the hand. Log unable to support its own weight and has collapsed to be elliptical in cross section. Stumps mostly collapsed. Other plants may be growing on the decaying wood (in wetter forest types), and there may be high moss cover.

**Point of Germination**: Point at which tree seedling takes root and becomes established. For lignotubers or coppicing stumps, the point at which the stem has originated on the original stump.

**Primary Branches:** Larger branches within a tree crown constituting a significant component of a trees total crown.

**Sample Point:** Nominal grid point defined in a GIS, on a 2 km point grid overlay of Victoria. .

**Sample Point Identification Code**: Unique Sample Point identification code, comprising P (for Plot), E (for Easting), the first four numbers of the vicgrid94 eastings (X) coordinates, N (for Northing) and the first four numbers of the vicgrid94 northings (Y) coordinates. E.g. PE2875N2430.

**Sample Point Location**: Point established in the field using differential GPS, on or very close to the Sample Point.

**Sample Point Location Stake**: Stake on or offset from the Sample Point Location – which marks the site of the Sample Point Location.

**Slope Correction:** A tape correction applied to a distance measured on a slope in order to reduce it to a horizontal distance, between the vertical lines through its end points.

**Tree:** Any species with its Plant Growth Form listed in the Flora Information System (FIS) as LT (Large Tree), T (Large Shrub to Medium Tree) or MT (Mallee Tree). These Growth Form categories are based on potential size, not actual. Note that tree ferns are not considered to be 'trees' in this classification. See Appendix 13.3 for list of all tree species.

**Tree Canopy:** The aboveground part of trees formed by a trees crown.

## Equipment list

Binoculars

Calculator

Compass (1), preferably a sighting type

Clinometer

Diameter tape (1)

Measuring tape (50m)

Field First Aid Kit

Field Forms

Field Notebook

Hypsometer

Marking tape

Personal Protection Equipment (PPE)

Spherical canopy densiometer

Tree tags

Pig-tail stakes (4)

## Procedure

**Large Tree Plot Establishment:**

*Mark out Large Tree Plot (LTP)*: The Sample Point Location (which is also the Stake location if the Stake is not off-set from the Sample Point Location), marks the centre of the Large Tree Plot (LTP). *SOP 11: Establishing and Marking Sample Point Location*, describes the procedure for establishing and marking out the Sample Point Location. Using the slope (degrees, to the nearest degree) recorded in the *Physical and Biotic Characteristics Form* (refer to *SOP 12: Recording Physical And Biotic Characteristic*), refer to the Slope Adjusted Radius Table (Appendix 13.2, Table 1) to determine the slope adjusted LTP radius in metres. From the LTP centre, along 0° (magnetic north), run flagging tape out the required slope adjusted radius distance (horizontal to the ground) and secure the tape to the ground using a pig-tail stake. In a clockwise direction repeat, using this measurement and mark out flagging tape along each of the cardinal bearings (east, south and west)

to divide the LTP into quadrants (North East, South East, South West and North West).

*Temporarily Tag Trees:* Starting in the North East quadrant, use wire to attach a temporary tag to all living (standing or fallen) and dead (standing only) trees with a DBH of at least 10 cm. Trees should be tagged in a clockwise order, regardless of their proximity to the LTP centre. Temporary tree tags should be clearly labelled using black permanent marker with the quadrant prefix (i.e. NE, SE, SW etc.) and the number within the quadrant (e.g. NE01 for the tree closest to North East quadrant edge at 0° north). Refer to Appendix 13.2, Figure 1 for an example illustration of LTP marking out and tagging trees.

Forked-trees may be regarded as a single tree or as separate trees depending on the height at which the fork occurs. If the fork occurs *above* 1.3m height *and* the stem has a measurable DBH greater than or equal to 10 cm within the LTP, then the tree should be tagged *on the main stem*. If the fork occurs *below* 1.3 m height *and* two or more forks each have a DBH greater than or equal to 10cm within the LTP, then the forked-tree stems should be tagged separately. Separately tagged stems should be tagged and numbered in the same clockwise order as other trees in the quadrant. Finally, stems should be tagged as single tree where, a fork occurs below 1.3m *and* only one of the stems has a DBH of at least 10cm.

*Check Borderline Trees*: Check trees on or close to the LTP boundary ('borderline trees') by running a measuring tape at the required slope adjusted radial distance from the Sample Point Location to the tree stem point of germination. A tree leaning outside of the LTP border with its point of germination inside the LTP boundary should be considered inside the LTP. Conversely, a tree leaning into the plot, but with its point of germination outside of the LTP border should *not* be considered inside the LTP. Refer to Appendix 13.2, Figure 2 for examples of borderline trees.

**Tree Mensuration:**

*Assign Tree Status:* For all tagged trees assign a status class (either live standing, live fallen or dead standing). *Live Standing* can be described as live rooted trees with enough foliage to keep them alive (live cambium is present). Live Standing trees are intact and rooted to the ground and are self supporting – i.e. the tree would remain standing should any supporting material be removed. *Live Fallen* trees are not self supporting. *Dead Standing* trees are obviously (physiologically) dead. They are self supporting (rooted into the ground) and would remain standing should any supporting material be removed.

*Assign Tree Species*: For all tagged trees, assign a tree species using Appendix 13.3. For each unidentifiable species, follow the procedures outlined in *SOP 20A: Plant Specimen Collection and Identification Procedures* to collect specimens and to record ancillary information such as height, shape, bark type and branching angle. Create a temporary descriptive name that is unique to each specimen collected. This name should include two or more descriptors, for example, "Hairy grey daisy". Once a specimen is collected and a temporary name assigned, the name can be re-used on the Large Tree Plot Form each time the same unknown tree is detected.

*Assign Tree Death Cause*: For all dead tagged trees assign a probable cause of death. Refer to Appendix 13.4 for causes of death.

*Assign Tree Decay Class*: Using the three-class system: (1) sound; (2) moderate; or (3) advanced stage of decay (see Glossary, 'Level of Decay'), assign decay class for all dead tagged trees.

*Assign Tree Crown Class*: For all *Live Standing* tagged trees assign a Crown Class using descriptions within Appendix 13.5. For trees with broken or dead tops, assign a Crown Class to the remaining live portion of the tree crown, relative to its present interception of light in the immediate area around the measured tree.

**Table 13.1:** Tree characteristics and codes

| Tree Characteristic | Code |
|---|---|
| No characteristics | NC |
| Forked Tree | FT |
| Dead Top | DT |
| Near dead | ND |
| Bent over | BO |
| Ant infestation | AI |
| Head out | HO |
| Sweep | SW |
| Lightning strike | LS |
| Coppice | CP |

*Assign Tree Characteristics:* For all trees, assign one of more tree characteristic codes (Table 13.1) which best characterise and describe the tagged tree and may be useful for identifying the tree in the future.

*Measure DBH:* For all tagged trees, determine the uphill side of each tree – defined as the highest point of mineral soil or humus layer at the base of the tree. From this side of each tree, locate 1.3 m up the stem (or 1.3 m along the stem where the stem is curved or leaning). Measure the tree stem diameter at this point (to the nearest 0.1 cm) using a diameter measure tape, around the outside of bark and making no allowance for missing bark. If a fork or branch, bump or abnormal swelling occurs at 1.3 m, measurements are taken at points above and below the swelling/fork where the stem form is no longer affected and the average of these measurements is

calculated to represent the DBH. Appendix 13.2, Figure 3 shows example illustrations of DBH measurements. If the swelling begins below 1.3 m up (or along) the stem and extends greater than 2.5 m up (or along) the stem, the swelling is considered part of the "normal" tree growth and DBH measurement should be made at 1.3 m up the stem.

*Measure Tree Height*: Identify and measure the heights of the three tagged trees with the largest diameters (DBH) from the whole LTP (*not by quadrant*), that are Live Standing (tree status) and have a dominant, co-dominant, open grown or emergent crown class. Only measure trees with dominant, co-dominant, open grown or emergent crown classes even if there are fewer than 3 trees.

Using a clinometer and tape measure or hypsometer calculate tree height as shown in Appendix 13.6.

Total tree height is the distance along the axis of the tree from the base to its uppermost point. The line of sight to the top of the tree should be made through the crown rather than the outside of the crown. Clinometer measurements should be taken across slope to reduce slope angle and thereby remove the need for slope corrections. Height angle measurements (i.e. Field crew member location) should be taken at a distance of approximately 1 to 1.5 times the height of the tree being measured and no closer than a 45º angle between the Contractor Field Crew member and the uppermost tip of the tree. Contractor Field Crew members should be aware of the impact "tree lean" in windy conditions can have on accurate height measurements and not take tree height measurements in these conditions.

Appendix 13.6 includes detailed instructions on using a clinometer and hypsometer to measure tree heights.

*Measure the heights of 5 other trees across a range of diameters:* After identifying and measuring the heights of the three largest diameter trees, identify 5 other live trees from across the range of diameters of all tagged trees inside the LTP and measure these tree heights.

To identify the 5 trees, rank the DBH of each Live Standing tagged tree. Start with 1 being the smallest DBH. Divide the top rank number by 5 and if necessary round the result down to the nearest whole number (n). Check every *nth* number in the ranked list of trees and make a note of its tree tag number.

E.g. Highest ranked tree (largest DBH) = 20$^{th}$ tree

20 / 5 = 4, select the 4$^{th}$, 8$^{th}$, 12$^{th}$, 16$^{th}$ and 20$^{th}$ ranked trees in the list of tagged tree diameters.

Or, highest ranked tree rank (largest DBH) = 34$^{th}$ tree

34 / 5 = 6.8, select the 6$^{th}$, 12$^{th}$, 18$^{th}$, 24$^{th}$ and 30$^{th}$ ranked trees in the list of tagged tree diameters.

Measure the heights of these selected 5 trees using the steps outlined in the procedures section of this SOP.

A tool is included in the digital version (MS Excel or MS Access) of the *Large Tree Plot Form* that will automate the process of identifying the tree tag codes of the five trees across the DBH range of the LTP.

**Tree Canopy Cover**

Canopy Cover is measured from near the FMRIS Sample Point Location in four equally-spaced directions (north, south, east and west). Two field observers are required for this measurement so that an average value (partially accounting for between-observer error) can be calculated.

*Set up for measuring Canopy Cover:* Stand 1 m away from the Sample Point Location while aligned with, and facing, one of the required directions. Hold the spherical crown densiometer level and away from the body, such that your head does not appear on the grid. If understorey foliage just over head height is blocking a clear view of the canopy it may be held aside. Taller understorey foliage will need to be included in the assessment, as it will not generally be possible to move it aside or distinguish it from canopy foliage in the densiometer image. Assume that each of the 24 squares on the densiometer grid is divided up into 4 equally-sized, smaller squares. This will result in 96 'virtual' squares (see Appendix 13.7).

*Use the densiometer correctly:* Experience suggests that closing one eye will reduce parallax difficulties (whereby the reflected image appears to shift on the mirror as one refocusses). When the sun is overhead it may be necessary to hold your hand (as high as possible) above the densiometer to block the glare. This glare normally affects only one or two of the 24 main squares.

*Determine the best method for measuring Canopy Cover:* Before starting a measurement, each observer must individually decide whether it will be easier to conduct a Canopy Count or a Sky Count. This is done by making a quick visual assessment of the density of forest canopy reflected on the densitometer grid. In sparse forest it will be easier and more accurate to conduct a Canopy Count (option 1 – see procedure below). In dense forest it will be easier (and more accurate) to conduct a Sky Count (option 2 – see procedure below). The preferred method may change depending on the canopy conditions reflected in each of the cardinal directions.

*Measure Canopy Cover:* In sparse forest conduct a Canopy Count using option 1. In dense forest conduct a Sky Count using option 2. Note that dense foliage is treated as if it were solid, so this technique will tend to overestimate actual leaf cover.

- Option 1: Measure Canopy Count directly in sparse forest: Count the number of 'virtual' squares that have their major portion occupied by canopy (i.e., the opposite of procedure shown in Appendix 13.7). It is not necessary to convert a Canopy Count to a Sky Count.
- Option 2: Measure Sky Count in dense forest: Count the number of 'virtual' squares that have their major portion occupied by sky as per Appendix 13.7. Convert each Sky Count to a Canopy Count ( = 96 – Sky Count).

Each observer repeats this process for the cardinal directions (north, east, south and west) giving eight estimates in total of either canopy or sky cover.

*Calculate Canopy Cover:* Percent canopy cover may be calculated later by summing the eight individual Canopy Counts and multiplying by 0.13.

**Tree Canopy Health**

*Prepare at the office:* before visiting the Sample Point, all Contractor Field Crew members should become familiar with:

- the tree species they are to assess,
- any existing plot data relating to past inspections including canopy images previously observed and any defoliation noted so as to provide a baseline for future assessment,
- expected climatic variables that may influence crown assessment as factors including overcast conditions, fog and cloud, poor sun angles may all affect crown assessment.

*Broadly assess site:* broadly assess the site to identify any site specific variables that make the site distinguishable so as to place data collected in the context of the forest type to be assessed, and assist in calibrating tree-health scoring methodologies.

Ensure assessments are conducted from a position that maximises the view of the tree crowns but keeps disturbance of the plot to a minimum.

*Assess direction, distance and view of crown* **:** Tree crown assessments are undertaken on the height measured trees, hereafter referred to as "Height Trees". Assessments are made at ground level and are preferably conducted by two or more persons. In order to obtain the best possible position to assess the tree crown, the following assessment procedure is recommended:

- Observers should attempt to be at least half to one tree length away from the tree. It is recognised that this can be challenging in a dense canopy, closed forest (Appendix 13.8, Figure 1);
- View the crown from different angles and attempt to observe as much of the crown as possible, preferably from a minimum of two sides and at an angle greater than 90 degrees to each other where possible (Appendix 13.8, Figure 2);
- Assessments should be performed optimally at the same elevation as the tree or upslope as some crown assessments can be underestimated if crowns are monitored from a downslope position (Appendix 13.8, Figure 13.1), and
- Assessments should be undertaken where possible while looking away from the sun.

In some plots, obtaining a clear view of the tree crown is difficult due to factors such as heavy branching, background trees, dense understorey and associated difficulty in obtaining clear vantage points for viewing tree crowns, making it difficult to subsequently assess them accurately. It is suggested that while the above assessment procedures should be followed as a matter of best practice, judgement and common sense should always be used when crown assessments are being conducted. Factors involving assessor safety and plot disturbance should always be considered first prior to any assessment being conducted.

*Assess environmental conditions***:** Environmental conditions within native forest stands can be variable and can change from day to day, and from plot to plot. Climatic variables such as rain, cloudy and overcast skies, fog and poor sun angles may affect crown assessment. Care needs to be taken when viewing tree crowns under these conditions because:

- Identifying assessable crown can be affected by difficulties in observing the lowest green foliage, as colour is sometimes hard to distinguish;
- Crown defoliation and density measurements can be overestimated or underestimated when sunlight does not project well through the foliage, or in some cases the light may be too bright for a good estimate;
- Underestimation of crown defoliation and density is possible due to difficulties in observing crown dieback in small dead twigs and/or differentiating defoliated twigs from dead twigs, and
- Assessment from a single location in such climatic conditions can potentially give a distorted, unrepresentative view of the tree canopy. Contractor Field Crews should therefore move to another location if possible.

*Define Assessable Crown***:** To perform assessments of crown condition a definition of assessable crown is required. Assessable crown of a tree in context of this SOP, can be defined as:

- The lowest branch bearing live foliage excluding branches that may have had foliage in previous surveys (Appendix 13.8, Figure 3);

- Epicormic branches that are larger than 2.5 cm in diameter and less than 1.5 m from the main live crown (Appendix 13.8, Figure 3),
- Epicormic shoots below the main crown where they contribute greater than 30% of the leaf volume (Appendix 13.8, Figure 3),

*Assess Epicormic Shoots* **:** As epicormic shoots are an indicator of stress, they are included in an assessment of crown health.

For each Height Tree, Contractor Field Crews must make an assessment of the contribution that epicormic foliage makes to the tree's total foliage cover. Record epicormic foliage cover in 5% levels and assess the entire tree and not just the Assessable Crown.

*Assess tree crown defoliation and dieback* **:** Defoliation is generally assessed as leaf loss in a tree's crown as compared to an optimal tree with a full healthy crown located at the same site.

Assess defoliation of the Height Trees using a three-part rating system consisting of:

- proportion of primary branches which have died back (in 5% levels);
- length of dead top if present (in metres), and
- percentage of current crown as a proportion of estimated original crown from the assessable crown in 5% levels (excluding natural holes in the crown where no foliage would exist) using the crown defoliation card (Appendix 13.8, Figure 4). These levels are 0, 5 (>0-5%), 10 (>5-10%), 15 (>10-15%) and so forth. A tree with between >95% and 100% defoliation (which is still alive) is scored as 99%. A score of 100% is used for dead trees and this assessment should not occur in practice as only live standing trees are selected as Height Trees.

This rating system accounts for epicormics as described above. The canopy structure of native forest stands is variable and care is required when using the crown defoliation scale (Appendix 13.8, Figure 4), not to overestimate the amount of defoliation present in a naturally open growing crown.

*Assess crown foliage density and clumping* **:** Crown foliar density examines the trees assessable crown and estimates the amount of light able to penetrate the crown. This assessment is performed at the crown scale and indicates the amount of crown branches, foliage and reproductive structures that block light visibility through the crown including crown openness from crown structure.

Assess crown foliar density using the crown density card (Appendix 13.8, Figure 4) at 5% levels using the same eight height trees. These levels are 0, 5 (>0-5%), 10 (>5-10%) and so forth. A tree with between >95% and 100% density is scored as 99%. Assess crown clumping and assign as very sparse, sparse, moderate, dense and very dense (Appendix 13.8, Table 1 and Figure 6) using the same eight Height Trees.

*Assess foliage discolouration*: Discolouration is both important and difficult to assess as abiotic and biotic related disorders can result in loss of leaf function while the tree still retains foliage (Appendix 13.8, Figure 5). While trees can visually possess full canopies (100% density), leaf function may only be 50%, effectively meaning the tree is 50% 'defoliated'.

Assess discolouration of the Height Trees by:

- the use of binoculars;
- inspecting smaller trees of the same species in the immediate area for discolouration, and
- assigning 5% levels . These levels are 0, 5 (>0-5%), 10 (>5-10%) and so forth. A tree with between >95% and 100% discolouration is scored as 99%. A score of 100% is used for entire tree discolouration.

*Assess Crown Position*: Crown Position is important especially in mixed species forests as different trees species grow in differing light conditions. Open-grown trees usually have much larger crowns than trees in closed canopies. A change in the degree of shading may impact on crown condition especially in trees that are shade tolerant.

Assess Height Trees using the six-point scale taking account that Crown Position has the potential to change from one year to the next through, for example, thinning operations or storm damage (Appendix 13.8, Table 2 and Figure 7).

## Data and information recording

The steps in this section of the SOP, describe how and where to record data and information using a hardcopy (paper) format of the *Large Tree Plot Form*. Digital (i.e. MS Excel and MS Access) formats of the form will allow Contractor Field Crews to record information more efficiently, using drop down lists and combination boxes under fields. These instructions apply to both hardcopy and electronic versions of the Form.

### Large Tree Plot Identification and Establishment:

*Complete the* `Identification` *section at the top of each page on the Large Tree Plot Form*: Fill in the Sample Point Identification Code, Bioregion, the SOP version number, Date, Contractor Company Name and the Names of each Contractor Field Crew member present, in the `<sample_point_ID>`, `<bioregion>`, `<SOP version>`, `<date>` and `<contractor_company>` fields. Against each `<field_crew_member_number>` fill in the Contractor Field Crew member surname `<field_crew_member_surname>` and first name

<field_crew_member_firstname>. The Contractor Field Crew Leader should be the first name recorded in the Identification section of the form. The crew member who enters information on the form (i.e. the scribe) checks the box <Scribe> next to their name.

*Record LTP slope adjusted radius*: In the slope adjustment section of the *Large Tree Plot Form*, record the slope adjusted LTP radius in the <LTP Radius> field.

**Tree Mensuration:**

*Enter the number of tagged trees in each quadrant*: After marking out quadrants and tagging trees, in the Tree Mensuration section of the *Large Tree Plot Form*, record the tag codes of all tagged trees under the <Tree Tag Code> field. Record the tree tag codes in ascending order, starting with NE01…NE02 etc. followed by SE, SW and NW tree tag codes.

*Record the Tree Status of each tagged tree*: In the Tree Mensuration section of the *Large Tree Plot Form*, against the relevant tree tag code, record each tree as either LS (Live Standing), LF (Live Fallen) or DS (Dead Standing) in the <Tree Status> field.

*Record Tree Death*: In the Tree Mensuration section of the *Large Tree Plot Form*, against tagged trees recorded as *Dead Standing* (under Tree Status), record the probable cause of death in the <Tree Death>.

*Record Tree Decay Class*: In the Tree Mensuration section of the *Large Tree Plot Form*, against tagged trees recorded as *Dead Standing* (under Tree Status), record the decay class in <Tree Decay Class>.

*Record Tree Species*: In the Tree Mensuration section of the *Large Tree Plot Form*, against the relevant tree tag code, record the tree species in the <Tree Species> field.

Unidentifiable species should be given a descriptive name and recorded in the Field Form as <Tree Species>. Check the <temporary name> box to mark this record as an unidentified species that is temporarily named. The temporary name can be re-used on the *Large Tree Plot Form* each time the same unknown tree is detected. Follow the procedures outlined in *SOP 20A: Plant Specimen Collection and Identification Procedures* to record further information about this species on the *Plant Specimen Collection Form*.

*Record Tree Crown Class*: In the tree section of the *Large Tree Plot Form,* against the relevant tree tag code, record the crown class in the <Crown Class> field.

*Record Tree Characteristics*: In the Tree Mensuration section of the *Large Tree Plot Form,* against the relevant tree tag code, check one of more tree characteristics (e.g. bent over, near dead, head out etc.) which best characterise and describe the tagged tree and may be useful for identifying the tree in the future.

*Record the DBH of each tagged tree*: In the Tree Mensuration section of the *Large Tree Plot Form*, against the relevant tree tag code (recorded above) record the diameter (in cm, to the nearest 0.1 cm) in the <DBH> field. Calculate averages around branches and swellings prior to recording the DBH on the *Large Tree Plot Form*.

*Rank the DBH of each Live Standing tagged tree: :* In the Tree Mensuration section of the *Large Tree Plot Form*, rank the DBH in the <DBH Rank> field of each Live Standing (<Tree Status>) tagged tree.

*Record the height of the three largest DBH tagged trees:* In the Tree Mensuration section of the *Large Tree Plot Form,* against the relevant tree tag codes, record the heights (in cm to the nearest centimetre) of the three largest DBH trees in the entire LTP in the <Tree height> field and check the box in the <3 Largest DBH> field.

*Identify and record the heights of five other trees across the range of diameters in the LTP:* Check every *nth* number in the list of ranks under the <DBH Range Five> field, and make a note of its tree tag number. In the <Tree Height> field, record the heights of the 5 selected trees.

**Tree Canopy Cover:**

*Record Observer names:* In the Tree Canopy Cover section, fill in Observer 1's name in the <observer 1 name> field and fill in Observer 2's name in the <observer 2 name> field.

In the Tree Canopy Cover section, *Observer 1 records their Canopy or Sky Count for each direction:* When a Canopy Count is made, then this value is recorded in the <Canopy Count> field for the relevant <direction> and a dash (-) is recorded in the <Sky Count> field for the same direction. When a Sky Count is made, then this value is recorded in the <Sky Count> field for the relevant <direction> and Canopy Count is calculated ( = 96 – Sky Count) and recorded in the <Canopy Count> field for the same direction.

In the Tree Canopy Cover section, *Observer 2 records their Canopy or Sky Count for each direction:* When a Canopy Count is made, then this value is recorded in the <Canopy Count> field for the relevant <direction> and a dash (-) is recorded in the <Sky Count> field for the same <direction>. When a Sky Count is made, this value is recorded in the <Sky Count> field for the relevant <direction> and Canopy Count is calculated ( = 96 – Sky Count) and recorded in the <Canopy Count> field for the same direction.

*Calculate and record each observer's subtotal:* Calculate the sum of each observer's <Canopy Counts> and enter in the <observer subtotal> field of the Tree Canopy Cover section.

*Calculate and record the grand total Canopy Count:* Calculate the sum of each observer's subtotal and enter in the <Grand Total Canopy Count> field of the Tree Canopy Cover section.

*Calculate and record the average Canopy Cover:* Calculate the average Canopy Cover by multiplying the <Grand Total Canopy Count> by 0.13 and enter it in the <Average Canopy Cover %> field of the Tree Canopy Cover section.

**Tree Canopy Health:**

*Record the amount of epicormics present on each Height Tree:* In the Tree Canopy Health section, fill in the percentage of epicormic shoots present on the entire tree in 5% levels and record in <Epicormics Present> field.

*Record the proportion of dieback present in each Height Tree:* In the Tree Canopy Health section, fill in the percentage of dieback observed in the entire tree in 5% levels and record in <proportion of dieback> field.

*Measure and record the length of dead top present in each Height Tree:* In the Tree Canopy Health section, fill in the length of the dead top (if present) in metres in <length of the dead top> field.

*Record the amount of crown defoliated in each Height Tree:* Identify the percentage of crown defoliated in 5% levels and record in <Crown Defoliated> field in the Tree Canopy Health section.

*Record the amount of canopy density in each Height Tree:* Identify the percentage of canopy density in 5% levels and record in <Canopy Density> field in the Tree Canopy Health section.

*Record the crown clumping score in each Height Tree:* Fill in the crown clumping code that best describes the tree in <Canopy Clumping Score> field of the Tree Canopy Health section.

*Record the amount of crown discolouration in each Height Tree:* Identify the percentage of crown discoloured in 5% levels and record in <Crown Defoliated> field of the Tree Canopy Health section.

*Record the position of the crown in each Height Tree:* Fill in the crown position code that best describes the crowns relationship to its neighbouring tree in <Crown Position> field of the Tree Canopy Health section.

**Comments:**

*Record any comments*: Identify any site specific variables making the site distinguishable in the Comments section. Record any additional information relating to the plot or plot surrounds that are individual to that plot in this field.

**Form Checks:**

*Complete the Field Form Check section at the bottom of the form:* the Contractor Field Crew Leader initials the <Team Leader Initials> field, enters the date <Date checked> and writes down any comments about data verification in the <comments> field.

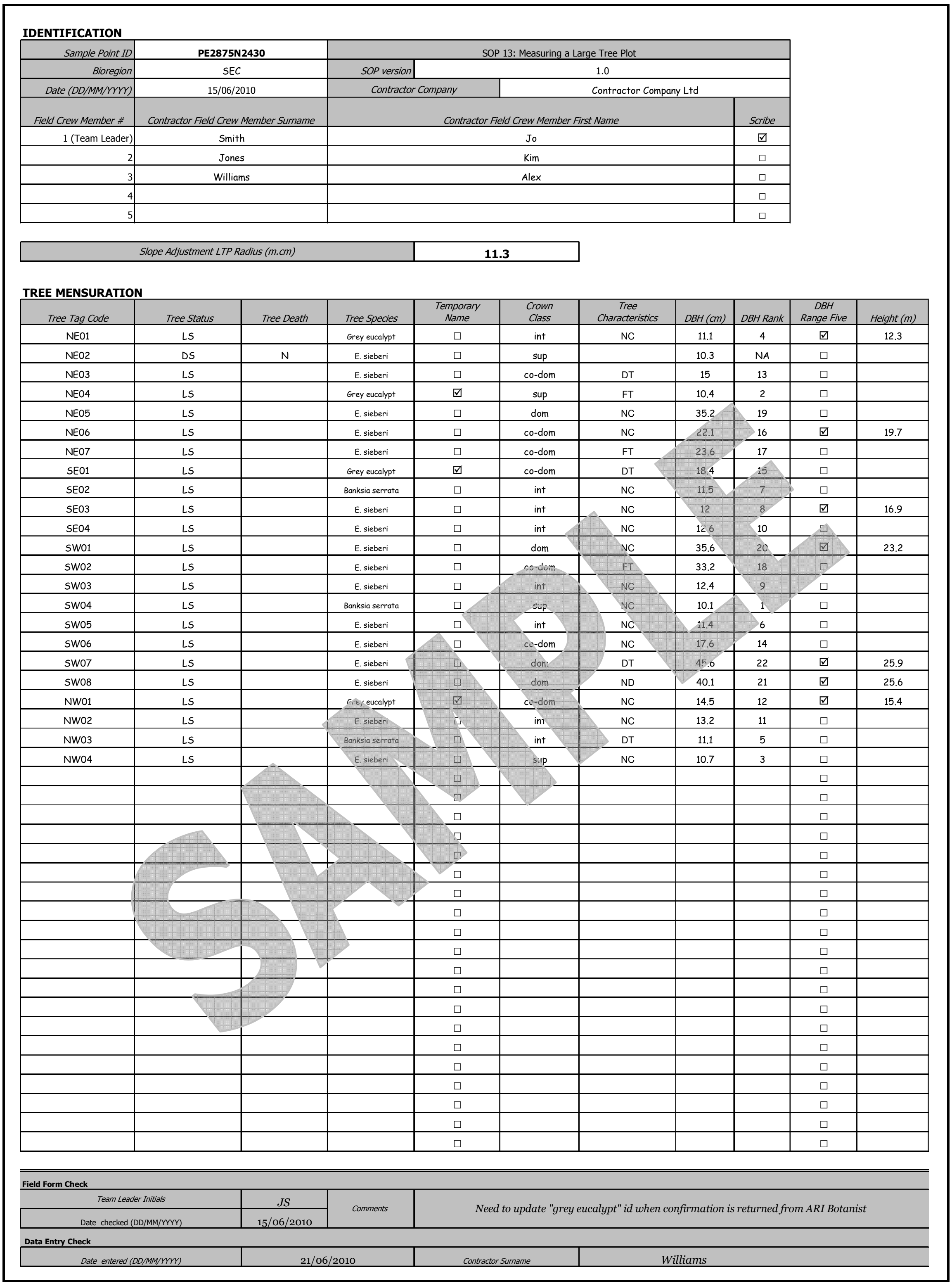
*Complete the Data Entry Check section at the bottom of the form:* the Field Crew member who enters the data into the Working Database writes their surname in the <Contractor Surname> field and the date data entry was completed for the form in <Date entered>.

| Version (current) | Version (previous) | Author | Date | Summary of changes |
|---|---|---|---|---|
| 1.0 | | am1k | 04/02/2010 | |
| 1.0 | 1.0 | am1k | 14/02/2010 | Updated data and information recording section |
| 1.0 | 1.0 | am1k | 23/03/2010 | Edits following team discussion (23/03/2010) |
| 1.0 | 1.0 | Nb29 | 27/04/2010 | Further edits made – SOP needs missing tables 13.4 and 13.5 |
| 1.0 | 1.0 | NB29 | 11/05/2010 | Minor edits accepted, issues documented, sample form added to appendix. |
| 1.0 | | Nb29 | 4/06/10 | Edits following meeting, 24/05 |
| 1.0 | | | 10/08/2010 | Incorporating health and canopy cover |
| 1.1 | 1.0 | mw0a | 04/07/2011 | Amendments made post field season 1 |

| | | | |
|---|---|---|---|
| **Endorsed** | | **Date** | **18/02/2011** |
| **Name:** | Andrew Haywood | | |
| **Position:** | Manager, Knowledge Unit | | |
| **Division/Branch:** | Forests and Parks Division / Management and Operations Branch | | |

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.1

## Example Large Tree Plot Form – page 1



**IDENTIFICATION**

| | | | |
|---|---|---|---|
| *Sample Point ID* | **PE2875N2430** | SOP 13: Measuring a Large Tree Plot | |
| *Bioregion* | SEC | *SOP version* | 1.0 |
| *Date (DD/MM/YYYY)* | 15/06/2010 | *Contractor Company* | Contractor Company Ltd |

| *Field Crew Member #* | *Contractor Field Crew Member Surname* | *Contractor Field Crew Member First Name* | *Scribe* |
|---|---|---|---|
| 1 (Team Leader) | Smith | Jo | ☑ |
| 2 | Jones | Kim | ☐ |
| 3 | Williams | Alex | ☐ |
| 4 | | | ☐ |
| 5 | | | ☐ |

| | |
|---|---|
| *Slope Adjustment LTP Radius (m.cm)* | **11.3** |

**TREE MENSURATION**

| *Tree Tag Code* | *Tree Status* | *Tree Death* | *Tree Species* | *Temporary Name* | *Crown Class* | *Tree Characteristics* | *DBH (cm)* | *DBH Rank* | *DBH Range Five* | *Height (m)* |
|---|---|---|---|---|---|---|---|---|---|---|
| NE01 | LS | | Grey eucalypt | ☐ | int | NC | 11.1 | 4 | ☑ | 12.3 |
| NE02 | DS | N | E. sieberi | ☐ | sup | | 10.3 | NA | ☐ | |
| NE03 | LS | | E. sieberi | ☐ | co-dom | DT | 15 | 13 | ☐ | |
| NE04 | LS | | Grey eucalypt | ☑ | sup | FT | 10.4 | 2 | ☐ | |
| NE05 | LS | | E. sieberi | ☐ | dom | NC | 35.2 | 19 | ☐ | |
| NE06 | LS | | E. sieberi | ☐ | co-dom | NC | 22.1 | 16 | ☑ | 19.7 |
| NE07 | LS | | E. sieberi | ☐ | co-dom | FT | 23.6 | 17 | ☐ | |
| SE01 | LS | | Grey eucalypt | ☑ | co-dom | DT | 18.4 | 15 | ☐ | |
| SE02 | LS | | Banksia serrata | ☐ | int | NC | 11.5 | 7 | ☐ | |
| SE03 | LS | | E. sieberi | ☐ | int | NC | 12 | 8 | ☑ | 16.9 |
| SE04 | LS | | E. sieberi | ☐ | int | NC | 12.6 | 10 | ☐ | |
| SW01 | LS | | E. sieberi | ☐ | dom | NC | 35.6 | 20 | ☑ | 23.2 |
| SW02 | LS | | E. sieberi | ☐ | co-dom | FT | 33.2 | 18 | ☐ | |
| SW03 | LS | | E. sieberi | ☐ | int | NC | 12.4 | 9 | ☐ | |
| SW04 | LS | | Banksia serrata | ☐ | sup | NC | 10.1 | 1 | ☐ | |
| SW05 | LS | | E. sieberi | ☐ | int | NC | 11.4 | 6 | ☐ | |
| SW06 | LS | | E. sieberi | ☐ | co-dom | NC | 17.6 | 14 | ☐ | |
| SW07 | LS | | E. sieberi | ☐ | dom | DT | 45.6 | 22 | ☑ | 25.9 |
| SW08 | LS | | E. sieberi | ☐ | dom | ND | 40.1 | 21 | ☑ | 25.6 |
| NW01 | LS | | Grey eucalypt | ☑ | co-dom | NC | 14.5 | 12 | ☑ | 15.4 |
| NW02 | LS | | E. sieberi | ☐ | int | NC | 13.2 | 11 | ☐ | |
| NW03 | LS | | Banksia serrata | ☐ | int | DT | 11.1 | 5 | ☐ | |
| NW04 | LS | | E. sieberi | ☐ | sup | NC | 10.7 | 3 | ☐ | |
| | | | | ☐ | | | | | ☐ | |
| | | | | ☐ | | | | | ☐ | |
| | | | | ☐ | | | | | ☐ | |
| | | | | ☐ | | | | | ☐ | |
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| | | | | ☐ | | | | | ☐ | |
| | | | | ☐ | | | | | ☐ | |
| | | | | ☐ | | | | | ☐ | |

**Field Form Check**

| | | | |
|---|---|---|---|
| *Team Leader Initials* | *JS* | *Comments* | *Need to update "grey eucalypt" id when confirmation is returned from ARI Botanist* |
| Date checked (DD/MM/YYYY) | 15/06/2010 | | |

**Data Entry Check**

| | | | |
|---|---|---|---|
| *Date entered (DD/MM/YYYY)* | 21/06/2010 | *Contractor Surname* | *Williams* |

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.1

## Example Large Tree Plot Form – page 2

**IDENTIFICATION**

| | | | |
|---|---|---|---|
| *Sample Point ID* | **PE2875N2430** | SOP 13: Measuring a Large Tree Plot | |
| *Bioregion* | SEC | *SOP version* | 1.0 |
| *Date (DD/MM/YYYY)* | 15/06/2010 | *Contractor Company* | Contractor Company Ltd |

| *Field Crew Member #* | *Contractor Field Crew Member Surname* | *Contractor Field Crew Member First Name* | *Scribe* |
|---|---|---|---|
| 1 (Team Leader) | Smith | Jo | ☑ |
| 2 | Jones | Kim | ☐ |
| 3 | Williams | Alex | ☐ |
| 4 | | | ☐ |
| 5 | | | ☐ |

**TREE CANOPY COVER**

| *Observer Number* | *Observer Name* | *#Count type* | *North* | *East* | *South* | *West* | *OBSERVER SUB-TOTAL* |
|---|---|---|---|---|---|---|---|
| Observer 1 | Kim | Canopy | 61 | 26 | 75 | 48 | 210 |
| | | Sky | 35 | - | 21 | - | |
| Observer 2 | Alex | Canopy | 59 | 21 | 78 | 45 | 203 |
| | | Sky | 37 | - | 18 | | |
| GRAND TOTAL CANOPY COUNT | | | | | | | 413 |
| *AVERAGE CANOPY COVER % | | | | | | | 54 |

# For Sky Count conversions: Canopy Count = (96 - Sky Count)

* The average canopy cover can be calculated later by summing the eight Canopy Counts (Grand Total) and multiplying by 0.13

**TREE CANOPY HEALTH**

| *Tree Tag Code* | *Epicormics Present* | *Proportion of Dieback* | *Length of Dead Top* | *Crown Defoliated* | *Canopy Density* | *Crown Clumping Score* | *Crown Discoloured* | *Crown Position* |
|---|---|---|---|---|---|---|---|---|
| NE05 | 5 | 5 | 0 | 5 | 75 | dense | 0 | 1 |
| SE01 | 10 | 10 | 0 | 10 | 60 | moderate | 0 | 3 |
| SE02 | 0 | 0 | 0 | 0 | 90 | very dense | 0 | 6 |
| SW01 | 5 | 5 | 0 | 5 | 75 | dense | 0 | 1 |
| SW07 | 5 | 30 | 2.6 | 15 | 60 | moderate | 0 | 2 |
| SW08 | 5 | 5 | 0 | 5 | 75 | dense | 0 | 1 |
| NW02 | 20 | 15 | 0 | 20 | 50 | moderate | 10 | 6 |
| NW04 | 10 | 20 | 0 | 20 | 30 | sparse | 10 | 6 |

**SITE SPECIFIC COMMENTS**

A general description of the state of the forest at the sample point, to help interpret results on this form - esp. growth stage of forest, ease of access, signs of recent disturbance, etc.

Silvertop regrowth stand

**Field Form Check**

| | | | |
|---|---|---|---|
| *Team Leader Initials* | JS | *Comments* | |
| Date checked (DD/MM/YYYY) | 16/06/2010 | | |

**Data Entry**

| | | | |
|---|---|---|---|
| *Date entered (DD/MM/YYYY)* | 21/06/2010 | *Contractor Surname* | Williams |

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.2

## Establishing a Large Tree Plot

**Table 1: Slope Adjusted Radius Table**

| Slope (°) | Radius (m) | Slope (°) | Radius (m) | Slope (°) | Radius (m) | Slope (°) | Radius (m) |
|---|---|---|---|---|---|---|---|
| 0 | 11.28 | 10 | 11.37 | 20 | 11.64 | 30 | 12.13 |
| 1 | 11.28 | 11 | 11.39 | 21 | 11.68 | 31 | 12.19 |
| 2 | 11.29 | 12 | 11.41 | 22 | 11.72 | 32 | 12.25 |
| 3 | 11.29 | 13 | 11.43 | 23 | 11.76 | 33 | 12.32 |
| 4 | 11.30 | 14 | 11.46 | 24 | 11.81 | 34 | 12.39 |
| 5 | 11.31 | 15 | 11.48 | 25 | 11.85 | 35 | 12.47 |
| 6 | 11.31 | 16 | 11.51 | 26 | 11.90 | 36 | 12.55 |
| 7 | 11.33 | 17 | 11.54 | 27 | 11.95 | 37 | 12.63 |
| 8 | 11.34 | 18 | 11.57 | 28 | 12.01 | 38 | 12.71 |
| 9 | 11.35 | 19 | 11.60 | 29 | 12.07 | 39 | 12.80 |

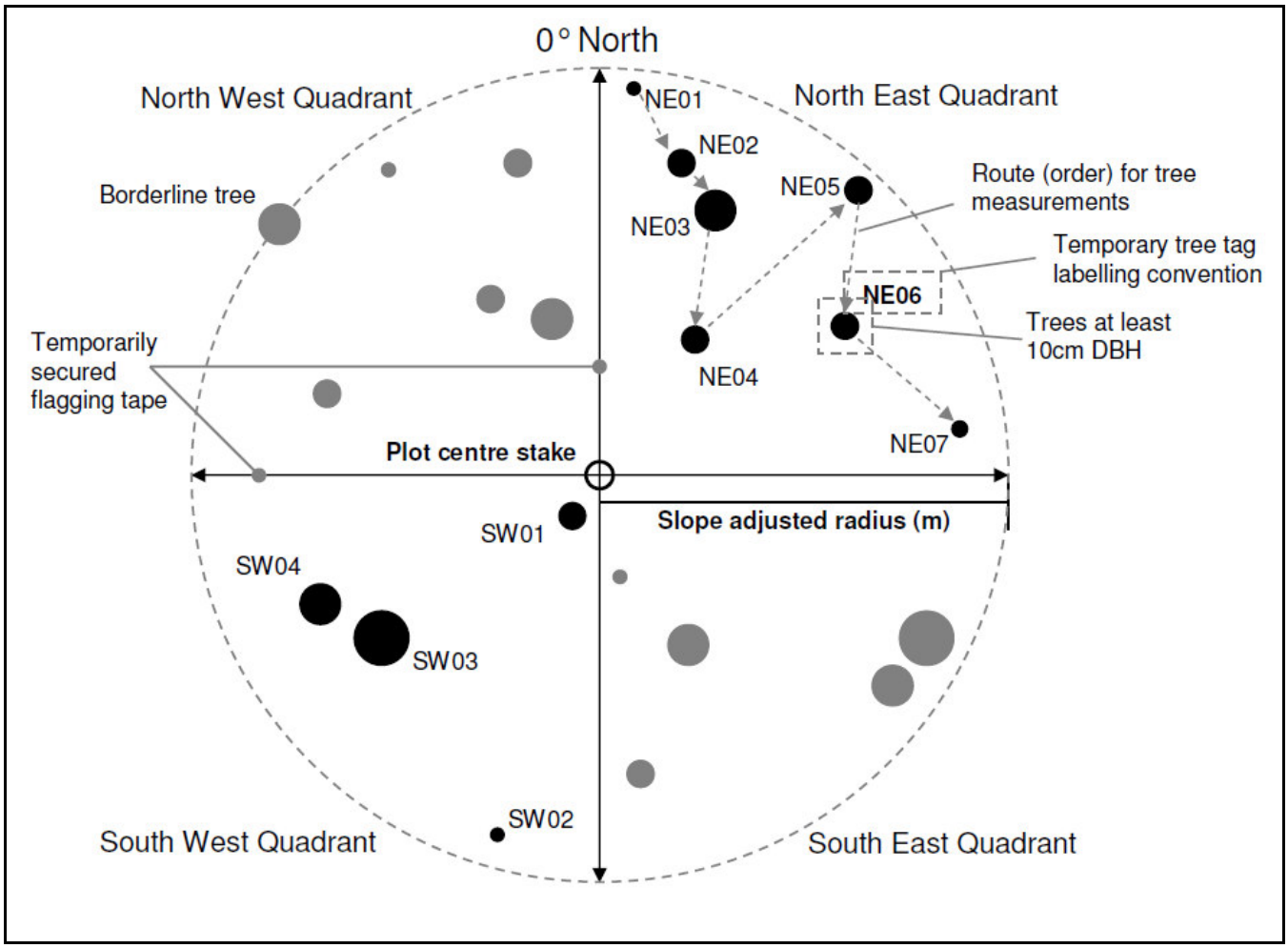


**Figure 1: Marking out and tagging trees on a Large Tree Plot**

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.3

## Establishing a Large Tree Plot

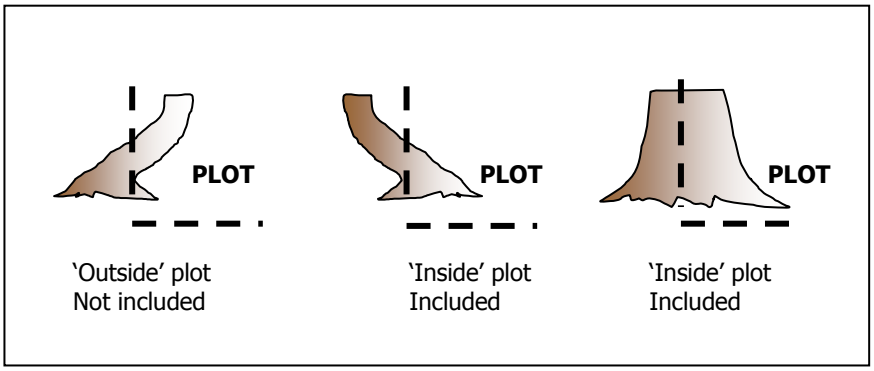


**Figure 2: Examples of borderline trees.**

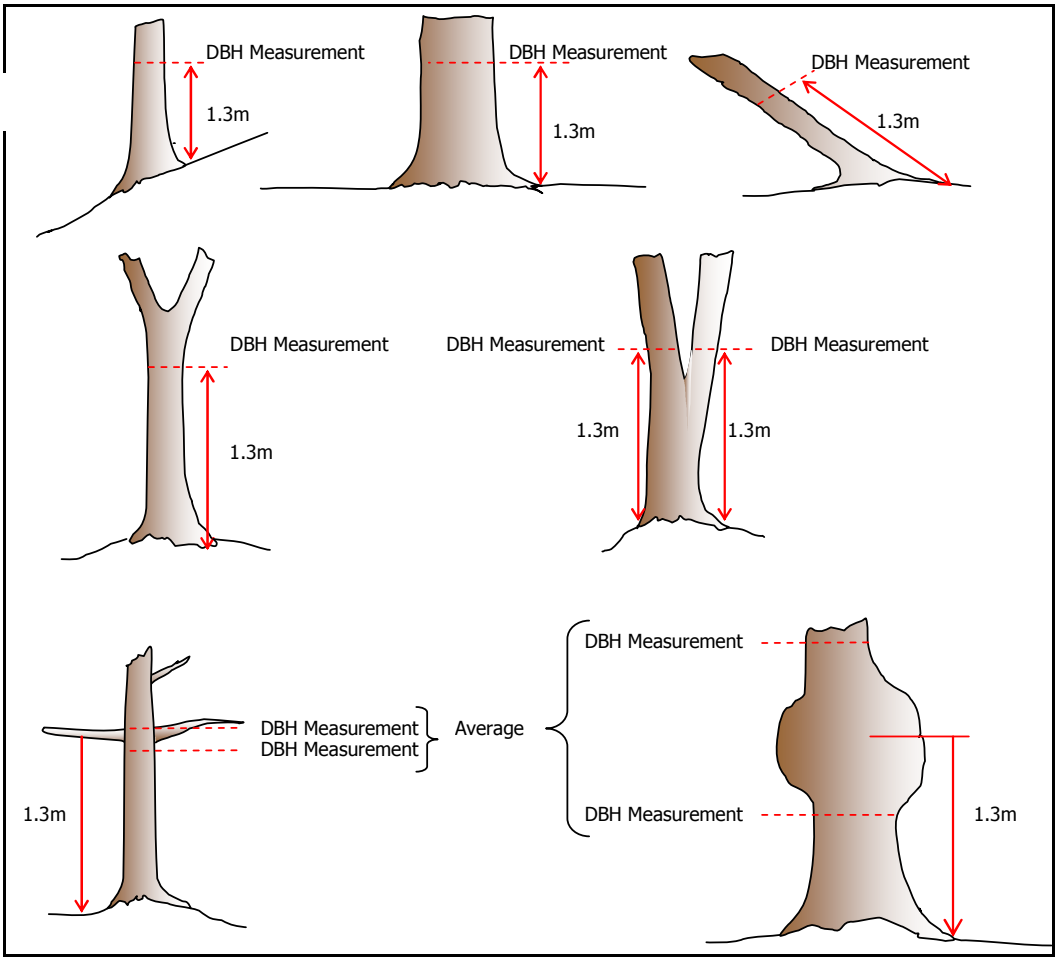


**Figure 3: Procedure for conducting diameter at breast height (DBH) measurements**

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.3

## Tree Species Reference Table

* This list comprises all species with an FIS 'LIFELOOK' code of LT, MT or T.

| SCIENTIFIC NAME | COMMON NAME | FIS No. |
|---|---|---|
| *Acacia binervia* | Coast Myall | 3635 |
| *Acacia caerulescens* | Limestone Blue Wattle | 3633 |
| *Acacia cognata* | Narrow-leaf Bower-wattle | 0021 |
| *Acacia dallachiana* | Catkin Wattle | 0023 |
| *Acacia dealbata* | Silver Wattle | 0025 |
| *Acacia deanei* | Deane's Wattle | 0026 |
| *Acacia decurrens* | Early Black-wattle | 0028 |
| *Acacia difformis* | Drooping Wattle | 0029 |
| *Acacia dodonaeifolia* | Sticky Hop Wattle | 4269 |
| *Acacia doratoxylon* | Currawang | 0030 |
| *Acacia elata* | Cedar Wattle | 0031 |
| *Acacia falciformis* | Large-leaf Hickory-wattle | 0033 |
| *Acacia floribunda* | White Sallow-wattle | 0036 |
| *Acacia frigescens* | Frosted Wattle | 0037 |
| *Acacia howittii* | Sticky Wattle | 0044 |
| *Acacia implexa* | Lightwood | 0045 |
| *Acacia irrorata* | Green Wattle | 3631 |
| *Acacia kettlewelliae* | Buffalo Wattle | 0046 |
| *Acacia leprosa* | Cinnamon Wattle | 0049 |
| *Acacia loderi* | Nealie | 0052 |
| *Acacia longifolia* | Coast/Sallow Wattle | 5128 |
| *Acacia maidenii* | Maiden's Wattle | 0055 |
| *Acacia mearnsii* | Black Wattle | 0056 |
| *Acacia melanoxylon* | Blackwood | 0057 |
| *Acacia melvillei* | Myall | 0058 |
| *Acacia mucronata* | Narrow-leaf Wattle | 0062 |
| *Acacia nano-dealbata* | Dwarf Silver Wattle | 0064 |
| *Acacia obliquinervia* | Mountain Hickory Wattle | 0067 |
| *Acacia obtusifolia* | Blunt-leaf Wattle | 0068 |
| *Acacia omalophylla* | Yarran Wattle | 0069 |
| *Acacia oswaldii* | Umbrella Wattle | 0070 |
| *Acacia pendula* | Weeping Myall | 0073 |
| *Acacia penninervis* | Hickory Wattle | 0074 |
| *Acacia phlebophylla* | Buffalo Sallow-wattle | 0076 |
| *Acacia podalyriifolia* | Queensland Silver Wattle | 5210 |
| *Acacia pravissima* | Ovens Wattle | 0077 |
| *Acacia prominens* | Gosford Wattle | 3649 |
| *Acacia pycnantha* | Golden Wattle | 0078 |
| *Acacia retinodes* | Wirilda | 0079 |
| *Acacia salicina* | Willow Wattle | 0083 |
| *Acacia saligna* | Golden Wreath Wattle | 0084 |
| *Acacia schinoides* | Frosty Wattle | 5133 |
| *Acacia silvestris* | Red Wattle | 0087 |

| SCIENTIFIC NAME | COMMON NAME | FIS No. |
|---|---|---|
| *Acacia stenophylla* | Eumong | 0090 |
| *Acacia subporosa* | Bower Wattle | 0093 |
| *Acacia terminalis* | Sunshine Wattle | 0095 |
| *Acacia verniciflua* | Varnish Wattle | 0099 |
| *Acer* - ALL SPECIES | MAPLE | |
| *Acmena smithii* | Lilly Pilly | 0115 |
| *Acronychia oblongifolia* | Yellow-wood | 0116 |
| *Agonis* - ALL SPECIES | MYRTLE | |
| *Ailanthus altissima* | Tree Of Heaven | 0163 |
| *Akebia quinata* | Five-leaf Akebia | 5799 |
| *Alectryon* - ALL SPECIES | ALECTRYON | |
| *Allocasuarina littoralis* | Black Sheoak | 0677 |
| *Allocasuarina luehmannii* | Buloke | 0678 |
| *Allocasuarina torulosa* | Forest Oak | 5383 |
| *Allocasuarina verticillata* | Drooping Sheoak | 0685 |
| *Angophora* - ALL SPECIES | APPLE | |
| *Arbutus unedo* | Irish Strawberry Tree | 0253 |
| *Atherosperma moschatum* | Southern Sassafras | 0311 |
| *Banksia integrifolia* | Coast Banksia | 0362 |
| *Banksia saxicola* | Rock Banksia | 0365 |
| *Banksia serrata* | Saw Banksia | 0366 |
| *Bedfordia arborescens* | Blanket-leaf | 0382 |
| *Betula aff. pubescens* | Birch | 5819 |
| *Brachychiton populneus* | Kurrajong | 0447 |
| *Bursaria spinosa* | Sweet Bursaria | 0515 |
| *Callistachys lanceolata* | Greenbush | 3908 |
| *Callistemon pallidus* | Lemon Bottlebrush | 0564 |
| *Callistemon salignus* | Willow Bottlebrush | 5398 |
| *Callitris endlicheri* | Black Cypress-pine | 0577 |
| *Callitris glaucophylla* | White Cypress-pine | 0576 |
| *Callitris gracilis* | Slender Cypress-pine | 0578 |
| *Callitris oblonga* | Dwarf Cypress-pine | 5365 |
| *Callitris rhomboidea* | Oyster Bay Pine | 0579 |
| *Callitris spp. (naturalised)* | Cypress-pine | 9281 |
| *Casuarina* - ALL SPECIES | SHEOAK | |
| *Codonocarpus cotinifolius* | Bell-fruit Tree | 0792 |
| *Commersonia sp. aff. fraseri* | Blackfellow's Hemp | 0802 |
| *Coprosma repens* | Mirror Bush | 0823 |
| *Coprosma robusta* | Karamu | 0824 |
| *Cornus capitata* | Himalayan Strawberry-tree | 4253 |
| *Correa lawrenceana* | Mountain Correa | 0831 |
| *Corymbia* - ALL SPECIES | GUM - BLOODWOOD | |
| *Crataegus monogyna* | Hawthorn | 0867 |
| *Cupressus* - ALL SPECIES | CYPRESS | |
| *Daviesia laxiflora* | Tall Bitter-pea | 4405 |
| *Dodonaea viscosa 'Purpurea'* | Purple Hop-bush | 5413 |
| *Elaeocarpus holopetalus* | Black Oliveberry | 1136 |
| *Elaeocarpus reticulatus* | Blue Oliveberry | 1137 |
| *Eremophila bignoniiflora* | Bignonia Emu-bush | 1198 |
| *Eremophila longifolia* | Berrigan | 1203 |
| *Eriobotrya japonica* | Loquat | 5295 |
| *Eucalyptus* - ALL SPECIES | EUCALYPT | |

| SCIENTIFIC NAME | COMMON NAME | FIS No. |
|---|---|---|
| *Eucryphia moorei* | Eastern Leatherwood | 1327 |
| *Euonymus europaeus* | Common Spindle Tree | 5943 |
| *Eupomatia laurina* | Bolwarra | 1344 |
| *Exocarpos cupressiformis* | Cherry Ballart | 1350 |
| *Ficus* - ALL SPECIES | FIG | |
| *Fraxinus* - ALL SPECIES | ASH | |
| *Geijera parviflora* | Wilga | 1419 |
| *Geissorhiza aspera* | Wine Cups | 5620 |
| *Grevillea barklyana* | Gully Grevillea | 1529 |
| *Grevillea robusta* | Silky Oak | 7157 |
| *Hakea laurina* | Pincushion Hakea | 5747 |
| *Hakea leucoptera* | Silver Needlewood | 1564 |
| *Hedycarya angustifolia* | Austral Mulberry | 1600 |
| *Ilex aquifolium* | English Holly | 1759 |
| *Lagunaria patersonia* | Pyramid Tree | 5751 |
| *Laurus nobilis* | Bay Laurel | 7480 |
| *Leptospermum grandifolium* | Mountain Tea-tree | 1955 |
| *Leptospermum laevigatum* | Coast Tea-tree | 1957 |
| *Leptospermum lanigerum* | Woolly Tea-tree | 1958 |
| *Leptospermum trinervium* | Paperbark Tea-tree | 1950 |
| *Ligustrum lucidum* | Large-leaf Privet | 2002 |
| *Lomatia fraseri* | Tree Lomatia | 2050 |
| *Malus pumila* | Apple | 2118 |
| *Melaleuca lanceolata* | Moonah | 2150 |
| *Melaleuca linariifolia* | Flax-leaf Paperbark | 7526 |
| *Melaleuca styphelioides* | Prickly Paperbark | 7288 |
| *Melia azedarach* | White Cedar | 5455 |
| *Metrosideros excelsa* | New Zealand Christmas Tree | 7533 |
| *Monotoca glauca* | Currant-wood | 3859 |
| *Myoporum insulare* | Common Boobialla | 2239 |
| *Myoporum laetum* | Ngaio | 5779 |
| *Myoporum montanum* | Waterbush | 2240 |
| *Myoporum platycarpum* | Sugarwood | 2242 |
| *Nematolepis squamea subsp. squamea* | Satinwood | 4814 |
| *Notelaea ligustrina* | Privet Mock-olive | 2280 |
| *Notelaea venosa* | Large Mock-olive | 2282 |
| *Nothofagus cunninghamii* | Myrtle Beech | 2283 |
| *Olea* - ALL SPECIES | OLIVE | |
| *Olearia argophylla* | Musk Daisy-bush | 2299 |
| *Paraserianthes lophantha* | Cape Wattle | 0169 |
| *Paulownia tomentosa* | Paulownia | 5456 |
| *Persoonia arborea* | Tree Geebung | 2459 |
| *Persoonia silvatica* | Forest Geebung | 2469 |
| *Phebalium squamulosum subsp. squamulosum* | Forest Phebalium | 4817 |
| *Philotheca trachyphylla* | Rock Wax-flower | 1227 |
| *Photinia glabra* | Red-leaf Photinia | 5862 |
| *Photinia serratifolia* | Chinese Hawthorn | 5863 |
| *Picea* - ALL SPECIES | SPRUCE | |
| *Pinus* - ALL SPECIES | PINE | |
| *Pittosporum bicolor* | Banyalla | 2540 |
| *Pittosporum crassifolium* | Karo | 3953 |

| SCIENTIFIC NAME | COMMON NAME | FIS No. |
|---|---|---|
| *Pittosporum tenuifolium* | Kohuhu | 5796 |
| *Pittosporum undulatum* | Sweet Pittosporum | 2543 |
| *Podocarpus sp. aff. lawrencei* | Errinundra Plum-pine | 4741 |
| *Polyscias murrayi* | Pencil Cedar | 2642 |
| *Pomaderris apetala subsp. apetala* | Grampians Pomaderris | 2649 |
| *Pomaderris aspera* | Hazel Pomaderris | 2650 |
| *Populus* - ALL SPECIES | POPLAR | |
| *Prostanthera lasianthos* | Victorian Christmas-bush | 2743 |
| *Prostanthera lasianthos var. lasianthos* | Victorian Christmas-bush | 4845 |
| *Prunus cerasifera* | Cherry Plum | 2758 |
| *Prunus cerasus* | Sour Cherry | 5987 |
| *Prunus dulcis* | Almond | 5530 |
| *Prunus laurocerasus* | Cherry Laurel | 2759 |
| *Prunus lusitanica* | Portugal Laurel | 5235 |
| *Prunus X domestica* | Plum | 5759 |
| *Pseudotsuga menziesii* | Douglas Fir | 5711 |
| *Pyrus communis* | Pear | 5201 |
| *Quercus* - ALL SPECIES | OAK | |
| *Rapanea howittiana* | Mutton-wood | 2916 |
| *Robinia pseudoacacia* | Locust Tree | 3967 |
| *Salix* - ALL SPECIES | WILLOW | |
| *Santalum lanceolatum* | Northern Sandalwood | 3005 |
| *Schinus molle* | Pepper Tree | 3027 |
| *Sorbus aucuparia* | Rowan | 5834 |
| *Stenocarpus salignus* | Scrub Beefwood | 7547 |
| *Symplocos thwaitesii* | Buff Hazelwood | 3330 |
| *Telopea oreades* | Gippsland Waratah | 3339 |
| *Trema tomentosa* | Peach-leaf Poison-bush | 3419 |
| *Tristaniopsis laurina* | Kanooka | 3458 |
| *Ulmus* - ALL SPECIES | ELM | |
| *Zieria arborescens* | Stinkwood | 3601 |

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.4

## Assessing Cause of Death

| CODE | Description |
|---|---|
| C | Crushed (smashed) by falling stag |
| D | Drought believed to be main cause of death |
| E | Lightning believed to be main cause of death |
| F | Fire believed to be main cause of death |
| H | Other human causes not associated with logging or treatment |
| I | Insect attack believed to be the main cause of death |
| L | Logged |
| N | Natural Death, eg Competition or Pathogen |
| P | Poisoning |
| R | Ring barked |
| U | Unknown |
| W | Wind or storm damage believed to be main cause of death |

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.5

## Assessing Crown Class

**Table 1: Crown Class codes and descriptions**

| Crown Class | Code | Description |
|---|---|---|
| **Dominant** | **D** | Trees with well developed crowns extending above the general level of the forest canopy. The crown receives full sunlight from above and partly from the sides. |
| **Co-dominant** | **C** | Trees with medium-sized crowns forming the general level of the forest canopy. Each tree crown receives full sunlight from above but very little from the sides. |
| **Intermediate** | **I** | Trees shorter than dominant and co-dominant trees and have small crowns extending into the forest canopy. Each tree receives a little direct light from holes in the canopy and very little light from the sides. |
| **Suppressed** | **S** | Trees with crowns more or less entirely below the forest canopy and receiving very little direct light either from above or from the sides**.** |
| **Emergent** | **E** | Trees with crowns totally above the canopy of the stand and receiving full sunlight from both above and from all sides. |
| **Open grown** | **OG** | Trees not growing near any other tree and with crowns receiving full sunlight from both above and from all sides. |

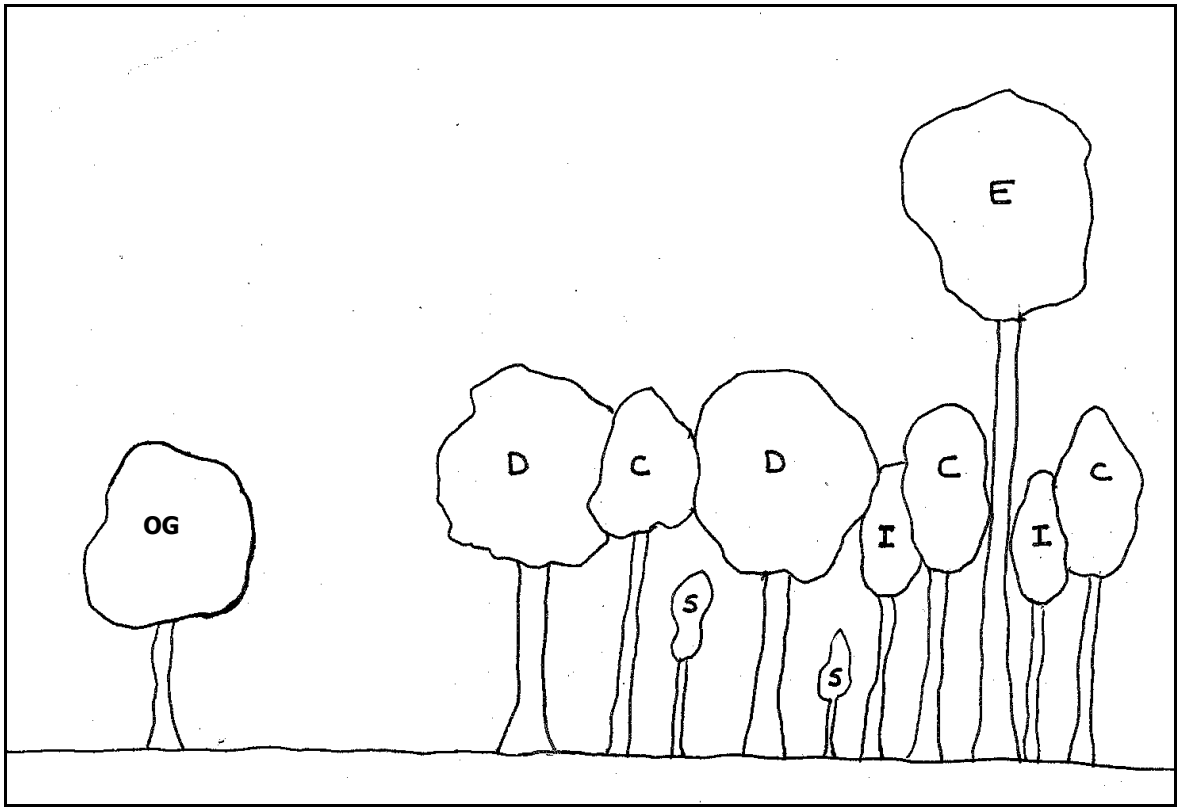


**Figure 1: Crown Class illustration. See Table above for descriptions and key.**

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.6

## Measuring Tree Height

**Procedure for using an electronic hypsometer to measure tree heights**

The hypsometer method eliminates the need to measure surveyor-to-tree horizontal distance. The height function automatically calculates slope angles and total tree height.

Three measurements are taken using the hypsometer to calculate height:

1. Horizontal Surveyor-to-tree Distance: Hypsometers have varying minimum and maximum distances over which they can operate with accuracy. The Impulse 200R operates effectively over a distance of 200m.
2. Base Height: This can either be ground level, if visible or an established base height (if it is an established base height then it must still be added to the total height calculated by the hypsometer).
3. Height to tip: Like a clinometer, hypsometers can only operate with assured accuracy up to an angle of 45° and therefore should still be used at a distance of at least 1 to 1.5 times the height of the tree.

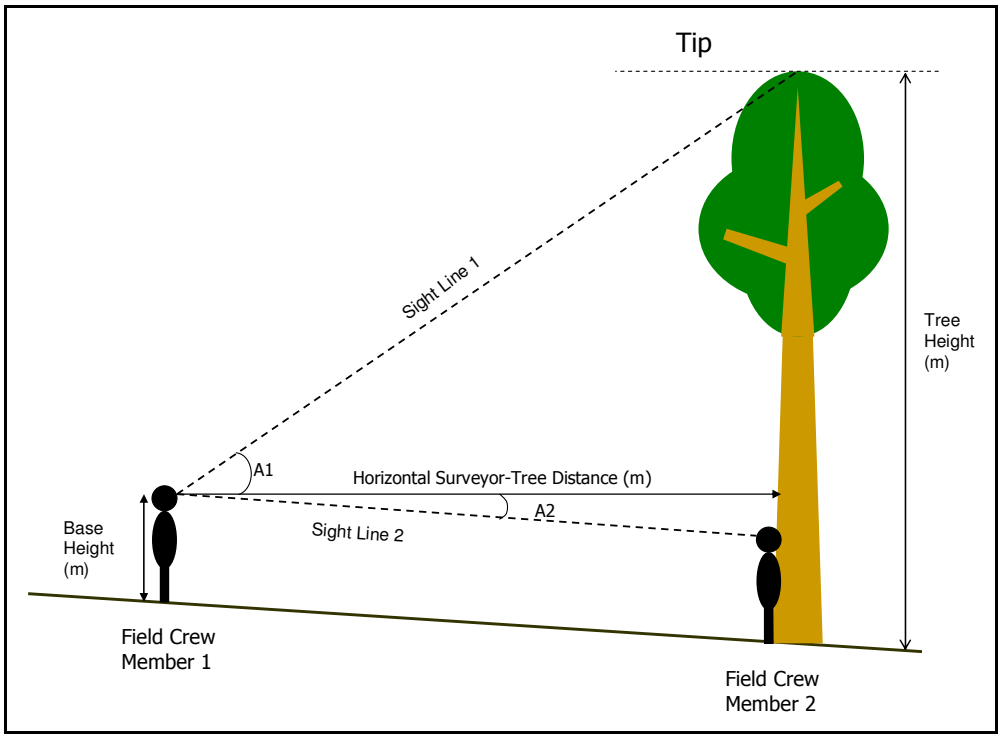


**Figure 1: Trigonometrical principles of tree height measurement.**

$$\text{Tree height} = \left\{ \frac{A1 + |A2|}{100} \times \text{Horizontal Surveyor-Tree Distance} \right\} + \text{Base Height}$$

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.6

## Measuring Tree Height

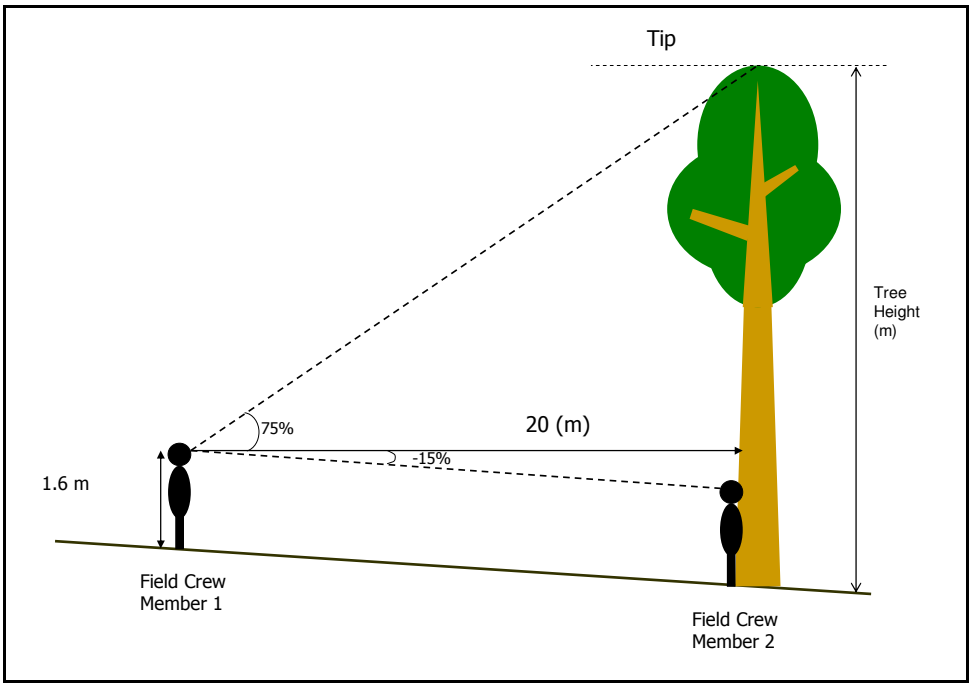


**Figure 2: Example tree height measurement using a hypsometer (illustration not to scale)**

*Horizontal distance (Surveyor to tree): 20m*

*Base height: 1.6m*

*Slope to tree tip: 75%*

*Slope to base height: -15%*

$$\text{Tree Height} = \frac{(75 + 15) \times 20}{100} + 1.6$$

*Tree Height = 19.6 m*

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.6

## Measuring Tree Height

**Procedure for using clinometer to measure tree heights**

A clinometer is used to simplify the trigonometric principles by converting the angle from the observer to the top of the tree at a known distance directly to a height scale shown on the instrument. Clinometers use 2 different height scale options: slope degrees and slope percent. The percent scale is used as an example in this procedure.

Height measurements taken by clinometer should be taken across the slope, where practicable, to reduce the sighting angle (angles greater than 45° or 100% will be inaccurate) and the need for slope corrections.

The procedure for using a clinometer is as follows:

1. Measure horizontal distance. The distance from the tree at which a clinometer measurement should be taken will depend upon the height of the tree. The distance should be in the region of 1 to 1.5 times the height of the tree. This distance is measured from a point perpendicular to the tip of the tree, whether this is from the centre of the tree bole on a straight standing tree or slightly away from the tree bole on a leaning tree. A 30m tape is held at a height that is approximately level with the measurer's eye. The tape is pulled and held to the measurer's eye in order to gauge the precise distance at which the clinometer should be held.

2. Looking through the clinometer eyepiece with both eyes open, sight to the top of the tree (or to green height, Top Point etc) and read the percentage angle (slope A1) through the eyepiece. The slope % to the top of the tree will be a positive figure (greater than zero on the clinometer) because this angle is above the horizontal plane.

3. Tilting the clinometer without significantly altering the height at which the instrument is held, or the distance from the tree, sight to a known base height. This base height may be the base of the tree bole, if visible, or a pre-determined visible height such as tag height (1.6m) or a point on a height staff or field crew member. (If the base height is not taken at the base of the tree bole, the base height must be added to get the final height measurement). Read the percentage angle (slope A2) through the eyepiece. The slope % for the base height may be a negative figure (below zero on the clinometer) if it is measured below the horizontal plane. Convert Angle A2 to a positive number before calculating tree height.

4. Measure the horizontal distance between field crew member and the tree

**Method 1: Using a fibreglass tape to measure horizontal distance**
Two people are required in order to use a tape effectively, with one person holding at each end. The tape must be held to the tree bole at a height that is approximately level with the eye of the measurer. The distance is taken from the tree bole to the point at which the clinometer will be held ie. the measurer's eye. The tape must be pulled taut to reduce 'sag' and be free of entanglements and obstructions which may affect the accuracy of the measured distance. Slope corrections are required where the measurement is taken over a slope greater than 5°.

**Method 2: Using a hypsometer to measure horizontal distance.**
A clear line of sight is required to avoid the risk of the laser beam or ultrasonic wave 'hitting' an object that is closer to the measurer than the targeted tree bole. Laser hypsometers should *not be used in the rain* or mist due to the risk of the beam being deflected.

Department of Sustainability and Environment

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.7

## Measuring Canopy Cover

### Procedure for using a spherical crown densiometer:

In the example illustrated (Figure 1), the best method for measuring Canopy Cover is to conduct a Sky Count, i.e. count the proportion of densiometer 'virtual' squares occupied mostly by sky.

There are around 26 out of 96 'virtual' squares dominated by sky (denoted by an 'X'). Sky Count = 26.

This is equivalent to (96 – 26) = 70 squares dominated by canopy. Canopy Count = 70.

The sum of Sky and Canopy counts must always equal 96.

Note that dense foliage is treated as if it were solid.

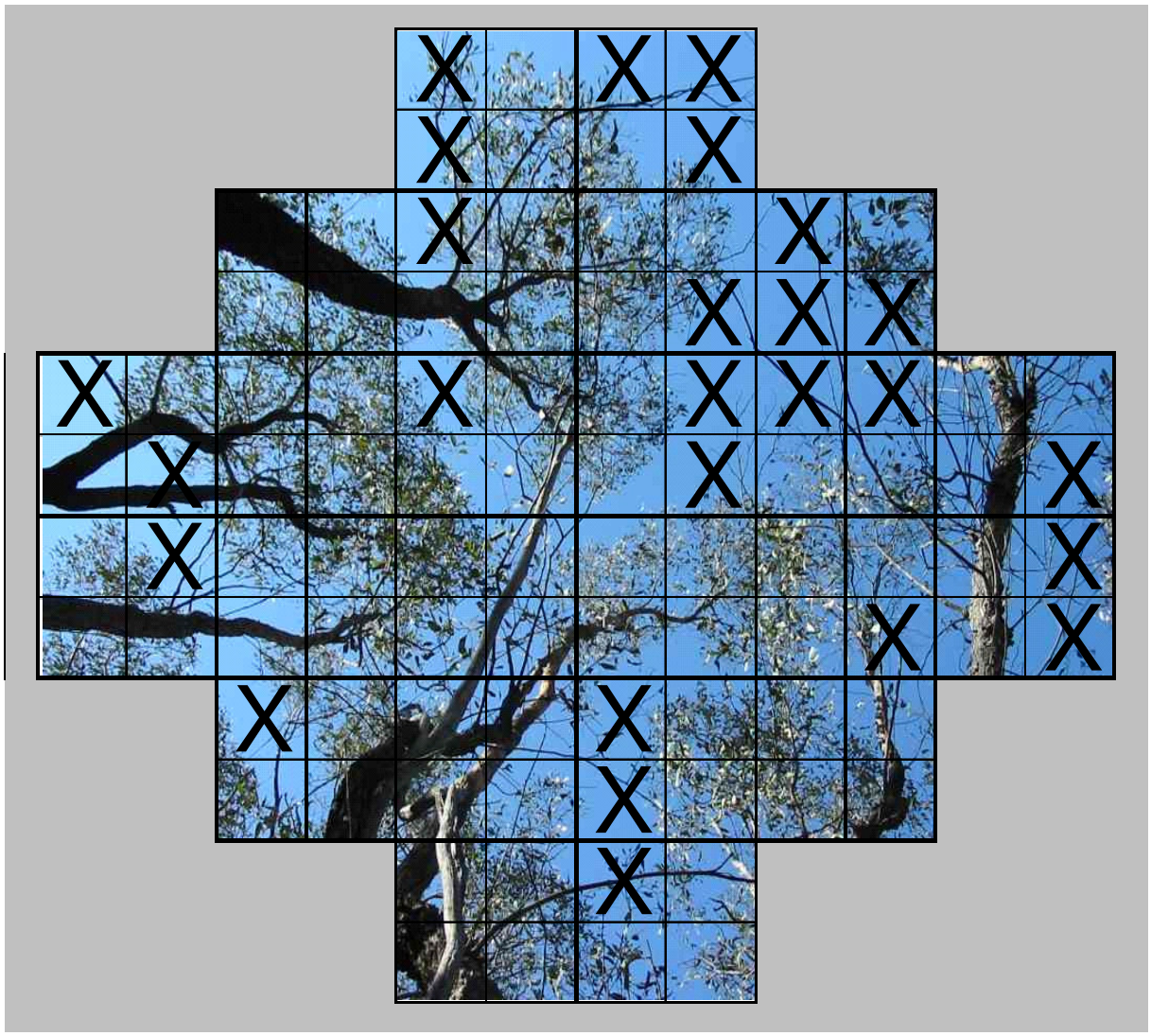

**Figure 1: Forest canopy view as shown in a spherical crown densiometer**

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.8

## Assessing Tree Canopy Health

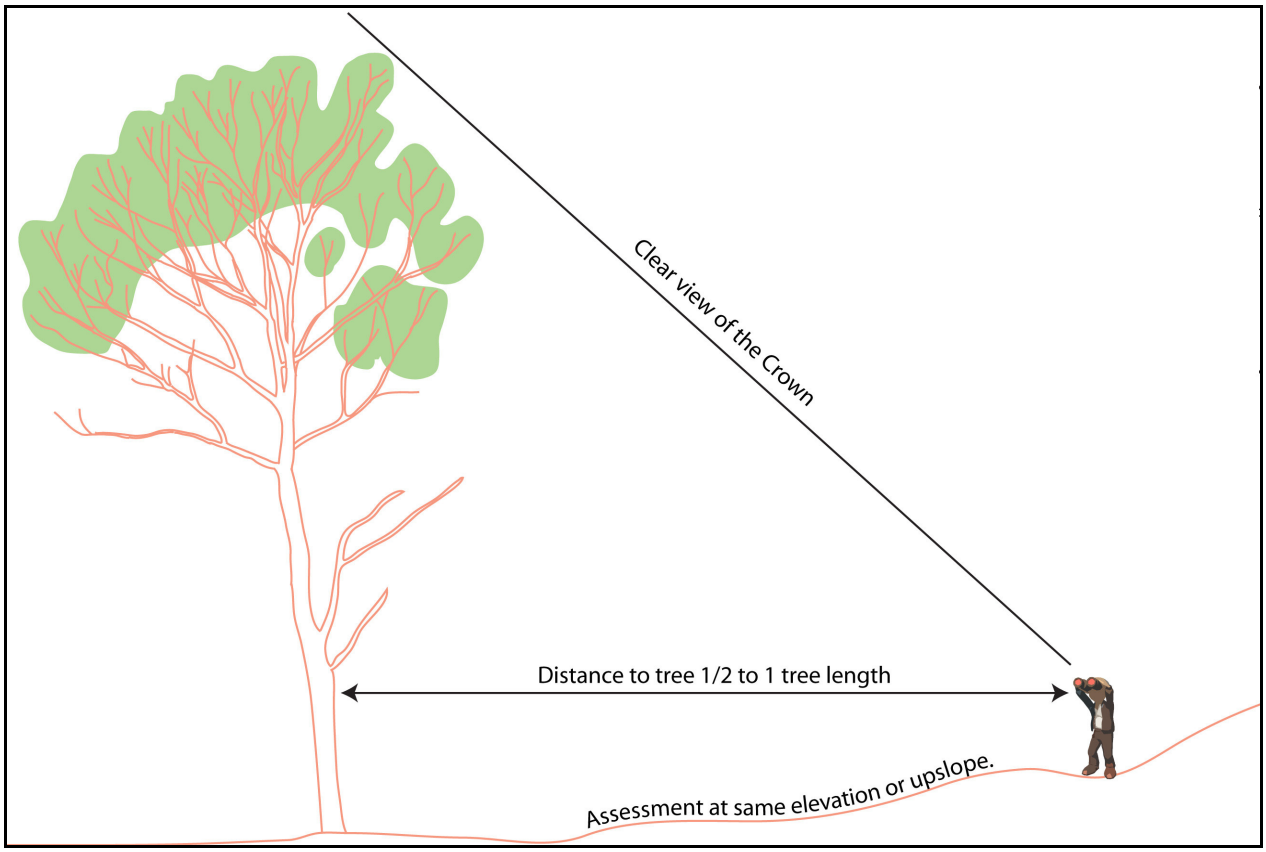


**Figure 1: Direction, distance and view of the crown when undertaking assessments of tree canopy health.**

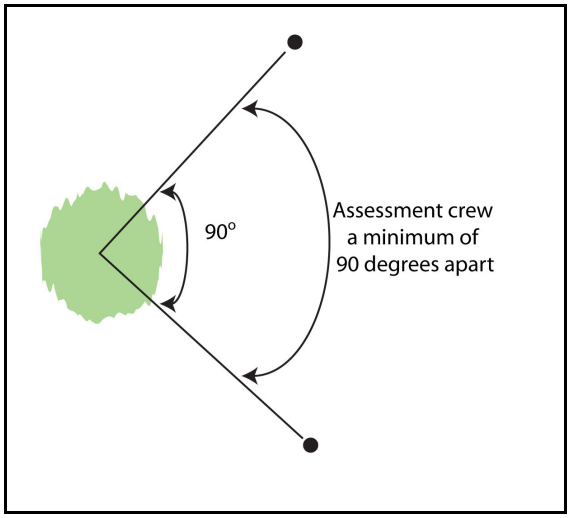


**Figure 2: Minimum angle between observations when undertaking assessments of tree canopy health.**

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.8

## Assessing Tree Canopy Health

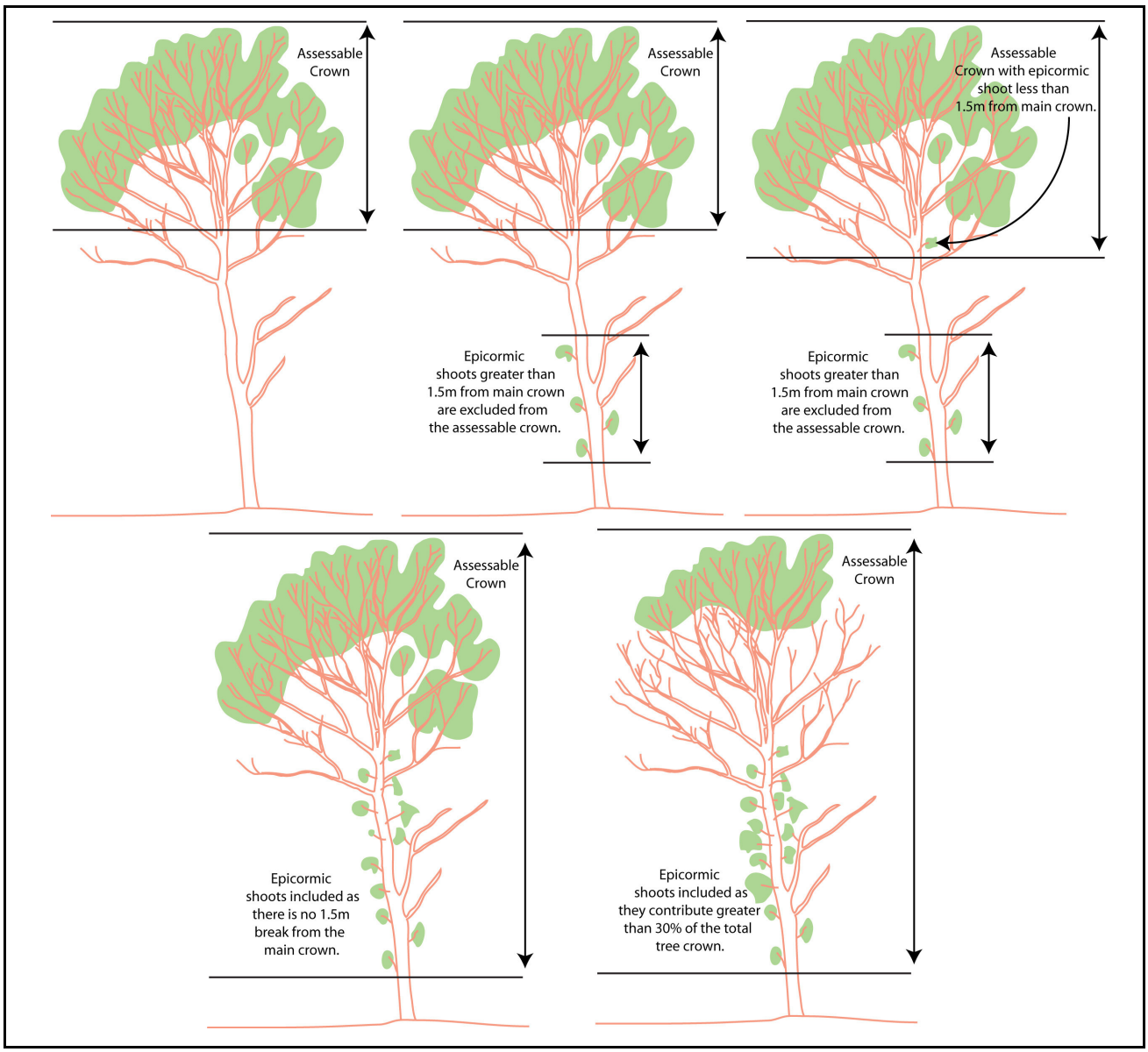


**Figure 3: Location and definition of the assessable crown and epicormic shoots when undertaking assessments of tree canopy health.**

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.8

## Assessing Tree Canopy Health

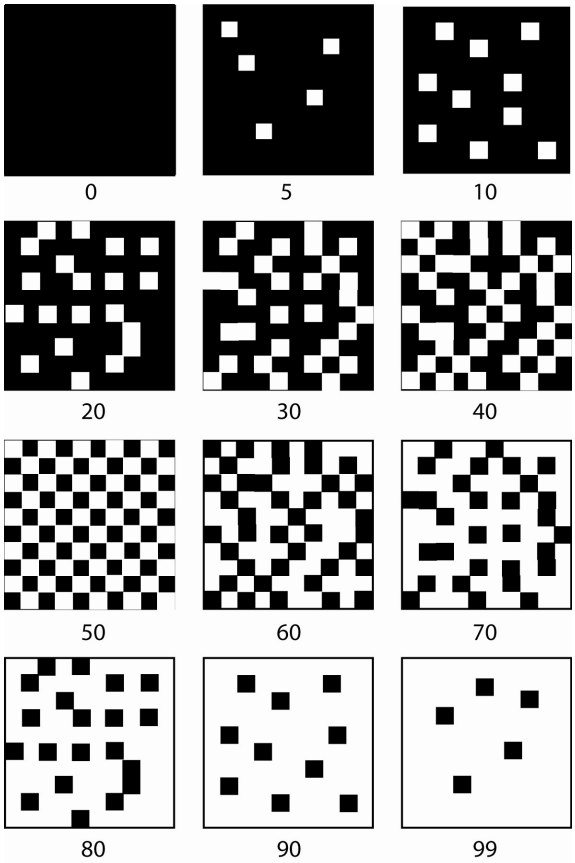


**Figure 4: Crown density and crown defoliation scale card used to assess canopy health.**

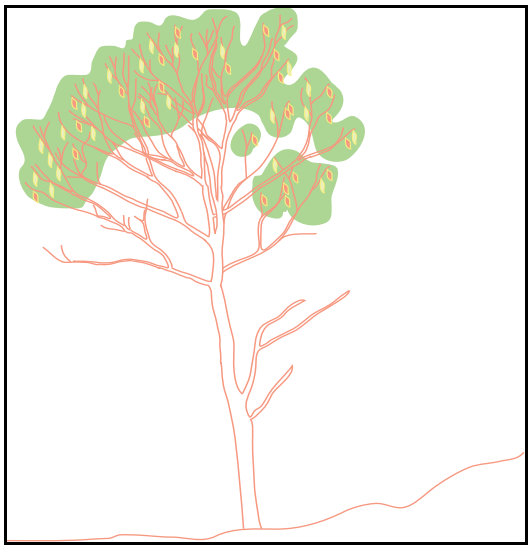

**Figure 5: Discolouration that can be observed within the crowns.**

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.8

## Assessing Tree Canopy Health

**Table 1: Five-point scale describing crown clumping.**

| Clumping Class | Code | Description |
|---|---|---|
| Very sparse | 1 | Very few leaves anywhere in crown |
| Sparse | 2 | Clumps are sparse and poorly spread |
| Moderate | 3 | Clumps of average density with reasonable distribution or dense clumps very unevenly spread |
| Dense | 4 | Dense leaf clumps distributed unevenly over the crown |
| Very Dense | 5 | Very dense leaf clumps with even distribution of clumps over the crown with very little light penetrating the leaf clumps. |

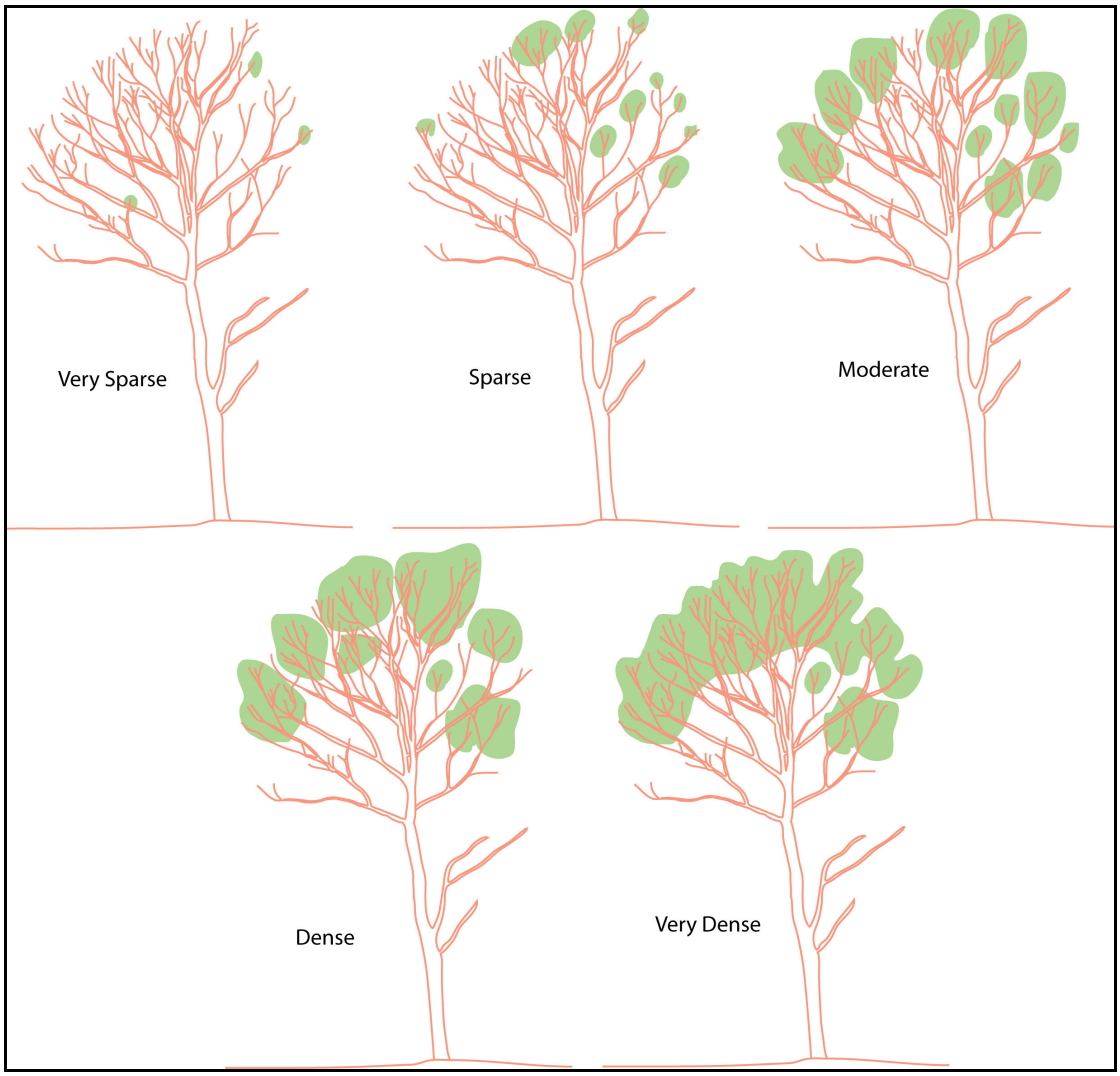


**Figure 6: Diagrams describing the five point crown clumping scale.**

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.8

## Assessing Tree Canopy Health

**Table 2: Six-point scale describing crown position.**

| Code | Description |
|---|---|
| 1 | crown significantly affected (shading or physical interactions) on one side |
| 2 | crown significantly affected (shading or physical interactions) on two sides |
| 3 | crown significantly affected (shading or physical interactions) on three sides |
| 4 | crown significantly affected (shading or physical interactions) on four or more sides |
| 5 | crown open-grown or with no evidence of shading effects |
| 6 | intermediate, suppressed or shade tolerant trees |

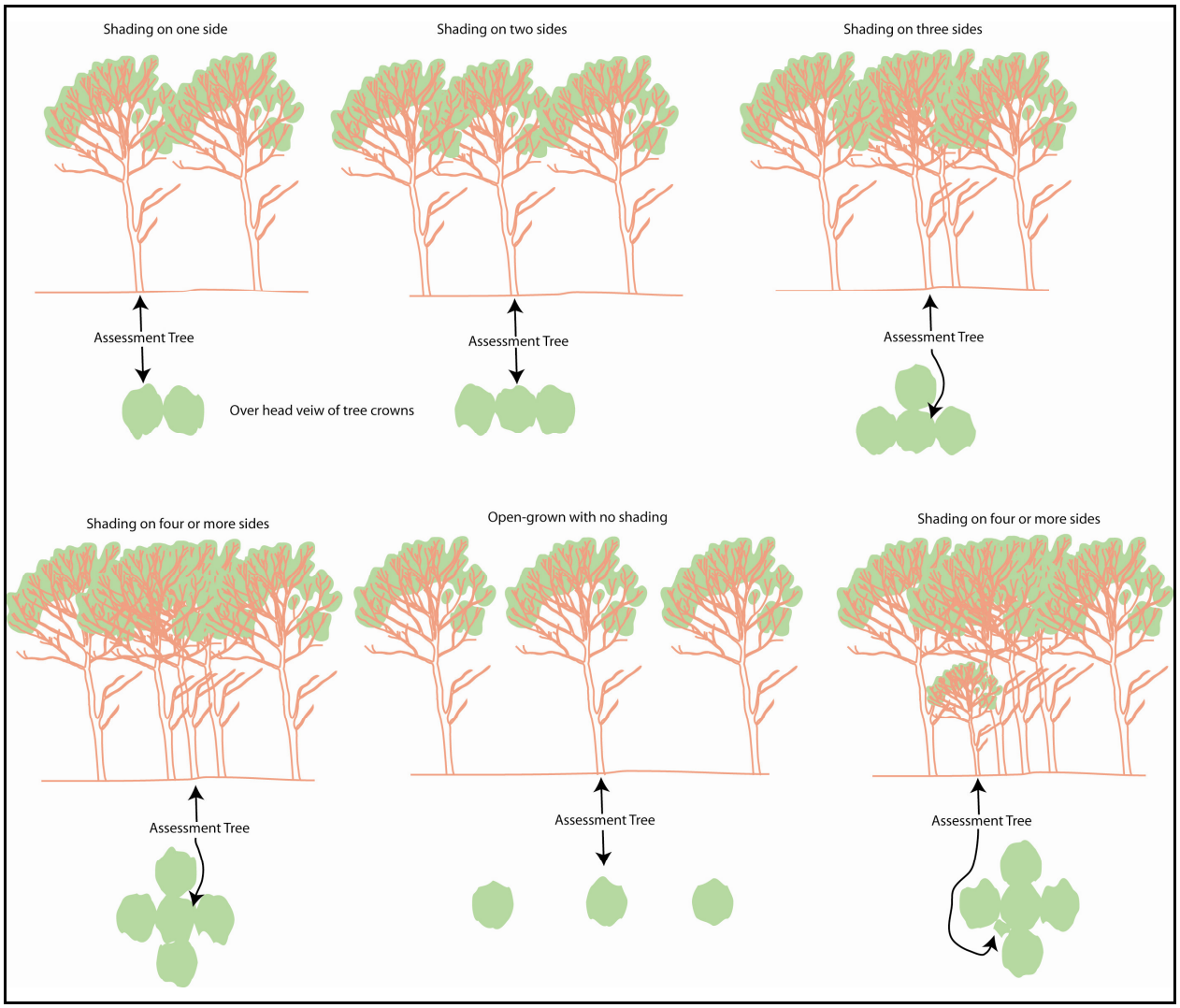


**Figure 7: Tree Crown Position within a forest stand and the influence of surrounding canopy shading and physical interaction to the assessment tree.**

# Standard Operating Procedure 13
# Measuring a Large Tree Plot
# Appendix 13.9

## Forked Tree Illustrations

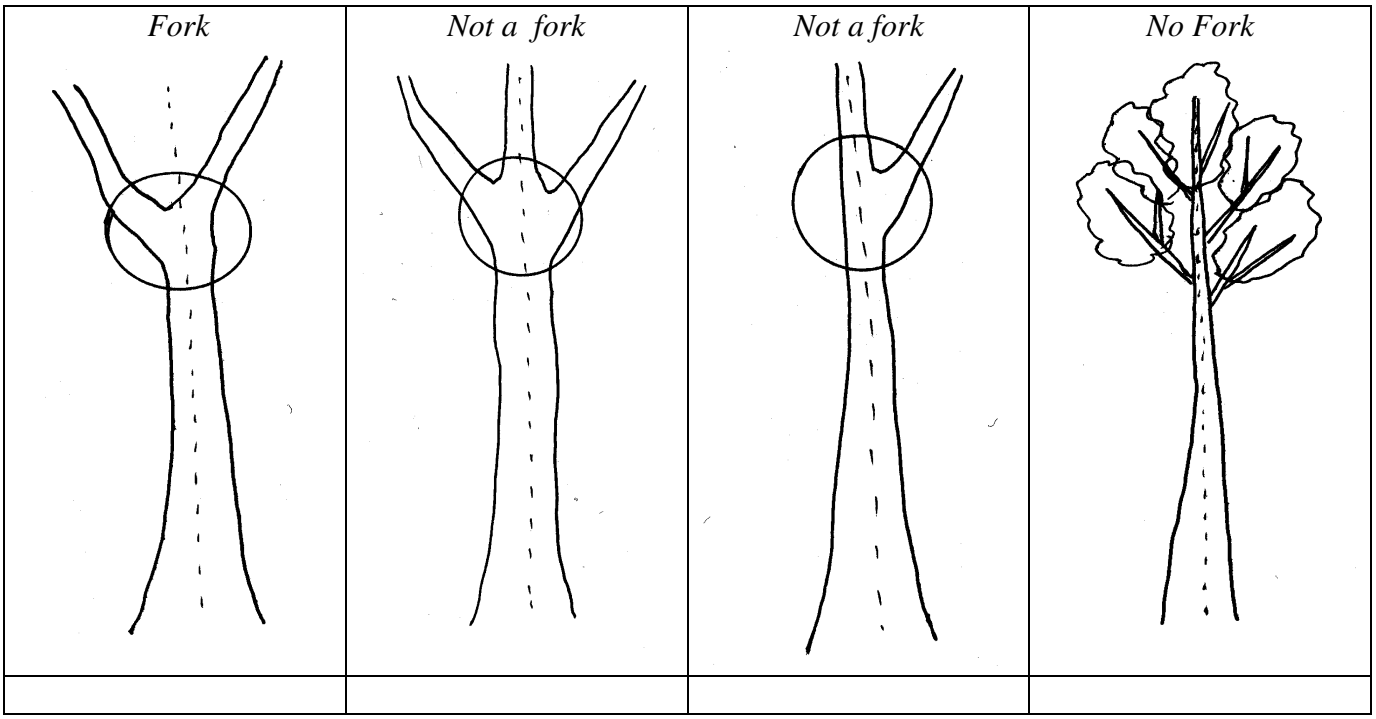


**Figure 8: Examples of what constitutes a forked tree**