Tools used in Forest Surveys

3.0 Describe the various tools and their common use in forest surveying.

3.1 Describe DBH and its rationale in forestry.

The most common measurement taken on a standing tree is its diameter at breast height (DBH). This location on a tree is a world-wide standard and is 1.3m above the mean ground level (or uphill side) of a tree. If a tree is forked below BH, then we treat it as two trees – in some cases measuring at 1.3m above the ground or other cases measuring 1.3m above the fork (depending on the agency involved). If the tree is forked above BH, we treat its measurement as one tree. DBH is taken as the norm of 1.3m above the mean ground level because it:

a) Eliminates the effect of "butt swell" from trees with large crowns
b) Eliminates some effect of taper on a tree
c) Is a convenient, less-fatiguing location to measure trees – as compared to stump diameter

Some other rules to follow when measuring DBH on a tree are:

1) Limbs, bulges, etc. – take measurement above the mark
   Why? (we don't want to exaggerate the measurements)
2) Tree on slope – measure from the up-slope side
3) Leaning tree – measure from the up-slope side
4) Snow on ground – use stick to locate DBH

3.2 Identify the various types of tools used in measuring diameters.

The parameter most commonly measured in forest inventory is diameter. A diameter is a straight line passing through the centre of a circle or sphere and meeting at each end of the circumference surface. Dendrometer is the name given to any instrument used to measure tree diameter. There are a variety of tools available that act as a dendrometer such as:

a) Caliper

b) D-tape

c) go – no – go d) Finnish tree fork e) Biltmore stick f) Carpenter's tape
g) Spiegel relaskop h) lazer devices

Our discussions will focus mainly on the caliper and the D-tape.

Recording of Diameters

Diameters can be measured and recorded in

a) Decimal centimetres or inches (0.1cm, 0.1in) – fairly precise measurement
b) Whole centimetres or inches (1cm, 1in) – relative to precision sought
c) Larger classes/intervals (2cm, 2in) – less precision required

Usually a tally form when diameters are recorded as in b) and c)

Diameters are commonly measured as opposed to radii to smooth over the different deformities associated with tree radius. Recall that radius x 2 = diameter.

NOTE: Diameters are measured and recorded in either centimeters or inches. Although their resultant use is for volume in either m^3 or ft^3.

The most common diameter measurements required in forestry:

1) Main stem – standing tree
2) Branches of standing tree – not common in our part of the world
3) Cut portions – scaling

* Diameter is the most important measurement in both standing and felled trees. Errors made are very serious. As an example a tree is 10cm at dbh, is measured as 9cm dbh and recorded at 9cm. The following errors result: DBH – if off by 10%, could result in errors of:

Basal Area (area at the diameter) – 18.9% difference

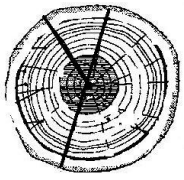
Volume – 23.1% difference

The terms precision and accuracy have been used extensively and they may need clarification. The term precision means how small or fine the measurements are, ie are they 1mm or 1cm or 10cm or 100m. For example, if a tool has graduations (markings indicating measurements) that are 5 graduations for 1cm, then each graduation is 2mm – meaning it is precise to 2mm or 0.2cm or 0.002m. Compare this to an odeometer on a Canadian car that measures to 0.1km (or 100m). The odeometer is not as precise as the previous tool.

Accuracy means how close the measurement is to the true value. In the case of calipers versus D-tapes, the D-tape will always overestimate the diameter when compared to the caliper. This means that the caliper is more accurate than the D-tape.

Some calipers measure to 1cm only meaning that they are not as precise as the D-tape, but they are more accurate than the D-tape.

B



A is approximately equal to B in this diagram meaning the radii could be different if measured from different points around this tree. A + B = diameter and would be very close to diameter measurement.

A

Tools for Measuring Diameters

1) <u>Calipers</u>

- A caliper is a dendrometer that has basically three components
    1. Fixed arm
    2. Sliding arm
    3. Scale
- The caliper is a very accurate instrument for measuring tree diameter, especially when the cruiser employs 2 caliper measurements (at right angles) to trees with abnormal or defective diameters
- The caliper has proven very useful when the range of tree diameter is 45cm (18in) or less. Any larger diameter requires larger calipers and makes it impractical in many applications.
- Calipers can be as precise as 0.1cm (0.1in) but more frequently exist at 0.5 cm or 0.5in (also 1cm/1in) level of precision. When calipers are used for recording actual measurements, they are generally calibrated to 3 different levels of precision (0.1cm, 0.5cm, 1.0cm, same for Imperial inches) and have the fixed arm as the 0.0 on the scale, (which is different than the one presented in the diagram below.
- Calipers can be designed for tree diameters that are tallied by classes or actual measurement, dependent upon the user's wishes.
- A lot of calipers are designed for the recording or tallying of diameters by classes, usually 2cm classes and they could be on the even or odd numbers (more commonly even). The recording by classes reduces the precision but allows for quicker measurements with little interpretation of the caliper scale by the cruiser. Calipers so designed may have the fixed arm without a "zero" at the scale start and use 2cm classes only.

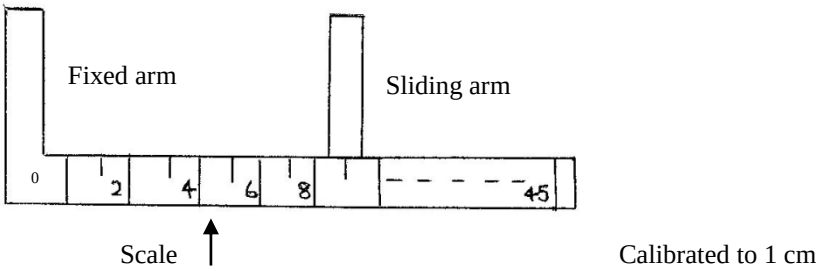
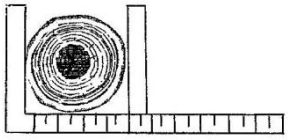


Figure 2. Caliper calibrated to 1cm class

Use of Calipers



- Use at right angles to the tree with scale touching the tree

- Avoid using the tips of the arm extremities because it will damage the arms over time.
- Ensure that the caliper is perpendicular to the tree; if it's anything but perpendicular then the reading will be higher.
- Two measurements should be taken if tree circumference is anything but circular.
- Calipers should be wiped with a solvent oil and a rag at the end of every day to prevent a build-up of resin and prevention of rust – ensuring that the sliding arm will continue to slide.
- Read the caliper at the point where the sliding arm touches the scale.
- Say aloud the reading to the Notekeeper. Most calipers are designed for tallying, so there may have to be some interpretation of the measurement(s) to put it into classes for tallying purposes.


Tally Methods

- When averaging two caliper readings, employ the odds go up/evens stay the same rule:

i.e. $\frac{(17\text{cm} + 18\text{cm})}{2} = 17.5 \rightarrow 18\text{cm}$ (odds go up) $\frac{(16\text{cm} + 17\text{cm})}{2} = 16.5 \rightarrow 16\text{cm}$ (evens stay the same)

The rationale for the "odds go up and evens stay the same rule" is that with traditional rounding, when an average landed on a 0.5, then we would always round up – always over-estimating. With this "odds go up/evens stay the same", it balances itself out a lot better.

2) Diameter Tape (D-tape)

- The D-tape is a tape designed to measure the circumference of a tree but return its circumference to the cruiser as a diameter. This is done by dividing the circumference by π for the cruiser. Almost all D-tapes would have the circumference measurement on one side and the diameter measurement on the other side of the tape. Note: when reading the diameter side of the tape 1.0cm actually measures 3.14 cm and has smaller size graduations.

- Because of its past level of precision (0.1cm), the D-tape has often been used for cruising, especially in areas where the run of diameters are larger (than say, 45 cm) and prohibits the carrying of calipers.
- One downside of the D-tape is that it almost always overestimates the diameter.

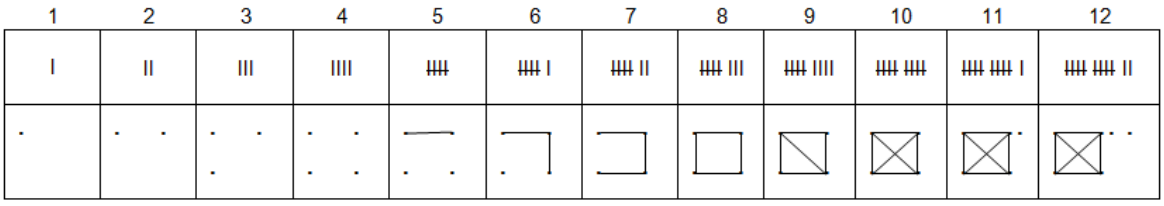
Use of D-tape

- Wrap tape around tree at BH or ascribed location
- Overlap such that "0" end crosses the tape
- Ensure tape is not wrapped below or above the ascribed location
- Try not to measure at branch stubs, burls or any abnormalities where possible
- Read the tape to 0.1cm

Note: think about the D-tape this way: if you took three diameter measurements at the same location on a tree, the lowest measurement is probably the closest to the actual diameter measurement.

Tallying Methods

There are two systems of recording a tally (or tallying) and these are known as the mill tally and the dot-dash tally method. Where trees are to be tallied (counted by class/size, etc), the standard system is to use the dot-dash method rather than the mill tally stroke. This allows for a greater number of entries per unit of tally space. This dot-dash tally method is very beneficial in times of high counts required such as a regeneration survey, or a down, woody debris survey. The diagram below reveals the mill tally (top), with the dot-dash tally below; with each tally system showing its numeral value on top. Mistakes are usually indicated by circling the tally miscounted, as seen in the diagram below the tally system illustration. Errors are never erased.



The circled dot represents an error made – this reads as eleven.

3.3 Describe Height measurement as it relates to forestry surveys

Tree Height – the height of a standing tree is the distance from the mean ground level to the tip of the tree measured along the axis of the tree. The usual abbreviation for tree height is H.

Unit of measurement was 1ft. (0.1ft) now is metres (0.1m)

Importance of Tree Heights

- Volume calculation or estimation
- Forest classification

Uses of Tree Height Measurement

1) To determine tree volumes

2) To give the basis for height-diameter curves
3) To determine site index – measure of site - capacity to grow trees
4) To prepare tree volume tables

Types of Height Measurement

Stem types

a) Excurrent (conifers) – trees which have the axis prolonged to form an undivided stem
   ─ total height is a good index of volume
b) Deliquescent (hardwoods) – trees with central stem divided in their lower portion due to branching
   - here merchantable height is what's commonly measured because that's the part mostly used.

As a general rule, we distinguish between height and length as when the tree is standing, we call it height, and when a tree is felled and on the ground we call it length. We also call a portion of a tree a length (as can be seen in the terms below), which means we use the term height for an entire standing tree.

Height – distance between stump and the top of tree, measured along the axis of the tree
Clear Length – the portion of the stem of a tree free from limbs from the ground to the lowest branches or branch stub

Merchantable Length – the length of a tree stem from the top of the stump to the end of the last merchantable section.
Live crown length – the portion of a tree covered with live, green branches

Instruments Used for Measuring Height and Length

Hypsometer – all insturments used for measuring tree height are called hypsometers

Most hypsometers are based on trigonometric principles – even the lazer hypsometers that are gaining lots of use today. The most common hypsometer in use today, other than the lazer types are the Suunto model. These are fairly inexpensive, about 1/20 the price of a lazer hypsometer. We will discuss the use of a Suunto here.

The Suunto consists of a viewing hole, an internal rotating drum with a scale(s), a horizontal bar line, and a string attached to carry it around your neck. The viewing hole is very small and designed to be viewed with only one eye, while the other eye looks at the desired height to be measured. The horizontal bar line is what is crossing the scale (to be read) and the desired height to be measured – this is why both eyes must be open at all times. The scales that are available for most Suuntos are: 1:15, 1:20, 1:66, and 1:100 or % scale. The drum rotates freely with a vertical movement.

Use of Instruments

1) Observer stands away from a tree and takes a reading at the base or some convenient height
2) From the same position the observer takes a reading at the tip of the tree
3) Depending on the position of the observer in relationship to the base of the tree will depend on whether the readings are added together or subtracted

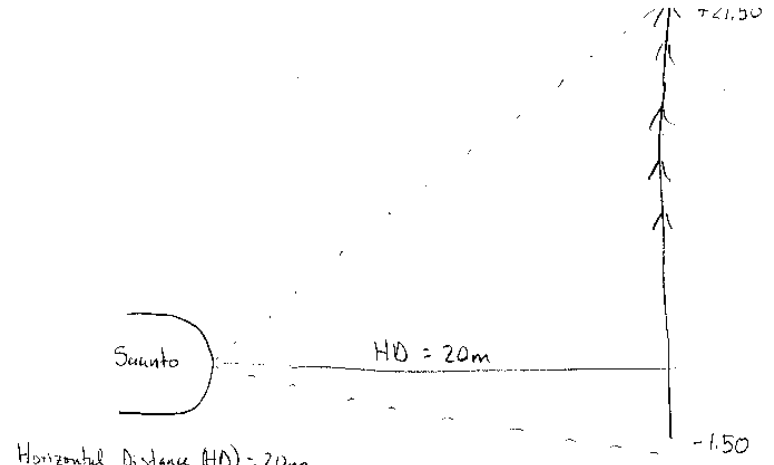

Remarks about Hypsometer

1) The base of the image and the top must be visible (clearly).
2) If snow is present and stump is not visible take reading to snow line. Measure snow depth and add to get total height. Another option is to shoot at BH and add 1.3m.
3) Always keep both eyes open.
4) Try to be at same elevation as the base of tree.
5) Leaning trees should be measured at about right angles to the lean.
6) Usually best to take two readings to verify it. Always use the second.
7) Measure horizontal distance very carefully. Pull tape tight from tree to chest of observer.
8) Keep eyes and hypsometer at same level for both shots.

Formula for using clinometers:

$$H = \frac{NR \times HD}{SU} + (1.3m)^*$$

where H = height of tree
NR = Net reading (obtained from instrument)
HD = Horizontal distance (from tree)
SU = Scale used
* = 1.3m or some other height if the bottom of tree can't be seen



Horizontal Distance (HD) = 20m
Scale used 1:20

Net Reading (add unlike signs)

= -1.50 +21.50

= 23.00

$H = \frac{NR \times HD}{SU}$ (+1.3m) → *Note that this is not required because the whole tree was measured.

$H = \frac{23.00 \times 20m}{20}$

H = 23.0m

3.4 Determining age of trees

There are relatively few ways to determine the age of a tree. In our climate, a growing season is followed by a dormant season, thus making it quite easy to age some trees species. Trees from the tropics are difficult to age because of the continual growth.

A simple way to age a young conifer is to count the whorls (cluster of branches) which represents one year's growth. Another way to age a tree is to cut down the tree and count the rings as they appear on the stump or the cut section.

Another method of tree-aging is to use an increment borer - which is composed of three components: handle, borer, extractor (or spoon).

An increment borer is a non-destructive method of sampling. An increment borer can age a tree at any point on the tree – but that would reveal the age at that point on the tree. Observe the diagram below about how a tree adds on layers of growth each year. Also note from the diagram that as you go up the tree, there are less annual rings showing that the tree is younger at the higher points on a tree. Worthy of note here is that a tree grows from the top upwards, and not by growing out of the ground. This means that if you put a nail at BH on a tree and came back in three years time, (while the tree grew 1m in height), that nail would remain at BH for the life of that tree. The most common location of age determination is at stump height or breast height (BH) – with stump height being older. Oftentimes, a correlation is found to accommodate for the age difference between stump height and BH in a local area for a given species. For example, if jack pine in a certain area had several trees bored at stump height and breast height and found that the average difference was 10 years younger at BH, then we could age at breast height and add 10 years to get stump age (actual age) for that area.

How to use the Increment Borer

1. Take apart the three components of the Increment Borer
2. Place the borer into the handle via the end opposite the threaded, boring end.
3. Lock the borer into place, with a locking clip → the instrument now resembles a "T"
4. Place the instrument against the tree at the desired boring location.
5. Estimate the distance to the center of the tree using the borer.
6. Push the borer against the tree, while turning in a clockwise direction.
7. Bore into the tree until you have reached halfway (the pith or center).
8. Insert the extractor into the borer, concave side up. This could require a bit of effort.
9. With the extractor all the way in turn the handle in a "counter-clockwise" direction for 360^0; this should break/snap off the core sample from the tree.
10. Withdraw the core sample from the tree, while keeping your hand underneath the sample to allow for separation of the sample.
11. Prepare the core sample for immediate counting or for counting at a later date.
12. Assemble the unit – ensuring the borer is clean of wood.

Tips for use of increment borer

1. Borer should be sharp as this helps to enter the tree and makes the counting easier.

2. Frozen wood can be difficult to bore.
3. Try to maintain a consistent pressure when boring.
4. The teeth at the end of the extractor help to hold the wood for it to snap off
5. An organized, labeling system for counting at a later date can save a lot of headaches.
6. When age is the only item of concern, boring at an angle can make counting easier.
7. Older trees with butt rot will be best bored at BH or higher.
8. Look for external indicators of rot prior to boring – may save some time.
9. Try to avoid "flag-staff" trees as these are good indicators of compressed wood and tension wood.
10. Select trees that are primarily healthy, have a large crown, and the crown is in the uppermost tree canopy.