## Measurement of Tree Basal Area \& Volume



## FOR 1001



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## Today's Objectives

$\square \quad$ Tree $\rightarrow$ Stand $\rightarrow$ Forest
$\square$ Basic geometric calculations

- Measurement of tree diameter
- Measurement of tree height
- Determination of:
- basal area
- volume
- biomass \& carbon
- \$ value


## Tree Basal Area

## What?

$\square \quad$ Simply the cross-sectional area of a tree stem measured at breast height (1.4m)


## Tree Basal Area

## Why?

- Basal area closely relates to volume
- Easy to measure \& calculate
- Useful measure of site occupancy
- Useful to forecast future development of stand


## Tree Basal Area

## How? $\quad$ Area of a circle

$$
\text { Area }=\mathrm{pi}^{*}(\text { radius })^{2}
$$

$\square \quad$ Diameter is twice the radius

```
Radius = diameter / 2
```

- Area of circle in terms of diameter is

$$
\text { area }=\mathrm{pi}{ }^{*}(\text { diameter } / 2)^{2}
$$

$$
\text { area }=\text { pi * diameter² / } 4
$$

## Tree Basal Area

## How? a Convert diameter of a circle to area of a circle

$$
\text { area }=\mathrm{pi}^{*} \text { diameter }{ }^{2} / 4
$$

$$
\text { Basal area }=\mathrm{pi}{ }^{*}(\mathrm{DBH})^{2} / 4
$$

- But DBH is usually in cm \& basal area is usually expressed in square metres
- 10000 cm per square metre

Basal area $=\mathrm{pi}$ * (DBH) $)^{2} /(4 * 10000)$

Basal area $=$ pi $^{*}$ DBH $^{2} / 40000$
Where: basal area in in $\mathrm{m}^{2}$ DBH is in cm

## Tree Basal Area

## How?

- Forestry naming \& unit convention
Basal area denoted by "BA"

$$
\text { Basal area = in } \mathrm{m}^{2}
$$

Diameter at breast height $=$ DBH in $\mathbf{c m}$

- Final form for basal area calculation

$$
\mathrm{BA}_{\left(\mathrm{m}^{2}\right)}=\mathrm{pi}^{*} \mathrm{DBH}_{(\mathrm{cm})}{ }^{2} / 40000
$$

## Tree Volume Calculation

## What?

- Volumetric content of tree

- Volume of different portions of tree (know which one you are talking about)
- Total volume (main stem from ground to tip)
- Merchantable volume (main stem excluding stump and tip defined to a minimum diameter)


## Tree Volume Calculation

## What?



## Total <br> volume <br> Merchantable volume

Tip

Stump

## Tree Volume Calculation

## Why?

- Product content and tree value are directly related to tree volume
- Carbon and biomass are directly related to tree volume


## Tree Volume Calculation

## How?

$\square$ Water displacement

- Geometry of solid shape approximating tree stem shape
- Cut stem into sections, measure \& sum


Either physically cut or measure sections on uncut stem

## Tree Volume Calculation

## How? $\quad$ Geometry of solid shape approximating tree stem shape

$$
\mathbf{g}=\text { cross sectional area of base; } \mathbf{h}=\text { height; } \mathbf{v}=\text { volume }
$$



## Tree Volume Calculation

## How?

- Tree form a mix of all these shapes
- Shape changes along tree stem
- So we calculate the form factor using stem analysis



## Tree Volume Calculation

## How? a Section tree (either cut or mark)

$\square$ Measure each section to calculate volume


- Sum all sections to obtain tree total
- Perform for many trees across range of sizes


## Tree Volume Calculation

How? $\quad$ Relationship varies somewhat by tree, region and treatment

- E.g. for Noonan (Kershaw)

$$
\mathrm{V}=0.42 * B A * H
$$

- Where: V = tree volume (m3) BA = tree basal area (m2)
H = tree height ( m )
- Sometimes more complex equations are developed

$$
V=D^{a} *\left[H^{2} /(H-1.4)\right]^{b} * e^{c}
$$

## Tree Volume Calculation

How? $\quad$ Sometimes tables are constructed that list volume by DBH \& height

|  | DBH | Spruce |  | Fir |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Height | Volume | Height | Volume |
|  | Class | (m) | ( $\mathrm{m}^{\wedge} 3$ ) | (m) | (m^3) |
|  | 2 | 2.2 | 0.000 | 2.0 | 0.000 |
|  | 4 | 4.2 | 0.003 | 3.9 | 0.003 |
|  | 6 | 6.0 | 0.009 | 5.6 | 0.008 |
|  | 8 | 7.6 | 0.020 | 7.2 | 0.019 |
| rime | 10 | 9.1 | 0.037 | 8.6 | 0.034 |
| a 100 | 12 | 10.5 | 0.060 | 10.0 | 0.055 |
| aled ales | 14 | 11.8 | 0.090 | 11.2 | 0.082 |
| ca rab | 16 | 12.9 | 0.128 | 12.4 | 0.116 |
|  | 18 | 14.0 | 0.173 | 13.4 | 0.156 |
|  | 20 | 14.9 | 0.226 | 14.4 | 0.203 |
|  | 22 | 15.8 | 0.286 | 15.3 | 0.257 |
|  | 24 | 16.6 | 0.355 | 16.1 | 0.318 |

## Tree Volume Calculation

## Know

- Volume equations allow you to calculate tree volume from tree diameter and height
$\square \quad$ They can be complex and very accurate
- Rough-and-ready approximation

$$
\mathrm{V}=0.42 * \mathrm{~g} * \mathrm{~h}
$$

- Volume tables allow you to "look up" tree volume from tree diameter and height

