Individual Tree Measurement: Key to Forest Assessment
Learning Objectives ...

- Know why we measure and sample vegetation
- Know how to measure basic tree attributes
- Know what basic tree & stand attributes are important
- Know basic forest development patterns and structures
Why Sample Forest Vegetation?

- Need information on forest vegetation for making sound decisions
  
  - What is the recreation potential?
  - What silvicultural treatment will result in best critical habitat enhancement?
  - What silvicultural treatment will result in best growth & regeneration of the trees?
  - What species is / are most suitable for reforestation?
  - What is the value of the timber and the land?
  - Is there sufficient value in timber to offset cost of silvicultural treatments?
  - What is the status of biodiversity on the area?
  - How is the forest currently storing carbon?
Why Sample Forest Vegetation?

- Ultimate objective is to obtain quantifiable information about the resource that allows reasonable decisions on its destiny, management, and use
Need to see the forest for the trees!

- Individual tree measurement forms the basis for all forest assessment / inventory
- Many relationships can be derived from individual tree attributes
  - Species
  - Age
  - Diameter
  - Height
- Direct measurement, sampling, prediction are all involved
Tree Measurement: Age

- Tree Age (in yr.)
  - Trees in temperate zones grow one distinctive layer of wood per year so age is found by counting these annual rings
    - Care is needed to avoid counting ‘false’ rings
  - Tree Age:
    - Total Age: Elapsed time since germination of a seed or time since budding of a sprout or cutting
    - Breast-height age: Elapsed time since tree height exceeded breast height
Individual Tree Measurement

- Diameter
  - Most frequently measured diameter is Diameter Breast Height, or, DBH for short
  - DBH is *average* stem diameter outside bark of a tree measured at breast height above ground level
    - In U.S., DBH is measures in inches; breast ht. = 4.5 ft.
    - On steep slopes measure on the uphill side of tree
    - Leaning trees require measurement along the bole
    - Trees forking below breast height are treated as two
    - Trees forking above breast height – avoid swells
    - Other stem deformities – move above it
  - Dendrometers measure tree diam’s: D-tape is common
Tree Measurement: DBH

(a) BH
(b) BH
(c) BH
(d) BH
(e) BH
(f) BH

(g) BH
(h) BH
(i) BH

Measure here
Measure here
Measure here

+ 1.5 ft (30 cm)
> 3 ft (1 m)
Tree Measurement: basal area

- Basal Area (ba)
  - ba (or g) is directly related to crown surface area
  - Cross sectional area of the tree at breast height – assuming stem circularity – in ft\(^2\)! (esp. in U.S.; m\(^2\) elsewhere)

\[
a = \pi r^2
\]

\[
a = \pi \left( \frac{d}{2} \right)^2
\]

\[
a = \pi \left( \frac{D}{2 \cdot 12} \right)^2 = 0.005454154D^2
\]

\[g = 0.005454154DBH^2\]
Tree Measurement: Height

- Tree Height (ft., in U.S., m. elsewhere)
  - Total height: distance from tree base to tip (volume, biomass, site quality)
  - Height-to-crown: distance from tree base to base of live crown
  - Merchantable height: Height to a minimum top diameter
- Instruments are called “hypsometers”
  - Direct measurement: Height poles
  - Indirect measurement
    - Similar triangles
    - Trigonometric principles (clinometer)
Height Measurement

Tree Height = DT + BD.
**Height Measurement**

Tree Height = DT + BD.

\[
\text{DT/OD} = \tan(\text{TOD}), \text{ therefore, } DT = \text{OD} \times \tan(\text{TOD})
\]

\[
\text{DB/OD} = - \tan(\text{DOB}), \text{ therefore, } DB = - \text{OD} \times \tan(\text{DOB})
\]

Tree Height = OD \times \tan(TOD) + [- OD \times \tan(DOB)], or,

Tree Height = OD \times [\tan(TOD) - \tan(DOB)].

Horizontal distance OD is measured with a tape.
Clino measures tangents of angles TOD, DOB in percent (100 x tan), so

Tree Height = OD \times [\frac{\text{TOD}}{100} - \frac{\text{DOB}}{100}], or

Tree Height = OD / 100 \times [\text{TOD}\% - \text{DOB}\%]
Slope correction for height measurement

OD/OD’ = \cos(DOD’)

OD = OD’ \times \cos(DOD’)

Measure angle DOD’ with clinometer in degrees & plug into height equation:

Tree Height = \left[OD’ \times \cos(DOD’)\right] / 100 \times \left[TOD\% - DOB\%\right]
Stand Attributes: Age

● Stand Age:
  ● Total age – average of tree total ages
  ● Breast-height age – average of tree b.h. ages
  ● Plantation age: Elapsed time since planting – regardless of seedling age

● Even-aged vs. Uneven-aged
Stand Attributes: DBH

- Average stand DBH is a useful statistic for silviculture, stewardship, management
  - Mean DBH (DBH) - The simple arithmetic mean DBH of all trees in the stand
  - Quadratic Mean DBH (DBHq, QMD, or sometimes Dg) – the DBH of the tree with mean basal area

\[ QMD = D_g = \sqrt{\frac{\bar{g}}{0.005454}} \]
Stand Attributes: Stand Table

- One view of Stand Structure
- Diameter (size) distributions

2006 Stand Table (plot 70303)
Tree Measurement: Crown Classes

D = Dominant: Crowns extend above general level of canopy; receives light from above and substantially from sides,

C = Codominant: Crowns form general level of canopy; receives light from above, but comparatively little from sides,

I = Intermediate: Shorter than two preceding with crowns extending well into general level of canopy; receiving some light from above

O = Overtopped: Crowns entirely below general level of canopy; receives no direct sunlight
Stand Attributes: Height

- Average Height
- Dominant Height
  - Definitions vary
    - Average height of just dominant trees (crowns extend above general level of canopy)
    - Average height of dominants and co-dominants (trees whose crowns form the general level of the canopy)
    - Predominant Height – average height of 100 tallest trees per hectare (40 per acre)
    - Top Height – average height of 100 largest diameter trees (40 per acre)
Stand Attributes: Site Productivity

- Dominant Height in relation to age - Site Quality
  - Trees are resource integrators
  - Site Index: The average height of undamaged dominant trees at a reference age
  - Dominant tree height insensitive to crowding
  - Reference, or base, or index age chosen appropriately
  - Species dependent
  - Sometimes dominant trees are unavailable; challenge esp. in mixed stands
  - Requires trees on the site
Site Productivity: Site Index

Other Stand Attributes …

- Trees Per unit Area (TPA) – Average number of live trees existing on a characteristic unit of area. The most basic measure of stand density. (In U.S.A., units are Trees Per Acre.)

- Stand Basal Area (SBA, BA, or G) – sum of individual tree basal areas in a stand.

- Species Composition – proportion of each species present in a stand. May use any or all of abundance, number, or size as the basis.
Permanent Sample Plot Layout

Large Tree measurement plot
- 0.1 acre plot ➔ 37.2 foot radius
- white PVC pipe at plot center ⭐; plot number written on it w/ indelible ink
- all trees within the plot have aluminum tags
- first tree on plot marked with pink flagging

Small Tree measurement plot
- 0.025 acre plot ➔ 18.6 foot radius
- same plot center as large plot
- trees are not tagged
- perimeter is not marked
# Plot and Tree Enumeration Card

**Date** __________  **Team** __________________________  **Forest** ____________

**Compartment** __________  **Stand** __________  **Plot** ____________

**Aspect** ________________  **Slope** __________  **Elevation** ____________

<table>
<thead>
<tr>
<th>Tree</th>
<th>Spp</th>
<th>DBH</th>
<th>Ht.</th>
<th>Dist</th>
<th>S (°)</th>
<th>B. (%)</th>
<th>T. (%)</th>
<th>C. (%)</th>
<th>Add-on</th>
<th>Comment(s)</th>
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Note: (S) represents the slope of the terrain, with (B) and (T) indicating the height and diameter of the trees, respectively.
Upper Canopy Surveys

- Field Trip to St. Edward State Park
- Tu, We 4, 5 Nov
- Depart from behind Bloedel Hall (C-10 parking lot) promptly at 12:30 P.M.
- Dress appropriately: long pants, sturdy footwear (with ankle support), rain gear(!?), etc.