Forest Ecology & Management

- Objectives
  - Application of basic ecological principles to the management of forest resources

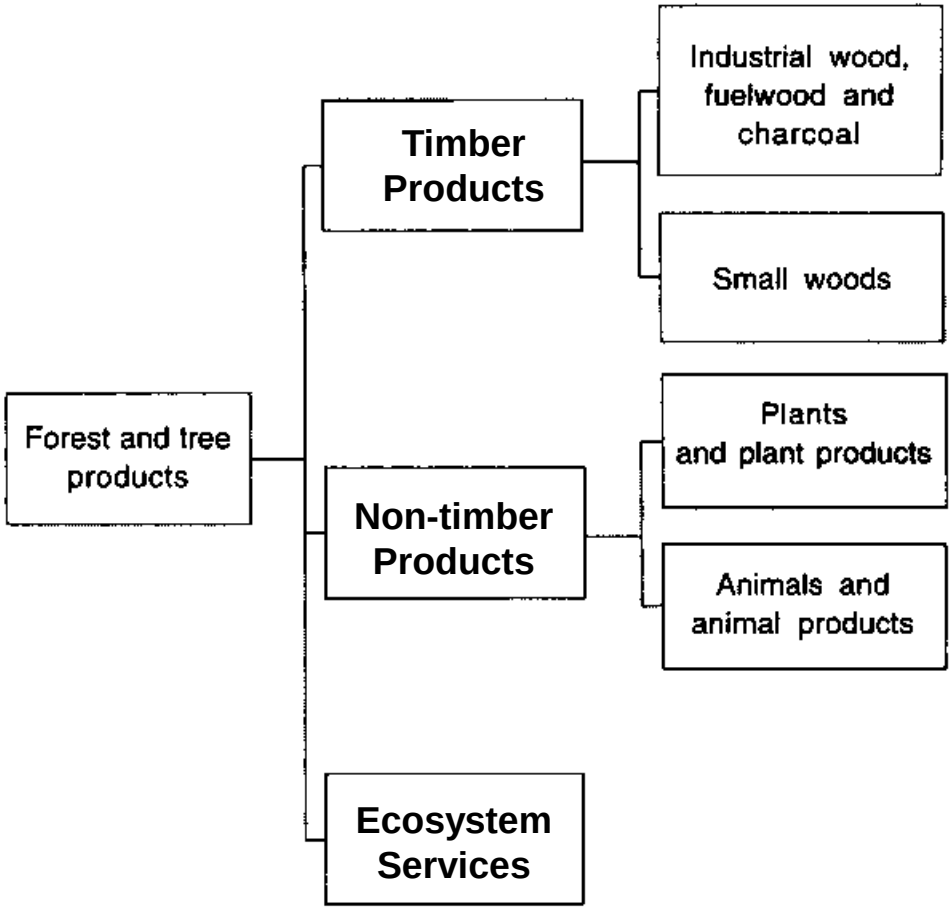
"*It should be apparent…that almost all human evolution, from primeval, primate stock to ground ape and then through agricultural, technical, and cultural revolutions to the present time, has been intimately associated with, and conditioned by,* ***forests***." (J.P. Kimmins 1987)

Forest Ecology & Management

- Definitions
  - *Forest*
  - *Forestry*
  - *Forest resources*
    - *Timber vs. non-timber vs. ecosystem services*

Forest Ecology & Management

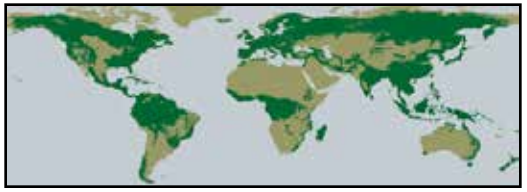
- Forest resources



Forest Ecology & Management

- ~60% of the Earth's pre-human land surface was forested
- ~30% of current land surface is forested
  - 0.62 ha (~1.5 acres) per person
- ~22% of original forest classified as "Frontier Forests"

Original Forest Extent



(60% of land surface)

Current Forest Extent

(30% of land surface; ~50% of original forest)

Frontier Forest Extent

(22% of original forest)

Forest Ecology & Management

- Forest Management - Categories

Silviculture

Restoration

Conservation

Forest Ecology & Management

- Forest Management - Spatial Scale

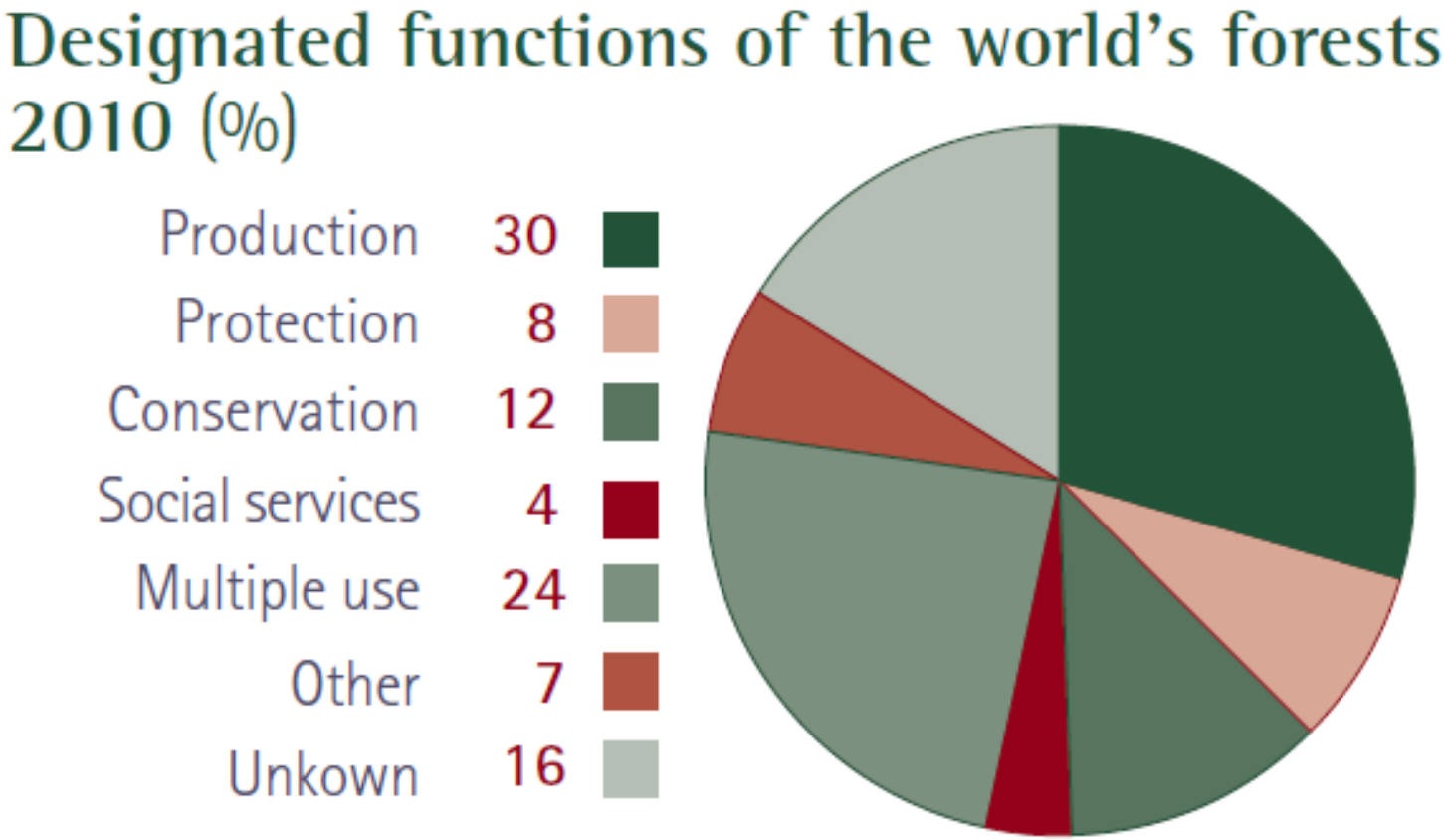
Stand

Watershed

Landscape

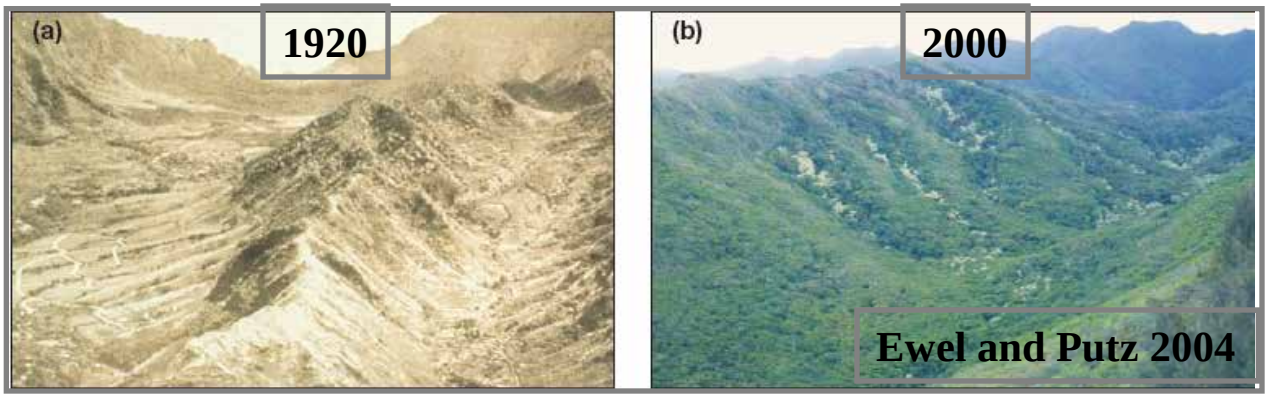
Forest Ecology & Management

- Forest Management - Global Uses



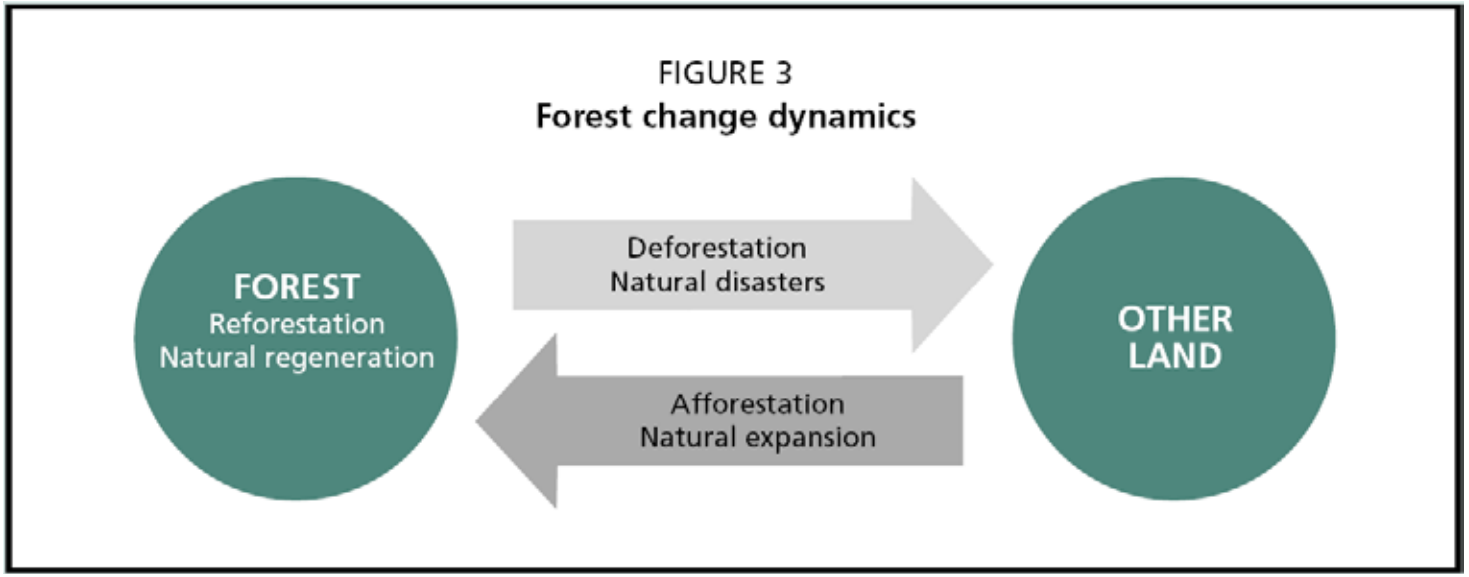
Forest Ecology & Management

- Forest Management - Hawai‘i Uses



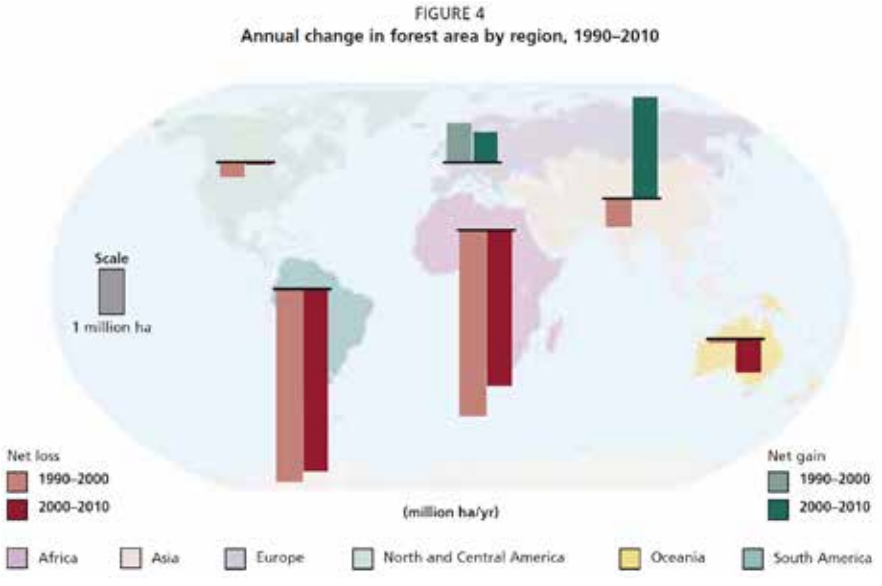
Forest Ecology & Management

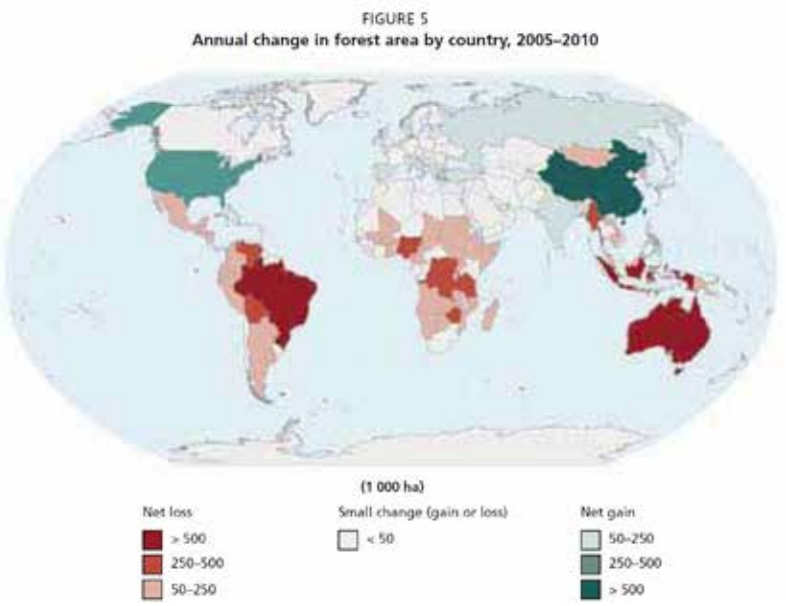
- Forest Management - Deforestation



Forest Ecology & Management

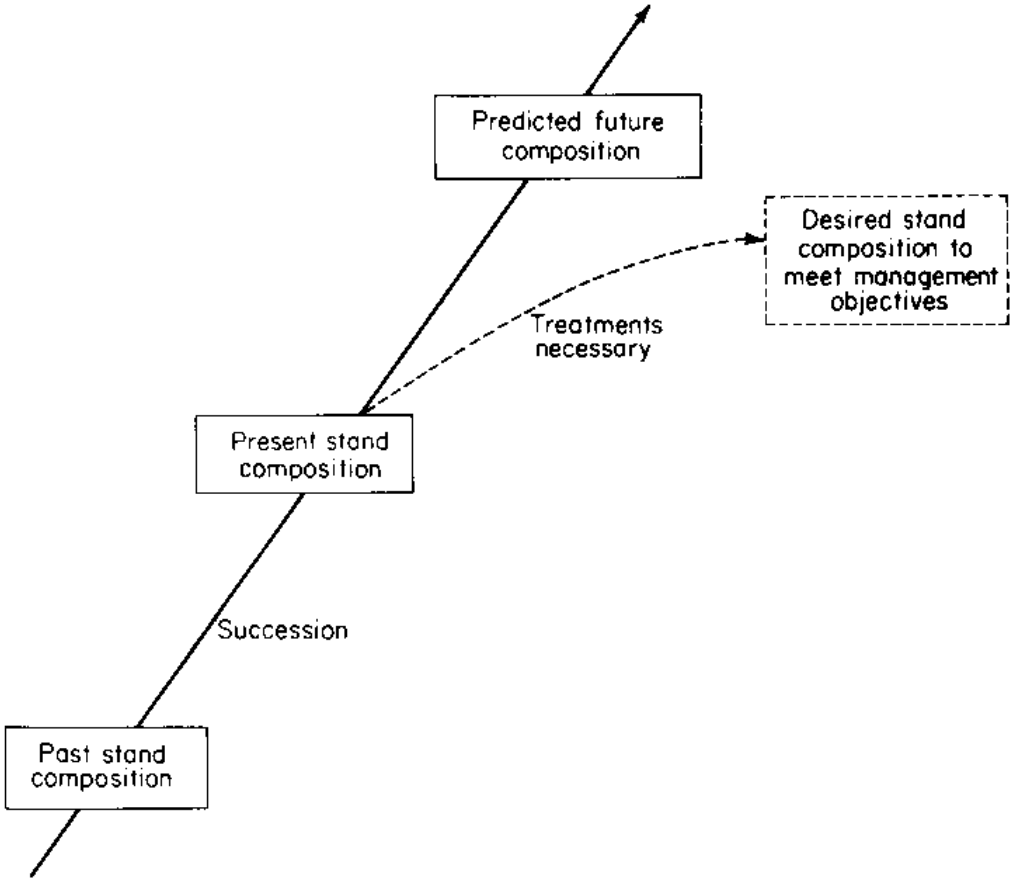
- Forest Management - Deforestation





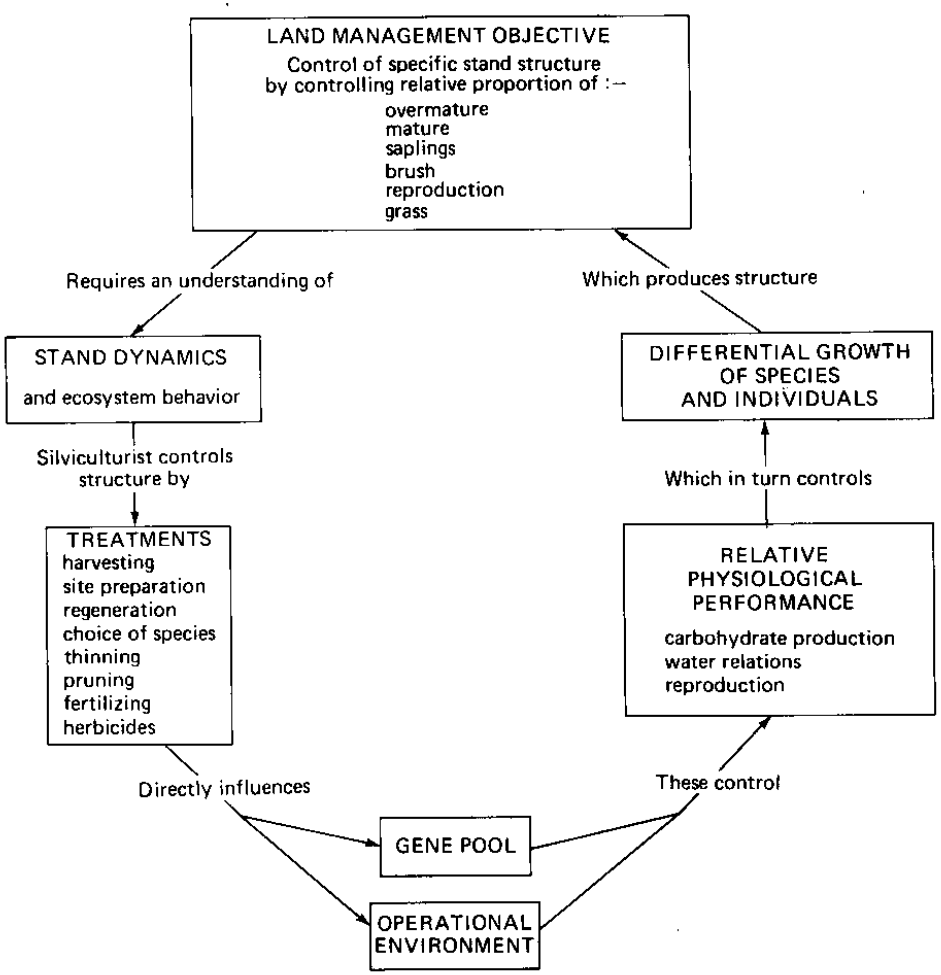
Forest Ecology & Management

- Forest Management - Objectives



Forest Ecology & Management

- Forest Management - Objectives



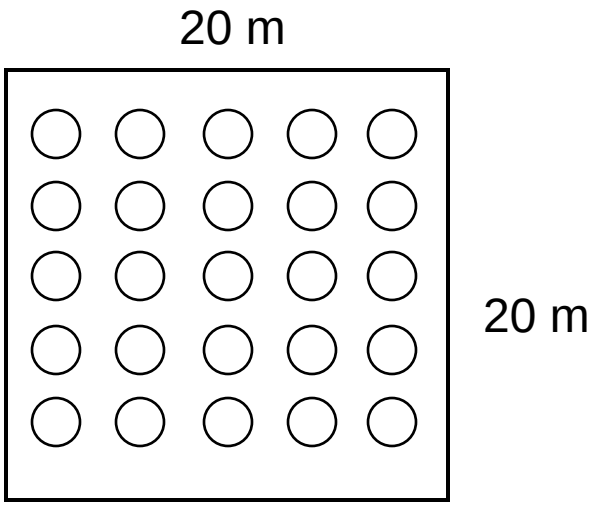
Forest Ecology & Management

- Forest Stand Metrics - Mensuration

  - *Density*
  - *DBH*
  - *Height*
  - *Basal Area*
  - *Volume*
  - *Biomass*
  - *Species Composition*
  - *Age structure*

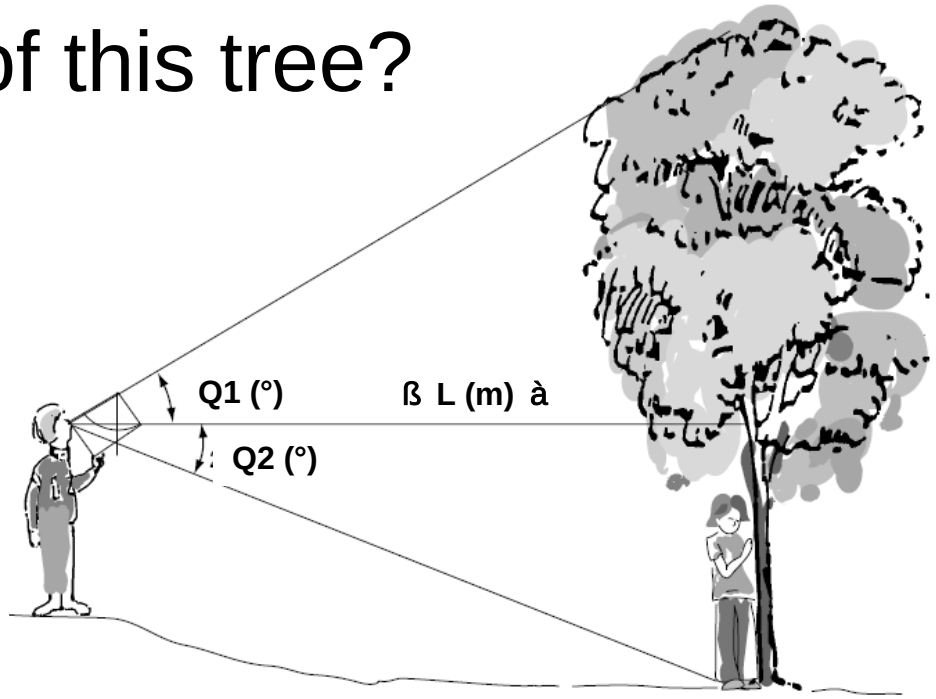
Forest Ecology & Management

- Forest Stand Metrics - Density
  - How many trees/ha?



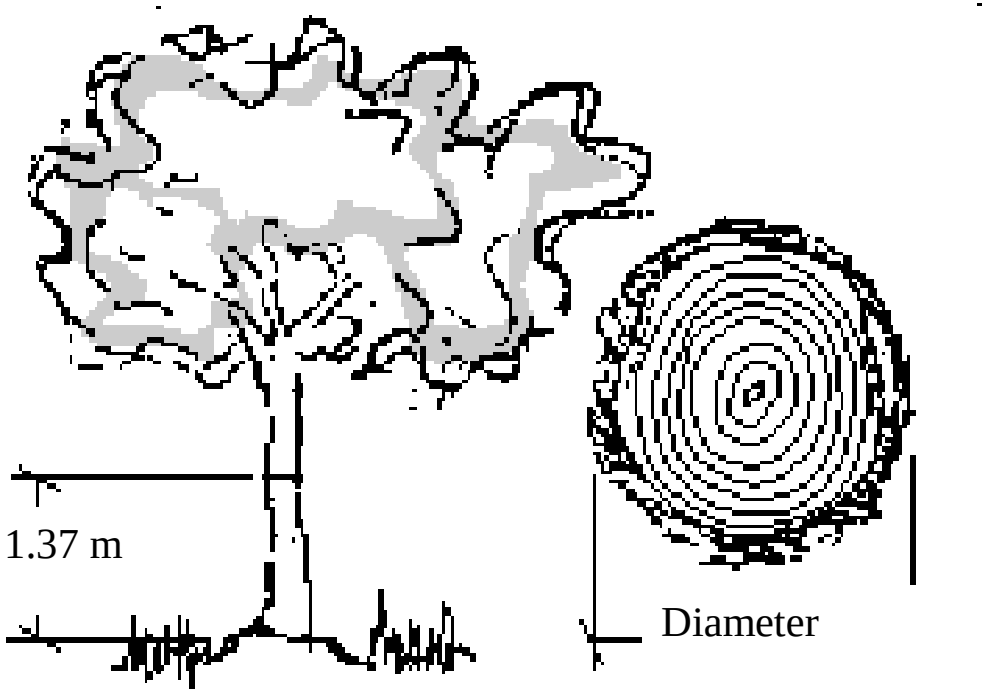
Forest Ecology & Management

- Forest Stand Metrics - Height
  - Tree ht = L * (tan Q1 + tan Q2)
  - What is the ht. of this tree?
    - L = 20 m
    - Q1 = 35°
    - Q2 = -15°



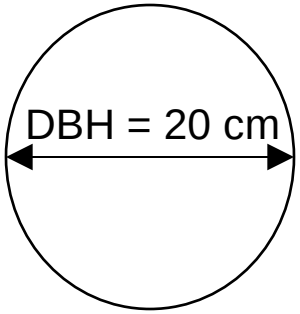
Forest Ecology & Management

- Forest Stand Metrics - DBH



Forest Ecology & Management

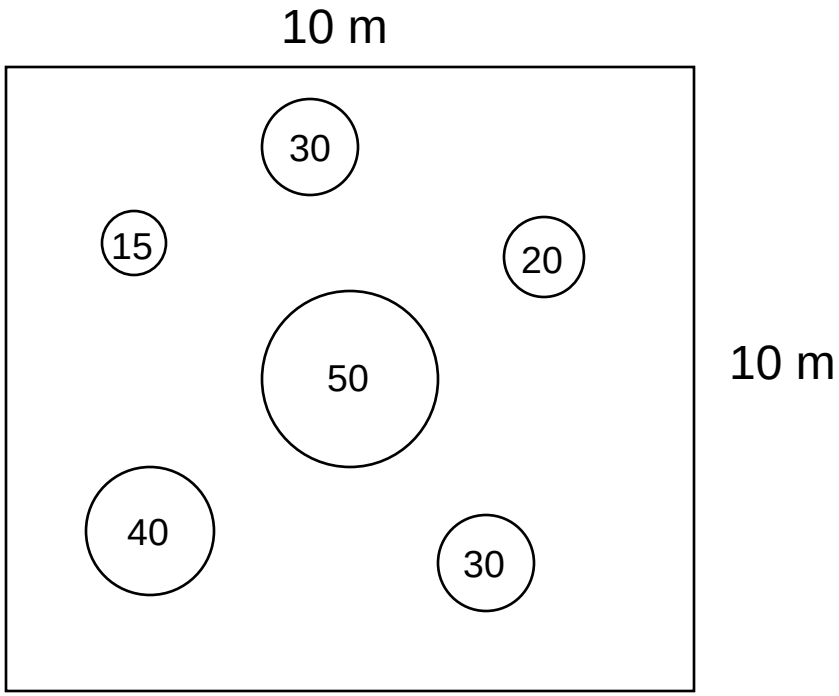
- Forest Stand Metrics - Basal Area (BA)
  - Cross sectional area of a tree at 1.37 m
  - $BA = (\pi * dbh^2) / 4$
    - For BA of a single tree (cm^2) when dbh is cm
  - $BA = (\pi * dbh^2) / (4 * 10{,}000)$
    - For BA of a single tree (m^2) when dbh is cm
  - What is the BA of this tree in cm^2 and m^2?



Forest Ecology & Management

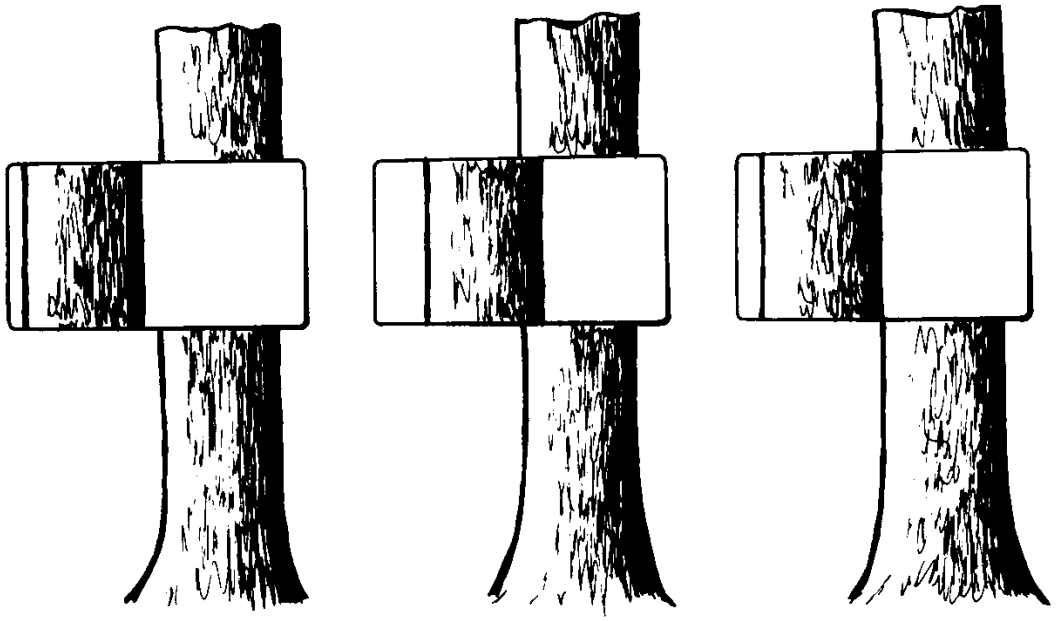
- Forest Stand Metrics
  - What is the density (# trees / ha)?
  - What is the stand basal area (m^2 / ha)?

inside circle is DBH (cm)



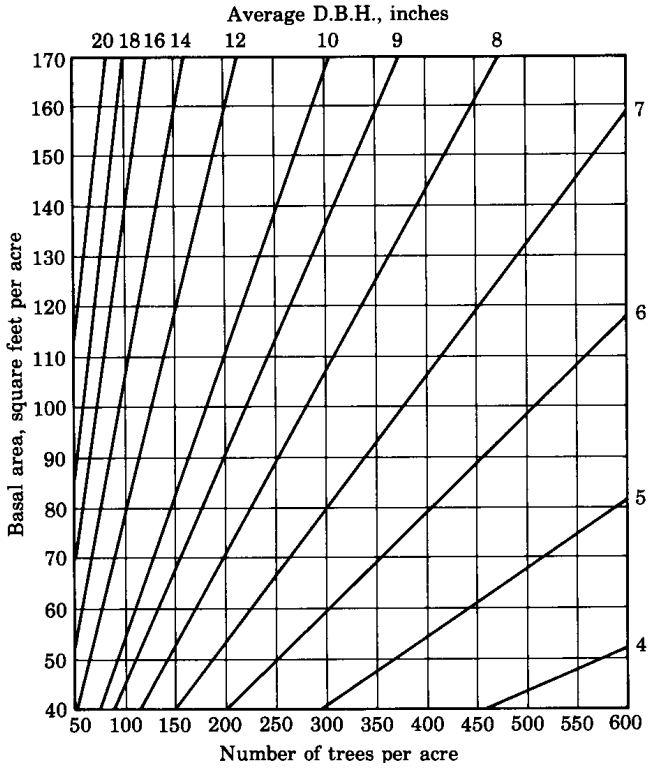
Forest Ecology & Management

- Forest Stand Metrics - BA with a "wedge prism"



Forest Ecology & Management

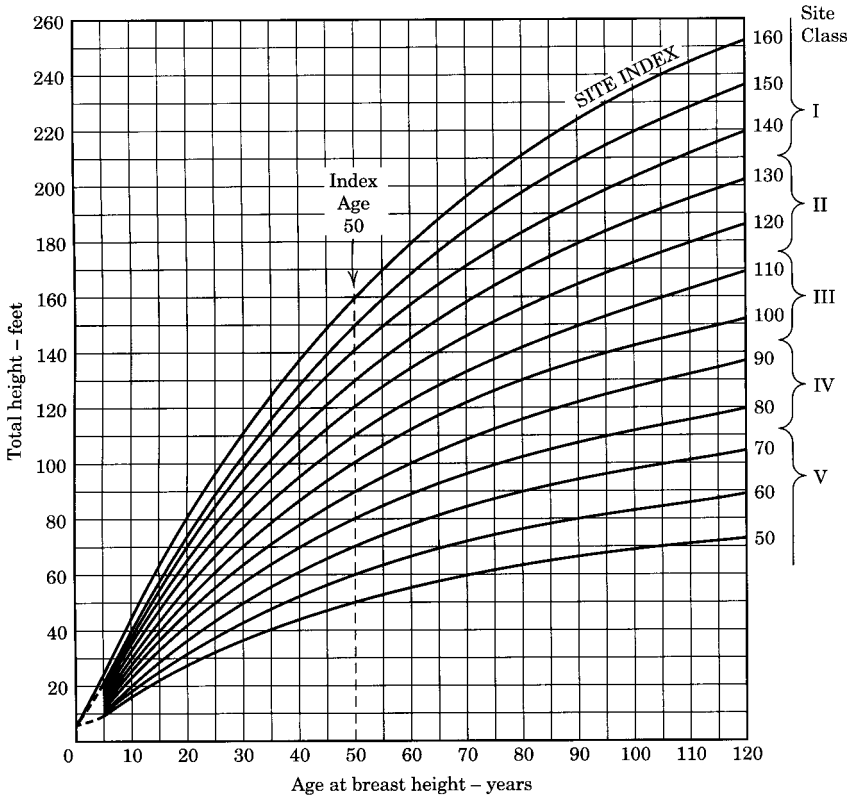
- Forest Stand Metrics - BA with a Nomogram



Forest Ecology & Management

- Forest Stand Metrics - Height & Age
  - Site index curves

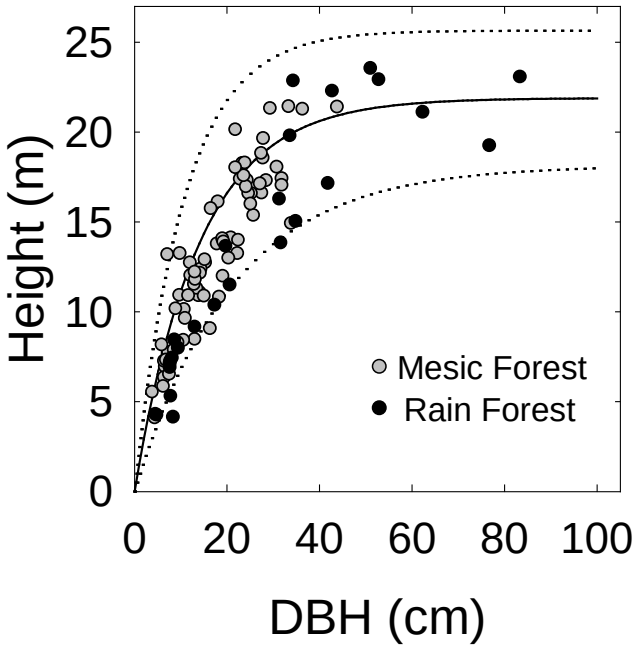
Douglas-Fir

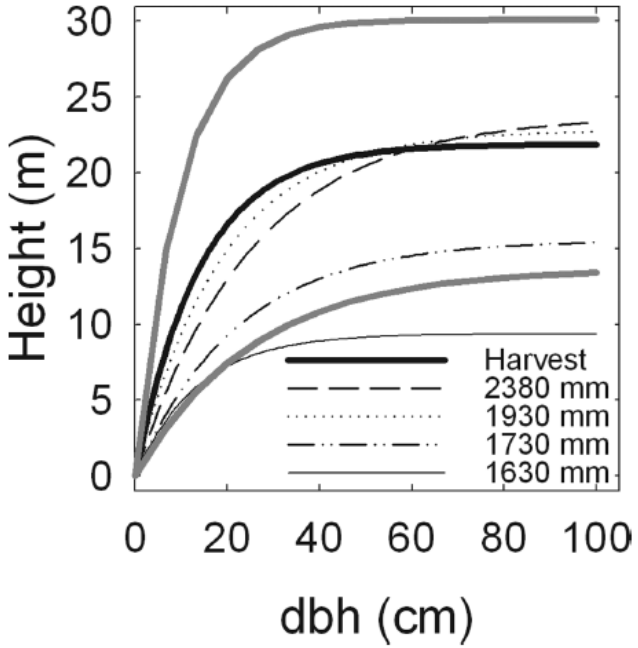


Forest Ecology & Management

- Forest Stand Metrics - DBH vs. Height Curves

Metrosideros polymorpha





Litton & Kauffman (2008)

Forest Ecology & Management

- Forest Stand Metrics - Volume

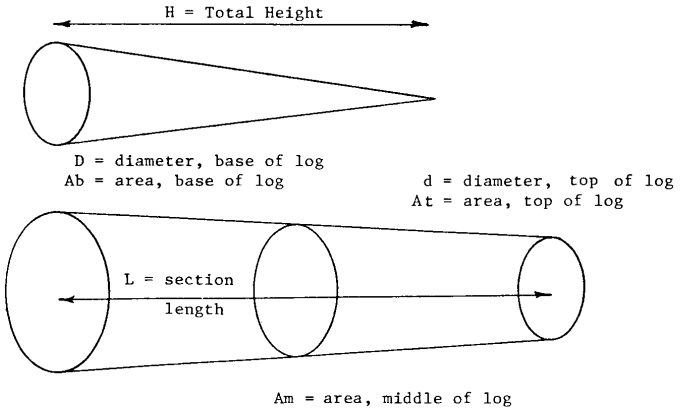


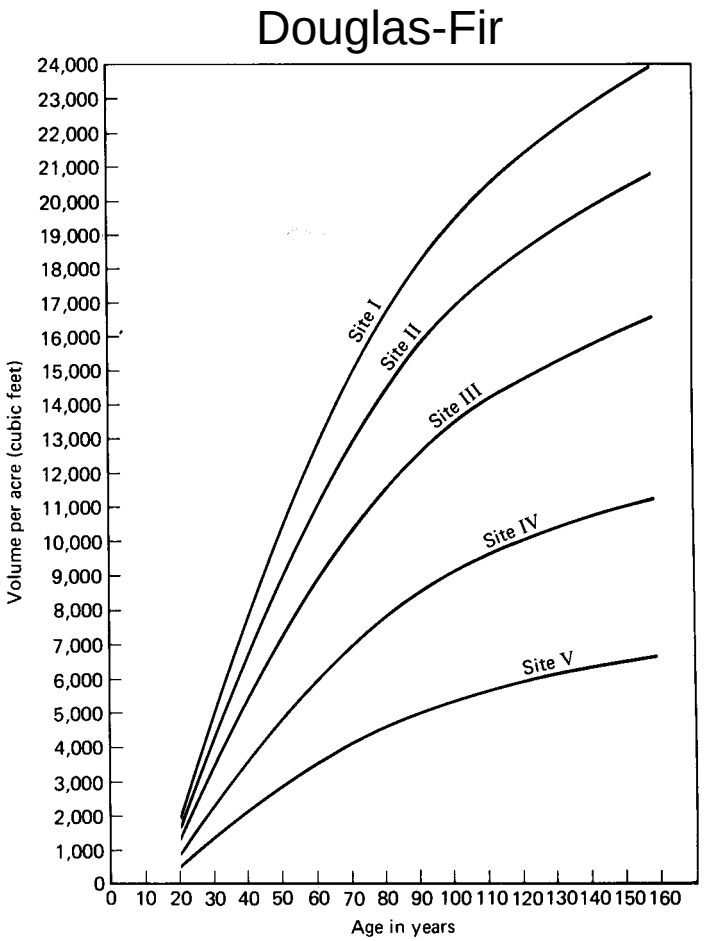
Fig. 9. Terms used in volume equations.

When dealing with a frustrum (section) of these forms the following formulas apply:

Neiloid*	$\frac{L}{4}\left[\left[\frac{Ab - At}{\left[\frac{Ab}{At}\right]^{1/3} - 1}\right] + Ab\right]$
Cone	$\left(\frac{L}{3}\right) \cdot \left(Ab + \sqrt{(Ab)(At)} + At\right)$
Parabola	$Am \cdot L$ (Huber formula)
OR	
	$\left(\frac{Ab + At}{2}\right) \cdot L$ (Smalian formula)
Cylinder	$\left(Ab \cdot L\right)$
For all forms (Newton formula)	$\left(L\right) \cdot \left(\frac{Ab + 4\,Am + At}{6}\right)$

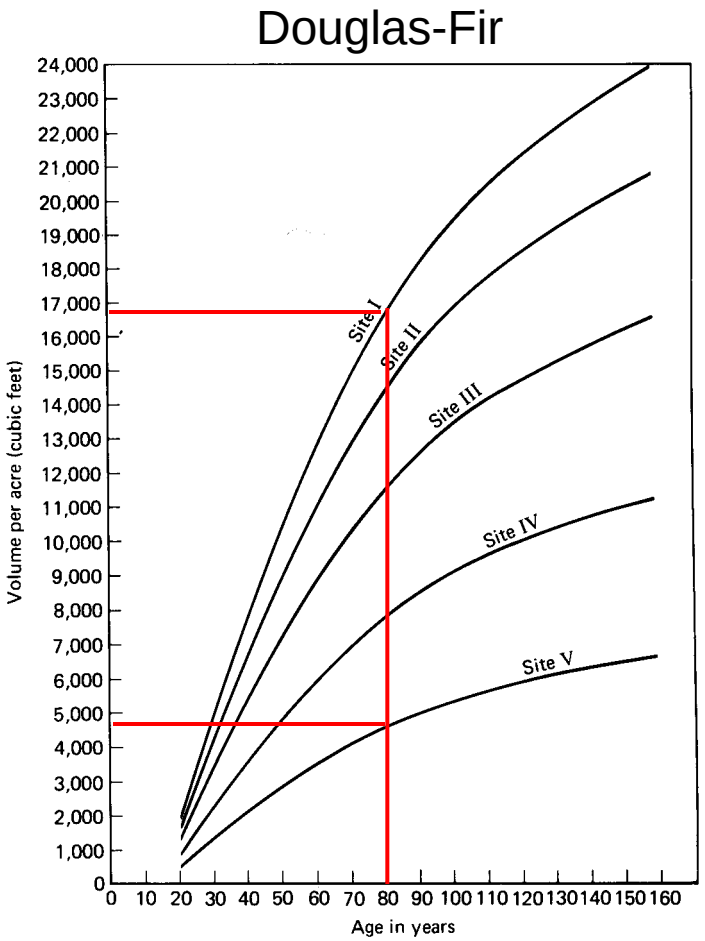
Forest Ecology & Management

- Forest Stand Metrics - Volume



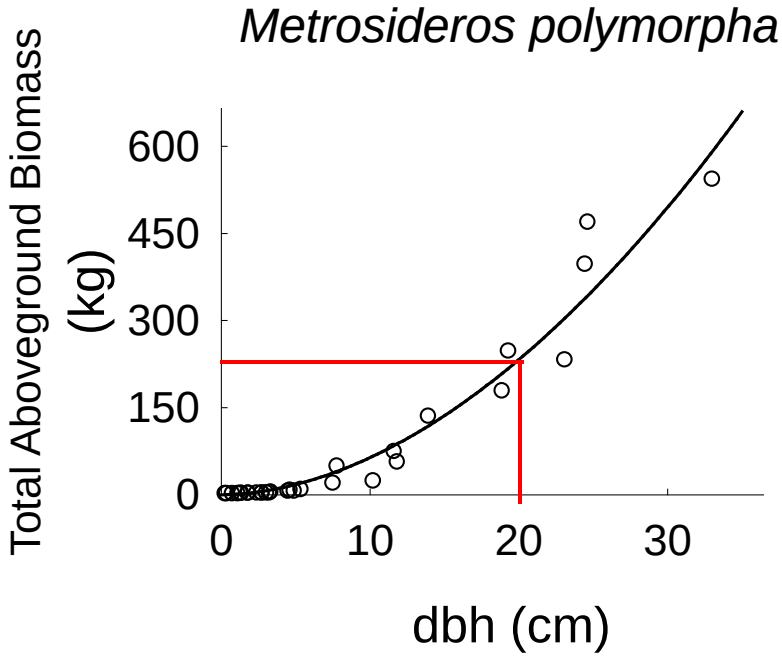
Forest Ecology & Management

- Forest Stand Metrics - Volume



Forest Ecology & Management

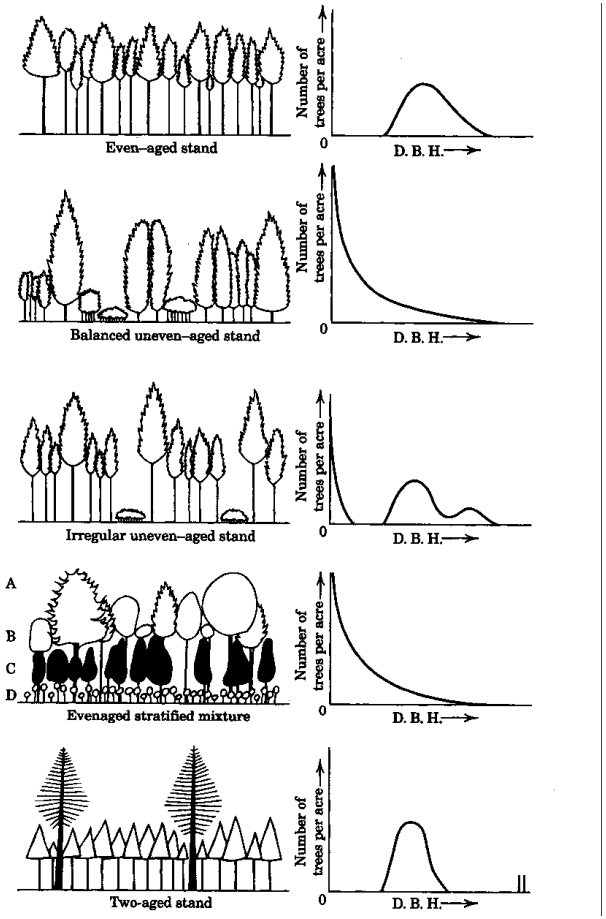
- Forest Stand Metrics - Biomass
  - $Y = aX^b$
  - $Y = 0.88*X^{1.86}$
  - *What is the biomass of a tree with a 20 cm DBH?*



Litton & Kauffman (2008)

Forest Ecology & Management

- Forest Stand Metrics - Species Composition & Age/Size Class Structure



Forest Ecology & Management

- Silviculture System
  - Silviculture aims to create structure or developmental sequences that meet management objectives over a rotation

Forest Ecology & Management

- Silviculture - Regeneration
  - Natural
    - Seedlings
    - Sprouts (Coppicing)
  - Artificial
    - Planting
    - Direct Seeding

Forest Ecology & Management

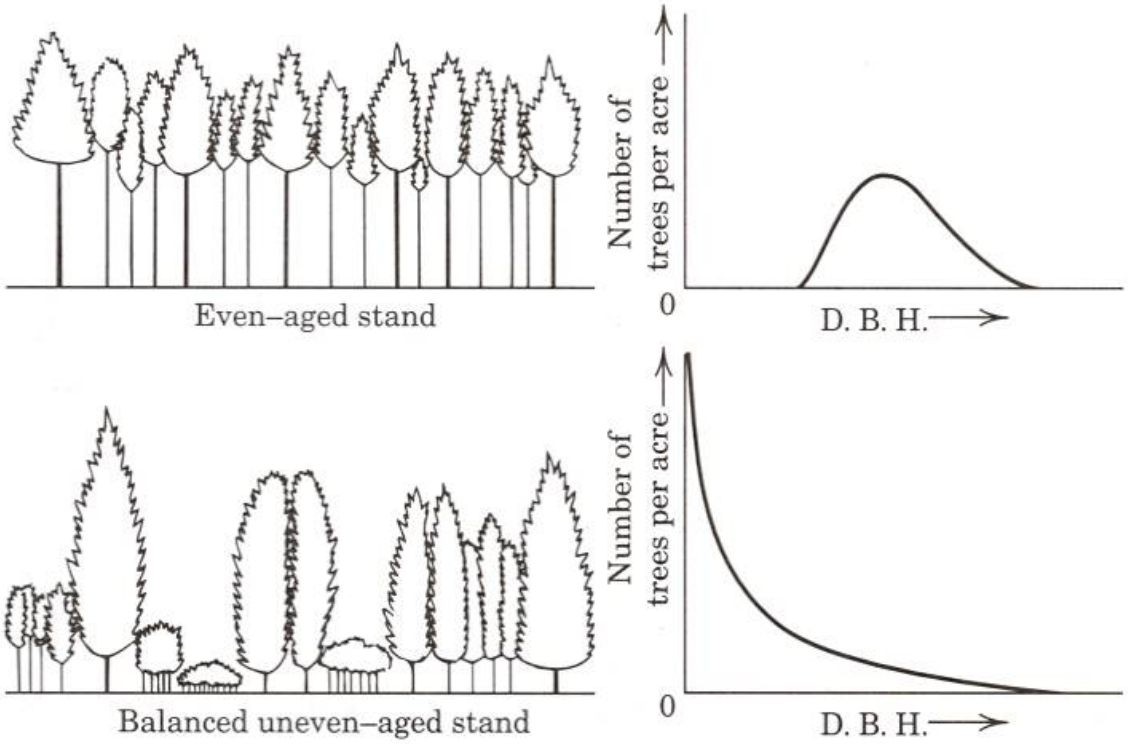
- Silviculture - Regeneration

Natural

Artificial

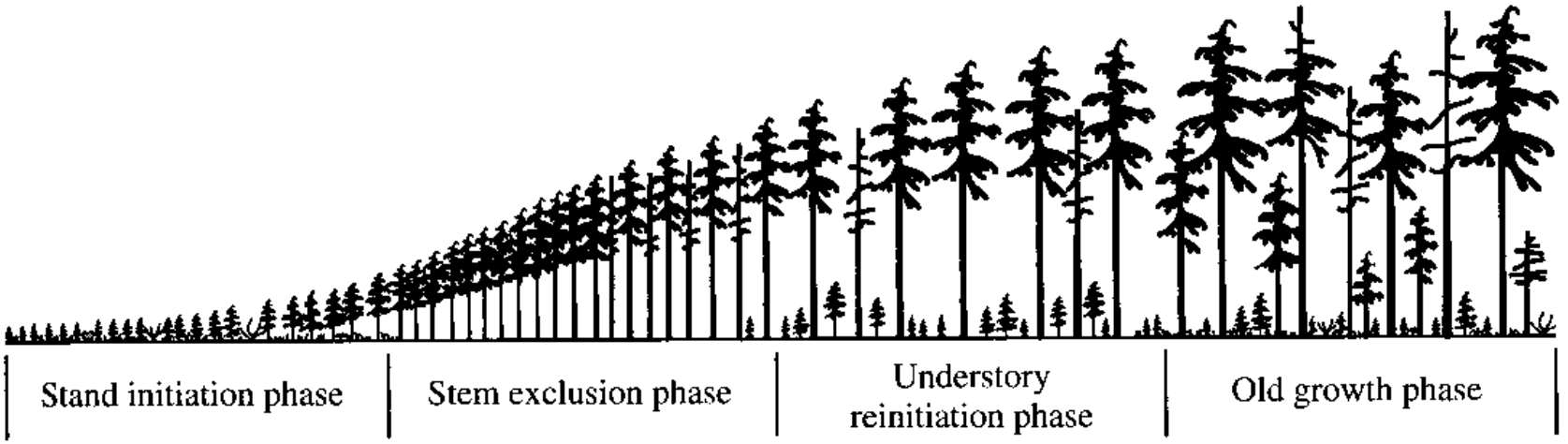
Forest Ecology & Management

- Silviculture - Stand Structure



Forest Ecology & Management

- Silviculture - Stand Development

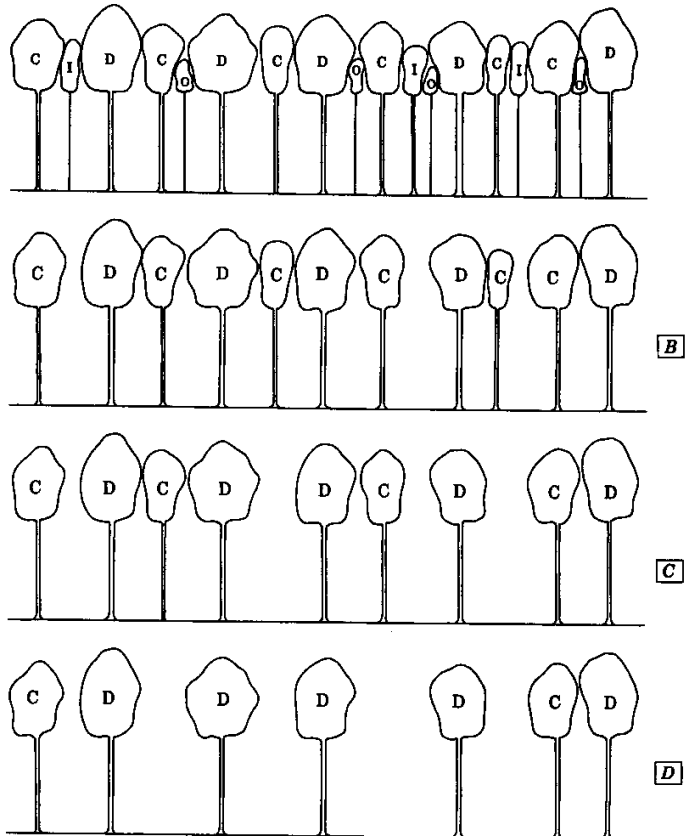


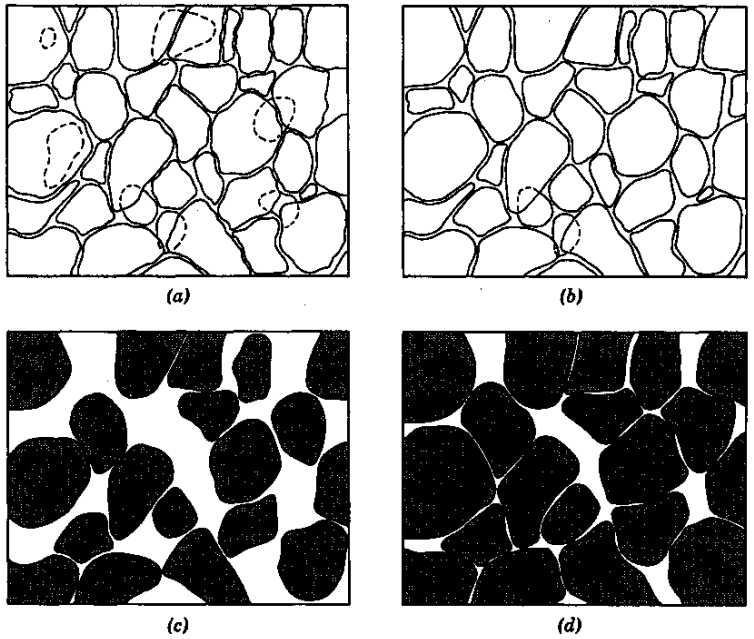
Forest Ecology & Management

- Silviculture - Intermediate Treatments
  - Fertilization
  - Herbicides
  - Pruning
  - Thinning
    - Remove undesirable/inferior individuals or species
    - Concentrate resources and growth in desirable species and/or crop trees

Forest Ecology & Management

- Silviculture - Thinning





Forest Ecology & Management

- Harvesting
  - Construction of roads?
  - Harvesting technique?
  - Transportation of harvest products?
  - Market for harvest products?

    - http://www.youtube.com/watch?v=89L8ZEC14Ec&NR=1