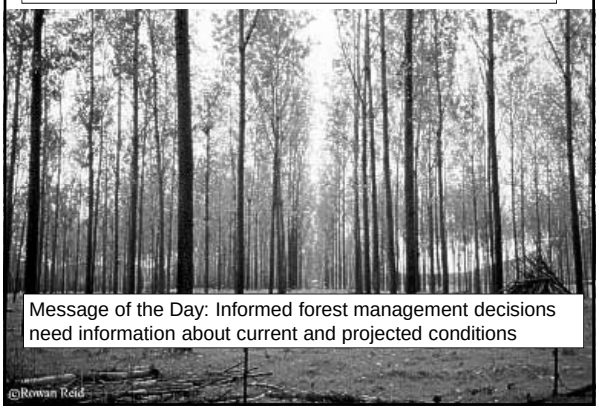
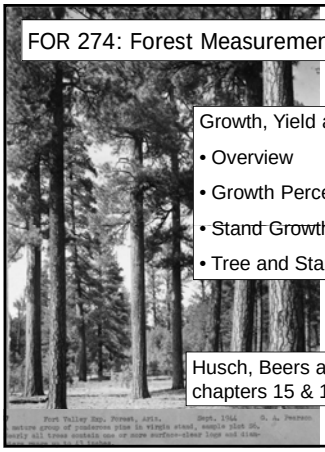
What Do You See?



Message of the Day: Informed forest management decisions need information about current and projected conditions

FOR 274: Forest Measurements and Inventory

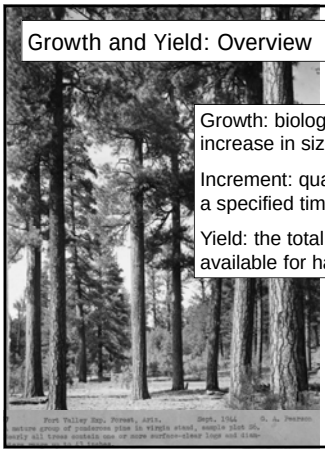


Growth, Yield and Biomass

- Overview
- Growth Percentage
- ~~Stand Growth~~
- Tree and Stand Biomass

Husch, Beers and Kershaw pp250-257, chapters 15 & 16

Growth and Yield: Overview

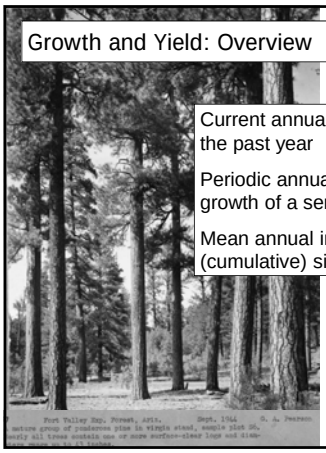


Growth: biological phenomenon of increase in size with time

Increment: quantitative increase in size in a specified time interval due to growth

Yield: the total amount (of timber) available for harvest

Growth and Yield: Overview

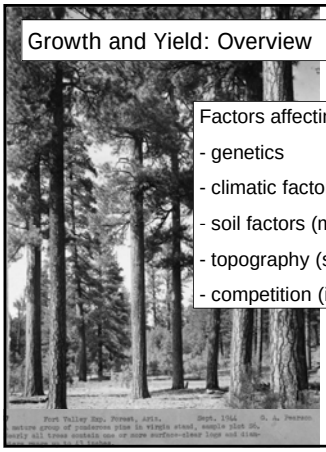


Current annual increment: growth within the past year

Periodic annual Increment: average growth of a series of years (5 or 10)

Mean annual increment: Current (cumulative) size divided by the age

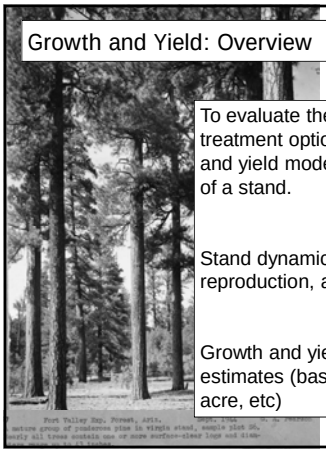
Growth and Yield: Overview



Factors affecting growth include:

- genetics
- climatic factors (temp, precip, wind, etc)
- soil factors (moisture, ph, etc)
- topography (slope, elevation, aspect)
- competition (influence of other trees)

Growth and Yield: Overview



To evaluate the usefulness of different treatment options we often use “growth and yield models” to forecast the dynamics of a stand.

Stand dynamics: Growth, mortality, reproduction, and other stand changes

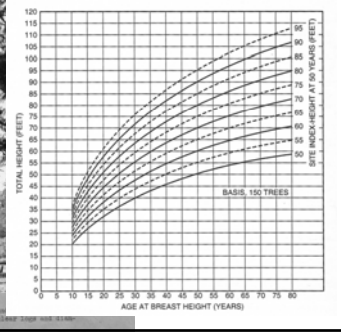
Growth and yield models produce stand estimates (basal area, volume, trees per acre, etc)

Growth and Yield: Overview

Growth Curve: Size plotted against age

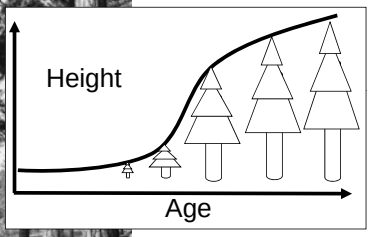
Sizes Include:

- Heights
- Volumes
- Diameter
- Weight



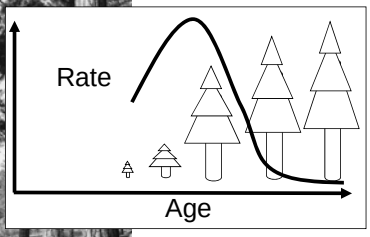
Growth and Yield: Overview

Growth Curve: S- (or sigmoid) shaped and shows cumulative growth at any age



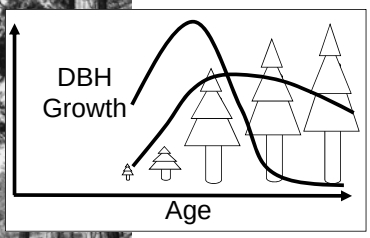
Growth and Yield: Overview

Rate of Growth Curve: Rapid growth in youth with decreasing rate as tree matures



Growth and Yield: Overview

Current and mean annual growth curves:



Growth and Yield: Growth Percentage

A measure of the average rate of change in size or volume over a given time interval

Growth percent = 100 * (V2-V1)/(N*V1)

V1 = Volume or size at start

V2 = Volume or size at end

N = number of years

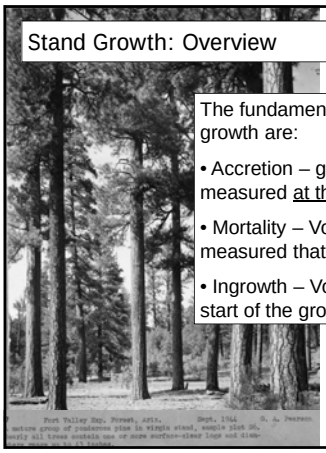
This measure is analogous to interest rates as found in economics

FOR 274: Forest Measurements and Inventory

Growth, Yield and Biomass

- Overview
- Growth Percentage
- Stand Growth
- Tree and Stand Biomass

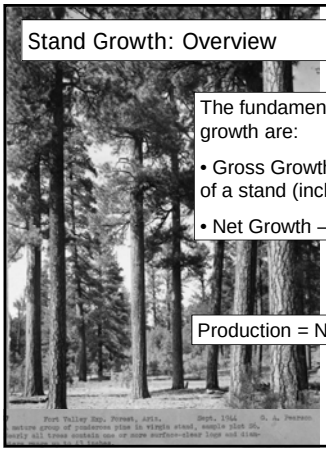
Stand Growth: Overview



The fundamental components of stand growth are:

- Accretion – growth of all the trees as measured at the start of the growth period
- Mortality – Volume of trees initially measured that died and not utilized
- Ingrowth – Volume of trees grown after start of the growth period (e.g., seedlings)

Stand Growth: Overview

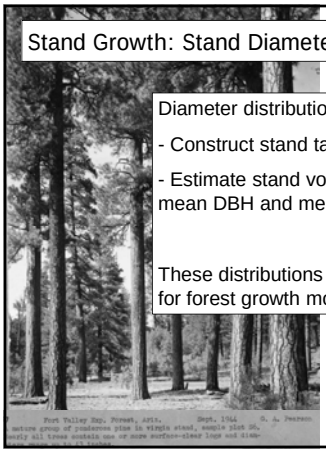


The fundamental components of stand growth are:

- Gross Growth – change in total volume of a stand (including mortality)
- Net Growth – excluding mortality

Production = Net Growth + Ingrowth

Stand Growth: Stand Diameter Distributions

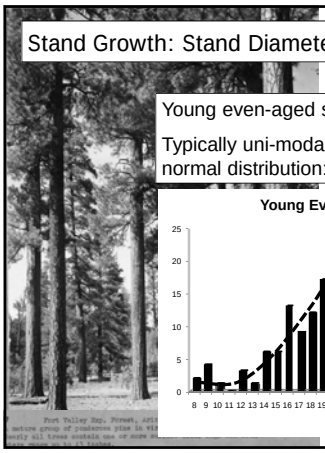


Diameter distributions are required to:

- Construct stand tables
- Estimate stand volume form a stand with mean DBH and mean height

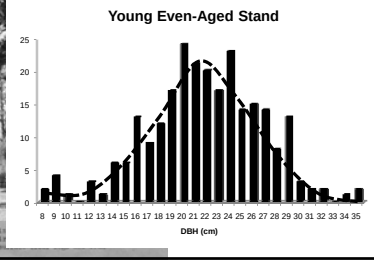
These distributions are essential components for forest growth models such as FVS

Stand Growth: Stand Diameter Distributions

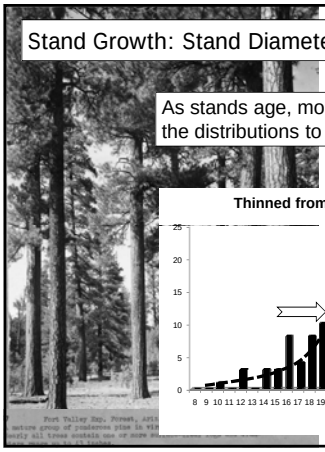


Young even-aged stands (before thinning):

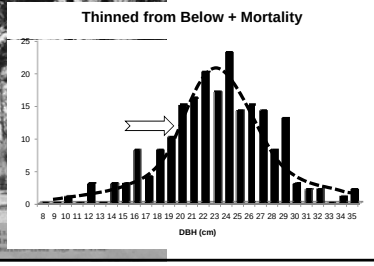
Typically uni-modal and approximated by a normal distribution:



Stand Growth: Stand Diameter Distributions

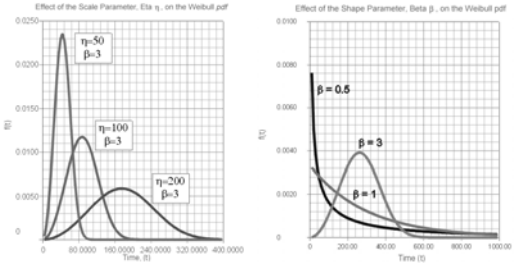


As stands age, mortality and thinning cause the distributions to become skewed:



Stand Growth: Stand Diameter Distributions

In natural resources we often seek to describe the lifetime of large numbers under stress: Weibull Distributions



Stand Growth: Stand Table Prediction

Growth projections according to DBH class:

- Develop stand table by DBH class

- Determine past growth via corers or past inventories

DBH Class (in)	Present Stand (stem count)	Expected Mortality (%)	Expected Survival (stems)	10-year DBH Growth (in)
6	522	40	313	2.2
8	352	35	229	2.3
10	179	25	134	2.4
12	88	20	70	2.2
14	40	15	34	2.4
16	11	10	10	2.6
18	10	10	9	2.1
20+	8	20	6	1.8
Total	**1210**		**805**	

Stand Growth: Stand Table Prediction

Growth projections according to DBH class:

- Apply past diameter growths to current stand table and estimate mortality and ingrowth

- Periodic stand growth = Volume of future stand - Volume of present stand

DBH Class (in)	Present Stand (stem count)	Expected Mortality (%)	Expected Survival (stems)	10-year DBH Growth (in)
6	522	40	313	2.2
8	352	35	229	2.3
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Total	**1210**		**805**	

Stand Growth: Producing Future Stand Tables

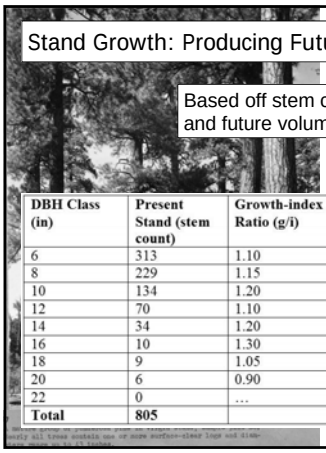
Need to account for “upward movement” of trees into higher DBH brackets

Growth-index Ratio = Diameter Growth / DBH increment = 2.2 / 2 = 1.10

DBH Class (in)	Present Stand (stem count)	Expected Mortality (%)	Expected Survival (stems)	10-year DBH Growth (in)
6	522	40	313	2.2
8	352	35	229	
	179	25	134	2.4
12	88	20	70	2.2
20+	8	20	6	1.8
Total	**1210**		**805**	

What This Means: 100% of the trees move up 1 DBH bracket and 10% move up two DBH brackets!

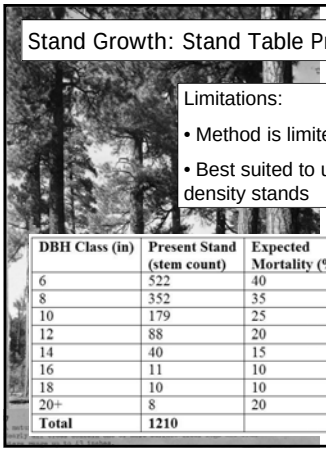
Stand Growth: Producing Future Stand Tables



Based off stem count and DBH the current and future volumes can be predicted

DBH Class (in)	Present Stand (stem count)	Growth-index Ratio (g/i)	# DBH brackets stems moving by: None	One	Two	Future Stem Count
6	313	1.10	0	282	31	0
8	229	1.15	0	195	34	282
10	134	1.20	0	107	27	226
12	70	1.10	0	63	7	141
14	34	1.20	0	27	7	90
16	10	1.30	0	7	3	34
18	9	1.05	0	8	1	14
20	6	0.90	1	5	0	12
22	0	…	0	0	0	6
Total	**805**		**1**	**694**	**110**	**805**

Stand Growth: Stand Table Prediction



Limitations:

- Method is limited when mortality is high
- Best suited to un-even aged and low density stands

DBH Class (in)	Present Stand (stem count)	Expected Mortality (%)	Expected Survival (stems)	10-year DBH Growth (in)
6	522	40	313	2.2
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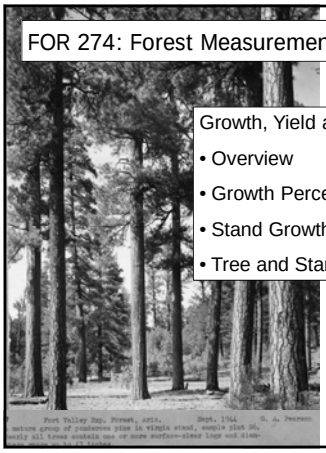
FOR 274: Forest Measurements and Inventory



Growth, Yield and Biomass

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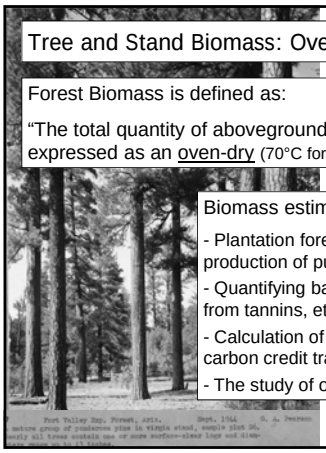
Tree and Stand Biomass: Overview



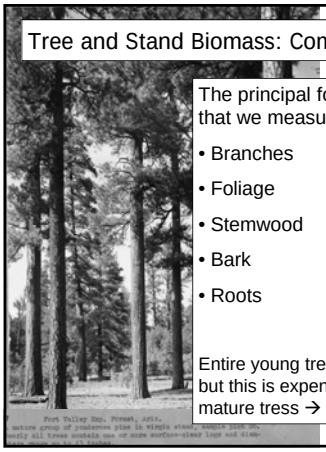
Forest Biomass is defined as:

"The total quantity of aboveground live organic floristic matter expressed as an oven-dry (70°C for 24hrs) weight"

Biomass estimation is important for:

- Plantation forests that are managed for production of pulpwood or energy
- Quantifying bark etc for products produced from tannins, etc
- Calculation of carbon pools and stocks for carbon credit trading
- The study of other biogeochemical cycles

Tree and Stand Biomass: Components

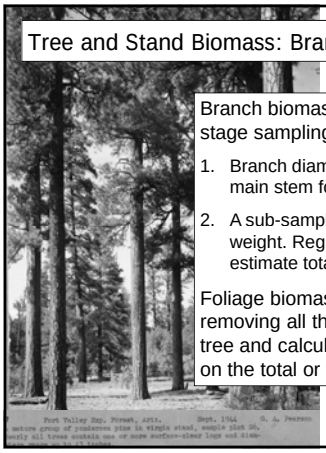


The principal forest biomass components that we measure include:

- Branches
- Foliage
- Stemwood
- Bark
- Roots

Entire young trees can be measured by felling but this is expensive and impracticable for mature tress → sampling methods

Tree and Stand Biomass: Branches and Foliage

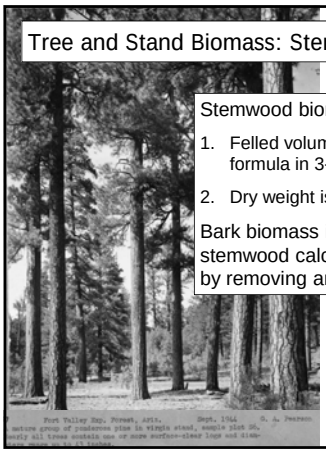


Branch biomass is often measured by a 2-stage sampling method:

1. Branch diameter is measured 1-2" from main stem for all branches
2. A sub-sample are used to estimate over weight. Regression model the used to estimate total branch weight.

Foliage biomass is often measured by removing all the needles/leaves from the tree and calculating the oven-dry weight on the total or from a 25% sample

Tree and Stand Biomass: Stemwood and Bark

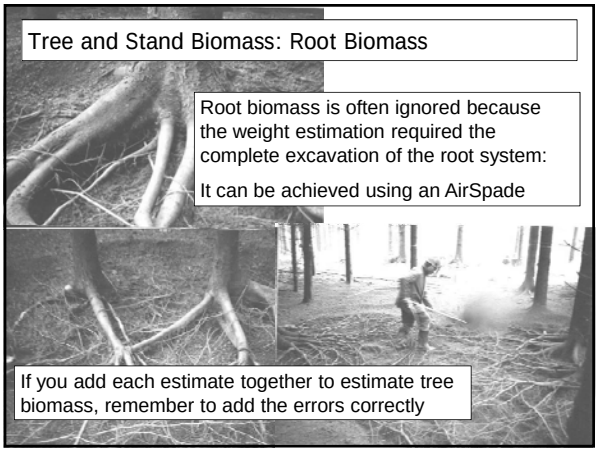


Stemwood biomass is often measured by:

1. Felled volume measured using Smalian's formula in 3-10' sections
2. Dry weight is calculated on cookies

Bark biomass is often clumped into stemwood calculations or can be achieved by removing and oven-drying the bark.

Tree and Stand Biomass: Root Biomass



Root biomass is often ignored because the weight estimation required the complete excavation of the root system:

It can be achieved using an AirSpade

If you add each estimate together to estimate tree biomass, remember to add the errors correctly