



## GROWTH AND YIELD

How will my forest grow?

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## GROWTH AND YIELD

Purpose of this presentation:  
To introduce you to concepts and methods of estimating growth and yield of forest stands and how you can use these in management of your forest

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## YIELD

is the amount of standing or existing volume, weight, mass or other characteristic of interest at a specified point in time



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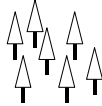
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**Pine stand @ age 15 years:  
81 tons/ac of standing  
merchantable fiber.**

**At age 20 same stand:  
108 tons/ac of standing  
merchantable fiber.**



**YIELD at age 15 is 81 tons/ac**

**YIELD at age 20 is 108 tons/ac**

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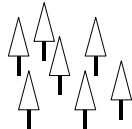
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**Stand thinned at age 20  
removing 54 tons/ac**

**At age 27 stand has  
100 tons/ac standing**



**Standing Yield @ age 27 = 100 t**

**Total Yield at age 27 is  
100 t + 54 t (thinned) = 154 t/ac**

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## **GROWTH**

**is the change in size,  
volume, weight or  
other characteristic  
of interest over a  
specified time period**



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At age 15 years -- 81 t/ac yield  
At age 20 years -- 108 t/ac yield

Periodic Growth over five years

= 108 tons - 81 tons = 27 tons  
= 10 cords @ 2.7 tons/cord  
(5400 lb/cord)

Average ANNUAL Growth is  
(27 tons/ac) / 5 yrs = 5.4 t/ac/yr  
= 2 cords/ac/yr

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### Basic concepts of growth and yield using an example planted pine stand

Example:  
540 trees/acre planted  
Site Index = 65 feet at base 25 yrs

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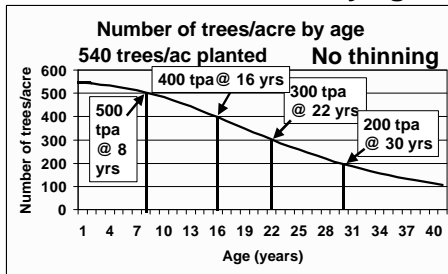
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### Example Planted Pine Stand Number of trees/acre by age



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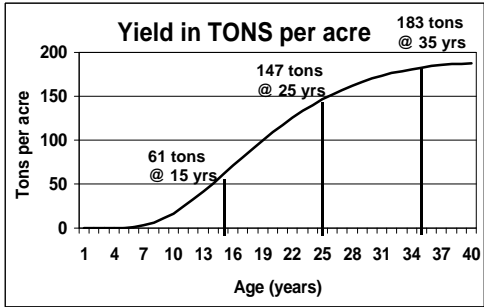
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### Example YIELD Curve




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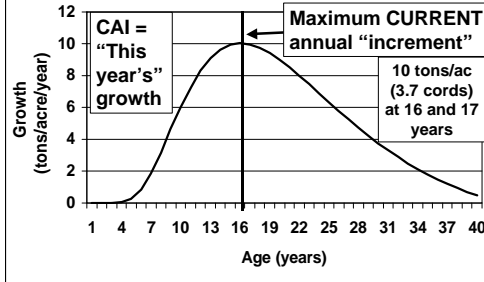
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### Current yearly growth (tons/acre) or Current annual increment (CAI)




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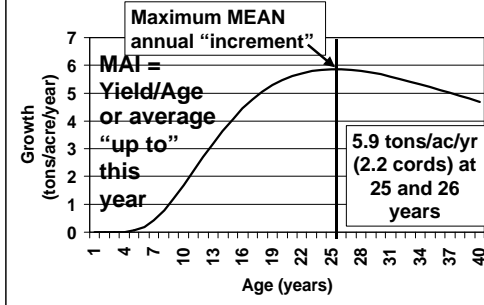
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### Mean annual increment (MAI) /acre




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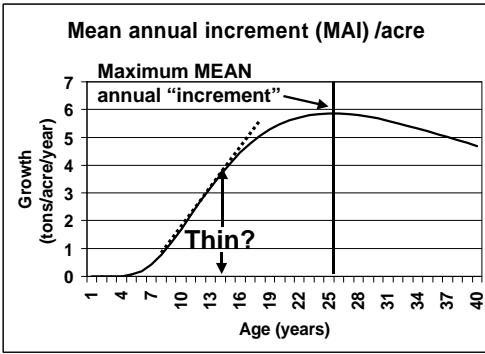
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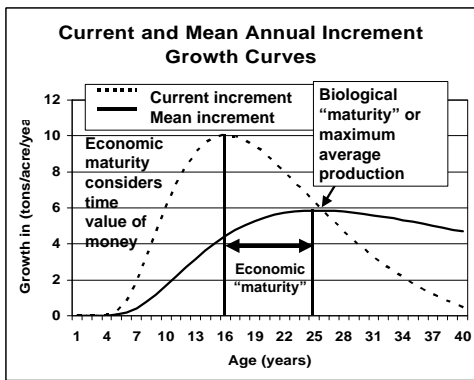
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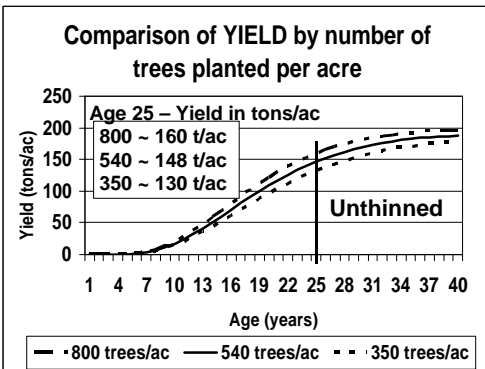
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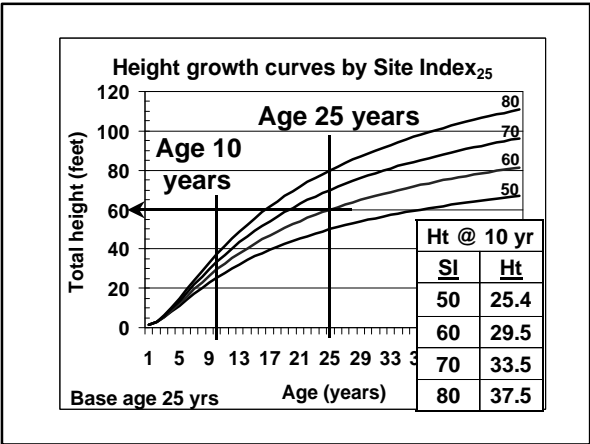
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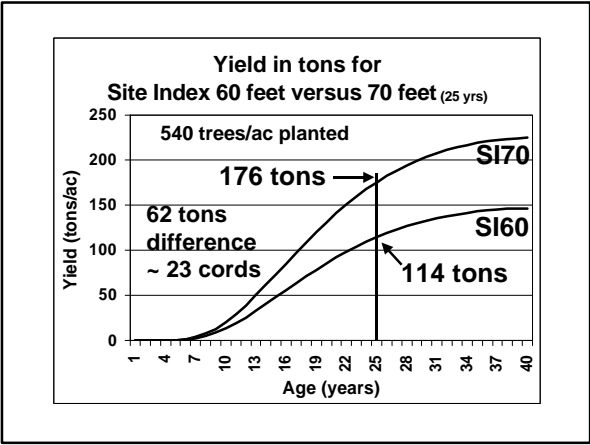
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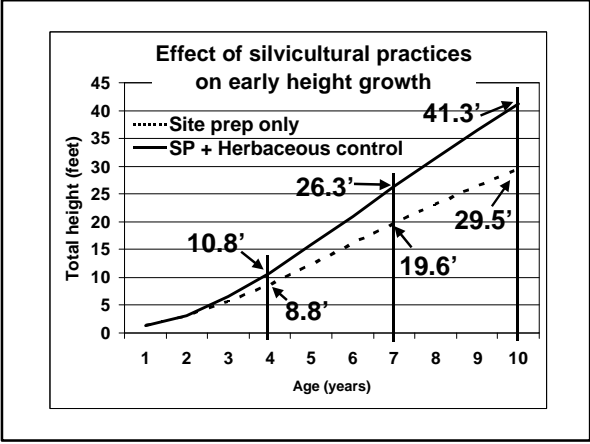
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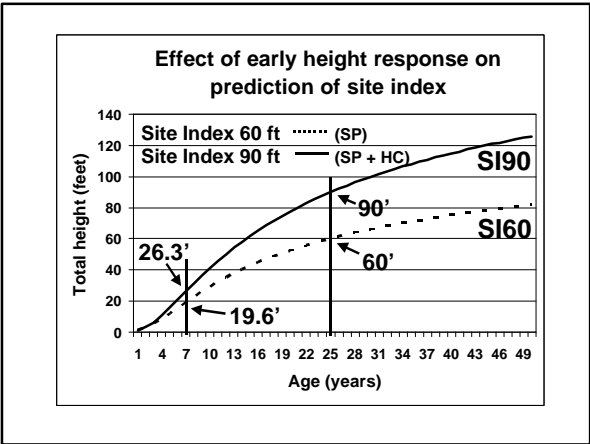
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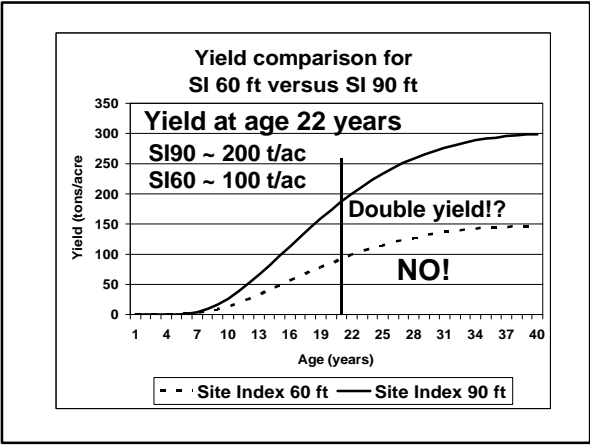
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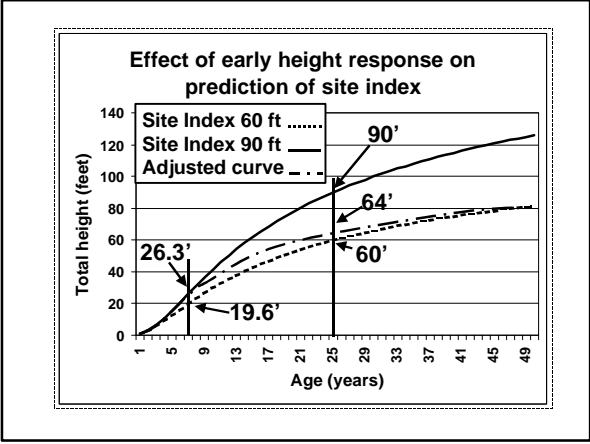
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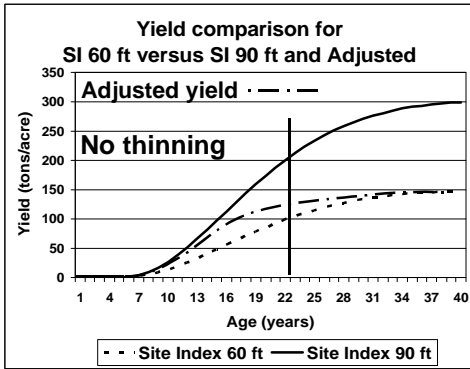
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## Types of Growth & Yield Projections

- Growth Percent
- Stand Table Projection
- Growth and Yield Equations and Models

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Growth percent is a simple expression of growth relative to a starting value over a specified time period

Annual Simple Growth percent =  

$$\frac{(\text{Yield @ Age2} - \text{Yield @ Age1})}{(\text{Yrs in period} \times \text{Yield @ Age1})} \times 100$$

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**Simple Growth Percent**  
**Example**

Yield at age 15 yrs: 47 tons  
Yield at age 20 yrs: 69 tons

Annual Growth %  
=  $\frac{(69 \text{ t} - 47 \text{ t})}{(5 \times 47 \text{ t})} \times 100 = 9.36\% / \text{yr}$

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**Simple Growth Percent Example:**

**Future Yield**

=Current Yield X  $\frac{((\text{AG}\% \times \# \text{ years}) + 1)}{100}$

=47 tons X  $\frac{((9.36\% \times 5 \text{ years}) + 1)}{100} = 69.0 \text{ t}$

=69.8 tons X  $\frac{((9.36\% \times 5 \text{ years}) + 1)}{100} = 101.4 \text{ t}$

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**Simple Growth Percent Example:**  
**(used to estimate timber basis for tax)**

Yield at age 35 yrs: 143 tons  
What was yield 12 years ago?  
Assume 6% average annual growth %

**Previous Yield**

=Current Yield  $\div \frac{((\text{AG}\% \times \# \text{ years}) + 1)}{100}$

=143 tons  $\div \frac{((6\% \times 12 \text{ years}) + 1)}{100} = 83 \text{ t}$

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**Stand Table Projection**

Stand table projection uses a current diameter distribution (stand table) and Recent Past Growth (usually from increment cores) to project or estimate future diameter distribution (and growth and yield)

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**Stand Table Projection**

Stand Table Projection works best in thrifty growing UNEVEN-AGED stands (for 10 years in South), but can be used in EVEN-AGED stands with CAUTION for short time periods (5 years in South)

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**Example Stand (and Stock) Table**

| Dbh (inches)  | Number of Trees/ac | Current Yield (tons) |
|---------------|--------------------|----------------------|
| 6 (5.6-6.5)   | 75                 | 7.9                  |
| 7 (6.6-7.5)   | 150                | 27.2                 |
| 8 (7.6-8.5)   | 165                | 45.4                 |
| 9 (8.6-9.5)   | 120                | 46.5                 |
| 10 (9.6-10.5) | 66                 | 34.5                 |
| Total         | 576                | 161.5                |

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### Projected Stand Table

| Dbh (inches) | Past 5-yr Growth | Current trees/ac | Future trees/ac |
|--------------|------------------|------------------|-----------------|
| 6            | 0.65"            | 75               | 26.3            |
| 7            | 0.85"            | 150              | 48.8+22.5=71.3  |
| 8            | 1.10"            | 165              | 127.5           |
| 9            | 1.52"            | 120              | 148.5           |
| 10           | 1.43"            | 66               | 16.5+57.6=74.1  |
| 11           | --               | --               | 62.4+37.6=100.0 |
| 12           | --               | --               | 28.4            |
| <b>Total</b> |                  | <b>576</b>       | <b>576</b>      |

Using Growth Index Ratio:  $R = \text{Growth} \div \text{dbh class size}$

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### Current and Future Yield

| Dbh (in.)    | Current Trees/ac | Current Yield (t) | Future trees/ac | Future Yield (t) |
|--------------|------------------|-------------------|-----------------|------------------|
| 6            | 75               | 7.9               | 26.3            | 2.8              |
| 7            | 150              | 27.2              | 71.3            | 12.9             |
| 8            | 165              | 45.4              | 127.5           | 35.1             |
| 9            | 120              | 46.5              | 148.5           | 57.5             |
| 10           | 66               | 34.5              | 74.1            | 38.8             |
| 11           | --               | --                | 100.0           | 68.3             |
| 12           | --               | --                | 28.4            | 24.7             |
| <b>Total</b> | <b>576</b>       | <b>161.5</b>      | <b>576</b>      | <b>240.1</b>     |

▲ No mortality ▲ t = tons

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### Growth and Yield Equations

Mathematical equations that estimate yield based on :

- Stand age
- Site index (indicator of site quality)
- A measure of density (basal area or number of trees)

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**Growth and Yield Equations**

Example--Bennett (1970) – Slash Pine

$$\ln(V) = 5.98812 - 121.713/S - 19.758/A + 0.89683 \ln(B)$$

(cu. ft.)

V = Volume Yield

S = Site Index (base age 25 years) = 60 ft

A = Age at desired yield, in years = 25 yr

B = Basal at age A = 150 sf  
(predicted from another equation)

V = 2128 cubic feet ≈ 27 cords (@ 80 cf/cord)

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**Diameter Distribution**  
**Growth and Yield Models**

Uses a series of equations to predict distribution of number of trees by diameter class for stand characteristics such as:

- age
- stand basal area
- site index

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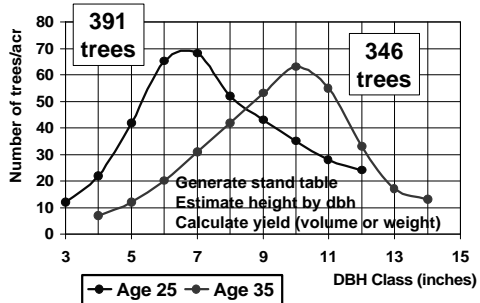
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**Diameter Distributions at Two Ages**




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**Individual Tree  
Growth and Yield Models**

A computer program links components of growth to simulate growth of individual trees, then aggregates these trees to provide stand-level (per acre) growth and yield

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**Individual Tree  
Growth and Yield Models**

The system is primarily driven by **COMPETITION** among neighboring trees

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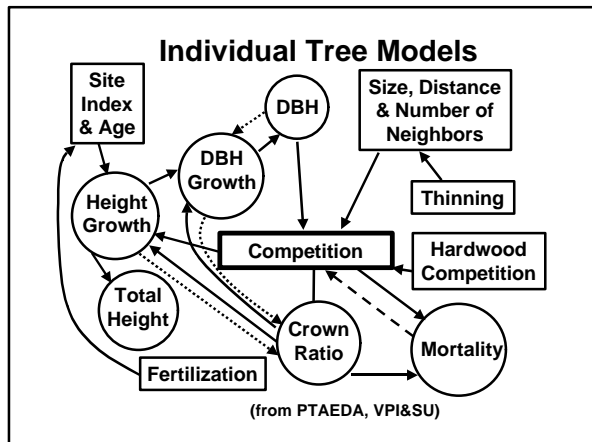
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**There is an adage  
that states:**

**ALL MODELS ARE  
WRONG, BUT SOME  
MODELS ARE USEFUL**

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**Most growth and yield models are  
developed from (and predict)  
“ideal” stands.**

**Models are mathematical equations  
that CANNOT completely mimic  
complex biological processes.**

**Models MUST be used  
with CARE, CAUTION  
and EXPERIENCE**

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**In Conclusion:**

**The proper inventory of  
products (and other  
resources) on your forest and  
the judicious projection of  
how your stands will grow  
can help you make better  
decisions about your forest.**

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**Making Good Decisions  
is a KEY to  
Successful  
Management**

**ENJOY YOUR  
FOREST!**

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