FOR 347: Silviculture
Instructor: Dr. Jeremy Stovall
Lecture 21: 04.12.2018
Thinning: Density Management 2
Group Exercise

• A landowner asks you whether this bottomland hardwood stand needs to be thinned. How do you respond? Explain your logic.

Density = 160 TPA
Basal Area = 120 ft²/ac
QMD = 12 in
Density, Stocking, and Relative Density

- **STAND DENSITY:** A quantitative, absolute measure of tree occupancy per unit of land area in such terms as numbers of trees, basal area, or volume.

- **STOCKING:** An indication of growing-space occupancy relative to a pre-established standard. Common indices of stocking are based on percent occupancy, basal area, relative density, and crown competition factor.

- **STAND RELATIVE DENSITY:** The ratio, proportion, or percent of absolute stand density to a reference level defined by some standard level of competition.
Who Decides Stocking Standards?

- EXPERT SYSTEM
- Art & Science Part

Figure 3. A computer model (COMPUTE_P-LOB) projection of two unthinned plantations with a site index (base age 25) of (A.) 65 and (B.) 55 ft, in relationship to the stand density management boundaries.
Quantitative Tools

• SDI
• Relative Density
• Stand Density Management Diagrams
• Gingrich Style Stocking Charts
• Live Crown Ratio
Stand Density Index (Reineke 1933)

- SDI = TPA × [QMD/10]^{1.605}
- Index value for stands with QMD of 10 inches
- Plot of logarithm of QMD vs log of trees/acre
- Obtained by graphing data collected in the field from fully stocked stands.
Logarithmic Scale
Stand Density Index for Upland Oak (Schnur 1937)

Slope = -1.5
### Stand Density Index (Reineke 1933)

<table>
<thead>
<tr>
<th>Species</th>
<th>Max SDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upland oaks</td>
<td>230</td>
</tr>
<tr>
<td>Longleaf pine</td>
<td>400</td>
</tr>
<tr>
<td>Shortleaf pine</td>
<td>400</td>
</tr>
<tr>
<td>Slash pine</td>
<td>400</td>
</tr>
<tr>
<td>Loblolly pine</td>
<td>450</td>
</tr>
<tr>
<td>Ponderosa pine</td>
<td>450</td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>595</td>
</tr>
<tr>
<td>Coastal Redwood</td>
<td>1000</td>
</tr>
</tbody>
</table>
Quantitative Tools

- SDI
- Relative Density
- Stand Density Management Diagrams
- Gingrich Style Stocking Charts
- Live Crown Ratio
Full Stocking

Relative density, like stocking, can be expressed in a variety of units:

<table>
<thead>
<tr>
<th></th>
<th>$ft^2 / acre$</th>
<th>$m^2 / hectare$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerant evergreens</td>
<td>130-230</td>
<td>30-53</td>
</tr>
<tr>
<td>Intolerant evergreens</td>
<td>80-130</td>
<td>18-30</td>
</tr>
<tr>
<td>Tolerant deciduous</td>
<td>70-160</td>
<td>16-37</td>
</tr>
<tr>
<td>Intolerant deciduous</td>
<td>50-80</td>
<td>12-18</td>
</tr>
</tbody>
</table>
Relative Density

Most common form of RD:
Actual SDI / Max SDI = Relative Density (%)

What is RD of a loblolly stand with SDI = 110?
Relative Density

• Crown Closure: RD = 15% \(\text{NATURAL STANDS}\)
• Imminent Mortality: RD > 55%
  – Also called lower limit of self-thinning
• Manage SYP in range of 30-45%
Quantitative Tools

- SDI
- Relative Density
- **Stand Density Management Diagrams**
- Gingrich Style Stocking Charts
- Live Crown Ratio
Density Management Diagrams

![Density Management Diagram](image)

**Figure 1.** The maximum size-density relationship and the natural stand data used in positioning this relationship.

Density Management Diagrams

Figure 3. A computer model (COMPUTE_P-LOB) projection of two unthinned plantations with a site index (base age 25) of (A.) 65 and (B.) 55 ft in relationship to the stand density management boundaries.

Density Management Diagrams

Figure 4. Size-density trends for three management regimes in a Douglas-fir plantation at Golden Downs, New Zealand.

http://www.ingentaconnect.com/content/saf/fs/1979/00000025/00000003/art00024
Density Management Diagrams

Figure 4. Computer model (COMPUTE_P-LOB) projections of a loblolly pine plantation with four management strategies: Case I—no thinnings; Case II—thinnings above the line of initial self-thinning (SDI = 220); Case III—thinnings between crown closure (SDI = 160) and initial self-thinning; Case IV—thinnings below crown closure.

Density Management Diagrams

Figure 2. A density-management diagram for slash pine plantations in the lower Coastal Plain.

Quantitative Tools

• SDI
• Relative Density
• Stand Density Management Diagrams
• **Gingrich Style Stocking Charts**
• Live Crown Ratio
Gingrich Style Stocking Chart
Stocking Diagrams Relate

- Number of trees/acre
- Basal area
- QMD

- $\text{TPA} \times 0.005454 \times \text{QMD}^2 = \text{BA}/\text{A}$
- So when any two are known, the third can be found on the stocking diagram
Stocking Guide for Southern Bottomland Hardwoods

A

B

FOR 347 Lecture 21 Revised 08.24.2016
Interpreting a Stocking Guide

• **A Level**
  – FULL stocking

• **B Level**
  – Assuming that the trees are evenly distributed, each tree will have all the growing space that it can use.
  – In Upland hardwoods this is about 58% of full stocking

• **C Level of Stocking**
  – Shows the stocking necessary for a stand to reach B Level within 10 years assuming average site quality.
  – Less time needed on better sites; more time needed on poorer sites.
Stocking guides show

• How completely a stand is occupying its available growing space.
• How much of the stand may be removed without wasting site resources (space).
• How the stand will grow following thinning
Relationship Between Stand Basal Area and Diameter Growth in Loblolly Pine

![Graph showing the relationship between initial basal area and annualized dbh growth in Loblolly Pine, with data points differentiated for unthinned and thinned conditions.](image-url)
Above the A Line

- Stands are overstocked
- Individual tree growth will be slow
- Mortality will be high
- Stand characteristics will tend to parallel the A line over time

Loblolly Pine  Overstocked for US, but not Brazil.

William Ciesla, FHMI, bugwood.org
Between the A and B Lines

• Stands are fully stocked
• Total growth per acre will be equal for stands of similar site and species composition
• However, diameter growth of individual trees will vary greatly
  – The fastest diameter growth will occur in stands near the minimum density
• Stand density can be manipulated within the area between the “A” and “B” levels to alter diameter growth and obtain trees of the desired diameter.
Stands between the B and C lines

- These stands are understocked
- All available growing space is not being effectively used
- Diameter growth will be rapid
- Total stand volume production is less than the site potential
- Very little competition induced mortality
Below the C Line

- Stands are considered understocked
- Diameter growth very rapid
- However some most of the available growing space is not used
- Stand volume production much less than potential
- At “C” line it will take more than 10 years to reach full stocking (return to B line)
Stocking Guides Vary By Species

• Stocking guides must be developed for each stand type due to species variation in silvical characteristics
  – Shade Tolerance
  – Growth Rate
  – Growth Form
  – Crown Form
  – Crown Size
Stocking Guides, Complex or Simple

Stocking guide for Allegheny hardwoods.
Can Plot Stand Growth & Plan Thinning
Quantitative Tools

• SDI
• Relative Density
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• Gingrich Style Stocking Charts
• Live Crown Ratio
Live Crown Ratio

• General Guidelines:
  – 25% growth is severely limited
  – 33% need to thin
  – 40% growth ideal

• Do you see any issues?