Wood Quality: The Effects of Planting Density and Thinning

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Why is managing stand density so important?
The manipulation and control of growing stock to achieve specific management objectives.

The basis for managing stand density is the fact that site resources are limited.

One objective of density management is to minimize competition-related mortality.

Steve Fitzgerald, OSU Extension
What are YOUR objectives?

- Maximum volume yield?
  - of thinnings and final harvest?

Large diameter of crop trees?

Short rotations?

Top quality trees & logs?
How do you want to manage wood quality?

By volume, characteristic, product?
bigger, faster
What is it that defines wood quality?

Density: earlywood/latewood proportions
Fiber length
Microfibril angle
Growth rate – rings per inch
Juvenile/mature wood
Knots
Slope of grain
Reaction wood
Sapwood/heartwood ratio
Juvenile Wood & Mature Wood

Property patterns within a tree due to physiology & genetics ➔ species

(Senft et al 1985)
Greatest contributor to relative density is proportion of latewood.
Processing Streams

Resource Size & Quality

- Appearance products
  - Veneer
  - Lumber
- Structural Products
- Round wood
  - Posts & Poles
- Particle and Fiber
  - Panel Products
  - Pulp and paper
  - Chemicals
  - Heat
- Energy
Mix High & Low Rated Material in Product Design
Reduce variation in raw material by stranding or milling for use in composite products.
What are some of your options for influencing wood quality?

- Initial spacing
- Pre-commercial thinning
- Commercial thinning
- Pruning
- Growth acceleration
  - fertilization
  - brush control
  - irrigation
- Genetic controls
Evaluation of Silvicultural Regimes

Growth and yield

Net value of products

Harvesting

Management costs

Fight et al. 1986
Initial spacing
(stocking density)
Many Small = One Large
Wood Quality and the Crown

Open Grown Tree

Tree from Dense Stand
Trees per acre vs. tree size

- **Zone of competition mortality**
- **Optimum growth zone**
- **Crown closure**
Douglas-fir Density Management Diagram

DENSITY MANAGEMENT DIAGRAM
DOUGLAS-FIR
(after Drew & Rewelling 1976)
Crossover effect

- Early, faster tree growth at close spacings
- Not sure how long this effect lasts
- Average height and diameter at breast height were larger as planting density increased (Scott et al. 1998)
What’s All This Mean?

*Branch Size*

- Trees grown at wide initial spacings tend to have large branches
- Large branches limit solid wood product potential
Other things to consider

- Stability: height/diameter ratios

  lower through reduced planting densities
  or early thinning

  Higher initial planting densities shorten the time period during which thinning can be expected to effectively lower future ratios

  Wilson and Oliver 2000
Thinning
Juvenile wood

JW to MW transition

Mature wood over juvenile wood core
Thin a 10-15 year old stand

- Think of starting with the middle & top part of the older tree
- Live crown is within the butt log
  - Larger branches & knots
- Whole tree is producing JW
  - Faster growth may widen rings & diameter of JW core in butt log
- Management choices can greatly affect value of butt log

Courtesy of David Briggs, University of Washington
What’s All This Mean?

Branch Size

- Trees thinned early tend to have large branches
- Large branches limit solid wood product potential
Knot Size, Lumber Width, & Lumber Grade

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<th>Knot Size</th>
<th>Lumber Width</th>
<th>S.Str. No.</th>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 3</th>
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<td>No. 1</td>
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</tr>
<tr>
<td>6”</td>
<td>1.5”</td>
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<td></td>
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<td>8”</td>
<td>2”</td>
<td>No. 3</td>
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Thin a 30-35 year old tree ➔ effect on Butt Log

- Dead branches ➔ knot size is fixed
- JW/MW transition occurred in past ➔ JW diameter is fixed
- All volume added is MW
- Increased ring width may exceed desired rpi
- JW % decreases
- Larger pieces possible

Courtesy of David Briggs, University of Washington
Thin a 30-35 year old tree ➔

effect on Middle log

- Live branches of lower crown get better light & growth
  - Slower crown recession
  - Larger knots
- JW/MW transition
  - done at log bottom
  - Will soon migrate past log top
  - JW diameter may increase a bit at upper end
- Volume added:
  - some JW at top but mostly MW
  - will have high JW %
- Increased ring width
- Somewhat larger pieces

Courtesy of David Briggs, University of Washington
Thin a 30-35 year old tree ➔ effect on Top log

- Will become longer
- Vigorous live branches ➔ larger knots
- Volume added: all JW until transition to MW moves into this position
- 100% JW % until MW transition enters the log
- Increased ring width (?)
- Pieces small but longer
- Log/lumber grades (low)
- $

Courtesy of David Briggs, University of Washington
What's All This Mean?

*Lumber Grades*

Earlier, heavier thinning result in larger trees sooner but only average lumber grades.

Later, lighter thinning result in smaller trees with better lumber grades.
What's All This Mean?

Mechanical Properties

Mechanical properties of both spruce and hemlock suffer from wide early spacings.

Later thinning does not seem to adversely affect mechanical properties.
Thinning Effects on Mature Wood Properties

- **Fibers:**
  - shorter, larger diameter, thinner walls, larger microfibril angle
  - small changes; important (?)

- **Specific gravity:**
  - increase, decrease, not change
  - changes generally within 5%

- **Growth rings:**
  - abrupt change from narrow to wide
  - may exceed desired rpi limits

- **Compression wood:**
  - may form ➔ heavier crown & wind

- As stand rebuilds toward competitive state, effects diminish

Courtesy of David Briggs, University of Washington
Yield of visually graded lumber & veneer

**LLAD** (largest limb average diameter) = branch index (bix)

Selecting the grading face.

- LLAD: Get diameter of largest knot in each face & average

![Graphs showing visually graded lumber and veneer recovery](image)

**Visually Graded Lumber Recovered**

**Visually Graded Veneer Recovered**

Courtesy of David Briggs, University of Washington

Fahey et al. 1991
Yield of Machine Stress Rated Lumber ➞ LLAD & JW

- If LLAD < 1 inch
  - 70 year has 20-40% of highest grade
  - 30 year has < 5% highest grade, but you can grow 2 stands of 30 year *in less time*

- If LLAD > 2 inch
  - Both stands have about 70% No 3 & Economy
  - Large knot size overwhelms JW effect

Courtesy of David Briggs, University of Washington
Knots: LLAD of a log is correlated with diameter of largest limb in the BH region of the tree (DLLBH)

- **Focus on BH region**
- **Simple to measure**

Diameter of largest branch in BH region (DLLBH)

Courtesy of David Briggs, University of Washington
Can translate a simple BH measurement into a log quality index or vice-versa

5 m log LLAD vs largest BH limb: Twin Peaks # 736

\[ y = 0.7045x + 10.718 \]

\[ R^2 = 0.5813 \]

Courtesy of David Briggs, University of Washington
Wood Quality

Consumer Preferences & Product requirements

Wood Properties
- stiffness
- strength
- dimensional stability
- machinability
- warp
- roughness
- peelability
- appearance
- growth acceleration
- genetics
- pulp yield
- log size
- log form
- knots
- grain angle
- wood density
- microfibril angle
- internal defects
- % extractives
- sapwood %
- reaction wood
- rotation length
- initial spacing
- thinning
- pruning
- growth acceleration
- genetics

Courtesy of Barbara Lachenbruch, Oregon State University
If your mind has a tendency to wander, take a walk in the woods.....
....then your mind and your body can wander together and keep each other company!
USDA Forest Service
PNW Research Station

Ecologically Sustainable Production of Forest Resources team

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* thank you *