Impact of Silvicultural Practices on Loblolly Pine Wood Quality

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Overview

- The Wood Quality Consortium (WQC)
- Sampling standing trees
- Densitometry
- Competition control at planting
- Mid-rotation thinning and fertilization
Industry will rely increasingly on fast-growing plantations to furnish the raw material for solid wood and fiber products in the South.

Highly productive plantations =

- Merchantable at younger ages
- Shorter rotation lengths
- Higher proportion of juvenile wood
- Wood and fiber properties?
WQC – formed in 1999

A research partnership between the University of Georgia, Warnell School of Forestry and Natural Resources and the USDA Forest Service, Southern Research Station

• R. F. Daniels and L. R. Schimleck (UGA)
• A. Clark III (USDA Forest Service, retired)

• Multiple industry partners: Arborgen
  Huber
  Rayonier
  Smurfit-Stone
  Weyerhaeuser
Initial goals of the WQC were:

1) to establish a regionwide baseline for wood properties in loblolly pine plantations;

2) to estimate the effects of intensive silvicultural practices on wood properties; and

3) to develop predictive models to predict wood properties at the tree, stand and regional levels.

This presentation will discuss research conducted to assess the effects of intensive silvicultural practices on wood properties.
Hydraulic borer used to remove cores
12 mm increment cores
X-ray densitometry
Example of x-ray densitometer simultaneous video and x-ray
Aim: to reduce herbaceous and woody competition, and improve growth owing to increased availability of moisture and nutrients (improved by fertilization)

Treatments:

1) Competition control (herbaceous and woody)

2) Fertilization (N and P if required)

3) Intensity of site preparation

Important in the southern USA where competing weeds and hardwood vegetation can inhibit growth of plantation trees
Ring specific gravity profiles

Control (LSP)
HSP
HSP+F
HSP+H
HSP+F+H

Physiological age (ring number)
Weighted LW proportion

Site/Treatment

<table>
<thead>
<tr>
<th>Site/Treatment</th>
<th>LSP 1</th>
<th>LSP 2</th>
<th>Intensive 3</th>
<th>LSP 4</th>
<th>Intensive 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>WLP (%)</td>
<td>42.4</td>
<td>48.5</td>
<td>58.6</td>
<td>47.3</td>
<td>47.2</td>
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</tbody>
</table>
Diameter of the juvenile core (DJC) for each treatment (all sites)

- LSP: 15.7 cm
- HSP: 15.9 cm
- HSP+F: 16.7 cm
- HSP+H: 16.8 cm
- HSP+F+H: 17.6 cm

Intensive treatments:
Proportion of juvenile wood (%JW) for each treatment (all sites)

- LSP: 66%
- HSP: 68%
- HSP+F: 66%
- HSP+H: 67%
- HSP+F+H: 69%

Intensive treatments
Estimated transition zone/age for each site-treatment combination

<table>
<thead>
<tr>
<th>Site</th>
<th>t</th>
<th>LSP</th>
<th>HSP</th>
<th>HSP+F</th>
<th>HSP+H</th>
<th>HSP+F+H</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>0.9</td>
<td>17</td>
<td>14</td>
<td>13</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>0.5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
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<tr>
<td></td>
<td>0.9</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
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<td>3</td>
<td>0.5</td>
<td>3</td>
<td>4</td>
<td>4</td>
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<td>4</td>
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<tr>
<td></td>
<td>0.9</td>
<td>10</td>
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<tr>
<td></td>
<td>0.9</td>
<td>14</td>
<td>14</td>
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</tr>
</tbody>
</table>

Transition age \( (t_{0.9}) \)

Transition JW / MW  Mature wood
Summary of main findings:

1) Significant growth responses observed (competition control = more resources for crop trees)

2) Earlywood SG, latewood SG, ring SG and latewood percent not significantly different from controls

3) Owing to improved growth when young the diameter of the juvenile core was increased, while density was decreased slightly

4) Competition control does not effect density at a given age or the length of the juvenile period

5) Herbaceous control ceases to influence stand at crown closure, woody control can influence growth for life of stand
Mid-rotation fertilization and thinning

Aim: remove small or diseased trees, therefore improving stand quality (retain best trees), also improves growth of remaining trees (aided by fertilization) and maintains stand vigor

Treatments include:

1) Thin at ages 12-14 years, or 2 years after crown closure to ensure that trees are producing mature wood

2) Fertilization (N and P if required) to enhance growth rates of mature wood

3) Second thin at approximately 20 years, fertilize

Mid-rotation fertilization has been rapidly adopted for southern pine plantations, area fertilized at mid-rotation has increased from 81,000 ha (1997) to 0.6 million ha (2002)
Influence of mid-rotation fertilization and thinning on latewood SG
Summary of main findings:

1) Mid-rotation fertilization post thinning produces a significant growth response

2) Only the highest rate of fertilization significantly reduced both ring SG and latewood SG for the 4 years following fertilization

3) Lower density corresponded to an increase in tracheid radial diameter and a reduction in tracheid wall thickness

4) The effect is transient and wood properties return to levels similar to untreated trees within a few years
Planting density is important as it determines the management regime that will be applied to the stand.

Presently in the southern USA trees are being planted at wider spacing’s in conjunction with weed control and fertilization = sawtimber sized trees in shorter rotations

Current practice in response to weak demand to small diameter loblolly pine

It is recognized that planting at wide-spacing stimulates crown and diameter growth resulting in larger diameter branches
### Average DBH and total height of trees on measurement plots by spacing at age 21

<table>
<thead>
<tr>
<th>Spacing (m)</th>
<th>Trees/ha (No.)</th>
<th>DBH Average</th>
<th>DBH Range (mm)</th>
<th>Total Height Average</th>
<th>Total Height Range (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8x2.4</td>
<td>2244</td>
<td>196</td>
<td>71-351</td>
<td>21.9</td>
<td>7.6-27.1</td>
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<tr>
<td>1.8x3.0</td>
<td>1794</td>
<td>213</td>
<td>117-325</td>
<td>23.2</td>
<td>15.8-27.7</td>
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<td>1.8x3.6</td>
<td>1495</td>
<td>221</td>
<td>104-333</td>
<td>22.9</td>
<td>12.8-27.7</td>
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<tr>
<td>2.4x3.0</td>
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<td>236</td>
<td>135-394</td>
<td>23.5</td>
<td>15.8-27.4</td>
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<tr>
<td>2.4x3.6</td>
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<td>246</td>
<td>102-366</td>
<td>24.4</td>
<td>11.0-28.7</td>
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<tr>
<td>3.0x3.6</td>
<td>897</td>
<td>259</td>
<td>145-345</td>
<td>24.7</td>
<td>16.8-28.7</td>
</tr>
<tr>
<td>3.6x3.6</td>
<td>746</td>
<td>279</td>
<td>81-417</td>
<td>24.7</td>
<td>8.8-28.0</td>
</tr>
</tbody>
</table>
Impact of initial spacing on survival of unthinned loblolly pine at age 21

![Bar chart showing the survival percentage for different spacings (m): 3.6x3.6, 3.0x3.6, 2.4x3.6, 2.4x3.0, 1.8x3.6, 1.8x3.0, 1.8x2.4. The survival percentage ranges from 80 to 100% for the different spacings.]
Effect of initial planting density on av. number of knots (live, dead and overgrown)
Effect of initial planting density on av. knot diameter (live, dead and overgrown)
Effect of initial planting density on proportion of static bending samples with MOE ≥ 11 GPa

![Graph showing the effect of initial planting density on the proportion of static bending samples with MOE ≥ 11 GPa. The x-axis represents the number of trees per hectare and the spacing, while the y-axis shows the proportion of bending samples (%). The graph includes three lines, each representing different spacings of 2.4 m, 7.3 m, and 12.2 m, with corresponding tree densities at 746, 897, 1122, 1344, 1495, 1794, and 2244 trees per hectare.]
Estimated proportion of lumber in grade number 1, 2, and 3 by spacing.
Summary of main findings:

1) Spacing’s ranging from 1.8×2.4 m (2244 trees/ha) to 3.6×3.6 m (746 trees/ha) were sampled, average DBH and height increased with increased spacing

2) Average number of knots, knot diameter and average maximum knot diameter increased with increased spacing

3) Highest proportion of high stiffness samples came from 1.8x3.6m spacing

4) Total stem green weight/ha (wood and bark) to a 75mm dob top was highest in the 1.8×3.6 m, 2.4×3.0 m and 2.4×3.6 m spacing’s
Other WQC studies

The WQC has been involved in a range of other studies examining effects of fertilization and other silvicultural practices that are not practiced operationally, including:

1) Annual fertilization and complete competition control

2) Fertilization and irrigation

3) Fertilization at different rates and intensities
Acknowledgements

Past and current industry members of the Wood Quality Consortium

Research partners of the Wood Quality Consortium

Students (undergraduate, M.S. and PhD), and UGA / WQC and USDA FS research staff
Past and current industry members of the WQC