Development of High Quality Hardwoods with Conservation Values

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Presentation Outline

• Purpose/Objectives

• Present Results of Afforestation in Bottomlands (NRCS) and Alternatives

• Research in Stand Dynamics to Create Mixed Species Stands through Afforestation
Question?

Can we have both conservation values and high grade hardwoods in planted stands?
Question?

Can we have both conservation values and high grade hardwoods in planted stands?

Emphatically YES
We need to plan ahead and decide what we desire and how to get there

i.e., *Pathways*
Common Goals of Afforestation

• Simulate natural stands
• Diverse flora and fauna
• Complex forest, several canopy layers
• Mixed species
• Wildlife habitat and mast
• High-grade trees, multi-products and multi-values
Present Afforestation Guidelines

- Generally follow cost-share program guidelines ----
- Few trees, wide spacings, single species
- Trying to minimize afforestation costs
Present Afforestation Results

• Pure species plantings
Present Afforestation Results

- Pure species plantings
- Poor form, many & large branches
Present Afforestation Results

- Pure species plantings
- Poor form, many & large branches
- Lack of canopy stratification
Present Afforestation Results

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- Wide spacing ---- late canopy closure
Present Afforestation Results

- Pure species
- Poor form, many & large branches
- Lack of canopy stratification
- Wide spacing ---- late canopy closure
- Crown abrasion (define)
Present Afforestation Results

• Pure species
• Poor form, many & large branches
• Lack of canopy stratification
• Wide spacing ---- late canopy closure
• Crown abrasion (define)
• Sufficient nat regen between widely planted trees does not occur
Single Species Hardwood Plantings
Single Species Hardwood Plantings
Monospecific

Little, if any, crown stratification in pure oak plantation – decurrent growth pattern

Example species – Cherrybark oak
Spacing for Closed Canopy

![Graph showing spacing for closed canopy](image)

**Axes:**
- **Horizontal crown surface area (ft²)**
- **Groundline diameter (inches)**

**Key Features:**
- The graph illustrates the relationship between horizontal crown surface area and groundline diameter.
- Years are marked along the graph, indicating growth over time.
- Distances such as 8 x 7 and 12 x 12 are indicated, possibly representing planting distances.

This graph helps in planning the spacing of trees to ensure a closed canopy is maintained.
Branch Size and Occlusion

- Oswalt, C. 2011.

Technique for predicting clear wood production in hardwood stems: A model for evaluating hardwood plantation development and management
Data - illustrated

- Overwood
- Occluded Branches
- Knotty Core
- Clear Wood
Identifying the "Knotty Core"
Identifying the “Knotty Core”
Branch Defects
Crown Abrasion

Brannon, Tyler 2012.

Evaluating Methodologies to Assess Abrasion in Tree Crowns
Pendulum Impacts for Bud Strength
Crown Abrasion

DORMANT SEASON 32.3-40.2 KPH

Z-AXIS ACCELERATION (G)

X-AXIS ACCELERATION (G)
# Force for Bud Breakage

<table>
<thead>
<tr>
<th>Species</th>
<th>Minimal Force (N)</th>
<th>0-8.1</th>
<th>8.2-16.1</th>
<th>16.2-24.1</th>
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<td>0.016</td>
<td>0.037</td>
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<td>Liquidambar styraciflua</td>
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<td>0.046</td>
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<tr>
<td>Liriodendron tulipifera</td>
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<td>Quercus alba*</td>
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<td>0.002</td>
<td>0.004</td>
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<tr>
<td>Quercus falcata*</td>
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<td>0.003</td>
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<td>0.017</td>
<td>0.037</td>
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<td>Quercus texana*</td>
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<td>0.002</td>
<td>0.004</td>
<td>0.008</td>
<td>0.015</td>
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Crown Abrasion

- Rubbing of buds (both flower & vegetative)
- Limits crown stratification & crown size
- Little mast production
- Adjacent crowns are physically battering each other ---- limits crown expansion
- CROWN NEEDS SPACE
Genetics (R. Rousseau)

Genetics can play a role too!
Defect:

High quality sawtimber is a product that is always in demand but very little is produced in oak plantations.

Characteristics such as: forking, epicormics, poor stem form, ramicorns, and stem blemishes are among those that we need to select against.

Combined selection including information concerning defects is needed to provide gains in growth and quality.
Oak Species Comparison Study

Test Design:

a) Split Plot Design
   - Six blocks
   - Five species
   - 49 tree-block plots
   - 9 x 9 ft. spacing

b) Herbaceous control
   - Year 1 - Diskings
   - Year 2 – Oust and Roundup
Survival of the five oak species at ages 1, 3, 5, 10, 15 and 20 years

<table>
<thead>
<tr>
<th>Species</th>
<th>Age 1</th>
<th>Age 3</th>
<th>Age 5</th>
<th>Age 10</th>
<th>Age 15</th>
<th>Age 20</th>
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<tbody>
<tr>
<td>Cherrybark</td>
<td>97.6bc</td>
<td>96.3a</td>
<td>96.3a</td>
<td>95.6a</td>
<td>90.1a</td>
<td>76.5ab</td>
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<tr>
<td>Nuttall</td>
<td>100.0a</td>
<td>96.9a</td>
<td>96.9a</td>
<td>96.9a</td>
<td>93.9a</td>
<td>82.6a</td>
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<tr>
<td>Pin</td>
<td>98.6ab</td>
<td>96.6a</td>
<td>96.6a</td>
<td>96.3a</td>
<td>92.9a</td>
<td>79.9ab</td>
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<td>Water</td>
<td>96.6c</td>
<td>88.1b</td>
<td>88.1b</td>
<td>86.4b</td>
<td>82.3b</td>
<td>70.1c</td>
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<tr>
<td>Willow</td>
<td>98.6ab</td>
<td>96.3a</td>
<td>95.9a</td>
<td>95.9a</td>
<td>93.5a</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>98.2</strong></td>
<td><strong>94.8</strong></td>
<td><strong>94.7</strong></td>
<td><strong>94.2</strong></td>
<td><strong>90.5</strong></td>
<td><strong>79.0</strong></td>
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</table>
Least square means of all oak species for height at ages 1, 3, 5, 10, 15 and 20 years

<table>
<thead>
<tr>
<th>Species</th>
<th>Age 1</th>
<th>Age 3</th>
<th>Age 5</th>
<th>Age 10</th>
<th>Age 15</th>
<th>Age 20</th>
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<tbody>
<tr>
<td>Cherrybark</td>
<td>1.7c</td>
<td>5.7d</td>
<td>10.4d</td>
<td>28.4c</td>
<td>45.9b</td>
<td>60.5c</td>
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<tr>
<td>Nuttall</td>
<td>1.9b</td>
<td>7.1c</td>
<td>11.9c</td>
<td>29.7b</td>
<td>43.0c</td>
<td>55.3d</td>
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<td>Pin</td>
<td>1.9b</td>
<td>8.1b</td>
<td>13.7a</td>
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<tr>
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<td>1.7c</td>
<td>7.8b</td>
<td>12.6b</td>
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<td>48.3a</td>
<td>63.1a</td>
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<tr>
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<td>2.3a</td>
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<td>13.4a</td>
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<td>Sp Diff</td>
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<td>5.0</td>
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</tbody>
</table>
Least square means of all oak species for dbh at ages 10, 15 and 20 years

<table>
<thead>
<tr>
<th>Species</th>
<th>Age 10</th>
<th>Age 15</th>
<th>Age 20</th>
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<tbody>
<tr>
<td>Cherrybark</td>
<td>3.8b</td>
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<td>7.1b</td>
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<td>Nuttall</td>
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<td>Pin</td>
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<tr>
<td>Water</td>
<td>4.5a</td>
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<tr>
<td>Willow</td>
<td>4.6a</td>
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<tr>
<td>Sp Diff</td>
<td>0.8</td>
<td>0.9</td>
<td>1.6</td>
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</table>
Characteristics of Oak Development in Plantation Management

Height growth reduced as seedling builds a large root system

Accelerated height growth following root production - trees overtop herbaceous competition and crowns greatly expanding

Crown closure – intensification of tree to tree competition followed by suppression and mortality
Combining Timber and Wildlife in Pure Oak Plantations

Thin Early with Strategic Selection:

Select larger crown trees for acorn production

a. Remove enough trees to allow for greater crown expansion and seed production

b. Remove sufficient numbers of trees to also allow for sunlight to the forest floor
Combining Timber and Wildlife in Pure Oak Plantations

Thin Early with Strategic Selection:

Select based on timber quality characteristics

a. Select trees based on stem form, crown traits and lack of defect in the butt log

b. Do not thin as heavily as was done for the wildlife component. Want to decease competition but not to the point of open grown
IF Pure Species

- Thin and perhaps prune
- Not simulating natural oak development
- More costly for desired conditions
- Less diversity
- Little crown stratification
- Lessens crown friction

There is another alternative
Planting MIXED Species
Factors

- Spacing within and between species
- Site suitability for each species, even within a genus
- Growth rate of each species
- Crown form of each species
Concepts

- Force Height Growth
- Reduce amount of pruning
- Limit branch size (diameter)
- Avoid epicormic branching and/or sun scald
Pine Mentality ???

• Conventional plantation mgmt
  – Tight Spacing
  – Monospecific
  – Thinning(s)
  – Volume instead of grade

• Probably will not work with most hardwoods – specifically oaks, crown stratification does not occur

• Value is grade in the butt log
Example: Cherrybark Oak and Sweetgum
(Natural Stands)

Approx. 20 years
Importance of Crown Form

Excurrent Form

Decurrent Form
Monospecific

Free space between crowns with an excurrent growth pattern

Example species - Sweetgum
Monospecific

Little, if any, crown stratification in pure oak plantation – decurrent growth pattern

Example species – Cherrybark oak
Multispecific
Multispecific
Multispecific
Multispecific
Comparison

Multispecific

Monospecific
Pressing Question

• What is the impact of various silvicultural decisions on the production of quality hardwood logs?

• Understanding is Critical

- Hardwood plantation spacing
- Hardwood plantation species mixtures
- Hardwood thinning schedules

Optimize for Grade
**Importance of Crown Stratification**

- Without stratification, **crown development** may be hindered.

- Without stratification, heavy intraspecific competition may result in **stagnation**.

- Without stratification, **stem quality** may be negatively influenced.
Spacing

Wide Spacing

- Increased weed competition & maintenance
- Reduced stem quality due to greater taper, longer branch retention, more knots (defects) ---
- Planting costs are less
- Trees have short boles and wide crowns
- Increased understory growth will provide wildlife food and habitat until canopy closes
Spacing

- **Close Spacing**
  - Increased planting and seedling costs
  - Faster crown closure resulting in less weed competition and maintenance
  - Improved stem quality (straighter boles and small, self-pruning branches)
  - Greater number of trees to select from during thinning operations
Spacing for Closed Canopy

- Horizontal crown surface area (ft²)
- Groundline diameter (inches)

- Years: 4, 5, 6, 7, 8, 9, 10
- Groundline diameter: 8 x 7, 12 x 12

Graph showing the relationship between horizontal crown surface area and groundline diameter.
## Spacing & Planting

<table>
<thead>
<tr>
<th></th>
<th>4'</th>
<th>5'</th>
<th>6'</th>
<th>7'</th>
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<th>9'</th>
<th>10'</th>
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<th>15'</th>
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</table>
What About Cost?

- Cost of seedlings --- 300 vs 600+
- Cost of planting seedlings with larger root systems
- Site preparation before planting
- Vegetation control after planting

Cost is a Major Consideration!
Conservation Planting Design

- Systematic

12 x 12
Conservation Planting Design

• Closer Spacing
Conservation Planting Design

• Even Closer Spacing - Recommended

concentrating competition control on smaller areas reducing cost
Planting Design Options

A

B

C
Ongoing Research

Planting at UT Cumberland Forest

3 species x 3 spacings x 3 reps

Planted in 2009 ----- 4 growing seasons
Mixed Species Planting Research

Spacings:  
6’ x 6’  1210 trees/A  
8’ x 8’  680 trees/A  
10’ x 10’  435 trees/A

Species ---- Cherrybark oak mixed with
a. Yellow-Poplar
b. Black Cherry
c. Sweetgum
Take Home Messages

Mixed Species Hardwood Plantings

• Most natural hardwood stands develop as mixed species, not single species

• Produce a forest that is more natural in appearance, more diverse flora & fauna

• Stand development is quite different from monocultures. Canopy stratification

• Generally produce more branch-free, high-grade timber than single species stands
Take Home Messages

Mixed Species Hardwood Plantings

• Provides both vertical and horizontal structure, emulates natural stands

• Different species grow at different rates make management more difficult

• More flexible management opportunities and less risk than single species stands

• Canopy stratification with mixed species ---- less chance of crown abrasion, more crown area for mast production
Questions and/or Comments if Time Permits