# Survival and Growth of Restored Piedmont Riparian Forests as Affected by Site Preparation, Planting Stock, and Planting Aids

*Sponsored by:*

- *Wetlands Studies and Solutions Incorporated,*
- *R.J. Reynolds Forest Research Extension Center,*
- *Virginia Tech Forest Resources and Environmental Conservation Department*

VIRGINIA TECH
Forest Resources
& Environmental
Conservation

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# Introduction

- Created wetlands and restored wetlands are used to offset wetlands destroyed or severely disturbed by permitted activities.
- Wetland creation projects for forested wetlands have a relatively poor record of success and mitigation ratios of 2:1 or greater have been used.


# Introduction

- **Common causes of forested wetland creation failures (e.g., low survival rates) include:**
- **Poor species selection**
- **Compacted soils**
- **Excessively wet site**
- **Lack of microtopography**
- **Low soil organic matter**
- **Acid conditions**

*(Daniels 2012)*

# Rationale

- Forest managers have successfully used mechanical site preparation to offset very poorly drained site conditions, severe soil compaction, and lack of microtopography since the 1950's. (≈ 60,000 acres in 2010).

- Preconditioning has been shown to influence outplantings.

- Little transfer of forest management research to forested wetland restoration projects.

# Objectives

**Subproject 1**

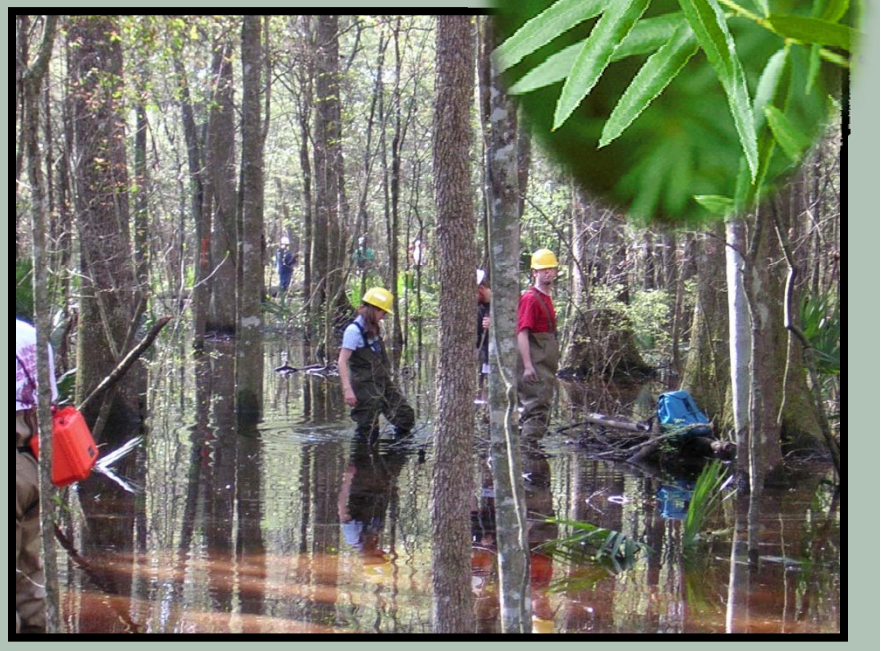
Determine the influence of seed source and/or preconditioning treatments on survival and growth of *P. occidentalis* and *Q. phellos* on Piedmont riparian wetland restoration sites.

**Subproject 2**

Quantify effects of site preparation treatments, regeneration source, and/or planting aids on survival and growth of *P. occidentalis* and *Q. phellos* on Piedmont riparian wetland restoration sites.

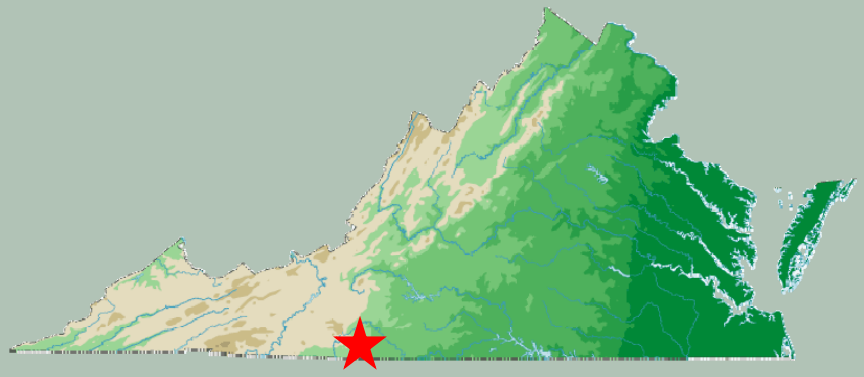
# Species selection based on availability and desire to have species of rapid growth and mast production

- Sycamore (*Platanus occidentalis)*



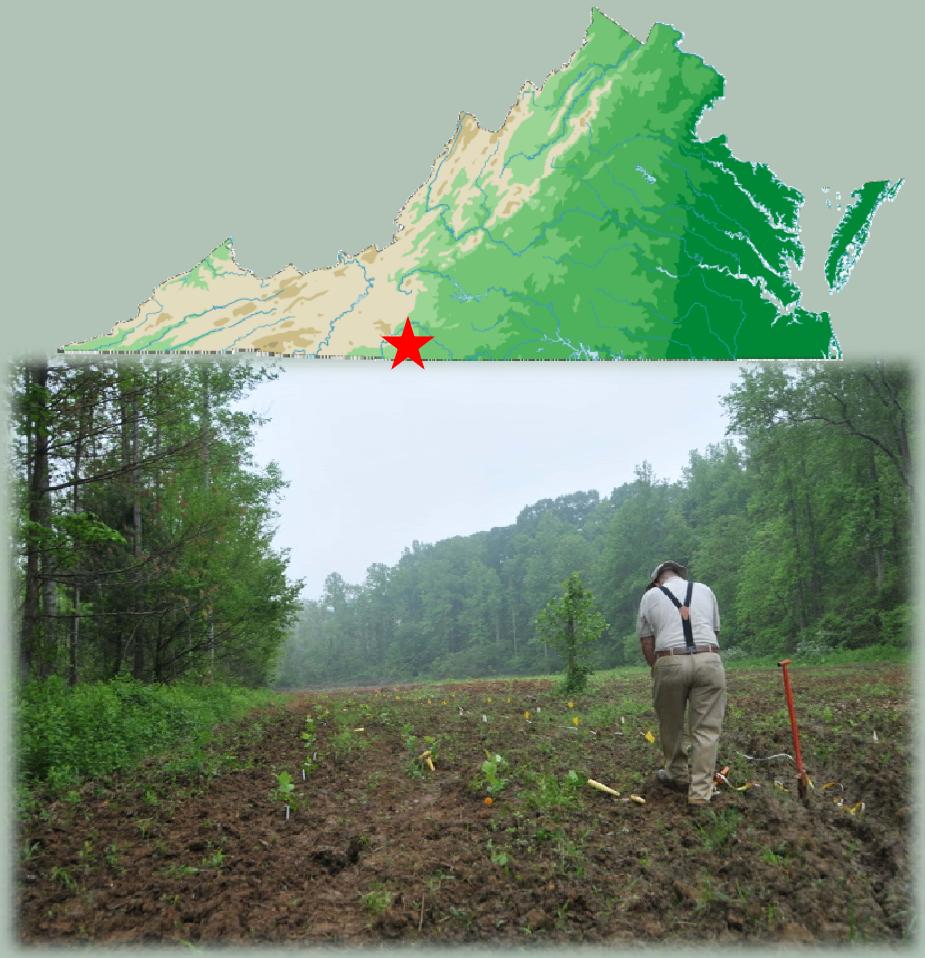
- Willow Oak (*Quercus phellos)*

# Study Site: RJ Reynolds Forest Research Extension Center



- Piedmont physiographic province, Patrick Co., Va.
- Tobacco plantation from 1840's - 1950's

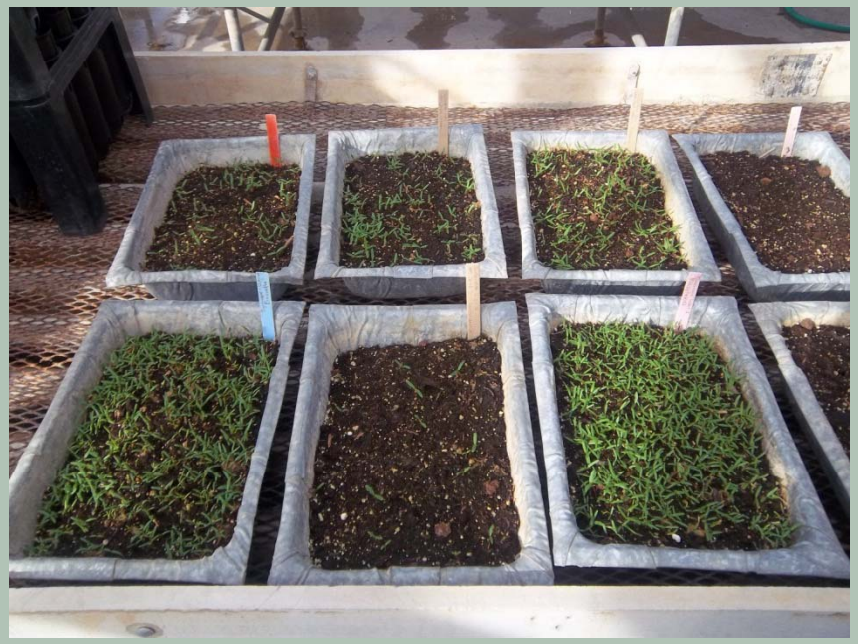
# Study Site: RJ Reynolds Forest Research Extension Center



- Study site is excessively wet, compacted by agriculture, research, and lacking microtopography.

# Subproject 1

- Seed Source and Preconditioning Study
  - Objective: Determine the influence of seed source and/or preconditioning on survival and growth of *P. occidentalis* and *Q. phellos* on Piedmont riparian wetland mitigation sites.



# Seed Sources

- Five Counties in Piedmont and Ridge and Valley
- Sources:
  - Dry (Upland areas)
  - Wet (Bottomland areas)

# Cultural Treatments

- **Control: Seedlings watered daily**
- **Flood: Seedlings saturated in water for multiple days, followed by one day of drying.**
- **Drought: Seedling drought stressed to visible wilting**

# Seedling Establishment

- Seedlings (Tubelings) were established in the Virginia Tech greenhouse in January 2011
  - Seedlings were allowed to grow for 2 months before preconditioning treatments were started
- Preconditioning occurred from March-April 2011
- Tubelings were transplanted to Reynolds Homestead in mid-April 2011

# Project Location

# Greenhouse Data Analysis

- Conducted after greenhouse treatments
- 5 sample seedlings from each seed source*treatment
  - Height, diameter, leaf area, and root length were obtained and used for preliminary analysis

# Outplanting Data Collection

- January – February 2012, November 2012
  - Measured Survival (Yes/No), heights (cm), and diameters (cm)

# Effect of Nursery Source after 1 Year

## Percent survival of tubelings

| | Sycamore | Willow oak |
|---|---|---|
| Virginia Tech | 83% | 86% |
| Commercial | 71% | 45% |

# **Willow oak** seedling performance after 2 growing season as influenced by **seed source**

| Seed Source | Height (cm) | Diameter (cm) | Biomass Index ($cm^3$) | Survival % |
|---|---|---|---|---|
| Pittsylvania – Wet | 63.2 bc | 0.76 a | 45.9 ab | 88.5 a |
| Pittsylvania 2 – Wet | 68.8 a | 0.80 a | 62.5 a | 88.4 a |
| Pittsylvania – Dry | 54.5 c | 0.62 b | 25.7 b | 91.7 a |
| Nelson – Dry | 52.5 b | 0.63 b | 29.4 b | 83.3 a |

# **Sycamore** seedling performance after 2 growing season as influenced by **seed source**

| Seed Source | Height (cm) | Diameter (cm) | Biomass Index ($cm^3$) | Survival % |
|---|---|---|---|---|
| Pittsylvania – Wet | 169 bc | 2.6 ab | 1679 ab | 93.5 a |
| Leon Jones – Wet | 192 ab | 2.7 ab | 1933 ab | 81.7 ab |
| Fishburn – Wet | 155 c | 2.4 b | 1471 b | 79.0 b |
| Fishburn – Dry | 181 abc | 2.6 ab | 1713 ab | 79.0 b |
| Fincastle – Dry | 209 a | 3.1 a | 2635 a | 93.3 a |

# Subproject 1 summary

- **Preconditioning had few effects. Few significant effects of cultural treatments during years one or two.**
- **Nursery stock had a significant effect on survival.**
- **Significant survival and growth differences were detected based on seed source.**

# Subproject 2 Objectives

Quantify effects of site preparation treatments, regeneration source, and/or planting aids on survival and growth of *P. occidentalis* and *Q. phellos* on Piedmont riparian wetland restoration sites.

# Experimental Design for each species

## *Randomized Complete Block Design with Split-Split Plot*

- 5 blocks
- 5 site preparation methods
- 4 regeneration sources
- 3 planting aids
- 4 stems of each combination
- ≈1200 stems for each species

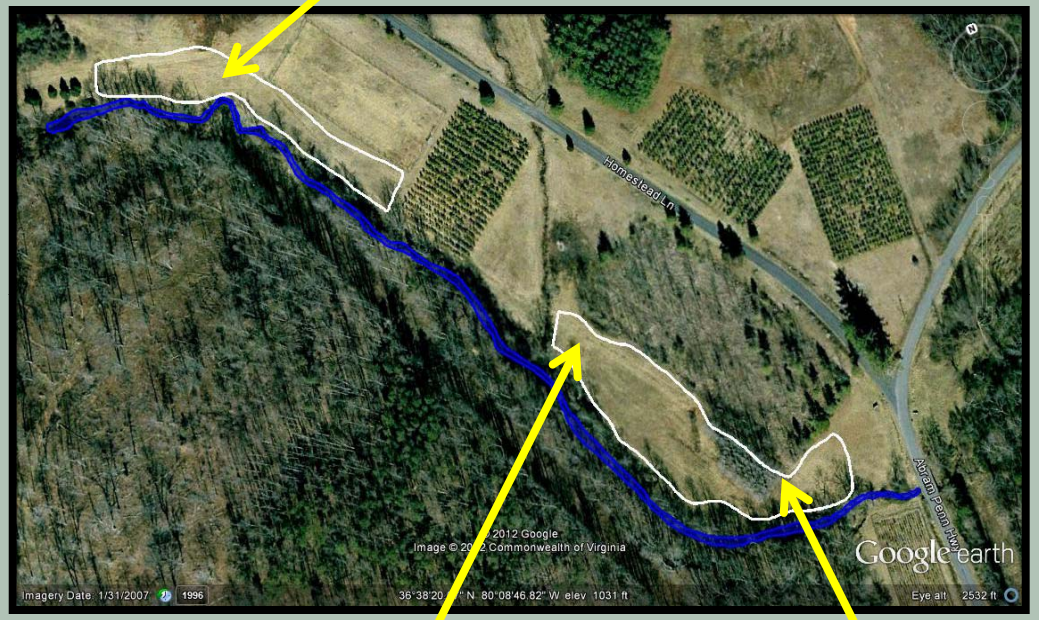
| | | | |
|---|---|---|---|
| Gallon (Mat) ▲ ▲ ▲ ▲ | Gallon (Control) ▲ ▲ ▲ ▲ | Direct Seed (Control) X X X X | Bare Root (Mat) • • • • |
| Tubeling (Control) ■ ■ ■ ■ | Tubeling (Tube) ■ ■ ■ ■ | Tubeling (Mat) ■ ■ ■ ■ | Direct Seed (Tube) X X X X |
| Direct Seed (Mat) X X X X | Bare Root (Tube) • • • • | Bare Root (Control) • • • • | Gallon (Tube) ▲ ▲ ▲ ▲ |

# Project Layout


- Odd numbers- Sycamore
- Even numbers – Willow Oak

# Soils

**Augusta: fine-loamy, mixed semiactive, thermic Aeric Endoaquults**




**Roanoke: fine, mixed, semiactive, thermic Typic Endoaquults**

**French: fine loamy over sandy, mixed, active mesic Fluvaquentic Dystrudepts**

# 4 (5*) Site Preparation Treatments – Flat Planting/Disk

## Flat Plant -Disk

## Rip


## Bed

## Pit and Mound*

# 4 Regeneration Sources

## Direct Seed

## Bare Root

## Gallon

## Tubeling

# 3 Planting Aids

## Tubex Tubes

## None

## Vispore Mats

# Planting and Culture

- Planting May 2011
- Planting Aids June 2011
- Minimal herbaceous control, summers 2011, 2012
- Measurements late falls 2011, 2012
  - *Survival*
  - *Ground-line diameter*
  - *Total height*
  - *Biomass index ($d^2h$)*

At Planting

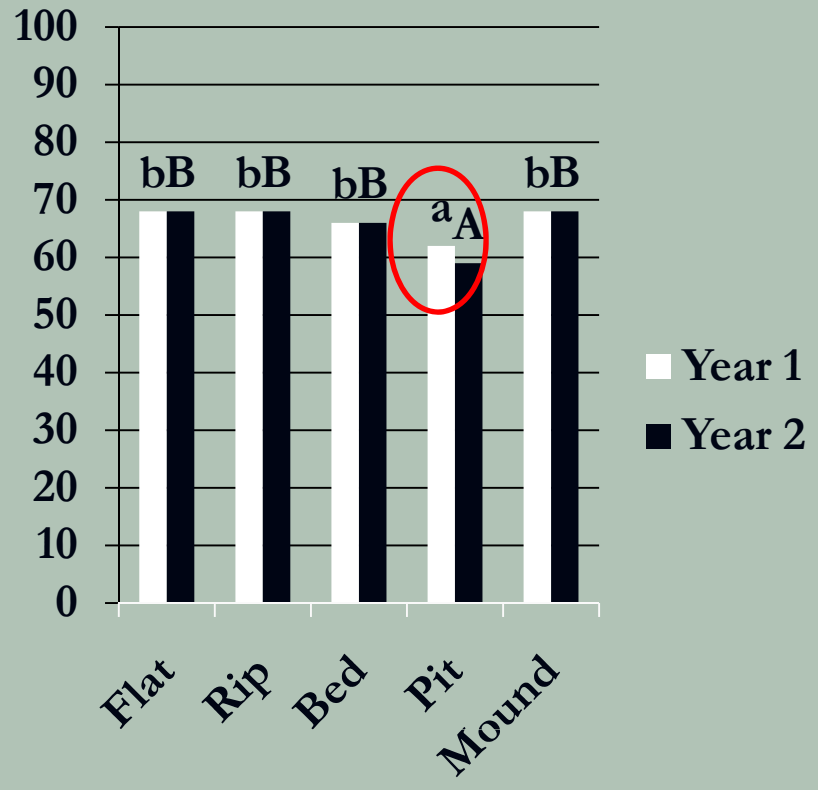
1st Growing Season

2nd Growing Season

# Survival % by Site Preparation

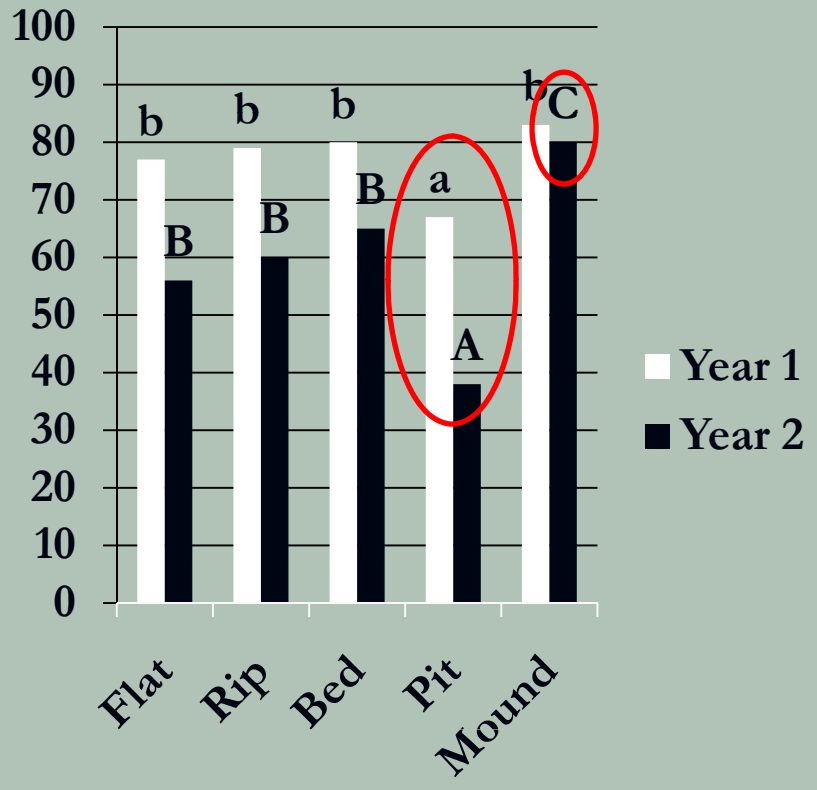
## Sycamore

**Yr 1 p < 0.0001, Yr 2 p = 0.0561**




## Willow Oak

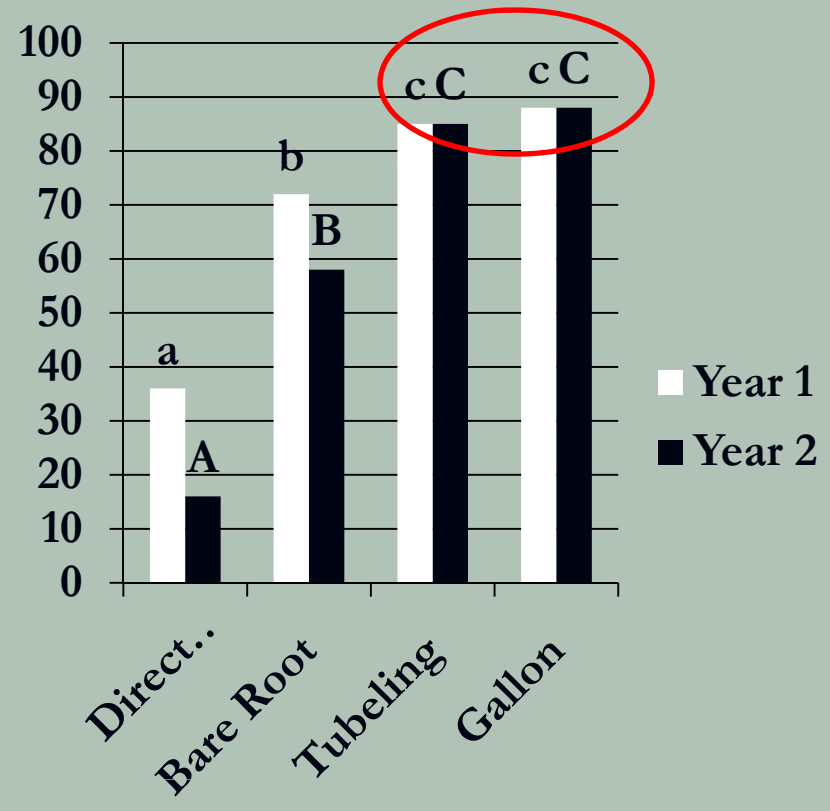
**Yr 1 p < 0.0001, Yr 2 p < 0.0001**



# Survival % by Regeneration Source

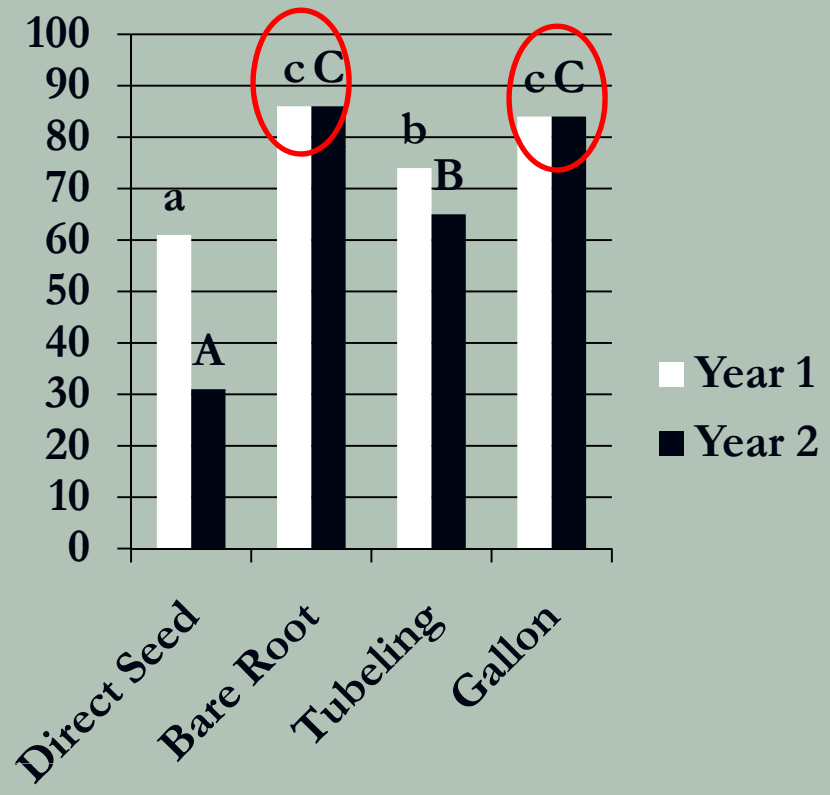
## Sycamore

**Yr 1 p < 0.0001, Yr 2 p = 0.0001**




## Willow Oak

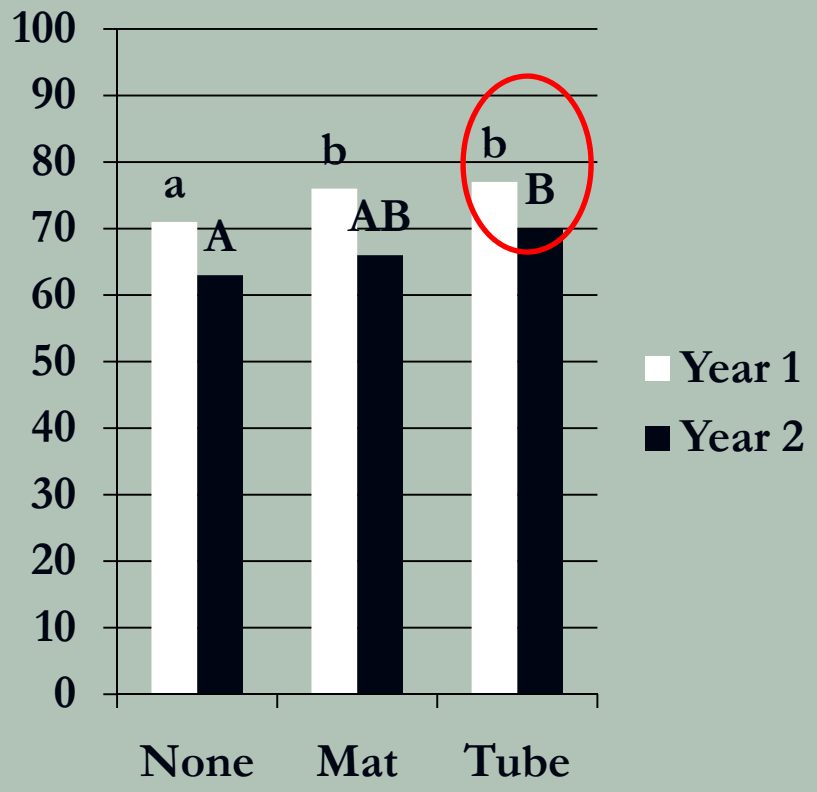
**Yr 1 p < 0.0001, Yr 2 p < 0.0001**



# Survival % by Planting Aid

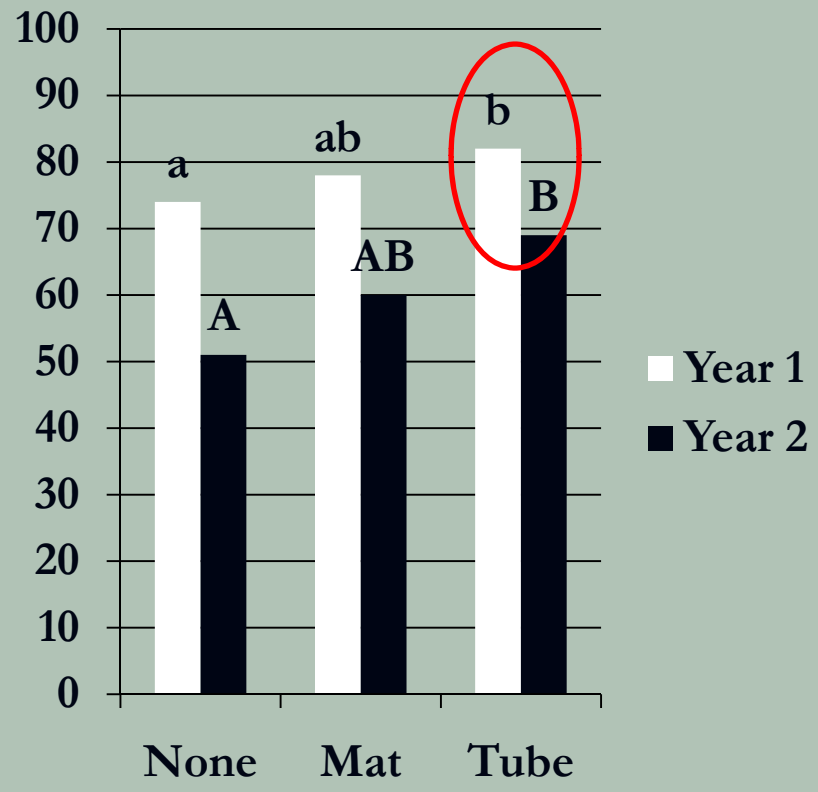
## Sycamore

**Yr 1 p = 0.006, Yr 2 p < 0.0001**




## Willow Oak

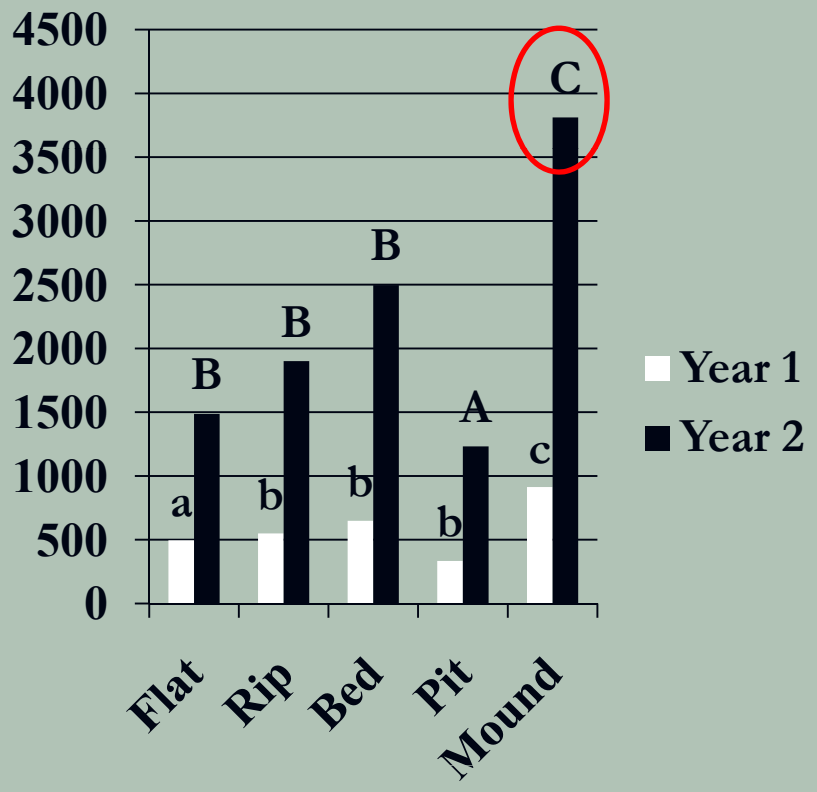
**Yr 1 p value < 0.0001, yr 2 p <0.0001**



# Biomass Index ($cm^3$)by Site Preparation

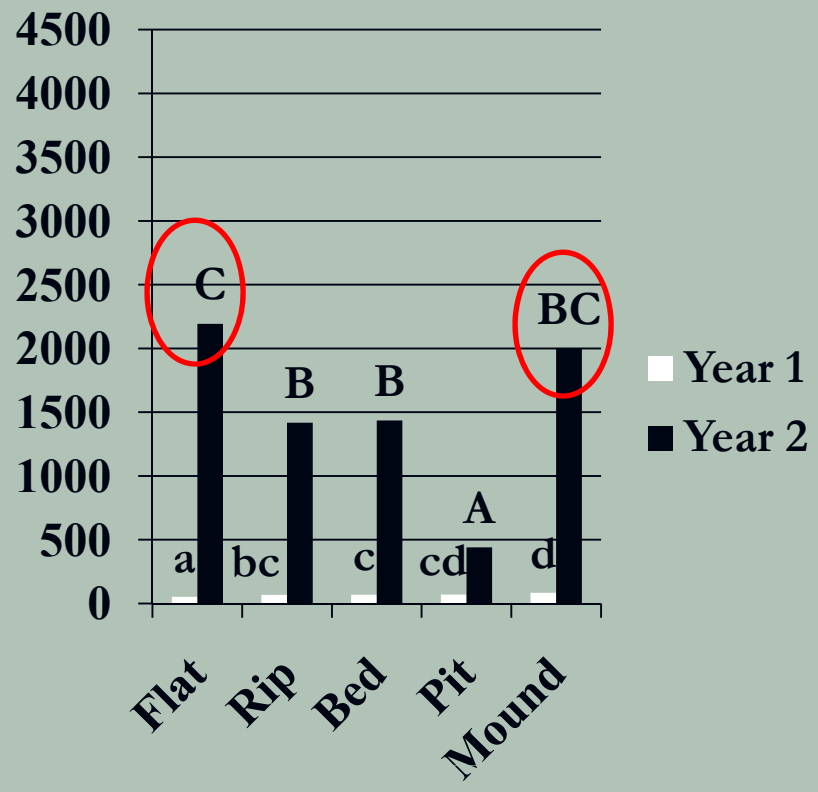
## Sycamore

**Yr 1 p = 0.0001, Yr 2 p < 0.0001**




## Willow Oak

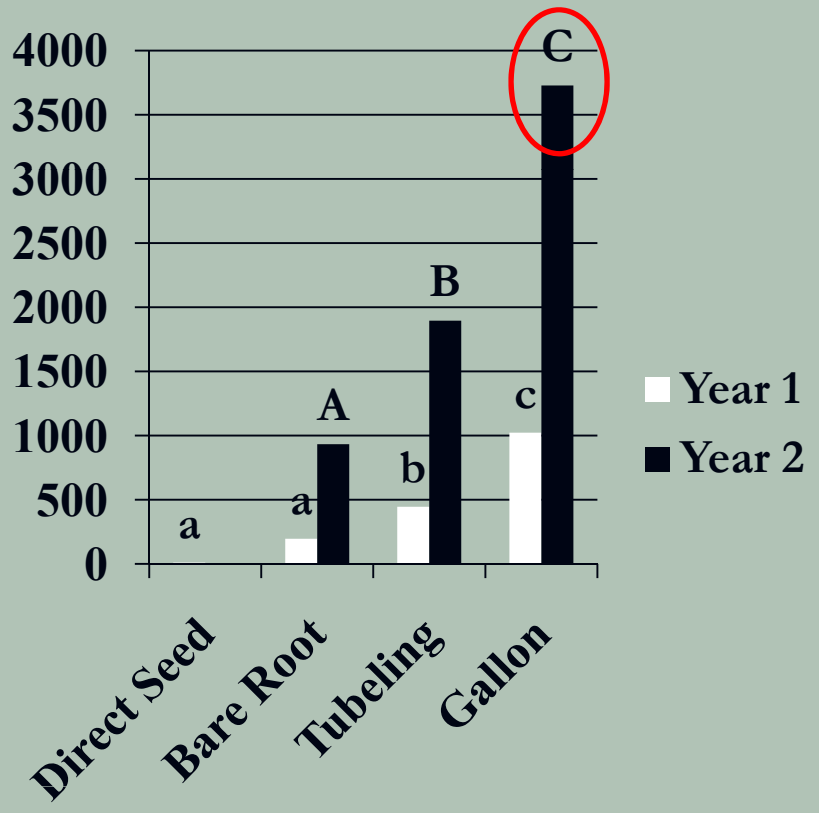
**Yr 1 p value < 0.0001, Yr 2 p <0.1507**



# Biomass Index ($cm^3$)by Regeneration Source

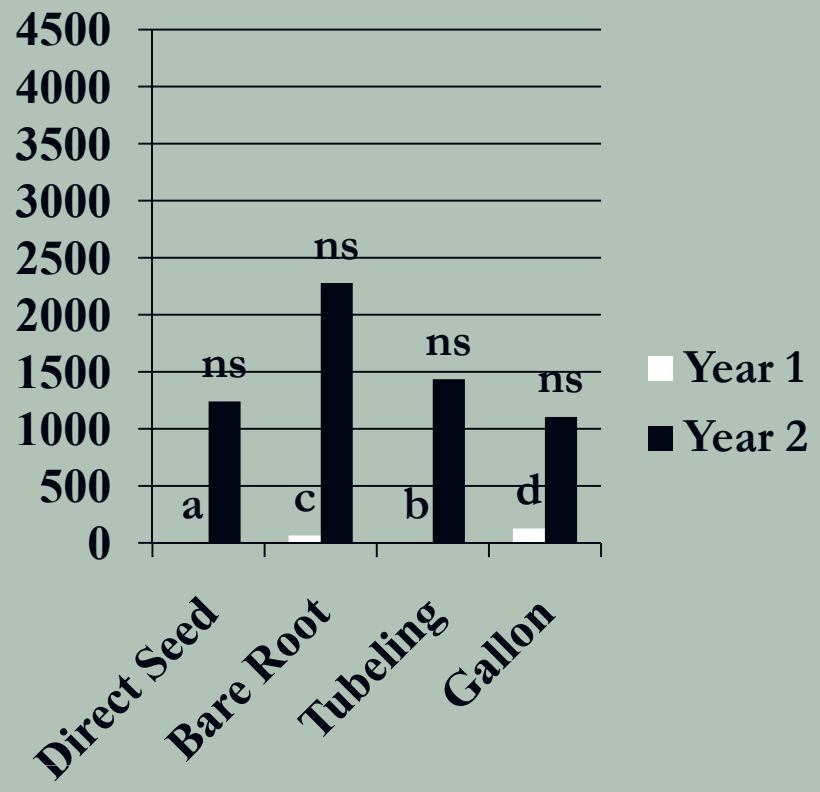
## Sycamore

**Yr 1 p = 0.0001, Yr 2 p < 0.0001**




## Willow Oak

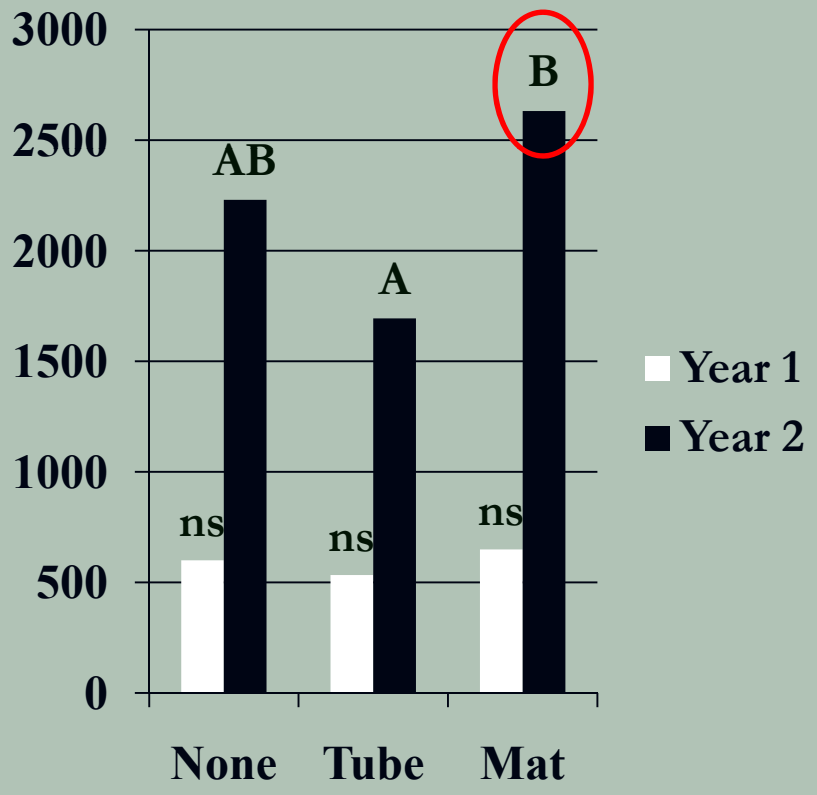
**Yr 1 p value < 0.0001, Yr 2 p <0.2038**



# Biomass Index ($cm^3$)by Planting Aid

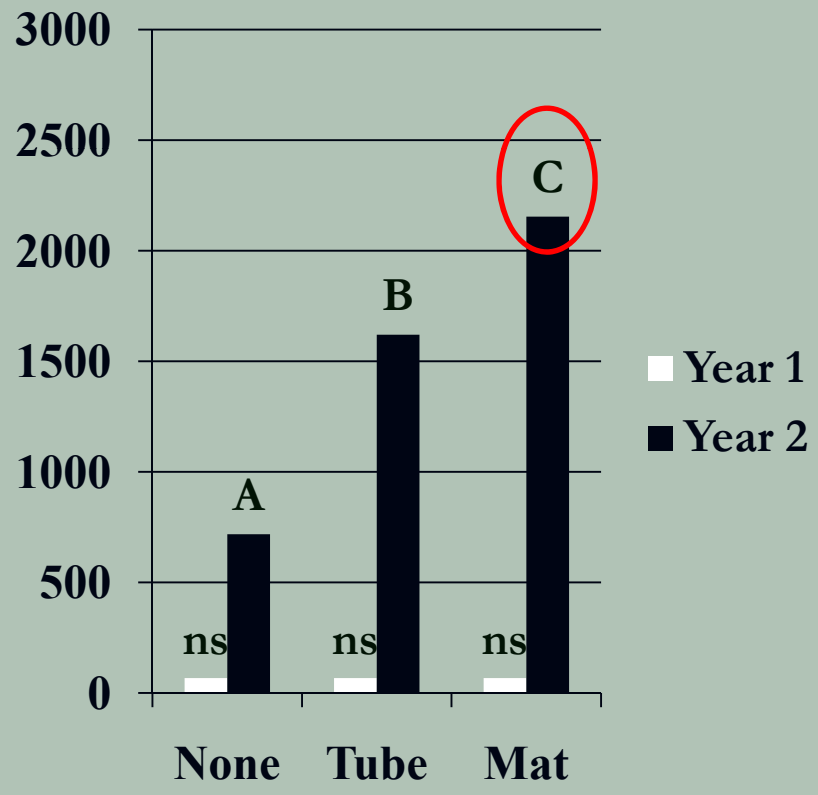
## Sycamore

**Yr 1 p = 0.6370, Yr 2 p < 0.0144**




## Willow Oak

**Yr 1 p value < 0.3323, Yr 2 p <0.0011**



# Sycamore performance index at 2 years
## (biomass index x % survival)

| Source-Aid | FLAT | RIP | BED | PIT | MOUND |
|---|---|---|---|---|---|
| Seed-None | 1 | 156 | 17 | 1 | 337 |
| Seed-Mat | 1 | 438 | 112 | 76 | 76 |
| Seed-Tube | 2 | 3 | 25 | 7 | 11 |
| Bare-None | 557 | 550 | 670 | 138 | 2023 |
| Bare-Mat | 426 | 530 | 770 | 257 | 1370 |
| Bare-Tube | 402 | 451 | 250 | 92 | 852 |
| Tubeling-None | 645 | 1523 | 2238 | 382 | 2234 |
| Tubeling-Tube | 721 | 831 | 1084 | 443 | 874 |
| Tubeling-Mat | 893 | 1616 | 1799 | 875 | **3119** |
| Gallon-None | 2192 | 2208 | 1923 | 1803 | **3113** |
| Gallon-Tube | 1684 | 2038 | **2735** | 1393 | **3456** |
| Gallon-Mat | 1592 | 1905 | **3532** | 2042 | **6234** |

# Willow oak performance index at 2 years
## (biomass index x % survival)

| Source-Aid | FLAT | RIP | BED | PIT | MOUND |
|---|---|---|---|---|---|
| Seed-None | 111 | 4 | 4 | 0 | 5 |
| Seed-Mat | 20 | 86 | 10 | 0 | 31 |
| Seed-Tube | 1 | 10 | 15 | 1 | 39 |
| Bare-None | 398 | 748 | **1541** | 145 | **1624** |
| Bare-Mat | **2173** | 516 | **1015** | 76 | **1025** |
| Bare-Tube | 669 | 674 | 787 | 237 | **1424** |
| Tubeling-None | 52 | 127 | 33 | 0 | 153 |
| Tubeling-Tube | 101 | 108 | 38 | 45 | 118 |
| Tubeling-Mat | 116 | 53 | 13 | 8 | 390 |
| Gallon-None | 727 | **1067** | **987** | 287 | **1480** |
| Gallon-Tube | 676 | **985** | **1157** | 518 | **1354** |
| Gallon-Mat | 888 | **972** | **1168** | 446 | **1201** |

# Conclusions after 2 growing seasons

- For Sycamore
  - Mound > Bed >>> Rip >>> Flat>>> Pit
  - Gallon >>> Tubelings = Bare root > Seed
  - Planting aid results were not convincing

- For Willow Oak
  - Mounding and Bedding performed well
  - Overall, Bare root with mats and Gallon performed well.

# Why Mounding?

## Microsites

- Greater rooting volume of loosened soil
- Inverted and mixed horizons
- Provided some competition control
- Enhanced survival/growth
- Increased habitat diversity

- Potential Problems:
  - Cost and available contractors

# Questions