

# 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*



**C. M. Curtis, W.M. Aust,  
J.R. Seiler, B.D. Strahm**

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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 3:1 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. ( $\approx$  60,000 acres in 2010).
- Little transfer of forest management research to forested wetland restoration projects.



# Objectives

## Subproject 1

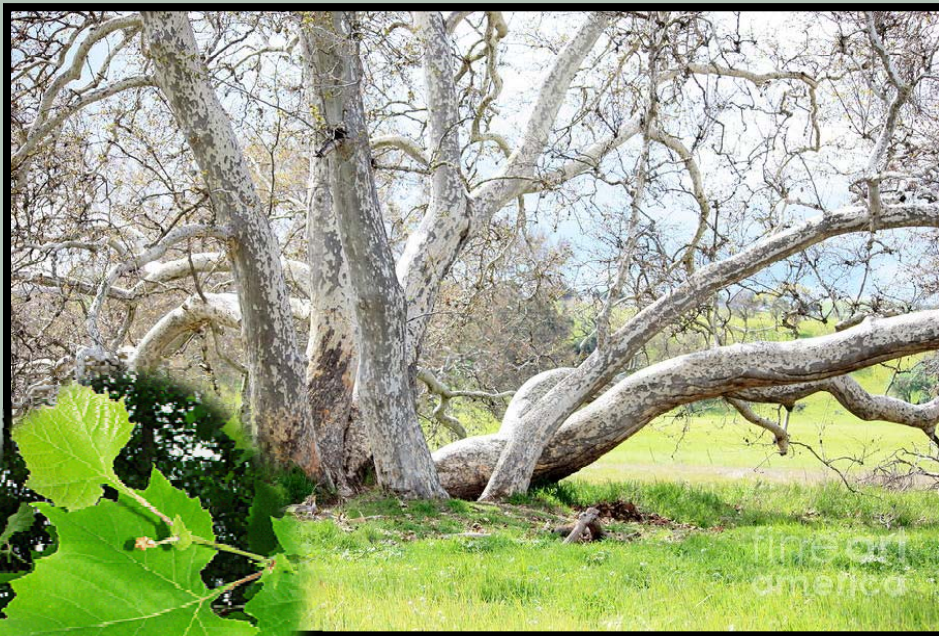
Determine the influence of seed source and/or preconditioning treatments on survival and growth of *P. occidentalis* and *Q. phellos* on Piedmont riparian wetland mitigation sites.

## Subproject 2 (Today's Talk)

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 mitigation sites.

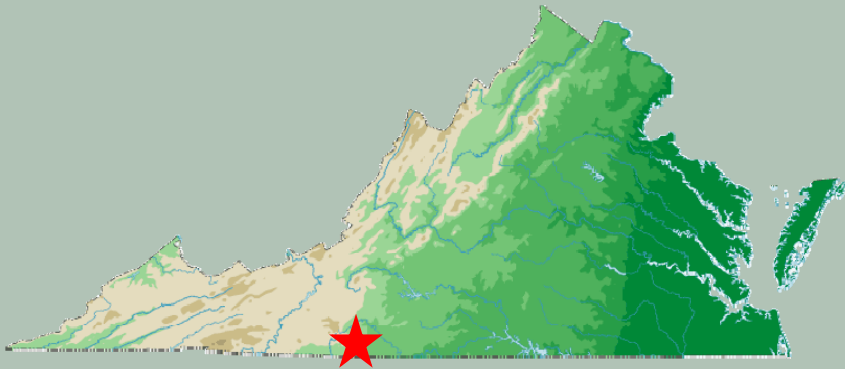
# Species selection based on availability and desire to have species of rapid growth and mast production

- Sycamore (*Platanus occidentalis*)



- Willow Oak (*Quercus phellos*)

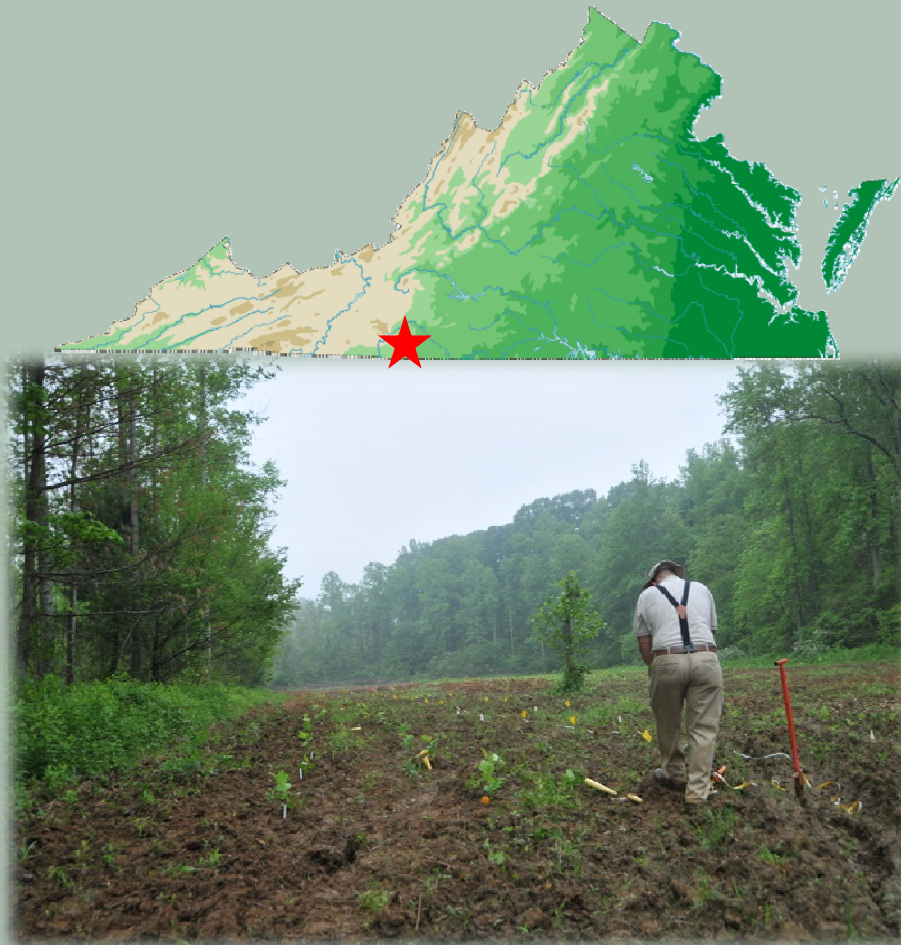
# Study Site: RJ Reynolds Forest Research Extension Center



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



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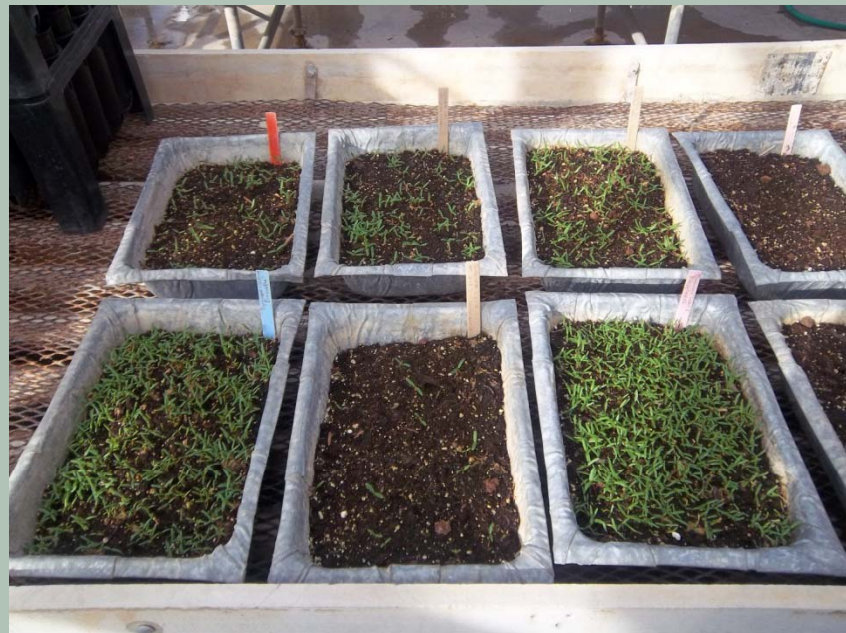


- Piedmont Physiographic province, Patrick Co., Va.
- Tobacco plantation from 1840's 1950's
- Study site is excessively wet, compacted by agriculture, research, and lacking microtopography.



# 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

- Appomattox, Pittsylvania, and Nelson Counties
  - All located in the Piedmont region of Virginia
- 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 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**
- **Seedlings were transplanted to Reynolds Homestead in mid-April 2011**

# Project Location



# 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)



# Results

- Fincastle upland site had the best survival and growth for Sycamore. Provenance matters.
- Few significant effects of cultural treatments during Year one.
- No significant effects of cultural treatments by end of second growing season.



## Percent survival after first growing season of tubelings as impacted by nursery

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	Sycamore	Willow oak
Virginia Tech	83%	86%
WSSI	71%	45%

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# 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 mitigation 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



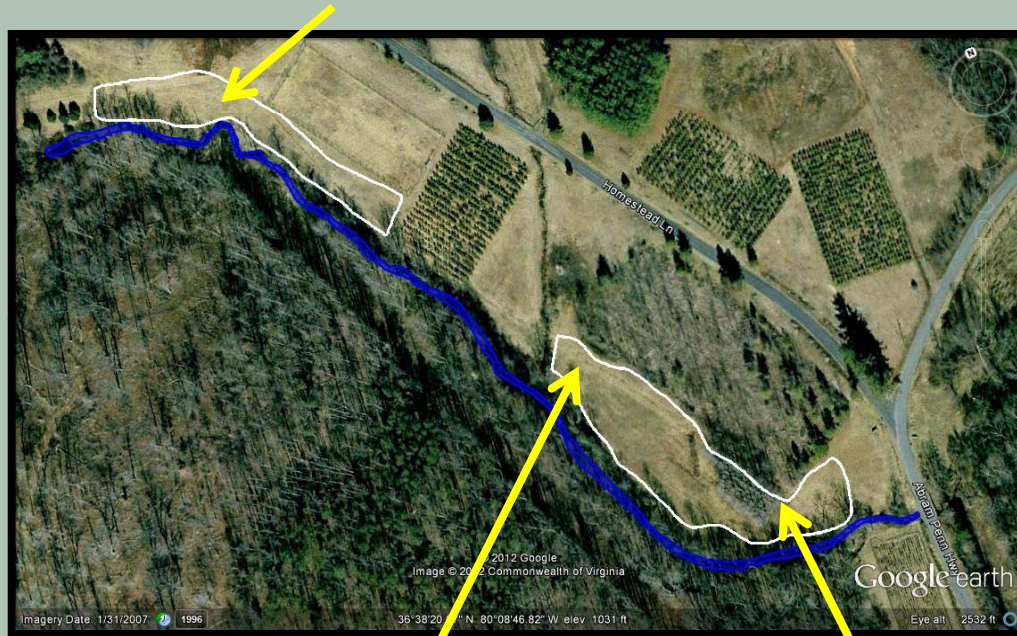
# Project Layout



- 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**



**VisporeMats**





**Example of 4  
Regeneration Sources x  
3 Plantings Aids and 4  
seedlings within 1 site  
preparation plot.**

**Each of 5 site  
preparation treatments  
are replicated 5 times  
for each species.**

<b>Gallon (Mat)</b> ▲  ▲  ▲  ▲	<b>Gallon (Control)</b> ▲  ▲  ▲  ▲	<b>Direct Seed (Control)</b> X  X  X  X	<b>Bare Root (Mat)</b> ●  ●  ●  ●
<b>Tubeling (Control)</b> ■  ■  ■  ■	<b>Tubeling (Tube)</b> ■  ■  ■  ■	<b>Tubeling (Mat)</b> ■  ■  ■  ■	<b>Direct Seed (Tube)</b> X  X  X  X
<b>Direct Seed (Mat)</b> X  X  X  X	<b>Bare Root (Tube)</b> ●  ●  ●  ●	<b>Bare Root (Control)</b> ●  ●  ●  ●	<b>Gallon (Tube)</b> ▲  ▲  ▲  ▲

# Planting and Culture

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



May 2011 following planting

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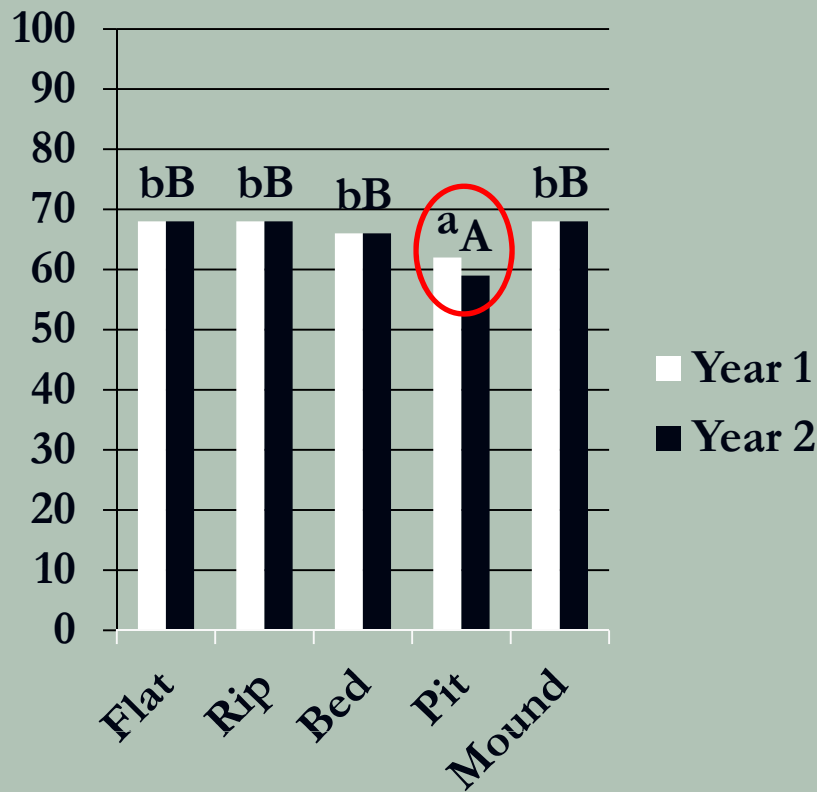


January 2012 following one growing season

# Survival % by Site Preparation

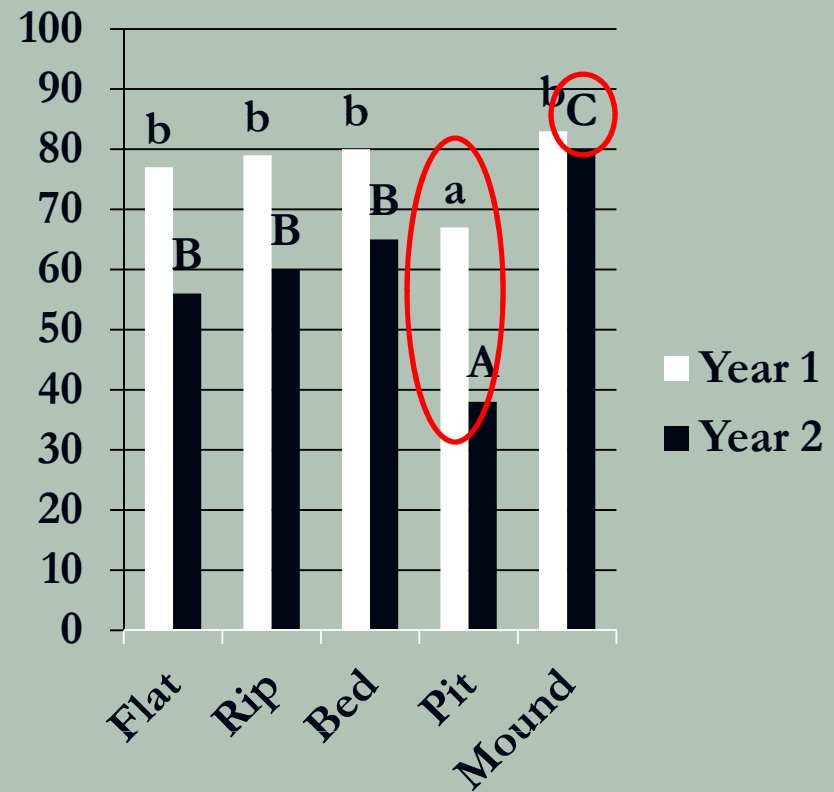
## Sycamore

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



## Willow Oak

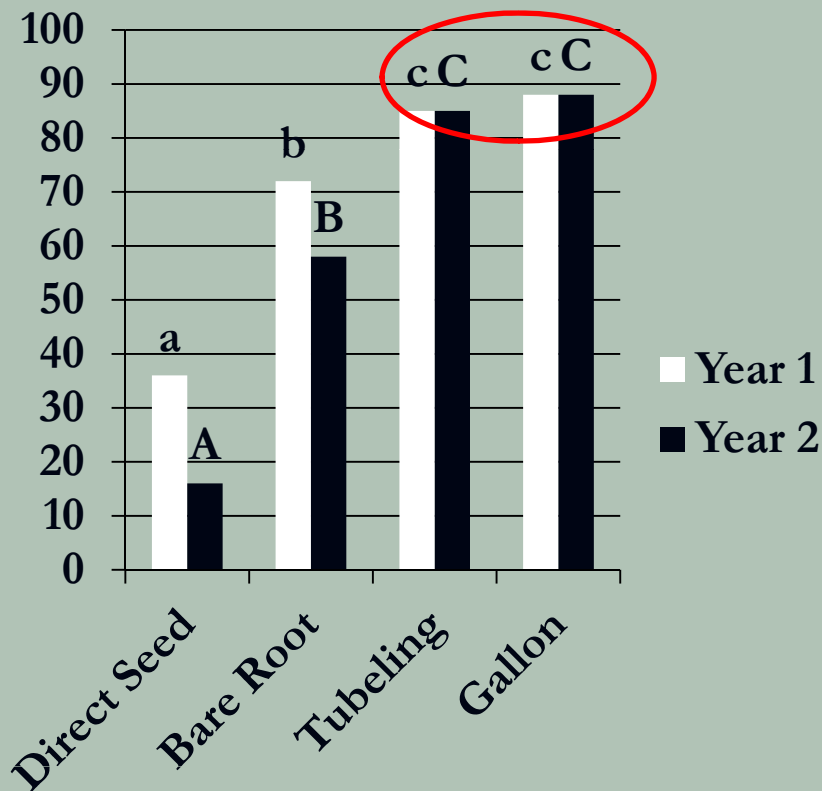
Yr 1  $p < 0.0001$ , Yr 2  $p < 0.0001$



# Survival % by **Regeneration Source**

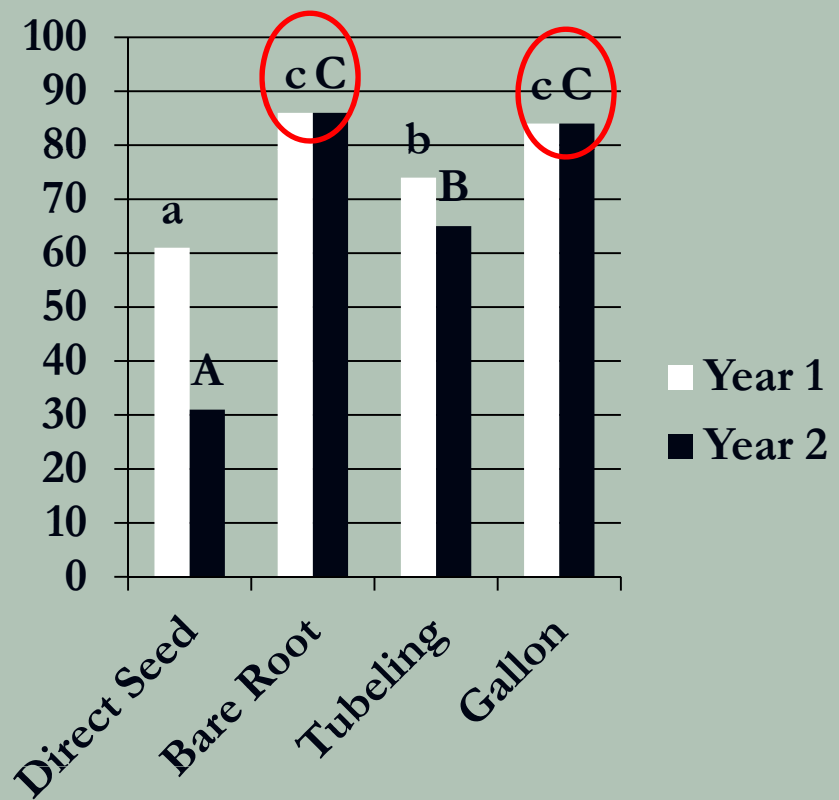
## Sycamore

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



## Willow Oak

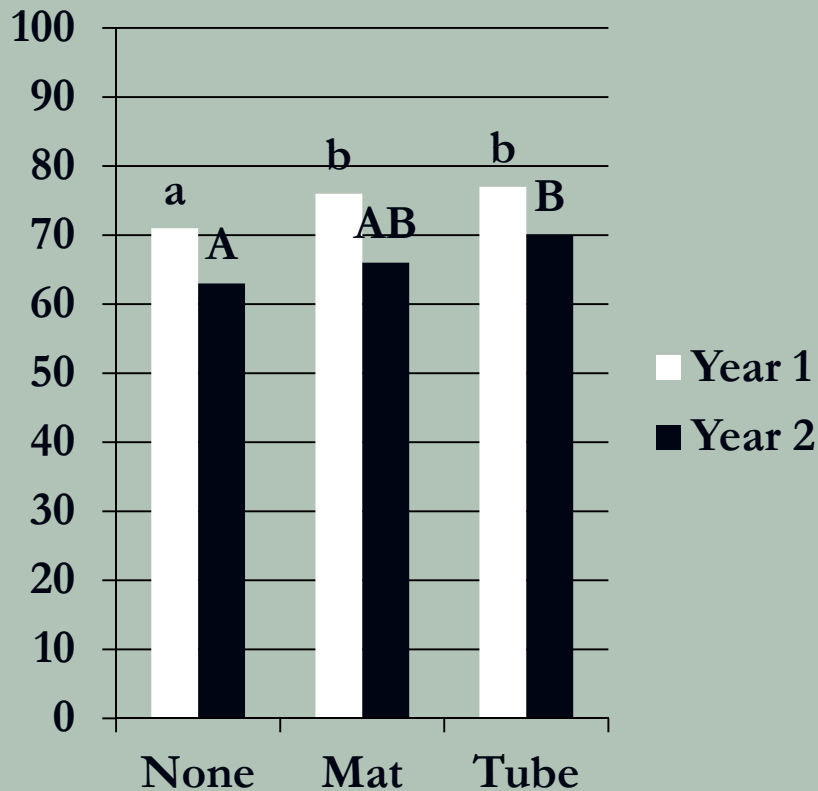
Yr 1  $p < 0.0001$ , Yr 2  $p < 0.0001$



# Survival % by **Planting Aid**

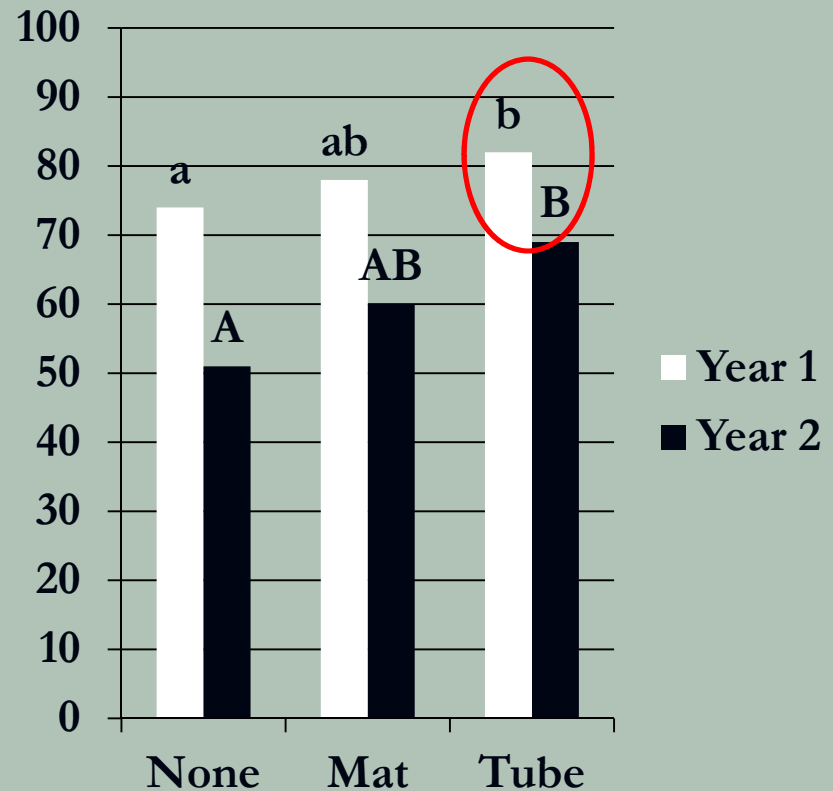
## Sycamore

Yr 1 p = 0.006, Yr 2 p < 0.0001



## Willow Oak

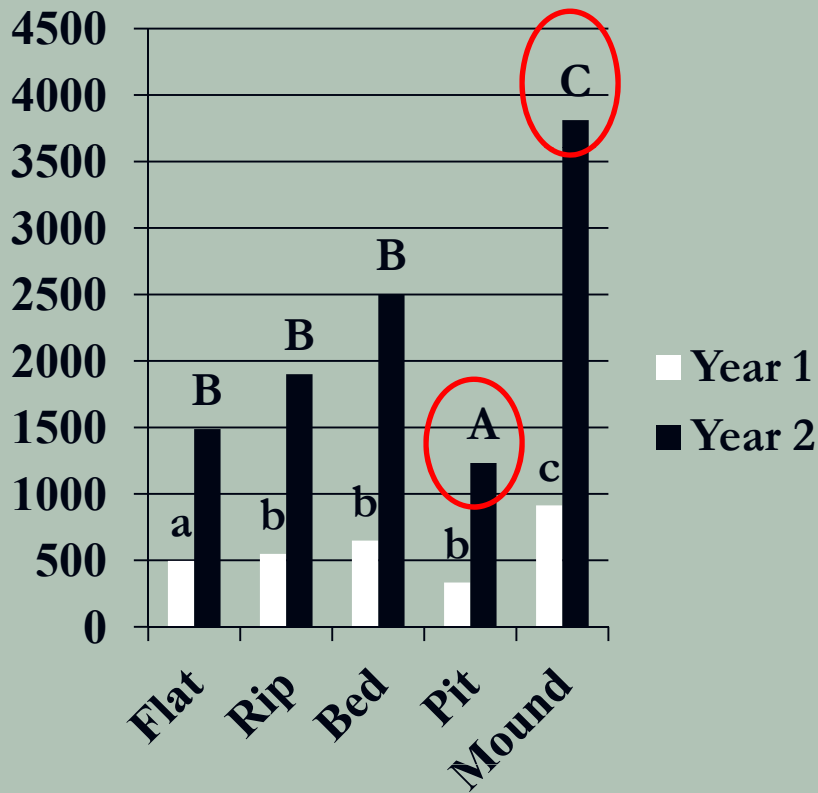
Yr 1 p value < 0.0001, yr 2 p < 0.0001



# Biomass Index (cm<sup>3</sup>) by Site Preparation

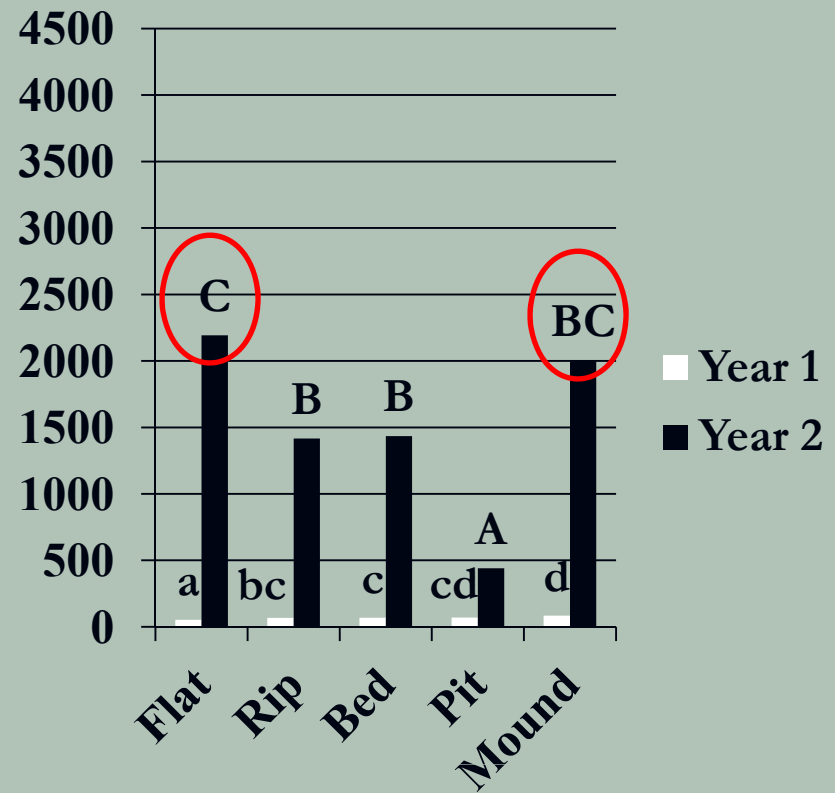
## Sycamore

Yr 1 p = 0.0001, Yr 2 p < 0.0001



## Willow Oak

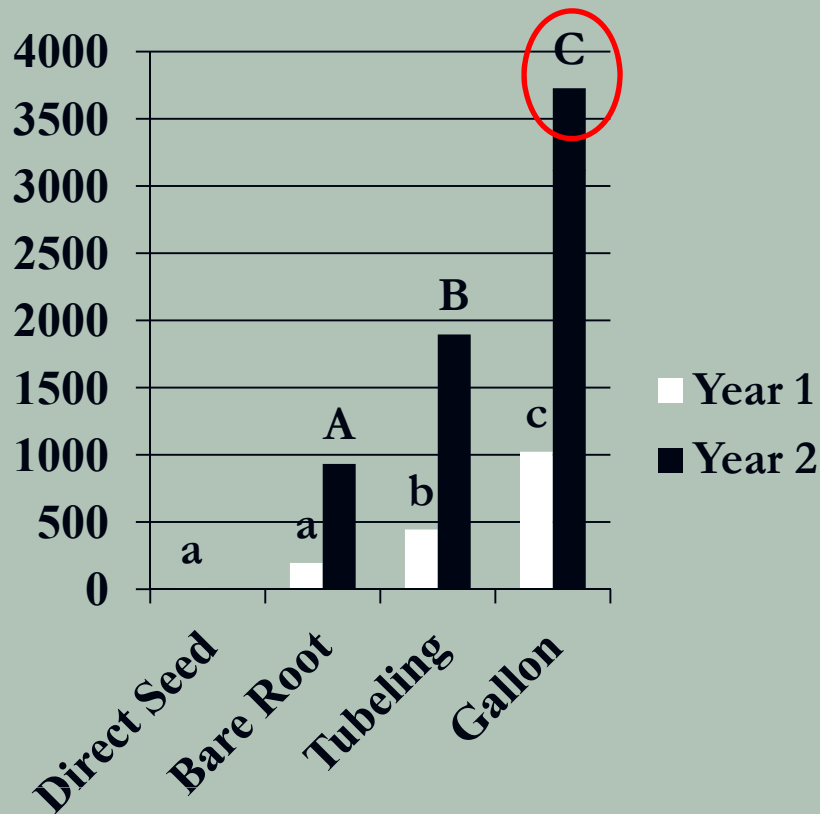
Yr 1 p value < 0.0001, Yr 2 p < 0.1507



# Biomass Index (cm<sup>3</sup>) by **Regeneration Source**

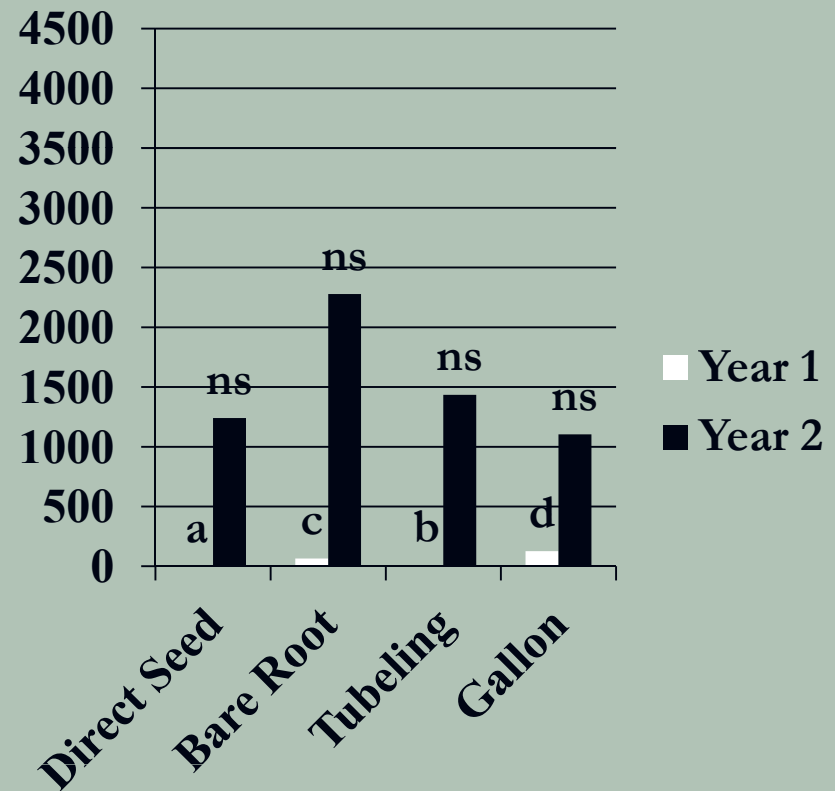
## Sycamore

Yr 1 p = 0.0001, Yr 2 p < 0.0001



## Willow Oak

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

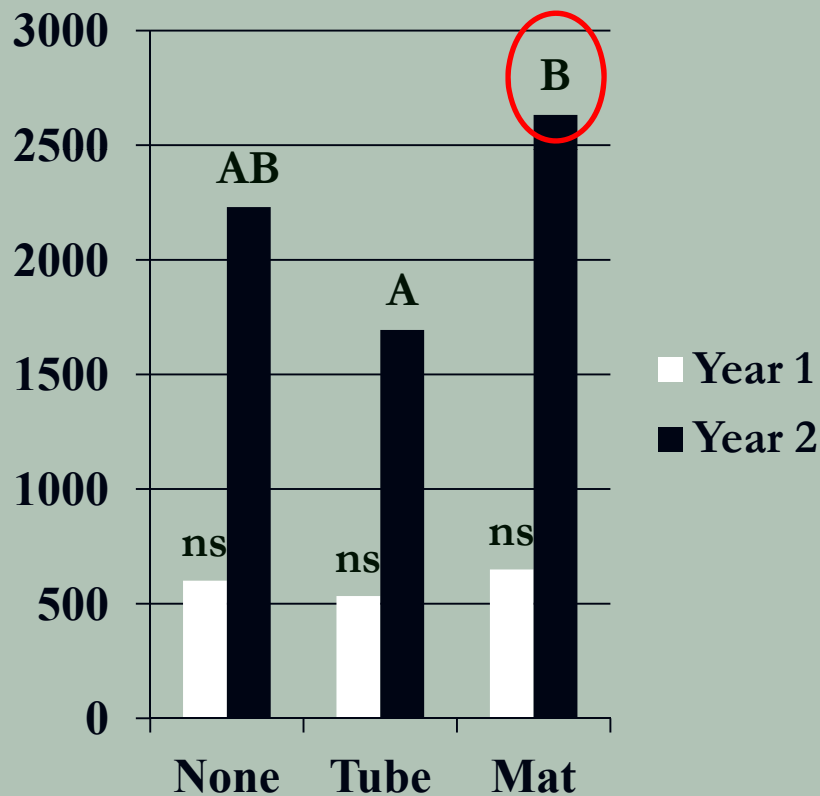




# Biomass Index (cm<sup>3</sup>) by **Planting Aid**

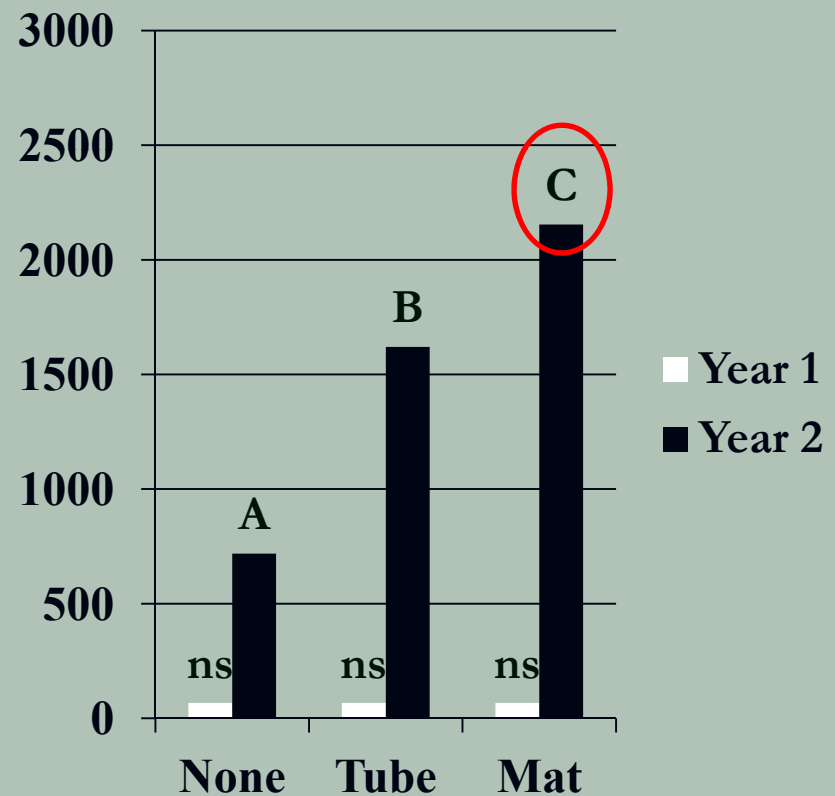
Sycamore

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 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 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
- Mixed horizons caused coarser texture
- Provided some competition control
- Enhanced survival
- Additional faunal habitats
- Potential Problems:
  - Cost and available contractors



# Questions

