

Relationship of Oak Seedling Height and Diameter with Bottomland Elevation

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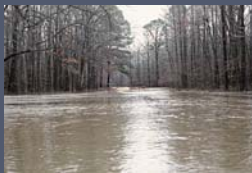
Overview

- Introduction
- Justification
- Objective
- Study area
- Methods
- Results
- Discussion
- Restoration Implications



Hardwood Bottomlands

- **Definition**
 - Forested wetlands adjacent to riverine systems that are periodically flooded during the dormant and growing season by overbank flow.



Benefits

- Wildlife habitat
- Timber production
- Environmental
 - Nutrient cycling
 - Floodwater storage
 - Improve water quality
 - Erosion control



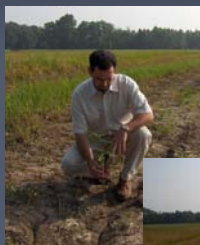
History

- Deforestation
 - U.S. (30%)
 - LMAV (75%)
 - Tennessee (60%)
- Protection & Restoration
 - Clean Water Act (1975)
 - Swampbuster Provision
 - Food Security Act
 - WRP and CRP (NRCS)



Tennessee Restoration

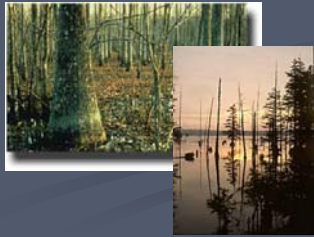
- Afforestation
 - Forested wetlands
 - NRCS (89.8%)
 - TWRA (21,050 ha)
 - Oak seedlings
 - Timber & Wildlife Value



Justification

- **Relative flood tolerance of hardwood bottomland species**
 - Few field studies
 - Most information from greenhouse studies
- **Seedling growth and bottomland elevation relationship**
 - Strongly correlated with flooding frequency and depth

- **Indices of growth**
 - Height and diameter
- **Relating to elevation contours**
 - Species-specific flood tolerance
 - Guidance in restoration



Objective

- Our objective was to relate height and diameter of 3 oak seedling species (**willow oak, *Quercus phellos***; **Nuttall oak, *Q. nuttallii***; **overcup oak, *Q. lyrata***) to relative elevation in a west Tennessee hardwood bottomland that was previously farmed and reforested January–March 2004.

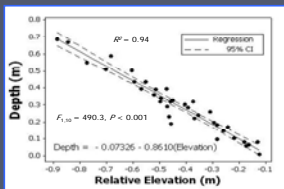
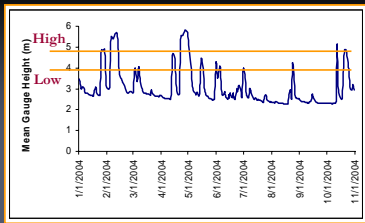


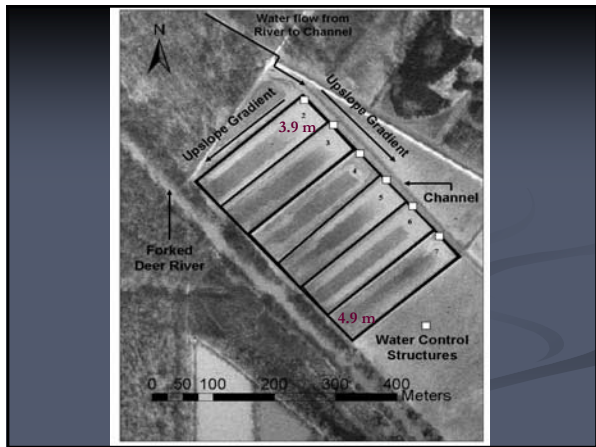
Study Area

- **West Tennessee Research and Education Center**
- **Six 1-ha Impoundments (2-7)**
 - 1 m high levees
 - Water control structures
 - Elevation gradient (NE to SW)
- **South Fork of the Forked Deer River**
 - USGS gage #07027720
 - 3.9 m lower elevations flooded
 - 48 days Jan. – Oct. 2004
 - 4.9 m all elevations flooded
 - 23 days Jan. – Oct. 2004
 - Depth strongly correlated with elevation



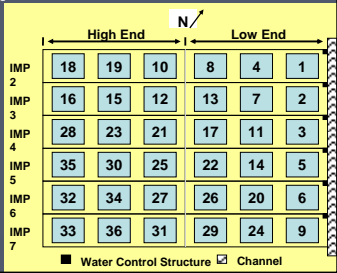
Bottomland Hydrology





Methods

- January – March 2004, 1-0 stock seedlings ($n = 3,771$)
- Whitfield® tree planter
- Monospecific plots
- 3×3 m spacing
- Six 36×36 m elevation blocks/impoundment
- Approx. 144 seedlings/block
- Randomly assigned species
- Sub-soiled rows



Methods

- **Relative Elevation**
 - Topcon® electronic total station
 - Ordinally ranked blocks 1 – 36
 - 1 = lowest
 - 36 = highest
- **Oust® XP** (reduce & standardize potential effects of herbaceous vegetation)
 - Prior to bud break
- **Roundup®**
 - June 2004



Methods

- October and November 2004
 - **Seedling height**
 - Ground to terminal bud
 - Meter stick
 - 0.5 cm
 - **Root-collar diameter**
 - Ground level
 - Calipers
 - 0.5 mm
- | | |
|---------------|-------------|
| • Total | • n = 3,771 |
| • Overcup oak | • n = 1,380 |
| • Nuttall oak | • n = 1,220 |
| • Willow oak | • n = 1,171 |
- Mean height and diameter/block
 - Linear regression
 - Normal distribution
 - SAS® ($\alpha = 0.05$)



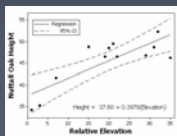
Results – Height

- Height was positively related to elevation for willow and Nuttall oak seedlings
- No relationship was detected for overcup oak

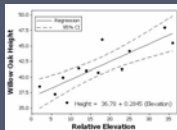
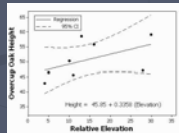
- **Nuttall oak**
 - P = 0.002
 - R² = 0.65

(reduced growth @ lower elevations for Nuttall & willow oaks)

- **Willow oak**
 - P < 0.001
 - R² = 0.70



- **Overcup oak**
 - P = 0.26
 - R² = 0.27



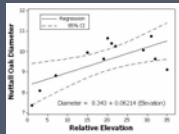
No relationship with elevation existed at planting—randomization

Results - Diameter

- Diameter was positively related to elevation for Nuttall oak seedlings only
- No relationship was detected for willow and overcup oak

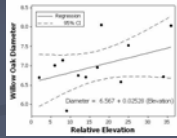
• Nuttall oak

- $P = 0.02$
- $R^2 = 0.46$



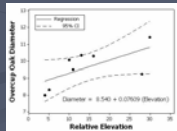
• Willow oak

- $P = 0.16$
- $R^2 = 0.18$



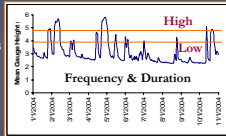
• Overcup oak

- $P = 0.08$
- $R^2 = 0.43$

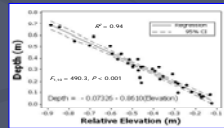


Discussion

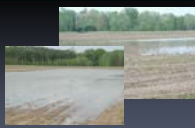
- Flood tolerance (increases in order)
 - Nuttall oak (hgt & dia)
 - Willow oak (hgt)
 - Overcup oak (neither variable)
- Lower elevations = greater hydrologic stress
- Previous studies support our conclusions
 - Gray and Kaminski (2005)
 - Hosner and Boyce (1962)
 - Anderson and Pezeshki (1999)
 - Farmer and Pezeshki (2004)



- First growing season
- Reasonable to assume that these trends will be maintained or magnified as opportunities for hydrologic stress accumulate.

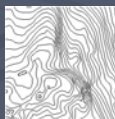
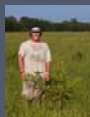
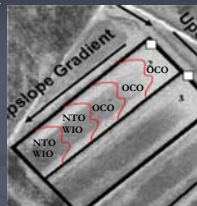


Gray and Kaminski (2005)



Restoration Implications

- Plant within contours — not random arrangement
- Overcup oak
 - Most flood tolerant
 - Plant it at lower elevations
 - Alternative Gray and Kaminski (2005)
 - Low elevation for moist-soil vegetation
 - Low timber value, marginal wildlife use
- Willow and Nuttall oak
 - Plant at intermediate to high elevations
- Median elevation (intermediate to high elevations)
 - 0.75 m above permanent water source (river)
 - Plant willow & Nuttall oak above 1 m contour



Acknowledgements

- Funding was provided by the Department of Forestry, Wildlife and Fisheries and the WTREC of the University of Tennessee
- Funds for seedlings were provided by the NRCS through a CRP agreement (Riparian Buffer Program) with WTREC
- Special thanks for study assistance and guidance
 - Dr. Bob Hayes (WTREC)
 - Gordon Percell (WTREC)
 - Ronnie Staggs (WTREC)
 - Zach Steele (technician)



Thank you for your time

Questions
