Survival and growth of seven tree species from three stocktypes planted in created wetlands in Loudoun County, Virginia

Mellony Seidel, Jacqueline D. Roquemore, and Robert B. Atkinson
Christopher Newport University

Introduction

- Forested wetlands are the most frequently lost wetlands in the eastern US, and tree establishment in wetland compensation sites is often challenging (Matthews and Endress 2008, Sharitz et al. 2006).
  - Tree establishment is difficult because wetland construction practices include removal of upper soil surfaces to the depth of the season high water table and result in soil compaction, lower organic content, higher bulk density, and greater predominance of gravel and larger particle sizes when compared to natural wetlands (Campbell et al. 2002).
- Selection of planting material for created wetland sites is difficult.There are numerous species of woody plants and planting types available for planting.
- However, there are few data driven studies that have addressed how the choice of species and stocktype affect survival and growth of planted vegetation.
- Early indicators of successful tree establishment are needed so that adaptive management efforts can proceed.
- The purpose of this study is to compare survival and growth rates using three morphometric parameters from seven woody plant species with three stocktypes planted in Loudoun County, Virginia.

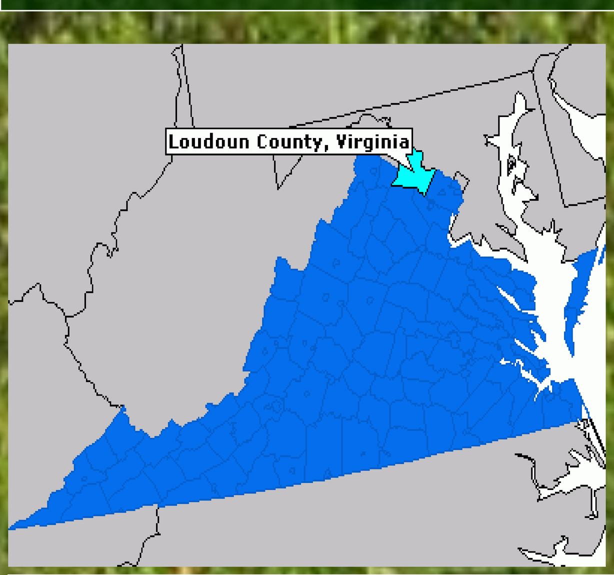

Figure 1. Sampling took place in Loudoun County, VA.

Figure 2. Shawn Wurst and Bayley Cook obtaining height, basal diameter, and canopy.

Species	Common Name	Family	Successional Status	Wetland Indicator Status
Betula nigra L.	river birch	Betulaceae	Primary	FACW
Liquidambar styraciflua L.	sweetgum	Hamamelidaceae	Primary	FAC
Platanus occidentalis L.	American sycamore	Platanaceae	Primary	FACW-
Quercus bicolor Willd.	swamp white oak	Fagaceae	Secondary	FACW+
Quercus palustris Münchh.	pin oak	Fagaceae	Secondary	FACW
Quercus phellos L.	willow oak	Fagaceae	Secondary	FAC+
Salix nigra Marsh.	black willow	Salicaceae	Primary	FACW+

Table 1. Trees species planted in created wetlands in Loudoun County, Virginia. Indicator status from NRCS Plant Database (2011).

Methods

- This study was conducted at three created wetlands in the Piedmont Province of Virginia. The sites (designated as Phase I, II, and III) are part of the Loudoun County Wetland and Stream Mitigation Bank.
- Seven woody tree species common to the forested wetlands of the province were selected for this study (Table 1). (1) bare root seedlings that were up to one year of age with no root ball or soil, (2) tubelings up to two years of age with a more developed root system, and (3) trees in 1-gallon containers which had a well-developed root ball and were planted with the soil that was present in the container.
- In March 2009, a total of 1596 trees were planted in 25 plots across the 3 sites Trees were planted on 2.4-meter (8-foot) centers. The 7 species and 3 stocktypes were planted in 21-tree replicate arrays nested within each plot and, depending on space availability, either 3 or 4 planting arrays were established per plot.
- Survival and morphometric data were collected during the last week of July from 2009 to 2012 following methods modified from Bailey et al. (2007).
- 3 morphometric parameters were measured:
  - Height of highest stem was measured with meter stick (H),
  - Three canopy diameter measurement were taken using a meter stick(CD),
  - Basal diameter was taken at soil level with a caliper(BD)

Species	Planting Type	2009 % Survival	2010 % Survival	2011 % Survival	2012% Survival
Betula nigra	Bare Root	89.5	48.7	46.1	46.1
Betula nigra	Gallon	97.4	75.0	69.7	62.7
Betula nigra	Tubeling	89.5	50.0	48.7	47.4
Liquidambar styraciflua	Bare Root	84.2	59.2	48.7	43.4
Liquidambar styraciflua	Gallon	94.7	77.6	68.4	66.2
Liquidambar styraciflua	Tubeling	62.3	22.1	22.1	18.7
Platanus occidentalis	Bare Root	69.7	35.5	30.3	30.3
Platanus occidentalis	Gallon	71.1	46.1	38.2	34.7
Platanus occidentalis	Tubeling	90.8	60.5	50.0	48.7
Quercus bicolor	Bare Root	89.5	63.2	57.9	53.3
Quercus bicolor	Gallon	98.7	96.1	94.7	92.1
Quercus bicolor	Tubeling	90.7	78.7	74.7	67.1
Quercus palustris	Bare Root	96.1	67.1	55.3	53.9
Quercus palustris	Gallon	97.4	89.5	85.5	84.2
Quercus palustris	Tubeling	86.8	72.4	65.8	61.5
Quercus phellos	Bare Root	86.8	36.8	31.6	22.1
Quercus phellos	Gallon	92.1	84.2	80.3	77.9
Quercus phellos	Tubeling	67.1	18.4	7.9	6.6
Salix nigra	Bare Root	77.6	38.2	34.2	30.2
Salix nigra	Gallon	98.7	72.4	71.1	68.4
Salix nigra	Tubeling	89.5	64.5	60.5	48.3

Table 2. Percent survival of all combinations of all species and planting types by year. Red represents < 29.4% survival. Planting trees on 8ft centers yield 681 stems/acre, therefore to ensure the required >200 stems/acre, the percent survival of planted trees must be greater than 29.4%.

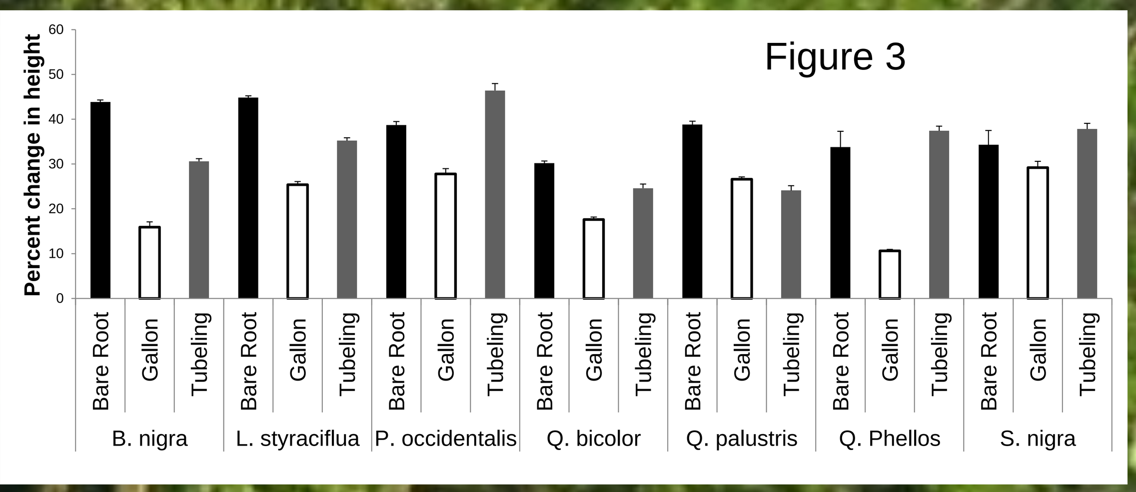

Figure 3. Percent change in height from 2011-2012 of tree species and stocktypes at the conclusion of the second growing season. Error bars = 1 ± SE

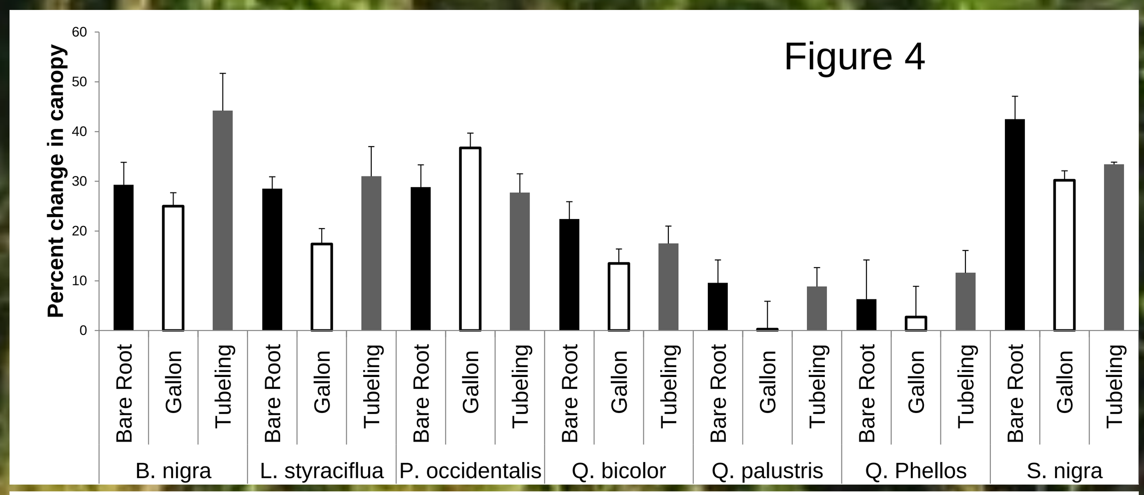

Figure 4. Percent change in canopy from 2011-2012 of tree species and stocktypes at the conclusion of the second growing season. Error bars = 1 ± SE

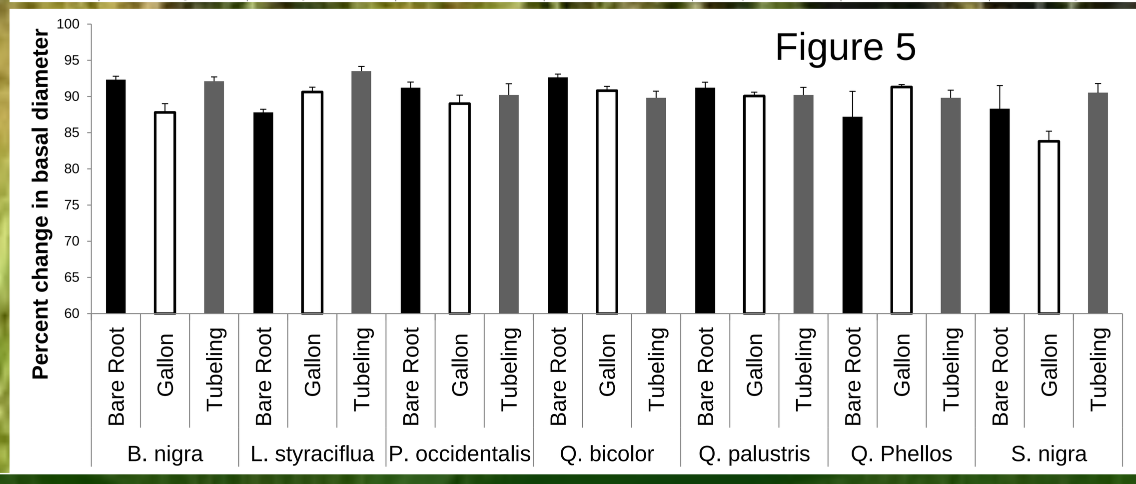

Figure 5. Percent change in basal diameter from 2011-2012 of tree species and stocktypes at the conclusion of the second growing season. Error bars = 1 ± SE

Results

- Overall survival after four years was 50.66%, and tree mortality was highest and growth rate was lowest between the first and second growing season (Table 2).
- *Q. phellos* tubelings had the numerically lowest overall survival of 6.58%, and *Q. bicolor* gallons had the numerically highest survival 92.1% (Table 2).
- Gallon stocktypes of all species had a higher survival than both bare root and tubeling stocktypes, except for *P. occidentalis* (Table 2).
- Percent change in height, canopy, and basal diameter was lowest in the first two growing seasons.
- *S. nigra* was a good performer and had moderate survival and growth for each stocktype.
- *P. occidentalis* tubelings had the highest percent increase in height from 2011 to 2012 (46.4%, Figure 3).
- *S. nigra* bare root had the highest percent increase in canopy from 2011 to 2012 (42.5%, Figure 4).
- *L. straciflua* tubelings had the highest percent increase in basal diameter from 2011 to 2012 (93.5%, Figure 5).

Discussion

- Of the trees planted in this study, 50.6% survived until the end of the second growing season. This is slightly higher survival than reported by Morgan and Roberts (1999) in an assessment of 50 wetland compensation sites in Tennessee which reported a combined average of 47% survival.
- Of the seven species planted, the two with the highest survival were secondary successional species (*Q. bicolor and Q. palustris*) (Table 2). Secondary species are characterized by higher shade tolerance and slower production (Horn 1974), which may be advantageous given conditions found at our sites.
- Growth rates vary with tree age in a sigmoidal pattern consisting of early slow growth followed by a period of rapid growth that plateaus at tree maturity (Zeide 1993). Tubelings had lower initial height, but exhibited faster growth than other stocktypes.
- There was no pattern of survival or growth among morphometric parameters within species or planting types, therefore no generalizations can be asserted
- *Q. bicolor* gallon containers had the highest survivorship and may be a good choice for projects in which stem count and tree height is evaluated during early establishment years.
  - Trees grown in 1-gallon pots survived better during the first two years; therefore, this stock type provide very early indicators of challenging site conditions.
- As the study continues it is expected for a continued trend of higher survival and higher growth rates when compared to the first two growing seasons.

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