Tree survival and growth in created wetland mitigation sites in Virginia: A field validation study

Wurst, S.J., J.D. Roquemore,
H.W. Hudson, III, J.M. Campo and
R.B. Atkinson

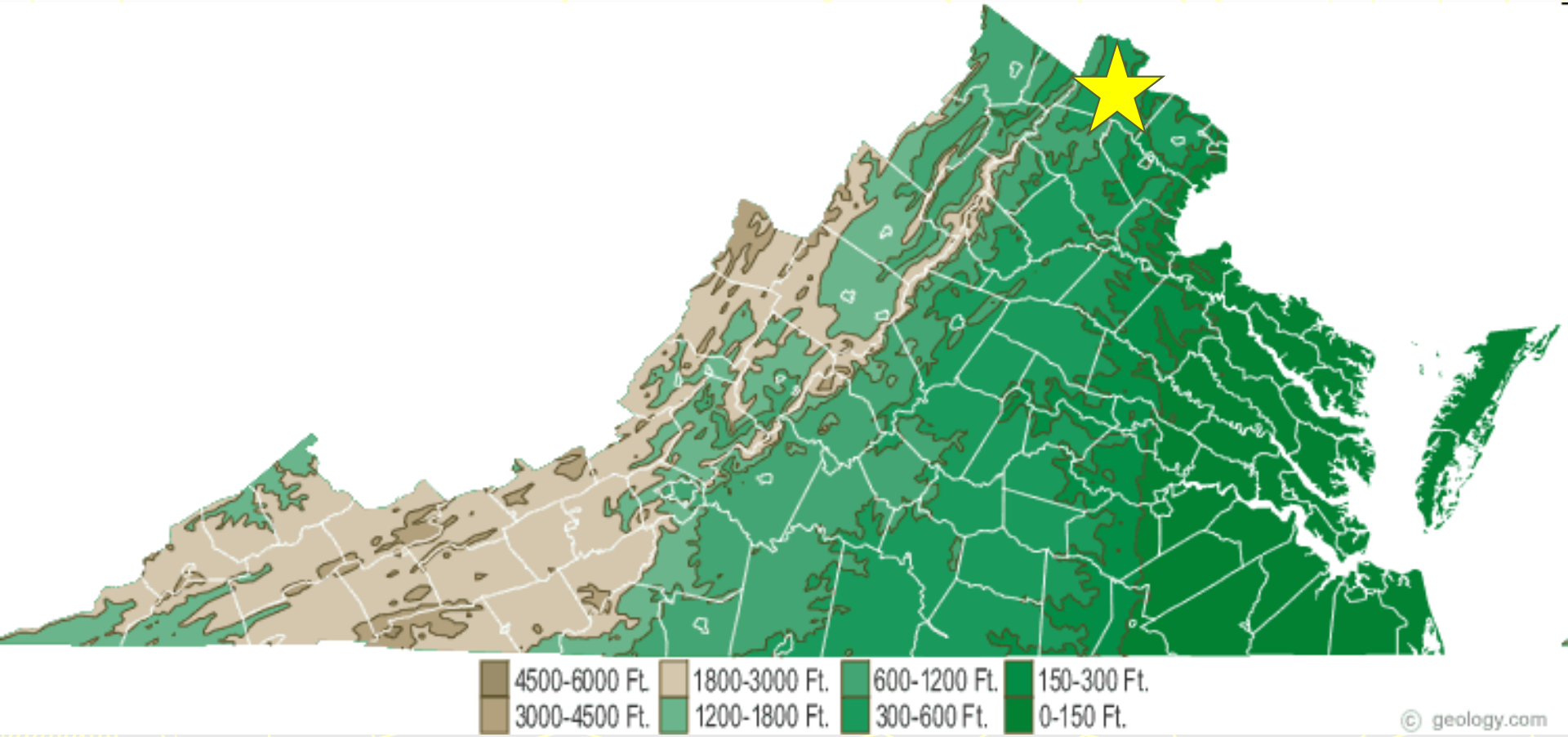
Introduction

- The mesocosm study investigated differences in survival and growth between:
  - Primary and secondary succession species.
  - Planting types.
  - Hydrologically-distinct cells.
- The purpose of the current study was to:
  - Evaluate seven tree species and three planting types based on survival and growth.
  - Compare our field results to the VIMS mesocosm results.

Site Description

- Study sites were in Loudoun County, Virginia.
- These three sites were located in the flood plains of streams and ranged in size from 0.81 to 3.93 Ha.
- Plots were established within Phase I, II, and III of a non-tidal forested wetland mitigation bank.

Location in Piedmont Province



Methods

- Trees were planted in spring of 2009 at the three sites.
- Survivorship and [illegible] gathered in the fa[illegible] summer 2010.

Species

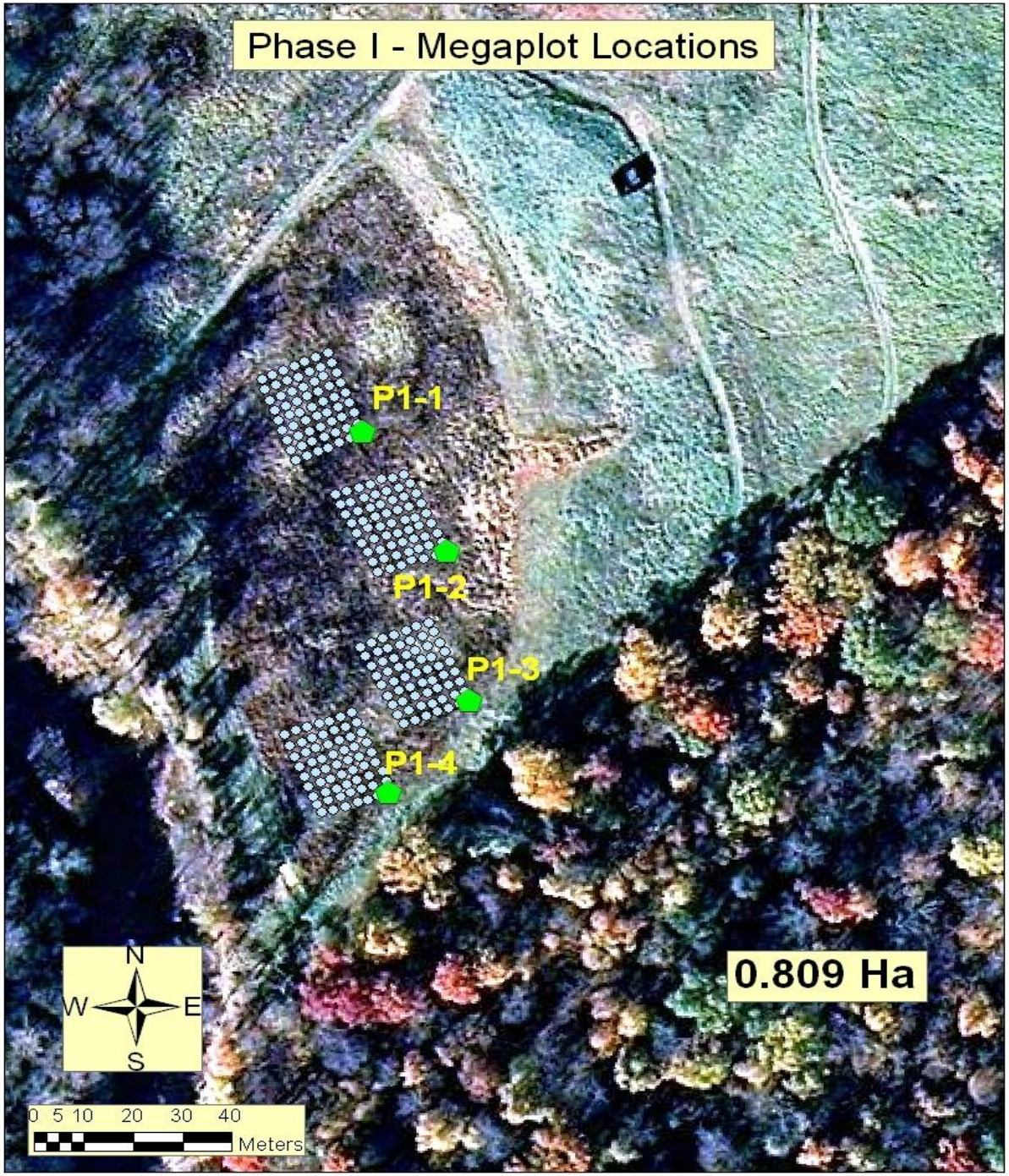
- *Betula nigra* River Birch
- *Liquidambar styraciflua* Sweetgum
- *Platanus occidentalis* American Sycamore
- *Quercus bicolor* Swamp White Oak
- *Quercus palustris* Pin Oak
- *Quercus phellos* Willow Oak
- *Salix nigra* Black Willow

Planting Types

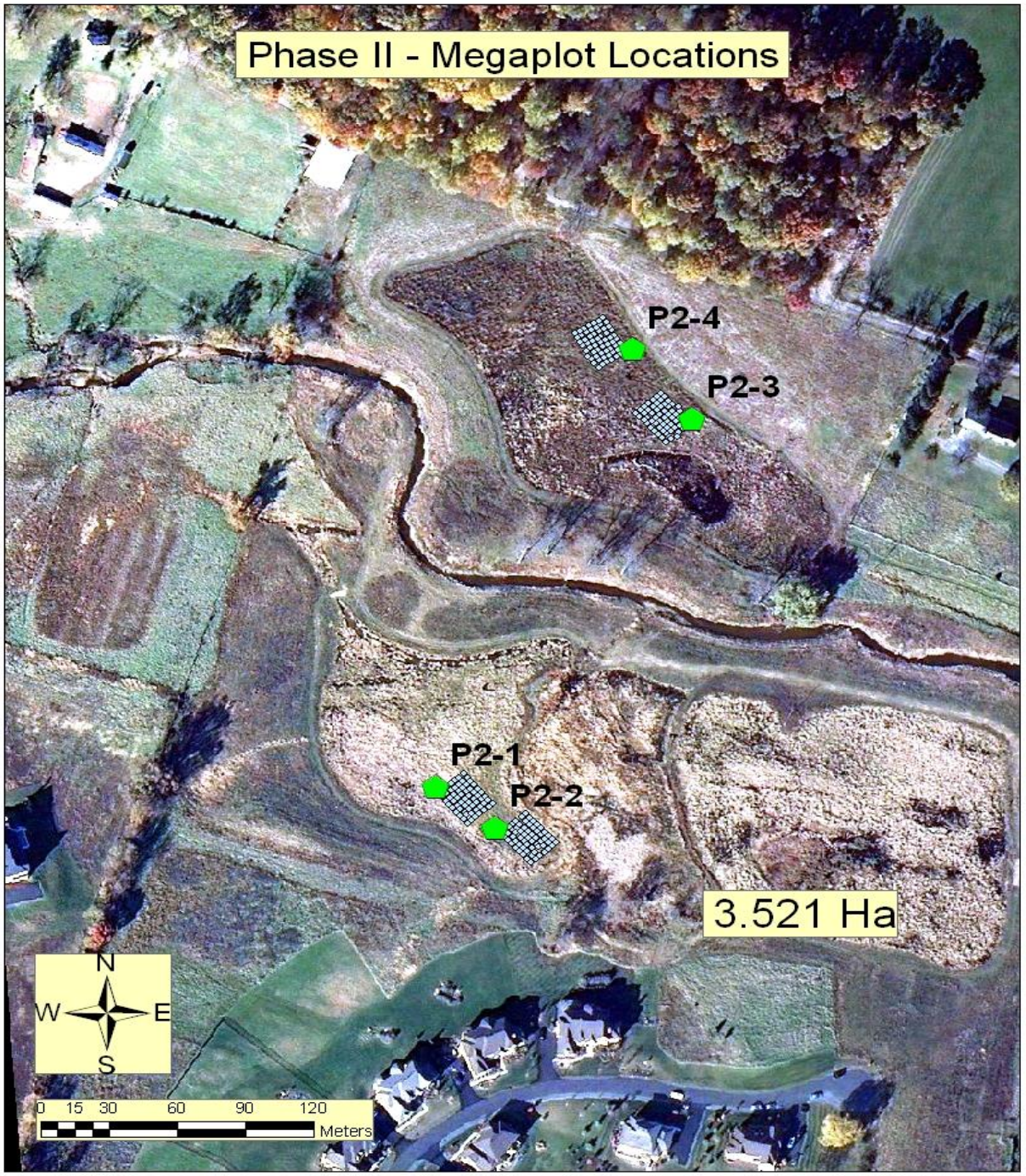
- Bare Root
- 1-Gallon pot
- Tubeling

Methods

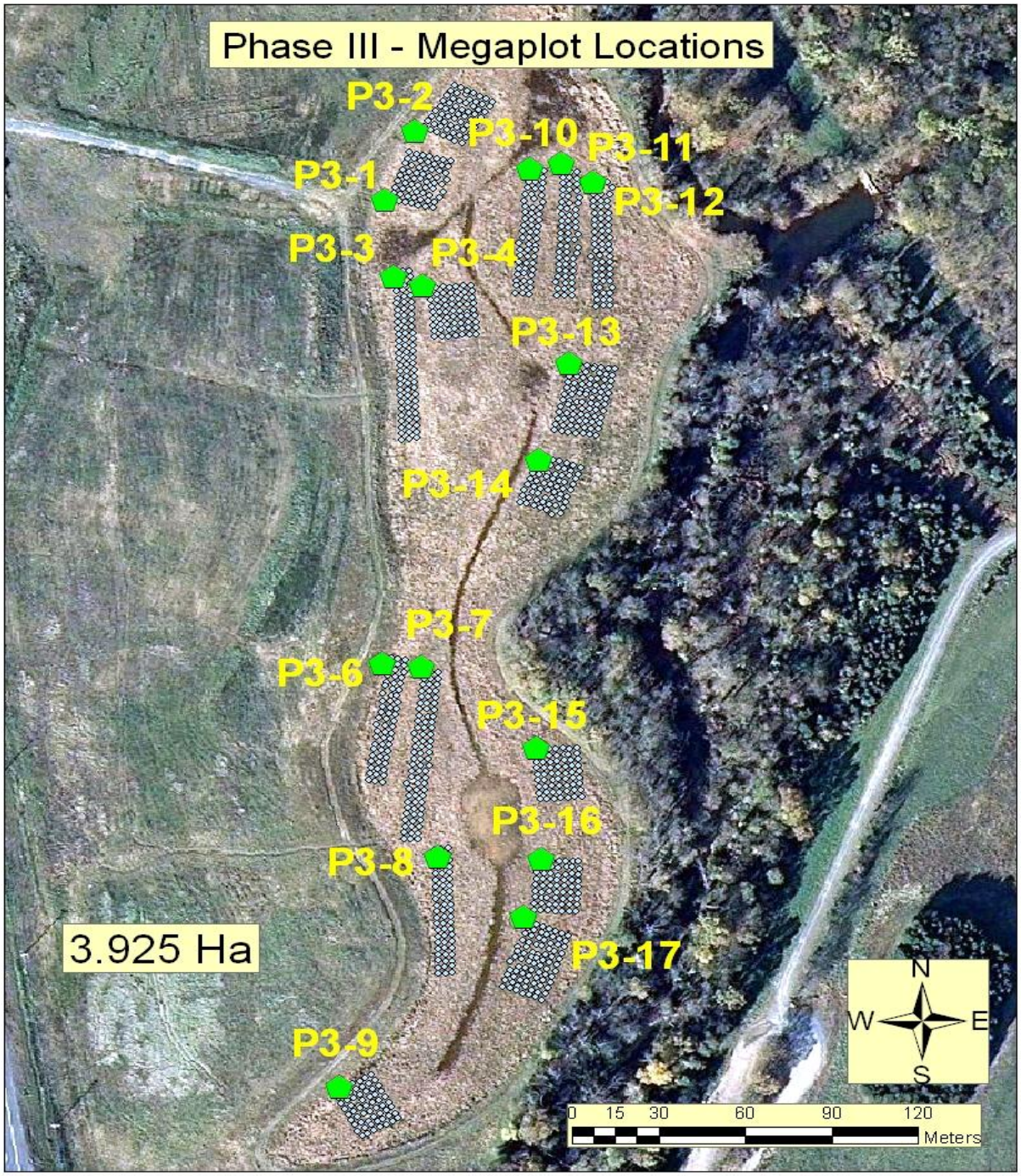
- A subsample consisting of one of the three planting types for each of the seven tree species was planted in a randomized 3 tree x 7 tree plot.
  - Plots dimensions were 7x17 m or 119 m^2
- 3 to 4 plots were arranged together to create "megaplots".
- 24 megaplots were established among the 3 sites.
- A total of 1596 trees were planted.


Phase I - Megaplot Locations
P1-1
P1-2
P1-3
P1-4
N
W
E
S
0 5 10 20 30 40
Meters
0.809 Ha

Phase I

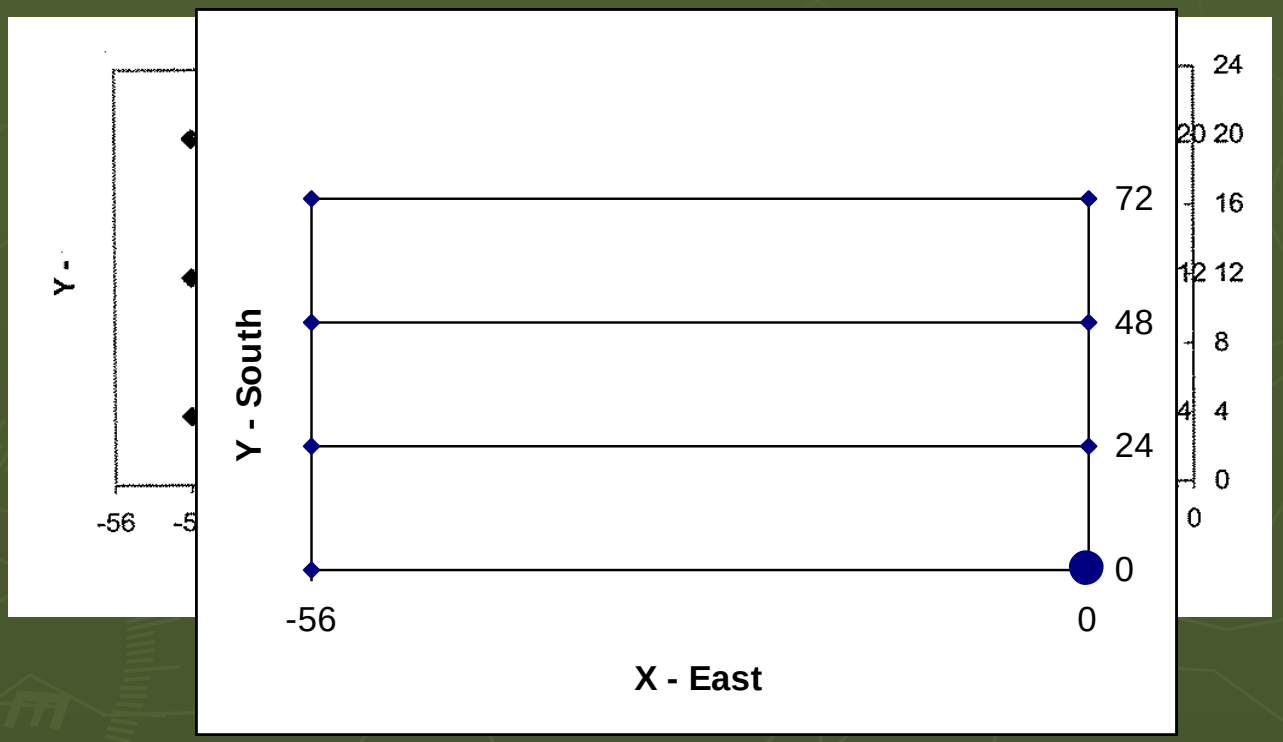

Phase II - Megaplot Locations
P2-4
P2-3
P2-1
P2-2
3.521 Ha
N
W
E
S
0 15 30 60 90 120
Meters

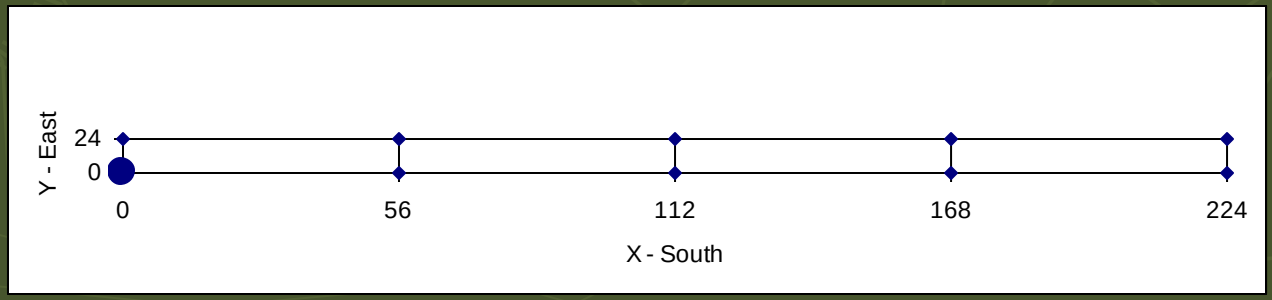
Phase II


Phase III - Megaplot Locations
P3-2
P3-10
P3-11
P3-1
P3-12
P3-3
P3-4
P3-13
P3-14
P3-7
P3-6
P3-15
P3-16
P3-8
3.925 Ha
P3-17
P3-9
N
W
E
S
0 15 30 60 90 120
Meters

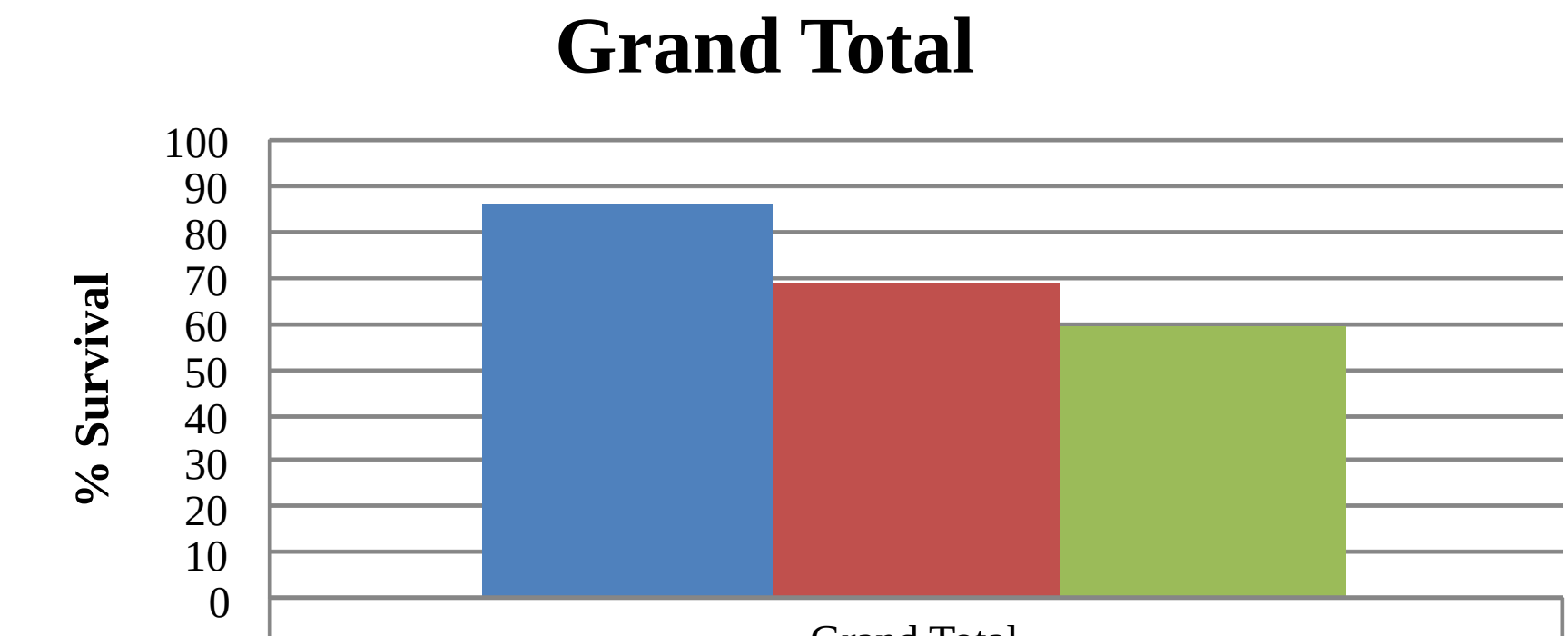
Phase III

Megaplot Designs

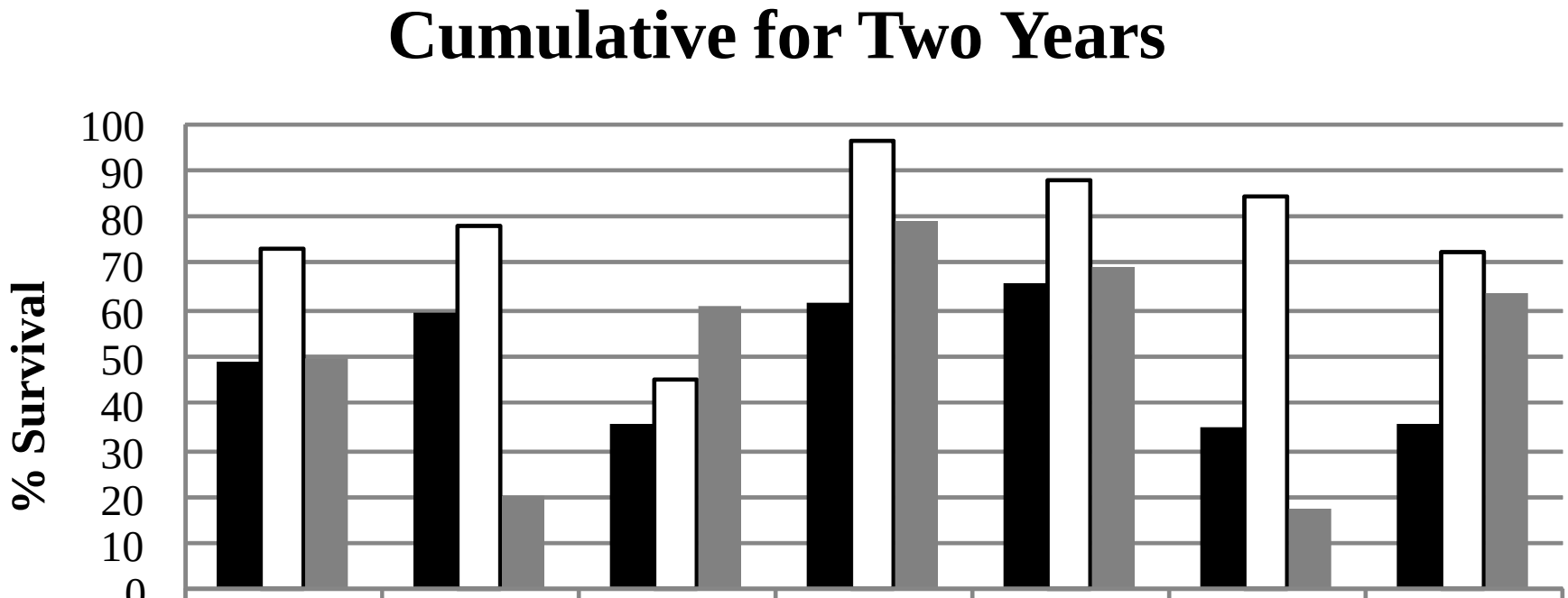




Results: Survival (Species and Planting Types combined)



Survival (Among Species and Planting Types)



	BetNig	LiqSty	PlaOcc	QueBic	QuePal	QuePhe	SalNig
BR	48.7	59.2	35.5	61.3	65.8	35.1	35.5
Gal	73.3	77.9	45.3	96.1	88.2	84.4	72.4
TB	50.0	20.0	60.5	78.9	69.2	17.1	64.0

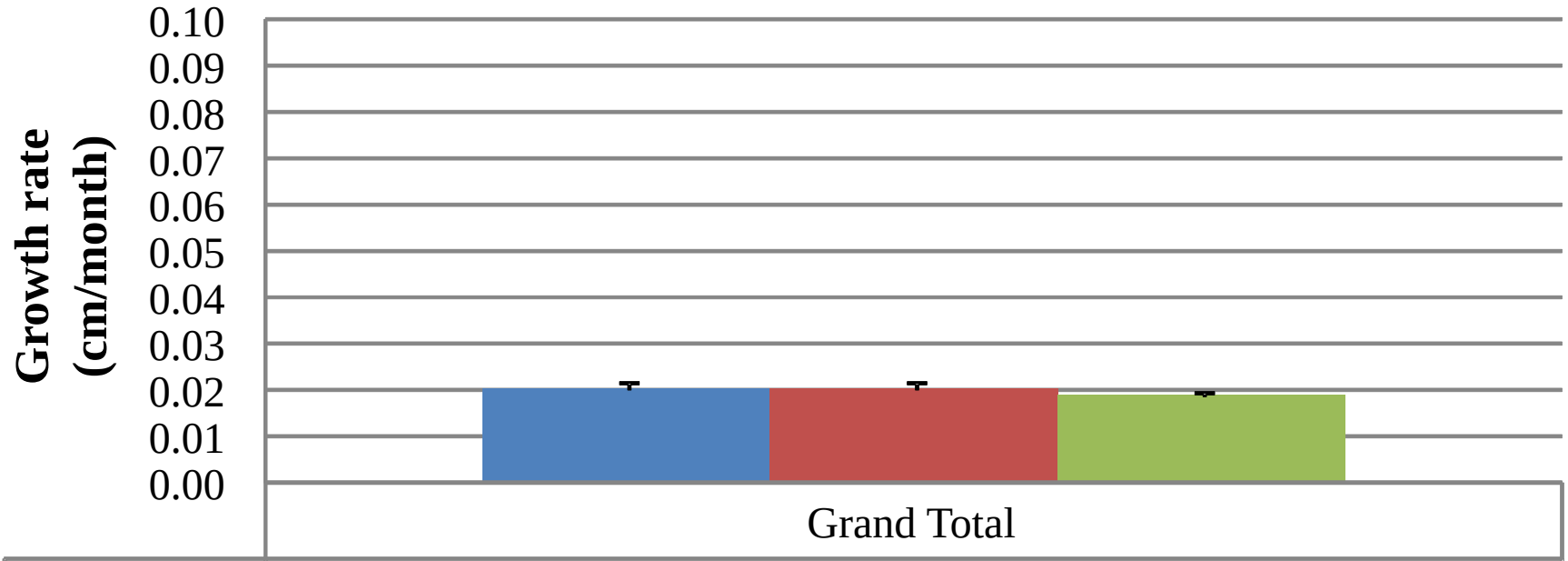
Survival Summary: Planting Type

- Trees planted as gallon pots survived better than either bare roots or tubelings.
- Tubelings and bare roots survived at a similar, lower rate.

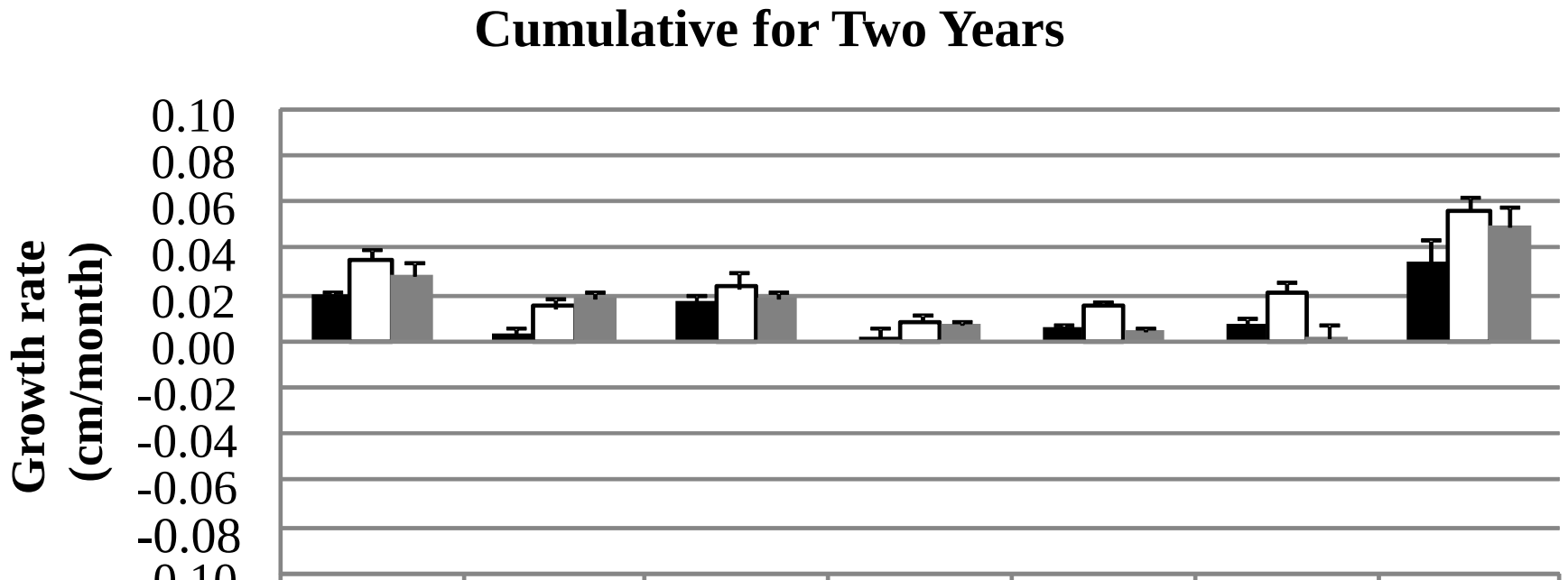
Survival Summary: Species

- Overall survival was highest for:
  - *Quercus bicolor*
  - *Q. palustris*
- Overall survival was lowest for:
  - *Platanus occidentalis*
  - *Q. phellos*

Results: Growth (Basal Diameter)



Basal Diameter (Among Species and Planting Types)

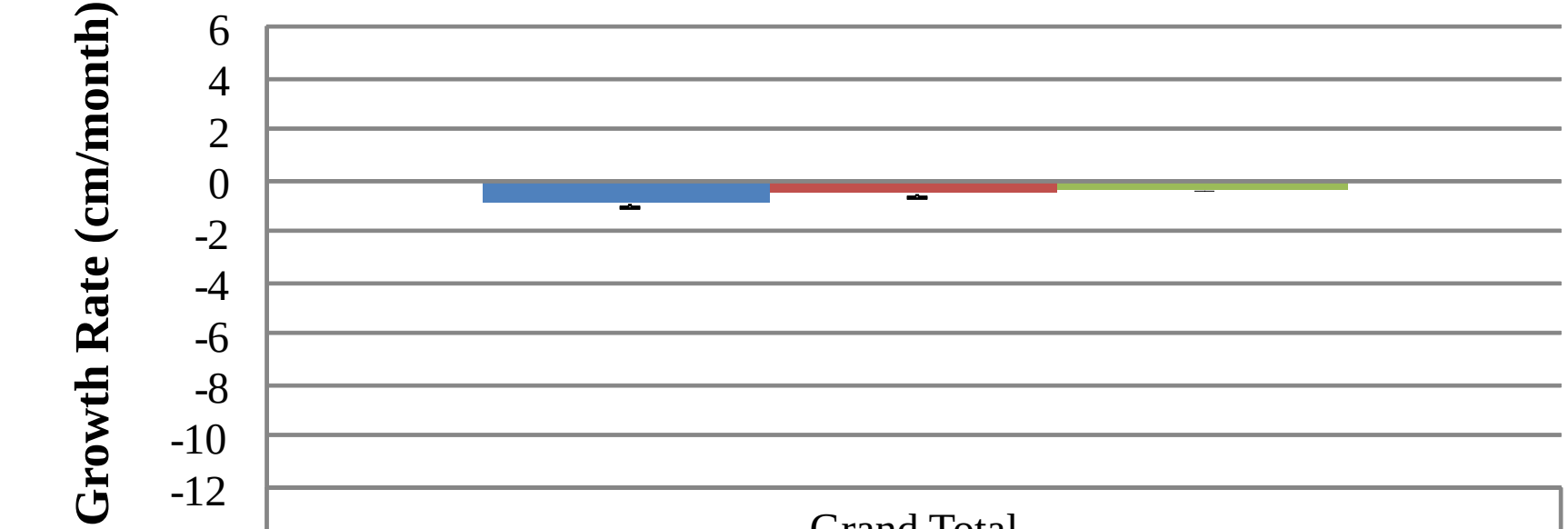


	BetNig	LiqSty	PlaOcc	QueBic	QuePal	QuePhe	SalNig
BR	0.02	0.00	0.02	0.00	0.01	0.01	0.03
Gal	0.04	0.01	0.02	0.01	0.02	0.02	0.06
TB	0.03	0.02	0.02	0.01	0.00	0.00	0.05

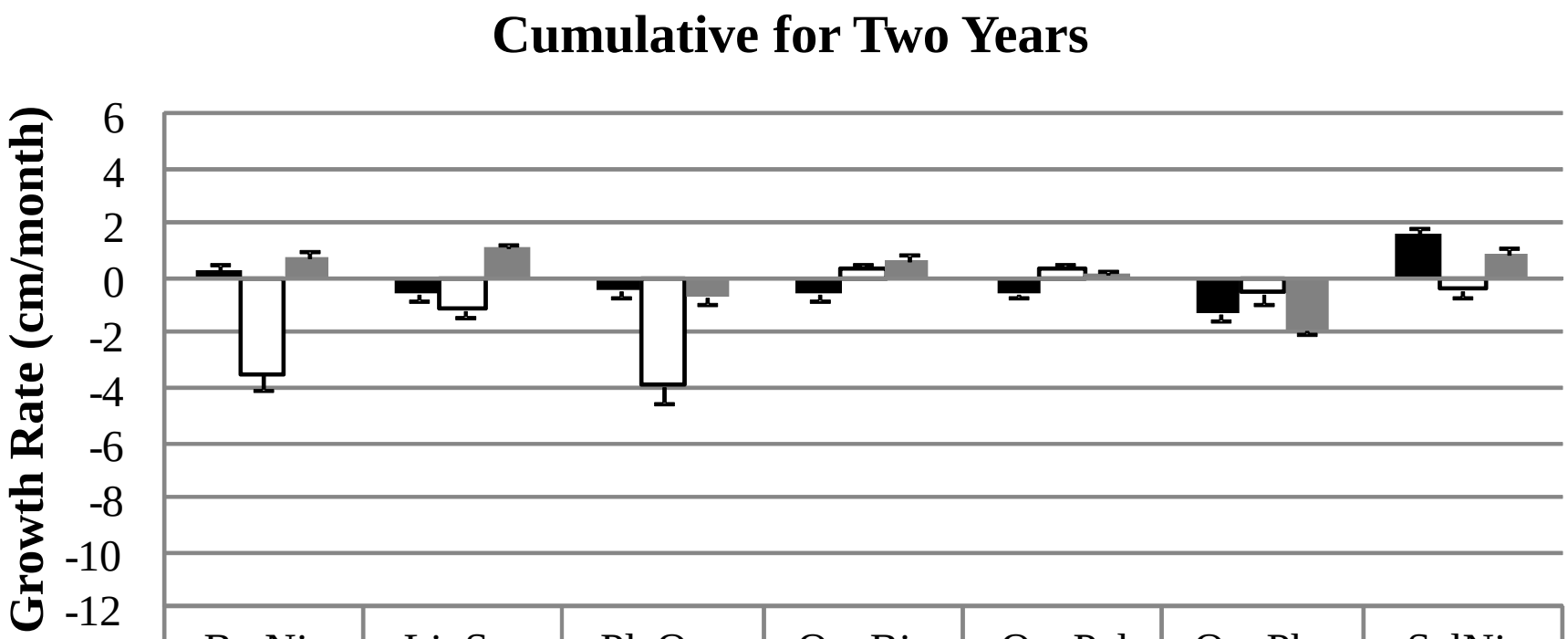
Growth Summary: Basal Diameter

- Consistent rate from year 1 to year 2.
- Gallon planting type grew at highest rate compared to bare root and tubeling planting types.
- *Salix nigra* had highest growth rates
- *Liquidambar styraciflua*, *Quercus bicolor*, *Quercus palustris*, and *Quercus phellos* exhibited minimal growth.

Results: Growth (Height)



Height (Among Species and Planting Types)

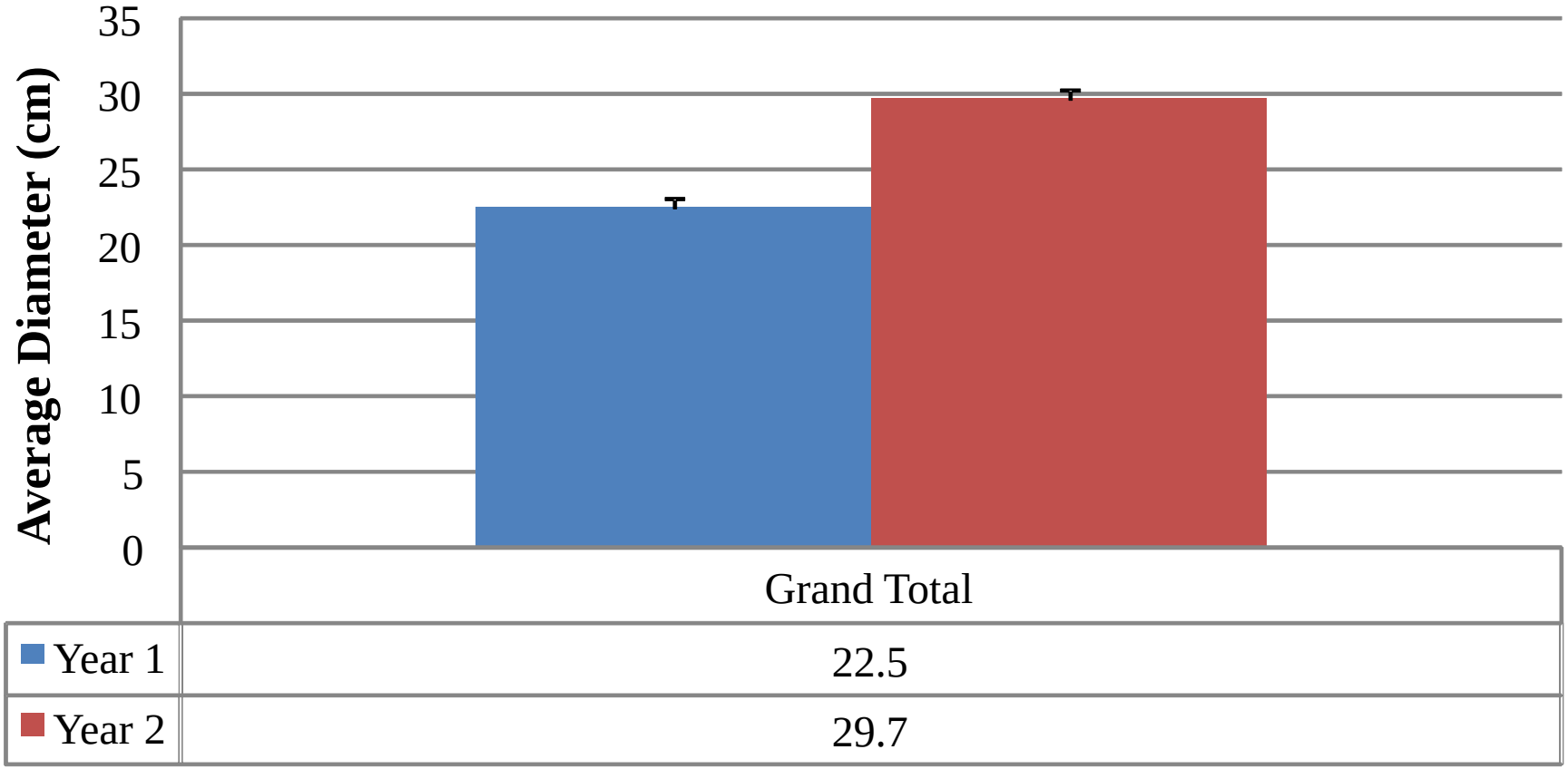


	BetNig	LiqSty	PlaOcc	QueBic	QuePal	QuePhe	SalNig
BR	0.3	-0.6	-0.4	-0.6	-0.5	-1.3	1.6
Gal	-3.5	-1.1	-3.9	0.4	0.4	-0.5	-0.4
TB	0.8	1.1	-0.6	0.7	0.2	-1.9	0.9

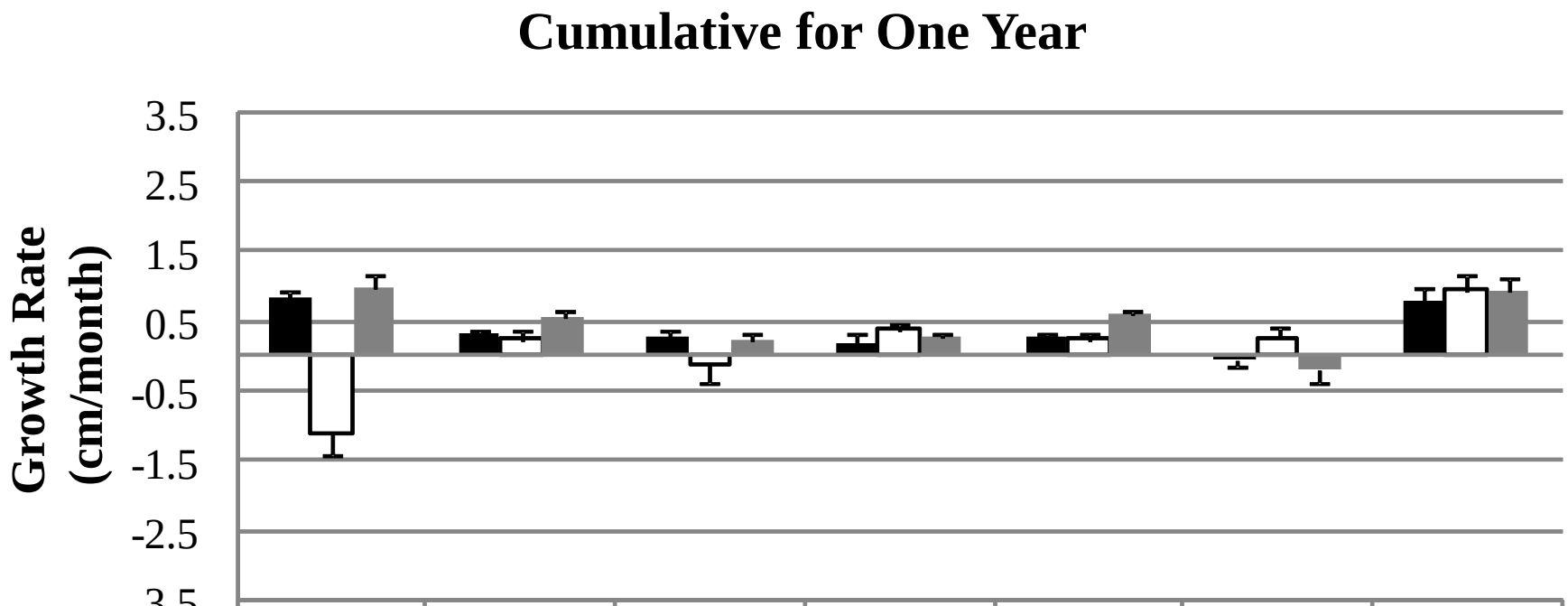
Growth Summary: Height

- Consistent rate from year 1 to year 2.
- Tubelings exhibited higher growth rates than bare roots, which was higher than gallons.
- *Salix nigra* had the highest growth rates and *Platanus occidentalis* had the lowest.
- Death of main stems followed by coppice resprouting.

Results: Growth (Canopy Diameter)



Canopy Diameter (Among Species and Planting Types)



	BetNig	LiqSty	PlaOcc	QueBic	QuePal	QuePhe	SalNig
BR	0.8	0.3	0.3	0.2	0.3	0.0	0.8
Gal	-1.1	0.2	-0.1	0.4	0.2	0.3	0.9
TB	1.0	0.6	0.2	0.3	0.6	-0.2	0.9

Growth Summary: Canopy Diameter

- Significantly higher in year 2.
- Canopy diameter growth rates highest in gallons compared to tubelings and bare roots.
- *Salix nigra* experienced highest growth rate while *Quercus phellos* had the lowest.

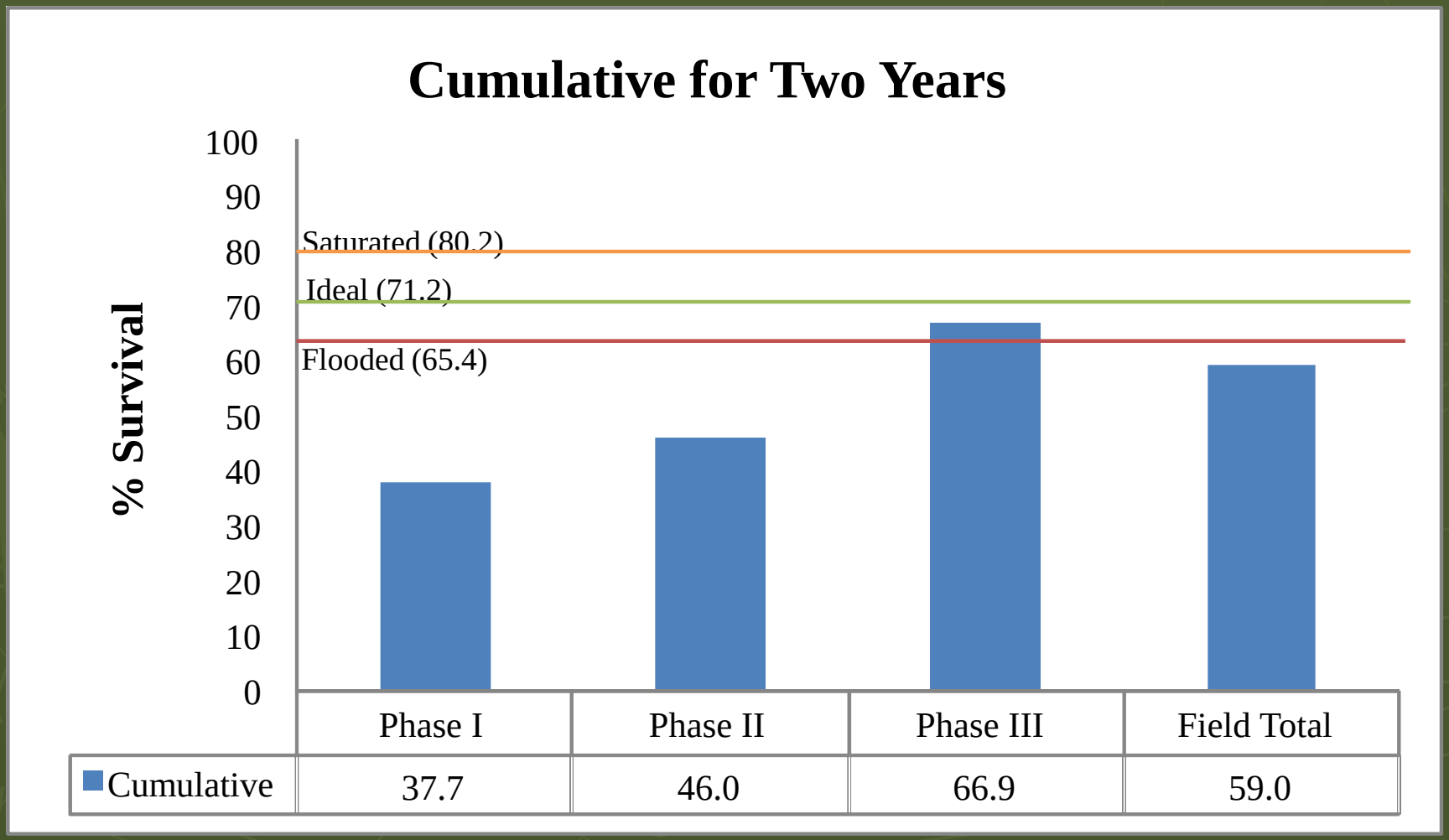
Results summary: Planting Type

- Gallon pots had highest rate of survival and high growth rates of basal and canopy diameter.
- Gallon pots exhibited a negative growth rate in height possibly resulting from main-stem die-back and coppice resprouting.
- Bare roots had similar but slightly lower levels of survival and growth compared to tubelings.

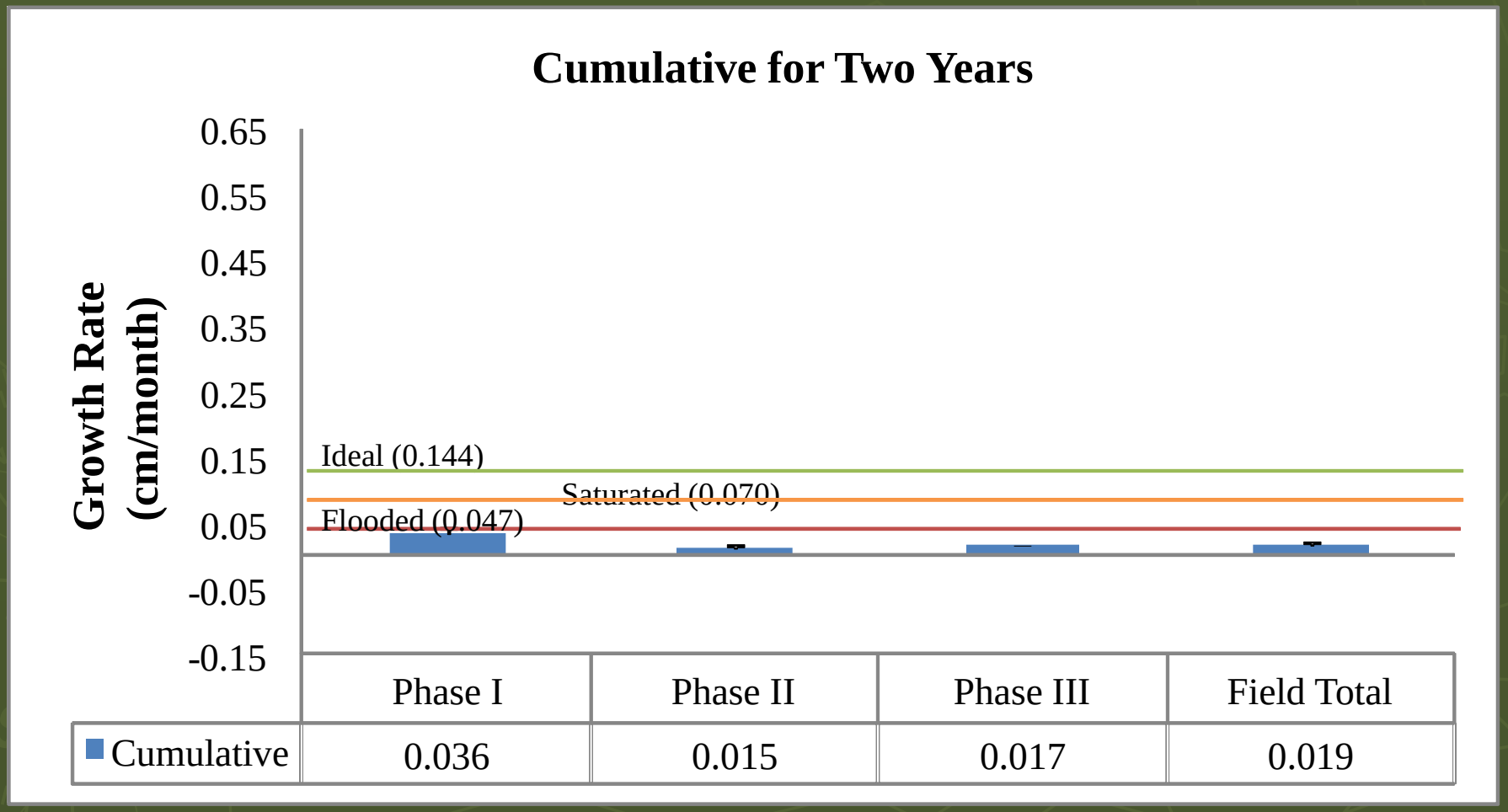
Results summary: Species

- *Salix nigra* had high rates of basal and canopy diameter growth, and intermediate values for survivorship and height growth.
- *Quercus phellos* had low survivorship and low growth rates.
- *Platanus occidentalis* had low survivorship, height and canopy growth rate, and intermediate growth in basal diameter.

Comparison of Field versus Mesocosm Survival

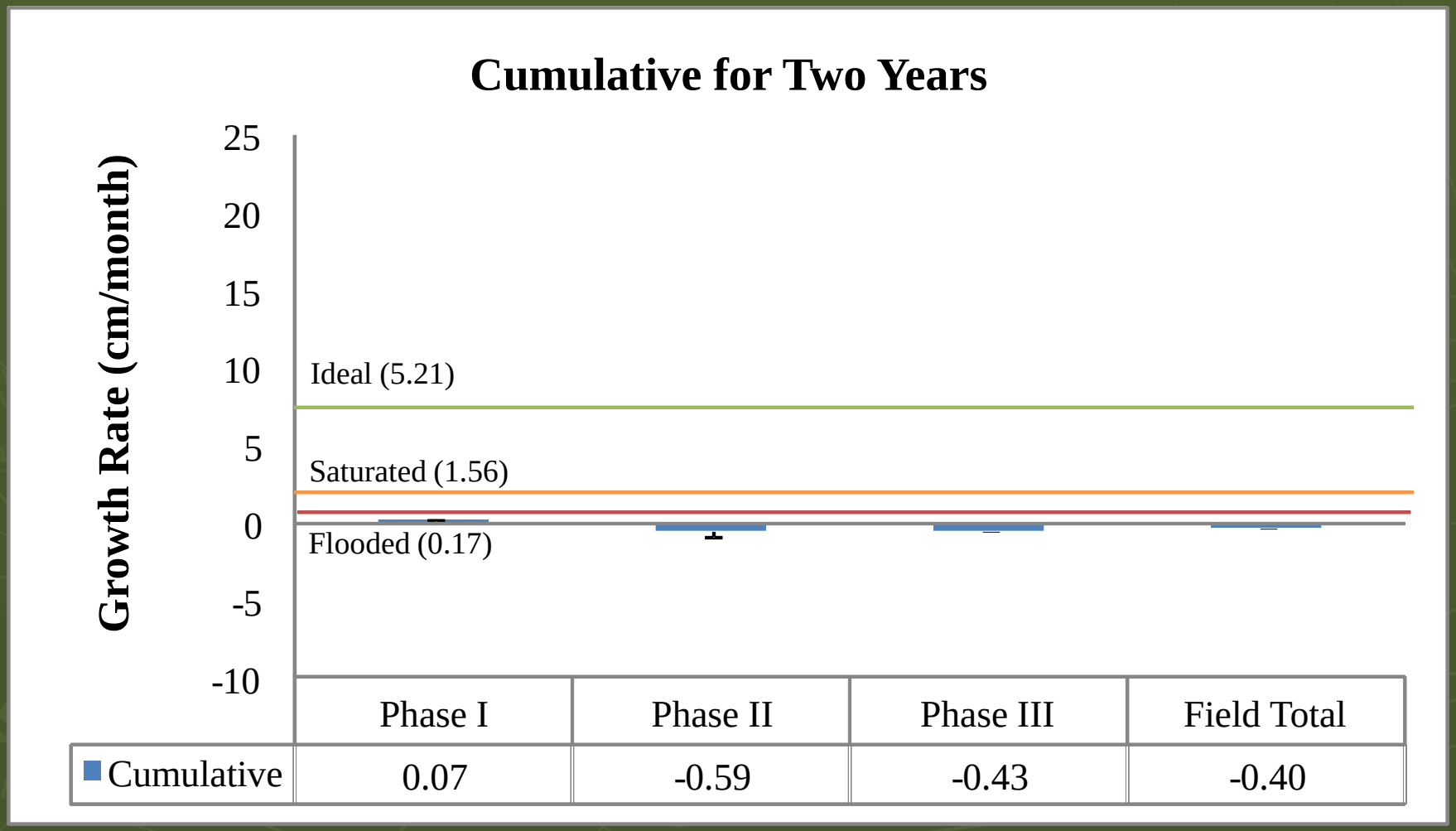


Field versus Mesocosm: Basal Diameter



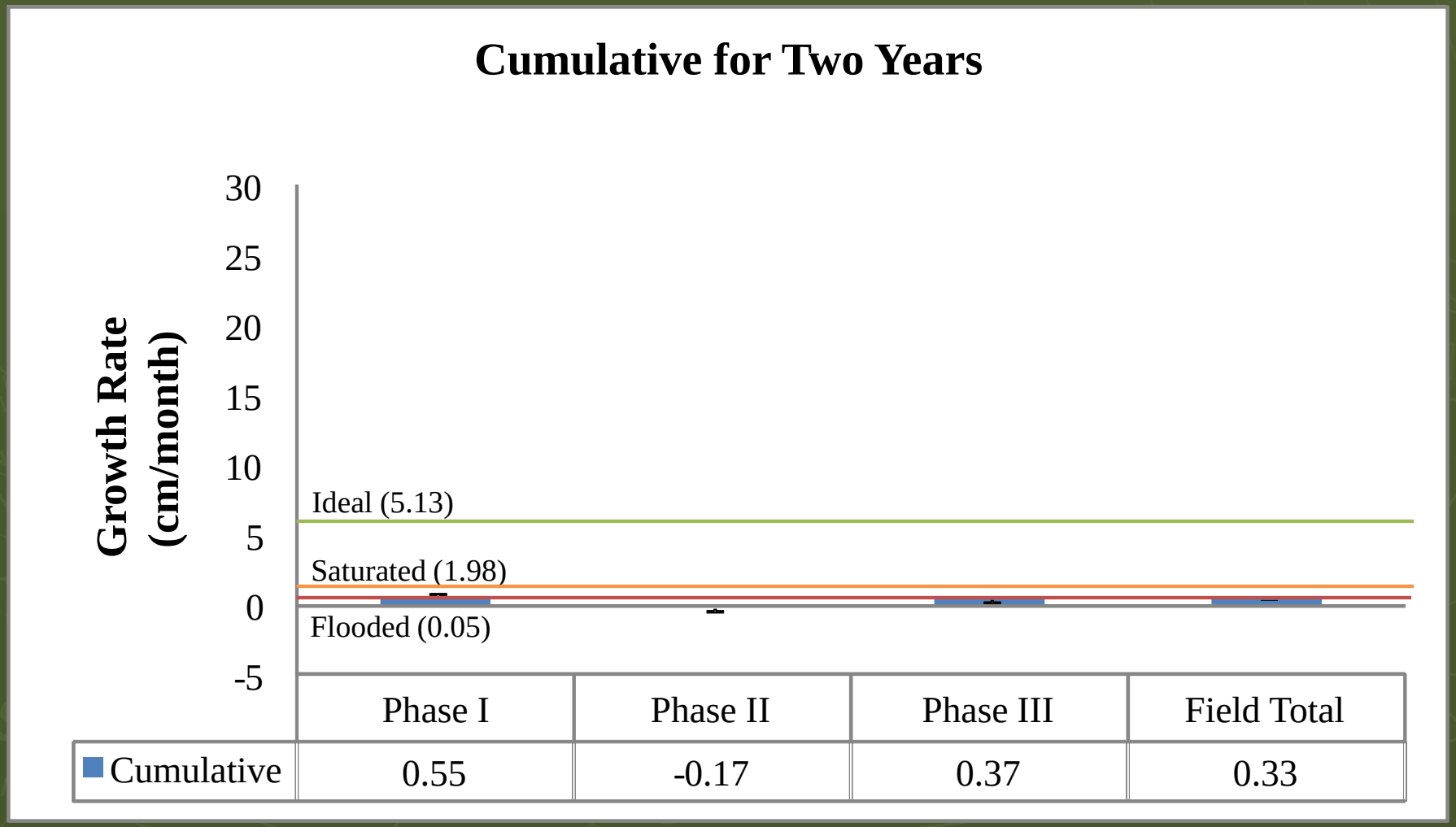
	Phase I	Phase II	Phase III	Field Total
Cumulative	0.036	0.015	0.017	0.019

Field versus Mesocosm: Height



	Phase I	Phase II	Phase III	Field Total
Cumulative	0.07	-0.59	-0.43	-0.40

Field versus Mescosm: Canopy Diameter



	Phase I	Phase II	Phase III	Field Total
Cumulative	0.55	-0.17	0.37	0.33

Selections for Tree Establishment

- Field
  - *Quercus bicolor*, *Q. palustris* (Survival)
  - *Salix nigra* (Growth)
  - Gallon pots (Survival)
  - Gallon pots (Growth: Basal/Canopy Diameter)
  - Tubelings (Growth: Height)
- Mesocosm
  - Secondary species (~Survival)
  - Primary species (~Growth)
  - Gallon pots (Survival)
  - Gallon~Tubeling~Bare root (Growth)

Discussion

- Survival and growth differences between field versus mesocosm may have resulted from:
  - Soil.
    - Field (clay) vs. Mesocosm (sand).
  - Herbaceous vegetation control.
    - Field (unmowed) vs. Mesocosm (mowed).
  - Hydrology.
    - Field (not actively managed-variable) vs. Mesocosm (managed-consistent).

Conclusions

- Survival highest among two secondary succession species.
- Growth highest in one primary succession species.
- Gallon pots generally performed better than other planting types.
- Survival and growth were lower in field than in mesocosms, possibly due to environmental conditions.

Future Plans

- Characterize soil, vegetative composition and hydrologic parameters.
- Use these parameters to develop a model that predicts survival and growth.
- Support functional assessment goals for work in the mesocosm study.
- Continue monitoring trees each year for the remainder of the seven-year study.

Works Consulted

- Hudson III, Herman. 2010. The effect of adjacent forests on colonizing tree density in restored wetland compensation sites in Virginia. MA Thesis, Christopher Newport University.
- Keever, C. 1950. Causes of succession on old fields of the piedmont, North Carolina. Ecological Monographs 20:229-250.
- United States Geological Survey. 1999. National Water Summary-Wetland Resources: Virginia. United States Geological Survey, USGS National Center, Reston, VA, USA. Supply Paper 2425.

Acknowledgements

- Peterson Family Foundation
- Wetland Studies and Solutions, Inc.
- Department of Biology, Chemistry and Environmental Science at CNU
- Center for Wetland Conservation

Peterson Family Foundation

Center for Wetland Conservation
at Christopher Newport University

Wetland Studies and Solutions, Inc.®


Thank You