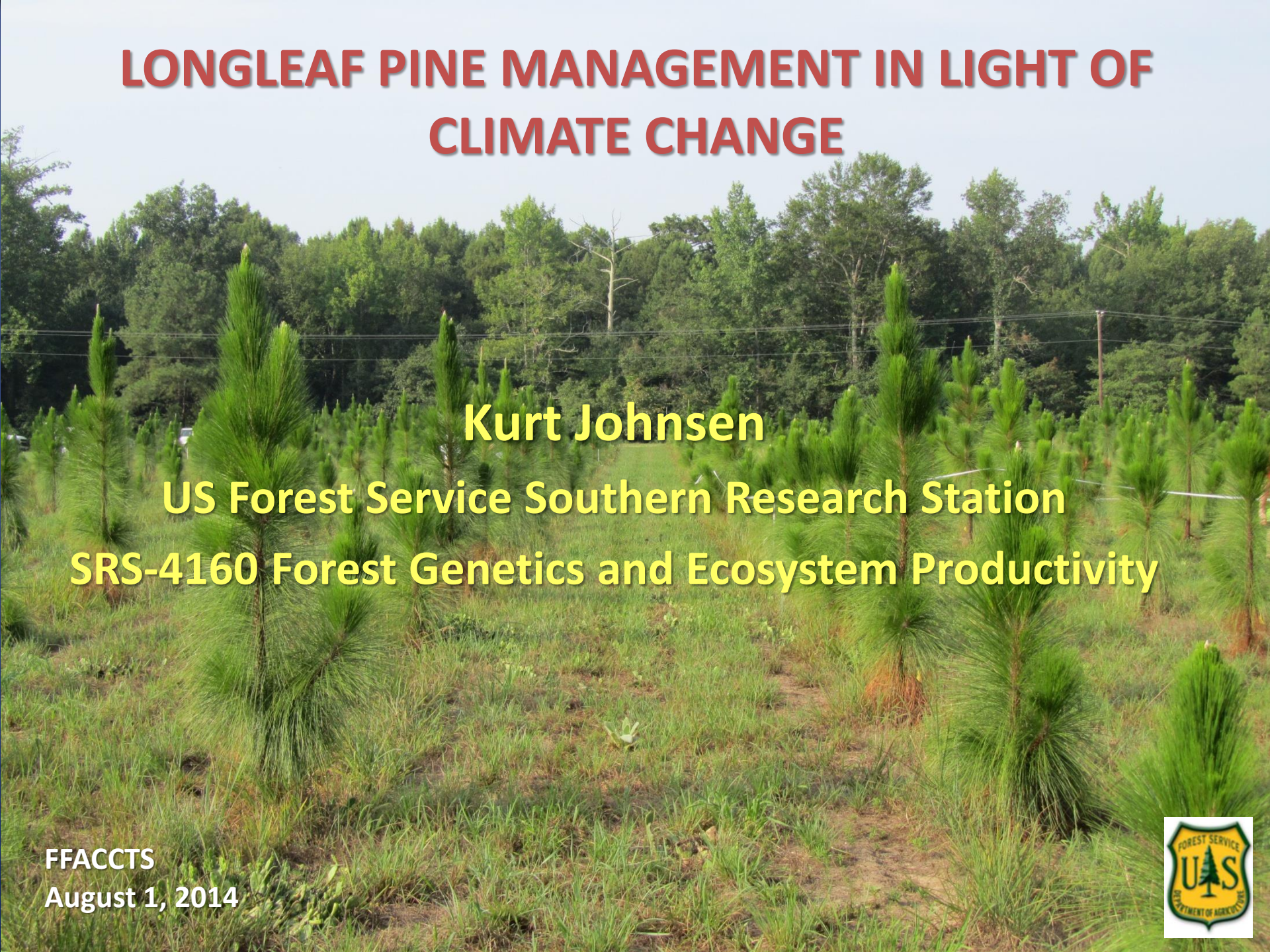
# LONGLEAF PINE MANAGEMENT IN LIGHT OF CLIMATE CHANGE

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US Forest Service Southern Research Station

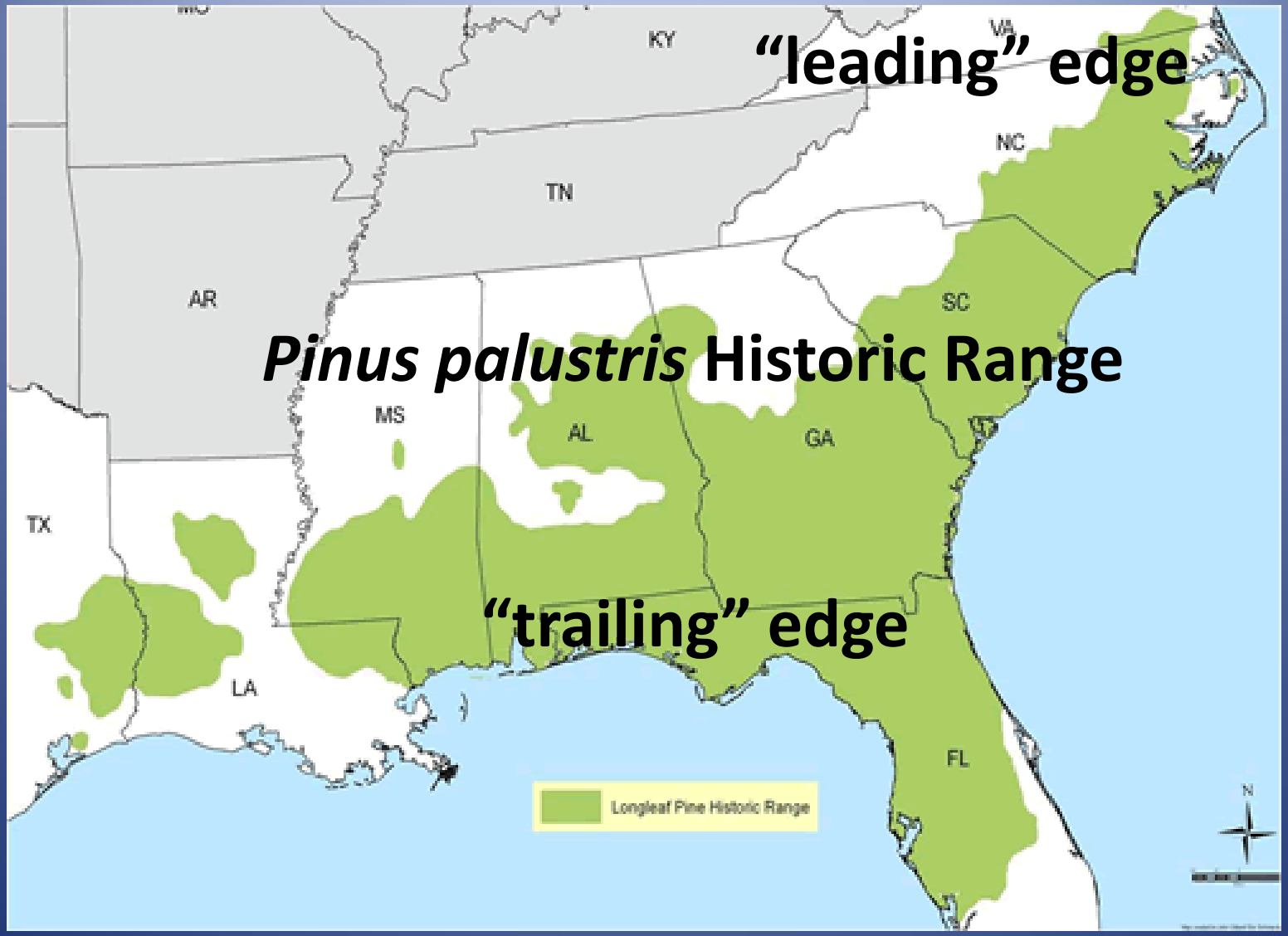
SRS-4160 Forest Genetics and Ecosystem Productivity


FFACCTS

August 1, 2014

# Longleaf Pine (*Pinus palustris* Mill.)

- Schmidtling (2007) concluded longleaf pine had one western refugium during the Pleistocene glaciation.
- It was one of the most extensive and ecologically important tree species in the southeastern United States
- Longleaf pine ecosystems are often extremely high in biodiversity
- It grows across a wide range of sites
- It is long-lived
- It has valuable wood
- It is relatively wind resistant
- It is the focus of restoration for Region 8, States and non-profits




# “leading” edge

# *Pinus palustris* Historic Range

# “trailing” edge

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# Current seed source transfer guidelines

- Unlike loblolly pine, east-west transfer is not usually a problem
- Moving north to minimum temperature within 2.75$^{o}$ C is safe and typically increases productivity
- Moving north to minimum temperature as much as 5.5$^{o}$ C lower may increase productivity but also may increase crop loss due to cold damage

***from Schmidtling 2001*, based on multiple provenance tests covering the species range including results from the Forest Service Southwide Pine Seed Source Study established in the 1950's by Philip Wakeley.

*However,* there have been remarkable examples of successful long distance seed source transfer of longleaf pine.

No *ecotypes* seem to exist

*Craig Echt's* (SRS-SIFG) work, using molecular markers, indicates fluid gene flow across the range. "Longleaf populations are one big happy family from a neutral allele gene flow perspective."

Longleaf pine, overall, leans toward being a *GENERALIST* rather than a *SPECIALIST*

Douglas-fir – *Specialist*
Western white pine - *Generalist*

# Should and can assisted migration be used in restoring Longleaf pine at the northern (leading) edge of it's range?

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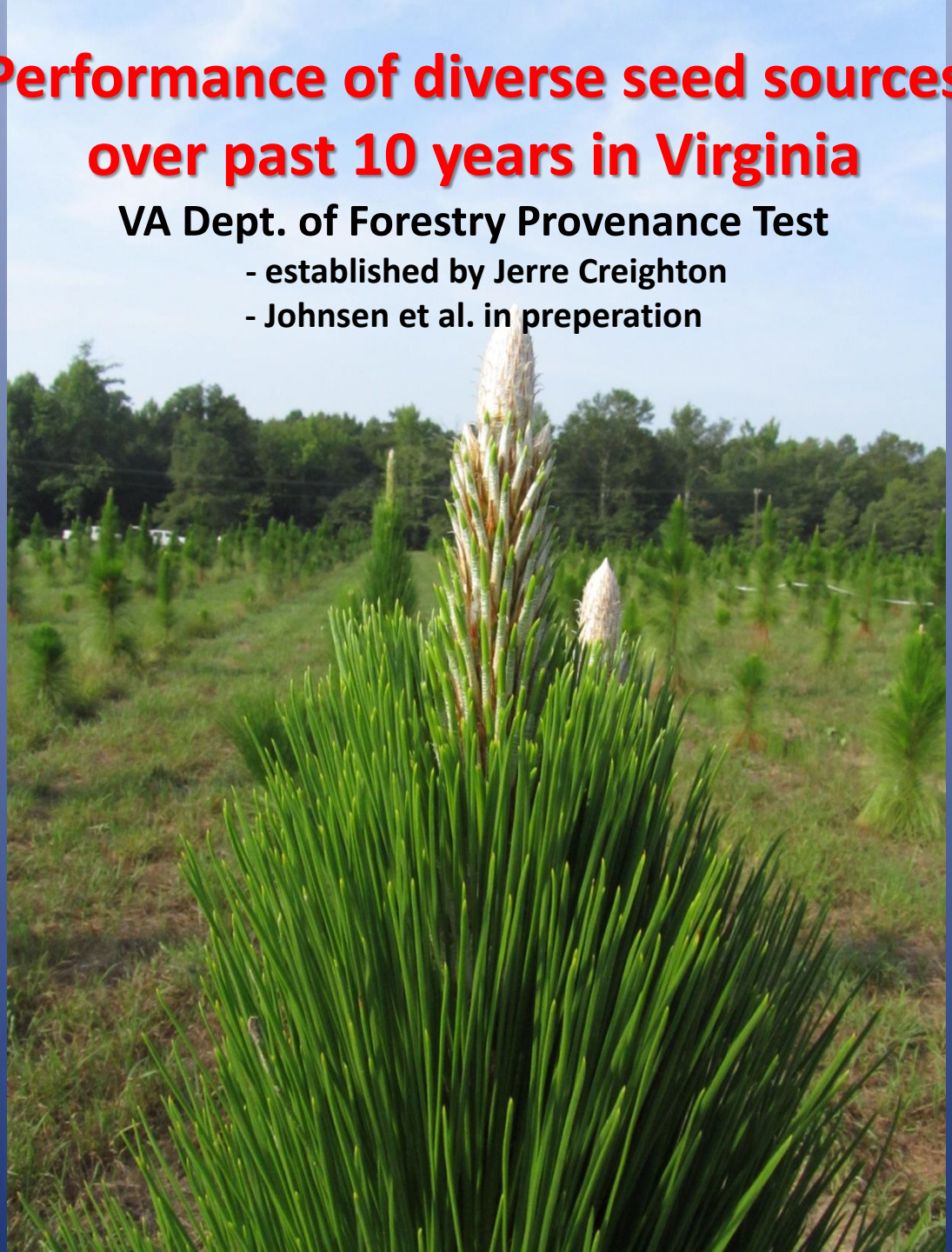
# Performance of diverse seed sources over past 10 years in Virginia

## VA Dept. of Forestry Provenance Test

- established by Jerre Creighton
- Johnsen et al. in preperation



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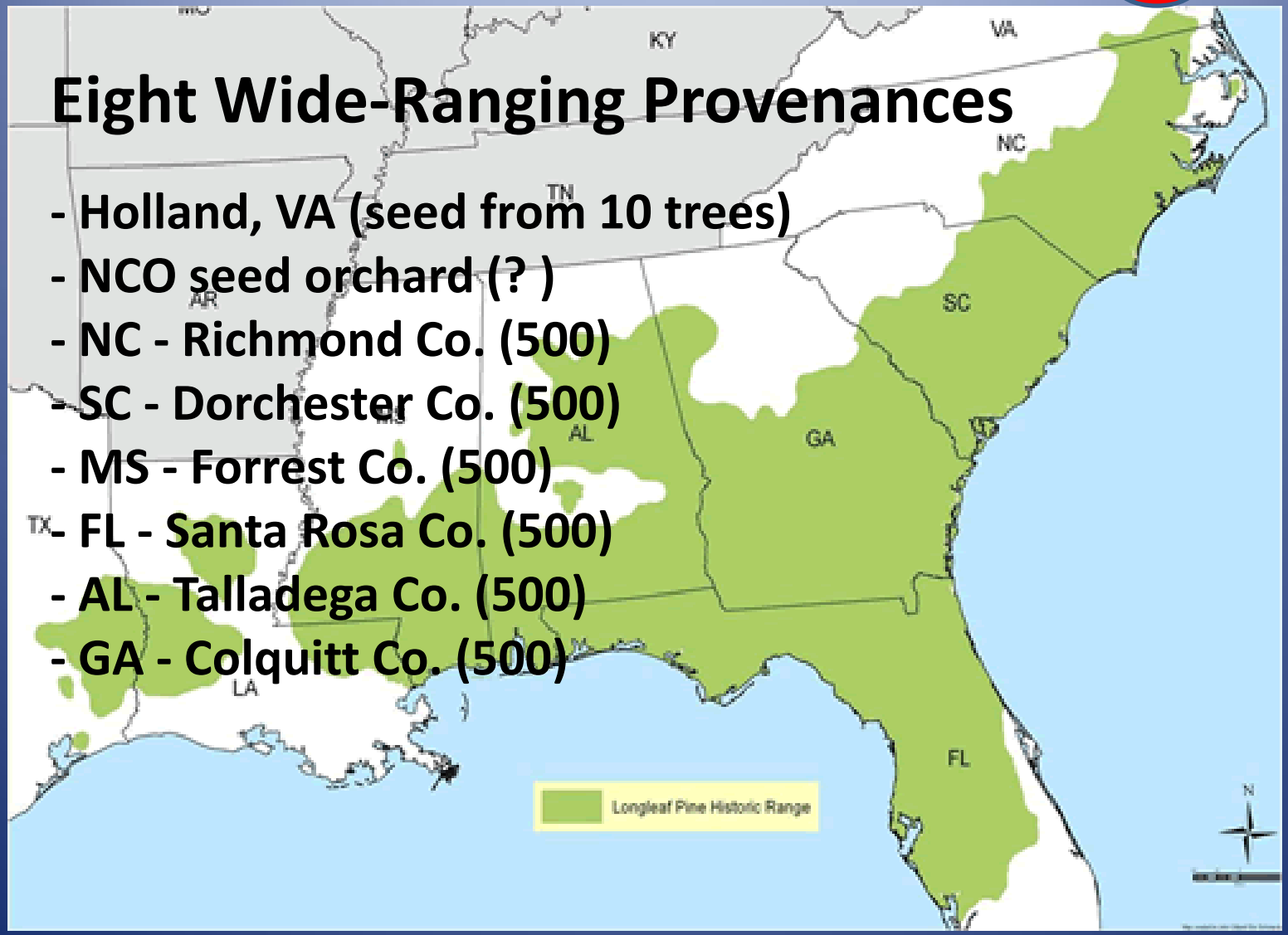
Test Sites

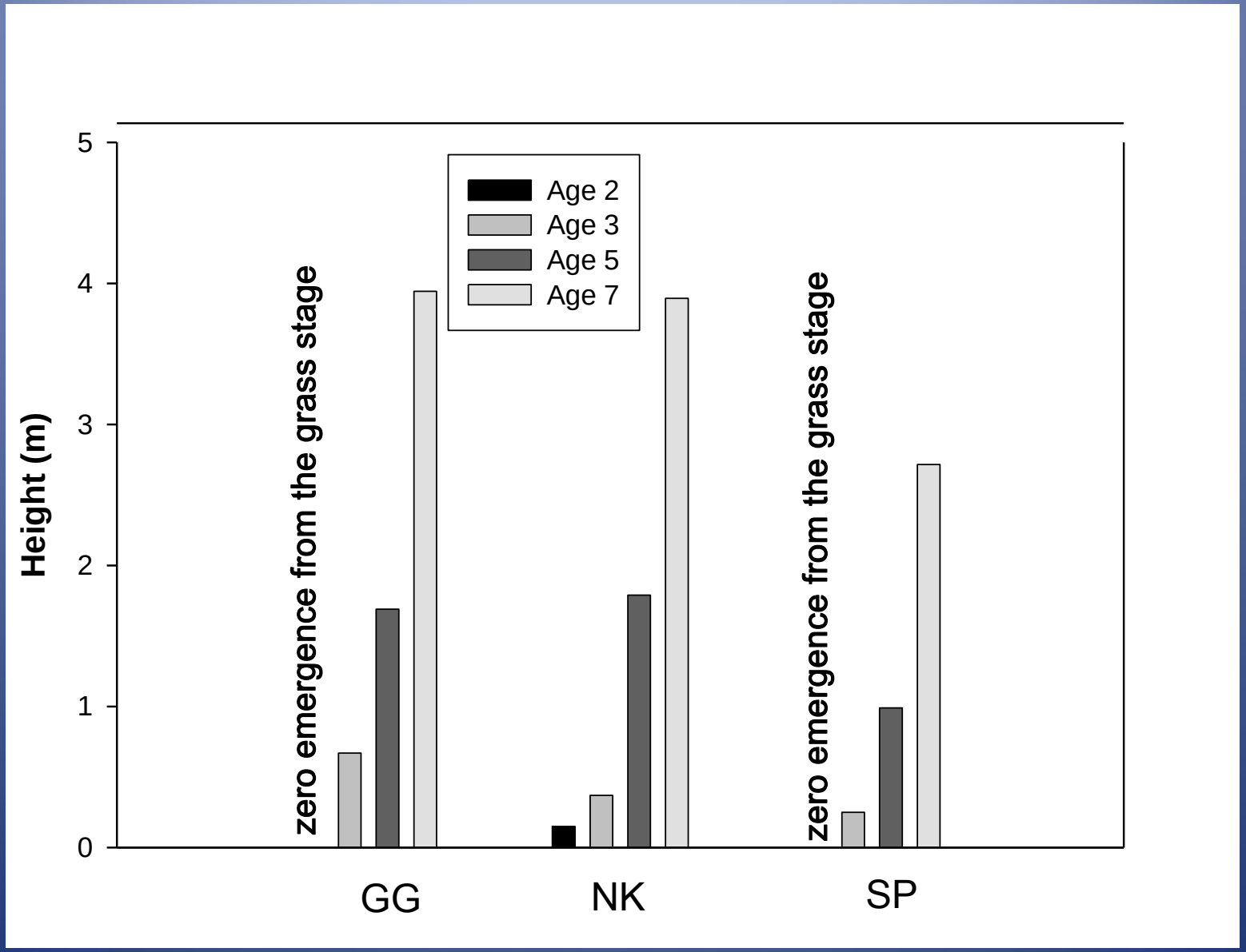
# Eight Wide-Ranging Provenances

- Holland, VA (seed from 10 trees)
- NCO seed orchard (? )
- NC - Richmond Co. (500)
- SC - Dorchester Co. (500)
- MS - Forrest Co. (500)
- FL - Santa Rosa Co. (500)
- AL - Talladega Co. (500)
- GA - Colquitt Co. (500)



# Experimental Design

- 3 sites (all near Richmond)
  - Garland Grey (former nursery site, sandy)
  - New Kent (former nursery site, sandy)
  - Sandy Point (cutover site, sandy/sandy loam)
- 2 blocks per site
- 25 trees per block
- 9 trees per block sampled for $^{13}C$ discrimination

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# Longleaf pine “grass stage”

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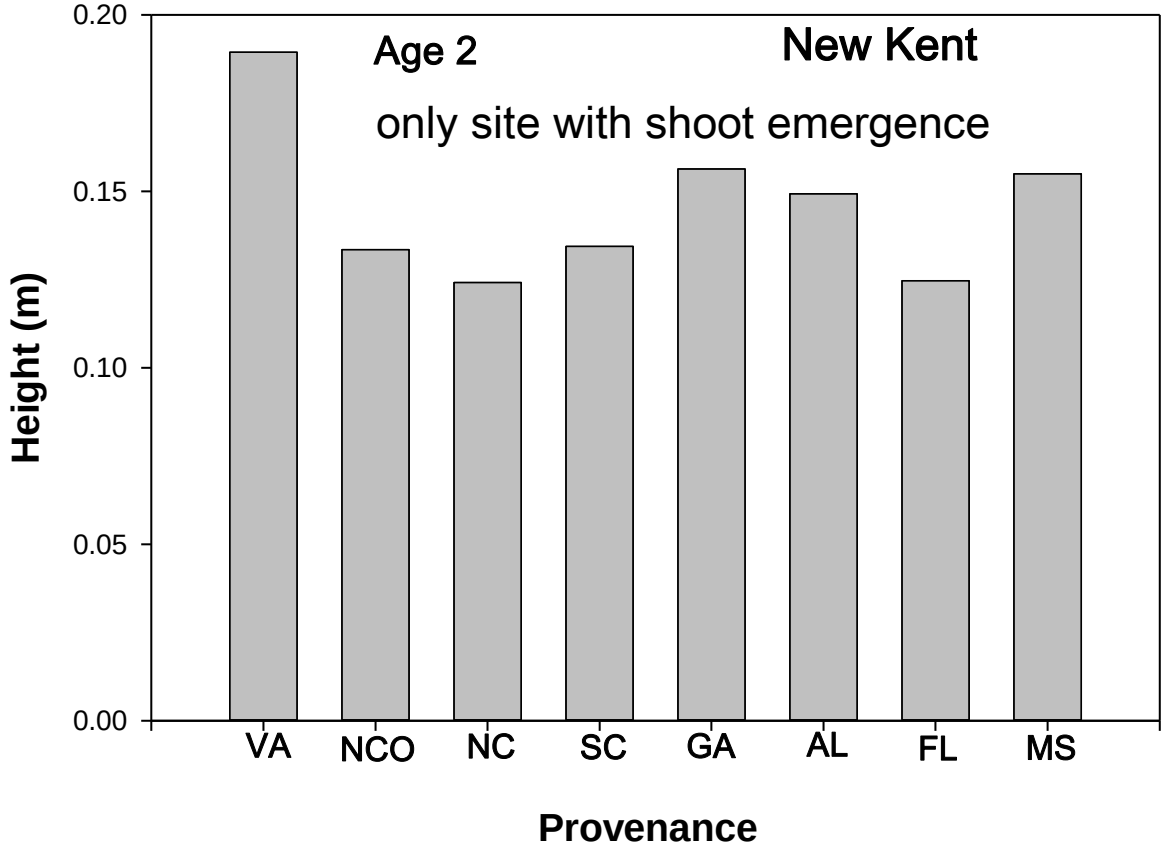


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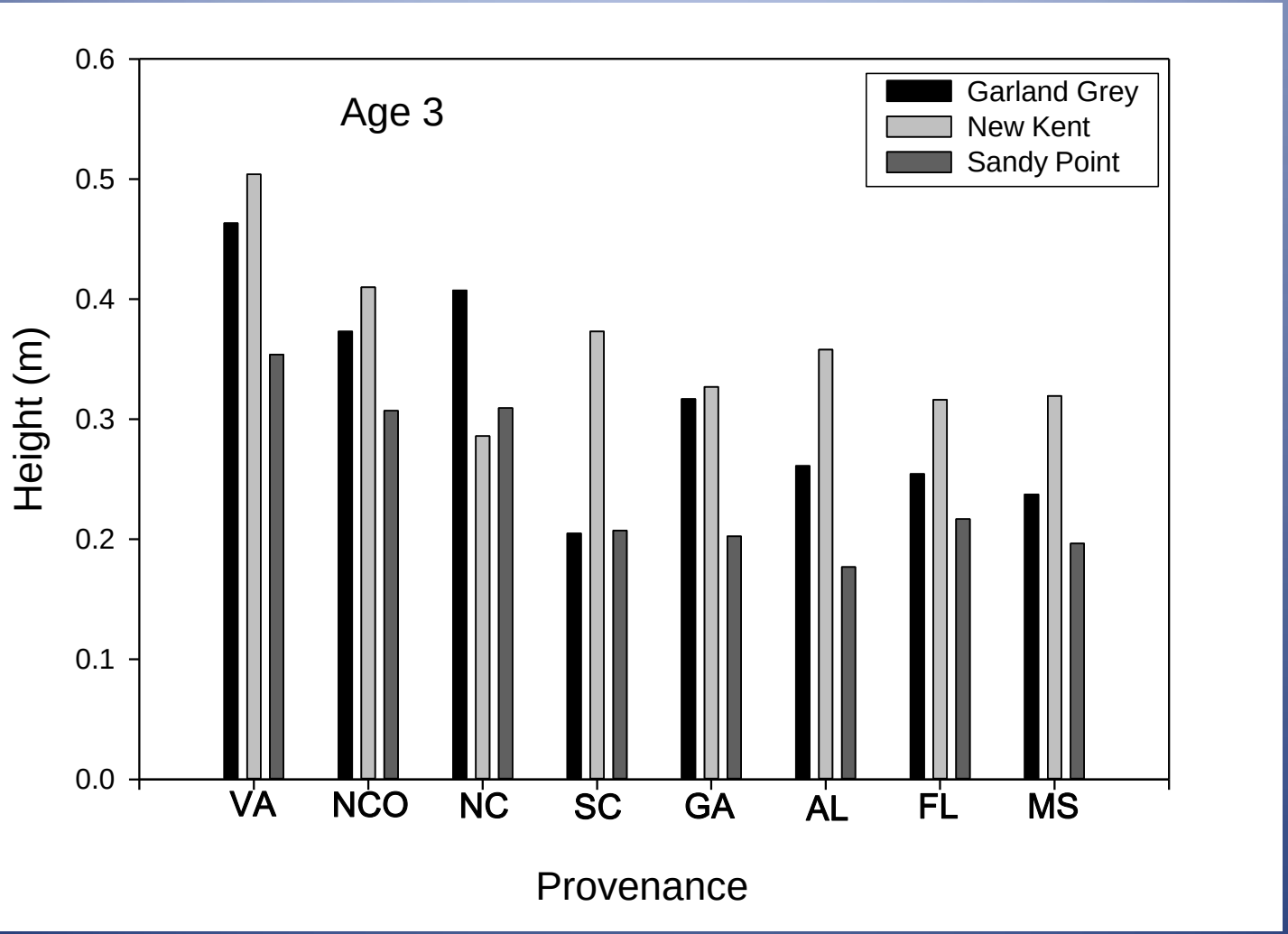


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# Age 4

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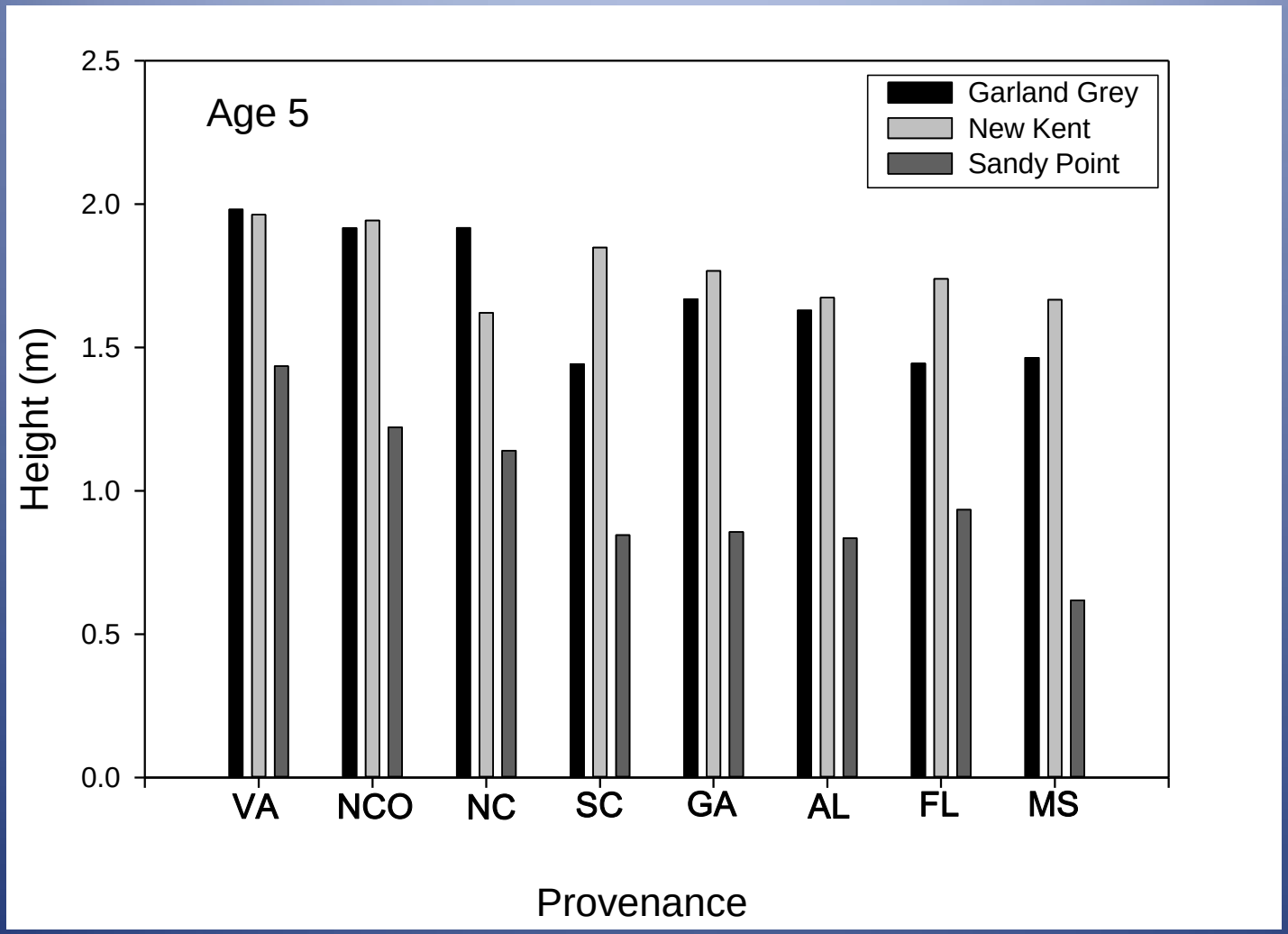


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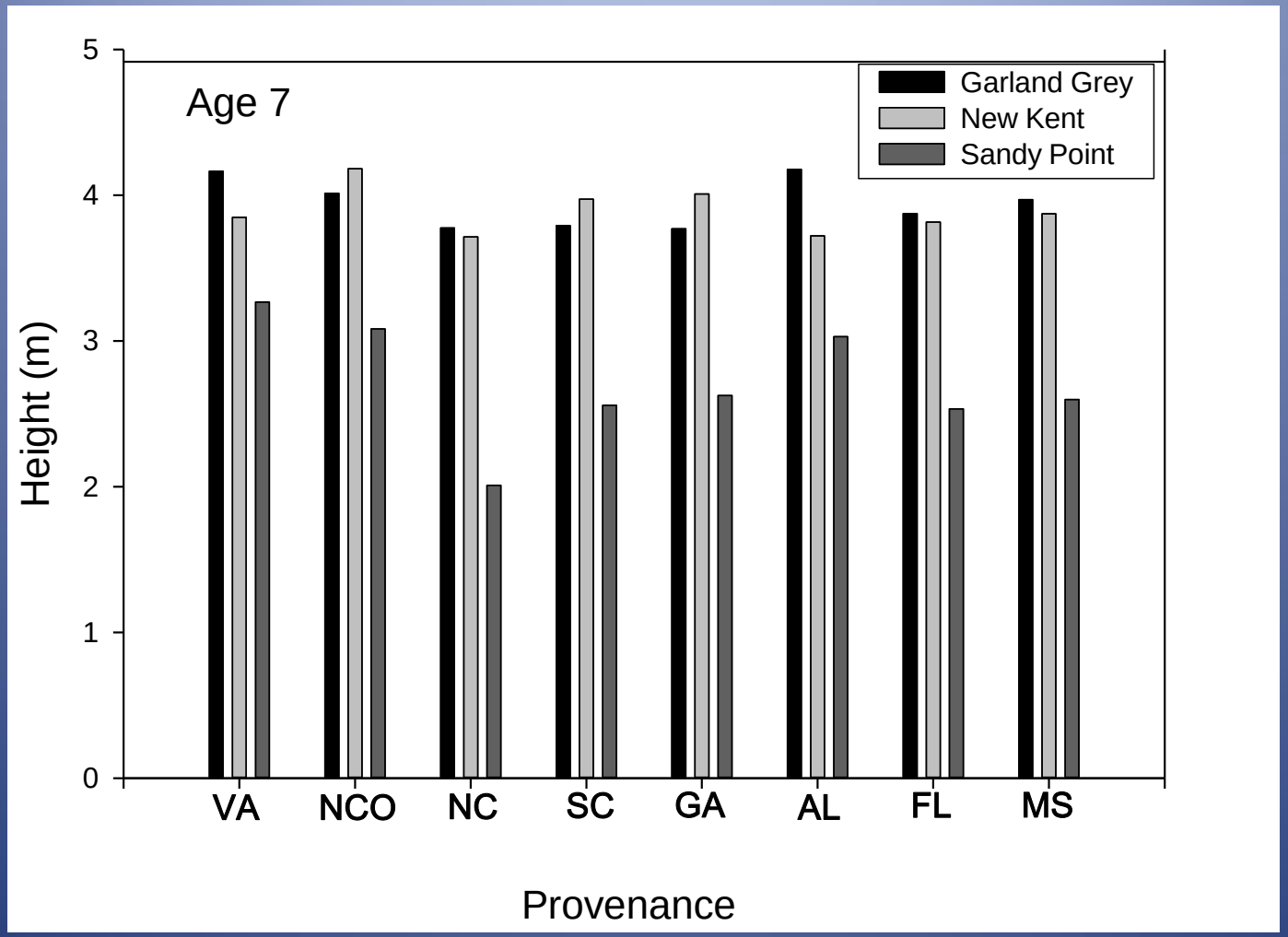


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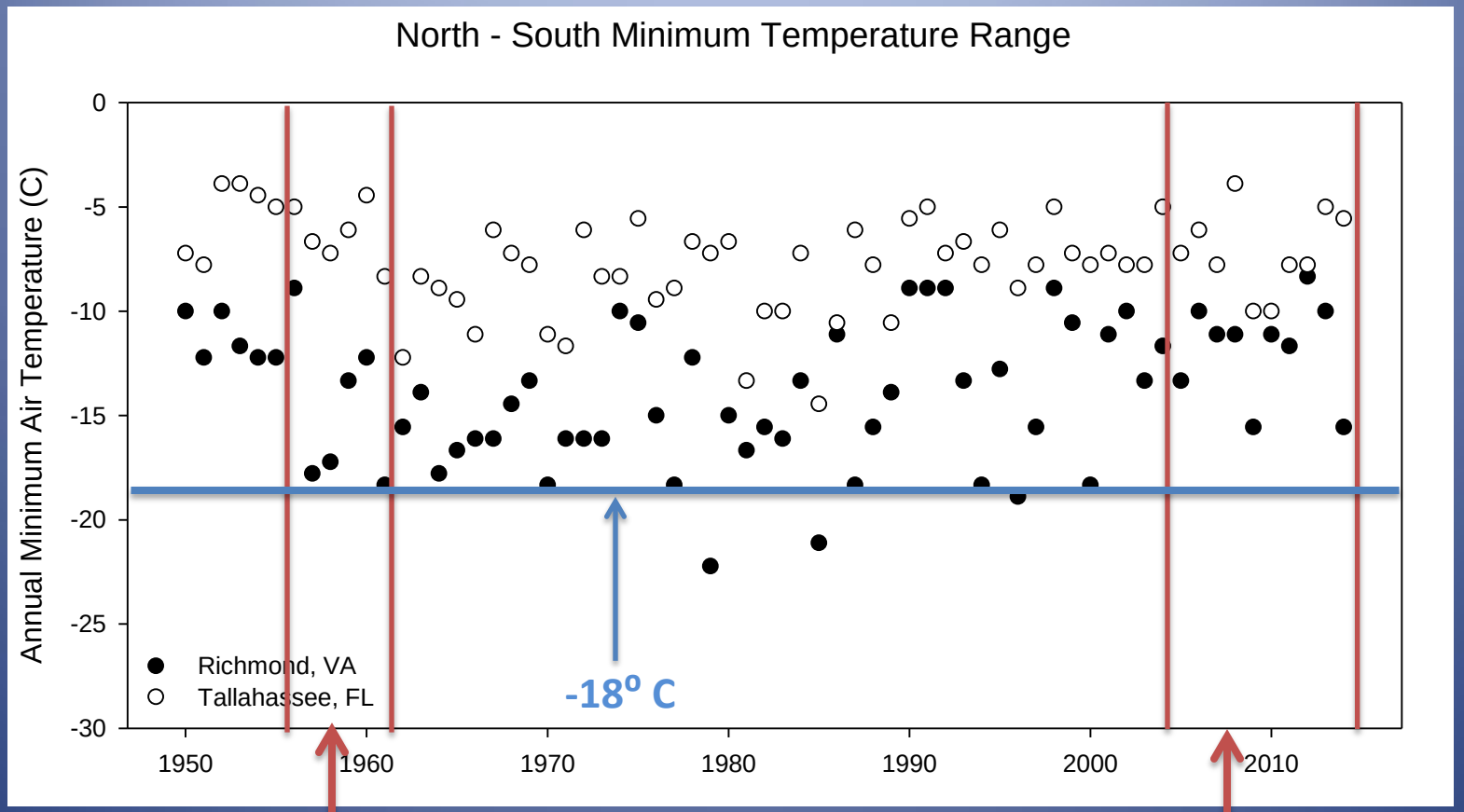
# How Cold Did It Get?




**Allen 1961 - Provenance test in VA**
**Seed sources: Virginia**
**Louisiana**
**Mississippi**
**Georgia**
**Florida (at extreme southern edge of range)**

**VA DOF Study**

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# Water Use Efficiency

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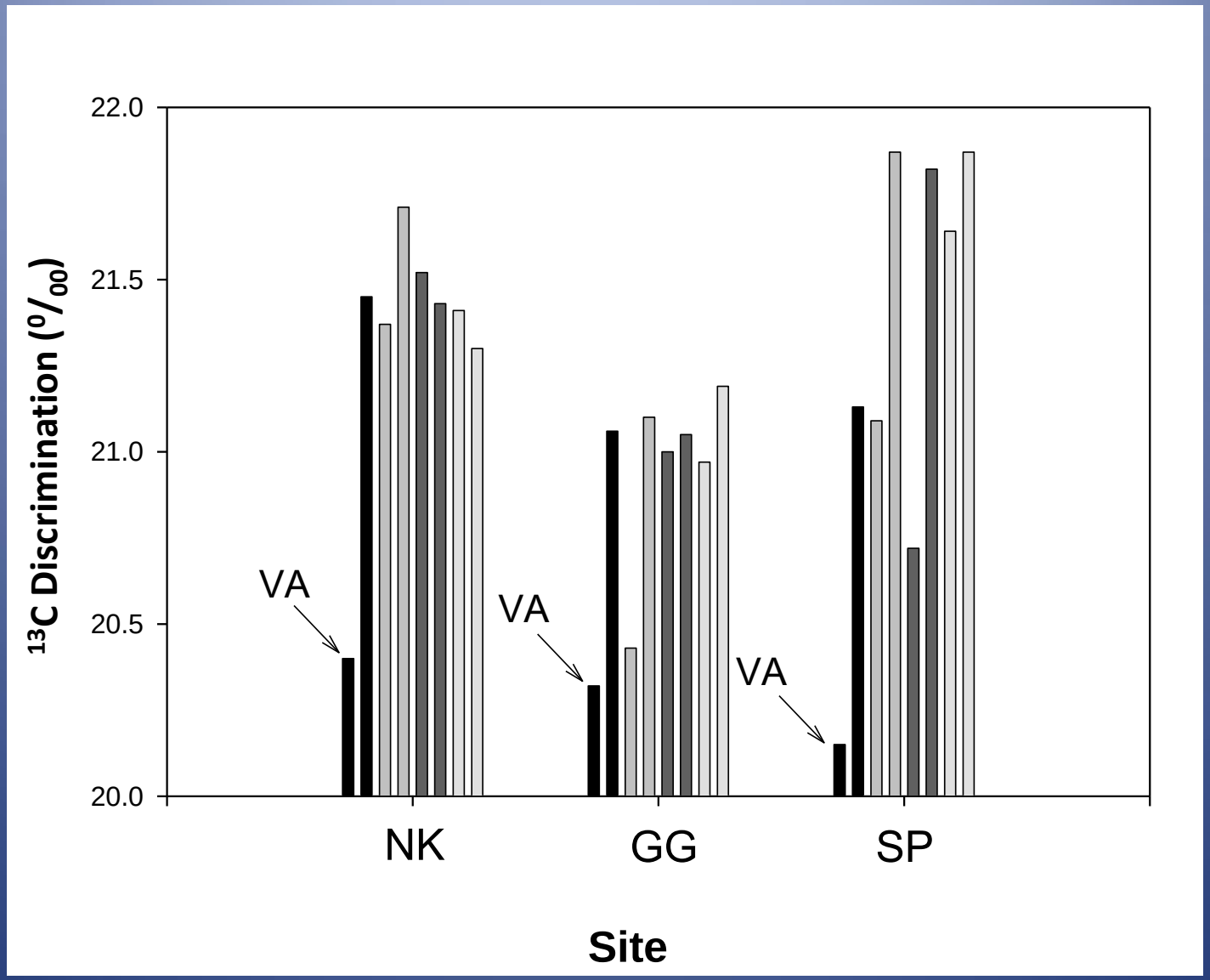


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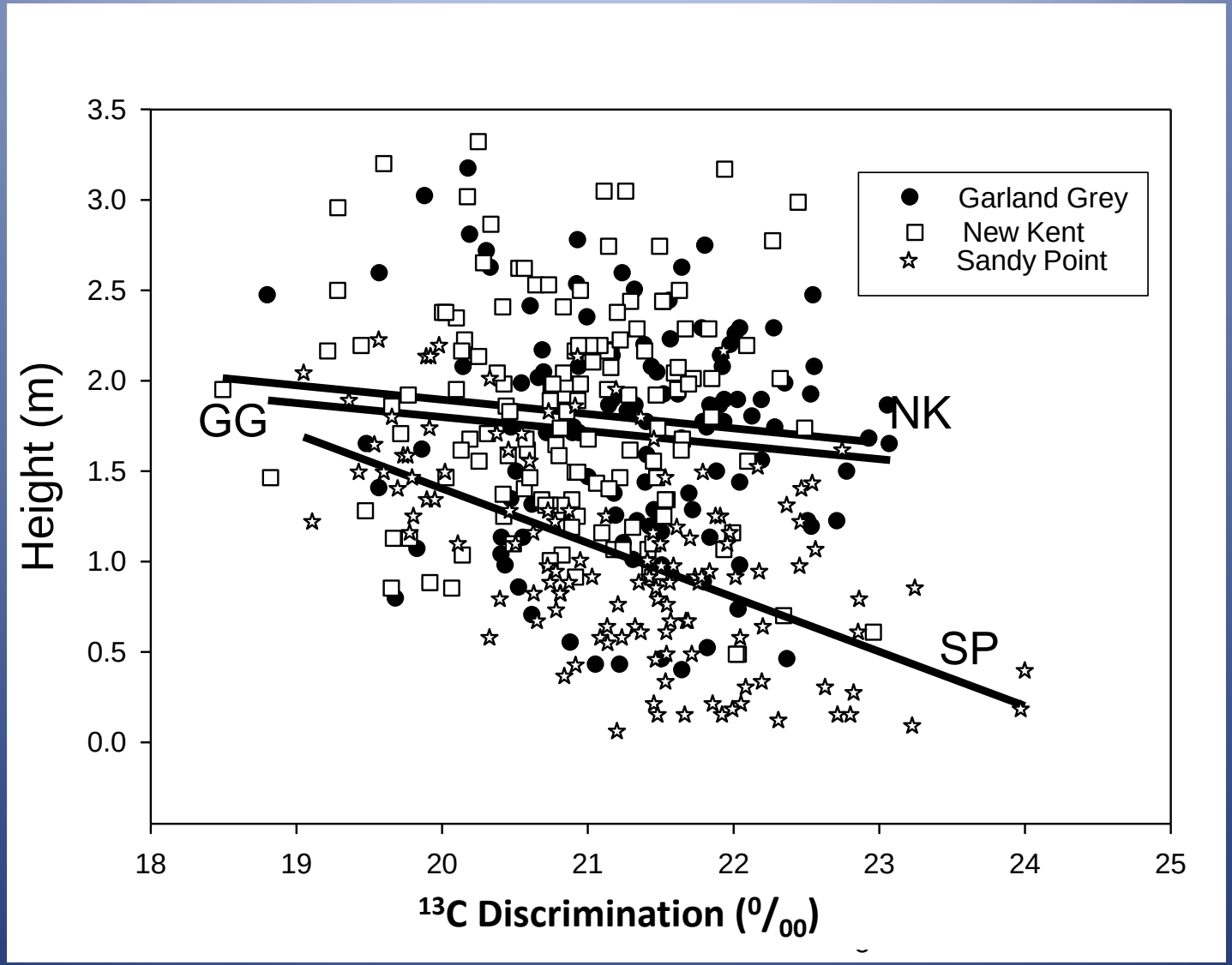


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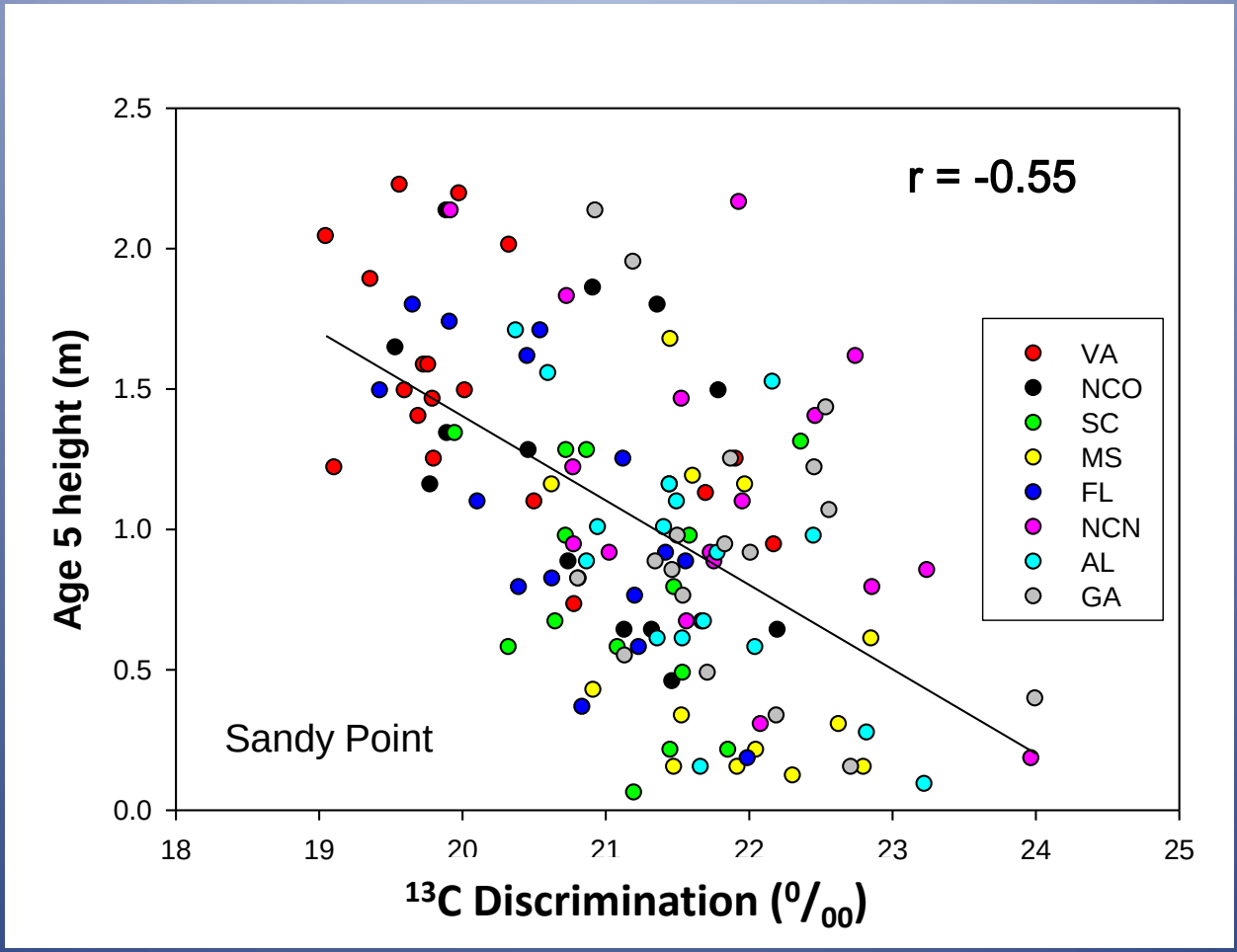


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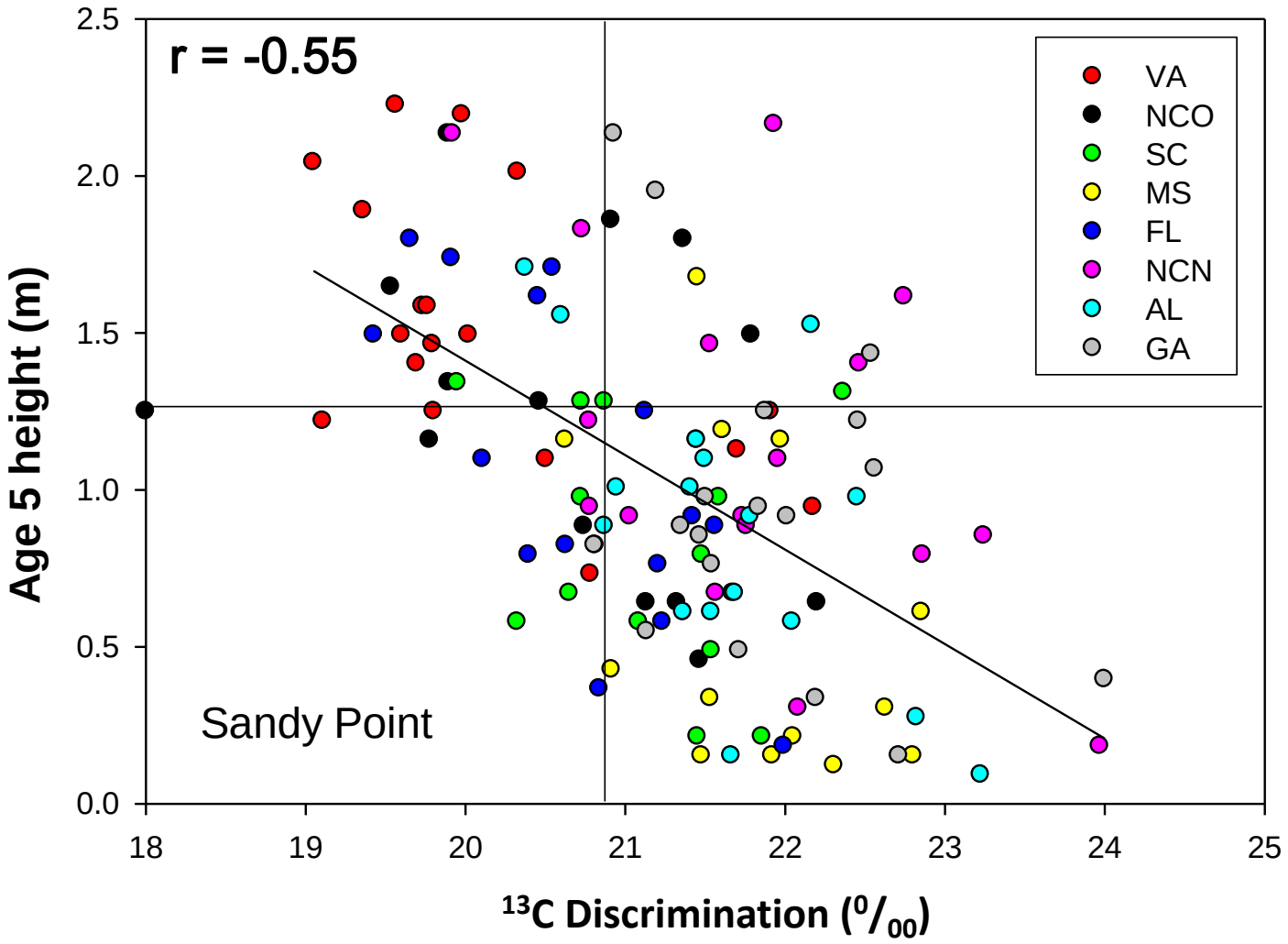


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# Black Spruce – 7 x 7 controlled diallel cross

## 22-year-old trees

Johnsen et al. 1999

**Fig 2.** Relationship between measured tree height and leaf $\Delta^{13}C$ value (phenotypic correlation), for *Picea mariana* trees grown on the three different sites at the Petawawa Research Forest.

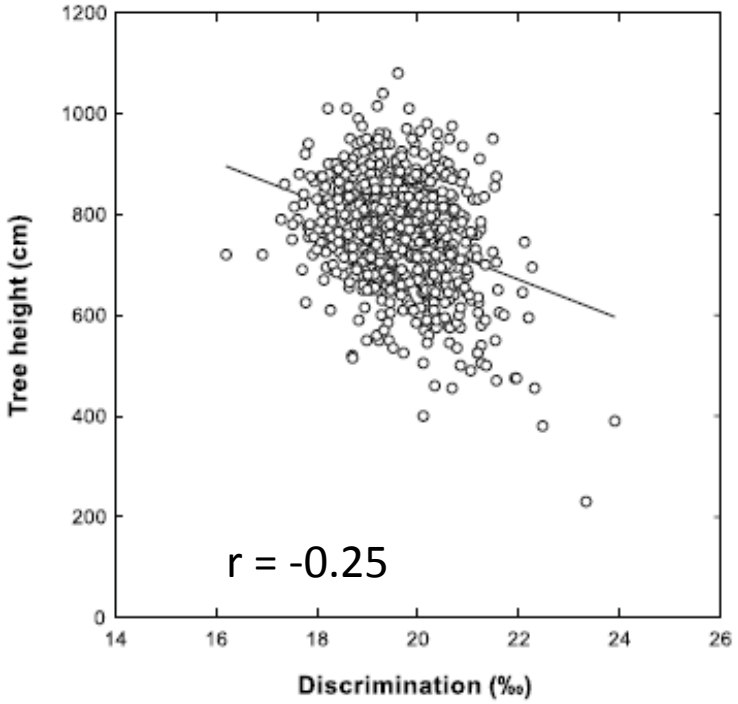
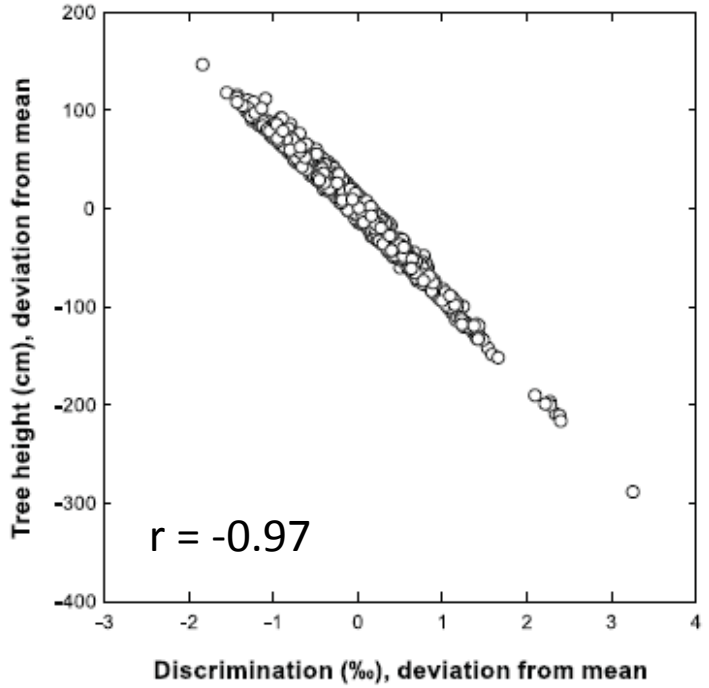



**Fig. 3.** Relationship between the calculated individual tree breeding values for tree height and leaf $\Delta^{13}C$ values (additive genetic correlation), for *Picea mariana* trees grown on the three different sites at the Petawawa Research Forest.




**Phenotypic Correlation**

**Genetic Correlation**

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# Conclusions

- Initially, seed source growth generally declined from north to south
- The clinal (north-south) pattern was not apparent after 5 to 7 years
- VA had highest WUE on all sites but WUE was only related to growth on the site with the poorest growth
- Substantial movement of seed sources north appears possible but cold hardiness needs to be assessed further. A blend of seed sources might be advisable at or past the leading edge of the species range.
- Need to further examine if we need to confirm other potentially adaptive variation is encompassed in populations used for assisted migration

# Other Related Studies

- Assess cold tolerance at Virginia sites
- New provenance/progeny test. Over 140 seed sources planted on 6 sites across the range. With NC State Tree Improvement Cooperative, Region 8 and Auburn University
- Genetic variation in C isotope discrimination using a 50-year-old 13 x 13 tree diallel study at the Harrison Experimental Forest (HEF). With NC State
- Enrichment planting study using seed sources from a longitudinal transect at the HEF
- Assisted Colonization studies north of the species range

# Collaborators

Pete Anderson (SRS)

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