

LONGLEAF PINE MANAGEMENT IN LIGHT OF CLIMATE CHANGE

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SRS-4160 Forest Genetics and Ecosystem Productivity

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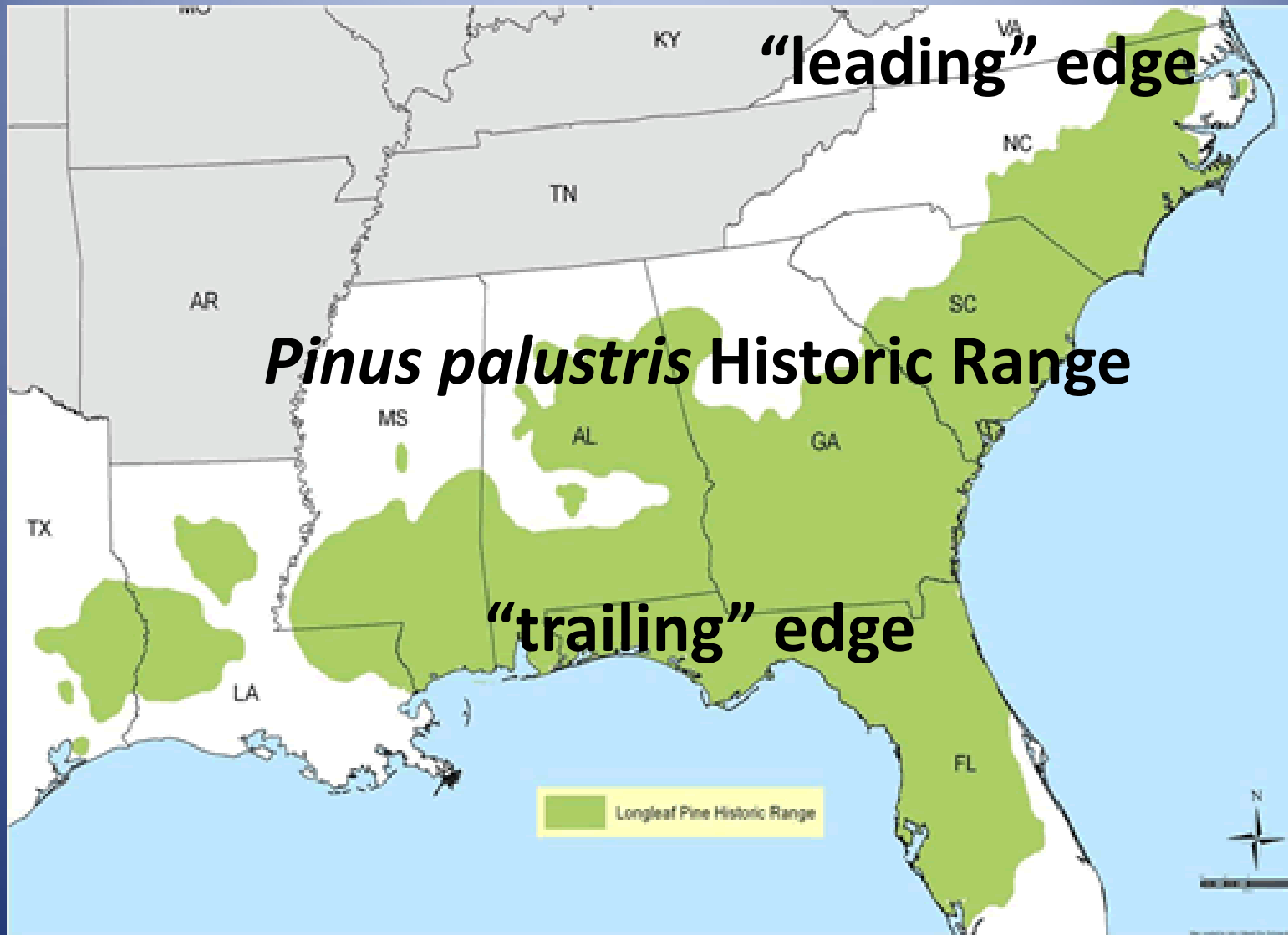
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Longleaf Pine (*Pinus palustris* Mill.)

- Schmidting (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





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*



A photograph of two men standing in a field of young longleaf pine trees. The man on the left is wearing a tan shirt and a tan cap, and the man on the right is wearing a green shirt and a white cap. They are both looking towards the trees. A blue line is stretched across the field, possibly marking a transect. The background shows a dense forest of taller trees under a clear sky.

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

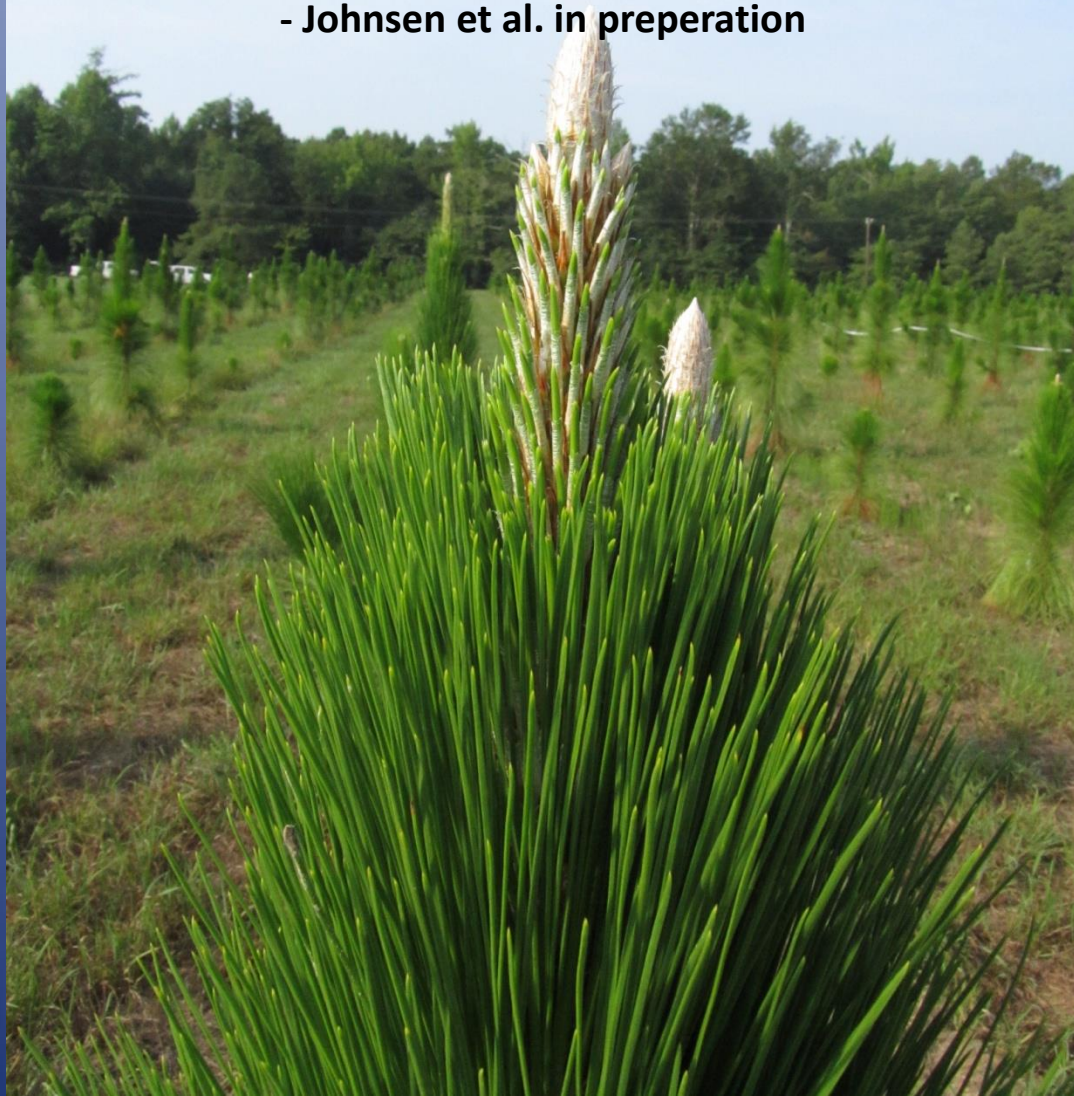
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Performance of diverse seed sources over past 10 years in Virginia

VA Dept. of Forestry Provenance Test

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



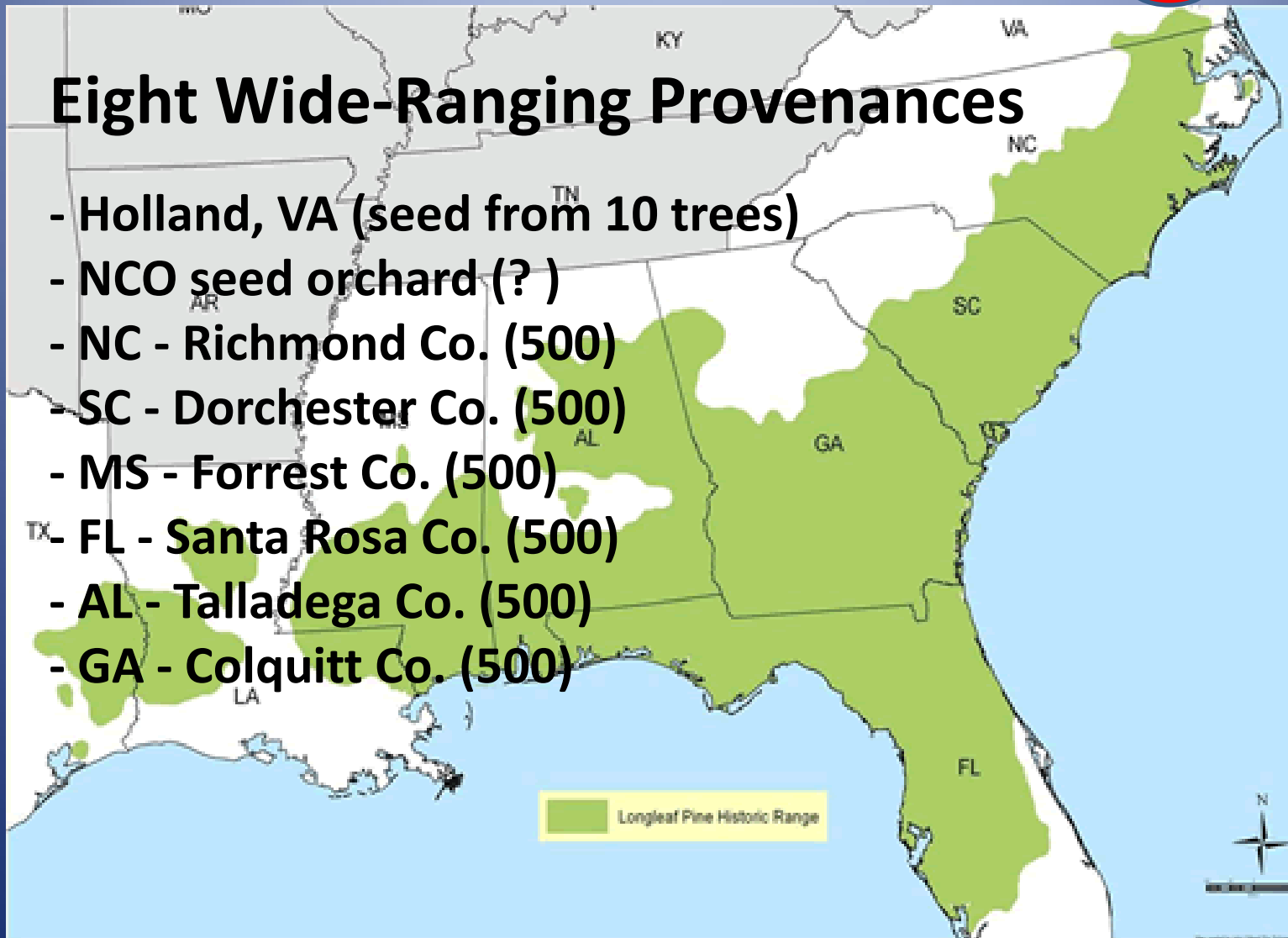
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Eight Wide-Ranging Provenances

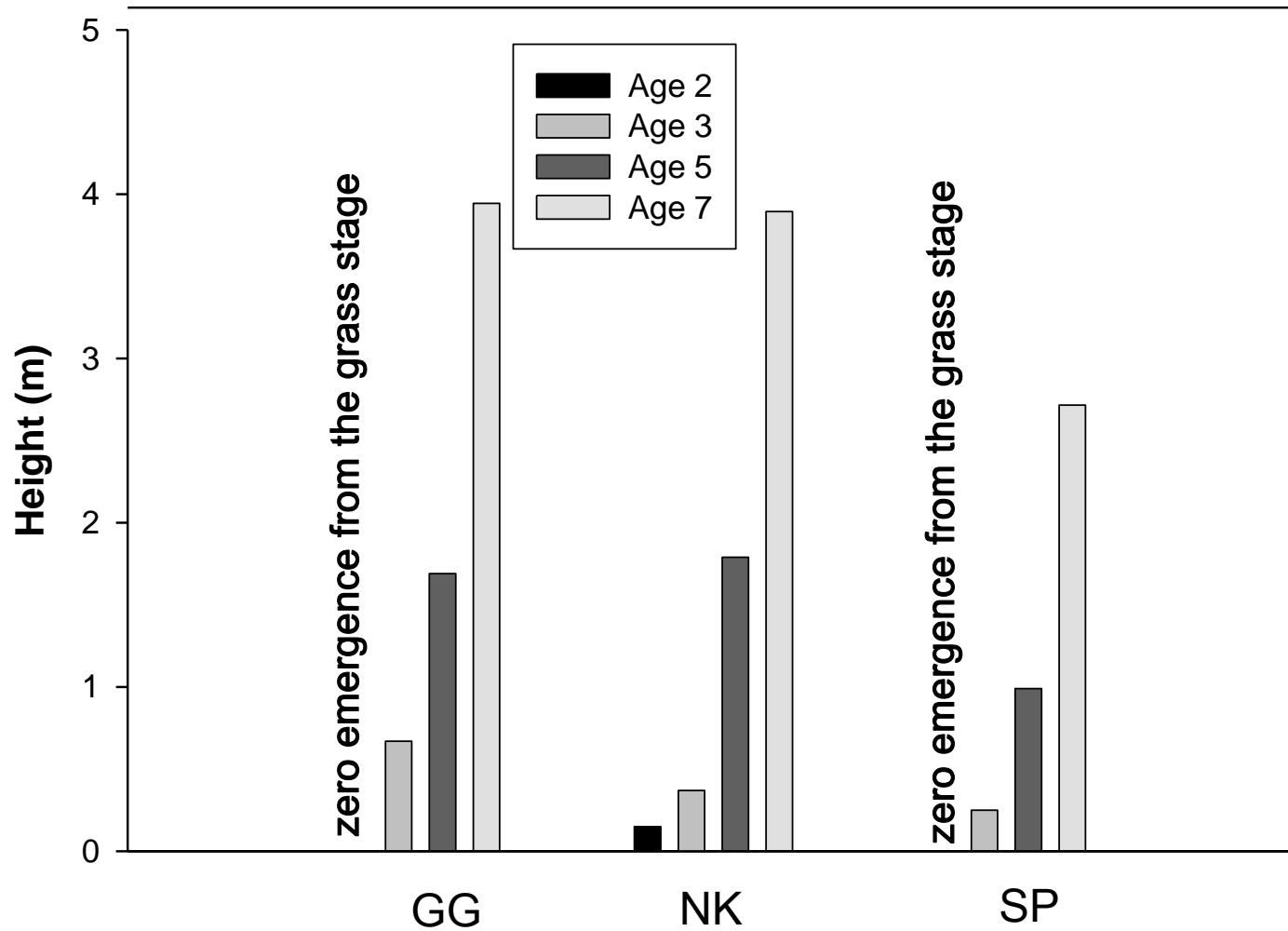
- Holland, VA (seed from 10 trees)
- NCO seed orchard (?)
- NC - Richmond Co. (500)
- SC - Dorchester Co. (500)
- MS - Forrest Co. (500)
- FL - Santa Rosa Co. (500)
- AL - Talladega Co. (500)
- GA - Colquitt Co. (500)



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



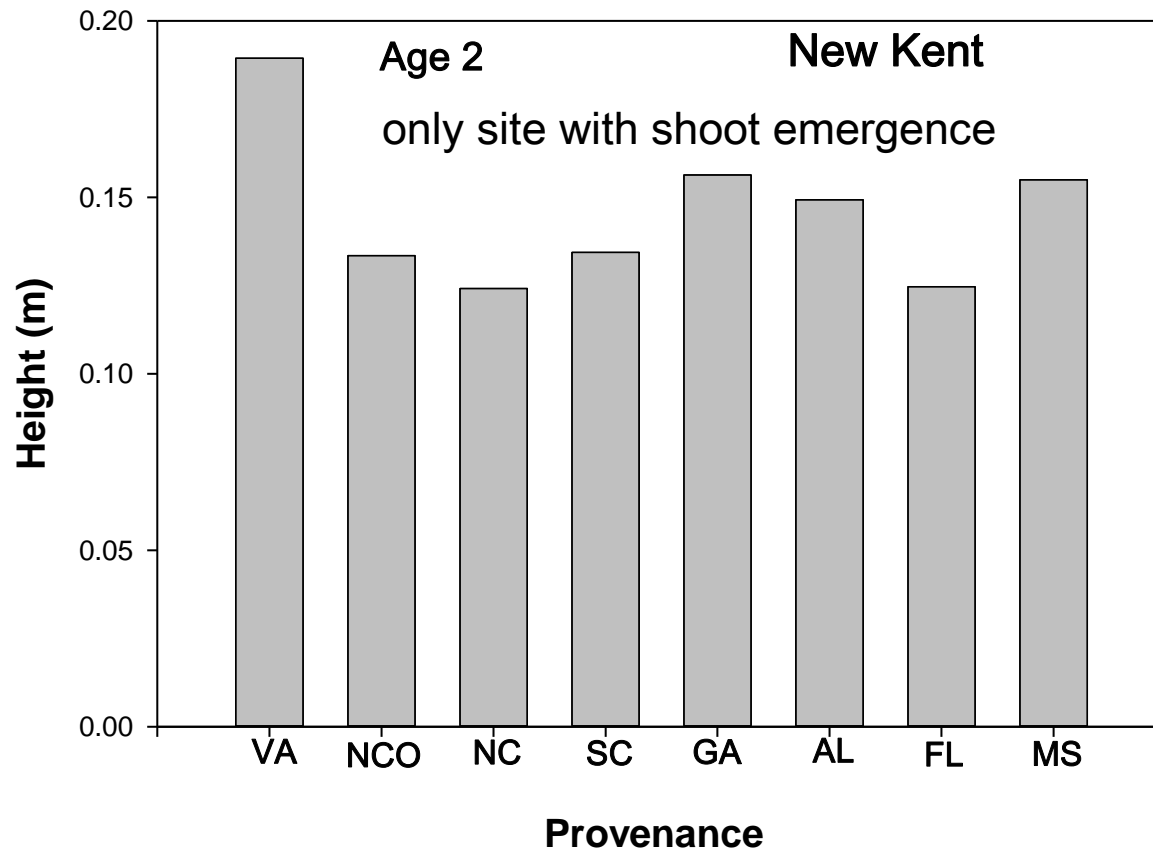


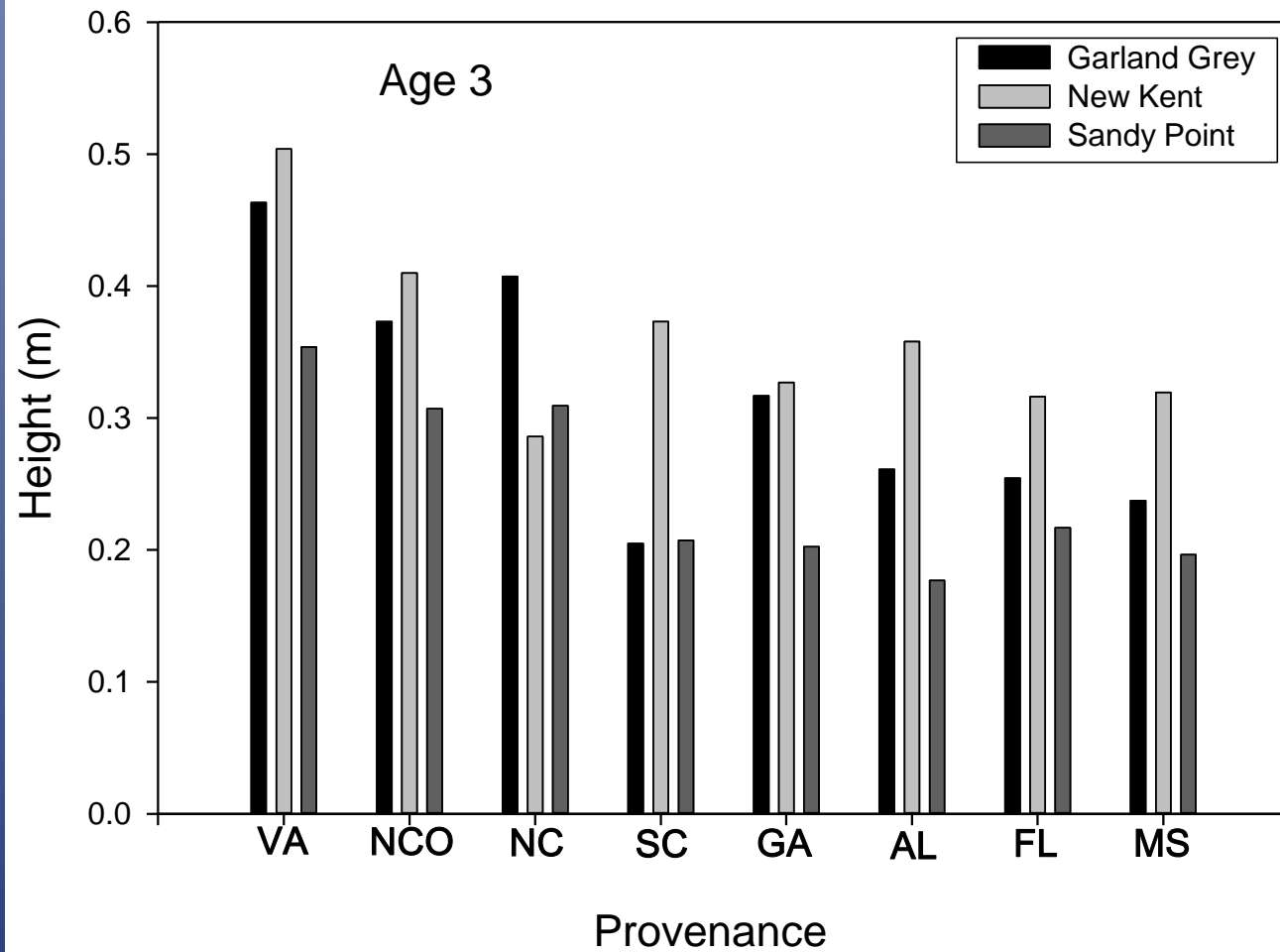


Longleaf pine “grass stage”

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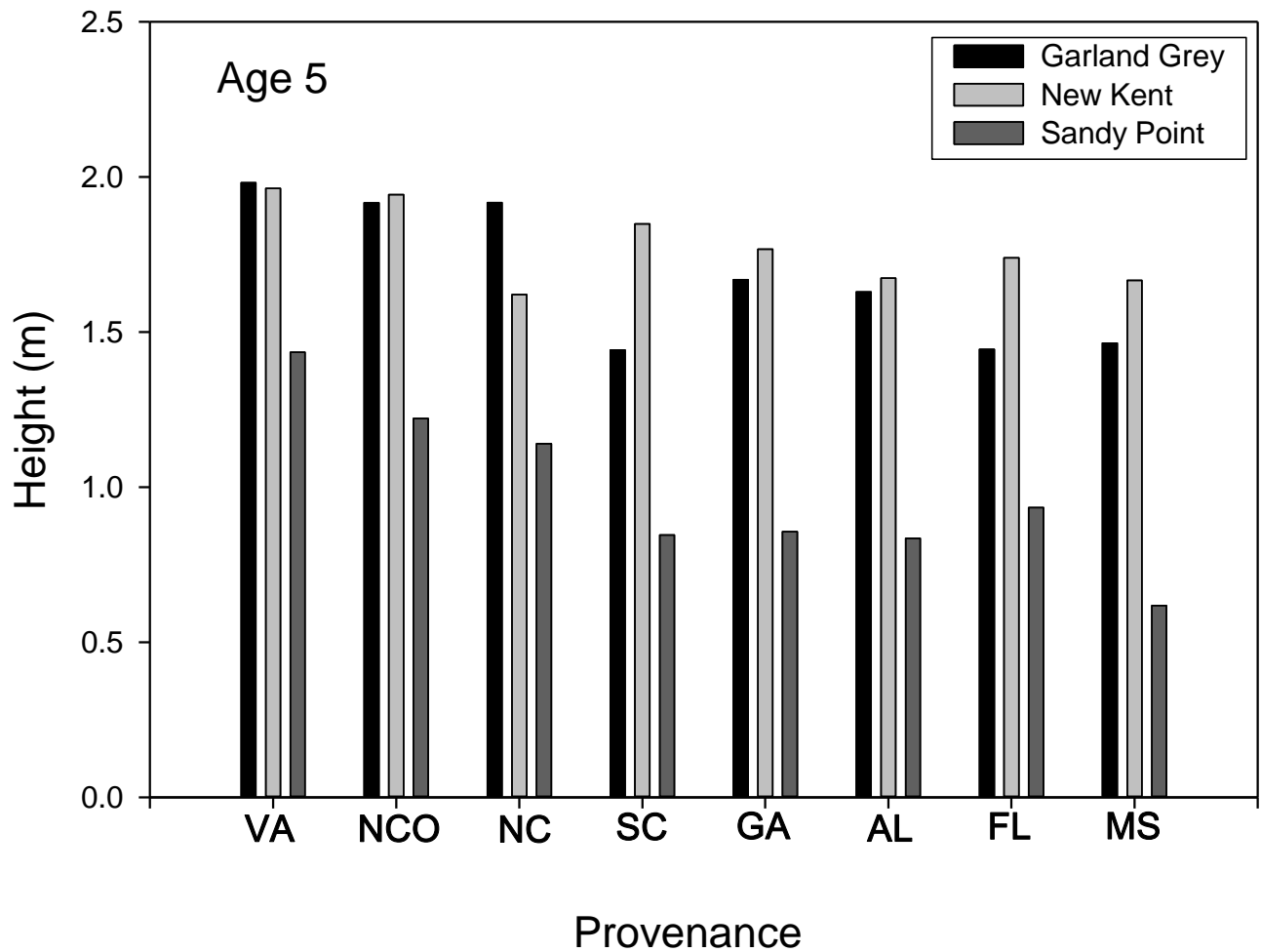


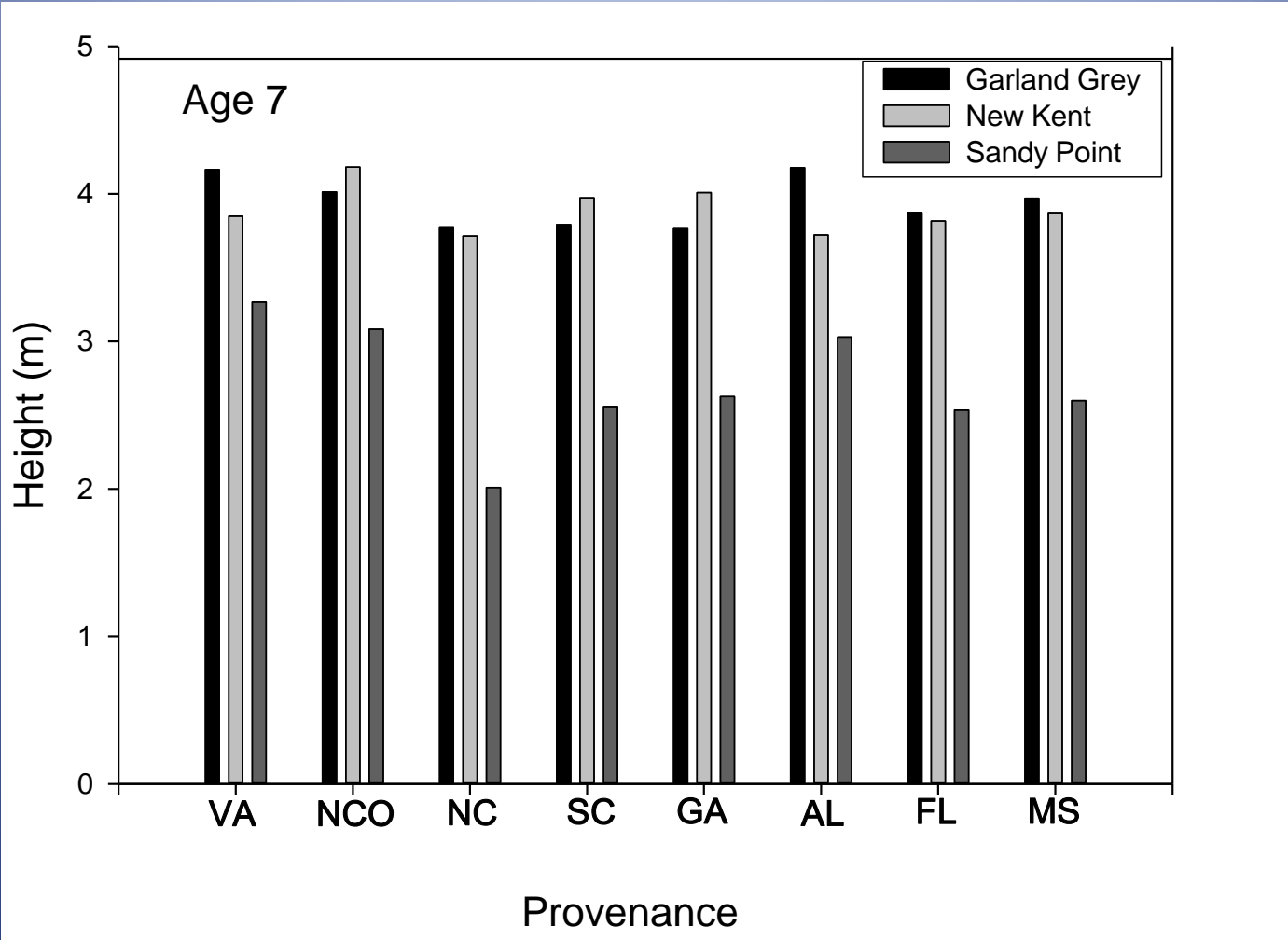
Age 4



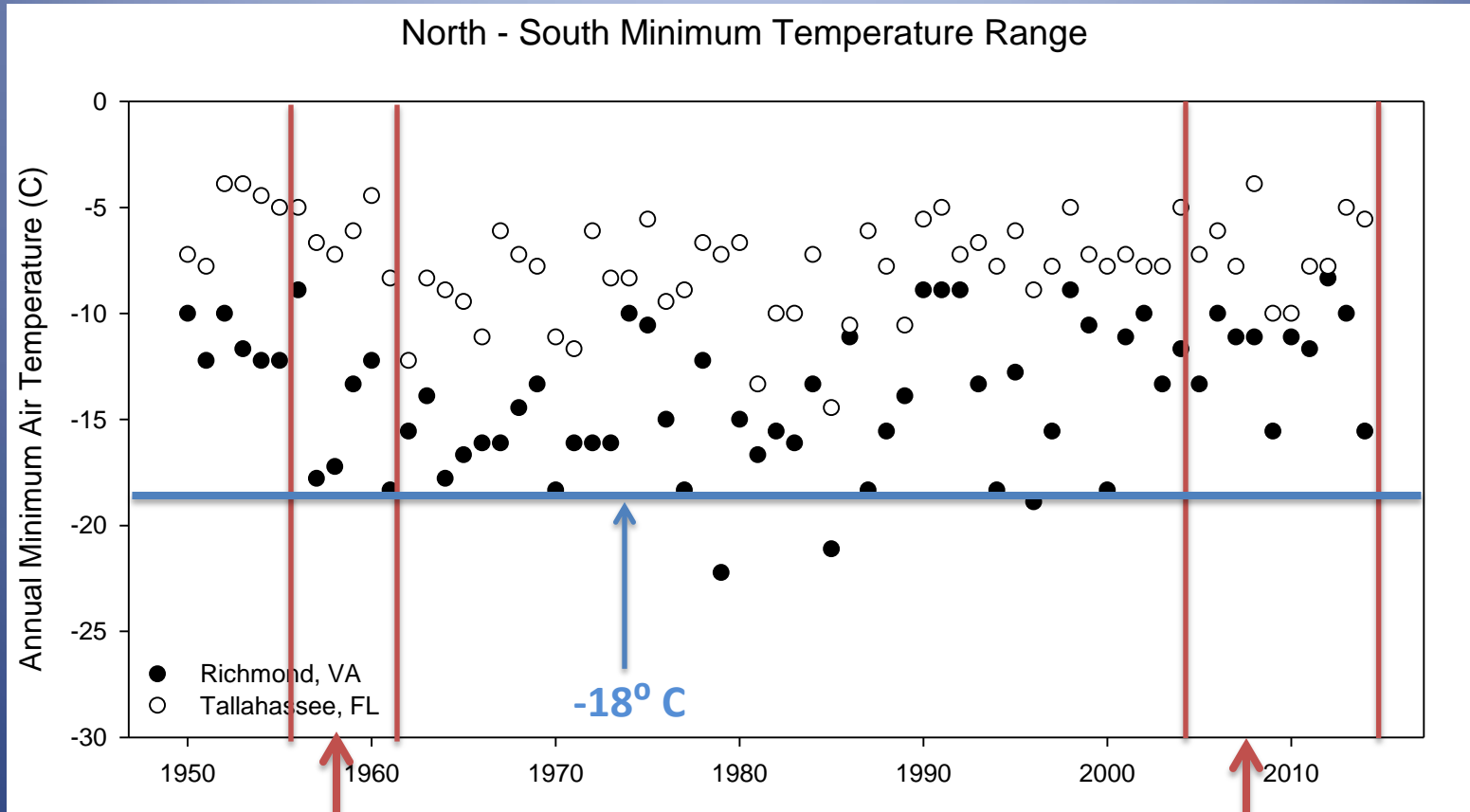
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How Cold Did It Get?



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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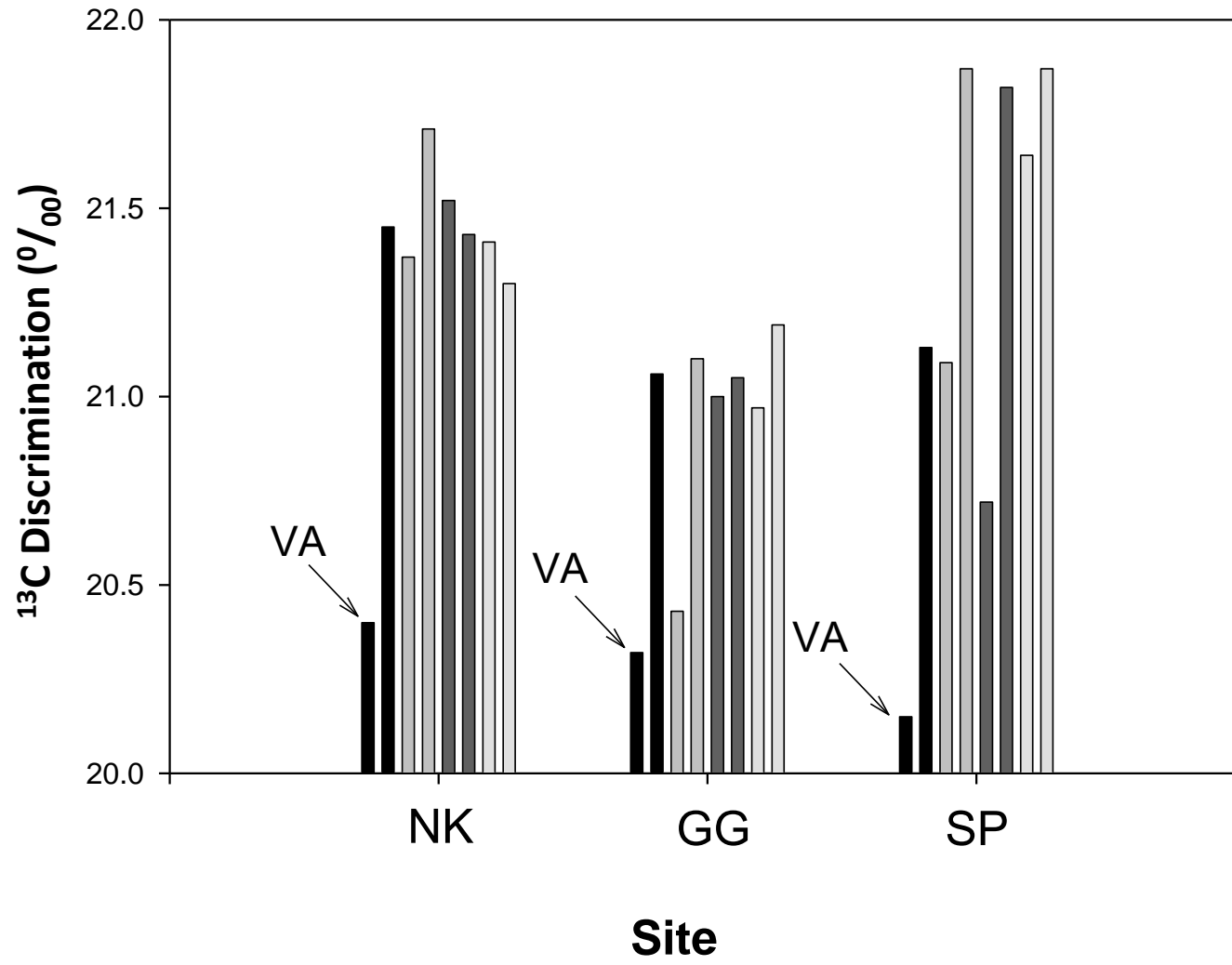


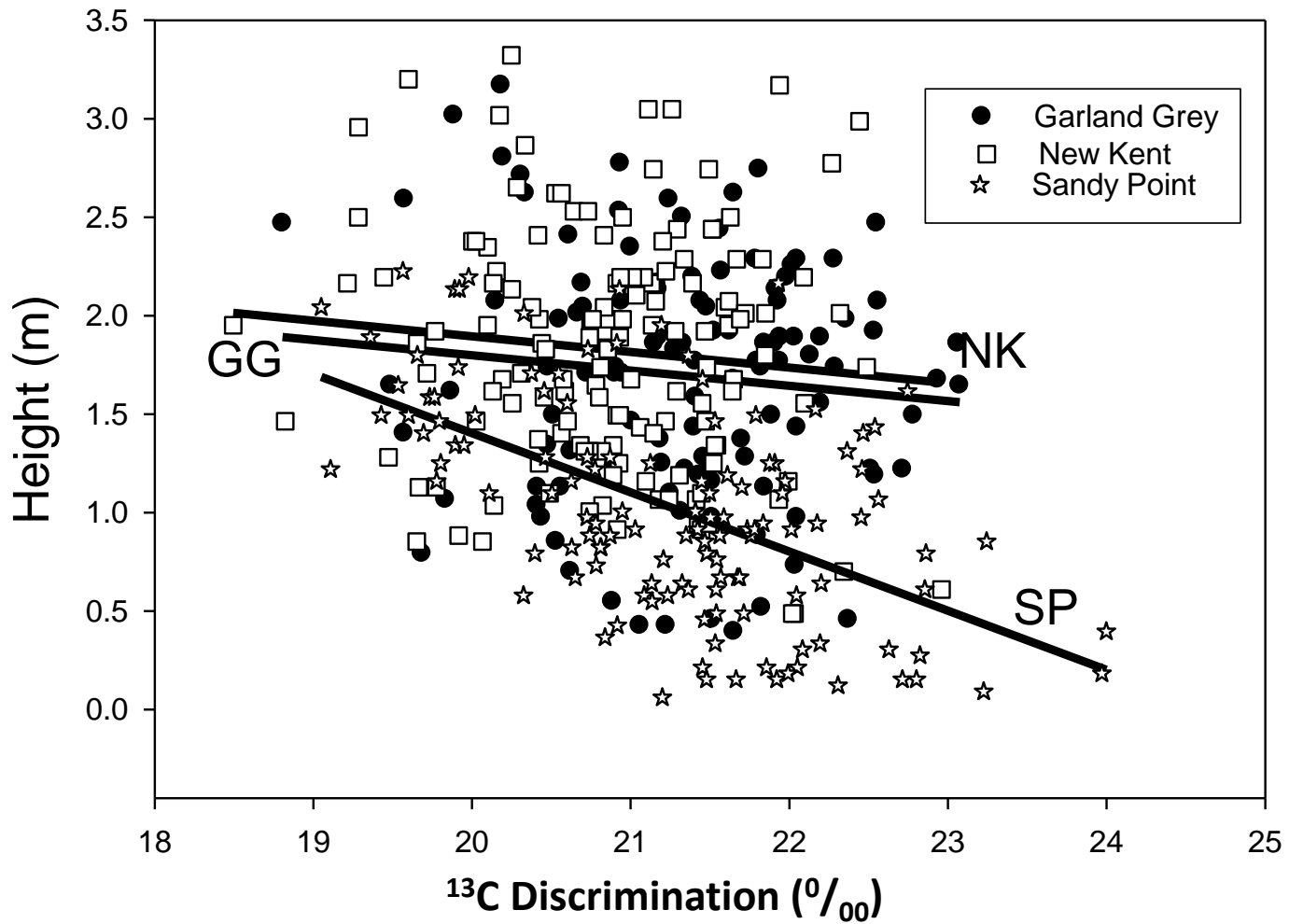
Water Use Efficiency

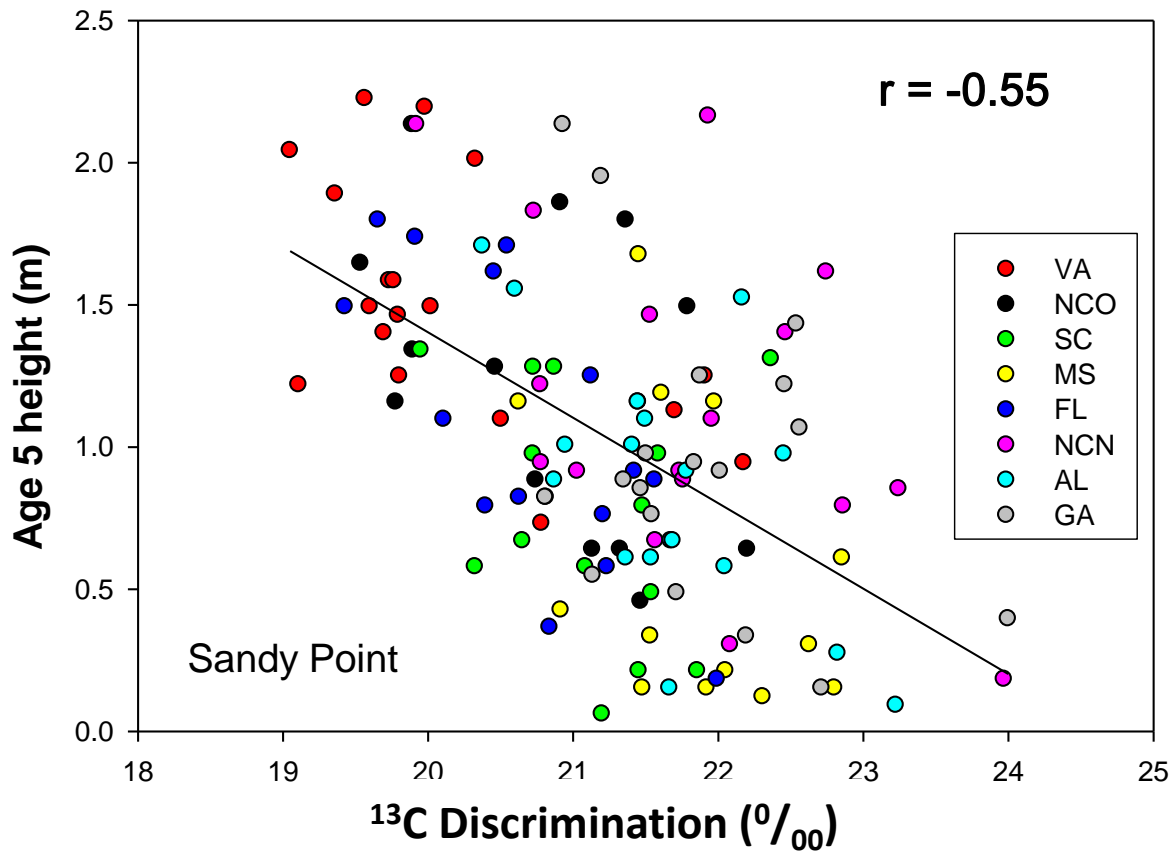


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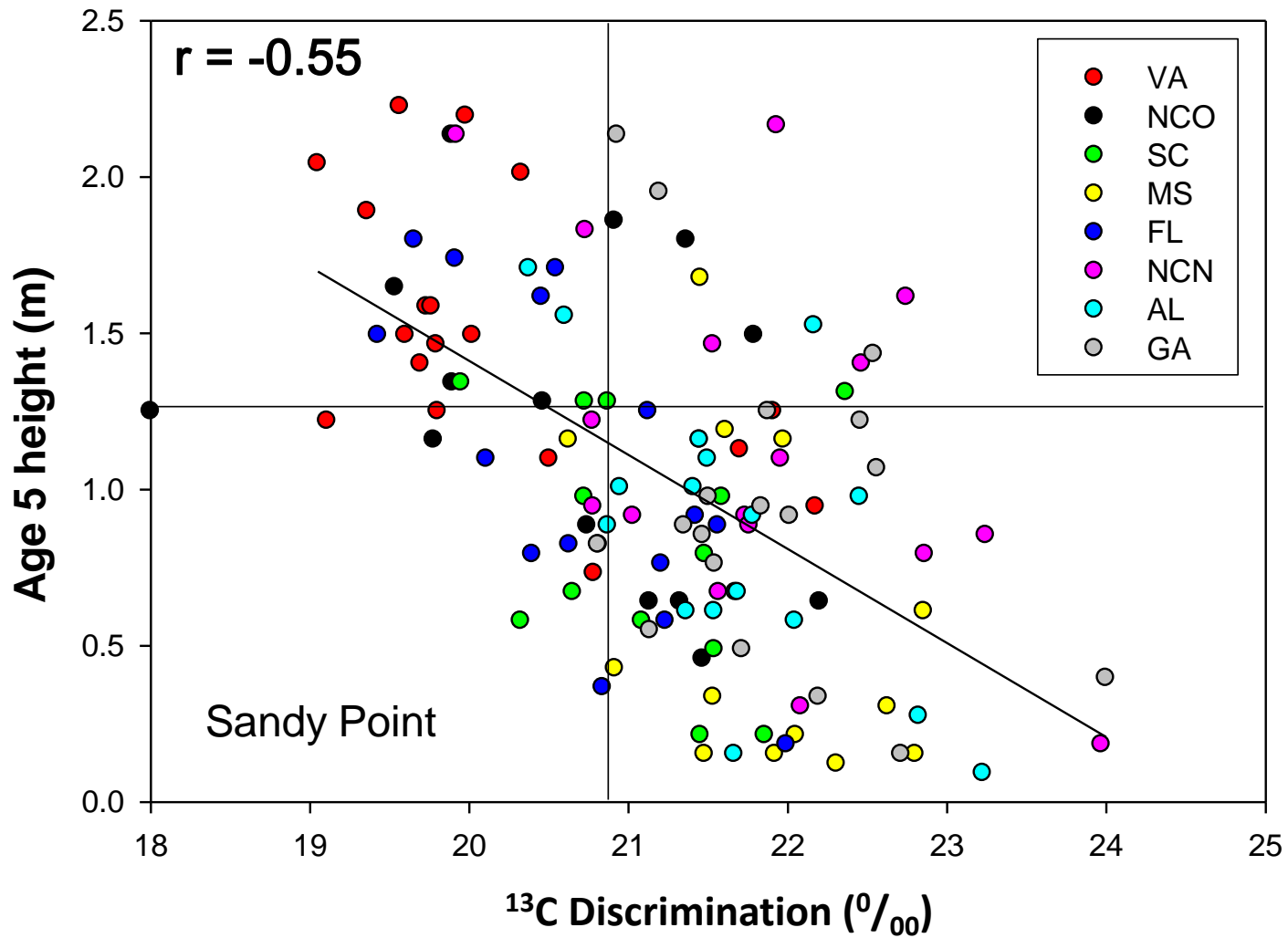






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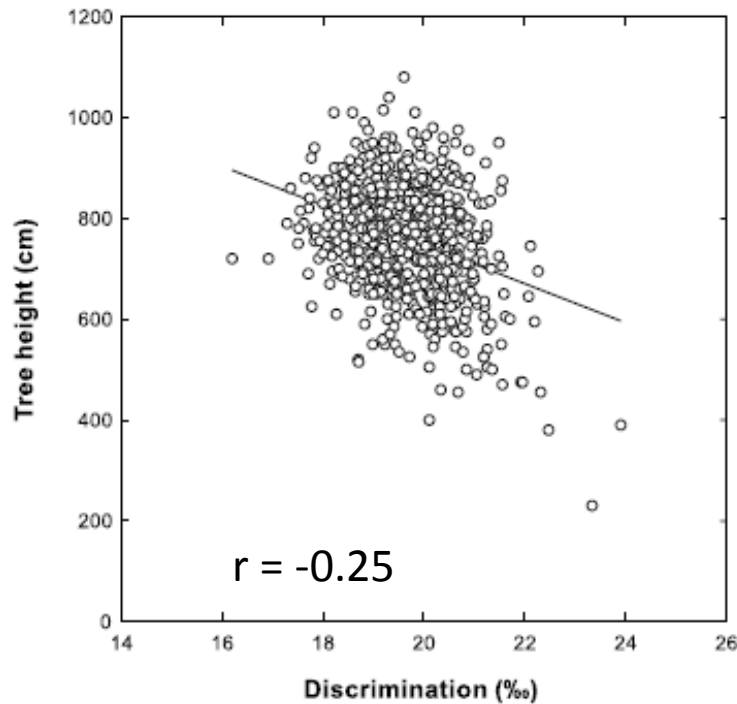


Black Spruce – 7 x 7 controlled diallel cross

22-year-old trees

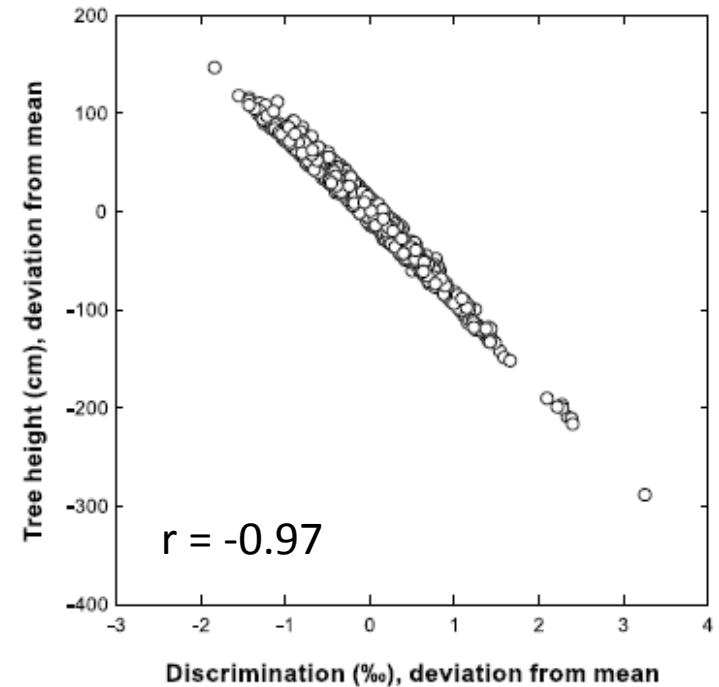
Johnsen et al. 1999

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



Phenotypic Correlation

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



Genetic Correlation

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)

John Butnor (SRS)

Barbara Crane (USFS Region 8)

Jerre Creighton (VA Dept. of Forestry)

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