

# American Chestnut (*Castanea dentata*) Restoration and Reintroduction Plantings in the Southern Appalachians

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# Demise of the American chestnut

Asian ambrosia beetle (Order: Coleoptera: Family Scolytidae ), ca. 1974



Asian gall wasp (*Dryocosmus kuriphilus*), ca. 1974



Asiatic oak weevil (*Cyrtopistomus castaneus*), ca. 1935



Talladega National Forest,  
Alabama

**Chestnut blight**  
(*Cryphonectria parasitica*), ca. 1904

**Root rot**  
(*Phytophthora cinnamomi*), ca. 1820

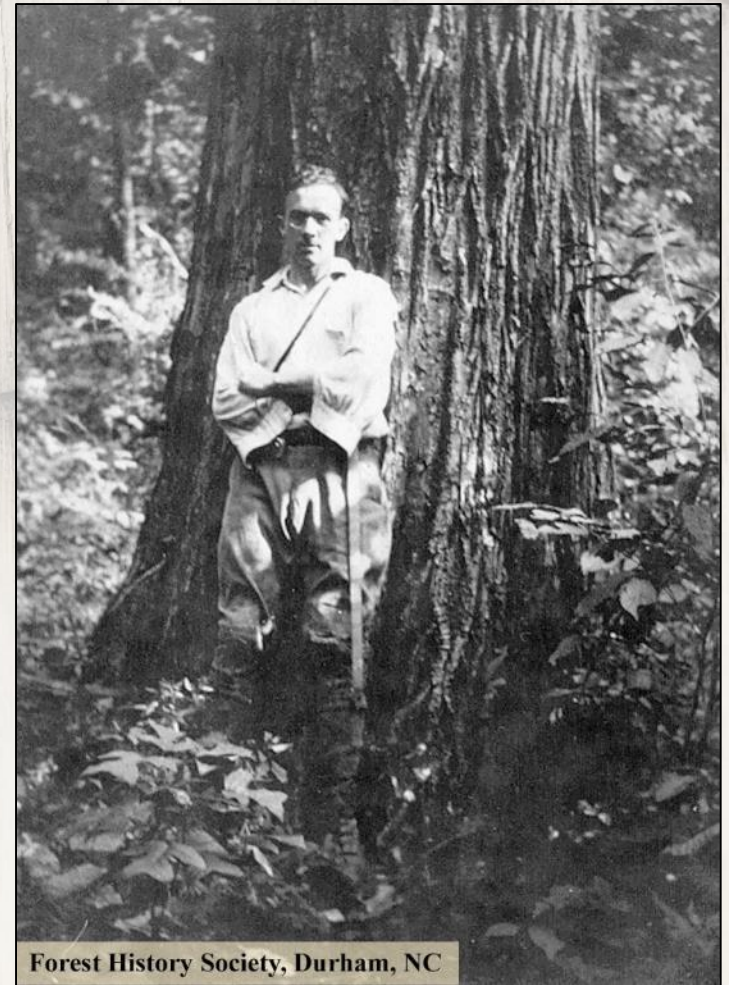


European gypsy moth (*Lymantria dispar*), ca. 1869



# Chestnut Demise and Restoration

Ashe (1911) reports  
“chestnut is one of the  
most promising trees for  
forest management”



# Partnerships for Restoration: The USDA Forest Service, The American Chestnut Foundation, and The University of Tennessee



Meadowview Orchard,  
VA



National Forest System,  
Southern Region



Southern  
Research Station



UT-Tree  
Improvement  
Program

# Approaches to Resistance

- Traditional breeding
  - **Confer Asian resistant genes into American chestnut genome through backcrossing**
    - The Connecticut Agricultural Experiment Station
    - The American Chestnut Foundation
  - Breed low levels of resistance among pure American
    - American Chestnut Cooperators Foundation
- Hypovirulence
  - Virus-like blight strains
- Biotechnology
  - Transgenic (genetically modified) trees using oxalate oxidase gene from wheat (State University of New York and TACF)



# The First Test Plantings by the USDA Forest Service

- Goal of test plantings
  - To test American chestnuts that have been traditionally bred for blight-resistance for the ability to survive, compete, and remain blight-resistant in forest environments within the species native range



# What are we testing?



Family D3 (BC<sub>3</sub>F<sub>3</sub>)



Small

Large



Chestnut sawfly

cicada



Within block error



Deer rub and browse

$$Y = \text{Genetics} + \text{Seedling Size} + \text{Planting Location} + \text{Random effects} + \text{Error}$$

# Seedling Production for Test Plantings

- Grown to **maximize** size in a commercial tree nursery for one year
- 3 to 4.3 ft average height
  - range 0.3 to 8.5 ft
- Problems with root rot (*Phytophthora*) in some southern nurseries

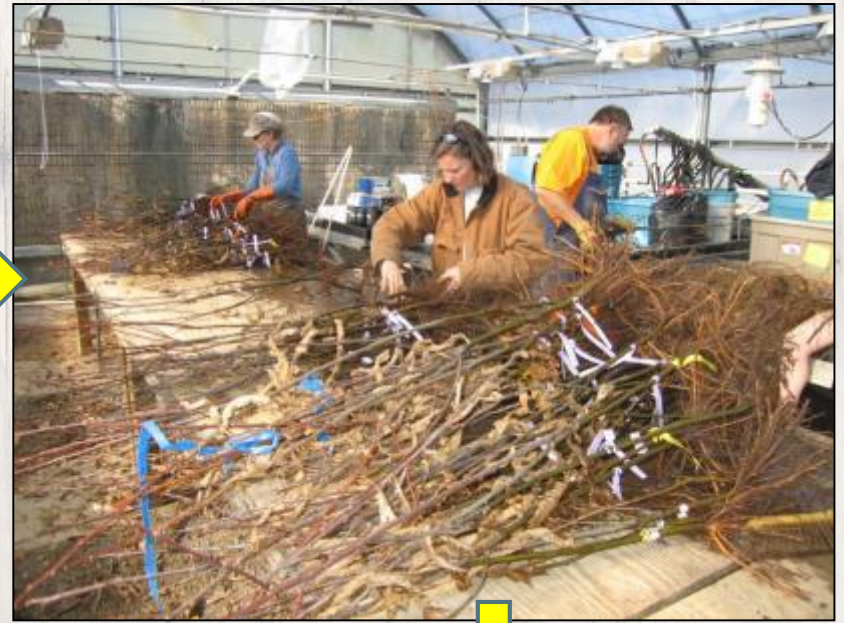




1. Measure seedlings and tag



2. Split each family into large and small sizes



3. Sort study into design



4. Plant using design



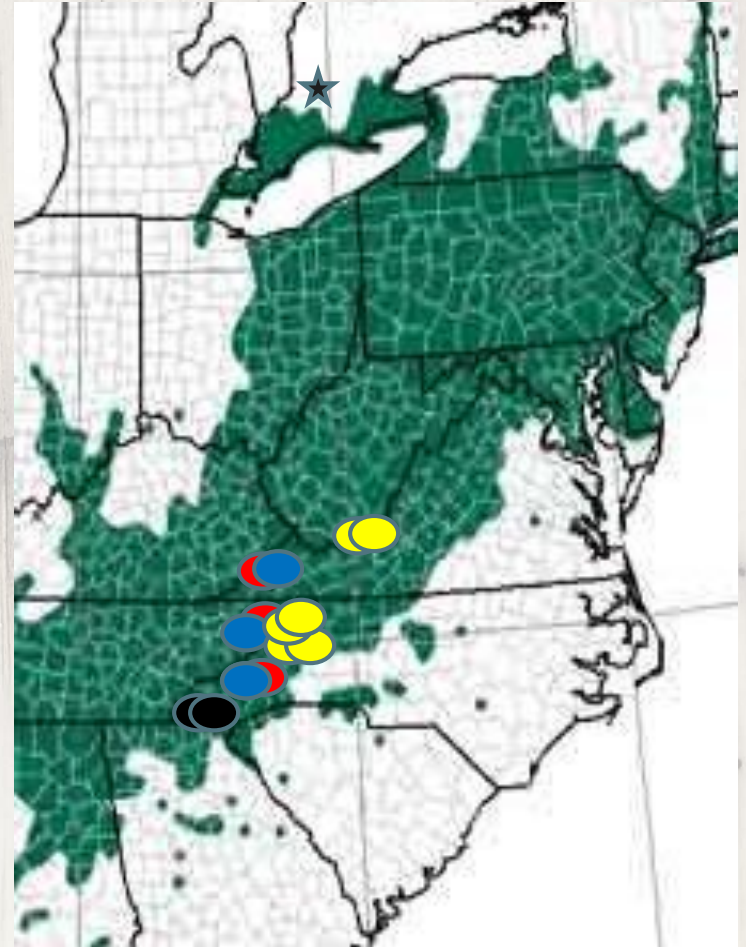
5. Measure seedlings



**Video**

# Experimental Material

- 15 plantings on National Forests in TN, NC, and VA (Blue Ridge Mountains)
- 2009 Plantings (4):
  - 331  $BC_3F_3$ , 1155 total
- 2010 Plantings (3):
  - 360  $BC_3F_3$ , 1092 total
- 2011 Plantings (6):
  - 1090  $BC_3F_3$ , 1689 total
- 2015 Plantings (2):
  - 384  $BC_3F_3$ , 557 total



# Study Sites

- 9 in even-aged regeneration harvests
  - Commercial timber harvests resulting in two-age stand
  - 30 ft<sup>2</sup>/acre of basal area
- 3 in midstory removal shelterwood stands
  - Midstory (trees 1-6 inches in diameter killed with herbicide injection)
- 2 in orchard plantings
  - Beech Creek seed orchard, Nantahala National Forest
- 1 in pitch pine restoration area
  - Non commercial felling and prescribed burn



Two-age stand after harvest

# Study Sites

- Deer protection provided if needed (shelters or spray)
- Herbicide treatment to control competition in two-age stands
  - Applied at planting to stump sprouts
  - Applied 5 years post-planting around individual planted trees



Erecting deer shelters in two-age stand



Year 3



Chestnut

John

Year 5

# Year 10

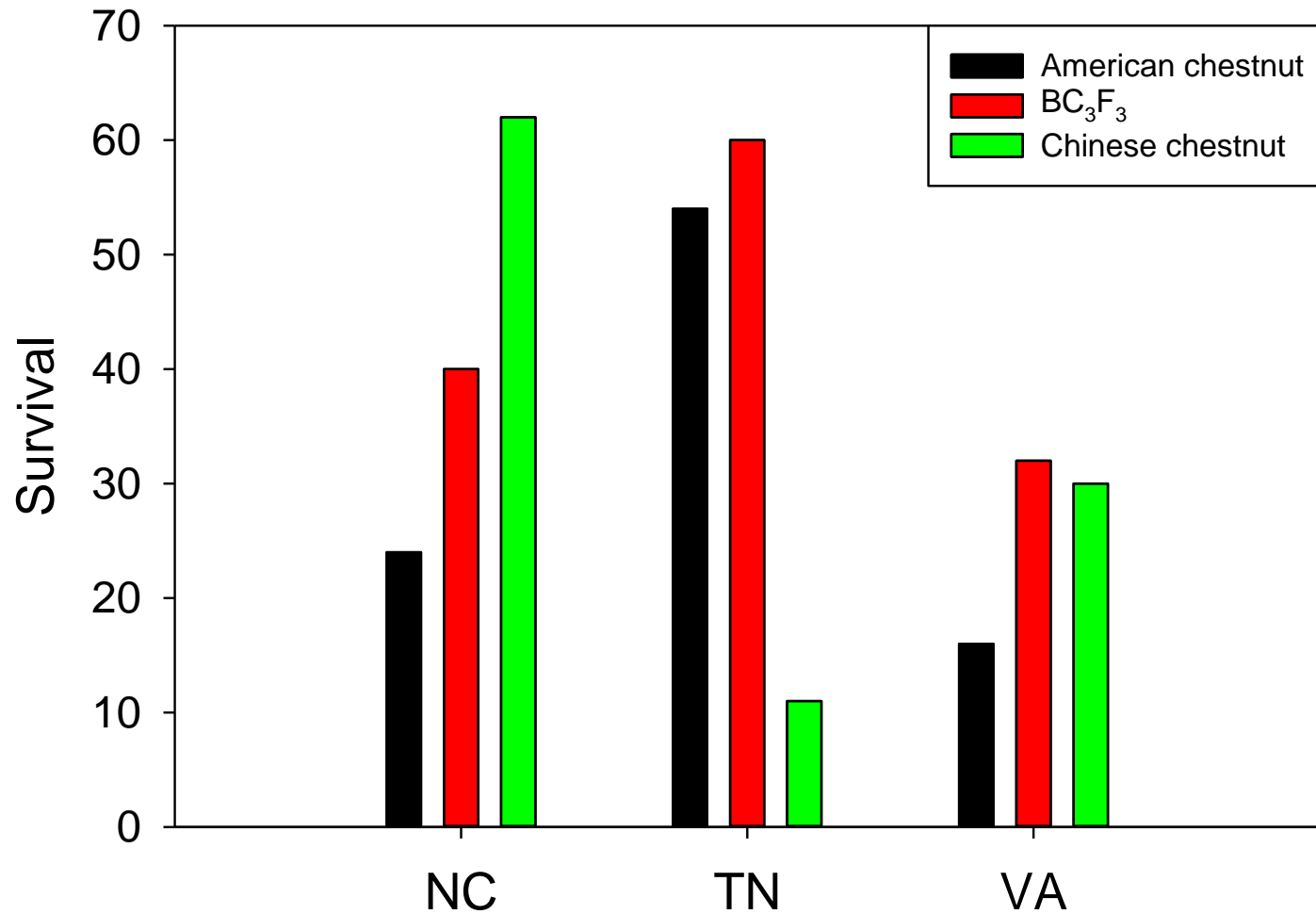




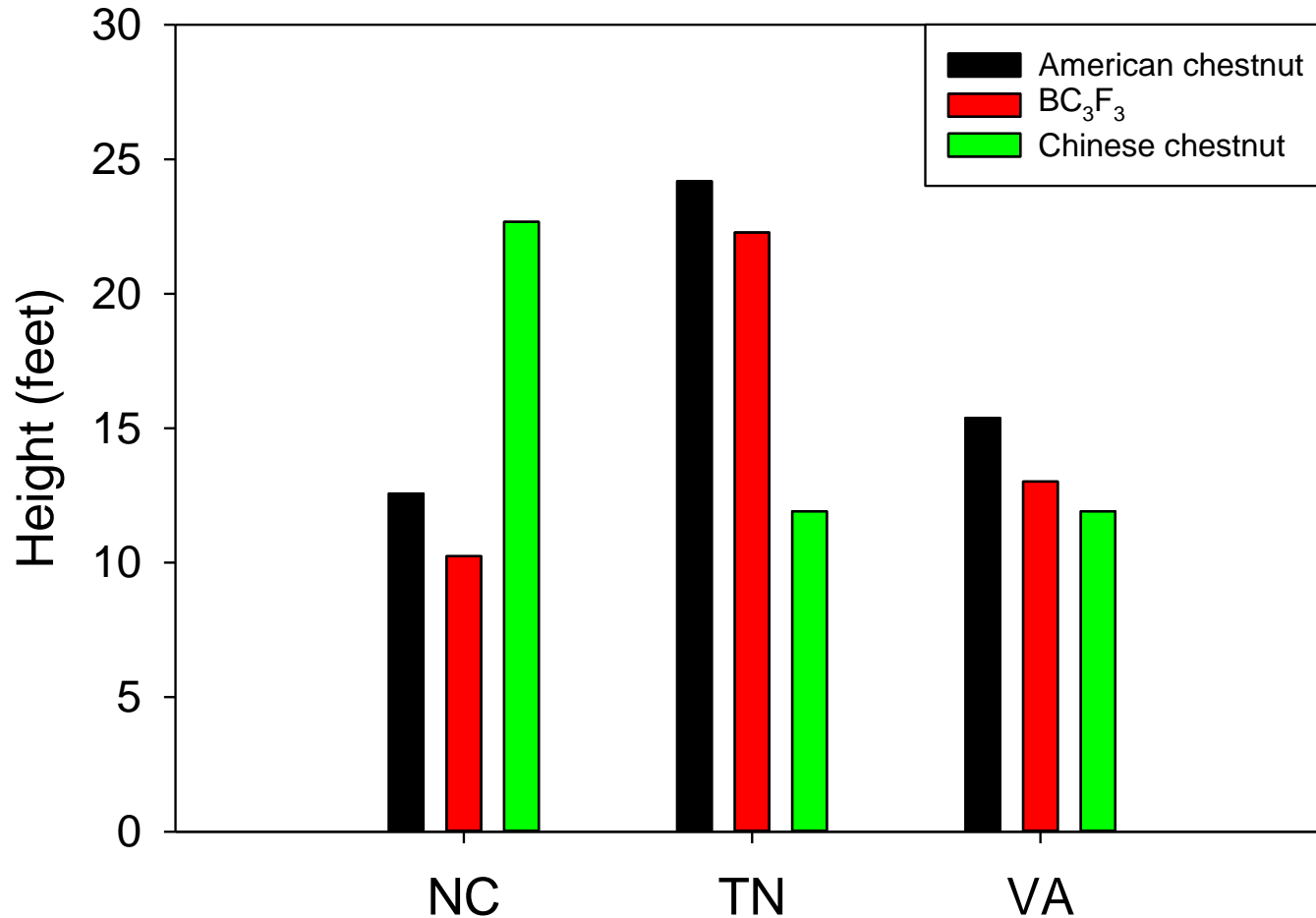
# Year 12



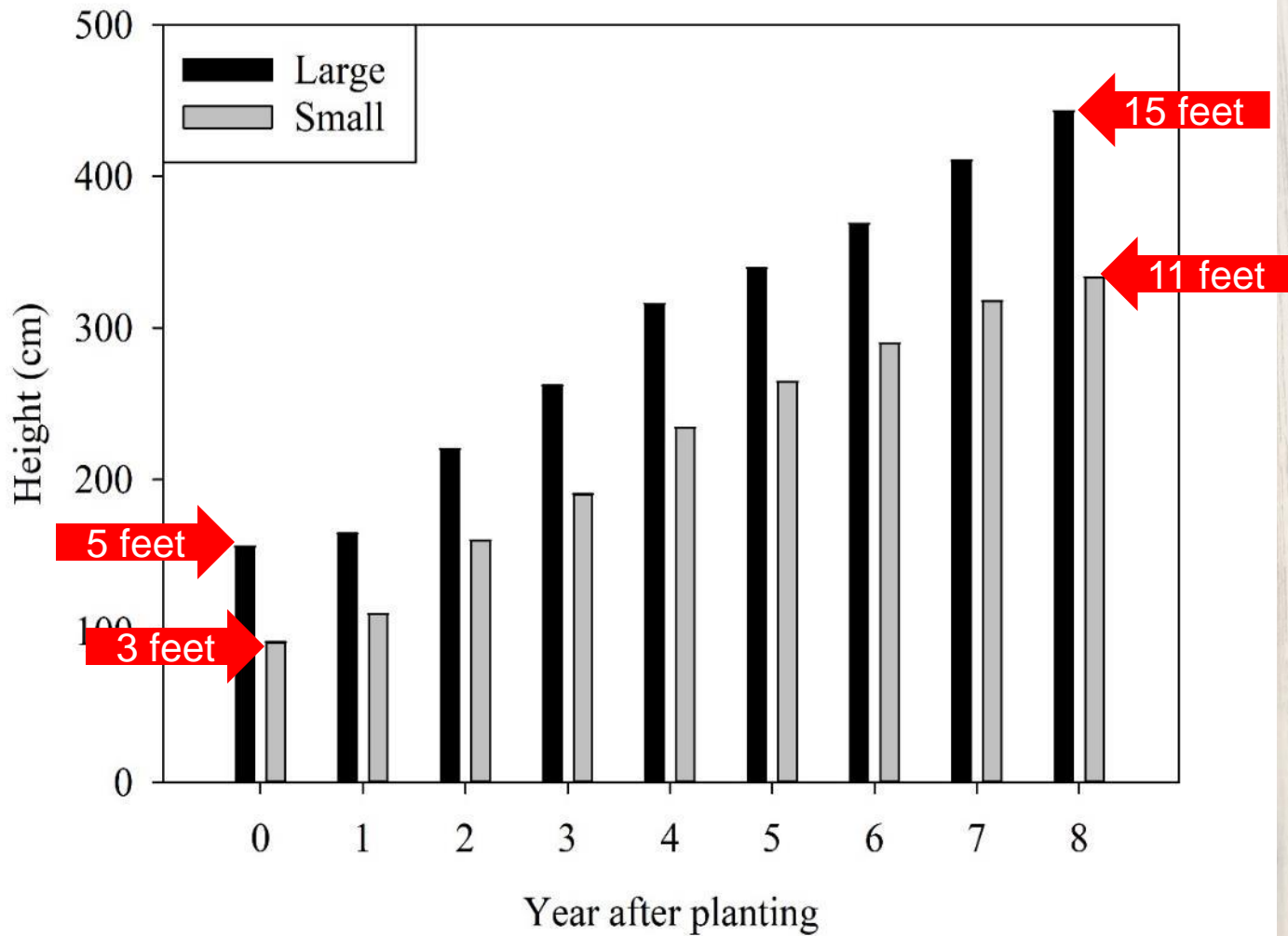
# Year 10 survival (2009 Plantings)



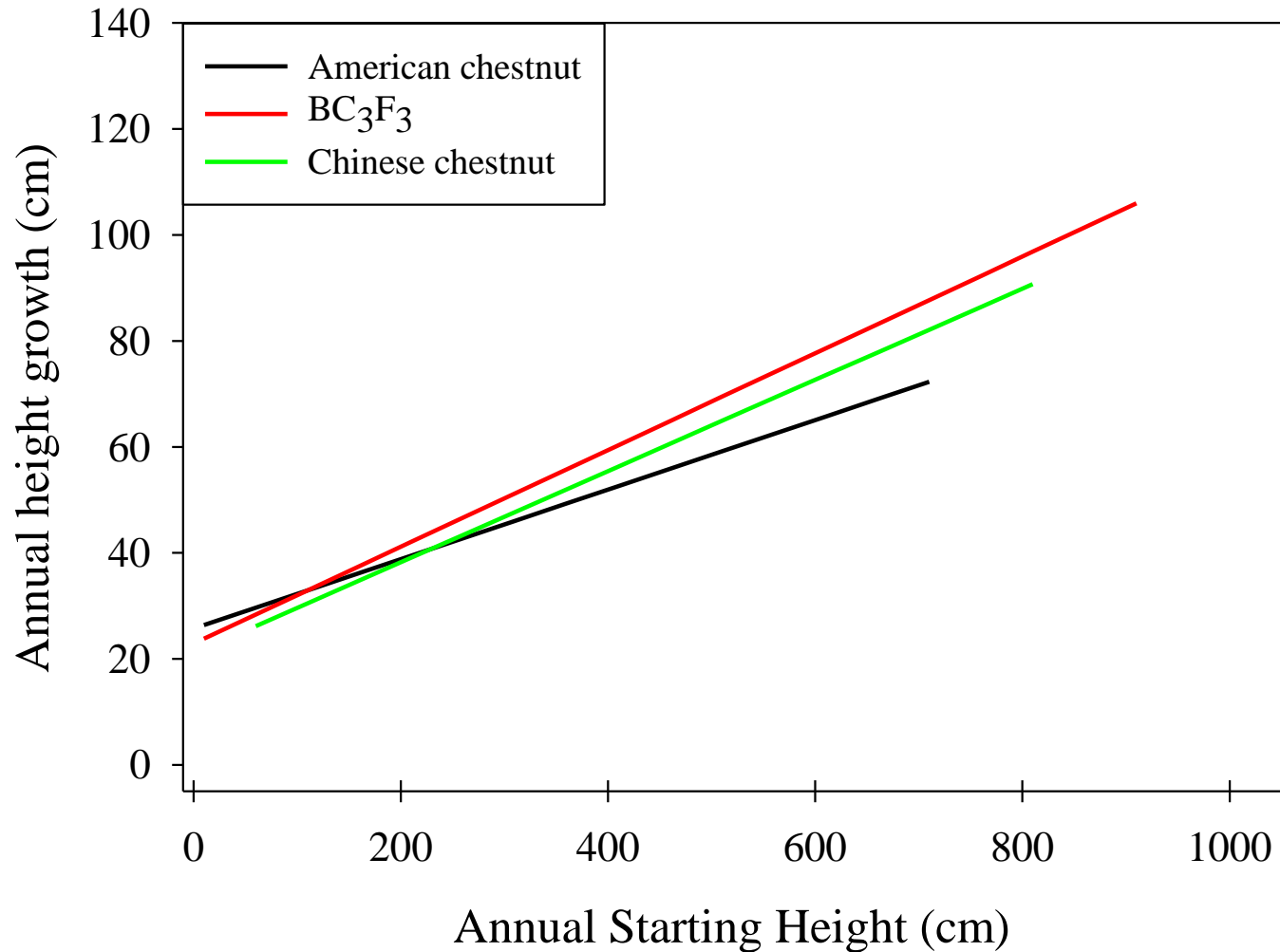
# Year 10 Height (2009 Plantings)



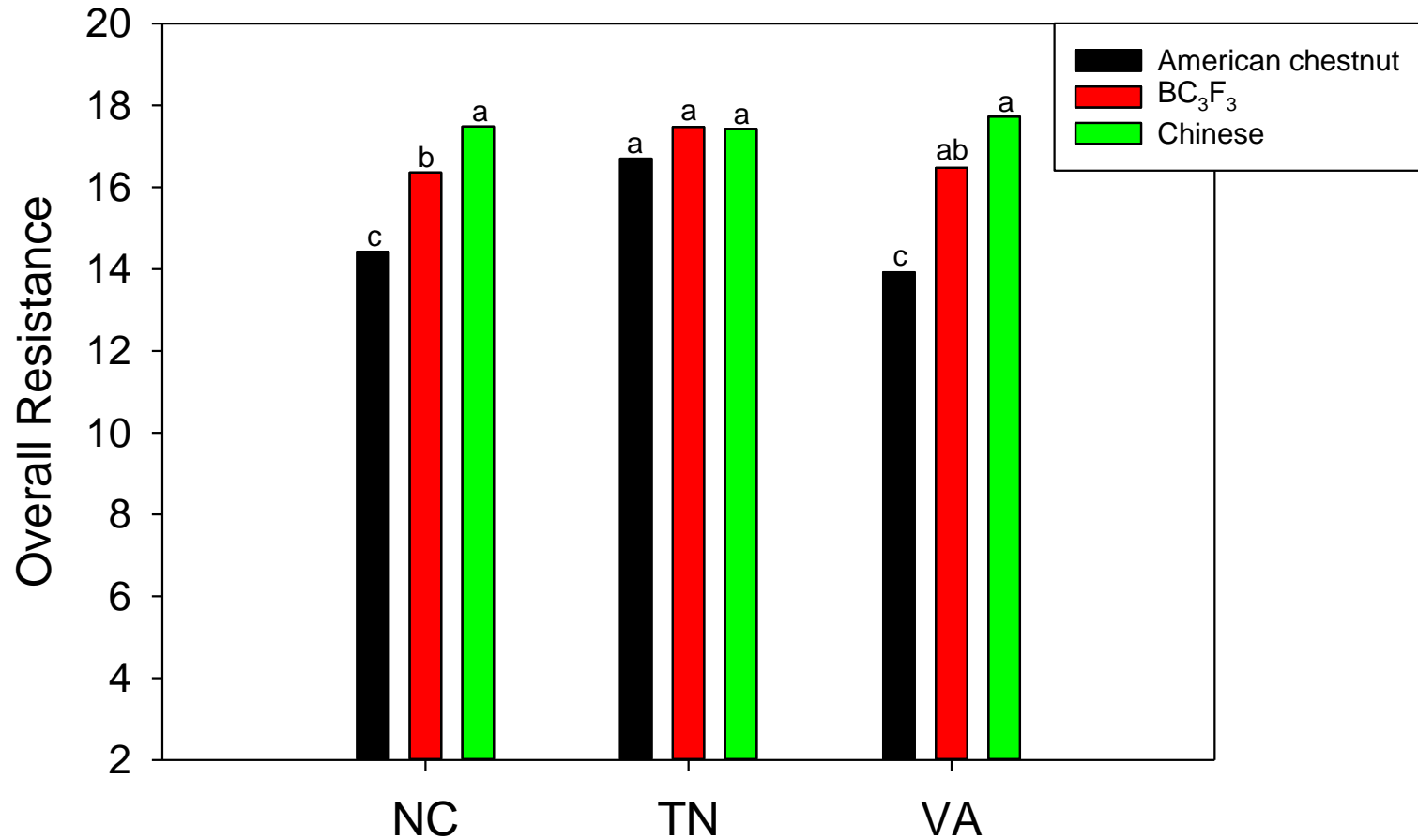
# Year 8 Height (2010 Planting)



# Height growth (2010 Planting)



# Year 8 Blight Resistance (2009 Plantings)



# Ten-year Blight Resistance (2009 Plantings)

- 51% of American chestnut dead from blight
  - 13% had killing cankers
  - 23% were blight free
- 21% of BC<sub>3</sub>F<sub>3</sub> dead from blight
  - 11% had killing cankers
  - 56% were blight free
- 10% of Chinese dead from blight
  - 3% had killing cankers
  - 80% were blight free



Cankers on 11-  
year-old BC<sub>3</sub>F<sub>3</sub>  
at NC site

# Other Non-native Pests

- Asiatic oak weevil (*Cyrtopistomus castaneus*)
  - Identified at all plantings
- Asian chestnut gall wasp (*Dryocosmus kuriphilus*)
  - Identified at all plantings
- Asian Ambrosia beetle
  - Identified only on weakened trees



Asiatic oak weevil



Asian gall wasp



# Biological Challenges: Phytophthora root rot?

- Caused severe to moderate die-off in some 2009, 2010 and 2011 plantings
- Use containerized seedlings?
  - RPM<sup>®</sup> (Root Production Method)
- Grow in northern nurseries?
  - Seedling quality?
- Plant on extremely well-drained sites



RPM seedling on left; bare-root seedling on right

# Biological Challenges: Deer

- Fence
- Use deer repellants or shelters
- Plant large seedlings



Deer browse on a planted American chestnut seedling

# Summary of Results

- $BC_3F_3$  was slightly shorter in height than American chestnut after 10 years
  - But considering initial height, was slightly more efficient in its growth rates
- $BC_3F_3$  had resistance more similar to Chinese chestnut than American chestnut
  - But not as good as Chinese chestnut
- Interaction between resistance and environment?
- Larger seedlings at planting remained larger and had less deer browse
- *Phytophthora* root rot and deer browse were major deterrents to success



# Challenges to restoration

- Resistance is currently at intermediate level (Steiner et al. 2016)
- National Forest System should remain in testing phase until resistance is more durable
  - Can't meet reforestation targets when long-term survival is unknown



12-year-old planted American chestnut with a virulent blight canker

# It will take more than a blight-resistant tree

Perceived challenges from National Forest System managers in the Eastern and Southern Regions:

1. Blight resistance levels,
2. Phytophthora root rot,
3. Lack of silvicultural knowledge,
4. Animal damage, and
5. Coordinating harvests with availability of planting material.



# **It will take more than a blight-resistant tree**

Other concerns from managers were:

1. Public opposition if planting coincides with increased timber harvests,
2. Public opposition to genetically modified (GM) chestnuts, and
3. Adequate funding for planting establishment, maintenance, and monitoring

*Strong partnerships with non-governmental organizations or volunteer groups could provide assistance.*

# We must move forward because chestnut was a keystone species



C. Turnage – Univ of TN

- Chestnut had perhaps irreplaceable values for forest ecosystems
- Chestnut had cultural significance
- Chestnut is a very charismatic species

# For More Information

<https://www.fs.fed.us/research/people/stacyclark>  
or internet search for 'Stacy Clark Forest Service  
Southern Research Station'





- The University of Tennessee Tree Improvement Program: Scott Schlarbaum (director); Others: Luke Allen, Tracy Binder, Becky Blue, Ashley Case, Catie Crocket, Stephen Grayson, David Griffin, Luke Hadden, Brian Hughett, **John Johnson**, Andrew Lambert, Allison Mains, Leah Messer, Tyler Nutter, Ben Reichert, Shelby Sanders, Ami Sharp, Alison Shimer, Jesse Troxler, Tan Watcharaanantapong
- The University of Tennessee Agricultural Experiment Station
- Forest Service, Region 8: John Blanton (retired), David Casey, Barbara Crane, Sandy Henning, Robert Lewis, Russ MacFarlane and staff, Jeff Matthews, Robert Makowski, Mark Miller, Jason Rodrigue and staff, Jim Steiner and staff, the late Don Tomczak, Roger Williams (retired), Tyler Williamson; FHE: Wes Letterson (retired), Bill Jones; SRS: Bud Mayfield, RRS: Lona Crockett
- The American Chestnut Foundation (TACF) Grants Program
- TACF: Jeff Donahue, Fred Hebard, Paul Sisco
- Tennessee Division of Forestry
- Georgia Forestry Commission
- Connecticut Agricultural Experiment Station: Sandy Anagnostakis
- Clemson University: Steve Jeffers, Inga Meadows, Suzie Sharpe
- Mississippi State University: Richard Baird
- North Carolina State University and Highlands Institute (Jake Ward and Mariah Goodman)
- American Chestnut Cooperators Foundation: Gary Griffin
- Salem College: Caitlin Caudle

**Thank You!**

# Upcoming On-line Chestnut Training

https://usda.courseavenue.com/Player-html5R/launchPlayer.html?skin=1177&&orgID=1011&userID=1746&launchMethod=PREVIEW&courseID=4774&courseCode=CHN-101&orgID=1011&teamID=1278&userID=1746&useDefaultSk



## Historical Value



### Historical value

#### American Chestnut Was Valued as a Forest Product

- **Tannin** for leather production
  - Chestnut constituted 2/3 of tannic acid production in the US in 1915 for the production of leather products
- **Medicinal properties:**
  - Native Americans used chestnut to treat whooping cough, heart problems, and skin ailments (Moerman 1986)
- **Charcoal** used to make iron in charcoal iron furnaces
- **Staves for cooperage** used to make whiskey
- **Kindling:**
  - good to ignite fires, but too highly combustible as logs in chimney fires



Forest History Society, Durham, NC

American chestnut staves for cooperage (1902)


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# Upcoming On-line Chestnut Video

☰ YouTube Search



2.9.mDV.Chestnut\_CherokeePlanting.xx10

8 views • Mar 9, 2018

👍 0 🗨️ 0 ➦ SHARE ⚙️ SAVE ⋮

The video player shows a forest scene with several workers. One worker in the center is wearing a red hard hat and holding a tool. Another worker is visible to the left. The ground is covered with fallen logs and branches, and there are red markers on the ground. The video player interface includes a progress bar at 1:06 / 16:42, a volume icon, and icons for settings, full screen, and expand.

# Upcoming On-line Chestnut Research Briefs



United States Department of Agriculture



Southern Research Station

**CompassPoints**



**Questions?**