Science to assist the restoration of American chestnut to Vermont

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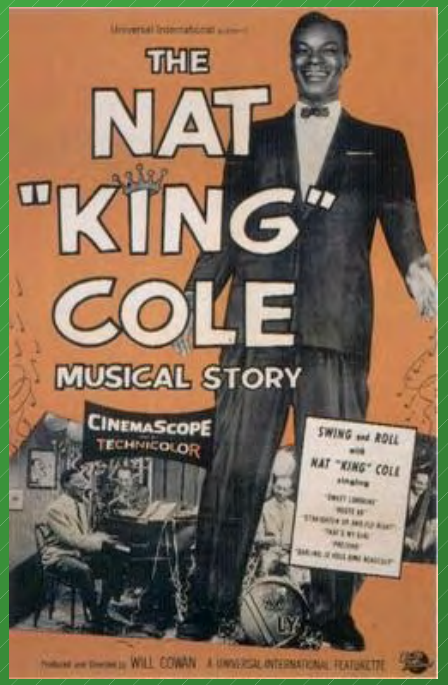
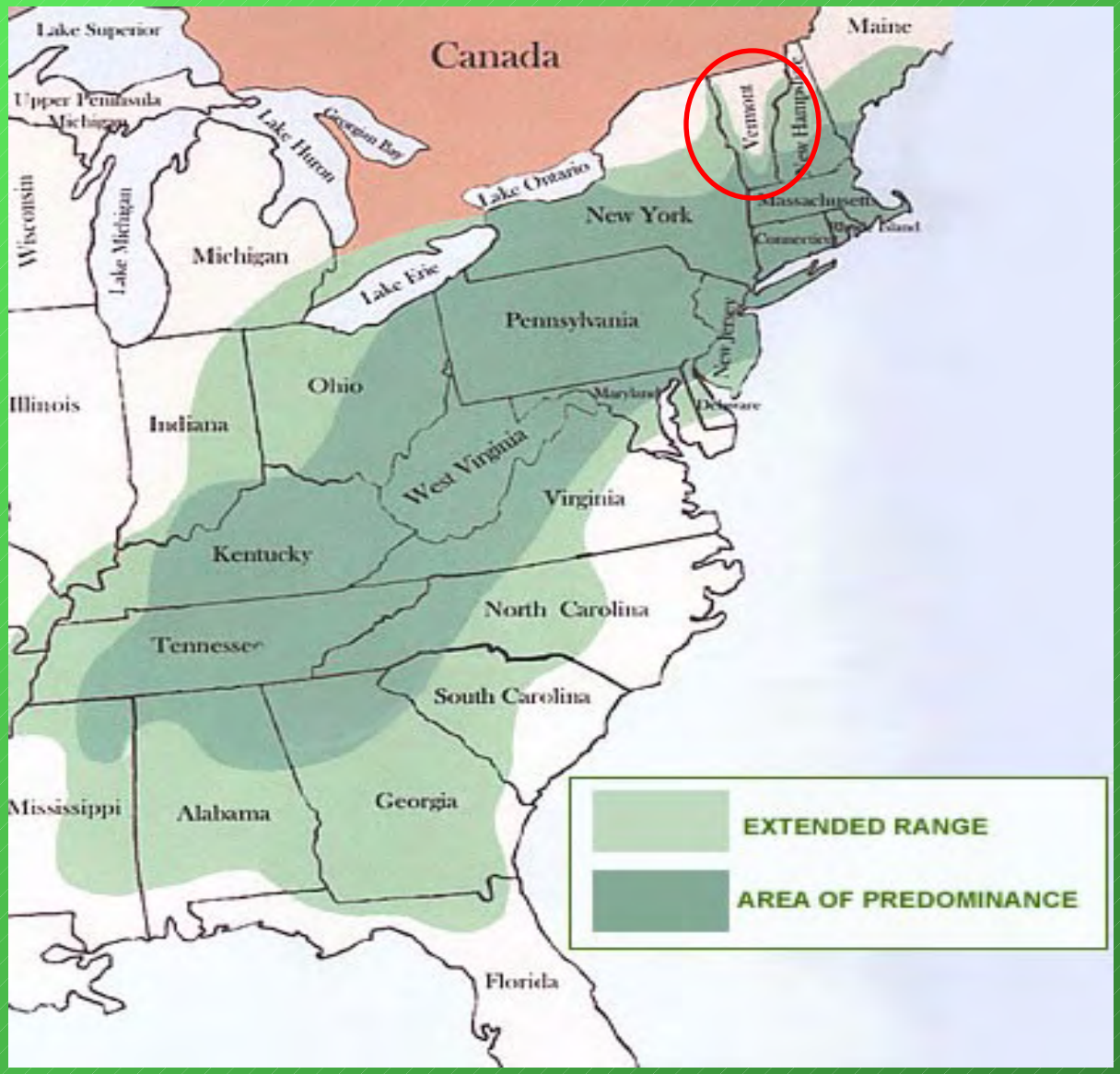
Past: American chestnut ruled!

- Major component of eastern forest
- Fast growth, large, extremely rot resistant
- High-value timber species
- Nuts valuable to wildlife/livestock/people
- Tannins used in tanning leather
- Culturally significant



Past: Historic Range



Past: Chestnut Blight

- Blight first identified in New York in 1904
- Fungus (Cryphonectria parasitica) girdling canker
- Spread quickly, functionally wiped out chestnut as overstory tree by 1950's

Past: Restoration Attempts

- Cultural methods - tree surgery, fungicide, forest gap barriers
- Identifying natural resistance among American chestnuts
- Hypovirulence
- Breeding

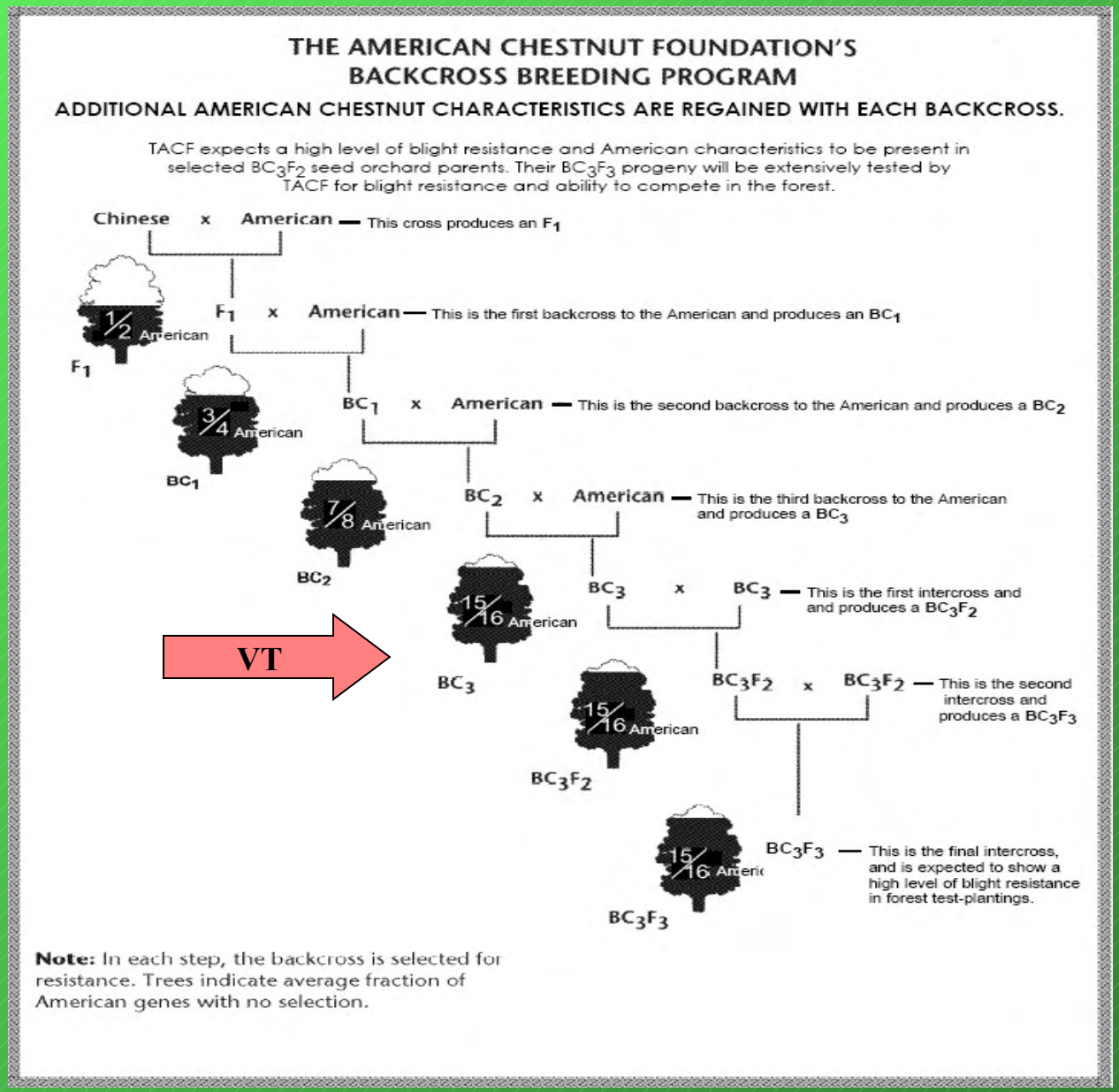
Past: Breeding Methods

- **Hybrid breeding -**
  - **American chestnut x Chinese chestnut**
- **Hybrid/backcross breeding -**
  - **American chestnut x Chinese chestnut**
  - **Offspring backcrossed with American chestnut**
  - **Intercross resistant offspring**

American chestnut

Chinese chestnut

Present: TACF Backcross Breeding



Present: Restoration in VT

- Tailor restoration to VT conditions
- Most breeding material from heart of range
- Very few mother trees from VT
- Genetic diversity, capture local genetics/adaptation, and potentially **augment <u>cold hardiness</u>**

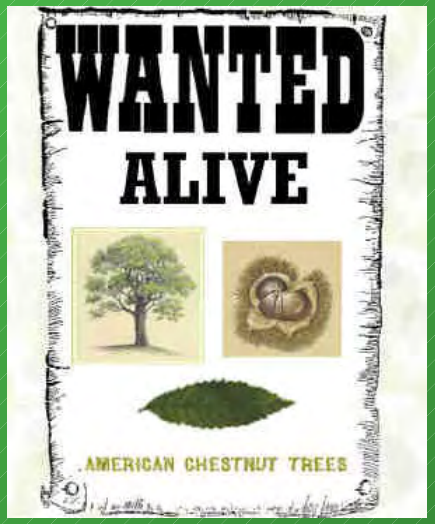
Present: Filling the VT Gap

- Locate new VT mother trees
  - Include in breeding program
  - Identify potential future restoration sites
- Conduct controlled pollinations in VT
- Cold tolerance trials
  - Look at American chestnut, hybrid/backcross chestnut, and native competitors

Point person: <u>Kendra Gurney</u>!

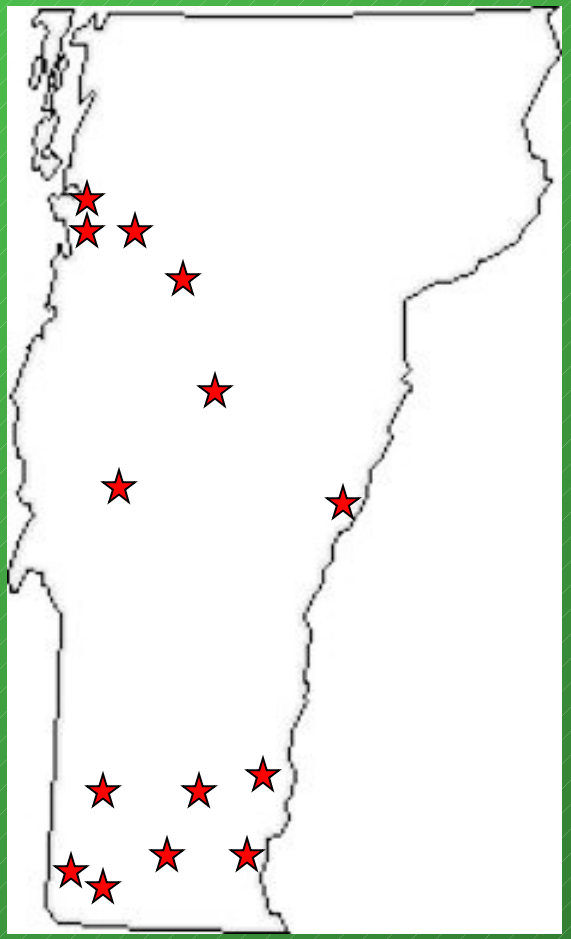
Present: Locating Vermont Chestnut

- Contact state and private foresters, ecologists, and researchers
- Field visits
  - Location, ID, pollination potential, blight status, basic measurements
- Spatial database for future pollination and eventual restoration



Present: Locating Vermont Chestnut

- Current inventory:
  - ~30 trees inventoried
  - ~14 sites
  - ~5 sprout sites
    (lesser priority)



Present: Controlled Pollination

Present: Harvest Results

Controlled Pollination Results

Tree	Year	Hybrid/Backcross Nuts Harvested
Berlin, Jr	2006	127
Colchester 1	2006	38
Berlin, Sr	2007	19
Colchester 1	2007	54
Colchester 2	2007	98

Goal: 100 seedlings per source

Non-viable vs. viable seed

Present: Cold Tolerance Tests - Shoots

Valley View Farm, Shelburne

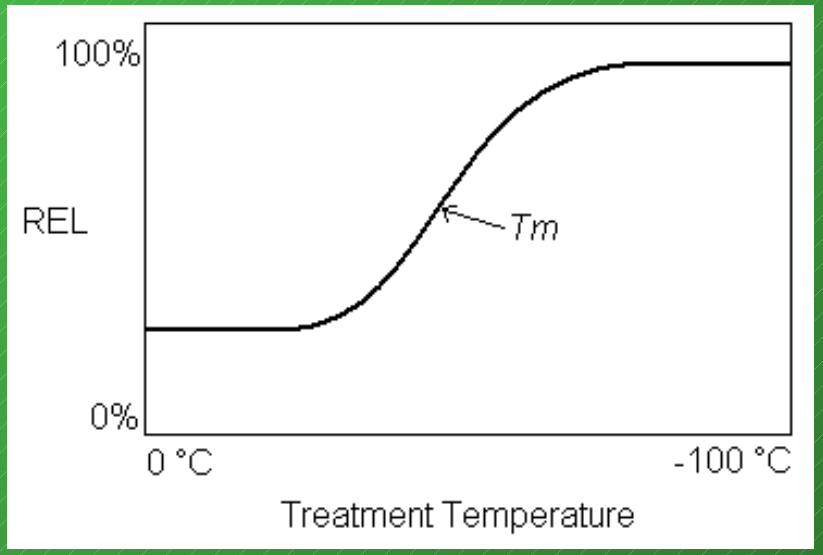
American & Hybrid/Backcross

GMNF Planting, Sunderland

American & Hybrid/Backcross

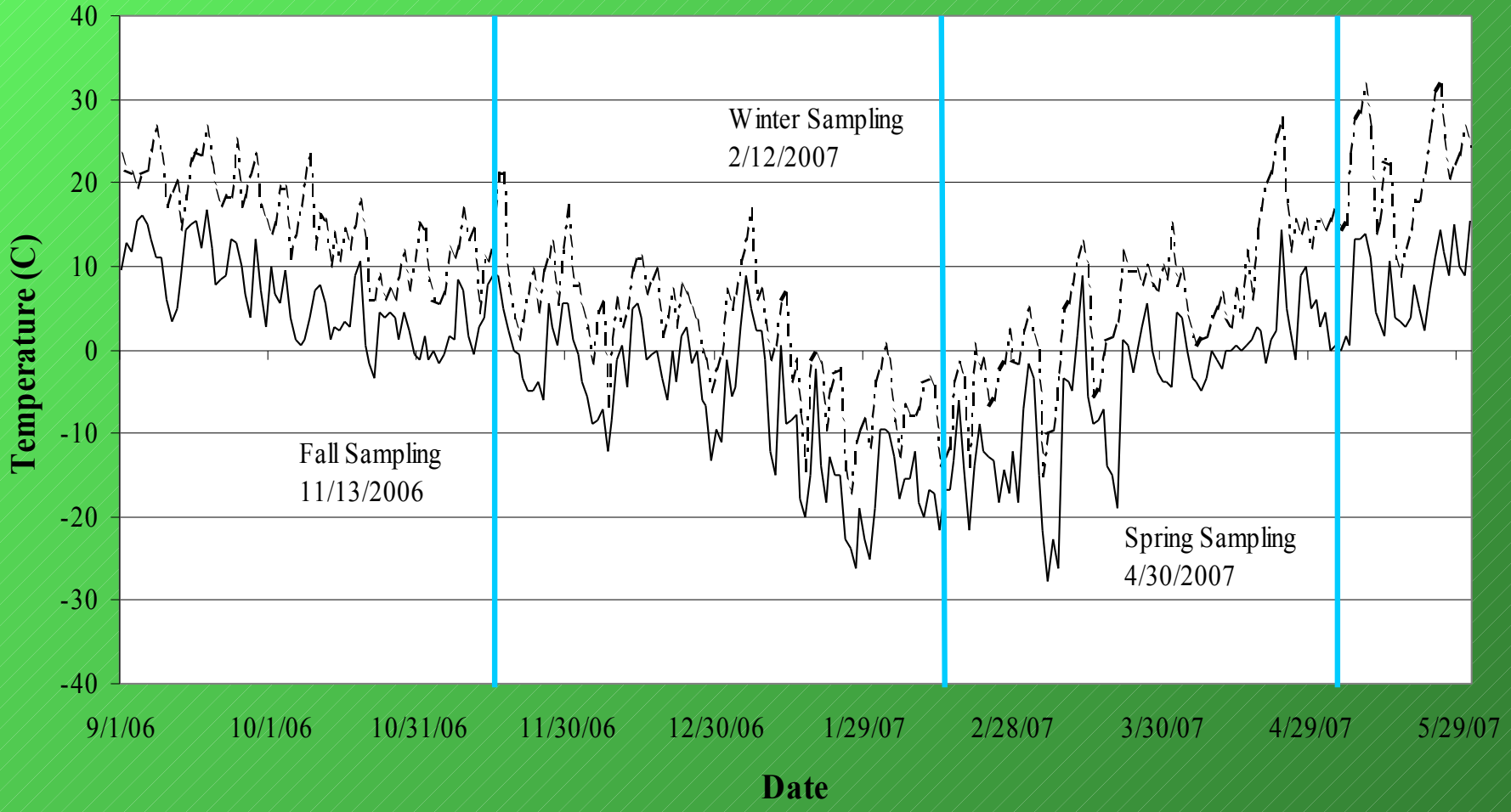
Compared to native sugar maple
and red oak beside Valley View planting

Present: Cold Tolerance Tests

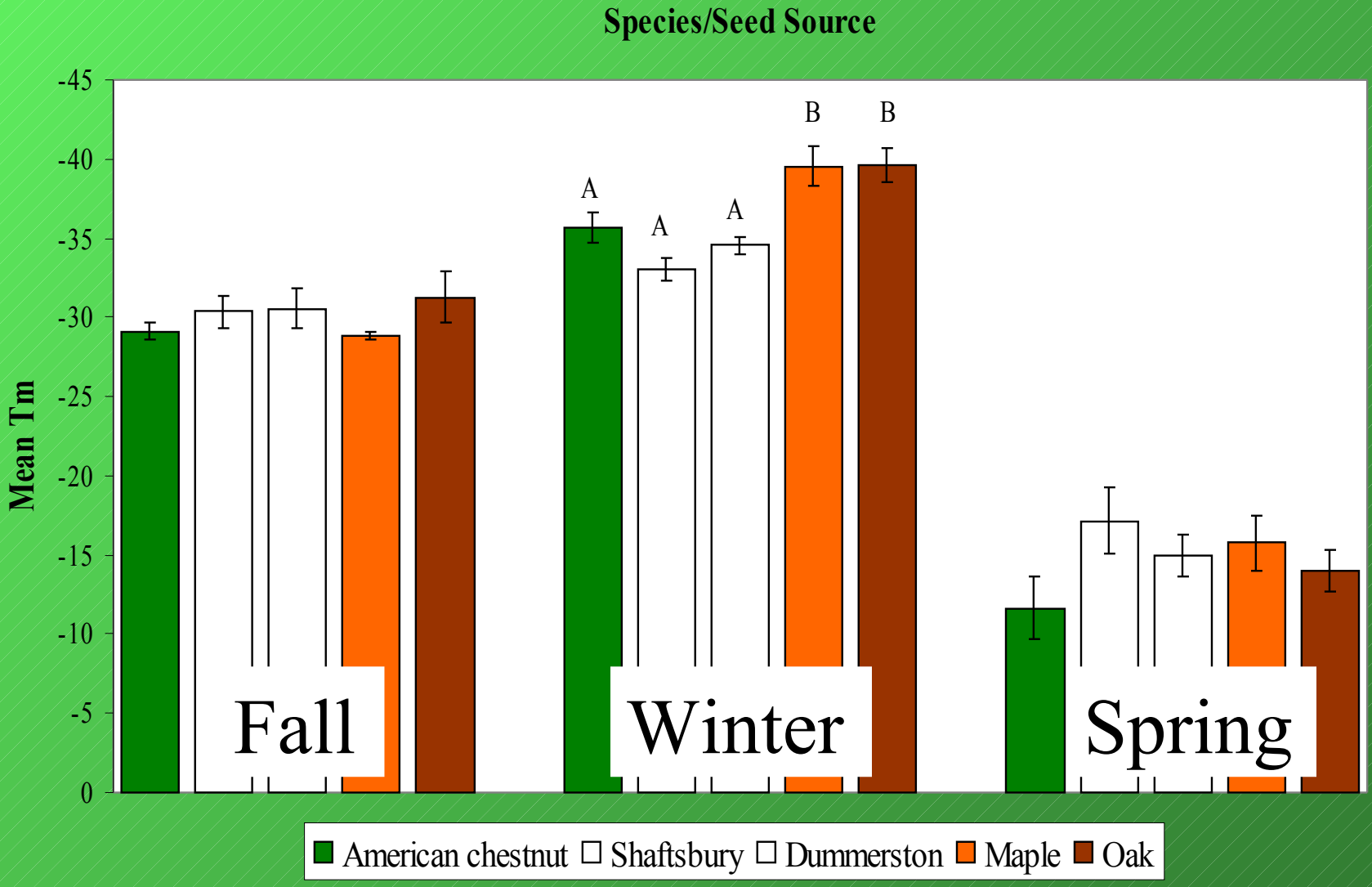


Dialy Air Temperatures from Fall 2006 - Spring 2007

Temperature Data from NOAA National Climate Data Center, collected at Burlington International Airport

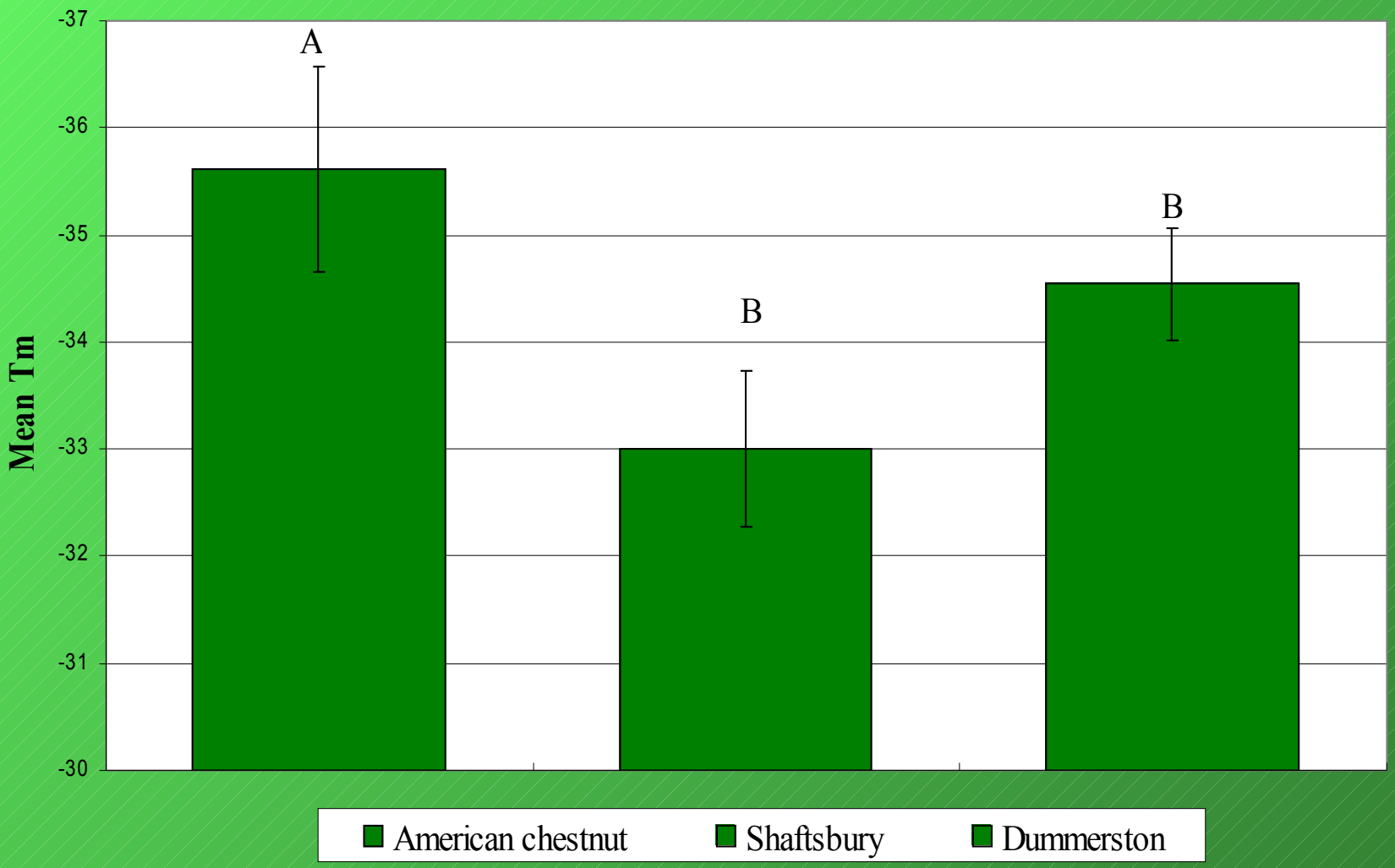


Mean Shoot Cold Tolerance (Tm) Measured in Shelburne, VT 2006-2007



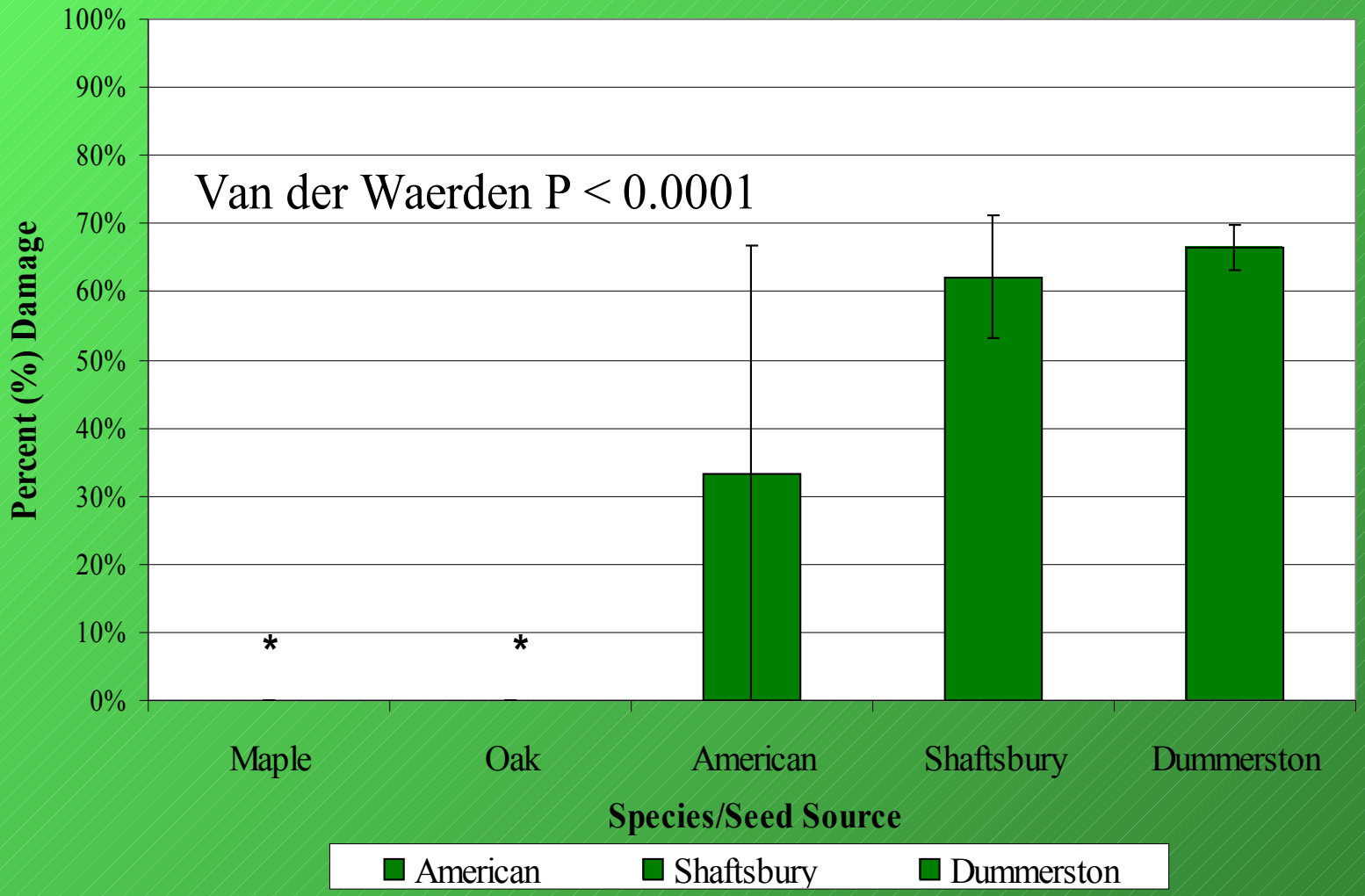
A and B are signaficantly different at $p < 0.0001$

Mean Winter Shoot Cold Tolerance (Tm) for Three Chestnut Sources in Shelburne, VT 2006-2007



A and B are signaficantly different at $P = 0.0745$

Mean Terminal Shoot Winter Injury in Shelburne, VT by Species/Seed Source, 2006-2007



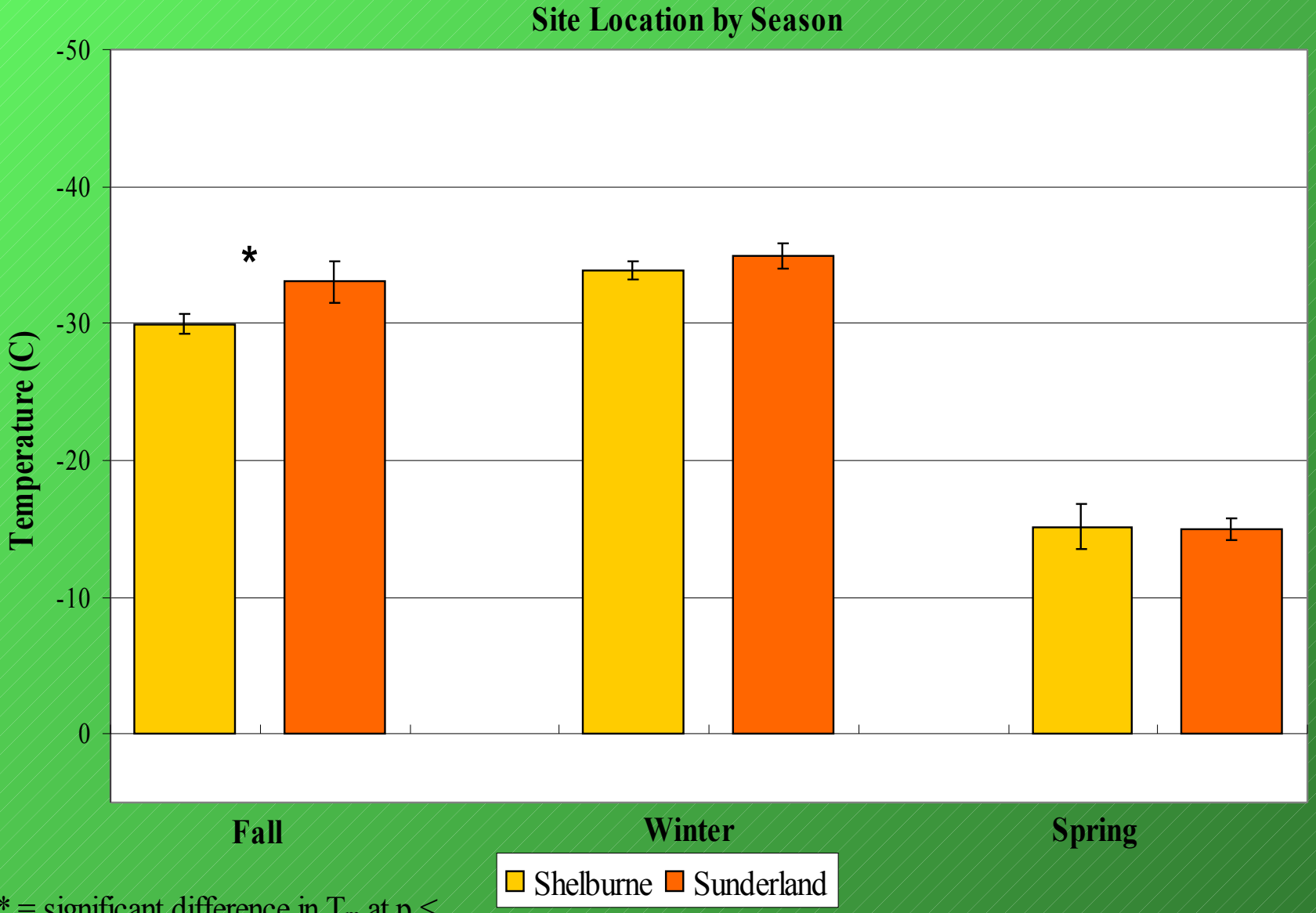
* No damage observed on these sources near chestnut

Present: Winter Injury Assessment

Terminal shoot dieback

Shrub-like growth habit

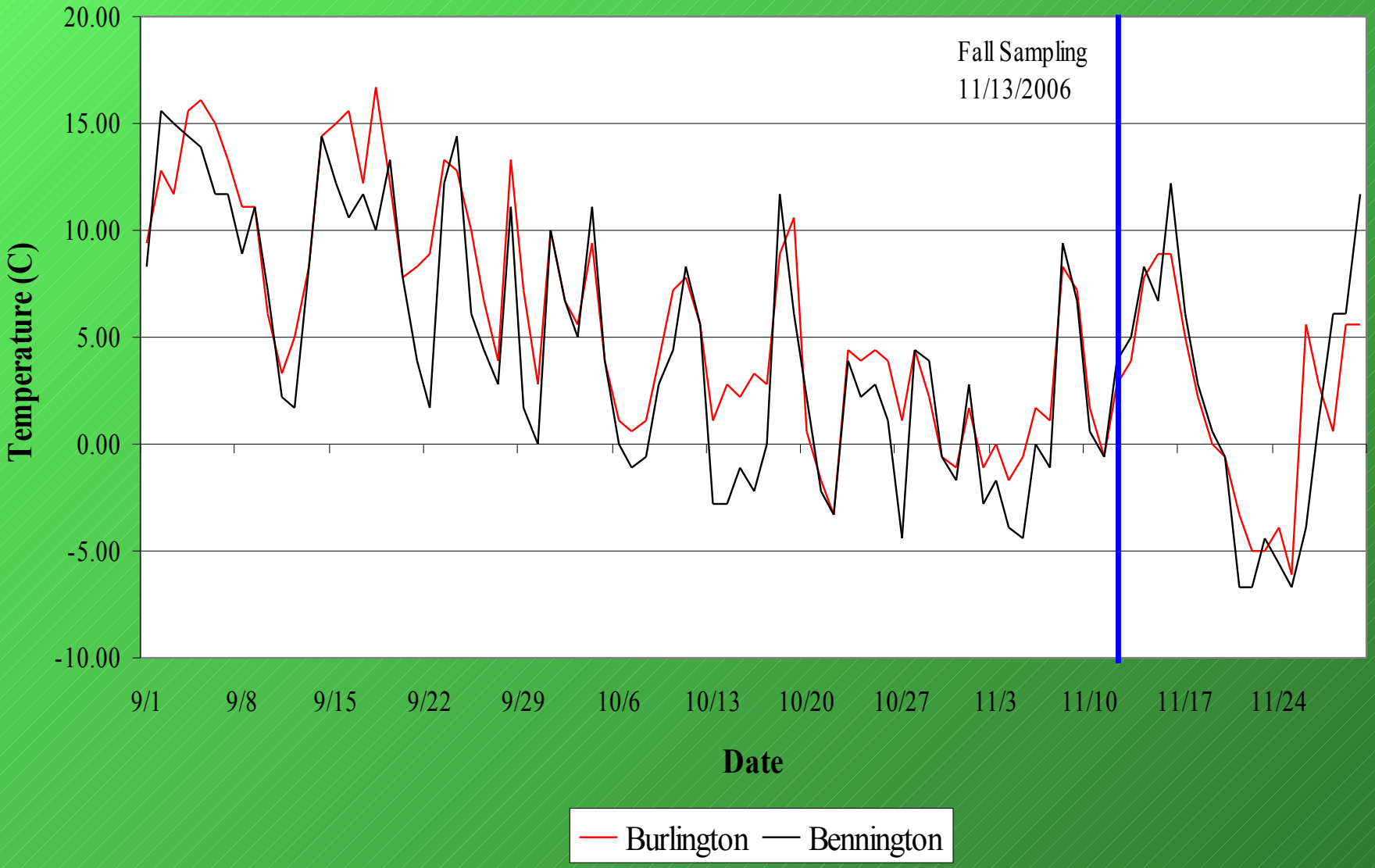
Mean Shoot Cold Tolerance (Tm) in Shelburne and Sunderland, VT 2006-2007



* = significant difference in T_m at $p \leq$

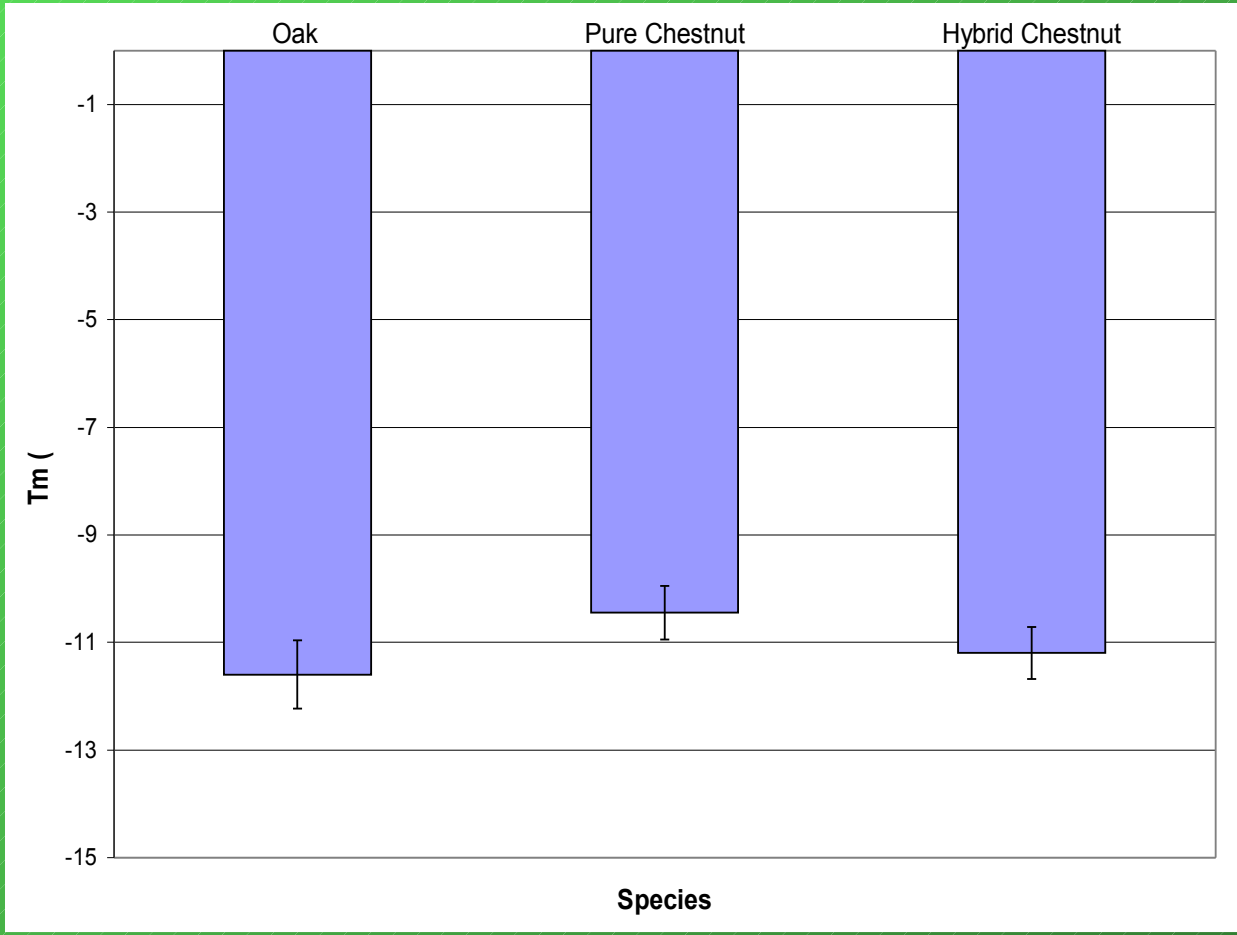
Minimum Daily Temperatures Fall 2006

Temperature Data from NOAA National Climate Data Center, collected at Burlington International Airport in Burlington, VT and at W. H. Morse State Airport in Bennington, VT

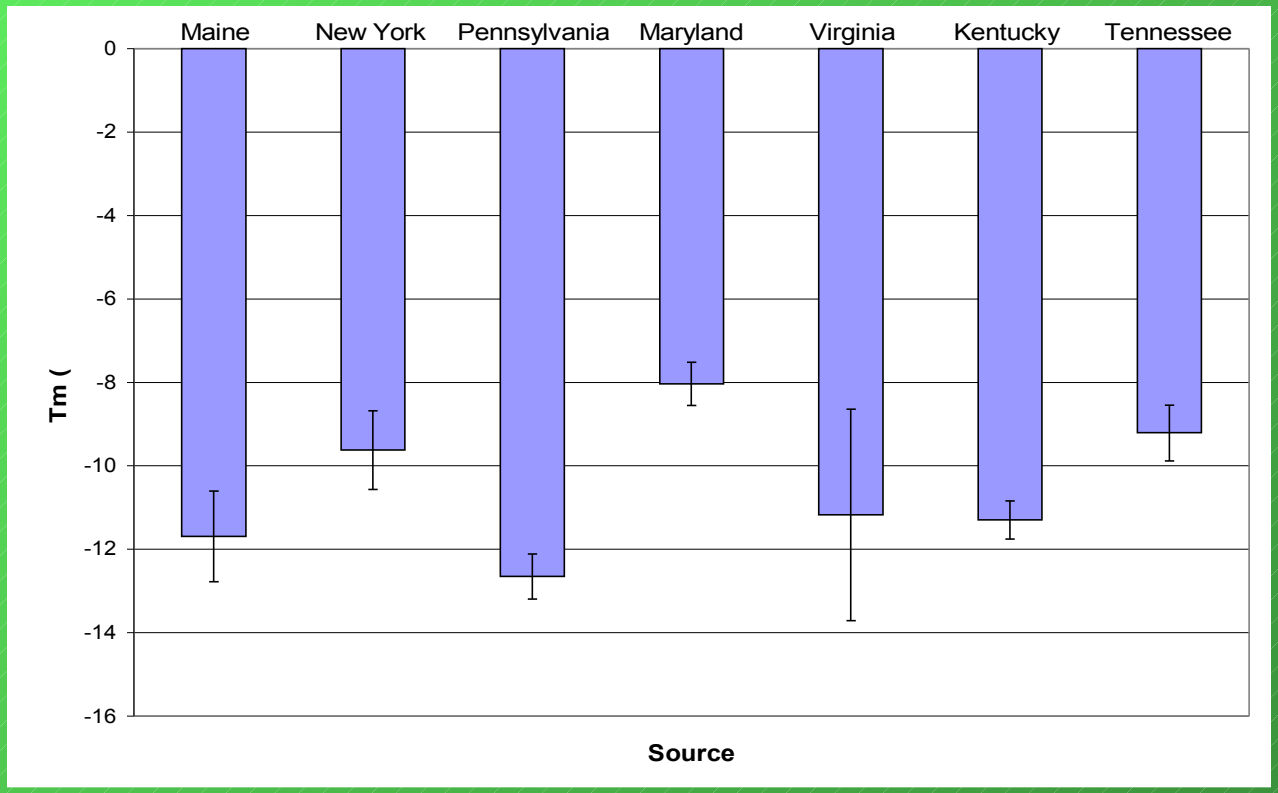


Present: Seed Cold Tolerance

- Pure American, backrossed, red oak
- No significant differences
- All intolerant to ambient air temperatures



Present: Seed Cold Tolerance



- **Different sources of American chestnut**
- **Significant differences among sources ($P = 0.043$)**
- **Potential for increased tolerance through breeding**

Future: Cold Tolerance Implications

- **Limited cold tolerance complicates restoration**
- **Augment seedling shoot cold tolerance**
  - Cultural practices - winter protection and fertilization options
  - Genetic selection for increased cold hardiness

Future: Climate Change Implications

- Warmer climate predicted northeastern US:
  - Winter warming of 2-3 ºC, with nighttime temperatures warming more than daytime
  - Future VT climate like Maryland – Georgia?
  - Decreased snow pack and days with snow on the ground

Potential Consequences of Climate Variability and Change for the Northeastern United States, National Assessment Synthesis Team, USGCRP 2004 and *Climate Change in the US Northeast*, NECIA 2006

Future: Climate Change Implications

- Warming beneficial to seedling/seed winter survival?
- Species shift from beech-birch-maple to oak-hickory (and chestnut?)
- Decreased snow pack potentially problematic
  - Less insulation for shoots of snow-buried seedlings
  - More soil freezing and damage to buried seed

Future: Climate Change Implications

- Wildlife benefits – annual mast
- Timber and biomass
- Carbon sequestration
  - Fast growth, large size/volume, rot resistance

Acknowledgements

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- **USDA Forest Service, USDA CSREES McIntire-Stennis Forest Research Program**

Questions?
Got chestnuts?
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