## Using silvicultural management and genetic selection to assist in the restoration of American chestnut to the Northern Forest

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<u>Take-home message</u>: American chestnut is vulnerable to shoot freezing injury, but can still outgrow native competitors given adequate light.

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## **Project Summary**

- <u>Rationale</u>: Restoring American chestnut to the Northern Forest requires the identification of genetic sources and management techniques that allow this prized species to prosper even at the northern extreme of its range.
- <u>Methods</u>: We measured long-term growth and winter shoot injury for American chestnut, Chinese chestnut and red oak in a replicated common garden planting under 3 silvicultural treatments: open, partial and closed canopies.
- <u>Major findings</u>: American chestnut is vulnerable to freezing injury, but not significantly more than a native competitor – red oak. Despite some vulnerability to freezing injury, American chestnut has great growth potential – especially when grown under open conditions.
- <u>Implications for the region</u>: Once blight-resistant stock is readily available, American chestnut has a great potential for growth and carbon sequestration in the north. However, silvicultural management to limit shading will likely be needed to realize maximum growth.

## **Background and Justification**

Breeding work is being conducted to increase the tolerance of American chestnut to chestnut blight – a disease that functionally removed this species from native forests. However, chestnuts in the north face a second challenge – freezing injury that kills shoots and alters tree form. The goal of this project was to examine how genetic selection and silvicultural treatment can be used to improve the winter hardiness and growth necessary for American chestnut restoration in the Northern Forest. We supported this goal by assessing the shoot winter injury and growth of American chestnut, Chinese chestnut and red oak in a unique common garden on the Green Mountain National Forest (GMNF). This planting incorporates American chestnut sources from southern, central, and northern portions of the species' range grown together in a replicated design under three levels of silvicultural treatments (open, partial and closed canopies).

## Methods

For this research we established a unique progeny planting on the Green Mountain National Forest (GMNF) where seedlings from 13 American chestnut sources from across the species' range were planted with 2 Chinese chestnut and 2 red oak sources in a replicated design under three silvicultural treatments: open, partial and closed canopy overstories. The following 2 slides outline some study details.

### Overall study design

- 13 pure American sources, 2 Chinese sources, 2 red oak sources
- Sources were from 3 temperature zones cold, moderate and warm defined by average winter temperature lows
- Saplings were planted under 3 silvicultural treatments

   closed canopy, partially closed and open canopy
- With 3 treatment replicates
- About 880 saplings planted overall

#### American chestnut source origins

#### **Common garden**



Source sites throughout native range



## **Result summary**

- <u>Species differences</u>: Chinese chestnut had highest early growth, but was most vulnerable to freezing injury. American chestnut had the greatest long-term growth and winter injury levels were similar to a native competitor red oak.
- <u>Temperature zone differences</u>: Initially, plants from the cold temperature zone grew less and experienced less winter shoot injury than chestnuts from the warm and moderate temperature zones. However, differences among temperature zones diminished over time.
- <u>Silvicultural treatment differences</u>: shoot freezing injury varied with treatment over time, but growth was consistently greatest in the open, with modest growth under partial canopy and lowest growth under closed canopies.
- The following slides depict these differences.

#### **Species Height and Winter Injury**



#### Field growth – Silvicultural differences



Open treatment

Partial treatment

**Closed treatment** 

#### Shoot winter injury American chestnuts



Year

#### Treatment heights American chestnut sources



Year

#### Mortality (%) of American chestnut as of 2015



# Implications for American chestnut in the North

- •Chestnuts are vulnerable to low temperature damage
- •Vulnerability varies among chestnut species/sources
- •Despite this, they have great growth capacity
- •Especially when sun-exposed



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#### Future directions

Given funding, our group will examine how :

1)other management alternatives (e.g., harvests that release shaded trees, and

2)nitrogen fertilization

affect the balance between growth and low temperature injury for American chestnut within the Northern Forest.



## Acknowledgement

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## **Publications**

Saielli, T.M., P.G. Schaberg, G.J. Hawley, J.M. Halman, K.M. Gurney, 2015. Genetics and silvicultural treatment influence the growth and shoot winter injury of American and Chinese chestnut seedlings grown in Vermont, USA. Forest Science 60(6):1068-1076.

Clark, S.L., S.E. Schlarbaum, C.C. Pinchot, S.L. Anahnostakis, M.R. Saunders, M. Thomas-Van Gundy, P.G. Schaberg, J. McKenna, J.F. Bard, P.C. Berrang, D.M. Casey, C.E. Casey, B. Crane, B.D. Jackson, J.D. Kochenderfer, R. MacFarlane, R. Makowske, M.D. Miller, J.A. Rodrigue, J. Stelick, C.D. Thornton, T.S. Williamson. 2014. American chestnut restoration in the National Forest System. Journal of Forestry 112(5):502-512.

Schaberg, P.G., T.M. Saielli, G.J. Hawley, J.M. Halman, K.M. Gurney. 2013. Growth and shoot winter injury of American chestnut seedlings grown in common garden at the species' northern range limit. In: Miller, G.W.; Schuler, T.M.; Gottschalk, K.W.; Lee, Brooks, J.R.; Grushecky, S.R; Spong, B.D.; Rentch, J.S., eds. Rroceedings 18<sup>th</sup> Central hardwood Forest Conference. Gen. Tech. Rep. NRS-P-117. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station Pp 72-79. Central Hardwood Forest Conference, March 26-28, 2012, Morgantown, WV.

## Presentations

Stern, R.L., P.G. Schaberg, G.J. Hawley, P.F. Murakami, K.M. Gurney. 2015. Restoration of
American chestnut: Assessing growth and winter injury of The American Chestnut Foundation's
B3F3 Restoration Chestnut 1.0 in a northern climate. Ecological Society of America Annual
Meeting, Baltimore, MD, August 14. (Abstract).

Stern, R.L., P.G. Schaberg, G.J. Hawley, P.F. Murakami, K.M. Gurney. 2016. Assessing growth and winter injury of The American Chestnut Foundation's B3F3 Restoration Chestnut 1.0 in a northern climate. Stern and Schaberg presented this poster at the Vermont Monitoring Cooperative's 25<sup>th</sup> Annual Meeting, Burlington, VT, December 11.

Hawley, G.J., P.G. Schaberg, P.F. Murakami, K.M. Gurney, J.M. Halman. 2015. Using silvicultural management and genetic selection to assist in the restoration of American chestnut to the northeastern U.S. Ecological Society of America Annual Meeting, Baltimore, MD, August 13. (Abstract).

Schaberg, P.G., P.F. Murakami, G.J. Hawley, J.M. Halman, R.L. Stern, K.M. Gurney. 2014. Exploring how silvicultural management and genetics influence the performance of American chestnut in Vermont. Vermont Monitoring Cooperative Annual Meeting, Burlington, VT. December 11. (Abstract).

Schaberg, P.G., G.J. Hawley, K.M. Gurney. 2014. **Restoration of American chestnut at the northern extreme of its range.** Northeastern States Research Cooperative Webinar, Burlington, VT and via web access, November 12.

## Presentations continued

Gurney, K.M., P.F. Murakami, P.G. Schaberg, J.M. Halman, G.J. Hawley. 2013. **Phenology assessments on the GMNF: implications of spring frost on chestnut health and restoration.** Annual New England Regional Meeting of The American Chestnut Foundation, Portsmouth, NH, December 7, 2013.

Murakami, P.F., P.G. Schaberg, K.M. Gurney, J.M. Halman, G.J. Hawley, S.F. Fitzsimmons. 2013. **Spring phenology of American chestnut sources in a Vermont provenance test: implications for foliar frost injury.** Poster presentation at the 30<sup>th</sup> Annual Meeting of The American Chestnut Foundation, Hemdon, VA, October 18-20.

Schaberg, P.G., G.J. Hawley, P.F. Murakami, R.L. Stern, K.M. Collins 2016. **Chestnuts thrive despite cold damage.** New England Chapters Meeting of The American Chestnut Foundation. Urban Forestry Center, Portsmouth, NH, September 10.

Schaberg, P.G., G.J. Hawley, P.F. Murakami, R.L. Stern, K.M. Collins. 2016. **USFS/UVM American chestnut research update.** Eight Annual Meeting of the VT/NH Chapter of the American Chestnut Foundation, Shieling Forest, Peterborough, NH, April 30.

Schaberg, P., Murakami, P., Gurney, K., Hawley, G., Saielli, T., Halman, J., Fitzsimmons, S. 2013. **How genetics and silvicultural management influence the performance of American chestnut in the north.** Poster presentation at the Vermont Monitoring Cooperative Annual Meeting, Burlington, VT, December 12.

## Presentations continued

Schaberg, P.G., Saielli, T.M., Hawley G.J., Halman, J.M., Gurney, K.M. 2012. Growth versus protection from the cold: a tradeoff for American chestnut grown at the species' northern range limit? Eastern CANUSA Forest Science Conference, The University of New Hampshire, Durham, NH, November 3.

Schaberg, P.G., Saielli, T.M., Gurney, K.M., Hawley G.J., Halman, J.M., Murakami, P.F. 2012. **Exploring the fit between genes and the environment relative to American chestnut restoration.** American Chestnut Summit, Asheville, NC. October 20.

Schaberg, P.G., Murakami, P.F., Gurney, K.M., Saielli, T.M., Hawley G.J., Halman, J.M., Fitzsimmons, S.F. 2012. Exploring how genetics and silvicultural management influence the performance of American chestnut in the north. American Chestnut Summit, Asheville, NC, October 20.

Schaberg, P.G., Saielli, T.M., Hawley G.J., Halman, J.M., Gurney, K.M. 2012. Winter injury of American chestnut seedlings grown in a common garden at the species' northern range limit. Proceedings of the 18<sup>th</sup> Central Hardwood Forest Conference, West Virginia University, Morgantown, WV. March 27. p. 30 (Abstract).