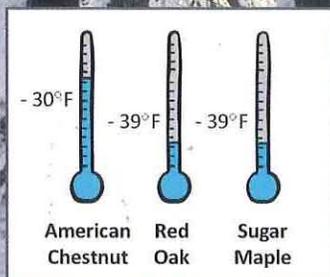


# Life in the Cold

## Another Challenge to American Chestnut Restoration?



by Kendra Gurney (TACF) and Paul Schaberg (USDA Forest Service)

During the winter, American chestnut was found to be 9°F less cold hardy than both red oak and sugar maple. Laboratory methods used to measure cold tolerance, while necessary to evaluate differences among species and sources, can produce fairly conservative results that seem to overestimate the cold tolerance of actual shoots in the field.

Credit: Paula Murakami, USDA Forest Service

The restoration of the American chestnut is a goal that unites chestnut enthusiasts from Maine to Georgia, from the East Coast to the Ohio River, and even beyond the boundaries of this majestic species' native range. But while our goal is the same—to restore this tree to its former place in the forest—the obstacles vary with each location this effort is undertaken.

In the northern and colder reaches of the American chestnut's native range, hardiness to low temperatures may be a challenge to returning this tree to the forest. If you look at a range map, it seems likely that the American chestnut

was originally limited in its northern range by low temperatures. Considering this, in colder locations it may be necessary to develop and plant American chestnuts that are resistant to not just one, but two ecological threats—one introduced (blight) and one native (cold).

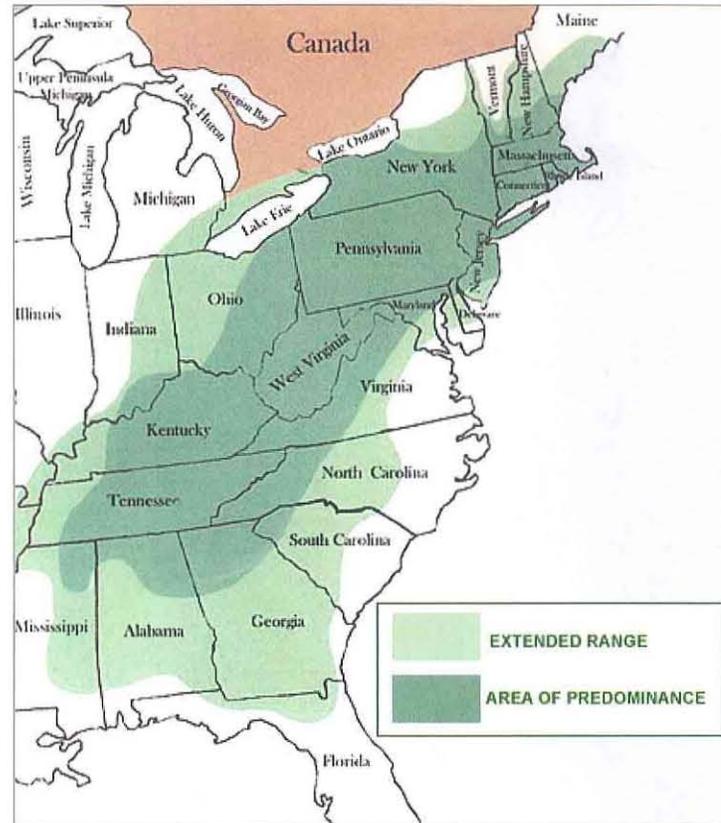
In 2005, TACF began working with a collaborative research group at the U.S. Forest Service Northern Research Station and the University of Vermont. Their first round of investigations focused on the cold tolerance of the woody shoots of American chestnut and backcross chestnut. Shoots, a tree's small woody stems, are exposed to the elements year-round and can become damaged, or even killed, by

low temperatures. Shoots from American and Vermont backcross chestnut, red oak and sugar maple were sampled from two sites in Vermont during the fall, winter and spring of 2006-2007 and then tested in the laboratory to assess their cold tolerance. While both sugar maple and red oak grow farther north than American chestnut, and are thus expected to be more cold tolerant, both species were chosen to represent fairly standard northern hardwood competition.

By testing the cold tolerance of shoots throughout the fall, winter and spring, it's possible to get a better picture of when trees start to acclimate to the cold, what their cold threshold is during the winter, and when they drop their guard in the spring. By April of 2007, it was clear at one of the sampling sites that many of the trees had been damaged by low winter temperatures. The tips of many terminal and lateral shoots had died back 6-12 inches, causing lateral buds on injured shoots to be released and resulting in a bush-like appearance of injured plants.

This kind of injury can be visually assessed, and field measures of shoot winter injury were made in the spring of 2007 on the same chestnut, oak and maple saplings used in laboratory assessments. Again, it was found that the chestnuts were less cold hardy. While there was significant winter injury measured on most of the chestnuts, none was observed on the oak or maple sampled from the same area. It's interesting to note that while the laboratory assessments identified a damaging winter temperature of  $-30^{\circ}\text{F}$ , actual lows measured at this site were only  $-18^{\circ}\text{F}$ , 12 degrees warmer than predicted to cause injury.

While the shoots of a tree are always exposed to the elements, there are other tissue types that must also survive the winter in order to aid natural regeneration. When considering the reintroduction, regeneration and spread of blight-resistant stock (the goal of American chestnut restoration), it is reasonable to wonder—are the nuts cold hardy enough to hold up to northeastern winter temperatures and successfully sprout in the spring? In order to answer this question, a preliminary nut cold tolerance experiment was conducted.



American chestnuts from throughout the range were laboratory tested for cold tolerance in a manner similar to shoots. Red oak acorns were also tested as a comparison. While this preliminary experiment did not uncover any regional or elevation patterns for the cold tolerance of chestnuts, it was found that chestnuts were about two degrees Fahrenheit less cold hardy than red oak acorns ( $-10^{\circ}\text{F}$  and  $-12^{\circ}\text{F}$ , respectively). Interestingly, neither chestnuts nor acorns were cold tolerant enough to survive ambient low air temperatures typical to the northeast. Thus, it is likely that the burial of nuts by rodents or the protection of winter snowpacks is needed to shelter both chestnuts and acorns from freezing damage and keep them viable through long northern winters.

Results from these first experiments highlighted the limited cold tolerance of American chestnut relative to ambient temperature lows and potential species competitors in the North Country. These results also raised new questions about how to best guide chestnut restoration in colder climates.

The range of the American chestnut. In New England, American chestnut trees may be found in a few exceptionally cold pockets, but in general it's limited to areas where milder temperatures predominate, such as lake and river valleys and lower elevations. Credit: Sara Fitzsimmons, TACF



Chestnut shoots killed by winter temperatures are easy to spot in the spring. The bark is darker, sunken and cracked at the site of injury. As the growing season progresses, the buds do not swell and leaves do not emerge on winter-injured shoots. Basically the shoot is, and appears, dead. While laboratory assessments predicted a damaging temperature of  $-30^{\circ}\text{F}$ , temperature lows measured at this site were 12 degrees warmer than predicted to cause injury. It's likely that damage was observed at higher temperatures in the field because temperatures in the natural environment can fluctuate drastically in a short period of time. This creates rapid freeze-thaw stresses that are often more damaging than the slow-freeze conditions of laboratory tests. Credit: Kendra Gurney, TACF

A large experimental planting established on the Green Mountain National Forest in Vermont in 2009 hopes to answer these new questions. American chestnuts from sources representing a large portion of the species' native range were planted in replicated plots under different levels of canopy cover. This larger collection of geographically diverse sources will allow for a more thorough look at the variation in American chestnut shoot cold tolerance associated with the genetic source of trees. In addition, the different levels of canopy cover used in the study should help to determine the best planting environment to provide optimal cold tolerance, growth and survival in colder climates.

These investigations into American chestnut cold tolerance were designed to improve restoration efforts, as well as to increase the body of knowledge about this important tree species. The first experiments have highlighted limited cold tolerance as a potential complication to restoration efforts in more northern climates. However, work continues to determine the best way to overcome this limitation. It's likely that laboratory and field tests will identify genetic sources of American chestnut that are significantly more cold tolerant than typical species averages. The targeted use of these sources in breeding efforts in the north could measurably increase overwintering survival and growth for a better overall outlook for the American chestnut across its traditional range and beyond. 

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