



Photo courtesy: Mike French

American chestnuts in bur.

American chestnut:

an Update for Kentucky Woodland Owners

by Lynn Garrison, Chris Barton, Fred Hebard, Anne Meyers Bobigian, and Scott Freidhof

Introduction

The American chestnut (*Castanea dentata*) was a dominant canopy tree species in eastern North America before populations were devastated by the introduction of the fungal pathogen *Cryphonectria parasitica*, which causes chestnut blight. The blight is believed to have come to North America on nursery stock from Asia in the late 1800s. By the 1950s the American chestnut had been devastated throughout its native range by the chestnut blight and was reduced to a shrub layer, seldom reaching canopy level. Some living roots remain, and these sprout suckers usually live long enough to produce a crop of seed, but the seedlings are often killed back to ground level before bearing seed.

In some areas, American chestnut comprised approximately 25% of the eastern deciduous forest within its native range, which included more than 200 million acres of forest (www.acf.org/range_close.php). It occurred in 71 counties in Kentucky. It was an integral component of a forest ecosystem that provided habitat and abundant food sources for animals and people. A late-flowering tree unaffected by seasonal frosts, it produced fruit annually with little variation from year to year, so chestnuts were a reliable food source for birds such as wild turkey and blue jays and for mammals such as squir-



The Shelton family poses for a picture in front of a large American chestnut tree. American chestnut trees were an important part of early mountain life in Kentucky providing food, fuel, and wood for construction.

Photo courtesy: The American Chestnut Foundation

rels, deer, and bears. The nuts were used to fatten livestock and were stored for food over the winter months. They were also an important cash crop for many rural families, and nuts were sent to major cities over the Christmas season to be roasted and sold by street vendors.

The American chestnut was also an excellent timber tree. Forest-grown trees were straight and were often free of branches for 50 feet. The wood was straight-grained, easy to work, and rot-resistant. The wood was used for telegraph poles, railroad ties, shingles, paneling, fencing, ship masts, coffins, fine furniture, musical instruments, pulp, and plywood. Production of American chestnut lumber in the United States reached a maximum of 663.9 million board feet in 1909. Maximum production in Kentucky was 42.8 million board feet in 1907, 5% of Kentucky's total hardwood production. In 1924, the volume of standing chestnut sawtimber in the United States was estimated to be 19.3 billion board feet.

In 1983 The American Chestnut Foundation (TACF) was founded by a group of scientists who recognized the severe impact the demise of the American chestnut had on the local economies of rural communities and upon forest ecosystems. They believed there was a strong chance of reviving the American chestnut by breeding for resistance using a backcross method. The goal of TACF is to restore the American chestnut tree to its native range within the woodlands of the eastern United States.

TACF Research

American chestnut restoration is entering several exciting new phases. First, after 25 years of work, 15/16th-American, 1/16th-Chinese 'Restoration' chestnuts are now being planted in the forest throughout the country. These test plantings will determine whether the 'Restoration' chestnut trees can grow like the American chestnut of old. Although it will take 50 years or more for the 'Restoration' chestnut to prove it can grow 100 feet tall, it should be apparent in 10 to 15 years whether or not it will be suitable for general planting in the forest.

Along with work to establish a blight-resistant tree, the TACF is starting to develop enough baseline data to incorporate



KDF Stewardship Forester Kevin Galloway is shown mud-packing a canker 20 feet up an Elliott County American chestnut tree. The life of infected American chestnut trees can be extended by mud-packing cankers.

resistance to *Phytophthora* root rot into 'Restoration' chestnuts. *Phytophthora* root rot struck American chestnut trees in Kentucky toward the end of the Civil War and prevents it from growing in many sites where it formerly grew. Resistance to the disease will enable more Kentuckians and residents of other states to enjoy the 'Restoration' chestnut.

Another exciting phase, perhaps in this case more exciting for biologists than for the general public, is that detailed DNA sequence information is becoming available for chestnut. These data will enable breeders to incorporate disease resistance into American chestnut with greater

precision. The data also might help clarify the mysterious factors that made American chestnut a dominant forest tree, in contrast to Chinese chestnut.

Looking into the future, it is helpful to remember the basic goal of the TACF breeding program, which is to give American chestnut an opportunity to resume evolving on its own. It is difficult to predict with much accuracy whether *Phytophthora* root rot will become a worse problem than it is now or whether gall wasp or Ambrosia beetle, other pests of chestnut, will become even more destructive. And additional pests may come forth to threaten chestnut. It needs to have the genetic resources to cope with these threats by itself.

TACF helps the tree assemble those resources by capturing most of the American chestnut's existing genetic diversity in our breeding programs. That is why the state chapters are so important, including the Kentucky chapter. Some genes in Kentucky chestnut trees are different from genes of chestnut trees anywhere else in its range. We do not know what they do, but we suspect very strongly that they are critical to the long-term survival of chestnut. It is the chapter's job to bring those genes into the breeding program.

Kentucky Chapter of TACF

TACF currently has 16 chapters, including the Kentucky TACF Chapter (KY-TACF). KY-TACF volunteers contrib-

Photo courtesy: Scott Freidhof



The Kentucky Chapter of The American Chestnut Foundation plays an active role in the restoration of the American chestnut. One way they contribute is through pollinating efforts like this image of Mike French at the top of a 40-foot TV antenna tower pollinating a Letcher County American chestnut tree.

ute time and energy supporting regional breeding programs, research, local education programs, and member recruitment. The mission of the Kentucky Chapter is to restore the American chestnut to its natural ecological role in the woodlands of Kentucky within its native range.

The backcross breeding program started by TACF has produced blight-resistant trees that are now being tested in Kentucky and across the historic American chestnut range. The Kentucky chapter is participating by breeding local genotypes adaptable to ecosystems in Kentucky and has established three different types of chestnut orchards in the state. The most common is the breeding orchard. Pollen applied to Kentucky's pure American survivors is usually from the backcross 2 generation (B2). B2 trees are 7/8th American trees at TACF's research farm in Virginia. Once the B2 pollen is applied to a Kentucky American, the new generation of nuts is 15/16th American and is termed the backcross 3 generation (B3). Breeding orchards contain two different genetic lines of these B3 nuts. After seven to eight years of growth in the orchard, the B3 trees are purposely inoculated with the blight fungus. In 2011, the orchard at Robinson Forest will be Kentucky's first trees to be inoculated.

A small percentage of the B3 trees will have inherited blight resistance from the Chinese parent in the original cross. The blight-resistant B3 trees will be kept in the orchard to cross-pollinate and make the first intercross generation (B3F2).

A second type of orchard is the pure American "Mother Tree" orchard. Mother Tree orchards are established by digging chestnut stump sprouts from the forest and transplanting them into an orchard setting. Two of these Mother Tree orchards have been established, one at the Kentucky Division of Forestry's Morgan County Tree Nursery and one at the Grayson Lake Wildlife Management Area in Carter County. Mother trees at the Morgan County orchard were dug from high elevations on Pine Mountain. Those trees began producing flowers in 2010 and will be included in the breeding program during 2011.

A third type of chestnut orchard, termed "restoration orchard," will be established in 2011. Experimental orchards of this type will contain some potentially blight-resistant seedlings (B3F3). A grant from the U.S. Fish and Wildlife Service Partners in Wildlife Program made the restoration orchards possible on private lands. Restoration orchards will restore forest habitat for the long-term benefit of wildlife.



Photo courtesy: Scott Freidhof

A backcross 3 (B3) orchard was planted at the University of Kentucky's Robinson Forest in 2005. The trees are 15/16ths American/Chinese chestnut and will be inoculated with the chestnut blight this year to determine which trees have blight resistance. A small percentage of the B3 trees will have inherited blight resistance from the Chinese parent in the original cross. The blight-resistant B3 trees will be kept in the orchard to cross-pollinate and make the first intercross generation (B3F2).

American Chestnut and Mined Land Reforestation

The use of surface mines for American chestnut reestablishment is gaining acceptance, as many successful reforestation projects following the Forestry Reclamation Approach (FRA) have been demonstrated on mine lands across Appalachia (www.arri.osmre.gov). Numerous reasons exist for planting American chestnuts on fresh mine spoils. First, loose mine spoils reclaimed using FRA techniques have shown good growth and high survival

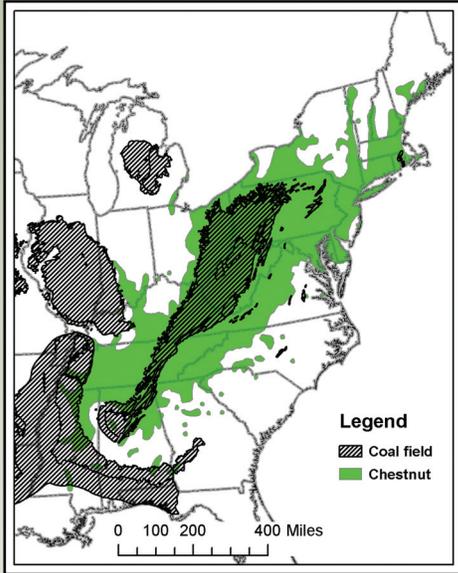


Figure 1. Overlay of the historic American chestnut range (green) with that of the Eastern United States coal field (black stripes). Note that the Appalachian coal field is centrally located within the natural distribution range for American chestnut.

rates for other native Appalachian hardwood species and may also be suitable for American chestnuts. Second, many surface mines exhibit light and soil chemical characteristics that are similar to higher elevation and ridgetop positions where American chestnuts were dominant. Third, loose mine spoils are initially devoid of vegetative competition, a hindrance to many reforestation efforts. Fourth, fresh mine spoils may initially be devoid of pathogenic microbial communities such as *Phytophthora*, which have hindered TACF's breeding and restoration efforts elsewhere. Moreover, loose mine spoils are well-drained, which may hinder establishment of *Phytophthora*. Lastly, the

Appalachian coal region falls almost entirely within the natural distribution of American chestnut (Figure 1). If loose mine spoils prove conducive to chestnut survival and growth, the establishment and dispersal from founder populations of blight-resistant backcrosses throughout the range of the Appalachian coal region would aid TACF's goal of restoring the chestnut throughout its historic range.

In anticipation of the widespread release of the blight-resistant backcross American chestnuts, research efforts are under way to evaluate the suitability of mined sites for American chestnut establishment per the FRA in the Appalachian coal region. Pure American chestnuts and TACF backcross seedlings have been planted on mine lands to serve as proxies for the true-breeding, blight-resistant backcrosses. We are examining differing types of spoil to determine which parent material fosters the best growth and survival for American chestnut. In addition,

studies aimed at determining the best way to establish *Phytophthora*-free plantings are under way. Most operationally planted reclamation projects use dormant, bareroot nursery stock; however, *Phytophthora* are present in the soil at many nurseries and may be transported to planting sites on the roots of seedlings. American chestnuts can be established from seed on the mine site to avoid *Phytophthora* contamination, but rodent predation of the seeds can be as detrimental to survival as *Phytophthora* (Figure 2). As such, different planting techniques are being evaluated (e.g., direct-seeded versus bareroot stock, use of tree shelters versus no shelter, fertilized versus no fertilizer). Much has been learned from this research, and many successful plantings have been established. Not only is survival high in many mined locations, but *Phytophthora* has only been detected in one sample from a spoil that contained residual soil material from the pre-mined site. Soil samples tested from unmined forests in the region yielded high (80%) *Phytophthora* detection rates.

Appalachia is one of the most beautiful and culturally rich regions in America. The heritage of Appalachia has been rooted in the forest and coal industries for centuries. Appalachia has experienced many hardships related to environmental degradation from coal mining, but the loss of the American chestnut was particularly troublesome to its citizens. At one time, virtually all of the land mined in Appalachia was forested. Where once were forests, we now have abandoned grasslands that will take Mother Nature centuries to restore. Recently, TACF and the Appalachian Regional Reforestation Initiative (ARRI) developed a program to both promote the reforestation of mine lands in Appalachia and restore the American chestnut. This program, referred to as "Operation Springboard," has been embraced by the mining community, environmental groups, and Appalachian citizens alike. In 2009, 520 volunteers and nine separate non-profit watershed groups held tree-planting events on 36 acres of surface mine land and

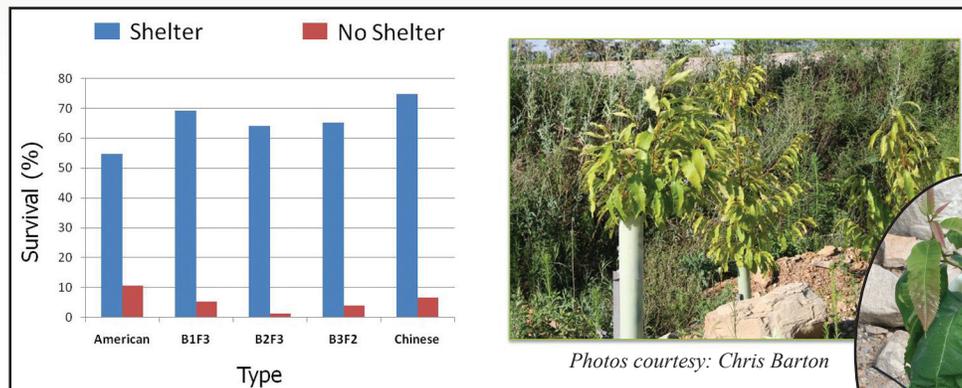


Figure 2. Influence of the use of tree shelters on chestnut survival on a surface mine in Pike County, KY. Tree shelters are plastic tubes placed over a seed or seedling to protect them from rodent predation and herbivory by browsing animals. American, Chinese, and backcross chestnut varieties (B1F3, B2F3, and B3F2) all benefited similarly from the protection provided by the shelter. Right: Recently germinated chestnut on a surface mine in Pike Co., KY.



Photos courtesy: Chris Barton



planted 27,500 trees. In 2010, over 175 acres were used for volunteer planting events, and nearly 115,000 trees were planted.

American chestnuts were planted on each of these sites, and many times it provided the incentive for volunteers to join in the planting events. The act of planting American chestnuts within its native range is important, but using the chestnut to promote reforestation efforts (all forested species) on these mined lands may be more significant because it puts individuals with varying views on mining together to engage in conversations about conservation, sustainability, and the future well-being of the region. These conversations and outcomes produced from them are the true measures of success and progress. Ultimately, it is hoped that these efforts will lead to the restoration of the American chestnut and the forests it once inhabited.

What can you do to help?

One of the best ways to help the Kentucky chapter of The American Chestnut Foundation accomplish its mission is to become a member. This membership provides financial support, with \$15 of the \$40 membership fee coming back to the state chapter. Some members also volunteer for chapter planting projects by assisting with site preparation, weed control, and planting. Other members help with orchard maintenance at one of the chapter's orchards.

If you believe you have found an American chestnut, you can contact Lynn Garrison at (Lynn.Garrison@earthlink.net), as volunteers have found many surviving trees in Kentucky, several that can be used as mother trees that may be pollinated with pollen from TACF's Meadowview Research Farm or as pollen donors for Meadowview trees.

This American chestnut orchard was established in 2008. This breeding orchard in Oldham County has one of the highest survival rates thus far in Kentucky and has been used extensively for educational and outreach efforts.

Photo courtesy: Anne Meyers Bobigian

Can I get TACF blight-resistant seedlings/nuts?

"Restoration chestnut" seedlings/nuts are available to members through the TACF for a substantial sponsorship

(<http://shop.acf.org/annual-sponsor-seed-distribution.aspx>).

Blight-resistant American chestnut seedlings/nuts are not yet ready for full-scale distribution; they are still in the testing phase. These trees will

American chestnut trees bloom from mid-June to early July, depending on latitude and elevation. In this image of a rare mature American chestnut flowering, the male flowers (long white-yellowish catkins) are clearly visible along with the female flowers (the green burs at the base of the branches). American chestnut trees rarely self-pollinate so at least two chestnut trees need to be near each other for viable nut production.

Photo courtesy: Michael French

be distributed to cooperators who are assisting in a formal, rigorous testing program. When seeds that are not needed for formal, rigorous testing programs become available, they will be distributed principally to members of TACF for informal testing. TACF sponsor-level members now have access to some of these seeds for testing purposes.

Pure American chestnut seedlings can be purchased from the national TACF, and KY-TACF may occasionally have pure American seedlings. These seedlings are susceptible to the blight but may live long enough to produce seeds for a few years, helping preserve native germplasm. They may also be used for future breeding programs. With proper care one may be able to grow trees to a 5-6" diameter at breast height (4.5' above the ground) and 30 feet tall, depending on location and presence or absence of *Phytophthora cinnamomi*, before they die of blight infection.

About the Authors:

This article was a group effort of the following individuals:

Lynn Garrison, President of the Kentucky Chapter of TACF, Email: lynn.garrison@earthlink.net

Chris Barton, PhD, Associate Professor University of Kentucky Department of Forestry, Email: barton@uky.edu, Phone: 859.257.2099

Fred Hebard, PhD, Chief Scientist of The American Chestnut Foundation, Email: fred@acf.org, Phone: 276.944.4631

Anne Meyers Bobigian, MD, Restoration Orchard Coordinator for the Kentucky Chapter of TACF, Email: annemonique@bellsouth.net

Scott Freidhof, Wildlife Biologist with the Kentucky Department of Fish and Wildlife Resources, Email: scott.freidhof@ky.gov, 606.783-8634