The demise of the American chestnut (*Castanea dentata*) is likely one of the great ecological disasters of current time. Through the first-half of the 20th century, the species was virtually eliminated from the landscape by an Asiatic blight fungus (*Cryphonectria parasitica*) introduced on exotic plant materials imported by plant explorers in the late 1800s.

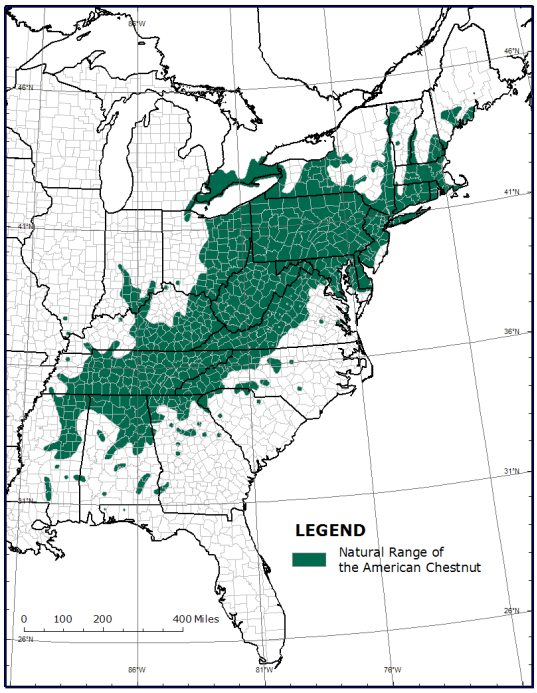

Figure 1. **The Natural Range of the American Chestnut.** Courtesy TACF.

The chestnut was very densely populated with a range from Maine to Georgia (Figure 1). In Pennsylvania, the Blight Commission estimated that more than 25% of the state hardwoods were American chestnut trees[1]. In virgin forests throughout their range, mature chestnuts are storied to have averaged up to five feet in diameter and up to one hundred feet tall (Figure 2). Many specimens of eight to ten feet in diameter were recorded, and there were rumors of trees bigger still.

Due to their abundance and enormous size, the American chestnut once ranked as the most important wildlife plant in the eastern United States. A large American chestnut tree could produce 10 bushels or more of nuts. Chestnut mast supported many species indigenous to Pennsylvania including: squirrels, wild turkey, white-tailed deer, black bear, raccoon and grouse, which once depended on chestnuts as a major food source.

Figure 2. **Large Chestnut Logs**. Photo courtesy USFS Asheville.

Because of the species' capacity to regenerate from the root collar, the American chestnut continues to survive. Once the "king of the forest", the American chestnut is typically only found as a small stump sprout, rarely reaching over 20 feet in height. Although the tree has escaped the threatened and endangered species list because of its fairly numerous population size, the blight fungus typically kills those stems before they can reach sexual maturity, reproduce and/or expand within its native range.

[1] The full proceedings of the PA Blight Commission are available on-line through Penn State's digital collections: http://chestnut.cas.psu.edu/PaBc.htm

Though hundreds of thousands of sprouts are thought to exist throughout the original range, recent Forest Inventory Analysis (FIA) data indicate a reduction in overall number of chestnut stems throughout the eastern United States' forests. Different management strategies, the importation of other exotic and invasive species, and the influence of Pennsylvania's ravenous deer herd all have had an effect on the species capacity to continue surviving simply through resprouting.

CONNECTION TO WILDLIFE

It's been said that an adventurous squirrel used to be able to travel all the way from Maine to Georgia, without ever touching the ground, and only on chestnut trees. Based on the density of chestnut trees in the 1800s, that may have been true, but I'm sure it's up for debate.

What isn't really up for debate is that our forested ecosystem in the Appalachian Mountains lost a huge nutrition source when the chestnut was lost. Table I shows the approximate nut production, based on size, of chestnut compared to oak species, another important mast producing species. Besides the ability to fruit at an early age, chestnuts' main secret to success in masting is that it doesn't flower until late June, almost always beating late frosts. Oaks, on the other hand, tend to flower in mid-to late May, leaving many vulnerable to frost and thus, a loss of crop.

SPECIES	Diameter (inches)	Nut production per tree	Fruiting age (years)
Chestnut[2]	15	600	8+
Chestnut	24	6000	8+
White oak[3]	20+	8000	20+
Red Oak[3]	20+	1600	25+
Shagbark Hickory[3]	17.8	225	40+

Table I. Approximate nut production capacity of several eastern US hardwood species

SPECIES	Protein content (% dry mass)	Fat content (% dry mass)	Carbohydrates (% dry mass)
Chestnut	7	4	78
Oak	7	32	53
Hickory	14	64	18

Table II. Approximate nutritive content of several eastern US hardwood mast crop species[4]

[2]

[3] Data from Silvics of North America, Volume 2, Hardwoods: http://www.na.fs.fed.us/spfo/pubs/silvics_manual/volume_2/vol2_Table_of_contents.htm

[4] Nutrition Data. 2008. http://www.nutritiondata.com/. March 4, 2008.

Another strong component to chestnut's importance to wildlife is its nutritive content (Table II). By dry weight, the fruit typically has the highest carbohydrate content of the eastern US mast producing species.

RESTORATION EFFORTS

There are several efforts underway to restore the American chestnut involving both traditional breeding methods, simple conservation strategies, methods that would reduce the virulence of the blight fungus, as well as modern gene-transformation techniques. The American Chestnut Foundation dabbles in each method, but focuses primarily on classical breeding techniques. While the broadest goal is to restore the American chestnut species, the organization focuses on two major objectives:

1. introducing the genetic material responsible for the blight resistance of the Chinese tree into the American chestnut;
2. to preserve the genetic heritage of the American chestnut species by conserving the native germplasm throughout the original range before it disappears.

Each chestnut species – of which there are about seven – varies with regard to blight-resistance. Blighted North American chestnut species die, while blighted Asiatic chestnuts typically suffer only cosmetic damage, if any at all. With that in mind, Chinese and Japanese chestnuts offer a potential solution to the American tree's susceptibility to chestnut blight through hybridization.

It is thought that chestnut blight resistance is controlled by a three-gene system acting in an incompletely dominant fashion. Based upon that assumption, a breeding system to create a true breeding, blight-resistant American chestnut population would require a minimum of six generations. The first generation crosses an American and a resistant species. The next three looks to increase American character with crosses back to American chestnuts. And the final two generations work to increase resistance.

To avoid inbreeding and to maximize inclusion of regionally-adapted genetic complexes TACF backcrosses different American chestnut trees from each of our sources of blight resistance at multiple locations throughout the native range of the chestnut tree. As a result, each backcross generation – of which there are three - requires the planting of approximately 2500 trees each. Those straight backcross generations are grown for a minimum of 5-8 years before they can be tested and properly selected for resistance and American type. The intercross generation – or the fifth overall generation of breeding – requires the planting and selection among a minimum of 13,500 trees from any given source of resistance.

Plant pathogens frequently evolve to overcome plant defenses. Although the blight fungus is not known to have overcome the defenses of the numerous Chinese chestnut trees planted in the U.S, a future "breakdown" of resistance in blight-resistant chestnut trees is possible. To minimize this

possibility, our breeding program uses genetic material from different Chinese and Japanese trees, each creating a potential new source of resistance.

Trees are tested for blight resistance by actually taking the blight, putting it in the trees, and then seeing how the trees resist the infection. Trees that fight well are then usually control-pollinated by volunteers and resulting progeny are subsequently planted in Chapter orchards with volunteer growers.

TACF relies on its core of citizen scientists to accomplish many of the breeding activities, and business partners to donate bucket trucks during pollination season. In Pennsylvania, volunteers maintain more than 150 orchards and have planted over 30,000 trees. There are over 975 members dispersed throughout Pennsylvania who have combined to log about 10,000 hours of volunteer time per year!

To find out more about how you can help, visit http://www.patacf.org or call the Penn State office at 814-863-7192.