TACF External Talking Points

Two-Sentence Mission Description:

"Using the latest biotechnology and plant breeding techniques, The American Chestnut Foundation and its partners are rescuing an economically and ecologically significant keystone tree species on the road to extinction from a lethal pathogen. Through the leading edge of conservation science, we hope our new discoveries will ensure other imperiled tree species can be saved from disease, creating more diverse and productive forest ecosystems."

About the Organization (boilerplate messaging)

What is The American Chestnut Foundation (TACF)?

We are a nonprofit conservation, education and scientific organization with one of the most ambitious rescue missions in the natural world--to save a beloved tree species in North America from extinction. Founded in 1983 and based in Asheville, NC, TACF and its 16 state chapters are working to restore the American chestnut tree to eastern forests. We employ breeding, biocontrol and biotechnology to develop a blight-resistant American chestnut tree in order to save the species and return it to its native range which stretches from Maine to Alabama. We are supported by private individuals and family foundations, and the majority of our work is done by thousands of dedicated citizen scientists and partners.

About Chestnut Restoration (general)

What is the current situation with the American chestnut trees?

Chestnut blight, a fungal disease from Asia, entered the US in the early 20th century. Since that time, it has decimated the species, leaving it functionally extinct - meaning it can't sustain itself in the wild and no longer provides its vital ecological services. And because sexual reproduction in the species is limited, the current population of American chestnut trees are unlikely to evolve resistance to this disease on their own.

Why should people care about saving the American chestnut tree when there are so many other tree species (including other chestnuts) still thriving?

The American chestnut has a remarkable place in American history, and holds tremendous promise for the future. This keystone species was a vital component of the Appalachian Mountain ecosystem, economy and landscape. It is suited to grow on scarified land that had been abandoned after surface mining. And because of its size, rapid growth, long life and decay resistance, when we return the American chestnut to its native range, it will contribute substantially to carbon sequestration and play a major role in combating the threat of global climate change we are facing today. Looking into the future, the methodologies employed for restoration of the American chestnut can provide a template for the rescue of other threatened tree species.

How is TACF restoring the American chestnut (what is the 3BUR method)?
TACF takes a holistic approach, utilizing a three-pronged research strategy known as the 3BUR method (Breeding, Biocontrol, and Biotechnology United for Restoration). These research tracks are meant to be integrated through collaborations that are mutually beneficial, so we can explore all avenues to reach the common goal of saving and restoring the American chestnut as quickly as possible. The three tracks are as follows:

- **Breeding –** This program crosses Asian species of chestnut trees, naturally resistant to the blight, with American chestnut trees. The traditional breeding program was built upon research which suggested that blight resistance was a relatively simple trait controlled by only 2-3 genes. Through decades of backcrossing and, now, integration of genomic analysis, we have learned that blight resistance is a complex trait that is controlled by many genes. As a consequence, backcrossing to American chestnut has partially diluted blight resistance. In the last 10 years, we have planted over 35 restoration trials to determine if the intermediate blight resistance of backcross trees is sufficient for trees to survive, compete, and reproduce in eastern forests. To improve blight resistance in the traditional breeding program, we plan on conducting additional generations of breeding and selection for blight resistance. We may also breed a subset of backcross trees with transgenic trees to improve blight resistance pending federal approval. The long-term blight resistance of transgenic trees in forest conditions is not currently known. Therefore, TACF is committed to continuing traditional breeding approaches that are informed by genomics separately from breeding with transgenic trees.
- **Biocontrol –** The primary biological control method being explored by TACF and its partners is called hypovirulence. This is the term used for the infection of the chestnut blight fungus by a virus, thereby weakening the fungus and reducing its ability to cause lethal infections. Using this method, the natural defenses of the chestnut tree may enable it to halt canker growth. Other fungi and bacteria are being investigated which may play additional roles in reducing the effect of the chestnut blight fungus on American chestnut trees. This method is deployed in Europe on European chestnut trees; however, hypovirulence is proving to be more difficult in North America due to greater genetic diversity in the blight fungus populations, which hinders virus transmission. Scientists at the University of Maryland developed 'super-donor' strains of the blight fungus that is capable of transmitting viruses to the diverse population of the blight fungus in North America. These super donor strains are currently being tested for their efficacy in controlling blight infection.
- **Biotechnology –** Scientists from SUNY College of Environmental Science and Forestry (ESF) have found that inserting a gene called oxalate oxidase (OxO) from wheat into the genome of American chestnut significantly enhances the blight tolerance of American chestnut. This tolerance comes from a single gene, which means that the trees are 99.9999% American chestnuts. We are conducting extensive research to ensure the safety and viability of this approach. This will simplify breeding efforts and enable us to rescue more of the native genetic diversity from American chestnut by way of crossing trees containing OxO gene with a diverse population of wild trees. Approximately 50% of the progeny from these crosses will inherit the blight tolerance enhancing OxO gene.

- OxO detoxifies oxalic acid produced by the blight fungus, which is a primary cause of the tree's death. The blight fungus still survives on OxO-containing American chestnuts, but resulting cankers are typically much smaller. This can be called "tolerance" instead of "resistance" because the tree is not repelling or killing the fungus but rather reducing damage from the acid while allowing both organisms to survive.

What research is being conducted now?

- **Climate adaptations:** Research is being conducted to understand how the tree is adapted to climate throughout its native range. This includes how the chestnut was adapted to historical climate when the blight occurred, and its potential response to future climate change scenarios. Research will help predict where the tree will be best adapted and this data will guide general restoration plans and an assisted migration strategy that will help optimize plantings of genetically-diverse chestnuts in appropriate environments. Chestnut, as a species, may also help mitigate the climate crisis as its long life and rot resistance could sequester large amounts of carbon.
- **Blight tolerance genes from other chestnut species:** Researchers have found that the blight resistance in Asian chestnut species is not a simple trait (controlled by a few genes), but is more complicated than originally thought. With new technological advancements, researchers are sequencing the genomes of American and Chinese chestnut to discover the genes that confer blight resistance to Chinese chestnut. Once these genes are discovered, they can be used separately or stacked with the OxO gene through traditional breeding or genetic engineering to enhance resistance further and may provide a more durable resistance.
- **Phytophthora root rot resistance**: A separate disease called Phytophthora root rot (PRR) has been a threat to American chestnuts for more than 150 years. TACF is partnering with the U.S Forest Service to screen and select individual hybrid trees that inherited resistance to PRR from Chinese chestnut. We are also working to identify the individual genes that enhance PRR resistance in Asian chestnut species. Once identified, these genes can be stacked with blight resistance through breeding, biotechnology, or a combination of techniques.

About Transgenic Trees

Has there ever been a successful restoration of another plant/tree species through transgenics?

No, there has not been a successful restoration of plant/tree species using transgenics because the technology was not available until now - the chestnut will likely be the first success story! Environmental researchers at SUNY-ESF and elsewhere are exploring possibilities for biotechnology to be used in other tree restoration applications, but research on these species is not as far along as the work on American chestnut. The American chestnut will be the first demonstration of how this technology can be safely and successfully integrated with more traditional methods and can provide a model to help rescue other threatened tree species.

Are there unknown risks involved with introducing transgenic trees into the wild, where they will be for hundreds of years? Could there be lasting negative impact/damage to the ecosystem?

There are unknown risks in every human endeavor. The risks for this program are no greater than those from many of the traditional methods being used, and we are carefully studying the various impacts of each of our research studies, including the impact of introducing transgenic trees into the wild. The oxalate oxidase (OxO) gene in particular is especially unlikely to have any negative impacts, since it is found in a wide variety of both wild and cultivated plants, including rice, wheat and banana. Even so, scientists at SUNY-ESF, TACF, and elsewhere are conducting dozens of experiments to observe interactions with other organisms to ensure there will be no adverse effects on the environment. Details about the safety tests performed thus far at SUNY-ESF can be found here: https://www.esf.edu/chestnut/poster.htm

We know for certain that doing nothing has the greatest risk and will result in the extinction of this species. We are currently in a climate crisis, and recent research has even shown that plant species are going extinct at a rate 500 times faster than naturally expected.

How are U.S. regulators (i.e. USDA, FDA, EPA) addressing the introduction of transgenic trees into the wild?

The USDA, EPA, and FDA will rigorously evaluate data on the trees, along with potential health and environmental effects, before the trees can be distributed or widely planted outside of permitted test plots. We believe that governmental approval can be obtained within the next three years.

- The USDA Animal and Plant Health Inspection Service (APHIS) oversees all outdoor plantings of transgenic chestnuts under permits, and they also will review a petition for "nonregulated status" of these trees (expected formal submission by fall 2019). The USDA's review process includes two open comment periods, where the public has a chance to provide feedback to the agency.

- The FDA has jurisdiction over human food and animal feed so we will submit information for the regulators to evaluate including data on nutritional composition of American chestnuts and other issues relevant to food & feed safety. The OxO gene is in foods that have been consumed by people for eons, and it is present in many foods that do not cause allergies.

- The EPA regulates pesticides and is currently considering whether or not this falls under their jurisdiction. With some transgenic plants like corn that contains insecticidal biotech proteins, it is clear that these plants incorporate pesticidal mechanisms, and should be subjected to EPA review. However, the transgenic chestnut with OxO does not kill or repel any pests, rather it protects the tree from damage caused by oxalic acid produced by the fungus. We are providing the EPA with research data demonstrating that the OxO gene allows the blight fungus to co-exist with American chestnut.

Is this process (transgenics) safe?
We are firmly committed to the safety of people and wildlife that interact with these genetically rescued chestnuts, and with the integrity of their surrounding environment. No trees will be released if there is any indication of increased risks. Tests to date on transgenic American chestnuts have not shown any safety concerns or elevated risks to people, animals, or the environment: In fact, some tests have shown that transgenic plants carry fewer risks or changes than traditional breeding.

What future implications will this have, if it is successful?
If successful, the American chestnut will be restored to the forest, and will continue to survive and thrive within its original ecosystem. The research behind these genetically rescued trees will serve as an example of what can be done with technology to save other endangered species in the future, while retaining 100% of their original genes.