FALL 2017 ~ ISSUE 3 VOL. 31

Chestnut

THE JOURNAL OF THE AMERICAN CHESTNUT FOUNDATION

A BENEFIT TO MEMBERS

THE AMERICAN CHESTNUT FOUNDATION®

2017-2027 Strategic Plan ~ Plant-a-Tree at Flight 93 ~ Carter Center Dedication ~ Genomic Selection

FALL 2017 ~ ISSUE 3 VOL. 31

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THE JOURNAL OF THE AMERICAN CHESTNUT FOUNDATION

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A BENEFIT TO MEMBERS

THE AMERICAN CHESTNUT FOUNDATION®

CHARITY NAVIGATOR
★★★★
Four Star Charity

Lisa Thomson

President and CEO

DEAR CHESTNUT ENTHUSIASTS,

Greetings from Asheville, where solar eclipse fever has come and gone. Many of us rejoiced in observing something otherworldly, which happens often once in a lifetime.

What does a solar eclipse have to do with chestnuts? It helps us frame time and space. Without the energy of our closest star, we would have no life on Earth and the amazing web of biodiversity unique to our planet. Throughout the millennia of the Earth's existence, ecosystems developed, species evolved, and sadly, many became extinct, some due to human intervention.

We are facing some of the most challenging conservation problems ever. The future health of our planet depends on focused, strategic goals and collaborative efforts by scientists, conservation groups, government agencies, thoughtful leaders and citizenry. The mission of The American Chestnut Foundation may seem like a microcosm to these enormous challenges. However, it is an optimistic, deliberate, and concentrated effort, fueled by volunteerism, partner organizations and private philanthropy, to reach an ambitious reforestation goal many of us may not live to see. And our work leverages activism and discoveries.

Because the horizon of our success is a long one, we developed our first ten-year Strategic Plan. We chose to address a decade of work with the caveat that this plan will be annually reviewed and have an accompanying implementation plan to ensure it holds us accountable for our actions. The plan starts on page 3 and I hope you enjoy reading it. As always, we welcome feedback.

We look to our Strategic Plan as a guide for the future. We know the future is sometimes uncertain, so course corrections are anticipated and reflective in our organizational values: optimism, patience, science-based decisions, innovation, integrity, and collaboration.

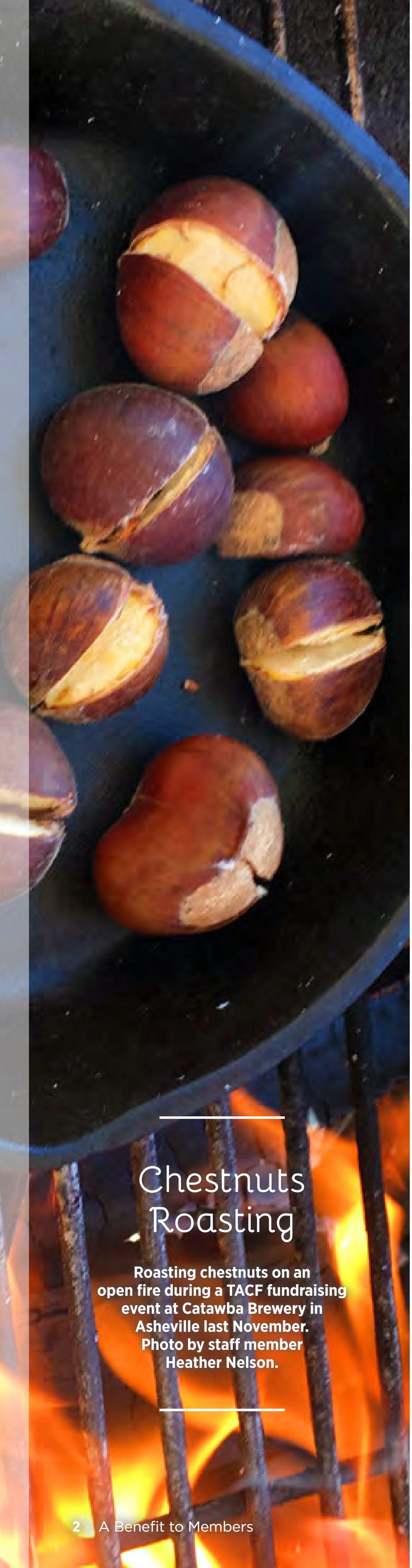
I am humbled and inspired by the dedication of all the hard working members of the TACF community and look forward to serving you and the mission for years to come. Think of where we will be with large scale restoration when the next Great American Eclipse returns in 2024!

With gratitude,

Lisa Thomson

Lisa Thomson, President and CEO
The American Chestnut Foundation

Follow me on Twitter (@MadameChestnut).



Chestnuts Roasting

Roasting chestnuts on an open fire during a TACF fundraising event at Catawba Brewery in Asheville last November. Photo by staff member Heather Nelson.

THE
AMERICAN
CHESTNUT
FOUNDATION®

WHAT WE DO

The mission of The American Chestnut Foundation is to return the iconic American chestnut to its native range.

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2017–2027 Strategic Plan

It is a testament to the deep engagement of our volunteers, that members of TACF's board of directors and chapter and committee leadership were the lead authors of the plan, and they are acknowledged on page 9. The 18-month process required draft after draft of written priorities to refine our messages and goals; lively debate and conversation in 16 virtual conference calls; and outside final review from key stakeholders to ensure our language and goals resonated with external audiences. To better reflect where the organization is today, we revised the mission statement, and, for the first time, developed a vision statement. You will see these statements on all of our print materials and online presence going forward. The overall plan and our new vision and mission statements were approved at our April board meeting.

Plans should not sit on shelves, but instead drive activities for the greater good and, ultimately, mission success. To view an online version of the plan in its entirety, visit this page on TACF's website: www.acf.org/about-us/ and click on the 2017-2027 Strategic Plan button below the mission statement.

OUR VISION is a robust eastern forest restored to its splendor.
OUR MISSION is to return the iconic American chestnut to its native range.

Why the American Chestnut?

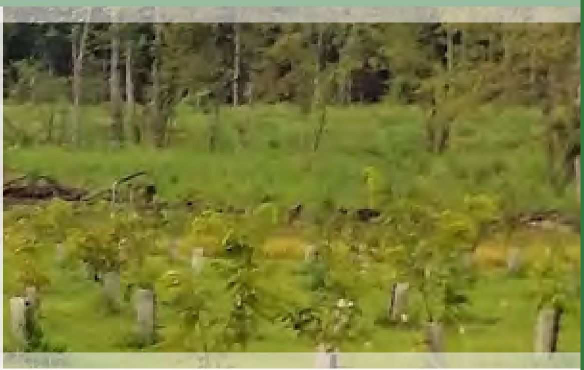
When Europeans arrived in eastern North America, they found a seemingly inexhaustible treasure in our land and its forests and wildlife. Since then, the primeval majesty of that landscape has been compromised, with many of its key forest species now in severe decline. There is no more suitable metaphor for that lost Eden than the distinctive American chestnut tree that was destroyed by an imported fungal blight early in the last century. The loss of this tree was catastrophic. With its demise, a dominant feature of the earlier forest was gone. And now there are few people alive who remember the living tree. Thankfully, an ambitious effort to preserve the original character of the American forest is underway through the rescue of the American chestnut tree, the energetic anchor in a range so vast it stretched from Maine through Mississippi.

As its name implies, our country's chestnut tree was uniquely American, playing a central role in the ecology, economy, and culture of Appalachia and adjoining regions. A dominant species and competitive in multiple environments, it sometimes reached enormous sizes. Because of its rot resistance, chestnut barns and homes have endured for decades. Its use for tannin supported an entire industry. Its wild-collected nuts, sold and distributed into big-city markets, were an important cash crop in rural areas. Since the demise of the American chestnut also spanned the Great Depression, the loss of this invaluable food resource, with its nutritious nuts for humans and wildlife alike, was a particularly devastating tragedy.

Just as the tree's history and the stories that surround it are remarkable, so is its future. Unlike many other species, the chestnut tree is able to grow on an estimated one million acres of scarified land that has been abandoned after surface mining. Because of its size, rapid growth, long life, and decay resistance, if the chestnut were returned to its former ecological role it could contribute substantially to carbon sequestration. The food available to humans and wildlife from a mature American chestnut tree is 3 to 5 times more abundant, and much more nutritious, as that from oak trees of a comparable size. When restored, its prolific nut production may help take wildlife pressure off existing crops. The restoration of this American icon is a key to restoration of the ecosystem of our temperate forests, long-term sustainability, the struggle against global climate change, and an enhanced quality of life along its range.

The chestnut is a paradigm for the hope that exists for all threatened species. The American Chestnut Foundation (TACF) has played the lead role in rescuing the American chestnut through its innovative breeding and genetics research for more than three decades. Our long-term goal is for nature to take over and create self-sustaining populations, with blight-resistant trees growing stronger with each succeeding generation. More than just preventing environmental destruction, TACF is restoring a natural legacy for our grandchildren. And, perhaps that gift will propel them to become stewards of a better world.

Michael Doochin, Chair, Board of Directors



Why Strategic Planning?

The key strengths of The American Chestnut Foundation lie in the diversity and passion of its vast constituency – its chapters, volunteers, board members, donors and research partners. Its mission was built on the groundbreaking work of our founders in a bold and courageous effort to bring back a functionally extinct species, with no guaranteed outcome. Yet the hope of restoring this iconic tree has kept us hard at work. Its staff and volunteers have planted, hand-pollinated, and inoculated tens of thousands of chestnuts in more than 500 breeding orchards on public and private land.

We deeply appreciate this decades-long progress in the breeding programs, and are grateful that new scientific developments will radically accelerate our work. With genetic mapping, we will identify markers for blight resistance and improve the accuracy with which superior trees are forwarded for further field-testing. The State University of New York, College of Environmental Science and Forestry program's research, supported by its state chapter to produce blight-resistant transgenic trees, is also yielding promising results. This transgenic tree is expected to be available in a matter of a few years, pending regulatory registration. Advances in restoration ecology and other genomic engineering developments will build on and complement this work as we seek to reintroduce American chestnut trees to the forest. TACF welcomes an increasingly integrated approach, with the best available scientific and research innovations, to ensure mission success.

This strategic plan is designed to focus efforts on that integration. It will be a living document, with a strong implementation in four areas: Science and Technology, Restoration, Promotion and Outreach, and Organizational Advancement. It will help us make more informed decisions and set clear priorities for future work. With an ambitious 10-year timeframe, we will adjust our strategies as new technologies emerge.

We hope you will join with us to embrace these advancements through collaborative and philanthropic efforts aimed at restoring the American chestnut. The following goals and strategies will be adapted in light of what we learn, what financial resources we have available, and the unique talents and interests of our collective human resources. We look forward to sharing this exciting journey with you.

Lisa Thomson

Lisa Thomson, President and CEO

Science & Technology

Successful restoration of the American chestnut across its former range requires the development of a population of genetically diverse American chestnuts that are resistant to at least two imported pathogens, *Cryphonectria parasitica* (chestnut blight) and *Phytophthora cinnamoni* (ink or root rot disease). While TACF is encouraged by the progress of its traditional backcross breeding program, and the large-scale volunteer engagement it created, it is committed to incorporating the rapidly advancing knowledge and capabilities of the biological sciences and the techniques of modern biotechnology to achieve this goal. To ensure that TACF's science programs are aligned with its goals and mission, TACF regularly evaluates it programs internally, and also periodically conducts comprehensive external peer reviews.

Since its inception, TACF has pursued several different major paths to restore the American chestnut (Roadmap Pages 10-11.) These have included the backcross breeding program, biotechnology, and hypovirulence.

The backcross breeding program uses traditional plant breeding techniques to move genes for pathogen resistance from resistant chestnut species into American chestnuts. It has been implemented by TACF at its research farm in Meadowview, VA, and at orchards planted by sixteen different state chapters. The backcross breeding program is focused on identifying both blight and root rot resistance, and incorporates genome mapping and marker assisted selection to further refine and identify its most disease resistant trees suitable for large-scale restoration.

The biotechnology program has developed under the auspices of the State University of New York, College of Environmental Science and Forestry (SUNY-ESF) and the New York Chapter of TACF. In this program, individual genes are tested for their ability to enhance pathogen resistance in American chestnut using the tools of genetic engineering and molecular biology. Through this search, a gene has been found and incorporated into American chestnut that enhances blight resistance significantly.

Hypovirulence is a persistent viral infection of the blight fungus that reduces its virulence, and has resulted in the biological control of chestnut blight in several regions of the world. Hypovirulence and future biological controls may best be used when combined with the increased resistance afforded by the breeding and biotechnology advances.

These programs are now reaching such a point of maturation that TACF is integrating them to shorten the time to achieve a population of trees of regeneration with the form and function of the original American chestnut for restoration.

Restoration

Restoration will be accomplished when the American chestnut can continuously and sustainably evolve in the wild to reassume its former ecological role. TACF's goal is to reestablish the American chestnut's function in its native range.

The work-to-date (science and technology) will eventually progress into broad-scale production and ultimately natural regeneration. Our goal is to create viable plantings of trees that can spread naturally or with human help, each with the genetic variability necessary for long-term success under natural selection. This section sets goals and strategies explaining how the existing resources will be used in preparation for seedling and nut production at the level our developed science and proven silvicultural practices allow. Restoration will involve increasing seedling and nut production at a large scale and will be a broadly cooperative venture. Partnerships are necessary across a variety of public and private entities, in full cooperation and coordination with the existing strong chapter, volunteer, and donor base.

Promotion & Outreach

The promotion and outreach strategy is a comprehensive approach to develop TACF into a more externally focused organization in which fundraising and marketing are core functions. It will catapult TACF to become an organization with the scale and strategy required for success. Efficient outreach to current and future donors, increased social media presence, and the maturation of the education program will complement and promote efforts and achievements in science and restoration.

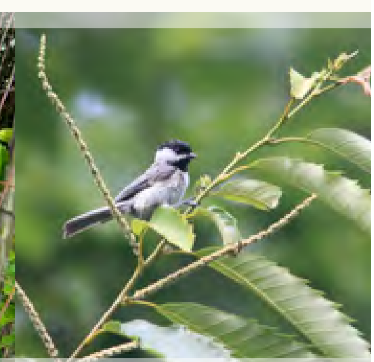
The product of our work, disease-resistant American chestnut populations, anticipates new technological advances that will require consistent funding in order to maintain pace with those innovations. We must move quickly to identify and cultivate our current donors, future prospects, and key stakeholders who are committed and invested in the restoration of this species and reach out to those audiences who may not know the compelling story of its comeback. These audiences include younger generations who will be reached by targeted educational leaders, social media platforms, and outreach to the public to ensure continued success.

Organizational Advancement

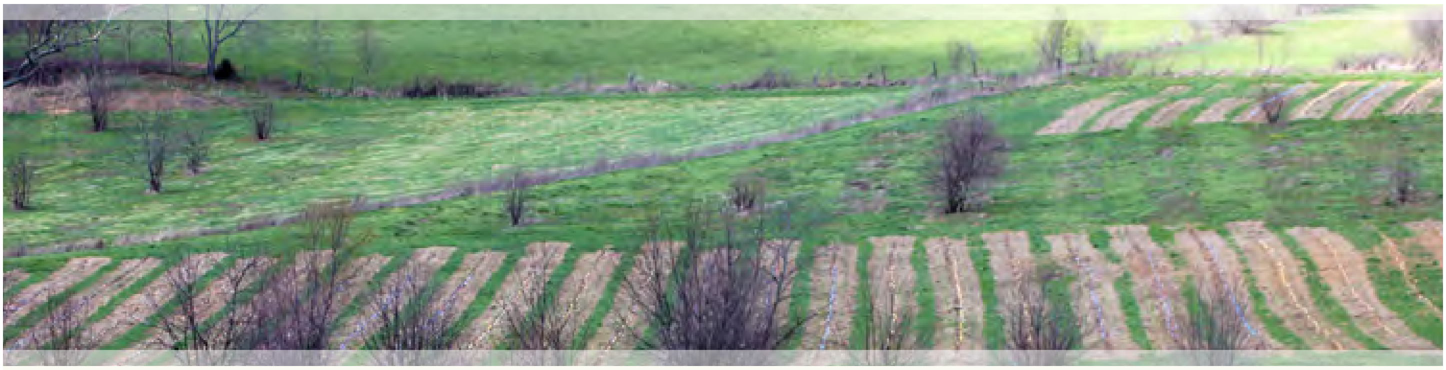
The effectiveness of an organization is based on how well its parts function individually and as an integrated unit. The American Chestnut Foundation is a strong, multi-faceted non-profit organization comprising a board of directors and committees, professional and scientific staff, volunteers, members, partners, and donors. These organizational constituents and ambassadors depend on each other for clear and consistent communication, sharing of resources and technology, and building from existing and future collaborative efforts toward a shared mission and vision. TACF is committed to advancing the efficient and effective function of each of these entities, individually and collectively, and to the overall advancement of the Foundation as a whole. TACF also recognizes that its current structure may require reorganization as the Foundation grows and evolves.

TACF's National office will work with chapters in a collaborative process to streamline administrative operations, and to develop an action plan for the existing chapter-sponsored orchards. Along with the board and its working committees, we will ensure consistency of messages and communication across chapter and regional boundaries. This coordination will enhance the effectiveness of TACF and prepare all entities for the challenging work ahead.







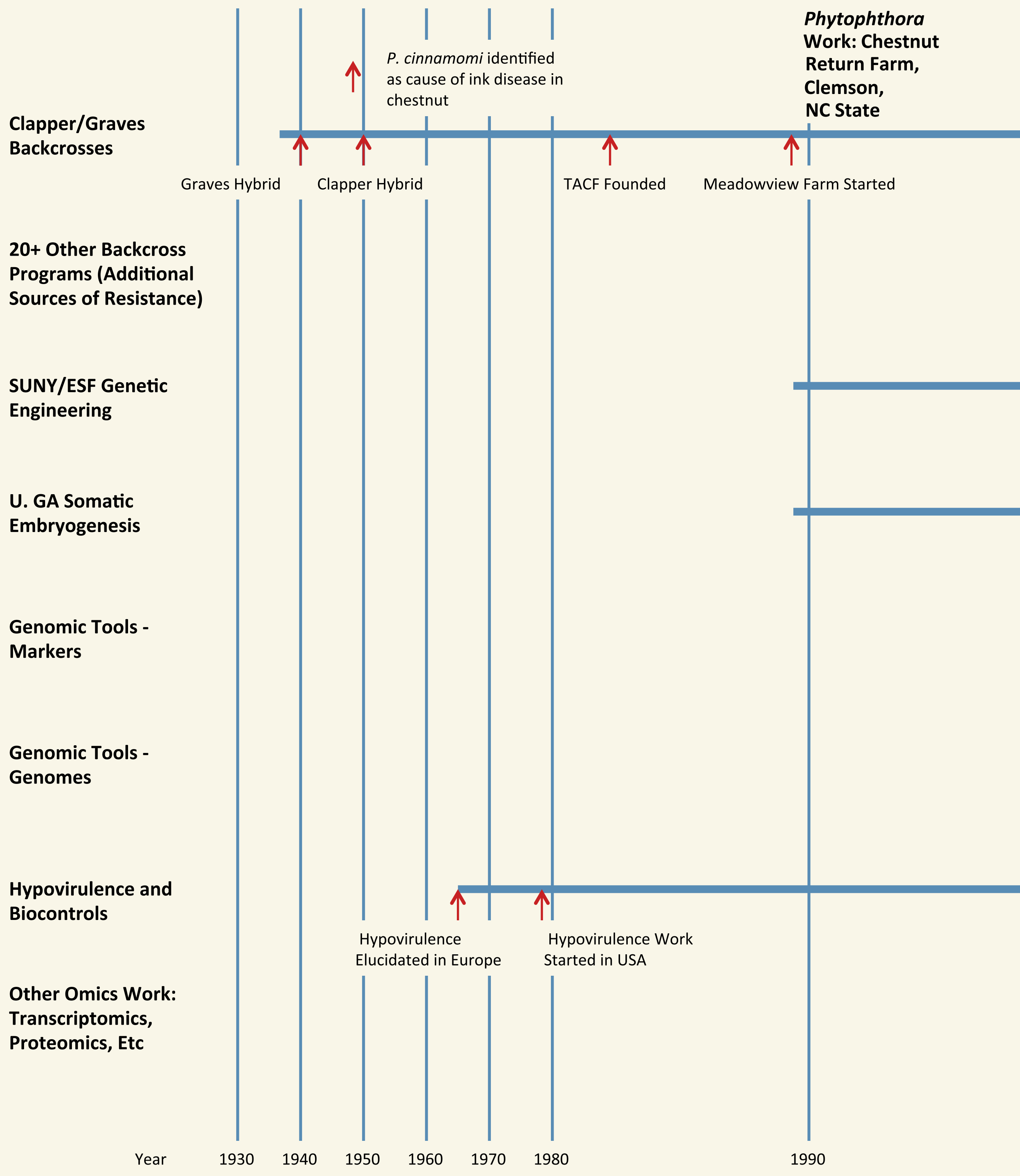
Acknowledgements & Timeline

The American Chestnut Foundation was profoundly shaped in the development of this strategic plan. The process invited important dialogue, honest assessment, and significant points of disagreement and convergence. The result is a refreshed clarity of focus and a working document to be assessed annually for accountability and future program guidance.

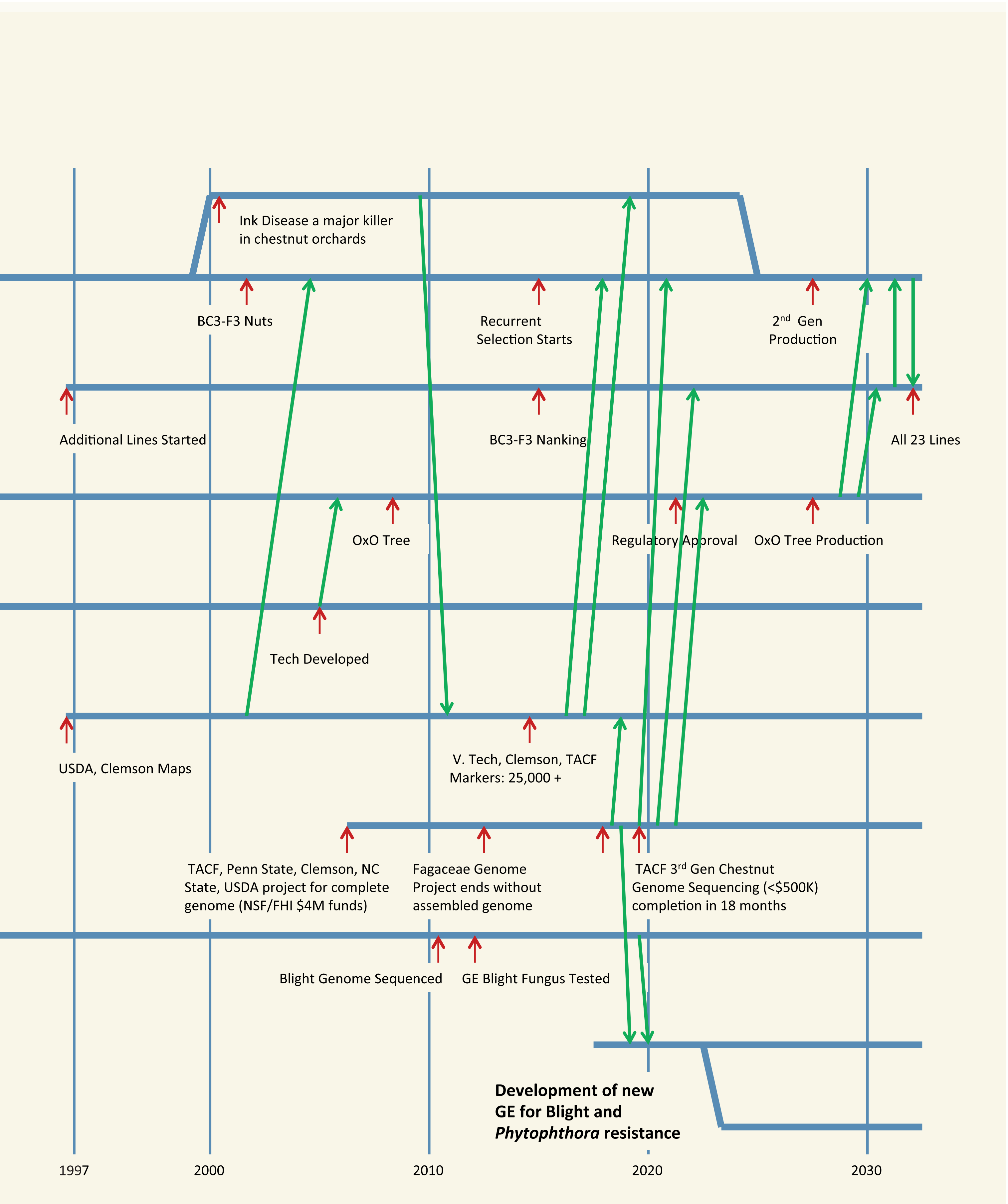
In the fall of 2015, a "Tiger Team" led by Penny Firth helped design the overall structure of the plan in a strategic framework. That team surveyed TACF's board, staff, and committee members, Chapter presidents, and emeritus/honorary members to assess the strengths, weaknesses, opportunities and threats facing TACF, and sought input into the vision and mission of TACF going forward.

The process continued in February 2016 with the commission of a strategic planning team comprised of active TACF members with diverse skills, interests, and experiences. This team, led by board member Lewis Lobdell and facilitated by Nancy Walters, an independent consultant, contributed countless hours in the exploration of TACF's past, present, and future. Team members included Steve Barilovits, Jay Cude, Michael Doochin, Penny Firth, Sara Fitzsimmons, Lynn Garrison, Lewis Lobdell, Kim Steiner, Lisa Thomson, and Barb Tormoehlen. Bill MacDonald, Cathy Mayes, Brian McCarthy, Jay Mills, Allen Nichols, and Don Willeke were consulted periodically to engage in specific topics and to review drafts. The plan was thoroughly discussed and revised by members of TACF's board at various intervals and approved in April 2017. We are grateful for the deep engagement and hard work of the talented individuals who contributed to this plan so the critical mission of the Foundation will flourish in years to come.

Science & Technology Roadmap



*Created by TACF Treasurer and board member Steve Barilovits



Ink Disease a major killer in chestnut orchards
BC3-F3 Nuts
Recurrent Selection Starts
2nd Gen Production
Additional Lines Started
BC3-F3 Nanking
All 23 Lines
OxO Tree
Regulatory Approval
OxO Tree Production
Tech Developed
USDA, Clemson Maps
V. Tech, Clemson, TACF Markers: 25,000 +
TACF, Penn State, Clemson, NC State, USDA project for complete genome (NSF/FHI $4M funds)
Fagaceae Genome Project ends without assembled genome
TACF 3rd Gen Chestnut Genome Sequencing (<$500K) completion in 18 months
Blight Genome Sequenced
GE Blight Fungus Tested
Development of new GE for Blight and Phytophthora resistance
1997
2000
2010
2020
2030

Carolina Native Nursery

HELPS TACF GROW POTENTIALLY BLIGHT-RESISTANT CHESTNUT

Bill Jones inspects potentially blight-resistant chestnuts growing at his Carolina Native Nursery in Burnsville, NC.

TACF National Office has recently teamed up with Carolina Native Nursery, one of North Carolina's most successful native plant growers, to help raise potentially blight-resistant chestnuts for development and demonstration purposes. Carolina Native Nursery is located in Burnsville, north of Asheville. At approximately 2,600 feet, the nursery sits at the base of the highest mountains in the eastern U.S. They sell plants all over the east coast and have material planted in high-profile locations, such as the Biltmore Estate, the Mall in D.C., and New York's Central Park.

TACF connected with Carolina Native Nursery through Samantha Bowers, TACF grants manager, who got to know Bill Jones, Carolina Native's owner, when they both served on the board of a local non-profit. Jones' nursery is certified by the North Carolina Department of Agriculture and grows native (indigenous) shrubs and woody species but has also branched out into perennials, grasses and ferns. Now in its 14th year of business, Carolina Native sells close to 200 varieties of flowering trees and shrubs.

When approached by TACF, Bill eagerly accepted the challenge of helping us grow attractive containerized chestnut trees for development and outreach opportunities on a pro-bono basis. Carolina Native supports TACF's efforts to develop a blight-resistant chestnut among its many commitments to the local community and the environment. In addition to his work with TACF, Jones and his staff members have served on several municipal tree commissions and the board of a local land trust and supports a number of local organizations, such as Asheville GreenWorks. Bill has also contributed critical expertise and advise in the planning and building of green- and shadehouse facilities at Meadowview. Through the contribution of time, energy, and resources, Bill and Carolina Native Nursery will continue their relationship with TACF, helping to eventually restore American chestnuts to the eastern forest.

PART 1
of a 4-part Series

Preserving Genetic Diversity in Maine

By Thomas Klak, Gene Conservation Committee Chair, TACF Maine Chapter and Professor, Department of Environmental Studies, University of New England; Biddeford, Maine

The American Chestnut Foundation's 2017-2027 Strategic Plan encouraged state chapters to create Germplasm Conservation Orchards (GCOs) planted with seedlings from wild and local pure American chestnuts. The aim is to capture and preserve American chestnut genetic diversity in easily-accessible orchards. While some state chapters, particularly Pennsylvania and New York, have been long-term GCO leaders, and others such as Maine are GCO newbies.

Beginning in the summer of 2016, the Maine chapter responded to the national call by consulting the TACF database (a/k/a *dentatabase*) and searching the state for accessible wild trees bearing catkins and then burs. Chapter volunteers returned to some of these fertile trees in October to gather seeds (before all were eagerly taken by wildlife!). They separated seeds from burs, and then cold moist stratified them in peat moss in refrigerators until February. During the winter dormancy season, chapter directors sought out suitable landowner partners and sites for GCOs across Maine. Next, ecology students at the University of Maine-Orono, Unity College and the University of New England sowed the seeds and then tended to the seedlings in pots in their respective campus greenhouses. From late May through July, teams of chapter directors, interns and members planted the seedlings and created GCOs at four distinct locations. Limited rainfall created a need for frequent watering throughout the summer.

Each of Maine's four GCOs has its own interesting story of partnerships and geographical context. The magazine will therefore feature these orchards in a four-part series. The first one (pages 14-16), is an orchard sited in Dover-Foxcroft, at the far northern end of the American chestnut's native range. It is managed by a dedicated and enthusiastic team from the Piscataquis County Soil and Water Conservation District. Enjoy!

Trees for Seeds in Maine

AMERICAN CHESTNUT GERMPLASM CONSERVATION ORCHARDS PRESERVE GENETICS FOR RESEARCH AND BREEDING

By Joanna Tarrazi, Piscataquis County Soil and Water Conservation District executive director

Deep in a field in Dover-Foxcroft, Maine, the Piscataquis County Soil and Water Conservation District (PCSWCD) partnered with scientists from the Maine Chapter of The American Chestnut Foundation (TACF), the University of Maine and the University of New England (UNE) to plant a new Chestnut Germplasm Conservation Orchard (GCO) on public land called the Law Farm. This GCO is one of four planted in the State of Maine in 2017 with seedlings grown by the University of New England's Ecological Restoration class. It is a perfect place to trial American chestnuts, as this area of Maine is located on the northern edge of where chestnuts grew before becoming almost wiped out by blight in the early 1900s. In this region, there are still several large American chestnut trees, indicating they were buffered from blight, perhaps by being somewhat isolated from other chestnuts.

Foxcroft Academy students work with PCSWCD technical coordinator Lynn Lubas to carry mulch to the American chestnut seedlings.

The other newly planted GCOs are in Blue Hill, Maine on Long Island, in Georgetown on University of Maine land, and at Wild Meadow Farm in Saco, owned by Jim Rough and Anne Hallward. Wild Meadow Farm has similar growing conditions as the Law Farm orchard, although the latter is about 140 miles further north. Other differences include elevation – the Saco orchard is only 85 feet above sea level and the Law Farm site is at about 365 feet in elevation. The Law Farm is located in the USDA Plant hardiness Zone 4b, indicating minimum winter temperatures between 20 to 25 degrees below zero whereas the Wild Meadow Farm site is in zone 5a with minimum temperatures of 15 to 20 degrees below zero. The Law Farm has Penquis Plaisted soils, which are good for agriculture. Wild Meadow Farm has Lyman loam soils that developed in a thin mantle of glacial till. These comparison orchards will enable researchers to see how geographical differences between sites effects chestnut growth and health.

Dr. Thomas Klak, Maine TACF gene conservation committee chair, proudly displays the root development on this American chestnut seedling. These seedlings were grown in a greenhouse at the University of New England by Klak's Ecological Restoration students.

Seedlings from more than a dozen wild, pure American chestnut source trees were planted in the four GCOs across Maine. Seedlings include several sources from southern states in addition to Maine, New Hampshire and Vermont. As Brian Roth, Maine TACF science and data coordinator noted, "The lineage of the seedlings is matrilineally traced but not paternally, as these seedlings come from open-pollinated trees."

These trees will grow about one foot in the first year and two feet a year in subsequent years. They will eventually succumb to blight in perhaps 10 to 15 years, but before they do, pure American chestnut seeds can be harvested and used in a variety of ways, such as furthering cutting edge research, selling to the public during the PCSWCD annual Tree and Plant Sale, and harvesting for roasting or other delicious chestnut recipes at PCSWCD community events featuring local foods. The wood can be used for a variety of crafts, much like the chestnuts from yesteryear, which were a vital part of our Maine economy before being mostly eradicated by blight. It is projected that these trees will have a 75 percent survival rate in the next decade.

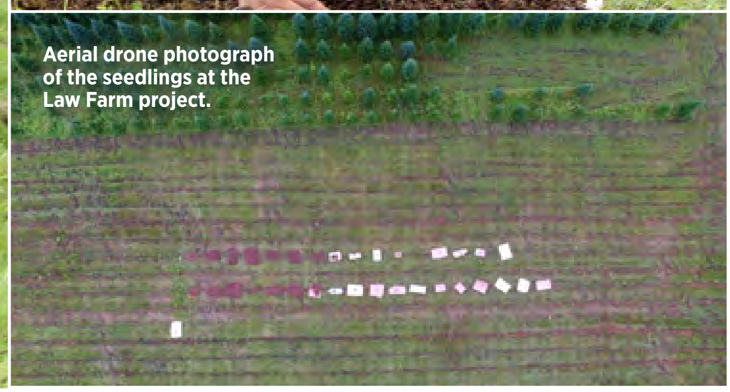
The chestnuts planted at the Law Farm are nestled between Christmas trees from a earlier Kids and Trees program, and hazelnuts that were planted as part of a community forestry initiative through a Project Canopy Grant to the PCSWCD. The seedlings have full field exposure where, compared to woodland settings, there is more sun, more wind, more weeds/grasses to compete with and more opportunity for rodents and deer to try to graze on the seedlings.

The seedlings at both Wild Meadow Farm and the Law Farm are being grown organically, with no pesticides or herbicides. Wild Meadows seedlings have landscape fabric and the Law Farm seedlings have cardboard and wood chip mulch around the base of each seedling to protect them from competing weeds in the field. The orchards are protected by a solar powered electric fence. Aerial drone photography for the Law Farm project is provided by Nelson Cole of New Farmer Films.

Baseline data gathering and on-going monitoring of the Law Farm Germplasm Orchard is being provided by the Foxcroft Academy (FA) science teachers and students. The types of data being collected are growth rates, photosynthesis rates and also data on the trees in their later years that will measure blight and decline. It

Dr. Thomas Klak and EPSCoR intern Ethan Jacobs work together to install the solar-powered electric fence at the Law Farm Chestnut Germplasm Orchard.

Foxcroft Academy student Gabe Williams enjoying his role helping to plant and protect seedlings at the Law Farm's new Chestnut Germplasm Orchard that was planted in July, 2017.



Aerial drone photograph of the seedlings at the Law Farm project.

is a priority of the PCSWCD to engage the FA youth in nature and environmental sciences. They are our future leaders and decision-makers and need to be prepared to make good choices managing natural resources so that these resources are sustainable for future generations.

The PCSWCD was formed over 70 years ago to protect the soil, water, farms and forests of this region and has grown to help steward all of Piscataquis County's natural resources, including 400 acres of public lands it owns and manages. The 108-acre Law Farm, donated to the PCSWCD in 2009, is being developed as an educational, technical training and recreational asset for the Piscataquis County region. The PCSWCD is very much committed to TACF's mission and vision to "return the iconic American chestnut to its native range and to create a robust eastern forest that is restored to its splendor." The American Chestnut Foundation is restoring a species—and in the process, creating a template for restoration of other tree and plant species."

ABOUT TACF MAINE CHAPTER:

TACF's Maine Chapter is focused on protecting, conserving, preserving, and propagating trees from all important remaining native Maine American chestnut populations in the state, and restoring American chestnuts to a place of ecological and economic importance and self-sustainability throughout their original forest range in Maine. This chapter hopes to make blight-resistant American chestnuts available to the people of Maine as soon as possible.

REFERENCES:

USDA Natural Resources Conservation Service Web Soil Survey, 2017

USDA Plant Hardiness Maps, 2017

Photos provided by Piscataquis County Soil and Water Conservation District executive director, Joanna Tarrazi.

Planted in 1902, this is likely the largest, oldest, and tallest American chestnut tree living at the Terverun Arboretum near Brussels. Photo by Jacques Deltenre

AMERICAN CHESTNUT

Trees in Belgium

When the tallest tree in Maine made the news at The American Chestnut Foundation (TACF) in 2015, it was stated that the tallest American chestnut tree in the world was in Belgium.

This past spring, board emeritus member Rufin Van Bossuyt traveled to the Tervuren Arboretum in Belgium and found a grove of Northeast American tree species. In the grove were five or more very large American chestnut trees, along with Sugar maple, Silver maple, Eastern white pine, Canadian hemlock, Black birch and Cucumber magnolia.

In another area, there were very large Pacific Northwest tree species and Redwoods.

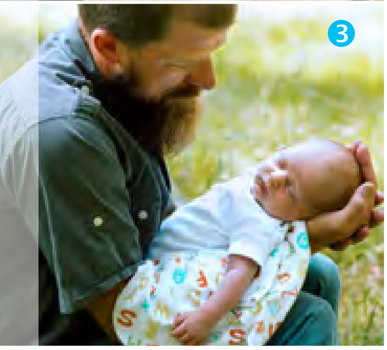
Elsewhere in Belgium, he visited a former convent and saw a large European chestnut that is 11.75 feet in diameter and 60 feet tall. It was planted in 1662.

Van Bossuyt graciously shared his pictures with TACF and we thought our readers would enjoy seeing the variety of large chestnut trees he witnessed during his travels in Belgium.

This large European chestnut is located in Herent, Belgium. Photo by Rudy Sonck

Old bur and leaf compared to new leaf growth, all found at the Terverun Arboretum in an area dedicated to the Appalachian range. Photo by Rena Richard






CHESTNUT BABIES

at The American Chestnut Foundation

In 2017, TACF's regional science coordinators (RSC's) and one staff member have been especially industrious in a different kind of breeding program – producing chestnut babies! New England RSC, Kendra Collins got the ball rolling when she welcomed her daughter, Riona, into the world on March 11. On July 3, Director of Restoration, Sara Fitzsimmons gave birth to her second child, Reid. Shortly after, PA/NJ Orchard Manager, Steve Hoy also had a son, Cooper, on July 17. Not to be outdone, Mid-Atlantic RSC, Tom Saielli welcomed the birth of his third child, Elia Rae, on August 10. Now THAT's a lot of chestnut babies over the course of a few months!

Kendra returned from her maternity leave in early June and Sara will be back October 8. Both Steve and Tom are back to work. As Steve put it, "The grass and insects don't seem to care whether or not you have a newborn!"

TACF congratulates Sara, Kendra, Steve, Tom and their families on the births of these four healthy miracles.

1 **Judging by the smile, Riona loves being held by Mom.**

2 **Sara and family enjoying time together at home.**
Photo credit: Erin McCombie of EGM Photography

3 **Steve gives Cooper an early taste of the great outdoors.**
Photo credit: Red Headed Ninja

4 **Big sister Anna (left) and big brother Owen happily hold their new baby sister, Elia Rae.**

Monthly Giving

MADE EASY

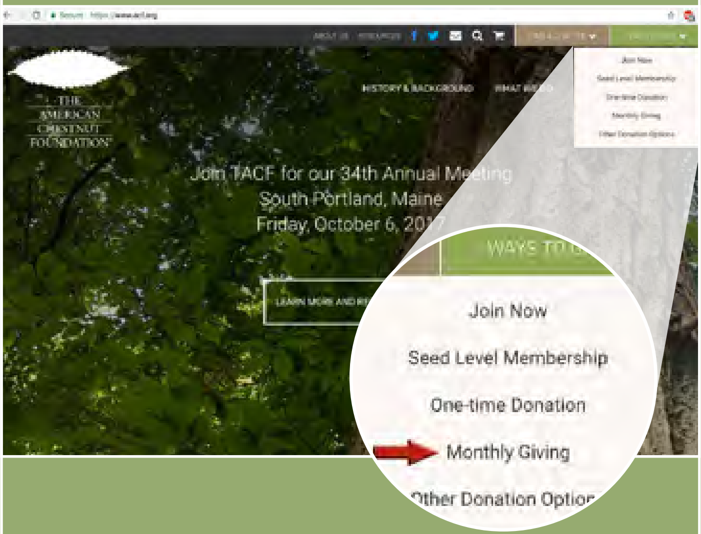
Monthly giving is now available through TACF's website

acf.org,

making it a secure and easy way to give.

Recurring donations sustain TACF's infrastructure, allowing us to focus on our mission to return the iconic American chestnut to its native range.

To make your donation, simply click on "WAYS TO GIVE" in the upper right-hand corner, then on "Monthly Giving." Thank you for making a difference!



THE AMERICAN CHESTNUT FOUNDATION®

Pictured from left to right, TACF Board Member Lewis Lobdell, Kate Lobdell, TACF Forester Michael French, and CEO Lisa Thomson (holding chestnut tree saplings).

FROM COALFIELDS TO CHESTNUTS: Plant-a-Tree AT FLIGHT 93

By Samantha Bowers, TACF Grants Manager

"From coalfields to chestnuts," said NPR contributor Jonna McKone. Over the course of two days (May 19-20, 2017), the National Park Service, Friends of Flight 93, and the National Park Foundation continued a major reforestation effort that will result in large areas of new forest at the Flight 93 National Memorial. These trees, which are a mixture of several native species, will form an essential windbreak to protect trees planted in the nearby Memorial Groves. Much of what is now the memorial is a former surface coal mine and this effort will help re-establish woodland wildlife habitats and cultivate a living memorial. The Plant-a-Tree at Flight 93 annual event is part of a larger effort to reforest former coal mines all across Appalachia.

BY THE NUMBERS

2012: 500+ volunteers planted 14,369 seedlings across 20 acres **2013:** 500+ volunteers planted 17,300 seedlings across 23 acres **2014:** 400+ volunteers planted 20,489 seedlings across 30 acres **2015:** 400+ volunteers planted 22,000 seedlings across 32 acres **2016:** 400+ volunteers planted 15,600 seedlings across 23 acres **2017:** 500+ volunteers planted 11,600 seedlings across 17 acres

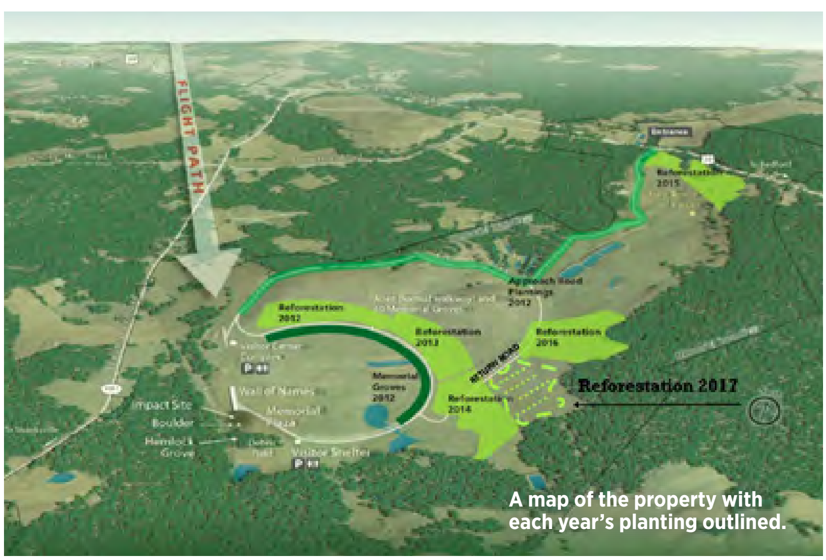
Samantha Bowers during the planting, with the Flight 93 Memorial in the distance.

Found to be a textbook habitat for bluebirds, the USFS installed bluebird boxes this year.

National Park Service Ranger Adam Shaffer. Photo courtesy Green Forests Work

TACF Board Member Lewis Lobdell shared the following after attending this year's event:

"The Flight 93 National Memorial has converted an act of hatred and fear into one of optimism and restoration. The planting introduced me to people from all over the country who annually renew their commitments to loved ones and a positive future. The restoration of American chestnut is a message that the people who come to plant find reassuring and compelling. The enthusiasm each planter gives and receives is a source for the next year's work of forming the future we all want to live in."



A map of the property with each year's planting outlined.

This year, some 500 volunteers came out to plant 11,600 new seedlings among 17 acres. In attendance, TACF staff including President and CEO, Lisa Thomson; Director of Restoration, Sara Fitzsimmons; Forester, Michael French; Grants Manager, Samantha Bowers; and TACF Board Member, Lewis Lobdell and wife Kate Lobdell. Forester Michael French plays a key role in organizing the event. As National Park Service Ranger Adam Shaffer said, "Working with TACF has been a meaningful relationship. I think it is a great story with chestnuts coming back alongside the memorization. I look forward to [TACF Forester] Michael French visiting every year."

By 2020, leaders hope to have 150,000 trees. TACF began supporting these efforts in 2012 with a donation of 75 chestnut seedlings. Funding from the Richard King Mellon Foundation has allowed TACF to greatly increase the number of trees donated to as many as 1,500 seedlings per year. From 2012-2017, over 100,000 seedlings, including more than 6,000 TACF chestnuts, have been planted by volunteers across approximately 145 acres at the Memorial.

About Flight 93 National Memorial

On September 24, 2002, President Bush signed into law the Flight 93 National Memorial Act. The Act created a new national park unit to commemorate the passengers and crew of Flight 93 who, on September 11, 2001, courageously gave their lives thereby thwarting a planned attack on our nation's capital. The memorial is near Shanksville, Pennsylvania, where Flight 93 crashed with the loss of its 40 passengers and crew. For more information visit www.honorflight93.org.

TACF Welcomes

Cherin Marmon-Saxe, Administrative Coordinator

Cherin joined TACF in May 2017 after relocating back to the United States from England, where she lived for 13 years. Her professional career spans more than 30 years, specializing in project management, process improvement, and systems integration across a multitude of countries and markets. Prior to joining TACF, she owned a hotel in the beautiful Northern Lake District of The United Kingdom.

Cherin has a Bachelor of Science degree in Hotel and Restaurant Management with a secondary degree in Human Resources. She joins TACF's family with great enthusiasm to expand her involvement and experience within the non-profit sector.

Ben Jarrett, Southern Regional Science Coordinator

Ben re-joined TACF in July 2017 as the Southern Regional Science Coordinator, after working as a project manager in Madison, Wisconsin for two years. He is an alumnus of TACF, having worked in the past as an intern in the Mid-Atlantic Region from 2014 to 2015.

Ben has a Bachelor of Science degree in Environmental Science from the University of Virginia where he completed his undergraduate thesis project on American chestnut sprouts and their response to fire. He couldn't be happier to hit the ground running in the Southern Region and to be back with TACF.

Rogueing

AT MEADOWVIEW RESEARCH FARMS

By Dan Mckinnon, TACF Seed Orchard Supervisor

The term "rogue," when used as a verb and pertaining to agricultural practices, is the process of removing inferior, unwanted, diseased or non-typical plants from a crop or field. It is also defined as a noun by Merriam-Webster as "a mischievous, dishonest or worthless person," which could also be applied to our process of genomic selection by replacing the word "person" with "tree" – yes, unwanted trees can be mischievous in a breeding orchard! Other terms you might have heard or used in an agricultural setting, such as "culling" or "thinning," are synonymous with the task of rogueing in an orchard but usually pertain to livestock or row crops.

Applied specifically to the field of tree breeding, rogueing provides its intended result as well as many additional benefits to the individual remaining trees and their microenvironment. Some of the unintended benefits include increased airflow and sunlight through the plot, not only reducing fungal growth, but also strengthening the tree's cell walls making them more resistant to environmental damage such as strong wind and the weight of accumulated snow and ice. Removing unneeded trees from a plot also provides more room for the others to grow, allowing more space per tree and more nutrients available to the individuals that remain. The remainder are also less likely to be damaged during plot maintenance. Mowing, spraying herbicide or pesticide and fertilizing require room for the necessary personnel and/or equipment to move throughout the area, and rogueing gives more space to move freely with lessened

Allan Lee and Jim Tolton, TACF Field Technicians, chipping the brush from rogued trees.

risk of breaking limbs or running over the trees. Dense growth of trees and understory plants also provides ideal habitat for mammal and insect pests, such as groundhogs and Japanese beetles, to carry out their lifecycles with ease and little fear of their natural predators or human attempts to control them via other means.

The primary goal of rogueing is to decrease the number of trees that have been determined to have very little or no resistance to *Cryphonectria parasitica* (chestnut blight), rendering them unnecessary or as earlier stated, "worthless" in our breeding effort. The American Chestnut Foundation (TACF) recognized that the seed orchards in Meadowview were populated with an abundance of trees that were not only extremely susceptible to chestnut blight, but were becoming crowded to the point of being in full shade, impeding the growth of their neighbors and making it impossible to move equipment through the area without damaging the trees and/or the equipment. We determined that it was necessary to remove the large number of disease-susceptible chestnut trees and "volunteer" trees such as cherry, poplar and Autumn Olive that were becoming established in the orchards.

In winter of 2016, coordinating with TACF's Director of Science, Jared Westbrook, and TACF's Director of Restoration, Sara Fitzsimmons, the Meadowview team developed a plan to begin rogueing the unwanted trees in a timely and cost-effective manner so as to not disrupt the upcoming growing season. Due to the size and abundance of the mature trees, and in compliance with Animal and Plant Health Inspection Service (APHIS) regulations, we determined that felling, chipping, burying the woodchips and grinding the stumps were the best ways to proceed. The decision was made to purchase a Ventrac stump grinder, rent a wood chipper and dump trailer from Sunbelt Rentals, and ask Steve Hoy, orchard manager for the PA/NJ Chapter at Penn State University (PSU), to help with the work involving the use of chainsaws. Thousands of selected trees were then flagged for removal, felled with chainsaws leaving a short stump (~6" above ground) so the stump grinding crew could find them amongst the understory, dragged to piles and chipped directly into the dump trailer, then hauled to the Glenn C. Price Farm to be buried with a backhoe in a small area determined to be unsuitable for future plantings. To complete the task, the stumps were then ground to a depth of 6-8" to prevent resprouting. In the few months following the first round of rogueing, we have observed a reduction in mammal and insect pests, visibly healthier growth of the remaining trees, and easier access into the plots for site maintenance and pollination activity. The effort to remove the most blight-susceptible trees and increase the value of our breeding orchards will continue in the fall and winter of 2017.


TACF Seed Orchard Supervisor, Dan Mckinnon uses a chainsaw to cut up a recently rogued tree.


Steve Hoy, Seed Orchard Manager for the PA/NJ Chapter cuts down a susceptible tree.

Reprinted from
*NEA Today for NEA-Retired Members**, Spring 2017

The American Chestnut Tree

Retired Educators Help Return It To Glory

It's been called one of the worst ecological disasters in American history. Four billion American chestnut trees dead within the first half of the 20th century. But the efforts of conservationists and volunteers over the last three decades have breathed life back into this tree that was well on its way toward extinction.

More than 100 years ago, according to The American Chestnut Foundation (TACF)-an organization committed to restoring the American chestnut tree-chestnut trees covered over 200 million acres of eastern woodlands, from Maine to Mississippi, and from the Piedmont plateau in the Carolinas west to the Ohio Valley.

In the late 1800s, chestnut trees imported from China and Japan brought with them chestnut blight, a deadly fungal disease that quickly infected the American chestnuts, sometimes strangling them in less than a year. By 1950, the American chestnut tree was functionally extinct.

In 1983, a group of plant scientists and novices established TACF to bring these trees back to their full glory. A breeding station was built and three of TACF 's founding scientists developed a backcross breeding method.

According to the Foundation's website, the scientists crossed Chinese chestnut trees, which are naturally resistant to the blight, with their American cousins. The process created trees that were 50 percent American and 50 percent Chinese. The new trees were backcrossed to the American species, which created trees that were, on average, 75 percent American. The procedure was repeated once more, and the result was a chestnut tree with the growth and form of the American version, but with the blight resistance of its Asiatic ancestor. The effort has met with great success, and while it will take decades-if not centuries-the American chestnut tree population is on the way back.


Bill Trarbach tends the ground on his property.

Planting a New Generation of Trees

From an early age, Tom Struble of Pennsylvania was taught to care for the environment. His parents were teachers, but his father's love of nature compelled him to leave the profession to become a conservationist. Eventually, he became the executive director of the Brandywine Valley Association, the nation's oldest watershed organization.

"I've heard about conservation all my life," two years in Chester Upland School District and another 36 years in Unionville Chadds-Ford School District says Struble, who taught math for before his retirement in 2010. "My father instilled in all of his children a sense of stewardship to take care of this land because we don't own it," says Struble, who along with his siblings, has spent a lifetime planting trees.

In the late 1990s, Struble learned about the American chestnut tree, its blight, and TACF 's restoration efforts, which he equates to "bringing back an extinct animal, a large extinct animal."

*NEA: National Education Association

The educator followed the Foundation's work, and in 2005, he joined the Pennsylvania/New Jersey Chapter of TACF.

His work with the local chapter has led to management of an orchard that's growing 100 American chestnut trees that have been cross pollinated to increase blight resistance. Their nuts will be cross pollinated, too.

Struble is also growing 50 American chestnut trees on his own property, and credits the Foundation for giving several tree varieties a path to survival. "Other trees are in danger as well," he says.

Tree of Knowledge

Bill Trarbach retired after 30 years of mostly teaching fifth-grade elementary school in the Kaukauna Area School District in Wisconsin. In 2011, he and his wife, Kathy, also a retired teacher, moved to New Jersey to be closer to their adult children.

Like Struble, he volunteers with TACF's Pennsylvania/New Jersey Chapter. As a member, he's had the opportunity to participate in a five-day, American chestnut tree restoration program organized by Road Scholar, the Boston-based organization that sponsors travel and educational opportunities for seniors. Attendees spend time on a farm, meet with scientists, and work with trees at different breeding stages.

Experiences like these have led Trarbach to sharpen his green thumb. Last fall, he planted six chestnut seedlings around his property.

"Five made it through the winter," he says, adding, "In fairness it was a pretty mild winter." He recently planted 10 uncrossed American chestnut trees on his property, too.

His volunteerism stems from his concern about trees that, like the American chestnut, have been overcome by disease.

During a 2006 visit to Michigan, Trarbach learned of the Emerald Ash Borer, an adult beetle that took hold around Detroit in 2003. The insects snack on ash foliage but cause little damage. But the insects' larvae feed on the inner bark of ash trees, disrupting the tree's ability to transport water and nutrients, according to the Emerald Ash Borer Information Network.

Trarbach is worried about his five-and-a-half acres of land, half of which is covered in ash trees. "It looks like the ash trees around here are going to expire," he says. "I'm no scientist, but the science the Foundation is doing will also be applicable to other situations."

A Helping Hand

The Foundation's work and the efforts of volunteers have helped to revive thousands of trees. There's still plenty of work to do to help continue restoration efforts.


Tom Struble takes a closer look at a chestnut bur.

THE AMERICAN CHESTNUT FOUNDATION®

Mobilize our Mission

2017
End-of-Year Appeal

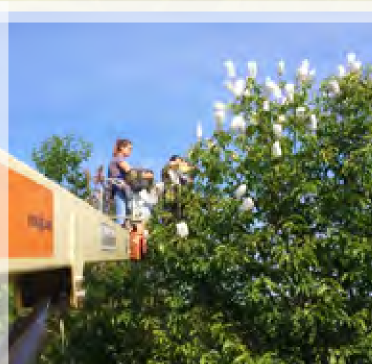
Emerging technologies offer scientific promise as we move closer to a chestnut tree that has both blight and root rot resistance. By embracing these new technologies, such as genomics and early screening, we are speeding up the selection process that is underway for the next generation of seed orchards, progeny tests and germplasm conservation orchards.

This selection fieldwork, carried out by our amazing corps of dedicated volunteers and staff, takes a great deal of coordination, both in time and need for critical equipment.

Help us mobilize our mission and be a part of history by helping us create a future of eastern forests filled with American chestnut.

Donations can be made through our website at acf.org or by calling the National office.

(828) 281-0047 ~ chestnut@acf.org



President Jimmy Carter Speaks at

Carter Center Dedication Ceremony

for The American Chestnut Foundation

President Jimmy Carter, Honorary Director at The American Chestnut Foundation (TACF) addressed guests in the gardens of the Carter Center in Atlanta, GA on Wednesday, July 19, 2017. Celebrating the dedication of The American Chestnut Tree Demonstration Orchard, Carter spoke of his life commitment to help restore and reintroduce the American chestnut back into its native eastern forests.

Attendee's pose for a group picture with President Carter.

"My heart's been in [American chestnut restoration efforts] from the beginning. We are grateful for what The American Chestnut Foundation has done. This is an exciting experiment in bringing back some of the heritage we enjoyed once. Every week I check on the trees we have planted here. For the rest of my life, I will be a part of it," President Carter shared.

The Carter Center Demonstration Orchard exhibits the success of the backcross breeding program, intended to build blight resistance in the American chestnut tree. The program will breed five generations, or backcrosses, of Chinese and American chestnut trees.

"Restoring a species is a hopeful and ambitious undertaking. We are thankful and honored that President Carter is so supportive of our mission to restore a blight-resistant American chestnut tree, once one of the most important hardwood trees in the eastern forests," said TACF President and CEO, Lisa Thomson.

President Carter greets guests following the dedication ceremony.

Dr. Martin Cipollini, Georgia Chapter member and Dana Professor of Biology at Berry College, speaks about restoration efforts in the Georgia Chapter.

Educating Scouts

ABOUT THE AMERICAN CHESTNUT AT THE 2017 NATIONAL BOY SCOUT JAMBOREE

By Sam Muncy, West Virginia Chapter Treasurer

The 2017 National Boy Scout Jamboree at the Summit Bechtel Reserve in Glen Jean, WV was a huge success. The American Chestnut Foundation (TACF) booth volunteers got to chat with more than 2,500 scouts and leaders that visited the Conservation Trail.

Steve Antoline (left) receives a hand-crafted box made from recovered American chestnut wood, given by Sam Muncy, WV Chapter Treasurer and Jamboree Booth Leader.

Warren Laws explaining the plight of the American chestnut.

One notable event that took place during the Jamboree was the dedication of the Steven A. Antoline Family Conservation Center. Antoline is a committed member of TACF. As part of the ceremony, Antoline, along with TACF Director of Development Vic Hutchinson, planted two of our most blight-resistant B_3F_3 trees at the entrance to the Conservation Trail where the Center will be constructed. During his speech, Antoline shared his vision of a conservation training and experimental facility where young Americans can learn how to manage our environment, and at the same time, utilize our natural resources. Antoline wants TACF to have a space in the Center where efforts to bring back the American chestnut can be displayed for scouts and visiting scientists.

Volunteers from Pennsylvania, New York, Virginia, North Carolina and Maryland put in many hours to make one-on-one contact with Boy Scouts at TACF's booth. It was a learning experience for TACF members to hear about each other's work within their own state chapters. My sincere thanks go to Robert Sypolt, Warren Laws, Jerry Legg, Rob Herman, Jodi Arrington, Jeff Skousen, Mark Double, David Bisceglia, Joseph Golden, Sharon Cottrill, Rick Sypolt, Vic Hutchinson, Jimmie Sizemore, Leslie Sizemore, Paul Wolfe, Joe Lancaster, Bill Bogard, Jim Eberly and Steve Swank for their committed participation. The booth was successful because so many contributed their time and knowledge during this event. It was wonderful to witness stories about and passion for the American chestnut.

Several scout leaders also spoke about their experience of the tree and how American chestnut logs were used in many camp buildings. It was especially gratifying to hear of the many standing wild American chestnut trees that are thought to be growing on various scout camp properties. Tom Saielli, Mid-Atlantic Regional Science Coordinator, prepared a wonderful brochure for the booth summarizing how to find and report wild American chestnut trees. Many of these brochures went home with the scouts, and TACF hopes to receive requests in the near future to investigate the trees at these various Boy Scout camps.

SPECIAL

Holiday Raffle

TACF member and consulting forester, Pat Straka, has once again crafted and donated a beautiful handmade chestnut Skinny Quilt to be raffled!

The quilt, entitled "Chestnut Mountain" boasts of rich colors with a stunning gradient blue background. The dimensions are 66 ½" x 28".

TACF staff was in awe when it arrived at the National office in Asheville. If you win, you'll have the opportunity to admire its radiance every day!

Tickets are sold in sets of five only: 5 tickets = $20

To purchase tickets, visit our website at acf.org or call (828) 281-0047.

Drawing takes place December 15th and the quilt will be mailed to the lucky winner.

Don Surrette

By Scott Carlberg, Carolinas Chapter Member

A heavy July morning dew clung to the trees and grass as Don Surrette walked through his woods to his stand of American chestnuts. His keen sense of awareness clicked on. "A deer has been through here," he said, eyeing a grassy patch along a tree line. The silvery blush of dew was split by a fine shadowy trail, moisture disturbed when something crossed from thicket to thicket.

Don opens the entrance gate onto his property.

Transylvania County, in southwestern North Carolina, is prime for chestnuts. Summer highs average 80 degrees, and winter lows near freezing. Four to five inches of rain fall each month. The soil is right, offering good drainage. Just as important, it's where Don Surrette lives, long-time and committed volunteer with The American Chestnut Foundation (TACF).

Don crafts a walking stick in his woodshop from reclaimed American chestnut.

Don's grandfather, Elzie (right), around 1910 with oxen. Close to the Dunn's Rock area near Brevard, NC.

Volunteering in February, 2017 at the Bent Creek Resistance Screening Center in Asheville, NC.

"I'm not planting these chestnuts for myself," Don says. "They are for others, like my granddaughter. The next generation."

Plants are in Don's DNA. "Loggers and farmers," he says. "No bootleggers, just consumers that I know of." Don's involvement with TACF started before 1990, the year he became a charter member of the Carolinas Chapter. His history of care-taking trees started as a 4-H teen. He won first place in the state for a timber stand improvement project.

His kin came to this land in the 1780's as indentured servants, carpenters and farmers. Their loyalty to the land grew in the Walton War, armed and legislative battles from 1802 to 1818 over a 12-mile strip, disputed by the Carolinas and Georgia that was dubbed Walton County. 1804 marked the height of real fighting. Georgians even captured one of Don's ancestors and eventually released him unharmed.

Surrette's maternal grandfather, Perry Elzie Raxter, was a Transylvania County logger. Even then chestnuts were in the family. "Grandpa told me how large the chestnut trees were. My dad, as a boy, would gather chestnuts in the fall, use chestnuts to fatten off their pigs, ate them raw, roasted them, made flour for bread," says Surrette.

His dad, Lewis, "...had green arms, not green thumbs. He knew the secret of trees." After a short stint studying arboriculture at North Carolina State University in the early 1940's, Lewis took to the trees. Literally. "He could throw a rope around over a big branch, pull himself up and prune the tree." Lewis was later employed at the Ecusta paper mill at Pisgah Forest until 2002. Ecusta manufactured paper for crisp Bible pages, cigarettes, gift wrap, and more.

For 30 years at DuPont's Cedar Mountain plant, Don helped troubleshoot manufacturing controls for the polyester base of medical x-ray film. It was an exacting job. That tenacious, inquisitive temperament underlies his drive for blight-resistant American chestnuts. Don has been part of TACF's efforts across the Southeast. When he isn't with the trees, he's speaking on behalf of TACF.

Don's chestnut trees (B3F3's) are maybe a five-minute walk from his house at the edge of his ten acres. He counts at least 50 different tree species on his land, and he's caretaker of them all. "Trees are nature's air filters. We need them."

Tending chestnuts requires precision and perseverance. His 150 seedlings from last spring are down to 30, but he isn't deterred. "I'm not planting these chestnuts for myself," Don says. "They are for others, like my granddaughter. The next generation."

PARTNERING WITH THE US ARMY CORPS OF ENGINEERS:

Enabling TACF to Advance

THE BREEDING EFFORT AND SUPPORT OUTREACH AND EDUCATION IN COMMUNITIES ACROSS THE COUNTRY

By Tom Saielli, Mid-Atlantic Regional Science Coordinator

The American Chestnut Foundation (TACF) has implemented backcross breeding at more than five hundred orchards, demonstration plantings and research plantings, as well as hundreds of ceremonial plantings located throughout sixteen different state chapters across the eastern United States. The success of our program is due in large part to the partnerships that TACF has created with other organizations. These partners have provided land, resources and long-term management for many of those plantings. Among these partnerships, the US Army Corps of Engineers (USACE) provides some of the most valuable support with dozens of successful collaborations on plantings and outreach events over the last two decades, with many more in store for the future.

In 2009, the Corps and TACF entered into a national Memorandum of Understanding (MOU) where both parties agreed to coordinate efforts and work cooperatively to restore the American chestnut. Jeff Krause, national program manager for the Corps Environmental Stewardship Program notes that the MOU quickly spurred enthusiasm at the project where opportunities existed to leverage local communities, partners and volunteers to engage in this historic restoration effort.

"It is exciting for the U.S. Army Corps of Engineers to partner with The American Chestnut Foundation in the recovery of this ecologically, culturally, and economically significant tree species," said Heather Burke, U.S. Army Corps of Engineers National Partnership Program Manager. "Many Corps lakes on the eastern seaboard exist in ecoregions where chestnut trees historically occurred. This partnership provides an opportunity to support TACF's breeding program, enhance our environmental stewardship mission, and provide educational and volunteer opportunities for the public."

According to Keith Chasteen of USACE's Louisville District, "The American Chestnut Foundation saw value in partnering with the Corps of Engineers, as there are Corps projects spread throughout a variety of ecosystems across the chestnut range. This provides a great opportunity to get trees growing across different regions, at different elevations and within different population areas. With the many demo plantings now in place at Corps visitor centers and office locations, there are opportunities for literally millions of people to learn about the American chestnut and efforts in its restoration. The Corps rangers are able to use the chestnut plantings as a focus for interpretive talks, which helps to tell the story of the chestnut tree even more so. It is a win-win partnership for both organizations."

So, who is USACE and what is their mission?

George Washington appointed the first engineer officers of the Army in 1775, during the American Revolution. From the beginning, USACE has served both military and civilian works. Throughout the 19th century, the Corps supervised the construction of coastal fortifications and mapped much of the American West. USACE also constructed lighthouses, helped develop jetties and piers for harbors, and carefully mapped the navigation channels.

In the 20th century, the Corps became the lead federal flood control agency and significantly expanded its civil works activities, becoming, among other things, one of the country's leading providers of recreation. Furthermore, in the late 1960s, the Corps became a leading environmental preservation and restoration agency. It now carries out natural and cultural resource management programs nationwide.

With their skills, experience, and resources, USACE has been a strong and reliable partner in the effort to restore American chestnut. They have helped bring awareness to our program throughout the eastern United States, through silviculture research projects, breeding orchards, demonstration plantings and more.

The first initial work done by the Corps began in 1999 at Raystown Lake where a pure American chestnut orchard was established in partnership with the Pennsylvania Chapter. That orchard was later converted to a breeding orchard followed by 5 additional orchards including a progeny test, a seed orchard, and several demonstration orchards, over 4,500 trees have been planted at Raystown Lake to date.

A few other successful projects include:

USACE helps with the breeding program

Carr Creek Lake in Kentucky – USACE has been a reliable partner in the establishment of backcross breeding orchards like Carr Creek Lake in Kentucky where they planted a two-line backcross orchard in 2014. Before the backcross orchard was established, the Corps installed a demonstration planting in 2012, which included six potentially blight-resistant American chestnuts and a three-panel interpretive sign. In 2014, a wild American chestnut tree was found in the tail water area below USACE's on-site office. Some canopy opening was performed around the tree in 2015, and the first male and female flowers were identified in 2017.

Interpretive signs at the ceremonial site of six potentially blight-resistant American chestnut trees at Carr Creek Lake, Kentucky, Corps of Engineers, Louisville District in 2012. Photo by Keith Chasteen

Lake Allatoona, Georgia – USACE has also been supportive of creative problem solving leading to new and successful projects. One example of this is in Lake Allatoona, Georgia. Originally intended as a restoration planting, most of the trees were lost soon after planting due to the presence of *Phytophthora cinnamomi* in the soil. Instead of writing off the orchard as a failure, the USACE collaborated with TACF to turn the project into a new kind of success. According to Marty Cipollini, TACF Georgia Chapter member, "the folks at the Army Corps of Engineers have been great. They thought they were getting a restoration planting, but after the trees all died from Phytophthora, they helped us convert the site to a Phytophthora resistance breeding orchard, which is now a significant part of our breeding program in the south."

Originally intended to be a restoration planting at Lake Allatoona, Georgia, this site was converted to a *Phytophthora* resistance breeding orchard after P. cinnamomi was discovered. Now a successful and important part of the regional breeding program in 2013. Photo by Marty Cipollini

GA Chapter volunteers and Corps members appreciate a strong and successful partnership between TACF and the Corps at Lake Allatoona Restoration Planting in 2013. Photo by Marty Cipollini

USACE helps with research

W. Kerr Scott Lake in Wilkesboro, North Carolina – In March of 2017, TACF teamed up with USACE's Wilmington District, Appalachian State University, North Carolina Department of Agriculture Forest Service, West Wilkes High School Agriculture Program, and Friends of W. Kerr Scott Lake to establish approximately 640 seedlings in a silviculture study at W. Kerr Scott Dam and Reservoir, in Wilkesboro, NC. While this project provided an essential silviculture research opportunity, intended to aid in our understanding of how forest canopy differences can influence survival and drought tolerance of chestnuts, the partnership-building between TACF, USACE, and several other organizations establishes an even deeper meaning. Our cooperation built a community of people who are invested in the project, in the place, and in the mission of the work - a community that will be able to enjoy the fruits of their labor for years to come as they watch the trees grow and become permanent parts of the surrounding forest.

Calumet Creek Natural Area near Clarksville, Missouri – An earlier collaboration between TACF and USACE, along with the U.S. Forest Service at Purdue University, resulted in the establishment of 700 mixed chestnut genotypes in a silviculture study at Calumet Creek Natural Area near Clarksville, MO in April, 2013. This research was intended to assess survivorship and growth of seedlings planted in two sites with significantly different soil types. Predictably, the results indicated that survival and growth were greater in coarse loamy soils versus heavy clay soils. In describing this research planting, Jim McKenna, Forestry and Natural Resources Biologist at Purdue University spoke of the great partners he worked with, stating "These folks [USACE] have been a true pleasure to work with – committed, dedicated, on-time and never say fail."

Student volunteers from Wilkesboro High School work with TACF volunteers and Corps of Engineers staff to plant seedlings, record data, and install tree tubes and cages at W. Kerr Scott Reservoir in 2017. Photo by Tom Saielli

Park Rangers with U.S. Army Corps of Engineers Wilmington District prepare a field site for silviculture research at W. Kerr Scott Reservoir in 2017. Photo by Tom Saielli

Chris Hopfinger, Corp of Engineers, Clarksville, Missouri, poses next to a chestnut seedling at the Calumet River silviculture trial in 2013. Photo by Jim McKeena

USACE helps with outreach and education

Mosquito Creek Lake in Cortland, Ohio – In addition to large-scale research plantings, USACE has participated in a variety of small to medium plantings, such as ceremonial and demonstration plantings. Recently they, along with TACF's Ohio Chapter and Ohio Department of Natural Resources, collaborated to plant approximately 100 potentially blight-resistant American chestnuts in a series of demo plantings at Mosquito Creek Lake reservoir in Cortland, OH. The trees, planted with 2′ tubes and 4′ wire cages were all in the ground within three hours, thanks to such a strong volunteer effort!

Washington Aqueduct in Maryland – According to TACF Maryland Chapter President Gary Carver, in 2012 John Chadwick and other members of the Maryland USACE planted about a dozen chestnut trees around the Dalecarlia Reservoir at the Washington Aqueduct, and four B3F2s on a hill across MacArthur Boulevard from the nearby water treatment plant. Carver states that the trees help to frame the beautiful old plant that was built by the Corps more than a hundred years ago - exhibiting rustic and charming architecture - a fitting place for ceremonial chestnut trees.

A ceremonial chestnut tree grows on a hill overlooking the Corps of Engineers Washington Aqueduct water treatment plant in Maryland in 2012. Photo by Gary Carver

Other Important Demonstration Plantings – The partnership between TACF and USACE has also provided opportunities to establish pure American orchards like the demonstration and breeding plantings in Shenango Lake, and Caesar Creek Lake. Other notable USACE demonstration plantings include Jennings Randolph Lake and Tygart Lake in West Virginia, Francis E. Walter Dam in Pennsylvania, Cape Cod Canal in Massachusetts, and in 2014 approximately 100 potentially blight-resistant American chestnut were planted at Philpott Reservoir in Virginia. There are also chestnut trees planted on Corps property along the Green River in Kentucky. Keith Chasteen points out that "demonstration plantings have been established at nearly every Corps Lake within Kentucky, including those in Huntington and Nashville Districts." That is a grand accomplishment!

A beautiful demonstration orchard planted by Corps of Engineers, Volunteers from PATACF and Penn State University at Shenango Lake, Pennsylvania. Photo courtesy of Rich Egger from Shenango River Lake, USACE Pittsburgh District

Keith Chasteen, Corps of Engineers Louisville District, and Kevin Wright, Carr Creek Lake park ranger, plant a chestnut tree at the Carr Creek Lake backcross orchard in 2014. Photo courtesy of Keith Chasteen

All of the above projects offer a glimpse into the many ways that TACF and USACE have worked together. There is great history and a promising future – something that is worth appreciating.

Genomic selection for disease resistance

IN AMERICAN CHESTNUT BACKCROSS POPULATIONS

By Jared Westbrook

With the recent revolution in genomic sequencing technology, it is now feasible to use DNA sequencing to predict disease resistance American chestnut backcross populations. The American Chestnut Foundation is currently developing genomic prediction of disease resistance to accelerate selection in the backcross breeding program. Preliminary results are show that genomic selection has the potential to be sufficiently accurate to make final selections in seed orchards at Meadowview Research Farms. More research is required to demonstrate that genomic predictions developed for the Meadowview breeding program will be applicable to TACF's chapter breeding programs.

Jason Holliday inspects rooted poplar cuttings at the Reynold's Homestead Forestry Research Center, Critz, VA

Background and rationale

For over 30 years, The American Chestnut Foundation has been selecting for chestnut blight resistance in American chestnut backcross populations by inoculating trees with the fungus that causes chestnut blight (*Cryphonectria parasitica*) and culling all trees except for those with the least severe cankers. Over 60,000 American chestnut backcross trees have been planted in TACF's Meadowview seed orchards since 2002. After inoculation and culling, 5000 trees remain from which to make the final selections of 500 of the most disease resistant trees. As we continue to select against susceptible trees it becomes increasingly difficult to distinguish the most resistant trees by sight alone. A tree's apparent disease resistance is a function of the resistance genes that it inherited and the environment that it is growing in. To separate the effect of genes and environment on disease resistance, TACF plants 30 – 50 progeny of mother trees in seed orchards in randomized field trials that are known as *progeny tests*.

The genetic levels of blight resistance of these mother trees may be estimated from the average canker severity of their progeny. The effect of environment on disease resistance may be accounted for by replicating progeny in multiple environments. Progeny testing also enables us to screen for resistance to Phytophthora root rot (PRR), a second disease that kills American chestnut. Currently the orchards at Meadowview are not affected by PRR and we screen for resistance off site to prevent it from spreading there.

The problem with progeny testing is that it is too slow and laborious to meaningfully contribute to selection in seed orchards. Since 2011, only 600 of 5000 mother trees in Meadowview seed orchards have been progeny tested for blight resistance. Progeny from 300 mother trees have been screened for resistance to PRR. At current rates of progeny testing, it would take over 50 years to complete selection with progeny testing alone!

Fortunately, there is another way to make accurate selection of the most genetically resistant trees – *genomic selection*. The basic principle of genomic selection is to develop a prediction model that enables us to rank trees' disease resistance with DNA sequencing. The prediction model is developed by estimating correlations between a genome-wide sample of DNA variants and disease resistance in a training population of mother trees that have been progeny tested. The underlying genetic resistance of mother trees that have not been progeny tested is predicted by genotyping the same DNA variants as were genotyped in the training population and summing the effect of the DNA variants on disease resistance (**Figure 1**). The principle advantage of genomic selection is that it will enable us to accelerate selection of the most disease resistant trees

How genomic selection works

One way genomic selection works is by way of sequencing *DNA markers* in proximity to genes involved in disease resistance. We need not know what these genes are and where they are located to predict resistance. Current DNA sequencing technology has the power to identify tens of thousands to hundreds of thousands of DNA markers at random intervals scattered across the genome. By chance, some markers will be near disease resistance genes. The DNA markers near resistance genes are expected to be more strongly correlated with disease resistance than markers that are far away.

Another way genomic selection works is by tracing relationships between trees in the training population and the trees in which predictions of disease resistance are to be made. Genomic relationships are defined as the proportion of DNA variants that are shared between a pair of trees. You can think of the predicted genetic resistance of a tree as a weighted average of the disease severity of that tree's relatives. The disease severity of trees that are more closely related are more heavily weighted in making the prediction than distant relatives.

If many genes control disease resistance, then the predictive ability of genomic selection is expected to be derived predominately from the DNA markers' ability to estimate relatedness. The DNA markers will more accurately predict resistance in trees that are more closely related to trees in the training population than those that are more distantly related.

If, on the other hand, there are a few genes that have major effects on disease resistance, then the predictive ability of the markers in close proximity to disease resistance genes will be high regardless of how related the trees in the training population are to the prediction population.

Genomic selection in TACF's chapter breeding programs

From where the predictive ability of DNA markers is predominantly derived has implications for the amount of progeny testing required to develop accurate genomic prediction models for TACF's chapter breeding programs. Currently 13 of 16 chapters of TACF are participating in backcross breeding. Many chapters have begun planting seed orchards and are inoculating trees to make the first round of selection. Like at Meadowview, TACF's chapters will eventually confront the challenge of making final selections of the most disease resistant parents from thousands of trees that remain after initial culling.

Currently, mother trees from TACF's Meadowview seed orchards are being genotyped to develop genomic prediction of disease resistance. It is uncertain whether genomic prediction models developed from Meadowview training populations will accurately predict resistance in chapter breeding programs. The American chestnut parents used for the last backcross differ in Meadowview and chapter breeding programs although all trees in TACF's chapter seed orchard share backcross grandparents with trees

Glossary

TRAINING POPULATION – A subpopulation of the total breeding populations in which correlations between DNA variants and variation in the trait under selection are estimated to develop a prediction model.

GENOTYPING – A method of detecting DNA variants within a population.

DNA MARKER – A location in the genome where DNA varies between individuals.

GENOTYPING-BY-SEQUENCING – A method of detecting DNA variants between individuals through sequencing short segments of DNA (100 – 150 nucleotides in length) from the ends of genome fragments. Prior to sequencing, genomic DNA from multiple individuals are cut at similar locations with restriction enzymes such that homologous fragments of DNA are sequenced and can be compared between individuals.

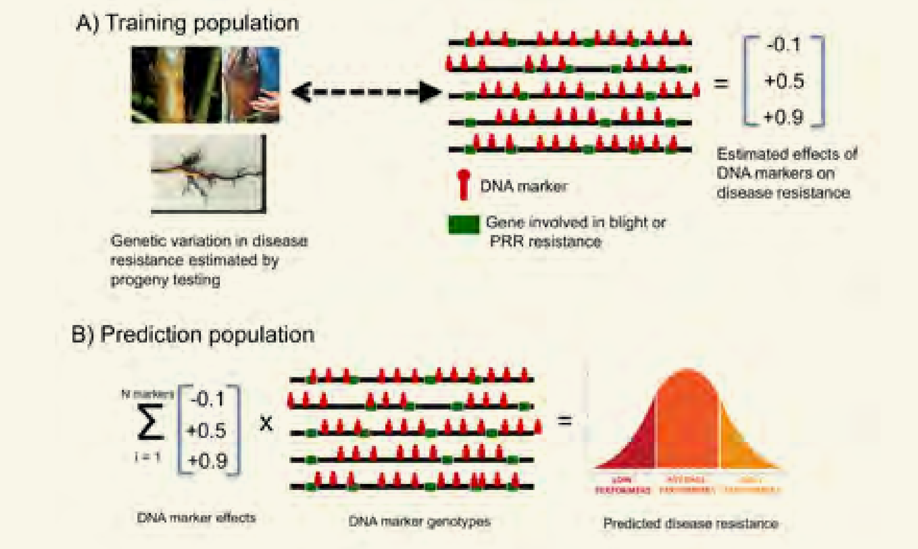
RESTRICTION ENZYMES – Enzymes from bacteria that bind and cut DNA at specific DNA recognition sites.

DNA SEQUENCING – Determining the nucleotide sequence of a fragment of DNA. There are many different technologies for DNA sequencing but most are based on replicating the complementary strand of a single stranded DNA template. During the replication process as DNA nucleotides are incorporated different technologies use different methods of detecting the identity of the particular DNA nucleotide that was incorporated at a particular position with respect to the template DNA.

ALLELES – Alternative DNA variants at a location in the genome. Single nucleotide polymorphisms are typically bi-allelic, meaning that two nucleotide variants occur at a particular genome location within a population.

REFERENCE GENOME – A complete DNA sequence of an individual in which the fragments of DNA generated by DNA sequencing have been assembled into chromosome length sequences.

Figure 1



Genomic selection for disease resistance in American chestnut backcross populations. A) The effects of DNA markers on genetic variation in disease resistance is first estimated in a training population. B) The same DNA markers are sequenced in individuals that have not been progeny tested. The effects of these DNA variants are summed across the genome to predict genetic variation in disease resistance.

planted in Meadowview. If relatedness drives genomic prediction accuracy, then genomic prediction accuracy will be lower in chapter seed orchards than in Meadowview seed orchards. To increase genomic prediction accuracy, it may be necessary to progeny test and genotype parents in chapter seed orchards.

No additional progeny testing will be necessary in chapters if we identify a subset of highly predictive markers that are in close proximity to disease resistance genes. However, it may be necessary to identify separate sets of DNA markers that are predictive of disease resistance in backcross populations that descended from different sources. TACF's three primary sources of resistance - Clapper, Graves, and Nanking – all descend from different Chinese chestnut parents. It is uncertain whether these populations share the same resistance gene variants or whether the different sources of resistance have different resistance genes. If the latter is the case, then prediction models developed in one source of resistance (e.g., Clapper) will not accurately predict resistance in another source of resistance (e.g., Graves).

Genotyping

The DNA markers used to develop the prediction models are detected using a method called *genotyping-by-sequencing* (**Figure 2**). It is not cost effective or necessary to sequence the entire genomes of all remaining trees to predict their disease resistance. The trees in the training population are related to one another and to the trees whose resistance we are predicting. Related trees share large blocks of chromosomal segments, which are identical in DNA sequence. With genotyping-by-sequencing, DNA variants are detected at random intervals scattered throughout the genome. With a sufficient density of DNA markers, individual markers adequately represent all segments of the genome that are shared between related trees.

To detect these DNA variants with genotyping-by-sequencing, the DNA is fragmented with one or more restriction enzymes that cut the genome at specific DNA recognition sites. Recognition sites are DNA sequence motifs that are typically 4 – 8 nucleotides long that occur by chance at many locations across the genome. By cutting the genome

Figure 2

Genotyping-by-sequencing. Genomic DNA is digested with restriction enzymes that cut DNA at specific recognition sites (e.g., AACC). The ends of the DNA fragments are sequenced. The sequenced fragments are aligned to a reference genome to detected single nucleotide polymorphisms (SNPs).

at specific restriction sites, the DNA sequences around these sites may be compared among trees by sequencing the ends of the genome fragments. Hundreds of millions to billons of DNA sequence reads, each 100 – 150 nucleotides in length, are generated in a single sequencing run. The raw sequence reads are then aligned to where they best match the DNA sequence of the Chinese chestnut or American chestnut reference genomes to determine the chromosomal location of these fragments. Once the sequences are aligned, the sequences from different trees are compared to each other and the reference genome. The locations where trees' DNA sequence differs from the reference genome by one nucleotide are called single nucleotide polymorphisms (SNPs).

Proof-of-concept

As a proof-of-concept for genomic selection, genotyping-by-sequencing has been performed on 480 Graves mother trees from Meadowview seed orchards. Over 20,000 SNPs were detected in this population. Genomic prediction models for blight resistance were first developed by estimating the relationships between the SNPs and variation in subjective canker severity rating of these individual trees. The predictive ability of the SNPs was estimated with cross-validation. The effects of SNPs on canker severity was first estimated in 9/10ths of the population. The SNPs effects were then multiplied by the number of SNP *alleles* in remaining 1/10th of the population and summed to obtain genomic predictions of canker severity. This procedure was repeated nine more times with different partitions of the population into training and prediction sets to obtain canker severity predictions for all individuals.

The strength of the correlation between predicted and observed canker severity were used to estimate genomic predictive ability. The predictive ability for raw canker ratings was only 0.2 on a 0 to 1 scale. Canker ratings are influenced by genetic and environmental effects, including the bias of the people rating the cankers. To more accurately estimate the underlying genetic resistance, the effects of seed orchard block and year of inoculation were accounted for. Then the canker ratings of siblings and progeny were factored in a weighted average of canker ratings for each individual tree to estimate the underlying resistance. The predictive ability of the SNPs increased to 0.6, presumably because genetic resistance was more accurately estimated in the training population (**Figure 3**).

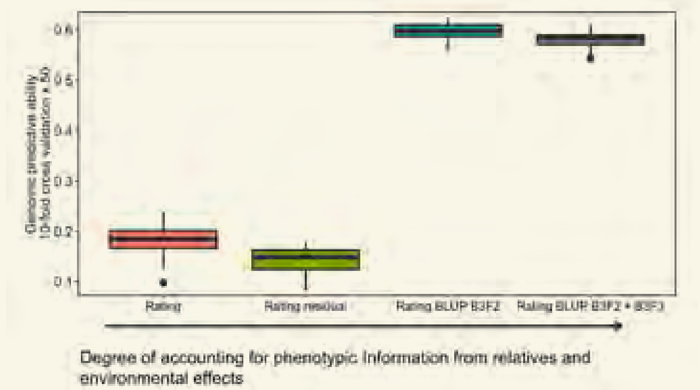
The end goal is to use progeny test data to develop genomic prediction models. As a proof-of-concept, genomic prediction was performed with 47 BC_3-F_2 mother trees whose underlying genetic resistance to chestnut blight was estimated from progeny tests. Between 11 and 30 progeny of each of these mother trees inoculated with the fungus that causes chestnut blight. Genomic predictive abilities were near zero for the average canker ratings of the progeny but approximately 0.55 and 0.4 for canker lengths from inoculations with weak and strong strains of the chestnut blight fungus, respectively (**Figure 4**). Genetic variation in PRR was also predicted with genomics. Predictive abilities were higher for the severity of root rot lesions and mortality (0.65) than for above ground wilting (0.45) (**Figure 5**).

These results suggest that traits differ in how accurately they represent underlying genetic levels of disease resistance – canker length more accurately represents blight resistance than canker rating. Mortality and severity of root lesions represents PRR resistance more accurately than above ground wilting. The genomic predictive abilities for chestnut blight canker length, root rot severity, and root rot mortality were encouragingly high despite the small training populations used to develop the prediction models.

Next steps

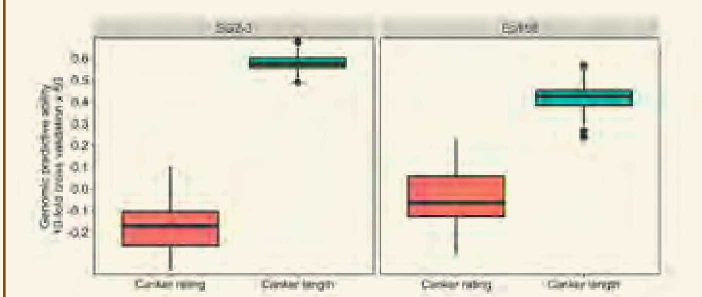
Genomic predictive abilities are expected to increase by genotyping more progeny tested trees. TACF is collaborating with Professor Jason Holliday at Virginia Tech to genotype all mother trees in Meadowview seed orchards that have been progeny tested for resistance to chestnut blight and/or PRR. These trees will be the training populations to develop genomic prediction models

Figure 3



Genomic prediction of blight canker rating phenotypes among 480 Graves BC_3-F_2s that were genotyped at 22,397 SNPs. The accuracy of genomic prediction was estimated with ten-fold cross validation repeated by partitioning the population randomly into 10 sets 50 times. Predictive ability (i.e., correlation between genomic prediction and progeny test results) were compared for raw canker ratings (Rating), ratings after adjusting for the effect inoculation year and seed orchard block (Rating residual), weighted average of ratings of individual BC_3-F_2 trees and their siblings (Rating BLUP B_3F_2), and weighted average of the canker ratings of BC_3-F_2 siblings and BC_3-F_3 progeny (Rating BLUP B_3F_2 + B_3F_3).

Figure 4



Genomic prediction of genetic variation in blight resistance estimated from progeny tests. Genetic variation in canker rating and canker length was estimated from these measurements in 11 – 30 BC_3-F_3 half sib progeny of 47 BC_3-F_2 mothers. Genomic predictive abilities were estimated with ten-fold cross validation (repeated 50 times) using 22,397 SNPs and were compared between cankers that developed six months after inoculation with a weakly pathogenic strain (SG2-3) and strongly pathogenic strain (Ep155) of the chestnut blight fungus (*Cryphonectria parasitica*).

for resistance to these pathogens. Approximately 300 Clapper and 300 Graves mother trees will have been progeny tested for blight resistance by 2019. In addition, 300 Graves mother trees have been progeny tested for PRR resistance. Separate genomic prediction models will be developed for Graves and Clapper because of the possibility that these sources of resistance inherited different disease resistance genes.

In addition, 1200 Clapper and 800 Graves trees from Meadowview seed orchards that remain after the initial culling of the most blight-susceptible trees, but that have not yet been progeny tested, are also being genotyped. Once all of the individuals in the population are ranked with respect to blight or PRR resistance, final selections will be made of individuals with the highest disease resistance. The rest of the individuals will be culled from the orchard.

To test accuracy of genomic prediction models developed at Meadowview for selection in TACF's chapter seed orchards, we are also progeny testing and genotyping BC_3-F_2 mother trees from chapter seed orchards. Predictions of resistance in chapter seed orchards will be made from Meadowview prediction models. The accuracy of those predictions will be estimated from the correlation with progeny test rankings of disease resistance.

How resistant will trees be after selection is complete?

It is expected that as all but 1% of the most disease resistant trees from seed orchards are culled, the average blight resistance of BC_3-F_3 seed coming from these orchards will increase. Exactly how blight-resistant the seed will be depends on the selection accuracy not only at BC_3-F_2, but also in earlier generations of breeding. Based on canker severity variation in progeny tests, it is expected that BC_3-F_3s will have blight resistance that is intermediate between Chinese chestnut and American chestnut. The BC_3-F_3 population is not expected to be as blight-resistant as Chinese chestnut, on average, because it is likely that selection was not sufficiently accurate to select for the full suite of blight-resistant alleles in backcross lines over multiple generations. Once selection is complete in Meadowview seed orchards, offspring will be planted in restoration trials to determine if the level of resistance is sufficient to sustain competitive and reproductive populations in the forest. Selection for blight resistance and PRR resistance will be made separately because resistance to these diseases are conferred by different genes. To combine blight and root rot resistance, additional breeding between trees selected for resistance to either disease will be required.

ACKNOWLEDGEMENTS

Initial funding for proof-of-concept for genomic selection was provided by the U.S. Foundation for Forestry and Communities, Inc. Subsequent funding to develop genomic prediction models was provided by USDA-NIFA Project # 2016-67013-24581. Funding for genotyping to predict resistance of remaining trees in Meadowview seed orchards and to test prediction accuracy in chapter seed orchards was provided by the Allegheny Foundation, the Tucker Foundation and an anonymous foundation.

PART 1

Although much has been written in the popular press about the chestnut blight, there are many interesting facts about the blight in scientific publications that are inaccessible to most of the public. Some of those facts will be revealed in a three-part series in this, and subsequent issues of *Chestnut*. Part one focuses on the biology of the fungus (*Cryphonectria parasitica*) that infects and ultimately kills native American chestnut trees. Part two will describe events that occur at the chromosomal level during the traditional breeding process to create Asian-American hybrid chestnut trees. Part three will explain the technological advances in genetic engineering that could be used to insert genes that increase resistance to fungal infections into the chromosomes of native American chestnut trees.

The American Chestnut Tree Returns

WITH NEW PAIRS OF GENES

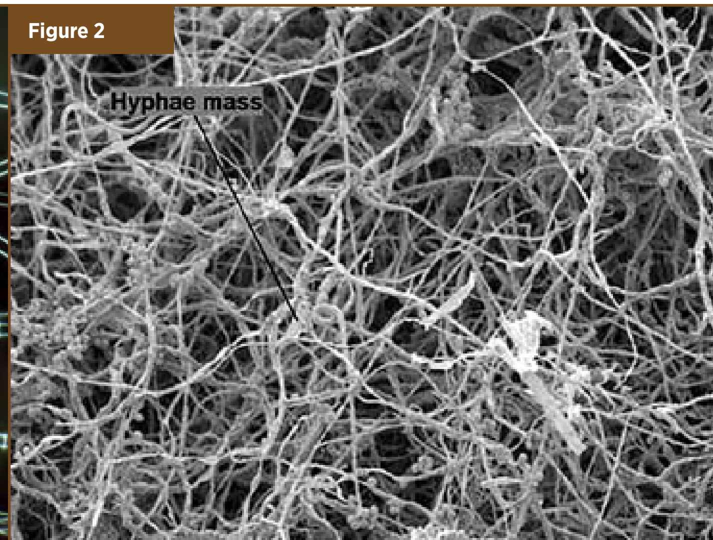
By Kent Wilcox
Republished from the 2017 spring issue of *The Little River Watermark*, membership newsletter of Friends of DuPont Forest

In 1820, there were four-fold more American chestnut trees living in the Appalachian Mountains than there were people living on the entire planet. When Alabama and Maine were admitted to the United States in 1819 and 1820, approximately 25% of the trees in the forests of the Appalachian Mountains were American chestnut (*Castanea dentata*). Referred to by some as "mighty giants," American chestnut trees could reach a height of 120 feet and a circumference of thirty feet. In contrast to the four billion trees shedding chestnuts from Alabama to Maine in 1820, there are probably fewer than 200 American chestnuts with a circumference greater than six feet growing wild in the Appalachian forests today. **So, what happened?**

Figure 1

Microscopic image of linear array of cells in individual hyphae of the fungus *Sordaria fimicola*.
Courtesy of George Barron, University of Guelph

Figure 2



Scanning electron micrograph of a mass of hyphae produced by *Aspergillus*
Courtesy of Alan Box, University of Lethbridge.

Figure 3

Mycelium of an unidentified fungus growing on dead wood.
Courtesy of Robin Kobaly, The Power of Plants

Figure 4

Canker formed by chestnut blight. Spread of the fungus from an initial wound creates a series of vertical cracks in the bark. USDA Forest Service, Region 8 Southern, bugwood.org

As many of us learned in school, the demise of the American chestnut was not a consequence of logging operations, forest fires, climate change, woolly adelgids or gypsy moths – but was in fact due to the chestnut blight. That answer would end the quiz on Jeopardy, but it's just the beginning of this article. Chestnut blight is an infectious disease caused by a fungus called *Cryphonectria parasitica*. This fungus was growing in Japanese chestnut trees when they were imported to the United States in the late 1800s for use as ornamental trees. The fungus was discovered on chestnut trees in the New York Zoological Park in 1904, although by then it was spreading throughout forests in the eastern United States. By 1940, most of the three billion American chestnut trees in the United States were dead. The distinction between "most" and "all" is quite important. In contrast to the American chestnut trees, all of the three billion passenger pigeons that populated the skies of the United States in the late 1800s were dead well before 1940. Thanks to those few remaining American chestnut trees, attempts to repopulate our forests with American chestnut trees are a lot more promising than attempts to repopulate our skies with passenger pigeons.

To understand why some American chestnut trees continue to bear fruit today, we need to understand a bit more about the ecology of the fungus and of the chestnut tree. The fungus *C. parasitica* infects trees at sites where the bark has been damaged by woodpeckers, deer rubs, boring insects, or other insults. The fungus grows by

Figure 5

Orange tendril (cirrhus) extruded from a yellow asexual fruiting body (pycnidium) contains thousands of spores. Photo courtesy of Mark Double, Division of Plant and Soil Sciences, West Virginia University.

Figure 6

Yellow fruiting bodies containing spores produced by chestnut blight. Joseph O'Brien, USDA Forest Service, bugwood.org

creating branched filamentous hyphae (singular = hypha) that extend into the vascular tissue beneath the bark to obtain nutrients produced by the tree. Hyphae consist of a thin (less than 1/10 the diameter of a human hair) tubular array of cells (**Figure 1**). The hyphae intertwine and form bundles of filaments (**Figure 2**) that make up the body of the fungus, referred to as the mycelium (plural = mycelia) (**Figure 3**). Most of the cells in the mycelium of *C. parasitica* are haploid, i.e., the nucleus of each cell contains one complete set of chromosomes (nine different chromosomes in the case of *C. parasitica*). The hyphae extend by cell division at the tip of the filament. As the hyphae spread from the original site, adjacent tissue is killed and an open wound called a canker is formed on the tree (**Figure 4**). When a canker completely girdles a tree, which can take two to ten years, the flow of nutrients between the roots and the crown is blocked and the tree dies.

Cryphonectria parasitica reproduces by both an asexual process and a sexual process. In the asexual process, the fungus creates fruiting bodies (pycnidia) the size of a pinhead that extrude sticky yellowish-orange tendrils called cirrhi (singular = cirrhus) (**Figure 5**). These tendrils contain microscopic haploid spores called conidia (singular = conidium). A canker surrounded by a cluster of yellowish-orange dots on a chestnut tree is a strong indication of chestnut blight (**Figure 6**). The sticky conidia are released from the fruiting body and carried by birds, insects, and wind to nearby trees. Each conidium is capable of forming a new organism (mycelium) that can reproduce by an asexual or sexual process. The mycelium that grows from a conidium is genetically identical to the parent fungus and thus is essentially a clone.

To create genetic diversity, *C. parasitica* reproduces by a sexual process in which a conidium (functioning in this case as a male gamete) produced by a mycelium of one mating type fuses with a female reproductive structure produced on a hypha of a mycelium of a different mating type. This fusion results in a cell with two nuclei and initiates a complex process that ultimately results in production of a sac called an ascus (plural = asci) that contains haploid ascospores. Each ascospore is capable of forming a new organism (mycelium) that can reproduce by an asexual or sexual process. Millions of microscopic asci are enclosed in a fruiting body called a perithecium (plural = perithecia) (**Figure 7**) and are ejected through a tube into the surrounding environment. Sexual reproduction creates diversity because some of the genes in each ascospore are derived from one parent and some are derived from the other parent that participate in the mating process.

Although *C. parasitica* reproduces quickly beneath the bark of chestnut trees, it does not infect portions of chestnut trees that are below the soil. Consequently, the roots of infected chestnut trees may survive for many years and continue to send up new shoots. There are chestnut saplings in DuPont State Recreational Forest today that have sprung from the roots of trees that died more than 75 years ago. Most of these saplings will die from the blight before they produce fruit. One possible explanation for the failure of *C. parasitica* to reproduce in the roots of chestnut trees is the presence of microorganisms (bacteria and fungi) in the soil that secrete substances that inhibit the growth of *C. parasitica*. Dr. W. Weidlich reported at the 16th American Chestnut Symposium in 1978 that cankers on chestnut trees can be "cured" by packing soil around the canker. Although this method has been used, it is obviously an impractical remedy for thousands of infected trees.

Figure 7

Close up of sexual fruiting bodies called perithecia. Spores are released through the curved stalks called ostioles. With permission from the American Society of Microbiology and thanks to Dr. Donald Nuss. This photo appeared in an article by Sun, Choi, and Nuss published in 2009 in ***Eukaryotic Cell***, Volume 8, pages 262-270

Figure 8

Perhaps the tallest surviving American chestnut in the United States. Photo courtesy of Susan Sharon, Maine Public Radio.

When the blight was first discovered, it was thought that the most effective way to eliminate the fungus would be to remove all infected chestnut trees and wait a few years for the fungal spores to die out. In 1911, the Pennsylvania state legislature appropriated $275,000 to eradicate chestnut blight by cutting down every infected tree in the state. By the end of 1913, more than 50,000 chestnut trees had been cut down in Pennsylvania while the fungus continued to spread in neighboring states. We understand now that there are no simple, effective methods to rid the Appalachian forests of *C. parasitica* spores because the fungus continues to infect species such as white oak, scarlet oak, red maple, and shagbark hickory. These species have some resistance to the infection and thus are not killed, but they serve as effective hosts for the spread of fungal spores to chestnut saplings. Consequently, all attempts to reforest the Appalachian Mountains with American chestnut trees are focused on either finding or creating a variant that can thrive in the presence of *C. parasitica*.

Do variants of the American chestnut that are naturally resistant to *C. parasitica* exist in the wild? The American Chestnut Foundation, the USDA Forest Service, and many state forest services are constantly searching for such variants among the few saplings that have grown to maturity in the wild in the Appalachian Mountains

There are stands of mature American chestnuts that have prospered in areas where the blight is less prevalent. In 1885, Martin Hicks planted nine American chestnuts as a fence row on his farm near West Salem, Wisconsin. The trees produced enough fruit over the next hundred years to create a forest with more than 2,500 chestnut trees. In the last twenty years, most of those trees have succumbed to the blight, but a few are still producing flowers, pollen, and fruit that can be used for breeding purposes. There is a small grove of healthy American chestnut trees in Michigan, including one with a circumference of more than 10 feet. A 115 ft tall American chestnut tree was discovered in Maine in 2015 (**Figure 8**). Survival of these pockets of American chestnut trees is due primarily to a low incidence of *C. parasitica* in the area. Consequently, there are currently no known naturally-occurring, blight-resistant American chestnut trees that produce a sufficient supply of nuts to repopulate Appalachian forests. The alternative is to create a genetically-modified, blight-resistant tree using either traditional breeding methods or new technologies that incorporate genetic engineering, tissue culture, and/or clonal propagation.

Traditional breeding methods will be described in Part 2.

BIO:

Kent Wilcox is a retired scientist who lives in Cedar Mountain, NC. He has been a member of Friends of DuPont Forest since 2002 and served on its board for six years. He is a long-time member of The American Chestnut Foundation.

Round as a Ball, Sharp as an Awl

By Larry Brasher, Past President of the Alabama Chapter

Adron Willingham remembers gathering chestnuts on Red Mountain near his home in Greasy Cove, Alabama, when he was a youngster in 1950. The trees were dying remnants of the species in its southern range, the last to succumb to blight. Adron is someone folklorists call a "tradition bearer." He remembers and delights in old ways. He douses for water, plays the French harp, and plants by the signs. He also tells riddles he learned from elders as a child. At a Greasy Cove overnight for a college class I taught, Adron told a riddle that none of the students could answer:

Round as a ball,
Sharp as an awl;
Lives in the summer,
Dies in the fall.

The riddle, too, is a remnant of a time when young people would have guessed the answer – a chestnut.

On a recent visit to the Detroit Institute of Arts, my wife Louise and I, spotted the beautiful still life painting (pictured) by nineteenth-century artist John F. Francis (1808-1886). Francis painted it in Pennsylvania in 1858, also a place and time in which everyone knew chestnuts. In the painting along with the chestnuts, Francis features local apples and hard cider. His still life was prescient. We now welcome the return of heirloom apples, hard cider, and soon, the American chestnut.

"Still Life with Yellow Apples," 1858 (oil on canvas), Francis, John (1780-1861) / Detroit Institute of Arts, USA / Founders Society purchase and Gibb-Williams fund / Bridgeman Images

The Ripple Effect of Dr. William MacDonald

By Emily Nowels

Yilmaz Balci, USDA-APHIS, Riverdale, MD and former post-doc with Bill; wife Selin Balci, famous bio-artist who uses fungi for art; Roger Bartlett, accountant for Bill and Nora (Bill's wife); Bill, Nora, Shannon Geiman, Nora's niece from Hanover, PA, and her husband Jeff; Jane Schneider and husband Dennis Fulbright, colleague and friend from Michigan State University.

The 1975 cover of *Science Magazine* featured a somber black and white photograph of a bare chestnut tree devastated by blight. In West Virginia, a state once dominated by the American chestnut tree, the article stimulated increased interest throughout the state and legislature. In response to the article, the Forest Management Review Commission reached out to the dean at West Virginia University (WVU) to find out what WVU was doing to restore the chestnut tree. And at the time, the answer was: not much.

So, the Dean contacted Dr. William Lloyd MacDonald, who was an assistant professor researching the spread of oak wilt at WVU, and they held a meeting with a legislative committee that promptly granted WVU an appropriation of $10,000 to begin research. And with that, saving the American chestnut tree became the focus of Dr. MacDonald's career, as well as a deeply rooted passion.

MacDonald and his coworkers kicked off their research by holding a symposium, where more than 30 scientific papers were presented to over 100 people. The event included presentations from two European scientists on the topic of hypovirulence, which in layman's terms, refers to controlling the chestnut blight through a virus that spreads and kills the fungus infecting chestnut trees.

This strategy had proved highly effective in controlling the chestnut blight in locations throughout Europe, and MacDonald was interested in how the phenomenon might be applicable in North America. This quickly became his main focus. For more than 35 years, MacDonald conducted numerous experiments and co-authored many research papers on the topic.

"When I first came to WVU, my predecessor spent a couple weeks with me. [...] I can remember him taking me out [...] and we stopped and looked at some young chestnut sprouts. He said 'It's probably a lost cause, but it still sprouts,'" Dr. MacDonald recalls. "And I thought, well, I'll probably never have an opportunity to work with that tree. Little did I know that this phenomenon of hypovirulence would come along and really, I'd say, change my life, as the tree has changed my life."

"When I first came to WVU, my predecessor spent a couple weeks with me. [...] He said 'It's probably a lost cause, but it still sprouts,'" Dr. MacDonald recalls. "And I thought, well, I'll probably never have an opportunity to work with that tree. Little did I know that this phenomenon of hypovirulence would come along and really, I'd say, change my life, as the tree has changed my life."

Around the same time that MacDonald was becoming involved in chestnut research in the East, another group of scientists in Minnesota, including plant geneticist Charles Burnham, were also taking a keen interest in the chestnut tree. An interest which eventually grew into the establishment of The American Chestnut Foundation (TACF) in 1983.

Given Burnham's success as a breeder, the group in Minnesota was largely focused on developing blight-resistant chestnut trees through an advanced breeding program. But they were also intrigued by hypovirulence, so they invited Dr. MacDonald to a meeting to speak on the phenomenon. Not long after, they invited MacDonald to become a member of their organization.

In addition to MacDonald's research, he was also key to the development of TACF due to his connections

MacDonald's colleagues, former students, family, and close friends attended the three-hour celebration, some of whom he hadn't seen in decades.

on the east coast. Afterall, while there was no lack of passion in Minnesota, the fact remained that chestnuts were never very prevalent in the state and a majority of the research at the time was based in the East.

Over the years, the breeding program has often taken the spotlight, and the application of hypovirulence has had its struggles, mainly in getting the virus to spread in a natural environment. However, MacDonald still believes hypovirulence has a role to play. Partially due to the fact that it reduces the need to reintroduce an entire population of trees to the forest.

"Control the fungus and then you've got the American chestnut back as it was.[...] The trees that still exist today could survive. So, I think we still hold out that hope," MacDonald said. "Currently, we have a project at the university we call our marriage experiment. We have a lot of the hybrids from TACF planted in one of our research farms, and we are using hypervirulence in conjunction with the hybrids to see how the two types of technologies can be married."

When asked about his contributions to TACF and the chestnut, MacDonald will humbly redirect the conversation back to the importance of the tree and the science at work around it. But the fact is, he has been a key player through the years. In 1997, he was awarded the USDA Secretary of Agriculture Honor Award for Excellence, and in 1998 he received WVU's Benedum Award for outstanding research. TACF also presented him with the 2004 Board of Director's Award for 18 years of dedicated service.

But perhaps his greatest contribution throughout the years, has been his role as a teacher and mentor, inspiring new generations to study the American chestnut tree.

Dr. Mannon Gallegly, Professor Emeritus at WVU said, "First and foremost, Dr. MacDonald is an educator. His impact can be found in a quote from noted CBS news anchor, Dan Rather who said, 'The dream begins with a teacher who believes in you, who tugs and leads you to the next plateau, sometimes poking you with a sharp stick called the truth.'"

The students MacDonald has mentored have become successful teachers, doctors and veterinarians, working at universities from Texas A&M to the University of Maine and federal agencies ranging from the USDA Animal Plant Inspection Service to the National Institute of Health. Many have become TACF members, and continue to follow the tree's progress.

MacDonald's long-time friend and research assistant Mark Double said, "A stone tossed into a pond produces a multitude of ripples; the ripple effect of Dr. MacDonald's influence can be seen across the nation."

This August, Double planned an evening to celebrate MacDonald's 46 years of service at WVU.

Eighty-four people attended the event, many of whom MacDonald hadn't seen in decades. President and CEO Lisa Thomson and Vice President for Operations Betsy Gamber traveled from Asheville to attend.

"What struck me was the length and breadth of Bill's influence with faculty colleagues, former and current graduate students, and field volunteers who attended, near and far. Many of these loyal followers are devoting their academic research or life's interest to bringing back the American chestnut, thanks to Bill's mentoring and encouragement," Thomson said. "Bill handled his evening of glowing tributes with his natural graciousness and humility, which all made for an unforgettable experience."

MacDonald is grateful for the people he's met along the way, and calls them the highlight of his career so far.

"Probably my best memories are the interactions with people in the meetings where we exchanged scientific ideas principally relative to chestnut," MacDonald said. "This, along with students and colleagues, many of whom became close friends."

How to Roast Chestnuts the Right Way

Roasted chestnuts ready to serve.

Sakshi selling his roasted chestnuts at Greenlife Grocery in Asheville.

Sakshi Gantenbain knows how to roast chestnuts the right way, and that's not an easy task, as there are many ways to get it wrong! He's been roasting and selling the delectable chestnuts since 2000 in Asheville, NC, and many years before that in Switzerland.

When asked about what's key to the roasting process, Sakshi says it begins well before the chestnut is to be scored and ready for the oven or fire. "Knowing how to store and keep them fresh is where it all starts. They need to be nice and dry and kept in a cool place since they're very perishable," explains Sakshi. Doing this shortly after harvesting or buying chestnuts, gives one the ability to roast them all season long. If you score them across their rounded surface and put them in a freezer bag, they'll keep even longer.

One of the great pleasures of eating roasted chestnuts isn't just the sweet flavor. It's one of those foods that isn't available year-round, so it represents special moments and memories, like the holidays, festive gatherings, and creating delicious chestnut dishes during the colder months of the year.

Sakshi generously offed this guide on how to make roasted chestnuts at home:

❶ **Preheat oven to 500 degrees.**

❷ **Put baking sheet or cast iron pan in oven until hot.**

❸ **Take scored chestnuts and carefully place them on baking sheet, one layer thick.** (Chestnuts should be scored from "ear to ear" on the rounded side, not the flat side.)

❹ **In about 5 minutes, use a wooden spoon (or your hands in an oven mitt) to stir, and lower temperature to 475 F.**

❺ **Stir every 5 minutes until done, which may take 25 minutes.** They are done when the chestnut is no longer glossy, but matte, and when you take your thumb nail and press into it and it gives a little (like a boiled potato).

❻ **Wait a few minutes to pick them up so you don't burn your fingers.** Open them by gently squeezing and pulling apart the sides of the shell. Enjoy!

Sakshi can be found selling his roasted chestnuts in October, November, December, and January in Asheville, outside of Greenlife Grocery, and at the Dickens Festival in Biltmore Village.

Remembering Stacey Levin

By Doug Levin, Virginia Chapter

In 2011, Stacey and her soulmate Doug moved to Abingdon, Virginia from central New Jersey seeking a simpler way of life. That winter they enrolled in the local Master Gardener class, and first discovered The American Chestnut Foundation and the Southwest Virginia Restoration Branch as a way to earn volunteer hours. Their prior knowledge of the American chestnut could be summarized in the phrase, "I think it's a tree."

Intrigued by the chestnut story and the work going on in nearby Meadowview, they joined the branch, were soon coordinating volunteer efforts and quickly became a driving force within the group. Stacey enjoyed all aspects of physical restoration work and along with Doug, became fixtures at the branch information table displayed at area spring events, sharing the story and her smile with those she met. Stacey took pride in promoting education, participated for several years in a county-wide event for all area middle schoolers and helped plan the first traveling teacher-in-service program for the branch. Doing this helped TACF's story reach teachers well outside the Meadowview area.

When not volunteering for TACF, Stacey could be found working in the garden, hiking, kayaking, baking, traveling or volunteering for the Mount Rogers Appalachian Trail Club, Washington County Master Gardeners or the National Park Service on Lake Powell, a favorite destination. In everything she did, her energy and infectious laugh inspired everyone around her.

People are said to "battle" cancer. Stacey denied its existence, ignored the side effects of treatment and lived life to the fullest for nearly all 15 years following her first diagnosis. She will be missed by all who knew her but will live on in the memory of each and every one of us.

"Stacey was the most wonderful kind of volunteer to work with. She always came with good ideas and a fun attitude. She and Doug were the most amazing team and have been an inspiration to our branch."

Tommie Waters

"Whether cutting hundreds of weed mats for chestnut seedlings or spending half a day in the mud picking through wormy apples, Stacey's constant bright and positive spirit inspired the best from others."

Stan & Anne Tucker

"We have all benefited from Stacey's persistent, positive outlook on life. I recall a time that came close to testing this upbeat attitude. It was a cold, windy, miserable day in March but there was Stacey with her warm smile, reminding the rest of us to enjoy being out on a beautiful snow-covered mountain planting chestnuts."

Dick Olson

IN MEMORY AND IN HONOR OF OUR TACF MEMBERS

MARCH 28, 2017 – AUGUST 25, 2017

IN MEMORY

Essie Burnworth
from:
Victoria Jaycox

Emilie B. K. Crown
from:
Dr. Gary and Darlene Carver

Lyle Forer
from:
Beth Keller

Richard Gaier
from:
Robert and Elaine Bryan
Kenneth Boben, Jr.
Jane Gilbert
Sharon McCague and family
Stephen Robinson
Thomas Stephanic

Ray Henry
from:
Faye Henry

William Hofert
from:
William Hofert

Ben M. Laursen
from:
John Laursen

Roy Eugene Leach
from:
Megan Robertson

Stacey Levin
from:
Candacia Hebda
Diana and Paul Rosenberg

Nick Lopata
from:
Theresa and Robert Fitzgerald
Thomas Gift
Patrick and Melody Kemp
Thomas Lopata
Ellen Martignetti

Tina Lorentzen
from:
Eric S. Lorentzen

Monroe Marlowe
from:
Monroe U. Marlowe

Edward L. Nicholson
from:
Shirley Nicholson

Walter M. Norton
from:
Sandra Davis

William Payne
from:
Jacqueline Payne

Dr. Alfred Karl Pfister
from:
Nancy Pfister

Chan Robbins
from:
Patuxent Wildlife Research and Graham Humes

Ed Cooley Roberts
from:
Joseph Perella
Ralph Ripley
Doug Roberts
Christine and Ed Schultz
Kathryn Swiatek

Edgar and Ruth Smith
from:
Carolyn R. Smith

Ivan Smith
from:
Johnny Mullen

Thomas Sumter Sparrow
from:
James T. Sparrow

Gene and Norma Stoots
from:
Ed Stoots

Mrs. Eleanor Thorsen
from:
Nancy Gray
Jim Thorsen

Jack C. Torkelson
from:
Vicki Turner

Charles Wilkins
from:
Johnny Mullen

James Martin Wilson
from:
Jeananne Campbell
Carol Cavallo and Betty Tumelavich
Carl and Nancy Clark
Meagan Cupka
Glenn C. Edwards
Geri and John Engel
Jay and Paige Frith
Ann Gallagher
W. Lee Hussey
Carol and A.J. Melton
SMP Association
David Perry
Maryann Senderling
Margaret Smith
Jan Thomas

Arlene Wirsig
from:
Arthur and Nancy Loefstedt
Lisa and Walter Thomson

Louis J. Yess
from:
Vivian Wadlin

IN HONOR

Bruce Crawford
from:
Sybil L. Crawford

Doug Gillis
from:
Anonymous

Jones Bender Hamilton
From:
Kenn Nilsen

Dr. Fred Hebard
from:
Richard and Carol Will

Stuart Johnson
from:
Cynthia D. Tall

Larry McReynolds
from:
Larry Joe McReynolds

Skip Mersereau
from:
James and Barbara Mersereau

Eustace B. Nifkin
from:
Ann G. Knudson

Dick Olson
from:
Jack Webb

Shirley Porter
from:
David Lee

K.O. Summerville
from:
Steve Barilovits III
Robert L. Johnson
Don Surrette
Dr. Greg Weaver

Lisa Thomson
from:
Robert L. Burns
Highland Biological Station
Mimosa Garden Club
Polly and Thaddeus Seymour
Toxaway Falls Garden Club

Volunteers of the Virginia Chapter
from:
Deborah Fialka

John Wenderoth
from:
Alan Palmer

Jared Westbrook
from:
Highland Biological Station
Toxaway Falls Garden Club

We regret any errors or omissions and hope you will bring them to our attention.

THE AMERICAN CHESTNUT FOUNDATION®

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