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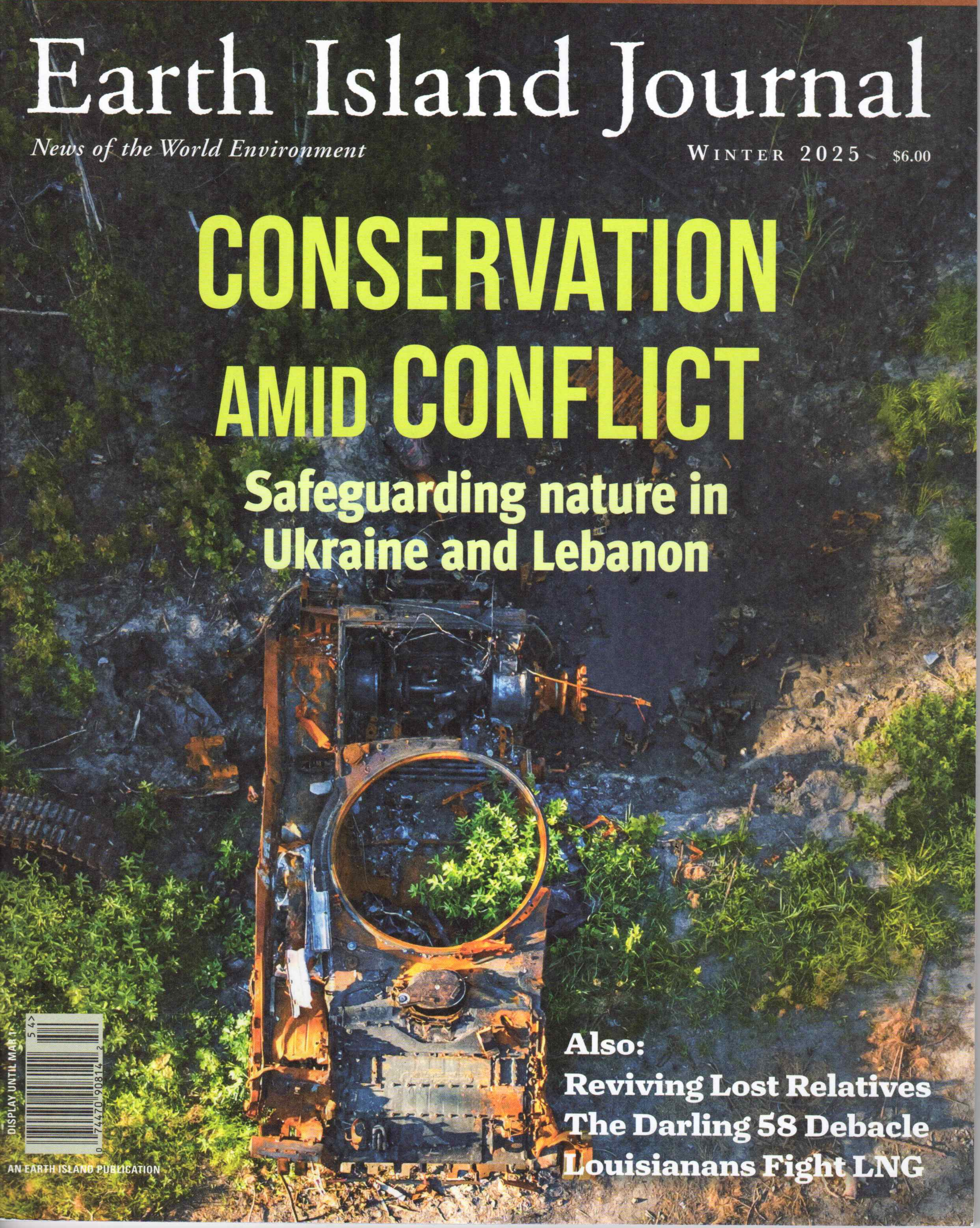

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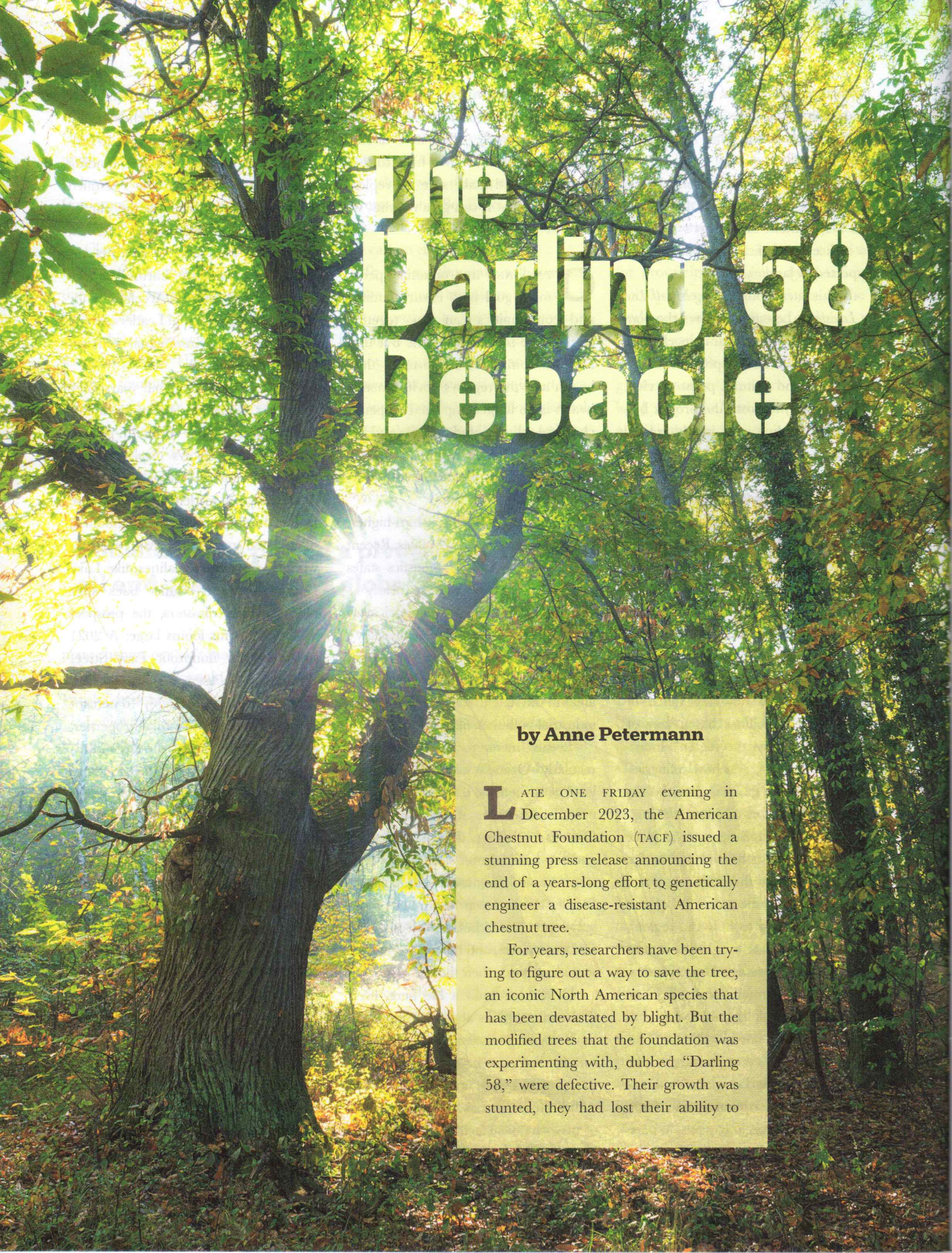

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The Darling 58 Debacle

by Anne Petermann

LATE ONE FRIDAY evening in December 2023, the American Chestnut Foundation (TACF) issued a stunning press release announcing the end of a years-long effort to genetically engineer a disease-resistant American chestnut tree.

For years, researchers have been trying to figure out a way to save the tree, an iconic North American species that has been devastated by blight. But the modified trees that the foundation was experimenting with, dubbed "Darling 58," were defective. Their growth was stunted, they had lost their ability to fight off disease, and many of them had died. For proponents of genetic engineering (GE), the news was a major setback. To those of us who prefer less extreme measures, however, it was a reprieve.

Until the early 1900s, the American chestnut tree was common across the Eastern United States and was an important component of the forest ecosystem that provided food for Indigenous peoples as well as for wildlife. Then disaster hit. The spread of an introduced blight devastated the species. This prompted dramatic but failed attempts by scientists, foresters, and government agencies to try to prevent the spread of the blight, caused by a foreign fungus called *Cryphonectria parasitica*, a native to East and Southeast Asia that made its way into Europe and North America in the early 1900s. These efforts included cutting down countless American chestnuts, including healthy ones that might have been able to tolerate the disease.

Today, an estimated 4 million American chestnuts still exist in the forests of the eastern US. Most of these have sprouted from the stumps of the felled giants, but some are large survivors that never succumbed to the disease.

Efforts are underway to build the population back, but there are two camps. On one side, anti-GMO American chestnut restoration enthusiasts are working to bring the chestnut back naturally. The other camp, which advocates for GE interventions, believes in a faster approach. And it has a lot of backing.

The GE approach to chestnut rescue began in earnest in 1989, when a construction magnate from Buffalo, New York, Herb Darling, reached out to two researchers at the State University of New York's College of Environmental Science and Forestry (ESF), William Powell and Chuck Maynard, to see if they could use genetic engineering to create an American chestnut tree resistant to blight. One year later, Darling co-founded the New York chapter of the American Chestnut Foundation — a national organization established several years earlier with the goal of bringing back the American chestnut.

By 2013, the national leadership of TACF had also embraced the genetic engineering approach and began conducting research on the GE American chestnut in partnership with ESF, investing millions of dollars into ESF's research.

In 2020, three decades after Darling reached out to ESF, Powell submitted a petition to the US Department of Agriculture (USDA), requesting the agency deregulate the ESF's latest GE American chestnut tree, named "Darling 58," in honor of Herb Darling. The tree was modified with a wheat gene that enabled it to produce oxalate oxidase (OxO), an enzyme that neutralizes the acid produced by chestnut blight. Though it would not prevent the blight from infecting trees, researchers believed it would enable them to survive infection.

Many argued that the 2020 petition was premature. The trees, after all, had only been growing in controlled outdoor field trials for three years. If approved, though, the genetically engineered trees would be distributed — via widespread and unmonitored planting — throughout wild forests, with the aim to pollinate wild American "mother" chestnuts with transgenic pollen, thus spreading the GE trait farther and farther throughout the forests. The release of a self-spreading GMO plant into the wild had never been done before, and Donald Davis, author of *The American Chestnut: An Environmental History,* called this "a massive and irreversible experiment with our forests."

As it turned out, the skeptics were right. Three years was not enough time to understand the impacts of modifying the genes of a tree that can live for centuries.

Failed attempts to genetically engineer the American chestnut tree are a warning against rash solutions to complex problems.

SCIENCE MOVES SLOWLY, often more slowly than its backers might like. It can be hard to maintain sustained interest in the slow burn of rigorous testing, especially when an iconic tree is at stake. And yet, as we have learned time and time again, rash science can lead to devastating outcomes.

But there are always other forces at play. In the case of the American chestnut, those forces are large companies that would prefer less skepticism from the public when it comes to genetic modification of trees. If genetic engineering could return to North America one of its most beloved trees, perhaps the public might find other modifications more palatable. Greater public support would open the door to ever more modifications, with the potential to increase the production and profitability of timber, pulp, and

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even biofuels.

A large contingent of actors, in other words, wanted to see Darling 58 succeed. Among these was Duke Energy, which backed the GE chestnut because it hoped to grow it on strip-mined landscapes and, it said, "one day provide high-quality lumber [and] biomass fuel for electric generation." Duke worked with the US Forest Service (a federal agency that typically views forests as a crop) and others on a plan called the Forest Health Initiative, with the specific goal of removing regulatory barriers to GE tree development.

In 2009 and 2010, the initiative funneled some $1 million to ESF for chestnut research. Other financial and technical backers of the research have included ArborGen, the South Carolina-based GE tree research and development company, and the biotech giant Monsanto, which had fought a public backlash against its GMO crops since the 1980s.

There was yet another profit motive for the deregulation of the GE tree. According to reporting in *New York Magazine*, in 2022 ESF's research head, William Powell, began meeting with a for-profit company called American Castanea, a start up "whose founders saw a huge opportunity in meeting the intense demand for seedlings they expected to follow deregulation" of Darling 58, the magazine reported in June. A recent article in *Technology Review* notes that the genetic defects in ESF's genetically engineered Darling chestnuts have not stopped the idea to sell them for profit. The article says that the American Castanea is now planting and propagating Darling 58 in New York State and plans to plant "up to a million of its chestnuts per year as soon as they're ready and approved."

For its part, TACF eventually expressed "profound concerns" about ESF's deal with American Castanea, writing to its members in May that "pricing seedlings to yield a commercial profit would jeopardize success and is inconsistent with our commitment to advance TACF's mission."

Meanwhile, a juggernaut of pro-GE chestnut articles has continued to appear in the media, including *The New York Times*, *Wall Street Journal*, *National Geographic*, and *Washington Post*. A *Post* headline exemplifies the way national media have often framed this story: "Gene editing could revive a lost tree. Not everyone is on board." The take-away message of much of this coverage is that genetic engineering is the only hope for the American chestnut.

Whatever your opinion of genetically modified organisms, good science, no matter its aim, shouldn't be rushed.

But many scientists and researchers disagree. For more than 40 years, the American Chestnut Cooperators Foundation (ACCF) has dedicated its work to the restoration of the wild American chestnut, without the use of genetic engineering. The grassroots organization has done this by breeding together pure American chestnuts that exhibit some level of blight resistance. It began releasing the seedlings and nuts from this effort in 2022. "The American chestnut is not rare or extinct," the organization says in a letter to growers. "Existing healthy root systems continue to sprout prolifically throughout Eastern forests. If given advantage, these American chestnuts have potential to once again fill forest canopy space [and] can be competitive in natural forest settings."

Other efforts to restore the American chestnut include hybridizing American chestnuts with Chinese chestnuts, which are naturally resistant to the blight. This effort has been going on for decades and has resulted in a tree that is 15/16 American chestnut. The goal is a tree with the blight resistance of a Chinese chestnut but the physical characteristics of an American chestnut. Chinese chestnuts are short and bushy, better for orchards than forests. To compete in a forest, blight-resistant American chestnuts need to be taller. So far, the effort has not produced American chestnuts that would be likely to thrive in wild forests.

IN GENETIC ENGINEERING, there are many risks involved, one of which is the risk of human error. The Darling 58 story includes a bizarre turn that reminds us of the potential for mistakes and their widespread consequences.

In November 2023, TACF's chief conservation officer, Sara Fitzsimmons, told supporters that ESF researchers had made a crucial error: They had given TACF the wrong pollen, way back in 2016. All of the subsequent research on Darling 58, it turns out, was conducted on a completely different Darling variety, D54. And in that variety, an important gene had been deleted.

The research mix-up strained the relationship between the American Chestnut Foundation and the SUNY researchers. In December 2023, the foundation withdrew its support from ESF's tree research, citing the mix-up,

While some scientists have focused on genetic engineering to save the American chestnut, The American Chestnut Cooperators Foundation has been breeding pure trees that exhibit some level of blight resistance. It began releasing seedlings and nuts from this effort in 2022.

PHOTO HEATHER WHARRAM / ALAMY

along with "inconsistent blight resistance" in Darling 58 field trials and "decreased survival rates." They also cited the "commercialization of the D54/58 transgenic chestnut," due to the potential deal with American Castanea.

SUNY-ESF disagrees with the findings of TACF and their partner researchers. While they admit that the D54 has a deleted gene, they argue that this does not cause any problems. They do acknowledge, however, that their results are "premature at this stage due to small sample sizes."

Andrew Newhouse, the current director of the ESF lab, told *New York Magazine* in June that whether or not the variety is D58 or D54, it shows promise, and that their USDA deregulation efforts will continue. "The series of environmental tests we've done were actually done with Darling 54; some knowingly, and some when we thought it was 58," he told the magazine. "We've seen that it's not detrimental, it's not harmful to other organisms."

But scientists at the industrial agriculture watchdog group, Center for Food Safety, challenge this assertion. In comments to the USDA regarding ESF's deregulation petition, they called out the inadequacy of research and safety studies of Darling 58. Because American chestnuts live so long — several hundred years — and because they are not fully susceptible to blight until they are five years old, it would be premature to deregulate a genetically modified variety after only a few seasons of research, they said.

They also pointed out that the petition failed to adequately study how pollinators or other wildlife might be affected by the spread of Darling 58, noting that the studies did not actually use genetically engineered chestnut pollen.

"SUNY-ESF has a responsibility to withdraw its request for approval," Lucy Sharratt, coordinator of the Canadian Biotechnology Action Network (CBAN), says. "This genetically engineered tree has been found to be useless a full three years after developers asked the US government to approve its release. The developers rushed this GE tree into regulatory review based on assumptions and hope rather than sound science and valid testing."

This is a crucial lesson of the chestnut tree debacle. Whatever your opinion of genetically modified organisms, good science, no matter its aim, shouldn't be rushed. Yet ESF still wants the USDA to approve the deregulation request. Their 2024 Progress Report states, "At this stage we believe that Darling is suitable for release and further study as part of the restoration effort." The threat remains that these defective trees could be planted in forests and contaminate remaining wild chestnuts with genetically defective pollen. It could be a new disaster for the American chestnut, a possible end to the species.

The USDA confirms that the petition for deregulation is still pending and that they are waiting for additional information from ESF as to how they want to proceed.

The American Chestnut Foundation claims to have learned important lessons from the experience with Darling 58/54. And yet the group continues to publicly and enthusiastically promote

It's not just the American chestnut that is being genetically engineered. Other forms of GE tree research are underway, and opponents fear regulatory approval of GE chestnuts will pave the way for the approval of other GE trees as well.

genetic engineering as a "restoration" tool. Perhaps it hasn't learned a hard enough lesson.

The foundation insists it will now implement rigorous testing in GE experiments going forward, especially ahead of regulatory submissions. But it also wants its GE trees to be "comprehensively vetted and released in a reasonable time frame."

But when it comes to trees, what's a reasonable time frame?

American chestnuts do not even begin producing nuts until they are 20 or more years old. Yet testing the safety and efficacy of any GE organism must include several generations of the organism. Given this, "rigorous testing" in a "reasonable time frame" seems unlikely.

Rachel Smolker, director of Biofuelwatch, a nonprofit that works to raise awareness about the negative impacts of industrial biofuels, gets to the root of the problem. "Engineering trees is not about 'forest health,'" she says. The GE chestnut is instead a "Trojan horse for an industry that wants to profit from trees engineered to produce more biomass, grow faster, be more easily processed in biofuel refineries or pulp mills, or produce fuels and chemicals that can be used in industrial processes. Let's not be fooled by the restoration rhetoric."

THE IMPLICATIONS OF this debacle go beyond the Darling 58 debate. Many other GE trees are being developed for industrial products. In Brazil, the pulp giant Suzano has been given permission to commercially grow nine different varieties of eucalyptus trees genetically engineered with traits including resistance to Monsanto's RoundUp, the toxic glyphosate-based herbicide. The company is not yet developing these trees commercially due to a ban by the Forest Stewardship Council (which has banned the certification of any GE tree or GE tree product as one of its core principles since it was founded in 1993). This has been a significant market impediment to the commercial development of GE trees.

Yet other forms of GE tree research are underway, with the hope of evading regulation altogether. Gene editing is a form of genetic engineering that involves cutting specific genes out of the genome of an organism in order to confer or suppress specific traits in that organism. GE poplar trees are being edited to reduce their lignin, a fundamental component of trees that protects and strengthens them but that must be removed at great expense to make paper, engineered wood, and other products. Successfully developing low-lignin trees could be worth billions to industry. Because gene editing does not involve introducing foreign genes, many regulatory bodies do not consider gene-edited products as GMOs, and exclude them from regulation. The industry hopes the same will be true of the FSC.

But as Dr. Ricarda Steinbrecher, a molecular geneticist with the Federation of German Scientists, points out, gene editing is extremely disruptive and results in mutations and injuries to an organism's genome. Genes, she cautions, do not function alone, but have complex interactions with other genes as part of the whole genome, and when one or more genes are removed, it disrupts the genome in unpredictable ways.

Perhaps that is the lesson we should take away: Just because researchers know how to use genetic engineering technologies on trees does not mean they understand how these trees function when they grow — especially in the environment — once they have been tinkered with. The evolutionary mandate of trees and the financial mandate of corporations are not the same thing. ■

Anne Petermann is the co-founder and executive director of Global Justice Ecology Project. She currently coordinates the international Campaign to STOP GE Trees.

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