Conservation in the Face of Novel Pests and Pathogens

By Kayla Seaforth and Richard Sniezko

Pests and pathogens play an important role in natural selection but can also exact a toll on plant communities already strained by climate change and habitat fragmentation. With the arrival of emerald ash borer to Oregon, there is opportunity to examine how breeding efforts have helped develop more pest and pathogen-resilient genotypes. The genetic variation within a tree species is its key to evolving in the face of both biotic and abiotic threats or challenges. Even in the case of the threat of a non-native, invasive pest or pathogen this genetic variation may be key to assisting the recovery of a tree species. Selective plant breeding of this type has served society for thousands of years.

Port-Orford-Cedar

One story of successful genetic resistance breeding for forest trees comes from the USDA Forest Service's **Dorena Genetic Resource Center**, where Port-Orford-cedar has been selected and bred to resist the non-native, invasive pathogen *Phytophthora lateralis* that threatens its existence in areas of northern California and southern Oregon. With resistant seed now available and in use by numerous groups if current efforts continue, Port-Orford-cedar may be the first tree species to be functionally restored after being considered threatened by such an impactful pathogen.

After discovering some genetic resistance to the pathogen in the late 1980s, scientists quickly got to work breeding resistant trees and had the first resistant seedlings available for field trials in just five years. The resistant stock from seed orchards has been planted out in many locations since then, and staff at the Dorena Resource Center are aiming to increase the level and frequency of resistance and expand the number of parent trees (to increase genetic diversity) present in seed orchards. This is promising news for getting additional resistant Port-Orford-cedar back on the landscape and may provide a road map for quickly operationalizing the reintegration of genetically resistant stock back into reforestation and restoration efforts. Read more about the program to breed resistance Port-Orford-cedar **here**.

American Chestnut

The American Chestnut was almost entirely wiped out by the introduction of a devastating blight in the early 20th century. In 1983, **The American Chestnut Foundation (TACF)** was founded with the simple mission: "return the American chestnut to its historic range." The statement is simple, but the task is enormous. The efforts of TACF have brought together scientists to determine whether the blight resistance of the Chinese chestnut could be bred into the American chestnut, and backcrossed to American chestnut for a number of generations, so that eventually chestnuts nearly identical to those that covered the landscape of eastern North America before the blight arrived could coexist with the blight, thanks to the addition of resistance from the Chinese chestnut lineage. After several decades of working with breeding systems and extensive trial and error, TACF has bred trees that are likely resistant to the chestnut blight, and for the last 15 years have engaged groups across the American Southeast in

American chestnuts in experimental trials.

One major avenue for chestnut research and field trials has been mine site reclamation. These sites were formerly capped with non-contaminated soil and seeded with grasses (often non-native). Through many partnerships, these sites have been selected for planting trials of resistant American chestnuts, often with great results. Learn more about these efforts in **this story** by the New York Times.

Inoculation trial of whitebark pine. Photo Credit: Richard Sniezko

For more information on white pine blister rust and conservation efforts, including climate change considerations, this **article** by the USFS provides a great introduction and links for further reading.

field and silvicultural trials to work out the many details needed to return the chestnut to its historic range. A second group, lesser known, American Chestnut Cooperators Foundation (ACCF) has been working with the natural variation within American chestnut and their efforts are showing success, but as with most programs further breeding will be used to advance the level of resistance further.

Western White Pine

Another story of loss and restoration has taken place in the Western United States. Western white pines were a major element of the west's forests until the early 20th century when, in addition to overharvesting, pine-beetle outbreaks, and excessive fire suppression that led to limited regeneration opportunities, a non-native fungal pathogen that causes white pine blister rust disease was introduced to the landscape. All 5-needled pines are susceptible to the pathogen (there are nine species native to the U.S), but the impact of western white pine susceptibility was especially profound because of the tree's formerly large presence across the landscapes of the west. This pathogen and resulting disease reduced the white pine population to less than 10% of its historic range, according to a **report** by the US Forest Service.

While the blister rust brought overwhelming loss to western forests, as with most diseases, some resistant individuals were able to persist. Using materials from these individuals, resistant pine trees have been the subject of **breeding programs** since the 1950s, with numerous field trials to confirm their ability to survive in the presence of the pathogen. While this program was eventually successful, it may have been hampered somewhat by actions in the decades following the massive dieoff. Much of the unaffected white pine population was harvested to salvage what was left before it became infected with the rust. Looking back, many managers regret this decision, as it further reduced the available genepool for restoration efforts. The western white pine and Port-Orford-cedar are probably two of the top five examples in the world of successful disease resistance programs in forest trees to a non-native pathogen. A related five-needle pine species, whitebark pine, is now listed as threatened under ESA in the U.S., but the resistance breeding efforts and plans for a national restoration plan provide optimism for the future of this species.

Oregon Ash and Emerald Ash Borer

In 2022, the emerald ash borer (EAB), which has wiped out ash trees across much of the American east and midwest arrived in Forest Grove, Oregon, infesting the much beloved Oregon ash. This species has shown a high degree of mortality when exposed to EAB in first, early trials, and it is expected that much of the ash across Oregon, Washington and California will be killed over the next decades as the ash borer spreads. Scientists and managers have anticipated the arrival of EAB on the West Coast for several years, and response plans have been put into action.

Dr. Jennifer Koch and her team at the US Forest Service's **Northern Research Station** have been working hard to establish a genetic testing and breeding program for the eastern ash species that have been decimated by EAB already. Some genetic resistance has been observed, and work is ongoing to breed subsequent generations from the resistant parent trees. Most of this work has focused on green ash, however work is underway to collect and test white ash, black ash, blue ash and pumpkin ash, and in the past year Dr. Sniezko has sent her seedlings of Oregon ash for the first resistance testing. So far 16 families of Oregon ash have been sent to the Ohio facility, where they will be grown for another year before undergoing an initial round of resistance testing. Learn more about these efforts in a 2022 American Forests story **here**.

The **Dorena Genetic Resource Center** in Oregon and **WSU Puyallup's Research and Extension Center** in Washington have also set up a common garden trial to examine adaptive genetic variation. **Dr. Jill Hamilton** at Pennsylvania State University is also leading genomic screening of Oregon ash leaf materials to examine the pattern of genetic variation within and across conservation collections of the species, with hopes that this work will help with EAB-resistance breeding program development. Finally, a number of groups have contributed to conservation collections of Oregon ash seed over the last two years, with the most extensive collections to-date by Oregon Department of Forestry. Some of these seeds will be put into long term storage, while approximately one-third will be sent to Dorena to be a part of the center's "working collection."

Genetic resistant breeding specialists are hopeful that, like other species that have been severely impacted by novel pests and pathogens, the work to propagate and plant stock that is genetically resistant to EAB will spell hope for trees and ecosystems as the beetles become naturalized in North America.