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The American Chestnut: A Resilient Species?

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The early 20th century introduction of *Cryphonectria parasitica* into eastern North America resulted in a host-parasite interaction that eliminated the American chestnut (*Castanea dentata*) as a forest tree and had unparalleled ecologic, economic and sociologic consequences. Fortunately, the species has been saved from extinction by its ability to sprout from surviving root systems. Best survival has occurred on some of the poorer, rocky sites where the forest canopy is less complete, permitting more sunlight to reach the populations of understory chestnut sprouts. On most high-quality sites with closed canopies, the species likely is extinct. Restoration of the American chestnut, although a daunting task, may be possible as a result of concerted efforts to breed blight-resistant trees and research designed to diminish the virulence of the blight fungus. Two foundations have supported breeding as an approach to blight control. One is attempting to enhance the limited resistance that exists in the American species by intercrossing surviving American chestnut trees. The other has supported the back-cross breeding approach to generate hybrid chestnuts that possess traits phenotypically like the American chestnut but carry blight-resistance genes from their Oriental relatives. As these trees are developed they will be released into sites across the original chestnut range. Special attention will be paid to incorporate local germplasm so that the trees are regionally adapted. These plantings will represent small interbreeding populations that eventually will generate resistant seed. The discovery of hypoviruses that debilitate the chestnut blight fungus has been a noteworthy biological control in several areas of the world. This phenomenon could be instrumental to the survival of these small developing populations of trees breed for blight resistance, as well as to the residual American trees that still exist in the forest. This especially may be true for trees that do not possess higher levels of resistance. Any restoration approach must consider the many complex factors that regulated the ecosystems chestnut once was dominated.

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Historic Forests and Endemic Mountain Pine Beetle and Dwarf Mistletoe

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Mountain pine beetle has always been a significant disturbance agent in ponderosa and lodgepole pine forests in Colorado. Most studies have examined the impacts to forest structure associated with epidemic populations of a single disturbance agent. In this paper we address the role of endemic populations of mountain pine and their interactions with dwarf mistletoe infections in forest structure and, the accumulation of coarse woody debris. We also discuss how mixed forests in the Colorado Front Range have shifted over the last 1,000 years and discuss how we may be able to learn about future epidemics under climate change by understanding the past. Understanding the behavior of endemic disturbances and past stand history may allow us to "paint" a picture for the future and develop strategies to maintain the resiliency of our forests.

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Beech Bark Disease Resistance: Genetic Mechanisms and Markers for Management

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Beech Bark Disease (BBD) is widespread throughout the eastern United States and although it has devastated populations of American Beech (*Fagus grandifolia*), resilient survivors can regularly be found surrounded by infected trees. Estimates of infection can range from 80% to nearly 100% of beech in some areas with thousands of acres affected from Acadia National Park to the Great Smoky Mountains. Infection diminishes tree life expectancy drastically and has a detrimental effect on beech mast production. It has been generally assumed that resistance or susceptibility to BBD by beech has a genetic component that is either reinforced or compounded by environmental factors, respectively. Our laboratory has taken multiple approaches to begin to take a molecular snapshot to determine if there are real measurable differences in the expression of certain genes that can help a tree to withstand the onslaught of the beech scale, *Cryptococcus fagisuga* Lind, (and avoid the subsequent attack by the deadly fungi *Nectria coccinea* var. or *N. galligena* Bres.), the deadly pathogenic duo responsible for BBD. Before this molecular work could begin, it was essential for us to genotype the trees at our study site (over 200 trees in Poultney, Vermont, Deanne Nature Preserve) to ensure that we are truly comparing genotypically distinct trees (since beech can vegetatively reproduce). Our preliminary genomics studies have focused on three gene signals that are more prevalent/abundant in resistant beech trees relative to susceptible trees within the same stand. These promising leads implicated in BBD resistance have been linked to responses to environmental stressors in other plants. We are now in the process of evaluating these differences locally by using additional validation protocols. We will then screen trees regionally to see if these resistance mechanisms are universal. From here, inexpensive and efficient screening for BBD resistance can be provided directly to foresters. By actively managing for more resistant individuals, we can ensure the longevity of this critical and once abundant and healthy species of our eastern forests.

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The Northern Forest Futures Project: Projecting the Impact of Emerald Ash Borer Spread on Midwest and Northeast United States Forests through 2060

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Since being introduced to a novel environment in North America in the 1990s, the non-native invasive emerald ash borer (*Agrilus planipennis* Fairmaire; EAB) has caused considerable mortality to North American ash (*Fraxinus* spp.). In contrast to urban forests or street trees, there appear to be no economically viable treatments for ash in non-urban forest stands. Therefore, it is estimated that by 2055 EAB will kill nearly all ash throughout their ranges in eastern North America. Ash mortality will result in economic and ecological damage, including changes in forest composition and structure and resultant impacts on associated wildlife habitat and ecosystem functions. This may especially be the case in riparian and wetland systems where ash is prevalent. Forest landowners could potentially suffer losses in the hundreds of millions of dollars over the next decade. As part of the Northern Forest Futures Project, we used a series of models to project the future composition of forests after EAB-caused ash mortality. This presentation will describe the modeling framework and provide an overview of the model's results. Despite the assumption that EAB will cause almost complete mortality of *Fraxinus* spp., model results suggest a transition from ash to a variety of co-occurring species as forests slowly respond to EAB infestation.

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