USDA FS Forest Health Initiative Summary Report
September 2009 – July 2014

Introduction:
The Forest Health Initiative (FHI) is a collaborative effort supported by the USDA Forest Service, a private for-profit, and a non-profit organization, to support groundbreaking university and Forest Service research into the potential of using biotechnology to address forest health issues.

Originally envisioned with a challenge grant by the U.S. Endowment for Forestry and Communities, FHI is guided by a multi-stakeholder Steering Committee and supports work in a braided approach where scientific study operates openly in a collaborative effort with social/environmental and regulatory networks.

The primary purpose is to support core activities needed to promote the health and restoration of threatened forest tree species. These activities include biological science research that is creating technology platforms for genome-guided breeding and genetic engineering[1]. The activities of this biological research are reinforced by parallel activities focused on social, environmental and policy aspects of biotechnology, in order to engage broad communities of users seeking options for restoration of threatened forest tree species. The American chestnut (*Castanea dentata*) is the case study.

The FHI is a directed effort at developing and demonstrating a Rapid Response Plan for forest health issues. The RRP includes a careful analysis of the situation followed by a directed research effort that integrates work across the realm of biotechnologies, including genome sequencing and bioinformatics, population genotyping for breeding, early screening for disease resistance, micropropagation of the best genetic materials, and transformation of native genotypes with resistance genes from related and other plant species. All information generated is in the public domain and will be made readily available for reference and use.

In short, the FHI seeks to involve scientists, policymakers, and social, environmental and economic stakeholders in determining how biotechnology may be used in addressing forest health challenges.

Science Review:
Several biotechnologies are being developed that may influence American chestnut restoration. The sequencing of Chinese chestnut (*C. mollissima*) as a reference genome for the identification of blight resistance genes is completed and published. These data are now available to other researchers within and outside of FHI to inform breeding and engineering strategies for American chestnut and other related taxa such as *Quercus* and *Fagus spp*.

Several cooperators are providing germplasm identified across the range of American chestnut and its hybrids. This ensures that disease resistant trees within these programs can be quickly identified using biotechnologies developed by FHI and subsequently used in restoration plantings across the range of American chestnut.

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[1] Nelson, CD, WA Powell, CA Maynard, KM Baier, AE Newhouse, SA Merkle, CJ Nairn, L Kong, JE Carlson, C Addo-Quaye, ME Staton, FV Hebard, LL Georgi, AG Abbott, BA Olukolu. 2013. The Forest Health Initiative, American chestnut (*Castanea dentata*) as a Model for Forest Tree Restoration: Biological Research Program. Acta Hort (in press).

Twenty seven candidate genes for blight resistance have been introduced into American chestnut lines, producing 1554 transgenic trees that have been planted at 6 locations, and so far 20 events have demonstrated intermediate to high levels of resistance according to a newly developed leaf assay. This early blight resistance screening protocol can consistently distinguish between blight resistant and susceptible chestnut seedlings, reducing the testing time by 4 years. In addition, work with Clemson and TACF-NC cooperators is progressing to test trees engineered with *Phytophthora* resistance candidate genes for resistance against root rot.

Tree cloning using somatic embryogenesis technology is being successfully developed, providing a means to potentially mass-produce the most resistant genotypes for restoration plantings. In addition, embryogenic cultures have been cryogenically stored, allowing conservation of the full range of native germplasm. Somatic seedlings derived from potentially blight-resistant large surviving American chestnuts as well as hybrid backcross material are being produced and field tested by cooperators.

Field trials now underway include mixed plantings of transgenic, hybrid, and native chestnut clones on sites along the species range and include one reclaimed mine site. These will be evaluated for essential physiological characteristics, including viability, growth, adaptability, growth form, and blight and root rot resistance. All of these approaches augment current efforts and offer additional mechanisms to generate disease resistant trees for evaluation in restoration plantings.

Research is being lead by Principle Investigators at five Universities (John Carlson, Penn State; Bill Powell and Chuck Maynard, SUNY- Syracuse; Scott Merkle, University of Georgia; Jason Holliday, Virginia Tech; and Mark Needham, Oregon State University) and the Southern Research Station (Dana Nelson).

Social and Environmental Review:
Assuming genetically engineered (GE) trees are found useful for restoration, the Social and Environmental and Policy/Regulatory groups are working to see if and how this will be feasible. The social and environmental aspects to introduction of a GE American chestnut are of paramount importance. These issues are being directly addressed by 1) a stakeholder group populated with a broad diversity of federal and state agencies, conservation groups, landowner organizations, foundations, academics and industry and 2) a Social Science research project entitled "Forest Health Biotechnologies: What are the Drivers of Public Acceptance?" The latter involves group meetings with stakeholders and constituents, public surveys, and the impacts of message information and framing.

Policy/Regulatory Review:
U.S. Regulatory agencies, APHIS, EPA and FDA, were brought into the process early and consulted regularly to ensure that all research and development activities and products comply with all regulations. This also catalyzes thought and discussion around using GE for species restoration; that is going beyond the usual industrial perspective for GE products. At present this group is being led by Adam Costanza and Susan McCord, Institute of Forest Biotechnology.

Outreach Review:
An interactive Roadmap was developed and is accessible from the FHI website at foresthealthinitiative.org. The goal of this material is to support civil discourse and inform decisions about how to respond to current and potential forest health threats. The emphasis is on deciding if and how to intervene, with a focus on when genetic approaches to improving tree resistance might be appropriate to pursue. A video describing the FHI can be found at the website and is aimed at informing the public.