Establishment of a Tropical Hardwood Tree Regeneration and Improvement Program in the State of Hawaii with a Focus on Research and Application Needs

Problem
Climate change and new diseases threaten native species across Hawaii and the Pacific, with potentially large impacts for both dry and wet forest species. Climate change will also be affecting the tropics broadly – especially changes in precipitation – as will the accidentally but continued introduction of diseases and pests. These threats are growing, but responses are lagging because understanding of appropriate planting materials and actions are lacking across this quickly changing region. Overall, tropical tree improvement and regeneration lags behind that of temperate regions, despite the global role of tropical biodiversity, the importance of tropical timber production, and the growing need for large-scale approaches to restoration.

Need
There is a growing need for an expanded capacity in tropical hardwood tree improvement and regeneration to serve the needs of Hawaii, the US Affiliated Pacific Islands, and Pacific Rim nations. In Hawaii, there is a specific need for an *Acacia koa* improvement and regeneration program. *Acacia koa*, a fast-growing tree Hawaiian endemic of great ecological, economic and cultural value, is a member of a globally important and widely planted genus, but our understanding of *A. koa* silvicultural practices remains rudimentary. Such a program would address the following needs: (i) the restoration or rehabilitation of currently degraded sites with improved *A. koa* material; (ii) expanded reintroduction of improved *A. koa* into fire prone and / or invaded areas; (iii) expanded supplies of improved *A. koa* materials for restoration planting with improved disease resistance, growth rates, and canopy attributes; (iv) provision of technical assistance to private sector efforts with material to produce improved *A. koa* materials, including disease resistance, tree form, wood quality and growth rates; (v) assisting with the building of partnerships and or cooperatives dedicated to this species; (vi) develop new sources of *A. koa* for planting at low elevations, and improved materials for mid and high elevations sources; and (vii) refine or create new regeneration techniques to enhance nursery practices and the deployment of new materials across Hawaii. Hawaii also has large expanses of previously forested but now degraded agricultural or pastoral lands (>200,000 acres) that currently support only marginally economically viable activities. These lands also are becoming hot spots for invasion by noxious weed species, often bringing with them novel fire regimes that threaten to further degrade sites through lost nutrients and soil erosion. For two decades, afforestation of limited areas of high elevation pasture lands with *A. koa* has shown that such a strategy can achieve multiple objectives: high value timber production, enhanced watershed function, soil rehabilitation, site restoration, increased ecological benefits for wildlife, mitigation of the effects of invasive species, and
increasing carbon sequestration. This fast growing species has high genetic diversity and nitrogen-fixation rates that can exceed 20 kg N ha\(^{-1}\) yr\(^{-1}\) in young stands, and so the potential exists for a greatly expanded approach to A. koa regeneration and improvement, but the technologies have been lacking – especially for low elevations where A. koa is strongly affected by disease and pest issues. Other native species also are threatened by climate change, imported diseases and pests, and so also will need to be the focus of a diversified regeneration and improvement effort. A tropical improvement and regeneration center will provide critical expertise for improving the management of other native species, especially for the disease resistance and growth required to adapt to new climate conditions. To this end, such a tropical program will provide critical expertise in tree regeneration and improvement for the 100s of federally listed plant species in Hawaii – many with populations of <1000 individuals in the wild.

The Case for the Pacific Region. Across the Pacific region including the US Affiliated Pacific Islands and southeast Asia, there are tremendous opportunities for Hawaii-based tree improvement and regeneration program – for conservation and restoration but also commercial forestry applications. A Hawaii-based program could provide critical resources and expertise in tackling a multitude of forest-related issues across the Pacific. The PSW Research Station and State and Private Forestry – Region 5, through their various programs in Hawaii and across the region, have developed a network of forestry professionals who are increasingly prepared to take advantage of a tropical tree improvement and regeneration program. Finally, there are growing international partnerships between the USDA Forest Service that would benefit from the creation of a tropical hardwood tree improvement and regeneration center. This new program ultimately will enhance capacity in land management by expanding options for ecosystem restoration at watershed to landscape scales, with benefits to watershed function, as well as cultural and economic benefits. By creating management and improvement options for native flora across Hawaii and the Pacific, this effort also will help to maintain the deep cultural linkages between native peoples and the forest.

Background

A workshop, “Emerging silvicultural technologies for Acacia koa restoration” was conducted in Hilo, Hawaii, March 3-4, 2010. The workshop identified key land-use issues contributing to the need for hardwood tree improvement and regeneration: (i) conversion of low elevation forests for crops and higher elevation forests for livestock grazing; (ii) overharvesting of koa timber with little sustainable management; and (iii) forest degradation by exotic plants and animals. This workshop brought together 50+ natural resource and conservation partners, including Hawaii-based administrators and resource specialists from Universities, federal and state agencies, private industry, NGO’s, and landowner community. The workshop consisted of presentations on tree improvement, nursery production, disease screening, and regeneration or restoration efforts. The workshop was organized because of the state of deforestation and forest degradation that exists for one of the World’s most economically valued hardwood species that also has significant cultural and ecological value. Further, the confluence of
changes has opened opportunities for land uses including koa forest restoration as well as koa forestry for commercial timber production. Workshop participants suggested that despite current conditions, opportunities to restore A. koa forests and the ecosystem services that those forests would provide exist because of:

- Decreased economic viability of cattle production in Hawaii
- Marginal economic viability of low value forestry operations in low elevations
- High ecological, cultural and economic value of restored native forests

**Regeneration objectives**

Hardwood planting of koa occurs because of multiple objectives by various landowner segments. Some is planted for timber, but to date most other trees are planted for conservation purposes, especially enhancing wildlife habitat for threatened avian species. Government incentives, both federal and state, would encourage conservation plantings while plantings for timber have the ability to be profitable on their own if planted and managed successfully. Broader regeneration needs exist for nearly all other native tree species of Hawaii and the U.S. affiliated Pacific Islands.

**Recommendations**

1. Develop stable funding for cost-share programs and possibly partner with NGO’s to increase public support.
2. Enhance current tree improvement efforts through the formation of a regional koa hardwood cooperative to expand nursery and tree improvement research and development.
3. Facilitate information exchange by convening the same workshop participants and other interested parties for workshops and field tours.
4. Develop regional advocacy for hardwood regeneration and management.

**Research, Development and Technology Transfer Needs**

**Genetics and Tree Improvement**

1. Expand investigations of the genetic diversity of koa populations and koa progeny trials, as well as for other native species using both traditional and molecular tools
2. Develop seed zones to guide movement of native seed and seedlings for restoration
3. Develop seed certification standards
4. Use molecular tools to identify economically and ecologically important traits.
5. Breed koa, and other native species for genetic improvement traits such as form, growth, yield, branch angle, wood quality, disease resistance and crown architecture.

6. Develop vegetative propagation techniques for elite clones of koa and other species

7. Provide koa research on stresses such as cold hardiness and wilt resistance

**Nursery Production**

1. Increase native species seed availability, especially for koa through expanded seed orchards across Hawaii

2. Develop seedling quality standards and improved nursery production methodologies

3. Transfer information and technical expertise on nursery management among users

**Field Establishment and Silviculture**

1. Develop site selection guidelines

2. Link nursery practices with field performance

3. Expand understanding of site preparation requirements, especially for degraded sites

4. Expand understanding of control measures for vegetation competition

5. Expand understanding of nutrition requirements

**US Forest Service response**

Considerable talent and expertise exists in the State of Hawaii and within the larger Pacific Southwest and Northern Research Stations of the USDA Forest Service. Within the PSW, research staff at the Institute of Pacific Islands Forestry has worked for decades on *A. koa*, while researchers with the Institute of Forest Genetics (IFG) and the National Forest Genetics Lab (NFGEL) have a strong capacity to conduct research in tree improvement. Researchers from the NRS-based Hardwood Tree Improvement and Regeneration Center (HTIRC) are already active in koa nursery production research on the Island of Hawaii, as are State and Private Region 5 staff. The PSW and R5 S&P would provide infrastructure and capacity support for this new effort. The HTIRC would aid in the development of a regional hardwood cooperative, which would include expectations for funding and staffing needs both at the Federal and University level and oversee the function of the Cooperative. The PSW would benefit from this effort and partnership by growing capacity in tropical hardwood improvement and regeneration, with one goal being to bridge California based scientists with those in Hawaii. The NRS would benefit by growing the HTIRC into an international center for hardwood tree improvement, while creating new opportunities for understanding the role of improvement and regeneration for northern hardwood species. Together, the partnership benefits from a shared effort to enhance capacity for tree improvement and regeneration for conservation, restoration and commercial forestry applications.
Expected Partners and Participants

**USDA Forest Service State and Private Forestry**
1. Diane Haase, Regional Nursery Specialist
2. Phil Canon, Regional Plant Pathologist, R5

**USDA Forest Service Research and Development**
1. Charles Michler, HTIRC Director – NRS
2. Andrew Groover, IFG – PSW
3. Valerie Hipkins, NFGEL – PSW
4. Kas Dumroes, National Nursery Specialist
5. Christian Giardina, Institute of Pacific Islands Forestry – PSW
6. Paul Scowcroft, Institute of Pacific Islands Forestry – PSW

**USDA NRCS**
1. Michael Whitt, Honolulu
2. David Clausnitzer, Waimea

**USFWS**
1. Loyal Merhoff
2. Steve Miller

**Mainland Universities**
1. Doug Jacobs, Asso. Prof. Forest Regeneration, Purdue University
2. Anthony Davis, Assist. Prof. and Dir. Center for Forest Nursery and Seedling Research, University of Idaho

**Hawaii Universities**
1. Christopher Dunn, University of Hawaii
2. Travis Idol, Asso. Prof., University of Hawaii, Manoa
3. James Leary, Assist. Specialist, University of Hawaii, Manoa
4. James Brewbaker, Prof., University of Hawaii, Manoa
5. J.B. Friday, Est. Forester, University of Hawaii, Manoa
6. Creighton Litton, Assist. Prof., University of Hawaii, Manoa

**Hawaii State Agencies**
1. Mike Robinson, Department of Hawaiian Home Lands
2. Mike Constantinides, Hawaii Division of Forestry and Wildlife

**NGO’s**
1. Peter Simmons, Kamehameha Schools
2. John Henhaw, The Nature Conservancy
3. Nick Dudley, Hawaii Agricultural Research Center
4. Chipper Wichman, NTGB
5. Deanna Spooner, Hawaii Conservation Alliance

**Industry**
1. Jill Wagner, Forest Nursery
2. Jeffrey Dunster, Hawaiian Legacy Hardwoods
3. Jonathan Keyser, Native Nursery LLC
4. Nick Koch, Forest Solutions
5. Hawaii Forest Industry Association