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Adapting forests to a changing climate

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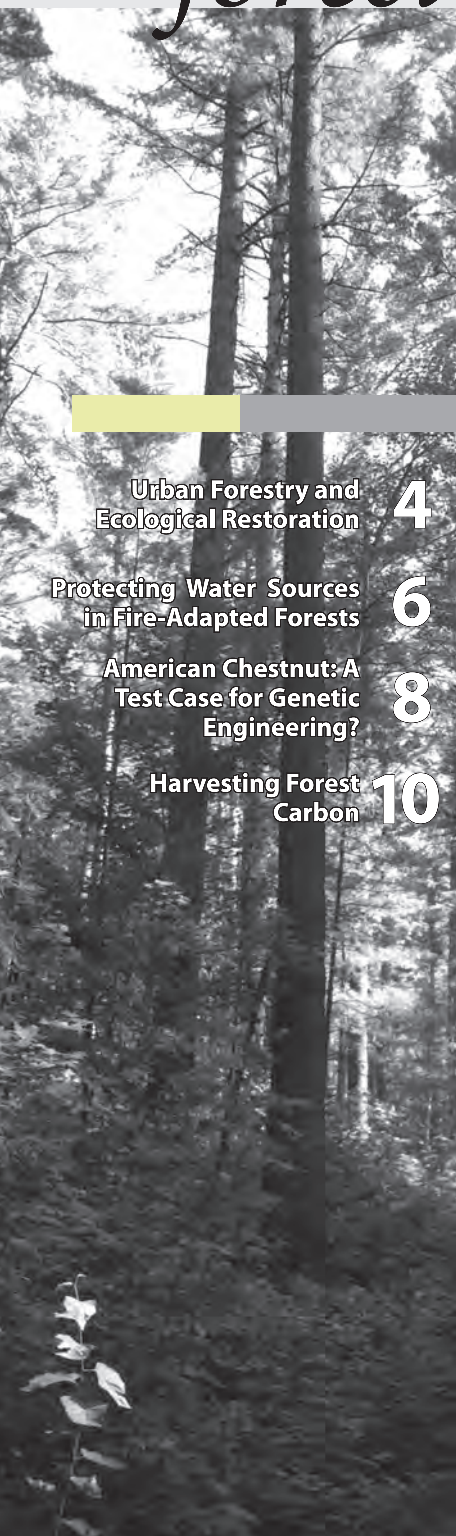

Climate Change Tools and Approaches for Land Managers: A Forest Adaptation Training

by Nancy Patch

The Vermont Department of Forests, Parks and Recreation (VTFPR), the Northern Institute of Applied Climate Science, and the US Forest Service (USFS) held a two-day workshop in December 2013 for foresters and other practitioners on Forest Adaptation Planning and Practices at the Vermont Technical College in Randolph, Vermont. This workshop was designed to approach the complicated issue of climate change from a practical and on-the-ground perspective. Training intermixed with interactive sessions allowed foresters to think about challenges in forest management implementation and how these challenges may be affected by climate change stress. These collaborative, real-world exercises were led by Maria Janowiak and Chris Swanston of USFS Northern Research Station, Houghton, Michigan; and Sandy Wilmot of VTFPR, Essex Junction, Vermont.

Prior to the workshop, participants were asked to review several publications as well as attend or review a webinar. In addition, all those planning to attend the second day were asked to assemble relevant materials to address management planning for an active project. The first workday started with Dr. Alan Betts of Atmospheric Research, Pittsford, Vermont, presenting comprehensive climate science, both predictions and current weather events that describe Vermont's changing climate. Dr. Betts set the stage for the rest of the working conference: the science is complicated, the predictions from models are being realized, and we cannot yet know what the outcome may be. So, how do we as forest managers make decisions and introduce actions to mitigate climate change effects when we cannot know the results of our actions?

The answer to that question is probably not a surprise to the readers of this publication. We foresters have always taken the long view, and that long view has always been unpredictable. Our past experience can inform our present. One comment heard throughout the two days was that actions that mitigate climate change effects are not that different from what we are doing right now. Both Swanston and Janowiak have heard this same comment in other areas of the country. (There may of course be a slight

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Above: Forest Adaptation Planning and Practices workshop.

Photo courtesy of Sandy Wilmot.

April, 2014

Dear Forest Guild members and friends,

2014 marks the 30-year anniversary of the founding of the Forest Trust – parent organization of the Forest Guild. Back in 1984, the Forest Trust, under the leadership of Henry Carey, had the vision that the best way to resolve natural resource management issues was not through conflict, but through cooperation and collaboration. The work of the Forest Trust was groundbreaking in the area of community-based forestry, collaborative forest restoration, and ethical forest stewardship. The emphasis on the latter gave birth to the National Network of Forest Practitioners, the Progressive Foresters Network, and the Forest Stewards Guild.

I recently went back and read the synthesis from the first meeting in 1995 of what would become the Forest Stewards Guild. Below is an excerpt.

> *In the concluding discussion, participants took a look at themselves as a group. They observed the common ground among them and noted points that differentiated them from the mainstream of the forestry profession as they perceived it. The essential cord that seemed to both unify and distinguish this group was identified by one participant as a "deeply held passion for the forest." This passion is perhaps the fundamental force behind the principles enunciated throughout the meeting.*

After almost 20 years, a deeply held passion for the forest remains the fundamental force behind the Forest Guild. While the Guild may not represent the mainstream of forestry yet, look how far we've come. The economic, ecological, and social principles that helped form the Forest Guild are reflected in forest certification, forest restoration policy, and state management practices. When considering such game-changing topics as climate change impacts on forests, it is hard to imagine not having leadership from an organization like the Forest Guild whose members take a principled approach to management.

Building on the Guild's tradition of thoughtful forest stewardship, this issue of Forest Wisdom shares Guild member perspectives and experiences on the topic of managing forests in a changing climate and leads into to a climate-change adaptation focus at the 2014 National Meeting, June 19–21 in Burlington, Vermont. The national meeting will once again provide an opportunity for a group of stewards with a deeply held passion for the forest to come together to identify solutions that benefit the entire forest ecosystem. The national meeting will also provide an opportunity to celebrate and reflect on 30 years of the Forest Trust and almost 20 years of the Forest Stewards Guild.

I hope to see you in Vermont in June.

Michael DeBonis, Executive Director

bias because of who attends these workshops.) Excellent forestry is an ethic of the Guild and practiced by many but not all in the profession. The biggest difference between what we can do to mitigate climate change and what we are doing already is to look for the nuance, have intentionality in planning and implementation, talk to landowners about the subject without fear, lead by example, and recognize that what we have experienced in forest change will be far greater in decades to come.

But where to start? The main publication used in the workshop was *Forest Adaptation Resources: Climate Change Tools and Approaches for Landowners*, General Technical Report NRS-87, 2012, edited by Chris Swanston and Maria Janowiak www.nrs.fs.fed.us/pubs/42179. As stated in its introduction, "This publication provides a wide-ranging menu of adaptation strategies relevant to Northern Wisconsin in a workbook form, to help land managers consider ecosystem vulnerabilities, select adaptation approaches that meet their needs, and devise tactics for implementing them."

The ten adaptation strategies described include the following:

1. Sustain fundamental ecological functions
2. Reduce the impact of existing biological stressors
3. Protect forests from severe fire and wind disturbance
4. Maintain or create refugia
5. Maintain and enhance species and structural diversity
6. Increase ecosystem redundancy across the landscape
7. Promote landscape connectivity
8. Enhance genetic diversity
9. Facilitate community adjustments through species transitions
10. Plan for and respond to disturbance

The strategies and approaches in this document provide a variety of ways to approach climate change through resistance, resilience, and response (transition). Resistance improves the forest's defenses against anticipated changes or directly defends the forest against disturbance in order to maintain relatively unchanged conditions. An example would be in Strategy 2: Reduce the impact of existing biological stressors; Approach 2.2: Prevent the introduction and establishment of invasive plant species and remove exotic invasives. Resilience actions accommodate some degree of change, but encourage a return to prior conditions after a disturbance, whether naturally or through management. An example of resilience could be Strategy 3: Protect forests from severe fire and wind disturbance; Approach 3.3: Alter forest structure to reduce severity or extent of wind and ice damage. Altering

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Nancy Patch
Nancy is a county forester for the Vermont Department of Forests, Parks and Recreation, and was a consulting forester for many years prior to her state employment. Nancy was also recently elected to the Forest Guild Membership Policy Council.

At left: 2010 frost damage.

Photo courtesy of Sandy Wilmot.

Cover photo at top: 2011 Hinesburg windstorm.

Photo courtesy of Sandy Wilmot.

Cover photo at left: Marsh-Billings-Rockefeller National Historic Park.

Photo courtesy of Amanda Mahaffey.



Exploring the Intersection of Urban Forestry and Ecological Restoration: Challenges, Opportunities, and Random Musings

by Michael Leff

Michael Leff
Michael Leff is a research urban forester with the Davey Institute, a division of the Davey Tree Expert Company. He is based at the USDA Forest Service Philadelphia Field Station, where, among other things, he is leading the development of "Sustainable Urban Forestry Standards."

Having both feet in both camps, I strongly believe that urban forestry must be viewed and pursued as a form of ecological restoration. In addition to its direct ecosystem benefits to the urban environment itself, the urban forest plays a critical role in the health and function of surrounding natural areas, especially where urbanization is dense and likely to increase. And, I believe, it is a linchpin to the integrity and resilience of the environment at the broadest regional and even global levels.

This article, which is based on a recent presentation at a Forest Guild conference in New Jersey, will give an overview of the various considerations involved, including challenges and opportunities. But first, a few definitions:

Ecological restoration is…

> *the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed*.

That's the official definition from the Society for Ecological Restoration. To me, it's an invitation to push urban forestry further than it might otherwise be inclined to go.

What's an "urban forest"?

There is no set definition of that concept. In fact, some folks seem to think it's something of an oxymoron. But practitioners in urbanized areas know better.

For my purposes, I describe the urban forest as including all vegetation layers – canopy and understory trees for sure, but also shrubs and the herbaceous layer. It includes street and park trees as well as natural areas, but it also includes trees and other vegetation on private property – which is in fact where most of the urban forest is situated.

These days, it's equally important to consider where trees are not – but might be. That's especially so because of declining tree cover in most cities, due to multiple factors ranging from rampant development to simple senescence. So in thinking about the urban forest, it's wise to look for places that could support more trees, including worthless turf and needlessly paved areas.

Beyond all that, I would include everything else it takes to make a forest from the trees: the soil, water, and even the air we – and trees – breathe.

The scope and practice of **urban forestry,** then, embraces everything it takes to understand, protect, manage, improve, and grow the urban forest. And that involves many of the same or similar concerns as ecological restoration, in this case with a focus on a particular ecosystem – namely, the urban ecosystem, which, to reflect back on the textbook definition of ecological restoration, is certainly highly degraded, if not outright damaged or destroyed.

Unlike some, I don't take a purist stance toward ecological restoration. To me, it's not an absolute condition, but rather a spectrum of possibilities, depending on setting, structure, time, and resources (human, material, and financial), plus climate change, or "global weirding," and a dash of the unknown. My philosophy can be summed up this way:

> I believe, especially in an urban context, that every effort to manage the landscape should be informed by the principles of ecological restoration to the fullest extent possible.

Constraints and challenges

Easier said than done. In fact, at times it seems nearly impossible to bring a restoration ethic to an urban environment. Of course, there are the usual "givens" – insufficient funding, political will, and/or public support – but those constraints are hardly unique to urban areas. More characteristic are harsh urban conditions like deficient soil, unnatural successional patterns, contaminated sites, salt in icy cities, heat, drought, flashy streams, and overall dysfunctional hydrology.

Then there's "urban wildlife," which brings trash, dumping, ATVs, and other so-called "incompatible uses". As for non-human pests, there's an array of introduced insects, such as the emerald ash borer and Asian long-horned beetle, an overabundance of deer in my neck of the woods, and a variety of disease agents. Assorted invasive plants can create a veritable urban jungle of trees, shrubs, exotic grasses and other herbaceous plants, and vines – especially vines. In one local arboretum where I spent some years as land manager, I battled several offenders, but porcelainberry was my nemesis. Acres of once-stately trees had become nothing more than the skeletal structure supporting a vast blanket of impenetrable vines. The place looked like a huge topiary display, but poorly done.

Of course, the urban forest – like many other settings in the human-dominated environment – is always under threat of encroachment by development of one sort or another. Along with that comes habitat loss, further fragmentation, and extreme edgy-ness, with ever-dwindling "core forest" stands.

Combined, all those stressors make it particularly tough to be a tree in the city.

Practicing the art of the possible

On the bright side, when you're starting with such poor conditions and the odds stacked against you, maybe it's easier to show some degree of improvement. You'll never defeat all those foes, but on the other hand, opportunities for small victories abound. And taken together, those measures can go a long way toward making the urban ecosystem far more hospitable to trees and the web of life they support. In my experience, I have encountered a wide variety of creative opportunities at the intersection of the practice of urban forestry and the principles of ecological restoration. Here's a sampling:

- **Go beyond the traditional tree pit** – Here in Philadelphia and some other older East Coast cities, there are neighborhoods where a street tree either gets squeezed into a 3'x3' tree pit (AKA tree coffin) or gets squeezed out altogether. Of course, even a little bigger is way better, so where space permits going the extra feet makes a huge difference in survival and size. If space and resources permit, expanded and engineered tree trenches, even extending beneath sidewalks, can ratchet up the success rate and long-term performance.
- **Turn grey infrastructure green** – Tree trenches are just one example of "green infrastructure," whereby vegetation assists with some of the tasks historically relegated to stormwater systems, treatment plants, and other traditional municipal infrastructure. Such green innovation has the added benefits of habitat value and community amenities.
- **Make community connections** – Involving local residents and community groups in tree planting and stewardship goes a long way toward combatting those triple "givens" I mentioned above: Boosting public support (1) bolsters political will (2), which yields funding (3). And it's a key part of promoting trees on private property. Plus, engaging enthusiastic volunteers, while not always easy, is some of the most fun and gratifying urban forestry work.
- **Convert rails to trails** – Here's a trend that's crisscrossing the country, much like the old railroad network that some bike paths are built upon. In urban areas, these rec trails offer opportunities for creating contiguous green spaces that knit together communities and fight fragmentation as they support overall sustainability.
- **Occupy vacant lots** – Another urban ill that Philadelphia and other older cities face is an excess of abandoned properties. Allowed

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Above: Abandoned vacant lot.
Photo courtesy of Pennsylvania Horticultural Society .

Opposite page:
Photos courtesy of Pennsylvania Horticultural Society (left), Michael Leff (middle), and Philadelphia Water Department (right).

"Every effort to manage the landscape should be informed by the principles of ecological restoration to the fullest extent possible."

Laura McCarthy

Laura is Director of Conservation Programs for The Nature Conservancy in New Mexico. She served on the Forest Guild Board of Directors from 2007 to 2013 and was on the Forest Guild staff from 1997 to 2005. She also worked for the New Hampshire State Forester and the USDA Forest Service in Idaho, California, Vermont, and New Hampshire.

Right: Las Conchas Fire 2011.

Photo courtesy of Craig Allen.

Protecting Water Sources in Southwestern Fire-Adapted Forests

by Laura McCarthy

In the Southwest's fire-adapted forests, widespread changes resulting from fire-exclusion, climate change, and past land uses are affecting water sources and supplies for people who live in the region. Wildfire size and severity has been increasing as a result of higher temperatures and drought conditions. The 2000 Cerro Grande Fire in the Jemez Mountains, considered a large and destructive fire at the time (42,885 acres), is now overshadowed by the 2012 Whitewater-Baldy Fire (297,845 acres). Fire severity is also a concern, as the 2011 Las Conchas Fire showed with a greater than average percent of high-severity burn.

Public concerns about wildfire in Southwestern forests are dwarfed by concerns about water supplies from forests. For example, most precipitation in New Mexico comes as snowfall and is stored in forested mountains until spring. Snowmelt is the primary source of surface water for agriculture as well as municipal and industrial use. Rainfall on the extensive recent burn areas has caused hydrologic damage in many watersheds across the region, garnering more interest and concern than the wildfires themselves.

Water Funds as a Forest Restoration Tool

Water funds are a payment-for-ecosystem-services mechanism, with roots in Latin America and applicability for the Southwest. A small number of cities and towns have created a payment-for-water-services mechanism that links the water forests provide with the funding needed to restore overgrown forests. For example, in Denver, Colorado, the 1997 Buffalo Creek and 2002 Hayman fires caused Denver Water to spend $26 million to dredge Strontia Springs, treat water, and reseed the watershed. Subsequently, Denver Water entered into a partnership with the Forest Service, Rocky Mountain Region, to share the cost of reducing fuels on forests that are important water sources. This Forest to Faucets Partnership represents a 5-year, $16.5 million commitment by both parties to invest in restoration on the Pike and San Isabel, Arapaho, and Roosevelt National Forests.

In another example, voters in Flagstaff, Arizona, passed a $10 million bond in 2012 for the thinning of two specific forest areas that are critical to water sources and supplies. The full cost of the 15,000-acre Schultz Fire of 2010 is estimated at between $130 and $147 million in fire-suppression and related post-fire flooding damage, which motivated the city to take action and to seek specific protection for their water supply.

Both Denver and Flagstaff demonstrate that community leaders are becoming aware of the connections between the security of their water sources and the condition of the fire-prone forests that supply their water. Water utilities face big bills for the cost of post-fire cleanup and have an incentive to co-invest in prevention. Forest conditions have deteriorated to the point that federal appropriations for Hazardous Fuels Reduction are insufficient to meet the need in fire-prone forests. Community leaders are increasingly seeking solutions that give them some control over the situation, instead of passively waiting for the Forest Service to fix the problem. In New Mexico a large water fund is proposed for the Rio Grande Valley to protect water sources for about half of the state's population.

Context for the Rio Grande Water Fund

Albuquerque is the biggest city in New Mexico and has spent several decades planning for a sustainable water future. The Albuquerque Bernalillo County Water Utility Authority's (Water Authority) long-range water supply plan, completed in 2007, outlined the use of water imported from the Colorado River Basin to replenish groundwater and recharge Albuquerque's aquifer as a drought reserve, and to establish surface water as the city's primary supply. Incentives were provided for municipal and industrial conservation measures, and as a result per capita use of water has dropped from more than 250 gallons per person per day in the 1990s to 150 gallons per person per day today.

Today about half of Albuquerque's water comes from the Colorado River Basin via a transmountain diversion known as the San Juan-Chama project, a system of diversion structures and tunnels that moves water from the Navajo River in the San Juan River Basin to the Rio Grande Basin. About 110,000 acre-feet of water are authorized for diversion, and most New Mexico cities have purchased rights to this water.

The Las Conchas Fire of 2011 was the first of the recent New Mexico wildfires to have a large impact on municipal water sources. The fire was notable for the extent of moderate- and high-severity burn — 42 percent of the area. The fire occurred in New Mexico's Jemez Mountains, within 30 miles of roughly half of the state's population. The severely burned areas in Las Conchas left nothing but ash and occasional standing dead trees and boulders. Monsoon rains about six weeks after the fire started created heavy debris flows in four canyons draining directly to the Rio Grande. For example, rainfall of 1.5 inches on August 21 and 22, 2011, caused debris flows in Bland Canyon and Cochiti Canyon and lowered the dissolved oxygen content of the Rio Grande well past the point where fish and other aquatic species can survive. Utility operators in Albuquerque and Santa Fe decided the water was unfit for treatment, and shut down their surface water use for 40 and 20 days respectively.

Making the Case

The Nature Conservancy began exploring the idea of a water fund centered on securing water sources from damage by wildfire and post-fire flooding in the Rio Grande valley in 2012 with funding from Lowe's Charitable and Educational Foundation. Unlike Santa Fe, Albuquerque had not yet considered the possibility of wildfire and post-fire debris flow threatening their surface water or contaminating their San Juan-Chama water. However, the Las Conchas Fire provided a tangible demonstration of the problem, and city and business leaders were soon convinced that a solution must be found.

The Nature Conservancy convened a Rio and Forest Advisory Board in April 2013 for the specific purpose of establishing a water source protection fund for the Middle Rio Grande and forested watersheds. The Advisory Board is made up of leaders from federal and state forest and water management agencies, business community leadership, university experts, and a diverse cross-section of interest groups, from traditional agriculture and recreation to wood products.

A number of studies are underway to establish a clear case for a water source protection

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"Public concerns about wildfire in Southwestern forests are dwarfed by concerns about water supplies from forests."

American Chestnut: A Test Case for Genetic Engineering?

by Leila Pinchot

Leila Pinchot
Leila is a research ecologist with the US Forest Service Northern Research Station and a member of the Forest Guild Membership Policy Council.

Above: Transgenic American chestnut seedling, developed at the American Chestnut Research and Restoration Project at SUNY College of Environmental Science and Forestry.

Photo courtesy of Bill Powell.

The thought of genetically engineered (GE) trees might conjure images of mutant trees with unnatural and invasive tendencies, but there is much more to the story. GE trees are a new reality that, like it or not, will probably be part of the future of forestry. The basic inclination of most Forest Guild stewards is to reject GE trees as violating our principle to imitate nature, but are there cases where GE trees should be used? The American chestnut (*Castanea dentate*) may be the most compelling case thus far for the use of genetic engineering. Bill Powell and Chuck Maynard, both from the American Chestnut Research and Restoration Project at SUNY College of Environmental Science and Forestry would tell you that the GE American chestnut trees they have developed look and act very similarly to non-GE American chestnuts, except for the simple fact that they seem to be resistant to the chestnut blight fungus. While the long-term blight resistance of these trees needs to be extensively tested, early results offer the hope of a blight-resistant American chestnut in the not so distant future.

Forest biotechnologists are the new kids in town when it comes to American chestnut restoration. Breeders have been working to develop a blight-resistant American chestnut since the 1920s, when it became clear the species would be lost to the non-native chestnut blight fungus. Though well accepted, breeding is a form, perhaps the oldest, of biotechnology, i.e., the use of a living organism to make products for a specific use. Compared side by side, traditional breeding and genetic engineering each have their pros and cons. In some ways, breeding is much simpler – it involves crossing together individual trees with desired characteristics; in the case of the chestnut, six crosses are necessary to develop a tree with the blight-resistance of a Chinese (*Castanea crenata*) or Japanese (*Castanea mollissima*) chestnut, with the growth characteristics of the American chestnut. Alternatively, GE chestnuts are the product of no crosses, only genetic manipulation. Scientists make use of a natural genetic engineer — *Agrobacterium tumefaciens*, a widely spread soil bacterium that naturally inserts genes into plants to cause the development of galls. Scientists transfer genes of interest into a plasmid, a small circular DNA strand, which is then inserted into the agrobacterium. Finally, the agrobacterium containing the desired genes is injected into chestnut embryos. If all goes right, this process will transfer the selected genes (in this case genes that confer resistance) into the chestnut embryos, which are then grown into seedlings. While this process is expensive (though becoming less so), it offers some benefits not afforded by traditional breeding. For example, using genetic modification scientists can introduce several genes conferring desired traits into the species of interest, while breeding introduces thousands of genes, with very little control. In the chestnut, researchers have found that the backcross hybrid still shows some signs of its Asian progenitor, including earlier bud-break, which may have ecological consequences, particularly in the northern extents of the tree's range. On the other hand, trying to confer long-term blight resistance through the introduction of only a small number of genes may not replicate the complexity of blight resistance found in Chinese chestnuts.

But it is not the case of one strategy against another. In fact, combining forest biotechnology with traditional breeding may provide the most effective route to securing stable blight resistance. Scientists from various institutions working together as part of the Forest Health Initiative (FHI), described below, have nearly completed sequencing the genome of the Chinese chestnut. The hope is to locate the genes in Chinese chestnut responsible for blight resistance. Breeders will then be able to identify which of their progeny contain the desired genes, and cull those that do not. This technique, termed marker-assisted selection, allows breeders to ensure the genes that confer desired traits – such as blight resistance or good timber-form – are present in the individuals chosen for breeding.

Genetic modification may offer modern solutions to modern ecological challenges; however, the technology may also pose ecological threats. Perhaps the threat that incites the most concern is gene flow from transgenic trees to sexually compatible wild trees. For example, if a transgenic poplar tree modified for increased insect resistance pollinated a compatible wild poplar tree, the transgene may be present in the resulting progeny. This would be particularly worrisome if the escaped gene gave its host a competitive advantage over other trees, which also raises concerns about the potential for GE trees to become new invasive species. In the case of chestnut, it will actually be the goal for the transgenic tree to reproduce with the wild American chestnut, to increase genetic diversity of the transgenic trees, while also disseminating the transgenes that confer blight resistance. Other potential risks of GE trees include unintended impacts on other organisms. To address this particular concern, researchers, including Powell and Maynard, are studying potential impacts of the transgenic chestnut on mycorrhizal fungi. Early results suggest no difference in mycorrhizae on transgenic and wild American chestnuts. Long-term testing, of course, is imperative to evaluate the potential ecological threats.

Using genetic engineering to promote forest health is a relatively new practice. For the first several decades of forest biotechnology research, the primary focus of the technology was to increase the production of high-yield forest plantations. For example, much of the research focused on modifying plantation tree species, like poplar and eucalyptus, for increased wood production, herbicide resistance, and decreased lignin production, among other modifications. These uses of biotechnology have been controversial among the forestry community, as well as among the general public, both because of possible ecological threats, described above, and because of proprietary issues related to transgenic plants – that is, who will own, control, and regulate transgenic trees. While this research is still continuing, the focus of forest biotechnology has expanded dramatically to include the restoration of threatened three species, as well as climate change mitigation and adaptation.

This change in focus is exemplified by the FHI– a collaborative effort with representatives from the federal government, academia, industry, and the non-profit sector– all working together "to advance the country's understanding and the role of biotechnology to address some of today's most pressing forest health challenges," using the American chestnut as a test case. As John Heissenbuttle, one of the FHI's original stakeholders, put it, "We saw potential for saving an icon of U.S. forests – American chestnut – through transgenics." What made the FHI unique was that, from the very beginning, the group understood the importance of involving multiple stakeholders through the entire process of developing the GE chestnut—it couldn't just be industry biotechnicians working behind closed doors. To encourage a productive conversation about the potential uses, threats, and benefits of this technology, a transparent conversation is absolutely imperative.

Because the Forest Guild's position statement (available online at www.forestguild.org) opposed the use of genetic engineering of trees for any

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" ***Genetic modification may offer modern solutions to modern ecological challenges; however, the technology may also pose ecological threats.*** "

Below: Jennifer DeRosa taking leaf samples from a transgenic chestnut seedling developed by Powell and Maynard.

Photo courtesy of Kathleen Baier.

Right:

Photo courtesy of Paul Rezendes.

Keith Ross

Keith is a Senior Advisor with the Real Estate Consulting Group of LandVest, a broad-based real estate company involved in all aspects of land planning, real estate brokerage, consulting, development, and conservation planning.

Harvesting Forest Carbon: One Consulting Forester's Thoughts

by Keith Ross

Many foresters have become aware since their last harvest cruise of an emerging forest product to be included in their management planning processes. While timber, cordwood, and pulpwood have been the mainstays for many years, and regional opportunities for maple and birch sap, mushrooms, medicinals, and decorative materials continue to grow, the most intriguing and potentially lucrative product may be the ability to harvest the carbon sequestered in the forest. Carbon harvesting differs from most of the other forest products in that machinery is not required to enter the forest, harvesting crews consist of periodic cruising to verify growth and carbon volumes, and the products are best left on-site, to be available for other income sources for the forest landowner, such as wildlife, unique hunting habitats, recreation uses, public drinking water supplies, and scenic vistas, to name a few.

My forestry practice has evolved from a traditional dirt forester approach, working with private and municipal landowners managing forests for periodic income from harvesting wood and developing forest management plans. The last 20 years have been focused on working for families trying to figure out how to pass their forest land on from one generation to the next. Often that includes the need to generate cash to buy out other owners, or any one of a number of demanding and legitimate financial needs. They all generally have in common the desire to limit the development uses of the forest and to retain as much of the forest in its natural state as possible. Conservation easements have been an important tool, but funding these sales of development rights and finding diverse income streams to support long-term stewardship can be difficult in many regions.

My role as mediator in helping families make difficult decisions around their forest ownership can affect many generations of present and future owners of the land. I work with multiple generations of owners, each with a particular point of view and understanding of how the forest benefits their interests. Studies of landowner attitudes identify wood harvesting as one of the less important reasons why people own forestland these days. I would like to find a way to combine the sales of carbon credits on smaller New England woodlots to meet my client's interests for diversified income and less disturbance in the forest.

Are consulting foresters prepared to alter their conventional thinking and incorporate a carbon product along with traditional harvesting products?

We have all seen recent examples of carbon sales supporting the conservation of forests from Maine to California. But concerns exist about how compatible carbon credit sales are with traditional timber harvesting. Is it possible to do both within the same forest ownership? Conventional wisdom says that most non-industrial private landowners harvest much less than 100 percent of annual growth. Here in southern New England it is closer to 20 percent and, for many, far less. In addition, there are many landowners who do not appreciate the changes that take place in their forest during and after a harvest, which further limits their desire to create income from wood harvesting.

I think it is possible to manage portions of a forest for high-quality timber as well as carbon. Utilizing the wood harvested for long-lasting products such as furniture, flooring, housing, and similar carbon-storage-stable uses supports a carbon sequestration goal. At the same time, identifying those portions of the forest that can bring income from producing a carbon product while maintaining unique undisturbed habitat for wildlife and recreation uses can maximize a landowner's short- and long-term income.

Linking the long-term commitment of a permanent conservation easement with the 100-year contracts required for a carbon credit sale could make sense for many landowners with large acreages. But most of my clients, and most forestland owners in the U.S., own less than the minimum 2,000-acre size needed to have a carbon project be financially profitable after all the long-term costs associated with monitoring and reporting are met. Could it be financially viable to group together several smaller landowners to reach the minimum size required, utilizing a single entity to represent the landowners on the proper registry to enable the sale of carbon credits? When combined with a conservation easement, it would seem to be a fit. The vast majority of forests in the Northeast are made up ownerships of much less than 2,000 acres. I have been exploring the concept of grouping landowners interested in carbon in partnership with several non-profits, a carbon investor company, and private landowners. In each case the landowners' interest is for a diversified source of income that allows for a combination of traditional forest harvesting of wood products with wildlands management that maximizes carbon sequestration on-site.

It is my understanding that in most cases the income from the sale of a carbon credit is greatest in the first year when the results of your inventory place the stocking level at a point higher than the standard stocking level for your region of the country (as determined by the US Forest Service FIA data). The greater the difference, the greater the first year income. From that point forward, each year's carbon sales will be the net growth on those acres dedicated to that product. In my area of New England, that can be approximately 2 tonnes per acre per year, and the initial "bump" generated by the carbon above the "line" can run from 60 to 110 tonnes per acre, thus creating a significant income when a conservation easement is placed over the property in the same year. Now, I am sure there is a wide variety of possible values associated with the program, since New England forests are quite diverse as well, but this simplified example demonstrates there could be significant value in this forest product as well as increased opportunities to meet a wider range of landowner objectives for continued forestland ownership.

Above:
Photo courtesy of Paul Rezendes.

There are a number of innovative and aggressive companies in the marketplace seeking carbon-offset credits for the California carbon market. The people that staff these companies are well-versed in the program's specifics and in many cases provide all the up-front capital needed to qualify a landowner's forest for a carbon credit sale. Typically these companies, who are funded by investment capital, require anywhere from 15 to 30 percent of the first five years of credits to repay their up-front investment and achieve their return. The demand for the credits will likely increase as more and more carbon emitters fall under the law. If the program is successful and the market price to emit carbon encourages alternative energy sources until the price of carbon credits drop or disappear, we all benefit. Until such time, the opportunities for foresters involved in carbon credits will increase as qualified professional foresters are required for the periodic re-cruising that will need to be completed every 6 to 10 years for each property along with third-party check cruises and the annual reporting of growth and removals required to establish the credit on the registry. Foresters with clients considering a conservation easement might consider a carbon credit sale for a portion of the funds needed to secure permanent conservation for a forest. ■

> *"I think it is possible to manage portions of a forest for high-quality timber as well as carbon."*

Urban Forestry from page 5

to decay, they do nothing but drag down their surroundings. But seized upon (sometimes literally) as an opportunity, these choice bits and pieces offer the chance to “in-fill” with trees and other greenery, again yielding multiple benefits.

- **Promote urban ag and agroforestry** – Vacant lots can be converted to community gardens, and other open spaces can also support the same. In addition to flowers and vegetables, these sites can advance agroforestry when planted with fruit- and nut-bearing trees. Maintaining orchards can pose challenges, but, according to the Alliance for Community Trees, species that yield such “edibles” now garner the fastest growing interest in urban trees among individuals and community groups. That’s why they launched their new “Community Groves” program, which offers excellent guidance: http://actrees.org/what-we-do/community-groves/
- **Manage natural areas** – Street trees are essential, but hardly sufficient. Some parks that house rec centers and playing fields can support more trees and even woods. But the greatest opportunity for ecological restoration within the urban forest lies in larger natural areas – with which Philadelphia is blessed, especially with the extensive Fairmount Park tracts on both sides of the Schuylkill River. This is a huge topic in itself, so I will simply point to the comprehensive new Parkland Forest Management Framework recently released by Philadelphia Parks and Recreation, which I highly commend (see below):

> The ultimate goal of the Parkland Forest Management Framework is to achieve a viable, self-perpetuating, native-dominated and resilient forest ecosystem. – *Philadelphia Parks and Recreation*
>
> www.phila.gov/ParksandRecreation/PDF/PPR_Parkland_Forest_Mgmt_Framework.pdf

- **Go native and promote diversity** – One fundamental tenet of ecological restoration is to utilize native species wherever possible, and certainly in all natural areas. However, from my work with street trees, I know it may not be possible everywhere, due to those harsh curbside conditions noted above. In such cases, certain “exotics” may be more “urban tolerant” and thus more successful – so long as they are not *invasive* exotics. Another thing: Not all natives are equal in terms of ecosystem services provided, including wildlife habitat value, so it’s important to mix it up.

Of course, both species and age diversity are essential elements of a resilient and sustainable urban forest, or any forest for that matter.

There are plenty more opportunities for bringing an ecological restoration mindset to the urban forest: Planting meadows and trees on vast expanses of barren turf that serve no purpose. (One “turf conversion” program in Henderson, Nevada, defines such non-functional turf this way: “If the only time you step on it is to mow it, it’s non-functional.”) Daylighting streams that were funneled into pipes and buried long ago – sometimes running under those very same non-functional fields. Creating or enhancing riparian, or streamside, buffers where mowers or pavement have encroached. Recycling wood “waste” into the soil. I could go on.

Cutting-edge tools

Finally, working as I do on the Ecosystem Services team of the Davey Institute, I would be remiss if I did not plug i-Tree – a state-of-the-art, peer-reviewed, freely accessible software suite from the Forest Service in collaboration with Davey and other partners. As many readers probably know, i-Tree provides urban forestry analysis and benefits assessment tools that can help communities of all sizes strengthen their urban forest management and advocacy efforts. The latest version (6.0) was released earlier this year. If you are unfamiliar with these tools, you can check them out at www.itreetools.org.

I mention i-Tree in the context of ecological restoration and urban forestry because some users have begun to apply the tools to advance that cause in various ways:

- Quantifying ecosystem services and values
- Analyzing and understand the forest resource
- Improving planning and management
- Collecting baseline data and monitor change
- Evaluating different restoration scenarios
- Empowering advocacy and case-making

Other ideas are currently under discussion and development. If you have suggestions for such applications that might help bridge the two fields, I invite you to contact me at Michael.Leff@davey.com. ■

Above: Photo courtesy of Keith Ross.

At right: Abandoned vacant lot before greening.

Photo courtesy of Pennsylvania Horticultural Society.

fund. The purposes of the four studies are to

1. Identify the watersheds that are most vulnerable to high-severity wildfire and post-fire flooding, and that are most likely to deposit sediment in reservoirs and the Rio Grande
2. Estimate hydrologic changes that may result from the forest management treatments
3. Assess the full economic costs of the Las Conchas wildfire
4. Survey municipal water users and agricultural users to determine their understanding of the threats to water security and willingness to pay for restoration treatments of at-risk forests

The outcome of these studies and engagement of the Advisory Board will be to produce a comprehensive water security plan for the Rio Grande from Albuquerque north to the Colorado border. The plan will include a prioritized list and map of restoration treatments for forests and riparian areas; estimated costs and capital needs to implement the plan, including NEPA assessment for federal lands, wood product utilization and infrastructure investment needs; and a detailed plan for water fund structure, governance, and revenue.

Early estimates are that the Rio Grande and forested watersheds in the area from Albuquerque north to the Colorado border include 1.7 million acres of ponderosa pine and mixed conifer forests, where fire regimes were historically frequent and low-severity, and where mechanical thinning and controlled burning are effective treatments to reduce fuel loads. Assuming that 40 percent of the 1.7 million acres of eligible forests would actually be treated, the preliminary goal is to treat 700,000 acres in 10–30 years, depending on how quickly the rate of treatment can be escalated. At a cost of $500 per acre, about $7–15 million in revenue would be needed annually, assuming current markets for low-value wood and assuming federal appropriations at current levels are available as matching funds.

Raising $7–15 million in non-federal funds each year for 30 years will not be easy. The water fund needs to be structured to receive funds from a variety of sources, including payments by municipal water users and irrigation district members, homeowner's insurance premium taxes, and corporate and voluntary donations. These options are under study now. After fuel reduction treatments are completed, a program of controlled burning and mechanical thinning with commercial by-products will need to be sustained long-term. The annual costs of maintaining forest and watershed resiliency after the initial treatments should be far less, estimated at $1–3 million.

Conclusion

The discussion in New Mexico about water security is gaining far more traction than forest restoration garnered on its own. All aspects of New Mexico life are touched by water availability and reliability. The Las Conchas Fire and subsequent flooding and debris flows provided water managers, water users, and politicians with a firsthand view of the consequences of inaction. Forests in New Mexico function much like water towers do in wetter parts of the United States. Community leaders are starting to understand the risk of waiting to take large-scale action to restore forests. The water fund model from Latin America provides a structure for customized local solutions to water security problems in places like the Southwest where climate change is causing extensive changes to forests. It remains to be seen if a project as large in scale as the proposed Rio Grande water source protection fund can be achieved. The concept, however, is gaining serious traction and with strong leadership may be established in 2014. ■

Editor's note: A copy of the complete article including references and endnotes may be downloaded from the Forest Guild website at www.forestguild.org/FW21.html

Valles Caldera National Preserve Rio San Antonio flooding.

MISSION

The Forest Guild promotes ecologically, economically, and socially responsible forestry as a means of sustaining the integrity of forest ecosystems and the welfare of human communities dependent upon them. The Guild provides training, policy analysis, and research to foster excellence in stewardship, to support practicing foresters and allied professionals, and to engage a broader community in the challenges of forest conservation and management.

Above: Las Conchas up close.

Photo courtesy of Craig Allen.

Climate Change Tools from page 3

the forest structure allows the forest to recover from disturbance by self-adapting. Response actions intentionally accommodate change and enable ecosystems to adaptively respond to changing and new conditions. Examples of response could include Strategy 4: Maintain or create refugia; Approach 4.3: Establish artificial reserves for at-risk and displaced species; Strategy 9: Facilitate community adjustments through species transition; Approach 9.7: Establish or encourage new mixes of native species; and Approach 9.8: Identify and move species to sites that are likely to provide future habitat. All approaches are relevant in particular situations. Keep in mind that, resistance is not necessarily a negative and response (transition) a positive. Resistance and resilience are in many cases viable options, especially for the short term, and are easy to incorporate into current management.

The second day, participants came with self-identified projects to set in motion on the ground in the coming months as examples of forest adaptation strategies. Nine different forest adaptation projects were addressed, ranging from regenerating spruce-fir stands in the Northeast Kingdom to managing oak forests in the Taconics to managing existing and new forest recreation. One project that I will be involved in is to work with a group of ten neighboring landowners to see how they are currently managing their forests for resiliency, connecting these management practices to climate change strategies (raising their level of awareness), and how they can perhaps go further in their own management to address forest adapatation. Follow-up assistance is planned by staff from the Northern Institute of Applied Climate Science.

VTFPR has also recently prepared a forest adaptation document: *Creating and Maintaining Resilient Forests in Vermont: Adapting Forests to Climate Change*. This document, currently in draft form, takes a similar approach using the list of strategies in NRS-83-2011 and NRS-87-2012 but applies them to Vermont's forests using Vermont natural communities as a framework. Natural communities have a foundation built on by site factors that will likely respond to climate change in a similar manner. Therefore, strategies based on natural communities should provide more consistent outcomes for each forest situation. In addition, the document covers topics that the authors feel must be addressed to mitigate the added stress of climate change, including forest connectivity and land protection, forest operations and water quality, soil productivity, herbivory, and invasive pest management.

The strategies and approaches are not new but in a changing climate become more important to address in an intentional, more aggressive way. Identifying vulnerabilities and then taking actions to reduce those vulnerabilities, being flexible, implementing the low hanging fruit and explaining it to landowners, taking action even under uncertain conditions, and increasing ways to sequester carbon are all steps in managing for a more resilient and self-adapting forest. ■

> *"How do we as forest managers make decisions and introduce actions to mitigate climate change effects when we cannot know the results of our actions?"*

At right: Forest Adaptation Planning and Practices workshop.

Photo courtesy of Sandy Wilmot.

American Chestnut from page 9

At left: American chestnut grown in tissue culture.

Photo by Bill Powell

purpose, FHI invited the Forest Guild to participate in the conversation. Professional Member and forest manager Kim LaDuke, skeptical of genetic engineering, agreed to join the conversations. "I felt like a juror foreman on a murder trial. My job was to ask all the hard questions I could ask them." LaDuke was concerned with genetic modification, in part because trees have such long generations: "We're talking hundreds of years before you find out what you've done."

In 2012, three years into the project, the FHI successfully reached one of their primary research goals– to develop a putatively blight-resistant transgenic American chestnut.

While early results indicate a geneically engineered chestnut may resist the deadly blight fungus, not everybody is comfortable with this approach. Martha Crouch is a molecular biologist who consults for non-profits, and helped write a report critical of genetically engineered trees for the Center for Food Safety, a group that generally opposes genetic modification in agriculture. She is concerned with potential unpredictable long-term consequences of the release of GE chestnut trees. Additionally, she questions the ability of scientists to develop a transgenic chestnut with durable blight resistance, given the complicated pathways that confer fungal resistance in plants. In traditional breeding, she argues, "The breeder has a goal and facilitates crossing and screening, but the trees provide the genetic information that they have fine-tuned over many environments. With something like chestnut trees that are long-lived, and poorly known ecologically, can the theories of [genetic] engineers come close to the 'intelligence' of the trees themselves?" And should breeding fail, Crouch finds hope for American chestnut in the resilience of nature and the healing power of deep time, citing the example of the near extinction of hemlock. Some 5,000 years ago, Eastern hemlock (*Tsuga Canadensis*) experienced a sudden and drastic decline in abundance, likely caused by a pest or pathogen, a similar scenario to the impact of chestnut blight. Over the time span of 1,000 years or more, hemlock gradually recovered in abundance. "Our time frame for success," she suggests "may simply be too short".

We are in a geologic era, called the Anthropocene, defined by the action of humans, as opposed to naturally occurring forces. As articulated by the title of Bill McKibben's 1989 book, in some ways we are experiencing "the end of nature", in a world where ecosystems can no longer be thought of as independent of humans. Forest management in the Anthropocene is very complex, as it requires that we make management decisions today that may or may not reflect the ecological conditions of the future. It is in this context, in which we may lose the American chestnut, the eastern hemlock, the American beech, the butternut, the black walnut, the Port-Orford cedar, the flowering dogwood, the American elm, and the ashes— all species threatened with functional extinction and all candidates for protection or restoration via GE techniques, that we ask what tools are appropriate for forest management in the Anthropocene. Should we count on traditional breeding, should we wait for the hope of natural recovery, or do we need every tool to bring back this keystone species to hold together threatened forests? ■

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