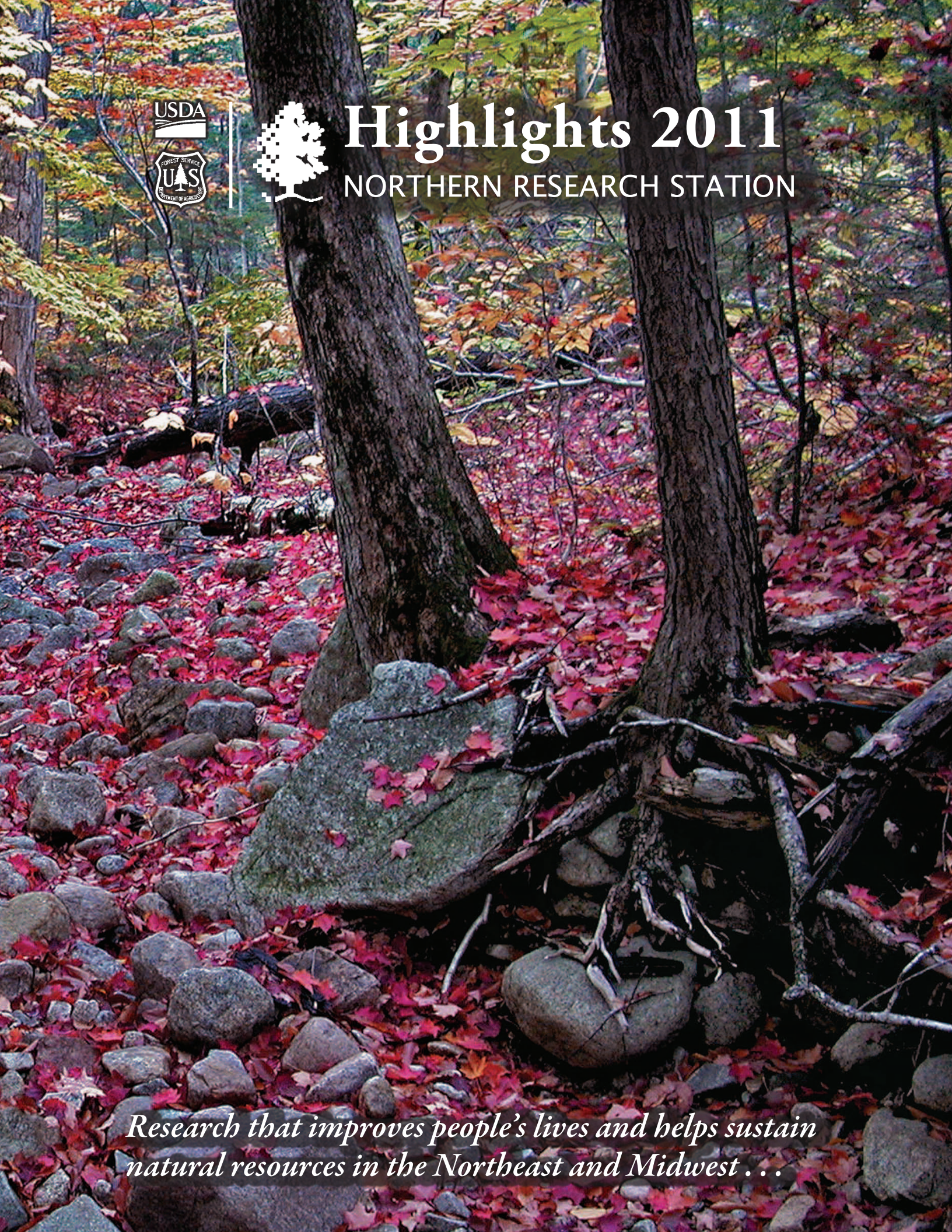

Highlights 2011

NORTHERN RESEARCH STATION

Research that improves people's lives and helps sustain natural resources in the Northeast and Midwest . . .

FROM THE STATION DIRECTOR

The science highlighted in this document touches your life, whether you manage a forest or a back yard, whether you walk city streets or forest trails, whether you live in the Northeast or the Midwest or the West Coast. The Northern Research Station pursues science to improve people's lives and the health of the nation's natural resources, and our approach can truly be described as all lands and all people.

In fiscal year 2011, our research ranged from studying tiny organisms in specific places, such as the role of the ectomycorrhizal fungus in American chestnut restoration on reclaimed mined sites, to a study showing that global forests sequester one-third of the world's annual fossil fuel emissions. We looked at what motivates homeowners to mitigate fire risk, and we discovered how the negative impacts of the emerald ash borer on Native American culture can be lessened. We assessed the vulnerability of northern Wisconsin's forests to climate change, we studied the long-term differences in forests with different deer densities, we evaluated the environmental and economic benefits of short-rotation poplar energy crops, and we used traditional Hmong story-telling to create a video introducing new Americans to using public lands.

The projects described in the following pages are just the highlights of the past year, which marked the fifth anniversary of the creation of the Northern Research Station through a merger of two smaller research stations. You can learn more about the Northern Research Station and see 11,000 research articles produced by Station scientists on our website at: www.nrs.fs.fed.us

In the new fiscal year, Northern Research Station science will address critical issues such as how oil and gas development impact forests and assessment of the current state of Northern forests. We are also launching the Philadelphia Field Station, which will be a hub for collaborative research on the urban environment.

I am proud of what the Northern Research Station accomplished in 2011 for the people and the natural resources of the Midwest and Northeast, and I am excited to begin another year of inquiry, discovery, and science delivery.

Michael T. Rains

OUR VISION: HEALTHY FORESTS, HEALTHY PEOPLE, HEALTHY COMMUNITIES

The Northern Research Station serves the most densely populated and most heavily forested portion of the United States. We envision a region where trees and natural resources support a high quality of life; where resilient habitat supports thriving wildlife, fish, and plant communities; where clean water abounds and where people work together to sustain, and where necessary, restore the health of forests, from urban centers to deep wilderness. We further envision forests that provide a wide array of benefits and renewable products from hardwood for furniture to bark for native basketry, to bioenergy to heat homes and schools, to a sunset viewed from a mountain top. The Northern Research Station is dedicated, organized, and staffed to provide the high-quality scientific information that people need in a form they can use to improve their lives.

Overview

NORTHERN RESEARCH STATION

KEY POINTS

As part of the U.S. Forest Service Research and Development mission area, the Northern Research Station provides leading-edge science and technology applications and effective information delivery.

- Our work extends across 20 states of the Northeast and Midwest, as well as the inventory and monitoring of forests in Kansas, Nebraska, South Dakota, and North Dakota.
- Our 24 field locations include Baltimore, Chicago, and New York City.
- We operate a network of 24 official and cooperating experimental forests that produce unique insights into long-term trends in natural resource conditions.
- We work with a wide range of clients and partners to conduct research and deliver results.

Our work helps advance the stewardship of landscapes along a rural to urban gradient to ensure the long-term health and productivity of the region's natural resources.

SCIENCE THEMES

The Northern Research Station's five science themes are the driving force of its science portfolio. The program direction for each theme is achieved through the coordinated actions of 13 research work units. Our science themes are:

- Forest Disturbance Processes
- Urban Natural Resources Stewardship
- Sustaining Forests
- Providing Clean Air and Water
- Natural Resources Inventory, Monitoring, and Assessment

Our program focus of environmental literacy, to help create a more informed citizenry, integrates NRS research into regional efforts to improve environmental literacy, which helps people make responsible choices about the environment through lifelong, place-based, inquiry-based learning.

FOREST DISTURBANCE PROCESSES

FIREFLUX EXPERIMENTS IMPROVE SAFETY OF PRESCRIBED BURNS IN THE NEW JERSEY PINE BARRENS

Prescribed fires are an essential fuels management tool for improving ecosystem health and protecting people, homes, and property from wildfires. When prescribed fires are conducted near urban centers or areas where air pollution is already a problem, federal, state, or local air quality standards can be exceeded. To improve the safety of prescribed burns in such areas, Forest Service scientists conducted three large fire-fuel-atmosphere interaction (also known as Fireflux) experiments. They measured fuel loading and consumption, atmospheric turbulence, fluxes of energy, water vapor and CO_2, and smoke transport at the landscape scale during prescribed fires in the New Jersey Pine Barrens. Results from the experiments indicate that most of the heat and water vapor released from fuel consumed in the fire was indeed captured by flux measurements, and that particulate matter ($PM_{2.5}$) concentrations returned to below EPA standards rapidly after flames passed. Measurements of fuel consumption, fluxes, and atmospheric circulations during fires are essential for evaluating and improving predictive models used by fire and land managers to plan for prescribed burns and manage smoke from them.

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Nicholas Skowronski, U.S. Forest Service

Instrumented towers set up within and in the vicinity of prescribed fires in the New Jersey Pine Barrens provide critical meteorological and air quality data for validating smoke prediction tools.

SAVING BLACK ASH WOOD FROM EMERALD ASH BORERS FOR NATIVE AMERICAN BASKETRY

Black ash has great cultural and economic importance in the northeastern and midwestern United States, especially for Native Americans. Widespread destruction and removal of black ash following the discovery of an emerald ash borer (EAB) infestation site is a painful prospect for tribes and basketmakers. In a unique collaboration, a Forest Service entomologist and a Forest Service geographer combined traditional knowledge with scientific expertise to save black ash wood for basketmakers. They demonstrated that sinking black ash logs in running water for 2 to 3 months in the spring kills emerald ash borer larvae and preserves the wood qualities necessary for basketmaking. The scientists worked with a family of basketmakers from the Gun Lake Tribe throughout the research.

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Therese Poland, U.S. Forest Service

Left: Forest Service technicians tossing a log in the river. Right: Ed Pigeon, Tribal Vice-Chairman of the Match-E-Be-Nash-She-Wish Band of Pottawatomi Indians of Michigan, pounding a log.

PARTNERS
Ed Pigeon, Angie Pigeon, and Monte Davis, Match-E-Be-Nash-She-Wish Band of Pottawatomi (Gun Lake Tribe), Michigan

NOVEL ECTOMYCORRHIZAL FUNGUS BENEFICIAL FOR RESTORING AMERICAN CHESTNUT ON RECLAIMED MINED SITES

Shiv Hiremath, U.S. Forest Service

Planting American chestnut on a reclaimed mine site on the Wayne National Forest.

A major problem in reforestation efforts on nutrient-poor abandoned mined lands is the survival and establishment of planted seedlings in the harsh environment. Inoculating seedlings with suitable mycorrhizal fungi can mitigate this problem by providing improved nutrient and water uptake to the seedlings.

As part of a project to restore American chestnut, Forest Service scientists have planted thousands of blight-resistant American chestnut seedlings on reclaimed abandoned mined lands in southeastern Ohio. While evaluating various planting protocols, they tested inoculation with several species of ectomycorrhizal fungi (which play a vital role in tree nutrition), but found that a novel species of ectomycorrhizal fungus belonging to the genus *Scleroderma* was the most active and effective in the locations tested. This species appeared to be native to the reclaimed mined lands and was aggressive in forming beneficial symbiotic associations with chestnut seedlings, even replacing the other species. Identification through DNA sequencing indicated that the novel species was closely related to *Scleroderma areolatum* and *Scleroderma citrinum*. This newly identified ectomycorrhizal fungus appears to be better suited to form functional mycorrhizae under environmental extremes. Large-scale tests of this fungus for restoring chestnut as well as for reforesting reclaimed mined sites are planned.

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THE EL NIÑO SOUTHERN OSCILLATION MODIFIES FOREST GROWTH UNDER ELEVATED CARBON DIOXIDE AND OZONE LEVELS

In northern Wisconsin, Forest Service scientists examined 10 years of growth and meteorological data for annual changes in the growth responses of model trembling aspen forests. As part of the Aspen FACE experiment, these forests were grown in natural conditions but exposed to elevated concentrations of atmospheric carbon dioxide and ozone expected in the mid-21st century. The strongest responses to both gases (that is, positive growth response to carbon dioxide and negative response to ozone) occurred in summers with the least rainfall and the most sunny days, which were preceded by warm temperatures the previous autumn. The global climate phenomenon El Niño Southern Oscillation (ENSO) is known to influence North American climate for up to 6 months before and after its peak during North American winter. Comparison to sea surface temperature data in the tropical Pacific Ocean showed that periodic ENSO cold phase (La Niña) events produced the regional climatic conditions that stimulated forest growth responses to both elevated carbon dioxide and ozone. The results of this study suggest that current dynamic global vegetation models, used to couple global carbon cycle and climate models, might underestimate forest uptake of carbon dioxide under a changing climate.

U.S. Forest Service

The Aspen FACE experiment revealed a connection between tree response and the El Nino climate phenomenon that may alter current global vegetation growth models used to estimate effects of a changing climate.

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URBAN NATURAL RESOURCES STEWARDSHIP

CULTURALLY APPROPRIATE CONSERVATION EDUCATION FOR THE HMONG AMERICAN COMMUNITY

Connecting ethnic minority communities with nature and nature-based activities is challenging, especially when conservation professionals and educators lack culturally appropriate materials and outreach tools. A Forest Service scientist, working with academics and Hmong natural resource professionals and the Hmong arts and theater community, developed a DVD—"The Wildlife and Wilderness Exploration Show"—in a modern twist on traditional Hmong storytelling with English subtitles. In contemporary Hmong American culture, DVDs are a popular form of entertainment and cultural learning, particularly appropriate for new refugees and elders with little proficiency in English. The educational messages in the DVD cover topics such as using public land, following regulations and safety practices, preventing fire, gathering wild plants, and following the concept of "leave no trace." These messages were identified through interviews with Hmong natural resource professionals across the U.S.

"The Wildlife and Wilderness Exploration Show" DVD

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NONNATIVE FOREST PATHOGENS COST HOMEOWNERS MILLIONS OF DOLLARS ANNUALLY

Quantifying expenditures and losses to landowners is critical to strategies for preventing, managing, and researching nonnative forest pathogens. Two big killers of residential trees—oak wilt in the East and sudden oak death (SOD) in the West—cost homeowners millions of dollars annually. Millions are spent to treat, remove, and replant oak trees, and millions are lost in property value wherever these diseases have spread. Forest Service researchers predicted the spread of SOD in California and oak wilt in Anoka County, MN, over the decade 2010-2020 and then predicted annual expenditures for oak treatment, removal, and replanting and property value losses associated with tree mortality. For SOD in California, annual expenditures could reach almost $1 million and annual property value losses could reach up to $13 million. For oak wilt in a single county in Minnesota, annual expenditures could range from $2 to $6 million. The researchers also found that programs to slow the spread of forest diseases such as oak wilt and sudden oak death provide important benefits, in terms of reduced expenditures and losses, to both homeowners and communities.

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Joseph O'Brien, U.S. Forest Service

Nonnative pathogens, such as this oak wilt, cost homeowners for treatment, replanting, and property value losses.

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FIVE YEARS AFTER THE FIRE, EFFECTS ON COMMUNITY STILL LINGER

Karen Wattenmaker, U.S. Forest Service

A scene from the Rodeo–Chediski fire. Impacts can still be felt 5 years later.

Organizations helping communities recover from wildfire need to understand the issues and conditions that are likely to persist even years later. Soon after the Rodeo-Chediski fire in 2002, Forest Service social scientists visited several communities in southeastern Arizona and found that the wildfire had triggered both social solidarity and conflict. Five years later (in 2007), Forest Service scientists and their university colleagues revisited these communities. They found that although the communities took some positive actions in response to the fire, other negative impacts persist.

As social theory predicts, the wildfire still affected citizens' views of disaster management, actions to improve disaster preparedness, and the creation of groups to address disaster management. In the years since the fire, local residents supported thinning projects to reduce fuels on national forests, a previously contentious issue. In addition, a number of new community groups were formed to encourage landowners to reduce wildfire risk and support more collaborative wildfire management. However, many residents and local firefighters continued to voice resentment toward federal firefighting teams and the incident command hierarchy because of the persistent belief that incident commanders did not respect local knowledge and had no local accountability. Younger leaders emphasized building local capacity for emergency response.

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STREET-LEVEL VIEWS OF A CHANGING CLIMATE

Forest Service researchers and partners interviewed residents of two Chicago neighborhoods about their awareness of climate change and their own climate-friendly behaviors. This study was done to help the City of Chicago implement its Climate Action Plan. The researchers found that some residents were aware of climate change and the actions they could take to minimize its effects. Many others were less aware of climate change but still engaged in some climate-friendly practices that could be supported and built upon.

The findings suggest that to advance the goals of the Climate Action Plan at the neighborhood level, the City of Chicago needs to understand the important issues in each neighborhood, assess how these are related to climate change mitigation or adaptation, and develop climate change goals that address residents' concerns.

"Word cloud" of North Kenwood–Oakland residents' responses to the question "What three words come to mind when you hear "climate change?" Image by Field Museum.

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SUSTAINING FORESTS

LONG-TERM DIFFERENCES IN FORESTS WITH DIFFERENT DEER DENSITIES

In a large-scale, 30-year controlled experiment, Forest Service scientists found that 10 years of different densities of white-tailed deer created contrasting forest tree communities with effects that ricocheted up the food chain even 20 to 30 years later. Higher deer densities during stand initiation resulted in significantly reduced diversity of tree species and density of canopy foliage, canopy insects, and birds, even 30 years later. Because recruitment of trees from seedlings to the canopy occurs over a relatively brief, early period (about 10 years), these results show that even short-term variations in deer density may cause centuries-long disruptions to forest ecosystem structure and function. As numbers of predators decline and herbivores increase worldwide, similar effects may persist long after herbivore density becomes effectively managed.

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Photo on file at Forestry Sciences Laboratory in Irvine, PA. Photographer unknown.

Deer browsing exerts top-down selection on plant communities, which over time ricochets back up the trophic web to affect insects and birds.

HOUSING TRENDS AND IMPACTS ON THE SECONDARY WOOD INDUSTRY

Forest Service researchers and their partners analyzed the current housing market through the perspectives of subscribers to a major U.S. trade publication, "Wood & Wood Products." The 33,000 subscribers—manufacturers of cabinets, flooring, architectural fixtures, and related products—are users of lumber from the Nation's hardwood forests. The survey of subscribers measured the impacts of the housing downturn on the wood products industry and determined what actions were being taken to remain profitable.

The survey results will help manufacturers (especially smaller firms) better understand current economic conditions and tactics within their industry and are valuable to researchers as a barometer of industry activity and perceptions. The results were published in the July 2011 edition of "Wood & Wood Products" as a cover feature and posted on the magazine's Web site.

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IMPEDIMENTS TO WOODY BIOMASS UTILIZATION ON FEDERAL LANDS

Dennis Becker, University of Minnesota. Used with permission.

Conducting fuels reduction in mixed coastal species in southern Oregon.

Dennis Becker, University of Minnesota. Used with permission.

Biomass receiving gate for a Burlington Electric power station.

Although increasing utilization of woody biomass from federal lands is seen as a key part of facilitating fuels treatments on those lands, efforts to increase utilization have met with limited success. Therefore, Forest Service researchers studying the social dynamics of biomass use on 10 sites on federal lands paid particular attention to assessing the reality of persistent conventional wisdoms about what limits utilization. Because "accepted truths" may only be perceptions, they can negatively influence the framing of problems and actions. The researchers found that the conventional wisdoms were reasonably accurate, although the degree to which each impeded progress varied.

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RECOVERY OF PAPER BIRCH FROM CROWN INJURY IS LINKED TO SOIL CALCIUM

Joshua Halman, University of Vermont

Field technician using increment borer to collect cores from paper birch trees.

PARTNERS
National Forest System, Green Mountain National Forest; Joshua M. Halman, Gary J. Hawley, and Christopher F. Hansen, University of Vermont; Vermont Department of Forests, Parks, and Recreation

The destructive regional ice storm of 1998 damaged the crowns of many hardwood trees, including paper birch. Subsequent crown dieback and mortality of paper birch has been reported throughout New York and New England. A Forest Service scientist and collaborators evaluated the timing and nature of decline in Vermont and found that birch experienced dramatic reductions in woody growth following the 1998 ice storm. However, trees on calcium-rich soils rebounded in growth after initial declines, whereas trees on calcium-poor soils experienced continued low growth and crown deterioration. This phenomenon has been previously documented for red spruce and sugar maple in the region, highlighting the importance of calcium—a nutrient vulnerable to leaching loss from acid rain—for tree recovery from environmental stress.

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GLOBAL FORESTS SEQUESTER ONE-THIRD OF ANNUAL FOSSIL FUEL EMISSIONS, MUCH MORE THAN PREVIOUSLY THOUGHT

Forested land plays a much larger role in removing carbon from the atmosphere than was previously thought, according to an international team of scientists from 14 institutes, led by two Northern Research scientists. One of the key findings in the study is that global forests have annually removed 2.4 billion tons of carbon (8.8 billion tons of carbon dioxide) from the atmosphere, about one-third of annual fossil fuel emissions for the period of 1990-2007.

Understanding the location of the current forest carbon sink (the net gain of carbon by forests), and the wide range of mechanisms responsible for it, is an important step toward understanding Earth's changing climate system. The international research team estimated the global forest carbon sink based on millions of on-the-ground measurements in forests around the world. The study reveals the dominant role of tropical forests for the exchange of carbon between the land and atmosphere and illustrates the importance of reducing tropical deforestation to limit the buildup of atmospheric carbon dioxide. It also highlights the risk of passively relying on forests to continue to remove carbon from the atmosphere, for such carbon sequestration can be reversed by increased drought, wildfires, and forest degradation.

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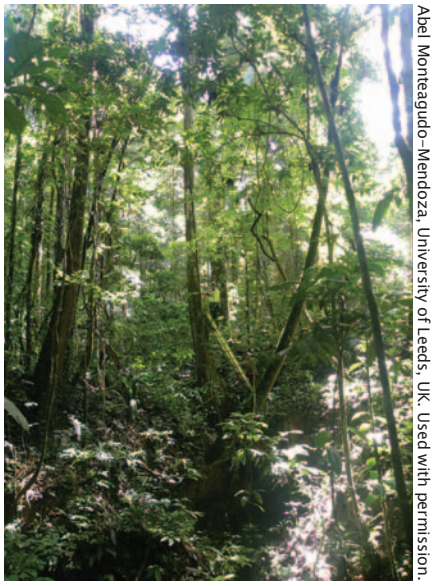

Abel Monteagudo-Mendoza, University of Leeds, UK. Used with permission.

Forest interior in a permanent plot in Amazonian Peru; note the buttressed tree being measured (center) at 5 m with the help of a ladder.

CHLORIDE CONCENTRATIONS IN RECOVERED HYDRAULIC FRACTURING FLUID USED IN EXTRACTING NATURAL GAS

The hydraulic fracturing, or "fracking," method of natural gas extraction injects a mixture of acids, water, gases, and other additives into a bore hole under high pressure, fracturing the bedrock and releasing natural gas. "Flowback" is the portion of this fluid that is recovered and temporarily stored in pits or aboveground tanks before permanent disposal. As natural gas production increases, the safe disposal of flowback fluids has become a critical issue. In some states, flowback can be disposed of through land application if chloride levels meet state requirements. This study examined the gradation of chloride at different depths within storage tanks and the reliability of field test kits in measuring chloride concentration. The study is a first step in understanding chloride concentrations in flowback fluids and developing science-based recommendations for land applications of fracking fluids.

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Pam Edwards, US Forest Service

Sampling tank-stored fracking fluids.

ASSESSING THE VULNERABILITY OF NORTHERN WISCONSIN'S FORESTS TO THE EFFECTS OF A CHANGING CLIMATE

A team of scientists and managers from the Forest Service and other organizations assessed the effects of a changing climate on the forests of northern Wisconsin. Scientists from the Northern Research Station and the University of Wisconsin modeled these effects on forest productivity and the suitability of habitat for specific tree species as well as the changes in forests that are most important for land management. Results of this work are available in a recent publication "The Ecosystem Vulnerability Assessment and Synthesis." This assessment is part of the larger Northwoods Climate Change Response Framework project in Minnesota, Michigan, and Wisconsin, which is developing an integrated set of tools, partnerships, and actions to support "climate-smart" conservation and management.

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A new assessment provides information on the effects of climate change on northern Wisconsin's forested landscape.

PARTNERS

National Forest System, Eastern Region and Chequamegon-Nicolet National Forest; State & Private Forestry, Northeastern Area; Michigan Technological University; University of Wisconsin; Wisconsin Department of Natural Resources; Wisconsin Initiative on Climate Change Impacts

ENVIRONMENTAL AND ECONOMIC BENEFITS OF SHORT-ROTATION POPLAR ENERGY CROPS

Woody production systems and conversion technologies help maintain healthy forests and ecosystems, create high-paying manufacturing jobs, and meet local/regional energy demands. Poplars are dedicated energy crops that also conserve soil and water, recycle nutrients, and sequester carbon.

Building on work that began in the late 1960s, Forest Service scientists and their partners have completed extensive studies that tested the genetics, physiology, and silviculture of poplar crops in a regional network of field trials first established in 1995. They are currently studying the carbon implications of 10- and 20-year-old plantations throughout the Midwest. They have analyzed biomass, rooting, and other important traits from hundreds of genotypes grown throughout the northern United States, as well as mechanisms that regulate tree growth in the face of varying environments and changing climate. These results are currently being used to increase the energy potential of the trees and increase the efficiency of plantation establishment, helping meet U.S. energy demands.

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Industrial energy crop plantation.

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HURRICANES DISTURB NON-TREE SPECIES COMPOSITION IN SUBTROPICAL WET FOREST

Omar Perez Reyes, U.S. Forest Service

The Bisley Experimental Watersheds have various fern species, and these are important to forest succession in the Luquillo Experimental Forest.

NRS researchers tracking hurricane disturbance in subtropical forests of Puerto Rico found pronounced and persistent changes in the non-tree species composition, shedding light on similar disturbances in eastern temperate forests, which periodically sustain damage from severe wind storms. Researchers tracked the response and recovery of tropical forest herb, shrub, and vine communities to multiple hurricanes over 21 years on the 13-ha Bisley Experimental Watersheds in the Luquillo Experimental Forest. They found that hurricanes altered non-tree community species composition by promoting the dominance of rapidly spreading ferns and vines. The non-tree community often accounts for the majority of vascular plant species in both tropical and temperate forests, and their response to catastrophic wind events provides insight into overall patterns of forest renewal and shifts in plant diversity.

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FOREST LAND ESTIMATES IMPROVED BY NOVEL AUTOMATED MAPPING TECHNIQUE USING WINTER SATELLITE IMAGERY

Most automated satellite-based approaches for mapping forest lands rely on summer satellite imagery and are usually inconsistent with FIA plot-based estimates. Forest Service scientists found that incorporating winter satellite imagery in the mapping approach (with the vegetation change tracker or VCT) helps reduce the abundant false positives for forest and forest disturbance that frequently occur during the growing season. False positives for forest and forest disturbance are a serious problem for the gaps in many FIA data grids, especially in intermixed forest and wetland and agricultural landscapes.

The VCT, an automated forest mapping algorithm, exploits the Landsat archive to produce comprehensive maps of forest changes and is well-suited for filling in data gaps between FIA plots. Reliable mapping of forest canopy disturbances allows customers to explore forest dynamics beyond the grid of FIA plots.

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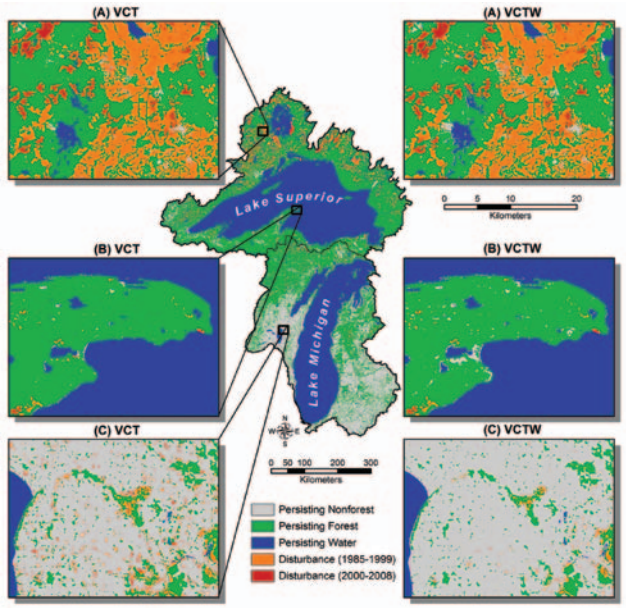

Comparison of vegetation change tracker output products without (left) and with (right) snow-covered winter satellite imagery. Image by Kirk Stueve, U.S. Forest Service.

PARTNERS
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TROPICAL WETLANDS FOUND TO BE AMONG LARGEST CARBON POOLS ON EARTH

Tropical wetlands provide well-known values and ecosystem services, but few studies have examined the carbon stocks of these ecosystems or the carbon dynamics related to land cover change. Although tropical wetlands, especially peat swamps and mangroves, are clearly important in global carbon cycling, tremendous uncertainties exist about how they are changing and what their potential is as a source and sink of greenhouse gases. Forest Service scientists working with international colleagues have found that mangroves have among the largest carbon stocks of any tropical forest. They assessed carbon pools above and below the ground in 25 mangrove sites across Micronesia, Indonesia, and Bangladesh, comprising about 40 percent of the global area covered by this ecosystem. Because land cover change rates are the highest in mangroves of any tropical forest type, greenhouse gas emissions may be as high as 10 percent of that of the total from tropical deforestation.

This information is greatly needed for better understanding the global role of these ecosystems as well as for monitoring, reporting, and verifying proposed programs for reducing deforestation or degradation as strategies to mitigate climate change.

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Sampling the muck in a mangrove swamp.

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HOW LARGE-SCALE FOREST CONDITIONS INFLUENCE NORTHERN GOSHAWK NESTING

Forest Service scientists, in partnership with staff from the Chequamegon-Nicolet National Forest, studied nesting habitat requirements of the northern goshawk, a forest-sensitive species in northern Wisconsin. Goshawks are woodland raptors that use a variety of forest types for nesting, making it difficult to determine nesting habitat requirements at the regional level. The hawks are associated with mature forests with large trees and open understories but may select nesting locations as close as possible to foraging habitats. Using 10 years of nest survey data from the Chequamegon-Nicolet, researchers examined how landscape-scale forest composition and road density at several different distances from nest sites and random locations throughout the forest influenced goshawk nesting presence.

They found that the key driver of goshawk nest occurrence was the ratio of conifer cover to aspen-birch cover surrounding a potential nest site and that primary roads in the area surrounding nest sites were fewer than in other areas.

Contact: Deahn Donner-Wright (ddonnerwright@fs.fed.us)

PARTNERS

Dan Eklund and Matthew St. Pierre, National Forest System, Chequamegon-Nicolet National Forest, Wisconsin; Dean Anderson, Landcare Research, New Zealand

Chequamegon–Nicolet National Forest

Adult goshawk in northern hardwood stand in Chequamegon–Nicolet National Forest, Wisconsin.

HUBBARD BROOK ENVIRONMENTAL LITERACY PROGRAM

One of the Northern Research Station's primary partners in supporting environmental literacy, that helps create a more informed citizenry, is the nongovernmental Hubbard Brook Research Foundation, through its Environmental Literacy Program.

The Northern Research Station and Northeastern Area, State and Private Forestry are lead partners with the foundation in statewide efforts to strengthen teachers' abilities to analyze and interpret real ecological data with their students. With partners from across New Hampshire, the foundation's Environmental Literacy Program is creating innovative science inquiry programs for middle and high school educators using data sets and real life examples from the Forest Service's Hubbard Brook Experimental Forest. Partnerships with local schools help the program and its partners brainstorm, develop, and test new materials to help students understand the process of science, not just the results.

J. Wilson, Hubbard Brook Research Foundation

Educators can now use Hubbard Brooks long-term data sets to teach inquiry in their classrooms.

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PARTNERS

New Hampshire Education and Environment Team; Long-Term Ecological Research Network's Schoolyard Program; New Hampshire Project Learning Tree; New Hampshire Fish and Game; The GLOBE Program; New Hampshire Project WET; New Hampshire Project WILD; Project HOME; New Hampshire Department of Education.

PROJECT SMART: EDUCATING AND MOTIVATING TALENTED HIGH SCHOOL STUDENTS IN MATH AND SCIENCE

Forest Service funding from the Northern Research Station and Conservation Education helped 39 talented high school students from 11 states and Greece, Turkey, and India attend Project SMART (Science and Mathematics Achievement through Research Training), a summer institute at the University of New Hampshire.

With funding support from the NRS Civil Rights Diversity Committee's Special Project Funds and Conservation Education's More Kids in the Woods, the Forest Service was able to collaborate with the University of New Hampshire and the Liberty Mutual Foundation to offer this exceptional experience in July 2011. The students spent 4 weeks putting science into action through research projects on various topics including monitoring of terrestrial and aquatic systems in the White Mountains and other forest management practices, climate change and its impact on forest productivity, and forest health. Several students are expected to continue these research projects during the academic year and will present their findings at regional high school science symposia to compete for tuition and cash scholarships. The goal of these efforts is to help improve instruction and student performance in math and science as a contribution toward good citizenry.

Contact: Rakesh Minocha (rminocha@fs.fed.us)

Kevin T. Smith, U.S. Forest Service

Students learning about forest management as part of the marine and environmental science curriculum for Project SMART.

PARTNERS

National Forest System, White Mountain National Forest; State and Private Forestry, Washington Office, Conservation Education; University of New Hampshire

NRS RESEARCH WORK UNITS

RWU No.	Research Work Unit	RWU Leader
NRS-01	Ecological and Economic Sustainability of the Appalachian Forest in an Era of Globalization	Jan Wiedenbeck
NRS-02	Sustaining Forests in a Changing Environment	Susan Stout
NRS-03	Ecology and Management of Invasive Species and Forest Ecosystems	Kurt Gottschalk
NRS-04	Genetics, Biological Control, and Management of Invasive Species	Jim Slavicek
NRS-05	Forest Inventory and Analysis	Dennis May
NRS-06	Climate, Fire, and Carbon Cycle Sciences	Rich Birdsey
NRS-07	Center for Research on Ecosystem Change	John Brissette
NRS-08	Urban Forests, Human Health, and Environmental Quality	Dave Nowak
NRS-09	People and Their Environments: Social Science Supporting Natural Resource Management and Policy	Lynne Westphal
NRS-10	Biological and Environmental Influences on Forest Health and Productivity	Kevin T. Smith
NRS-11	Sustainable Management of Central Hardwood Ecosystems and Landscapes	Dan Dey
NRS-13	Institute for Applied Ecosystem Studies: Theory and Application of Scaling Science in Forestry	Eric Gustafson
NRS-14	Hardwood Tree Improvement and Regeneration Center	Charles Michler

*NRS-12 has been discontinued and its program components moved to other units within the Northern Research Station.

Covers, pages 1 and 2, photos by Ken Dudzik, U.S. Forest Service; page 14–15, photo by Tim McCabe, Natural Resources Conservation Service, forestryimages.org.

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