Ice Storm Research at the Hubbard Brook Experimental Forest

Ice storms are an important natural disturbance in forest ecosystems of the “ice belt,” an area extending from east Texas to New England. Although these glazing events (defined as 0.25 inches of ice accretion on the branches of trees and shrubs) are often perceived as rare occurrences, the return interval is as short as 2 to 5 years in the most ice-storm-prone northeastern United States. In this region, ice storms are among the most prominent natural disturbances. Despite their influential role in shaping forest ecosystems and the services they provide, knowledge of ice storms and their impacts remains relatively limited. Emerging questions about how climate change may be altering the frequency and severity of ice storms have heightened the need for information. Research at the Hubbard Brook Experimental Forest in New Hampshire is beginning to address some of these topics using a multifaceted approach that involves field experiments, examination of long-term data, and modeling.

What appears to be the first-ever controlled, experimental ice storm manipulation in a forest ecosystem was conducted in February 2011. To simulate a glaze-ice event, water was pumped from Hubbard Brook and sprayed over the forest canopy during subfreezing conditions. The falling water froze on contact and produced 0.4 inches of ice accumulation, comparable to measurements at Hubbard Brook during the major ice storm of

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The Santee Experimental Forest (SEF) is located in the lower coastal plain of South Carolina in an area known as the Lowcountry, which is characterized by a very low topographic gradient, subtropical climate, and productive soils and estuaries. The land comprising the SEF has been managed since the early 1700s. The land was conveyed to European settlers in the late 1600s; plantation management involving agricultural and forest uses began in the early 1700s and continued through the early 1900s. Most of the bottomlands were converted for rice cultivation, as were areas of imperfectly drained uplands. Rice cultivation involved elaborate water management systems consisting of reservoirs, channels, dikes, control structures, and fields. The land was used intensively for agriculture through the 1890s, when it was acquired by timber companies. Subsequently, the upland woodlands were heavily logged. Accordingly, development of present-day forests began in the early 1900’s, and afforestation of former agricultural lands occurred without direct intervention. Today, the Santee provides reference “natural” ecosystems for the rapidly urbanizing southeastern coastal plain landscape.

The first forest research study in South Carolina was established in 1905 on land now contained within the SEF. Since formal establishment of the Santee in 1937, scientists have made significant contributions to forest science and management of southern forests, especially in the areas of loblolly pine (Pinus taeda L.) and bottomland hardwood silviculture, prescribed fire, forest hydrology, tree physiology, and disturbance ecology. Hurricane Hugo (1989) was a defining event for the SEF, with the majority of the forest canopy trees damaged or killed by the storm. The bottomland and upland forests on what had been agricultural lands were a testament to the resiliency of southern forests; ongoing studies continue to chronicle post-Hugo forest responses. The SEF contains nested gauged watersheds representing first-, second-, and third-order streams, with hydrologic records dating to the mid-1960s, recently augmented by LIDAR data. That infrastructure, in addition to the long-term climatological data (since 1942), is an important foundation for field and modeling studies at multiple scales. The Southern Research Station recently upgraded laboratory and office facilities on the SEF, positioning the site to address contemporary and future forest resource issues. The SEF is home to the Center for Forested Wetlands Research which is part of the Forest Watershed Science Unit (SRS-4353). You are invited to participate in the Santee’s celebration of its 75th anniversary in April 2012.

For more information, visit http://www.srs.fs.usda.gov/charleston/.
How do you balance the habitat management requirements for elk, deer, and cattle on the same summer range landscape? This was a primary motivation for the establishment in 1940 of the Starkey Experimental Forest and Range (SEFR) in northeastern Oregon. It is the only experimental forest and range in the extensive Forest Service EFR network. A myriad of research projects have ensued that focus on livestock and wildlife interactions in forested grasslands and mixed-conifer forests. This legacy was strengthened in 1987 with the genesis of the Starkey Project, an innovative, long-term research project that was begun on the SEFR to address four key management issues: elk herd productivity, effects of intensive timber management on deer and elk, road and traffic effects on deer and elk, and competition for forage among elk, deer, and cattle. The research proposed by the project’s leaders required commitment and support from a multitude of partners, especially in light of the controversial need for fencing more than 10,000 hectares (24,711 acres) of prime summer range habitat for mule deer, elk, and other native wildlife. The project’s primary partner was the Oregon Department of Fish and Wildlife, which continues to play a major role in Starkey research. Other key partners included the Forest Service Pacific Northwest Region, Boise Cascade Corporation, National Council for Air and Stream Improvement (NCASI), Eastern Oregon Agricultural Research Center, and Rocky Mountain Elk Foundation. More than 40 other partners have participated in various aspects of Starkey research since the project’s founding.

Current research on ungulates and a variety of other taxa continues under the auspices of the Starkey Project with a diverse suite of partners. One example is development of new habitat models for elk, replacing outdated models that often relied on expert opinion but had not been validated. Research scientists from the Pacific Northwest Research Station’s Starkey Ungulate Ecology Team are using the project’s extensive elk radiotelemetry and habitat data sets to develop and validate a landscape-level elk habitat model for the Blue Mountains of eastern Oregon and Washington. The model will be used in land management planning and includes an explicit nutritional component that estimates dietary digestible energy and forage biomass. Tame elk, raised and housed at Starkey and grazed in landscapes of the Blue Mountains by ungulate scientists from NCASI, were used to develop the nutrition models. Without the support of NCASI and the host of Starkey partners, the complex spatial analyses, compilation of data layers, and timely delivery of modeling products to management required by the project would have been impossible to complete.

For more information about the elk habitat modeling project, visit http://www.fs.fed.us/pnw/calendar/workshop/elk/index.shtml. Additional information about the Starkey Project can be found at http://www.fs.fed.us/pnw/starkey/.
One of the older U.S. Forest Service research sites in California is the Stanislaus-Tuolumne Experimental Forest, with studies installed as early as the 1920s. Led by influential Forest Service scientist Duncan Dunning, researchers collected data that formed the foundation of much of what we know about the Sierra Nevada mixed-conifer forest. In 1929, to better understand regeneration following harvest, Dunning established several 10-acre plots in an unlogged area and had the location of every tree, shrub, and downed log mapped. Plots were then logged at a range of intensities, and data were collected until 1947, after which the plots were abandoned. The value of well-documented data frequently increases over time. Fortunately, maps stashed away at the Pacific Southwest Research Station (PSW) lab in Redding, along with plot corner monuments and individually numbered tree tags, enabled us to find the old plots. A visit to the National Archives, where data ledgers and old photographs were stored, helped fill in the story.

These plots were recently remapped, showing the tremendous changes that have occurred as the forest recovered from logging under management that excluded fire. Tree density and basal area have increased, shrubs that historically covered 30 percent of the forest floor have declined precipitously, and the understory plant community has shifted primarily to shade-tolerant species. The 1929 data also provide a valuable template for restoring forests to a more fire-resilient and biodiverse state. Stand maps show the forest to have been exceedingly variable, with dense groups of trees intermixed with small gaps and areas with more widely spaced large trees. We used this information to develop a thinning prescription for producing greater complexity in forest stands than those generated by the typical thinning prescription used by forest managers in the recent past. Together with our Stanislaus National Forest partners we are currently installing a new “variable density thinning” study, in which stands thinned for high variability are being compared to stands thinned to a relatively even crown spacing and an unthinned control, all with or without prescribed fire as a followup. After treatments are fully implemented, researchers from PSW as well as the University of California–Berkeley and the University of California–Merced will continue with followup monitoring of variables that include natural tree regeneration, fuel continuity, snow accumulation and water balance, and understory plant cover and diversity, as well as small mammal and bird abundance. In light of growing interest in restoration and managing forests for multiple values, it is our hope that data generated here will help refine future management strategies.

For more information, go to http://www.fs.fed.us/psw/publications/documents/psw_sp013/.
Temperature Records From Experimental Forests and Ranges Add to the Story of a Warming Planet

There are many untapped sources of additional scientific information to garner from the experimental forests and ranges (EFR) network. Forest Service Chief Tom Tidwell recently asked that temperature records from the experimental forest and range network be compiled to shed more light on the issue of climate change in North America.

Forest Service scientists are compiling and assessing long-term temperature records from the experimental forest and range network to help shed more light on the issue of climate change in North America. Many of our EFRs have maintained temperature records for as many as 100 years; the EFR Working Group has embarked on an effort to examine these data and help us explore what our long-term data could contribute to the understanding of this global phenomenon. Changes in temperature and the frequency of extreme climatic events predicted by climate scientists may have profound consequences for forests and rangelands of the United States, including effects on fire, insect pests, forest pathogens, invasive species, water quality and yield, wildlife, forest composition, productivity, and carbon sequestration.

Understanding Climate on Forest Service Lands

To our significant advantage, the 80 EFRs across the United States are located along broad gradients of temperature, precipitation, elevation, atmospheric nitrogen deposition, nutrient limitation, and vegetation and soil types representative of most national forests.

Experimental forests and ranges have a long history of baseline monitoring of environmental conditions, including air temperature and precipitation. These records show that mean annual temperatures across the network range from a low of about 21 °F to a high of 77 °F, with annual precipitation ranging from about 6.5 to 141 inches. (continued on next page)
NEW INITIATIVES

Data from EFRs typically are collected from the same location, using similar instruments, and without substantial changes in land cover over the measurement period. These characteristics are important for ensuring that observed changes result from climate variation rather than extraneous factors. Further, EFRs provide a wealth of additional long-term environmental data on a wide range of forest and rangeland properties, allowing for linkages to be made between changes in climate and in ecosystem structure and function. Long-term forest management studies on EFRs can also provide critical guidance on how climate change interacts with management activities, helping resource managers evaluate management options available for mitigation and adaptation.

Climate Synthesis Findings

Air temperature data were available from 26 sites that represented a range of ecosystem types, climatic regimes, and geographic locations.

- The span of recorded air temperature measurements ranged from 5 to 103 years.
- Fourteen sites had complete annual records (minimum of 90 percent of days reported in an annual cycle) for more than 25 years (the criteria selected for valid statistical analysis of long-term trends).

- Ten of the 14 sites showed statistically significant warming trends over the period of measurement. Sites spanned a wide range of life zones, latitudes, and elevations, and increasing temperatures were observed within most geographic regions.

- The rate of temperature increase ranged from 0.2 to 1.4 °F per decade, consistent with reported continental and global rates of change.

- The breadth of sites within the EFR network provides a uniquely powerful tool for the evaluation of subtle but important influences of topography, latitude, distance from coast and other ecophysical attributes on long term trends in temperature and climate.

Recommendations

1. Air temperature is among the most basic of all environmental parameters to measure, yet data were available for only 26 EFR sites (32 percent of the total); only 14 sites (17 percent) had a sufficiently long record for statistical analyses. It is critical to build on and support infrastructure and staffing for climate and meteorological research programs across the EFR network.

2. Climate records and syntheses are useful only if they are of high quality and accessible. The Forest Service could benefit from sustained support for quality assurance and increased accessibility to EFR climate data; current efforts to develop the research and development data archive should be accelerated to achieve these objectives.

3. A new generation of monitoring technologies (e.g., temperature sensors, data loggers, cell phone and satellite transmission) are available that will facilitate 21st century expansion of climate monitoring and data accessibility. The Forest Service could greatly benefit by investing in this new technology.

For further information, contact Dr. Lindsey Rustad (EFR Working Group Subcommittee Chair; 603-397-7406), or Dr. Laura Kenefic (EFR Working Group Chair; 207-581-2794).
**Experimental Forest Network Hosts Nationwide Bee Monitoring Project**

Much has been written about the status of native bee populations in North America in both the popular and scientific press. In many reports, the primary theme is that native bee populations have declined. However, to date, such declines have been quantified over large geographic areas only for bumblebees. Despite the recent publicity, we currently have no means to measure the status or trends of native bees across the United States. There are approximately 4,000 species of bees in the Nation and they pollinate 30 to 60 percent of all the plants in a given environment. Understanding changes in bee populations is critical because of their central role in maintaining habitats, their importance to agriculture, and the declining fortunes of honey bees and beekeepers.

Eleven Forest Service experimental forests and ranges participated in the first year of a nationwide bee monitoring project in conjunction with the U.S. Geological Survey Patuxent Wildlife Research Center. The locations, specifically selected to cover as broad an ecological range as possible, included sites in California, Colorado, Georgia, Idaho, Maine, Minnesota, Ohio, Oregon, Texas, Utah, and Puerto Rico. In 2010, more than 3,500 bees from 36 genera were collected from pan traps. Bumblebees and sweat bees were trapped in nearly all locations; other genera frequently were clustered in the Eastern or Western United States.

The first year of this study demonstrated the feasibility of conducting a national monitoring effort at fairly low cost. The data generated from a monitoring network can be used to estimate regional changes in bee populations and communities, better determine which species are common or rare in particular locations, assess seasonal trends in bee populations, and generate an extensive collection of specimens for future study.


**Forest Service Hydrological Science Represented at International Conference**

The 25th General Assembly of the International Union of Geodesy and Geophysics (IUGG) was held in Melbourne, Australia, June 28 to July 7, 2011. As part of the IUGG meeting, the International Association of Hydrological Sciences (IAHS) convened a workshop titled “Revisiting Experimental Catchment Studies in Forest Hydrology.” At the IAHS workshop, 46 oral papers and posters presented the results of forest hydrology research in Australia, Japan, China, France, South Africa, Canada, and the United States. Experimental-forest based paired watershed studies were featured in five oral papers and three posters. A paper by Deborah Hayes and others, titled “The U.S. Forest Service Experimental Forests and Ranges Network: A Continental Research Platform for Catchment Research in the United States,” presented an overview of watershed research in the experimental forest and range (EFR) network. Dan Neary, research soil scientist at the Rocky Mountain Research Station, presented all of the papers and posters as the Forest Service representative to the meeting. The other papers and posters covered such topics as long-term watershed studies in the Southwest, wildfires, prescribed fires, sediment yields, climate change, stream chemistry results from the EFR watershed network, and acid deposition chemistry at Bear Brook Experimental Forest in Maine and Fernow Experimental Forest in West Virginia.

An IAHS field trip to the Melbourne municipal watersheds and to areas burned by the devastating 2009 bushfires followed two days of presentations at the Melbourne Convention Center. More information on this workshop can be found at the IUGG Web site at [http://www.iugg.org/associations/iahs.php](http://www.iugg.org/associations/iahs.php).
Data Management

It's been a quiet summer tending the information garden. The harvest isn't actually in yet, but we are anticipating a crop of new Web sites. Some will simply use the new “Network” look and feel; others will augment the new look with a new data query and dissemination application. Expect more details and URLs in the next issue of this newsletter.

Forest Service Research and Development’s Research Data Archive is sponsoring two new EFR information proof-of-concept projects. One project, at Fort Valley EF, is developing a system for cataloging historical research data sets. This includes study plans, data, and supporting content (e.g., images). Development of catalogs is a prelude to actual conversion from paper-based to digital content that can be shared with the EFR network and broader science communities. The other project, at Penobscot EF, is devising a system for EFR records management. The National Archives and Records Administration (NARA) and the Forest Service Office of Records and Management Systems (ORMS) have had a number of conversations with Washington Office EFR staff about improving records management. This effort will help us bring our practices into conformance with legal requirements and enable us to more easily access the value contained in our records.

Forest stand damaged by ice accumulation.

Ice Storm Research at Hubbard Brook
(from page 1)

1998 that affected much of the northeastern United States and Canada. The goal of this initial experiment is to evaluate forest damage and effects on carbon sequestration, and plans are underway to build on the success of this approach.

The other aspect of this research is an evaluation of how climate change may alter ice storms in the future. Recent emphasis on linkages between climate change and extreme weather events (e.g., heat waves, hurricanes, and floods) has raised questions about trends in ice storms over time. As part of this investigation, climate change projections are being used to evaluate potential changes in the probability, duration, and extent of freezing rain events. The approach involves identifying the complex climatic conditions associated with past ice storms to make future projections. In total, this research is providing much needed insight on ice storms that will better prepare land managers, industry, policymakers, and the public.

For more information, contact Lindsey Rustad (lrustad@fs.fed.us) or John Campbell (jlcampbell@fs.fed.us).

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