United States Department of Agriculture

Smart Forests

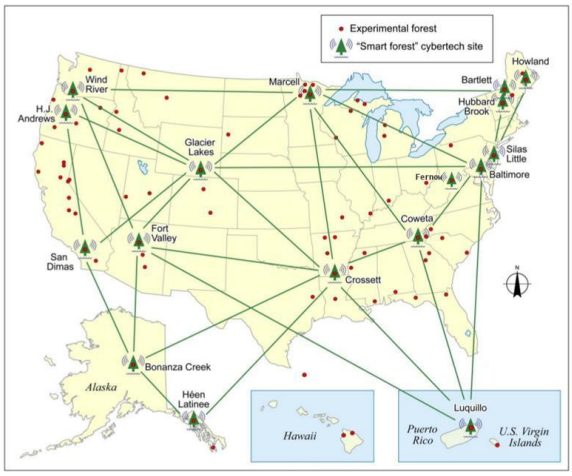
Experimental Forest Network

Continental Scale Observatory Platform Linking EFRs in Real Time

Science and sound resource management depend on accurate and timely environmental data. In Experimental Forests and Ranges (EFRs) throughout the United States, the USDA Forest Service is investing in digital environmental sensor and telecommunications capacity to create the Smart Forests Network, which is an integrated research and monitoring program for the nation's air, water, and forest and rangeland resources.

Smart Forests Will:

- Develop and implement cyber infrastructure to upgrade and enhance environmental monitoring at long-term research sites that are distributed strategically across major geographic, climatic, vegetation and land-use gradients.
- Collect and wirelessly transmit to a single web portal a foundational set of environmental measurements from these sites in real time.
- Apply visualization, modeling and outreach tools to engage researchers, resource managers, educators and the public with "Smart Forest" data.
- Provide a research base for addressing local-, regional- and continental-scale issues relative to the health and sustainability of the nation's forests and rangelands.



A Vision for a USFS Experimental Smart Forest Network

Key Components

- State-of-the-art wireless sensor network for capture and delivery of a core set of high resolution hydrologic and meteorological data.
- Cyber infrastructure and capacity to allow sites to add custom sensor packages.
- Streaming, real-time quality control (QC) procedures to ensure highest quality data capture and delivery.
- Centralized data delivery to a single web portal.
- Interactive data visualizations and content for scientists, educators, and the public.
- Question driven.

Issues Research is Addressing

Climate Change - Rapid changes in climate are fundamentally altering natural, managed, and built ecosystems at local to continental scales. Smart Forests will build on the foundation of climatic and hydrologic research and monitoring at EFR sites to provide a comprehensive, accessible suite of standardized atmospheric, meteorological and hydrological measurements with which to (i) benchmark changes in climate, (ii) provide input to models to project future changes, and (iii) provide context for understanding forest and rangeland response to climate change, with associated vulnerabilities and opportunities.

Extreme Weather Events – Climate change is altering the frequency, intensity, and spatial distribution of *extreme weather events* such as droughts, heavy rain, heat waves, high winds (hurricanes, microbursts, derechos, etc.). Smart Forests will provide fast access to data to better understand direct and indirect effects of extreme weather events on forest and rangeland ecosystems (including increased vulnerability to fire, pests, pathogens and invasives) and connected effects on adjoining or remote ecosystems (including nutrient export; aeolian transport; changes in water quality and quantity).

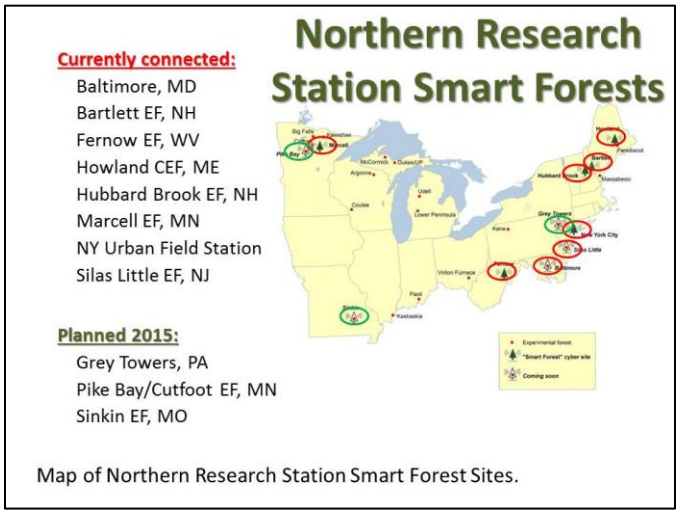
Forest Health, Productivity and Disturbance – The nation's forests and ranges are beset by multiple stressors, including air pollution, climate change, a shifting array of pests, pathogens and invasive species, and increased risk for fire. Each Smart Forest is equipped with at least one high resolution digital camera ('Phenocam') which takes hourly images of the forest canopy, providing quantitative measures of canopy phenology. Phenology is a robust integrator of the effects of year-to-year climate variability and longer-term climate change on forest productivity, and canopy feedbacks to the water cycle, energy balance and local climate.

Water Quantity and Quality – Smart Forests located at EFR's with long term hydrologic research programs are equipped with automated stream stage height, temperature and chemical conductivity sensors. Together, these provide a real-time snap shot of water quantity and quality at these EFR's. This information will be particularly important to inform management decisions before, during and after extreme hydrologic events.

Test Bed for Sensor Development – Smart Forests is taking a leadership role in development and deployment of new types of sensors. Examples include dendrometer bands and photosynthetically active radiation sensors for automated forest and rangeland productivity measurements; nitrate, dissolved oxygen, pH, and dissolved organic carbon sensors for automated water quality measurements; acoustical sensors for automated detection of presence or absence of wildlife species; optical sensors, including "critter cams" to capture and record wildlife presence and behavior, as well as more sophisticated phenocams and image extraction procedures to automate detection of canopy condition resulting from stressors such as drought, nutrient imbalances, pests or pathogens.

Accomplishments

- Gathered information on existing sensor technology and needs across EFR network. Results showed that 24% of EFRs across the country are already adopting sensor technology for a wide range of applications, and that the major obstacles are cost, staffing and basic knowledge of hardware, software, and computer programming.
- Implemented Smart Forests at 8 sites in the NRS (3 more planned for 2015; see map).
- Developed real-time streaming QC and visualization tools.
- Testing suite of new tree health and water quality sensors.



Map of Northern Research Station Smart Forest Sites.

Anticipated Outcomes

- Real-Time networking platform for new and existing research across a suite of digitally-connected EFR sites.
- New tools, apps and models for research on hydrology, biogeochemistry, silviculture and wildlife.
- Rapid reporting, contribution and relevance to long-term monitoring initiatives across the country.
- Early warning of extreme environmental conditions and events.
- Rapid assessments and evaluations of extreme events.
- Novel tools for education, outreach, and sharing USDA data with the public.

Scientific breakthroughs of the 21st century will be increasingly powered by tools that help researchers manipulate massive datasets, visualize that data, and offer new ways to understand the drivers of ecosystem change.

Smart Forests will help EFR sites around the nation face the technological challenges in meeting the information needs of the 21st century, while also creating a continental scale observatory platform linking EFRs in real time.

For more information, see: http://smartforests.org/ ;

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