

# Future Scenarios of Landscape Change in the United States

2011

Changes to the New England landscape over time • Left: 1880—agriculture dominated; Center: 2011—forest dominated; Right: 2060—?

## Advancing LTER Future Scenarios Research

### 1. LTER Future Scenarios Initiative

- ▶ Develop and pursue activities in LTER future scenarios prospectus.
- ▶ Publish *BioScience* paper on the use of Future Scenarios in the LTER Network.
- ▶ Document and communicate lessons from existing future scenarios projects at LTER sites, including: North Temperate Lakes, Bonanza Creek, Baltimore Ecosystem Study, and Central Arizona-Phoenix.
- ▶ Expand *Forest Scenarios* graduate course to include additional sites and topics.

### 2. Forest Scenarios Research Project

- ▶ Complete review of existing national assessments of climate and land use change funded by NSF to frame *Forest Scenarios* research.
- ▶ Build partnerships among existing scenario efforts within the five study regions, including: Maine Sustainability Science EPSCOR project, Lake Wingra future scenarios in Wisconsin, and Alaska SNAP (Scenarios Network for Alaska Planning) initiative.
- ▶ Expand stakeholder network at national and regional scales through interviews regarding major drivers of change, ecosystem services of concern, and related policy and management decisions.
- ▶ Expand Massachusetts *Forest Scenarios* case study by convening a workshop with stakeholders to define future scenarios that can be analyzed with the existing model.

## CURRENT FOREST SCENARIOS COLLABORATORS

David Foster *Harvard University, Harvard Forest LTER*  
Kathy Fallon Lambert *Harvard University, Harvard Forest LTER*  
Jonathan Thompson *Smithsonian Conservation Biology Institute*  
Tom Spies *US Forest Service, Andrews LTER*  
David Mladenoff *University of Wisconsin*  
Steve Carpenter *University of Wisconsin, North Temperate Lakes LTER*  
Rob Scheller *Portland State University*  
Terry Chapin *University of Alaska, Bonanza Creek LTER*  
Rob Lillieholm *University of Maine*  
Charles Driscoll *Syracuse University, Hubbard Brook LTER*  
Ted Gragson *University of Georgia, Coweeta LTER*  
David Wear *US Forest Service, Southern Research Station*  
David McGuire *Bonanza Creek LTER*  
Teresa Hollingsworth, *University of Alaska, Bonanza Creek LTER*

**THE LONG TERM ECOLOGICAL RESEARCH (LTER) program, established in 1980 and funded by the National Science Foundation, is a collaborative network of 26 ecological research sites, involving more than 1,800 scientists and students in the investigation of ecological processes over long temporal and broad spatial scales.**

To read the LTER prospectus of *Future Scenarios of Landscape Change*, go to <http://www.lternet.edu/decadalplan/>

For more information about the *Forest Scenarios* initiative, contact

Jonathan Thompson  
Smithsonian Conservation Biology Institute  
540-635-6580, [thompsonjr@si.edu](mailto:thompsonjr@si.edu)



Alaskan interior forest,  
by Douglas Yates, Ester, Alaska



## Long-Term Ecological Research and Future Scenarios of Climate and Land-use Change

The complexity of global change and the need for integrated approaches to evaluating land use and climate change are driving future scenarios analyses within the Long Term Ecological Research (LTER) program and other major research entities. Scenario analysis brings together plausible narratives about the future and spatial simulation models to evaluate the implications for a range of values including ecosystem services such as carbon sequestration, water quality, and habitat quality and continuity. The results of scenario analysis inform prescient planning and policy and advance fundamental research.

Through a series of workshops between 2004 and 2010, scientists engaged with LTER, the U.S. Forest Service and other networks including the National Ecological Observatory Network (NEON) called attention to the need for a suite of future scenarios analyses to advance sustainability and global change theory, transform the quality of ecological forecasting, and provide critical information to society and policy makers related to global change vulnerability, resilience and adaptability. Such analyses would engage stakeholders

and scientists across a broad array of landscapes and drivers of change and draw on the core strengths of the nation's research networks such as robust, public data archives; a commitment to long-term, place-based studies; and diverse suite of researchers who specialize across the social, physical and ecological sciences.

Scenario analyses have been conducted at local to global scales (e.g., Willamette Futures, CLAMS, and Millennium Assessment), are underway at several existing LTER sites and are emerging at clusters of sites with similar biomes and land use issues. These efforts embody many of the attributes of effective future scenario analyses and are helping to advance the overall LTER future scenarios effort through activities such as stakeholder engagement, development of visualization tools, contributions to training of students through new courses, and communication to decision makers. Among these emerging cross-site efforts is *Forest Scenarios*, which is spotlighted here. *Forest Scenarios* is an integrated future scenario project using consistent scenario development and modeling approaches across five major forested regions of the U.S.

Photos, l to r: Patch harvest in the Pacific Northwest, by Al Levno; Western post-fire landscape, by David Foster; Northern Wisconsin lake, by Terry Daulton .



## Forest Scenarios: Land Use, Climate Change and Transformations of Forest Landscapes

From wood products to clean water and climate mitigation, the 750 million acres of U.S. forests produce goods and services that are fundamental to human prosperity. *Forest Scenarios* will evaluate how national and regional drivers of environmental and land-use change may affect ecosystems and ecosystem services in U.S. forests over the next 50 years. With the goal of predicting and understanding future forest landscapes, the project brings decades of ecological research to bear on the questions and concerns of local and national decision-makers. The primary outcomes of the *Forest Scenarios* research initiative will include peer-reviewed publications, targeted regional reports, online maps and resources, and multi-media content targeted to specific stakeholder groups.

### The Purpose

- ▶ To develop plausible narratives for the future of U.S. forests.
- ▶ To expand understanding of the potential consequences of global change on forest conditions and ecosystem services at landscape to regional scales.
- ▶ To provide scientific resources to guide forest policy, conservation, and management and promote long-term resilience and adaptability.

### The Approach

The *Forest Scenarios* project combines scenario development, quantitative modeling and synthesis and distillation to expand scientific and public understanding of global change (Figure 1). Working with expert stakeholders, a set of future climate and land use scenarios will be developed for five forest study regions related to climate mitigation, biomass energy, global markets, and landscape-scale conservation and

other themes. The scenarios will be analyzed using a consistent forest simulation model (LANDIS-II) to project potential consequences for important ecosystem services including changes in carbon storage, habitat, and water quantity and quality. The implications of these changes will be distilled to inform regional and national forest conservation, policy and management.

### Proposed Research Questions

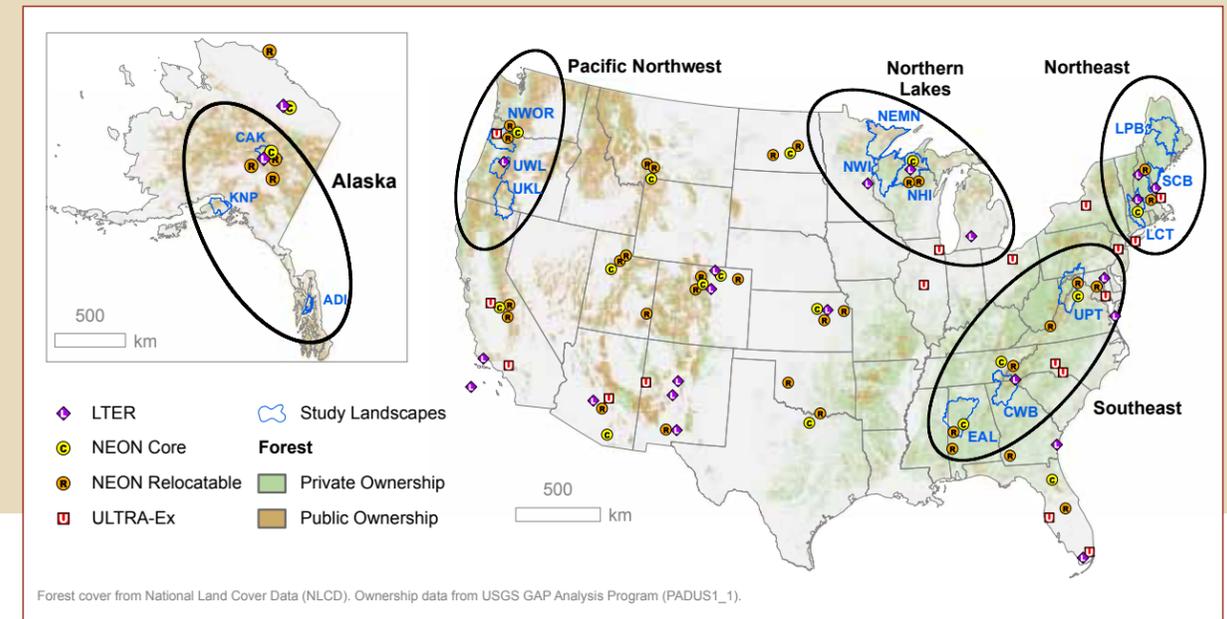
- 1) What will be the relative influence of climate change, natural disturbance, forest conversion, forest management and forest dynamics on ecosystem attributes and services over the next 50 years?
- 2) How will the relative influence of broad-scale presses vary along major social and ecological gradients across and among regions?
- 3) How do fine-scale processes regulate landscape response and influence landscape vulnerability to broad-scale presses?

### Activities to Date

**Planning Workshops.** In April 2009 and November 2010, ecologists gathered at the Harvard Forest with support from the LTER Network to lay the groundwork for the *Forest Scenarios* research initiative by reviewing existing assessments and establishing pilot projects.

**Stakeholder Dialogues.** In 2011, dialogues with national stakeholders were convened at The Heinz Center and the National Council for Science and the Environment to exchange ideas regarding key socio-economic, policy, and biophysical drivers of forest change in the U.S. Attendees included representatives from federal agencies, LTER scientists, regional and national conservation organizations, and landowner associations.

Figure 2. Forest Scenarios focal regions



### Forest Scenarios Case Studies

*Forest Scenarios* will investigate five regions that comprise a substantial measure and wide socio-ecological spectrum of U.S. forests (Figure 2). Pilot projects are ongoing in several of these regions. A key strength of these studies is the consistent framework of narrative scenario development and simulation modeling within and across regions.

#### Northeast Pilot Project

Researchers from the Smithsonian and Harvard University have conducted a landscape simulation experiment to evaluate regional forest change in Massachusetts over the next fifty years (2010 to 2060). First they projected a “business as usual” scenario for forest carbon biomass and tree species composition, assuming current trends of forest growth and recovery, climate change, forest conversion to developed uses, and timber harvest. Forest growth and recovery had the largest effect on total forest carbon, increasing biomass stores by as much as seventy percent over fifty years. Forest conversion and timber harvest reduced gains in forest carbon by 18 percent and four percent, respectively. Anticipated climate change increased biomass by 14 percent.

The *Forest Scenarios* group in the Northeast is now considering alternative scenarios to compare with the “business as usual” scenario described above. For Massachusetts, they are working on a suite of scenarios to estimate potential effects of increasing harvests to meet the state’s energy needs using wood biofuels and to assess the potential impacts of invasive pests like the hemlock woolly adelgid and the Asian long-horned beetle. The northeast group is also considering a mountains-to-sea transect from Massachusetts through New Hampshire and into Maine, where land tenure is in flux.

#### Northern Lakes Pilot Project

For more than twenty years, researchers at the University of Wisconsin-Madison have been analyzing alternative climate and timber harvest scenarios in collaboration with the U.S. Forest Service. They have pioneered many of the landscape simulation methods associated with the *Forest Scenarios* effort.

In one pilot study, they emulated the experimental design used in Massachusetts to study the relative impacts of current trends in climate and land use change on forest carbon biomass and tree species composition in a mixed-ownership forested landscape spanning northern Wisconsin. A comparison of these preliminary results to the Massachusetts data indicates that timber harvest has a higher relative influence on overall forest biomass in the Northern Lake region than in the Northeast—with an impact that is roughly equal to that of forest conversion to development (Figure 3).

Figure 1. Conceptual depiction of the Forest Scenarios process

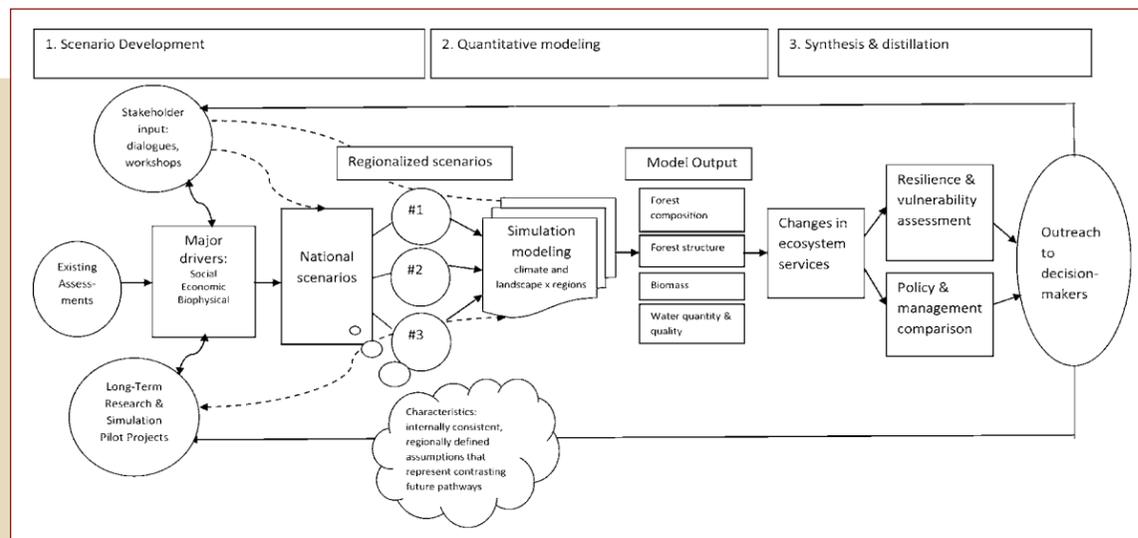


Figure 3. Impact of climate and land use change on forest carbon in two landscapes

