Resilience in action: Guiding management responses to ecological transitions from disturbance and tree mortality

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THE UNIVERSITY OF ARIZONA

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

School of Natural Resources and the Environment

USGS science for a changing world

Background and Project Overview

- Forests provide important benefits such as wildlife habitat, timber, carbon storage, and clean water.
- Tree mortality can be triggered by changing climate, extreme wildfire, insect attacks...
- Tree die-off is threatening ecosystem services and livelihoods.
- Multidisciplinary approach:
  - Ecosystem Ecology
  - Forest Management
  - Ecosystem Modeling
  - Plant Physiology
  - Climatology
  - Fire Ecology

Study Landscape – Jemez Mountains

Photo: Craig D. Allen

Research Questions and Objectives

- How will these ecosystems recover following these mortality episodes?
- How to manage terrestrial ecosystems under uncertain climate and disturbance?

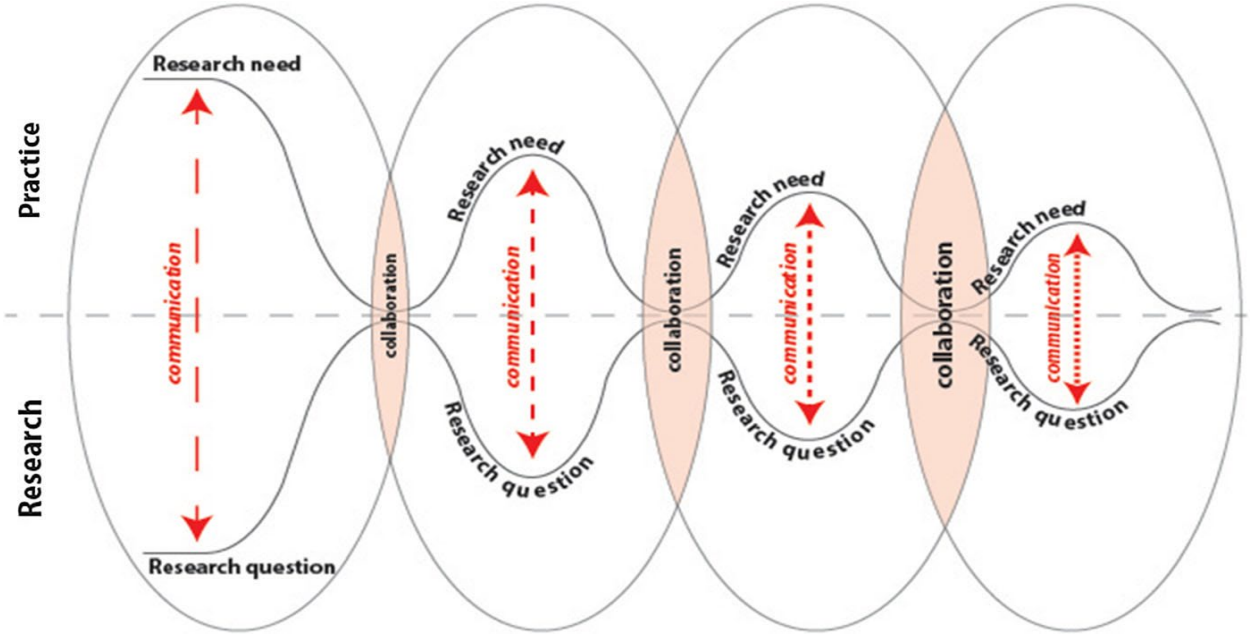


Photo: Craig D. Allen

- Need to better inform land managers:
  - Forest recovery and reorganization
  - Improve linkages between science and management

Photo: US Forest Service - Jemez Mountains - Kari Greer

Photo: US Forest Service - Southwest Jemez Mountains

Challenges in Managing for Forest Resilience

- Seedlings are critical bottlenecks to future population recovery following disturbance.
- Young trees lack the resources to endure extended periods of excessive heat or drought.
- Reduced seedling survival can potentially lead to extensive forest loss and ecosystem type conversion.
- Understanding regeneration patterns is critical in **managing for forest resilience**.

Experimental Design & Ecosystem Simulation Modeling

- Sapling Experiments:
  - Extreme drought
  - Hotter chronic temperature
  - Extreme heatwaves
- Tree Species:
  - Pinyon pine
  - Ponderosa pine
  - Limber pine
  - Engelman spruce
  - Douglas fir

Graduate student – Allie Lalor

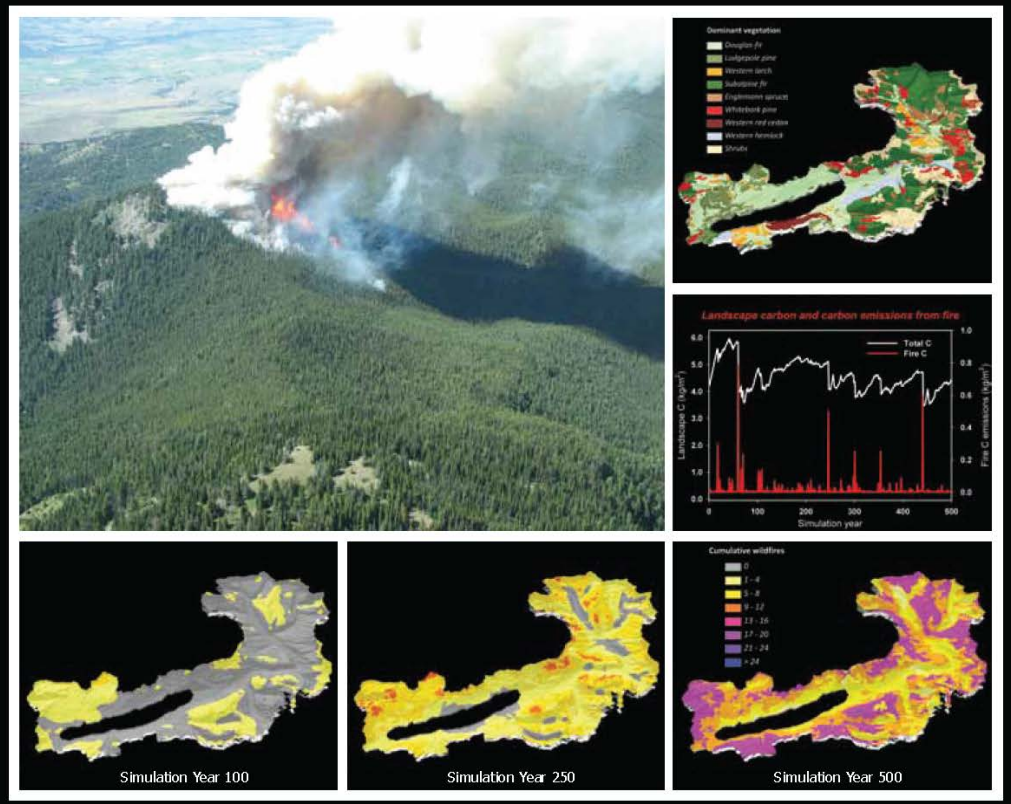
- Simulation Modeling: **FireBGC** – tracks the establishment, growth, mortality, and decay of individual trees across a simulated landscape.

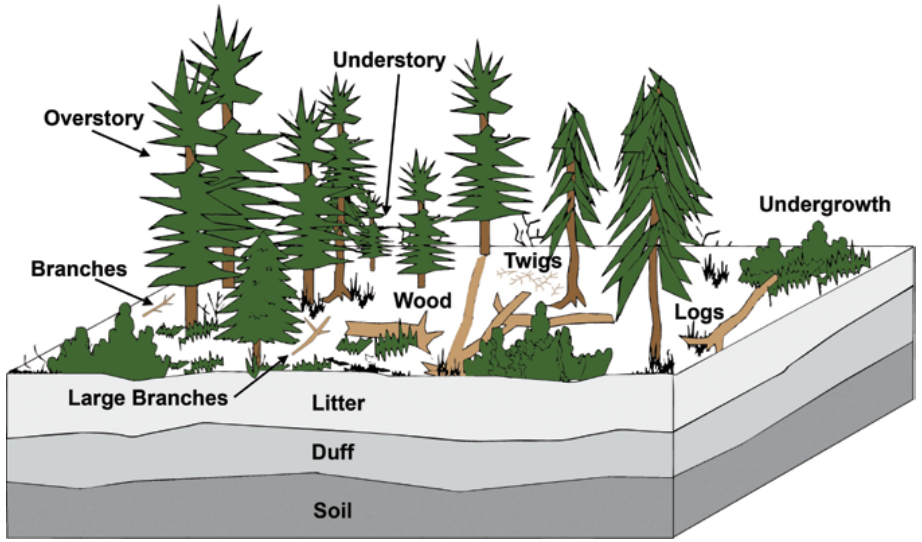
USDA
United States Department of Agriculture
Forest Service
Rocky Mountain Research Station
General Technical Report RMRS-GTR-255
March 2011

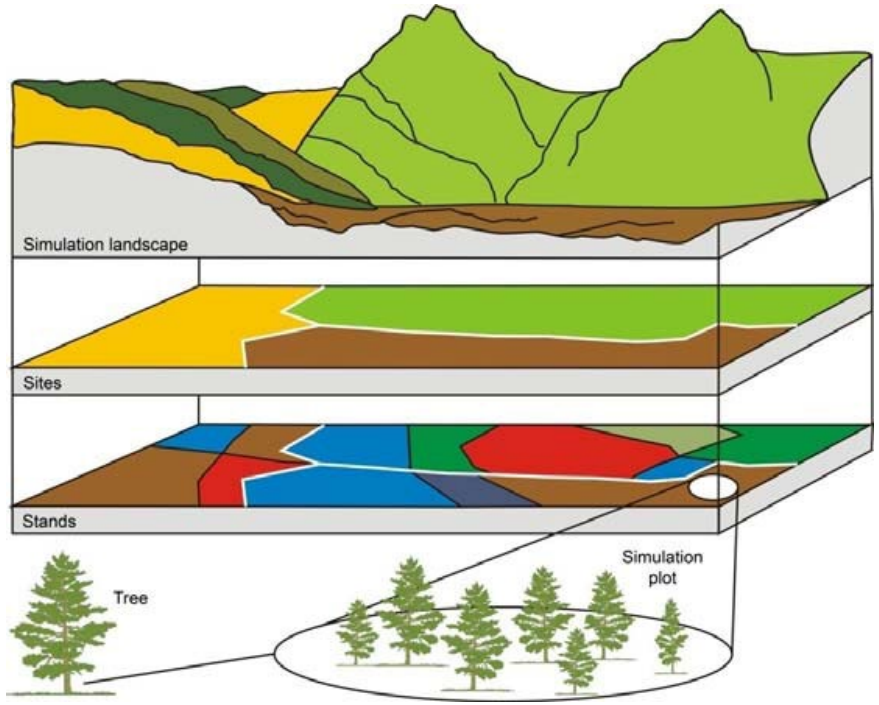
The FireBGCv2 Landscape Fire Succession Model:

A Research Simulation Platform for Exploring Fire and Vegetation Dynamics

Robert E. Keane,
Rachel A. Loehman,
Lisa M. Holsinger







Keane et al. 2011, USFS RMRS-GTR 255; Loehman et al. 2011, *Forests*

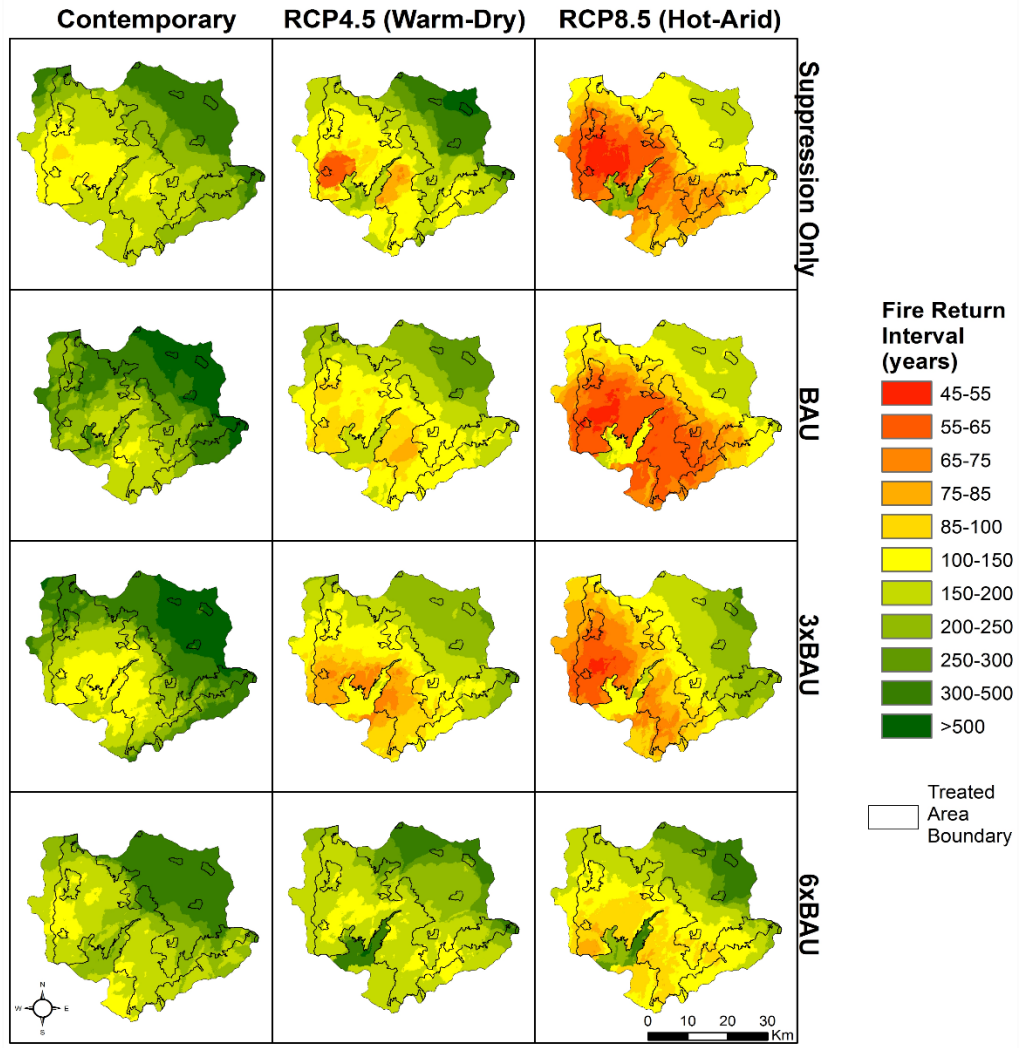
Experimental Design & Ecosystem Simulation Modeling

Inputs into FireBGC simulation include:

- **Species files (ecophysiological growth and survivorship parameters)**
- Site, stand, tree conditions, topography, map layers
- Weather and climate streams
- Fire regime
- Management actions

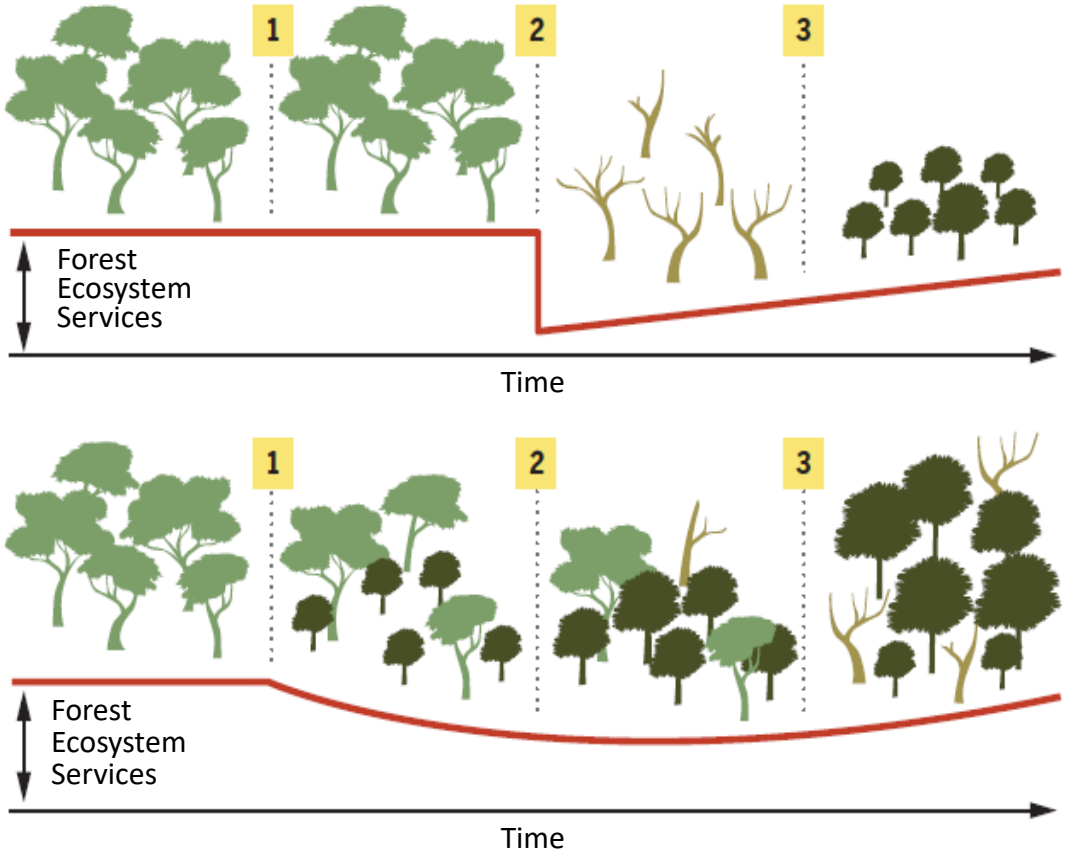
Output from FireBGC simulation can include:

- Species geographic distributions
- Tree size and age distributions by species
- **Mortality and recruitment**
- Landscape standing carbon
- Wildfire area burned



Anticipated Findings and Management Implications

- Results will aid land managers in their decisions regarding climate change and variability.
- Determine the most efficient uses of resources in guiding forest recovery and transitions.



Millar and Stephenson, 2015

USFS Adaptation and Management Strategy.

Example	Resistance	Resilience	Transition
All ecosystem types			
Shifts in plant composition	Limit	Allow	Encourage
Risk*	High	Moderate	Low

* *Risk to loss in ecosystem services in the long-term*

References and Acknowledgements

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Photo: Lauren Sommer

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