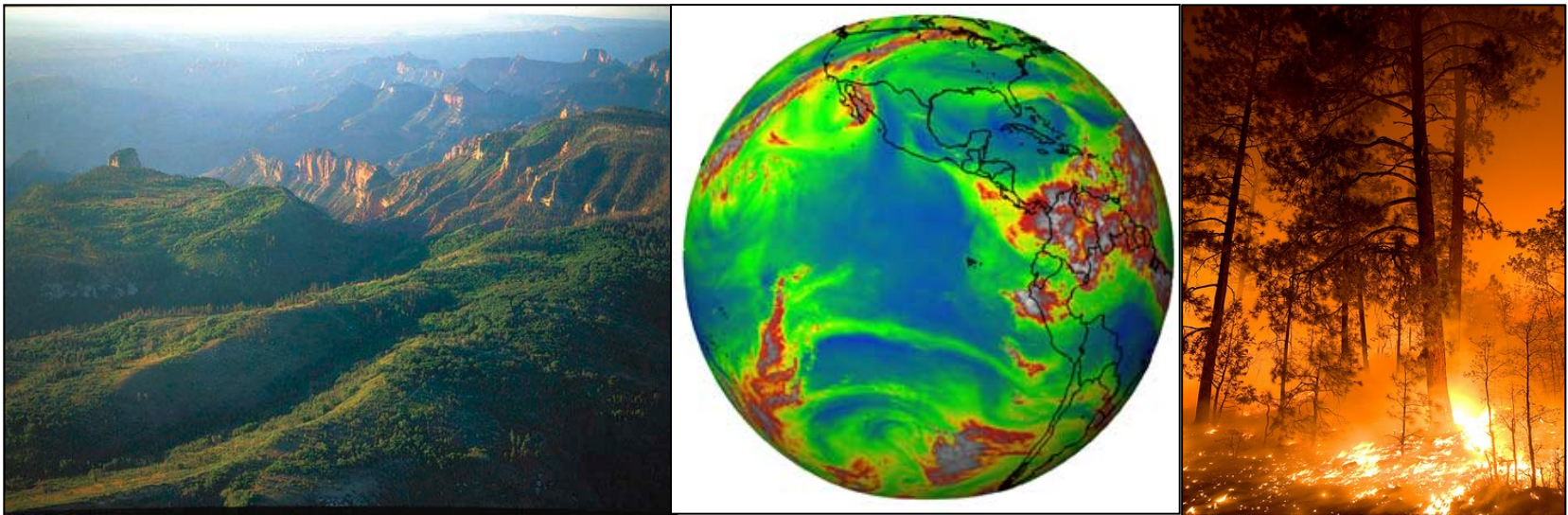


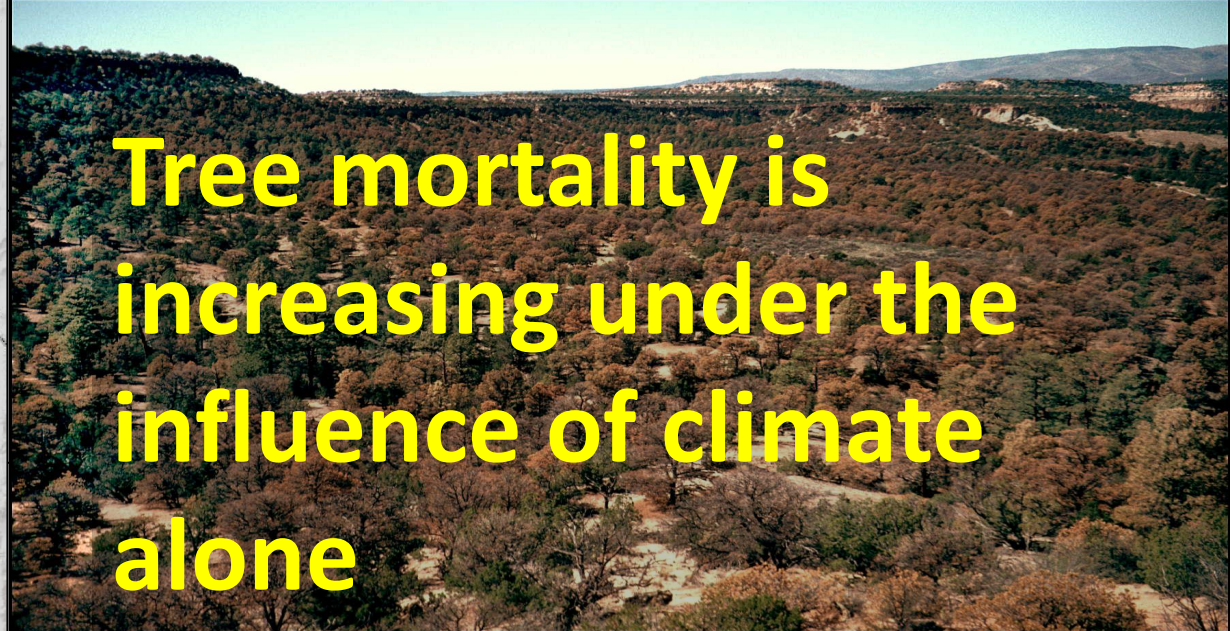
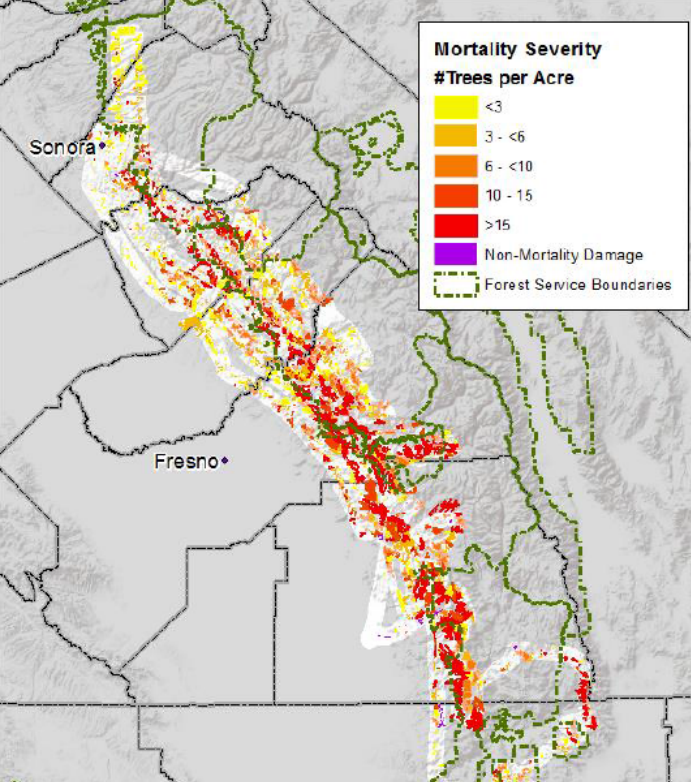
Ecosystem resilience to changing fire regimes

Don Falk

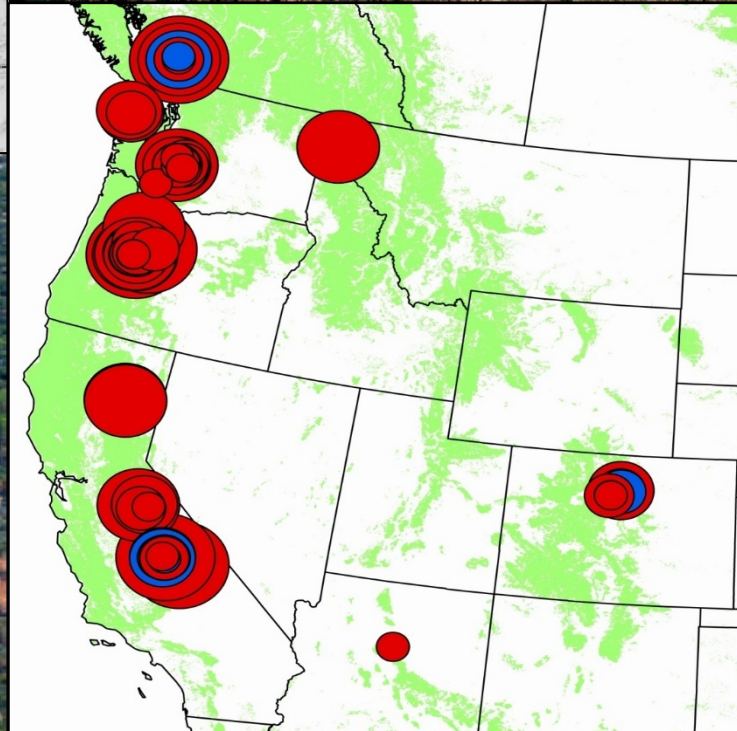
**School of Natural Resources and the Environment
University of Arizona**



**CLIMAS/SWCSC Colloquium
March 2018**



Tree mortality is increasing under the influence of climate alone



- 76 plots in undisturbed old forests observed 1981 - 2004
- 87% of plots increasing mortality rate ($p < 0.0001$)
- mortality ~ 18 yr DOUBLING period

Fires can trigger abrupt, dramatic change

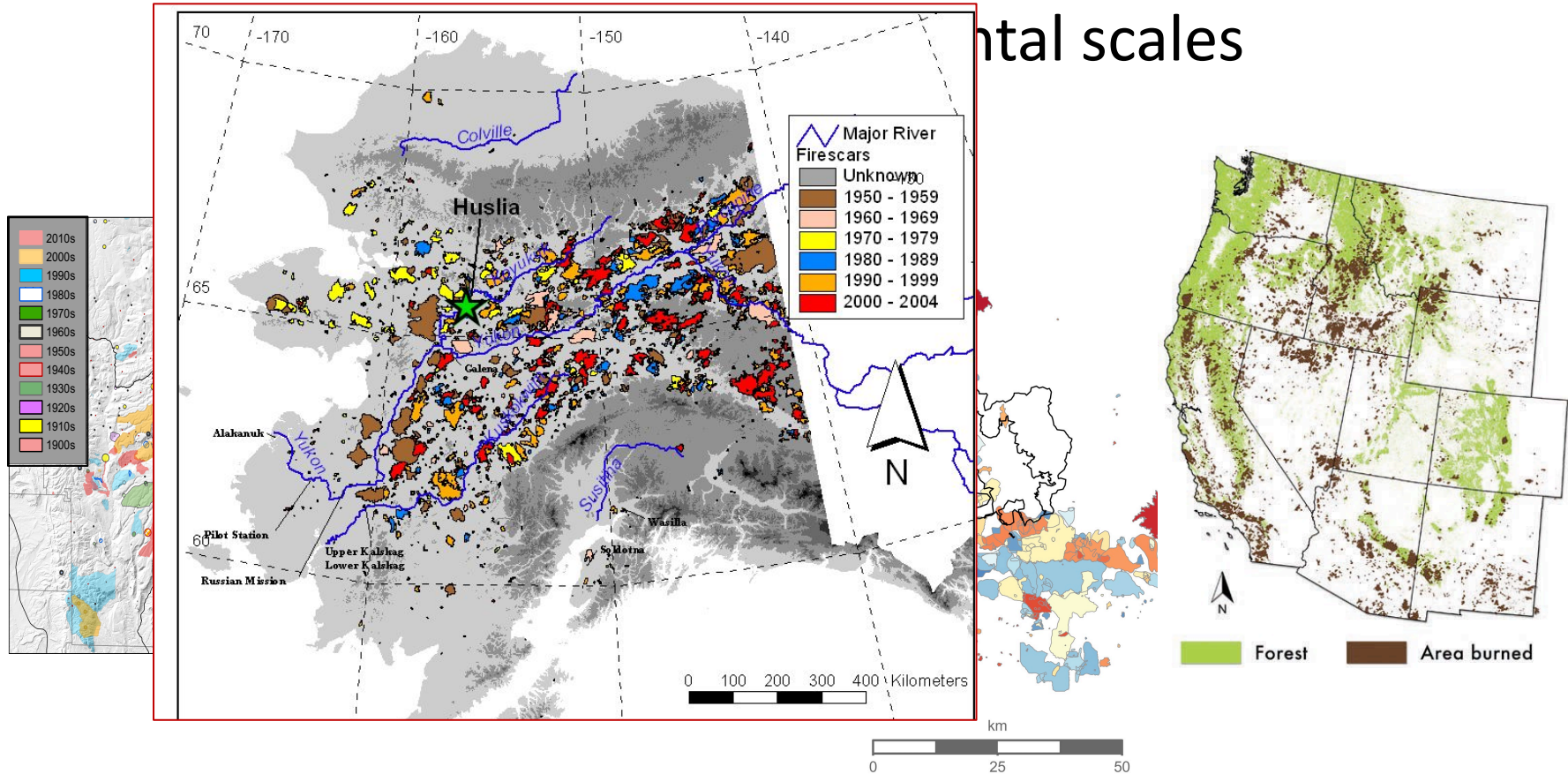
Large, high-severity disturbances can accelerate the pace of landscape transformation from decades to weeks

The biggest impacts are from interactions of climate change and large wildfires

Near-total overstory tree mortality and large (10^4 ac) high-severity patches, 2011 Las Conchas Fire, Jemez Mountains, NM

Processes such as wildland fire, disease, and insect outbreaks are affecting an increasing proportion of

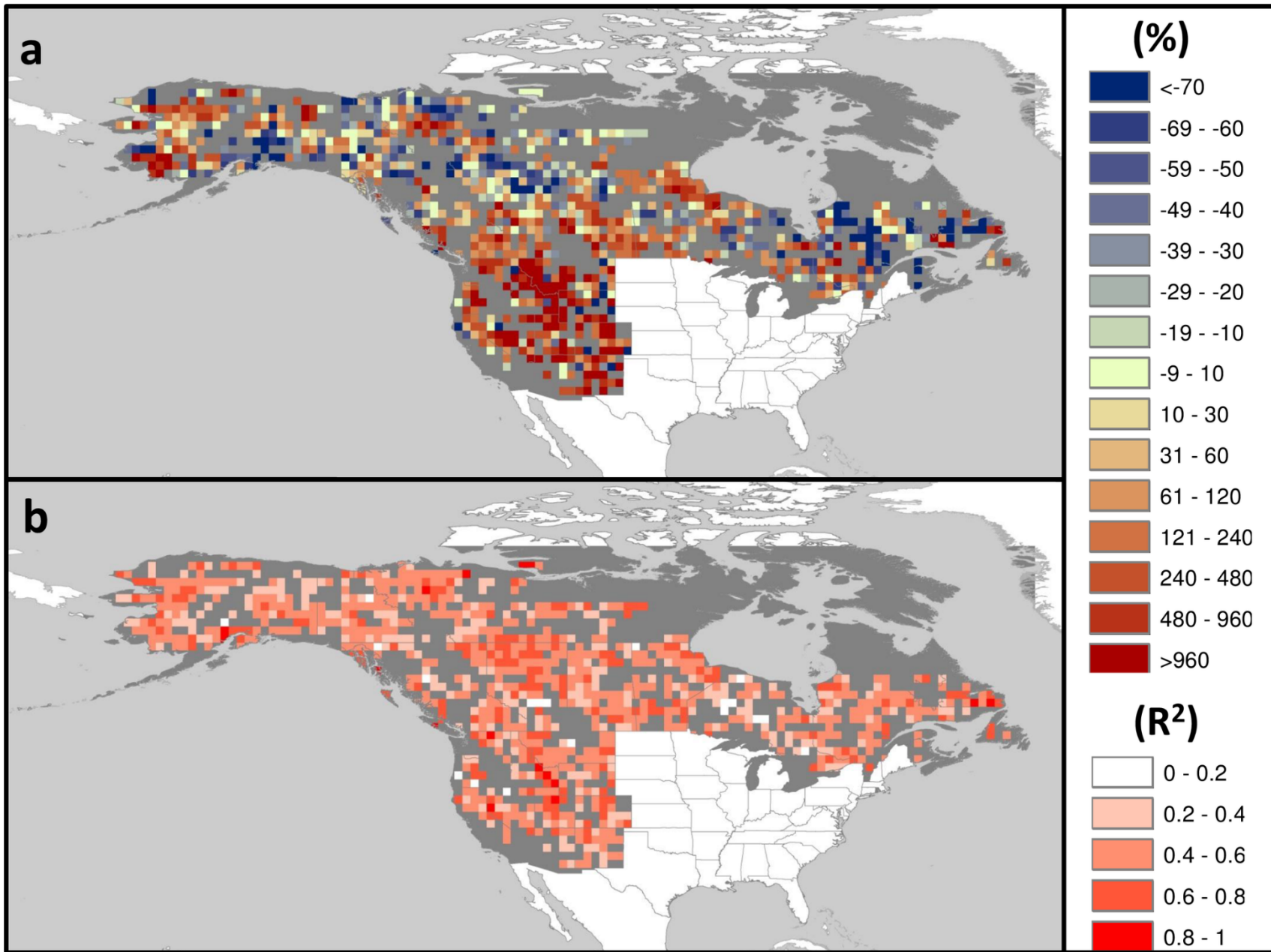
hundreds of thousands of hectares



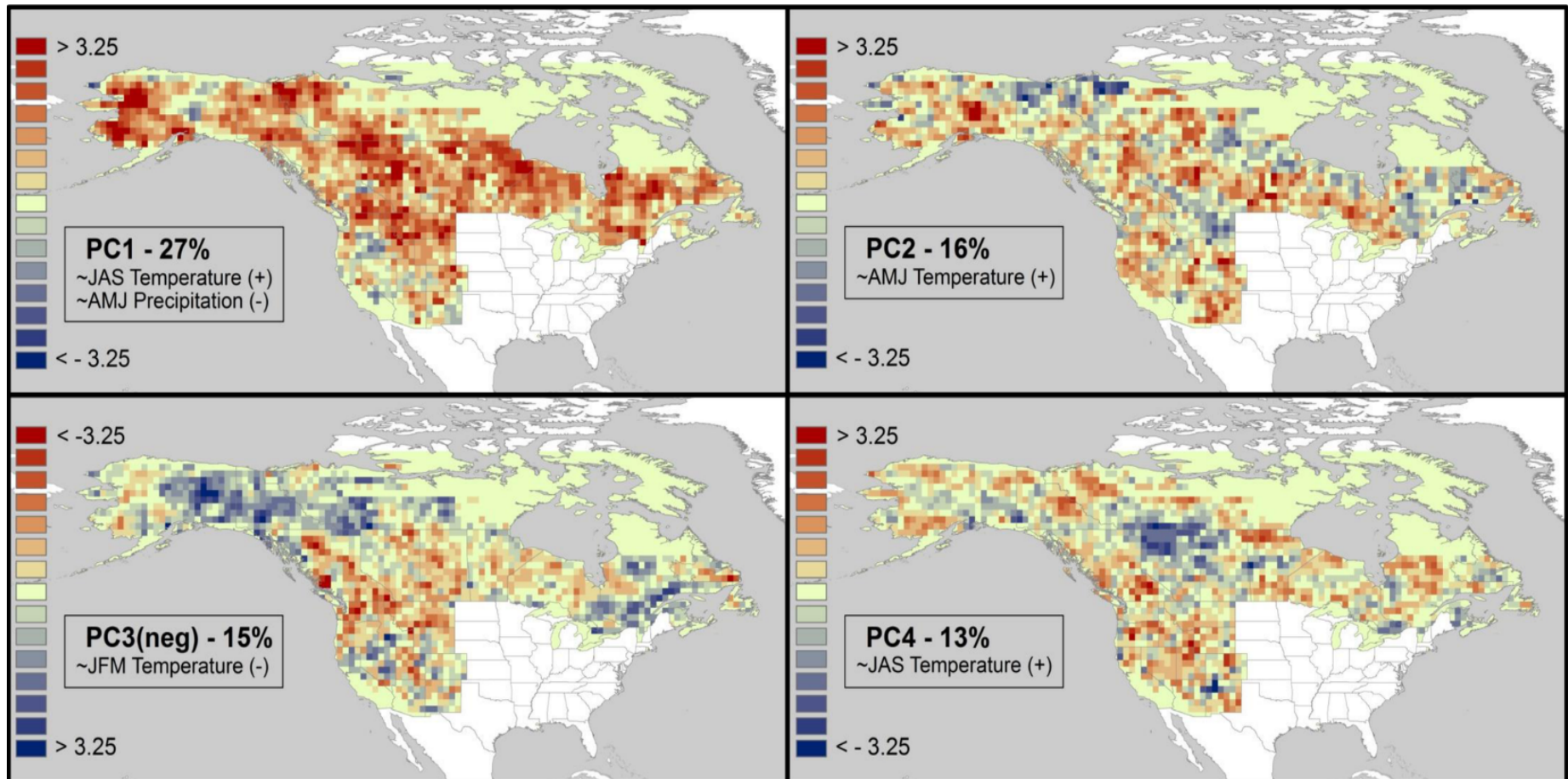
Left: Wildfire perimeters in the Jemez Mts, NM (1900-2013), compiled by Craig Allen (USGS) and Kay Beeley (NPS)

Center: Fire size distribution and perimeters 1983-2014, southern Sierra Nevada (from Krofcheck et al. 2017, *EcoSphere*)

Right: Wildfire perimeters western US 1983-2012, compiled from MTBS (Garfin et al. 2012)



Area burned is a **multiplier and accelerator** of processes that affect the rate and trajectory of ecosystem change



An aerial photograph capturing a massive forest fire. The fire is intense, with bright orange and yellow flames visible through the dense green forest. Large, billowing plumes of white and grey smoke rise from the fire, filling much of the sky. The fire appears to be spreading across a large area of the forest.

How do ecosystems recover after fire in an era of climate change?

2006 Nuttall-Gibson Complex, Pinaleno Mts.
Courtesy USFS and SW Fire Science Consortium

What is “ecological resilience”?

Hobbs and Suding 2009; Falk 2013

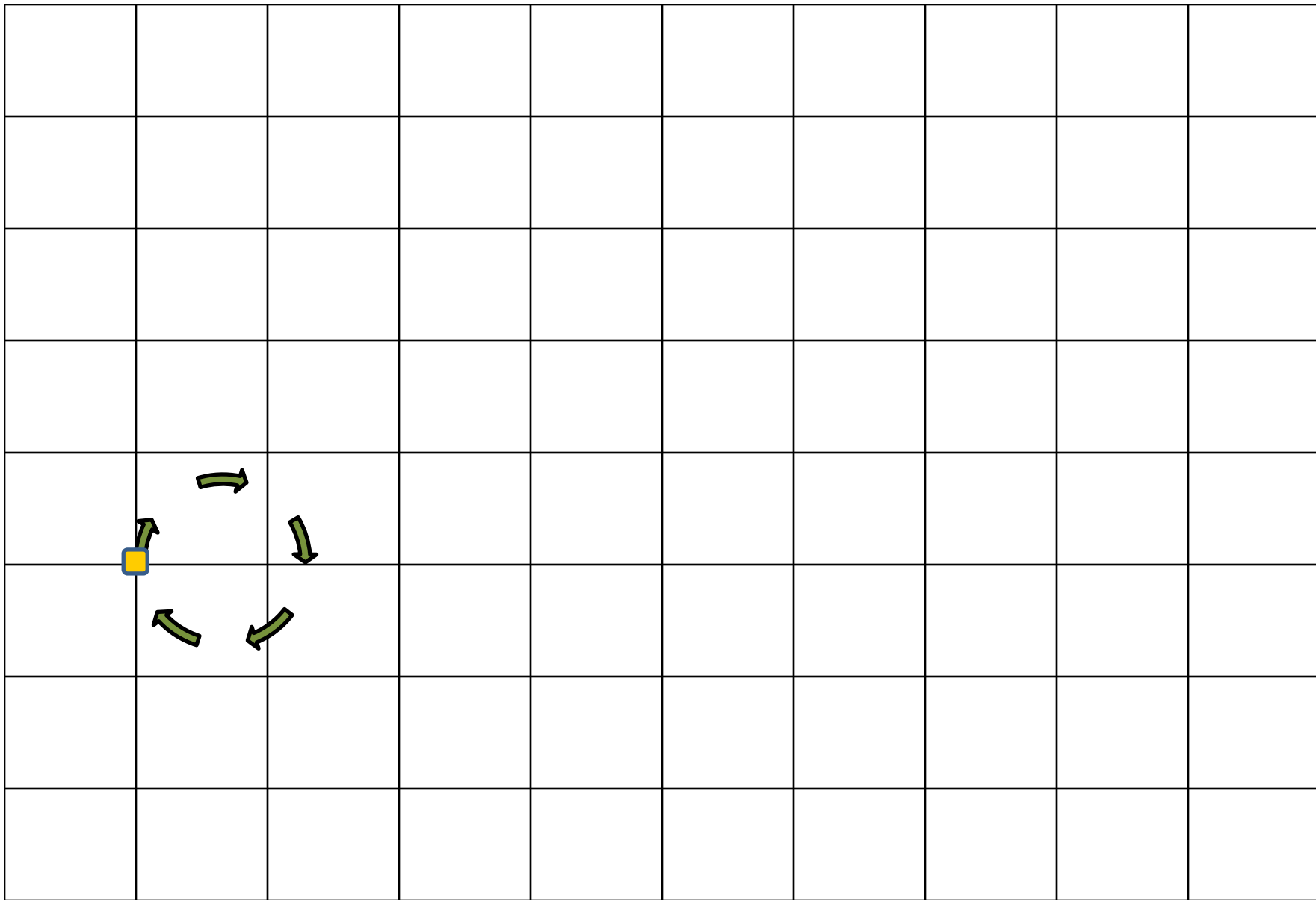
“The capacity of an ecosystem to recover to its pre-disturbance composition, structure, and/or function over time.”

Main components are:

- **Resistance**
- **Recovery**
- **Reorganization**



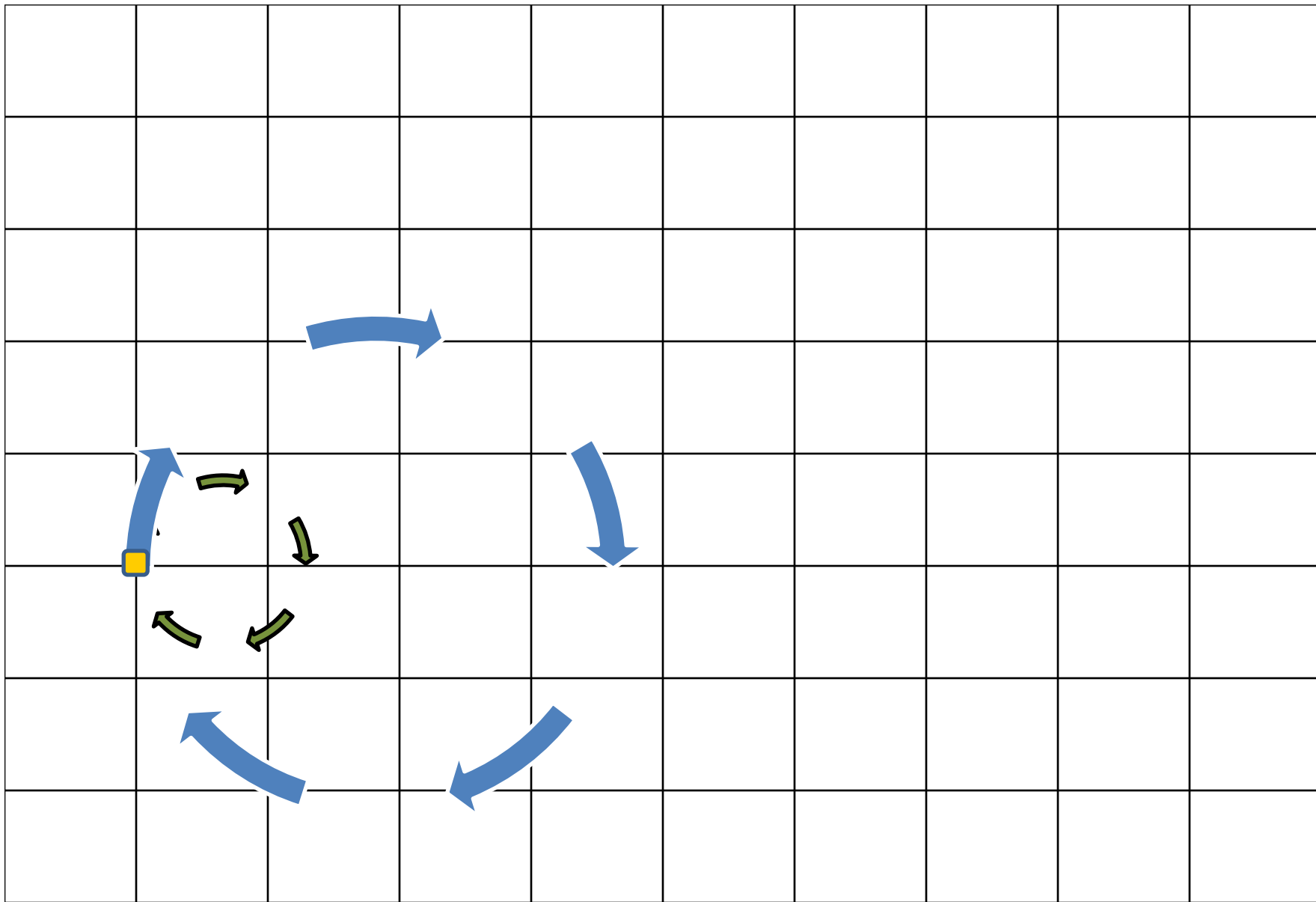
E_2



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E_1

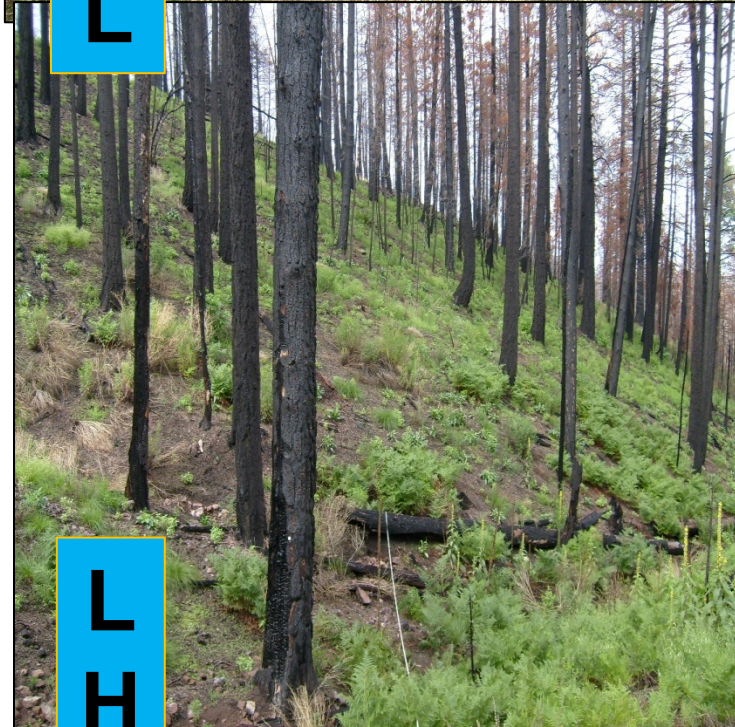
**Multiple post-fire trajectories in the
Chiricahua Mts. after two fires, 1994 and
2011 (J. Minor)**



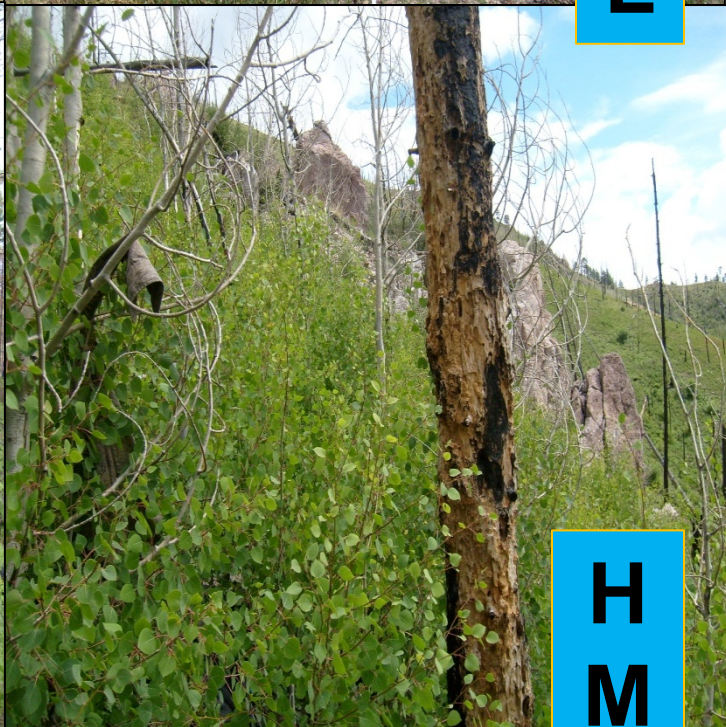
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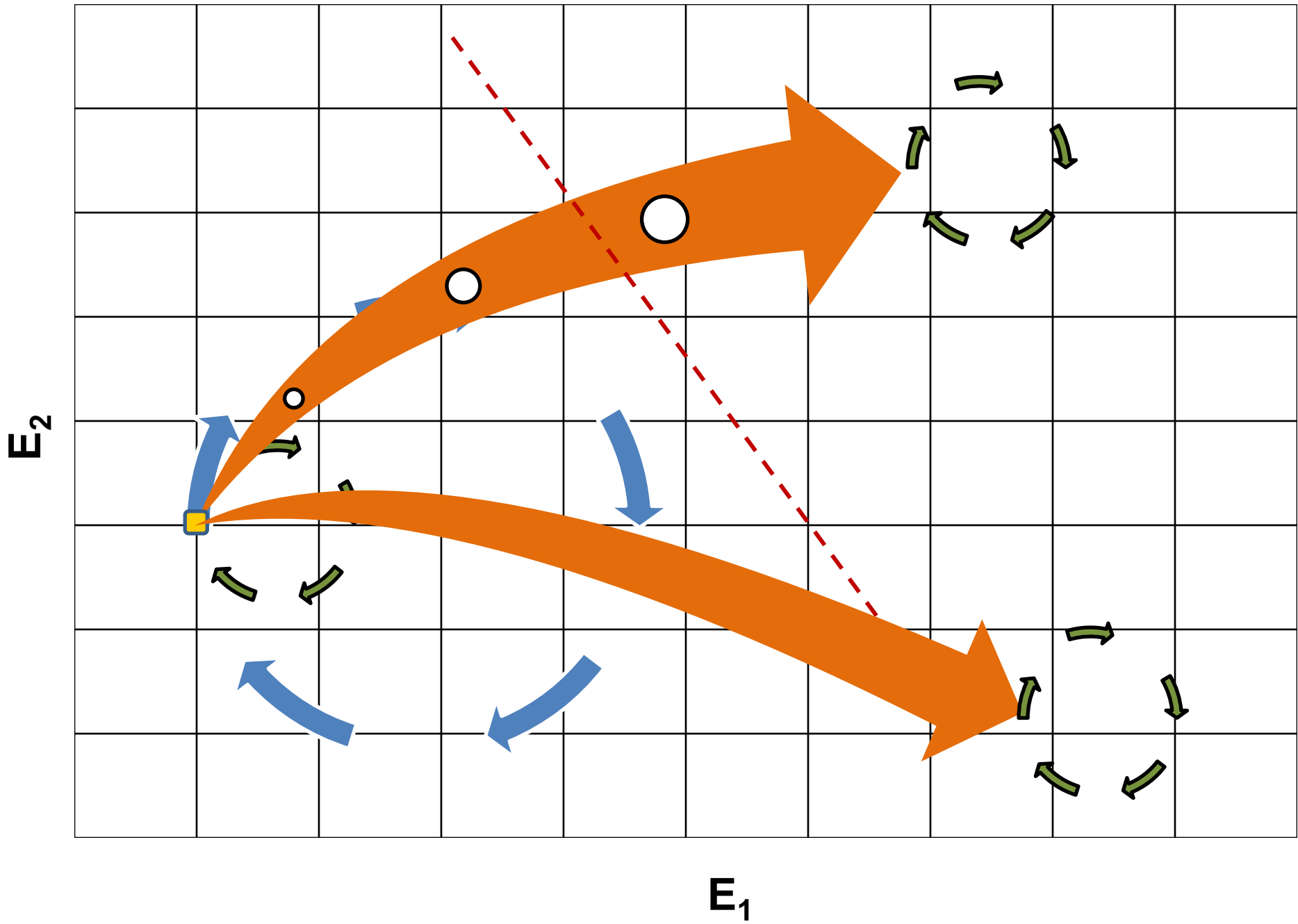
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Ecological “tipping points”

1. Generally involve some combination of climate stress and disturbance
2. System moves into a new state (e.g. forest to shrub or grass-dominated ecosystem)
3. **System is then resilient in its new state.**



Post-fire landscapes increasingly reflect alternative metastable states

A photograph of a hillside after a fire. The landscape is a mix of dead, charred trees and regrowing shrubs in autumn colors (yellow, orange, red). The sky is clear blue. The text 'Post-fire landscapes increasingly reflect alternative metastable states' is overlaid in white.

Type conversion from forest to shrubland, Dalton Fire (near Pecos, NM)

Resilience means accepting change

1. Which kinds and degrees of **change** are **adaptive**, and which are **destructive** of biodiversity and ecosystems?
2. How does a resilience framework change **decisions and actions on the ground**?
3. Are we prepared to **let go of some current ecosystems**, or would doing so violate core principles?

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Andrea Thode, Pete Fulé, Northern Arizona University

Ann Youberg, Arizona Geological Survey