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Western Ecological Research Center http://www.werc.usgs.gov

Sierra Nevada Global Change Research

Forests provide humans with important products and services, such as wood, clean water, biodiversity, and recreational opportunities. Yet many coniferous forests of the western United States have been altered by a century of fire exclusion, making them more prone to catastrophic wildfires. In coming decades, these forests are further expected to experience the effects of rapid global warming, with largely unknown consequences.

Scientists of the U.S. Geological Survey are working with colleagues from other research institutions to understand and predict the effects of environmental change on montane forests, with a focus on California's Sierra Nevada range. The research program focuses not just on the direct effects of climatic change on forests, but also on its indirect effects, through changing fire regimes. The program is organized around three themes.

The *contemporary ecology theme* takes advantage of the Sierra Nevada's substantive climatic gradients as "natural experiments," allowing researchers to evaluate climatic mechanisms controlling forest composition, structure, and dynamics. Elevation in the Sierra Nevada rises from near sea level to more than 14,000 feet, resulting in a spectrum of climates that range from warm subtropical to cold alpine.

The *paleoecological theme* takes advantage of the Sierra Nevada's rich record of past changes in climate, fire, and forest response. The region is unique in having at least four tree species from which multi-millennial tree-ring chronologies of climatic change can be derived. Additionally, fire scars within giant sequoia tree-rings contain fire histories spanning the last several millennia. Forest responses to changing climate and fire regimes are recorded in the age structures of both live and dead trees in existing forests.

Climatic change could alter the role of fire in western coniferous forests. Photo: N. Stephenson

Research is still needed on:

- The sensitivity of different tree life stages to environmental change
- Effects of climate on spatial extent, landscape pattern, and severity of fires
- Identifying which portions of landscapes are most sensitive to environmental change

The *modeling theme* uses computer models to integrate the findings of the contemporary and paleoecological themes. Additionally, modeling is an indispensable tool for scaling up site-specific research results to entire landscapes.

Work to date has demonstrated that the last 50 years in California have been among the wettest of the last millennium, and that severe multi-decadal droughts have occurred regularly in the past. The program's fire history reconstructions are now used by Sierra Nevada land managers as guides for restoring fire regimes. Investigations in forest pattern and dynamics have led to modifications in both prescribed fire and timber harvesting approaches in the Sierra Nevada. The program has also given managers computer models for planning prescribed fires, and predicting the effects of different management actions on forests.

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