

## Western Ecological Research Center

# Publication Brief for Resource Managers

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## Tree Deaths in California's Sierra Nevada Increase as Temperatures Rise

A new study by the U.S. Geological Survey (USGS) reports a rising death rate for trees in old-growth forests of the Sierra Nevada mountain range, paralleling increasing summer drought due to warming temperatures. These findings suggest Sierran forests, and potentially other forests of dry climates, may be sensitive to temperature-driven increases in drought, making them vulnerable to die-back during otherwise normal periods of reduced precipitation. This study, by USGS scientists Drs. Phil van Mantgem and Nate Stephenson, appears in *Ecology Letters*.

The study is the first detailed long-term analysis in which tree mortality was measured annually for more than two decades. This allowed the scientists to correlate short-term variations in tree mortality with short-term variations in climate and other potential drivers of change. After tracking the fates of over 20,000 individual trees in old-growth forests in Sequoia and Yosemite national parks in the Sierra Nevada, they found that mortality rate had increased significantly. Death rates increased not only for all trees combined, but also across most zones of elevation and for the two dominant groups of conifers, firs and pines (giant sequoias were too sparse to detect any trends). The authors emphasize that the increasing death rate has so far been occurring mostly in small trees. Large trees can survive moderate droughts as they have more extensive root systems and greater ability to store resources.

Few studies of real forests have examined possible environmental drivers of changes, but modeling studies suggest that, over a period of decades, even small changes in mortality rates can profoundly change a forest. Additionally, when stresses weaken a tree it becomes more susceptible to further complications.

### Management Implications:

- Ongoing climatic changes may be driving chronic changes in forests that otherwise appear to be healthy, and those relatively subtle, chronic changes may be a prelude to acute changes, such as sudden forest die-back.
- In the face of rising temperatures, managers of water-limited forests may wish to place extra emphasis on reducing other stresses. Examples might include reducing competition in unnaturally overcrowded forests (such as those that have experienced lengthy fire exclusion) or controlling non-native insects and pathogens.
- Rapidly changing climate may compel managers to rethink target reference conditions for restoration.

Consequently, the effects of other forest stresses such as air pollution will likely be amplified if drought stress increases.

These results pose a challenge to forest managers. Forest restoration often attempts to mimic conditions prior to Euro-american settlement. However, if forests respond rapidly to warming temperatures, attaining conditions similar to this relatively cooler target era may not be feasible or desirable.

*van Mantgem, P. J., and N.L. Stephenson. 2007. Apparent climatically-induced increase of mortality rates in a temperate forest. Ecology Letters 10:909–916.*