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ENVIRONMENT

## Trees shift upward as climate warms, data show

June 12, 2010 | By David Perlman, Chronicle Science Editor

The world's warming climate is forcing trees and the plant life around them into new territories where the environment is more like the areas where they normally thrive, scientists report from a new global survey.

Some forests and groups of vegetation have begun moving upward to higher elevations, or northward to higher latitudes to meet the climate change, while others in areas that are drying are shifting southward toward greater sources of moisture, the researchers say.

In California, for example, a detailed forest census along the west side of the Sierra in the Tahoe National Forest by UC Berkeley scientists found that the warming climate is shifting growth patterns uphill among many species of shrubs, oaks, firs and pines that for hundreds of years have been thriving at lower elevations.

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Similar forest changes are being found on every continent by biologists working around the world, according to a report published this week in the journal *Global Ecology and Biogeography*.

The global report was compiled by Patrick Gonzalez, a visiting scholar at Berkeley's Center for Forestry in the College of Natural Resources, together with U.S. Forest Service researchers at Corvallis, Ore.

Gonzalez is also leading a research group that has surveyed hundreds of trees and shrubs along a 12-mile transect of the Tahoe National Forest, ranging from the foothills at 2,300 feet to the High Sierra at 6,900 feet.

The researchers measured more than 1,000 trees and took 197 corings of the larger oaks, pines and firs to determine their ages. They found that in the past century, the oaks and Douglas firs that were normally found at lower elevations are beginning to be seen "upslope" in areas dominated by white firs and sugar pines, Gonzales said.

"Those species, in turn, may be moving into the higher elevations, where red fir thrives in the deep winter snow," he said in an interview.

Gonzalez said climate data for the Sierra transect have been clear because records taken at a National Weather Service station that has been operating in nearby Downieville since 1948 show that average annual temperatures there have been increasing at seven times the global rate. There has been no heavy logging, burning or grazing in the transect area, so climate change could be the primary cause of the changes in vegetation, Gonzalez concluded.

In their survey of observed changes in vegetation reported by other scientists around the world, Gonzalez and his colleagues noted that trees and shrubs in northern Africa's Sahel region have been dying where

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drought has increased as the climate warms, and have moved further south where rainfall is more abundant.

Similar changes have been taking place in the high Arctic, he said, where warming has brought new shrubs encroaching on the tundra, where caribou and other wildlife could be threatened.

The report on Sierra tree seedlings moving to higher elevations because of a warming climate reflects earlier evidence that many mountain-dwelling animals are also moving their ranges upward to cooler areas.

James Patton and Craig Moritz of UC Berkeley's Museum of Vertebrate Zoology surveyed 28 species of mammals living at sites from the San Joaquin Valley across Yosemite to Mono Lake and found that as average annual temperatures warmed by 5 degrees Fahrenheit during the past 90 years, more than half the species had shifted their ranges upward by as much as 1,600 feet. The two biologists published their survey in the journal *Science* on Oct. 10, 2008.

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