Drier conditions could doom Rocky Mountain spruce and fir trees

February 22 2018, by Trent Knoss

Credit: University of Colorado at Boulder

Drier summers and a decline in average snowpack over the past 40 years have severely hampered the establishment of two foundational tree species in subalpine regions of Colorado's Front Range, suggesting that

climate warming is already taking a toll on forest health in some areas of the southern Rocky Mountains.

The findings, which were published today in the journal *Ecology*, show that spruce and fir tree establishment was limited to a handful of years with above average snowpack and cooler, wetter summer conditions—all of which have grown scarcer in recent decades. The study is believed to be the first to reconstruct establishment frequency on an annual basis for the two conifer species.

"Since 1975, there have been fewer favorable years for seedling establishment," said Robert Andrus, lead author of the study and a graduate researcher in CU Boulder's Department of Geography. "Our study indicates that moisture availability is the key driver for these events in Colorado's high elevation forests."

Rising temperatures have increased the rate of tree mortality across the American west, including subalpine forests in the Colorado Front Range, making it imperative for spruces and firs to establish successfully and regularly in order to replace fallen cohorts. In subalpine coniferous forests, seedling establishment occurs when large quantities of available seeds coincide with favorable climate conditions.

The researchers counted over 150,000 tree rings from 450 Engelmann spruces and 500 subalpine firs collected across research sites from Rollins Pass to Brainard Lakes Recreation Area in Colorado's Front Range. The rings, which help gauge the year of the tree's establishment, could then be compared against climate and snowpack data dating back to 1940.

Prior hypotheses have suggested that tree seedling establishment might actually be aided by climate warming, with higher temperatures being more conducive to successful establishment as observed in some

maritime climates such as areas of the Pacific Northwest.

But the new study, which was funded by the National Science Foundation, NASA and the Australian Research Council signals the opposite trend in Colorado.

The data show that spruce and fir establishment years became notably less frequent from 1975 onward, a period characterized by declining snowpack, rising summer temperatures and longer periods of low moisture availability during the summer. Only three years out of the past 40 have been conducive to seedling establishment, compared to seven favorable years during the prior 40.

"This study provides more evidence that climate warming is, and has been, significantly and adversely affecting ecological processes in forests of the southern Rockies," said Distinguished Professor Tom Veblen, who co-authored the study. "It's important to realize that the effects of warming have started. This is not just a future effect, but something that is actually underway."

The findings suggest that seedling establishment in Colorado will continue to decline in the coming years, given future climate predictions. Identifying the frequency of establishment events and the required conditions will be essential for land managers as they forecast how climate warming will affect subalpine forests going forward, Andrus said.

"The first step is to identify the problem and give land managers a heads up that this is happening," Andrus said. "We're even seeing this same phenomenon occurring at lower elevations too in species such as the Ponderosa pine. The goal of our research is to characterize long-term trends in our forests that might not be immediately apparent."

More information: Moisture availability limits subalpine tree establishment , DOI: 10.1002/ecy.2134 , onlinelibrary.wiley.com/doi/10… 02/ecy.2134/abstract

Provided by University of Colorado at Boulder