

Tree Mortality in Drought-stressed Mixed-conifer and Ponderosa Pine Forests, Arizona

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We monitored tree mortality in southwestern mixed-conifer and ponderosa pine (*Pinus ponderosa* Dougl. ex Laws) forests from 1997 – 2007, a period of severe, global-climate-change type drought in this area. Mortality was pervasive, occurring on 100 and 98% of 53 mixed-conifer and 60 ponderosa pine plots (1-ha each) sampled, respectively. Most mortality was attributable to a suite of forest insects, mediated by drought stress. The number of trees dying over a five-yr period increased by over 200% in mixed-conifer forest and by 74% in ponderosa pine forest from 1997 – 2002 to 2002 -2007. Extent of mortality was spatially variable in both forest types. Median cumulative mortality in mixed-conifer forest increased from 11.3% in 2002 (range = 3.6 – 36.3%) to 21.1% in 2007 (range = 5.5 – 517.7%). In ponderosa pine forest, median cumulative mortality increased from 2.6% in 2002 (range = 0.3 – 28.4%) to 4.0% in 2007 (range = 0.3 – 111.0%). Median mortality rates from 2002 to 2007 were approximately 2.0% yr⁻¹ in mixed-conifer forest (range = 0 – 28.5%) and 0.4% yr⁻¹ in ponderosa pine forest (range = 0 – 13.6%). Mortality rates generally were not strongly related to stand density. Mortality was nonrandom with respect to availability of tree size classes and species. Proportions of trees dying were greatest in the largest size classes, particularly in mixed-conifer forest, where mortality in the largest size class exceeded 22% from 2002 to 2007. Proportional mortality of all species was greater in mixed-conifer than in ponderosa pine forest. Mortality in mixed-conifer forest was particularly pronounced for quaking aspen (85%) and white fir (28%), the least drought tolerant species present. These results provide an early glimpse of how these forest types are likely to respond to predicted climate patterns and resulting altered disturbance regimes in the southwestern US.

Conclusions – Tree Mortality

- Southwestern forests are experiencing high drought-mediated mortality that is altering species composition and size-class distributions
- Magnitude of changes will depend on climate interacting with disturbance regime
- Current forests do not appear resilient to climate change
- Restoring appropriate species mixes and stand structures may increase resilience??