Bet-hedging dry forest resilience to climate-change threats

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New research shows that the most significant current threat to western dry forests is from insect outbreaks and droughts, not wildfires; and historically abundant small trees offer the greatest hope for forest survival and recovery after these events. Dry forests are low-elevation western forests with tall pines. The study used government records of insect and wildfire damage to compare current threats to dry forests and used records from land surveys conducted in the late-1800s to understand how dry forests persisted for thousands of years in spite of insect outbreaks, droughts, and fires. These forests persisted, this study suggests, by having both young and old trees that together provided bet-hedging.

Data on recent threats to dry forests used government maps of insect outbreaks and wildfires from 1999-2012 across 64 million acres of western dry forests or 80% of the total dry-forest area. "When comparing the rates of insect outbreaks and wildfire over the past fourteen years, we were surprised to discover insect outbreaks impacted 5 to 7 times the area that wildfire did." said Dr. Mark Williams, a co-author of the study and recent PhD graduate of the University of Wyoming's Program in Ecology. "In contrast, restoration efforts to increase resilience of dry forests to changing climate focus primarily on threats from wildfire. Our work suggests that impacts from insect pests should be considered with greater weight when formulating restoration prescriptions."

To understand how forests were resilient to multiple disturbances in the

past, the researchers utilized historical data which included 45,171 tree sizes measured along 13,900 section-lines traversed by land surveyors in about 4.2 million acres of dry forests in Arizona, California, Colorado, and Oregon in the late-1800s.

"The late-1800s land surveys provide us with a spatially extensive and detailed view of how these dry forests persisted through unpredictable episodes of insect outbreaks, droughts, and wildfires" said Dr. William Baker, a co-author of the study and Professor Emeritus in the Program in Ecology and Department of Geography at the University of Wyoming. "What we see from the surveys is that dry forests historically had many large trees, that often survived wildfires, but even more small trees that were less prone to be killed during insect outbreaks and droughts. The combination of abundant youth and older trees provided bet-hedging insurance that allowed these forests to survive and recover regardless of whether an insect outbreak, drought, or wildfire occurred. These unpredictable events may increase with global warming."

The study's findings suggest current programs that remove most small trees to lower the intensity of wildfires in dry forests and restore large trees lost to logging, may reduce forest resilience to the larger threats from insect outbreaks and droughts. "Using historical forests as a guide, our study suggests we may want to modify our restoration and management programs so they do not put all our eggs in one basket, but instead hedge our bets by keeping both large trees and abundant small ones" said Dr. Baker.

Key findings:

● Over the last fourteen years, insect outbreaks have impacted 5 to 7 times more dry forests than have wildfires.
● Historically, dry forests had large trees, but were numerically dominated by small trees, 52-92% of total trees.

● The variable structure of past forests provided bet-hedging insurance against multiple disturbances and continued persistence. Removing most small trees for modern restoration treatments may reduce the resilience of these forests.

The study was published online in the international scientific journal, *Frontiers in Ecology and Evolution* and is freely available to download on their website. The title is: Bet-hedging dry-forest resilience to climate-change threats in the western USA based on historical forest structure.

More information: Bet-hedging dry-forest resilience to climate-change threats in the western USA based on historical forest structure, *Frontiers in Ecology and Evolution*, DOI: 10.3389/fevo.2014.00088

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