Spotlight on Climate

Setting the Stage for Future Ponderosa Forests

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(700 words)

I work with colleagues at Northern Arizona University, and other universities and agencies to understand impacts of climate change on forest regeneration, with a particular focus on the ponderosa pine forests of the southwestern US. Climate change is causing rapid tree die-offs and deforestation in our region due to the double whammy of unusually large, intense wildfires and severe drought stress, both of which are driven by warming and increasing aridity. This double whammy is becoming more severe because of ever rising greenhouse gas emissions. The future of ponderosa forests in this era of mega-disturbance depends on whether successful tree regeneration can make up for such forest losses.

To have healthy forests tomorrow we need regeneration of baby trees today. Our research shows that wildfire and aridity are also hampering ponderosa pine regeneration. We found that ponderosa does not regenerate well after severe wildfires that deforest large areas and kill seed trees. Ponderosa pine cannot regrow from roots after fire, and instead depends entirely on seeds from surviving trees. Ponderosa seeds disperse only about 300 feet in the wind and seeds and seedlings require relatively wet years to sprout and grow. This raises concerns about sustainability of ponderosa forests, because wildfires are increasing in size and intensity across the western U.S. Regeneration after such mega-disturbances likely will be dominated by shrubs and trees that can resprout from surviving roots and stumps. This means that oaks and alligator juniper, as well as grasses and other herbaceous plants that thrive in large openings, will come to dominate in place of ponderosa.

We have found constraints to ponderosa regeneration from aridity even without wildfire. Our results echo the conclusions of early scientists in the Flagstaff area, such as Gus Pearson, that ponderosa needs consistent moisture for seed germination and seedling growth. Recent ponderosa regeneration has been negligible at low-elevation, warm sites where ponderosa used to regenerate as we can see based on the current presence of mature trees. Ponderosa can still regenerate at higher elevation sites, especially after light disturbances such as tree thinning or low-intensity burning that increase light to the understory yet retain mature trees to supply seed. A good example of recent regeneration success is near Fort Tuthill County Park just outside of Flagstaff, where a bumper ponderosa seed crop in 2013 coincided with an impressively wet summer monsoon season. Unfortunately, arid conditions and inadequate regeneration in the warmer and drier parts of ponderosa's range are expected to spread upslope with further warming, raising concerns about future regeneration.

The double whammy of wildfire and aridity has prompted a burst of new research about ponderosa regeneration. Our research has shown that well-designed fuel reduction treatments are effective at preventing wildfires from becoming mega-disturbances, thereby promoting survival of seed trees. In cases where wildfires are mega and seed trees are lost, researchers and forest managers are investigating new ways of artificial regeneration. For example, instead of planting all acres of a severely burned site with tight rows of seedlings, as is common in pine plantations, new studies are testing the effectiveness of planting seedlings in patchy small groups, called nucleation plantings, aimed at establishment of seed trees for the future. Satellite data are also being used to identify moist micro-sites where seedlings have the best chance for survival, creating forest refugia from aridity.

New studies are evaluating the roles of seedling genetics and nursery environment in producing drought-tolerant planting stock. We are finding tradeoffs between seedling growth rate and drought tolerance for ponderosa seed sources that will inform future tree plantings. Another promising approach is the use of drought preconditioning in the nursery to acclimate seedlings to the dry conditions they will encounter after planting.

Future plantings may use a diversity of tree species, even on sites historically dominated by ponderosa, because we are finding that forests comprised of multiple tree species with different regeneration strategies, such as obligate seeders (e.g., most pines) and vegetative re-sprouters (e.g., oaks, some junipers, many shrubs), are more resilient to environmental changes than forests dominated by a single tree species. I hope our generation's grand- and great-grand-children can look back and marvel at our success at sustaining productive and climate-resilient forests in this era of mega-disturbance.

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