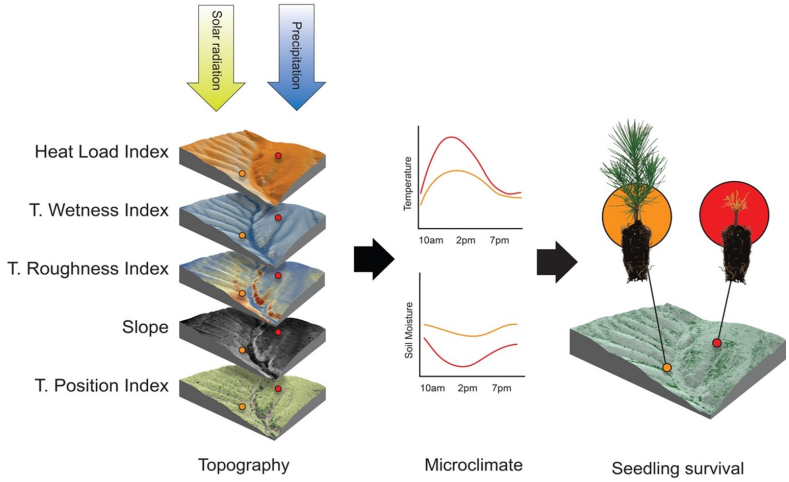
Earth Systems Ecology Lab



Climate variables interact with the landscape, altering microclimate over short distances sufficiently to influence planted seeding survival. High-resolution measures of topography can be used to predict planted seedling survival.

Using topography to predict seedling survival

Over a century of fire-exclusion and on-going climate change are increasing the area burned at high-severity and the size of high-severity burn patches in southwestern forests. Increasing high-severity patch size limits dispersal by ponderosa pine because its large seed size limits dispersal distance. Post-fire planting can overcome the dispersal limitation, but drought and high temperatures are causing high rates of mortality in southwestern US reforestation projects. To determine how planted seedling survival varies based on microclimate, we planted seedlings stratified by aspect and vegetation cover type (under shrub or in the open) in the footprint of the 2011 Las Conchas Fire in northern New Mexico. We then used these data and survival data from an additional 1145 seedlings planted by USFS to model the probability of survival as a function of topography.

We found that topographic positions that reduced the amount of incoming solar radiation and increased the amount of water available increased ponderosa pine planted seedling survival. We used a 1 m resolution digital elevation model to predict the probability of seedling survival based on the topographic attributes that alter microclimatic conditions. For ponderosa pine, these included heat load index, topographic wetness index and topographic roughness. Our model, which uses a machine-learning approach can predict the probability of planted seedling survival with 63% accuracy. Given that mean post-fire seedling survival across the southwest is 25%, this model will help facilitate planting in locations where survival is likely to be highest. The model framework allows us to assimilate new seedling survival data in the future, which will improve model predictions.

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Management Implications

Seedling planting following high-severity fire has low average success in the southwestern US because of heat and drought.

Identifying landscape positions where topography alters microclimate by reducing heat and drought stress can increase the chance of planted seedling survival.

We can use high resolution topographic data to predict where high survival probability locations exist and use this information to inform planting, increasing survival and reducing costs.

Publication:

Marsh, C, JL Crockett, D Krofcheck, A Keyser, CD Allen, M Litvak, MD Hurteau (2022), Planted seedling survival in a post-wildfire landscape: from experimental planting to predictive probabilistic surfaces. Forest Ecology and Management, 525:120524. https://doi.org/10.1016/j.foreco.2022.120524

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