Postfire Reforestation in Northern Sierra Nevada Forests: Testing Silvicultural and Genetic Approaches in a Changing Climate

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Overview:

- Scientist-manager partnerships are investigating novel silvicultural approaches for improving postfire reforestation success and fostering long-term climate-change adaptation in California's low-elevation, westside Sierra Nevada forests.
- A three-species assisted migration field trial of tree seedlings representing genotypes from a range of climates is being installed to (1) identify the most suitable species and seed sources for reforestation of low-elevation sites of varied quality and (2) validate the Climate Adapted Seed Tool developed from extensive provenance test data to inform seed transfer decisions.
- A parallel mixed-species planting study will assess whether species mixtures can aid short-term planting success by buffering against microclimate, site variation, and damaging agents.
- A greenhouse study will help identify key differences between seed sources driving the results of the genetics and mixed-species field experiments.
- On a separate site, a reforestation study will evaluate the effects of initial spacing and vegetation control on the performance of clustered plantings, a controversial and scientifically untested technique that some ecologists theorize could reduce fire risk and improve tree survival.

Summary:

Climate change is intensifying the scope and severity of California wildfires, causing widespread deforestation. Successfully reforesting burn areas is key to recouping lost carbon sequestration and storage, wood products, wildlife habitat, and aesthetics. However, rising aridity under climate change poses major challenges to reforestation success, depriving planted seedlings of moisture while elevating reburn risk, particularly on arid, low-elevation sites. In partnership with managers, we are establishing three experiments on recently

burned sites in the Plumas National Forest to identify attributes conducive to low-elevation reforestation success.

In the Concow Basin near Paradise, California, parallel genetics/silviculture field trials are being installed. To address genetics questions, we will plant ponderosa pine, incense cedar, and black oak seedlings from a range of current climates and evaluate their response to the novel environment. This trial will also validate the Climate Adapted Seed Tool developed using extensive provenance test data. The silvicultural study will plant the same species to assess growth and survival of mixed-species versus monoculture plantings and determine whether species mixtures boost planting success by buffering against microclimate, site variation, and damaging agents. A greenhouse component, using the same seed sources as the genetics trial, will help identify key physiological factors driving the results of the paired field experiments.

A separate initial spacing/vegetation control experiment will evaluate the effects on growth, drought-resistance and overall survival of clustered plantings, a technique that has gotten much attention recently. Some ecologists theorize that it may reduce fire risk and improve tree survival, but this hypothesis is untested.

Silvicultural Concepts:

- Tree species are expected to be locally adapted to the climate where they are found. By using information about current and modeled future climate at a planting site, it may be possible to select seed sources that are better adapted to the site than local seed. This idea is being tested by planting different seed sources of the same species in each planting area.
- Diverse plantings are anticipated to reduce the risk of reforestation project loss under drought, microsite variability, and future disturbance. The Concow Basin study will evaluate the initial performance of plantings ranging from monocultures to three-species polycultures.
- Mixed-species stands may enhance the rate and stability of stand growth, but biodiversity-productivity relationships frequently vary by site quality. The Concow Basin study will inform managers in selecting the most effective species combinations for the rapid, stable recovery of ecosystem services on challenging Nevada foothill sites.
- Two tactics to reduce the risk of reburn in young stands are (1) increasing initial spacing between trees, and (2) planting seedlings in clustered arrangements. Wider spaces between trees or clusters of trees are anticipated to increase the already critical importance of effective competing vegetation control. These techniques assure that trees grow quickly over the flame length and accumulate thicker bark that resists wildfires. Whereas the purpose of the cluster arrangement is to break up the stand

canopy, it may also increase the intensity of competition for soil water and nutrients, yielding slower stand growth.

Management Applications:

- Ryan Davy, Silviculturist, Feather River Ranger District, Plumas National Forest: “While recent research has provided a lot of foundational regeneration principles for the Central Sierras, large-scale fires have made it imperative to focus limited resources into successful reforestation efforts. This research will help refine multiple silviculture techniques and help guide us locally for tackling the challenges we have ahead.”
- Wolfgang Rougle, Forest Health Watershed Coordinator, Butte County Resource Conservation District: “Stand-replacing fires, while traumatic for a community, also furnish an opportunity to supplement local tree seeds with conspecific seeds from far-away locations. Seeds that are of a location’s native species, but come from hotter or drier parts of the native species’ range, could be well-adapted to the climate that will arrive in that location 5 or 10 years (or has already arrived). When it comes to this style of assisted migration, models exist to help land managers narrow down their guesses, but they have not been field-tested until now.”

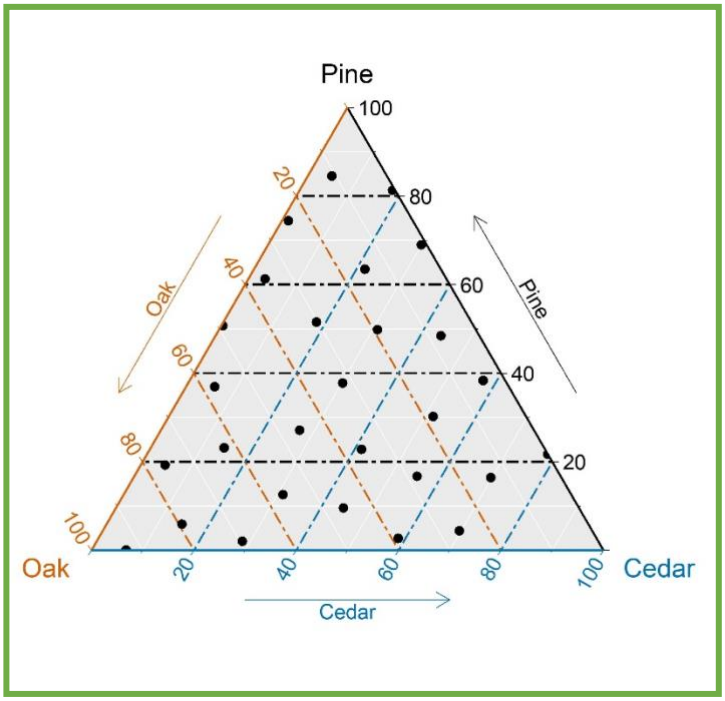

Figure 1—Ternary plot illustrating the space-filling design used to create three-way continuous mixtures of black oak, incense-cedar, and ponderosa pine.

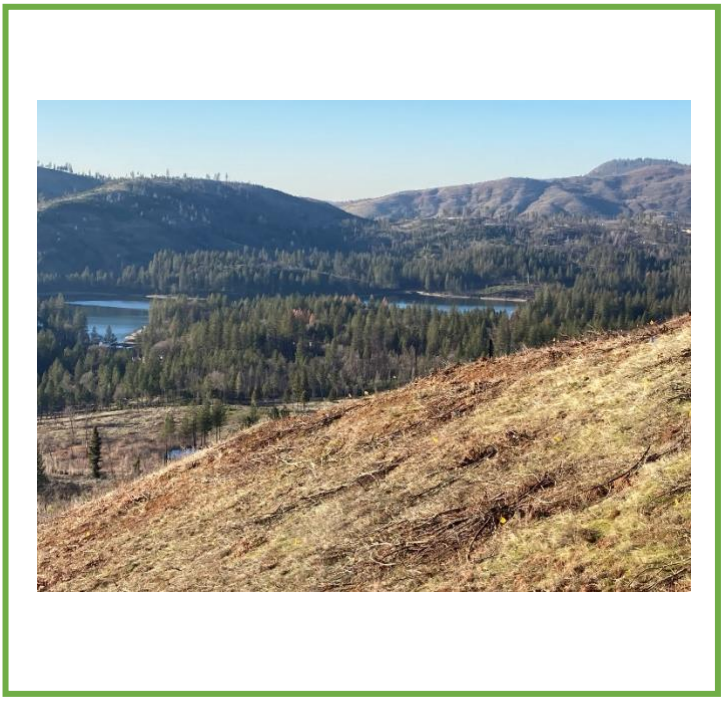

Figure 2—Example plot of the Concow Basin study following site preparation and monumentation prior to planting.