Effectiveness Monitoring Committee

Initial Concept Proposal

Deadline: 5:00 pm PDT September 14, 2022

Date Submitted: May 15, 2024

Project Title: *Reforestation for Resilience: Evaluating Climate-Smart Reforestation Techniques in California's Mixed Conifer and Yellow Pine Forests*

Project # (to be assigned by EMC):

Principal Investigator(s), Affiliation(s), and Contact Information (email, phone):

1. Malcolm North: USDA Forest Service Pacific Southwest Region; Department of Plant Sciences, UC Davis ([redacted]
2. Marc Meyer: USDA Forest Service Region 5 Ecology Program ([redacted]

Collaborator(s) and Affiliation(s):

1. Nicole Molinari: USDA Forest Service Region 5 Ecology Program, Southern California [redacted]
2. Lacey Hankin: USDA Forest Service Region 5 Ecology Program ([redacted]
3. Thierry Rivard: Director of Mountain Forestry, TreePeople ([redacted]
4. Dustin Herrmann: Principal Scientist, TreePeople ([redacted]

Research Theme(s), Critical Monitoring Question(s), and Rules or Regulations Addressed.

This proposal will address the following EMC priority thematic questions for Fiscal Year 24/25: *Are the FPRs and associated regulations effective in…*

- **Theme 6c:** *Managing fuel loads, vegetation patterns and fuels breaks for fire hazard reduction.*
  - By studying tree planting density and shrub cover as related to wildfire resilience.
- **Theme 6d:** *Managing forest structure and stocking standards to promote wildfire resilience.*
  - By studying spatial patterns that could improve the growth and survival of reforestation planting.
- **Theme 12a:** *Improving overall forest wildfire resilience and the ability of forests to respond to climate change (e.g., in response to drought or bark beetle; reducing plant water stress) and variability, and extreme weather events (evaluate ecosystem functional response to fuel reduction and forest health treatments).*
  - By studying early use of fire and other climate-smart reforestation practices across an environmental gradient, represented by different geographic regions of California.

Project Duration and Dates (MM/YY - MM/YY): 01/25 – 03/27

Estimated Funds Requested for Project: Please provide the total amount of funding requested from the EMC, broken down by year of expenditure, with a brief justification of costs not to exceed 200 words.

- ☐ **< $10,000**
- ☐ **$10,000 - $25,000**
- ☐ **$25,000 - $75,000**
- ☐ **$75,000 - $150,000**
- ✓ **$150,000**

TreePeople seeks support of $306,176.82 as a total project cost, inclusive of the partners' implementation team, contracting and supervision of local planting groups, with two years of field monitoring and data collection. TreePeople will also leverage a potential award in this proposal with funds already received from CalFire and future funding opportunities, to assist restoration planting sites related to field research locations in this project, as well as ongoing monitoring.

1. Year 1 – $24,623.06: Partner meetings, study design, site selection and planning.
2. Year 2 – $163,542.54: Planting in four project regions, plus first year monitoring and data collection.
3. Year 3 – $118,011.22: Second year of monitoring and data collection for all sites, as well as analysis.

Project Description: *In not more than 2,000 words*, describe the project, including (1) Background and Justification, (2) Research Question(s), including Objective and Scope, (3) description of Research Methods, (4) Scientific Uncertainty and Geographic Applicability, including identified monitoring location(s), and (5) a description of the roles of Collaborators and Project Feasibility.

1) Background and Justification: Fire suppression, cessation of Indigenous burning practices, and climate change have dramatically increased the scale and intensity of California wildfires over the past half-century. As a result, the scale of postfire restoration and reforestation needs present significant challenges to current forest agency workforces, budgets, and traditional practices. Recent publications such as PSW-GTR-270 and PSW-GTR-278 have proposed holistic approaches to western forest restoration to prioritize management actions across landscapes at scale. Complementary to these new approaches are strategic changes in reforestation and planting practices that can improve seedling survival and growth, and restore resilient forest structural conditions, in an era of changing climate conditions and disturbance regimes.

1a) Planting for Resilience: Variable Spacing, Lower Density, and Early Fire Use

For conifer restoration, traditional gridded planting design comes from an agronomic approach, designed to maximize tree stock to provide for sustained timber yield, boost initial growth rates, and rapidly shade competing shrubs. It has no analog in natural ecosystems, and depends heavily on future thinning treatments. Under current state and USFS regional guidance (i.e., recommended range of 150-300 trees per acre in drier pine to mesic mixed conifer), the dense, uniform structure of young stands (<60 years old) wastes limited seed and nursery capacity early on, while lacking resistance to fire and drought over time. More resilient reforestation approaches are needed, building on natural forest adaptation traits to ecosystem stressors. We will study these approaches using the following climate-smart reforestation practices:

1. *Application of planting spatial patterns based on Individual trees, Clumps of trees, and Openings (ICO) that improve forest resistance to severe fire. Species composition and spacing between and within clumps is selected in response to slope position, microsite moisture, and likely fire behavior.*
2. *Use of initial planting densities that are roughly 1.2-1.5 times the densities of mature forest (i.e., 60-160 seedlings per acre) with restored fire regimes.*
3. *The use of early beneficial fire and targeted shrub control to build young forest resilience.*

1b) Planting Patterns Considering Topographic and Microsite Variation

In studies of mature ICO patterns, local site conditions influencing soil moisture (i.e., concave shape, northerly aspect, gentler slope, less porous soils) and fire intensity (i.e., slope steepness, southwesterly aspect) affect forest composition and spatial patterns at topographic and microsite scales. In general, wetter, flatter slope positions can support larger tree clumps, including some fire-intolerant and moisture-sensitive species (i.e., fir and cedar). Steeper, drier topographies burn with greater intensity and frequency, favoring pines, individual stems and small tree clumps. Differences in these site factors provide a range of mature stand densities and spatial patterns, which could be used to guide reforestation patterns.

At finer spatial scales, variation among microsites that influence soil moisture, solar exposure, and fire intensity can influence the growth and survival of tree seedlings. Pockets of deeper soil can improve growing conditions for conifers, and understory vegetation can provide critical shading for developing seedlings in harsh environments. When planting for these mature forest conditions, the literature suggests following the percentage of trees occurring as individuals and in clump sizes based on topography, but planting at densities and distances that account for about 20-35% seedling mortality. Site conditions and future stand treatments, such as the use of prescribed fire, should also influence mortality estimates. Natural regeneration may be sufficient to meet desired densities and spatial arrangements of conifer seedlings, with wind-dispersal distance of live mature trees (generally about 200 ft), but strategic planting can help supplement low densities of these heavy-seeded pines.

1c) Shrub Control and the Use of Wildland Fire

Many shrub species that are common in Mediterranean climates rapidly resprout from below-ground root crowns and maintain persistent seed banks that germinate following fire. Depending on several factors, vigorous regrowth can either compete with or facilitate the recruitment of developing tree seedlings. Severely burned Sierra Nevada mixed conifer and yellow pine forests that contain high shrub cover (>60-70%) typically have low conifer regeneration densities, especially for large-seeded pines, which suggests a competitive effect of shrubs. However, under low-to-moderate levels of shrub cover (generally <50-60%) tree seedlings have higher growth rates in regenerating Sierra Nevada mixed conifer stands following fire, possibly associated with microsite conditions (e.g., lower evapotranspiration rates, greater soil moisture and nutrients). Under warming climate conditions, shrubs may have an increasing neutral or positive effect on regenerating conifers, by providing critical shading in hot and exposed post-fire environments. Under current climate conditions, recent studies of shrub cover in arid forestlands of southwestern and Mediterranean climate regions of the US suggest shrubs can have a neutral or facilitative effect on planted conifer seedling survivorship and growth. However, the influence of shrubs on post-fire conifer regeneration is largely untested in California, except under traditional gridded and high-density plantations under mild climate conditions.

Prescribed fire, cultural burning, and some wildfires (with beneficial effects) can be used before initial planting, and after saplings (especially pines) are at least 13-20 years old, to reduce shrub cover and surface fuels, and build greater seedling fire tolerance. Dry or old shrubs can be a fuel accelerant, but young, vigorous shrubs in burn scars can act as a heat sink, because of rapid uptake of soil moisture and relatively high foliar moisture content. Prescribed burns implemented shortly after rain can use shrubs to buffer adjacent tree seedling clumps from heat-related injury, while still consuming surface fuels. Beneficial fire can also promote heterogeneity in young, dense stands established with homogenous grid spacing. However, the use of these practices to build resilient heterogeneity in gridded plantations is also largely untested in California.

2) Research Question(s), including Objective and Scope: Our objective is to evaluate the effectiveness of climate-smart reforestation techniques based on active-fire regime landscapes in California's mixed conifer and yellow pine forests, addressing the following research questions:

1. *Does seedling spatial pattern in reforestation influence reforestation success?*
2. *Does planting at lower densities similar to historical conditions (i.e., natural range of variability) result in improved reforestation outcomes?*
3. *How does shrub cover influence conifer seedling survivorship and growth?*
4. *Do climate-smart reforestation outcomes vary across an environmental gradient, represented by different geographic regions of California?*
5. *Does early use of fire (prescribed fire, wildfire) result in reduced fuels and stem densities, and more variable spatial patterning in existing young (13-40 year old) gridded planted stands?*

3) Research Methods: Our study will include the use of a microsite cluster planting design, implemented across several representative forest regions of California – Southern California (Angeles National Forest), Southern Sierra Nevada (Sequoia NF, Sequoia National Park, or Inyo NF), Central/Northern Sierra Nevada (Eldorado, Plumas, or Lassen NF), and Northwestern California (Mendocino NF). Locations will be selected for feasibility of climate-smart reforestation actions implemented in the 2025 planting season, with several project areas already identified in existing NEPA and implementation plans. In each region, we will select one or more study sites in the mixed conifer and yellow pine forest zone that experienced a recent (past 10 years) stand-replacing fire or other disturbance, and that has been identified for climate-smart reforestation efforts by the US Forest Service (USFS) and agency partners. At each study site, we will plant 3-5 seedlings in a cluster, within 10-15 feet of a central point, in the following microsite conditions: (1) in open canopy, (2) at the edge of a shrub canopy, (3) in the shade of a perennial herb, stump, rock, or other shading structure, and (4) at the edge of a second shrub or herb species, if present.

Seedlings will be planted at least 6 feet apart in each cluster. This approach will skip areas of rocky soils, natural regeneration, resprouting hardwoods, and very high shrub cover (>70%). This planting design will result in a range of planted seedling densities (between 80-170 stems per acre) that will be compared to nearby traditional gridded planting designs, based on state and USFS regional stocking standards (i.e., 150-300 stems per acre) in each study site. Variations in this planting design and its comparison to traditional gridded planting will allow us to address Research Question 1 (spatial pattern), Question 2 (seedling densities), and Question 3 (shrub cover). Comparisons among study regions of California will address Research Question 4 (environmental gradient). Our reforestation metrics will include: (a) seedling survivorship and growth, (b) seedling densities (planted vs. target) and spatial arrangement, (c) understory species composition and diversity (including native versus invasive species), and (d) surface fuels. We will use fixed-radius plots for metrics (a) through (c) and Brown's fuel transects method, combined with ground cover estimates of coarse woody debris for metric (d).

We will identify plantations burned in a recent (since 2014) prescribed fire or wildfire to evaluate Research Question 5. Analysis will focus on recently managed wildfires (low-moderate severity) that had potential to create openings or significantly reduce stem densities and fuels in gridded plantations. Pre-fire treatment information will be gathered using USFS records and documentation. Partners have already identified study sites related to several recent burn scars in national forests of California (e.g., Sequoia NF, Inyo NF).

4) Scientific Uncertainty and Geographic Applicability: Climate-smart reforestation is relatively new and subject to uncertainty, especially studying planting designs that emphasize the importance of: (1) spatial heterogeneity, (2) lower stem densities (aligned with natural range of variability), (3) low-moderate shrub cover for seedling microsite suitability, and (4) early beneficial fire use for young stand resilience. Our study specifically aims to examine each of these areas of uncertainty, by using a design that addresses each of these factors independently or in combination. Our geographic applicability is Statewide, as relevant to both public and private lands, with a focus on study sites in public forests.

5) Collaborator Roles and Project Feasibility: TreePeople will lead implementation of climate-smart reforestation activities in Southern California, supervising implementation in additional regions through subcontract (such as with Great Basin Institute), to ensure project consistency. The USFS Region 5 Ecology Program (Nicole Molinari, Lacey Hankin, Marc Meyer, etc.) and PSW Research Station (Malcolm North) will oversee monitoring data collection in reforestation areas and coordinate closely with national forest staff and other partners (e.g., National Parks) to ensure climate-smart reforestation activities meet study requirements. Principal Investigators will coordinate data management and assist collaborators in analysis, reporting, and manuscript preparation.

Additional research partners may choose to participate in this project, as we seek to include local Tribes, and other partners interested in culturally-important conifer species (e.g., single-leaf pinyon pine). In addition, several study sites of recently-burned gridded plantations on national forests have already been identified by agency staff as readily accessible for field sampling. We also expect further sampling locations will emerge with focused interviews of agency staff as the project commences.

We anticipate high feasibility in this study, having already obtained commitments by the USFS Regional Forester's Office in the Pacific Southwest Region, several national forests currently planning climate-smart reforestation projects in recently burned areas (e.g., Sequoia NF, Eldorado NF, Mendocino NF), and additional agency partners planning similar reforestation efforts in mixed-conifer forests (e.g., National Park Service, American Forests). These commitments include strong logistical, planning (e.g., NEPA), and financial support of proposed climate-smart project activities across the region.