COLORADO FOREST RESTORATION INSTITUTE

ROCKY MOUNTAIN RESEARCH STATION

Post-fire Tree Regeneration and Forest Recovery Workshop Summary

Workshop Summary

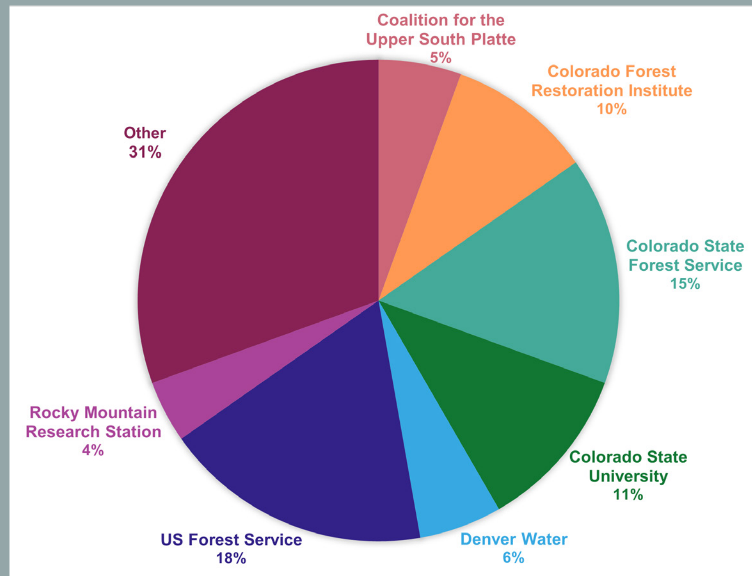
The US Forest Service Rocky Mountain Research Station and the Colorado Forest Restoration Institute at Colorado State University gathered professionals from 27 organizations on April 20, 2021 to discuss issues relating to natural forest recovery and reforestation following the 2020 wildfires in Colorado and Wyoming. The workshop provided the opportunity for:

a) local researchers to share highlights of post-fire forest research;

b) managers to discuss practical concerns and considerations about post-fire natural forest regeneration and planting;

c) managers, researchers, and stakeholders to discuss knowledge gaps and solutions.

The highlights of these discussions are the focus of this document.



"Other" organizations include: American Forests, Arkansas River Watershed Collaborative, Boulder County Parks and Open Space, Calwood Education Center, City of Fort Collins, Colorado Water Conservation Board, Coalition for the Poudre River Watershed, Colorado State University Extension, The Ember Alliance, Jefferson County Open Space, Larimer County, Mountain Studies Institute, The Nature Conservancy, Renew West, Trout Unlimited, University of Colorado, University of Texas, Wildland Restoration Volunteers.

Local research highlights potential post-fire regeneration challenges following the 2020 fires

Seedling growing after fire
Photo Credit: Zoe Schapiro

Post-fire responses vary widely among forest ecosystems, but there is evidence that post-fire tree regeneration has been unusually slow or scarce during recent decades in numerous forest types. In high-elevation ecosystems, wildfire occurrence is rare, and recovery of pre-fire forest composition is typically slow, so understanding of long-term regeneration dynamics is limited. Many lodgepole pine and Engelmann spruce dominated stands in northern Colorado and southern Wyoming have experienced significant tree mortality from bark beetles, and the 2020 fires created 'compound disturbances' that have poorly understood consequences on tree regeneration, especially under warmer and drier climatic conditions. For example, decreased seed viability of lodgepole pine killed 12-15 years ago by bark beetles creates a potential obstacle for post-fire conifer regeneration. After recent Colorado wildfires, subalpine fir and Engelmann spruce regeneration has been scarce, though these fires have stimulated lodgepole pine and aspen regeneration. Poor fir and spruce regeneration were attributed to above-average temperature and below-average precipitation. Since aspen can resprout and grow rapidly, fires can prompt a shift in species composition particularly in areas with extensive beetle-related tree mortality. Ponderosa pine dominated forests in the montane ecosystems of Colorado and across the western US have ample evidence of sparse or delayed recovery after large, high severity wildfires.

Land Manager Concerns After the 2020 fires

More than 1 million acres have burned on the Arapaho-Roosevelt and Medicine Bow-Routt National Forests during the last 20 years, much of which burned at high severity. After fire suppression and burned area emergency rehabilitation (BAER) treatments are complete, managers must make decisions about if, where, and when they should conduct post-fire reforestation. These decisions hinge on uncertainty about where and when natural forest regeneration will occur. Changing climatic conditions may further impact natural post-fire regeneration and reforestation success, and create additional unknowns regarding species selection, plantation design and implementation.

Lessons from two decades of post-fire reforestation on the Pike-San Isabel National Forest

Large-scale reforestation occurred after four wildfires on the Pike NF between 2003-present (1997 Buffalo Creek, 2000 Hi Meadow, 2002 Hayman, and 2012 Waldo Canyon Fires). Generally, managers prioritized reforesting ponderosa pine, Douglas-fir, and aspen in areas between 6500-9300 ft.

2002 Hayman Fire
Photo Credit: Tony Cheng

Early challenges (1-5 years post-fire): A lack of stand data across burned areas, physical infrastructure (e.g., coolers/refrigerators), internal infrastructure, institutional knowledge, and large seedling losses at the nursery due to fungal pathogens created obstacles to reforestation activities. Additionally, the large extent of the 2002 Hayman Fire and its proximity to Denver attracted external input and shined a spotlight on reforestation efforts.

Long-term challenges (20+ years post-fire): Continued lack of stand data, decreasing resources and capacity to run program, challenges with existing NEPA, increased administration required to manage increased partner involvement, and decreased cone collection and seed viability all effected reforestation program success. “Reforestation fatigue” occurred within the agency and resources available to the program diminished over time. Additionally, there has been a decline in seedling survival in recent plantings, likely due to drought, continued soil loss, or a shift to sub-optimal planting locations.

Lessons learned:

- **Define reforestation success:** What is acceptable seedling survival and over what time period?
- **Each planting site has unique challenges:** There is no substitute for ground truthing. On-the-ground surveys are crucial for planting layout and should not be replaced by remote imagery (drone/aerial).
- **Experimentation and adaptation:** Learn from successes and failures to improve future plantings, and adjust planting contracts to reflect best-available local science.
- **Maintain reforestation infrastructure:** Ensure viable seed inventory is available across forest types and elevation zones. Restore and improve seedling storage and transportation.
- **Build staff capacity:** Due to a general decrease in silvicultural expertise, spreading knowledge and capacity by training multiple employees will make the program more resilient to turnover.
- **Leverage partners:** Partnerships bring increased capacity, innovation, and resources, though these relationships require time and capacity to build and maintain.
- **See the forest, not just the trees:** Timber production is not the only outcome of reforestation and consideration of watershed, wildlife, and other resources can help direct planting activities.

General Observations

There was general concern about post-fire forest recovery across the range of forest types and disturbance histories affected by the 2020 wildfires. To understand the expected high spatial and temporal variability in wildfire effects and regeneration response in these forests, there is a clear need to conduct well-replicated sampling for multiple years. The success of reforestation efforts is likely to be complicated by variable climate patterns, such as multi-year drought cycles. However, post-fire landscapes provide opportunities to learn about how forest species and ecosystems adapt to changing climatic conditions. The 2020 wildfires create a living laboratory to evaluate and experiment with species migration in a number of forest types and elevational bands.

Sparse or slow post-fire tree and forest regeneration has consequences for many ecosystem attributes and services. Concerns were raised about the implications of low forest cover for timber production, carbon sequestration, wildlife habitat, watershed conditions, and the downstream implications for water supply, fisheries, and recreation. Forest ecosystem recovery should consider the life history traits and optimal growing conditions of multiple tree, shrub, and herbaceous species, establishment requirements, and belowground fungal symbionts. Participants noted there may be positive and negative outcomes of shifts in forest composition and structure or forest 'type conversion' (i.e., shift from conifer to deciduous forest or a grass/forb/shrubland). Such changes can alter biodiversity, fire hazard, wildfire behavior, water use, and ecosystem carbon stocks.

Factors Needed to Better Understand and Manage for Post-fire Forest Recovery

- **Integrated datasets** (e.g., site index, tree densities, severity of beetle mortality, cone serotiny)—in addition to new remotely sensed and on-the-ground monitoring—will be crucial to assess natural regeneration in the first post-fire years.
- **Collaborative partnerships and learning opportunities** (i.e., scientific publications, workshops, and field trips) with managers, researchers, and other stakeholders should expand knowledge, capacity, and innovation as forest recovery remains uncertain.
- **Additional funding and expertise.** Forest managers were already working at capacity prior to the fires, and post-fire management activities put additional strain on capacity and resources.
- **A cohesive, long-term strategy** to address the multiple post-fire management activities and needs is crucial. Reforestation activities designed to direct increasing post-fire planting efforts and responses to other climate-related disturbances should be included in upcoming US Forest Service Forest Plan revisions
- **Compatible pre-fire fuel mitigation and post-fire reforestation approaches.** Both approaches aim to create or sustain resilient forest ecosystems and associated functions and services.

2020 East Troublesome Fire
Photo Credit: Chuck Rhoades

Operational Barriers to Reforestation Success

- **Reforestation is a multi-step sequence of technical and administrative tasks** including seed collection and storage, nursery production, tree planting, monitoring, and subsequent forest management (i.e., thinning). There is widespread concern about sustained institutional and financial commitment to each link of the chain.
- **Institutional knowledge is in short supply** and capacity and infrastructure (i.e., manager expertise and time, seed inventory, nursery capacity, seedling refrigeration) are serious concerns. However, there was optimism that the 2020 fires may motivate agencies to restore needed capacity.
- **The "stove-piped" nature of our management agencies creates artificial knowledge gaps that limit planting decisions.** Planting aimed towards timber objectives does little to address post-fire watershed or wildlife priorities, for example.
- **Widespread planting is expensive and should be planned carefully and integrated with new research and long-term monitoring.** New understanding of post-fire forest recovery and tree regeneration can inform tree planting contracts and Forest Plan revisions.

Critical Research Needs

- **Natural post-fire forest recovery** — Will trees regenerate naturally on expected time scales and with desired densities? When and where are initial post-fire seedling densities predictive of long-term trajectories?
- **Compound disturbances' influence on forest recovery** — What feedbacks exist between disturbances and compound effects?
- **Tree species adaptation** — How might local or non-local tree species fill in early seral areas? Where and how often does aspen establish by seed rather than resprouting?
- **Effects of climate change on forest recovery and reforestation efforts** — How may forests shift in composition, structure, or location due to climate changes, and where should we expect this to happen? Should assisted migration or planting local species from hotter and drier areas be considered? What species should we plant in these fire scars, and what are the cold and drought tolerances of these species?
- **Soil burn severity, belowground microbial communities, and soil-water dynamics** — What roles do these play in natural forest recovery?
- **Seed predation and herbivory** — What roles do they play in forest recovery and are there opportunities for large scale direct seeding based on what we know about seed predation?

2020 Cameron Peak Fire
Photo Credit: Marin Chambers

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More resources are available at
cfri.colostate.edu and fs.usda.gov/rmrs
Contact:
marin.chambers@colostate.edu
charles.c.rhoades@usda.gov