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FOREST AND RANGELAND STEWARDSHIP
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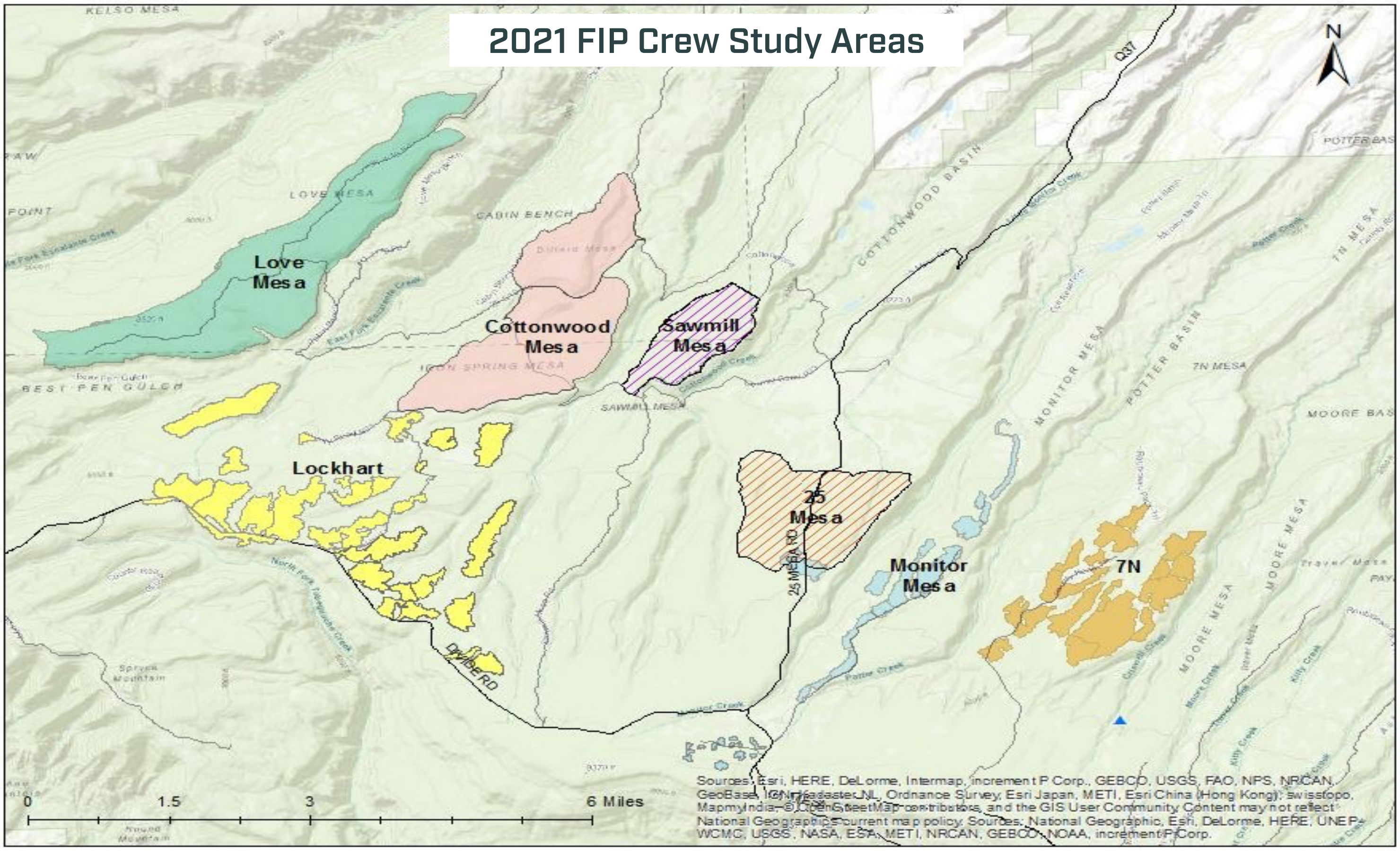
2021 Uncompahgre Plateau Collaborative Forest Landscape Restoration Project Forestry Internship Program (FIP) Monitoring Report

Figure 1: The 2021 Forestry Internship (FIP) crew taking field measurements using a logger's tape. From left to right: Brendon Ullmann, Ezra Nash, and Lyle Motley (crew leader).

The purpose of this report is to present a summary of data collected from the Escalante and Uncompahgre Mesas project during the summer of 2021, when members of the Uncompahgre Plateau Collaborative Forest Landscape Restoration Program (UP-CFRLP) Forestry Internship Program (FIP) crew (Figure 1), led by crew leader Lyle Motley and staff from the Colorado Forest Restoration Institute (CFRI), and supported by the US Forest Service, collected data on overstory trees, surface fuels, forest floor and understory cover, and tree regeneration in mechanically treated areas on the Uncompahgre National Forest. The 2021 FIP crew collected data in the Lockhart and 7N mechanical treatment areas following mechanical treatments (Figure 2). These data were collected five- or six-years post-mechanical treatment (hereafter "five-years post-treatment" for simplicity). Pre-treatment data was collected in 2016 for the 7N treatment area and then revisited in 2021, while



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Figure 2: Map of UP-CFRLP treatment areas and 2021 data collection sites in the Unc Mesas project area, Uncompahgre National Forest, Colorado.

pre-treatment data for the Lockhart treatment area were collected in 2015 and then revisited in 2021. In this report, data collected one-year post treatment were not analyzed due to a gap in data. The data for post one-year treatments were insufficient to be analyzed and contained unknown phases in some units leading to some uncertainty. Additionally, some gaps remain in these data due to the transfer of data from partners to CFRI.

Changes in basal area, trees per acre, and quadratic mean diameter

Mechanical treatments met the objectives of reducing tree density and trees per acre, and increasing Quadratic Mean Diameter (QMD; Figure 3) in the 7N and Lockhart treatment areas. Across these two units, mean basal area was nearly 100 ft^2ac^{-1} prior to mechanical treatments but was reduced to under 80 ft^2ac^{-1} basal area one-year post-treatment. Five years post-treatment, basal area remained similar to one year-post treatment (~78 ft^2ac^{-1}). Additionally, mean pre-treatment trees per acre values were ~83 trees per acre. After treatment, mean trees per acre were reduced to ~70 trees per acre. At five-years post-treatment, mean trees per acre were further reduced to ~65 trees per acre, most likely because of additional mortality of trees over time. The mean quadratic mean diameter remained similar (~15) to pre-treatment diameters across the three timeframes. However, QMD did increase just slightly (~16) during five-year post treatment measurements. This may be a result of smaller trees experiencing mortality or of trees getting slightly larger over time.

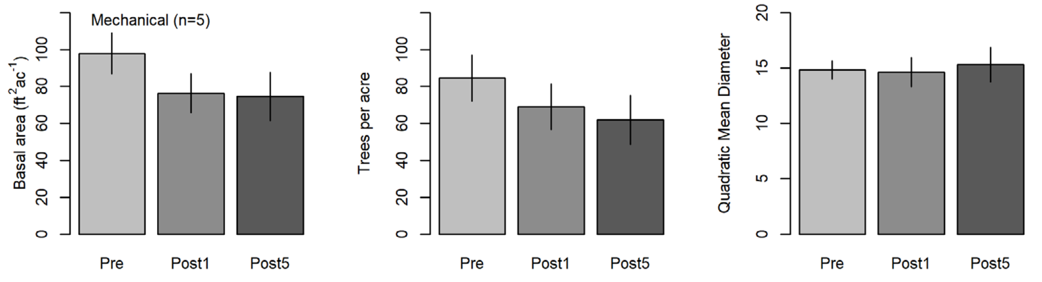


Figure 3: Mean (± standard error) basal area, trees per acre and Quadratic Mean Diameter pre-treatment and five-year post-treatment within mechanical treatment areas. “Pre” indicates pre-treatment, “Post1” indicates one-year post-treatment and “Post5” indicates five- or six-year post treatment monitoring.

Changes in tree species composition

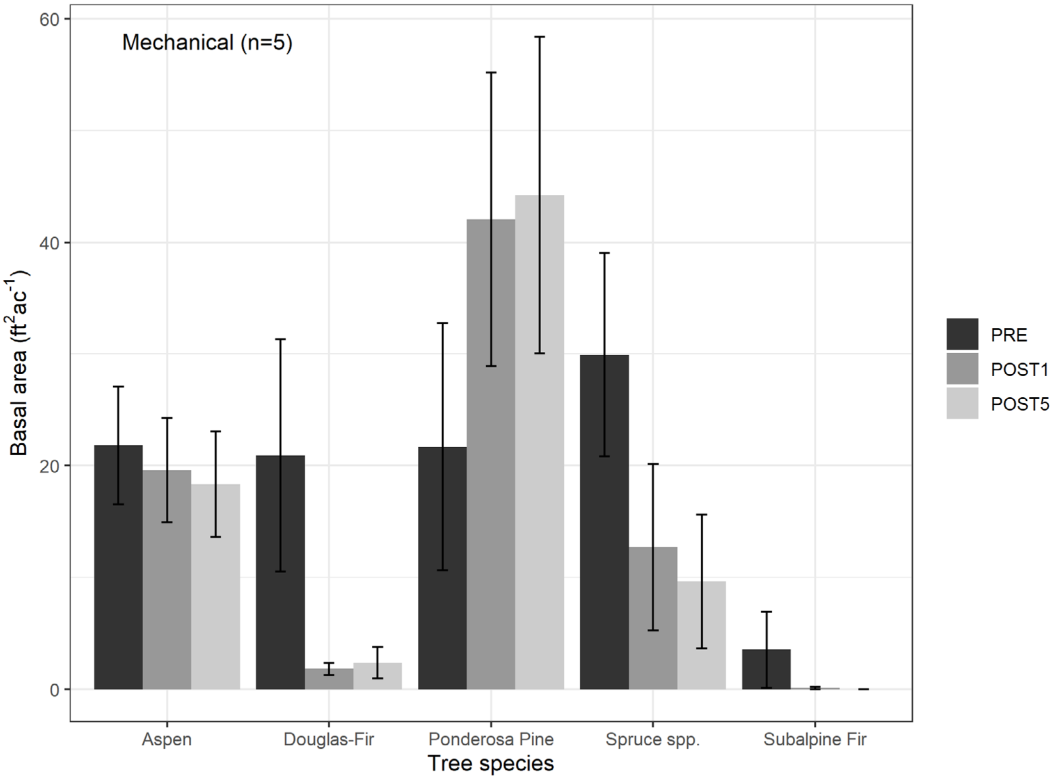


Figure 4: Mean (+/- standard error) basal area by tree species. “Pre” indicates pre-treatment, “Post1” indicates 1-year post-treatment, and “Post5” indicates 5- or 6-year post treatment monitoring.

Within mechanical treatment areas, stands met the objective of retaining fire-tolerant trees, such as ponderosa pine and aspen, and reducing fir and spruce species (Figure 4). Ponderosa pine had an increase in mean basal area between pre-treatment, one-year post-treatment, and five-years post-treatment conditions. This increase is likely due to a combination of sapling release and because of some level of human error. Mean aspen basal area was reduced slightly between pre-treatment, one-year post-treatment, and five-years post-treatment conditions, but was largely retained and will likely continue to produce saplings and larger trees over time (Figure 4, see Figure 9 and 10 for tree regeneration information). The mechanical treatments also resulted in a reduction in fire-intolerant conifer species, including Douglas-fir, spruce, and subalpine fir. Mean basal area of Douglas-fir was heavily reduced by the treatment but may increase over time as there was a slight increase in mean basal area of this species five-year post-treatment; this may indicate that saplings are releasing to small trees in these treatment areas. Mean basal area of spruce species (Englemann and blue spruce) was also reduced, but still exists on the landscape at higher mean basal area values than Douglas fir. Mean basal area of subalpine fir was dramatically reduced by mechanical treatment and have very little presence in the plots that were sampled five-years post-treatment.

Changes in surface fuels

Within mechanical treatment areas, mean fine surface fuel loadings decreased only slightly following one-year and five-year post-treatment from pre-treatment levels (Figure 5, Figure 6). This change is very small and with all treatments have a similar standard error. Relative to pre-treatment levels, the mean coarse fuel load decreased by about half a ton per acre one-year post-treatment and remained the same five years post-treatment.

Figure 5: Comparison photo-points in the 7N mechanical treatment area. Pre-treatment conditions are illustrated (top); as well as five-year post-treatment conditions (bottom). The five–year post-treatment photo (bottom) illustrates the reduction of tree density, the retention of ponderosa and aspen, and the reduction of shade-tolerant and fire-intolerant species such as spruce and subalpine/ Douglas fir. The increase in fine and coarse wood five-years post-treatment is still evident in the photo on the bottom.

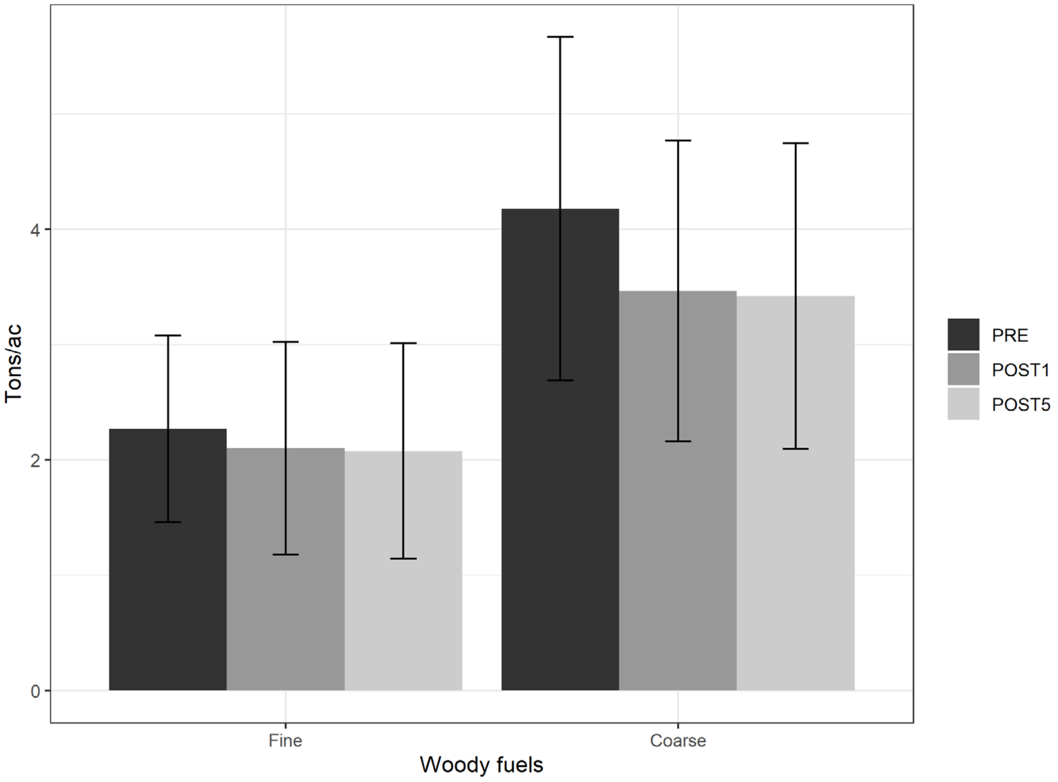


Figure 6: Mean (± standard error) tons per acre of fine (<3 cm diameter) and coarse (>3 cm diameter) wood pre-treatment, one-year post-treatment, and five-years post-treatment within mechanical treatment areas.

Changes in expected fire behavior

Changes in expected fire behavior were observed pre- and post-treatment, where there was a modeled increase in expected surface fire (Torch Index) behavior and a decrease in expected crown fire (Crown Index) behavior following treatments. These indices can be modeled in FFE-FVS ((Reinhardt, 2003); in this case we used all default options available for this region while inputting field data that was collected in 2021. We also modeled these metrics using 90th percentile fire conditions.

Torch Index indicates the wind speed needed to move fire from the surface of the forest floor into the crown of a single tree (a proxy for surface fire risk); a higher Torch Index indicates higher winds speeds needed to move a fire from the surface of a forest floor into the crown of a single tree. Crown Index indicates the wind speed needed to move fire from a single tree crown to another tree crown (a proxy for crown fire risk). When evaluating Crown Index, the higher the Crown Index, the higher the wind speeds needed to move fire from tree crown to tree crown. All of this should take into consideration standard wind speeds in that area to best understand local, on the ground conditions. According to the National Weather Service the average wind speed for the general Uncompahgre Plateau area was 7.7 mph, the average high speed was 42.25 mph, and the average gust speed was speed was 56.5 mph (US Department of Commerce, 2022).

Five-years post-treatment the Torching Index decreased from pre-treatment conditions, indicating that one-year and five-years following treatment, the potential for surface fire to spread into single tree was increased from pre-treatment conditions (Figure 7). Due to the Torching Index being lower, there is a greater possibility of fire spreading from the surface of the forest floor into the crown of a single tree one- and five-years post-treatment. These findings are consistent with mechanical treatment monitoring from years past on the Uncompahgre Plateau as well as numerous other CFRI monitoring projects of mechanical treatments across Colorado. However, mechanical treatments increased the Crowning Index one- and five-years post-treatment (Figure 7). According to the FFE-FVS fire model analysis, windspeeds needed to carry a fire from crown to crown rose from around 75 mph pre-treatment to over 120 mph one- and five-years post-treatment, a greater than a 60% increase. The increased windspeeds needed to have running crown fire indicate that there is less potential for continued crowning under 90th percentile conditions.

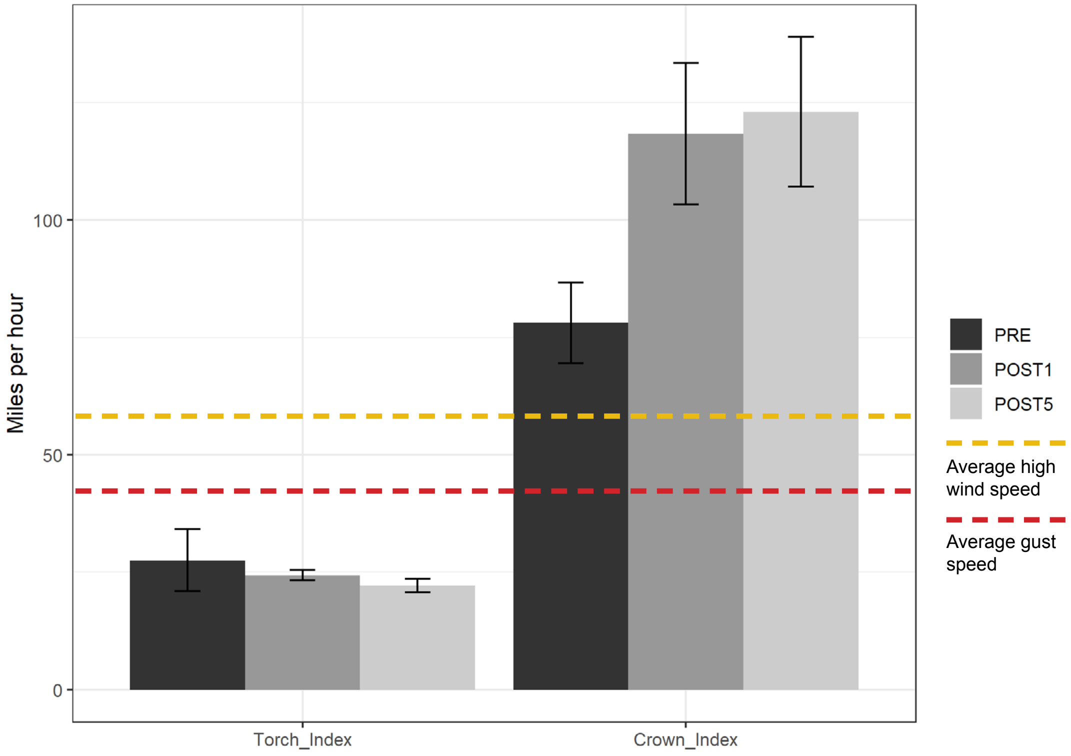


Figure 7: Mean (± standard error) of FVS generated torching and crowing index pre-treatment and five-year post-treatment within mechanical treatment areas.

Changes in understory and forest floor cover

In mechanical treatment areas five-years post-treatment, changes in understory and forest floor cover (%) saw a sustained reduction in understory vegetation cover (graminoids, forbs, and shrubs), and variable changes in other forest floor characteristics (Figure 8). Between pre-treatment and five-year post-treatment measurements, cover (%) of graminoids, forbs and shrubs were only a fraction of what they had been pre-treatment (~75%, ~25%, and ~25% for graminoids, forbs and shrubs respectively). Wayman and North (2007) found that species cover did not increase with thin-only or burn-only treatments; instead, they suggest that thinning and burning treatments were better for increasing plant cover as the thinning treatment increased the amount of light reaching the forest floor while burning also reduced the amount of litter, slash, and shrub cover (Wayman & North, 2007). In contrast, Korb et al. 2020 did not find any significant changes to understory vegetation richness, diversity, or cover in dry mixed conifer sites. Korb's finding contrasts with other studies, and the authors suggest that this may be due to treatment intensity, climate, or biotic factors (Korb et al., 2020). Due to the variety of studies, examining understory vegetation response to treatments, it is important to note that different factors may influence vegetation response in different areas and that even singular years can strongly influence the cover of understory vegetation due to an increase/decrease in precipitation.

We also observed that litter and duff cover (%) were reduced by over 30% five-years post-treatment from pre-treatment conditions. This decrease in litter/duff cover may be due to mechanical treatment activities and the increase in fine and coarse woody fuels that may be covering litter and duff. Rock cover remained relatively unchanged pre-treatment and five-years post-treatment. Soil cover (%) had a slight increase five-years post-treatment. Wood cover (%) more than doubled five-years post-treatment from pre-treatment levels, most likely due to the increase in fine and coarse fuels following mechanical treatment as seen in Figure 5. Notably, wood cover ((%), combined fine and coarse wood) represented in Figure 8 is measured in seven Daubenmire frames at each plot, whereas fine and coarse wood (tons/ac) reported in Figure 6 are collected via Brown's transects. The results seem to contradict one another, yet they are collected in a different manner and both represent the variable conditions of wood within these plots. Further monitoring will help illuminate fuels dynamics in these treatment areas over time.

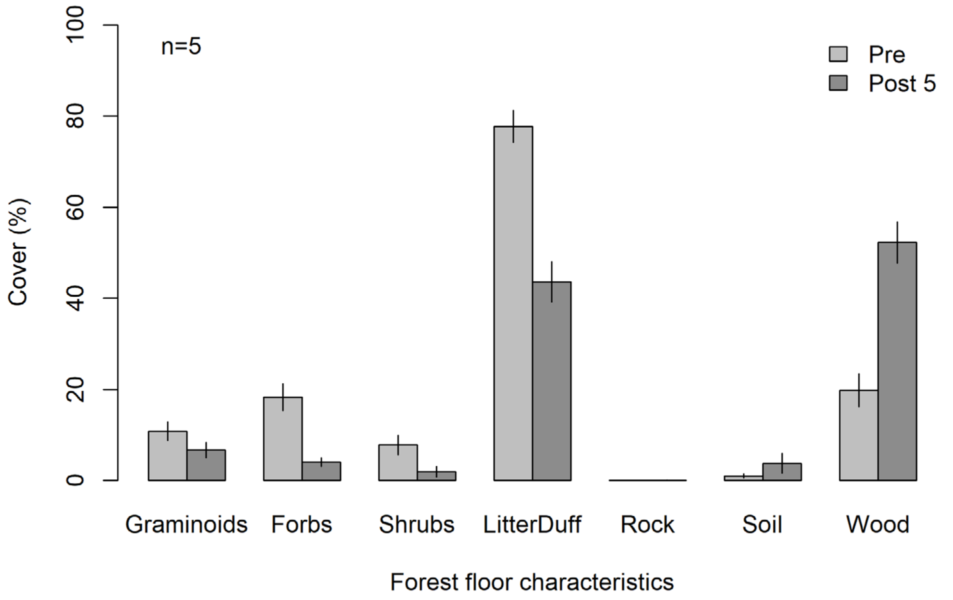


Figure 8: Mean (± standard error) percent cover of forest floor characteristics pre-treatment and five-year post-treatment within mechanical treatment areas. Cover was ocularly estimated within Daubenmire plots to the nearest 1%.

Tree regeneration

In 2016, 240 regeneration plots were established across the entire project area (Figure 2). In 2021, 88 of those plots were remeasured (n=88). According to these data, the dominant tree species that is regenerating in these plots is Gambel Oak (Figure 9). The other species that are regenerating are aspen, ponderosa pine, and subalpine/Douglas-fir. While spruce has the lowest average regeneration densities of all the species, it is still present in the regeneration plots that were measured in 2021.

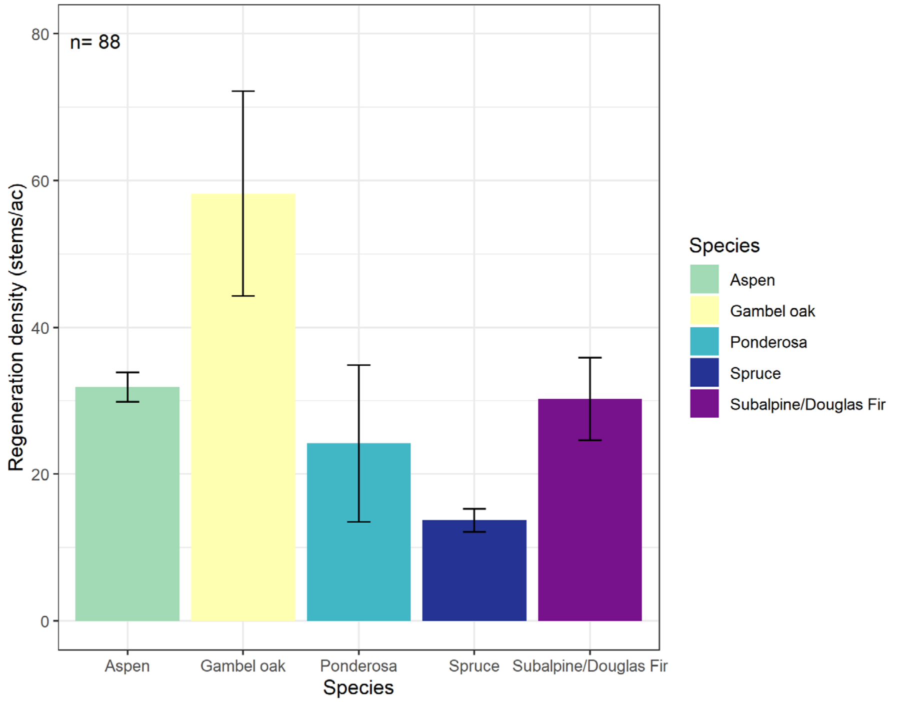


Figure 9: Mean (± standard error) density (stems/ac) of tree regeneration occurring across the entire Escalante and Unc Mesas treatment areas in uncut, cut, and cut and burned plots.

Tree regeneration by species and treatment type

Additionally, we examined tree regeneration across various treatment types: “cut” (plots that had experienced mechanical treatments only, n=47), “cut & burned” (plots that had experienced mechanical and prescribed burning treatments, n=12), and “uncut” (plots that had no mechanical or prescribed burning and were “control” plots, n=29). For this analysis, we were able to use data that included pre-treatment and five-year post-treatment data. Gambel Oak was the dominant tree species for regenerating species for cut and cut & burn treatments (Figure 10) but had similar mean regeneration densities as aspen in uncut areas five-years post-treatment. Aspen had increased mean regeneration densities over all treatment types between pre- and five-years post-treatment. Mean regeneration densities of ponderosa pine were lowest in cut treatment areas, while in cut & burn treatments mean regeneration densities decreased between pre-treatment and five-years post-treatment, and in uncut areas, regeneration densities of ponderosa pine remained the same. Mean spruce regeneration densities increased from pre- to five-years post-treatment in the cut treatment. Spruce was not present pre-treatment in the cut & burn areas but was present five-years post-treatment. In the uncut treatment, mean regeneration densities of spruce remained the constant between

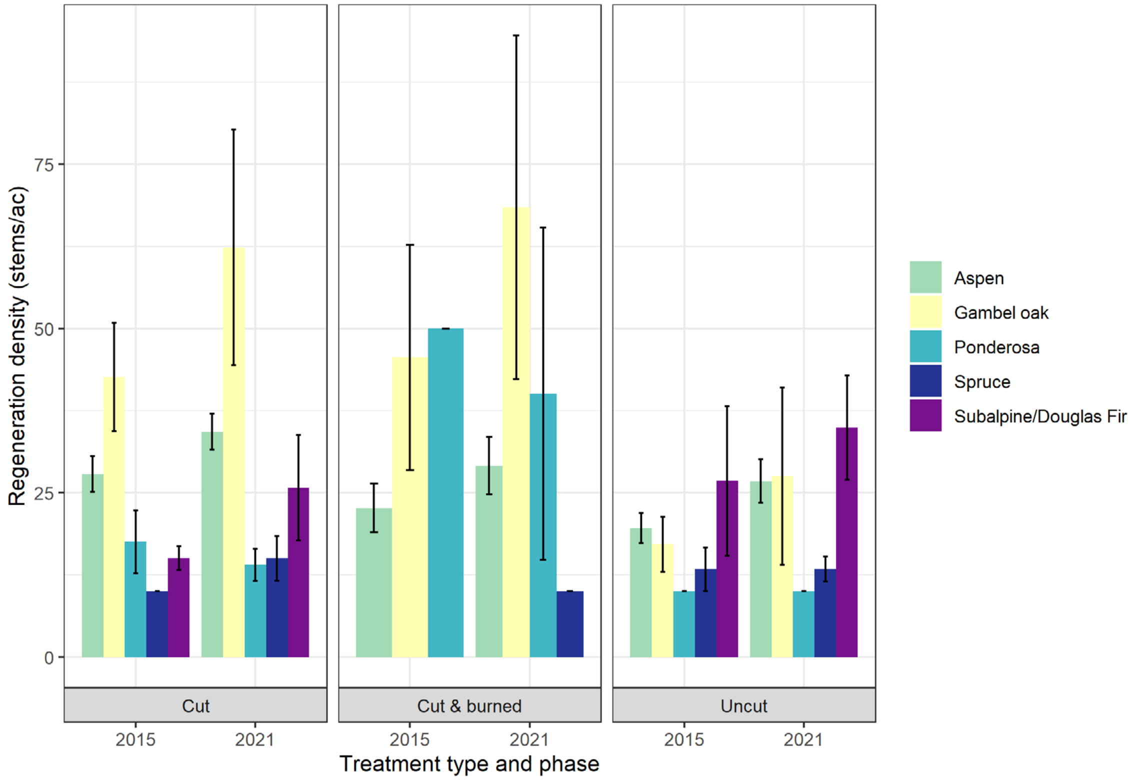


Figure 10: Mean (± standard error) density (stems/ac) of tree regeneration within uncut, cut, and cut and burned plots in the Unc Mesas treatment areas for pre-, and five years post-treatment.

pre- and five-years post-treatment. Mean regeneration densities of subalpine and Douglas-fir increased in the cut and uncut treatments, whereas subalpine and Douglas-fir were not present in the cut & burned treatment areas. Mean regeneration densities of subalpine and Douglas-fir were highest in the uncut treatment areas.

Discussion and management implications

These data illustrate that in the 7N and Lockhart treatment units, mechanical treatments did reduce basal area and trees per acre over the five-year monitoring period and slightly increased the size of remaining trees (QMD) in treatment units. Mechanical treatments also retained aspen and ponderosa pine, which dramatically reduced Douglas/subalpine fir and spruce species. Fine and coarse fuels were reduced slightly over the five-year period since treatment, while surface fire risk increased slightly, and crown fire risk was dramatically decreased. Mean percent cover of graminoids, forbs, shrubs and litter and duff remained reduced five-years following treatment while mean percent cover of soil and wood increased five years post-treatment.

These data also indicate that disturbance of Gambel oak lead to increased sprouting and therefore regeneration of Gambel oak within the cut and cut & burned units, which may or may not be desirable depending on goals of treatments relating to Gambel oak. Similarly, aspen appeared to respond to disturbance in the cut and cut & burned units by increasing mean regeneration density over time, although mean aspen regeneration increased after five years of monitoring in the uncut areas as well. Ponderosa pine, a focal species for retention in these treatments, had the lowest mean regeneration densities in the uncut areas, whereas appeared to have higher mean regeneration densities pre-treatment in the cut and cut & burned units but decreased over time. Further, mean regeneration densities of spruce and fir species, which were targets for reduction in these treatments, appeared to increase in cut and uncut areas over time, whereas in cut & burn areas, spruce was absent pre-treatment and increased over time while fir species were completely absent in these areas. This may indicate that mechanical and prescribed burning is effective at reducing fir species regeneration, slowing spruce species regeneration and promoting ponderosa pine regeneration. Further monitoring will help to illustrate these patterns across more of the treatment areas over time.

Monitoring will continue in these treatment areas through 2024. CFRI will continue to report on annual monitoring activities.

Citations:

Korb, J. E., Stoddard, M. T., & Huffman, D. W. (2020). Effectiveness of restoration treatments for reducing fuels and increasing understory diversity in shrubby mixed-conifer forests of the southern Rocky Mountains, USA. Forests, 11(5), 508. https://doi.org/10.3390/f11050508

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Wayman, R. B., & North, M. (2007). Initial response of a mixed-conifer understory plant community to burning and thinning restoration treatments. Forest Ecology and Management, 239(1-3), 32–44. https://doi.org/10.1016/j.foreco.2006.11.011

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