2022-2023 Uncompahgre Plateau Collaborative Forest Landscape Restoration Project Forestry Internship Program (FIP) Monitoring Report

The purpose of this report is to present a summary of data collected from the Escalante and Uncompahgre Mesas Collaborative Forest Landscape Restoration Project (CFLRP) throughout the 2022-2023 field seasons. During this time, members of the Montrose High School Forestry Internship Program (FIP) crew (Figure 1) conducted the field research effort, led by Lyle Motley and supported by the Colorado Forest Restoration Institute (CFRI) and the US Forest Service. The FIP crew collected data on overstory trees, tree regeneration, surface fuels and forest floor/understory cover in mechanically treated, prescribed burn, and untreated areas on the Uncompahgre National Forest (Figure 2).

The FIP crew collected post-treatment data in the Lockhart, Cottonwood, Monitor, and Sawmill Mesa study areas in 2022 and 2023 (Figure 2). Pre-treatment data was collected in 2014-2017 and one-year post-treatment data was collected in 2018-2020 for all treatment areas. Five- and six-year post-treatment (hereafter "5-year post-treatment" or "Post5" for simplicity) data was collected in 2022-2023. A total of 14 mechanically treated plots and 12 prescribed burn plots were collected in 2022 and 2023; these plots are used in the analyses for this report.

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

Average basal area and trees per acre generally decreased immediately following both mechanical and prescribed burn treatments (Figure 3). Within mechanical treatment areas, mean basal area pre-treatment was 95 ft^2ac^{-1}, decreasing to 75 ft^2ac^{-1} one-year post-treatment and remaining constant five-years post-treatment. Before mechanical treatments, plots had an average of 92 trees per acre; this value was reduced to 83 trees per acre one-year post-treatment and 75 trees per acre five-years post-treatment. This decrease in average trees per acre but not basal area in the mechanical plots could be explained by a die-off of smaller trees and saplings while larger trees were retained. Average quadratic mean diameter (QMD) was 14 inches prior to mechanical treatment, decreased slightly to 13 inches one-year

Figure 1. The 2022 and 2023 Forestry Internship Program (FIP) crews. The 2022 crew (left) from left to right: Brianna Tracey, Benjamin Perfors, Brendan Ullman, and Lyle Motley (crew leader). The 2023 crew (right) from left to right: Lyle Motley (crew leader) and Nels Motley.

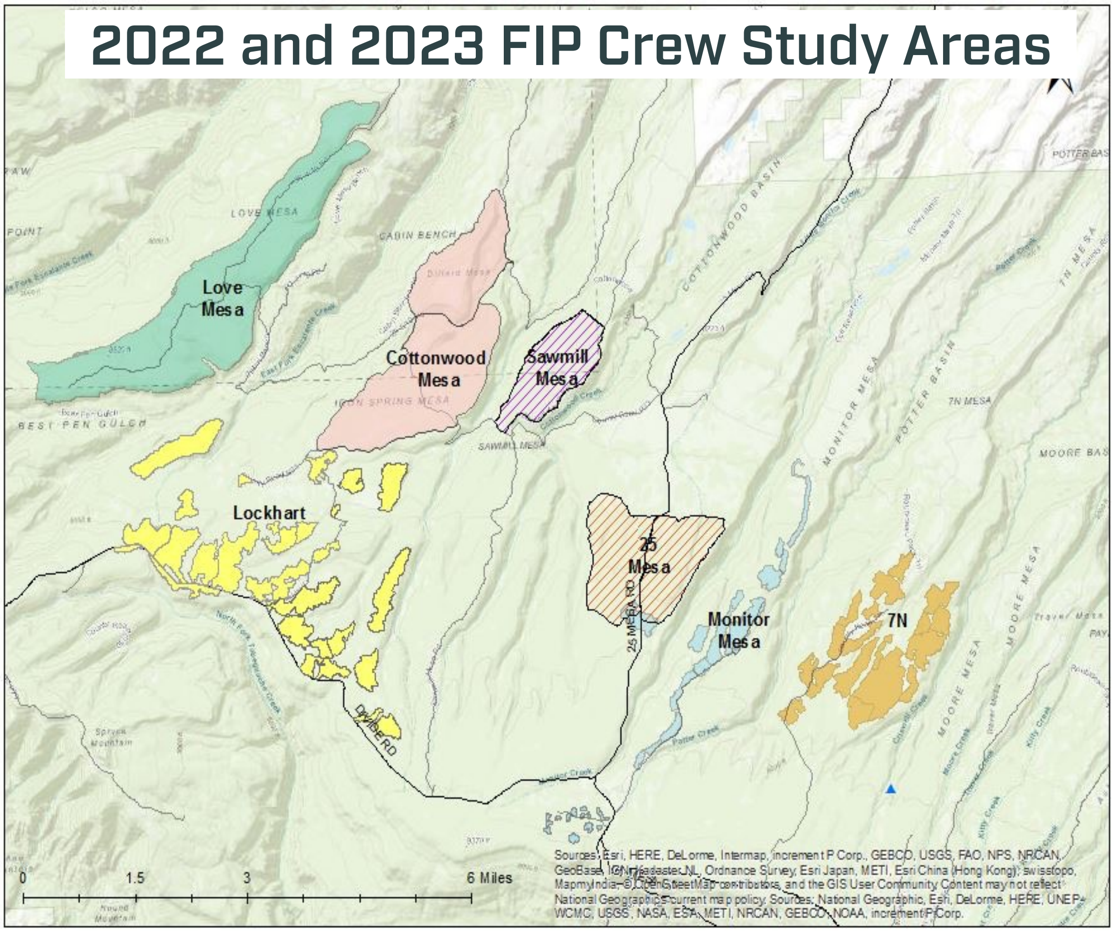

Figure 2. Map of UP-CFRLP treatment areas and 2022/2023 data collection sites in the Uncompahgre Mesas project area, Uncompahgre National Forest, Colorado.

post-treatment, then increased five-years post-treatment back to 14 inches. This change in average QMD may be a result of measurement error, this change in average QMD may be a result of measurement error one-year post treatment, or by natural growth of the trees over this five-year period.

Within the prescribed burn treatment areas, basal area and trees per acre remained constant between pre-treatment and one-year post-burning, but decreased five-years post-treatment, while QMD remained the same throughout each monitoring visit. Average basal area was 87 ft^2ac^{-1} pre-burning and one-year post-burning, decreasing to 79 ft^2ac^{-1} five-years post-treatment. Average trees per acre followed a similar pattern; pre- and one-year post-burning, plots had an average of 112 and 110 trees per acre, respectively, before decreasing slightly to 99 trees per acre five-years post-burning. These results illustrate that between pre- and one-year post-prescribed burning, basal area and trees per acre remained the same because the prescribed burn did not kill many trees in the overstory. The slight decrease in average basal area and trees per acre five-years post-treatment indicates that a few trees died in that time frame, either due to natural mortality or potentially delayed effects of the prescribed burn. Average QMD remained constant at 12 inches over all three monitoring visits, indicating that minimal change to average tree size occurred following prescribed burning.

Changes in tree species composition

Both mechanical and prescribed burning generally achieved the goal of retaining fire-resilient species (aspen and ponderosa pine), with varying results for less fire-resilient species (Figure 4, Figure 5). Average basal area of ponderosa pine was 29 ft^2ac^{-1} pre-treatment, decreased slightly to 28 ft^2ac^{-1} one-year post-mechanical treatment, and increased five-years post-treatment (31 ft^2ac^{-1}), likely due to

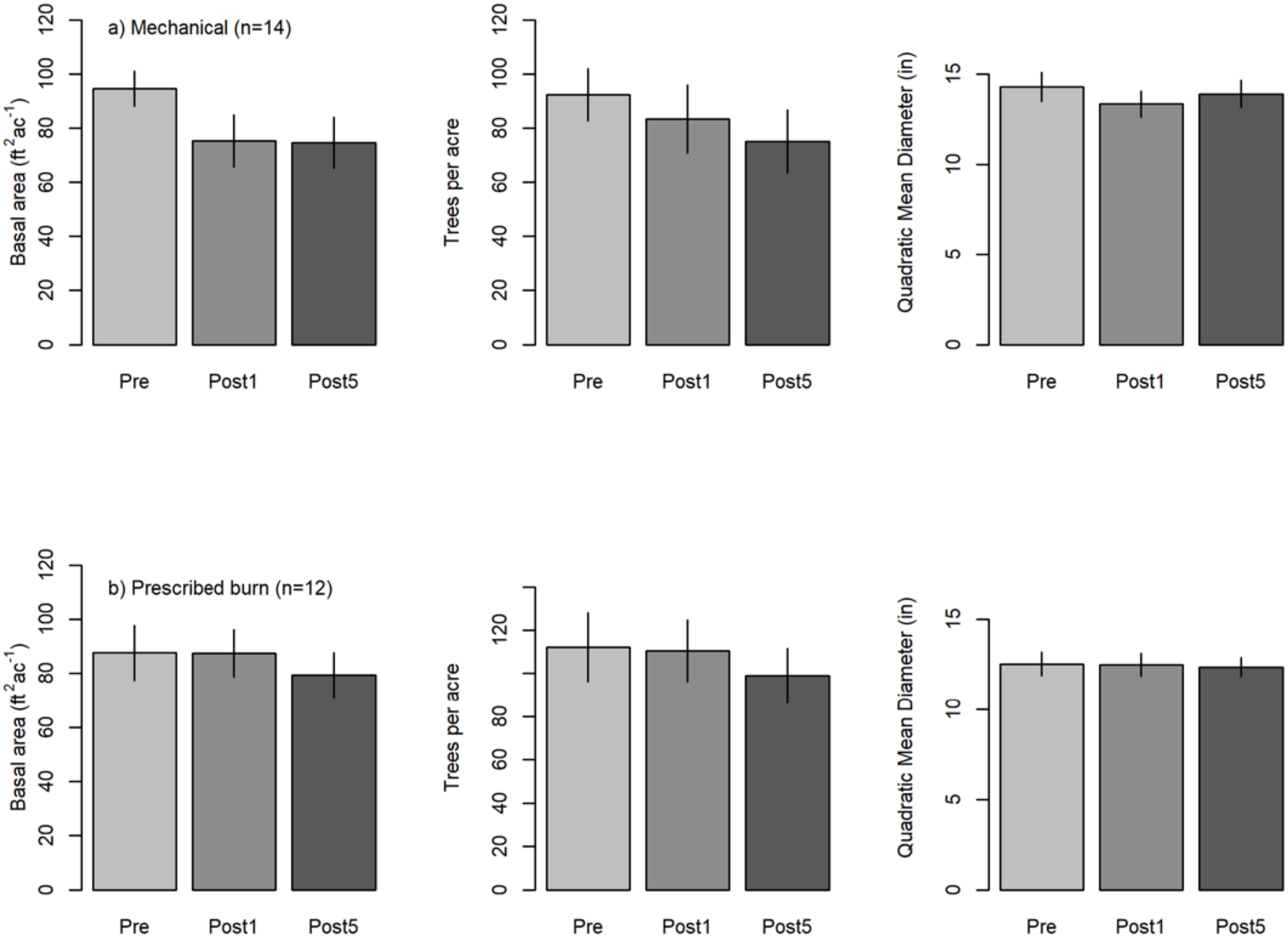

Figure 3. Mean (± standard error) basal area, trees per acre, and quadratic mean diameter pre-treatment within (a) mechanical and (b) prescribed burn treatment areas. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates five- or six-year post treatment or burning monitoring.

maturation of saplings over that time period. Average aspen basal area decreased by 2-3 ft^2ac^{-1} each visit (19 ft^2ac^{-1}, 17 ft^2ac^{-1}, and 14 ft^2ac^{-1} pre-treatment, one-year post-treatment, and five-years post-treatment, respectively). This may be related to a spring frost occurring in 2023 which dramatically impacted aspen for that growing season. One year following mechanical treatment, average basal area of Douglas-fir, spruce species (Engelmann and blue spruce), and subalpine fir were reduced to 14, 15, and 1 ft^2ac^{-1}, respectively. Average Douglas-fir and spruce species basal area remained relatively constant five-years post-treatment (14 ft^2ac^{-1} and 16 ft^2ac^{-1}, respectively). Five-years post-treatment, subalpine fir basal area decreased to 0 ft^2ac^{-1}.

In the prescribed burn areas, aspen, spruce species, and Douglas/subalpine fir showed trends of reduction in basal area. Ponderosa pine saw a slight decrease in basal area five-years post-burning but was largely retained as compared with the reduction or elimination of the other species. Average aspen basal area was 8 ft^2ac^{-1}, decreasing slightly to 7 ft^2ac^{-1} one-year post-treatment and further to 4 ft^2ac^{-1} five-years post-burning. Spruce species average basal area decreased over the course of five years (5 ft^2ac^{-1}, 4 ft^2ac^{-1}, and 2 ft^2ac^{-1} pre-burning, one-year post-burning, and five-years post-burning, respectively). Subalpine and Douglas-fir, already very small components of species composition pre-burning (1 ft^2ac^{-1}), were removed completely from the plots measured by five-years post-burning. Average ponderosa pine basal area remained relatively constant, increasing from 74 ft^2ac^{-1} pre-burning to 76 ft^2ac^{-1} one-year post-burning before decreasing to 74 ft^2ac^{-1} again five-years post-burning. These small changes in average ponderosa pine basal area can likely be attributed to either human error or possible seedling/sapling release and then subsequent die-off following treatment.

Changes in surface fuels

The data collected by the FIP crew in the Lockhart, Cottonwood, Monitor, and Sawmill treatment areas in 2022 and 2023 illustrates a slight decrease in fine woody fuels in both mechanical and prescribed burning areas, with an increase in coarse woody fuels in mechanical treatment areas and variable changes in prescribed burning areas following those treatments (Figure 6, Figure 8). Within mechanical treatment areas, average fine fuels decreased marginally post-treatment (6 tons/acre pre-treatment and 5 tons/ac one- and five-years post-treatment). The 2021 Uncompahgre CFRLP monitoring report (Snyder et al., 2025) illustrated comparable trends of decreased fine fuel loading following mechanical treatments, which is contrary to similar studies (Vaillant et al., 2009; Stephens et al., 2009). These unexpected results might be caused by the Brown's transects (Brown, 1974) utilized for data collection not fully capturing fine fuel loading in the treatment units. The Brown's

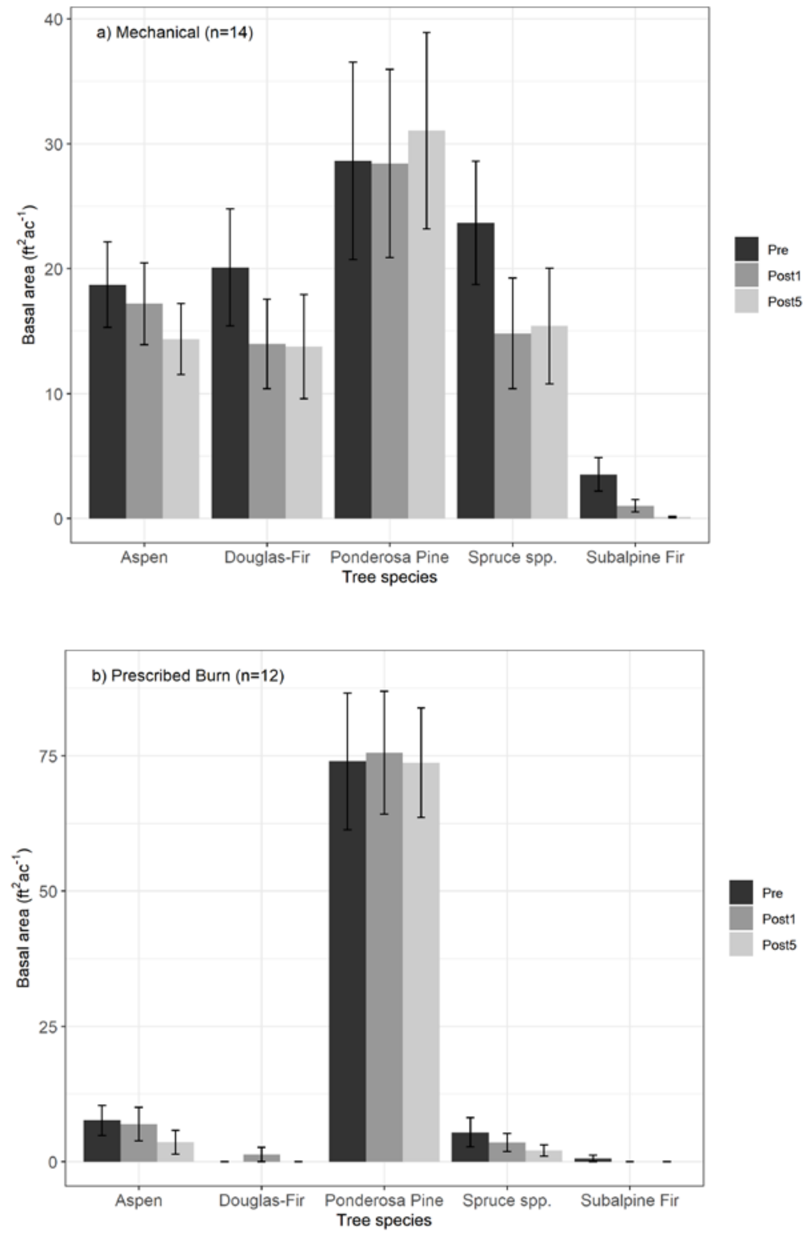

Figure 4. Mean (± standard error) basal area by species within (a) mechanical and (b) prescribed burn treatment areas. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates five- or six-year post treatment or burning monitoring. "Spruce spp." includes Engelmann and blue spruce species.

Figure 5. Comparison photo-points in the Lockhart mechanical treatment area. Pre-treatment conditions are illustrated (left); one-year post-treatment (center), as well as five-year post-treatment conditions (right). In the pre-treatment photo, an opening is illustrated, surrounded by a relatively dense forest comprised of ponderosa pine, Douglas/subalpine fir, aspen and spruce species with abundant growth in the understory. One-year post-treatment, the retention of predominately ponderosa pine and aspen along with some element of spruce/fir species is visible and the canopy has opened considerably; additionally, fine/coarse wood dominates the forest floor with minimal understory vegetation recovery. In the five-year post-treatment photo, a similar composition and structure of overstory trees is the same as one-year post-treatment, but recovery of understory vegetation is evident.

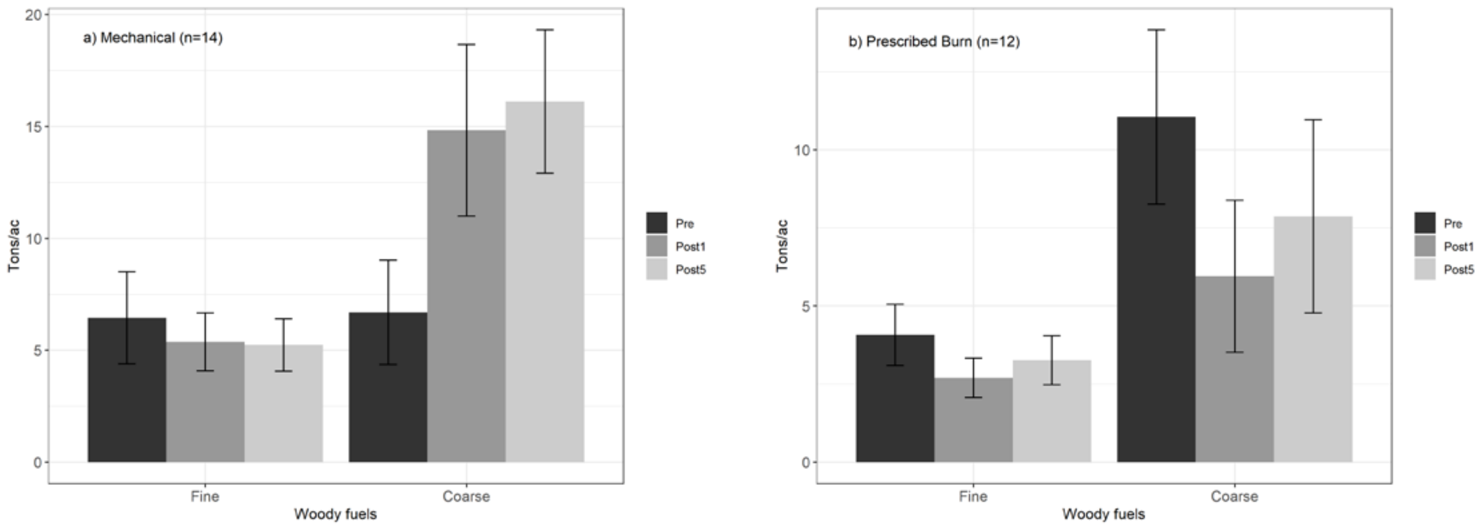

Figure 6. Mean (± standard error) tons per acre of fine (<3.0 inches diameter) and coarse (>3.0 inches diameter) wood within mechanical treatment and prescribed burn areas. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates five- or six-year post treatment or burning monitoring.

transect used in our monitoring protocol is a single 35 foot transect in a 0.6-acre plot, so it is possible that average data collected on these transects across our 26 total plots do not represent average fine fuel loading within these plots. It is also possible that this trend may be caused by differences in species composition between the treatment types combined with management activities, as the mechanical removal of spruce and Douglas-fir may produce different types and amounts of fuels compared with more ponderosa pine-dominated treatment areas. Meanwhile, average coarse fuel loading doubled immediately following mechanical treatment from 6 tons/ac pre-treatment to 15 tons/ac one-year post-treatment and increased further five-years following treatment (16 tons/ac) (Figure 6).

In the prescribed burn area, average fine and coarse wood fuel loading initially decreased following treatment but increased five-years post-treatment. Fine fuels decreased from 4 tons/ac pre-burning to 3 tons/ac one-year post-burning and increased slightly five-years post-burning (3.5 tons/ac). Average coarse wood followed the same trend following burning with a decrease of ~45% between pre-burning and one-year post-burning (11 tons/ac to 6 tons/ac pre- to one-year post-burning) before increasing to 8 tons/ac five-years post-burning. Like these results, prescribed burns have often been observed to decrease surface fuel loading (Schwilk et al., 2009) through fuel consumption one-year post-burning. Tree mortality, either natural or caused by effects of the prescribed burn, may account for the increase in coarse woody fuel loading five-years post-prescribed burn.

Changes in expected fire behavior

Both mechanical and prescribed burning resulted in little change to surface fire risk but did result in a decrease in crown fire risk (Figure 7). We measured this risk using torching and crowning indices as proxies for surface and crown fire risk by using the Fire and Fuels Extension of the Forest Vegetation Simulator (FFE-FVS; Reinhardt, 2003) to analyze fuels data and assess treatment impact on fire behavior. Regional defaults of FFE-FVS used in this analysis are comparable to Remote Automatic Weather Stations (RAWS) 97th percentile conditions for fire weather conditions. Torching index models 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), while crowning index indicates the wind speed needed to move fire from one tree crown to another (a proxy for crown fire risk). When evaluating torching and crowning indices, greater values indicate that higher wind speeds are needed to move fire from the surface of a forest floor into the crown of a single tree (torching index) or to move fire from tree crown to tree crown (crowning index). Knowledge of standard wind speeds in an area can best illuminate local conditions and changes in fire risk following treatments. According to the National Weather Service, the average wind speed in the general area of these treatments was 7 mph, the average highest speed was 39 mph, and the highest gust speed was 51 mph ([US Department of Commerce, 2025](#)).

Within mechanical treatment areas, the modeled torching index was 21 mph pre-treatment and declined slightly to 20 mph one- and five-years post-treatment, respectively. Meanwhile, crowning index was dramatically reduced following mechanical treatment one- and five-years post-treatment. Prior to treatments, crown index was 84 mph, increasing to 112 mph one-year post-treatment and 121 mph five-years post-treatment. These values indicate that crown fire risk in the plots has decreased, most likely due to the amount of basal area reduction (Figure 3) that occurred in these treatment areas.

The torching and crowning indices for the prescribed burn areas did not illustrate strong trends. Modeled torching index values increased slightly from 22 mph pre-burning to 23 mph one- and five-years post-burning, respectively. Modeled crowning index was similar pre- to one-year post-burning (96 mph and 95 mph, respectively) then increased to 100 mph five-years post-burning. Low fine fuel loading in these prescribed burn areas pre-, one-, and five-years post-burning (Figure 7) may illustrate a consistent surface fire risk (torching index). A small amount of tree mortality (Figure 3) and coarse fuel consumption (Figure 7) may contribute to lowered crown fire risk in prescribed burn areas between pre-, one-, and five-years post-burning.

Changes in understory and forest floor cover

The data collected by the FIP crew indicates that within both mechanical and prescribed burn treatment areas there is a recovery of understory vegetation five-years post-treatment or post-burning relative to pre-treatment/burning levels, with varying results for other forest floor characteristics (Figure 5, Figure 8, Figure 9). The understory/forest floor analysis revealed a resurgence of average cover (%) of graminoids, forbs and shrubs five-years post-treatment after an initial decrease one-year post-treatment/burning in both mechanical and prescribed burn plots (Figure 9). These results are similar to a systematic review which showed that, on average, forest understory vegetation decreased in abundance initially following both mechanical and prescribed burning treatments and then increased again within four years post-treatment ([Abella and Springer, 2015](#)). In agreement with the findings of

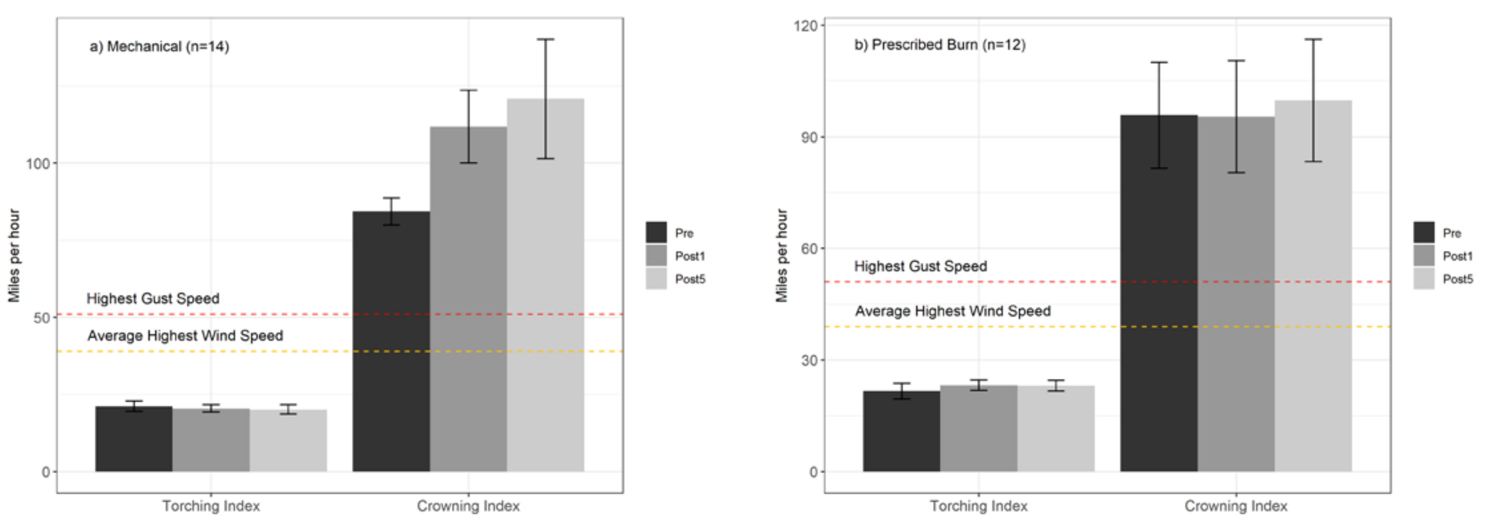

Figure 7. Mean (± standard error) of FVS generated Torching and Crowning Indices within mechanical and prescribed burn treatment areas. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates five- or six-year post treatment or burning monitoring. "Torching 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), while "Crowning Index" indicates the wind speed needed to move fire from one tree crown to another (a proxy for crown fire risk).

Figure 8. Comparison photo-points in the Sawmill prescribed burn area. Pre-burning conditions are illustrated (left); one-year post-burning (center), as well as five-year post-burning conditions (right). The pre-burn photo shows a ponderosa pine-dominated forest with some larger trees (forefront of photo) and numerous smaller trees. The understory is mostly composed of shrubs and graminoids mixed with some woody fuels. The one-year post-burning photo shows evidence of more intense prescribed fire around the trees. Understory and shrub cover has been reduced, and some seedlings and saplings have been partially or fully burned while most of the woody fuels appear unburned. Five-years post-treatment, understory cover has recovered and there are fewer seedlings/saplings visible compared with the pre-burning photo, particularly evident in the middle and right side of the photos.

Abella and Springer (2015), it seems likely that understory plants were impacted by treatments before rebounding over time under a more open canopy. Comparably, Fornwalt and Kaufmann (2014) found that understory cover initially decreased after wildfire before returning to pre-fire levels two to four years after the fire, depending on severity.

Average litter/duff cover (%) decreased in mechanical treatment areas one- and five-years post-treatment, while average litter/duff cover increased in prescribed burn areas slightly one- and five-years post-burning. Average soil cover (%) followed a similar trend in both mechanical and prescribed burn areas, possibly due to needle/leaf drop, especially following the prescribed fires. Average percent rock cover (%) remained relatively constant at low levels (<2%) over time in both mechanical and prescribed burn areas. Average wood cover (%) measurements in this figure include both fine and coarse wood cover collected in seven Daubenmire plots per plot, while the fuel loading measurements shown in Figure 6 were collected using Brown's transects. The trends seen here reflect what was shown in the above surface fuels analysis, with mechanical wood cover (%) increasing one-year post-treatment and staying relatively the same five-years after treatment, while in the prescribed burn treatment areas, average wood cover (%) decreased one-year after treatment and increased slightly five-years post-treatment.

Eighteen Daubenmire subplots (7 subplots normally completed for each plot) were dropped from the understory analysis due to human error. During data quality checks, a number of subplots were found to have ground cover observations that did not sum to 100%. The subplots with a sum exceeding 110%

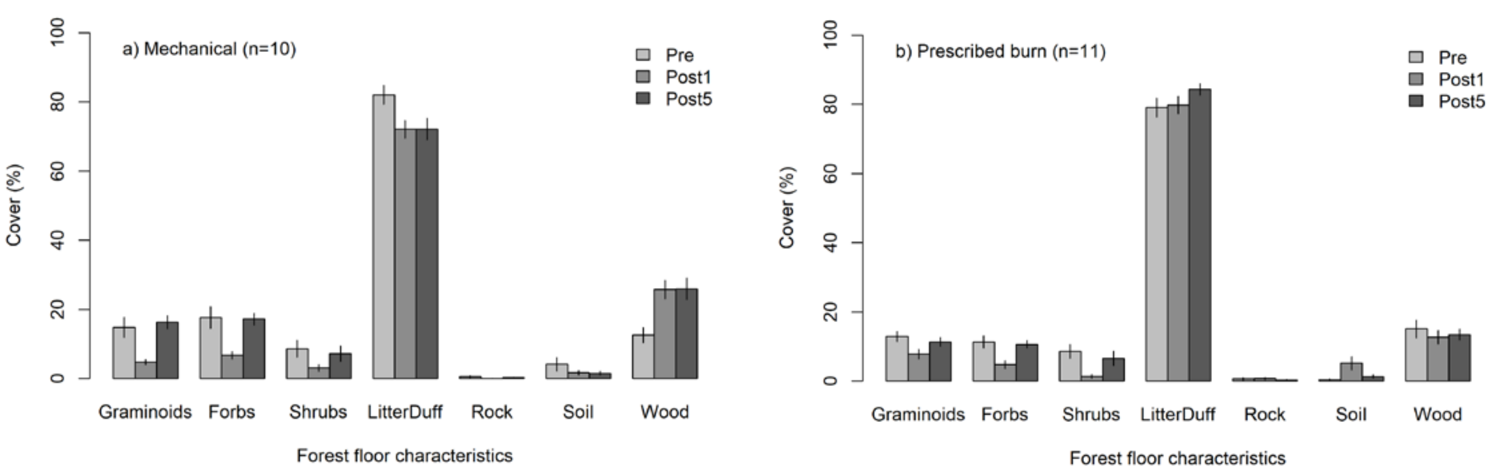

Figure 9. Mean (± standard error) percent cover of forest floor characteristics in (a) mechanical and (b) prescribed burn treatment areas. Cover was ocularly estimated within Daubenmire plots to the nearest 1%. "Pre" indicates pre-mechanical treatment or pre-burning, "Post1" indicates one-year post-treatment or burning and "Post5" indicates five- or six-year post treatment or burning monitoring.

or less than 90% were dropped. Dropped plots account for less than 4% of total ground cover data and further efforts to mitigate this error were pursued in summer 2024. Four mechanical plots and one prescribed burn plot were also dropped from the understory analysis due to a lack of pre-treatment data.

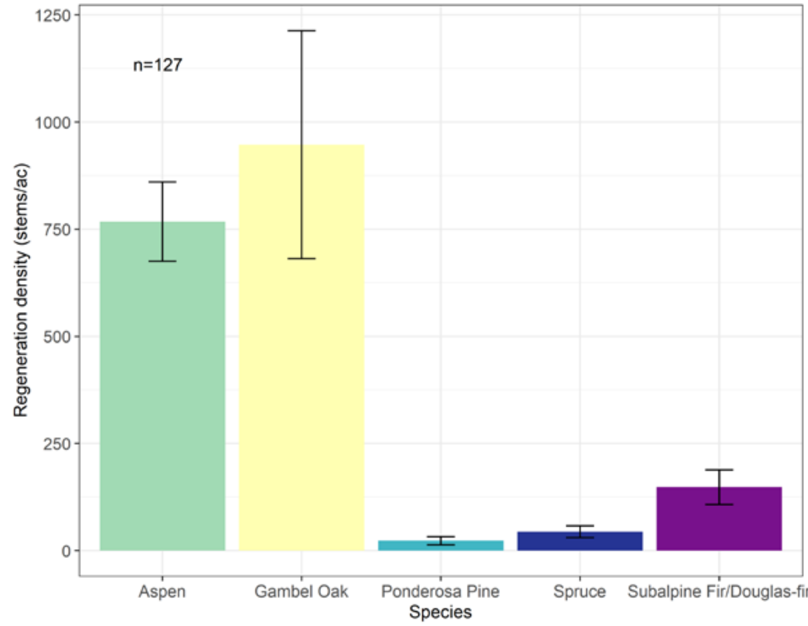

Figure 10. Mean (± standard error) density (stems/ac) of tree regeneration occurring across the entire Escalante and Uncompahgre Mesas treatment areas in uncut, cut, and cut & burned plots.

Tree regeneration

In 2016, 258 regeneration plots were established across the entire project. In 2022 and 2023, 127 of these plots in the Cottonwood, Monitor, Sawmill and 25 Mesa areas were remeasured. Based on the 2022/2023 subset of plots, regeneration in these areas was dominated by Gambel oak and aspen (Figure 10) with densities of 947 and 768 stems/ac, respectively. Subalpine fir/Douglas-fir regeneration was considerably lower at 148 stems/ac. Spruce and ponderosa pine contributed the least to overall regeneration with averages of 44 and 23 stems/ac.

Tree regeneration by species and treatment type

The 127 regeneration plots collected across the Uncompahgre Mesas treatment area in 2022 and 2023 were also divided into three different treatment types. A total of 66 plots were in "cut" areas (areas that experienced mechanical treatments only), 18 were in "cut & burned" (areas that experienced both mechanical and prescribed burning treatments), and 43 in "untreated" areas (areas that had no mechanical or prescribed burning and were "control" areas). For this analysis, only post 5-6-year ("Post5") data was used (Figure 11).

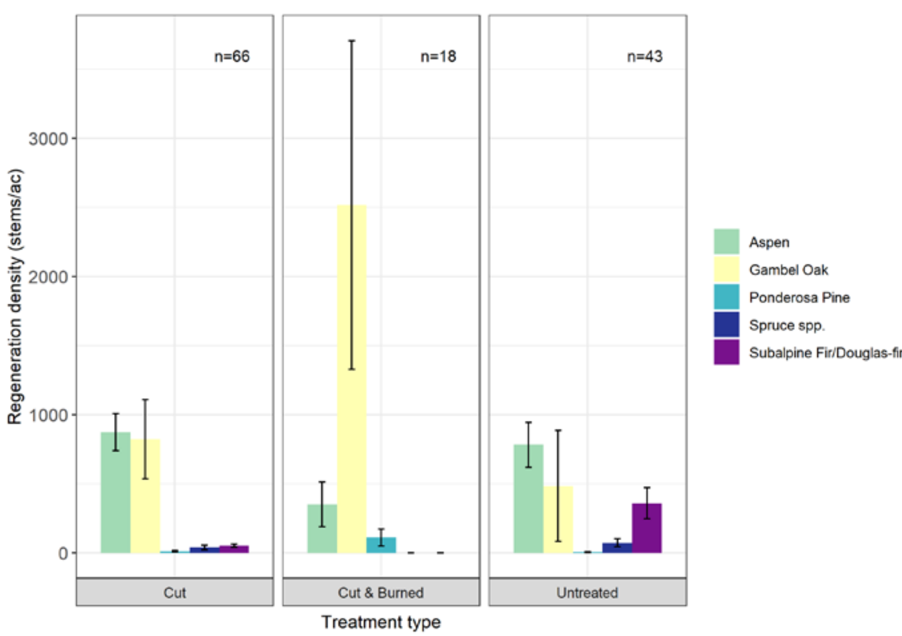

Figure 11. Mean (± standard error) density (stems/ac) of tree regeneration by species and treatment type within untreated, cut, and cut & burned plots in the Uncompahgre Mesas treatment areas in 2022 and 2023.

Across the treatment types, Gambel oak and aspen comprised most of the tree regeneration, though there was also a larger presence of subalpine fir/Douglas-fir in the untreated areas than other conifer species, and ponderosa pine and spruce species did not contribute greatly to overall regeneration. Aspen regeneration was highest in cut only and untreated plots with densities of 873 and 781 stems/ac, respectively, and notably lower in the cut & burned areas at 350 stems/ac. Gambel oak regeneration was notably greater in the cut & burned areas (2517 stems/ac) than the cut only (821 stems/ac) or untreated (484 stems/ac) areas. Ponderosa pine regeneration was greater in the cut & burned areas at 111 stems/acre than the cut only or untreated areas which had densities of 11 and 5 stems/ac, respectively. Spruce regeneration was 72 stems/ac in the untreated plots, 38 stems/ac in the cut areas and 0 stems/ac in the cut & burned areas. Subalpine fir/Douglas-fir regeneration density was 358 stems/ac in the untreated plots, as compared with 52 stems/ac in the cut only plots and 0 stems/ac in the cut & burned areas.

Management implications

Based on the data collected in 2022 and 2023, both mechanical treatments and prescribed burning were successful in achieving many of the management goals for the Uncompahgre CFLRP. Mechanical treatment and prescribed burning decreased total overstory basal area and trees per acre. Five years post-mechanical treatments, basal area and trees per acre were reduced 21% and 18%, respectively, while prescribed burning reduced basal area and trees per acre by 9% and 12%, respectively, five-years post-burning. The primary objectives of these mechanical and prescribed burning treatments were to retain "fire-tolerant" species (specifically ponderosa pine and aspen) and to reduce "fire-intolerant" species such as Douglas-fir/subalpine fir and Engelmann/blue spruce. Both treatment types retained pine in the overstory but were less successful at retaining aspen. However, in spring of 2023 there was a severe frost that, based on field observations, dramatically impacted deciduous species across the Uncompahgre Plateau, potentially accounting for some of this decline. Each treatment type also reduced the basal area of fire-intolerant tree species like subalpine fir, Douglas-fir and spruce species by ~20-50% five-years post-treatment. Though this does indicate that these treatments are retaining more fire-resilient conifer species, potentially higher regeneration rates of species like Douglas-fir and subalpine fir (Figure 11) may create the need for follow-up treatment to maintain desired forest structure and composition. According to the 2022-2023 regeneration analysis, the cut only treatment was more effective than the cut & burn treatment at reducing Gambel oak regeneration and retaining aspen. The cut only and particularly the cut & burned treatment types were more effective at suppressing subalpine fir/Douglas-fir regeneration than what was observed in the untreated plots.

Generally, treatments reduced or maintained modeled fire risk. Mechanical treatments reduced modeled crown fire risk, while prescribed burning did not have a significant impact. Prescribed burning was more effective at reducing fine and coarse woody fuel loading than mechanical treatment but increases in fuels five-years post-treatment may show a need for re-treatment in those areas.

In both treatment types, ground cover abundance of forbs, shrubs and graminoids initially declined following treatment but then recovered to pre-treatment levels five-years post-treatment. This indicates that while the treatments initially had a negative impact on the understory, recovery of understory vegetation (relating to cover (%)) appears to be advancing within five-years post-treatment.

CFRI will be reporting on the upcoming analysis of the complete 15-year UP-CFLRP monitoring dataset and will seek to clarify observed trends over the full course of the Uncompahgre CFLRP projects. Adaptive management of future projects based on the results of this report and similar studies, paired with subsequent ecological monitoring, could continue to improve knowledge of treatment efficacy and longevity in forests of the Uncompahgre Plateau.

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Contact: Marin Chambers, marin.chambers@colostate.edu • cfri.colostate.edu

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Authors: Maggie Parrish, Marin Chambers, and Vausha Snyder

Colorado Forest Restoration Institute, Department of Rangeland Stewardship, Masters of Forest Science, Colorado State University, Fort Collins, CO