National Park Service
U.S. Department of the Interior

Yosemite Fire Effects Monitoring

Pika Wildfire Report - 2023

Effects of Fire Managed for Resource Benefit

Surface fire activity within the Pika fire (2023)
NPS photos/S.Lyon

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Effects of Fire Managed for Resource Benefit

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Introduction

On June 29th, 2023, the lightning ignited Pika fire was discovered northwest of North Dome in Yosemite National Park. At the time of discovery, fire behavior was low with moderate spread potential, along with numerous natural (granite outcroppings) and man-made (well established trails) barriers surrounding the ignition site. These factors, as well as minimal risk to resources, and high fuel moistures from an above average winter snowpack, led park fire management personnel to choose a confine and contain strategy for resource benefit.

Much of the overstory composition within and around the Pika fire footprint consists of California red fir (*Abies magnifica*) and White fir (*Abies concolor*), while the understory consists predominantly of pinemat manzanita (*Arctostaphylos nevadensis*). Additionally, much of the burn area had not experienced fire within the past thirty years. The southern area of the Pika fire contained remnants of the 1978 Creek fire and 1992 Dome fire, while the fire's western perimeter was bordered by the 2015 Tenaya fire. However, the northern and eastern sections of the fire footprint do not contain any known records of recent fire activity.

Management objectives for the incident included managing ecosystems through natural processes to achieve target parameters (Table A1), minimizing duration and magnitude of smoke impacts, implementing best management practices for the preservation of special status and at-risk species and their habitat, and utilizing minimum impact suppression tactics to preserve the character of the wilderness. Operationally, Yosemite Fire Management sought to keep fire north of the Yosemite Valley rim, east of Lehamite Creek, south of Tioga Road, and west of Indian Ridge.

To better understand the effects of fire burning with minimal suppression efforts, the Yosemite Fire Effects crew installed five pre-fire monitoring plots. The plots were located roughly between 6,800 ft and 8,000 ft in elevation in both Red Fir (N = 4) and White Fir/Mixed conifer forests (N = 1). After being established pre-burn, the plots were revisited immediately post-burn (four to six days after 100% containment) and then again one year post. All plots burned at low to moderate fire severity according to field observations (Appendix B) and Normalized Burn Ratio values from remote sensing.

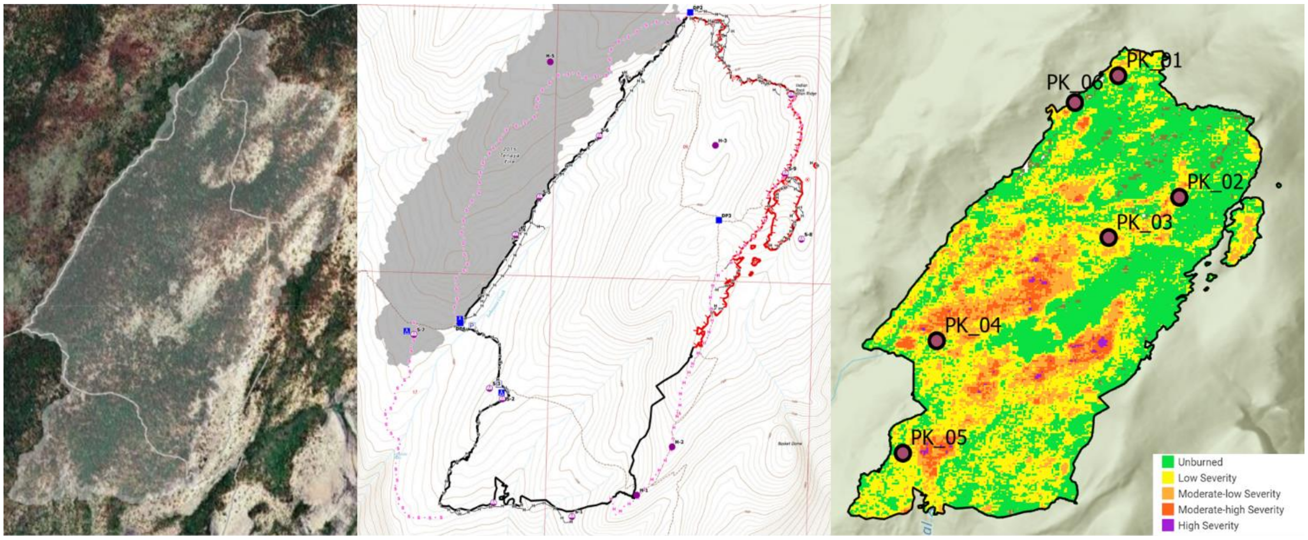


Fig 1. Pika Maps. A) Post-Fire Satellite Imagery of Burn Scar. B) Operations Map as of 7/31. C) Normalized Burn Ratio (dNBR) Severity Map. Estimated burn severity classes: High Severity – 0.33%, Moderate-high – 4.72%, Moderate-low – 15.4%, Low Severity – 39.2%, Unburned – 39.2%. Sentinel 2 Satellite Imagery used for A) and burn severity estimations in C). Burn severity map was created in Google Earth Engine using the UN-SPIDER Recommended Practice.

Fire Observations

Fire Behavior

The primary fuel type throughout the entirety of the burn area was timber understory (TU5), as well as a secondary brush component (Scott & Burgan 2005). There was also moderate to heavy concentrations of coarse woody debris patchily distributed throughout the burn area. Additionally, the terrain was comprised of large areas of granite, where fuel continuity and fire behavior decreased.

Upon discovery, fire behavior was minimal with smoldering, creeping, and backing observed throughout the previously described fuel types. This low exhibition of fire behavior throughout the early stages of the incident can be attributed to higher fuel moistures and higher relative humidity (RH). As a high-pressure system moved in around July 14th, temperatures increased and RHs dropped. Warmer and drier conditions led to increased fire behavior, with single tree torching, flanking, backing and some short-range spotting observed. Additionally, hand firing along control lines occurred at this time, aiding the increase in fire behavior.

Following the week of increased fire weather, fire behavior began to decrease as temperatures dropped and RHs increased. Creeping, backing, and flanking was again observed during the days surrounding July 20th, with areas of heat persisting along handlines and continued interior fuel consumption. Fire behavior continued to remain low in the following weeks, as temperatures remained below the seasonal average and thunderstorms brought light precipitation.

Fig 2. Pika Fire Behavior. Aerial photo of the Pika fire backing through timber understory west of Indian Ridge. NPS photos/S.Lyon

Smoke Observations and Impact

Consistent with the expectation of minimal smoke impacts (PIKA Incident Decision), air quality in the Yosemite Valley generally remained in the moderate range, though there was significant impact on July 16th (see Fig 3). Smoke was remotely monitored with a camera located near Glacier Point from July 13th through July 19th ([Pika Fire July 2023 Timelapse]).

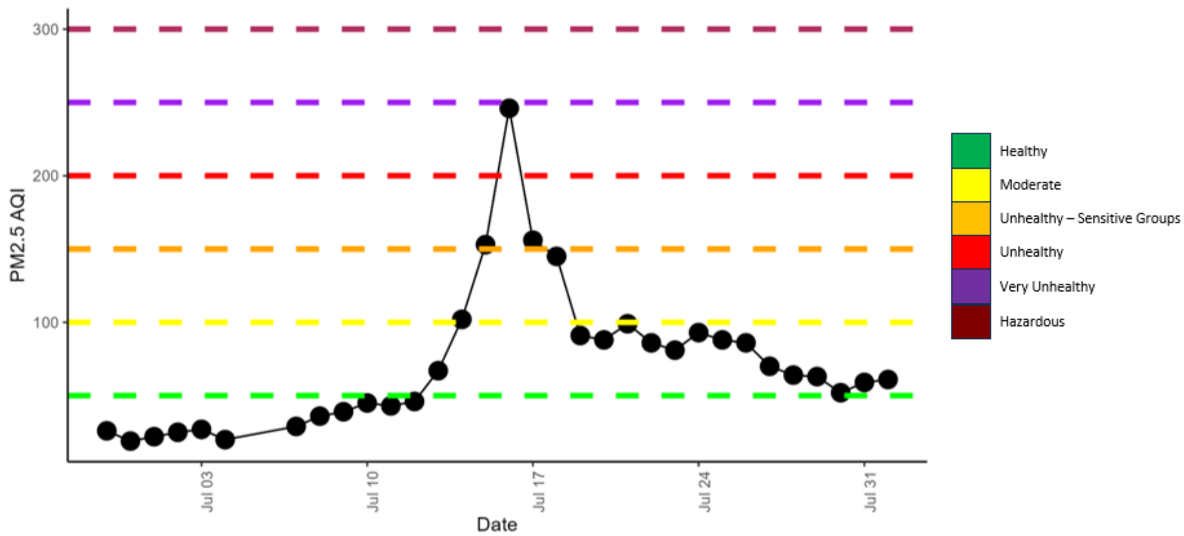


Fig 3. Pika Smoke Impact on Yosemite Valley. Data recorded at the Yosemite Village Welcome Center and accessed from World Air Quality Historical Database.

Narrative Observations

July 13th: Starting around 1100, white to light gray smoke observed dispersing to about 2000’ above ground level (AGL) and moving towards the NE. At 1900 the wind began to shift, pushing the smoke to the SW. An inversion occurred and remained until approximately 0900 on July 14th.

July 14th: Similar smoke behavior was seen as the previous day until 1430, at which point the color darkened from white/light gray to dark gray and dispersal height was observed to raise to approximately 3500’-4000’ AGL. The column appeared much thicker and stayed this way until the afternoon wind shift and evening inversion began to set in around 1930.

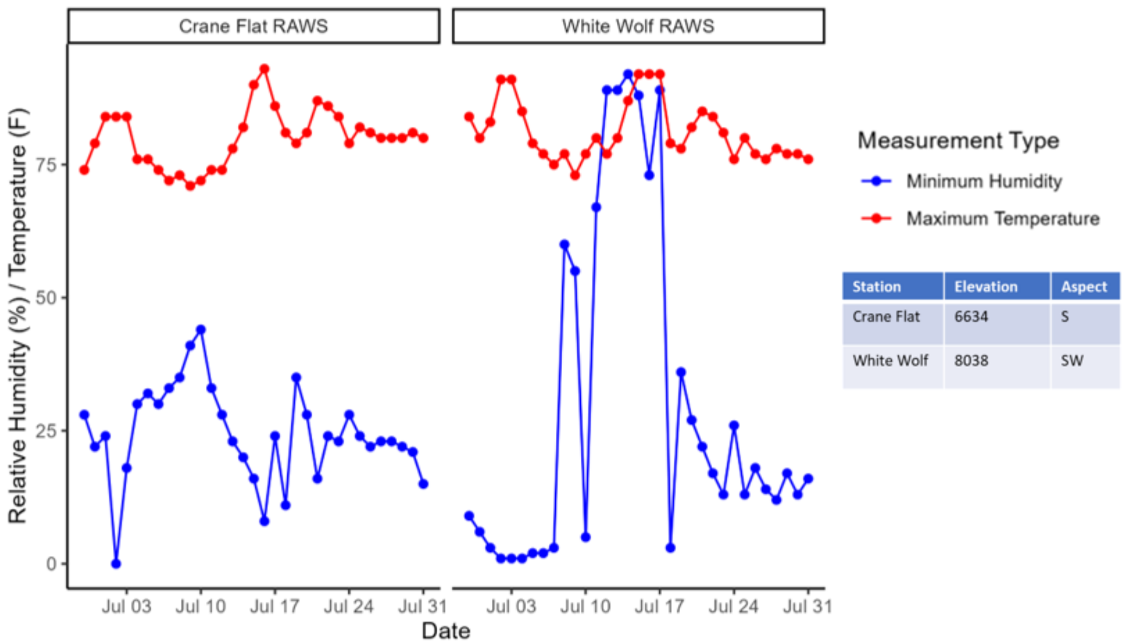
July 15th: Smoke behavior followed a similar trend with a darker color and larger column beginning around 1430 and lasting until approximately 1930.

July 16th: The smoke behavior was similar to July 13th (white to light gray smoke).

July 17-19: Smoke gradually became much less dense, lighter in color, dispersed up to 2000’ AGL, and was pushed to the NE during the day and the SW during the night.

Weather

While on-site weather observations records were not preserved, data from nearby RAWS weather stations at White Wolf and Crane Flat indicate temperatures reaching into the 90s and RHs below 20% during the burn period. Additionally, thunderstorms were observed over Yosemite National Park in the weeks following August 10th and produced 0.5” of rain over the fire area.



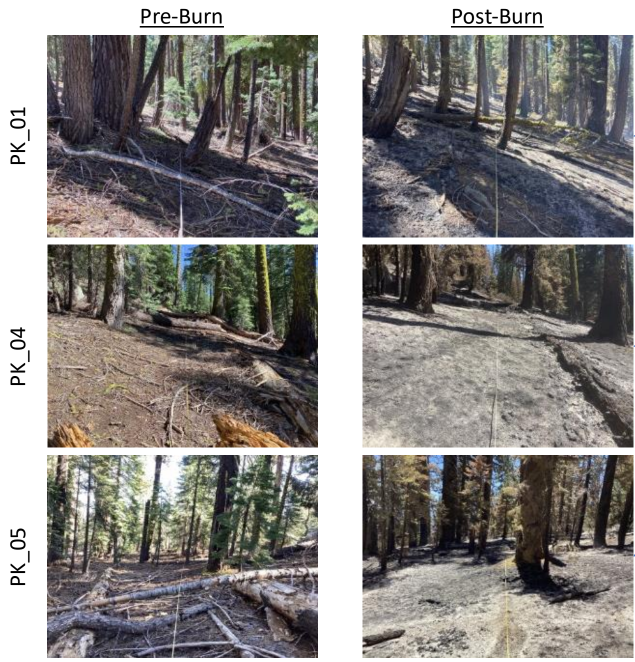
Station	Elevation	Aspect
Crane Flat	6634	S
White Wolf	8038	SW

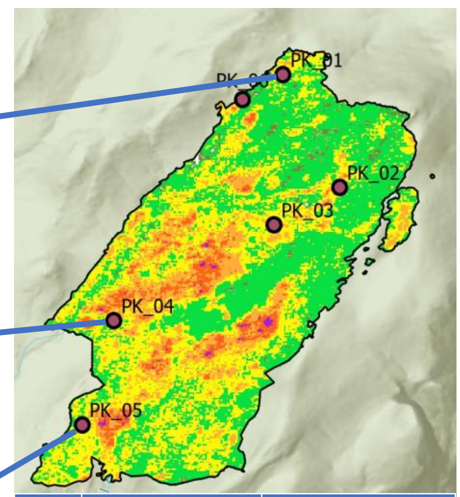
Fig 4. Pika Weather Conditions. White Wolf is both level in elevation with and more proximally located to the fire than Crane Flat. However, note the White Wolf RAWS humidity measurement error from July 10 – July 17. Both stations are located on a 26-45% slope.

Fire Effects

Burn Severity

Overall, managers achieved low to moderate severity fire effects over the vast majority (> 95%) of the burn footprint (Fig 1c). While the number of field plots with both pre- and post-fire data was limited by resources and operational tempo (N = 5), all plots were in low to moderate severity areas and thus likely to provide a reasonable picture of the overall fire impact on the forest (Fig 5). Field estimates of fire severity tended towards higher severity ratings than the corresponding severity estimate (dNBR) made using satellite data (Fig 5 table). However, given that our field-based assessments integrate soil and understory burn severity estimates, while dNBR methods are biased towards the vegetation component, this discrepancy may be explained by a greater impact of the ground fire on soils/understory than the canopy (Fig 5 pre/post photos). Most plots were established in the red-fir forest type, with only one plot (PK_05) dominated by a mixed conifer overstory, consistent with distribution of these vegetation types within the burn footprint.





Plot	Severity Class (Composite Burn Index)	Severity Class (Normalized Burn Ratio)
PK_01	Low	Low/Unburned
PK_02	Unburned	Low
PK_03	Moderate	Low
PK_04	Moderate	Low/Moderate-Low
PK_05	Moderate	Low
PK_06	Moderate	Low

Fig 5. Representative Photo Plots. Consistent with the overall distribution of fire effects, all plots experienced unburned, low, unburned, or moderate fire severity.

Understory Effects

Plot-based assessments of fuel loading suggest the fire effectively decreased available fuels across all classes, from duff to thousand-hour fuels (Fig 6). While sample size constraints prevent us from drawing statistically rigorous conclusions in all cases (such as 1000HR fuels), clear declines in fuel loading relative to pre-fire conditions were observed (see also Fig 5 pre/post photos). Additionally, one-year post-fire samples exhibited increases in the duff, litter, and fine woody debris components, but these increases were not sufficient to return ground fuel loading to pre-fire levels (Collins et al. 2016).

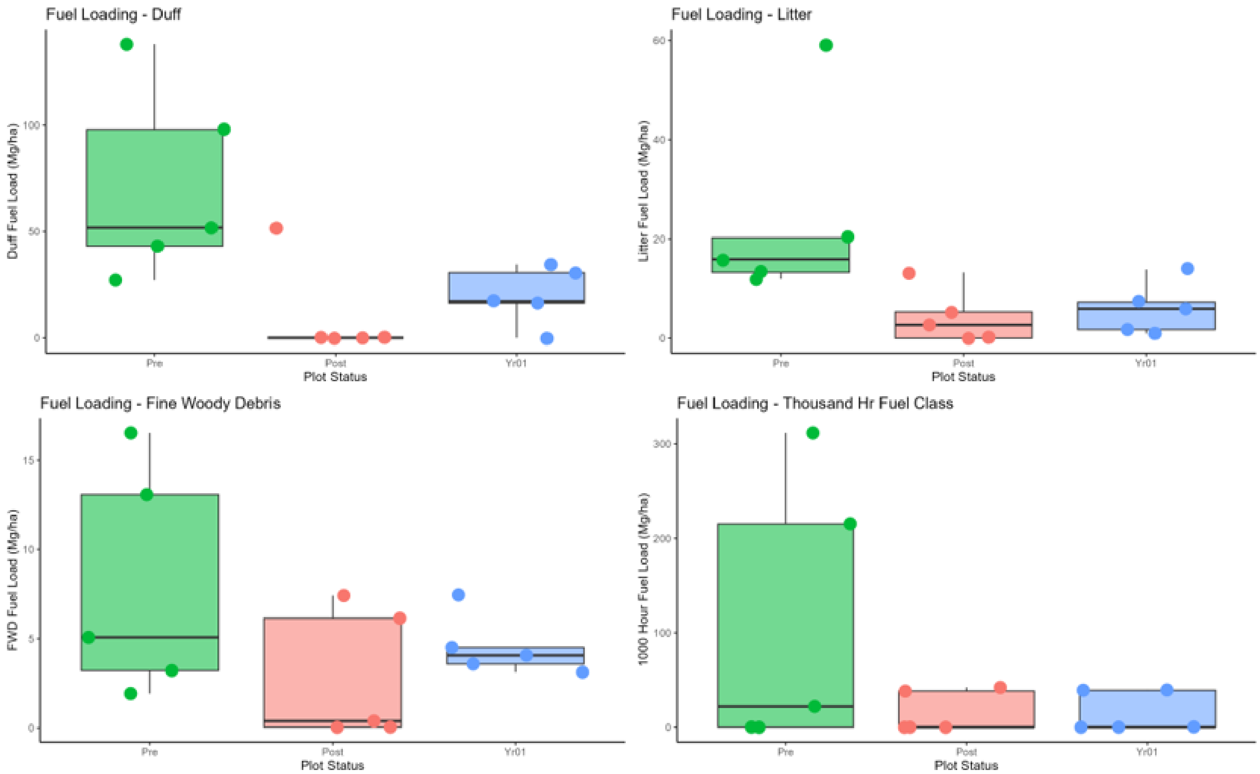


Fig 6. Pika Fuel Loading. Estimated fuel loads in Mg/ha for duff (top left), litter (top right), fine woody debris (bottom left), and 1000HR (bottom right) ground fuel classes.

Overstory Effects

Consistent with low to moderate severity fire, tree mortality largely occurred in saplings and medium-sized (<31 in DBH) trees, while large, pre-park establishment trees (>31 in) remained largely unscathed (Fig 7a). While our sample size is too small to make any final conclusions, preliminary evidence suggests the fire produced a decline in tree density consistent with management objectives, especially in terms of reducing the density of medium-sized (4-30in DBH) trees (Fig 7b, Table A1).

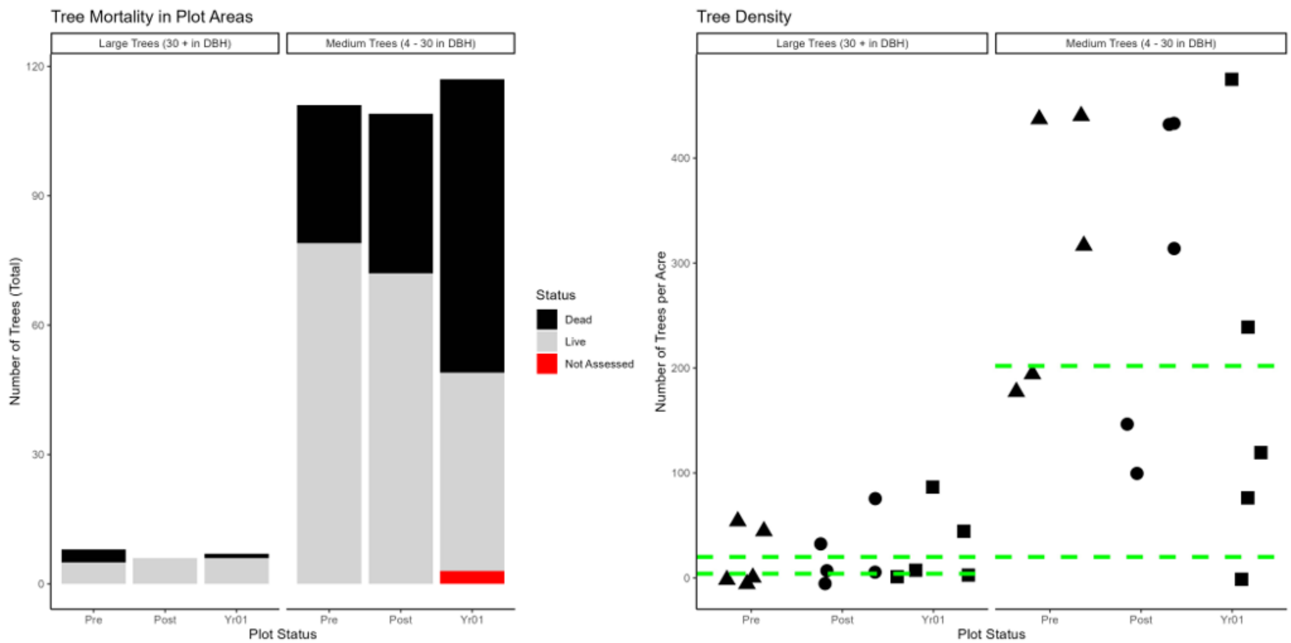


Fig 7. Pika Tree Characteristics. Left: Total number of live and dead trees counted in all plots during each sampling bout. **Right**: Number of trees per acre, with target range for tree density for Red Fir forests indicated with dashed green lines. Size classes are based on Yosemite Fire Management Plan objectives.

Conclusion

The Pika fire reached 100% containment on July 30th, 2023, with a total of 841 acres burned. This fire largely achieved its management goals, re-introducing low-to-moderate severity fire into a landscape that had not burned in approximately thirty years (PIKA Incident Decision). Firefighters safely reduced ground fuels and tree density while generally minimizing smoke impacts to values such as Yosemite Valley. While more monitoring plots would be ideal, data collected to date suggests the fire had a measurable, positive ecological impact that remains observable one year later.

References

Literature Cited

Collins, B. M., J. M. Lydersen, D. L. Fry, K. Wilkin, T. Moody, and S. L. Stephens. 2016. Variability in vegetation and surface fuels across mixed-conifer-dominated landscapes with over 40 years of natural fire. Forest Ecology and Management 381:74-83.

Scott, Joe H.; Burgan, Robert E. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p.

"PIKA Incident Decision." *Wildland Fire Decision Support System*, 5 July 2023.

Appendix A. Restoration Targets from the Yosemite Fire Management Plan

Table A1. Target conditions by vegetation type for restoring plant communities by reintroducing the natural fire regime in Yosemite National Park. Restoration target conditions are based on structural features of vegetation types.

Species	Fuel Load	Gap Distribution	Density & Composition	FRI	Fire Severity
Red Fir	% of Area 1-25% = 5-30 tons/ac 30-70% = 30-60 tons/ac 5-20% > 60 tons/ac	0.1-1 ha = 70-95% 1-10 ha = 5-30% 10-100 ha < 1% *and* 0-1% of the gaps < 1 yr old	20-202 trees/acre < 31.5 inches 4-30 trees/acre > 31.5 in *and* Composition is 70-100% fir + 0-30% pine	9-92 yr Median= 30	Low 30-60% Mod 20-40% High 0-15%
White Fire/Mixed Conifer	% of area 20-40% = 5-30 tons/ac 20-50% = 30-60 tons/ac 5-20% > 60 tons/ac	0.1-1 ha are 75-95% 1-10 ha are 5-25% 10-100 ha < 1%	20-89 trees/acre < 31.5 in 4-20 trees/acre > 31.5 in *and* Composition is 40-65% fir	3-35 yr Median= 8	Lower slopes: Low 60-100% Mod 5-35% High 5-10% Upper slopes: Low 0-35% Mod 20-35% High 30-90%

Appendix B. Fire Effects Sampling Protocol (FX Protocol)

This protocol is designed to capture fire-related changes in forest condition, biodiversity, and fire severity in an efficient sampling manner. It is also intended to be modular, where certain components may be omitted if applicable.

Plots will consist of a circular plot with a 12.62 m radius centered at plot origin, covering 0.05 hectares. There will be two transects running South to North and West to East, crossing perpendicularly at plot center. The South to North transect is Transect 1. The West to East transect is Transect 2. Each transect will span the diameter of the plot (25.24 m).

- **Terrestrial LiDAR Scanning (TLS):** TLS data will be collected using a Leica BLK360. Single scans will be collected from the center of the plot.
- **Plot Photos:** After the plot transects have been setup, use the iPad to take a photo along the N to S transect.
- **Aspect:** Cardinal and ordinal direction that the predominate slope of plot faces.
- **Elevation:** Elevation of plot center.
- **Slope Percent (%):** Slope from highest to lowest points of plot.
- **Overstory Trees:** All overstory trees (greater than 10 cm diameter at breast height (DBH)) will be assessed within the 12.62 m plot. All trees with a height reaching at least 1.37 m from ground and a DBH greater than 10 cm are considered overstory, including dead trees and snags. The sequence of tree measurements should begin at plot center, facing north, and proceeding eastward in a circle working outward. The following information is recorded: species, status (live, flagging, scorched, or dead), DBH, height to nearest meter for first two live trees of each species, and height of Live Crown Base (CBH) for first two live trees of each species to the nearest meter.
- **Saplings**: Within quadrants 1 and 3, tally saplings of each tree species. Saplings are any tree species greater than 137cm in height and less than 10cm DBH. Tally live and dead trees for each genus.
- **Seedlings:** Seedlings are any tree species less than DBH height (1.37m). Seedling counts are stratified by genus and live or dead status. They are tallied within all four quadrants.
- **Understory Composition:** Record the dominant or codominant understory species (up to two species) in the plot.
- **Understory Cover and Canopy Cover:** Conduct a point-intercept transect from 1 to 25m along each of the two transects. Record measurements every meter starting at 1m to 25m, for a total of 25 points on each transect (50 points per plot). Canopy cover can be recorded concurrently along the point-intercept transects at every 2 m mark. Both live and dead canopy are counted.

- **Surface Fuels:** Surface fuels are quantified with a Brown's Line sample along each of the two transects starting 2 meters from the transect end. Along the transect, tally the number of particles within each fuel class using a standard go-no-go gauge. 1-hr fuels are less than ¼ inch diameter. 10-hr fuels are less than 1 inch diameter. 100-hr fuels are less than 3 inches diameter.

- **Ground Fuels:** Measure the depth of litter and duff in centimeters at 4m and 14m on **both** transect tapes.

- **Fuel Bed Depth:** Measure the height of the tallest plant that crosses the transect between the following locations: between 4m and 4.5m; between 14m and 14.5m. Measure plant height from the top of the litter layer. Record the height to the nearest centimeter.

- **Soil Moisture:** Record soil moisture at 4m and 14m with the soil moisture probe.

- **Fire Severity:**

   a. **Soil burn severity**: Looking at the entire plot, estimate surface soil burn severity into low, moderate, or high based on the below classification.

   b. **Crown scorch percent**: Record percent of scorched needles/leaves on all trees within the plot. Ocular estimates can be binned by 25% increments: Record "1" = 0-25%, "2" = 26-50%, "3" = 51-75%, "4" = 76-100%.

   c. **Average maximum char height:** Record average maximum char height (m) across overstory trees within the plot. If char is uneven around the bole, use the maximum height along the bole. This can be a rough eye estimate. Record to the nearest meter.

   d. **Understory burn percent**: Record percent of plot that is burned to any degree below DBH. This includes charred plant material and ground covered in ash. Ocular estimates can be binned by 25% increments: Record "1" = 0-25%, "2" = 26-50%, "3" = 51-75%, "4" = 76-100%.

   e. **Overall Plot Burn Severity:** Plot level assignment of unburned, scorched, low, moderate, or high burn severity based on FMH severity classifications:

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Author’s Contributions
All authors contributed equally to this document.