Bluff Mesa & South Big Bear Prescribed Fire Monitoring

Wildfire is a natural process in mixed conifer and yellow pine forests. A short fire return interval averaging 11 to 16 years is important for reducing fuel loads and moderating the potential for high severity wildfire. Similar to other frequent fire forests in California, much of the Bluff Mesa and South Big Bear project areas have not experienced fire in over 100 years and are considered severely departed from the historical fire regime (Fig 1). Fire exclusion can result in vegetation and fuel densification and, when combined with wildfire, these conditions pose threats to forest resilience and community protection. The reintroduction of fire into these fire deficient ecosystems can reduce the risk of catastrophic wildfire to surrounding communities and natural resources.

A monitoring program was established within the Bluff Mesa and South Big Bear project areas to evaluate the effects of prescribed fire on vegetation and fuels. The primary goal of this monitoring is to determine whether the use of prescribed fire is sufficient in meeting forest health and community protection objectives as outlined in burn plans and environmental decision documents. We tracked the effectiveness of prescribed fire on 2 recently burned units, Unit H (Bluff Mesa EA) and Unit 86 (South Big Bear EA) and report the findings below.

Methods:

- Seventy monitoring plots were established across Bluff Mesa and South Big Bear throughout 2016-2021.
- Burn units H and 86 were subjected to broadcast burning in 2020 and 2021, respectively (Fig 1). Following fire, we revisited a subset of plots (5 plots in Unit H; 6 plots in Unit 86) that fell within the burned units and conducted Common Stand Exams, including Brown's Transects. Both units were monitored the year following fire, and Unit H was resurveyed two years post-fire to inform the extent to which vegetation and fuels conditions change over short time periods following fire.
- Burn intensity was quantified using tree characteristics, including bole char, crown scorch, and crown torch. Changes in pre and post-fire condition were calculated by averaging fuel and tree characteristics for all of the plots within a burn unit.

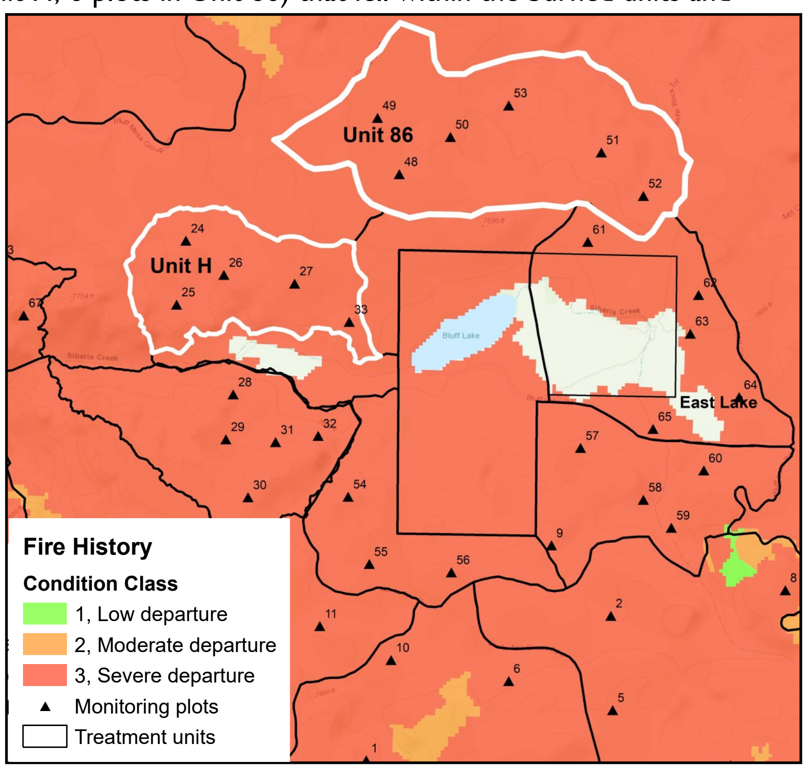

***Figure 1**. Burn history in the vicinity of Bluff Mesa and South Big Bear. Colors indicate condition class and departure from historical fire regime. Treatment units are outlined in black and recently burned units (H & 86) are outlined in white.*

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Results and Discussion

While the total tree density between the two burn units were similar prior to prescribed fire (42-45 trees per acre), the *pre-burn* composition and size of the trees in Unit 86 and H differed. Unit 86 was dominated by small diameter trees (<24” dbh), with white fir comprising a large proportion (41%) of the composition. Unit H on the other hand had a similar number of small and large diameter trees, with a low abundance of shade tolerant white fir (14.3%). Unit 86 also had 3x more shrubs than Unit H.

Burn intensity reflected the differences in the pre-fire condition, with Unit 86 exhibiting greater fire effects than Unit H (Fig 2). The pre-fire vegetation and fuel condition coupled with differences in antecedent rainfall (2020-2021 growing season had 1/2 of the average yearly rainfall), weather, and live fuel moisture likely contributed to differences in fire effects between the two burn units.

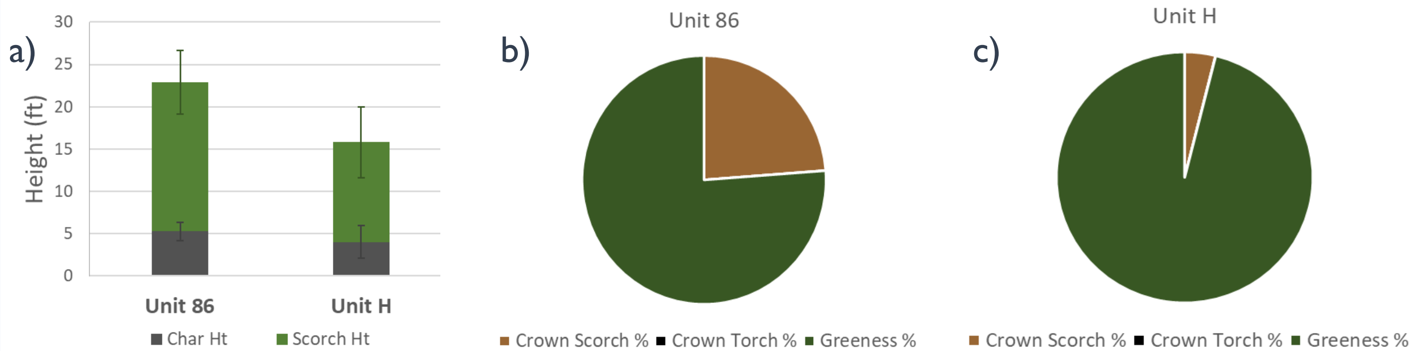

***Figure 2**. a) Bole char (gray) and crown scorch (green) height (ft). b) Twenty-four percent of the tree canopy was scorched (brown) from prescribed fire (Rx fire) in Unit 86 c) Four percent of the tree canopy was scorched (brown) from Rx fire in Unit H.*

To evaluate whether NEPA and burn plan objectives were met, the field monitoring data have been divided into three subsections:

I) Tree density and composition
II) Vegetation cover
III) Fuel structure

I) Tree density and composition

Objectives related to tree density and composition include:

- Limiting overstory tree mortality to less than 10% (SBB Burn Plan),
- Encouraging the dominance of large diameter trees (Bluff Mesa EA),
- Maintaining 3 (Bluff Mesa EA) or 4-8 (SBB EA) of the largest snags per acre.

LIVE TREES				
# per acre *(% of total)*	**Year**	**PIJE**	**ABCO**	**TOTAL**
Unit H	Preburn	36 *(86%)*	6 *(14%)*	42
	Postburn Yr1	34 *(85%)*	6 *(15%)*	40
	Postburn Yr2	34 *(85%)*	6 *(15%)*	40
Unit 86	Preburn	26 *(59%)*	18 *(41%)*	45
	Postburn Yr1	23 *(58%)*	16 *(42%)*	40

***Table 1**. Total number of live trees (>4” dbh) per acre in each of the burn units before and after Rx fire by species. PIJE = Jeffrey pine, shade intolerant; ABCO = white fir, shade tolerant. Numbers inside the parenthesis represent the proportion of trees that are PIJE vs. ABCO.*

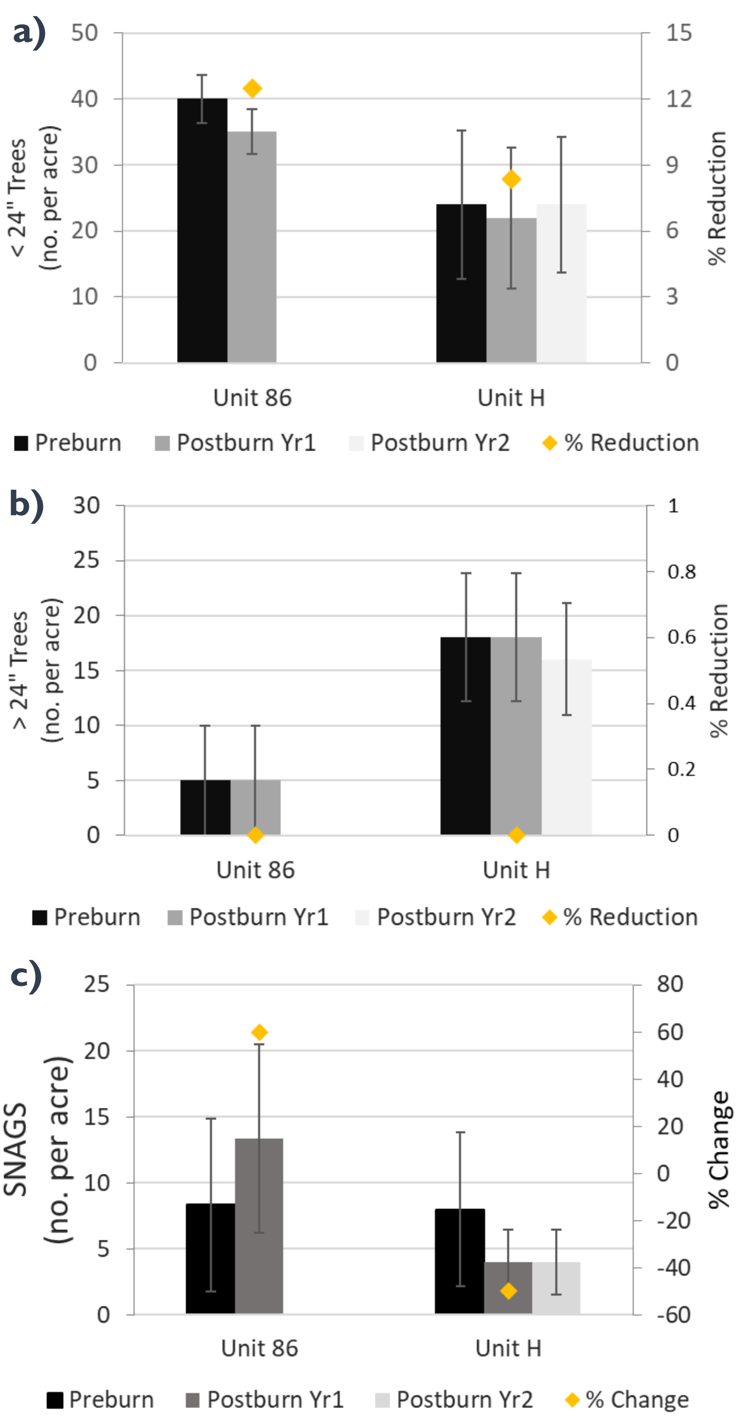

Figure 3. a) *Density of live trees between 4-24" dbh. Black bars represent pre-fire density and grey bars represent density the year following Rx fire. The yellow diamond is associated with the Y-axis on the right and represents the percent of trees lost between the pre and post fire surveys.* ***b)*** *The density of large diameter trees (>24" dbh) pre and post– Rx fire did not change.* ***c)*** *Snag (>4" dbh) density increased with Rx fire in Unit 86 as the result of mortality of small diameter trees (see Fig 3a). Snag density declined in Unit H due to consumption of snags during Rx fire.*

Major findings (Tree density & composition)-

⇒ Burn units were dominated by PIJE prior to Rx fire and PIJE dominance was maintained following fire.

⇒ Within the monitoring plots, no large diameter trees (>24" dbh) were lost to Rx fire thereby meeting the goal of overstory tree mortality not exceeding 10%.

⇒ Mortality of small diameter trees (<24" dbh) did not exceed 13%, and the loss of small diameter trees was consistent with the goal of promoting trees with a large diameter.

⇒ Pre-burn snag density fell within the desired conditions (4-8 snags per acre). On average, snags increased in Unit 86 as the result of trees being killed by fire. Unit H experienced a decline in snag density due to consumption from the burn.

⇒ Tree regeneration was improved following fire in Unit H. Seedlings of the shade intolerant Jeffrey pine increased 5x and occupied 3x more plots in the year following fire compared with pre-fire. The abundance of the shade tolerant white fir remained stable. Unit 86 had little seedling recruitment during the survey period.

Table 2 *(below). Seedling recruitment of Jeffrey pine (PIJE) and white fir (ABCO) within the burn units. Numbers represent live seedlings per acre and numbers within ( ) indicate the percent of plots with seedlings present. Given the small number of seedlings within Unit 86, it may be beneficial to increase the survey area for seedlings in the future.*

	PRE			POST YR1			POST YR2		
Unit	PIJE	ABCO	TOTAL	PIJE	ABCO	TOTAL	PIJE	ABCO	TOTAL
H	41.8 (20%)	14 (20%)	55.8 (20%)	251.2 (80%)	14 (20%)	265.1 (80%)	139.5 (40%)	14 (20%)	153.5 (40%)
86	0	0	0	0	11.6 (17%)	11.6 (17%)	N/A	N/A	N/A

II. Vegetation cover

Objectives related to vegetation cover include maintaining canopy cover above 50% (SBB and Bluff Mesa EAs). The SBB burn plan recommends the top-kill of >50% of resprouting shrubs, while the SBB EA suggests maintaining shrub cover between 30-50% for treatment units that fall within the 'threat; WUI zone'. These conditions may be consistent with one another if the initial shrub cover, prior to Rx burn, is high (60-100%).

TREE COVER		Gap Analyzer Cover Estimate (%)	
		Range	AVG
Unit H	Preburn	N/A	N/A
	Postburn YR1	2.5 - 62.3%	25.6%
	Postburn YR2	2.0 - 51.6%	19.7%
Unit 86	Preburn	0.2 - 44.2%	22.3%
	Postburn YR1	0.2 - 35.2%	21.9%

***Table 3**. Tree cover estimated through photo interpretation using Gap Analyzer Software. The range of cover values highlight the heterogeneity in cover across the burn units. The Gap Analyzer protocol was not used to assess pre-burn conditions in Unit H, but there was a decrease in cover from year 1 to year 2 following fire. This may be the result of needle cast. In Unit 86 canopy cover dropped slightly following fire. Ocular cover estimates were also taken and are correlated with the measurements presented here.*

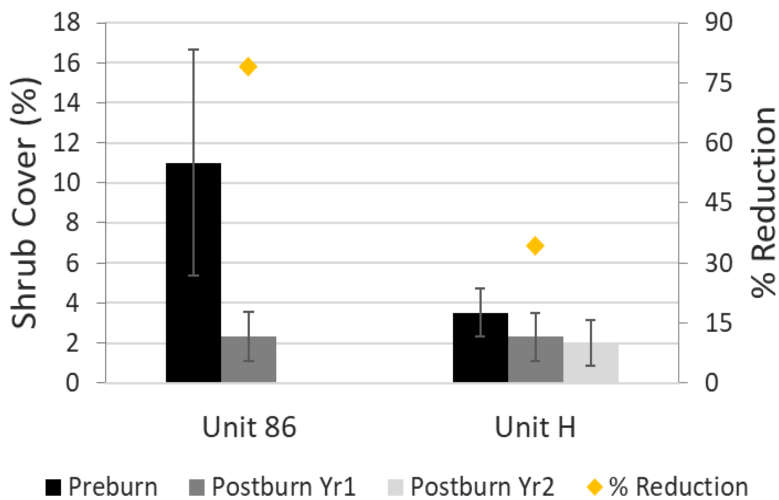

***Figure 4 (right)**. Shrub cover prior to the Rx burn was heterogenous, especially in Unit 86 (range: 0-38%). Shrub cover declined post-fire and became more homogenous (range: 0-7%). The average reduction in shrub cover was 75% for Unit 86 and 34% for Unit H. Two years after fire, cover remained low and had not returned to the pre-burn conditions.*

***Figure 5 (below)**. Photos of Plot 50 in burn Unit 86. This plot had the highest initial shrub cover (38%) of all the plots surveyed (left panel) and was dominated by manzanita (Arctostaphylos patula), snow bush (Ceanothus cordulatus) and chinquapin (Chrysolepis sempervirens). Following the burn, shrub cover was reduced to 0.5% (right panel).*

Major findings (Vegetation cover)-

⇒ Pre-burn canopy cover varied greatly from plot to plot highlighting the heterogeneity in cover throughout the burn units. Landscape level heterogeneity remained following Rx fire, with a slight reduction in overall canopy cover.

⇒ Shrub cover was also heterogenous across the burn units, this was especially evident in Unit 86 (note large error bars in Fig 4). In most plots, shrub cover prior to fire was already below the minimum suggested in the SBB (<30% or 30-50% depending on Treatment group) and Bluff Mesa (30%) EAs. Average shrub cover was reduced by nearly 80% in Unit 86 and 34% in Unit H.

⇒ Shrub cover was related to the % of crown canopy scorch, but not to bole char height or canopy scorch height.

⇒ Herbaceous cover was low in the burn units and never exceeded 2% (Unit H) or 6% (Unit 86). The non-native cheatgrass (*Bromus tectorum*) was not observed in any plots, although it was located nearby. Care should be taken to minimize cheatgrass spread in the future.

III. Fuel structure

Objectives related to fuel structure include increasing canopy base height to 10-15ft (SBB and BM EAs), reducing litter and duff by 1" (SBB Burn Plan), and consumption of 50-100% of residual material from mechanical treatments. There is also guidance for maintaining 9 (SBB EA) and 6 (Bluff Mesa EA) large logs per acre.

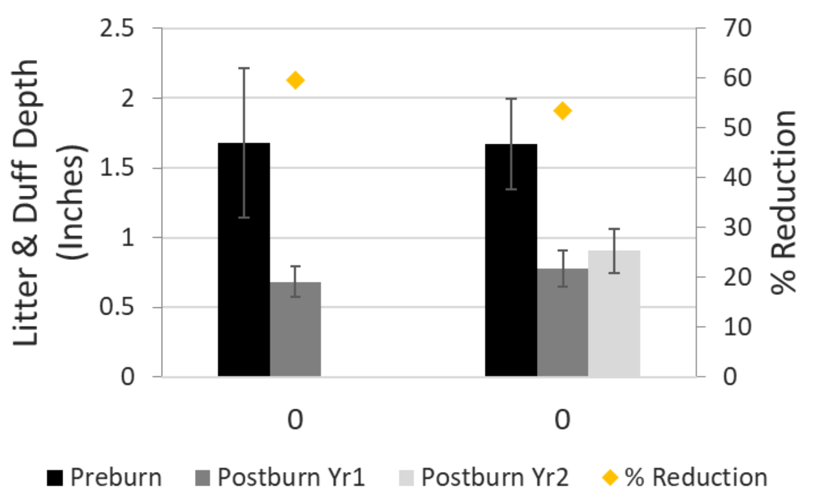

Figure 6 *(above). Litter & duff were measured from the top of the mineral soil to the top of the litter layer. Surface fuel depth decreased by more than 50% and nearly 1" across both burn units. Note that litter and duff depth was quite variable pre-burn (large error bars) and became more homogenous through consumption.*

Figure 7 *(above). Photo shows the effects of mechanical work including chipping. Chips were deep in some areas (causing concern for prolonged residence time). Chip depth was > 7" in this plot.*

SURFACE COVER	Year	Litter (%)	Ash (%)	Bare Soil (%)
Unit H	Preburn	71.5	0.0	1.6
	Postburn Yr1	65.5	4.1	3.6
	Postburn Yr2	65.1	3.5	4.7
Unit 86	Preburn	72.8	0.0	7.7
	Postburn Yr1	59.3	16.7	5.3

Table 4*. Average surface cover for litter, ash (white oxidized material) and bare soil.*

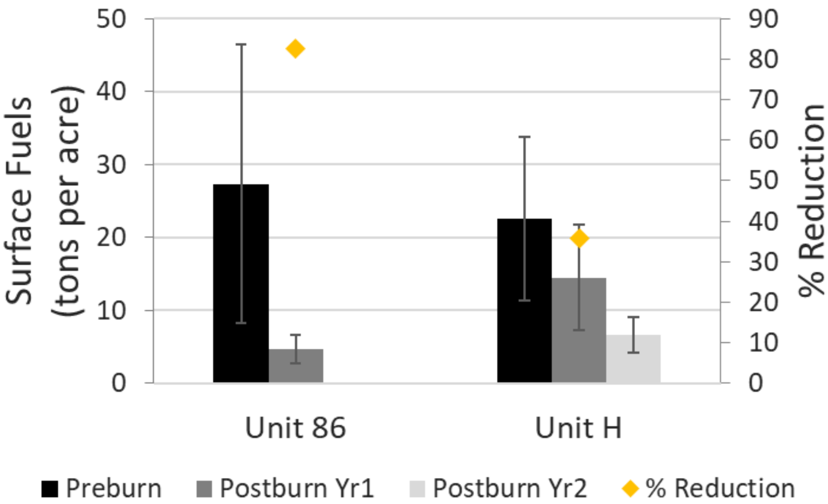

***Figure 8**. Surface fuels include 1, 10, 100 and 1000 hour fuels measured by Brown's transects. The abundance of fuels varied greatly (large error bars) prior to the burn and that variation was reduced by fire. The abundance of surface fuels also declined by an average of 80% (Unit 86) and 35% (Unit H).*

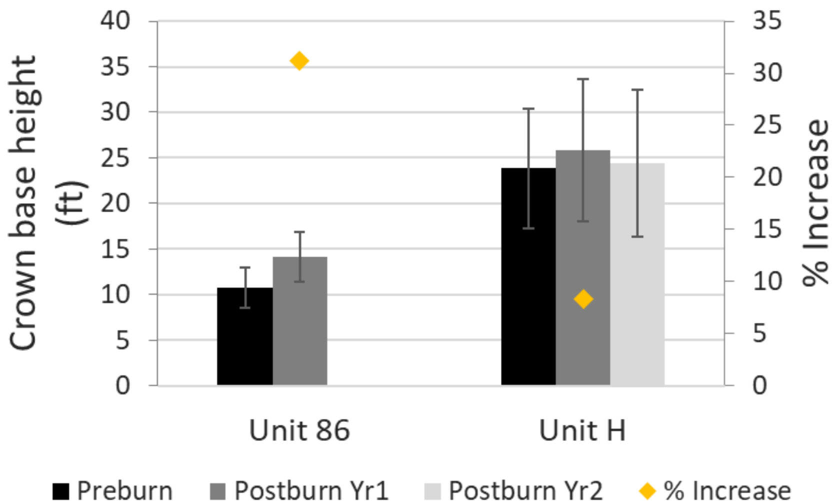

***Figure 9**. Height to live crown represents the distance from the soil surface to the height of the first living branches that appear in more than 2 quadrants of the trunk. The 2nd y-axis indicates an increase in the height to live crown.*

Major findings (Fuel structure)-

⇒ Consistent with the goals of the project, both burn units had a reduction in litter and duff of approximately 1" depth.

⇒ Fuels were heterogenous throughout the burn units prior to fire and were less variable post-fire.

⇒ Crown to base height was already in prescription (>10 ft) prior to the initiation of the burn and increased slightly post-fire. An increase in crown height reduces the opportunity for wildfire to spread from the ground into the tree crowns.

⇒ The number of logs in each plot was not counted as part of the 2018-2021 surveys. This metric will be include as part of future surveys.

Future direction: There is a plan to continue monitoring fuels reduction and forest health projects within the vicinity of Bluff Mesa and South Big Bear. We're hopeful this report will inform whether objectives associated with forest projects are being met and spur conversations that lead to adaptive management that aligns future activities with project goals. In addition, this monitoring report showcases the type of vegetation and fuel data that can be collected locally and via partner groups. The data presented here may serve as a reference when developing measurable burn plan objectives.

Preburn, 2020

Postfire, 2021

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