Immediate Fire Effects of the Alder Fire in the Wishon Grove
and
1-Year Post-Fire Effects of the Pier Fire in the Black Mountain Grove

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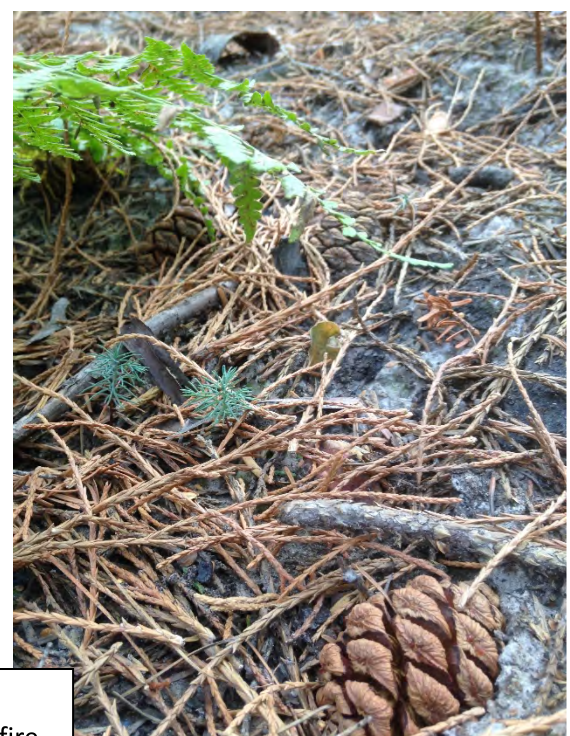

Left Figure - fire burning under a giant sequoia in the Wishon Grove.
Right Figure - giant sequoia seedlings in the Pier Fire area, 1 year after fire.

Alder Fire Summary

The lightning-caused Alder Fire was discovered October 4, 2018 on the north side of North Alder Creek, south of the Wishon Grove (Western Divide Ranger District, Sequoia National Forest, CA). The fire burned through dense timber with extensive tree mortality which is a serious safety concern for firefighters. A confine and contain strategy was used to meet incident objectives because of these conditions. The Alder Fire was generally confined using natural features (areas with zero to limited vegetation) and limited direct suppression tactics (helicopter water drops and hand lines), and strategies were implemented to protect nearby communities and infrastructure. The fire was 5,942 acres on Nov 26th.

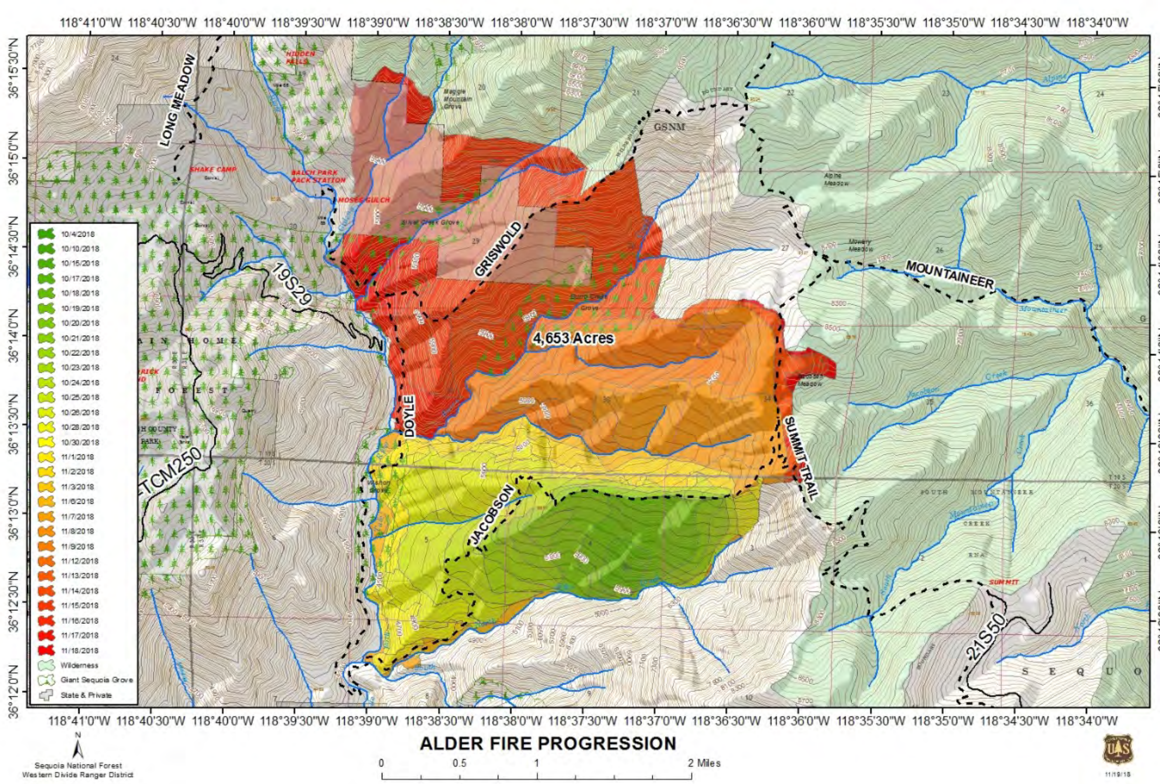

Figure 1. *Alder Fire Progression Map as of Nov 26th, 2018*

Due to a minimal availability of resources, high dead tree hazard, and other factors, FBAT utilized a concise and simple approach on the Alder Fire. FBAT objectives were 1) assessing fire effects on giant sequoia in the Wishon Grove of the Alder Fire, 2) assessing fire behavior utilizing new prototype equipment, and 3) documenting 1-year post-fire effects of the 2017 Pier Fire on the Black Mountain Grove to help capture that learning opportunity. In assessing the fire effects on the Wishon Grove, the surface and ground fuels methods as well as photo points were used from the typical FBAT methods. Post-fire the Composite Burn Index rating system was used.

For more detail on these methods, please see page 6 of the Rough Fire report: https://www.fs.fed.us/adaptivemanagement/reports/fbat/2015RoughFire_FBAT_Summary_Final_2Mar2016.pdf

Fire Ecology of Giant Sequoia

Giant Sequoia (*Sequoiadendron giganteum*) are found only in roughly 75 groves in the western Sierra Nevada, California, including the Wishon Grove, along the Tule River within the Alder Fire. Giant sequoia are generally found in the mixed conifer vegetation type. The giant sequoia in the Wishon Grove grow in association with white fir (*Abies concolor*) and incense-cedar (*Calocedrus decurrens*) as well as scattered black oak (*Quercus kelloggii*) and sugar pine (*Pinus lambertiana*). Near the Tule River mountain dogwood (*Cornus nuttallii*), bigleaf maple (*Acer macrophyllum*) and white alder (*Alnus rhombifolia*) grow in the understory. The Alder Fire area, similar to other parts of the southern Sierra Nevada, is currently experiencing heavy tree mortality due to the combined effects of drought and beetles. Much of the tree mortality in the Alder Fire area has been dead several years, leaving weakened trees that can easily lose limbs and fall creating a safety hazard, especially after being weakened by fire. Most mortality has been concentrated in the pine species, with some in incense-cedar, and fir.

Giant sequoia is a fire-adapted species which thrives when a natural fire regime occurs. Giant sequoia reproduce mainly from seed. Giant sequoia seed germinates best in mineral soil in the spring moistures/temperatures (50-60 °F) when sufficient moisture is present (Harvey 2007). Convective heat from a fire triggers seeds to fall from cones, and surface fire consumption prepares a bare mineral soil seedbed for germination. Without fire, giant sequoia reproduction would be very limited or nonexistent. Although young giant sequoia may succumb to fire, older trees are fire resistant due to thick bark and high branches ("naturally pruned", or from wind, precipitation, or "summer branch drop") (Habeck 1992, Harris 1983). A lack of fire in an ecosystem supporting giant sequoia threatens the giant sequoia community. If no fire occurs, then reproductive conditions are not created and live and dead vegetation (or fuels) accumulate to build conditions that could support high intensity fires that could be lethal to giant sequoia (Vale 1975).

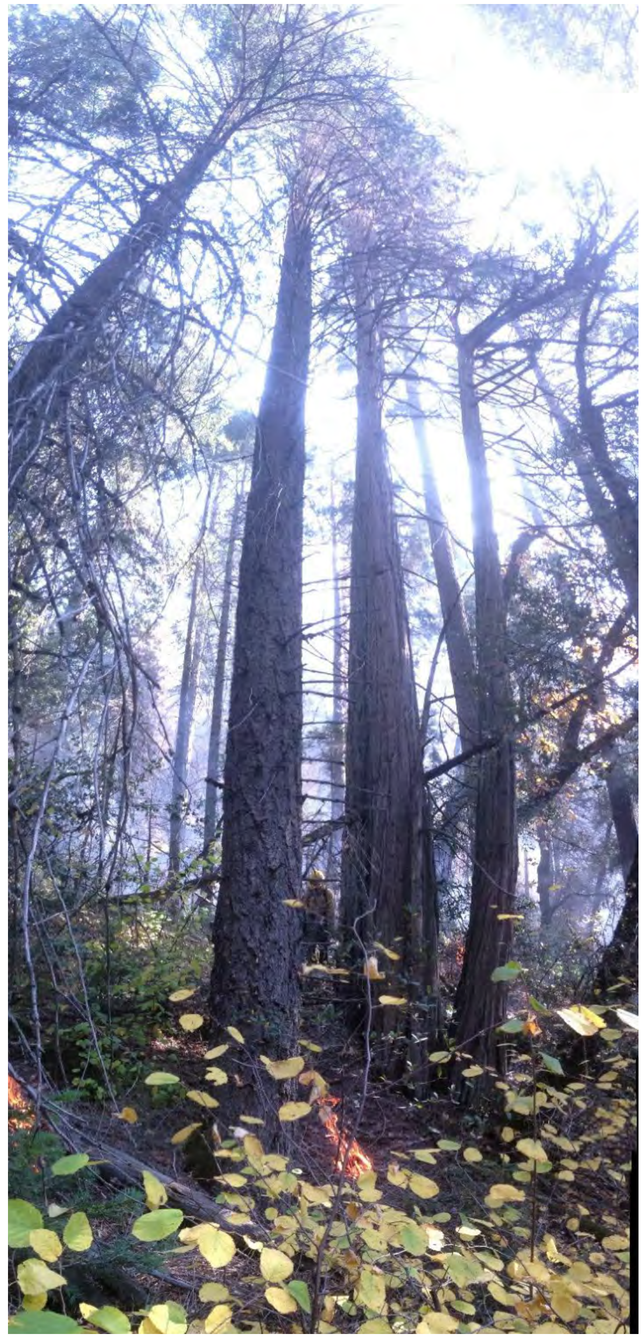

Figure 2. *Dot firing (in the Wishon Grove) to allow small portions of fire to grow together slowly lowers the initial momentum when firefighters want to control the intensity of fire used to consume fuels ahead of the main fire, and control the fire along a fuel break. In this case, the fuel break used was the Middle Fork of the Tule River.*

The mixed conifer vegetation type in the Sierra Nevada is an ecotype that was historically fire adapted. Historic fires probably occurred less than every 20 years. Given that frequent of a fire return interval, it is unlikely that fuels would have built up to the extent to allow large, continuous high-severity fire effects to occur, as have been occurring in the past decade (McKelvy et al. 1996).

The species associated with the giant sequoia found near the Tule River also have adaptions to fire, which demonstrates the dynamic resiliency of this landscape to fire processes. Bigleaf maple, mountain dogwood and white alder all have thin bark, and are easily killed by fire, however they sprout after fire (Fryer 2011, 2014 and Gucker 2005). Severe fires may kill the root crowns of these trees. Severe fires are unlikely in the areas where these associate species grow because they are generally located near rivers on flat topography. These species may experience high severity fire effects on a large scale under heavy fuel accumulations.

Figure 3. *Very low fire severity under a giant sequoia in the Wishon Grove. Although only the top layer of litter/duff was consumed, this fire was probably hot enough to kill some of the seedling-sized trees. This is one way of thinning some of the smaller trees from a stand to allow more water and light resources for the remaining trees to be resilient against drought, disease, and insects.*

Returning fire as an ecosystem process via unplanned fire and/or prescribed fire is necessary for the long-term health and resiliency of many ecosystems, including those supporting giant sequoia. Nuances in the intensity and timing of reintroducing fire factor into its subsequent effects. After many decades of fire suppression, abnormally high fuel loadings can set the stage for high severity fire effects. Various negative effects can occur when high severity patches occur on large scales. Additionally, overly-dense stands are more susceptible to problems caused by insects, disease and drought, as well as intense fire. Reintroducing fire to western Sierra ecotypes which have not had fire in many decades can result in large-scale, high severity patches with some negative fire effects, **if** the first fire in decades occurs in hot/dry weather. Kilgore (1975) recommends reintroducing fire in two-stage prescribed burns to gradually thin smaller diameter trees and reduce fuels before entering into a more natural 8-20 fire return interval. Sometimes this two-stage process can be costly in terms of time to plan and implement and the slow pace and scale, but it needs to be considered for higher risk areas.

Fire Effects of the Alder Fire in the Wishon Grove

The Alder Fire backed downhill toward the Middle Fork of the Tule River through the Wishon Grove between approximately Oct 25th and Nov 10th. Although no precipitation occurred during this time, the fire backed slowly due to cooler/moist fall weather, short days, and no significant wind events. The Middle Fork of the Tule River is a fairly wide and deep drainage running north-south which is sheltered from the sun for much of the day by the opposing ridges. The Tule River and sheltering from the sun create more cool and moist conditions in the Wishon Grove than exist on nearby slopes, or smaller drainages at higher elevations, such as the Burro Grove.

As the Alder Fire backed toward the Middle Fork of the Tule River, some firing operations were accomplished by helicopter and on the ground to remove fuel between the main fire and the Middle Fork of the Tule River during favorable conditions. This left less fuel to burn during unfavorable conditions, or when staffing on that portion of the fire would be reduced. The fire that moved through the grove burned with low flame lengths (generally <1 foot) and very slow rates of spread (5-500 feet/day) except when making short, uphill runs in available fuels, or when burning pockets of heavy downed woody material.

Figure 4. *Plot 2, Transect 3 shows fair litter consumption, in the foreground, but some down woody fuels and small diameter trees remain unconsumed.*

Available fuels were very high in the Wishon Grove, as would be expected in an area of the Sierra Nevada mixed conifer that has not had a recent history of fire or other fuels treatment. FBAT installed 4 plots, all located at the base of the slope, and probably representing higher fuel loadings than would occur on the steeper slopes. Fuel loadings of 1, 10- and 100-hour fuels were characteristic of standard timber fuel models, however, 1000-hour fuels and duff loadings were very high, characteristic of mixed conifer locations which have not experienced fire for decades (Table 1). Not all dead fuels were consumed by the fire, indicating it was a rather low intensity, low severity fire in the Wishon Grove near the river.

Table 1. *Fuel loading by category for each of the four FBAT plots installed.*

	Plot 1		Plot 2		Plot 3		Plot 4	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1-hour (tons/acre)	1.4	0.5	2.8	0.3	2.1	0.3	0.9	0.5
10-hour (tons/acre)	3.5	1.4	4.2	0.5	4.7	1.4	1.6	1.4
100-hour (tons/acre)	20.0	0.9	2.8	1.8	3.7	2.8	2.8	0.9
1000-hour (tons/acre)	22	12	37	15	115	0	21	6
Litter (tons/acre)	14.1	11.7	22.6	0.7	33.6	3.4	54.8	11.7
Duff (tons/acre)	225	33	311	3	387	3	212	33
Max fuel bed depth (inches)	42	16	32	16	72	14	51	16

The fire effects observed at the foot of the slope, near the river, were low to moderate, with some unburned fuels intermixed. Only occasionally trees torched (most foliage fully consumed). This fire likely killed a fair amount of small diameter white fir and incense-cedar in the understory, but likely did no significant damage to mature, fire-tolerant trees such as the giant sequoia. Composite burn index scores (Table 2) showed low severity overall at all 4 plots. The only moderate fire effects found were in the substrate category, and this is understandable due to the high fuel loads of litter and duff that consumed over days. Note that fire severity across the entire Alder fire was not measured, but given field observations, likely included mainly low and moderate effects.

Table 2. *Composite Burn Index (fire severity 0-3, unburned to high severity) scores by strata and total.*

	Plot 1	Plot 2	Plot 3	Plot 4
Substrates	1.8	2.0	2.4	2.1
Herbs/shrubs	0.8	1.0	1.0	1.0
Tall shrubs	0.8	0.7	0.7	0.7
Intermediate trees	0.1	0.2	0.1	0.1
Big trees	0.3	0.1	0.1	0.5
Total	**0.8**	**0.8**	**0.9**	**0.9**

1-Year Post-Fire Effects of the 2017 Pier Fire in the Black Mountain Grove

The fire effects of the 2017 Pier Fire ranged from low to high severity, with some high severity patches being fairly large. One-year post-fire photos were gathered for the Pier Fire on Nov 4th, 2018 mainly along the 21S12 road in the Black Mountain Grove in the vicinity of plots and photo points FBAT had installed during the Pier Fire. Fire effects on giant sequoia were also targeted.

Most of the literature on giant sequoia fire effects describes young giant sequoia as being susceptible to fire, but older giant sequoia being fire resistant. FBAT observations one year after the Pier Fire, as well as observations of a separate field monitoring effort by Save the Redwoods League, assessing fire effects on monarch (old growth, large size) giant sequoia **found *that some older and larger trees did die related to the Pier Fire*. *This phenomenon of mature sequoia succumbing to fire seems fairly novel, and highlights how different current fuel accumulations, tree densities, and fire return intervals may be in relation to conditions from 100+ years ago.***

Figure 5. *A cat-faced giant sequoia which had fire climb the bole and weaken the lower trunk is found with only the lower 30 feet standing after the Pier Fire.*

Figure 6. *In the left photo taken immediately after the Pier Fire, the limbs on the left side of giant sequoia were torched. In the right photo taken November 4, 2018, one year after the Pier Fire, the same giant sequoia had limb loss, with three branches with green needles remaining.*

Figure 7. *Moderate/high severity area on slope with lower severity along ridge.*

Although high and moderate severity fire effects were both found on the Pier fire in large patches, some small patches of low severity occurred. The trees remaining in these low severity patches across the landscape will serve as seed sources for eventual recruitment of the next forest and as flora and fauna refugia (Fites-Kaufman et al. 2005).

Figure 8. *Giant sequoia in moderate severity area with partial or full crown mortality.*

Often trees which experience less than 100 % needle scorch (needles killed, but remaining on the tree) can overcome this setback and thrive in future years. Some species, especially hardwood and understory/shrub species will sprout new branches, whereas other species' branches will remain fire-pruned higher, leaving those tree canopies safer from the reach of flames from the next fire. Even trees which have experienced 100% torch may grow green needles again several years after the fire, if sufficient moisture is available.

Figure 9. *Oaks resprouting 1 year after Pier Fire on Plot 1, which experienced intense fire.*

Some mixed conifer areas which have experienced moderate and high severity fire effects may convert for short to long periods to being shrub and/or oak dominated.

Figure 10. *Timeseries photos of Pier Fire FBAT Plot 2, transect 3, 0-50ft: left photo is pre-fire, center photo is immediate post-fire, right photo is 1-year post-fire.*

Figure 11. *Giant sequoia seedling carpet in plot 2. This is a moist area under dogwood.*

In some areas where the Pier Fire had burned litter and duff away, exposing mineral soil, a 'carpet' of giant sequoia seedlings were found. Giant sequoia seedlings were generally either found in abundance, or not found at all. Many of the areas and microsites where the seedling carpets were found were moist. It is possible that moisture trends and other factors like fire intensity, are affecting whether or not giant sequoia seedlings establish and thrive in early years.

Discussion

When most low and moderate intensity fires are suppressed in the heavy fuels and dense stand conditions found today, then subsequent wildfires can be difficult to suppress, and tend to result in larger, high severity patches. Capitalizing on opportunities to reduce fuels on the landscape using fire, and to increase the proportion of acreage burned in low and moderate conditions should be strongly considered when it is safe, in order to break out of the cycle of fuel accumulation and infrequent, but large, intense fires. In today's stand conditions in the Sierra Nevada, which include high density dead tree hazards, controlling fire from optimal locations on the landscape (rivers, ridges, rocky areas, areas with minimal fuel) rather than sending firefighters in to build fireline adjacent or close to the fire, has multiple benefits. Confine and contain strategies not only reduce risks to firefighters, but may also reduce the cost per acre and allow for more control of fire effects by including some backing fire (fire spreading against wind and/or slope) under controlled conditions, which 'evens the score' more in favor of the natural range of fire effects. Reducing fuels and returning fire as an ecosystem process is necessary to protect the very systems we do not want to see 'go up in flames' in large, intense fires.

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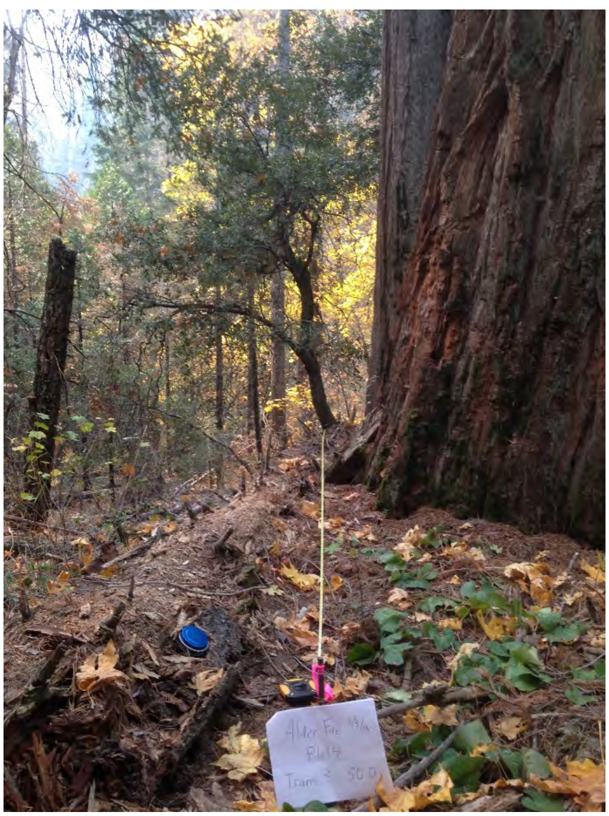
Paired photos

Plot 1, Transect 3, 0-50 ft pre then post

Plot 1, Transect1, 50-0 ft pre then post

Plot 4, Transect 2, vertical panoramic shots next to Giant Sequoia, pre and post-fire


Plot 2, Transect 2, 50-0 ft pre, then post




Plot 4, Transection 3, 50-0ft, pre then post