# Initial Condition Assessment of Sequoia Groves within the Rough Fire

Report for Sequoia N.F. and Kings Canyon N.P. Rough Fire Interagency BAER Team

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**Figure 1. Fire effects in the Little Boulder Grove in an area of high soil burn severity.**

## Assessment Summary

Within the perimeter of the Rough Fire there were 8,888 acres of giant sequoia groves, in both Sequoia National Forest and Kings Canyon National Park. Soil burn severity mapping indicated unburned/low severity over 74% of the groves, 21% moderate, and 5% high. Seven sequoia groves were also assessed on the ground to evaluate vegetation condition related to fire effects. Grove most severely impacted by the fire—Converse Mountain and Lockwood—were generally adjacent to lower elevation drier vegetation types where it appeared the fire made headfire runs from lower elevation shrublands or dry conifer forest. Of the areas assessed Converse Mountain was the grove most adversely affected by the fire with Lockwood having the greatest impacts to monarch sequoias. However, most grove interiors and higher elevation grove areas were not adversely impacted by the fire and likely benefitted from the fire after 100+ years of fire exclusion. All groves showed a moderate to extensive giant sequoia seed rain with good potential for a significant amount of sequoia regeneration in areas burned, although moisture conditions over the next year or two will be important in determining establishment success. Follow-up visits to these groves and a more extensive survey of groves are recommended for 2016 to evaluate longer-term effects.

## Introduction and Background

On July 31, 2015, a lightning strike started a wildfire on the steep northern side of the Kings River Canyon in the Sierra National Forest. By mid-August the Rough Fire had burned into Kings Canyon National Park (KNP) and Sequoia National Forest (SQF) and on August 18 it jumped to the south side of the Kings River. The fire burned for an additional six weeks and expanded to over 151,000 acres (58,541 ac SQF and 9,413 ac KNP) and was 89% containment by October 4. It burned through a wide variety of vegetation types across steep elevation gradients on both sides of the Kings Canyon Gorge. This included blue oak savanna at 1,000 feet elevation to sub-alpine forest at over 10,000 feet elevation, with intervening chaparral shrublands, a wide variety of forest types such as live oak, black oak, ponderosa pine, pinyon

pine, white fir-mixed conifer, red fir, and giant sequoia forests, as well as montane meadows. Within the fire perimeter BARC analysis indicated approximately two-thirds (68%) of the area is unburned to low soil burn severity, 28% moderate soil burn severity, and 4% high soil burn severity.

**Figure 2. Sequoia seeds (oatmeal sized flakes) scattered in ashes and bare mineral soil in Evans Grove.**

On the south side of the Kings River the Rough Fire burned into a number of giant sequoia groves within both Sequoia National Monument (8,788 ac) and Kings Canyon Nation Park (100 ac). The vast majority of this burned area was within the Converse Basin and the Evans Grove Complex (Lockwood, Evans, Burton, Kennedy, Little Boulder, and Boulder Creek Groves) in the monument. Other groves affected by the fire include General Grant, Abbot, Cherry Gap, Cabin Creek, Converse Mountain, Deer Meadow, and Agnew. The fire burned around the Boole Tree and Chicago Stump on the monument and within 215 yards of the General Grant Tree (the nations Christmas Tree and the only living national shrine) in the park. Visits were made to seven of these groves in early October; Converse Basin, Converse Mountain, Little Boulder, Evans, Lockwood, Cherry Gap, and General Grant.

Topographically most groves within the Rough Fire perimeter are located in basins, shallow drainages, or plateaus and are predominantly on the north aspect of the King River drainage. The lowest elevations at which groves occur is at about 5,200 ft (Cabin Cr. and Lockwood) on north aspects and at higher elevations on warmer drier southerly aspects.

2015 was the fourth year of drought in California with low rainfall coupled with higher than normal temperatures. The drought has resulted in severe impacts to vegetation, which is particularly noticeable in lower elevation oak woodlands and conifers forests where stressed trees are being attached bark beetles resulting in significant levels of mortality. Also of particular note in 2015 there was an unusual amount of summer convective precipitation (June and July) on the west slope of the Sierra Nevada, particularly at higher elevations, a result of monsoonal flow. July rainfall totals at Grant Grove and Giant Forest were the second greatest in the last 90 years (1.60 and 1.19 inches respectively and greater amounts at high elevations with 2.71 in Sugarloaf and 4.15 inches at Atwell). This coupled with greater than normal rainfall in June may have ameliorated drought effects to some degree at these elevations and influenced fire effects.

Disturbance history and pre-Rough Fire condition of the groves varied greatly, which would have influenced fire effects. A number of the groves had had giant sequoias logged historically (before being added to SQF), from the 1880s through 1926. Post-logging regeneration was evident during visits to these groves (probably 75 to 125 year old sequoia trees). Sequoia stumps from this logging were also still present although burned to various degrees by the fire. Additionally, the Cherry Gap Grove appears to have been burned severely by the 1955 McGee Fire and trees in this area probably regenerated following this event (50 to 60 years old). Other groves appeared largely undisturbed with the exception of fire exclusion over the last 100+ years, the

exception being portions of the General Grant Grove in KNP that had been burned by prescribed burns over the last 35 years. Large old monarchs were observed in General Grant (NPS), Little Boulder, portions of Evans (east end), and Lockwood Groves.

**Figure 3. High soil burn severity in Converse Mountain Grove where a stand replacing fire occurred.**

Historically fire occurred relatively frequently in giant sequoia groves. Fire history reconstructions using fire scarred trees and tree-ring analysis indicate that fires occurred about every 10 to 25 years (Swetnam et al. 2009). These burns were probably spatially quite heterogeneous with varying spread and severity patterns within a grove. Giant sequoia possess a number of fire related adaptations including thick bark that resists heat conduction, wood that burns poorly, and very high crowns of mature trees. The species is also largely dependant on fire for regeneration, being shade intolerant and having semi-serotinous cones, with successful seedling germination requiring bare mineral soil and generally the best seedling establishment and growth in area where canopy gaps have occurred. Mature sequoias have also been found to have periods of increase growth following fires (Mutch 1994, Caprio et al. 1994). Mortality of mature sequoia trees can occur directly following severe crown scorch or basal cambial kill, or indirectly due to fire caused bole failure. However, sequoias often survive extensive crown scorch or loss of large portions of a bole.

## Landscape Level Soil Burn Severity - BARC Analysis

Burned Area Emergency Response (BAER) maps are primarily measures of fire effects on soils. Wildfire does not always impact soils and vegetation in the same way and care needs to be taken in interpretation. What may be severe vegetation impacts may not show as severe soil impacts and a separate extended landscape vegetation burn severity assessment using dNBR/RdNBR analysis is frequently used to assess impacts to vegetation one year postfire. Within the fire perimeter BARC analysis indicated approximately two-thirds (68%) of the area is unburned to low soil burn severity, 28% moderate soil burn severity, and 4% high soil burn severity. Within just the groves (8,888 ac) soil burn severity was 74% unburned/low, 21% moderate, and 5% high. The set of groves in the Converse area showed the greatest amount of high soil burn severity with this centered on the Converse Mountain Grove. Cherry Gap and General Grant also had a high percentage of area with high soil burn severity. The groves with the least impact were Deer Meadow and Agnew. Areas of high severity did not always equate to significant impacts to overstory vegetation. For example, the area pictured above (Fig. 1) in Little Boulder Grove was mapped as high soil burn severity but although there was a very deep ash layer (6-10 inches) impacts to overstory trees appeared to be minimal. In contrast, other locations mapped as low soil burn severity had in some cases 100% overstory tree mortality but the dead canopy foliage was intact. Additionally, portions of the mapped

areas for giant sequoia vegetation are actually non-sequoia forest types with these areas often having greater overstory mortality than areas where giant sequoias are present, which may result in a higher estimate of soil burn severity.

Soil burn severity rating overview: **High Soil Burn Severity Rating** (severe damage to the soils): deeply burned soils with high water repellent soils (tend to be places where the fire burned the forest canopy, ground cover, roots, and organic matter in the topsoil). **Moderate Soil Burn Severity Rating**: burned soil with moderate water repellent soils can produce increased water run-off and soil erosion depending on the timing, magnitude, and duration of future precipitation. The remaining vegetation could quickly resprout and provides some cover from dead needles and leaf fall to reduce erosion. **Low Soil Burn Severity Rating**: light soil burning includes land that may have burned in recent occurrences with brush or young timber growing on it.

**Soil burn severity by severity level for each grove or grove complex by acres and percent of area.**

| | Acres | | | | | Percent | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Row Labels** | **High** | **Low** | **Moderate** | **Unburned/ Very Low** | **Grand Total** | **High** | **Low** | **Moderate** | **Unburned/ Very Low** | **Grand Total** |
| Abbott | 0 | 16 | 3 | 6 | 25 | 1% | 63% | 12% | 25% | 100% |
| Agnew | | 24 | 4 | 15 | 43 | 0% | 56% | 10% | 34% | 100% |
| Cherry Gap | 17 | 86 | 62 | 3 | 167 | 10% | 51% | 37% | 2% | 100% |
| Converse Basin | 327 | 1756 | 924 | 896 | 3903 | 8% | 45% | 24% | 23% | 100% |
| Deer Meadow | | 84 | 6 | 78 | 168 | 0% | 50% | 4% | 46% | 100% |
| Evans | 65 | 2115 | 713 | 1363 | 4255 | 2% | 50% | 17% | 32% | 100% |
| Grant | 24 | 119 | 110 | 36 | 289 | 8% | 41% | 38% | 13% | 100% |
| Indian Basin | 1 | 19 | 10 | 7 | 37 | 2% | 51% | 28% | 19% | 100% |
| **Grand Total** | **434** | **4218** | **1833** | **2404** | **8888** | 5% | 47% | 21% | 27% | 100% |

**Figure 4. Cherry Gap Grove surrounded by areas of moderate and severe soil burn severity.**

## Individual Sequoia Grove Postfire Condition Assessments

Seven groves were visited and fire effects visually assessed. The assessments provide a general overview of grove condition immediately following fire occurrence (in most groves residual burn-down of litter/duff, stumps, or snags was still occurring). Because giant sequoias are a fire adapted species condition assessments could indicate negative or positive effects of the fire. A specific grove assessment did not include a visit to all areas of a grove but included areas relatively easily assessable by vehicle or on foot with the BARC soil severity map used as a guide to find areas of varying soil burn severity to evaluate.

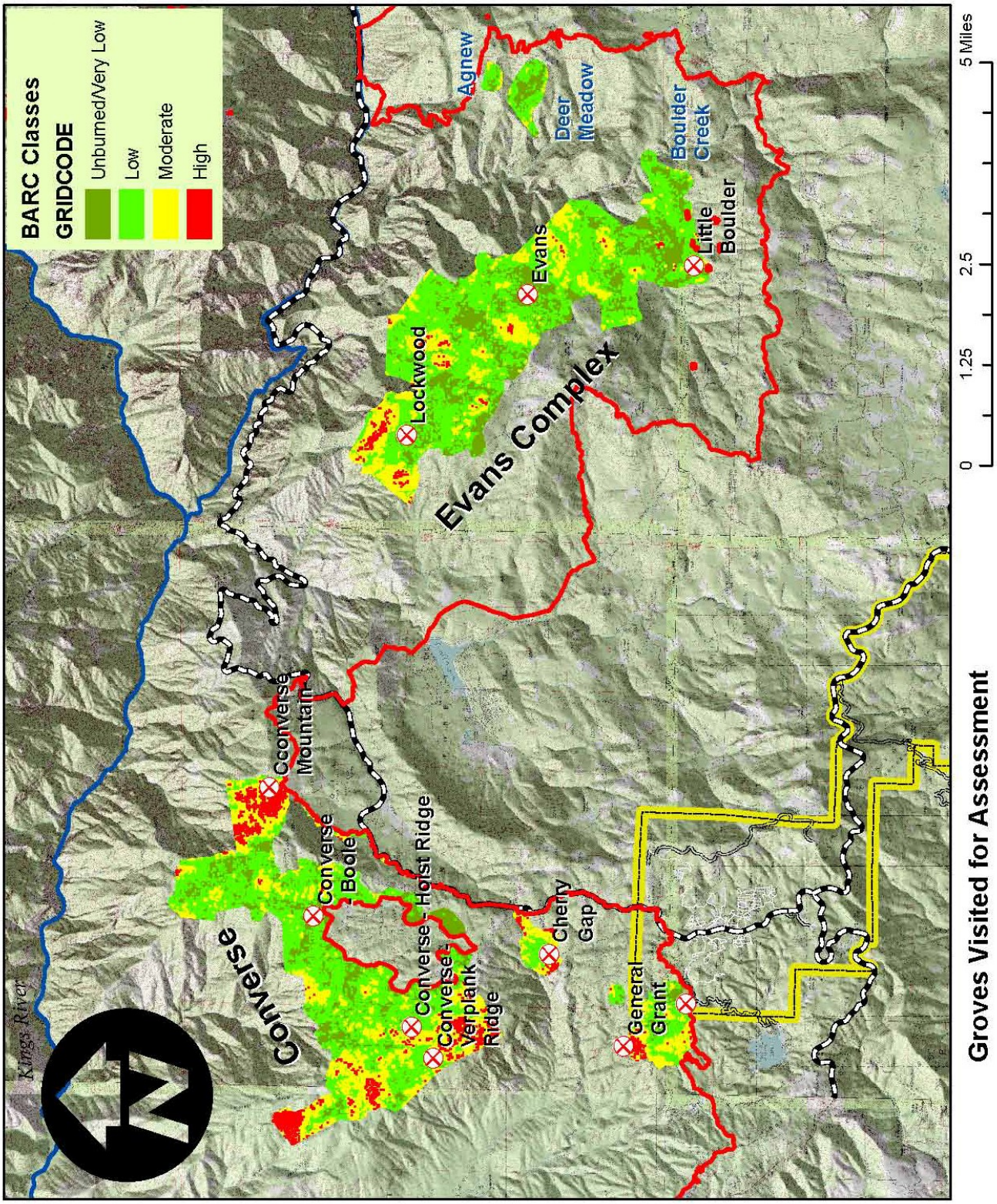


**Figure 5. Map showing location of the seven groves visited for the assessment, the designated grove boundaries, Rough Fire perimeter (red), and BARC soil burn severity rating within the grove perimeters.**

1) **Converse Basin** - This is second growth sequoia grove, a result of historic logging experienced generally low/moderate fire severity with many unburned patches but also some high severity canopy gaps created. Areas visited were Verplank Ridge (road 13S03), Hoist Ridge (road 13S66) and the Boole Tree area (road 13S55). On Verplank Ridge where the fire was severe the occurrence of sequoias in small drainages greatly moderated impacts. Overall, the varied burn severity of the fire reduced fuels, thinned post-logging sequoia regeneration, created canopy gaps, and provided opportunity for sequoia regeneration. Areas of non-sequoia forest, primarily second growth pine, within the larger forest grove perimeter experienced greater fire severity.

2) **Converse Mountain** (considered part of the Converse Basin Grove for the BARC analysis) - Grove is second growth from historic logging and experienced very high fire severity with sequoia trees in the majority of the area visited burned by crown fire or appearing to be 100% scorched. Large sequoia stumps from the historic logging activities remained but were heavily burned (Fig. 3). A fairly heavy rain of sequoia seeds were observed on the ground under burned trees even though the trees were relatively immature. Moisture conditions over the next year or two will be important in determining how well sequoias reestablish in this area. This area could potentially develop doghair thickets of young trees. However, if there are no reproductive overstory trees the area could be impacted by another fire if it occurs prior to when trees become reproductive. Area was accessed via road 13S07.

3) **Little Boulder** (part of the Evans Grove Complex for the BARC analysis) – A grove of monarch sequoias with low to moderate fire severity to sequoias in the part of the grove visited although BARC indicate some high soil severity. Heavy litter and duff accumulations resulted in deep ash layer but there appeared to be minimal scorching of sequoia bases. Grove was accessed via Burton Pass Road and road 13S53.

**Figure 6. Lockwood Grove with an area of high burn severity (east side of grove) and low burn severity (center of grove).**

**Figure 7. Second growth giant sequoias (conical crowns) in Evans grove. View north across Kings Canyon from near Camp Six along the old railroad grade.**

**Figure 8. Monarch giant sequoias in the east side of Evans Grove, near Camp Seven at the end of the old railroad grade.**

4) **Evans** (part of the Evans Grove Complex for the BARC analysis) - Consists of logged (western ~80-90%) and unlogged (eastern ~10-20%) sections. The grove was accessed via the old logging railroad grade (road 13S05) from Burton Pass Road. The majority of the area of second growth sequoias burned with low to moderate soil burn severity. Some of these areas have dense stands of second growth sequoias where the fire resulted in some tree mortality but in general the stands remained quite dense (Fig. 7). Large sequoia stumps from the historic logging activities remained but were often heavily burned. In the unlogged area with monarch trees the fire also burned with low to moderate severity reducing heavy surface fuels and reducing density of non-sequoia species (Fig. 8). Several large sequoia tree failures also occurred caused by the fire burning out the tree bases weakened by fires prior to fire exclusion (probably pre-1900). A very heavy rain of sequoia seeds were observed on the ground under monarch trees (Fig. 2).

5) **Lockwood** (part of the Evans Grove Complex for the BARC analysis) - Very varied fire effects were observed in this grove which is the lowest and most westward grove of the Evans Complex. The grove occupies three subdrainages. Portions of the grove were severely impacted when a headfire burned uphill into 10 Mile and Lockwood Creek drainages after crossing the Kings River. Lower portions of the grove contained many smaller sequoias that appeared to be second growth trees with the upper and eastern 1/2-2/3 of the grove containing monarch trees. The areas of second growth were severely impacted with considerable mortality, particularly in the western edge of the grove. In the central portion of the grove, where the greatest concentration of monarchs occurs the fire burned lightly with patches remaining unburned (Fig. 6b). However, the eastern subdrainage burned very severely with most of the monarch trees (~14 trees) either burned by crown fire or appearing to have been complete crown scorched (Fig. 6a). A fairly heavy rain of sequoia seeds were observed on the ground under burned trees. Moisture conditions over the next year or two will be important in determining how well sequoias reestablish in this area. The grove was accessed via the old logging railroad grade (road 13S05) from Tenmile Road.

**Cherry Gap** - This grove appears to be composed of second growth trees from the 1955 McGee Fire. Although surrounded by areas of severe fire in immature pine forest much of the grove burned with low to moderate severity with some exceptions, particularly in the grove periphery (Fig. 4). It was also interesting to note that these sequoia trees, which were probably less than sixty years in age, dropped a fair number of seeds within patches of higher severity. Accessed was via road 13S58.

**Figure 9. Understory burn and old sequoia stumps in General Grant Grove, Sequoia National Forest.**

**General Grant -** mature sequoia inside KNP and second growth in SQF. A mix of fire effects were observed in this grove, both within KNP and SQF. The majority of the area within KNP that was burned by the Rough Fire had previously been burned 2-3 times by prescribed burns (the most recent were either 2004 or 2005). Fire effects were low and patchy with some relatively large unburned areas remaining. Unburned park lands along the boundary outside the prescribed burns burned at much greater severity with crown fire or very heavy crown scorch of a number of monarch sequoias and heavy mortality of other overstory species. These effects appeared to be the result of a headfire run the fire made from down-canyon outside the park onto the park. The fire severity in this area also impacted the adjacent edges of the prescribed burn units but did not carry far into the units. Fire effects in the second growth portion of the grove in SQF were mixed with predominantly understory fire (Fig. 9) with some patches of crown fire where the fire made runs. Little mortality of the second growth sequoia trees was observed. Stumps from the historic logging remained, although partially burned by the fire. Lower potions of the grove were accessed via an old logging railroad grade (road 13S58) and the upper areas from KNP and road 13S63.

**Agnew**, **Deer Meadow**, and **Boulder Creek Groves -** Visual assessment from a distance were made of these groves (Fig. 10). While specific condition could not be ascertained the groves did not appear to have been impacted by high severity fire.

**Figure 10.Boulder Creek Grove (top) and Agnew and Deer Meadow (bottom; left and right).**