2013 Rim Fire
Stanislaus National Forest and Yosemite National Park

Fire Behavior Assessment Team Summary Report

Fire Behavior Assessment Team (FBAT) of
Adaptive Management Services Enterprise Team (AMSET)
And
Calaveras Wildland Fire Module, Stanislaus NF
And other
Federal Firefighters

Carol Ewell, Science Lead/Tech. Specialist
Gus Smith, Technical Specialist, YNP Lead
Matt Hilden and Seth Greene, Operations, Module Leaders
Dawn Coultrap, Kevin Robinson,
Nicole Vaillant, Alicia Reiner, and
Tiffany Norman as Technical Specialists

Revised June 10, 2015 (Draft 2)

Images show before, during, and immediately after the Rim fire at site 4 in Rockefeller Grove, Yosemite NP

Table of Contents

Introduction

Wildland fire management is dependent upon good fire behavior and resource effects predictions. Existing prediction models are based upon limited data from wildfire in the field, especially quantitative data. The Fire Behavior Assessment Team (FBAT) collects data to improve our ability to predict fire behavior and resource effects in the long-term and provides short-term intelligence to the wildland fire managers and incident management teams on fire behavior, fuel, and effects relationships. Increasing our knowledge of fire behavior is also important to fire fighter safety; the more we know the more we can mitigate hazards and prevent accidents, as well as making steps towards improvement in natural resource management.

This report contains the results of a one week assessment of fire behavior, vegetation and fuel loading and consumption, and fire effects to vegetation and soil resources for two areas on the Rim Fire. The Rim Fire started by an escaped campfire on Aug. 17th, 2013 near the vicinity of the confluence of the Clavey and Tuolumne Rivers on the Stanislaus National Forest (STF) on the Groveland Ranger District and spread East into Yosemite National Park, and all other directions on the STF and private land. Fire behavior was measured at nine sites, and pre- and post-vegetation and fuel conditions were measured at five of those sites from August 30 to Sept. 8, 2013. The Calaveras Wildland Fire Module, numerous National Park Service (NPS) and STF employees, and a few incident staff from multiple agencies joined and trained with FBAT on fire behavior equipment and fuels/vegetation inventory techniques.

Objectives

Our objectives were to:

1. Characterize fire behavior and quantify fuels for a variety of fuel conditions. A key consideration was sites which could be measured safely given access and current fire conditions.
2. Measure representative vegetation and fire behavior at recent fuel treatments; initial focus area was on fire behavior at the Yosemite Forest Dynamics Plot (AKA “Big Plot”) in Rockefeller Grove to supplement other ongoing research efforts.
3. Assess fire severity and effects at the study sites based on immediate post-fire measurements.
4. Cross-train and work with some of the STF Calaveras Wildland Fire Module and NPS and STF staff during the field study, as well as collaborate with local ecologists.
5. Produce a summary report based on preliminary analysis for fire managers and the Sierra National Forest.

Applications

This information will be shared with managers to evaluate the effects or fire behavior of the Rim Fire on the Big Plot and sites with recent fuel treatments. The information would also prove valuable when shared with: firefighters to improve situational awareness; managers to improve predictions for fire planning and future silviculture planning; and scientists for improving emissions and/or fire behavior modeling.

Approach/Methods

FBAT selects study sites to represent a variety of fire behavior and vegetation/fuel conditions. Site selection priorities are also based on safe access and areas that would most likely be burned over within the timeframe that FBAT was at the incident. Within each site data is gathered on both fuels and fire behavior (Figure 1). Pre- and post-fire fuels and fire behavior measurements were taken at nine sites within Rockefeller and Tuolumne Groves inside Yosemite National Park, and in the NW corner of the fire on STF managed land from July 26 and Aug. 4, 2013 of the Rim Fire. The maps (Figures 2 and 3) displays daily fire progression and approximate site locations.

Figure 1: Schematic of FBAT fuels and fire behavior site set up.

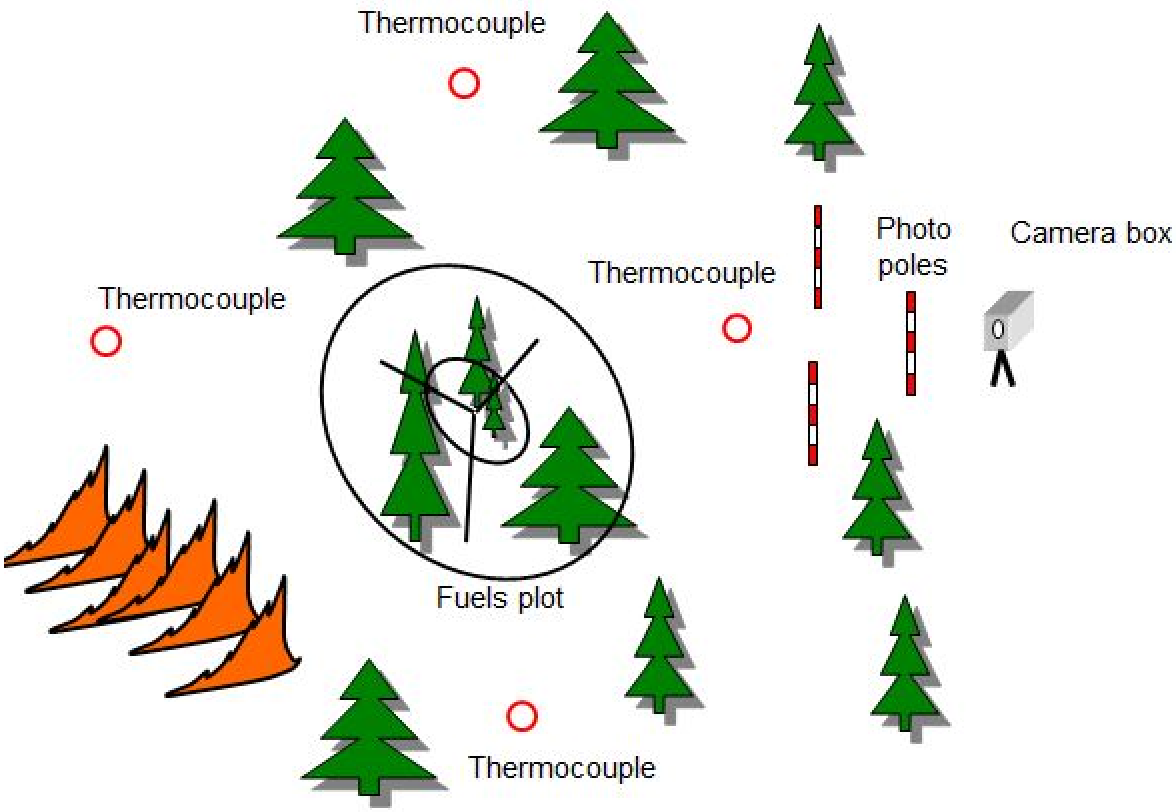


Figure 2: Rim Fire progression and location of FBAT fuels and fire behavior sites in the NW and SE corner of fire.

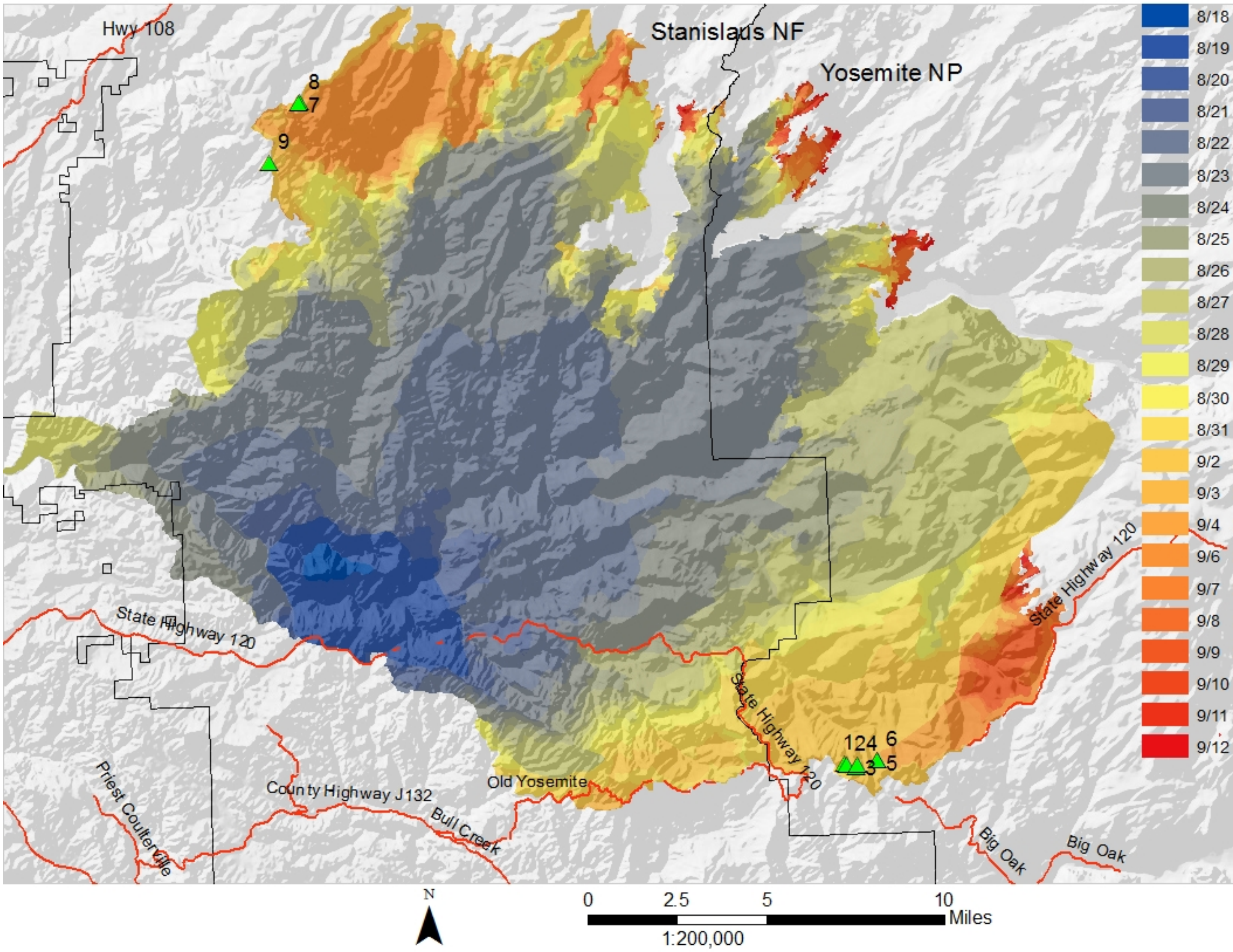
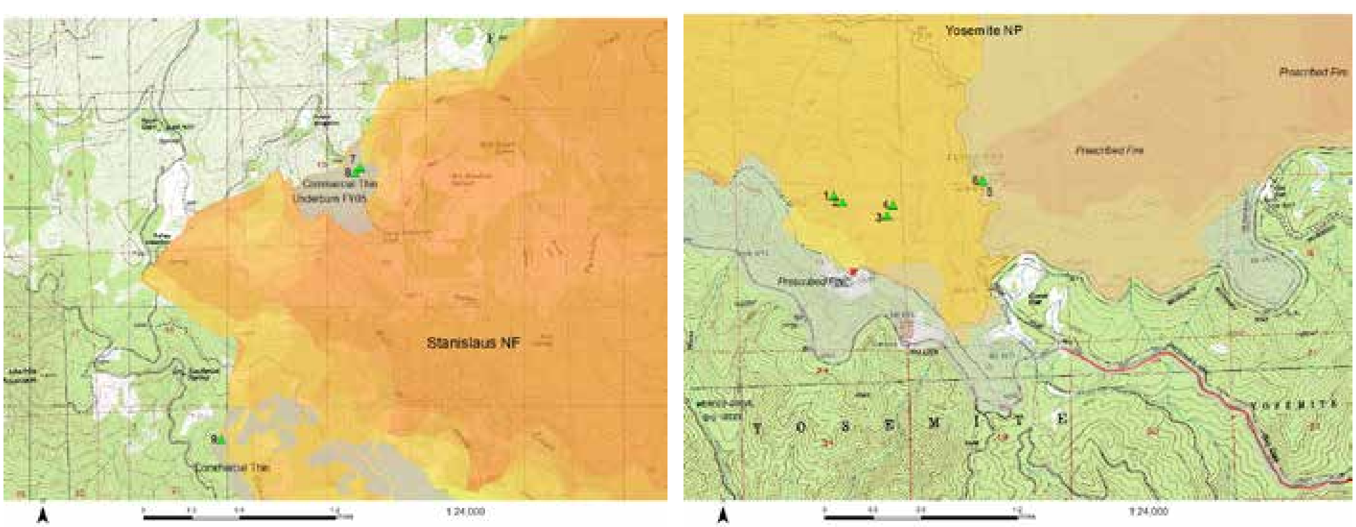


Figure 3: Left side - FBAT sites in NW corner of fire on Stanislaus NF. Right side - FBAT plots in SE corner of fire on Yosemite NP. Grey overlay areas are fuel treatments with recent treatment type labeled.



Pre- and Post-Vegetation and Fuel Measurements

Vegetation and fuels were inventoried both before the fire reached each site and then again after the fire.

Figure 4: Example paired photos where vegetation and fuel data collection occurred pre- and post-burn at Site 8 on the Stanislaus NF.

Crown Fuels and Overstory Vegetation Structure

Variable radius sub-plots were used to characterize crown fuels and overstory vegetation structure. A relescope (slope corrected tree prism) was used to create individual plots for both pole (>2.5 to 5.9 in diameter at breast height (DBH) and overstory (>6 in DBH) trees. When possible a prism factor was selected to include between 5 and 10 trees for each classification. Tree species, status (alive or dead), DBH, height, canopy base height, and crown classification (dominant, co-dominant, intermediate or suppressed) was collected for each tree before the fire. Tree height measurements were completed with a laser rangefinder; DBH was measured with a diameter tape.

After the fire maximum bole char, scorch, and torch heights and percentages were recorded for each tree. After fire trees were assumed to be live if any green needles were present. Changes in canopy base height were estimated from the percent scorch and torch values rather than the maximum heights because of uneven values that were affected by slope and tree alignment with heat. Because of smoke and poor lighting, visibility of the full crown is sometimes difficult. If a more accurate assessment of tree survivorship in the plots is desired we recommend another site visit next year.

The Forest Vegetation Simulator program (FVS, Crookston and Dixon 2005) and its Fire and Fuels Extension (FFE-FVS, Rebain 2010) was used to calculate canopy bulk density, canopy base height, tree density, and basal area both pre- and post-fire. FVS/FFE-FVS is stand level growth and yield program used throughout the United States. The Western Sierra variant was used for all calculations.

Understory Vegetation Structure and Loading

Understory vegetation was measured in a one meter wide belt along three 50-foot transects before and after the fire. The fuel and vegetation transects were in view of the video camera (which will be described below in the “Fire Behavior Measurements and Observations” section). Species, average height and percent cover class (based on an ocular estimation) were recorded for all understory shrubs, grasses and herbaceous plants. Biomass of live woody fuels (shrubs and seedlings) and live herbaceous fuels (grasses, herbs, subshrubs) were estimated using coefficients developed for the Behave Fuel Subsystem (Burgan and Rothermel 1984), and calculations were done on a spreadsheet (Scott 2005). See Appendix C for Firemon calculation comparisons.

Surface and Ground Fuel Loading

Surface and ground fuels were measured along the same three 50-foot transects as the understory vegetation at each site. Surface (litter, 1-hr, 10-hr, 100-hr and 1000-hr time lag fuel classes and fuel height) and ground (duff) fuels were measured using the line intercept method (Brown 1974, Van Wagner 1968). One and 10-hr fuels were tallied from 0 to 6 ft, 100-hr from 0 to 12 ft and 1000-hr from 0 to 50 ft. Maximum fuel height was recorded from 0 to 6 ft, 6 to 12 ft and 12 to 18 ft. Litter and duff depths were measured at 1 and 6 ft. All measurements were taken both pre- and post-fire. The measurements were used to calculate surface and ground fuel loading with basal area weighted species specific coefficients (van Wagtendonk et al. 1996; 1998); and then percent fuel consumption.

Burn Severity

A rapid assessment of burn severity was completed along each transect and for the entire site area to document the effects of fire on the surface and ground (USDI National Park Service 2003). The National Park Service (NPS) uses fire severity ratings from 1 to 5 when evaluating fire severity. In this rating system, 1 represents high fire severity, while 5 represents unburned areas (Appendix B).

Fire Behavior Measurements and Observations

At each site, multiple temperature sensors and a video camera were set up to gather information on fire behavior. The sensors include the capability to capture day and time of temperatures and heat duration to calculate rate of spread. The sensors are described in more detail below. The video camera is used to determine fire type, flame length, variability and direction of rate of spread and flame duration (Figure 5).

Figure 5: Example of fire resistant video camera box (center of image) at two Rockefeller Grove sites, post-fire.

Rate of Spread and Temperature

Rate of spread was determined by video analysis and rate of spread sensors (MadgeTech data loggers with a thermocouple attached). The data loggers are buried underground with the thermocouple at the surface of the fuel bed. The thermocouple is able to record temperature up to six days or until thermocouple is damaged by heat. The distance and angle between data loggers were measured to utilize the Simard et al. (1984) method of estimating rate of spread using geometry.

Fire Type

Fire type is classified as surface fire (low, moderate or high intensity) or crown fire. Crown fire can be defined as either passive (single or group torching) or active (tree to tree crowning). Fire type was determined from video as well as post-fire effects at each site. For example, sites where there was complete consumption of tree canopy needles indicate at least torching or passive crown fire.

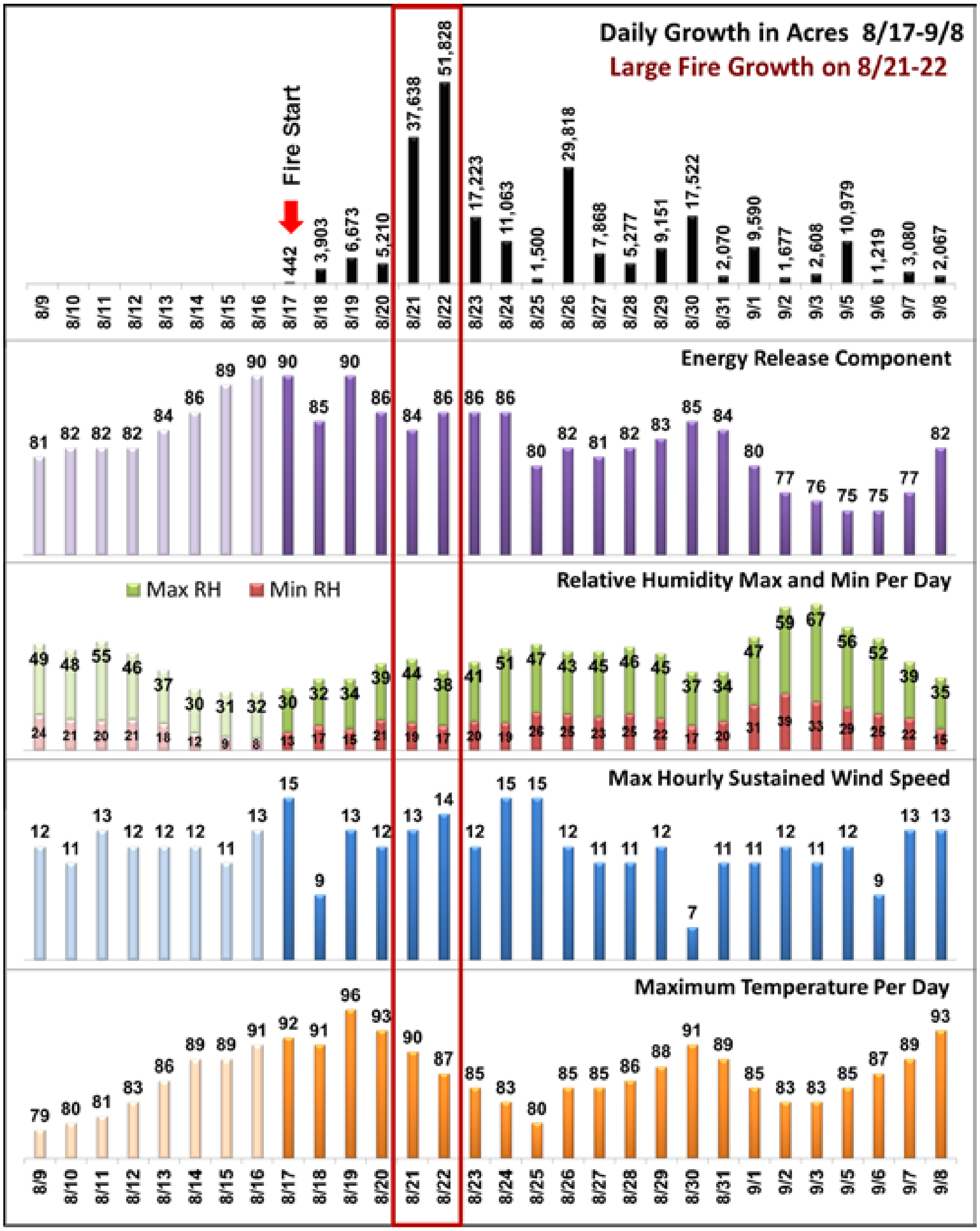
Flame Length and Flaming Duration

Flame length was primarily determined from video footage. If needed, flame length values could be supplemented by tree char height. Flaming duration was based on direct video observation and/or when temperature was measured, from those sensors as well.

Weather

Weather data was downloaded from two permanent remote automated weather stations (RAWS); Mt. Elizabeth (for ERC) and Smith Peak (for humidity, wind, and temperature) by the Stanislaus NF Fire Planner, S. Crook and summarized below (Figure 6, 2014).

Figure 6. Rim Fire histogram displaying the daily growth in acres, Energy Release Component, and weather conditions for Aug. 9 to Sept. 8, 2013 from Smith Peak RAWS (except ERC was Mt. Elizabeth RAWS). The week prior to the start of the Rim Fire is included to set the stage for the conditions that were in place on August 17th when the Rim Fire began. Two large fire growth days are highlighted by red box (days before FBAT data collection).



Findings/Results

Fuels and fire behavior data were successfully collected at six sites. The six sites represented different forest/vegetation types (Table 1). Paired photographs of all the sites are available in Appendix A.

Table 1: Description of the nine sites.

Site	Forest/Vegetation Type	Slope (%)	Aspect (deg.)
1*	YNP Rockefeller Grove - mixed conifer, no fuel management activities in recorded history	29 to 40	96 to 116
2*		25 to 45	30 to 357
3*		33 to 47	295 to 331
4*		33 to 45	2 to 69
5	YNP Tuolumne Grove – Giant sequoia with mixed conifer, recent prescribed fire	25	234
6	YNP Tuolumne Grove - Sequoia with mixed conifer and ephemeral stream area, no prescribed fire	30	240
7	STF plantation - ponderosa pine dominated, tree thinning treatment	21	94
8	STF plantation - ponderosa pine dominated, tree thinning and jackpot burn treatments	15	87
9	STF plantation - ponderosa pine dominated, older tree thinning treatment	15	130

*Sites 1 to 4 were not regular FBAT plots, so slope and aspect values were derived from the LiDAR DEM imagery.

Pre- and Post-Vegetation and Fuel Measurements

Overstory Vegetation Structure and Crown Fuels

This FBAT case study attempts to illustrate some trends based on the site level data collected. Some generalizations are made about the change in canopy characteristics overall. Canopy base height, canopy bulk density, and canopy continuity are key characteristics of forest structure that affect the initiation and propagation of crown fire (Albini 1976, Rothermel 1991). Canopy base height is important because it affects crown fire initiation. Continuity of canopies is more difficult to quantify, but clearly patchiness of the canopy will reduce the spread of fire within the canopy stratum. The data summary listed in Table 2 provides a snapshot of stand characteristics for two areas of the Rim Fire.

Forest treatments that target canopy base height and canopy bulk density can be implemented to reduce the probability of crown fire (Graham et al. 2004). Thinning to reduce canopy bulk density to less than 0.10 kg/m^3 is generally recommended to minimize crown fire hazard (Agee 1996, Graham et al. 1999), and for the most part below this point, active crown fire is difficult to achieve (Scott and Reinhardt 2001). Canopy bulk density varies somewhat within the stands summarized, and reaches a maximum value of 0.072 kg/m^3 at Site 5. Very few changes were detected with the site data being analyzed at the stand level (1 acre/stand) in FVS-FFE. Though, changes in canopy base height were calculated during analysis. Fire is a natural process, or reduction method, for reducing canopy fuels. Tree mortality and canopy fuel changes cannot be determined with certainty until one or more years post-fire due to delayed mortality effects and tree recovery rates.

Tree species within the five sites included: giant sequoia, dogwood, ponderosa pine, sugar pine, white fir, incense cedar, and California black oak. Pre- and post-fire tree metrics are presented in Table 2. Forest structure changes due to surface fire behavior were minimal as detected by our immediate post-fire measurements and calculations (scaled up to one acre, see bold font in below table), though surface and substrate fire effects were detected (Tables 3 to 8).

Table 2: Pre- and post-fire overstory vegetation and crown fuel data by site. QMD is the quadratic mean diameter based on tree data collected at the site scale.

Site	Overstory (>6 in DBH) trees/acre		Pole-size (<6 in DBH) trees/acre		QMD (in)		Basal Area (ft²/acre)		Canopy Cover (%)		Canopy Height (ft)		Canopy Base Height (ft)		CBD (kg/m³)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
5*	61	61	136	136	23	23	590	590	73	73	148	148	9	17	0.072	0.072
6	**48**	**50**	65	65	15	15	131	141	35	36	61	67	4	4	0.027	0.027
7	104	104	0	0	24	24	322	322	69	69	88	88	**33**	**27**	**0.062**	**0.065**
8	49	49	0	0	26	26	179	179	47	47	99	99	27	27	0.027	0.027
9	111	111	0	0	14	14	119	119	41	41	73	73	12	39	0.059	0.045

*Plots 1 to 4 were sensor-focused plots. See Big Plot study for more info (Jim Lutz).

Fire Effects: Tree Canopy Scorch and Torch

A few days after the fire burned through each site to allow for cooling, safety, and smoldering combustion, additional measurements were gathered (char height, maximum scorch and torch heights, and percentage of the crown scorched and torched) to better assess the fire effects at each site. Percentage values were determined using ocular estimations, and heights were measured with a laser rangefinder. Severity or fire effects can be accessed from the percentage of scorch and torch for each study site (Table 3). The fire had scorched (cooked foliage) portions of most tree canopies, but only torched (consumed) portions of a few tree canopies.

Table 3: Overstory canopy average, minimum and maximum percent scorch and torch at each site.

Site	% Scorch			% Torch		
	Average	Min	Max	Average	Min	Max
1*	68	0	100	0	0	0
2*	16	0	65	0	0	0
3*	66	10	95	0	0	0
4*	36	10	100	0	0	0
5	21.4	0	100	0.5	0	5
6	1.1	0	15	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	57.5	20	90	0	0	0

*Plots 1 to 4 were sensor-focused plots with most trees in plot center checked for char, scorch & torch. See Big Plot study for more info.

Understory Vegetation Structure and Loading

The understory vegetation was sparse to patchy at most study sites. Very few grasses or herbaceous species were observed or measured by the three understory/fuel transects at sites 1 to 5, and 8 (Table 4). At Sites 6 to 9 the herbaceous and grass understory component was completely/near completely killed or consumed by the fire (Table 6). Sites 6 and 9 had the highest pre- and post-fire shrub load (Table 4). Dominant shrubs present at the sites included rose, manzanita, snowberry, service berry, bear clover, gooseberry, and ceanothus species, as well as tree seedlings are included (function like woody shrubs for fire behavior calculations). Additional species were found at site 6 that overlapped or bordered a riparian-type area. Some shrubs were burned down to stobs (shrub stumps, Table 5). See Appendix C for a comparison to the Firemon calculations. The paired photographs in Appendix A show a sample of the distribution and density of understory flora for each site, as well as illustrate the change post-burn. Note Plots 1 to 4 were sensor-focused plots; See Big Plot study for more info (Jim Lutz).

Table 4: Pre-and post-fire mean understory vegetation fuel loading by site using Burgan and Rothermel (1984) calculations.

Site	Grass/Herb (ton/ac)						Shrub/Seedlings (ton/ac)					
	Pre-Fire			Post-Fire			Pre-Fire			Post-Fire		
	Live	Dead	Total	Live	Dead	Total	Live	Dead	Total	Live	Dead	Total
5*	0.008	0.001	0.010	<0.000	0.001	0.001	0.006	0.001	0.007	0.001	0.002	0.003
6	0.060	0.011	0.071	<0.000	<0.000	<0.000	2.218	0.200	2.418	0.448	0.476	0.924
7	0.038	0.004	0.042	<0.000	<0.000	<0.000	0.054	0.017	0.071	0.001	0.004	0.005
8	0.007	0.001	0.008	<0.000	<0.000	<0.000	0.044	0.004	0.048	<0.000	0.001	0.002
9	0.004	0.002	0.006	<0.000	<0.000	<0.000	0.163	0.065	0.227	0.026	0.065	0.091

*Plots 1 to 4 were sensor-focused plots. See Big Plot study for more info (Jim Lutz).

Table 5: Average height pre-and post-fire of grass/herbs and shrub/seedlings for each site.

Site	Grass/Herb Height (in.)		Shrub/Seedlings Height (in.)	
	Pre	Post	Pre	Post
5	4	3	6	5
6	6	1	40	34
7	6	0	14	5
8	13	1	14	8
9	7	0	25	14

Table 6: Mean Understory vegetation consumption for each site.

Site	Consumption (%)	
	Grasses/Herbs	Shrub/Seedlings
5	88	62
6	99	62
7	100	94
8	99	97
9	97	60

Surface and Ground Fuel Loading

The predominant fuels were duff and litter (forest floor) and 1000-hour fuels (logs on ground ≥ 3 inch diameter at transect intersection) at sites 5 and 8 (Table 7). The fuel bed depth ranged from a few inches to up to two feet. Sites 7 and 8 had a large understory vegetation component, and dead and downed 1-hour fuels were limited. Consumption amounts varied both by fuel category and site (Table 8). Site 5 had the lowest total consumption (41%) probably due to its recent prescribed burn, and Sites 6, 7, and 9 the highest (95 to 99%). Immediate post-fire fuels recruitment is not counted during the immediate post-fire site visit, even if it is found (needle and branches that have fallen).

Table 7: Average pre-and post-fire fuel loading and fuel bed depth*.

Site	Mean Fuel Loading (tons/acre)														Fuel Bed Depth (ft)	
	Duff		Litter		1-hr		10-hr		100-hr		1000-hr		Total load			
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
5	5.6	2.5	3.5	1.1	0.3	0.1	0.4	0.1	0.3	0.2	6.3	6.0	16.5	9.8	2.1	0.8
6	31.7	0	9.2	0	0.2	0	1.3	0.1	1.3	0.1	2.8	0.3	46.6	0.5	0.5	0.2
7	38.9	0	3.7	0	0	0.1	0.6	0	1.5	0	3.4	2.2	48.2	2.3	0.7	0.2
8	14.0	0	9.0	0.1	0	0.1	1.3	0.1	0.4	0	16.6	8.1	41.3	8.4	1.0	0.6
9	33.5	0.5	5.7	0.2	0.1	0	0.5	0.2	0.8	0	2.7	0	43.3	0.9	0.2	0.0

*Each metric is based on an average of three transects, except the total loading per site is an average of three transects totals and not a sum of the average metrics listed for each category.

Table 8: Average percent fuel consumption per metric and for site overall, based on above table.

Site	Percent Consumption (%)							% Change in Fuel Bed Depth
	Duff	Litter	1-hr	10-hr	100-hr	1000-hr	% Total load on site	
5	56	70	74	87	50	5	41	63
6	100	100	88	93	90	90	99	63
7	100	100	N/A	100	100	35	95	74
8	100	99	N/A	94	100	51	80	44
9	98	97	78	63	100	100	98	84

N/A: Not possible to calculate the percent consumption because fuel loading was zero pre-fire.

Soil, Substrate, and Vegetation Burn Severity Rating

The National Park Service's severity categories were used to assess post-burn soil/substrate and understory vegetation severity along each transect and for the entire site. Vegetation burn severity is only based on the vegetation that was documented pre-burn. Figures 5 and 6 show the site level estimates. For full descriptions of the categories, please see Appendix B.

Figure 5: Mean post-fire surface soil (substrate) severity rating by site.

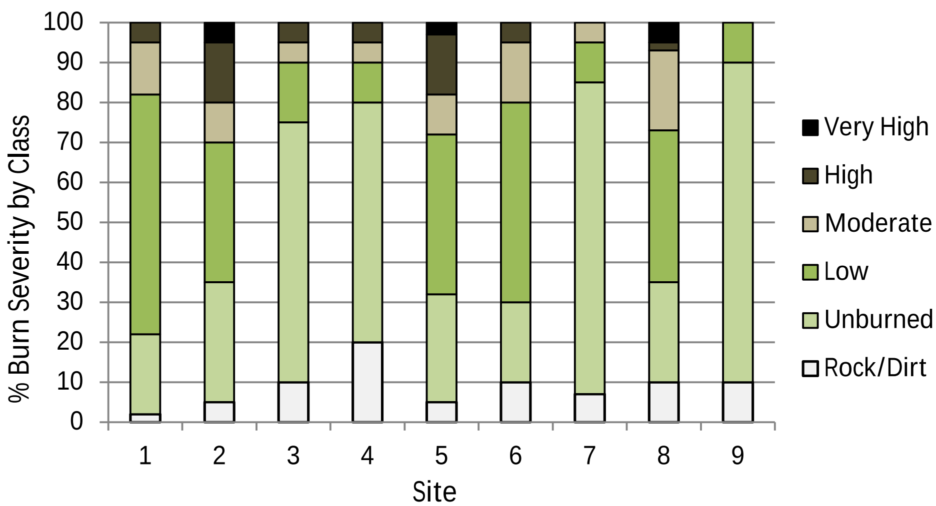
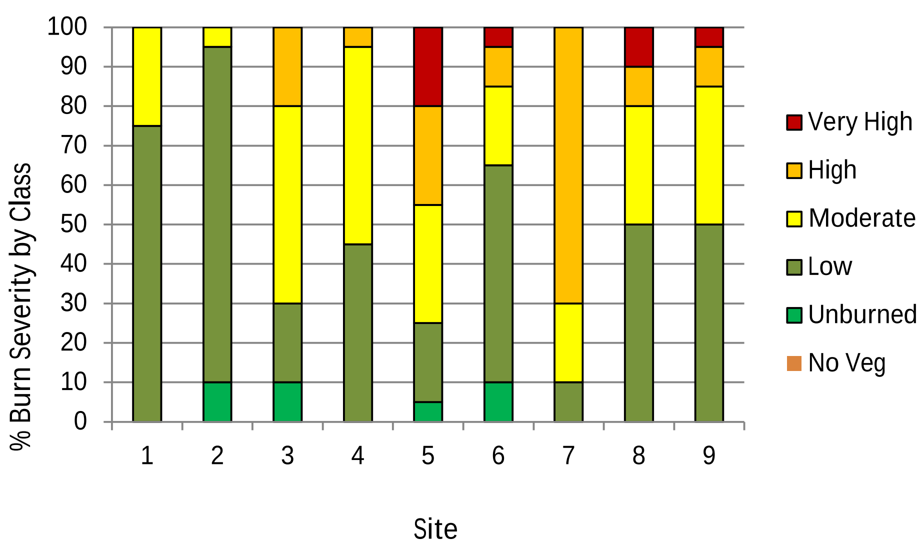


Figure 6: Post-fire understory vegetation severity rating by site.



Fire Behavior Observations and Measurements

The nine study sites at YNP Rockefeller Grove (mixed conifer), YNP Tuolumne Grove (giant sequoia with mixed conifer), and the STF plantations (ponderosa pine dominated) burned between August 31 and Sept. 2, 2013. Below is a site by site description of fuels and fire behavior observations from onsite videos and then the temperature sensors. The still shots captured from the video include vertical poles for scale that have 1-foot gradients. See Appendix A for matching pre- and post-fire vegetation pictures.

Fire Behavior Measurements from the Video Camera Footage

In addition to the sensors, fire behavior data can be obtained from the video footage. Table 10 below lists the fire type, flame length, flame angle, rate of spread and duration of active consumption. All values are determined by watching the video footage using photo poles in view of the camera. Subtle differences were found between the fire behavior measurements between the video camera and the other sensors.

Table 10: Fire behavior data based on the video camera footage.

Site	Fire Type	Flame Length (ft)	Flame Angle (%)	ROS (ch/hr)	Date, Approx. Start of Fire	End of Active Consumption
1	Surface	1 to 2, occasional 2 to 4	50 to 200%	Unknown: view area already burning at video start	9/01/2013 10:31	11:49+Forground consumed at start
2	Surface and little torching	2 to 5, ½ tree heights	150 to 200%	1	9/01/2013 01:39	03:01+ foreground never burned, Background burning still
3	Surface and little torching	1 to 2, 2 to 5 in 1000hrs	150 to 200%	<1	9/01/2013 12:59	14:21+ foreground never burned, Background burning
4	Mod to high intensity Surface with little torching	2 to 6, some 10	150 to 200%	Unknown: view area already burning at video start	9/02/2013 10:46	1130+
5	Surface and some torching, Burnout	1 to 3, 4 to 6 in pockets, ½ tree height	150 to 200%	<1	8/31/2013 15:00	16:22+
6	Surface	1 to 2	150 to 200%	<1	8/31/2013 17:46	19:07+
7	Around same time as site 8, no video recorded					
8	Surface	1 to 2	50 to 100%	1 to 2	9/01/2013 12:56	14:10 foreground consumed
9	Surface with some torching, (very smoky)	Very smoky and high camera angel			9/01/2013 14:38	About 1600, smoky

Sites 1 to 4, Rockefeller Grove, Mixed Conifer, No management activities in recorded history

Sites 1 to 4 were priority locations for fire behavior and immediate post-fire severity measurements inside the large Yosemite Forest Dynamics Plot (AKA, "Big Plot") to complement the intensive fuel and vegetation measurements. This area had a mix of large old conifer and hardwood overstory species and a large variety and size of understory species, younger trees, and snag densities. Sites were located in a variety of fuel and vegetation conditions, aspects, and hillslopes. Long term monitoring markers/tags on the forest floor and trees, as well as casual access trails were evident in the area. Incident management tactics were employed to manage when and how fast the Groves were burned in order to lesson severity and reach incident containment goals. The fire triggered the video camera and heat sensors from Sept. 1st at 01:39 to Sept. 2nd at 10:46 (about a 33 hr period) and captured a low surface fire with primarily a backing/flanking orientation, with some isolated tree or shrub torching. Winds appeared calm based on the fire shelter-type flagging on the photo reference poles (Figure 7).

Figures 7 to 10. Representative fire behavior in order from Site 1 to 4, which mostly had a surface fire pass in front of the video camera.

Figure 7, Site 1, burned at 10:31 on 9/1st

Figure 8, Site 2, burned at 01:39 on 9/1st

Figure 9, Site 3, burned at 12:59 on 9/1st

Figure 10, Site 4, burned at 10:46 on 9/2nd

Site 5 and 6, Tuolumne Grove, Giant Sequoia and Mixed Conifer Stand – Treatment comparison sites
These sites are located in Yosemite's Tuolumne Grove very close together (about 200 yards); the area has high visitor use, including trails and roads. Site 5 was inside a 2005 prescribe fire treatment, and site 6 though technically spatially inside that unit boundary probably had not been burned in 2005 (or was limited consumption potentially because it included an ephemeral riparian area). Neither site area had wildfires recorded at them in the last 108 years before the Rim fire. Incident management tactics were employed to manage when and how fast the Groves were burned in order to lesson severity and reach incident containment goals. Both sites burned Aug. 31st, with low intensity surface fire (Figures 11 and 12). The Park's famous Tunnel Tree, a historical/heritage site, was in this nearby area and video recorded that special site as well (figure 13, with evidence of water use to protect this ember receptive "snag").

Figures 11 to 13. Site 5 on the left, Site 6 on the right, and Tunnel tree is bottom picture.

Sites 7 to 9, Stanislaus National Forest, Ponderosa Pine Plantations - Treatment comparison sites
Sites 7 and 8 were about 100 yards apart in a pine plantation, divided by a dirt road, and were part of an area that had commercial tree thinning treatments from 1995 to 2001. Site 8 also had a follow up 2005 treatment labeled "jackpot" burning (spatially scattered concentrations of underburn treatments or pile burn pattern). All three of these sites were inside the 1950 Wrights Creek Fire perimeter. Due to their proximity the sites 7 and 8 presumably burned in a similar time frame, but the in-fire video trigger failed at site 7 and did not record. Temperature sensor data at sites 7 and 8 were recorded on Sept. 1st and into the next night on Sept. 2nd, respectively.

Site 9 was in an older pine plantation and had a commercial tree thinning treatment during 1999-2004. Wildfire video was recorded Sept. 1st but is very smoky, which recorded a low quality fire behavior image. Incident management tactics were employed to manage when and how fast these areas burned in order to lesson fire severity and reach incident containment goals. These sites are located at the edge of the Rim fire perimeter and provided increased opportunities for perimeter containment, partially due to their reduced fuel loads. Based on sensor and video data, and immediate post-fire site visits all three sites burned with low intensity surface fire (Figures 14 and 15).

Figures 14 and 15. Site 8 on the left, Site 9 on the right (no video image was recorded at site 7).

Data Collected from Temperature Sensors

Rate of spread and temperature data were gathered using fire resistant data loggers, or sensors, at each site (Table 11). Sites 1 to 5 and 8 had three out of four sensors in a grid formation function well, which is the minimum needed to calculate rate of spread across the site. Sites 6, 7, and 9 had problematic sensor data, ranging from unreasonable (too low) fire temps recorded to downloading and battery problems. Overall, the low rates of spread calculated do seem to accurately capture the incident operational tactics for those areas, as the Rim Fire perimeter was contained near many of these sites.

Table 11: Rate of spread (ROS), max temperature, and duration of heat from the temperature sensors.

<table>
<tr><th>Site</th><th>Date, Time fire 1st detected by 1 sensor</th><th>ROS (ch/hr)*</th><th>Maximum Temperature at 1 sensor (°C)</th><th>Heat Duration Range Above 80 °C at 1 sensor (min.)</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">9/1/13, 14:54</td><td rowspan="3">0.7</td><td>151</td><td>3</td></tr>
<tr><td>103</td><td>1</td></tr>
<tr><td>208</td><td>3</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">9/1/13, 03:39</td><td rowspan="3">0.1</td><td>1,105</td><td>32</td></tr>
<tr><td>933</td><td>10</td></tr>
<tr><td>445</td><td>180</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">9/1/13, 12:11</td><td rowspan="3">0.07</td><td>485</td><td>15</td></tr>
<tr><td>694</td><td>7</td></tr>
<tr><td>130</td><td>50</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">9/2/13, 09:57</td><td rowspan="3">0.1 to 0.7</td><td>874</td><td>13</td></tr>
<tr><td>96</td><td>1</td></tr>
<tr><td>388</td><td>1</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">8/31/13, 14:47</td><td rowspan="3">1.7</td><td>69</td><td><1</td></tr>
<tr><td>810</td><td>25</td></tr>
<tr><td>93</td><td><1</td></tr>
<tr><td>6</td><td colspan="4">Multiple sensor failure, no fire temperatures recorded; no ROS value</td></tr>
<tr><td>7</td><td>9/2/13, 01:22</td><td colspan="3">Multiple sensor failure; no ROS value</td></tr>
<tr><td rowspan="4">8</td><td rowspan="4">9/1/13, 12:51</td><td rowspan="4">0.3 to 0.5</td><td>648</td><td>8</td></tr>
<tr><td>750</td><td>110</td></tr>
<tr><td>305</td><td>10</td></tr>
<tr><td>146</td><td>7</td></tr>
<tr><td>9</td><td colspan="4">Multiple sensor failure; no ROS value</td></tr>
</table>

*When only one ROS value listed, then 1 or more sensors did not record a value; so we're unable to calculate a range of ROS.

Summary and Accomplishments

The following summary is for two areas of the Rim fire, Yosemite's Rockefeller and Tuolumne Groves, and Stanislaus' ponderosa pine plantations in NW corner of the fire, due safe access and when FBAT was on the incident (Aug. 28th to Sept. 9, 2013, based on on-call member availability).

Our objectives were to:

1. Characterize fire behavior and quantify fuels for a variety of fuel conditions. A key consideration was which sites could be measured safely given access and current fire conditions.
2. Measure representative vegetation and fire behavior at recent fuel treatments; initial focus area was on fire behavior at the Yosemite Forest Dynamics Plot (AKA "Big Plot") in Rockefeller Grove to supplement other ongoing research efforts (contact james.lutz@usu.edu).
3. Assess fire severity and effects at the study sites based on immediate post-fire measurements.
4. Cross-train and work with some of the STF Calaveras Wildland Fire Module and NPS and STF staff during the field study, as well as collaborate with local ecologists.
5. Produce a summary report based on preliminary analysis for fire managers, such as those at Yosemite National Park and associated researchers and at Stanislaus National Forest.

Nine sites were successfully measured and burned over in the Rim fire, in two separate area of this large fire from Aug. 28th to Sept .6th, 2013. Numerous vegetation mixed-severity areas are found within the fire perimeter, and mostly lower severity sites were encompassed by the FBAT sites. The five sites outside Rockefeller grove were in and adjacent to recent fuel treatments, and fire behavior was able to be more demonstratively controlled by incident tactics (e.g., burning operations and timing) compared to the first few days of the fire.

We met the above objectives, including continuation of our great safety record, and communicate results through the distribution of this report and its input data. We had some equipment or sensor failures that serve as learning lessons for FBAT, as well as focused areas for improvement (that have been addressed in subsequent seasons). This report presents multiple datasets to compare fuel and fire behavior between the sites and other fires.

This information is shared with managers to evaluate the effectiveness of fuel treatments and the less actively managed Rockefeller Grove area during one wildfire. The information can be valuable when shared with: firefighters to improve situational awareness; managers to improve predictions for fire planning; and scientists for improving smoke and fire behavior modeling. A BAER study was conducted of the soil burn severity, as well as numerous additional studies; please see those reports for further details. This report will be distributed to Rim Fire personnel, the Stanislaus National Forest, and Yosemite National Park and Big Plot researchers, and USFS Fire and Fuels Management.

Lessons Learned and Improvements Needed

Successful cross-training with module and federal fighters

1. We increased our skill set between the Type 1 Calaveras Wildland Fire Module (WFM), available on-call FBAT members, NPS staff, and overall FBAT module cohesion. We continued to focus upon our priority safety goal and meet our 100 percent safety record. We will continue to improve our proficiency with setting up additional sensors and post-fire data processing.

Immediate and current data sharing

2. Immediate data sharing occurred with the incident staff. This report and detailed site data is shared with interested Forest and Park staff; additional data details are available upon request.

Equipment/Sensors

3. We overheated some temperature data loggers, had anemometer and temperature data recording and download failures, and one in-fire video trigger failure. Since we had a large ratio of temperature sensor failures, we've increase from four to five per site in subsequent seasons, that have increased the success ratios.
4. We captured limited site specific wind measurements, due to data recording failures and the return to including this as part of our normal protocol. However, wind direction and general wind speed trends (using the Beaufort scale) can be obtained from video footage taken facing the flagging (serves as a wind vein) tied to the video reference pole.
5. We desire to incorporate nearby on-site emissions monitors and weather stations, that would not be subject to nearby fire or heat impingement.

Acknowledgements

Special thanks and appreciation to those not mentioned on the report cover: Stanislaus National Forest's Calaveras Wildland Fire Module (those not mentioned on the report cover include William Barber, Ian Zoellner, Jason Lynn, Thomas Payne, Dan Sielicki, Ryan Hindman, and Jeff Rivas), Yosemite National Park staff and NPS READs (Joe Meyer, Jun Kinoshita, Brian Mattos, Martin Hutten, Erin Babich, Todd Erdody, Jenifer Gibson), John Clark (Cal Fire FOBS), Christiana Kittel, Corbin Murphy (BLM), Chelsea Morgan, Siuslaw National Forest 10 person module with Zac Hayes, Rob Griffith, the CA Central Sierra Incident Management Team (IMT, especially Dave Cooper and Ben Jacobs,) the Southern Region "Blue" IMT, Stanislaus NF staff such as Steve Baran, Shelly Crook, Carly Gibson, and Mark Schug; Jim Lutz and the Big Plot cooperators, and many other incident staff who were supportive and helped with study site establishment and logistics. Thanks to past FBAT members and assistance, including the USFS WO and PSW Regions FAM, and others who helped build our FBAT program to its current worth.

References

Albini , Frank A. 1976. Estimating wildfire behavior and effects. USDA Forest Service. GTR INT-30. Intermountain Forest and Range Experiment Station.

Agee, J.K. 1996. The Influence of Forest Structure on Fire Behavior. 17th Forest Vegetation Management Conference. University of Washington, Seattle, WA.

Brown, J.K., 1974. Handbook for inventorying downed woody material. USDA For. Serv. Gen. Tech. Rep. GTR-INT-16. 34 p.

Crookston, N.L., Dixon, G.E., 2005. The forest vegetation simulator: a review of its structure, content, and applications. Comput. Electron. Agric. 49, 60–80.

Graham, R.T., Harvey, A.E., Jain, T.B., Tonn, J.R. 1999. The effects of thinning and similar stand treatments on fire behavior in Western forests. Gen. Tech. Rep. PNW-GTR-463. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Graham, R.T., McCaffrey, S., Jain, T.B. (tech. eds.). 2004. Science basis for changing forest structure to modify wildfire behavior and severity. Gen. Tech. Rep. RMRS-GTR-120. Fort Collins, CO: Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Lutes, D.C., Keane, R.E. Caratti, J.F., Key, C.H. Benson, N.C., Sutherland, S., Gangi, L.J., 2006., Database User Manual in FIREMON: The fire effects monitoring and inventory system. USDA For. Serv. Gen. Tech. Rep. RMRS-GTR-164-CD.

Rebain, S.A. (Comp.), 2010. The Fire and Fuels Extension to the Forest Vegetation Simulator: Updated Model Documentation. USDA For. Serv. Int. Rep. 408 p. (revised July 2013)

Rothermel, R.C. 1991. Predicting behavior and size of crown fires in the Northern Rocky Mountains. Research Paper. INT-438. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Scott, J.H., Reinhardt, E.D. 2001. Assessing crown fire potential by linking models of surface and crown fire behavior. Research Paper. RMRS-RP-29. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Simard, A., J. Eenigenburg, K. Adams, R. Nissen Jr., and A. Deacon. 1984. A general procedure for sampling and analyzing wildland fire spread. Forest Sci., Vol. 30, No. 1.

USDI National Park Service. 2003. Fire Monitoring Handbook. Boise, ID: Fire Management Program Center, National Interagency Fire Center, 274p. Program information available online: http://www.nps.gov/fire/fire/fir_eco_mon_protocols.cfm (Aug. 2, 2011).

van Wagtendonk, J.W., Benedict, J.M., Sydoriak, W.M., 1996. Physical properties of woody fuel particles of Sierra Nevada conifers. Int. J. Wildland Fire. 6, 117–123.

van Wagtendonk, J.W., Benedict, J.M., Sydoriak, W.M., 1998. Fuelbed characteristics of Sierra Nevada conifers. West. J. Appl. Forestry. 13, 73–84.

Van Wagner, C.E. 1968. The line intersect method in forest fuel sampling. Forest Sci. 14:20-26.

Appendix A: Representative Paired Photographs from Pre- and Post-Vegetation and Fuel Sites

Plot 1 (3^{rd} to 2^{nd} ROS) Pre-fire

Plot 1 (3^{rd}-2^{nd} ROS) Post-fire

Plot 2 (2^{nd}-3^{rd} ROS) Pre-Fire

Plot 2 (2^{nd}-3^{rd} ROS) Post-fire

Plot 2 (1^{st}-2^{nd} ROS) Pre-fire

Plot 2 (1^{st}-2^{nd} ROS) Post-fire

Plot 3 (1^{st}-2^{nd} ROS) Pre-fire

Plot 3 (1^{st}-2^{nd} ROS) Post-fire

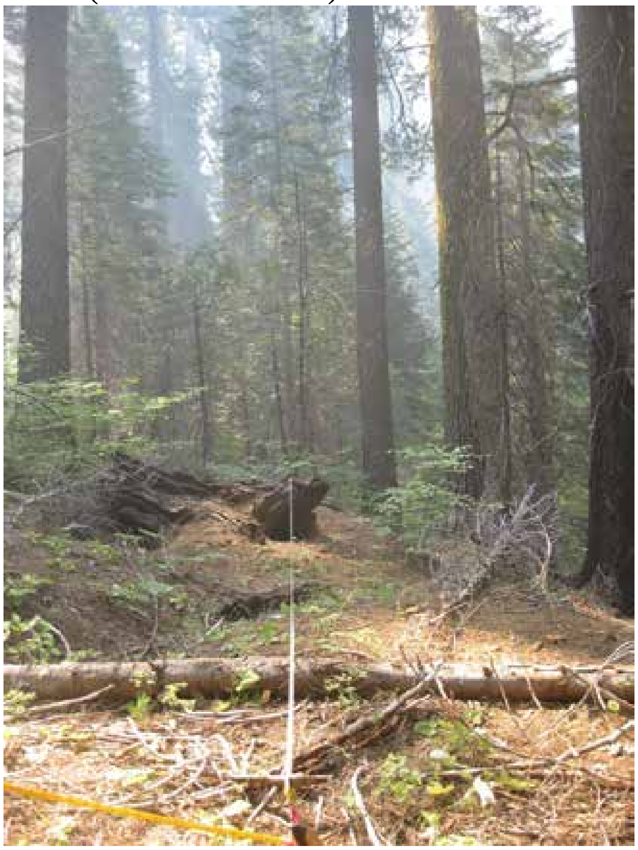
Plot 4 (3rd-Home ROS) Pre-fire

Plot 4 (3rd-Home ROS) Post-fire

Plot 4 (3rd-2nd ROS) Pre-fire

Plot 4 (3rd-2nd ROS) Post-fire

Plot 5 (Transect 3: 50-0ft) Pre-fire



Plot 5 (Transect 3: 50-0ft) Post-fire

Plot 5 (Transect 2: 50-0ft) Pre-fire

Plot 5 (Transect 2: 50-0ft) Post-fire

Plot 6 (Transect 1: 50-0ft) Pre-fire

Plot 6 (Transect 1: 50-0ft) Post-fire

Plot 6 (Transect 2: 50-0ft) Pre-fire

Plot 6 (Transect 2: 50-0ft) Post-fire

Plot 7 (Transect 2: 0-50ft) Pre-fire

Plot 7 (Transect 2: 0-50ft) Post-fire

Plot 7 (Transect 1: 50-0ft) Pre-fire

Plot 7 (Transect 1: 50-0ft) Post-fire

Plot 8 (Transect 1: 50-0ft) Pre-fire

Plot 8 (Transect 1: 50-0ft) Post-fire

Plot 8 (Transect 3: 50-0ft) Pre-fire

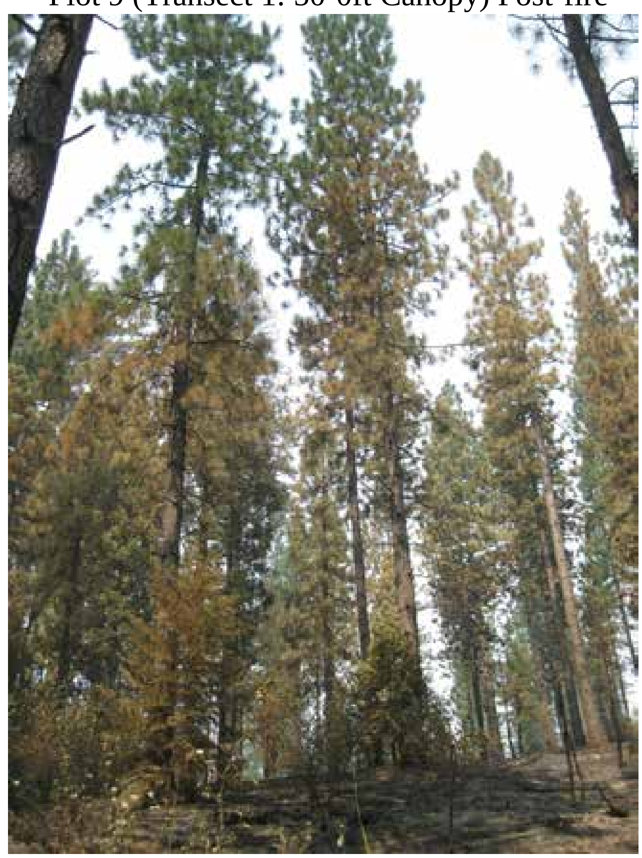
Plot 8 (Transect 3: 50-0ft) Post-fire

Plot 9 (Transect 1: 50-0ft) Pre-Fire

Plot 9 (Transect 1: 50-0ft) Post-fire

Plot 9 (Transect 1: 50-0ft Canopy) Pre-fire

Plot 9 (Transect 1: 50-0ft Canopy) Post-fire



Appendix B: Burn severity coding matrix from the National Park Service

Table 12. Burn severity coding matrix from the National Park Service (USDI 2003).

Code	Forests		Shrublands	
	Substrate	Vegetation	Substrate	Vegetation
Unburned (5)	not burned	not burned	not burned	not burned
Scorched (4)	litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged	foliage scorched and attached to supporting twigs	litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged	foliage scorched and attached to supporting twigs
Lightly Burned (3)	litter charred to partially consumed; upper duff layer may be charred but the duff layer is not altered over the entire depth; surface appears black; woody debris is partially burned	foliage and smaller twigs partially to completely consumed; branches mostly intact	litter charred to partially consumed, some leaf structure undamaged; surface is predominately black; some gray ash may be present immediately after burn; charring may extend slightly into soil surface where litter is sparse otherwise soil is not altered	foliage and smaller twigs partially to completely consumed; branches mostly intact; less than 60% of the shrub canopy is commonly consumed
Moderately Burned (2)	litter mostly to entirely consumed, leaving course, light colored ash; duff deeply charred, but underlying mineral soil is not visibly altered; woody debris is mostly consumed; logs are deeply charred, burned-out stump holes are common	foliage, twigs, and small stems consumed; some branches still present	leaf litter consumed, leaving course, light colored ash; duff deeply charred, but underlying mineral soil is not visibly altered; woody debris is mostly consumed; logs are deeply charred, burned-out stump holes are common	foliage, twigs, and small stems consumed; some branches (0.25-0.50 inch in diameter) still present; 40-80% of the shrub canopy is commonly consumed.
Heavily Burned (1)	litter and duff completely consumed, leaving fine white ash; mineral soil visibly altered, often reddish; sound logs are deeply charred and rotten logs are completely consumed. This code generally applies to less than 10% of natural or slash burned areas	all plant parts consumed, leaving some or no major stems or trunks; any left are deeply charred	leaf litter completely consumed, leaving a fluffy fine white ash; all organic material is consumed in mineral soil to a depth of 0.5-1 in, this is underlain by a zone of black organic material; colloidal structure of the surface mineral soil may be altered	all plant parts consumed leaving only stubs greater than 0.5 in diameter
Not Applicable (0)	inorganic pre-burn	none present pre-burn	inorganic pre-burn	none present pre-burn

Appendix C: Understory Vegetation Loading Comparison

The FBAT program has traditionally used the Burgan and Rothermel (1984) methods adapted by Scott (2005) to estimate and calculate live understory fuel loading (i.e., grass, herbs, shrubs, seedlings), as presented in the body of the report (Tables 4 and 6). Fire Effects Monitoring and Inventory Protocol (FIREMON, Lutes et al. 2006) is an accepted protocol by the fire and fuels community, so we did a quick comparison of the formulas and values using five FBAT sites at the Rim fire (Tables AC1 and AC2, below). Note all plots had three understory vegetation transects, but sometimes a transect contained no herb/grass or shrub/seedling components to measure.

Table AC1: Pre- and post-fire understory vegetation fuel loading by site based on FIREMON.

Site	Grass/Herb (ton/ac)						Shrub/Seedling (ton/ac)					
	Pre-Fire			Post-Fire			Pre-Fire			Post-Fire		
	Live	Dead	Total	Live	Dead	Total	Live	Dead	Total	Live	Dead	Total
5	0.043	0.006	0.049	0.004	0.008	0.012	0.059	0.009	0.068	0.007	0.019	0.026
6	0.208	0.039	0.247	<0.000	<0.000	0.001	7.316	0.655	7.971	1.571	1.526	3.097
7	0.136	0.016	0.152	0	0	0	0.286	0.086	0.373	0.003	0.012	0.015
8	0.073	0.008	0.081	<0.000	0.001	0.001	0.432	0.040	0.472	0.007	0.032	0.038
9	0.046	0.017	0.062	0	0	0	1.281	0.420	1.700	0.247	0.478	0.724

Table AC2: Understory vegetation consumption by site based on FIREMON.

Site	Consumption (%)	
	Grass/Herb	Shrub
5	76	62
6	100	61
7	100	96
8	99	92
9	100	57

In general for the Rim fire, the grass, herbaceous and shrub components in these plots were minimal. Plots with more live fuel loading would be a better test case. Because the grass and herbaceous component were often minimal amounts, field data was often estimated to be less than or equal to 1 percent cover for each species. The calculated bulk densities are highly dependent on the user-assigned vegetation type and vegetation density values chosen. When a user chooses lower vegetation types and densities, then usually very light bulk densities are calculated; this transitions to heavier bulk densities when heavier vegetation types and densities are chosen.

Note that inherent differences between the bulk density values used in Burgan and Rothermel and FIREMON equations for calculating live understory fuels drive differences in outputs. The bulk densities used in Burgan and Rothermel and FIREMON equations have different ranges. The bulk densities used in the Burgan and Rothermel equation can range from 0.80 to 1.44 for grasses and herbaceous plants and 0.18 to 14.71 kg/meter-cubed for shrubs, whereas the bulk densities in the FIREMON equations are 0.8 and 1.8 kg/meter-cubed for herbs and shrubs, respectively. The bulk densities for the Burgan and Rothermel equation are chosen based on a look up table of type and density. The lower combinations of type and density values yield lower Burgan and Rothermel total fuel loadings than the FIREMON equations, and the higher values for type and density yield fuels loading yield higher amounts than FIREMON values. Note these relationships generally hold true when plant percent cover and height are both 1 (sensitivity analysis), and change only slightly with percent cover and height greater than 1.

Our comparison shows that overall, the FIREMON estimates were higher for herb/grasses and mixed for shrub/seedlings, probably due to lower vegetation and density types observed and chosen for the Burgan and Rothermel calculations (Tables AC3 and AC4, below). A notable exception is the loading differences for sites 6 (Giant Sequoia mixed-conifer untreated site) that have a range or difference up to 5.5 tons/acre. **Unfortunately, this comparison shows two different estimates of fuels with no clear indication of which is more accurate, but it does show the possible range of conditions depending on calculation methods.** Further investigation is needed between these calculations to find which is more representative of understory vegetation loading in Sierra mixed conifer and other ecosystems, such as by literature comparison, conversations with specialists, and conducting destructive sampling and measuring actual amounts.

Table AD3. Comparison of herb and grass loading by Burgan and Rothermel and FIREMON.

Site	Status	B & R Total Load (ton/ac)	FIREMON Total Load (ton/ac)	Difference
5	pre	0.010	0.049	-0.039
	post	0.001	0.012	-0.011
6	pre	0.071	0.247	-0.175
	post	0.000	0.001	0.000
7	pre	0.042	0.152	-0.110
	post	0.000	0.000	0.000
8	pre	0.008	0.081	-0.073
	post	0.000	0.001	-0.001
9	pre	0.006	0.062	-0.056
	post	0.000	0.000	0.000

Table AD4. Comparison of shrub and seedling loading by Burgan and Rothermel and FIREMON.

Site	Status	B & R Total Load (t/ac)	FIREMON Total Load (ton/ac)	Difference (tons/acre)
5	pre	0.007	0.068	-0.061
	post	0.003	0.026	-0.023
6	pre	2.418	7.971	-5.553
	post	0.924	3.097	-2.174
7	pre	0.071	0.373	-0.302
	post	0.005	0.015	-0.010
8	pre	0.048	0.472	-0.423
	post	0.002	0.038	-0.037
9	pre	0.227	1.700	-1.473
	post	0.091	0.724	-0.634

Appendix D: About the Fire Behavior Assessment Team (FBAT)

The Fire Behavior Assessment Team (FBAT) operates under the management of the Adaptive Management Services Enterprise Team (AMSET) of the USFS. We specialize in measuring fire behavior and fuels on active wildland and prescribed fires. We utilize heat-resistant sensors and video cameras to measure direction and variation in rate of spread, fire type (e.g. surface, passive or active crown fire behavior), onsite weather, and couple this with measurements of fire effects, topography, and fuel loading and moisture. We measure fuel load changes from fire consumption and compare the effectiveness of past fuel treatments or fires in terms of fire behavior and effects. We are prepared to process and report some data while on the incident, making information immediately applicable for calibrating LTAN, FBAN, or Air Resource Advisor predictions. In addition, the video and data are useful for conveying specific information to the public, line officers and others. We can also collect and analyze data to meet longer term management needs, such as calibrating fuel and fire behavior modeling for fire management plans, unit resource management plans, or project plans.

Since 2003, The FBAT program has built a rich dataset and library of products for fire and fuels managers; fire training and safety; and fuel, fire, and smoke scientific communities. FBAT video has been utilized by the Wildland Firefighter Apprenticeship Program and USFS PSW ecological restoration video series; and FBAT data and program information were shared with the **JFSP crown fire behavior knowledge synthesis project** (p. 41) and a **PSW Research Station project** about CA wildfire emissions and evaluated FOFEM. Other collaborations to collect and utilize FBAT data are in progress including: supplying data to support fire safety zone research at the Missoula Fire Sciences Laboratory; continued interagency wildfire consumption data related to emissions estimates; and continued field sampling for black carbon measurements Michigan State University.

FBAT is a module of fireline qualified technical specialists and experienced fire overhead. The overhead personnel include a minimum of crew boss qualification, and more often one or more division supervisor qualified firefighters. The team can vary in size, depending upon availability and needs of order, from 5 to 12 persons. We have extensive experience in fire behavior measurements during wildland and prescribed fires. We have worked safely and effectively with over 17 incident management teams. We are comprised of a few AMSET FBAT core members and other on-call firefighters from the USFS and other agencies. We can train other interested and motivated firefighters while on fire incidences, as time allows.

We can be ordered from ROSS, as Fire Behavior Assessment Team (FBAT) members, and are in the CA Mobilization Guide (near the BAER Teams). We can be name requested, and we'll facilitate requesting additional on-call personal to join our team, like a Wildland Fire Module (based on availability). Please contact us directly to notify us that you are placing an order, which will speed up the process. You can reach Carol Ewell at 530-559-0070 (cell) or via the Stanislaus NF dispatch (209-532-3671 x212). Or you can reach Alicia Reiner at 530-559-4860 (cell). We may be available if you call dispatch and we are already assigned to a fire; we can work more than one fire simultaneously and may be ready for remobilization. This is the FBAT web page, which has links to most FBAT Incident Summary Reports: http://www.fs.fed.us./adaptivemanagement/projects/FBAT/FBAT.shtml