Antelope Complex

Fire Behavior Assessment Report

fire burning across site 2 at night

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Executive Summary

Introduction
Wildfire suppression and wildland fire use fire management are dependent upon good fire behavior and resource effects predictions. Existing fire behavior and resource effects prediction models, such as FsPro and FARSITE are based upon limited data from fire 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 use managers and wildfire 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. The team also collects other information on fire fighter safety, such as convective heat in safety zones as opportunities arise.

This report contains the results of the assessment of fire behavior in relation to fuels, weather and topography, and fire effects to resources in relation to fire behavior on the Wheeler fire of the Antelope Complex.

Objectives
Our first objective was to quantify fire behavior in relation to fuels and weather for a variety of fuel conditions, especially through areas treated for fuel hazard reduction. Our second objective was to conduct a rapid assessment of fire behavior across the fire in relation to the time of day, suppression activities, fuel treatments and vegetation conditions.

Two different approaches were used. For the first objective we gathered detailed, quantitative data on pre-fire fuels, fire behavior and post-fire conditions. For the second objective, we conducted a rapid, on the ground survey, of immediate post-fire evidence of fire behavior (i.e. scorch, crown consumption, needle freeze) and interviewed firefighters present.

Accomplishments
Quantitative pre-fire fuels data were collected at 18 sites. Fire behavior, pre-fire fuels and post-fire conditions were measured at 9 of the 18 sites that burned. Amongst the 18 sites sampled, 13 had received some type of treatment ranging from prescribed fire to thinning and burning, and selective harvest/thinning. Direct observation of the fire behavior and suppression in relation to the treatment sites were made. Many of the unburned sites that had previously been treated were utilized for suppression activities that resulted in the sites not burning. The sites encompassed a variety of vegetation and fuel types. This included eastside yellow pine (Jeffrey and/or ponderosa pine) with grass or bitterbrush and manzanita or mahala mat understories and transitional (between eastside and westside) forests comprised of various mixtures of yellow pine, white fir and Douglas-fir. The mixed transitional forests had various understories with the most prevalent plants including tobacco leaf ceanothus, greenleaf manzanita, mahala mat, bitterbrush, snowberry and various grasses. One mixed white fir and lodgepole pine stand was sampled.

For the rapid assessment, 61 rapid plots were established, including photos, GPS locations, severity ratings for the tree canopy and soils and evidence of fire behavior (i.e. needle freeze). A treatment history layer was obtained from the Plumas National Forest and interviews with firefighters that staffed the fire from initial attack to when the team arrived were conducted.

Introduction

Introduction
Wildfire suppression and wildland fire use fire management are dependent upon good fire behavior and resource effects predictions. Existing fire behavior and resource effects prediction models, such as FsPro and FARSITE are based upon limited data from fire in the field, especially quantitative data. It is difficult to accurately predict fire behavior in the outside environment based upon laboratory data, limited experimental data on prescribed burns or broad field observations. 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 use managers and wildfire 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. The team also collects other information on fire fighter safety, such as convective heat in safety zones as opportunities arise. (See Appendix C for information on the Fire Behavior Assessment Team).

This report contains the results of the assessment of fire behavior in relation to fuels and weather, and immediate fire effects in relation to fire behavior on the Wheeler fire of the Antelope Complex.

Objectives
Our objectives were to characterize fire behavior in relation to fuels and weather for a variety of conditions, in particular for areas that had been treated for hazardous fuel reduction. A key consideration was which sites could be measured safely given access and current fire conditions.

Applications
The information will be shared with firefighters to improve situational awareness, managers to improve predictions for fire planning, and scientists for improving fire behavior models. A proposal will be submitted to the Joint Fire Science Program to conduct further detailed analysis and more formal publication of the information.

Approach

Pre- and post-fire fuels and fire behavior measurements were made at sites throughout the fire. Sites were selected to represent a variety of fire behavior and vegetation or fuel conditions. Priority was on sites that would most likely receive fire. A rapid assessment of fire severity and effects was conducted across the portions of the fire that had burned.

Quantitative Fire Behavior Measurements and Observations

At each site, sensors were set up to gather information on fire behavior including: rate of spread, fire type, flamelength, and flaming duration. Temperature and wind speed were also measured at most sites.

Flamelength and Flaming Duration
Flamelength was determined from video and sometimes supplemented by tree height or char. If crowning occurred above the view of the camera, then tree height was used to estimate the minimum flamelength. Flaming duration was based on direct video observation and when temperature was measured, from those sensors as well.

Figure 1. Installing fire behavior sensors and measuring fuels at one of sites.

Fire Type
Fire type was determined from video as well as post-fire effects at each site. Sites where there was complete consumption of needles in the crowns was classified as crown fire.

Rate of Spread and Temperature
Rate of spread was determined by video analysis and rate of spread sensors (RASPS) which have a piece of solder attached to a computer chip (buried in the ground) that records the date and time when the solder melts or from thermocouples that measure temperature. In addition, on most sites, thermocouples attached to Campbell Scientific data loggers were also used for rate of spread. The distance and angle between RASPS or thermocouples were measured and the Simard (1977) method of estimating rate of spread using trigonometry was applied.

Vegetation and Fuel Measurements
Vegetation and fuels were inventoried before the fire reached each site and then again within a few days after fire had burned through. Consumption and fire effects (i.e. scorch) were inventoried after burning. Mortality was not determined for trees, since mortality can be delayed for some time after the fire, and is not possible to determine immediately post-fire.

Crown Fuels and Overstory Vegetation Structure
Tree density, basal area, tree diameters, tree heights and canopy base heights were measured by species for each site. A relaskop was used for overstory and pole tree plots. Heights were measured with an impulse laser. Diameters were measured with a Biltmore stick. The Fire Management Analyst program, based on the Forest Vegetation Simulator (FVS) program was used to calculate canopy bulk density, canopy base height, tree density and basal area.

Fuels were measured along a 50 foot transect at each site, in view of one of the video cameras. Surface fuels were inventoried with a Brown's planar intercept. Understory vegetation and live fuels were estimated occularly in a 1 meter wide belt plot along the Brown's transect. The Burgan and Rothermel (1984) fuels photo series was used in order to estimate tons per acre of live fuels.

Foliar Moisture and Weather

Live foliage was collected on each plot and oven dried to determine foliar moisture. Weather data was downloaded from the Pierce permanent remote automated weather station (RAWS), 8 miles to the northwest of the fire.

Findings

Overall

Fire behavior and post-fire data were collected at 9 sites that burned (Figure 2). Nine additional sites did not burn due to suppression actions. Sites were grouped into dominant vegetation types and whether they had recent prescribed fire to summarize the data (Table 1). Four vegetation types were sampled including: yellow pine/grass, meadow border; yellow pine/shrub; yellow pine- Douglas-fir – white fir; and white fir- lodgepole pine.

A variety of fire behavior was measured across the sites, although most was surface fire. On several of the sites there was torching, particularly where concentrations of surface fuels (particularly downed logs) or tree crowns extended to the ground or dense patches of seedlings or saplings occurred.

Table 1. Vegetation types assigned to each site and used to group data.

Site	Description
	yellow pine/grass meadow border, untreated
11,17	Untreated, dense yellow pine with light grass understory next to meadow.
	yellow pine/grass meadow border, treated
18	Yellow pine with light grass understory next to meadow. **Treated** with prescribed fire.
	yellow pine/shrub, untreated
15	Untreated open pine with bitterbrush understory.
	yellow pine/shrub, treated
12	Open yellow pine with mixed shrub understory of bitterbrush, Greenleaf manzanita and mahala mat. Boulders throughout site. **Treated** with selective harvest/thin.
14	Yellow pine plantation with dense tobacco leaf ceanothus understory. **Thinned** plantation. *Unburned.*
19	Mature Yellow pine with occasional white fir, greenleaf manzanita and grass understory. **Treated** with understory/midstory thinning.
	yellow pine-Douglas-fir-white fir, treated
2	Open yellow pine stand with scattered Douglas-fir and white fir. Bitterbrush and greenleaf manzanita understory. **Treated** with selective harvest/thin.
8	Open Douglas-fir mixed conifer. **Treated** with selective harvest and pile burning.
10	Shrubby young Douglas-fir mixed conifer with an understory of tobacco leaf ceanothus, bitterbrush, greenleaf manzanita, mahala mat, grass and mule's ears. **Treated** with selective harvest and thinning.
3	Open pine with scattered white fir. Understory with tobacco leaf ceanothus, greenleaf manzanita and mahala mat. **Treated** with thinning and burning. *Unburned.*
4	Very open yellow pine and incense cedar with scattered Douglas-fir. Greenleaf manzanita and bitterbrush in the understory. **Treated** with selective harvest/thin. *Unburned.*
5	Yellow pine and white fir with sparse herbaceous and grassy understory. **Treated** with thinning and burning. *Unburned.*
9	Yellow pine overstory with scattered white fir midstory. Patchy understory of greenleaf manzanita, bitterbrush, mahala mat and grass. **Treated** with selective harvest/thin. *Unburned.*
1	Douglas-fir mixed conifer with understory of Greenleaf manzanita, mahala mat and grass. **Treated** with selective harvest/thin. *Unburned.*
7	Yellow pine and white fir with understory of tobacco leaf ceanothus and grass. **Treated** with thin/burn. *Unburned.*
	yellow pine-Douglas-fir-white fir, untreated
13	Untreated Douglas-fir mixed conifer/in a draw with numerous boulders and understory of tobacco leaf ceanothus, Scouler's willow and thimbleberry. *Unburned.*
	white fir-lodgepole pine/snowberry
6	Untreated dense young white fir and lodgepole pine with snowberry in the understory. *Unburned.*

Figure 2. Map with locations of sample sites.

(See associated antelope_map.pdf file that is attached.)

Vegetation, Fuels, Fire Behavior and Effects

Data on pre-fire vegetation structure (tables 2 and 3), pre-fire live fuels (table 4), pre-fire surface fuels (table 5), fire behavior (table 6), post-fire consumption of surface fuels (table 7) and immediate post-fire effects (table 8) were summarized.

Pre-fire Vegetation Structure and Fuels

Vegetation and fuels varied amongst the sites (Tables 2, 3, 4, 5). Overall canopy covers were lowest in treated sites but mostly were less than 50% across all plots. Most sites had well developed shrub layers.

Table 2. Canopy cover by lifeform by site. Canopy cover is based on ocular estimates of cover classes. Classes were: <1%, 1-9%, 10-24%, 25-49%, 50-74%, >75%. Covers are based on overlapping cover of individual shrubs (can add up to more than 100%).

Canopy Cover by Lifeform (%)					
Site	**Tree Overstory**	**Seedlings**	**Shrubs**	**Herbs**	**Grasses**
yellow pine/grass meadow border, untreated					
11	50-60	1	0	2	11
17	>60	0	0	2	10
yellow pine/grass meadow border, treated					
18	50	0	22	2	12
yellow pine/shrub, untreated					
15	20-30	0	55	2	11
yellow pine/shrub, treated					
12	20	0	>60	4	12
19	40-50	0	3	8	25
14	40-50	0	>60	7	0
yellow pine-Douglas-fir-white fir, treated					
2	20-30	0	43	1	1
8	20-30	1	5	5	5
10	5	5	51	1	6
3	20	0	30	4	5
4	0-15	1	52	3	33
5	40	0	0	0	0
9	0-30	7	17	22	0
1	30-40	1	41	2	25
7	30	0	10	11	25
yellow pine-Douglas-fir-white fir, untreated					
13	30-40	9	39	3	3
white fir-lodgepole pine/snowberry					
6	70	5	5	0	0

Table 3. Pre-fire forest structure calculated using FMA (Fire Management Analyst), based on algorithms from the Forest Vegetation Simulator. California wildlife habitat relations types (CWHR) computed with GAMMA, a custom program used for the Sierra Nevada Forest Plan Amendment EIS. CWHR codes as follows: 2-average tree diameter 6-11" DBH, 3-average diameter 12-23" DBH, 4-average diameter $\geq$24" DBH. Density classes: S- 10 to 24% tree cover, P – 25 to 39% cover, M – 40-59% cover, D- $\geq$60% cover.

Site	California Wildlife Habitat Relations Types (CWHR)	Basal Area (ft^2/ac)	Average Stand Height (ft)	Canopy Ceiling Height (ft)	Canopy Bulk Density (kg/m^3)	Canopy Base Height (ft)
yellow pine/grass meadow border, untreated						
11	5M	24	53	108	0.14	15.0
17	5/3D	33	50	102	0.17	13.0
yellow pine/grass meadow border, treated						
18	4/5M	16	53	92	0.02	6.0
yellow pine/shrub, untreated						
15	5/2P	22	18	59	0.12	2.0
yellow pine/shrub, treated						
12	4S	15	54	83	0.21	11.0
19	3M	7	36	54	0.33	na
14	2M/P	1	12	17	0.08	1.0
yellow pine-Douglas-fir-white fir, treated						
2	5P	28	49	84	0.07	13.0
8	3P	2	36	44	0.09	na
10	3S	8	36	48	0.04	4.0
3	4S	11	56	85	0.06	7.0
4	5/3S	16	74	92	0.10	14.0
5	5/4P	14	60	91	0.09	16.0
9	4P	8	49	84	0.14	9.0
1	5/4P	18	30	92	0.09	na
7	4/5P	10	39	57	0.16	7.0
yellow pine-Douglas-fir-white fir, untreated						
13	3/2P	7	44	84	0.14	2.0
white fir-lodgepole pine/snowberry						
6	2/4P	9	15	89	0.68	7.0

Table 4. Live and dead fuel loading of lifeforms by site before the Wheeler fire of the Antelope Complex. Understory fuels were calculated using the Burgan and Rothermel (1984) photo-series method.

Site	Live & Dead Grass, Herb (tons/acre)	Percent live grasses %	Percent live herbs %	Live & Dead Shrub, Seedlings (tons/acre	Percent live shrubs %	Percent live seedlings %
Yellow pine/grass meadow border, untreated						
11	0.03	30	83	0.05	0	100
17	0.03	43	70	0.00	0	0
yellow pine/grass meadow border, treated						
18	0.03	45	80	4.32	49	0
yellow pine/shrub, untreated						
15	0.07	60	60	7.30	55	0
yellow pine/shrub, treated						
12	0.02	25	40	19.45	57	0
19	0.14	20	53	0.01	85	0
14	0.02	30	0	13.18	45	0
yellow pine-Douglas-fir-white fir, treated						
2	0.00	90	80	8.14	58	0
8	0.01	20	65	0.01	90	100
10	0.02	30	60	5.25	70	20
3	0.05	40	63	0.39	93	0
4	0.07	37	85	10.43	53	100
5	0.00	0	0	0.00	0	0
9	0.14	28	43	2.72	75	95
1	0.02	60	50	1.58	93	100
7	0.24	0	50	0.83	83	0
yellow pine-Douglas-fir-white fir, untreated						
13	0.01	48	95	7.18	59	80
white fir-lodgepole pine/snowberry						
6	0.00	0	0	0.54	90	70

Table 5a. Litter and duff pre- and post-fire. Calculated from litter and duff depth using van Wagtendonk et al. (1998).

Pre-fire					Post-fire				Consumption (%)	
Site	Litter Depth (in)	Duff Depth (in)	Litter Weight (tons/ac)	Duff Weight (tons/ac)	Litter Depth (in)	Duff Depth (in)	Litter Weight (tons/ac)	Duff Weight (tons/ac)	Litter	Duff
yellow pine/grass meadow border, untreated										
11	0.6	0.8	1.6	20	0.6	0.0	1.6	4.8	0%	76%
17	2.4	1.2	9.7	48	0.2	0.0	0.0	0.0	100%	100%
yellow pine/grass meadow border, treated										
18	1.3	0.6	5.3	13	0.2	0.3	0.8	6.4	85%	50%
yellow pine/shrub, untreated										
15	1.2	0.8	4.9	31	0.0	0.0	0.0	0.0	100%	100%
yellow pine/shrub, treated										
12	0.4	0.8	1.6	13	0.2	0.6	0.8	0.8	50%	94%
19	0.9	0.8	3.6	25	0.0	0.0	0.0	0.0	100%	100%
14	1.0	0.0	4.0	10	*	*	*	*	*	*
yellow pine-Douglas-fir-white fir, treated										
2	2.3	1.6	9.3	60	0.0	0.0	0.0	0.0	100%	100%
8	0.2	1.8	0.8	21	0.0	0.0	0.0	0.0	100%	100%
10	0.6	0.4	2.4	12	0.2	0.1	0.8	2.8	67%	77%
3	1.2	1.2	4.9	24	*	*	*	*	*	*
4	0.6	0.2	2.4	12	*	*	*	*	*	*
5	1.2	1.0	2.4	34	*	*	*	*	*	*
9	1.2	2.4	4.9	60	*	*	*	*	*	*
1	1.0	1.6	4.0	43	0.0	0.0	0.0	0.0	100%	100%
7	1.2	0.0	4.9	10	*	*	*	*	*	*
yellow pine-Douglas-fir-white fir, untreated										
13	1.2	2.4	4.9	60	*	*	*	*	*	*
white fir-lodgepole pine/snowberry										
6	0.6	1.8	2.4	34	*	*	*	*	*	*

Table 5b. Pre and post-fire surface fuel loading and consumption calculated from Brown's planar transects.

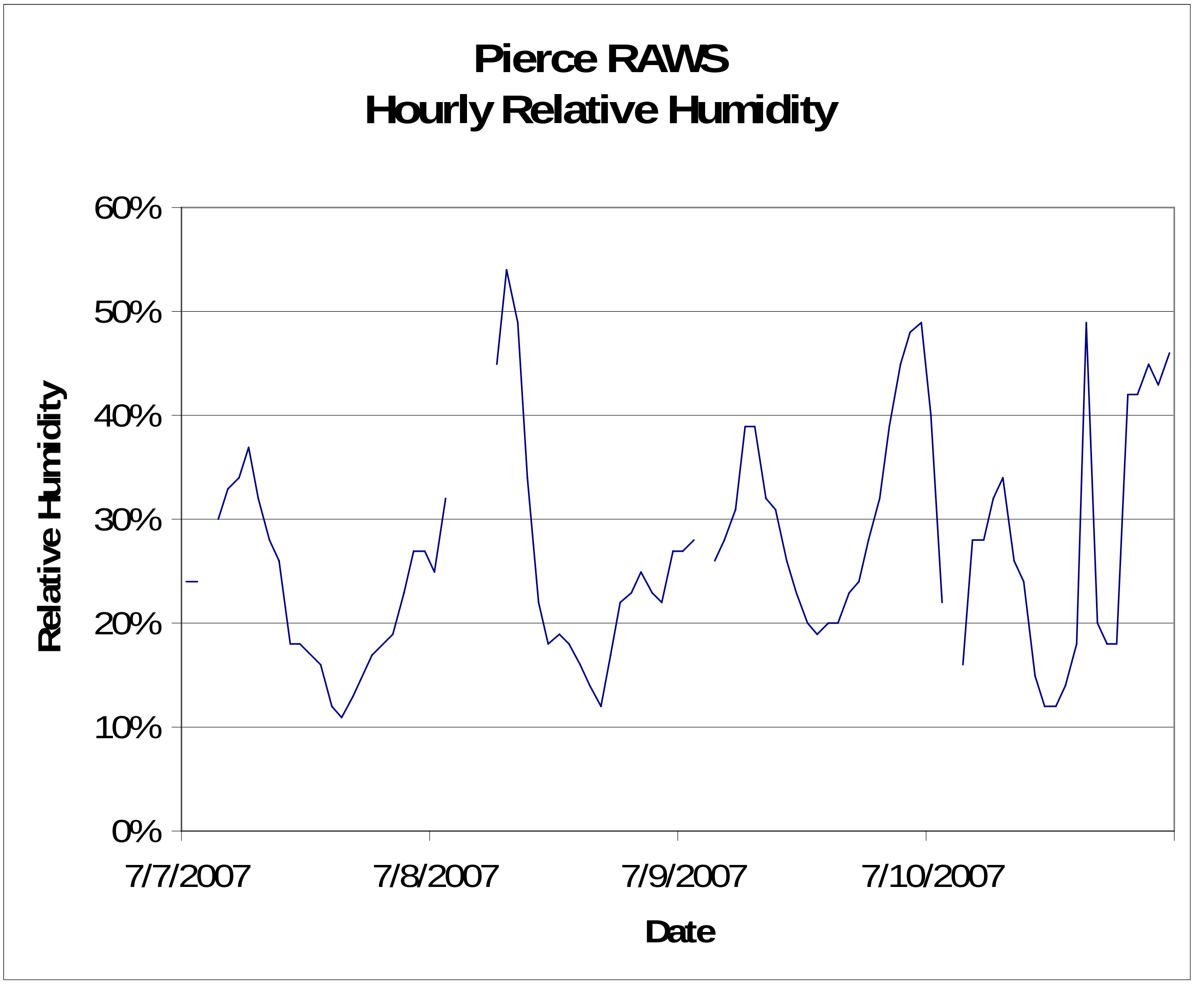
Site	Pre-fire Fuels						Consumption (%)	
	1 hour	10 hour	100 hour	total < 3" fuels	1000 hour rotten	1000 hour sound	< 3" fuels	> 3" fuels
yellow pine/grass meadow border, untreated								
11	0.0	0.0	0.0	0.0	0.0	0.0	100%	na
17	0.0	1.3	0.0	1.3	12.5	2.5	100%	100%
yellow pine/grass meadow border, treated								
18	0.1	1.2	3.6	4.9	1.8	0.0	90%	100%
yellow pine/shrub, untreated								
15	0.0	0.3	0.0	0.3	0.0	0.0	0%	na
yellow pine/shrub, treated								
12	0.0	0.0	2.4	2.5	0.0	0.0	99%	na
19	0.0	1.8	3.6	5.5	0.0	0.0	70%	na
14	0.1	1.2	6.1	7.4	9.2	1.4	*	*
yellow pine-Douglas-fir-white fir, treated								
2	0.0	1.8	1.2	3.1	11.1	3.6	100%	100%
8	1.5	1.8	1.2	4.6	0.0	0.0	100%	
10	0.4	2.7	0.0	3.2	3.9	20.4	85%	55%
3	0.3	1.2	1.2	2.7	0.0	3.2	*	*
4	0.1	0.6	1.2	1.9	2.1	8.2	*	*
5	0.1	0.9	2.4	3.4	5.7	12.4	*	*
9	0.0	0.3	2.4	2.8	3.5	9.9	*	*
1	0.3	0.0	1.2	1.5	21.9	3.4	*	*
7	1.2	1.8	1.2	4.2	0.0	0.0	*	*
yellow pine-Douglas-fir-white fir, untreated								
13	1.2	3.4	8.1	12.7	3.9	17.0	*	*
white fir-lodgepole pine/snowberry								
6	0.8	1.8	4.8	7.5	0.0	11.0	*	*

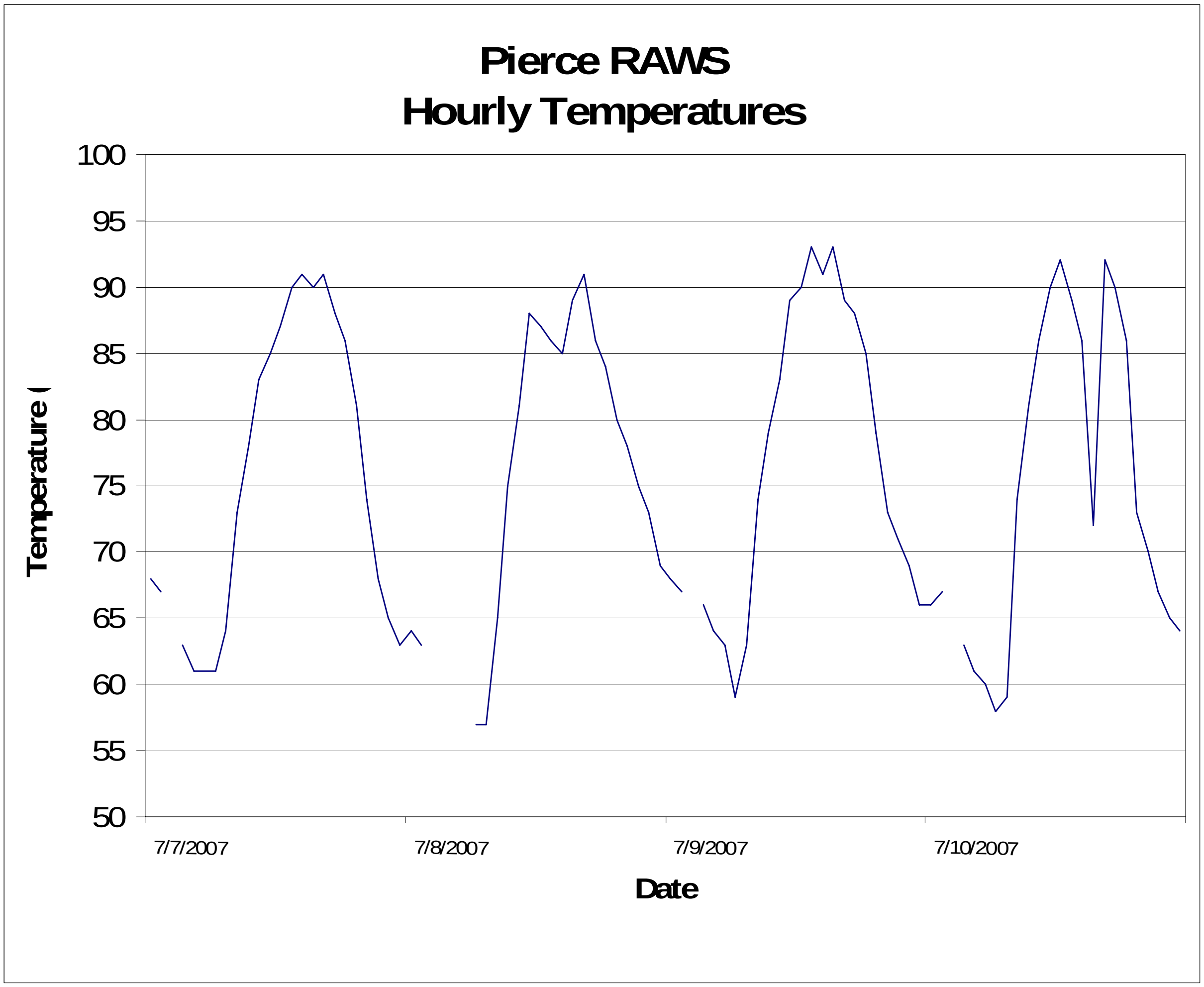
Weather and Fuel Moisture

Weather data was summarized from the nearby Pierce RAWS station, which is located 8 miles to the west of the fire. Additional RAWS stations were set up on the incident closer to the fire behavior measurement sites, but these were installed after the sites had burned.

Fuel moisture samples were gathered but the oven malfunctioned and the data were not representative.

Figures 3a, 3b. Summary of weather data from the Pierce RAWS weather stations during the times when sites burned. Weather at the fire behavior plots may differ because of the distance of this RAWS from the sites. Site specific temperatures and windspeeds were taken on many of the sites.

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Fire Behavior and Fire Effects

The descriptions of fire behavior and effects below are based on an initial rapid assessment. Videos were assessed visually for now, and the estimates might change with future more detailed digital analysis of the imagery.

<u>Sites Unburned Due to Suppression</u>

Half of the sites where fire behavior equipment was set up did not burn due to suppression actions (Table 6). This included suppression of spot fires, direct suppression and indirect line placement (Figure 4).

Figure 4. Bulldozer going through site 1, tripped camera wire and site did not burn due to line construction.

Table 6. Description of suppression actions for sites that did not burn.

Site	Description of sites that did not burn and site 10 where fire behavior was substantially modified by suppression actions (Site 10)
Treated Sites Used In or Affected by Suppression Operations	
1	Unburned. Initially, spot was contained by a bulldozer line adjacent to the site along the 27N59 road. Later the fire progressed north and across the 27N59 road, but this portion of the treated area never burned.
4, 7	Unburned. Site 7 unburned due to direct line built below the plot, to the east of the 28N01 road. Site 4 had bulldozer line cut below and above the fire behavior sensors through a treated area. Below the site was direct attack and above the site was a secondary fire line.
10	Site burned at low intensity on its own, but was affected by suppression. Camera was triggered by dozer operations at 2200 hours and it was apparent that helicopter water drops were made in vicinity. Burned as a slow, low intensity backing fire at night.
	Treated and Untreated Sites where Fire Never Made it due to Strategy and Tactics
3,5,6,9	Fire never made it to these sites north of the 27N36 road due to successful suppression below. Site 6 was untreated; the other sites had recent or older treatments.
Untreated Sites Affected by Suppression	
13, 14	Sites unburned due to direct attack (hand and dozer line) below and to east of sites, was planned to be in part of large burn operation along 26N46 and 99 roads but change of tactics.

Site 10, Fire behavior substantially modified by suppression

Site 10 was in the interior of the fire, below road 27N36. At the time the fire behavior equipment was placed and pre-fire fuels were measured, there was fire on three different sites of the sample site during the early evening. Later that evening a bulldozer went up into the edge of the plot, restricting fire spread from two directions. There were also apparently water drops from a helicopter either that evening or the following morning. The site burned with low intensity and with some unburned patches remaining due to suppression actions. The camera ran out of video tape (90 minutes) before the fire entered the site and there are no pictures.

Sites that Burned

The team arrived the evening of July 6th, when very active fire behavior occurred, including development of a pyrocumulus that collapsed and resulted in an extensive area of high intensity fire that moved rapidly. The associated rapid assessment report contains a description of the fire behavior during the first two days of the fire when fire progression was most rapid and fire intensity the greatest.

Of the 9 sites that burned, most burned as low intensity surface fires, many at night (Table 7, Figures 5-7). These were all placed and burned from July 7th through 12th. There were several that burned as moderate or high intensity surface fires with torching. On all of the sites, where concentrations of surface fuels, shrubs, logs, or tree seedlings were present, the fires burned more intensely and there was high fuel consumption. Where tree crowns were low to the ground or where tree crowns were above ladder fuels or logs, torching occurred. All but one of these sites burned in a green island in the interior of the fire.

Figure 5. Site 2, burned as head fire against the wind at night.

Figure 6. Site 18, burned as low intensity backing fire through area treated with prescribed fire.

Figure 7. Pictures of understory torching at site 19.

Table 7. Fire behavior measurements and observations by site that burned.

Untreated Sites Affected by Suppression					
Site	**Fire Type**	**Flamelength (ft)**	**Rate of Spread (chains/hr)**	**Flame Duration and Temperatures (^{0}F)**	**Comments**
Burned in interior island					
2	low intensity surface fire at night, head fire upslope against the wind	3’ to 5’	10 to 20 until it hit the top of the plot and slowed down to 0.5 to 1	280^{0}F maximum , combustion >90 minutes (length of tape), combustion for 21 hours from consumption of logs	
8	low intensity, backing surface fire at night	1 to 4’; but 6’ to 23’ when it ran up fir trees with crown bases to the ground	0.5		
11	low intensity, backing surface fire at night	<1'	0.2-0.5	370^{0}F maximum	at 03:50 in the morning
12	low intensity surface fire	<1 to >4'	variable from <0.1 to 0.5	900^{0}F maximum, fire extended for >1 day slowly in a patchy pattern through the plot	fuels were patchy and discontinuous, no video of the fire with 2 tapes because of slow spread
15	moderate intensity surface fire with some torching in midstory trees	4 to 6'	3 to 7	none measured	
17	low intensity surface fire at night	0.5 to 1'	0.1 to 0.5	590^{0}F maximum, 10 hours of combustion including burning logs	
18	low intensity, backing surface fire	0.5 to 1'	1	none measured	
19	high intensity surface fire with torching in midstory and overstory	4 to 30'	sensors malfunctioned	none measured	

Post-fire Consumption and Immediate Effects

The fire effects that we measured and observed post-fire are immediate. The effects reported here include fuel consumption, crown scorch and consumption by vegetation layer (overstory tree, midstory tree, shrub, grass) and changes in soil color and cover (Tables 8 and 9). It is not possible to determine tree mortality or mortality of understory plants that may resprout so soon after the fire.

Table 8. Substrate severity rating (National Park Service).					
Site	**Very high (1)**	**High (2)**	**Moderate (3)**	**Low (4)**	**Unburned (5)**
yellow pine/grass meadow border, untreated					
11	30	30	30	10	
17	10	30	60		
yellow pine/grass meadow border, treated					
18	10	20	70		
yellow pine/shrub, untreated					
15	5	30	30	35	
yellow pine/shrub, treated					
12		10	20	50	20
19	30	60	10		
yellow pine-Douglas-fir-white fir, treated					
2	5	70	20	5	
8		30	70		
10		15	25	5	40
National Park Service, substrate severity ratings: 1- very high, white ash, some discoloration of soil; 2 – high, gray and black ash; 3 – moderate, ash and some patches of charred litter or duff; 4 – low severity, charred litter and some unburned litter and duff remain; 5 – unburned.					

Table 9. Summary of immediate post fire effects per site. Mortality is not included, since survival cannot be determined immediately post-fire. Trees that are scorched can survive. Data below shows **torch, where needles are consumed**, and **scorch, where needles are brown** but not consumed. Results below are based upon a rapid analysis of measured crown scorch and torch. Detailed data by individual tree was recorded but not summarized quantitatively at this time.

	Understory consumption			**Midstory**		**Overstory**	
Site	**Grass/herb**	**Shrubs**	**Tree seedlings**	**Scorch (%crown)**	**Torch (%crown)**	**Scorch (%crown)**	**Torch (%crown)**
yellow pine/grass meadow border, untreated							
11	100%	none	100%	none		0%	none
17	100%	none	none	50-100%	none	mostly none	none
yellow pine/grass meadow border, treated							
18	100%	100%	none	none	none	none	none
yellow pine/shrub, untreated							
15	70%	70-100	none	100%	0-100%	20-80%	0-10%
yellow pine/shrub, treated							
12	80-100%	20-100%	none	none		50-70%	none
19	100%	95%	none	1 pre-fire, consumed		80-100%	0 to 90%
Yellow pine-Douglas-fir-white fir, treated							
2	100%	90-100%	none	none		0-20%	none
8	100%	100%	none	none		50-95%	30-50%
10	0-100%	0-100%	0%	1 snag, consumed		0-20%	none

Antelope Complex
Fire Behavior Plot Photos
Adaptive Management Services Enterprise Team 7/14/07


Plot 2, pre- and post-burn. Low intensity surface fire at night, head fire upslope against the wind.


Plot 8, pre- and post-burn. Low intensity, backing surface fire at night.

Plot 11, pre- and post-burn. Low intensity, backing surface fire at night.

Plot 12, pre- and post-burn. Low intensity surface fire.

Plot 15, pre- and post-burn. Moderate intensity surface fire with some torching in midstory trees.

Plot 17, pre- and post-burn. Low intensity surface fire at night.

Plot 18, pre- and post-burn. Low intensity, backing surface fire.

Plot 19, pre- and post-burn. High intensity surface fire with torching in midstory and overstory.

Appendix B
Antelope Fire Temperature Graphs

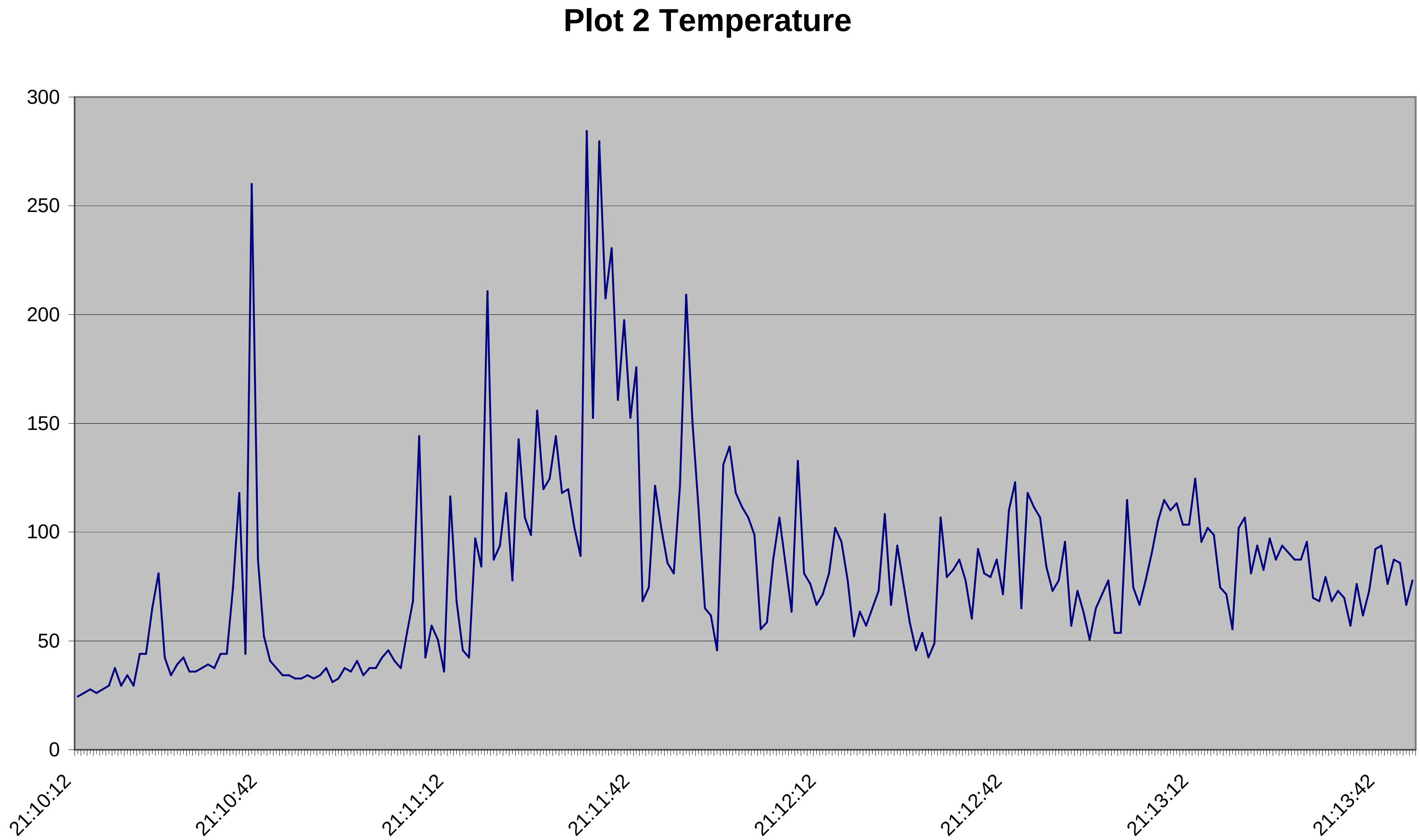

Figure B1. Plot 2 temperature data Y axis degrees Celsius X axis in time

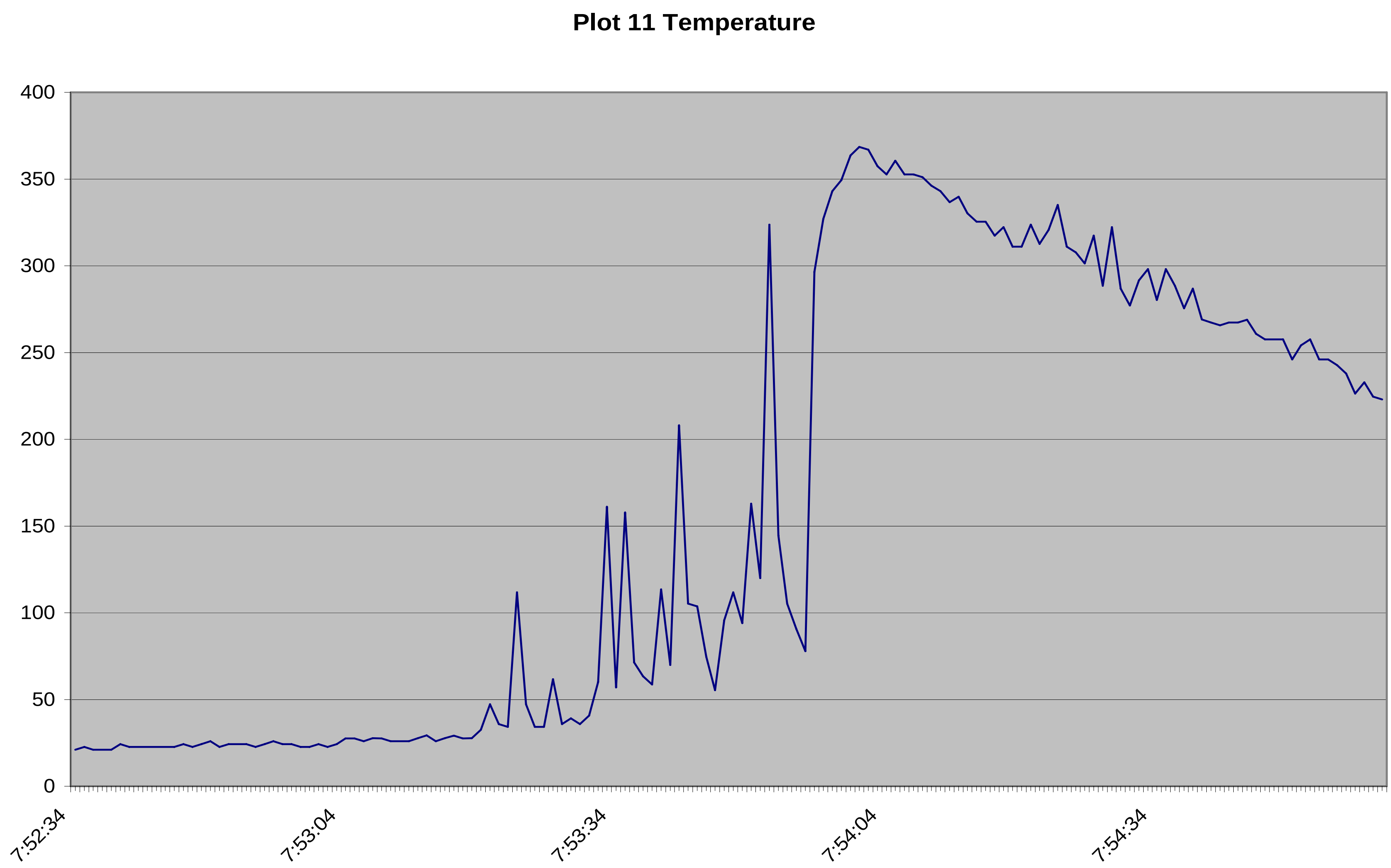

Figure B2. Plot 11 temperature data Y axis degrees Celsius X axis in time

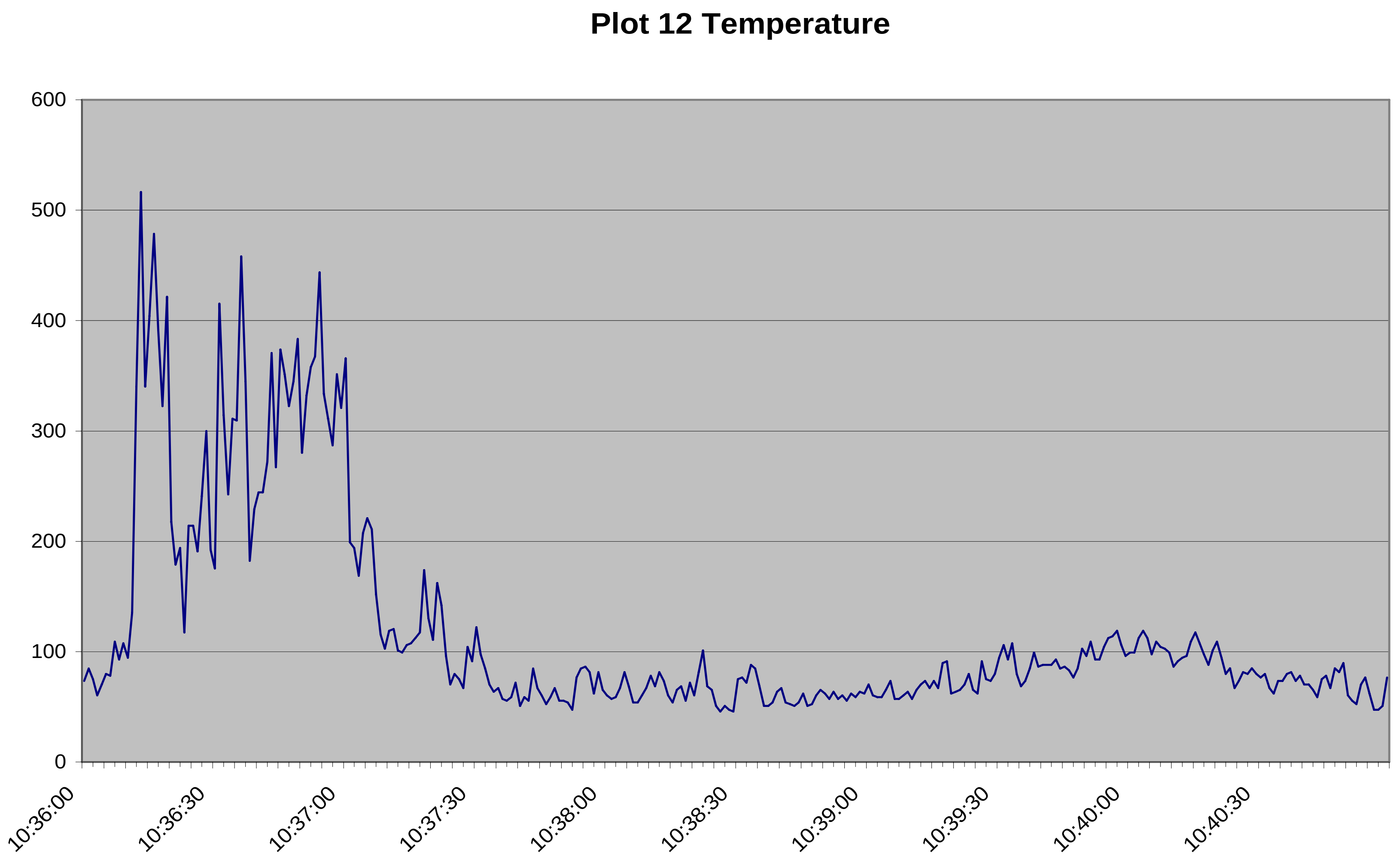

Figure B3. Plot 12 temperature data Y axis degrees Celsius X axis in time

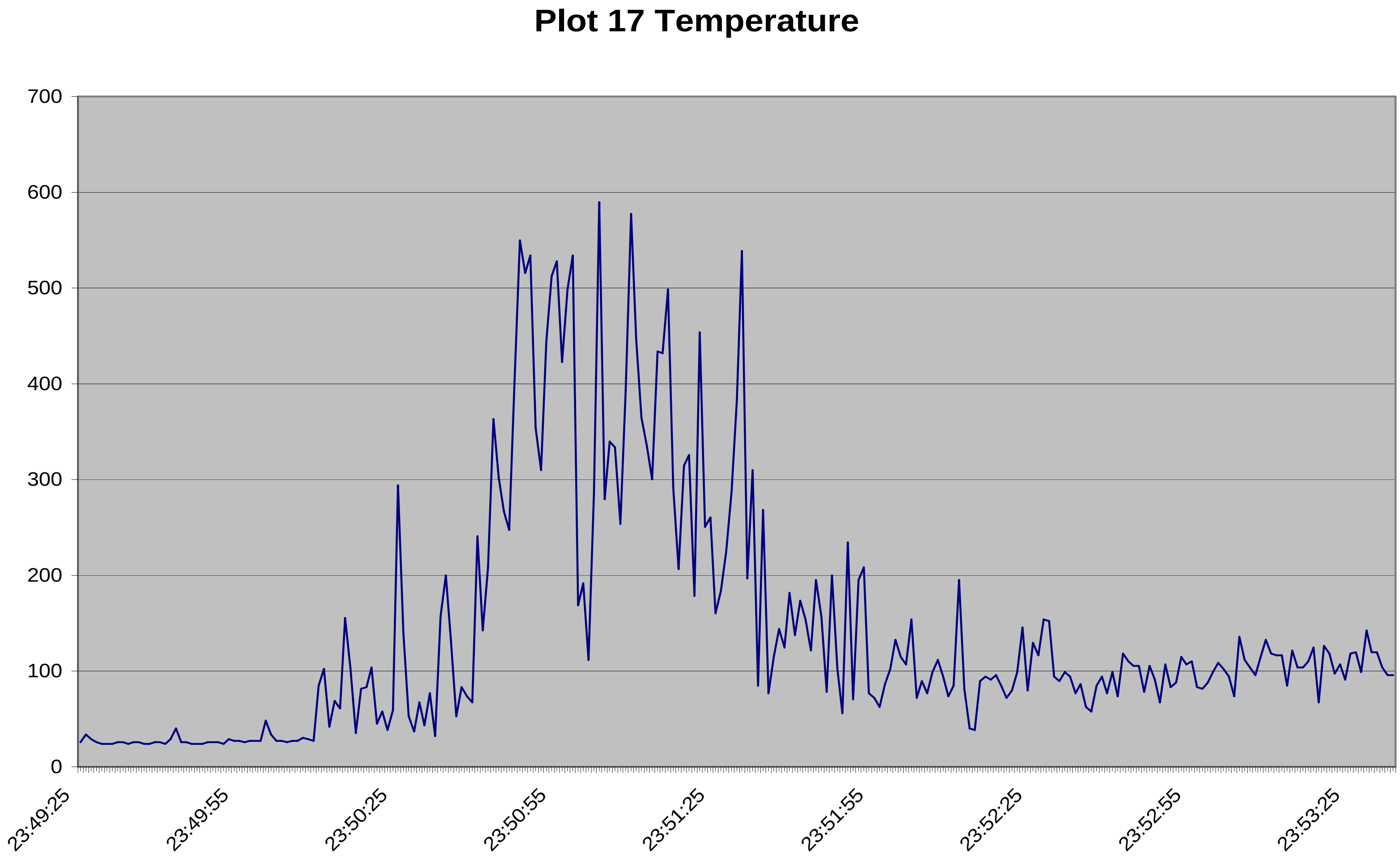

Figure B4. Plot 17 temperature data Y axis degrees Celsius X axis in time

Appendix C

About the Fire Behavior Assessment Team

We are a unique module that specializes in measuring fire behavior on active fires of all kinds including wildland fire use fires, prescribed fires or wildfires. We utilize fire behavior sensors and special video camera set-ups to measure direction and variation in rate of spread, fire type (e.g. surface, passive or active crown fire behavior) in relation to fuel loading and configuration, topography, fuel moisture, weather and operations. We measure changes in fuels from the fire and can compare the effectiveness of past fuel treatments or fires on fire behavior and effects. We are prepared to process and report data while on the incident, which makes the information immediately applicable for verifying LTAN or FBAN fire behavior prediction assumptions. 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 verifying or testing fire behavior modeling assumptions for fire management plans, unit resource management plans or project plans.

We are team of fireline qualified technical specialists and experienced fire overhead. The overhead personnel includes a minimum of crew boss and more often one or more division supervisor qualified persons. The team can vary in size, depending upon availability and needs of order, from 5 to 12 persons. Our lead fire overhead is Mike Campbell, Division Supervisor. We have extensive experience in fire behavior measurements during wildfires, wildland fire use fires, and prescribed fires, having worked safely and effectively with over 16 incident management teams.

We can be ordered from ROSS, where we are set up as “TEAM- FIRE BEHAVIOR ASSESSMENT – FITES”. We can be requested by the following steps: 1) Overhead, 2) Group, 3) Squad, and 4) in Special Needs box, “Requesting –Fire Behavior Assessment Team- Fites’ Team out of CA-ONCC 530-226-2800.

You can also contact us directly by phone to notify us that you are placing an order, to speed up the process. You can reach Jo Ann at 530-478-6151 or cell (only works while on travel status) at 530-277-1258. Or you can reach Mike Campbell at 530-288-3231 or cell (only works while on travel status) 530-701-3644. Or you can reach us through Tahoe NF dispatch (530-478-6111), who has our home phone numbers as well. Do not assume that we are not available if you call dispatch and we are already on a fire. We have and can work more than one fire simultaneously and may be ready for remobilization. For more information about the Fire Behavior Assessment Team (FBAT) please see our website at http://www.fs.fed.us/adaptivemanagement/.