Bar Complex
Fire Behavior, Fuels, and Effects

Prepared 8/14/2006
Fire Behavior Assessment Team

Jo Ann Fites, Team Leader
Mike Campbell
Todd Decker
Clint Isabell
Alicia Reiner
Lauren Shapiro

Contents

Executive Summary

Wildland fire management including wildland fire use fire planning and implementation, prescribed fire planning and implementation, and wildfire suppression is dependent upon good fire behavior and resource effects predictions. Existing fire behavior and resource effects prediction models 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 communities, tribes, managers and wildfire incident management teams on fire behavior-fuel and effects relationships. The team also collects information on community and 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 for the Bake and Oven fires, part of the Bar Complex. It also contains recommendations for additional logistical expenses to improve the amount of data capture on fires with little access.

Objectives
The team spoke with Julie Titus, Arlen Cravens and Joe Millar. The priority was:

> provide information for future management plans on the Shasta-Trinity for Wildland Fire Use

In order to meet this objective, we sought to quantify fire behavior and effects in plant communities in relation to fuels, topography and weather for both free-burning fire and burn operations. We also evaluated how our operations were affected by limited accessibility and how they would need to be adjusted and at what additional expense to get the same or similar rate of data capture on other fires.

Accomplishments
- 4 sites completed including with burn operations and 2 with free-burning fire (video, rate of spread, fuels and vegetation pre and post)

INTRODUCTION

Background

Wildland fire management including wildland fire use fire planning and implementation, prescribed fire planning and implementation, and wildfire suppression is dependent upon good fire behavior and resource effects predictions. Existing fire behavior and resource effects prediction models 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 communities, tribes, managers and wildfire incident management teams on fire behavior-fuel and effects relationships. The team also collects information on community and 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 for the Bake and Oven fires, part of the Bar Complex. It also contains recommendations for additional logistical expenses to improve the amount of data capture on fires with little access.

Objectives

The team spoke with Julie Titus, Arlen Cravens and Joe Millar. The priority was:

> provide information for future management plans on the Shasta-Trinity for Wildland Fire Use

In order to meet this objective, we sought to quantify fire behavior and effects in plant communities in relation to fuels, topography and weather for both free-burning fire and burn operations. We also evaluated how our operations were affected by limited accessibility and how they would need to be adjusted and at what additional expense to get the same or similar rate of data capture on other fires.

Potential Application of Information

The monitoring data and assessment will be useful for characterizing fuels and fire effects, and prescription development for wildland fire use plans, prescribed burn planning and fuel hazard project planning. If the sites are revisited at a later date to gather longer-term fire effects information, then the data will be useful for predicting longer-term post-fire effects, such as the effect of summer burning on vegetation.

APPROACH

Pre- and post-fire fuels and fire behavior measurements were made at 2 sites on the Bake fire and 2 sites on the Oven fire. Sites were selected based on road and trail access and to represent a variety of fire behavior and vegetation or fuel conditions, including free-burning fire and burn operations. Priority was on sites that would most likely receive fire and on safety considerations.

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.

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. If the video camera failed (due to extreme temperatures or trigger malfunction), then char height on tree boles or direct observation were used to estimate flamelength. Flaming duration was based on direct video observation and when temperature was measured, from those sensors as well.

Fire Type

Fire type was determined from video as well as post-fire effects at each site. Observations from the video were recorded on transitions to crown fire, including the type of fuel that carried the fire from the surface to crown.

Rate of Spread and Temperature

Rate of spread was determined by 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. The distance and angle between RASPS or thermocouples were measured. In some cases where the RASPS failed, rate of spread was estimated from the video.

Vegetation and Fuel Measurements

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

Vegetation Composition, Structure and Fuels

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 plots. Heights were measured with an impulse laser. Diameters were measured with a biltmore stick or in some cases a diameter tape. On some very steep sites, diameters were measured for some trees for calibration and then the remaining trees estimated. The GAMMA program was used to calculate canopy bulk density, canopy base height, tree density and basal area. The GAMMA program is based upon Forest Vegetation Simulator (FVS) algorithms but includes hardwoods.

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 fuels photo series was used in order to estimate tons per acre of live fuels. Duff pins were placed along the fuels transect line to measure litter and duff consumption.

Understory composition including herbs, grasses, shrubs and tree seedlings was measured by ocular estimation of canopy cover within a 3.28 by 50 foot belt transect along the Brown's planar intercept line. The proportion of dead vegetation and average height by species was recorded.

Findings

OVERALL

A total of 4 sites Figure 1) were sampled, two in free-burning fire (Oven Fire) and two in burn operations (Bake Fire). It took 2 days to install the two different sites and a little longer to do post-burn re-measurements, since it took several visits to check on the status and wait for the final Oven site to burn.

Table 1. Characteristics of each site.

Vegetation Type		
Douglas-fir -canyon live oak, very steep	Mature Douglas-fir overstory with scattered live oak in the midstory and understory. Very steep site, 70% slope, near the upper portion of the slope. Burned in free-burning fire.	1
Douglas-fir/grass	Old growth Douglas-fir overstory with scattered large black oak and madrone. A well developed understory of grass. Along the nose of a spur ridge with moderate slopes. Burned in free-burning fire.	1
young mixed hardwood	Dense, mixed hardwood stand with madrone, tanoak and some live oak. All apparently developed from sprouts. Some evidence of past logging of Douglas-fir, some stumps. Gentle slope. Burned in burn operation.	1
Douglas-fir – maple, gentle slope	Moderately dense, mature Douglas-fir with well developed overstory and a pocket of big-leaf maple in the midstory. Understory sparse. Slope moderate to gentle. Burned in burn operation.	1

[page for GIS map]

PRE-FIRE FOREST AND VEGETATION STRUCTURE

Basal areas were moderate, ranging from 165-212 ft^2/acre, except for the site 4 on the Bake fire, with a basal area of 320 (table 2). Tree densities were more varied, with the highest densities on Oven Site 1, reflecting the presence of smaller stemmed live oak and maple in the understory. Two of the sites had larger trees present (Oven site 2 and Bake site 4).

Table 2. Pre-fire forest structure calculated using GAMMA (Wilson 2006), based on Forest Vegetation Simulator equations with additions to include California hardwood crown fuels.

Site	Basal Area (ft^2/acre)	Trees per Acre (no/acre > 1" dbh)	Quadratic Mean diameter (inches)	Trees per acre >24" dbh	Trees per acre >30" dbh
Oven Sites					
1	212	961	12.2	8	0
2	165	595	27.7	14	14
Bake Sites					
3	170	369	13.2	0	0
4	320	110	25.5	38	8

PRE-FIRE FUELS

Pre-fire Dead Surface Fuels

Surface fuels (1-100 hour) were greatest at the second Bake site (7.52 tons/acre; table 3). On the remaining sites, surface fuels ranged from approximately 1.1 to 4.6 tons/acre, excluding litter and duff. Litter and duff layers were well developed on all sites except the steep site (Oven, site 1), ranging from 2.5 to 4.4 inches. On sites with well developed litter and duff layers, surface fuel loadings will be greater than that estimated based on the stick counts alone but information was not available for this area to calculate the depths into tons/acre with site specific coefficients. Thousand hour fuels ranged from 0 on the steep site to 7 tons/acre.

Table 3. Pre-fire surface fuels by site. Sampled using Brown's planar intercept method.

Site	Small Surface Fuels (tons/acre)				1000 hour fuels (tons/acre)		Forest floor depths (inches)	
	1 hour[1]	10 hour	100 hour	Total	Rotten	Sound	Litter	Duff
Oven Sites								
1	0.5	1.7	2.4	4.6	--	--	0.5	0.5
2	0.2	0.3	0.6	1.1	7.0	--	0.8	1.7
Bake Sites								
3	0.1	1.4	0.6	2.1	4.1	--	3.0	1.4
4	1.2	1.5	4.8	7.5	2.8	3.2	1.0	1.6

1- does not include litter, although litter contributes significantly to 1-hour fuels. Litter was not included because there are not coefficients specific to these vegetation types and location.

Pre-fire Live Fuels

Canopy fuels were similar across all but site 4 on the Bake fire (Table 4). Canopy bulk densities were between 0.18 and 2 kg m^{-3} and canopy base heights from 4-6'. Bake site 4 had slightly lower canopy bulk densities (0.14 kg m^{-3}) and much higher canopy base heights (42'), reflecting the more uniform mature stand structure. Seedlings contributed to a moderately well-developed live understory layer on all but the steep sites, ranging from 2.8 to 15 tons/acre. These higher loadings reflect in part the prevalence of coarse leaved tanoak, madrone and live oak. Shrub fuels ranged from none on Bake site 4 to 0.1-0.15 tons/acre on the other sites. Most of the shrub fuels were poison oak. Grasses and herbs were sparse except for on Oven site 2.

Table 4. Pre-fire live fuels by site.

Site	Total Understory Live Fuels (tons/acre)			Height to Live Crown (ft)	Canopy Bulk Density (kg/m²)
	grass/herb	shrub	seedlings		
Oven					
1	0.01	0.01-0.13	0.06-0.1	4	>0.2
2	0.09	0.03-0.14	3-15.7	6	0.2
Bake					
3	<0.01	0.11	6.4	6	0.18
4	<0.01	0	2.8	42	0.14

Foliar moisture samples were taken from all sites at the time of plot installation but it took several days or more for each site to burn. Although we processed these samples, since we delayed setting up the oven for part of a day when we set up base operations at Orleans, it appears that the samples had already dried some. We therefore continued to collect samples near the New River trailhead when we revisited to check on plot status (table 5). The Douglas-fir was considerably lower in foliar moisture than what we measured on the nearby Orleans complex (>100%) and this could reflect two differences. First, the Orleans sites were closer to the coast and presumably receive more precipitation. Secondly, the Douglas-fir samples from the Bar complex were from seedlings on a rocky slope, and therefore reflect a harsher site. There were some live oak samples also collected on the harsher site in the New River canyon that yielded moisture levels of 50% or a little less. We were not confident that the true moisture levels were that low and believe the samples may have been compromised from the spiny leaves poking through the plastic bags. Since that time, we have purchased more spine resistant collection containers.

Table 5. Foliar moisture for representative species collected near the New River trailhead, from August 5, 2006

Aspect	Species	Fuel Moisture (% dry weight)
East	Tan Oak	113[1]
northwest	Deerbrush (no dead leaves)	88-91
southeast	Douglas Fir	71-81[2]

1- one sample was estimated at 50%, from the understory. This sampled seemed low.
2- samples from seedlings in the understory on rocky site, overstory trees likely had higher moisture values (values of 96-10&% measured on Orleans Complex to the northwest)

FIRE BEHAVIOR

Fire Type, Flamelength, Rate of Spread

Fire behavior at the sites was low to moderate intensity surface fire (Table 6; Figures 2 and 3). Two of the four total sites burned as part of a burn operations along control lines on the Bake fire (Figure 2 and 3). Rates of spread and flamelengths were generally low.

Fire behavior on the sites in the Oven fire, where it was free-burning was more varied. One the lower site, site 2, along the nose of a spur ridge it took the fire a long time to back down to the site and then very slowly move across part of it. This resulted in our camera being triggered and then the film all used up before the fire made it in front of the view. We were able to observe the fire behavior directly, when we went to check on its status. This was after it had rained lightly and there was a readily perceptible change in 1-hour fuel moisture, considerably higher. The fire was creeping very slowly and reaching some spots and stopping. The fire effects reflect this very patchy burn pattern.

Figure 2. Low intensity fire at Bake Site 1, from burn operation.

On the other Oven fire site, site 1 that was on a very steep slope, near the top of the ridge (a lower ridge above the main peak and ridge), the fire apparently behaved differently. This is not surprising since slopes exceeded 70% in the vicinity. Our camera did not trigger properly on this site but from the post-fire observations it is clear that the fire backed down in portions but mostly made an uphill run across the main part of the site. Understory trees were heavily scorched but taller overstory trees were not. Fuel consumption was high were the fire made the runs.

Figure 3. Low intensity fire at night from burn operations at Bake Site 2.

Spatial Pattern

Fire was patchy on sites that experienced natural fire, varying from 30 – 40% burned on the less steep slopes to 70 -80 % burned on sites with steeper slopes (table 6). The patterns varied on the sites burned as part of burn operations on the Bake fire. On one, site 3, very little was unburned. On site 4, there was more of a mosaic.

Table 6. Fire behavior measurements and observations by site.

Site	**Slope (%)**	**Fire Type**	**Type of Burn**	**Flame Length (feet)**	**Rate of Spread (chains/ hr)**	**Flame Duration Across Site**	**Percent Plot Burned**
Oven Fire							
1	68 – 72	Low –moderate intensity surface fire, patchy.	natural	0.5-2[1]	0.36	Unknown [1]	70 – 80
2	15 – 35	Low intensity surface fire, very patchy.	natural	0.4-0.8[2]	see below[2]	At least 1 day or more[2]	30 – 40
Bake Fire							
3	37 - 40	Low intensity surface fire	burnout	0.7-2	0.1 - 0.5	55	90
4	37	Low intensity surface fire backing at night	burnout	0.7-3	0.02 - 0.25	>90 minutes[3]	40 – 80

1 – derived from char height, camera malfunction. Based on steep slope and evidence of fire in the site, it apparently burned rapidly or in several bursts over a short period of time.
2 – no sensors burned and flames not visible in camera view (triggered camera while behind it and moved very slowly over a period of more than a day and night to burn the rest of the plot in front of the camera), unable to obtain rate of spread, very patchy burn. The site was visited on several consecutive days. Flamelengths from visual observation during site visits and from char heights.
3 – slow backing fire, ran out of tape before it finished crossing the entire camera view

FUEL CONSUMPTION and OVERALL FIRE EFFECTS

Fuel consumption and fire effects were commensurate with the fire behavior observed on each site. In general, surface fuel consumption (both live and dead) was high, except where the fire burned in mosaic patterns (two of the sites) (table 7).

Live vegetation in the understory was generally consumed or sometimes scorched, except in the unburned portions (Table 8). There was little to no crown scorch in the overstory on the sites measured. There were certainly other portions of the fire in the New River canyon that showed crown scorch, but it appeared to be in a coarse scale mosaic pattern with about 30% scorched patches. The remainder burned as surface fires, similar to what we measured.

Table 7. Surface and ground fuel consumption by site. Consumption ratings and data apply to burned portion only (see % burned column). Information derived from plot transects and post-fire site observations.

Site	% Site Burned	Soil Severity (NPS rating)[1]	Consumption (%)					
			Duff	Litter	Surface Fuels			
					1-hour	10-hour	100-hour	1,000 hour
Oven Fire								
1	70 - 80	3, 4	20	30	20-90[3]	40-90[3]	75-100[3]	--
2	30 - 40	4	17	25	No change	No change	100	94
Bake Fire								
3	90	3[2]	86	97	90	70-80	No change	--
4	40 – 80	3[2], 5	Fuels transect in unburned patch, remaining area showed 70-100% consumption, particularly of the 1 and 100 hour fuels.					

1 – 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.
2 – white ash where 1000 hour fuels (>3" consumed).
3 – the fuels transect on one plot was in an unburned patch but in the remaining area, fuel consumption was high.

Table 8. Summary of immediate post fire effects per site. Data applies to burned portion of site (see % burned column). 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.

Site	% Site burned	Understory scorch or consumption (%)		Midstory (pole trees)		Overstory Tree Severity		Bole Char Heights (feet)
		Grass/ herb	Shrubs /seedlings	Scorch (% crown)	Torch (% crown)	Scorch (% crown)	Torch (% crown)	
Bake								
1	70 - 80	80-100	Overall 70% consumed. Poison oak consumed to stobbs, rest 100% scorched, except a few unburned seedlings	0-100%, many of live oaks with crowns to ground all scorched	0	5-10% or none on most larger trees, unless next to a mid-story tree with a low crown	0	3-15' (greater char heights on larger trees)
2	30 - 40	80% consumption where burned[1]	0-10% scorch	0-10% (one tree)	0	0	0	0-6' (most without char)
Oven								
3	90	100% consumption	100% consumption, most to stobbs at ground	0-50%	0	0	0	3-6'
4	40 – 80	10-100%	100% consumption, to stobbs	None pre-fire		0	0	0.5-3'

1 – high consumption (>80% where burned) but only 20% of transect in grass burned

VEGETATION COMPOSITION AND FIRE EFFECTS

Pre and post-fire canopy cover are summarized for each site in the following sections. Post-fire effects are limited to those immediately observable. It is nt possible to determine the level of plant mortality or fire-stimulated germination or sprouting immediately post-fire. However, the plots are permanently marked and can be relocated for later assessment of plant survival, sprouting and germination.

The sites varied in their burn pattern and effects. Two of the sites, one each of a burn operation and free-burning fire, burned with a very patchy mosaic. The other two burned more completely and with greater consumption.

Oven Site 1 – Steep Slope

Pre-fire A relatively dense canopied forest of mostly Douglas-fir with smaller live oak and some madrone poles characterized this site. The understory contained patches of well developed poison oak and other scattered herbs and grasses. A few scattered taller shrubs of mock orange and scattered poles of big-leaf maple were present (figure 4, table 9)

Immediate post-fire Most of the understory was consumed where it burned, particularly in and near the patches of poison oak. A few shrubs, herbs and understory trees were missed. In the tree canopy, the midstory was affected but not the overstory. At least half of the pole-sized live oaks were scorched. Most of the overstory and midstory species are sprouters and will likely resprout following the fire.

Figure 4. Pre and post-fire photos along a fuel transect at the lower fuels plot at Oven site 1.

Table 9. Plant cover by species at Oven fire site 1 (upper plot above and lower plot below). Pre- and post-fire cover class for tree species is expressed as percent canopy cover at plot center. Pre- and post-fire cover class for remaining life forms is expressed as follows: 1= <1%; 10= 1-10%; 25= 10-25%; 50= 25-50%; 75= 50-75%; 100= 75-100% cover along a 1-meter wide belt transect and in the surrounding area (herbs and grasses only).

Upper Plot			
Common Name	**Scientific Name**	**Pre-Fire Cover Class**	**Post-Fire Cover Class**
Trees			
Douglas-fir	*Pseudotsuga menziesii*	70	70
Pacific madrone	*Arbutus menziesii*		
Sugar pine	*Pinus lambertiana*		
Canyon live oak	*Quercus chrysolepis*		
Seedlings			
Canyon live oak	*Quercus chrysolepis*	1	1
Shrubs			
Mock orange	*Philadelphus lewisii*	1	1
snowberry	*Symphoricarpus sp.*	10	1
Poison Oak	*Toxicodendron diversilobum*	25	0
Herbs			
Hooker's fairybells	*Disporum hookerii*	1	0
Sword fern	*Polystichum munitum*	1	0
Leafless wintergreen	*Pyrola picta spp. aphylla*	1	0
Arnica	*Arnica sp.*	1	0
Bedstraw	*Galium sp.*	1	0
Grasses			
Multi-stemmed sedge	*Carex multicaulis.*	1	0

Lower Plot			
Common Name	**Scientific Name**	**Pre-Fire Cover Class**	**Post-Fire Cover Class**
Trees			
Douglas-fir	*Pseudotsuga menziesii*	70	70
Pacific madrone	*Arbutus menziesii*		
Big leaf maple	*Acer macrophyllum*		
Seedlings			
Canyon live oak	*Quercus chrysolepis*	1	1
Shrubs			
snowberry	*Symphoricarpus sp.*	1	0
Poison Oak	*Toxicodendron diversilobum*	1	0
Herbs			
White hawkweed	*Hieracium albiflorum*	1	0
Vancouveria / Insideout flower	*Vancouveria sp.*	1	0
Grasses			
Multi-stemmed sedge	*Carex multicaulis*	1	0

Figure 5. Pre and post-fire photos in lower plot vicinity of site 1 at the Oven fire.

Oven - Site 2 along spur ridge

Pre-fire A moderate canopy cover of large Douglas-fir and black oaks, over a dense layer of large, dry grass characterized this site. There were pockets of some shrubs and smaller trees.

Immediate post-fire This fire burned in a very patchy pattern over at least one to several days time. It rained lightly before fire reached the site, resulting in higher surface fuel moisture levels, undoubtedly contributing to a very slow, mosaic burn. Only about 1/3 of the site burned. The effects of the fire were light and patchy on the understory (figure 6, table 10).

Figure 6. Pre and post fire photos at Oven site 2.

Table 10. Plant cover by species at Oven fire site 2. Pre- and post-fire cover class for tree species is expressed as percent canopy cover at plot center. Pre- and post-fire cover class for remaining life forms is expressed as follows: 1= <1%; 10= 1-10%; 25= 10-25%; 50= 25-50%; 75= 50-75%; 100= 75-100% cover along a 1-meter wide belt transect and in the surrounding area (herbs and grasses only).

Upper Plot / Lower plot			
Common Name	**Scientific Name**	**Pre-Fire Cover Class**	**Post-Fire Cover Class**
Trees			
Douglas-fir	*Pseudotsuga menziesii*	40 / 70	40 / 70
Pacific madrone / Canyon live oak	*Arbutus menziesii* / *Quercus chrysolepis*		
Black oak	*Quercus kelloggii* **Seedlings**		
Canyon live oak	*Quercus chrysolepis* **Seedlings**	25	25
Tanoak / Canyon live oak	*Lithocarpus densiflora* / *Quercus chrysolepis*	10	10
Tanoak	*Lithocarpus densiflora* **Shrubs**	1	1
snowberry	*Symphoricarpus sp* **Shrubs**	25	10
Poison Oak / Creeping snowberry	*Toxicodendron diversilobum* / *Symphoricarpus mollis*	10	10
Poison Oak	*Toxicodendron diversilobum* **Herbs**	25	10
Lupine	*Lupinus sp* **Grasses**	25	25
Fescue	*Festuca sp* **Grasses**	75	50
Fescue	*Festuca sp.*	75	50

Bake – Site 1

Pre-fire A dense stand of mostly hardwoods over a well developed litter layer characterizes this site (figure 7, table 11). Few herbs and grasses occurred on the site, although there was one patch of Oregon grape on one plot. Tanoak regeneration had high cover on one of the plots.

Immediate post-fire The understory was mostly consumed or scorched but the overstory changed little. Most of the understory includes perennial plants that sprout and it is likely they will resprout.

Figure 7. Pre and post-fire photos along the upper plot fuel transect at Bake Site 1, burned in a burn operation.

Table 11. Plant cover by species at Bake fire site 3 (upper plot). Pre- and post-fire cover class for tree species is expressed as percent canopy cover at plot center. Pre- and post-fire cover class for remaining life forms is expressed as follows: 1= <1%; 10= 1-10%; 25= 10-25%; 50= 25-50%; 75= 50-75%; 100= 75-100% cover along a 1-meter wide belt transect and in the surrounding area (herbs and grasses only).

Upper Plot / Lower			
Common Name	**Scientific Name**	**Pre-Fire Cover Class**	**Post-Fire Cover Class**
Trees			
Douglas-fir	*Pseudotsuga menziesii*		
Black oak / Ponderosa pine	*Quercus kelloggii* / *Pinus ponderosa*	55	55
Pacific madrone / Ponderosa pine	*Arbutus menziesii* / *Pinus ponderosa*	70	70
Pacific madrone	*Arbutus menziesii* / **Seedlings**		
Douglas-fir / Klamath plum	*Pseudotsuga menziesii* / *Prunus sp.*	1	0
Tanoak	*Lithocarpus densiflora* / **Shrubs**	75	0
Rose	*Rosa sp.* / **Shrubs**	1	0
Hazelnut / Oregon grape	*Corylus cornuta* / *Berberis repens*	20 / 15	0
Oregon grape	*Berberis repens* / **Herbs**	10	0
Hooker's fairybell / snowberry	*Disporum hookeri* / *Symphoricarpos sp.*	1	0
sweet-cicely / Poison-Oak	*Osmorhiza sp.* / *Toxicodendron diversilobum*	10 / 1	0
Grasses / Herbs			
Melica / sweet-cicely	*Melica sp.* / *Osmorhiza sp.*	1	0
Grasses			
melica	*Melica sp.*	1	0

Bake – Site 4

Pre-fire A mature stand with high canopy cover but little midstory or understory trees or plants characterize this site (figure 8, table 12).

Immediate post-fire The fire was patchy in the vicinity of the plot, particularly around the clump of big-leaf maple on one side. There was little to no effect to the overstory that was immediately visible.

Figure 8. Pre and post fire photos at Bake fire, site 4.

Table 12. Plant cover by species at Bake fire site 4. Pre- and post-fire cover class for tree species is expressed as percent canopy cover at plot center. Pre- and post-fire cover class for remaining life forms is expressed as follows: 1= <1%; 10= 1-10%; 25= 10-25%; 50= 25-50%; 75= 50-75%; 100= 75-100% cover along a 1-meter wide belt transect and in the surrounding area (herbs and grasses only).

Common Name	**Scientific Name**	**Pre-Fire Cover Class**	**Post-Fire Cover Class**
Trees			
Douglas-fir	*Pseudotsuga menziesii*	80	80
Seedlings			
Canyon live oak	*Quercus chrysolepis*	10	0
Tanoak	*Lithocarpus densiflora*	10	5
Herbs			
Inside out flower	*Vancouveria sp.*	1	1
Hooker's fairybells	*Disporum hookerii*	1	0

CONSIDERATIONS ON FUTURE WORK ON SITES WITH LIMITED ACCESS

Over the past several years, most of the fires that we have been able to successfully collect information on have had easy access off of roads to carry in equipment and provide ready egress out. Safety is the primary consideration with our operation, and since we are generally setting up with unburned fuel or "green" between us and the fire, we have to consider safety zones (often scarce in the near vicinity) and a typical mitigation is very rapid transit time to vehicles and ability to drive out at least two different routes. However, last year, we were able to set up numerous sites (7 in several days) on the Crag WFU fire on the Sequoia National Forest that had limited access. Since this was a WFU fire, there was helicopter support available to us to internally haul in equipment. In addition, numerous wet meadows around the area provided ready access to safety zones. In the future, we believe that we could adjust to limited access but would need to have the approval of the unit and IMT for the extra expense of utilizing pack trains when not being used for suppression or primary WFU activitites. For the most part, our equipment is designed to be able to stay ahead of the fire for up to two weeks. There may be some adjustments we would need to allow the video camera trigger batteries to last longer.