Prescribed Fire & Fuel Treatment Effectiveness & Effects

Monitoring Program

Fuels, Vegetation, and Wildlife Habitat

Fire and Aviation Management

USDA Forest Service, Pacific Southwest Region

Volume I: 2003 Summary Report

Prepared by:

USFS Adaptive Management Services Enterprise Team

Wildland Fire Specialists

Jo Ann Fites-Kaufman

Erin Noonan

Scott Dailey

Marian Kadota

Carol Ewell

Crystal Kolden

Nicole Vaillant

2003 Summary Prescribed Fire & Fuel Treatment Monitoring Report Vol. 1

Adaptive Management Services Enterprise Team

CONTENTS

I. INTRODUCTION

In 2001, Fire and Aviation Management of the Pacific Southwest Region of the USDA Forest Service (Forest Service) commenced a fire effects and fuel treatment monitoring program. The primary purposes of the monitoring were to quantify and evaluate the effectiveness of projects in meeting fire effects and fuel objectives to vegetation and wildlife habitat. This is an identified part of the National Fire Plan. A secondary purpose was to coordinate monitoring across other agencies in California already conducting similar monitoring, including the National Park Service (Park Service) and California Department of State Parks and Recreation.

An initial goal was to conduct a several year project to gain information on the feasibility, costs, advantages, and disadvantages of conducting monitoring across the entire Region (addressed in Volume II, Chapter IV of the detailed report). The project/program was modeled after the National Park Service fire effects monitoring program because this is a well established program and the Forest Service would like to coordinate and share data with other land management agencies (with little need to modify the database). The focus of the program is on vegetation structure and composition for evaluation of changes in dead and live fuels, soil cover and surface organic matter, plant species composition, and wildlife habitat.

This annual report contains a summary of the objectives, design, and results to date (2001-2003). The design is based upon collection of data before and after (prescribed and unanticipated wildland) fire and mechanical application treatments.

Objectives

The objectives of the regional fire monitoring program include:

1) commencement of interagency coordination on fire effects and fuel treatment effectiveness monitoring;
2) collection of baseline information on prescribed fire and mechanical fuel treatment effects on fuels, wildlife habitat and vegetation composition and structure, and effectiveness of treatments in achieving fuel objectives for application in future fire use planning;
3) evaluation and comparison of different surface fuel loading sampling methods to ensure applicability to fire behavior modeling;
4) establishment of estimates on the cost and effort to derive results with different levels of statistical confidence; and,
5) evaluation of the feasibility and utility of pooling data across the region.

Products

Information on the prescribed fire and fuel treatment monitoring program is presented in two written volumes and a website (under development). The digital media contains photographs, individual plot data and interactive maps. This document represents Volume I, an overview of the design and a summary of results. The detailed report (Volume II) includes the overall design and protocol description, preliminary results and work accomplished in 2001-2003, and adaptive management implications, including statistical results tables.

At this time, there is not enough post treatment data to come to statistical conclusions to address all the objectives for this annual report. With additional post treatment data being collected this year, next year's report will better address the goals and objectives of this project/program, including more detailed analysis and provide more substantial implications for adaptive management. Due to limited post fuel treatment data and available budget, the focus of this year's report is on fuels. Subsequent reports will include more comprehensive analysis of overall vegetation structure and composition and wildlife habitat. Chapter III, of this report, provides preliminary results of all projects to date. Chapter IV compares pre and post one-year treatment for those vegetation types that had a large enough sample size to complete a graphical statistical analysis.

II. OVERALL DESIGN: SELECTION OF SITES & RESPONSE VARIABLES

The goal is to conduct monitoring on one prescribed fire or other fuel treatment projects prior to treatment on all National Forests throughout the Region. A long-term goal is to monitor post treatment conditions at 1, 2, 5, 10 and 20-year intervals. The Forests were asked to provide one or several candidate projects that would be treated in the current or following year. The Regional Office requested projects have an initial focus on prescribed burning; vegetation types or locations that are the highest priority for treatment in that bioregion; and, that would be the most consistent for use in sampling statistics calculations. Project area locations included mixed conifer, Douglas-fir and pine dominated forests and oak woodland and chaparral in southern California forests. More recently, there has been an emphasis on evaluation of fuel treatment effectiveness for all types of fuel treatments, including mechanical. Mastication has been a particular recent emphasis since it is an increasingly used method in the wildland urban interface, yet little is known about effects or fire behavior implications. The intent was to track responses by major vegetation types rather than individual projects. This was the most cost effective way to collect enough data to assess effects of treatments in a short time frame.

Initially, a minimum of three plots were randomly placed within each project unit selected. A sample size of three replicates was chosen for the fuels treatment monitoring program because it provides the minimum needed to compute statistics for a project. In 2003, the protocol was modified to collect surface fuels data across six plots, instead of three, to better represent variability within units. Data are summarized by dominant vegetation type. Future analysis will summarize data by dominant vegetation and treatment types (i.e., prescribed fire, mechanical).

Response Variables

All aspects of vegetation, excluding non-vascular plants (e.g., lichens and mosses) were monitored; including, fuel configuration and amount, vegetation density, size, cover, and species composition (Table 1). Based upon key management issues, additional measurements (from the National Park Service protocol) were included (e.g. tree canopy cover).

Table 1 - *Monitoring Response Variables*

		Resource Addressed			
Response Variable	**Measure**	**Fuels**	**Wildlife Habitat**	**Soil Quality Standards**	**Plant Species and Community Response**
ground and surface fuels	tons/acre by size & depth	x	x	x	
herbs and grasses	cover by species	x	x		x
shrubs	cover, height, and % dead by species	x	x		x
	stem density & size (chaparral only)	x			x
tree density, size and crown bulk density	density by dbh and species	x	x		x
	height to live crown and crown height	x	x		
	overstory tree cover	x	x		
	snag density, dbh	x	x		
predicted fire behavior	flame length	x			
	rate of spread	x			
	fire type	x			

III. PRELIMINARY RESULTS &WORK ACCOMPLISHED IN 2001-2003

Work Accomplished

A total of 36 projects have been sampled, to date, across 17 National Forests, including 129 pre-treatment monitoring plots and 28 post-treatment plots. Table 2 summarizes the projects studied from 2001-2003. Nearly all projects were in vegetation or fuel types that are National Fire Plan priorities. They represent lower elevation vegetation found in wildland urban interfaces. Yellow pine (ponderosa, Jeffrey and coulter pine), Douglas-fir/white fir, chaparral/mixed forest chaparral, and ponderosa pine/white fir vegetation types have more than one project represented. Table 2 further describes the dominant vegetation types and the majority of tree species (vegetation sub-type) that compose each type per project. This means that statistical analysis will be possible representing broad trends in the region by vegetation/fuel type for those vegetation types with enough post fuel treatment data. Projects are not referred to by name because sample design was not developed to assess individual projects.

Table 2 - *Summary and Status of Prescribed Fire Monitoring Projects from 2001-2003.*

Forest	Project Name	Establishment Year	Treatment Type	Dominant Vegetation Type	Vegetation Sub-Type	Status as of 2003
Angeles	Angeles-02 post1	2002	wildfire	chaparral	chaparral	1st year re-measure
Cleveland	Cleveland-01a	2001	prescribed burn	chaparral	chaparral	Pre-treatment
Cleveland	Cleveland-01b*	2001	Prescribed burn	Oak Woodland	Coastal Sage/Riparian Oak	Pre-treatment
Eldorado	Eldorado-02	2002	prescribed burn	Douglas-fir/white fir	Douglas-fir-Black Oak	Pre-treatment
Eldorado	Eldorado-03	2003	mechanical	Ponderosa pine/white fir	Ponderosa Pine - White fir	Pre-treatment
Eldorado	Eldorado-01	2001	prescribed burn	Douglas-fir/white fir	White Fir - Mixed Conifer	Pre-treatment
Inyo	Inyo-02	2002	prescribed burn	Yellow Pine	Jeffrey pine	Pre-treatment
Inyo	Inyo-03*	2003	mechanical	Red fir/Jeffrey Pine	Red fir - Jeffrey Pine	Pre-treatment
Klamath	Klamath-01	2001	prescribed burn	Douglas-fir/white fir	Douglas Fir-Canyon Live Oak	Pre-treatment
Klamath	Klamath-02 post1	2002	prescribed burn	Ponderosa pine/white fir	Ponderosa Pine - White fir	1st year re-measure
Lassen	Lassen-02	2002	prescribed burn	Ponderosa pine/white fir	Ponderosa Pine - White fir	Pre-treatment
Lassen	Lassen-01 post2	2001	prescribed burn	Yellow Pine	Ponderosa Pine-Black Oak	2nd year re-measure
Los Padres	Los Padres-01	2001	prescribed burn	chaparral	Big Pod Ceanothus Chaparral	Pre-treatment
Los Padres	Los Padres-03	2003	prescribed burn	chaparral	chaparral	Pre-treatment
Los Padres	Los Padres-02 post1	2002	prescribed burn	Yellow Pine	Jeffrey pine	1st year re-measure
Mendocino	Mendocino-03	2003	mech & rxburn	Ponderosa pine/white fir	Ponderosa Pine - White fir	Pre-treatment
Mendocino	Mendocino-02 post1	2002	prescribed burn	Yellow Pine	Ponderosa Pine - Black Oak	1st year re-measure
Modoc	Modoc-02 post1	2002	prescribed burn	Yellow Pine	Ponderosa Pine	1st year re-measure
Modoc	Modoc-03	2003	mech & rxburn	Yellow Pine	Ponderosa Pine	Pre-treatment
Plumas	Plumas-03	2003	mech & rxburn	Ponderosa pine/white fir	Ponderosa Pine - White fir	Pre-treatment
Plumas	Plumas-02	2002	prescribed burn	Douglas-fir/white fir	White fir - Douglas-fir	Pre-treatment
Plumas	Plumas-01 post2	2001	prescribed burn	Douglas-fir/white fir	White Fir - Black Oak	2nd year re-measure
San Bernardino	San Bernardino-03	2003	mechanical	Yellow Pine	Coulter Pine	Pre-treatment
San Bernardino	San Bernardino-01	2001	wildfire	Yellow Pine	Coulter Pine-Black Oak	Pre-treatment
Sequoia	Sequoia-02	2002	prescribed burn	chaparral	Chaparral/Oak woodland-grassland	Pre-treatment
Shasta-Trinity	Shasta-Trinity-02 post1	2002	prescribed burn	Ponderosa pine/white fir	Ponderosa Pine - White fir	1st year re-measure
Sierra	Sierra-02 post1	2002	prescribed burn	Yellow Pine	Ponderosa Pine	1st year re-measure
Sierra	Sierra-01	2001	prescribed burn	Yellow Pine	Ponderosa Pine - Black Oak	Pre-treatment
Six Rivers	Six Rivers-02	2002	prescribed burn	Douglas-fir/white fir	Douglas-Fir-Black Oak	Pre-treatment
Six Rivers	SixRivers-01	2001	prescribed burn	Douglas-fir/white fir	Douglas-Fir-Tan Oak	Pre-treatment
Stanislaus	Stanislaus-01	2001	mech & rxburn	Yellow Pine	Ponderosa Pine	Pre-treatment
Stanislaus	Stanislaus-02	2002	prescribed burn	Ponderosa pine/white fir	Ponderosa Pine – Black Oak	Pre-treatment
Tahoe	Tahoe-01a	2001	Mech & rxburn	Douglas-fir/white fir	Douglas-Fir- & Ponderosa Pine Mcn	Pre-treatment
Tahoe	Tahoe-01b post1	2001	mech & rxburn	Douglas-fir/white fir	Douglas-Fir- & Ponderosa Pine Mcn	1st year re-measure
Tahoe	Tahoe-01c post2	2001	mech & rxburn	Yellow Pine	Douglas-Fir- & Ponderosa Pine Mcn	2nd year re-measure
Tahoe	Tahoe-03	2003	mech & rxburn	Douglas-fir/white fir	Douglas-fir	Pre-treatment

***Cleveland-01b and Inyo-03 projects have a unique vegetation type for this report. They have been combined with other vegetation types.**

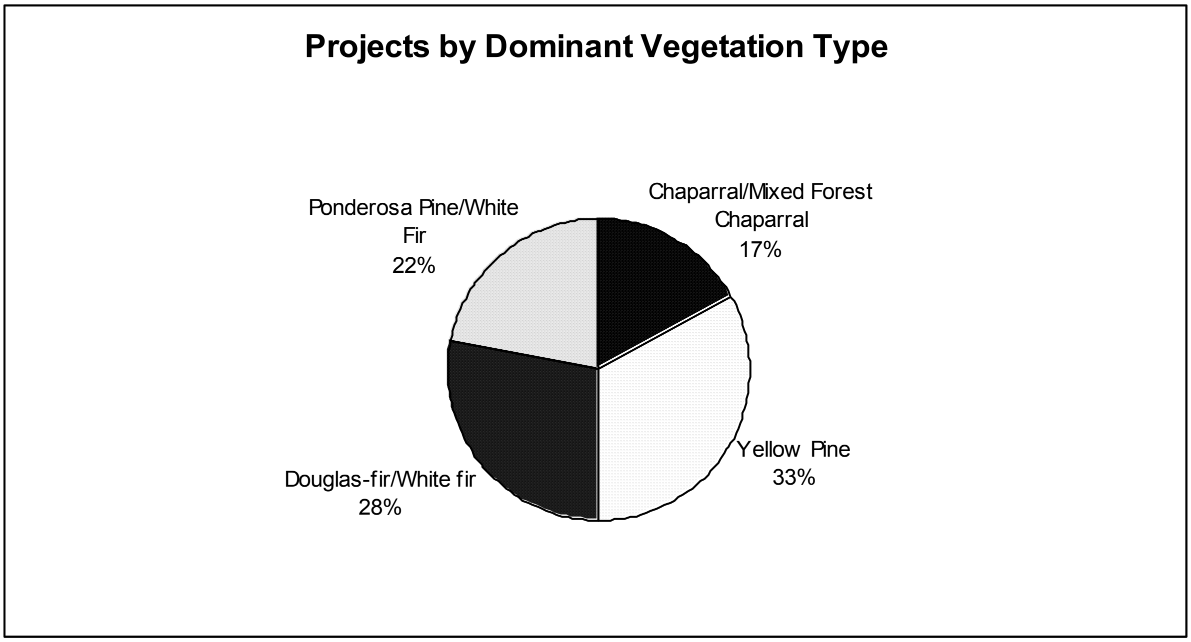

Figure 1 - The percentage of projects (from 2001-2003) by dominant vegetation type addressed in this report.

Results

This report contains results after the third year of the fire effects and fuel treatment monitoring program. Data are presented below by dominant vegetation type for all years of the fire effects and fuels treatment monitoring program, which includes 36 projects (Table 2). Eleven of these projects have been partially or entirely treated. This includes eight forested projects treated with prescribed fire, two forested projects treated with mechanical and prescribed fire, and one chaparral project, burned by wildfire. The eleven projects are composed of a total of 28 pre and post one and/or two-year treatment plots.

In projects that received treatment, not all plots measured during pre-fuel treatment were modified by post fuel treatment. Only those plots that received treatment were re-measured. The results shown in this Chapter represent project data.

Where possible, the results documented in the following pages are divided into forest vegetation types and chaparral vegetation types. However, in two projects (Eldorado-03 and Mendocino-03), the results for both are presented in two vegetation types (i.e., ponderosa pine/white fir and mixed forest/chaparral) to facilitate comparison across all vegetation types.

The Cleveland-01b (oak woodland) and Inyo-03 (red fir/Jeffrey pine) projects do not fit into the four major vegetation types analyzed in this annual report. Until more projects are included in these two vegetation types, Cleveland-01b is included in chaparral and mixed forest/chaparral and Inyo-03 is included in ponderosa pine/white fir vegetation types.

The heights to live canopy results, shown below, were produced using GAMMA, a program used by the Region 5 Planning Analyst, and based upon the Forest Vegetation Simulator, Fire & Fuels Effects Module (FVS FFE source code circa 2001). A key difference between GAMMA and FVS is that GAMMA incorporates crown fuels from hardwoods, such as black or live oak. A recent limitation to the underlying crown fuel calculations for both programs is that they are not always sensitive to changes in crown conditions from fuel treatments that result in increased canopy base height of individual trees. Modifications to improve this sensitivity to changes in crowns from fuel treatments are underway. In the mean-time, these limitations can sometimes result in an estimate of increased crown fuels post-treatment even though trees have been removed or especially crown heights increased from prescribed burning or pruning. Future reports may contain modified estimates of crown fuels due to incorporation of any improved programming.

Additional data is represented in the detailed annual report (Volume II).

Some of the data displayed in the graphs below (and in Volume II) provide preliminary trends, but should not be viewed as conclusive. This is due to the small sample size of treatment plots.

Ponderosa Pine/White Fir Sites

The ponderosa pine/white fir types are composed primarily of *Pinus ponderosa* (ponderosa pine) with a mix of *Abies concolor* (white fir), *Calocedrus decurrens* (incense cedar), or *Quercus kelloggii* (black oak) in the understory. Ponderosa pine/white fir projects collectively include eight projects with two projects (Klamath-02 and Shasta-Trinity-02) that have pre and post treatment data.

Pre and post one-year data are further described in Section IV, Pre and Post One-year Treatment Data, of this report.

Fuel Load

The average surface fuel loading for small downed fuels (litter and 0-3” diameter) for the projects in this vegetation type was 9.5 (range: 6.4-16.2) tons per acre pre-fuel treatment. Klammath-02 and Shasta Trinity-02, had an average small downed fuel load of 8.1 (range: 7.9-8.2) tons per acre pre fuel treatment and 3.4 (range: 2.9-4.0) tons per acre post fuel treatment (Figure 2). Of the two projects treated in this vegetation type, the mean total fuel load was reduced by 58% for small downed fuels.

The average surface fuel loading for large downed woody fuels (greater than 3” diameter) for the projects in this vegetation type was 17.2 (range: 6.1-32.4) tons per acre pre-fuel treatment. Klammath-02 and Shasta Trinity-02 had an average large downed woody fuel load of 12.2 (range: 6.6-17.7) tons per acre pre-fuel treatment and 5.0 (range: 3.0-7.1) tons per acre post fuel treatment (Figure 2). Total fuel load was reduced by 59% for large downed fuels for the two projects treated in this vegetation type. Looking at Table 2, the Inyo-03 project is dominated by *Abies magnifica* (red fir) and *Pinus jeffreyi* (Jeffrey pine) tree species. This may be one reason the 1000 hour fuels (greater than 3” diameter) are higher for this project site.

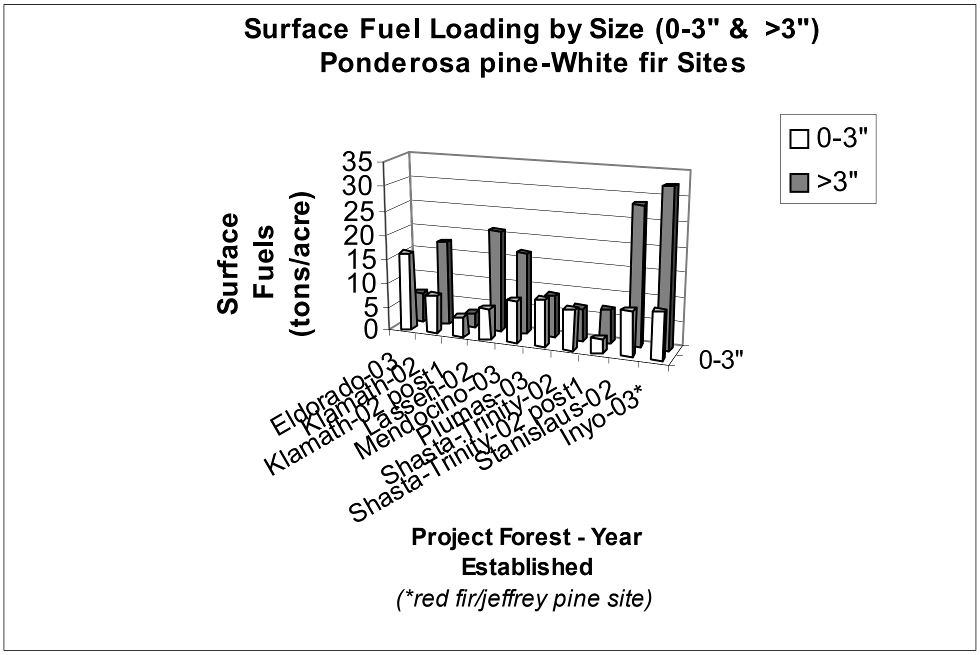

Figure 2 - Surface fuel loading by size (0-3" & >3" diameter) for Ponderosa pine and white fir dominated sites. 0-3" fuels include litter weights predicted from regressions on litter weight.

Crown Fuels

Figures 3 and 4 provide graphs showing canopy data. Height to live canopy is computed by applying a running mean along the length of a tree canopy. The mean must equal or exceed a 75-pound threshold in order to compute a height to live canopy value, similar to the method employed in the Forest Fire Extension of the Forest Vegetation Simulator. If stand data failed to meet the 75–pound minimum threshold, then height to live canopy would not be computed.

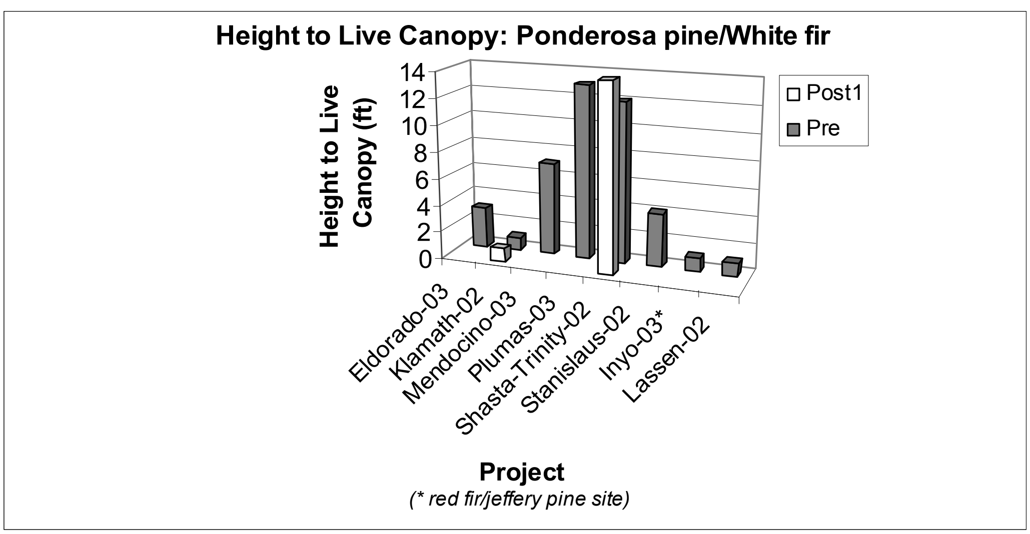

Figure 3 - Height to live canopy for ponderosa pine/white fir, calculated using the same method as the FVS-FFE extension with a 75-lb minimum threshold (Scott and Reinhardt, 2001).

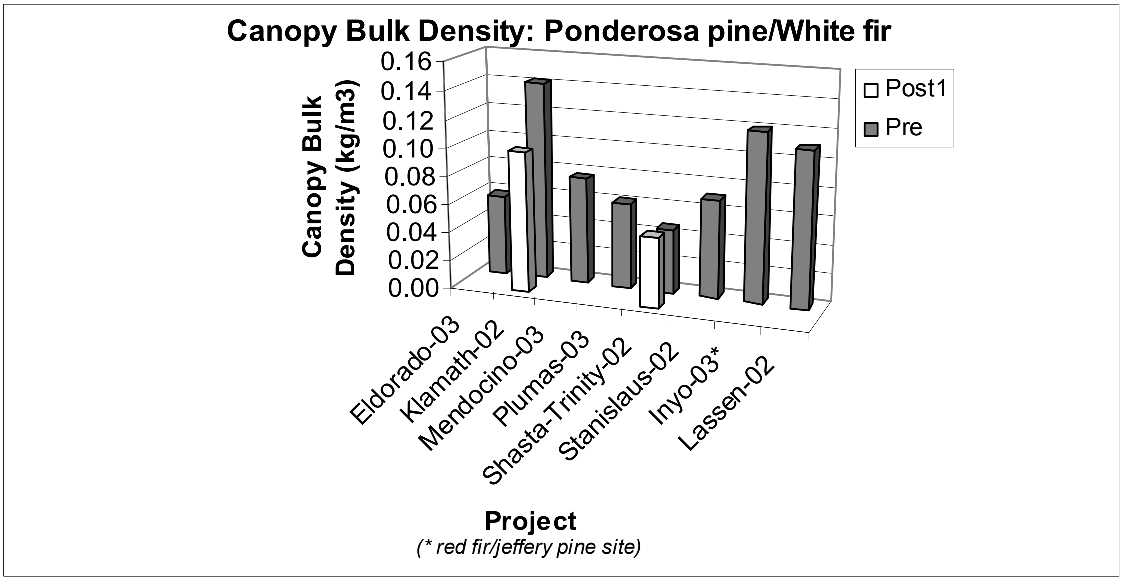

Figure 4 - Canopy bulk density (kg/m3) for ponderosa pine/white fir.

Percent Cover

Two projects, Klamath-02 post1 and Shasta Trinity-02 post1, represent pre and post one-year treatment data and show changes in percent cover as a result of prescribed fire. Both projects indicate trends where mean grass and herb cover decreased one-year post treatment. The absence of mean tree cover for the Shasta-Trinity-02 post1 project indicates that these data are not available and does not mean that tree cover was 0% for the post measurement (Figure 5).

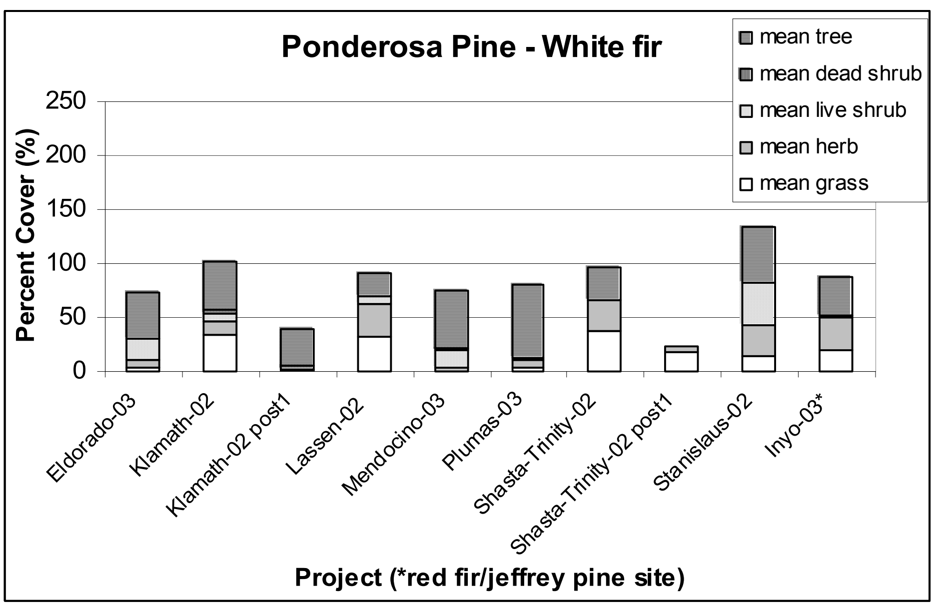

Figure 5 - Vegetation cover (%) by layer for Ponderosa pine-white fir dominated projects.

Photographs

Figure 6 shows pre and post treatment (prescribed burn) photos taken in a ponderosa pine/white fir vegetation type.

Figure 6 - Pre and Post photo pair, Klamath-02 Project, Klamath National Forest. Pre-treatment and one-year post-treatment photographs.

Yellow Pine Sites

These sites are composed of primarily ponderosa pine and Jeffrey pine with some *Pinus coulteri* (Coulter pine) in the southern California projects. Twelve projects are included in the yellow pine data with six projects having pre and post treatment data (Lassen-01, Los Padres-02, Mendocino-02, Modoc-02, Sierra-02, and Tahoe-01c).

Fuel Load

The average value for small downed fuels (litter and 0-3" diameter fuels), for all projects within this vegetation type, is 11.4 (range: 5.4-17.8) tons per acre pre fuel treatment. The average value for small downed fuels for the six projects treated within this vegetation type is 10.6 (range: 3.6-7.7) tons per acre pre fuel treatment and 5.2 (range: 3.6-7.7) tons per acre post one-year fuel treatment (Figure 7). For the six treated projects, the average small downed woody fuels were decreased by 51% for the yellow pine vegetation type.

The average value for large downed fuels (greater than 3" diameter) is 12.5 (range: 1.2-25.2) tons per acre pre-fuel treatment for all projects within this vegetation type. The average value for the large downed fuels for the six projects treated in this vegetation type is 14.5 (range: 4.9-25.2) tons per acre pre-fuel treatment and 8 (range: 1.4-21.5) tons per acre post one-year fuel treatment

(Figure 7). The average large downed woody fuels were decreased by 45% for the yellow pine vegetation type.

Post measurements of surface fuel loads may exceed pre-treatment fuel loadings depending upon the type and status of the treatment. For instance, mechanical treatments combined with prescribed fire, or pole and tree snags that fall to the ground two to five years after the prescribed fire, may contribute to higher surface fuel loading. Furthermore, sometimes pre-treatment fuel loadings are representative of all plots of a project while post measurements may represent only one or two plots. This is an artifact of the treatment schedule where only part of a unit or project may be treated in any one year. The Lassen-01 project is an example of this scenario whereby the fuel loading is higher in the post one treatment (Figure 7). This is due to a combination of different sample sizes (3 plots represent pre-treatment fuel loading while 2 plots represents post fuel loading) for the post treatment re-measurements.

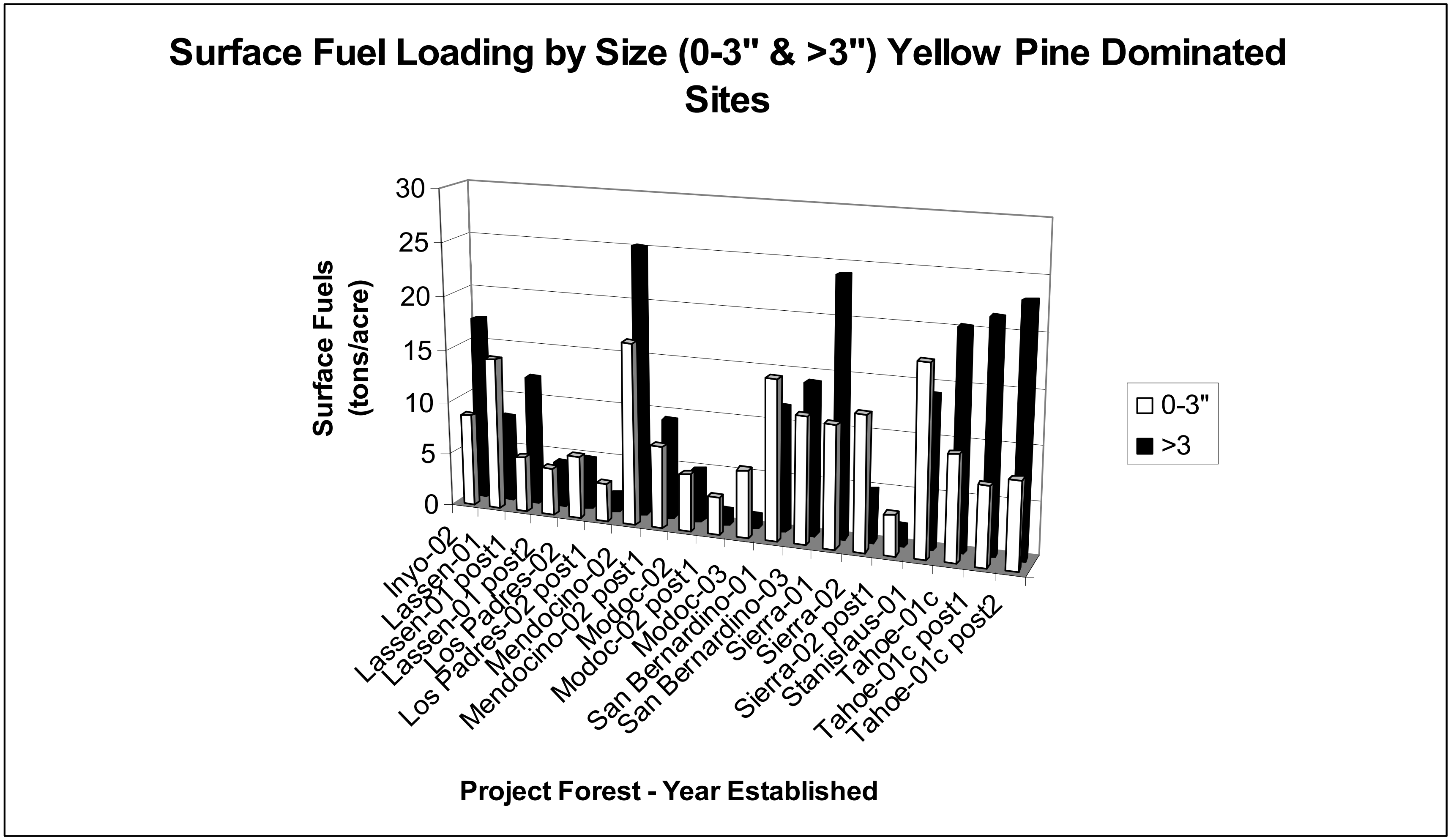

Figure 7 - Surface fuel loading by size (0-3” & >3” diameter) for yellow pine (ponderosa, Jeffrey and coulter) dominated sites, including pre and post treatments. 0-3” fuels include litter weights predicted from regressions on litter weight.

Crown Fuels

A summary of canopy fuel measurements for yellow pine vegetation types, such as height to live canopy (feet) and canopy bulk density (kg/m3), are shown in Figures 8 and 9. Pre and post one-year data are further described in Section IV, Pre and Post One-year Treatment Data, of this report. Similar to the ponderosa pine/white fir canopy graphs, height to live canopy may not be displayed for some projects if the tree data failed to meet the 75-pound threshold necessary for the computation of this value.

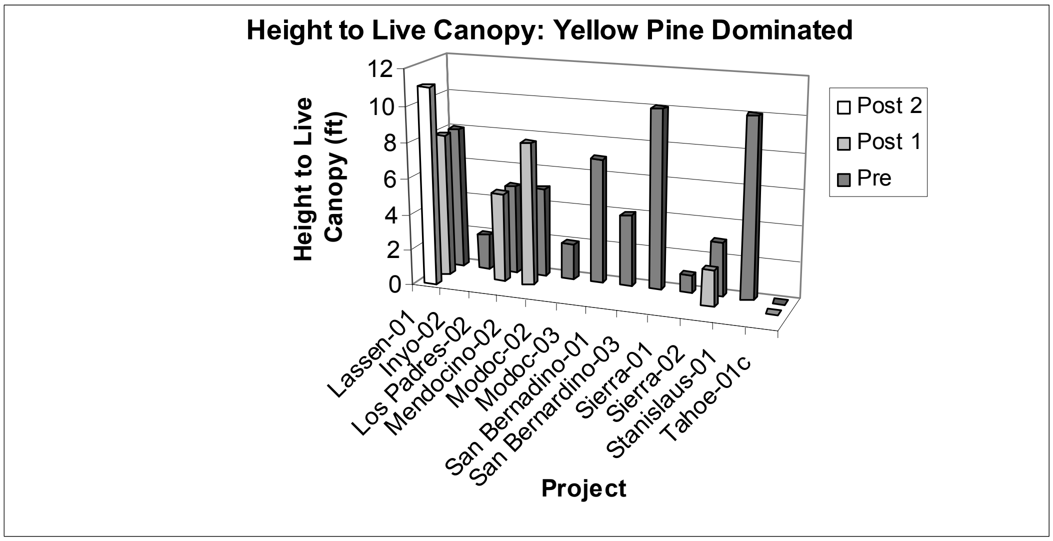

Figure 8 - Height to live canopy for yellow pine (ponderosa, Jeffrey, and coulter pine) calculated using the same method as the FFE-FVS extension with a 75-lb. minimum threshold (Scott and Reinhardt, 2001).

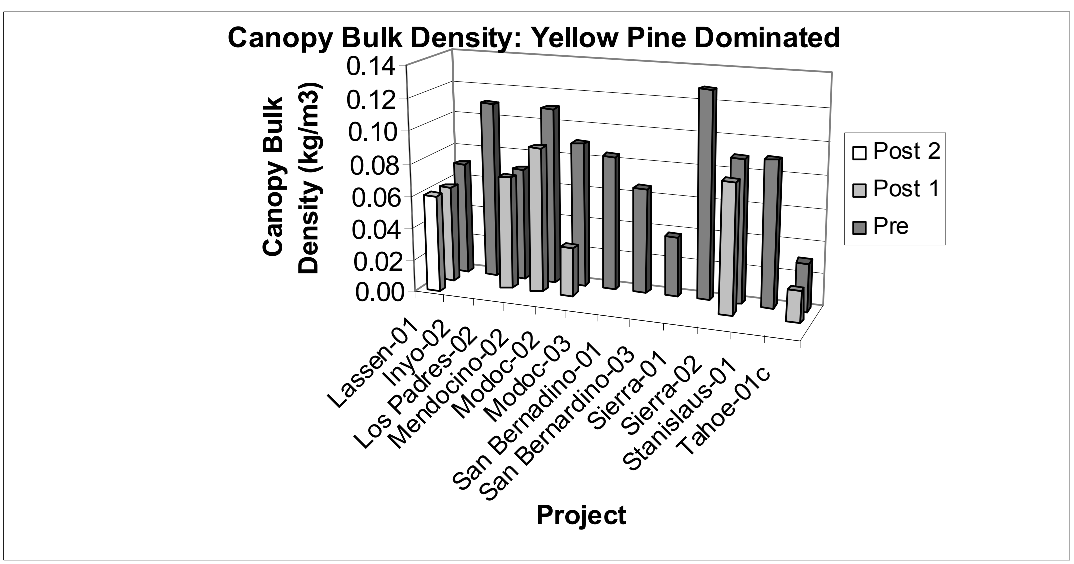

Figure 9 - Canopy bulk density (kg/m3) for yellow pine.

Percent Cover

Percent cover for grasses, herbs, dead and live shrubs and trees are shown in Figure 10. Six projects have data for pre and post treatment (Lassen-01, Mendocino-02, Modoc-02, Los Padres-02, Sierra-02, and Tahoe-01c). The Los Padres-02, Mendocino-02, and Modoc-02 projects show a post one-year increase in herbaceous cover. Generally, tree cover did not drastically change compared to pre and post year treatment measurements. Data show a reduction of approximately 18% (range: 0.25–34%) tree cover after prescribed fire or mechanical treatments, which is often contributed to the mortality of poles and small trees (Table 3 in Chapter V, Forest Mortality, in this document).

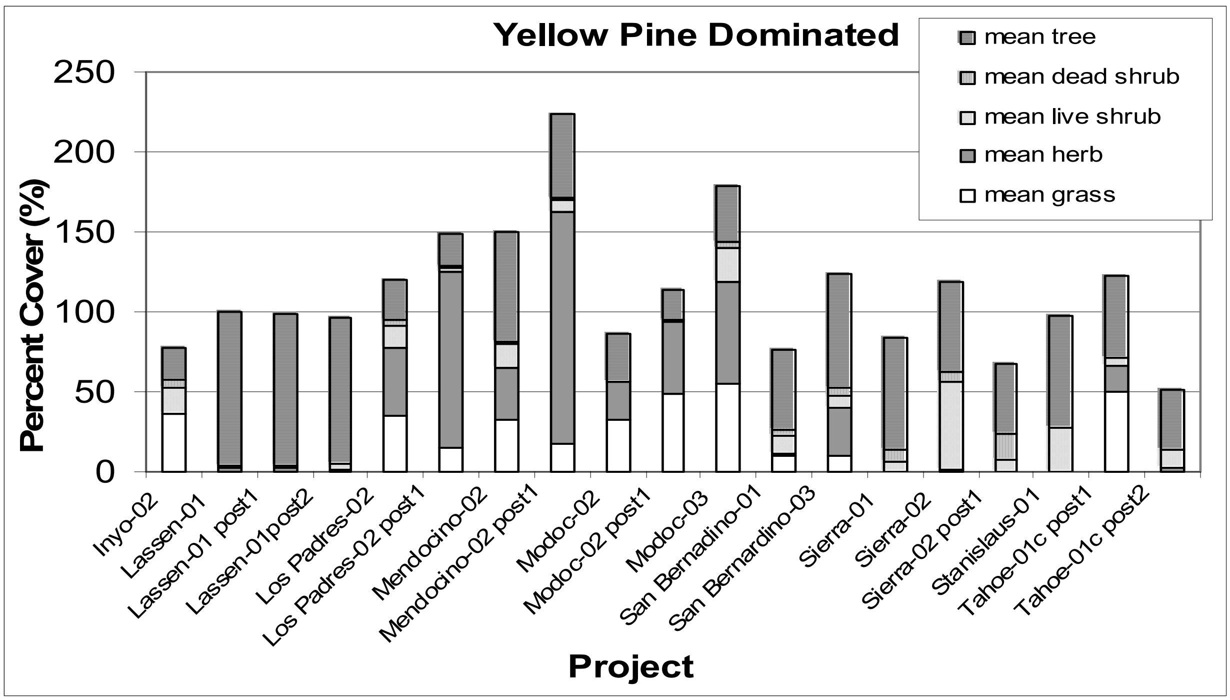

Figure 10 - Vegetation cover (%) by layer for yellow pine (ponderosa pine, Jeffrey pine, Coulter pine) dominated projects.

Photographs

Figure 11 shows pre and post fuel treatment (prescribed burn) photos taken in a yellow pine vegetation type.

Figure 11 - Pre and Post photo pair, Lassen-01 Project, Lassen National Forest. Pre-treatment and one-year post-treatment photographs.

Douglas-Fir/White Fir Sites

These sites are dominated by *Psuedotsuga menziesii* (Douglas-fir) and/or white fir projects. Ten projects are included in the Douglas-fir/white fir data with two projects that have pre and post treatment data (Plumas-01 and Tahoe-01b).

Fuel Load

The average value for small downed fuels (litter and 0-3" diameter fuels) is 10.2 (range: 5.8-15.7) tons per acre pre-fuel treatment for all projects within this vegetation type. The average value for small downed fuels in the two treated projects is 12.8 (range: 12.1-13.5) tons per acre pre-fuel treatment and 4.5 (range: 3.5-5.6) tons per acre post fuel treatment (Figure 12). The mean small downed woody fuels were decreased by 65% for the Douglas-fir/white fir vegetation type for the two treated projects.

The average value for large downed fuels (greater than 3” diameter) is 14.9 (range: 2.8-29.9) tons per acre pre-fuel treatment for the 10 projects within this vegetation type. The average value for large downed fuels for the two treated projects is 20.0 (range: 16.8-23.2) tons per acre pre-fuel treatment and 8.9 (range: 3.2-14.6) tons per acre post fuel treatment (Figure 12). The mean large downed woody fuels were decreased by 56% for the two treated projects within the Douglas-fir/white fir vegetation type.

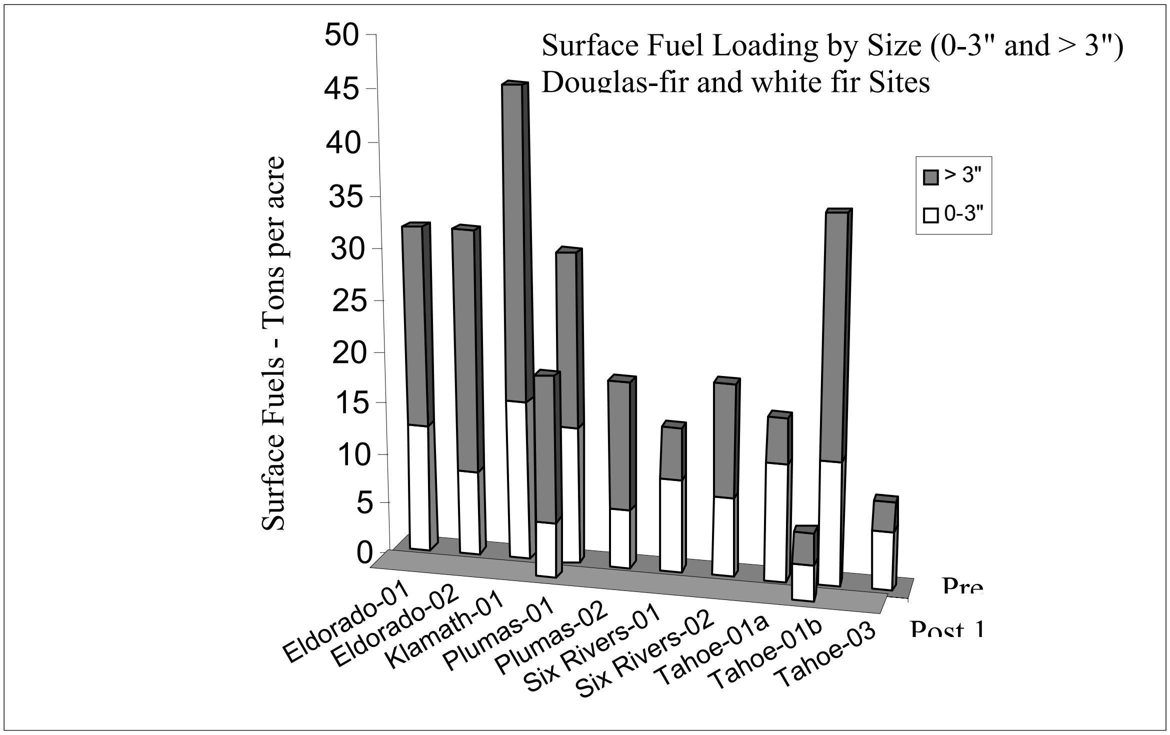

Figure 12 - Surface fuel loading by size (0-3” & >3” diameter) for Douglas-fir and white fir dominated sites. Two projects have pre and post treatment fuels. 0-3” fuels include litter weights predicted from regressions on litter weight.

Crown Fuels

Post measurements for crown fuels measured in 2003 show that height to live canopy tends to increase after treatment (Figure 13). Canopy bulk density ranged from 0.09-0.10 kg/m3 for all projects in the Douglas-fir/white fir vegetation types (Figure 14).

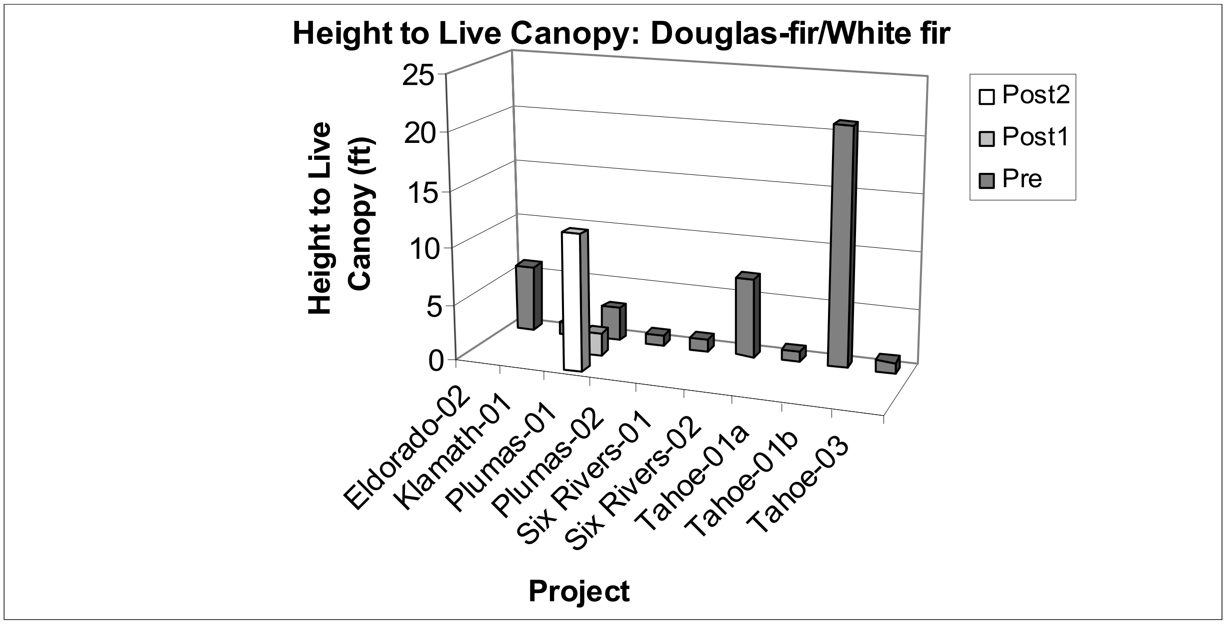

Figure 13 - Height to live canopy for Douglas-fir/white fir, calculated using the same method as the FFE-FVS extension with a 75-lb. minimum threshold (Scott and Reinhardt, 2001).

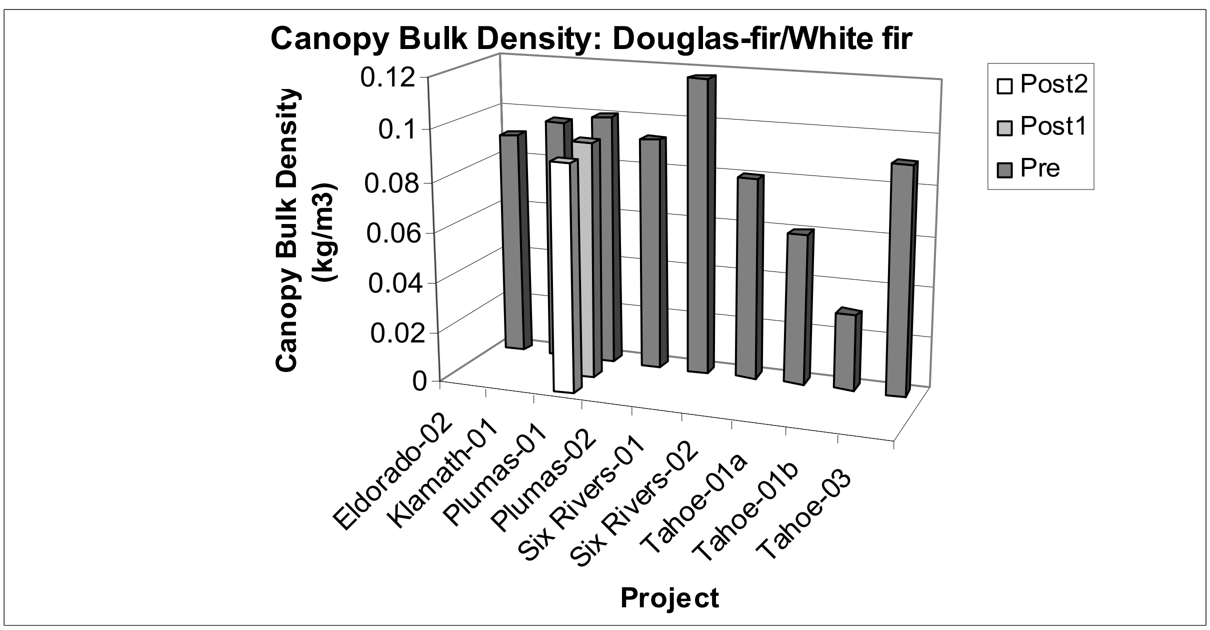

Figure 14 - Canopy bulk density (kg/m3) for Douglas-fir/white fir.

Percent Cover

Figure 15 is a graphic representation of the vegetation cover in the Douglas-fir/white fir projects. The two post-treatment projects are noted (i.e., Plumas-01 post1 and Tahoe-01b post1).

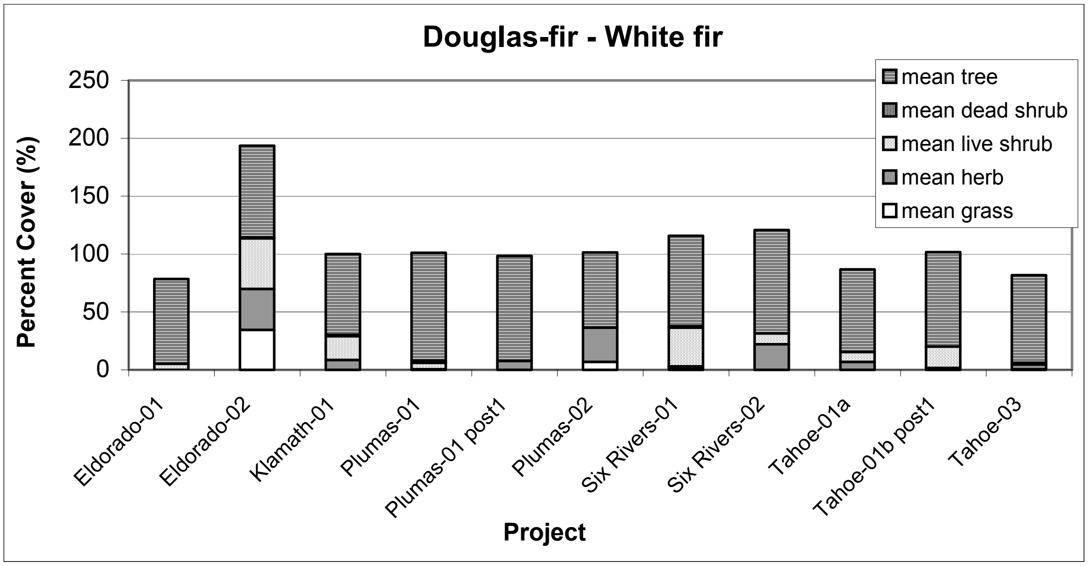

Figure 15 - Percent cover for Douglas-fir/white fir projects.

Photographs

Figure 16 shows pre and post treat ment (prescribed burn) photos taken in a Douglas-fir/white fir vegetation type.

Figure 16 - Pre-Post photo pair, Plumas-01 Project, Plumas National Forest. Pre-treatment and 2nd year post-treatment photographs.

Chaparral & Mixed Forest/Chaparral Sites

Chaparral and mixed forest/chaparral vegetation type plots do not follow the same methodology as the forest vegetation type plots. Consequently, data for surface fuels are not collected. The emphasis of sampling chaparral is capturing the structure, decadence, and cover of the dominant shrub and herbaceous vegetation types. The mixed chaparral plots often have an overstory of oak woodlands or coniferous species with a dense understory of shrubs, which are not adequately sampled with traditional methods. These projects are sampled differently from forested plots to capture the shrub component more thoroughly.

There is only one pre and post one-year project (Angeles-02) that was burned in a wildfire. The remaining projects in this vegetation type represent pre-burn treatment data. Cleveland-01b is an Oak woodland vegetation type; however, there is only one project in this vegetation type and little data is presently collected so this project has been included in the chaparral and mixed forest/chaparral vegetation types.

Shrub Decadence

Chaparral decadence was highest for the Cleveland and Los Padres projects (Figure 17). Average chaparral decadence for all projects was 15% (range: 2-31%). The mixed forest/chaparral plots had a lower average value for decadence (4.5%), as shown in Figure 18, compared to the pure stands of chaparral.

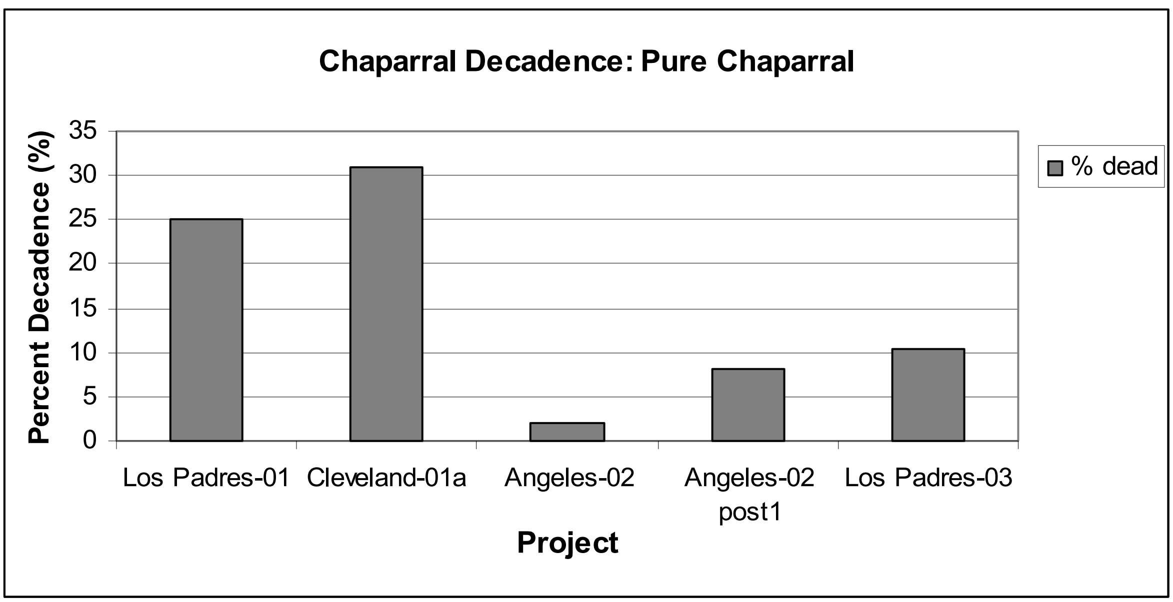

Figure 17 - Shrub decadence (% of stems or cover) for chaparral plots. Cleveland-01b is an Oak Woodland, so this project was not included in the graph.

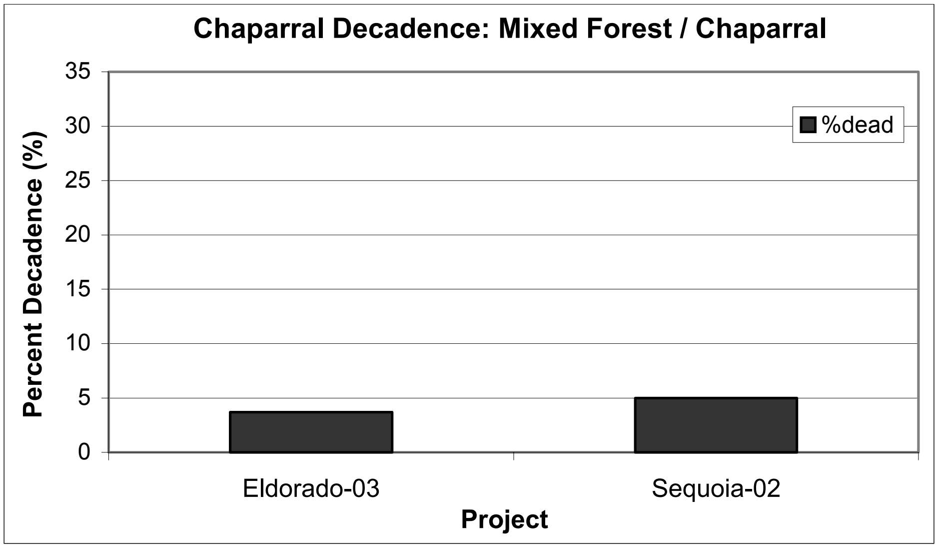

Figure 18 - Shrub decadence (% of stems or cover) for mixed forest/chaparral plots. Mendocino-03 data was not calculated for chaparral decadence.

Shrub Heights

Shrub heights in feet are expressed as 75th and 90th percentiles (Figures 19 and 20). The 75th percentile means that 75% of all the shrubs sampled are below the height that corresponds with the 75th percentile, leaving a remaining 25% that are equal or taller than the specified height. The 90th percentile follows the same ideology. The 75th percentile shrub heights are similar for both the chaparral and mixed forest/chaparral projects with averages of 5.3 feet and 5 feet, respectively. However, the 90th percentile data differs by one foot with averages of 6.1 feet for chaparral and 7.2 feet for the mixed chaparral stands.

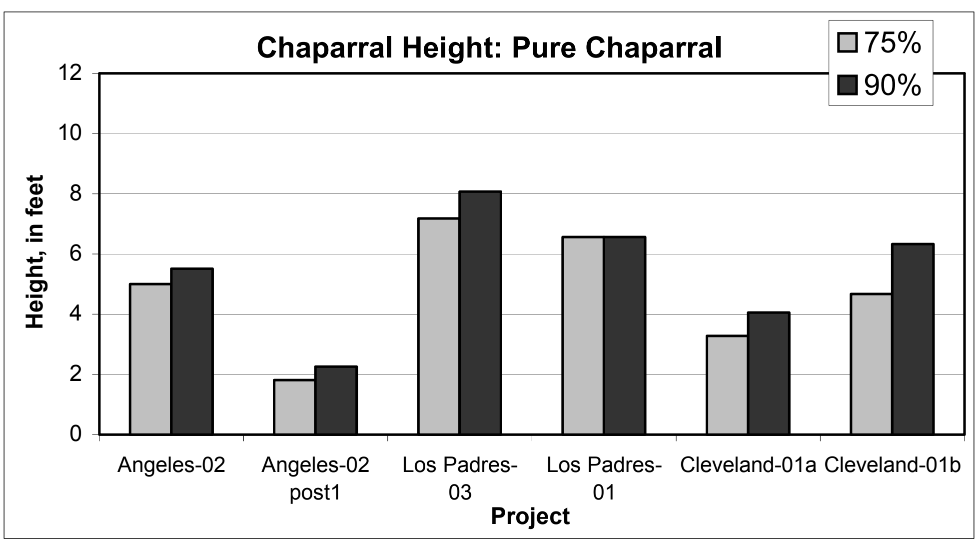

Figure 19 - Shrub heights (feet) expressed as 75th and 90th percentiles for chaparral plots. Cleveland-01b is Oak Woodland but was included in chaparral vegetation type.

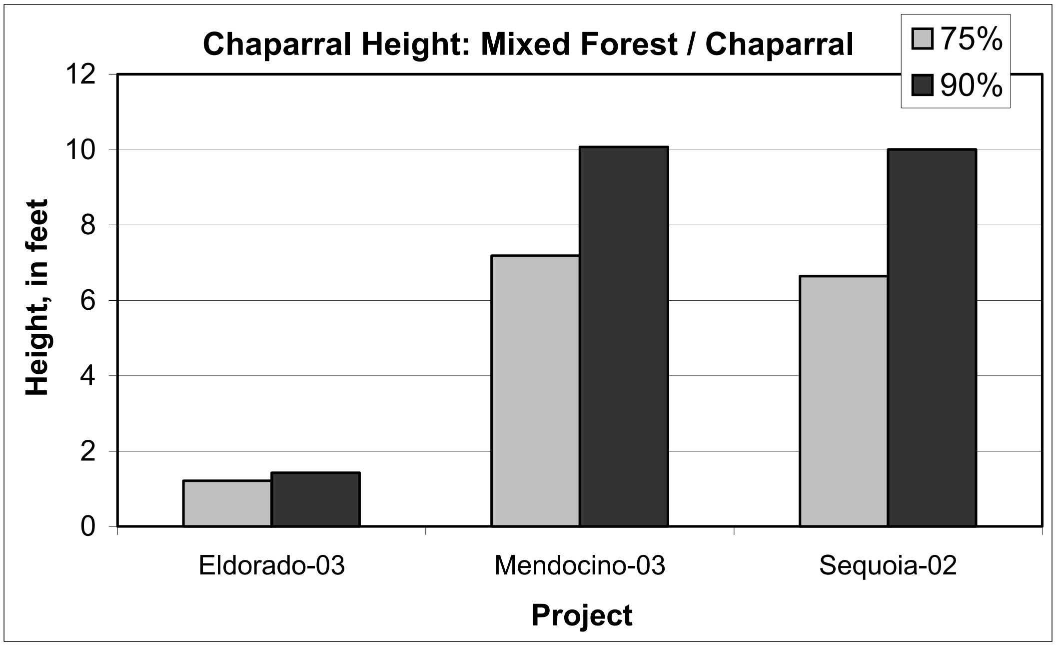

Figure 20 - Shrub heights (feet) expressed as 75th and 90th percentiles for mixed forest/ chaparral plots.

Percent Cover

Percent cover for both pure chaparral and mixed forest/chaparral stands are displayed together (Figure 21). Compared to other forest vegetation type projects, percent cover for live shrub is much higher. Angeles-02 post1 cover is approximately 10% the cover before the wildfire (Angeles-02). The Cleveland-01b, Mendocino-02, and Sequoia-02 projects are mixed, resulting in higher tree cover compared to the pure chaparral projects.

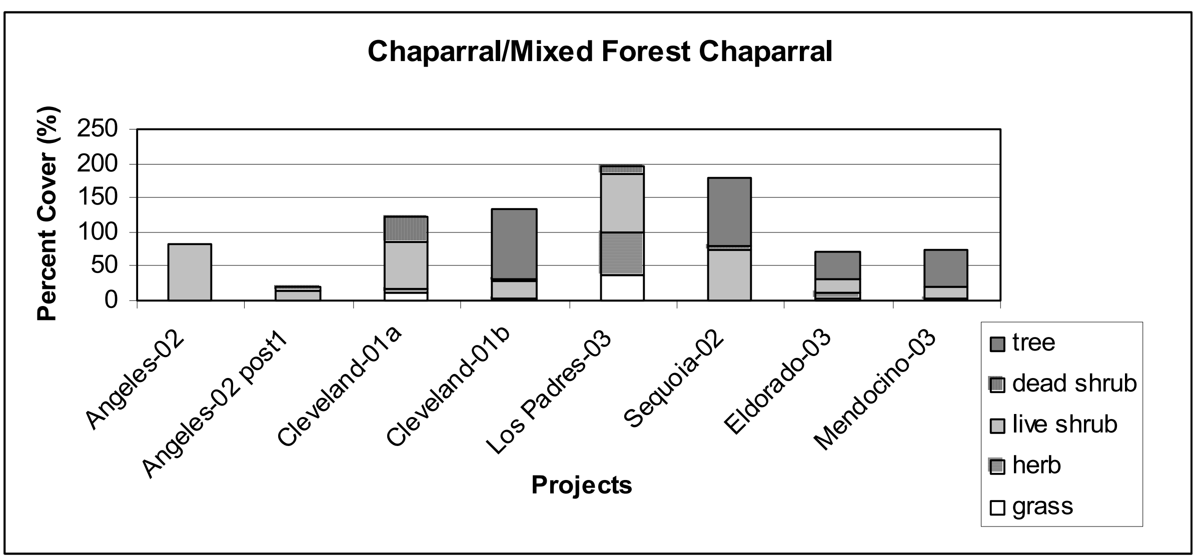

Figure 21 - Vegetation cover (%) by layer for chaparral and oak woodland/chaparral dominated projects.

Photographs

Figure 22 shows pre and post treatment (wildfire) photos taken in a chaparral & mixed chaparral vegetation type.

Figure 22 - Pre and Post photo pair, Angeles-02 Project, Angeles National Forest. Pre-treatment and one-year post-wildfire photographs.

IV. PRE AND POST ONE-YEAR TREATMENT DATA

The comparison between pre and post one-year treatment data was grouped into two dominant vegetation types: yellow pine and ponderosa pine/white fir. The Douglas-fir/white fir and chaparral vegetation types did not have a large enough sample size for pre treatment and post one-year treatment data, at this time, for inclusion into this analysis.

For graphs represented below, the data are displayed with box plots. Box plots show the median, interquartile range, outliers, and extreme cases of individual variables. The center horizontal line denotes the median, the upper and lower boundaries of the boxes are the 25th and 75th percentiles and the upper and lower horizontal lines are the maximum and minimum values, except where values exceeded twice the standard deviation. The latter values are shown individually.

Total Fuels

Surface fuel loading includes 1-100 hour fuels and litter weights in tons per acre. Fuel loading was lower for the two vegetation types in the post one-year re-measurements (Figure 23).

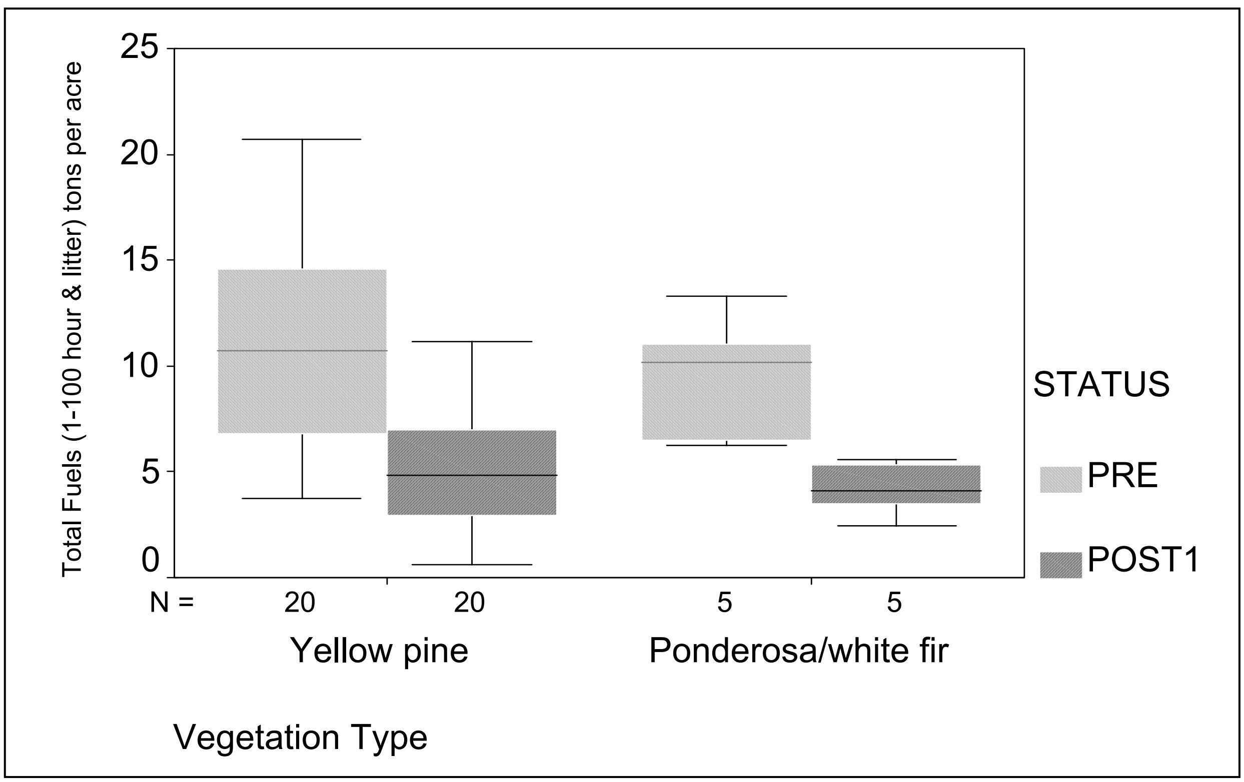

Figure 23 - Pre and one-year post total surface fuels including all 1-100 hour and litter in tons per acre. Vegetation types are yellow pine; and ponderosa pine and white fir.

Small Downed Fuels

Small downed (one hour) surface fuels are less than 0.25" in diameter, including litter. Small downed fuels are important for the propagation of fire spread during prescribed and wild fires. Fuel loading in this category is similar across all vegetation types when comparing pre and post one-year data, with the greatest variation in the yellow pine type (Figure 24).

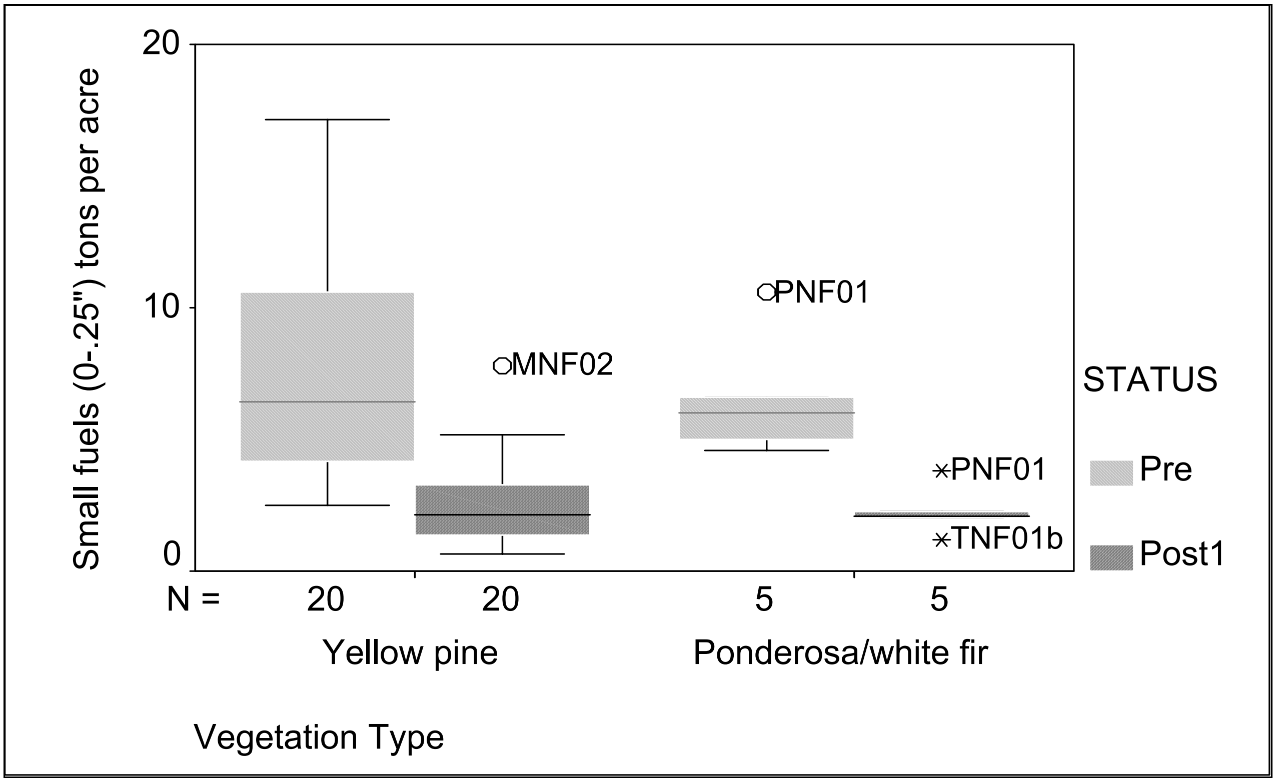

Figure 24 - Average one hour surface fuels, including litter, measured in tons per acre for pre and post one-year re-measurements. Vegetation is grouped into yellow pine and ponderosa pine/white fir.

Canopy Bulk Density

Canopy fuels data, such as height to canopy base and canopy bulk density, are summarized by dominant vegetation type. There are 19 pre and post plots used to compute canopy bulk density; however, only 3 plots were used to compute the ponderosa pine/white fir values (Figure 25). At this time, graphs should be viewed as possible general trends, but more conclusive data will not be available until more projects are re-measured in the future. The data show that canopy bulk density is higher for the ponderosa pine/white fir projects, which may be due to greater productivity of these sites resulting in more trees per acre. Furthermore, canopy bulk density decreased after post treatment, with the greatest decrease for the ponderosa pine/white fir types.

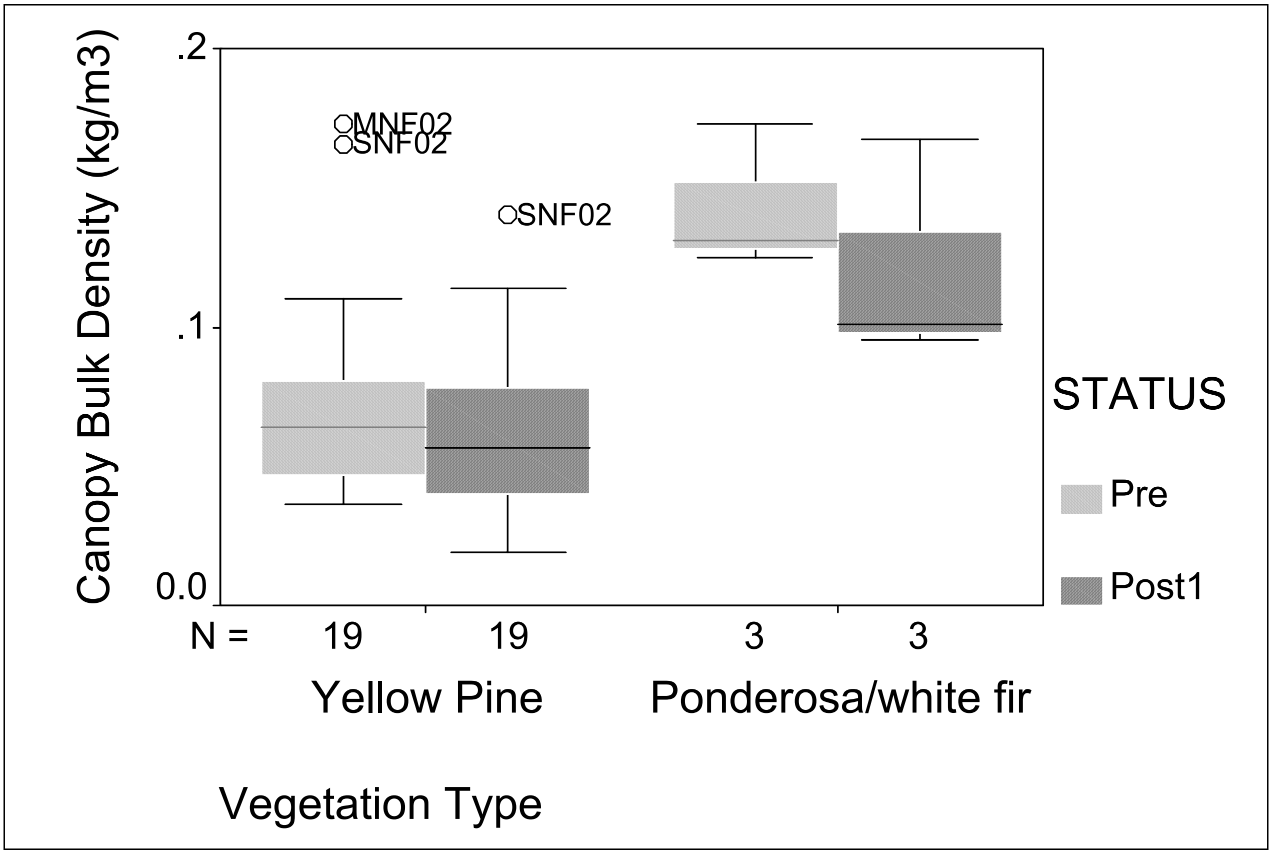

Figure 25 - Canopy bulk density (kg/m3) for pre and post one-year measurements. Data are grouped by yellow pine and ponderosa pine/white fir.

Preliminary trends indicate that height to canopy base is higher for yellow pine vegetation types compared to ponderosa pine/white fir (Figure 26). An unequal number of pre and post plots for the yellow pine data occurred due to the computation of height to canopy base using a 75-pound threshold. Height to canopy base increased after post one-year treatment with the greatest difference shown for the yellow pine sites.

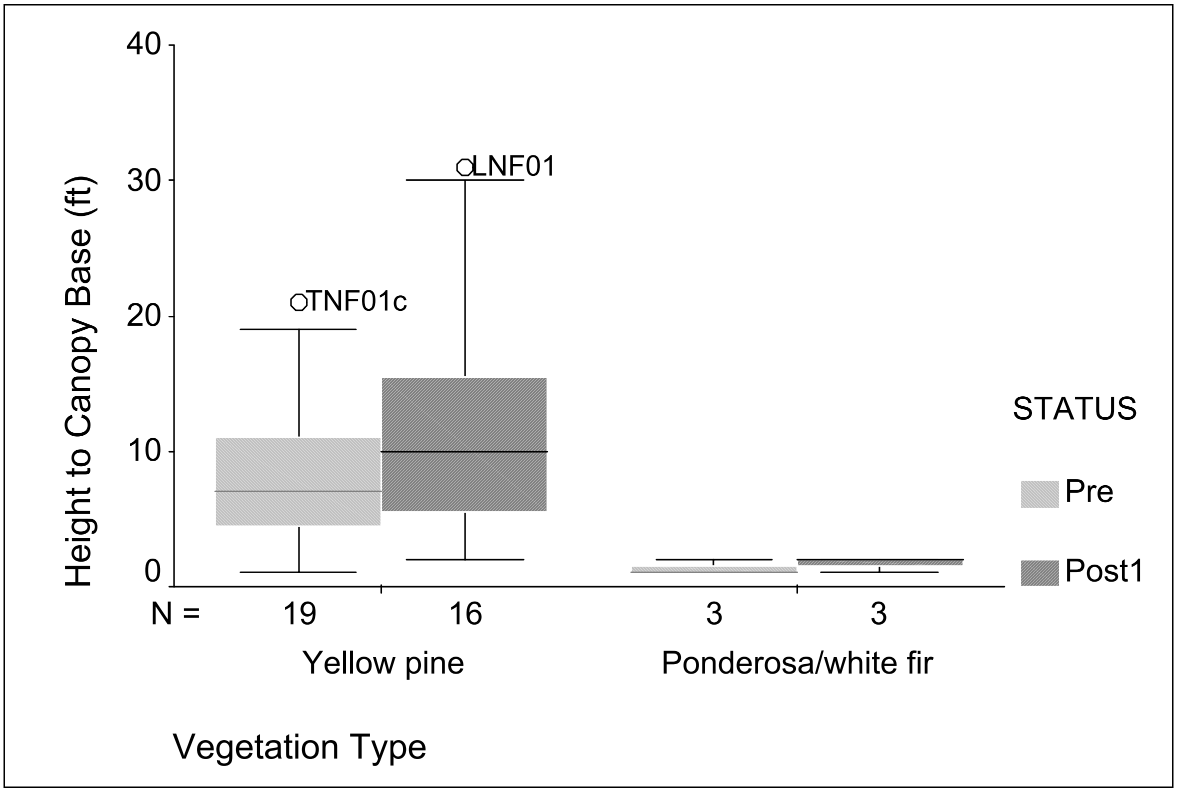

Figure 26 - Height to canopy base in feet for pre and post one-year measurements. Data are grouped by ponderosa pine/Jeffrey pine and ponderosa pine/white fir.

V. FOREST MORTALITY

Tree mortality (by species and diameter class) was computed for eight pre and post one-year treatment projects (Table 3). The highest mortality occurred in the seedling class followed by the pole class (dbh 0-6"). Data are presented as percent mortality with the number of trees that contributed to percent mortality in parentheses.

Table 3 - *Seedling, pole, and overstory mortality. Data are showed at percent mortality with the number of trees in parentheses.*

Project Name	Dominant Veg Type	Species	Seedlings	DBH 0-6"	DBH 6-12"	DBH 12-18"	DBH 18-24"	DBH 24-30"	DBH > 30"
Lassen01	Yellow pine	Doug-fir	100 (1)	38 (4)	7 (1)				
Lassen01	Yellow pine	Ponderosa			17 (1)	17 (1)	100 (1)		
Lassen01	Yellow pine	Sugar pine	100 (3)						
Lassen01	Yellow pine	Black Oak	100 (12)						
Plumas01	Douglas-fir/white fir	Doug-fir	100 (1)						
Plumas01	Douglas-fir/white fir	Ponderosa				100 (1)			
Plumas01	Douglas-fir/white fir	Sugar pine	100 (38)						
Plumas01	Douglas-fir/white fir	Red fir	100 (16)	50 (1)					
Plumas01	Douglas-fir/white fir	Inc. Cedar	100 (8)		20 (1)	17 (1)			
Plumas01	Douglas-fir/white fir	Black Oak						100 (1)	
Klamath02	Ponderosa pine/white fir	Ponderosa	100 (1)	58 (6)	4 (1)				
Klamath02	Ponderosa pine/white fir	Red fir	99 (400)	54 (6)	7 (1)	2 (1)			
Klamath02	Ponderosa pine/white fir	Inc. Cedar	99 (15)	13 (1)	17 (1)				
Los Padres02	Yellow pine	Jeffrey pine	90 (5)	100 (1)	17 (1)			11 (1)	
Los Padres02	Yellow pine	Sugar pine	100 (1)						
Mendocino02	Yellow pine	Doug-fir	100 (4)						
Mendocino02	Yellow pine	Ponderosa	100 (5)						
Mendocino02	Yellow pine	Black Oak	88 (57)	25 (2)					
Shasta_Trin02	Ponderosa pine/white fir	Ponderosa	100 (3)						
Shasta_Trin02	Ponderosa pine/white fir	Red fir	100 (27)	100 (2)		33 (1)			
Shasta_Trin02	Ponderosa pine/white fir	Inc. Cedar	100 (71)	100 (1)	50 (1)				
Shasta_Trin02	Ponderosa pine/white fir	Black Oak	64 (9)						
Tahoe01c	Yellow pine	Doug-fir	100 (21)	50 (7)	70 (3)		50 (1)		
Tahoe01c	Yellow pine	Ponderosa			50 (1)				25 (1)
Tahoe01c	Yellow pine	Inc. Cedar		100 (5)	50 (7)	50 (3)	50 (1)		
Tahoe01c	Yellow pine	Black Oak				50 (1)			50 (1)
Tahoe01c	Yellow pine	Cany. Liveoak	100 (19)						
Tahoe01c	Yellow pine	Tan Oak		100 (4)	75 (5)				
Modoc02	Yellow pine	Ponderosa		100 (3)				17 (1)	
Modoc02	Yellow pine	W. Juniper				50 (1)			