



Yosemite National Park Fire Ecology Program Annual Report Calendar Year 2007



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**Figure 1. YV-05 RX Burn, Merced Riverbank (foreground), Bridalveil Falls (background).
Cover photo: Sugar pine with burned away litter and duff accumulation, Gin Flat (PW-3) burn unit, 2007.
All photos: Yosemite Fire Effects**

Summary

Fire Ecology Program Overview

2007 was a busy and very successful year for the Yosemite Fire Ecology program. Several multi-year monitoring efforts were concluded and analyzed. The fire effects crew was able to complete all scheduled field work and data entry, get training opportunities, and still contribute on local prescribed burns and on off Park assignments in Idaho, northern and southern California.

Several big personnel changes occurred. Crew Assistant Ilana Abrahamson left to pursue graduate studies after six years with the Yosemite fire effects crew. She transitioned early in the fire season with Kristen Shive, the incoming assistant, to help provide continuity. Jen Hooke took the fire ecologist position at Redwood National Park. Before leaving she completed and analyzed a huge amount of monitoring data. A lighter workload than usual allowed new crewmembers to train and familiarize with the program and contribute on many fire operations and to the Resource Advisor program. There were several cross-training opportunities and presentations made to the public, school groups, VIPs and a delegation from Torres del Paine National Park in Chile.

Fire Season Overview

2007 was another active year for the Yosemite Fire Ecology Program. Regionally, the year proved to be one of the longest fire seasons on record in the Sierra. In Yosemite, lightning started a fire near the South Entrance on Good Friday, April 6th. The Jack Fire started October 29th near Wawona and stayed active well beyond Thanksgiving. Elsewhere, Idaho, the Southeast and the Eastern Great Basin were active in the summer months as was Southern California in the fall.

In Yosemite, a dry 06/07 winter contributed to predictions for a potentially volatile fire season. An early July lightning bust created several manageable starts. There were no new wildfires until a late October bust started many fires on the Park's western slope in and outside the suppression zone. Ultimately, though, no fires reached more than 1,300 acres. While resources were committed locally, Yosemite Valley prescribed fires took the lead. Five separate burns were completed in Yosemite Valley. Hodgdon and Yosemite West were also targets for successful burns.

Program Highlights

2007 Fire Ecology Project Status, In Brief

-Roadside Thinning Monitoring, Preliminary Results

Projects begun 2002-03. Analysis for Hodgdon CG, Yosemite West, Big Oak Flat Rd. Met specs for pole removal, heavy fuel reduction, raised height to live crown minimally. Pile-burned (not broadcast) = less reduction of fine fuels. Hodgdon still has heavy fuel loading due 1,000's (fall fire risk only). No increase in exotics, except some bull thistle that was hand-pulled. Wawona Rd and add'l Big Oak Flat Rd thinning begun 2005-06 to have results in 2008-09.

-Sugar Pine Mortality Study (PW-3), Preliminary Results

Fire impacts and Sugar pine decline? 2 yrs post. 11.9% mortality in trees >30cm. Pre-treating (lining/removing) fuels at base somewhat effective, reducing tree mortality to 9.5%. Total fuel reduction by 74%. Seedling regeneration dramatically dominated by white fir/incense cedar.

-Retardant on Mature Sugar Pine Study, Preliminary Results

Tuolumne Fire 2003. Heavy retardant use, no mortality or damage present. Study concludes 2008.

-Burn Severity Monitoring (Composite Burn Index [CBI])

Since 2001. Fires >300 acres. Data of burn severity/severity patterns. Compares satellite imagery with ground observations. Complements YOSE fire history data, Fire Atlas. Hoover, PW-3 ('02, '05), Wolf, Tuolumne, Kibbie, Snow, Whiskey, Meadow, Frog. Analysis performed by vegetation type and for individual fire to determine correlation between satellite and ground observations. All show strong correlation except Meadow Fire and '05 PW-3.

-Wildland Fire Use Monitoring, Ongoing

Begun 2003. Effort for long-term fuels/vegetation monitoring in higher elevation, less suppression-impacted fire regimes. Kibbie, Whiskey, Echo, Frog Fires.

-Valley Exotics Study, Completed

2002 WUI thin/pile burn. Overall exotics increase despite some removal during monitoring. Exotics increase in forbs and perennial grasses, little change in exotic annual grasses. Underscores need for partnership with Res Mgt to manage/monitor, short & long-term, for Valley exotics, notification of fire mgt projects, integration in project planning.

-Prescribed Burn Vegetation Monitoring, Ongoing

Gen'l Status; Rich data exist for sugar/ponderosa pine, white fir. Not for incense cedar, giant sequoia, chaparral or grass types. Ponderosa pine monitoring type description rewritten to include sugar pine, enhancing richness of data quality. Plot install in newly-combined Sugar Pine/ Ponderosa Pine monitoring type in Hodgdon PW-4. Grassland monitoring in Valley integrate with Res Mgt.

Program Successes

-Restricting Non-Essential Helicopter Flights in Backcountry Monitoring

Program commitment to reducing helicopter flights for backcountry monitoring (2 visits, Frog Fire). Backpack and L. Eleanor boat use.

-Presentations to Public and Interested Parties

Hosted Experience Your Yosemite Valley RX walk, senate appropriations committee Mariposa Grove walk, Wawona Elementary, Fresno State University, Torres del Paine National Park, Chile delegation.

-Operational Involvement and Training

Resource Advisor training, Resource Advisor assignment, Crew Boss (T) assignment, FEMOs trained, off-park to southern, northern CA/ID, Forest Health Team

2007 Notable Ecological Events

-Hodgdon Prescribed Burn

Additional WUI acres treated adjacent community, incorporating Backdoor Fire area (2005 human caused, suppression fire)

-Yosemite Valley Prescribed Burn

Five prescribed burns completed in Yosemite Valley for ecological restoration, community protection, and maintenance of historic landscapes

-Yosemite West Prescribed Burn

Additional WUI acres treated adjacent community, Wawona Road, incorporating roadside mechanical fuel reduction efforts

-Jack Fire

Lightning-caused fire on fire use/suppression boundary bordering Wawona managed intensively, allowing critical reintroduction of fire into ecosystem

Fire Effects Monitoring, Management Objectives, and Monitoring Results

Yosemite Fire Management is a complex and diverse program, and the Fire Ecology program's main purpose is to provide support for management decisions and to assess and evaluate management actions. The Fire Ecology program therefore mirrors the diversity of fire management actions by monitoring fire suppression, prescribed fire, WFU fire, and mechanical thinning treatments. 2007 updates from each of our monitoring projects (Fire Monitoring Handbook, "Retro" Fire Effects Monitoring, Rapid Assessment, Composite Burn Index, Yosemite Valley Exotics Survey, Sugar Pine/Fire Retardant Monitoring, and Sugar Pine Mortality Study) are presented here along with available results in relation to the original management objectives. All fuel loading analyses utilize fuel constants specific to the Sierra Nevada (van Wagtenonk et al. 1996, van Wagtenonk et al. 1998).

1. Fire Monitoring Handbook (FMH) Monitoring

No new FMH data analysis occurred in 2007, due to analysis performed for and reported in the 2006 Fire Ecology Annual Report and a desire to focus data analysis efforts on other projects. The White Fir/Mixed Conifer Forest (FABCO1T08) and Ponderosa Pine/Bear Clover Forest (FPIPO1T02) continue to be the most active monitoring types within Yosemite.

The Ponderosa Pine/Mixed Conifer Forest (FPIPO1T09) monitoring type was modified in 2007, after the Fire Effects crew had difficulty with locating new plots in areas of > 30% ponderosa pine (*Pinus ponderosa*) dominance (see 2006 Fire Ecology Annual Report, *FMH Notes from the Field*). Often a mix of ponderosa pine and sugar pine (*Pinus lambertiana*) was found in the overstory, together reaching > 30% dominance. The monitoring type was therefore expanded to include the sugar pine component, and the monitoring type name changed to Ponderosa Pine - Sugar Pine/Mixed Conifer Forest (FPIPL1T09) to reflect the dominance of both ponderosa and sugar pine in the forest canopy. With the modified requirements for canopy composition, the fire effects crew was able to install a new FMH plot in the PW-4 Hodgdon burn unit. The new FPIPL1T09 Monitoring Type Description Sheet (FMH-4) is attached as Appendix A.

The Giant Sequoia Forest (FSEGI1T08) monitoring type continues to be treated and monitored over time. Not enough plots have been treated with prescribed fire at this point in time to warrant data analysis. Monitoring types with low plot numbers include Incense Cedar/Mixed Conifer Forest (FCADE1T10), Lower Montane Chaparral (FARPA1D06), and Red Fir/Mixed Conifer Forest (FABMA1T08). No new plot installation is planned in the FCADE1T10 and FARPA1D06 types; and upcoming prescribed burns do not fall within the red fir forest, which puts plot installation in the FABMA1T08 type on hold.

The Mixed Conifer Mechanical Thinning (FMCMM1T09) type is currently inactive, due to the abundance of Rapid Assessment monitoring plots throughout the park and the Valley Exotics study. These two monitoring projects have provided ample data on the effects of mechanical thinning on the lower mixed conifer forest ecosystem.

Monitoring prescribed fire activities in Yosemite Valley continues to be a challenge, especially with the complexity of issues facing restoration of this beloved landscape. There is hope of creating a Landscape Management Plan for Yosemite Valley, which would be a collaborative effort among the Division of Resources Management and Science, United States Geologic Survey (USGS) staff, and Fire Management. This plan would lay the foundation and guidance for restoration projects within Yosemite Valley, including prescribed burning, cultural landscape and vista management, meadow and oak woodland restoration, hydrologic and stream bank restoration, and many others.

A new monitoring design needs to be developed for monitoring prescribed fire in Yosemite Valley, as the existing Dry Montane Meadow (BAGGI1D01) monitoring type design does not monitor current fire management objectives. All plots within this monitoring type have been inactive since 2003. Many of the monitoring plots were installed in October or November when meadow plants were dormant and impossible to identify, and poor location and plot azimuth information often resulted in the re-establishment of at least one end of the plot transect. These transects, then, are potentially in different locations than they were in previous reads. In addition, the monitoring design does not measure important monitoring variables such as meadow encroachment and oak mortality. Eight of these BAGGI1D01 plots were resampled this year prior to the Sentinel (YV-18) and Liedig (YV-19) meadow prescribed burns. The decision to resurrect these inactive plots was made because the plots were able to measure one important burn objective: the effect of prescribed fire on native to exotic plant ratios. The prior reads of these plots were conducted by skilled botanists, enabling the accurate measurement of this objective. The plots will be sampled one-year postburn in 2008. In order to streamline both sampling strategies and workload there needs to be greater coordination with the Division of Resources Management and Science, who also monitor non-native plant invasion in Yosemite Valley meadows.

2. “Retro” -Style Fire Effects Monitoring

No new data analysis for the “Retro” plots occurred during 2007. The Big Creek “Retro” plot data were analyzed and presented in the 2006 Fire Ecology Annual Report. Analysis of the “Retro” plots was hindered by a data entry and quality checking backlog. These plots are especially time-consuming to prepare for analysis due to the use of a variable-radius plot design to sample overstory trees. This plot design allows for “borderline” trees that appear and disappear from the data over time. Since individual trees aren’t tagged, it becomes somewhat difficult to determine the trees that should truly be included in the plot data. “Retro” data with analysis needs are the Mariposa Grove (MG) 2, 4, and 5; Yosemite Valley (YV) 8 and 10; and Aspen Valley data sets. At this point in time, it is not recommended that new “Retro” plots be resurrected and incorporated into the Fire Effects Monitoring workload. The reasoning behind this is based upon creating and maintaining a reasonable workload for the Fire Effects Monitoring crew. The FMH plot network should be able to adequately capture whether or not prescribed fire treatments are meeting management objectives. Having a reasonable workload for the Fire Effects Monitoring crew ensures that they are able to accommodate new monitoring demands made by Fire Management and Resources Management & Science staffs.

3a. Rapid Assessment Monitoring – Roadside

Beginning in 2002, Yosemite NP applied mechanical thinning treatments along roadsides to reduce small-diameter tree densities, dead & down fuel loading, and the probability of canopy fire to create and enhance escape corridors for visitors, employees, and residents. These treatments were placed 200' on either side of the road centerline. The thinning prescription called for cutting and piling 80% of live and dead conifers < 6" DBH (diameter at breast height), excluding sugar pine and deciduous trees. Piles were to be built in open areas (not under tree canopies when possible) and outside of wetland or riparian areas. Pile size was limited to that of a small car.

A Rapid Assessment plot design was created in 2002 to monitor the effects of roadside thinning treatments and address whether or not they were meeting management objectives. The mechanical thinning management objectives were as follows:

- Meet target conditions
- Reduce ground fuels
- Reduce canopy cover
- Do not increase exotic plant frequency
- Do not cause unacceptable soil disturbance
- Modify potential fire behavior
- Change condition class

Rapid Assessment plots were installed and sampled around the Hodgdon Campground (n = 11), the Big Oak Flat Road (n = 15), and the Yosemite West community (n = 17). These plots were sampled pre-treatment (PRE), post-thinning, post-thinning and pile burning, one year after thinning & burning (YR01), and three years after thinning and burning (YR03). Analysis compares the PRE, YR01, and YR03 plot visits. Additional plots exist along Highways 120 & 41 (n = 14). Data analysis presented here excludes the Highway 120/41 plots since they were burned in 2005 and 2006, and will be read three years postburn in 2008 and 2009.

A. Fuel Loading and Target Conditions

Paired t-tests were used to determine whether statistically significant ($\alpha = 0.05$) differences existed between PRE and YR01 plot visits. The management objective to reduce ground fuels was not achieved with statistical significance in the Hodgdon Campground plots or the Yosemite West (Yo West) plots. There was a significant reduction in all ground fuels (1, 10, 100, and 1000 hour fuels) found in the Big Oak Flat (BOF) plots ($p = 0.002$). Trends in 1, 10, and 100 hour fuels are presented in Figure 1, while Figure 2 shows changes in 1000 hour fuel loads.

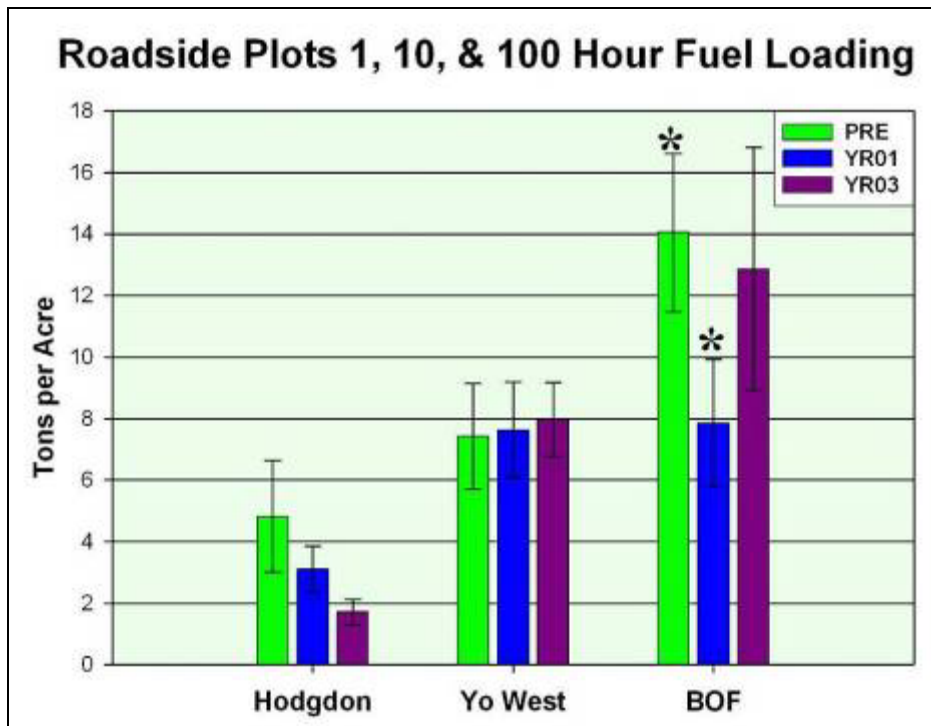


Figure 2. 1, 10, and 100 hour fuel loading for the Hodgdon Campground, Yosemite West, and Big Oak Flat Road plots. The only significant difference between PRE and YR01 was found in the BOF plots ($p = 0.025$). ‘*’ denotes statistically significant difference.

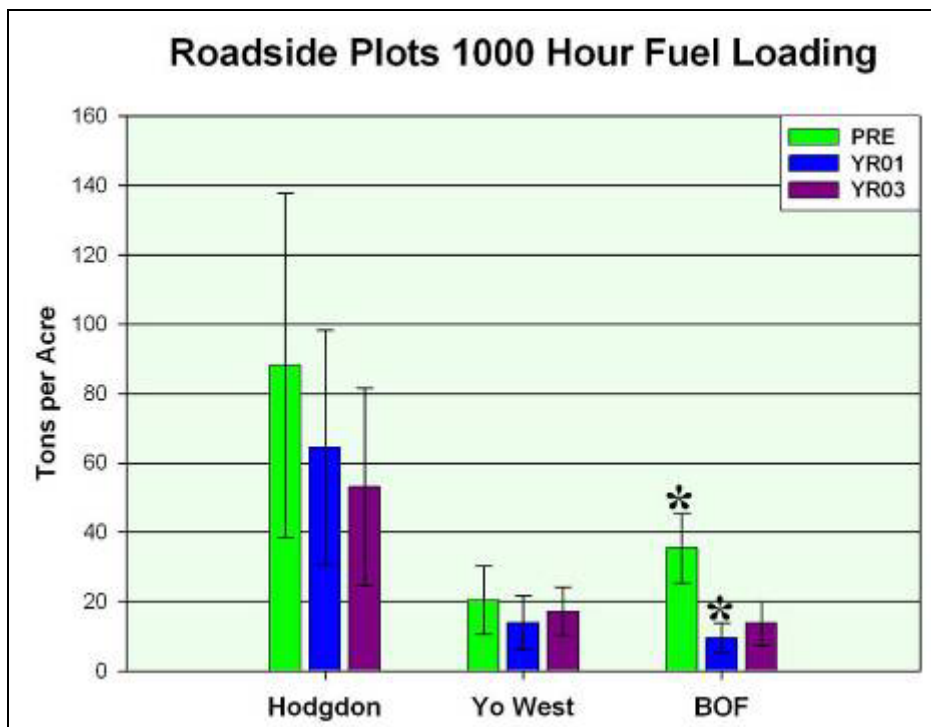


Figure 3. 1000 hour fuel loading data from the Roadside Rapid Assessment plots. The only significant difference between PRE and YR01 was found in the BOF plots ($p = 0.002$) ‘*’ denotes statistically significant difference.

When comparing the total fuel load from the Roadside Rapid Assessment plots with the Yosemite Fire Management Plan (YFMP) target conditions, all three treatment areas appear in the mid to upper range of the desired fuel loading mosaic. While being an effective tool for reducing small diameter trees and some surface fuels, mechanical thinning coupled with pile burning is not as efficient in reducing fuel loads as broadcast application of prescribed fire.

Table 1. Target conditions compared with on-the-ground conditions in the Roadside Rapid Assessment plots.

YFMP Target Conditions – FABCO1T08	Roadside Rapid Assessment Plot Data
Achieve the following fuel loading: • 20-40% = 5-30 tons/acre • 20-50% = 30-60 tons/acre • 5-20% = > 60 tons/acre	YR01 average total fuel loading: • Hodgdon: 102.1 t/a (SE = 34.7) • Yosemite West: 43.3 t/a (SE = 8.1) • BOF: 59.3 t/a (SE = 8.3)

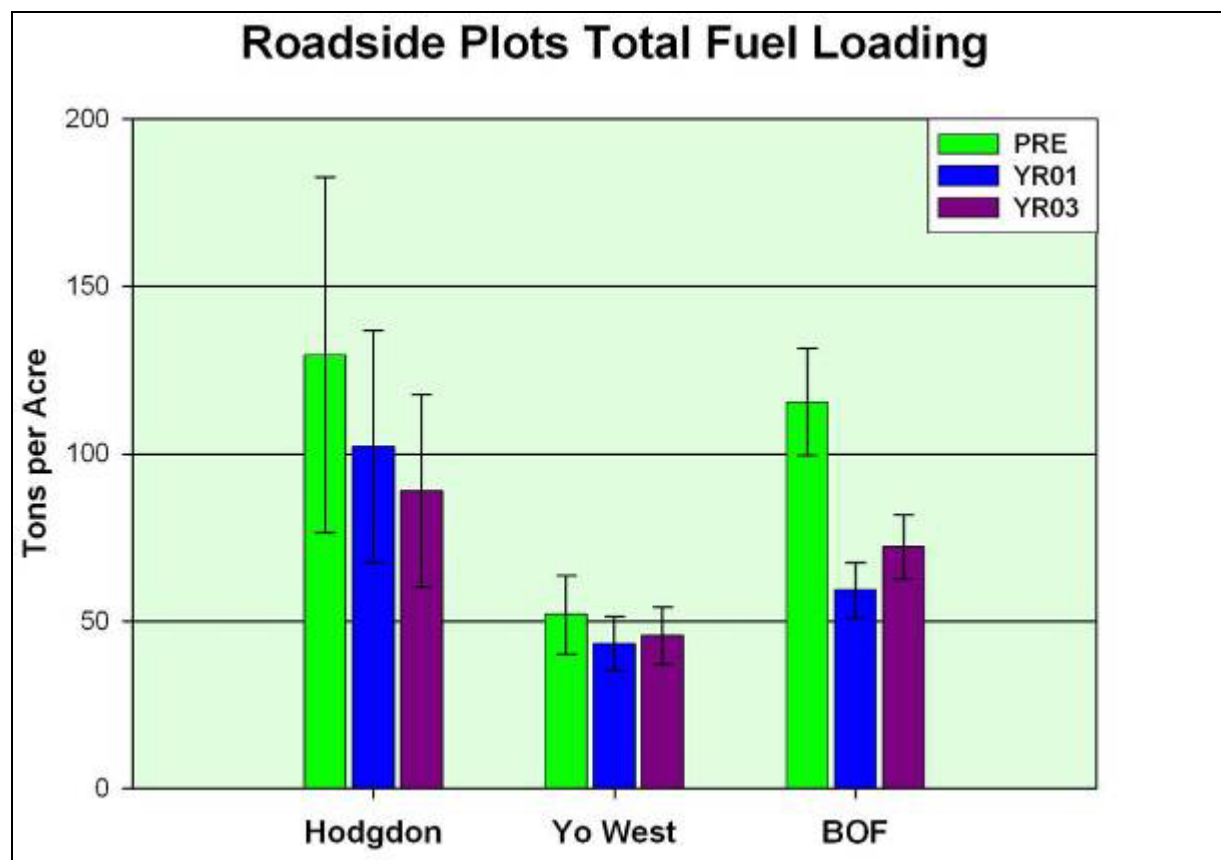


Figure 4. Total fuel loading for the Hodgdon, Yosemite West, and Big Oak Flat Road plots. The difference between YR01 and YR03 in the Hodgdon plots is due to sampling error or unexplained disturbance (plots are adjacent to the campground).

B. Canopy Cover

Paired t-tests were used to determine whether statistically significant ($\alpha = 0.05$) differences existed between PRE and YR01 plot visits. Canopy cover was reduced in all three areas, but

only two treatment areas, BOF ($p = 0.012$) and Hodgdon ($p = 0.008$) had a significant difference between PRE and YR01.

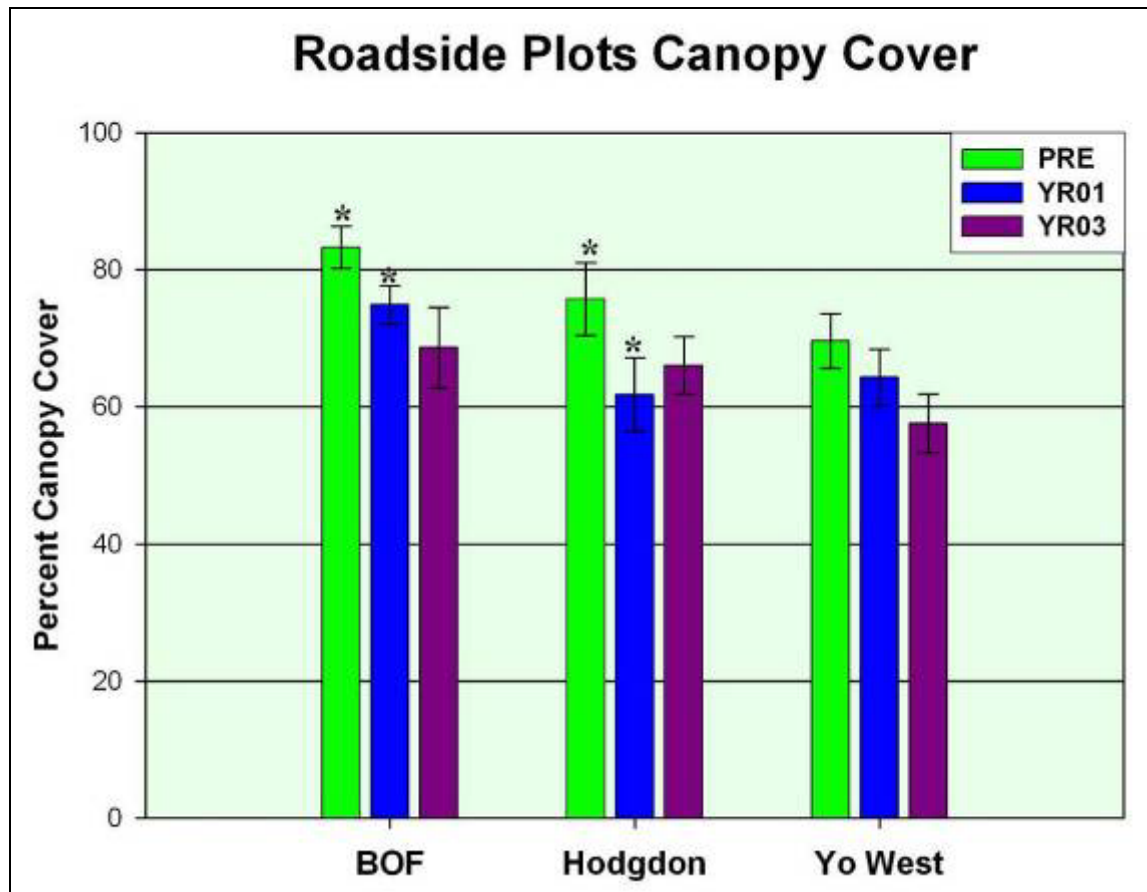


Figure 5. Reduction in canopy cover due to mechanical thinning and pile burning treatments. “*” denotes statistically significant difference between PRE and YR01.

C. Exotic Plants and Soil Disturbance

Plot data showed no increase in exotic plant frequency and no unacceptable soil disturbance. Bull thistle (*Cirsium vulgare*) was occasionally observed within the general sampling area, and manually removed when possible.

D. Potential Fire Behavior

Initial analyses and modeling efforts showed that the thinning treatments did modify potential fire behavior from that of a canopy fire to a surface fire. See the 2003 Fire Ecology Annual Report, Appendix B for more information.

E. Change in condition class

Since these areas were pile-burned rather than treated by a broadcast prescribed burn, fuel loadings were not reduced to the same level as would be possible by treating the area with prescribed fire. The reduction of trees $\leq 6''$ DBH was a significant treatment, but not effective enough to reduce overstory canopy densities to the degree that would warrant a condition class change. The thinning treatment will facilitate application of prescribed fire, which will then move these areas closer toward target conditions.

F. Additional Monitoring Data – Overstory Trees

Overstory trees ($> 6''$ DBH) were not targeted for mechanical thinning; however, they did experience a small change after the pile burning treatment. Figures 7 – 10 show changes in live overstory tree density and composition after the thinning and pile-burning treatments.

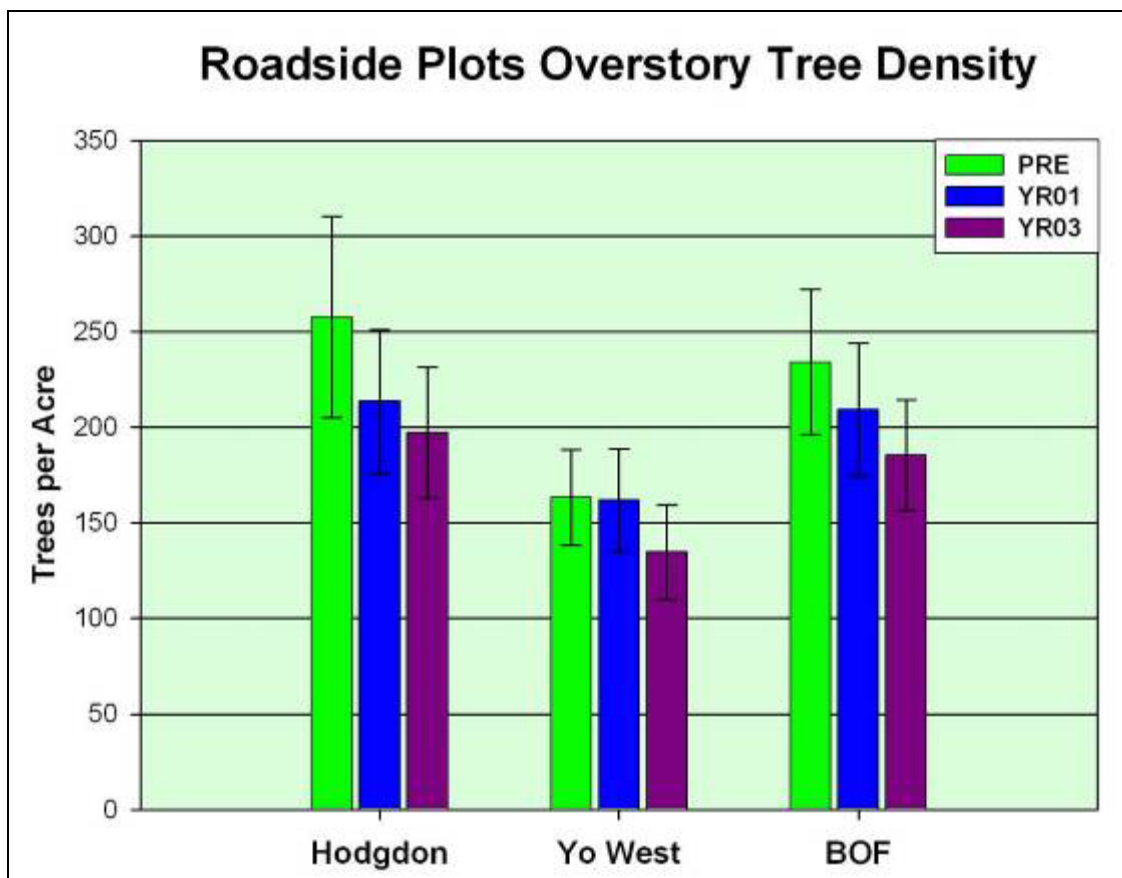


Figure 6. Changes in live overstory tree density due to thinning and burning treatments.

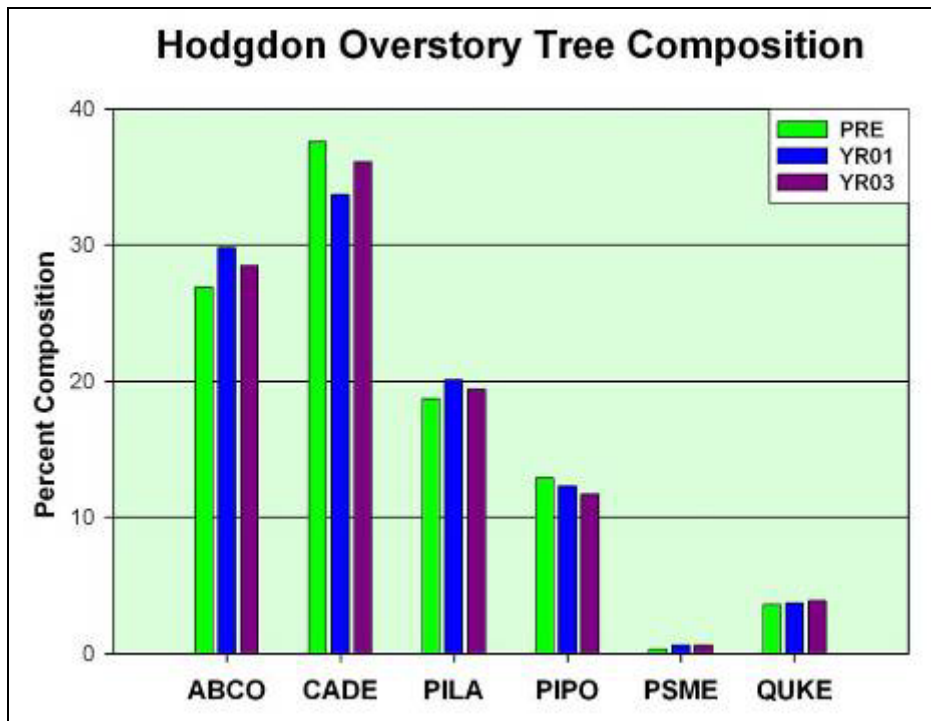


Figure 7. Changes in live overstory tree composition after thinning and pile burning in the Hodgdon Campground plots. ABCO = white fir; CADE = incense cedar; PILA = sugar pine; PIPO = ponderosa pine; PSME = Douglas fir; QUKE = black oak.

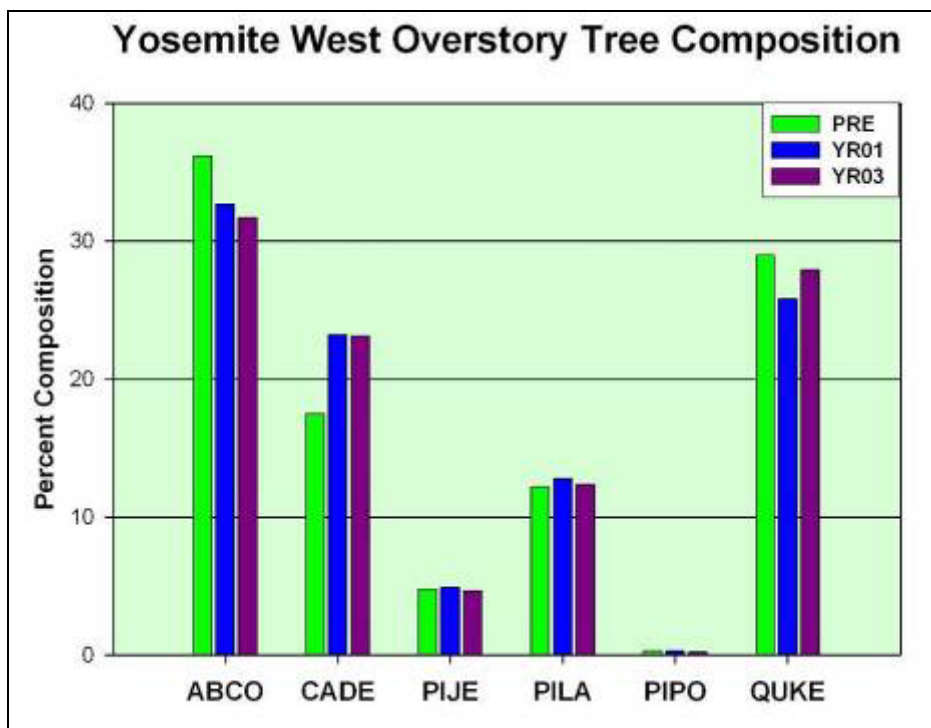


Figure 8. Changes in live overstory tree composition after thinning and pile burning around the Yosemite West community. ABCO = white fir; CADE = incense cedar; PIJE = Jeffrey pine; PILA = sugar pine; PIPO = ponderosa pine; QUKE = black oak.

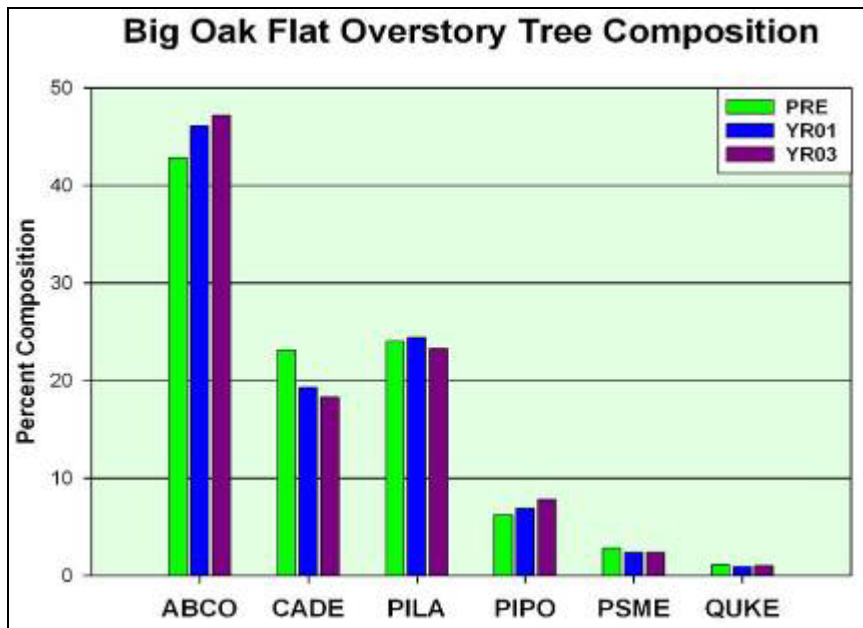


Figure 9. Changes in live overstory tree composition after thinning and pile burning in the BOF plots. ABCO = white fir; CADE = incense cedar; PILA = sugar pine; PIPO = ponderosa pine; PSME = Douglas fir; QUKE = black oak.

G. Additional Monitoring Data – Sapling Trees

Sapling trees, < 6" DBH, were the target size class of the thinning prescription. As expected, there were major shifts in live sapling tree densities and composition in this size class, illustrated by figures 11 - 14.

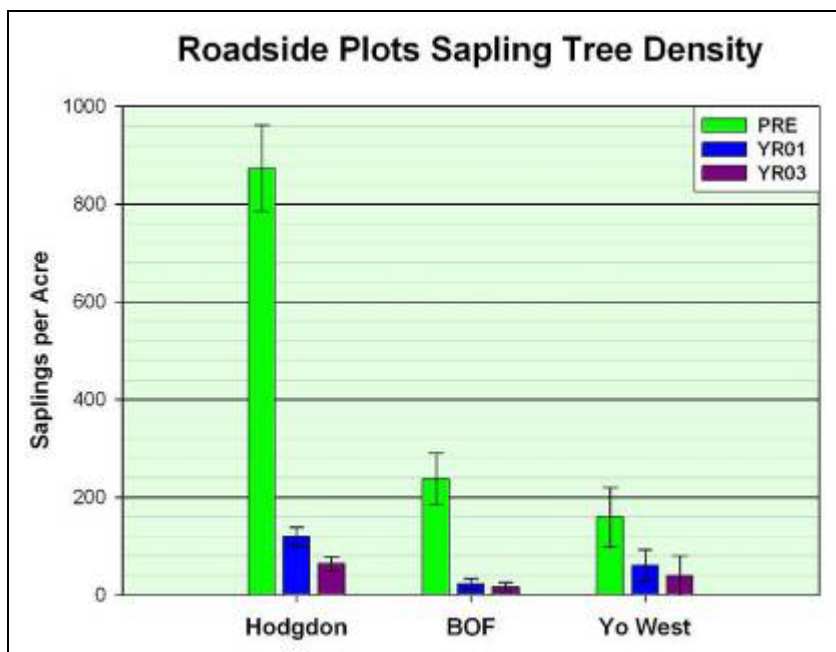


Figure 10. Live sapling tree densities were effectively reduced by mechanical thinning and pile burning treatments, especially around the Hodgdon Campground.

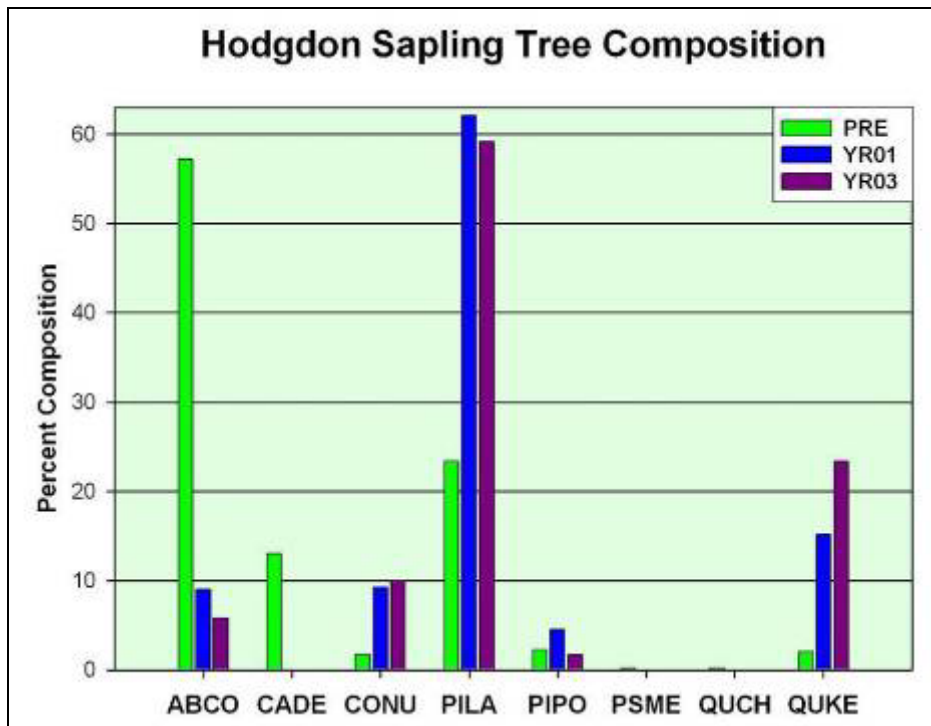


Figure 11. Changes in live sapling tree composition after thinning and pile burning around the Hodgdon Campground. ABCO = white fir; CADE = incense cedar; CONU = mountain dogwood; PILA = sugar pine; PIPO = ponderosa pine; PSME = Douglas fir; QUCH = canyon live oak; QUKE = black oak.

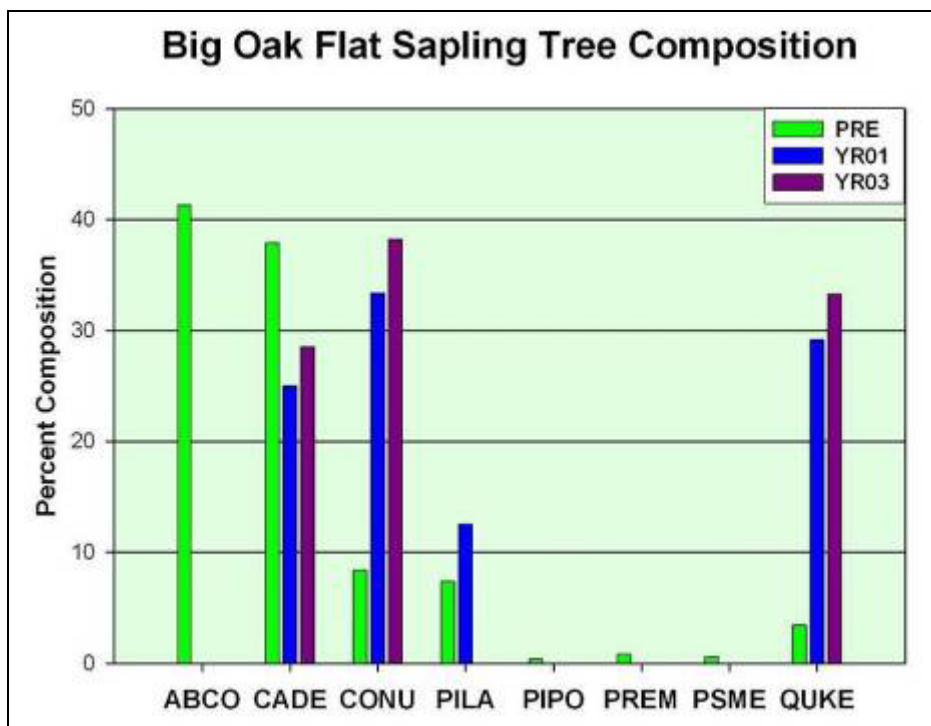


Figure 12. Changes in live sapling tree composition along the Big Oak Flat Rd. ABCO = white fir; CADE = incense cedar; CONU = mountain dogwood; PILA = sugar pine; PIPO = ponderosa pine; PREM = bitter cherry; PSME = Douglas fir; QUKE = black oak.

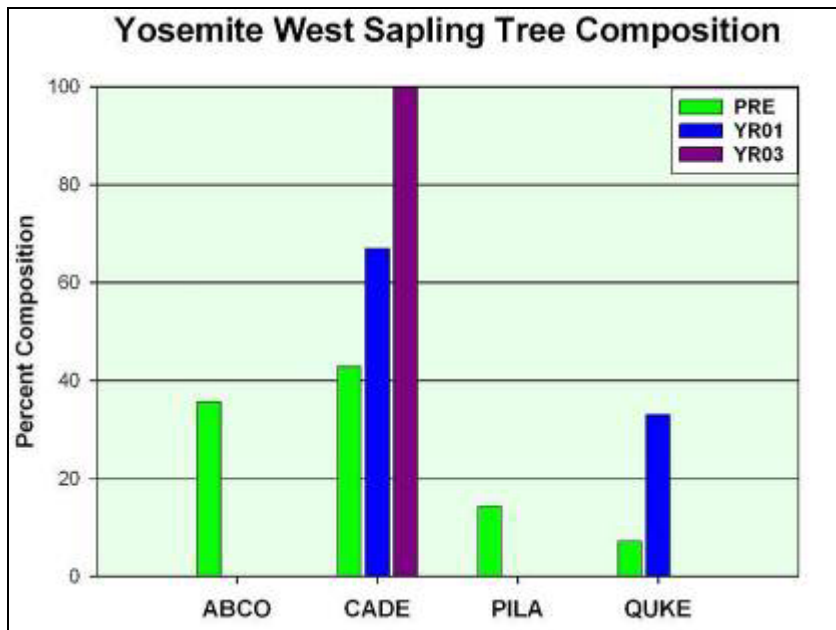


Figure 13. Changes in live sapling tree composition around the Yosemite West community. ABCO = white fir; CADE = incense cedar; PILA = sugar pine; QUKE = black oak.

H. Additional Monitoring Data – Height to Live Crown

Another important variable affecting whether or not fire will be carried by ladder fuels into the forest canopy is the height to live crown of the stand. The thinning and pile burning treatments were slightly effective at increasing the height to live crown; although no statistically significant differences were detected between PRE and YR01 in any of the plots.

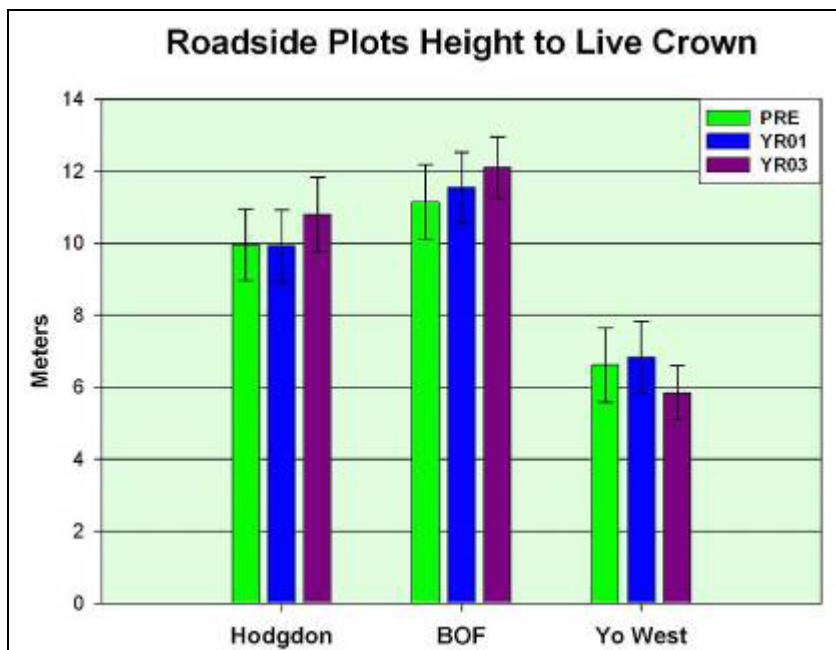


Figure 14. Changes in average height to live crown in the Roadside Rapid Assessment plots after thinning and pile burning treatments.

I. Repeat Photography

No amount of graphs can tell the story as well as repeat photography. Included here is a series of PRE and YR03 photos for all three Roadside Rapid Assessment plot sampling areas.



Figure 15. Before (PRE - 2003) and after (YR03 - 2006) photos of thinning and pile burning treatments around the Hodgdon Campground.



Figure 16. Before (PRE - 2003) and after (YR03 - 2006) photos of thinning and pile burning treatments along the Big Oak Flat Road.



Figure 17. Before (PRE - 2002) and after (YR03 - 2005) photos of thinning and pile burning treatments around the Yosemite West community.

3b. Rapid Assessment Monitoring – Wildland Fire Use (WFU)

The Rapid Assessment plot design used to monitor the effects of mechanical thinning and pile burning was applied to Wildland Fire Use fires beginning in 2003. Rapid Assessment plots were installed in the Kibbie (n = 10) and Whiskey (n = 11) WFU fires in 2003. Additional Rapid Assessment plots were installed in the Echo WFU Fire of 2005 (n = 5) and the Frog WFU Complex of 2006 (n = 7) with a modified plot design (for methodology, see 2006 Fire Ecology Annual Report Appendix 3). Since WFU fires are considered a natural event, no policy mandate exists to monitor the effects of WFU fires on vegetation and fuels. However, long-term monitoring of the interaction of fire with our higher elevation ecosystems that are less impacted by fire suppression yields highly interesting and useful information that helps us understand baseline conditions and fire regimes in these systems. Analysis of plot data is presented here by WFU fire.

A. Kibbie WFU Fire

The Kibbie fire was a lightning-ignited WFU fire that was converted to a suppression fire on September 25, 2003. This fire burned approximately 6400 acres within Yosemite and the Stanislaus National Forest. Ten Rapid Assessment plots were installed in red fir (*Abies magnifica*) forests and montane chaparral communities

between 6500 – 7000' elevation. Plots were

sampled preburn (PRE - 2003), one year postburn (YR01 -2004), and three years postburn (YR03 – 2006). Plots will be sampled five years postburn (2008), ten years postburn (2013), and every subsequent ten years.



Figure 18. The Kibbie WFU Fire of 2003.

Fuel Loading

The Kibbie Fire was effective at reducing fuel loading in all size classes. The fire greatly reduced loading of rotten 1000 hour fuels, litter, and duff. Rotten 1000 hour fuels were reduced by 96% from preburn levels of 25.1 tons/acre (SE = 11.9) to 1.0 ton/acre (SE = 0.7) one year postburn. Litter loadings experienced a 63% reduction from 8.4 tons/acre (SE = 1.5) preburn to 3.1 tons/acre (SE = 1.0) one year postburn. Duff loadings were reduced by 97%, dropping from 47.4 tons/acre (SE = 12.1) preburn to 1.1 ton/acre one year postburn.

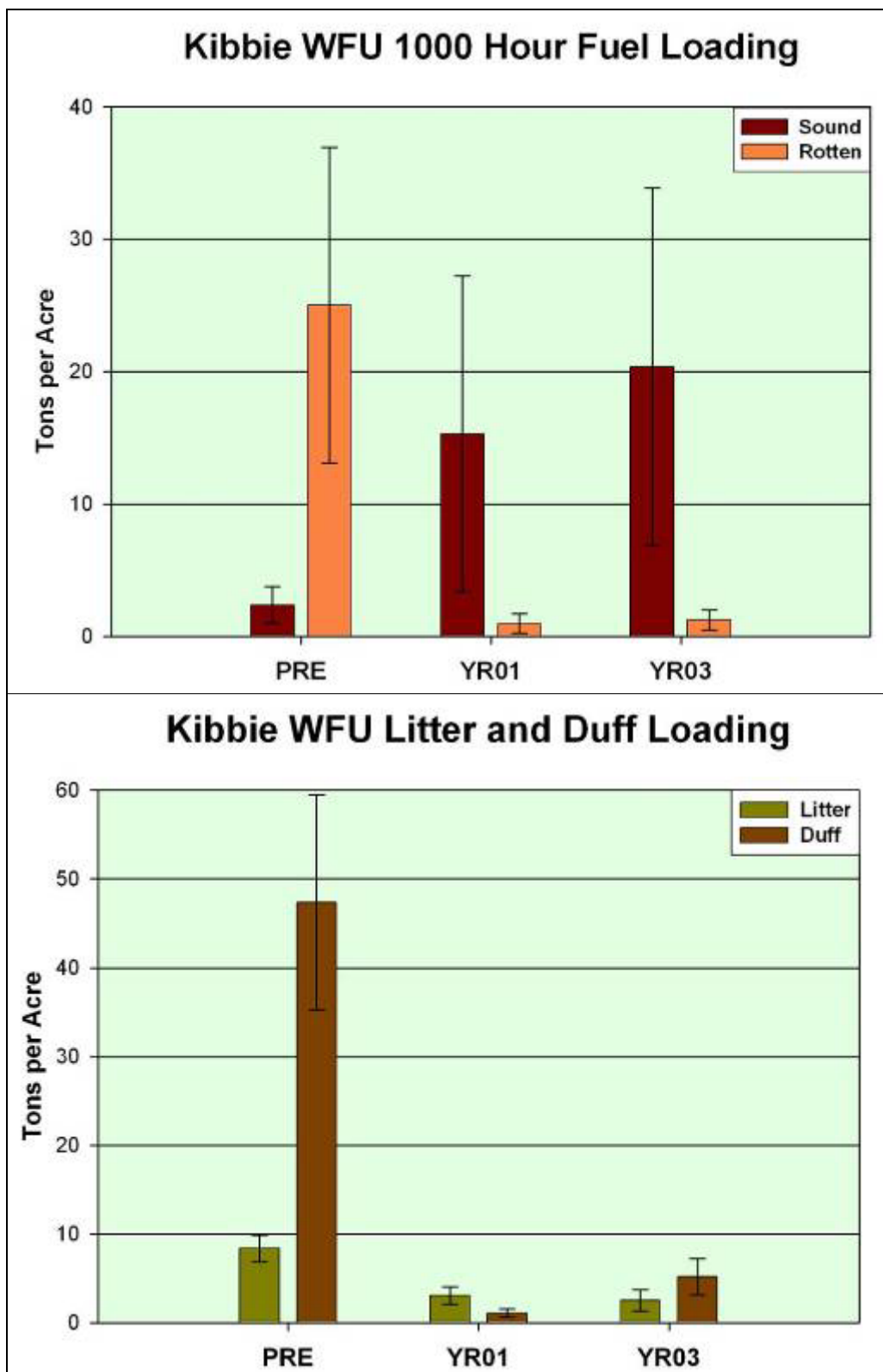


Figure 19. 1000 hour, litter and duff loading before and after the Kibbie fire.

Total fuel loading was also substantially reduced by the Kibbie fire. Preburn total fuel loads were 99.5 tons/acre (SE = 22.1); they were reduced 76% one year postburn to 23.1 tons/acre (SE = 12.3). By three years postburn, fuel loads had climbed 10 tons/acre to 33.2 tons/acre (SE = 13.6). Fuel loading in all size classes was reduced from preburn levels at three years postburn, with the exception of sound 1000 hour fuels. These fuels increased 750% to 20.4 tons/acre (SE = 13.5) three years postburn from 2.4 tons/acre (SE = 1.4) preburn. This is due to fire-killed trees falling down.

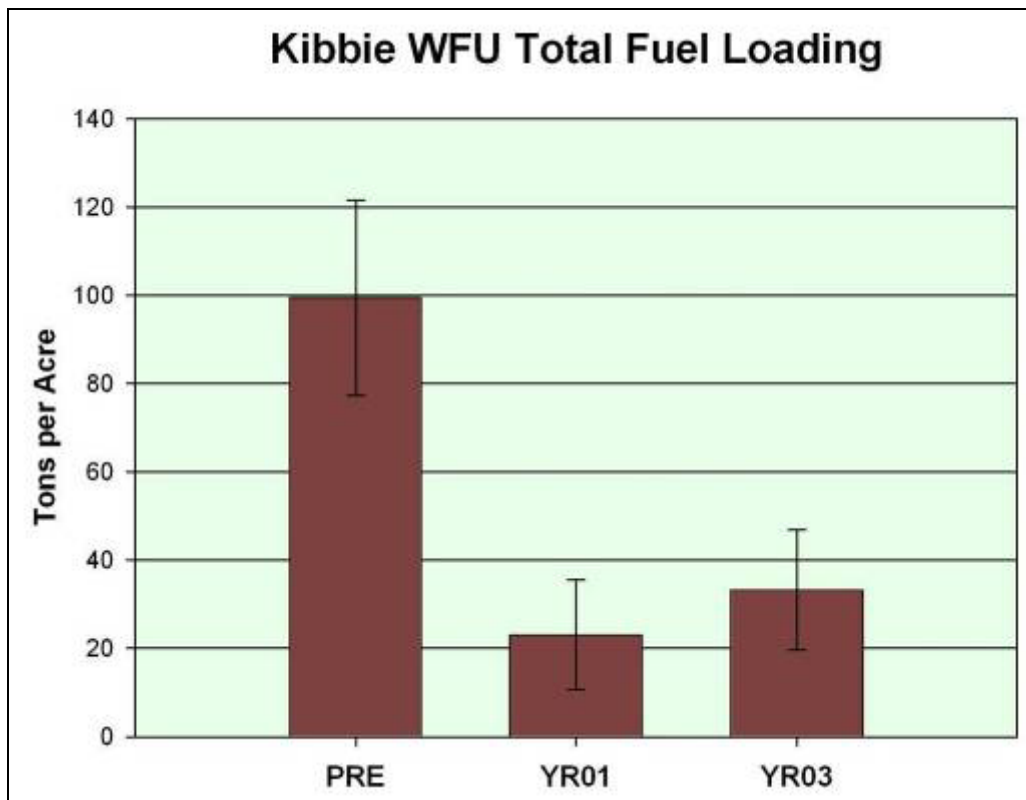


Figure 20. Total fuel loading was effectively reduced by the Kibbie fire.

Overstory Tree Density and Composition

Overstory tree (> 6" DBH) densities were greatly reduced by the Kibbie fire. Tree densities were reduced 68% from 71.4 trees/acre (SE = 22.8) preburn to 22.5 tons/acre (SE = 9.4) three years postburn. Overstory tree composition also changed postfire, with an increase in white fir and western juniper (*Juniperus occidentalis*) and a reduction in red fir.

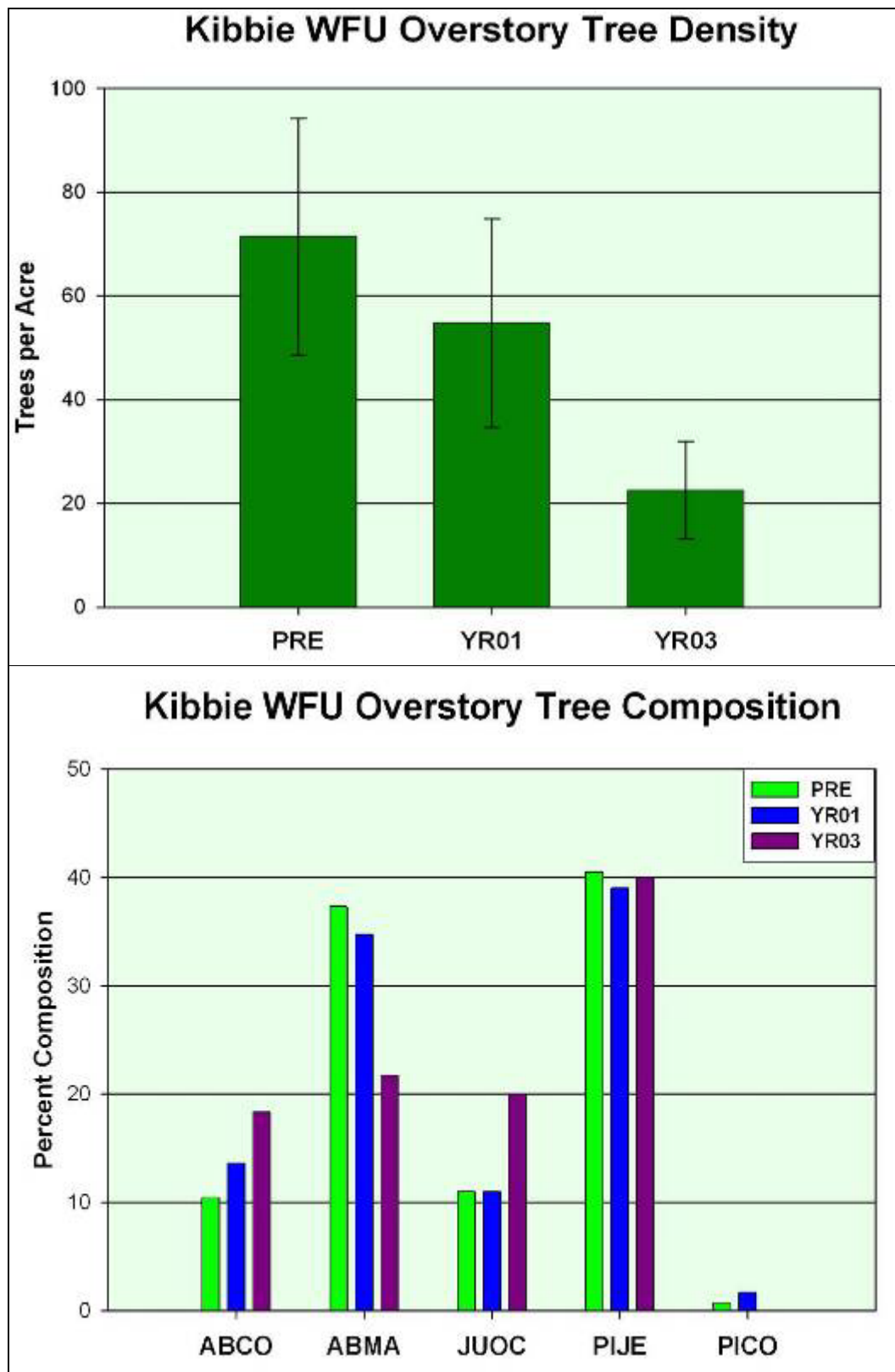


Figure 21. Changes in live overstory tree density and composition before and after the Kibbie fire. ABCO = white fir; ABMA = red fir; JUOC = western juniper; PIJE = Jeffrey pine; PICO = lodgepole pine.

Sapling Tree Density

Preburn sapling tree (< 6" DBH) density was 167.1 saplings/acre (SE = 3.5). There were no living sapling trees present YR01 and YR03. The Kibbie fire was completely effective at killing small-diameter trees found in Rapid Assessment plots.

Height to Live Crown and Canopy Cover

The Kibbie fire slightly affected the average height to live crown, and during the YR03 visit, the height to live crown was found to be lower than PRE values. Ladder fuels have been reduced in the Kibbie fire, as evident by the lack of sapling trees and the much lower overstory tree densities. The Kibbie fire reduced canopy cover by 73%, from 31.3% cover (SE = 7.7) preburn to 8.3% cover (SE = 5.8) three years postburn. Coupling the height to live crown data with the canopy cover data, we can see that much more light is available to the surviving trees. This may promote epicormic sprouting and fuller tree canopies.

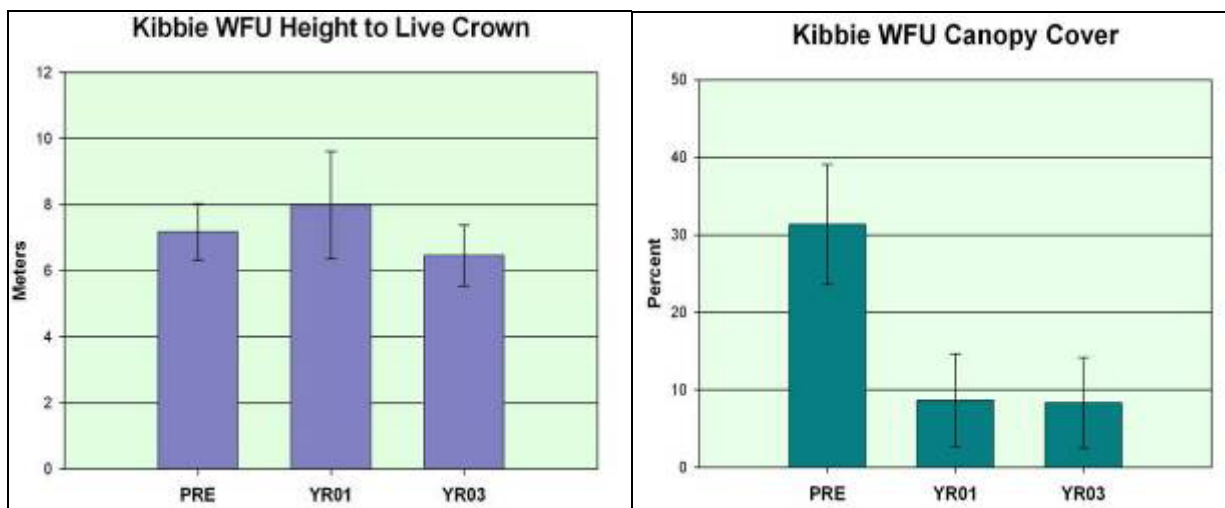


Figure 22. Changes in height to live crown and canopy cover from preburn through three years postburn in the Kibbie WFU fire.

Repeat Photography

A good way to visualize the changes across the landscape in the Kibbie fire is to examine photographs taken at the same location over time. Repeat photography will prove to be especially interesting as plots are sampled ten and twenty years postburn and beyond.



Figure 23. Photos taken preburn (2003) and one year postburn (2004) within the Kibbie WFU fire.



Figure 24. Same photo as Fig. 26 three years (2006) after the Kibbie fire.

B. Whiskey WFU Fire

The 2003 Whiskey WFU fire was ignited by lightning and was allowed to remain a WFU fire. This fire was completely within Yosemite NP boundaries and grew to 1225 acres in size. Eleven Rapid Assessment plots were installed in red fir dominated forest with components of lodgepole pine (*Pinus contorta*) and Jeffrey pine (*Pinus jeffreyi*) between 7800 – 8500' elevation. These plots have been sampled preburn (PRE – 2003), one year postburn (YR01- 2004), and three years postburn (YR03 – 2006). They will be sampled five years postburn (YR05 – 2008), ten years postburn (YR10 – 2018), and every subsequent ten years.



Figure 25. Preburn conditions within the Whiskey WFU Fire of 2003.

Fuel Loading

The Whiskey fire reduced all size classes of fuels, and was especially effective at reducing 1000 hour fuels and duff loading. Rotten 1000 hour fuels measured one year postburn were reduced 94% from preburn levels, dropping from 33.5 tons/acre (SE = 16.7) to 1.8 tons/acre (SE = 1.6). Duff loads were reduced 89% from preburn levels of 31.6 tons/acre (SE = 1.5) to 3.2 tons/acre one year postburn.

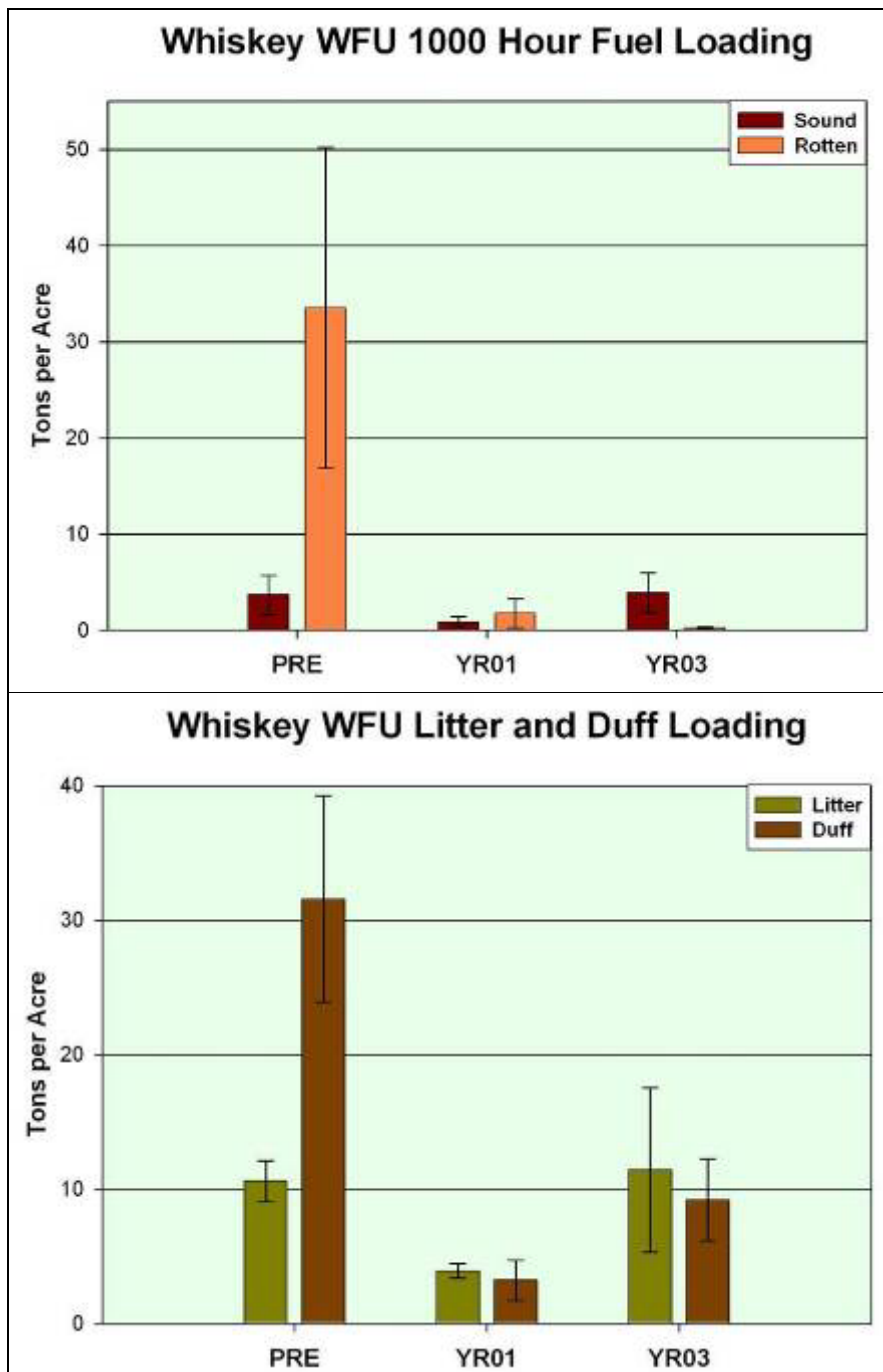


Figure 26. 1000 hour, litter and duff loadings were greatly reduced by the Whiskey WFU fire.

Total fuel loads were also dramatically reduced by the Whiskey WFU fire. Total fuel loading dropped from 88.9 tons/acre (SE = 18.8) preburn to 13.2 tons/acre one year postburn, which is an 85% reduction.

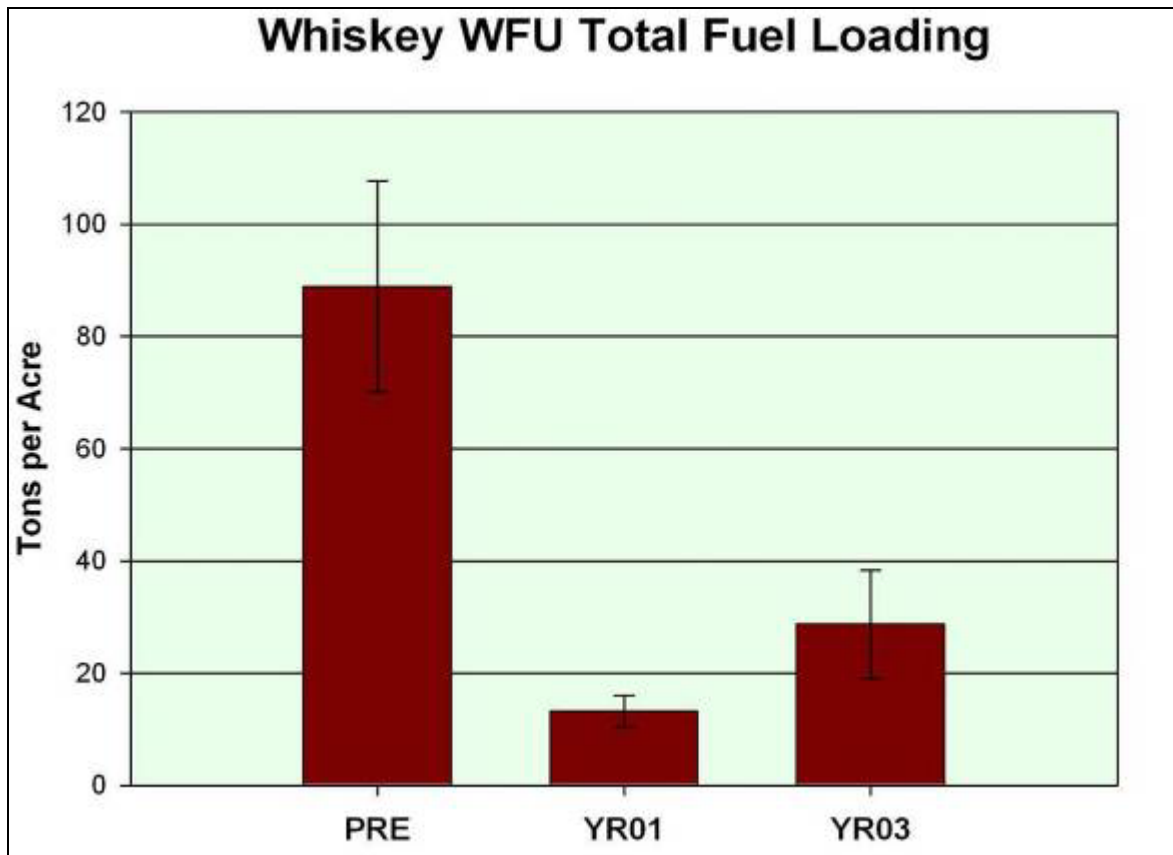


Figure 27. Changes in total fuel loading in the Whiskey WFU fire.

Overstory Tree Density and Composition

The Whiskey fire was effective at reducing live overstory (> 6" DBH) tree densities. A 44% reduction in overstory trees lowered densities from 126.1 trees/acre (SE = 27.2) preburn to 70.3 trees/acre (SE = 11.8) three years postburn. Live overstory tree composition did not substantially change, retaining red and white fir dominance in the canopy, with lesser amounts of lodgepole and Jeffrey pines.

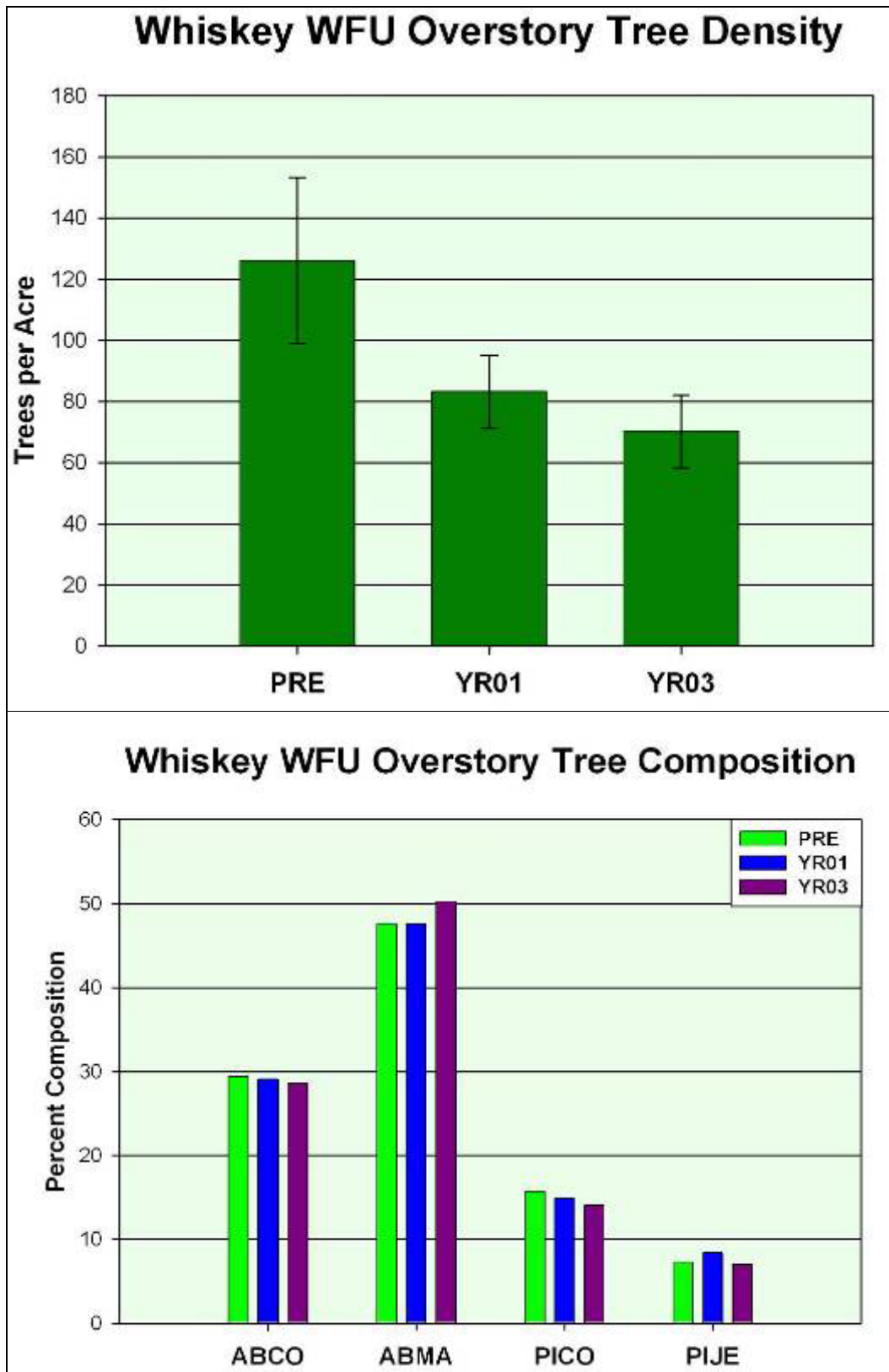


Figure 28. Despite a 44% reduction in live overstory tree density, live overstory tree composition remained more or less the same after the Kibbie fire. ABCO = white fir, ABMA = red fir; PICO = lodgepole pine, PIJE = Jeffrey pine.

Sapling Tree Density

Unlike the Rapid Assessment plots within the Kibbie fire, the Whiskey fire plots did not experience 100% mortality of sapling trees. There was an 89% reduction in live sapling tree density, from 270.9 saplings/acre (SE = 72.3) preburn to 29.3 saplings/acre (SE = 14.2) one year postburn.

Height to Live Crown and Canopy Cover

The Whiskey fire slightly affected height to live crown and canopy cover. Height to live crown increased 24% from 7.5 meters (SE = 0.8) preburn to 9.3 meters (SE = 0.9) one year postburn. As of YR03, height to live crown had decreased to 8.8 meters (SE = 0.9). Canopy cover was decreased by 29% from 62.4% cover (SE = 5.4) preburn to 44.2% cover (SE = 6.9) one year postburn. Canopy cover had risen slightly three years postburn to 49.4% (SE = 6.1).

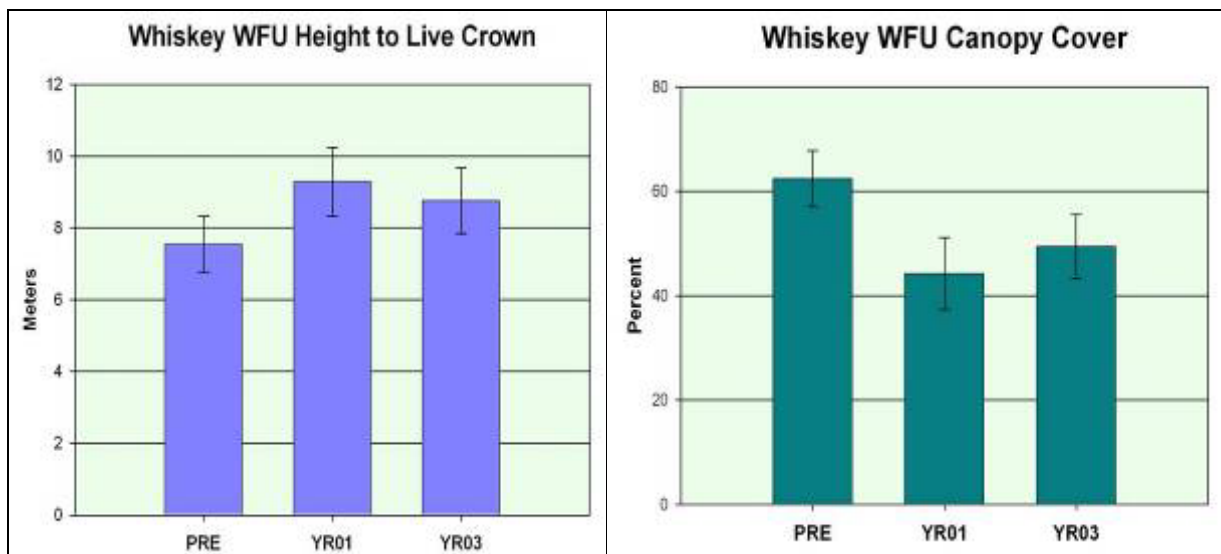


Figure 29. Changes in height to live crown and canopy cover before and after the Whiskey WFU fire.

Repeat Photography

Repeat photos taken at the same point over time illustrate changes in sapling tree density, overstory tree density, and fuel loading.



Figure 30. Preburn (2003) and one year postburn (2004) photos in the Kibbie WFU Fire.



Figure 31. Same photo as Fig. 27, taken three years postburn in the Kibbie WFU fire.

C. Echo WFU Fire

The Echo fire of 2005 was lightning-ignited and allowed to remain a WFU fire. This fire burned 133 acres and was located between 8000 – 9000' elevation. Ten Rapid Assessment plots were installed ahead of the fire in lodgepole pine, mountain hemlock (*Tsuga mertensiana*), western white pine (*Pinus monticola*) and red fir forests. Only five plots ended up burning, so the unburned plots were removed one year postburn and their data retained for use as baseline conditions for this area. The Echo Rapid Assessment plots were sampled preburn (PRE – 2005) and one year postburn (YR01 – 2006); they will be sampled three years postburn (YR03 – 2008), five years postburn (YR05 – 2010), ten years postburn (YR10 – 2015) and every subsequent ten years.



Figure 32. The 2005 Echo WFU fire at night.

Fuel Loading

The upper montane/subalpine forest type found in the Echo fire is dominated by tree species with fewer adaptations to resist fire than the lower mixed conifer forest type. Red fir and western white pine have thicker bark than lodgepole pine and mountain hemlock, and are generally thought of as being able to survive low-intensity fire (Agee 1993). Younger lodgepole pines and mountain hemlocks are especially susceptible to even low-intensity fire due to their thin bark, dense foliage and growth habit, and low limbs (van Wagtendonk and Fites-Kaufman 2006). Given the more sensitive nature of this forest type, it should be no surprise that many trees were killed by the Echo fire. This naturally contributes to an increased postfire fuel load.

Sound 1000 hour fuels increased 1693% from 4.3 tons/acre (SE = 4.3) preburn to 77.1 tons/acre (SE = 39.3) one year postburn. This is due to dead trees falling down after the fire. The fire did consume litter and duff loads. Litter was reduced 49% from 7.7 tons/acre (SE = 2.2) preburn to 3.9 tons/acre (SE = 0.7) one year postburn. Duff was reduced 77% from 28.0 tons/acre (SE = 11.4) preburn to 6.2 tons/acre (SE = 3.1) one year postburn.

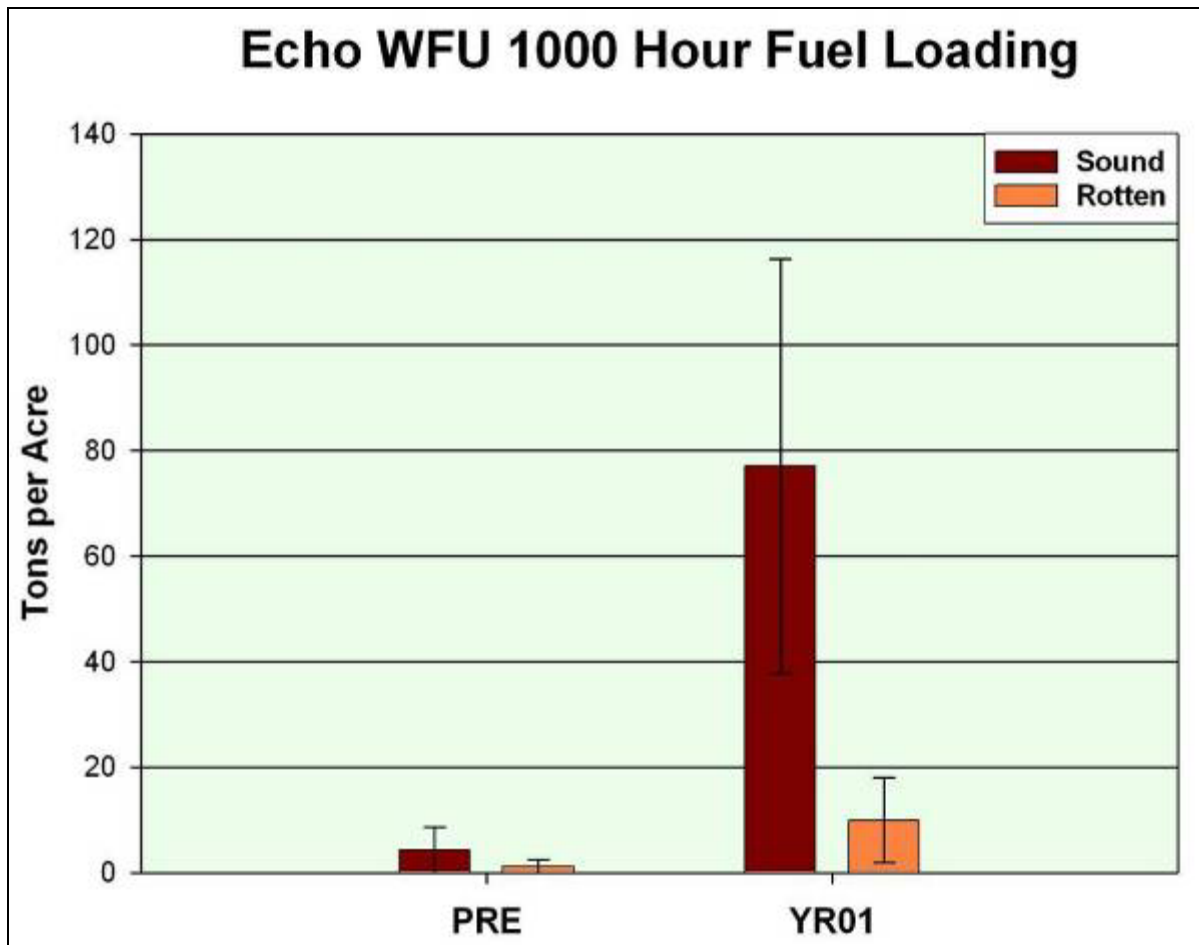


Figure 33. 1000 hour fuel loads increased after the Echo WFU fire.

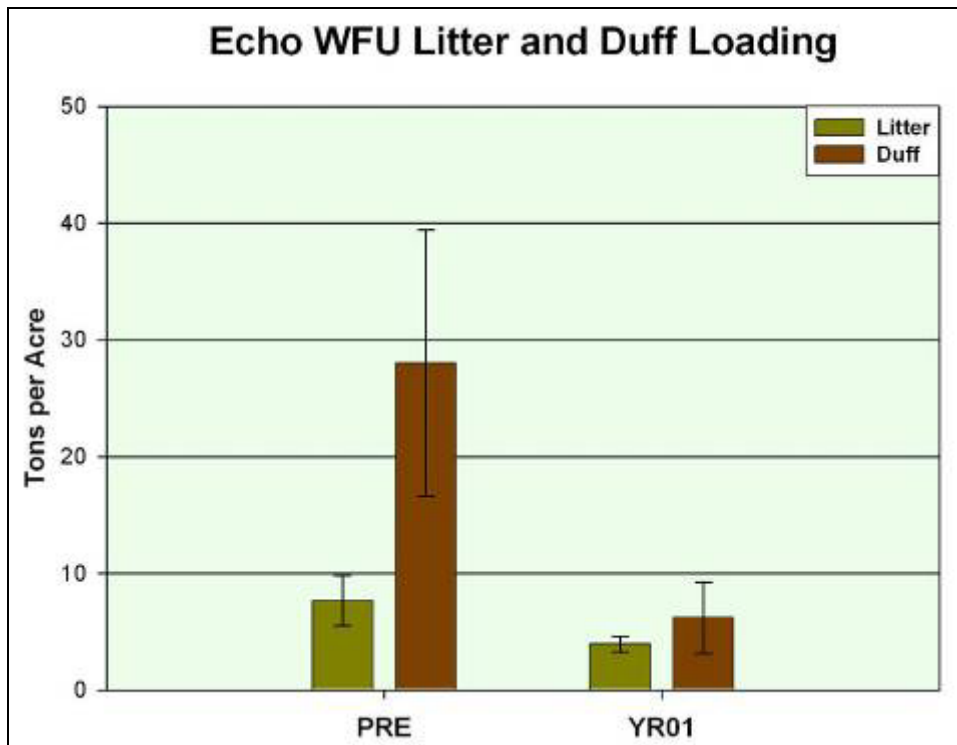


Figure 34. Litter and duff loads decreased after the Echo WFU fire.

Total fuel loading increased 130% after the Echo WFU fire from 45.9 tons/acre (SE = 14.3) preburn to 105.8 tons/acre (SE = 45.8) one year postburn.

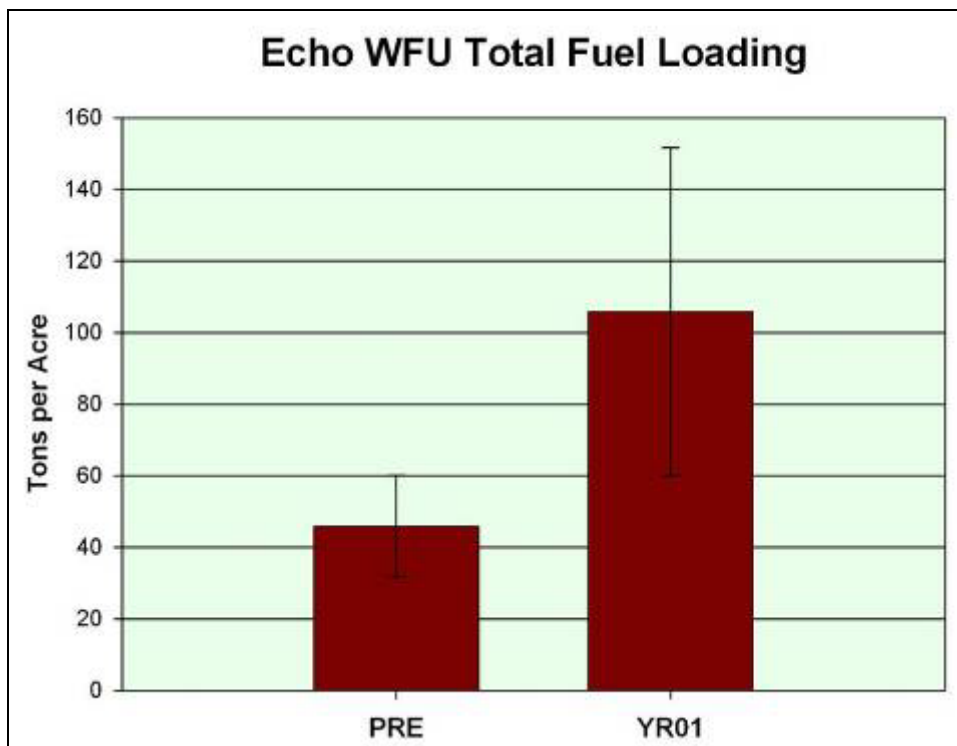


Figure 35. Changes in total fuel load in the Echo WFU fire.

Overstory Tree Density and Composition

Live overstory (> 6" DBH) tree density experienced a 23% reduction, dropping from 98.0 trees/acre (SE = 31.2) preburn to 74.8 trees/acre (SE = 17.5) one year postburn. Dead overstory trees increased by 62%, from 41.2 trees/acre (SE = 14.4) preburn to 67.0 trees/acre (SE = 21.3) one year postburn. This is a large increase when one considers that many standing dead trees present preburn were knocked down and consumed by the fire.

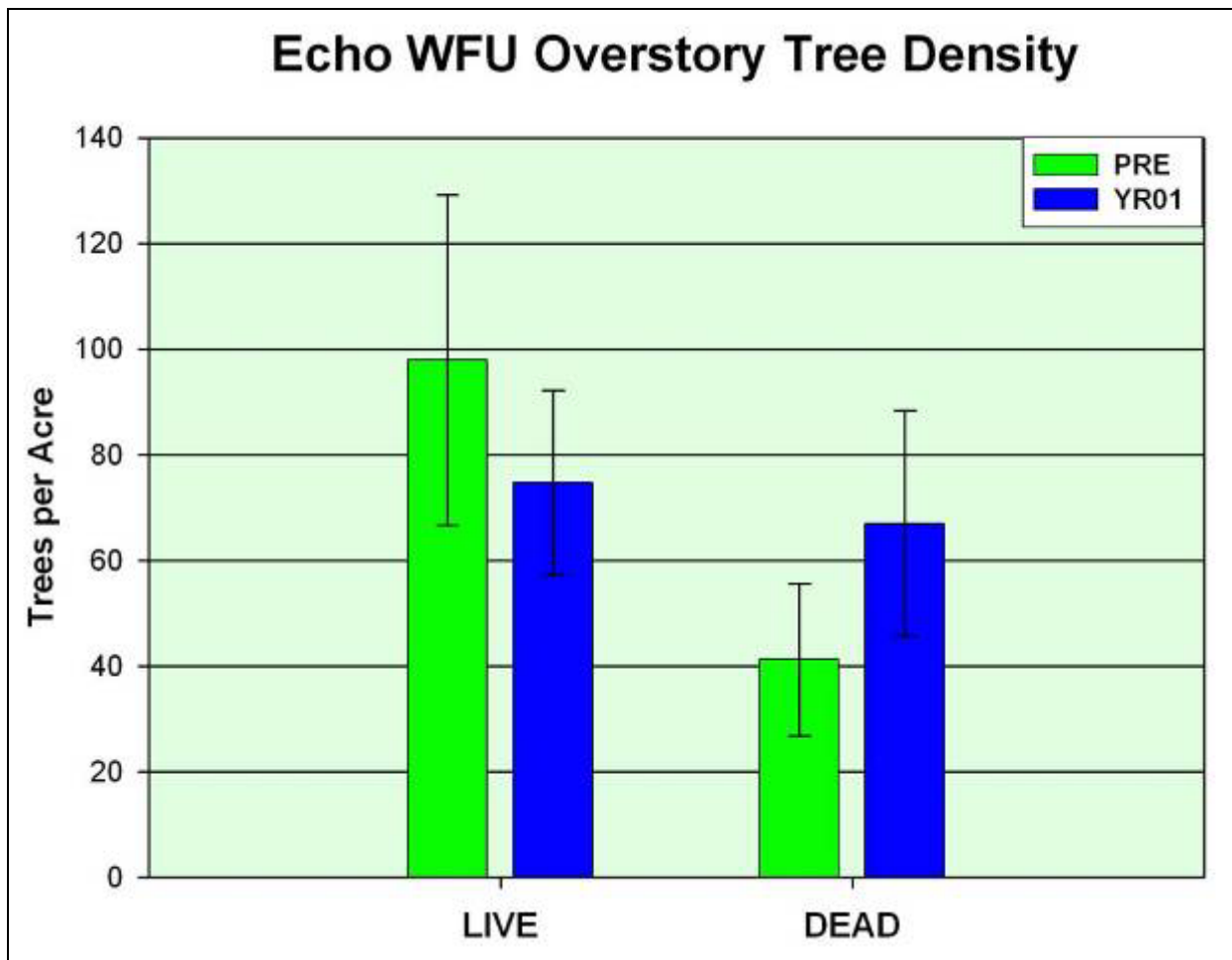


Figure 36. Changes in live and dead overstory tree densities in the Echo WFU fire.

Live overstory tree composition was moderately affected by the Echo fire. Red fir and lodgepole pine either increased or maintained their share of the canopy. Western white pine and mountain hemlock decreased their percentage of the canopy. Dead overstory tree composition was also moderately affected by the fire. Western white pine and mountain hemlock increased their dominance as dead canopy members, while dead lodgepole pines either burned or fell over with the passage of fire.

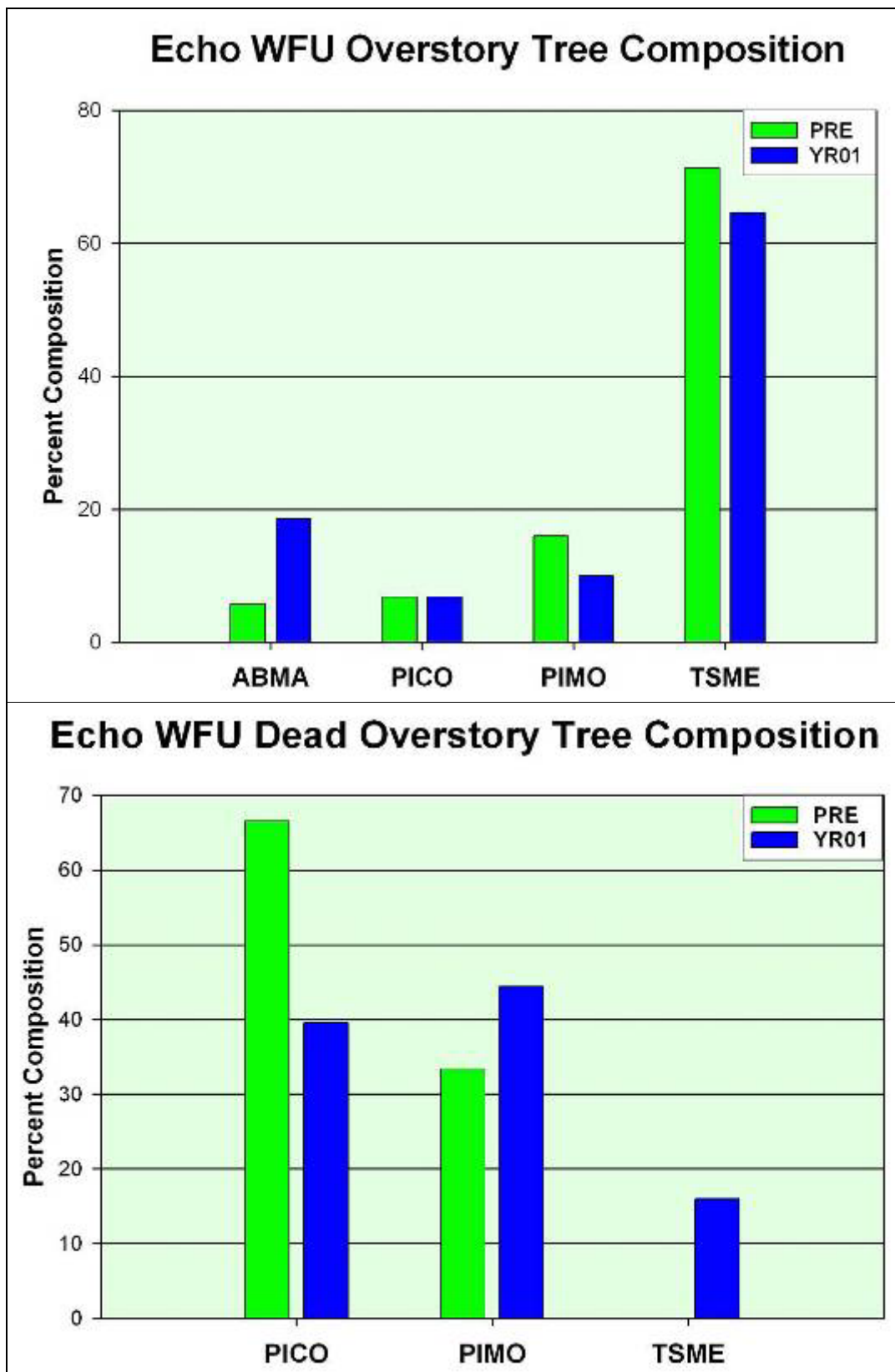


Figure 37. Live (above) and dead overstory tree composition before and after the Echo WFU fire. ABMA = red fir, PICO = lodgepole pine, PIMO = western white pine, TSME = mountain hemlock.

Sapling Tree Density and Composition

Live sapling tree density was greatly reduced by the Echo fire. Sapling tree density declined 86% from 257.8 saplings/acre (SE = 74.4) preburn to 36.2 saplings/acre one year postburn. Live sapling tree species composition was moderately affected. Mountain hemlock remained the most common sapling tree species, while western white pine saplings were eliminated from the Rapid Assessment plot data.

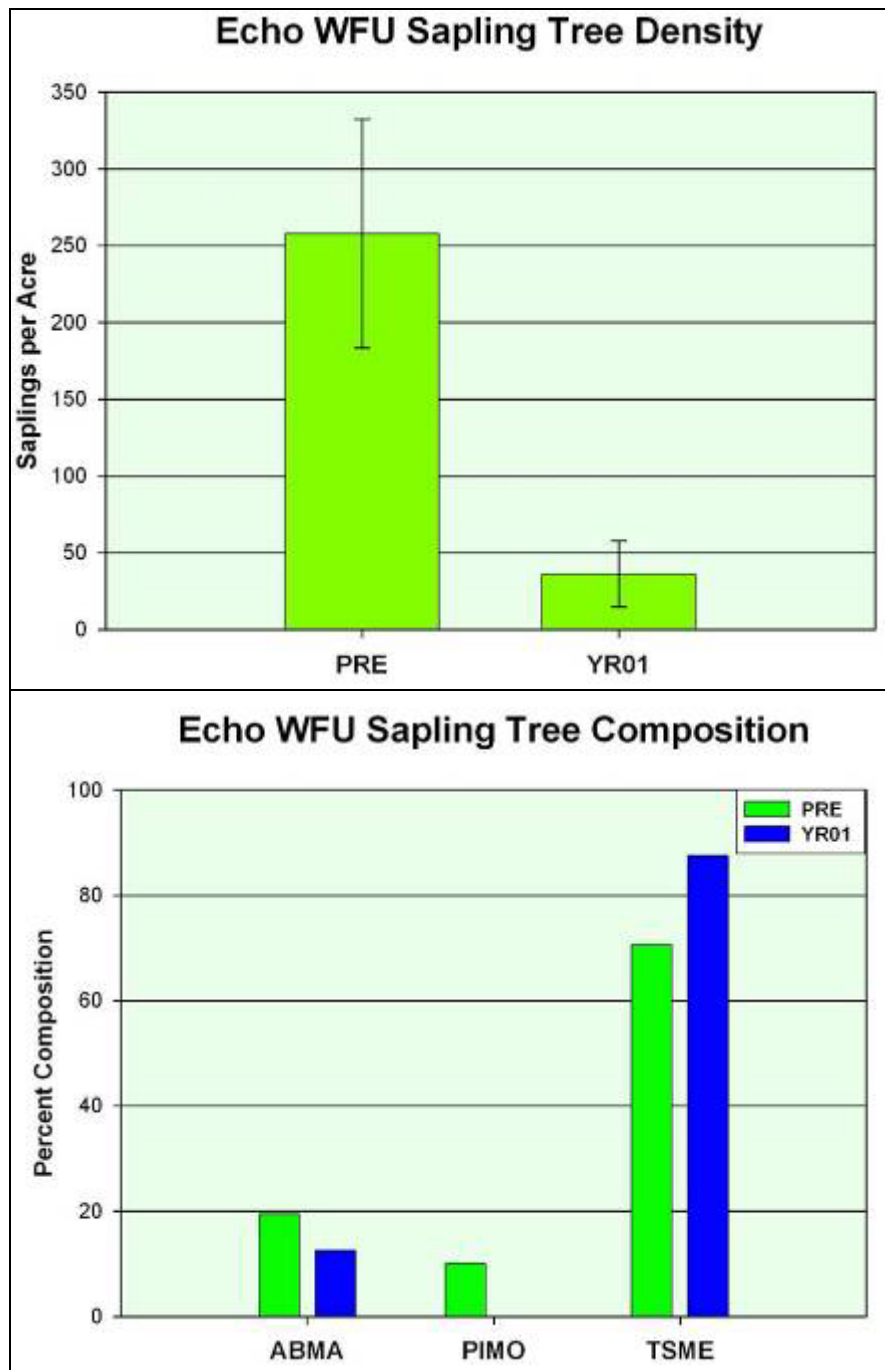


Figure 38. Sapling tree density and composition before and after the Echo WFU fire.

Height to Live Crown and Canopy Cover

Height to live crown was slightly increased by the Echo WFU fire. Average preburn height to live crown was 2.6 meters (SE = 0.8), while the average one year postburn height to live crown was 3.2 meters (SE = 1.1). Canopy cover was reduced by 36% cover from 43.3% (SE = 8.7) preburn to 27.3% cover (SE = 5.5) one year postburn.

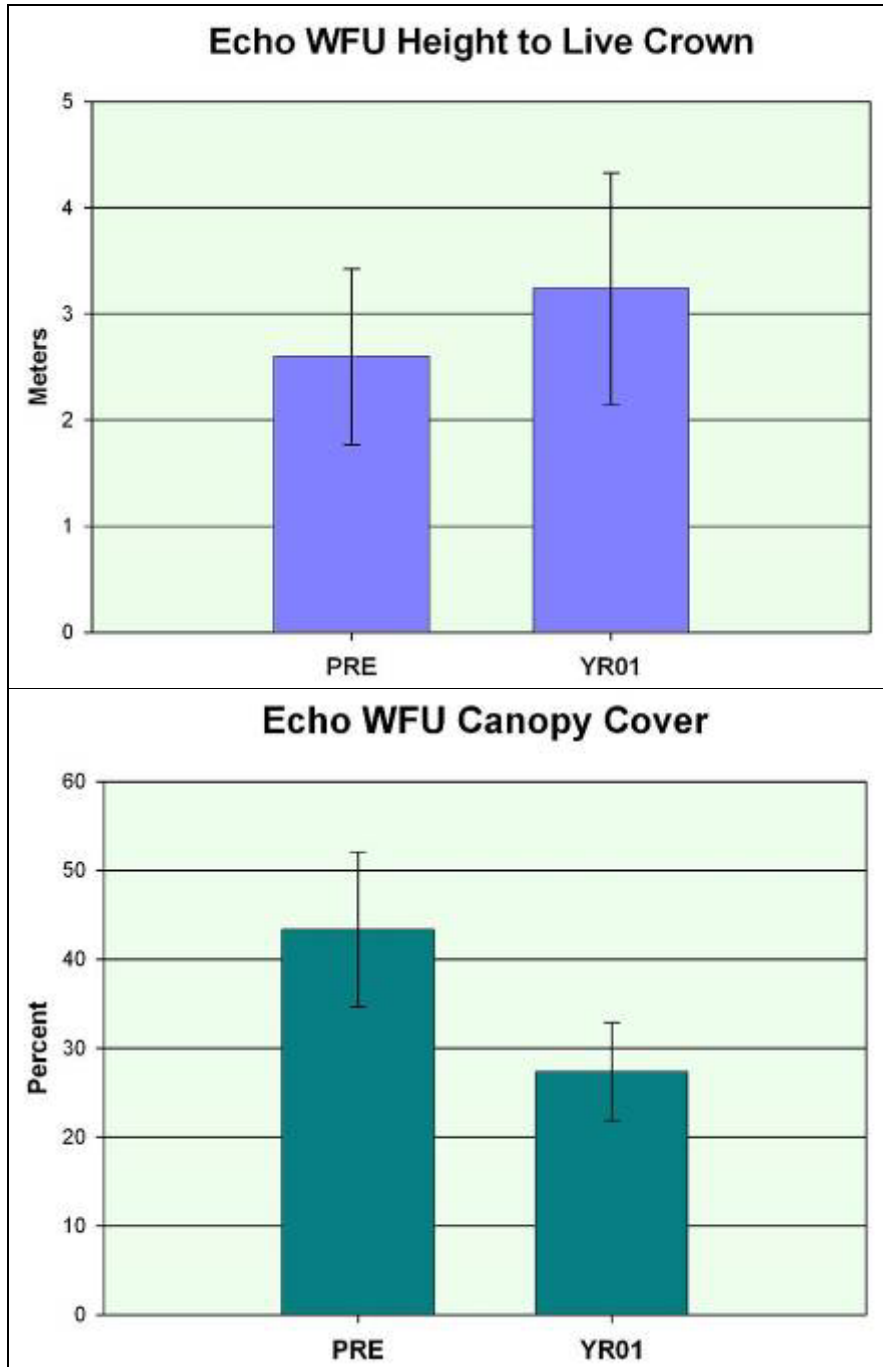


Figure 39. The Echo WFU fire increased average height to live crown and reduced average canopy cover.

Repeat Photography

The scenes here are interesting enough to include images from two Rapid Assessment plots.



Figure 40. PRE (2005) and YR01 (2006) images of the Echo WFU fire.



Figure 41. PRE (2005) and YR01 (2006) images of the Echo WFU fire.

D. Frog WFU Complex

The 2006 Frog WFU Complex, comprised of the Frog and Laurel fires, burned 6031 acres. Seven Rapid Assessment plots were installed at 6200 – 6600' elevation in white fir and ponderosa pine dominated mixed conifer forests and whitethorn (*Ceanothus cordulatus*) and snag dominated old fire scars. The plots were sampled preburn (PRE – 2006) and one year postburn (YR01 – 2007), and will be sampled three years postburn (YR03 – 2009), five years postburn (YR05 – 2011), ten years postburn (2016), and every subsequent ten years.



Figure 42. The 2006 Frog WFU Complex burning toward Lake Eleanor.

Fuel Loading

Fuel loading in all size classes was reduced by the Frog WFU Complex. Sound 1000 hour fuels were reduced 86%, from 12.5 tons/acre (SE = 9.2) preburn to 1.7 tons/acre (SE = 0.7) one year postburn. Rotten 1000 hour fuels were reduced 61%, from 33.1 tons/acre (SE = 23.2) preburn to 12.6 tons/acre (SE = 10.1) one year postburn. Duff loadings were reduced 66% from 16.8 tons/acre (SE = 4.5) preburn to 5.6 tons/acre (SE = 3.3) one year postburn.

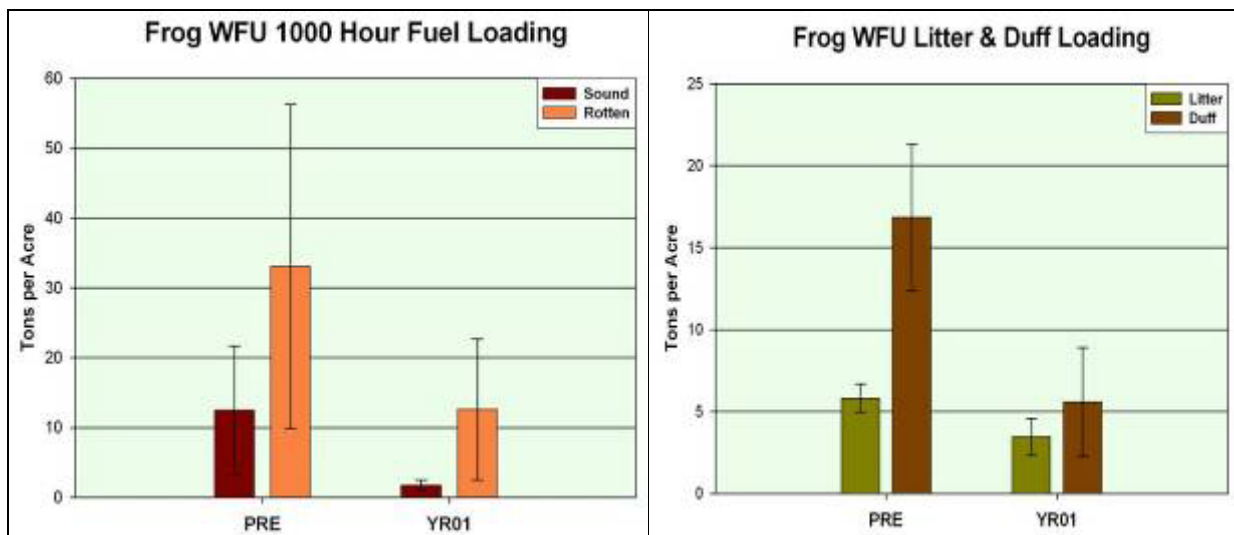


Figure 43. The Frog WFU Complex reduced 1000 hour, litter, and duff fuel loads.

Total fuel loading was also decreased by the Frog WFU Complex. Total fuel loads were reduced 67% from 74.3 tons/acre (SE = 27.7) preburn to 24.2 tons/acre (SE = 8.9) one year postburn.

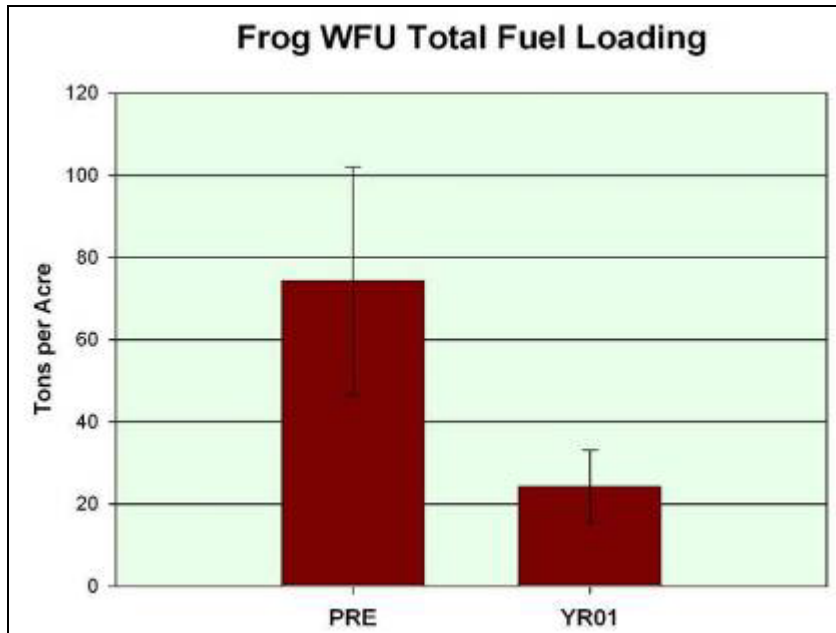


Figure 44. Change in total fuel loading due to the Frog WFU Complex.

Overstory Tree Density and Composition

The Frog WFU complex reduced live overstory tree (> 6" DBH) densities by 30%, from 90.2 trees/acre (SE = 24.2) preburn to 62.6 trees/acre (SE = 18.9) one year postburn. Dead overstory tree densities remained more or less stable.

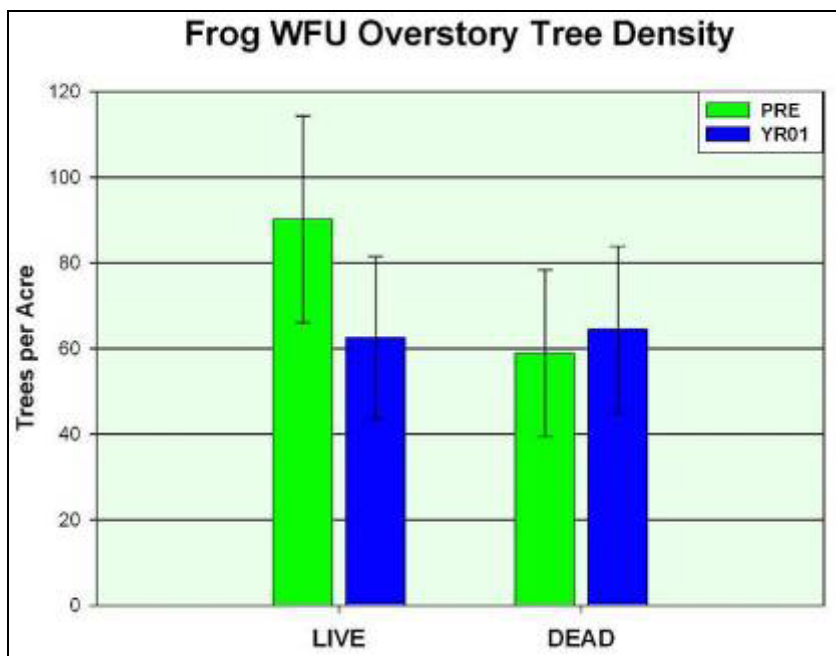


Figure 45. Change in live and dead overstory tree densities in the Frog WFU Complex.

Live overstory tree composition was slightly affected by the Frog WFU Complex. Jeffrey pine and black oak (*Quercus kelloggii*) slightly increased their proportions in the canopy, while white fir and incense cedar (*Calocedrus decurrens*) proportions were reduced. Dead overstory tree composition did not change substantially after the Frog WFU Complex.

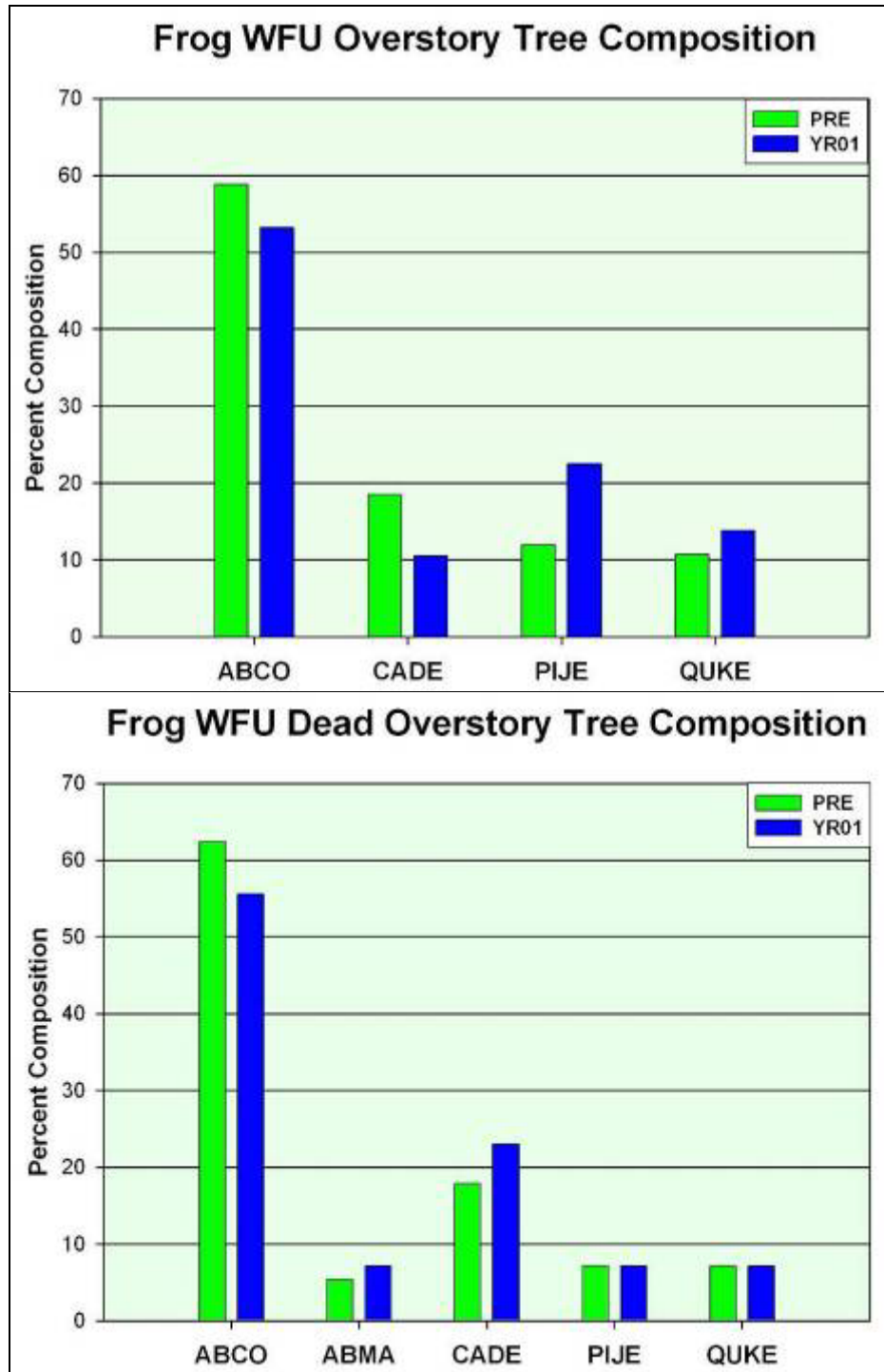


Figure 46. Live (above) and dead (below) overstory tree composition before and after the Frog WFU Complex. ABCO = white fir, ABMA = red fir, CADE = incense cedar; PIJE = Jeffrey pine; QUKE = black oak.

Sapling Tree Density and Composition

The Frog WFU Complex reduced average live sapling (< 6" DBH) tree density by 92%, from 184.0 saplings/acre (SE = 132.5) preburn to 14.4 saplings/acre (SE = 14.4) one year postburn. White fir was the only species that survived the fire to dominate sapling tree species composition in the Rapid Assessment plot data.

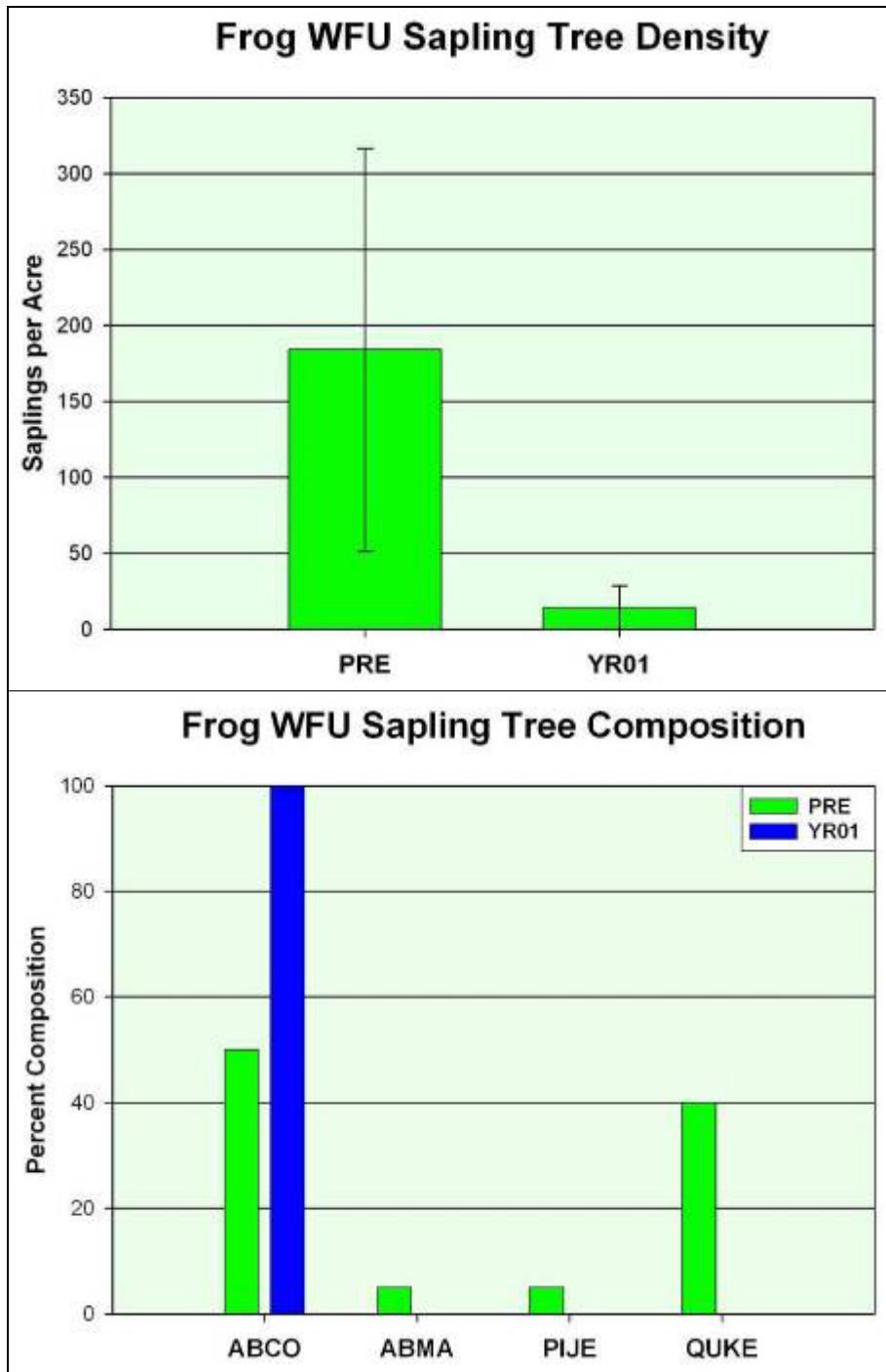


Figure 47. Changes in sapling tree density and composition after the Frog WFU Complex. ABCO = white fir; ABMA = red fir, PIJE = Jeffrey pine, QUKE = black oak.

Height to Live Crown and Canopy Cover

The Frog WFU Complex raised the average height to live crown 102%, from 4.6 meters (SE = 0.6) preburn to 9.3 meters (SE = 1.1) one year postburn. Canopy cover was only slightly affected, showing an 11% reduction from 34% cover (SE = 9.0) preburn to 30% cover (SE = 9.5).

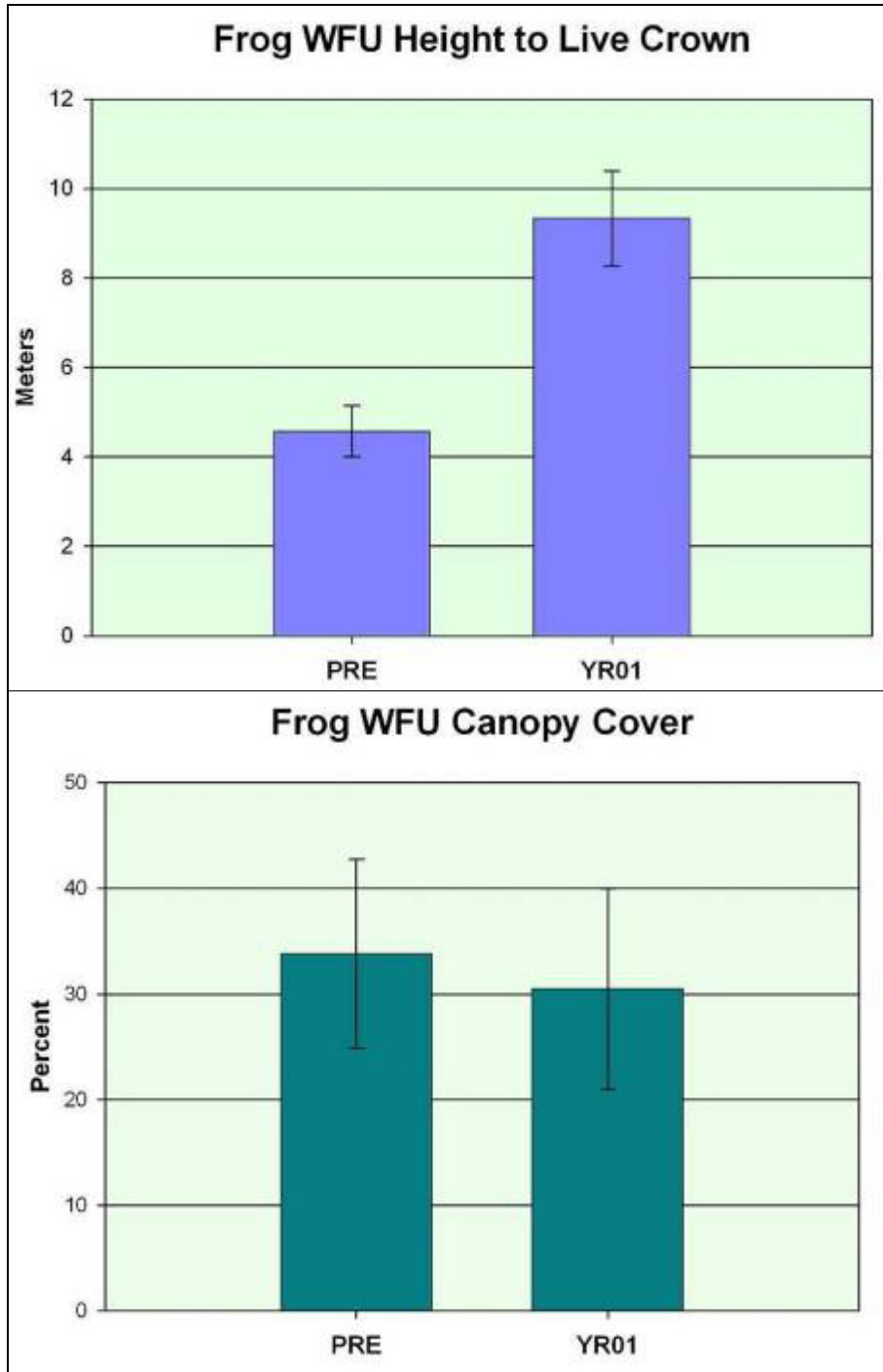


Figure 48. Changes in height to live crown and canopy cover before and after the Frog WFU Complex.

Repeat Photography

Two plots are featured here because of the great story-telling qualities of the photos.



Figure 49. PRE (2006) and YR01 (2007) images of the Frog WFU Complex.



Figure 50. PRE (2006) and YR01 (2007) images of the Frog WFU Complex. This plot was in an old burn scar dominated by whitethorn and snags; many of the snags were consumed by the fire.

4. Composite Burn Index

Burn severity data are very important to the Yosemite Fire Management program. These data complement our fire history data and have been used recently to create a Fire Atlas for Yosemite, dating back to 1974. Yosemite has been requesting burn severity data for our large fires (> 300 acres) since 2001 through the NPS-USGS National Burn Severity Mapping Project.

Burn severity data are based on analyzing pre- and post-fire Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM) scenes and assessing the change that can be attributable to the fire event. The Normalized Burn Ratio (NBR) is the metric used to determine burn severity (Key and Benson 2006). The NBR examines Landsat bands 4 and 7, which measure attributes of vegetation and surface properties that respond most to burning.

$$\text{NBR} = \frac{(R4 - R7)}{(R4 + R7)}$$

The NBR is differenced between pre and postfire scenes, resulting in a differenced NBR (dNBR) value that is an assessment of burn severity:

$$\text{dNBR} = \text{NBR}_{\text{prefire}} - \text{NBR}_{\text{postfire}}$$

Another index of burn severity is the Relativized dNBR or RdNBR. Relativization rescales the data based on the ranges of the original data (McCune and Grace 2002), and the RdNBR has been used with greater success than the dNBR in some ecosystems (Measuring Trends in Burn Severity Project).

Yosemite has received dNBR and RdNBR data for large fires dating from 2001 to 2003 from Andi Thode and Jay Miller of the USFS as part of the Yosemite Fire Atlas project. Since 2004, only dNBR data have been received from the NPS-USGS National Burn Severity Mapping Project (NBSMP).

The Composite Burn Index (CBI) is a field-based measure of burn severity, determined by establishing field plots and rating out the burn severity of various strata (substrates, herbs & low shrubs, tall shrubs, intermediate trees, and big trees). The individual strata are then averaged to reach a composite or total plot score of burn severity (Key and Benson 2006). The CBI burn severity score can then be compared to the dNBR or RdNBR assessment of burn severity to validate that the observations made by the Landsat sensors are valid on the ground.

Yosemite has been collecting CBI data on large fires since 2002. At this point, CBI plots exist for the following fires:

1. 2001 Hoover WFU fire (n = 55)
2. 2002 PW-03 Prescribed (Rx) burn (n = 41)
3. 2002 Wolf WFU fire (n = 35)
4. 2003 Tuolumne WFU/Suppression fire (n = 21)
5. 2003 Kibbie WFU/Suppression fire (n = 10)

6. 2003 Snow WFU fire (n = 5)
7. 2003 Whiskey WFU fire (n = 28)
8. 2004 Meadow WFU/Suppression fire (n = 52)
9. 2005 PW-03 Rx burn (n = 37)
10. 2006 Frog WFU Fire (n = 44)

Adequate field data have been collected at this point to facilitate the analysis of CBI data vs. dNBR and, where it exists, RdNBR data. This analysis has been performed per fire for fires with > 20 CBI plots. CBI vs. dNBR analysis has also been performed by vegetation type to determine if CBI/dNBR correlation varies by vegetation type. Burn severity validation analysis was performed using polynomial regression with a forward selection procedure (Zar 1999).



Figure 51. Differences in burn severity are evident in the photos above. Clockwise from upper left: low burn severity on the Wolf WFU fire; moderate-low burn severity on the 2002 PW-03 Rx Burn; high burn severity on the 2002 PW-03 Rx burn; and moderate-high burn severity on the 2002 PW-03 Rx Burn.

A. Analysis by Fire

Burn severity validation analysis of CBI vs. dNBR and/or CBI vs. RdNBR data were performed on seven fires spanning from 2001 to 2005. RdNBR data exist for the 2001 – 2003 fires; dNBR data exist for all fires. Graphical results of the regression analyses are presented below.

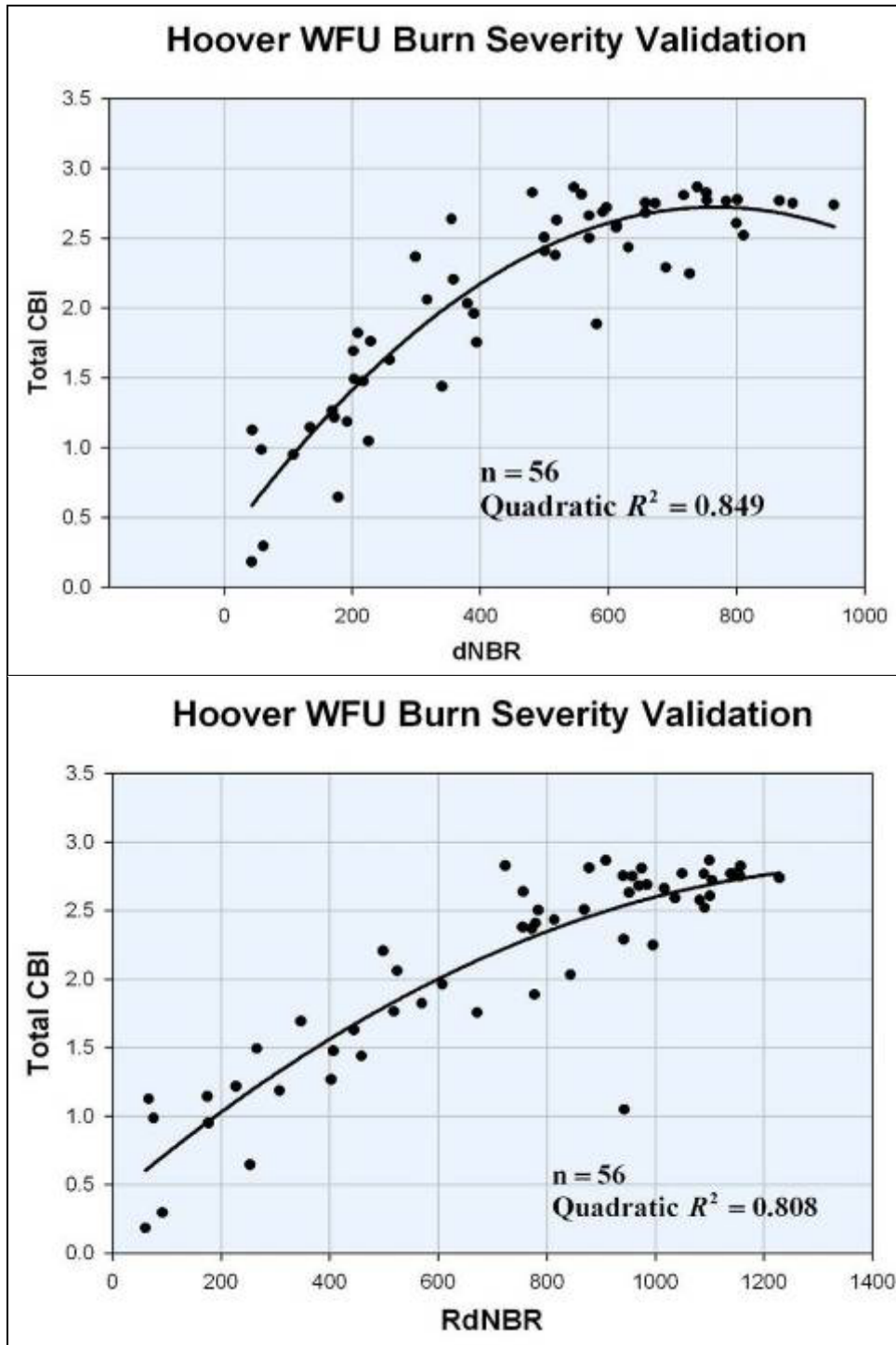


Figure 52. Total plot CBI scores have a stronger correlation with dNBR values in the 2001 Hoover WFU fire.

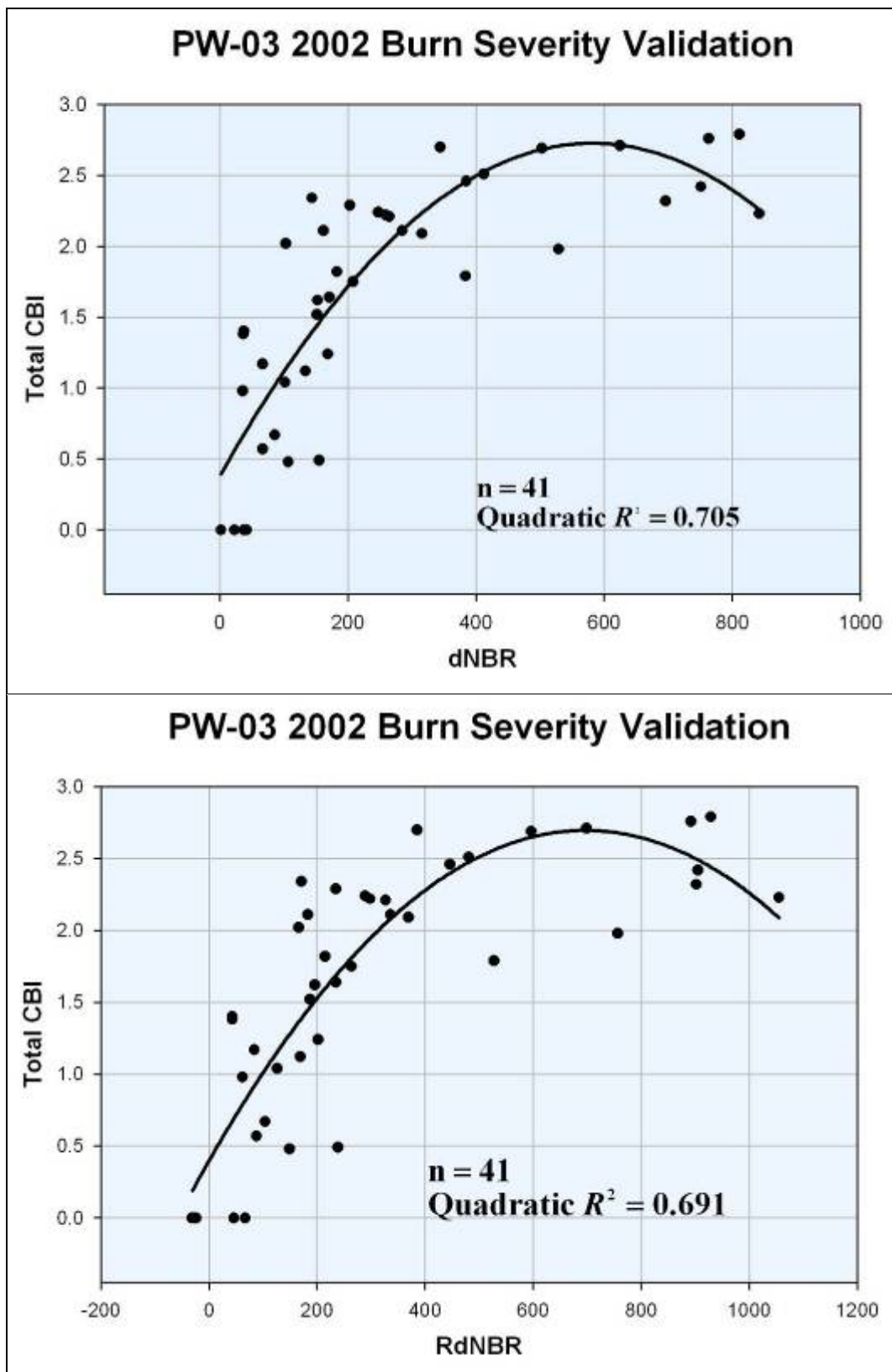


Figure 53. Total plot CBI scores have a higher correlation with dNBR values in the 2002 PW-03 Rx burn.

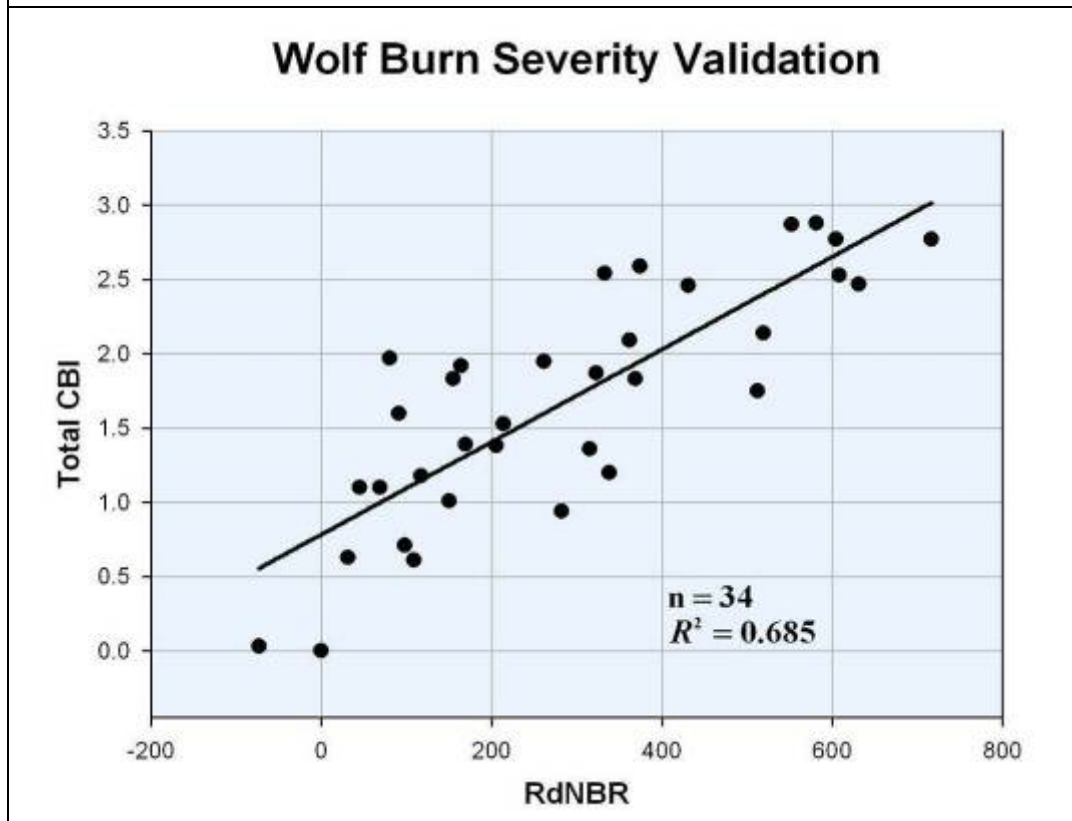
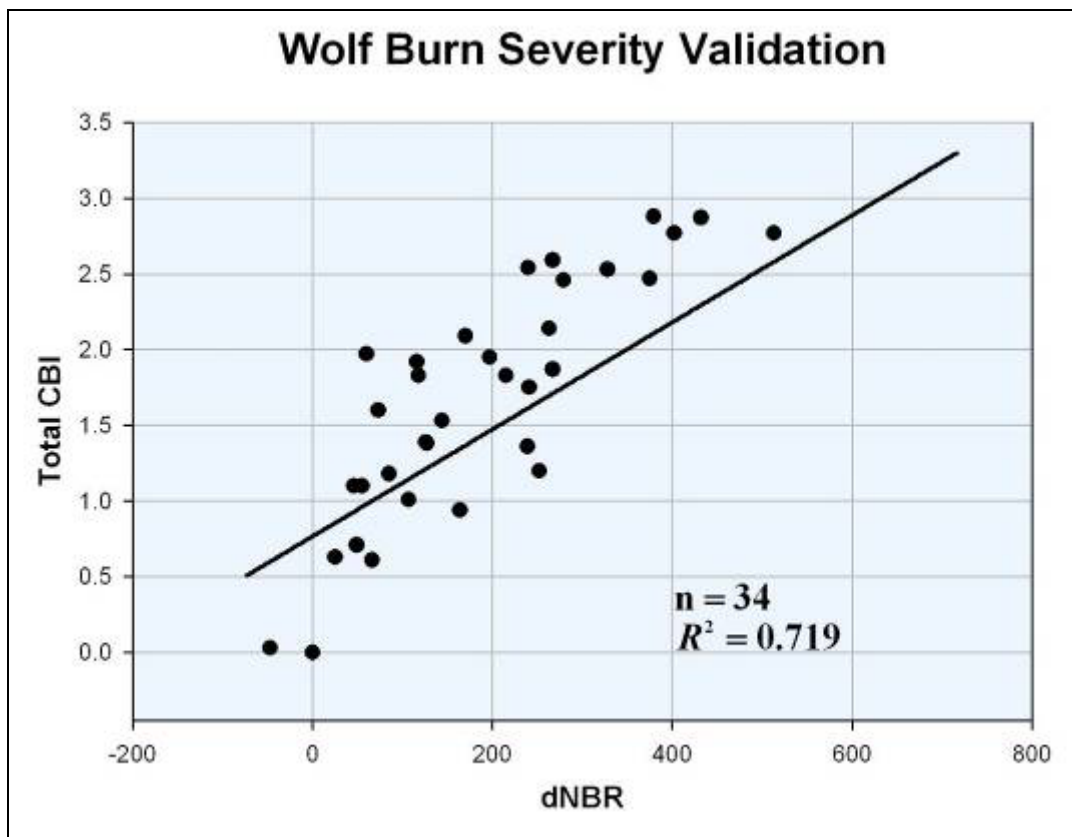


Figure 54. Total plot CBI scores have a stronger correlation with dNBR values in the 2002 Wolf WFU Fire.

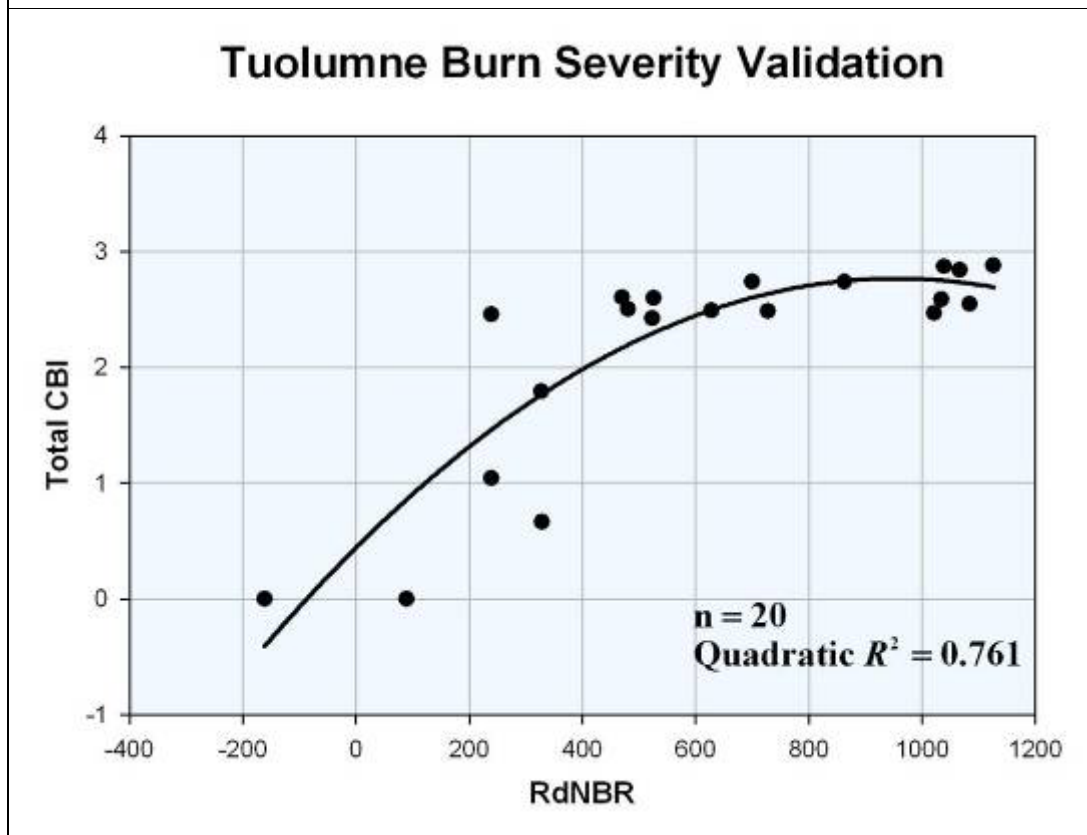
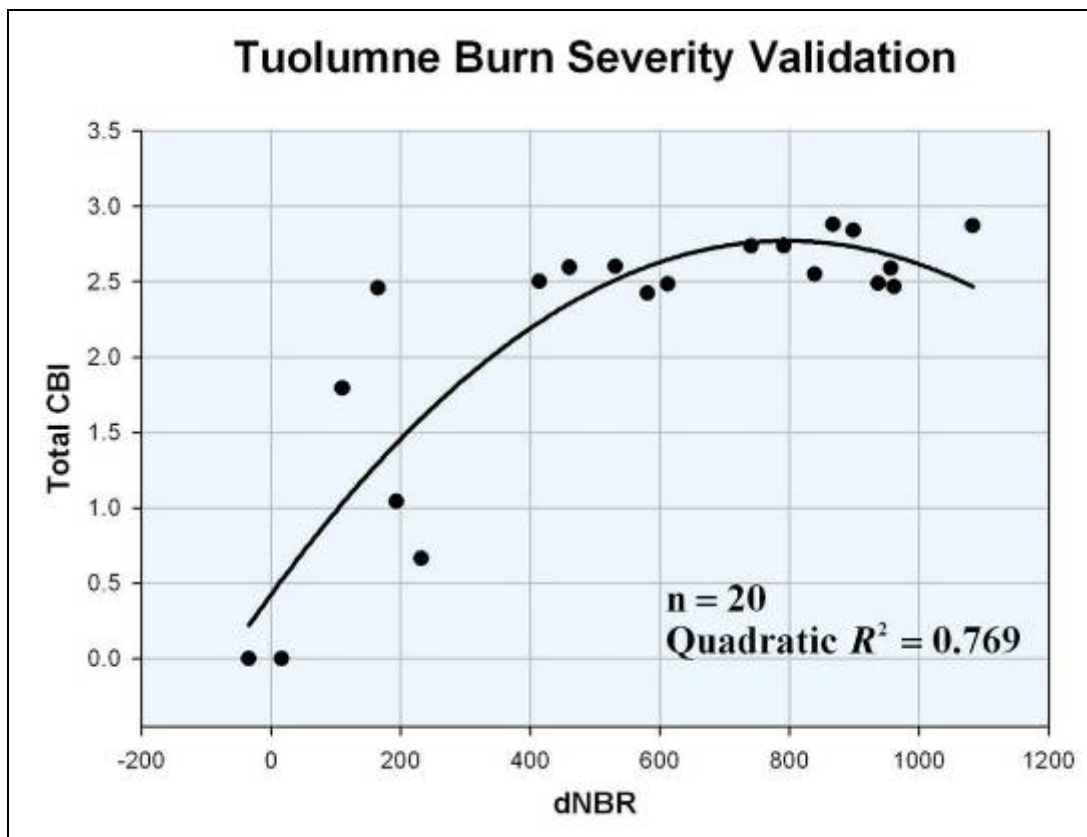


Figure 55. Total plot CBI has a stronger correlation with dNBR values in the 2003 Tuolumne WFU Fire.

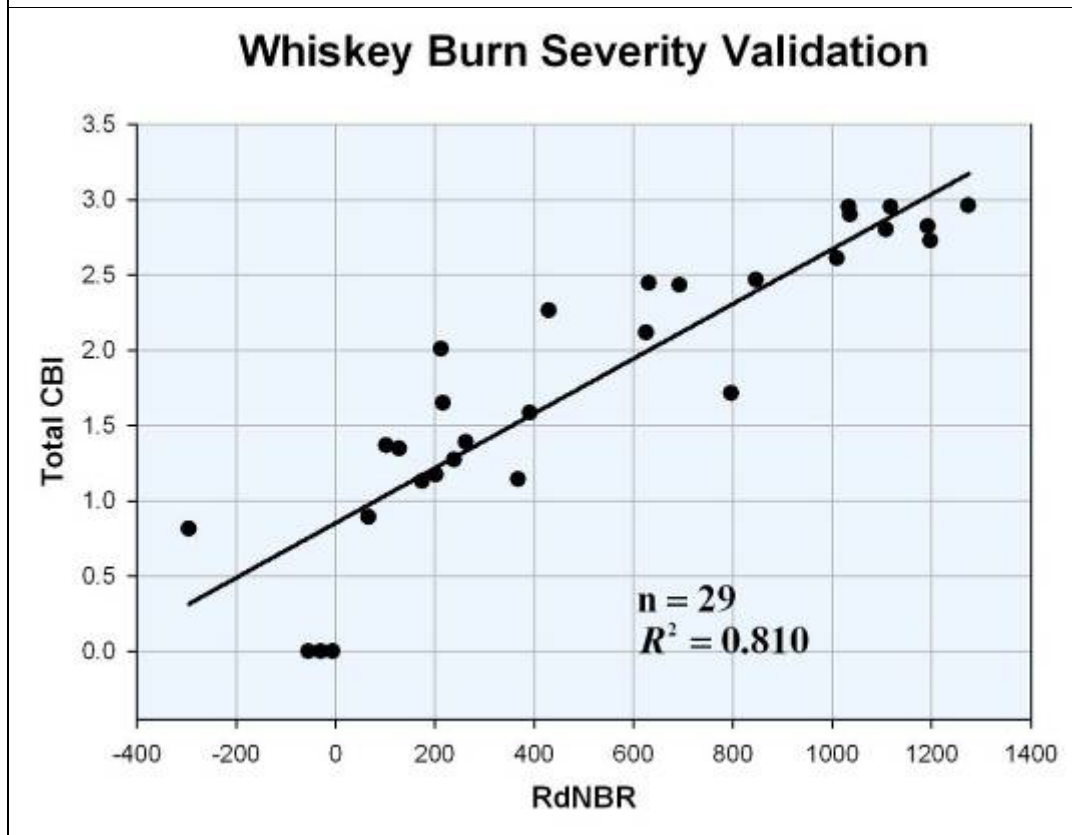
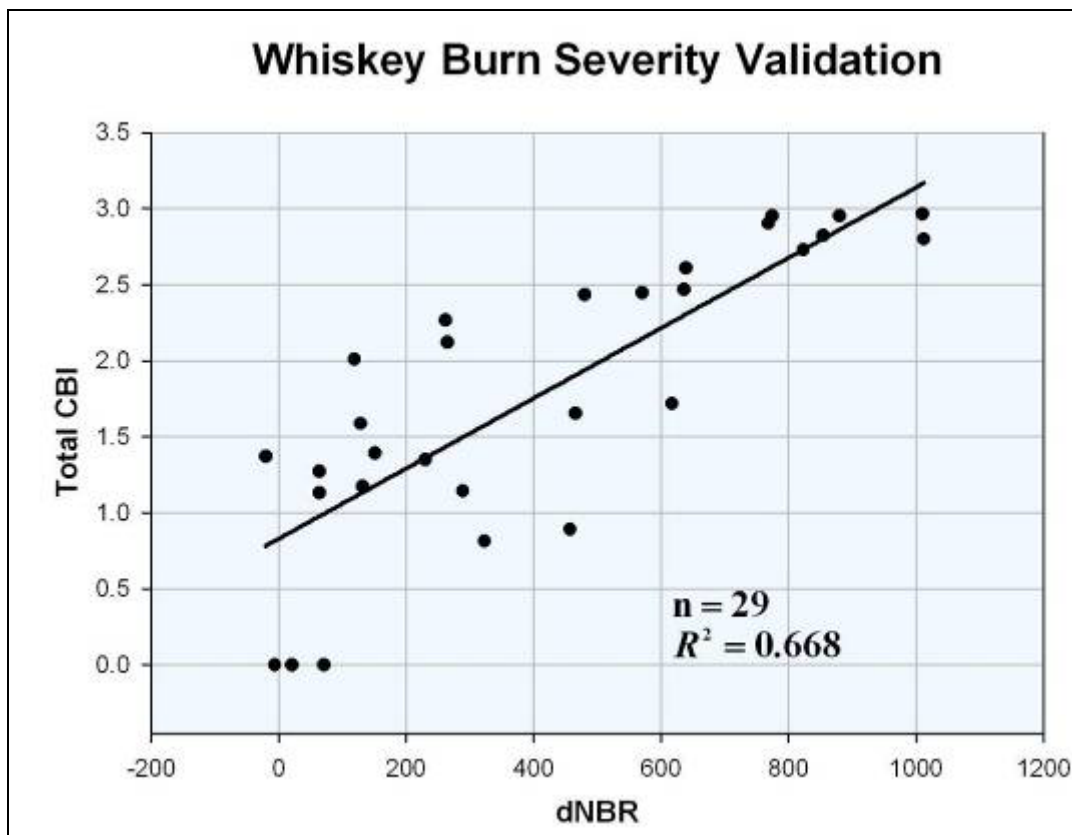


Figure 56. Total plot CBI has a stronger correlation with RdNBR values in the 2003 Whiskey WFU Fire.

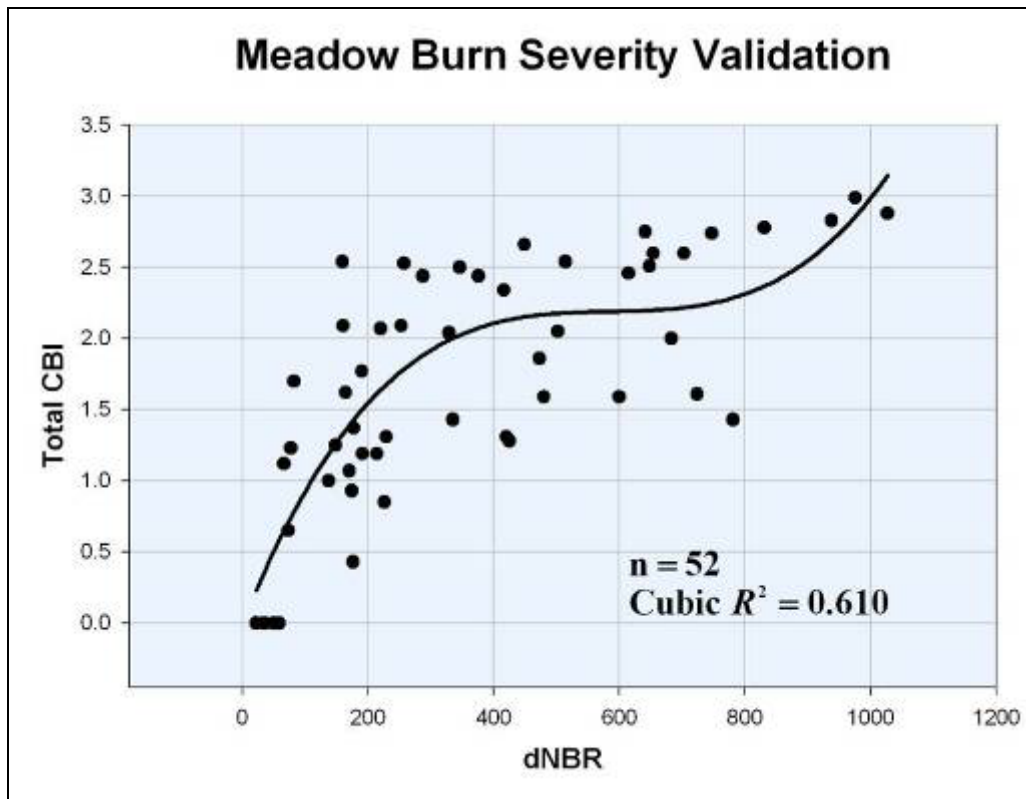


Figure 57. There is no strong linear relationship between total plot CBI scores and dNBR values in the 2004 Meadow WFU fire.

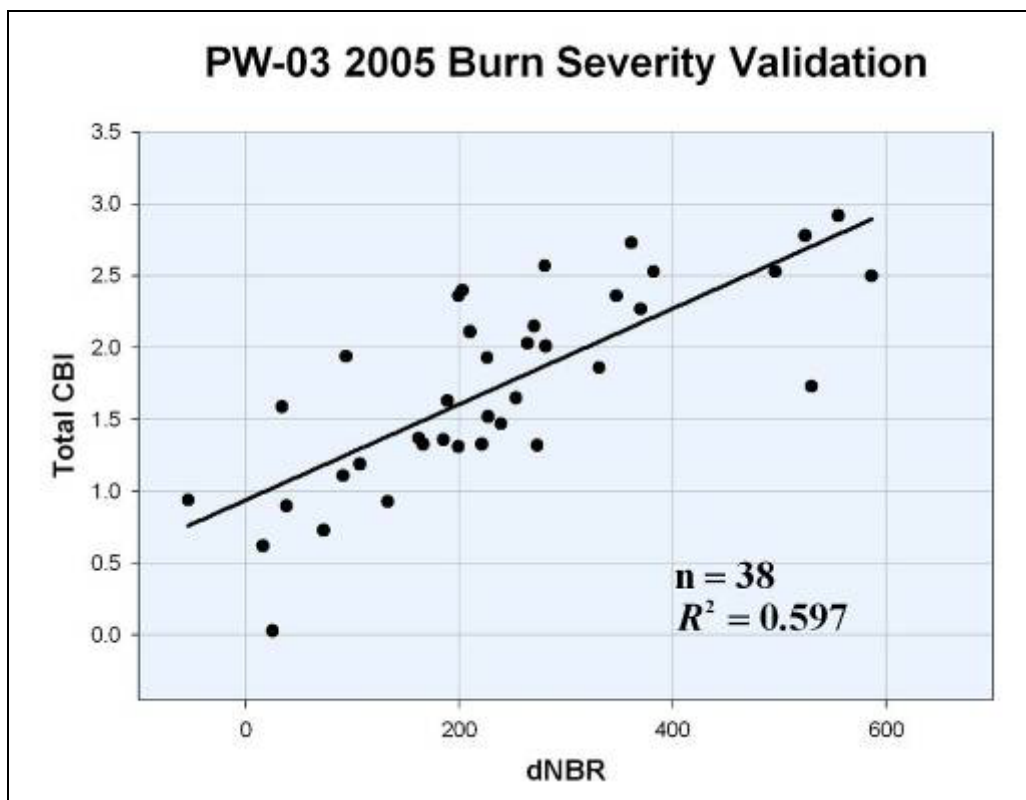


Figure 58. Total plot CBI scores have a moderate linear correlation with dNBR values.

When comparing the performance of dNBR and RdNBR values, total plot CBI scores were more strongly correlated with dNBR values in four out of the five fires. Only the Whiskey WFU had a stronger correlation between total CBI scores and RdNBR values. The NPS-USGS NBSMP will continue to provide burn severity data for Yosemite; hence only the dNBR value will be used in burn severity assessments.

There is a marked decrease in correlation between CBI and dNBR in the 2004 Meadow WFU fire and 2005 PW-03 Rx burn. This could be due to high canopy cover, low canopy cover, fire history, shrub cover, or any number of factors that affect the ability of the dNBR to detect change caused by fire. Another possible explanation is the use of different burn severity thresholds by Thode/Miller and the NPS – USGS NBSMP. The Fire GIS Specialist is currently investigating this issue.

B. Analysis by Vegetation Type

All CBI data were combined and analyzed by general vegetation type to explore whether burn severity validations differed based on dominant vegetation. Vegetation types were lumped into groups based on species dominance.

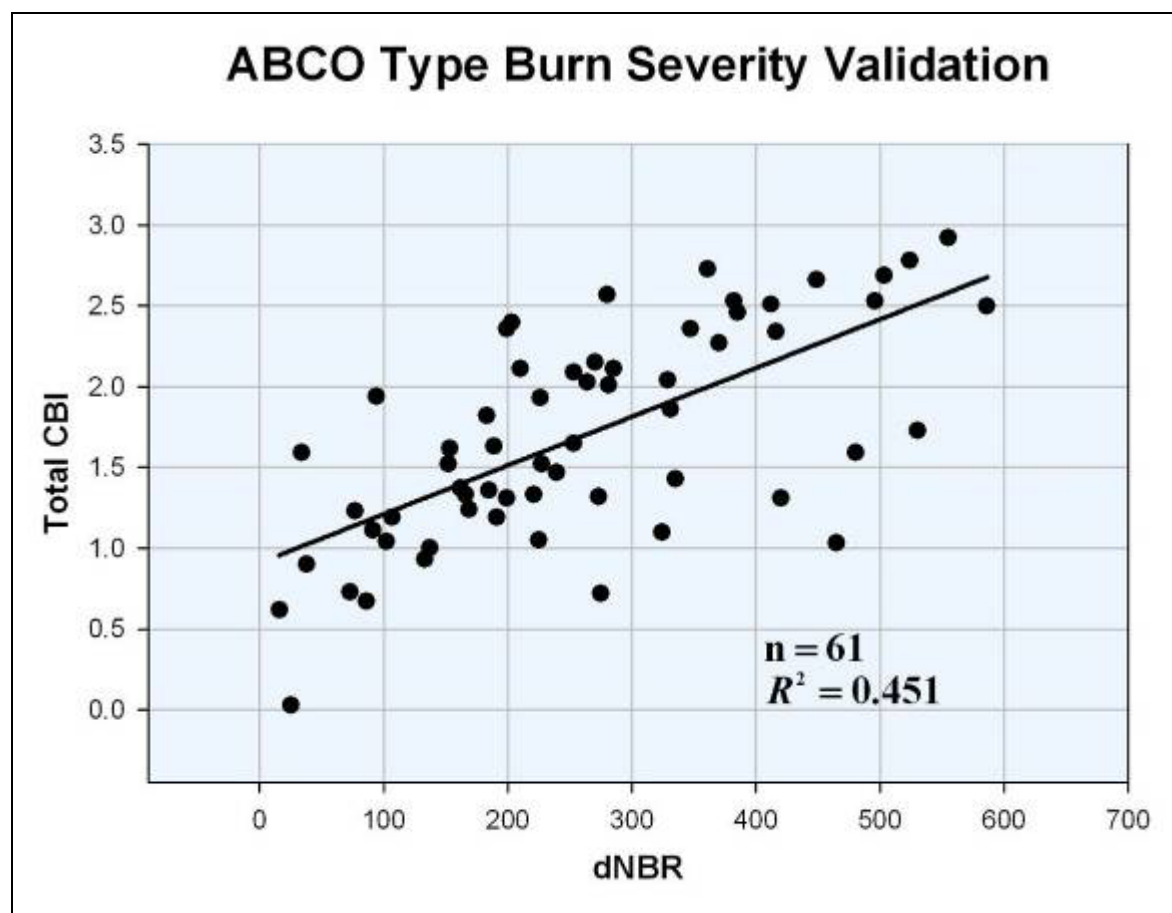


Figure 59. White fir (ABCO) dominated forests have a slight linear correlation between total plot CBI score and dNBR value.

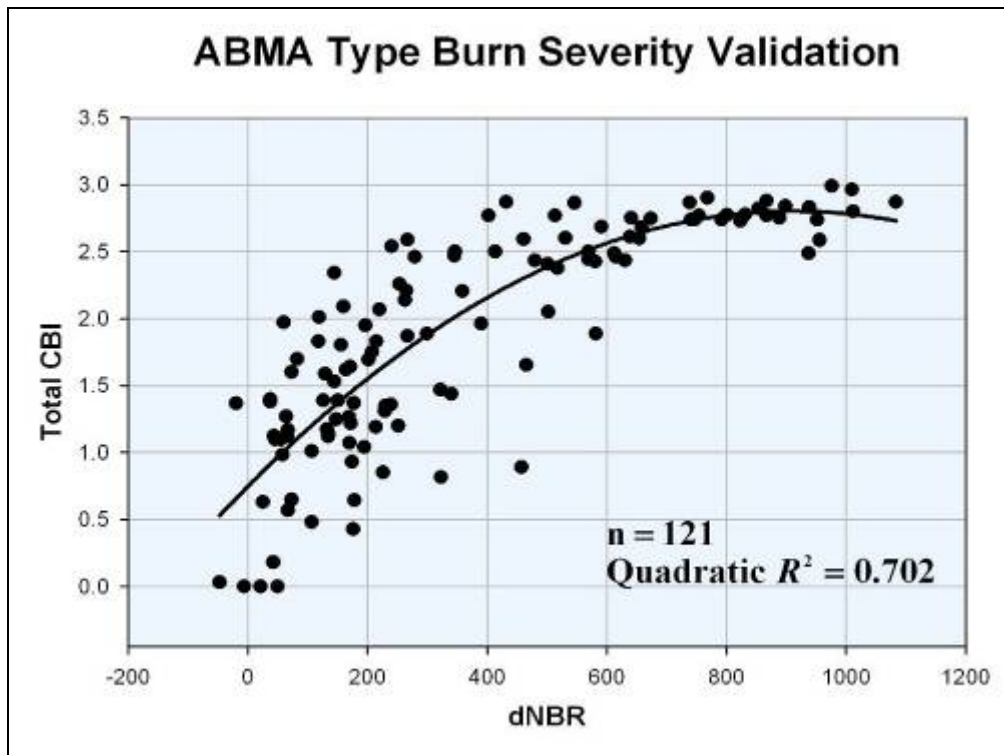


Figure 60. Red fir (ABMA) dominated forests have a moderate correlation between total plot CBI score and dNBR value.

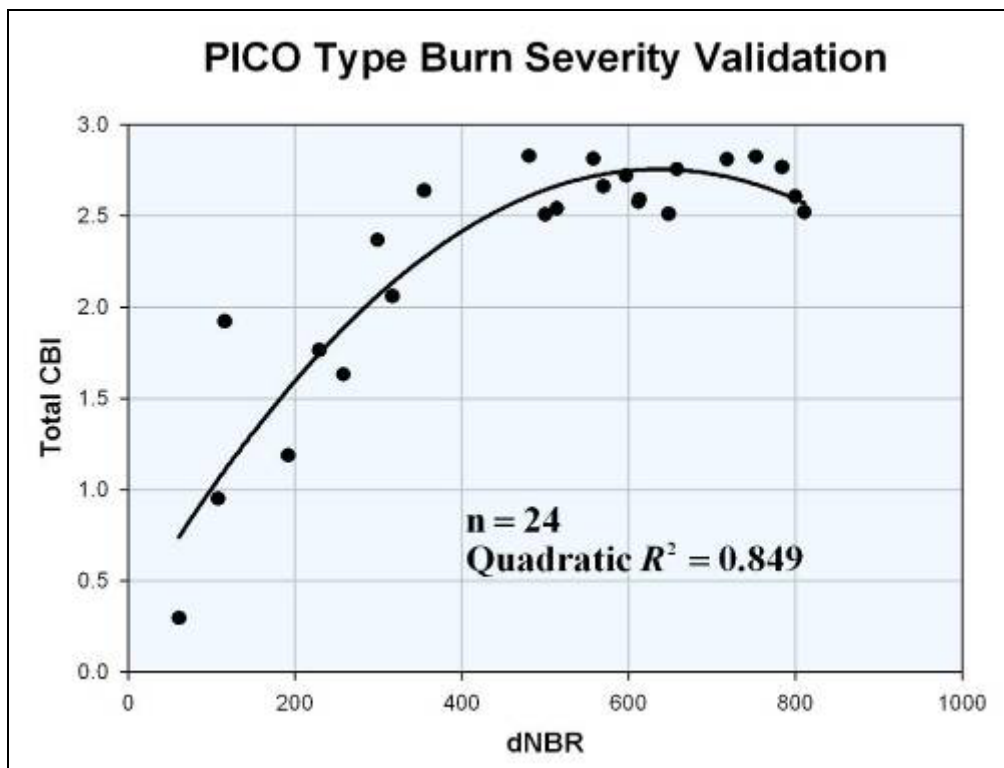


Figure 61. Lodgepole pine (PICO) dominated forests have a strong correlation between total plot CBI score and dNBR value.

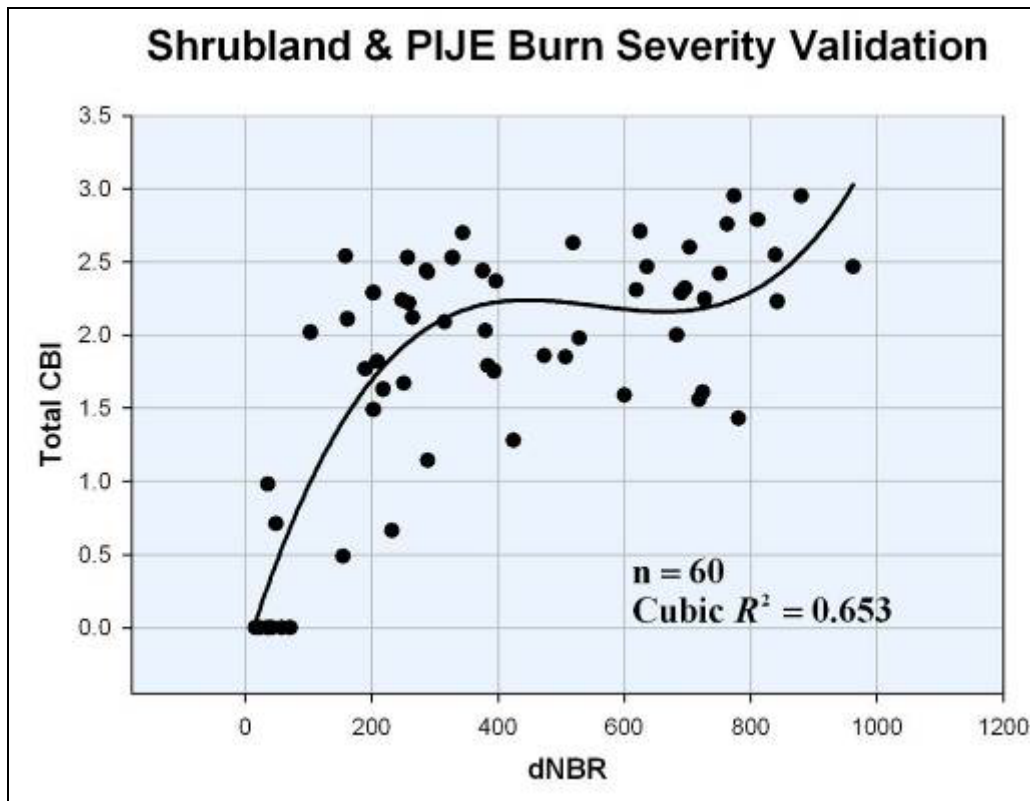


Figure 62. There is not a strong correlation between total plot CBI score and dNBR value in open areas dominated by shrubs, conifer reproduction, and/or Jeffrey pines (PIJE).

The majority of CBI plots have been established in areas dominated by red fir forest. There is a good correlation between total plot CBI score and dNBR values in our upper elevation forest types, represented here by red fir and lodgepole pine dominated forests. Poor correlation appears in our lower elevation forests (white-fir dominated) and open areas dominated by shrubland, conifer reproduction, and Jeffrey pine woodland. As CBI data are collected, this assessment will continue and hopefully contribute to future threshold adjustment.

5. Yosemite Valley Exotics Study

A study was implemented in 2002 to study whether mechanical thinning and pile burning increased the frequency of exotic plant species in the inner WUI (Wildland Urban Interface) of Yosemite Valley (for more information see 2002 Fire Ecology Annual Report). A nested frequency design was used to measure exotic plants. 17 plots were installed around residential areas northeast of Yosemite Village, the Ahwahnee Hotel, and the DNC stables in two different vegetation types: oak woodland and lower mixed conifer forest. Plots were sampled pre-treatment (PRE - 2002), immediately after pile burning (POST - 2002), and one (YR01 - 2003) and three years (YR03 - 2005) after thinning and pile burning treatments.

The methodology for this study includes directions to manually remove any exotic plants encountered while performing field work. This was beneficial in that it helped with exotic plant control in the thinned and pile burned areas. However, this effort also confounded efforts to detect how the treatments affected exotic plant frequency. In light of this, data presented here

represent trends in exotic plant frequency after mechanical thinning and pile burning treatments when some manual exotic plant removal has occurred.

Table 1 displays how exotic plant species and life forms responded to thinning and pile burning treatments. Nested frequency values for individual species are out of a possible score of 4.

Table 1. Exotic plant frequency over time in the Valley Exotics plots.

Exotic Plant Species	PRE (2002)	YR01 (2003)	YR03 (2005)
<i>Agrostis gigantea</i> (redtop)	0	0.824	0.647
<i>Bromus diandrus</i> (ripgut brome)	0.353	0.529	0.647
<i>Bromus madritensis</i> ssp. <i>rubens</i> (red brome)	0.235	0.294	0
<i>Bromus tectorum</i> (cheat grass)	1.882	1.059	1.000
<i>Cirsium vulgare</i> (bull thistle)	0	0.588	0.588
<i>Holcus lanatus</i> (velvet grass)	0.235	0.412	0.706
<i>Hypericum perforatum</i> (Klamathweed)	0	0	0.235
<i>Oxalis corniculata</i> (wood sorrel)	0	0.471	0.706
<i>Poa bulbosa</i> (bulbous bluegrass)	0	0.118	0.176
<i>Rumex acetosella</i> (sheep sorrel)	0.294	0.353	0.412
<i>Rubus discolor</i> (Himalayan blackberry)	0.235	0.353	0.176
<i>Rudbeckia hirta</i> (black-eyed Susan)	0	0	0.471
<i>Sonchus asper</i> ssp. <i>asper</i> (prickly sow thistle)	0	0	0.353
<i>Stellaria media</i> (chickweed)	0.118	0.176	0.471
<i>Tragopogon dubius</i> (yellow salsify)	0	0	0.118
<i>Verbascum blattaria</i> (moth mullein)	0	0	0.235
<i>Verbascum thapsus</i> (wooly mullein)	0	0.235	0.118
<i>Vulpia myuros</i> var. <i>myuros</i> (foxtail fescue)	1.471	1.059	1.412
Annual grass	3.941	2.941	3.059

Exotic Plant Species	PRE (2002)	YR01 (2003)	YR03 (2005)
Perennial grass	0.235	1.354	1.529
Annual forb	0.118	0.176	0.942
Biennial/Perennial forb	0.529	2.000	2.941
Total Exotics	4.823	6.471	8.471

Exotic plant frequency steadily increased from PRE to YR03, despite the occasional manual removal of exotic plant species. Many studies have shown that disturbance favors invasive plant introduction and spread. Subsequent disturbance in areas with existing populations of invasive plants can make the invasion worse (Merriam et al. 2006). The inner WUI areas of Yosemite Valley experience high levels of visitation and foot traffic; and many invasive plant populations are already well-established in these areas. When conducting mechanical thinning and pile burning treatments in areas that contain invasive plants, work needs to be coordinated with the branch of Vegetation & Ecological Restoration so that necessary invasive plant eradication can occur post-treatment.

6. Sugar Pine/Fire Retardant Study

In 2003, retardant drop on the Tuolumne WFU/Suppression fire affected large sugar pines. A study was implemented to explore whether the retardant affected tree mortality and/or damage. This study targeted nine trees affected by fire and slurry, nine trees affected by slurry, and ten control trees. These trees were monitored immediately after the slurry drop, and one year and two years after the slurry drop. So far no mortality or damage has been detected. The trees will be revisited five years after the slurry drop next year (2008), mortality and damage will be recorded, and tree tags will be removed. Results will be reported in the 2008 Fire Ecology Annual Report.



Figure 63. Retardant drop on the 2003 Tuolumne WFU/Suppression Fire.

7. Sugar Pine (PILA) Mortality Mitigation Study

Sugar pines are declining throughout the Sierra Nevada due to multiple factors including infection with the exotic pathogen white pine blister rust (*Cronartium ribicola*) and fire suppression (van Mantgem 2004). Due to a management concern that prescribed burns were contributing to this decline, a study was implemented in 2004 to address mitigating sugar pine

mortality (for more information, see 2004 Fire Ecology Annual Report). Twenty eight plots were installed in the 2005 PW-03 burn unit; these plots were read preburn (PRE - 2004), immediately postburn (POST - 2005), one year postburn (YR01 - 2006), and two years postburn (YR02 - 2007). Sampling will continue through five years postburn (YR05 - 2010). Twelve control plots were installed in 2004 and have been sampled at the same schedule as the treated plots. To date, control plots have shown no sugar pine mortality. Each plot contains three mature sugar pines. Three treatments were randomly assigned to each of the three sugar pines within each plot: “control” tree (no treatment), “lined” tree (litter and duff removed around base of tree to mineral soil), and “cleared” tree (ladder fuels ≤ 6 ” DBH and heavy dead & down fuels removed from tree). Data were also collected on fuel loading and sugar pine regeneration.

A. *PILA Mortality*

As of two years postburn, plot data show a total sugar pine mortality of 11.9%, with 7.1% of that appearing in the control trees, and 2.4% in both the lined and cleared trees. It appears that mitigation treatments are somewhat effective in reducing sugar pine mortality. Notes from plot data indicate that many of the control trees that were killed by the prescribed fire had existing fire scars or damage (mistletoe, fungus). Notes also indicate that the “cleared” tree prescription was not sufficient; much larger ladder fuels needed to be removed to reduce the degree and extent of canopy scorching.

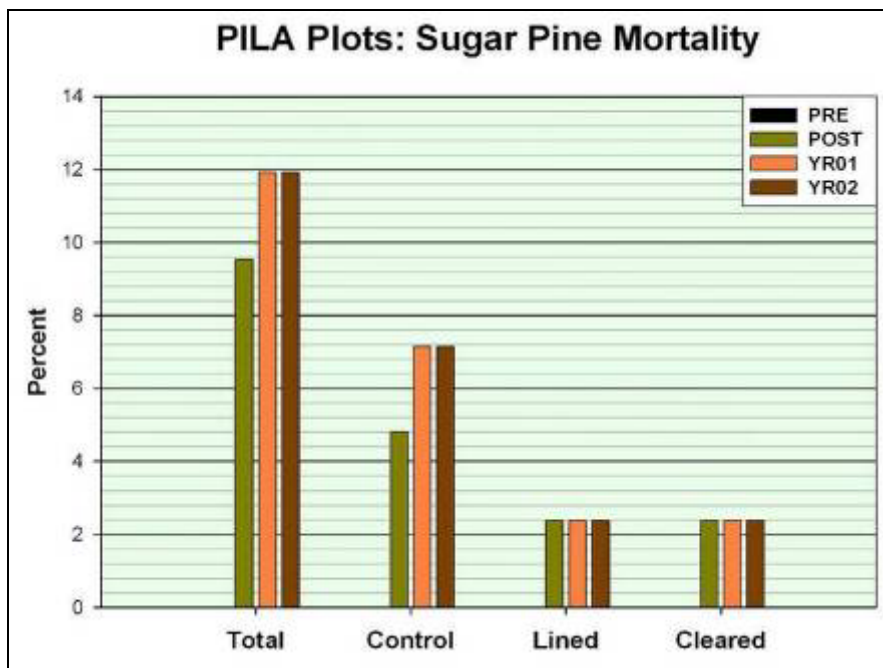


Figure 64. Sugar pine mortality over time by mitigation treatment.

B. Fuel Loading

The 2005 PW-03 prescribed burn was very effective at reducing dead & down fuel loads. Litter and duff depth was measured at the north side of each sampled sugar pine preburn, immediately postburn, and one year postburn. Preburn litter and duff depth was 6.60 inches (SE = 0.51); it was reduced by 98% to 0.14 inches (SE = 0.04) immediately postburn. Litter and duff loadings were reduced by 86% and 87%, respectively, from preburn to immediate postburn levels. High preburn fuel loadings add to concern about prescribed fire - induced sugar pine mortality.

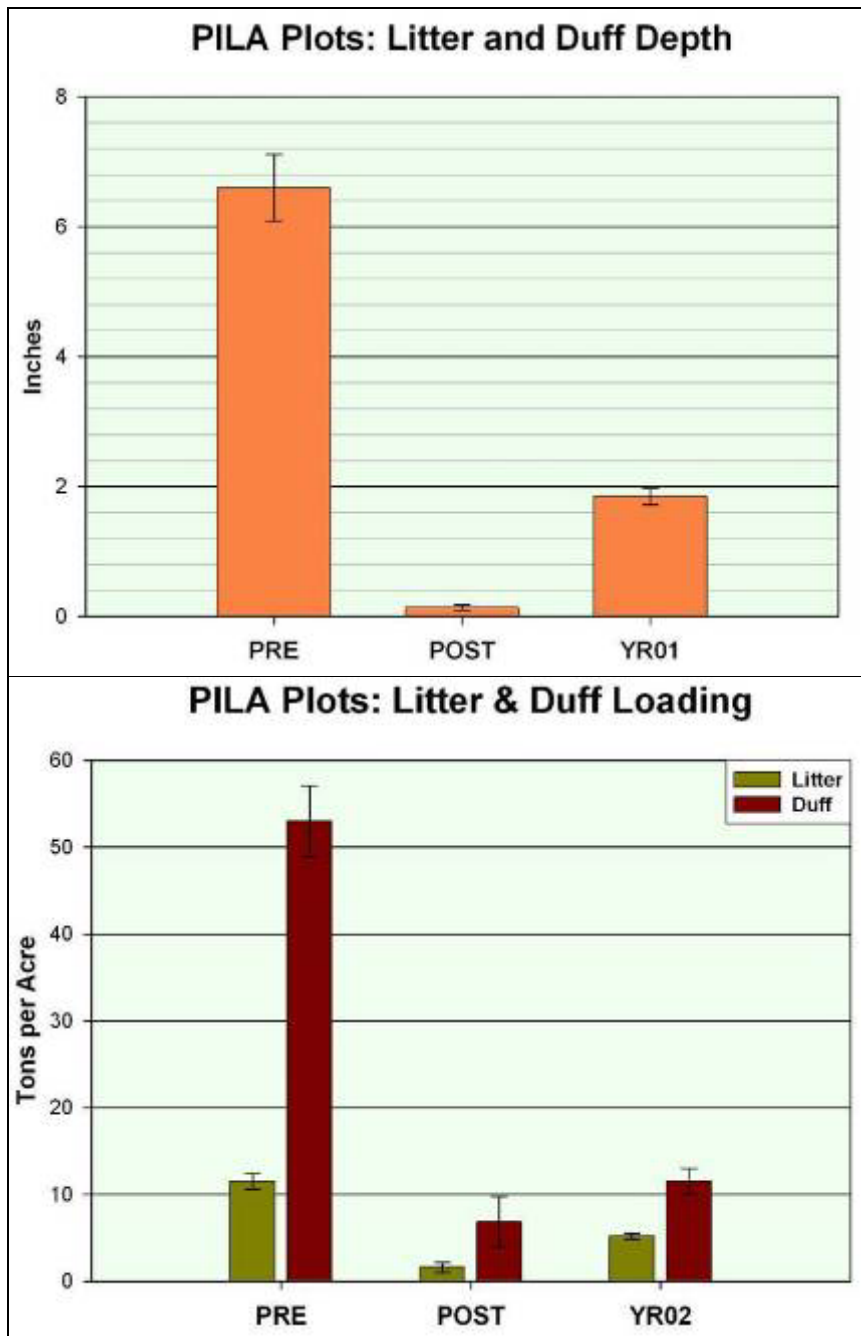


Figure 65. Litter and duff were substantially reduced in the PILA plots.

Rotten thousand hour fuel loading was reduced by the prescribed burn, but sound thousand hour fuels increased after the burn as trees were killed and/or partially consumed by the fire. Rotten thousand hour fuels decreased 76% from 42.5 tons/acre (SE = 12.6) preburn to 10.2 tons/acre (SE = 4.5) immediately postburn. Sound thousand hour fuels increased by 62% from 4.1 tons/acre (SE = 1.1) preburn to 6.6 tons/acre (SE = 4.2) immediately postburn. Total fuels experienced a 76% reduction from 128.2 tons/acre (SE = 13.9) preburn to 30.1 tons/acre (SE = 8.4) immediately postburn.

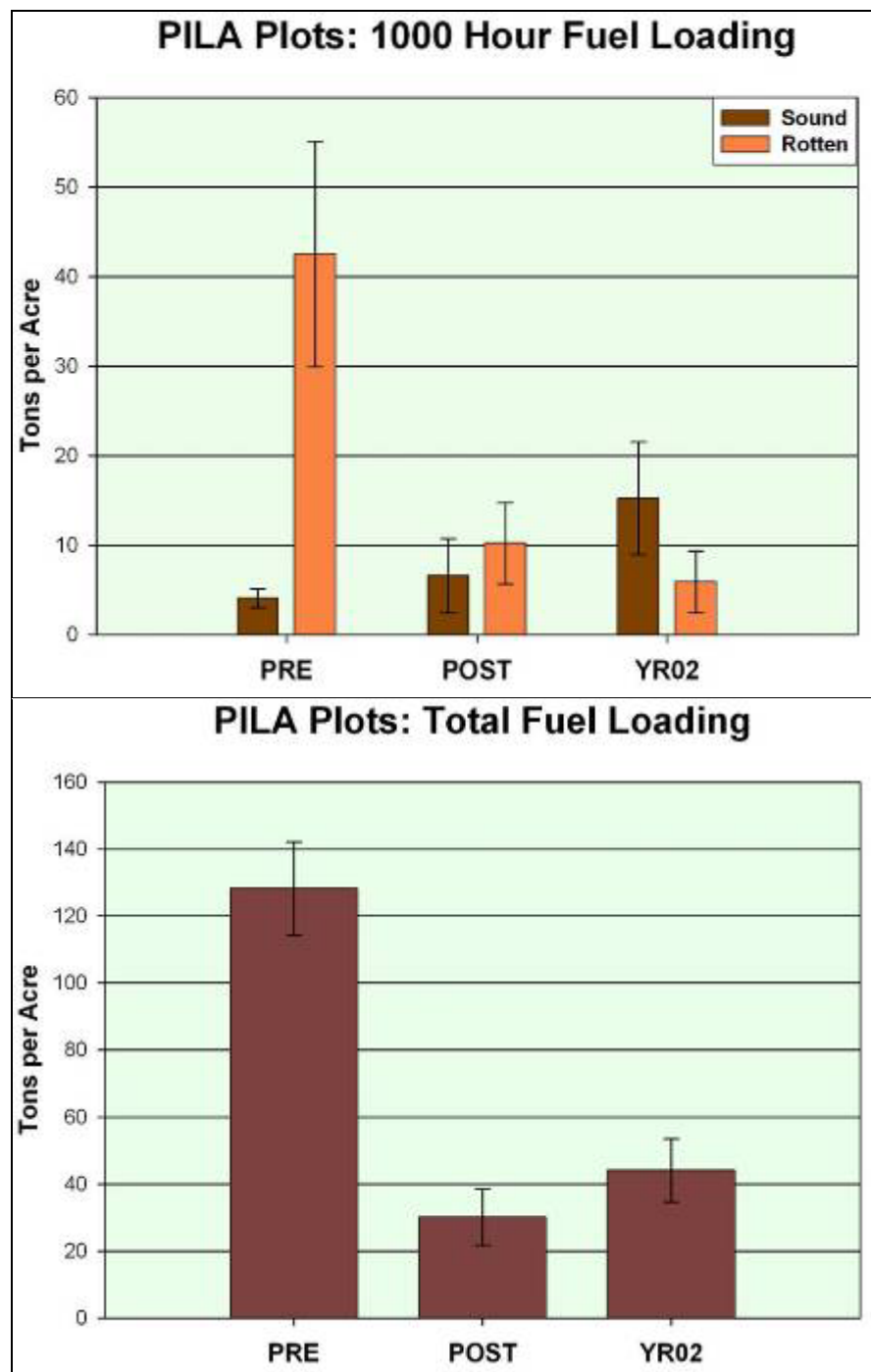


Figure 66. 1000 hour and total fuel loading in the PILA plots.

C. Height to Live Crown

The height to live crown (HTLC) was slightly increased in the sugar pine plots. Preburn HTLC was 15.7 meters (SE = 0.75); it increased by 10% to 17.3 meters (SE = 0.95) two years after the burn.

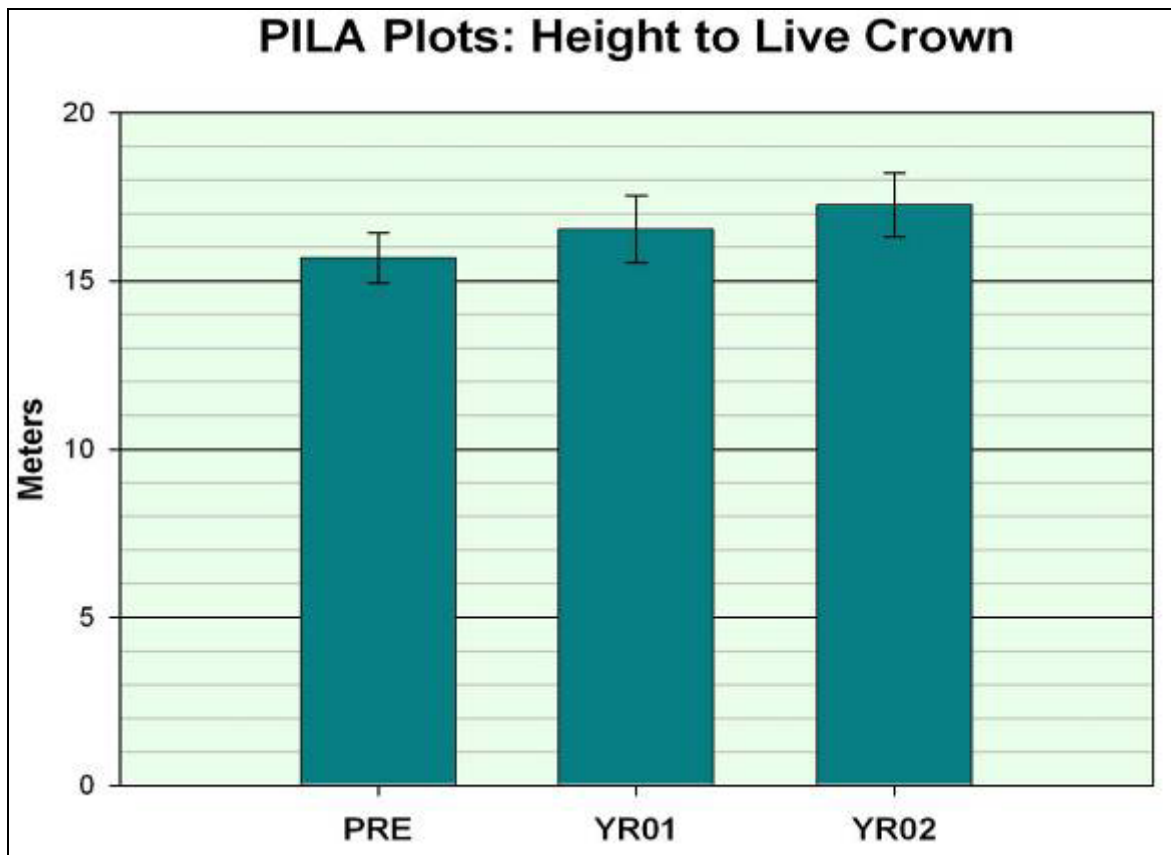


Figure 67. Height to live crown increased after the prescribed burn in the PILA plots.

D. PILA Regeneration

During the two year postburn sampling visit, many pine seedlings were too young to identify to the species level. Therefore, seedling data will be presented after the five year postburn data are collected. Seedling regeneration, however, is clearly dominated by White fir and Incense cedar. The existing Sugar and/or Ponderosa pine seedlings were generally found only in the few unburned areas on the ground, not in areas with soils exposed due to fire. Sugar pine sapling tree (< 6" DBH) densities were decreased by the prescribed burn 83% from preburn levels of 9.8 saplings/acre (SE = 3.89) to 1.6 saplings/acre (SE = 1.44) one year after the burn.

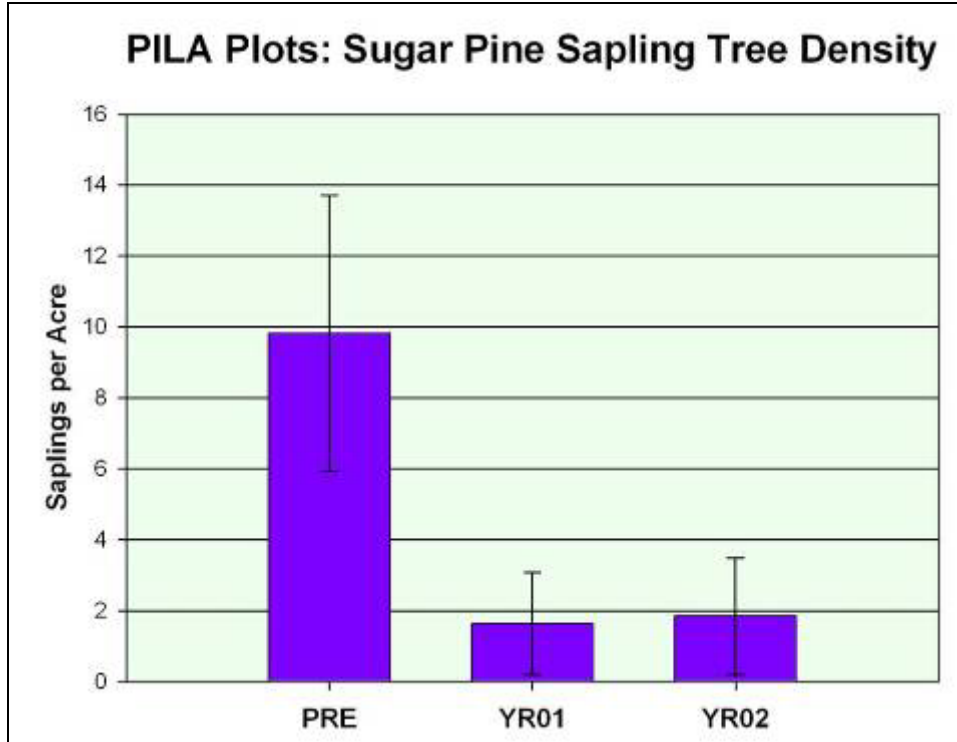


Figure 68. Sugar pine sapling density over time in the PILA plots.

Fire Effects Crew Accomplishments and Area of Focus

Table 2. Effects Crew Accomplishments/Focus Areas

Category	Percent Time	Notes
FMH plots	25%	29 Forest Plots, 16 Brush Plots, 1 new install
Mechanical Treatment plots	0%	No mechanical plots this year
CBI plots	10%	44 Plots in 2006 Frog Fire
PILA mortality study	15%	28 rereads/ 12 control
Other Plot work	10%	--15 Retro --Rapid assessment in WFU --pulled completed Valley Plots
Fire Assignments and Fuels Projects	15%	--Crew assisted on 7 prescribed fires as FEMO, FFT1 and FFT2 (~5 shifts) --Crew assisted on 6 WFU fires as FEMO, IC5, CRWB, FFT1 and FFT2 (~8 shifts) --4 crewmembers went on off park assignments with YNP WFU module or as single resource. (~16 shifts) --Crew assisted on off days as FFT2, not factored in Percent Time total
Data Entry	10%	--All FMH data from 2007 and majority of 2006 backlog entered into FEAT, Excel --Some of the backlog of Retro plots remain
Data Management and Information Technology	5%	--Quality checking --Problem solving FEAT networking, access, functionality, etc.
Supervision/Admin	5%	--Travel --Payroll --Meetings (Fire Staff and parkwide)
Training & Professional Development	5%	--All crewmembers attended refresher training --Intro to fire effects monitoring, plant i.d., data collection/entry --Jepson herbarium workshops (Mimulus/Poaceae) --Yosemite Forum --S-290 Int Wildland Fire, S-231 Crew Boss, B-3 Aviation Safety
Miscellaneous	5%	--Poster presentation for Fire Ecology Congress --Presentations for visiting elementary, high school and college groups --VIP walk through presentations in RX burns --Cross-training --Required online federal trainings

Workload and Staffing

Table 3. 2007 Fire Ecology Staffing

Staff Member	Starting Date	Ending Date	# of Pay Periods	Training and Development
Jen Hooke	1/01/07; 4/01/07	2/04/07; 10/13/07	16	NPS Certified Structural Firefighter; S271
Isaiah Hirschfield	3/04/07	12/22/07	21	S230/231 Crew Boss training, taskbook init, tasks completed; READ; Jepson (<i>Poaceae</i>);
Ilana Abrahamson	4/01/07	7/21/07	8	READ; Jepson (<i>Mimulus</i>); B-3
Kristen Shive	5/20/07	12/8/07	14.5	Jepson (<i>Poaceae</i>); Jepson (<i>Mimulus</i>); S-290; FEMO initiated; Moonlight Fire ARCH/READ, Poomacha Fire ARCH; B-3
Ann Calhoun	6/10/07	11/24/07	12	Intro to Fire Effects Monitoring; Plant ID Data Collection/Entry; FEMO initiated, tasks completed; FFT1 tasks completed; FFT2 Ranch/Harris Fires; B-3
Travis Espinoza	6/10/07	12/8/07	13	Intro to Fire Effects Monitoring; Plant ID Data Collection/Entry; FFT2 Rattlesnake Fire; B-3
Aaron Rinehart	5/13/07	11/24/07	14	Intro to Fire Effects Monitoring; Plant ID Data Collection/Entry; S290; FEMO initiated, tasks completed; FFT2 Ranch/Harris Fires; B-3

B-3 - Annual Aviation Safety Refresher, READ – Resource Advisor, FEMO – NWCG Fire Effects Monitor, S-290 - NWCG Intermediate Wildland Firefighting



Figure 69. Aaron Rinehart in PW-3 near Tuolumne Grove counting seedlings (all are white fire and incense cedar, unfortunately).

Table 4. Fire Effects Monitoring Crew plot workload

Treatment Unit & Geographical Area	Treatment Type	Monitoring Type	Type of Plot	# Years Post-Treatment (1-20 yrs)	Total Plots Read in 2006
Soupbowl – Wawona	Prescribed Fire	FPIPO1T02	FMH	2	5
Studhorse – Wawona	Prescribed Fire	FPIPO1T02	FMH	5	6
PW-4 – Hodgdon	Prescribed Fire	FPIPO1T09	FMH	2	1
PW-4 – Hodgdon	Prescribed Fire	FPIPL1T09	FMH	Install	1
Leidig Meadow –Yose Valley	Prescribed Fire	BAGAL1D01	FMH	14	5
Leidig Meadow – Yose Valley	Prescribed Fire	BAGAL1D01	FMH	Imm. Post	5
Sentinel Meadow – Yose Valley	Prescribed Fire	BAGAL1D01	FMH	14	3
Sentinel Meadow – Yose Valley	Prescribed Fire	BAGAL1D01	FMH	Imm. Post	3
MG-9 – Mariposa Grove	Prescribed Fire	FABCO1T08	FMH	10	3
PW-5 – Crane Flat	Prescribed Fire	FABCO1T08	FMH	1	2
PW-3 – YI/Aspen Valley Trail	Prescribed Fire	FABCO1T08	FMH	5	7
PW-3 – Tuolumne Grove	Prescribed Fire	FABCO1T08	FMH	2	2
PW-3 – Tamarack Cmpgrnd Rd	Prescribed Fire	FABMA1T08	FMH	2	2
YV-17 – Yosemite West	Prescribed Fire	FABCO1T08	FMH	2	1
MG-2 – Mariposa Grove	Prescribed Fire	-	Retro	1	15
PW-3 – Tuolumne Grove	Prescribed Fire	-	PILA Burn	2	28
Aspen Valley/Crane Flat Cmpgrnd	Prescribed Fire	-	PILA Control	2	12
Frog Fire	Wildfire	-	Rapid Assessment	1	7
Frog Fire	Wildfire	-	CBI	1	44

Total Plot Reads: 153

FEAT Notes

Using FEAT this year was relatively straightforward. Now that we are familiar with its quirks and limitations, data entry was fairly standard. As always, we had to problem-solve permissions and network-related issues throughout the field season to get FEAT to perform on all office computers. We once again found that the extra training, data and equipment management issues with using FEAT on hand-held PDA's did not justify using them regularly, particularly because the bulk of our crew was new to fire effects this year. In theory their use makes sense, but for our workload and workflow it makes more sense to frontload our availability in the field and do the bulk of data entry in the office when the field season ends.

Managing Unknown Plants

Much effort has been made in the last five to six years to better track unknown plants on monitoring plots. All unknowns from pre-2002 data were accounted for, given generic codes and entered into FEAT. Newer protocols created around 2004 required more extensive descriptions of unknown plants and the establishment of unique codes for each unknown plant. In terms of data analysis, fire ecologist Jen Hooke recommended the program begin using generic codes, created at the genus and family level as needed. At the end of the 2007 season, generic codes were created for all existing unknown plants and changed in FEAT. All of the associated plot folders previous to those read during the 2007 field season need to be updated to reflect these changes. Under these new protocols, an unknown plant will still be described in detail in the field, and this description will be included in the corresponding plot folder. The only difference is that it will receive a generic code rather than a unique one. In addition, it is crucial to record the annual/perennial and native/exotic status of a plant when known, and this information should be recorded and attached to any new generic codes entered into FEAT.

Equipment Notes

The only significant change in equipment this year was the purchase of two new GPS units. We bought the Garmin 60csx. The improved satellite reception with those units actually made a *huge* difference. They got good reception even in our worst conditions – steep areas with high canopy cover – allowing us to create or double check and navigate to coordinates more accurately. We will still continue to create narrative directions that don't rely on GPS but these things are great!

Yosemite officially adopted the standard use of the NAD 83 datum for storing GIS data. Previously, the informal standard had been NAD 27. The shift has created some conflicts when using GIS data. Special attention had to and will need to be paid to the datum of original source material, the datum set in field GPS units, and the datum set to project GIS documents. Yosemite Aviation currently uses the WGS 84 datum which generates coordinates that are nearly the same as those in NAD 83, thereby eliminating potential errors in communicating fire locations and operational information.

Proposed Changes for 2008 Field Season

The field season generally went very smoothly this year. Delays in posting our seasonal job announcements and the inefficiency of our physical and drug testing requirements had a ripple effect in hiring. We started two seasonals in mid June who therefore missed fire season orientation and the opportunity to take S-290 training. We hope once again to have our jobs announced earlier this year to avoid the same problem in 2008.

Field planning worked well as far as reading plots when they were in peak phenology, despite the early spring this year. The one exception was our visit to the Frog Fire to do YR01 rapid assessment plots where plant ID was impossible on many dried specimens.

Logistics for this year's Frog Fire CBI was a pain. We had to accommodate a few more personal and work scheduling conflicts than usual and kept pushing back the site visit. We just beat the rain and we got our equipment boated out of Lake Eleanor the last day the boat was staffed. If possible set (as firm as possible) dates early in the season to try and avoid scheduling conflicts and to try and get commitments for help from other folks. Also, funding for CBI and any post-incident fire monitoring needs to be included in budgeting while the incident is still active.

Yosemite Valley monitoring needs restructuring in consultation with Resource Management to more effectively monitor fire effects, particularly regarding exotic species monitoring.

Appendix Notes

The newly-revised monitoring type description sheet for Ponderosa and/or Sugar Pine Mixed Conifer Forest is attached.

Document Notes

Document Name: Yosemite Fire Ecology Annual Report 2007

Document Network Locations;

Protection Division Server

\\Inpyosems22\users\Prot\!Fire\FIRE ECOLOGY\Annual Reports\2007 annual report

Resource Management Server \\inpyosems6.nps.doi.net\common\Resource Advisor Kit\Fire Ecology Report\2007 annual report

Authors: Jen Hooke, Isaiah Hirschfield, Kristen Shive

Date Completed: 12/17/07

Literature Cited

Agee, J.K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Washington, D.C., USA.

Key, C.H. and N.C. Benson. 2006. Landscape Assessment (LA): Sampling and Analysis Methods. USDA Forest Service General Technical Report RMRS-GTR-164-CD.

McCune, B. and J.B. Grace. 2002. Analysis of Ecological Communities. MjM Software Design, Gleneden Beach, Oregon, USA.

Merriam, K.E., J.E. Keeley, and J.L. Beyers. 2006. Fuel breaks affect nonnative species abundance in Californian plant communities. *Ecological Applications* 16: 515 – 527.

Monitoring Trends in Burn Severity Project Methods website:

<http://fsgeodata.fs.fed.us/mtbs/methods.html>

NPS-USGS Burn Severity Mapping Project website:

http://burnseverity.cr.usgs.gov/fire_main.asp

van Mantgem, P.J., N.L. Stephenson, M. Keifer, and J. Keeley. 2004. Effects of an introduced pathogen and fire exclusion on the demography of sugar pine. *Ecological Applications* 14: 1590 – 1602.

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

van Wagtendonk, J.W., J.M. Benedict, and W.M. Sydoriak. 1998. Fuel bed characteristics of Sierra Nevada conifers. *Western Journal of Applied Forestry* 13: 73 – 84.

van Wagtendonk, J.W. and J. Fites-Kaufman. 2006. Sierra Nevada Bioregion. Pp. 264 – 294 in N.G. Sugihara et al., eds., *Fire in California Ecosystems*. University of California Press, Berkeley, California, USA.

Zar, J.H. 1999. *Biostatistical Analysis: Fourth Edition*. Prentice Hall, Upper Saddle River, New Jersey, USA.

FMH-4 Monitoring Type Description Sheet

Yosemite National Park

Monitoring Type code: FPIPL1T09

Monitoring Type name: Ponderosa Pine and/or Sugar Pine Mixed Conifer Forest

Prepared by: Hooke

Date: 5/31/07

PHYSICAL DESCRIPTION

Located at 3000-6000 feet elevation on all aspects with slopes ranging from 0 –60%. Soils are generally xeric, coarse textured and acidic with depths ranging from shallow to very deep (especially those above bedrock joints). Parent material is typically granitic and is derived from colluvium and till. The deepest colluvium occurs in areas of ancient landslides, which formed in northwest to southeast deposits in the southwestern portion of the park.

BIOLOGICAL DESCRIPTION

Ponderosa pine (*Pinus ponderosa*) and/or sugar pine (*Pinus lambertiana*) dominate the overstory (> 30% of overstory) with components of white fir (*Abies concolor*), canyon live oak (*Quercus chrysolepis*), black oak (*Quercus kelloggii*) and incense cedar (*Calocedrus decurrens*) in both the overstory and understory. Shrubs such as whitethorn (*Ceanothus cordulatus*), deer brush (*Ceanothus integerrimus*), wild rose (*Rosa* sp.), and manzanita (*Arctostaphylos* sp.) comprise < 35 % cover. Herbaceous cover is sparse to moderate and may include sedges (*Carex* sp.), violets (*Viola* sp.), spring beauty (*Claytonia* sp.) and bedstraw (*Galium* sp.).

REJECTION CRITERIA

Large rocky outcroppings or barren areas > 20% of plot area; areas with anomalous vegetation; areas with < 30% ponderosa or sugar pine overstory tree cover; areas with > 20% bear clover (*Chamaebatia foliolosa*) cover; areas within 50 m of roads, trails, firelines, monitoring type boundaries, riparian areas, human-created clearings and slash piles and areas within 20 m of significant historic or prehistoric sites.

TARGET CONDITIONS

1. Achieve the following fuel loading mosaic:
 - 5-30 tons/acre across 20-40% of monitoring type
 - 30-60 tons/acre across 20-50% of monitoring type
 - > 60 tons/acre across 5-20% of monitoring type
2. Achieve the following tree density and compositional targets:
 - 4-91 trees/acre < 31.5" DBH

- 4-30 trees/acre > 31.5" DBH
- 60-95% pine, 15-40% cedar, 1-10% oak

3. Limit mortality of mature sugar pine (DBH > 50 cm) to < 20%

BURN PRESCRIPTION

Units will be burned spring to fall using heading, flanking and backing fire as needed to meet burn objectives. Initial burn will be followed by a series of maintenance burns conducted at intervals designed to maintain primary variables of interest within specified target condition ranges.

Burn Prescription Elements	
RH = 20—65%	1-hour TLFM = 4—10%
Dry Bulb = 40—85 °F	10-hour TLFM = 6—16%
Average mid-flame wind speed = 0—6 mph	100-hour TLFM = 7—20%
Average rate of spread = 1.9—2.3 ch/hr	Live fuel moisture = 65—170%

MONITORING VARIABLES

1. Total fuel load
2. Tree density
3. Overstory tree composition
4. Sugar pine mortality (measured beginning 01YR05)

FIRE MONITORING OBJECTIVES

1. Install enough plots to sample total fuel load with 80% confidence that totals are within 25% of true population mean.
2. Install enough plots to sample pole-size and overstory tree density with 80% confidence that totals are within 25% of the true population mean.

Note: Do not collect density data on clonal species such as bear clover.

PLOT PROTOCOLS FOR FPIPO1T09

GENERAL PROTOCOLS		YES (X)	NO (X)		YES (X)	NO (X)
Preburn	Control Plots/Opt		X	Herb Height/Rec	X	
	Herbaceous Density/Opt		X	Abbreviated Tags	X	
	OP/Origin Buried		X	Crown Intercept/Opt		X
	Voucher Specimens/Rec	X		Herb Fuel Load/Opt		X
	Stereo Photography/Opt		X	Brush Individuals/Rec	X	
	Belt Transect Width	2 x 50 m		Stakes installed: All		
	Number of belts recorded	2				
	Herbaceous Data and Brush Data Collected at: Q4-Q1 and Q3-Q2					
Burn and Postburn	Duff moisture/Rec		X	Flame zone depth/Red	X	
	Herbaceous Data/Opt		X	Herb Fuel Load/Opt	X	
	100 pt burn severity/Opt	X				

Forest Plot Protocols		YES (X)	NO (X)		YES (X)	NO (X)
Overstory	Area sampled:	50 x 20 m		Quarters sampled	Q1, Q2, Q3, Q4	
	Tree damage/Rec	X		Crown Position/Rec	X	
	Dead Tree Damage/Opt		X	Dead crown Position/Opt	X	
Pole-size	Area Sampled	25 x 10 m		Quarters sampled	Q1	
	Height/Rec	X		Poles Tagged/Rec	X	
Seedling	Area Sampled meters	10 x 5		Quarters sampled	subset of Q1	
	Height/Rec	X		Seedlings mapped/Opt	X	
Fuel Load	Sampling Plane Length	50 feet		Fuel Continuity/Opt		X
	Aerial Fuel Load/Opt		X			
Postburn	Char Height/Rec	X		Mortality/Rec	X	

Rec = Recommended Opt = Optional