Effectiveness and longevity of fuel treatments in coniferous forests across California

Managers' Report: Tahoe National Forest

Prepared by

Nicole Vaillant, Fire Ecologist, nvaillant@fs.fed.us, USDA Forest Service, Western Wildland Environmental Threat Assessment Center

Erin Noonan-Wright, Fire Application Specialist, enoonan02@fs.fed.us, USDA Forest Service, Wildland Fire Management Research Development and Applications

Scott Dailey, Fire Ecologist, scottdailey@fs.fed.us, USDA Forest Service, Adaptive Management Services Enterprise Team

Carol Ewell, Fire Ecologist, cewell@fs.fed.us, USDA Forest Service, Adaptive Management Services Enterprise Team

Alicia Reiner, Fire Ecologist, alreiner@fs.fed.us, USDA Forest Service, Adaptive Management Services Enterprise Team

Kevin McCrummen, Biological Science Technician, kmcrummen@fs.fed.us, USDA Forest Service, Adaptive Management Services Enterprise Team

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Integrating science, technology and fire management.

Wildland Fire Management RD&A

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Background

Longevity of fuel treatment effectiveness to alter potential fire behavior is a critical question for managers preparing plans for fuel hazard reduction, prescribed burning, fire management, forest thinning, and other land management activities. Results from this study will help to reduce uncertainty associated with plan prioritization and maintenance activities. From 2001 to 2006, permanent plots were established in areas planned for hazardous fuel reduction treatments across 14 National Forests in California. Treatments included prescribed fire and mechanical methods (i.e., thinning of various sizes and intensities followed by a surface fuel treatment). After treatment, plots were re-measured at various intervals up to 10 years post-treatment. Very few empirically based studies exist with data beyond the first couple of years past treatment, and none span the breadth of California's coniferous forests. With the data gathered, this research aimed to meet three main objectives:

Objective 1) *Determine the length of time that fuel treatments are effective at maintaining goals of reduced fire behavior, by*

a) measuring effects of treatments on canopy characteristics and surface fuel loads over time, and
b) modeling potential fire behavior with custom fuel models.

Objective 2) *Quantify the uncertainty associated with the use of standard and custom fuel models.*

Objective 3) *Assess prescribed fire effects on carbon stocks and validate modeled outputs.*

This managers' report is meant to compliment the final report to the Joint Fire Science Program and supply project specific information that is not included in the regional assessment. This report includes a summary of Key Findings and Management Implications from the regional study as well as individual Forest-level information for each plot (i.e., Project history, map, navigation directions, plot level findings, and plot protocol). For your use, we included a number of supplementary files with the digital version of this report. Included on the thumb drive are the following also described in Appendix A:

- Final report to the JFSP
- FVS Input database for your Forest for all projects (database file)
- Photo pairs for the plots on your Forest (power point file)
- Plot maps for each project on your Forest (pdf file)
- GIS shapefile with the plots on your Forest

All datasets for the regional project were input into the FFI (Feat/FIREMON Integrated) tool (www.frames.gov/partner-sites/ffi/ffi-home/) for future use and comparisons. Please contact Nicole Vaillant (nvaillant@fs.fed.us) for more information on obtaining the FFI data or other questions.

Key Findings

Objective 1- Determine the length of time that fuel treatments are effective at maintaining goals of reduced fire behavior, by measuring effects of treatments on canopy characteristics and surface fuel loads over time, and modeling potential fire behavior with custom fuel models.

Results have shown initial reductions in surface fuels from fire treatments recover to pre-treatment levels by 10 yr post-treatment. Mechanical treatments continue to have variable effects on surface fuels. With the exception of mechanical treatments in red fir, both treatment types resulted in increased live understory vegetation by 8 yr post-treatment relative to pre-treatment. Mechanical treatment effects on stand structure remains fairly consistent through 8 yr post. Fire-induced delayed mortality contributes to slight decreases in canopy cover and canopy bulk density over time. For both treatment types, overall canopy base height decreases in later years due to in-growth of smaller trees, but it remains higher than pre-treatment. The changes in fuel loads and stand structure are reflected in fire behavior simulations via custom fuel modeling. Surface fire flame lengths were initially reduced as a result of prescribed fire, but by 10 yr post-treatment they exceeded the pre-treatment lengths. Though a low proportion of fire type, initial reductions in potential crown fire returned to pre-treatment levels by 8 yr post-treatment; passive crown fire remained reduced relative to pre-treatment for the duration. Mechanical treatments showed variable and minimal effects on surface fire flame length over time; however the incidence of active crown fire was nearly halved from this treatment for the duration.

Objective 2- Quantify the uncertainty associated with the use of standard and custom fuel models

The Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS) was used to model potential fire behavior for plots treated with prescribed fire to determine the differences in modeled fire behavior using standard and custom fuel models. In general predicted fire behavior from custom versus standard fuel models were similar with mean surface fire flame lengths slightly higher using standard fuel models for all time steps until the 8 yr post-treatment. Similarly, custom fuel models predicted a higher instance of surface fire than standard fuel models with the exception of 8 yr post-treatment.

Objective 3- Assess prescribed fire effects on carbon stocks and validate modeled outputs.

To better understand the impact of prescribed fire on carbon stocks, we estimated aboveground and belowground (roots) carbon stocks using field measurement in FFE-FVS, and simulated wildfire emissions, before treatment and up to 8 yr post-prescribed fire. Prescribed fire treatments reduced total stand carbon by 13%, with the largest reduction in the forest floor (litter and duff) pool and the smallest reduction in the live tree pool. Combined carbon recovery and reduced wildfire emissions allowed the initial carbon source from simulated wildfire emissions and treatment to become a sink by 8 yr post-treatment relative to pre-treatment if both were to burn in a wildfire. In a comparison of field-derived versus FFE-FVS simulated carbon stocks, the total stand, tree, and belowground live carbon pools are highly correlated. However, the variability within the other carbon pools compared was high (up to 212%).

Management Implications

- ✓ Need more long term monitoring.
- ✓ The ability of a fuel treatment to maintain effectiveness in reducing fire behavior and effects depends on the accumulation rates and distribution of fuels, which are used as metrics to judge treatment longevity. Surface and understory fuel loading trends help inform managers' initial treatment and maintenance timelines, priorities, and adaptive management prescriptions.
- ✓ Stand and canopy structure trends help inform both fuel and silviculture integrated objectives and prioritizations.
- ✓ Despite extensive variability between plots, overall trends for treatment-forest combinations exist.
- ✓ Changes to modeled surface fire after prescribed fire treatment included an initial decrease in surface fire flame lengths, then an increase starting around 5 yr post-treatment.
- ✓ Overall, modeled fire behavior in mechanical treatments showed that goals of reduced fire behavior were initially reached, and then began diminishing around 5 to 8 yr post-treatment, with some positive changes still apparent through 8 yr post-treatment.
- ✓ In general, predicted fire behavior from custom versus standard fuel models was similar.
- ✓ Prescribed fire treatments reduced total stand carbon by about 13%, and total stand carbon stocks returned to 97% of pre-treatment levels after 8 yr post-treatment.
- ✓ Although the total stand carbon differences between field-derived and simulated carbon stocks are minimal, the variability within different carbon was great.

Project Websites

Please visit our project website in the next few months to year as reports are finalized and publications become available at http://www.fs.fed.us/adaptivemanagement/pub_reports/JFS_vaillant2.shtml.

The final report and many of our presentations and other deliverables will also be available via the Joint Fire Science Program website at http://www.firescience.gov/JFSP_advanced_search_results_detail.cfm?jdbid=%24%26Z%2F8W%20%20%20%0A.

Acknowledgements

We acknowledge funding for this research from the USFS Region 5 Fire Aviation and Management and Joint Fire Sciences program (JFS 09-01-1-01). This project would have never gotten off the ground without the passion and drive of Jo Ann Fites-Kaufman. We thank the countless number of field crew members over the past 12 years, especially T. Decker and K. McCrummen for serving as crew leads during the past four years. Thank you to all the fire and fuels specialists on all the National Forests in California for providing invaluable insight and information about their fuel treatments.

Borda (Project 59, Sierraville District)

Project history

The Borda project had six plots set up pre-treatment using two different plot styles (detailed and fuels 2003). In 2012 plot 2 changed to detailed style plot, leaving only Plot 4 a fuels style plot. For details about the protocol used, please see "Appendix B: Sampling Protocol" at the end of the report. Plot 1 was not treated and was no longer continued in the study. Plots were sampled prior to treatment (P00), then 1 yr post (P01), 2 yr post (P02), and 5 yr-post (P05)(Table 1).

For analysis at the regional level, plots from all projects were grouped into one of two treatment types (mechanical or prescribed fire) and one of three dominant forest types (yellow pine, red fir, or mixed conifer). All Big Love plots were grouped into the prescribed fire treatment category. Plots 2, 4, 5, and 6 were in the yellow pine forest type, and plot 3 was in the mixed conifer forest type. The Stampede RAWS was used for fire weather and fire behavior simulation modeling.

Table 1. Treatment visits completed by year for each of the plots in the project. ~ Indicates data was not collected for that plot and year.

Plot	2006	2007	2009	2011	2012
2	P00	~	P02	~	P05
3	P00	~	P02	~	P05
4	P00	P01	~	P05	~
5	P00	P01	~	P05	~
6	P00	P01	~	P05	~

Treatment information

Prior treatment: Plots 3, 4, 5, and 6 were thinned in 2004.

During the project treatment: Prescribed fire in January 2007 (plots 4, 5, and 6) and November 2007 (plots 2 and 3).

Future treatment: The whole area is slated to be treated again (NEPA document was out for comments in 2012) as part of the Saddle treatment. They will be doing radial thinning and group selection sometime in the summer of 2013 is the estimate.

Project location map

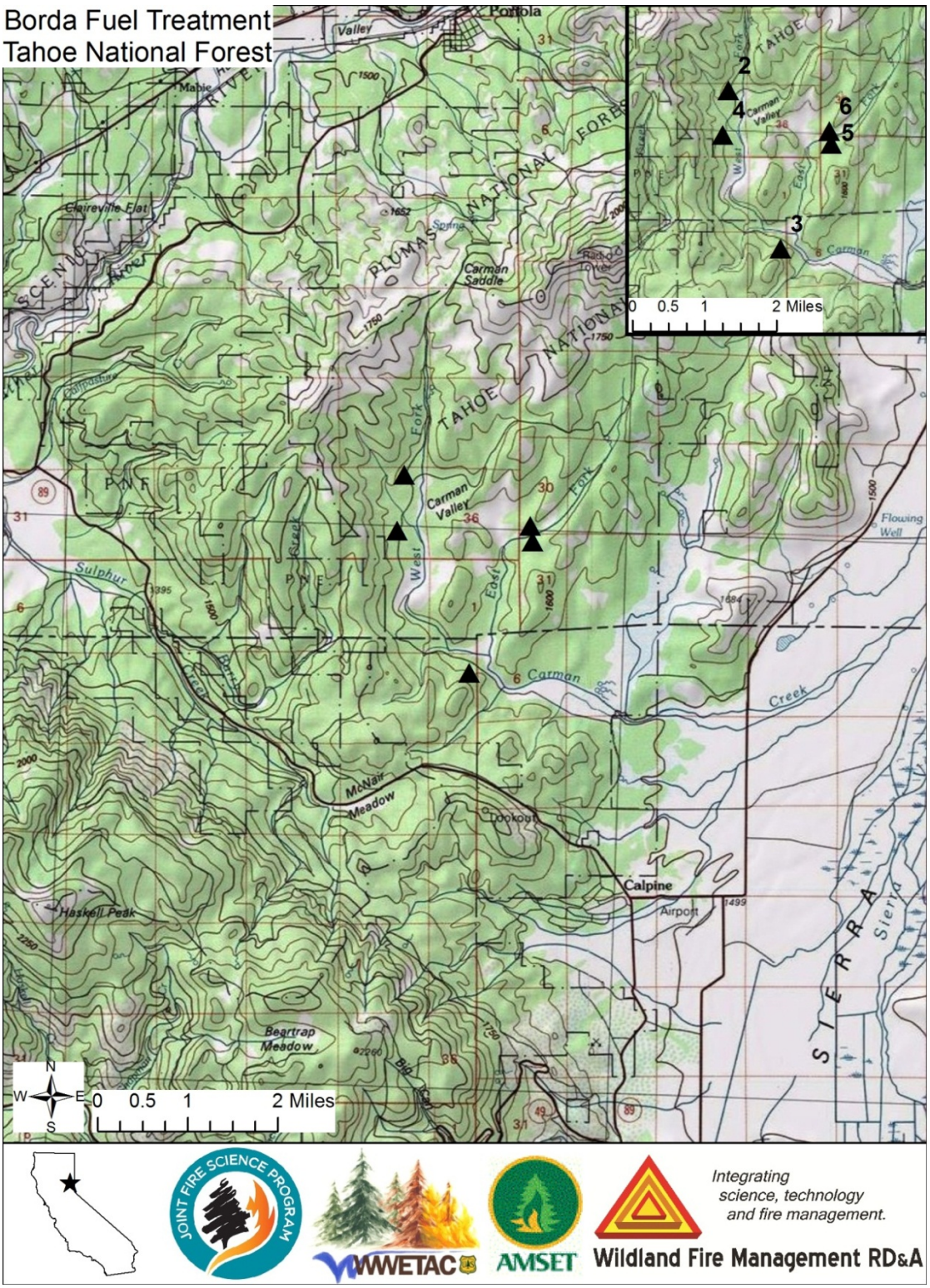

Figure 1. Location map for the Borda monitoring plots, showing general location of plots, and inset displaying increased detail of plot locations.

Driving directions/GPS/plot layout

Driving directions

Plot 2- From Hwy 89 turn onto Forest Road 0071 (FR 71) and travel about about 5.5 miles to the Y-intersection of 0071 and 0071-041, stay to the left and you will see 0071-046 on the left, go 0.2mi and you will see a large rock with trees in front of it and then an opening. The start tree is there.

Plot 3- From Hwy 89 turn onto Forest Road 0071 (FR 71) and travel 2.7 miles on to the start tree. The start tree is on the left where a turnout is.

Plot 4- From Hwy 89 turn onto Forest Road 0071 (FR 71) and travel 5 mi (just past a sign for mile 5 1/2) to the start tree.

Plot 5- From Hwy 89 turn onto Forest Road 0071 (FR 71) and 5.6 miles; go right onto 0071-41 for 3.7 miles and make a right onto logging road (heading south) where you will pass a gate. Start tree for plots 5 and 6 is 1.3 miles from the gate.

Plot 6- See Plot 5.

Table 2. Directions (distance and azimuth) for walking from the "start tree" to each plot. The azimuth takes into account the local declination. Distance and azimuth are approximate as they were recorded by crews walking in from the start tree (usually tagged tree near road edge).

Plot	Start tree (DBH and species)	Azimuth °	Distance
2	52 cm Jeffrey pine	140	73 m
3	68 cm Jeffrey pine	220	225 m
4	65 cm Jeffrey pine	345	77 m
5	68 cm Jeffrey pine	180	175 m
6	Same as Plot 5	350	120 m

Table 3. GPS coordinates for each plot (decimal degrees, datum NAD 1983, projection NAD_1983_California_Teale_Albers).

Plot	Latitude	Longitude
2	39.732277	-120.480531
3	39.700437	-120.466751
4	39.72327	-120.481946
5	39.721598	-120.453692
6	39.724143	-120.454168

Table 4. Plot layout line azimuths (degrees). See Appendix A for plot diagrams. CD is the main transect and F1 and F2 are the fuels transects.

Plot	Plot Type	CD	F1	F2
2	Detailed 2003	40	0	90
3	Detailed 2003	300	15	345
4	Fuels 2003	12	57	327
5	Detailed 2003	198	153	243
6	Detailed 2003	118	73	163

Paired pictures

Below is an example of pictures paired or matched over the time steps the plots were visited. All of the Paired pictures are available in the supplied power point file.

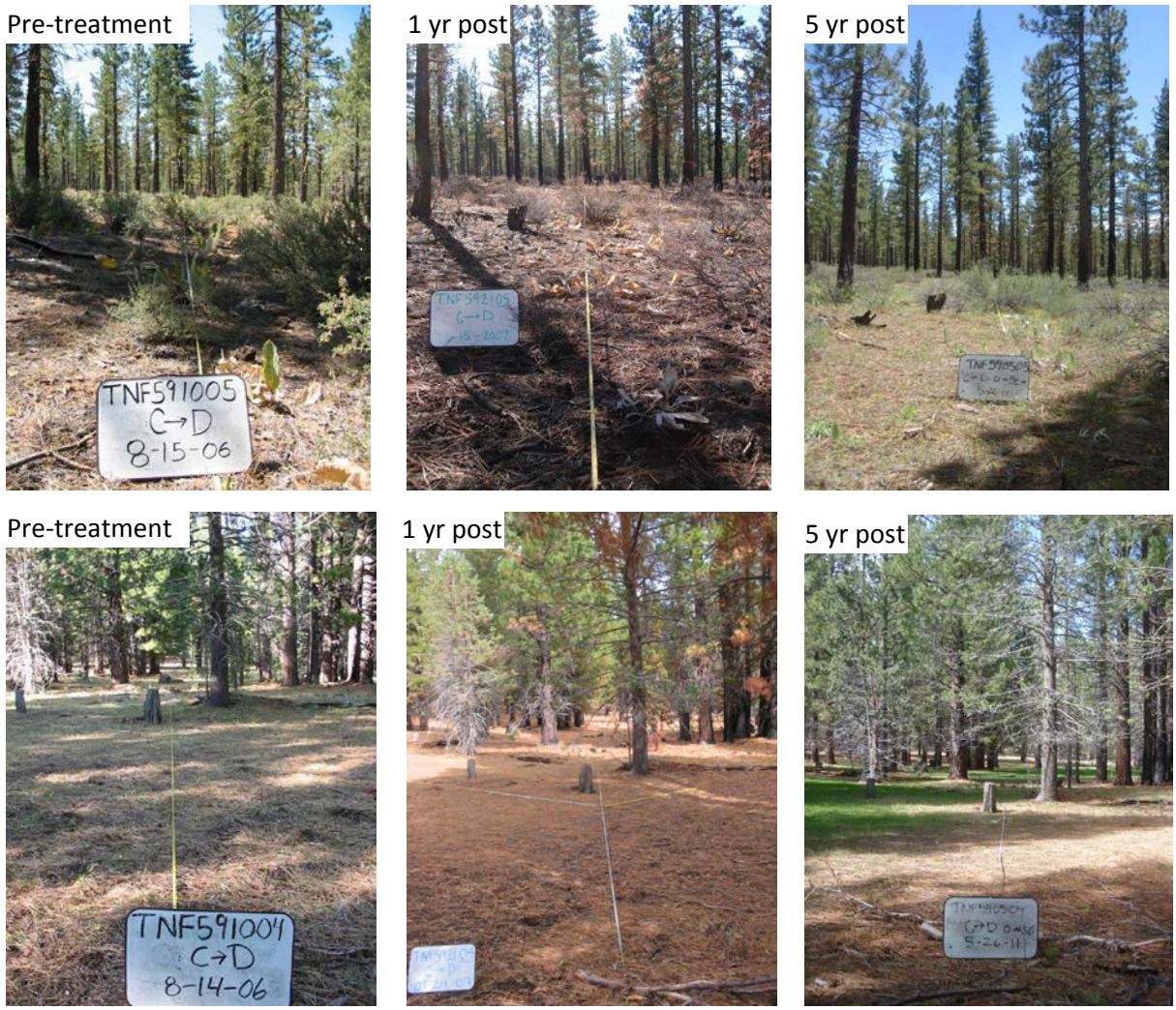

Figure 2. Example paired photos showing changes over the time steps for plot 5 (top row) and plot 4 (bottom row), for the CD or main transect line from pre-treatment in 2006 to 5 yr post-treatment in 2011.

Plot findings

Below are graphs and data tables of key metrics from the data gathered in the field for each plot and time period within the project.

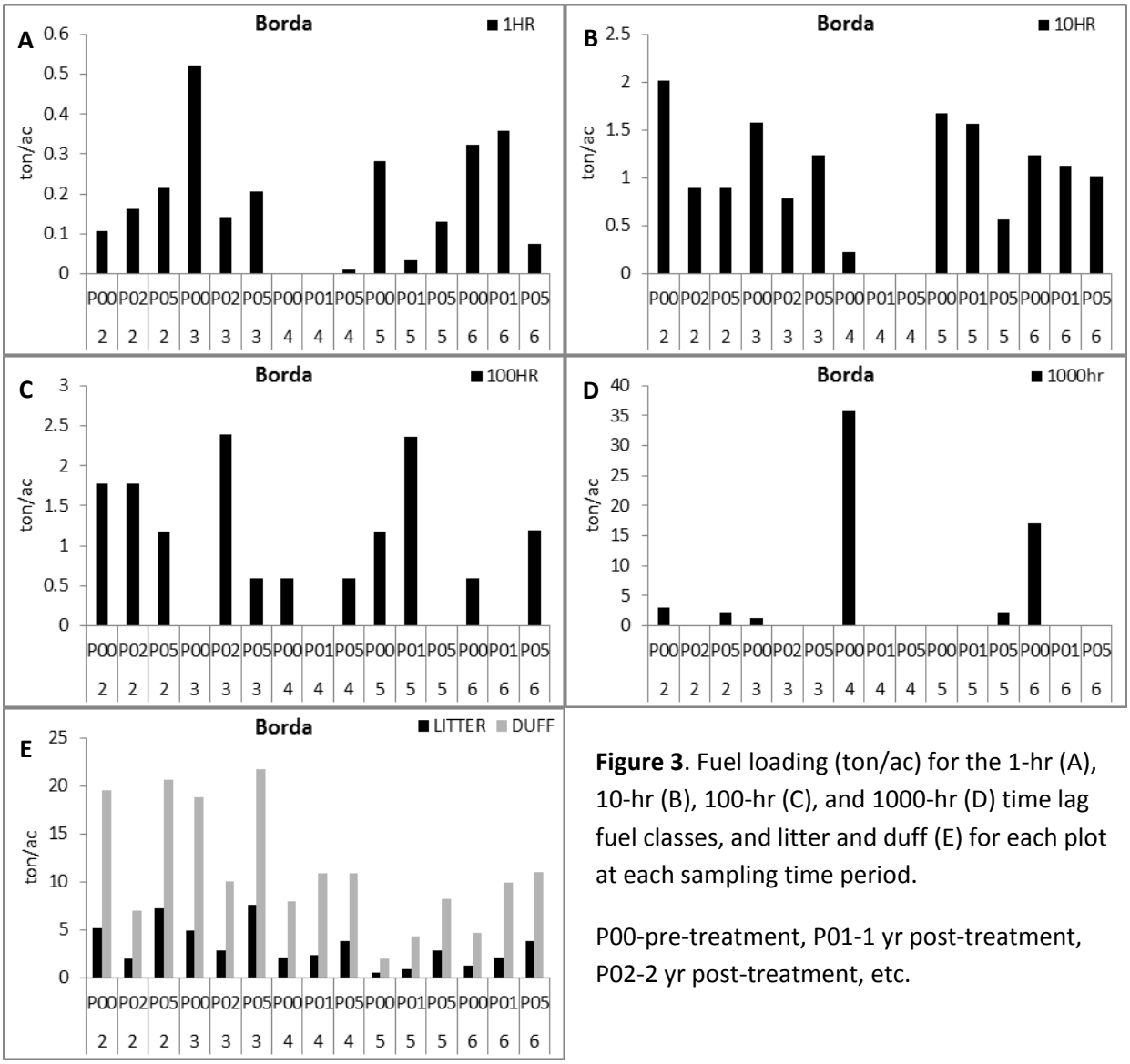

Figure 3. Fuel loading (ton/ac) for the 1-hr (A), 10-hr (B), 100-hr (C), and 1000-hr (D) time lag fuel classes, and litter and duff (E) for each plot at each sampling time period.

P00-pre-treatment, P01-1 yr post-treatment, P02-2 yr post-treatment, etc.

Table 5. Fuel loading (ton/ac) for the 1-hr, 10-hr, 100-hr, and 1000-hr time lag fuel classes, and litter and duff by time period for all the plots in the Borda fuel treatment project.

Plot	Time period	1-hr	10-hr	100-hr	1000-hr	Litter	Duff
2	P00	0.11	2.0	1.8	3.1	5.1	19.5
2	P02	0.16	0.9	1.8	0.0	2.0	7.0
2	P05	0.22	0.9	1.2	2.3	7.3	20.7
3	P00	0.52	1.6	0.0	1.3	5.0	18.8
3	P02	0.14	0.8	2.4	0.0	2.9	10.0
3	P05	0.21	1.2	0.6	0.0	7.6	21.7
4	P00	0.00	0.2	0.6	35.7	2.1	8.0
4	P01	0.00	0.0	0.0	0.0	2.3	10.9
4	P05	0.01	0.0	0.6	0.0	3.8	10.8
5	P00	0.28	1.7	1.2	0.0	0.6	2.0
5	P01	0.03	1.6	2.4	0.0	0.9	4.3
5	P05	0.13	0.6	0.0	2.3	2.9	8.2
6	P00	0.32	1.2	0.6	17.1	1.2	4.7
6	P01	0.36	1.1	0.0	0.0	2.2	9.9
6	P05	0.08	1.0	1.2	0.0	3.9	11.0

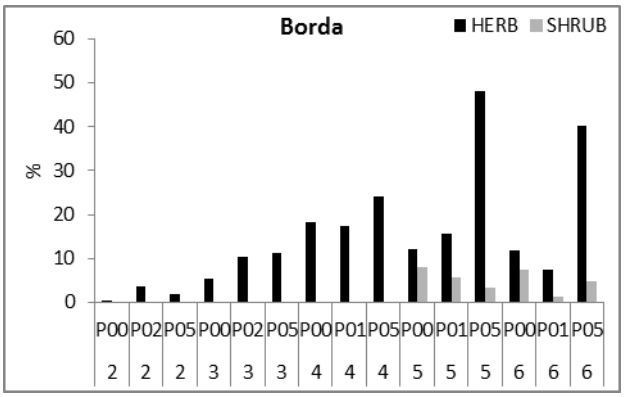

Figure 4. Average herbaceous plant and shrub cover for each plot at each sampling time period.

Table 6. Understory vegetation cover by time period for all the plots in the Borda fuel treatment project.

Plot	Time period	Herbaceous cover (%)	Shrub cover (%)
2	P00	1	0
2	P02	4	0
2	P05	2	0
3	P00	6	0
3	P02	10	0
3	P05	11	0
4	P00	18	0
4	P01	17	0
4	P05	24	0
5	P00	12	8
5	P01	16	6
5	P05	48	3
6	P00	12	7
6	P01	8	1
6	P05	40	5

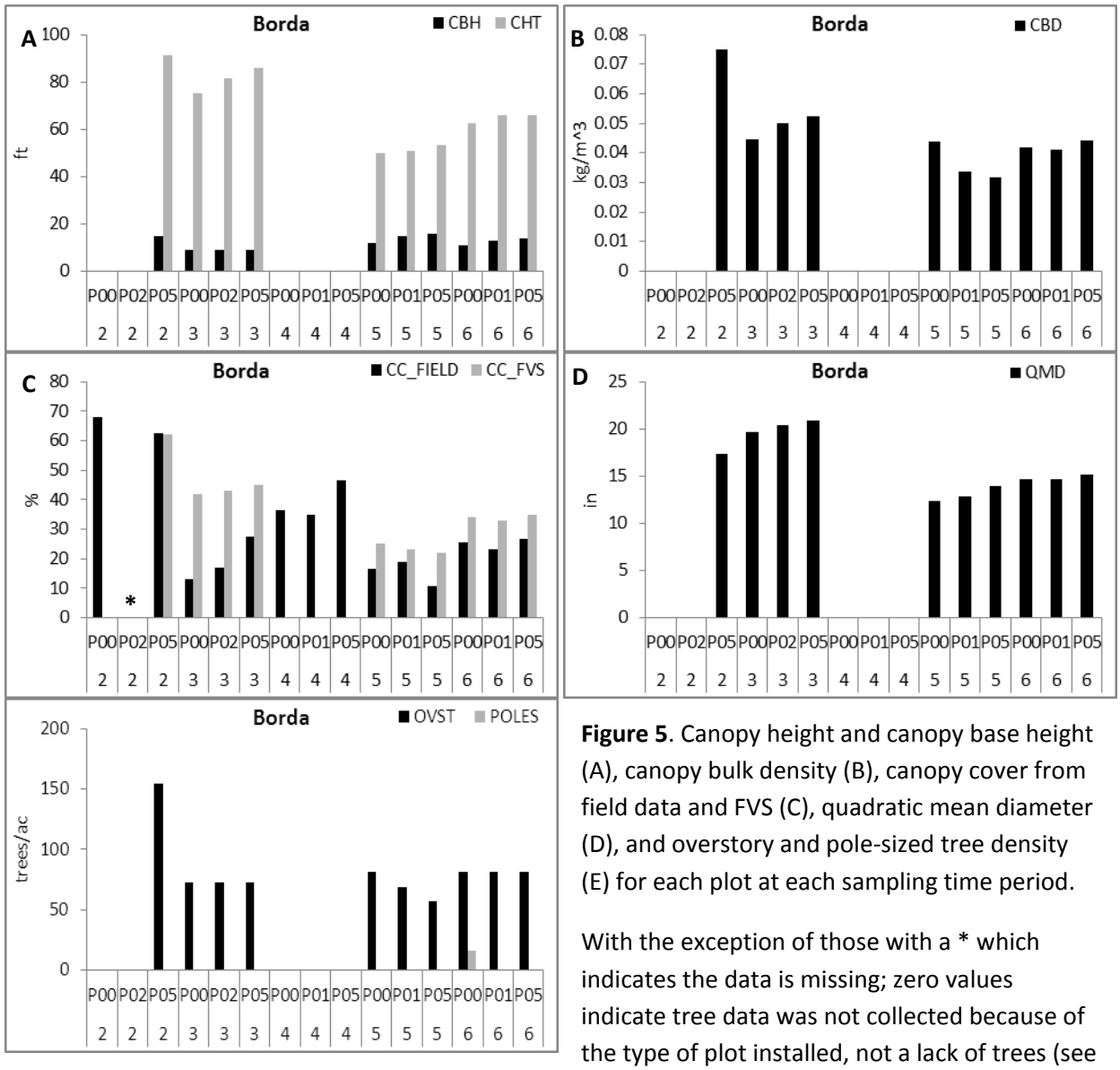

Figure 5. Canopy height and canopy base height (A), canopy bulk density (B), canopy cover from field data and FVS (C), quadratic mean diameter (D), and overstory and pole-sized tree density (E) for each plot at each sampling time period.

With the exception of those with a * which indicates the data is missing; zero values indicate tree data was not collected because of the type of plot installed, not a lack of trees (see Table 7).

Table 7. Canopy characteristics by time period for all the plots in the Borda fuel treatment project. * Indicates the data was not collected for the given plot and time period.

Plot	Time period	Canopy cover (%) - field	Canopy cover (%) - FVS	Canopy height (ft)	Canopy base height (ft)	Canopy bulk density (kg/m^3)	Quadratic mean diameter (in)	Overstory (trees/ac)	Pole-sized (trees/ac)
2	P00	68	*	*	*	*	*	*	*
2	P02	*	*	*	*	*	*	*	*
2	P05	63	62	91.4	15.0	0.075	17.3	154	0
3	P00	13	42	75.2	9.0	0.045	19.7	73	0
3	P02	17	43	81.6	9.0	0.050	20.4	73	0
3	P05	28	45	86.0	9.0	0.053	20.9	73	0
4	P00	36	*	*	*	*	*	*	*
4	P01	35	*	*	*	*	*	*	*
4	P05	46	*	*	*	*	*	*	*
5	P00	16	25	49.8	12.0	0.044	12.3	81	0
5	P01	19	23	51.0	15.0	0.034	12.8	69	0
5	P05	11	22	53.2	16.0	0.032	13.9	57	0
6	P00	26	34	62.8	11.0	0.042	14.7	81	16
6	P01	23	33	66.0	13.0	0.041	14.7	81	0
6	P05	27	35	65.8	14.0	0.044	15.2	81	0

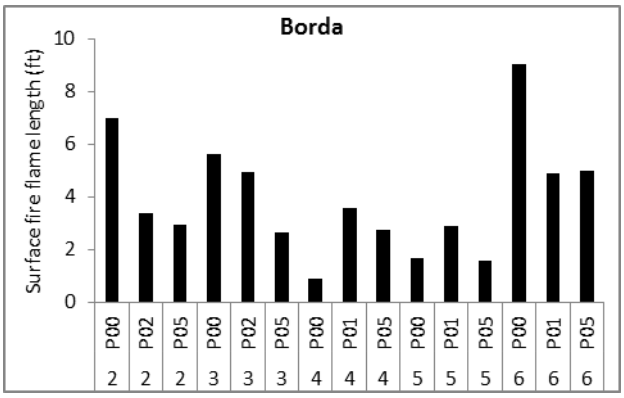

Figure 6. Surface fire flame length from custom fuel models using NEXUS for each plot at each sampling time period under 90th percentile fire weather conditions.

Table 8. Surface fire flame length (modeled in NEXUS with custom fuel models) and type of fire for 90th percentile fire weather conditions for all the plots in the Borda fuel treatment project. * Indicates the tree data was not collected and fire type was not modeled.

Plot	Time period	Surface fire flame length (ft)	Type of fire
2	P00	6.98	*
2	P02	3.39	*
2	P05	2.93	Surface
3	P00	5.64	Passive crown
3	P02	4.92	Surface
3	P05	2.64	Surface
4	P00	0.88	*
4	P01	3.58	*
4	P05	2.73	*
5	P00	1.68	Surface
5	P01	2.88	Surface
5	P05	1.58	Passive crown
6	P00	9.03	Surface
6	P01	4.91	Surface
6	P05	5.01	Surface

Hot Springs (Project 53, Sierraville District)

Project history

The Hot Springs project had three plots set up pre-treatment using the detailed 2003 plot style. For details about the protocol used, please see "Appendix B: Sampling Protocol" at the end of the report. Plots were sampled prior to treatment (P00), then 1 yr post (P01), 2 yr post (P02), 5 yr post (P05), and 8 yr post (P08) (Table 9).

For analysis at the regional level, plots from all projects were grouped into one of two treatment types (mechanical or prescribed fire) and one of three dominant forest types (yellow pine, red fir, or mixed conifer). For this project all plots were grouped into the mechanical treatment type and yellow pine forest type.

The Stampede RAWS was used for fire weather and fire behavior simulation modeling.

Table 9. Treatment visits completed by year for each of the plots in the project.

Plot	2004	2005	2006	2009	2012
1	P00	P01	P02	P05	P08
2	P00	P01	P02	P05	P08
3	P00	P01	P02	P05	P08

Treatment information

Prior treatment: All plots were found inside the perimeter of an unnamed fire (maybe the Cold Creek Fire) in 1959. No other past treatment is known.

During the project treatment: Mastication occurred in the project area on 10/15/2004.

Future treatment: None planned.

Project location map

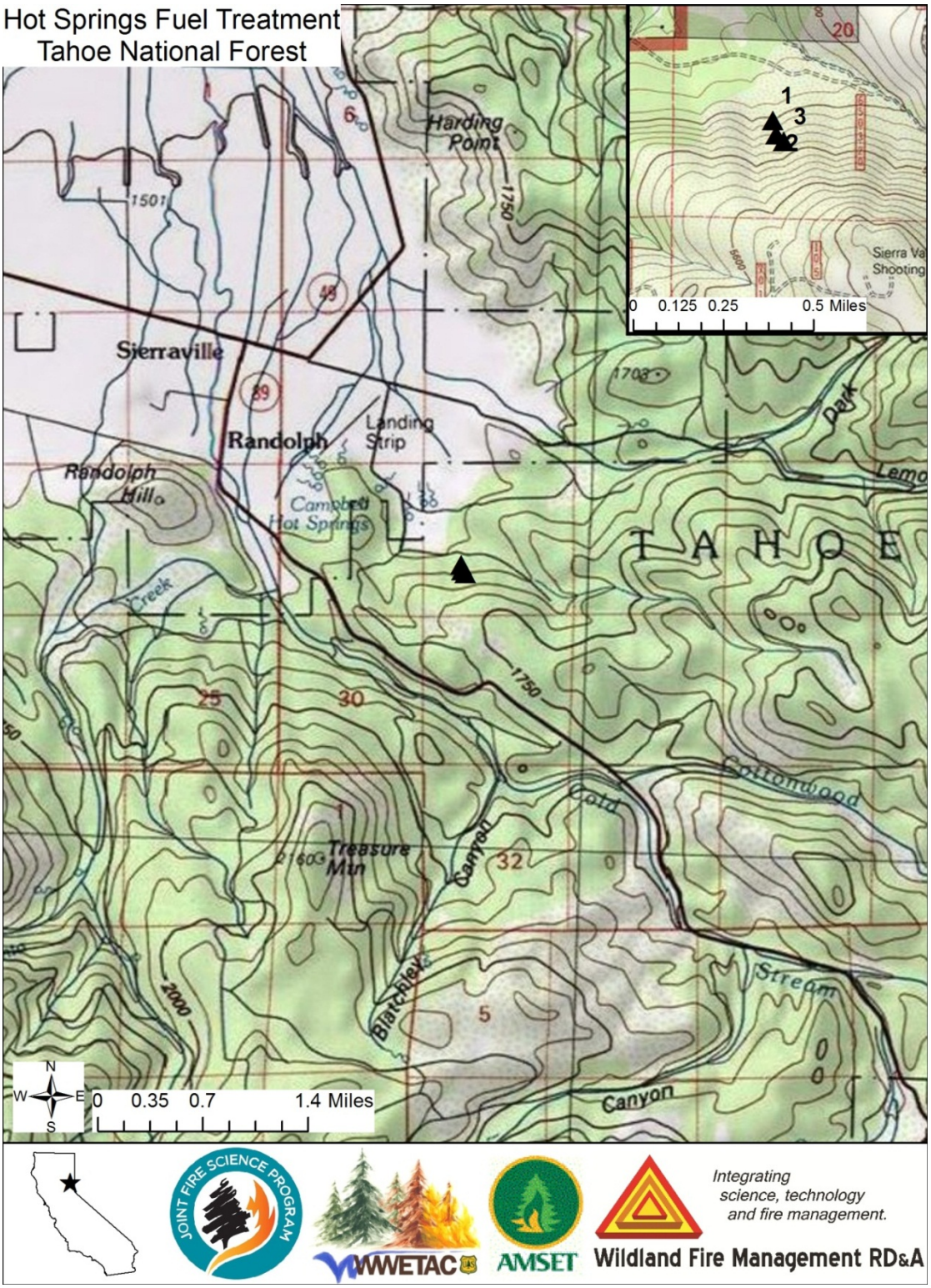

Figure 7. Location map for the Hot Springs monitoring plots, showing general location of plots, and inset displaying increased detail of plot locations.

Driving directions/GPS/plot layout

Driving directions

Plot 1- From Sierraville RD office in the center of Sierraville drive North on Hwy 89 for 0.4 miles to the intersection of Hwy 89/49. Turn right (east) onto Hwy 49 and drive for 0.4 miles. Turn right onto Lemon Canyon Rd. and drive for 0.5 miles. Turn right onto Campbell Hot Springs Rd. Pass through the bed and breakfast place at 0.8 mile. After B and B, stay to the right. At 1.1 miles there is a road to the right, but you travel left to stay on the main road. Pass a skid road on the right at about 1.4 miles. The start tree is between 1.5 and 1.6 miles on the right or south side of the road adjacent to the boundary marker sign (rust post with yellow sign, 5 inch square) with a placard on it, and about 3 m from the road, on the south side.

Plot 2- From Plot 1's origin or center rebar, go straight uphill 70 meters at a 180 degree azimuth to plot 2. Plot center is within 5 meters to the east of small stream channel.

Plot 3- From Plot 2's origin or center rebar, go 70 meters at a 133 degree azimuth (uphill, and to the left).

Table 10. Directions (distance and azimuth) for walking from the" start tree" to each plot. The azimuth takes into account the local declination. Distance and azimuth are approximate as they were recorded by crews walking in from the start tree (usually tagged tree near road edge).

Plot	Start tree (DBH and species)	Azimuth °	Distance
1	40 cm Jeffrey pine	156	200 m
2	Plot 1 origin rebar	180	70 m
3	Plot 2 origin rebar	133	70 m

Table 11. GPS coordinates for each plot (decimal degrees, datum NAD 1983, projection NAD_1983_California_Teale_Albers).

Plot	Latitude	Longitude
1	39.567643	-120.339541
2	39.567083	-120.339388
3	39.566807	-120.338983

Table 12. Plot layout line azimuths (degrees). See Appendix A for plot diagrams. Where AB and CD are the main transects and F1 and F2 are the fuels transects.

Plot	Plot type	CD	F1	F2
1	Detailed 2003	265	218	308
2	Detailed 2003	255	217	307
3	Detail 2003	268	195	285

Paired pictures

Below is an example of pictures paired or matched over the time steps the plots were visited. All of the Paired pictures are available in the supplied power point file.

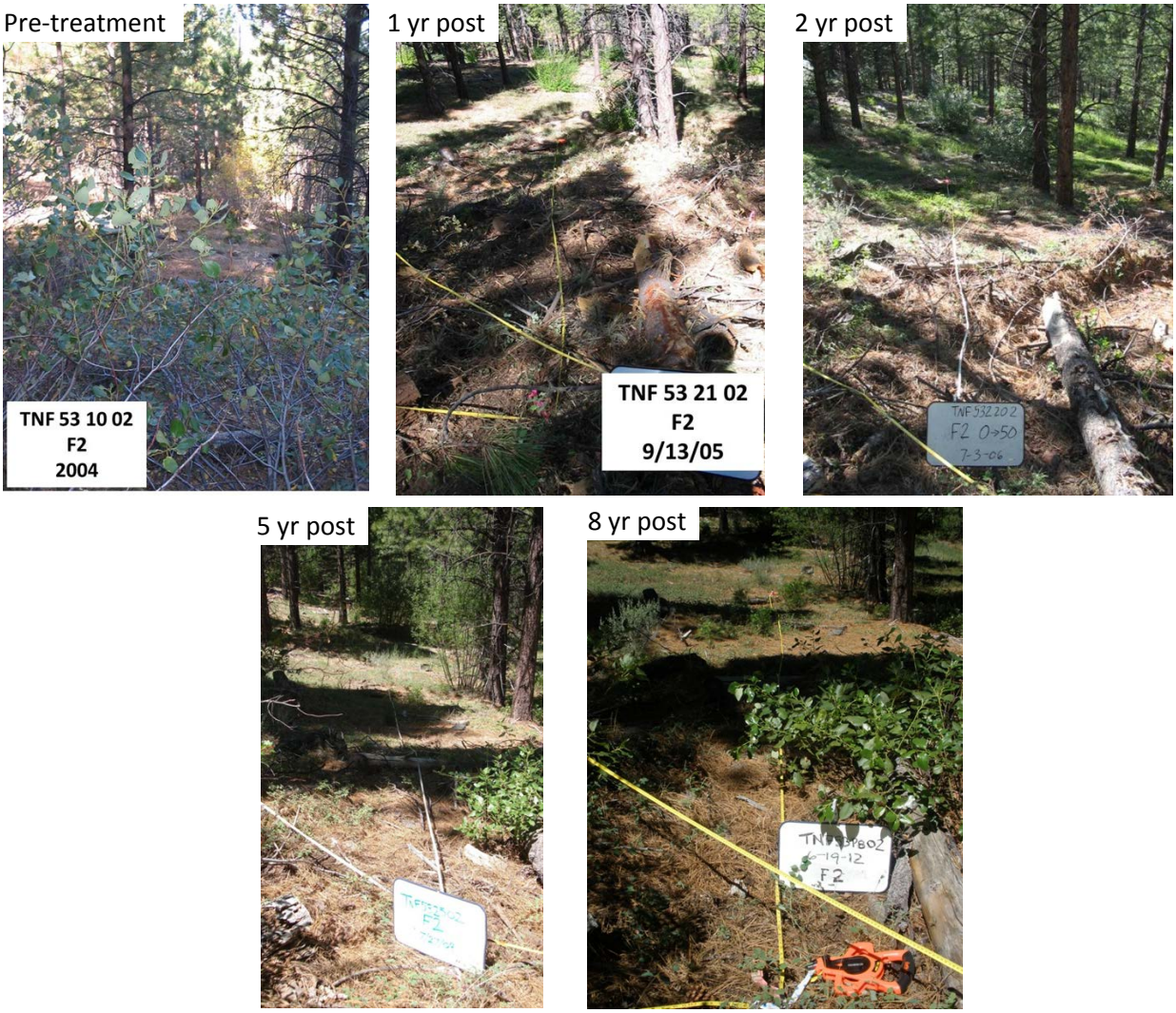

Figure 8. Example paired photos showing changes over the time steps for Plot 2 on fuels line 2 (F2) from pre-treatment in 2004 through 8 yr post-treatment in 2012.

Plot findings

Below are graphs and data tables of key metrics from the data gathered in the field for each plot and time period within the project.

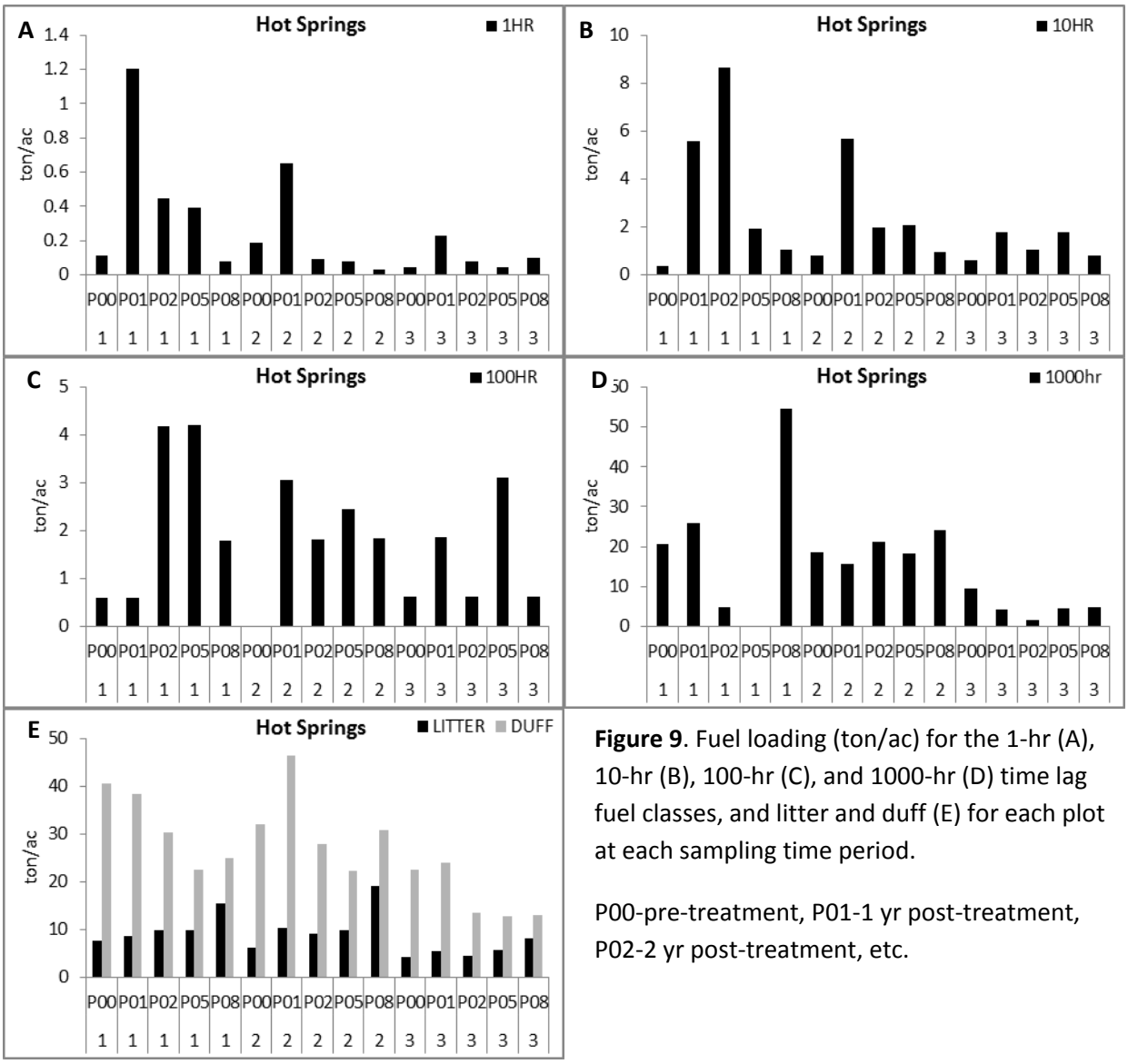

Figure 9. Fuel loading (ton/ac) for the 1-hr (A), 10-hr (B), 100-hr (C), and 1000-hr (D) time lag fuel classes, and litter and duff (E) for each plot at each sampling time period.

P00-pre-treatment, P01-1 yr post-treatment, P02-2 yr post-treatment, etc.

Table 13. Fuel loading (ton/ac) for the 1-hr, 10-hr, 100-hr, and 1000-hr time lag fuel classes, and litter and duff for by time period for all the plots in the Hot Springs fuel treatment project.

Plot	Time period	1-hr	10-hr	100-hr	1000-hr	Litter	Duff
1	P00	0.11	0.3	0.6	20.5	7.8	40.6
1	P01	1.20	5.6	0.6	25.9	8.6	38.4
1	P02	0.45	8.6	4.2	4.8	9.9	30.4
1	P05	0.39	1.9	4.2	0.0	10.0	22.6
1	P08	0.08	1.0	1.8	54.6	15.5	24.9
2	P00	0.19	0.8	0.0	18.7	6.1	32.1
2	P01	0.65	5.7	3.0	15.8	10.4	46.4
2	P02	0.09	2.0	1.8	21.3	9.0	27.9
2	P05	0.08	2.1	2.4	18.3	9.8	22.2
2	P08	0.03	0.9	1.8	24.2	19.2	30.8
3	P00	0.05	0.6	0.6	9.6	4.3	22.6
3	P01	0.23	1.8	1.9	4.3	5.4	24.0
3	P02	0.08	1.1	0.6	1.5	4.4	13.6
3	P05	0.05	1.8	3.1	4.6	5.6	12.7
3	P08	0.10	0.8	0.6	4.8	8.1	13.0

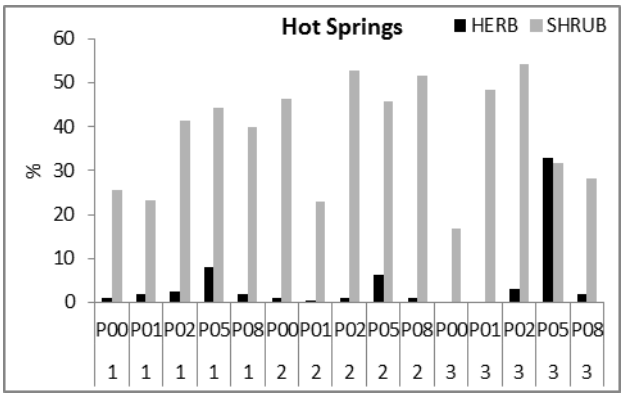

Figure 10. Average herbaceous plant and shrub cover for each plot at each sampling time period.

Table 14. Understory vegetation cover by time period for all the plots in the Hot Springs fuel treatment project.

Plot	Time period	Herbaceous cover (%)	Shrub cover (%)
1	P00	1	26
1	P01	2	23
1	P02	3	41
1	P05	8	44
1	P08	2	40
2	P00	1	46
2	P01	1	23
2	P02	1	53
2	P05	6	46
2	P08	1	52
3	P00	0	17
3	P01	0	48
3	P02	3	54
3	P05	33	32
3	P08	2	28

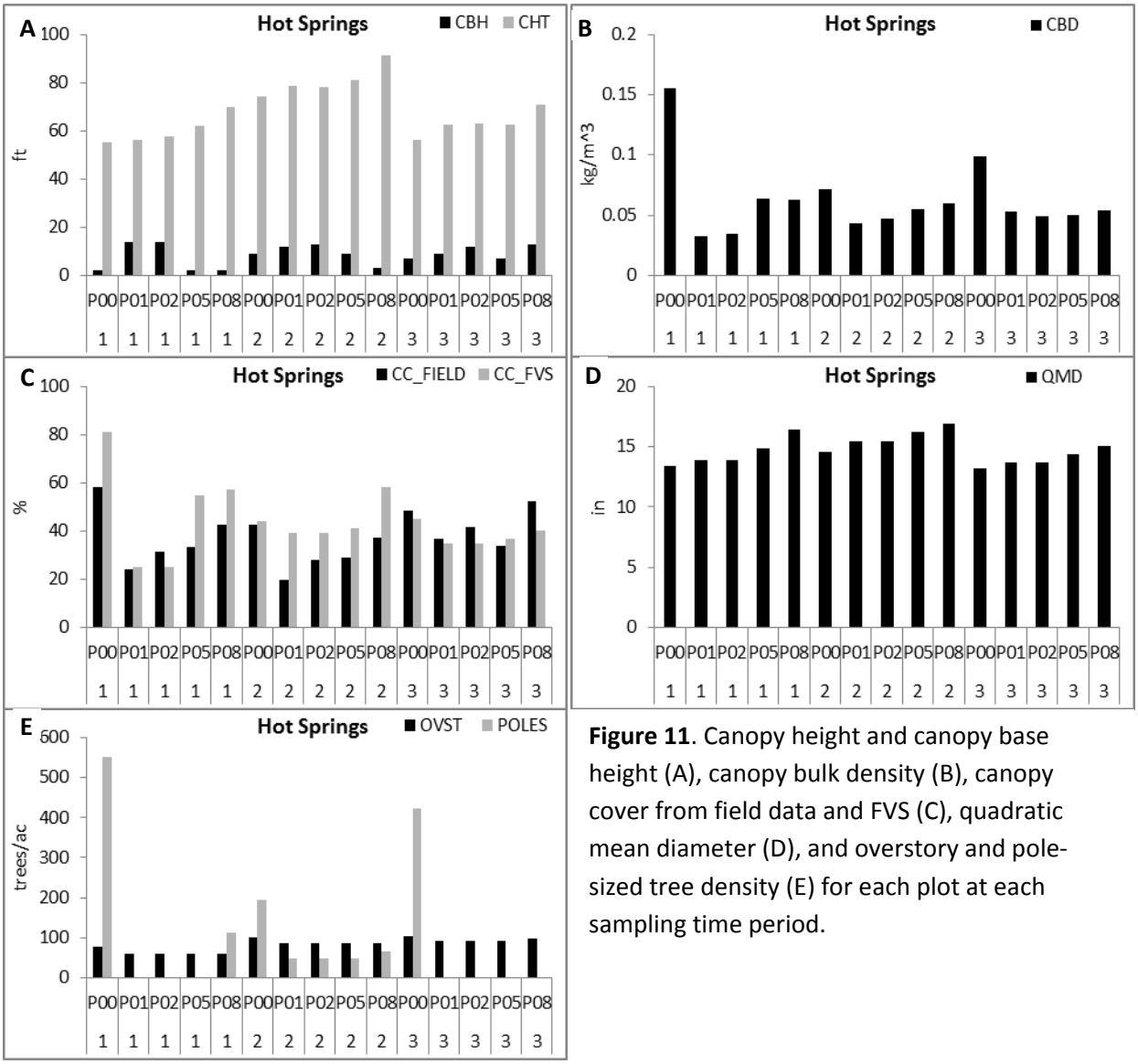

Figure 11. Canopy height and canopy base height (A), canopy bulk density (B), canopy cover from field data and FVS (C), quadratic mean diameter (D), and overstory and pole-sized tree density (E) for each plot at each sampling time period.

Table15. Canopy characteristics by time period for all the plots in the Hot Springs fuel treatment project.

Plot	Time period	Canopy cover (%) - field	Canopy cover (%) - FVS	Canopy height (ft)	Canopy base height (ft)	Canopy bulk density (kg/m^3)	Quadratic mean diameter (in)	Overstory (trees/ac)	Pole-sized (trees/ac)
1	P00	58	81	55.2	2.0	0.155	13.4	77	550
1	P01	24	25	56.0	14.0	0.033	13.9	61	0
1	P02	32	25	57.9	14.0	0.034	13.9	61	0
1	P05	33	55	62.3	2.0	0.064	14.9	61	0
1	P08	43	57	70.0	2.0	0.063	16.4	61	113
2	P00	43	44	74.5	9.0	0.072	14.6	101	194
2	P01	20	39	78.6	12.0	0.043	15.5	85	49
2	P02	28	39	78.4	13.0	0.047	15.5	85	49
2	P05	29	41	81.1	9.0	0.055	16.3	85	49
2	P08	37	58	91.3	3.0	0.060	16.9	85	65
3	P00	48	45	56.2	7.0	0.099	13.2	105	421
3	P01	37	35	62.8	9.0	0.053	13.7	93	0
3	P02	42	35	63.0	12.0	0.050	13.7	93	0
3	P05	34	37	62.5	7.0	0.051	14.4	93	0
3	P08	52	40	70.9	13.0	0.054	15.1	97	0

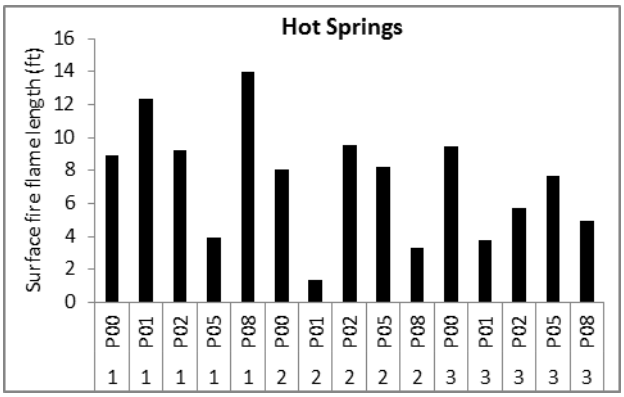

Figure 12. Surface fire flame length from custom fuel models using NEXUS for each plot at each sampling time period under 90th percentile fire weather conditions.

Table 16. Surface fire flame length (modeled in NEXUS with custom fuel models) and type of fire for 90th percentile fire weather conditions for all the plots in the Hot Springs fuel treatment project.

Plot	Time period	Surface fire flame length (ft)	Type of fire
1	P00	8.89	Active crown
1	P01	12.38	Surface
1	P02	9.24	Surface
1	P05	3.90	Passive crown
1	P08	14.01	Passive crown
2	P00	8.04	Passive crown
2	P01	1.39	Passive crown
2	P02	9.52	Passive crown
2	P05	8.21	Passive crown
2	P08	3.29	Passive crown
3	P00	9.45	Active crown
3	P01	3.79	Passive crown
3	P02	5.73	Passive crown
3	P05	7.70	Surface
3	P08	4.96	Surface

Columbo (Project 173, Yuba River Ranger District)

Project history

The Columbo project had three plots set up pre-treatment using the National Park Service (NPS) plot style. For details about the protocol used, please see "Appendix B: Sampling Protocol" at the end of the report. Only two plots were treated and maintained in the study. Plots were sampled prior to treatment (P00), then 1 yr post (P01), 2 yr post (P02), 5 yr post (P05), 8 yr post (P08), and then 10 yr post (Table 17).

For analysis at the regional level, plots from all projects were grouped into one of two treatment types (mechanical or prescribed fire) and one of three dominant forest types (yellow pine, red fir, or mixed conifer). For this project, all plots were grouped into the mechanical treatment type and mixed conifer forest type.

The Pike County Lookout RAWS was used for fire weather and fire behavior simulation modeling.

Table 17. Treatment visits completed by year for each of the plots in the project. ~ Indicates data was not collected for that plot or year.

Plot	2001	2002	2003	2006	2009	2011
7	P00	P01	P02	P05	P08	P10
8	P00	P01	P02	P05	P08	P10

Treatment information

Prior treatment: The San Juan NEPA document, from around 1995, had some timber sale and fuel treatments in it, but the Fuels Specialist thought this implementation was done further south than the plot area.

During the project treatment: Plots were thinned and burned, completed on 9/15/2001.

Future treatment: Nothing known.

Project location map

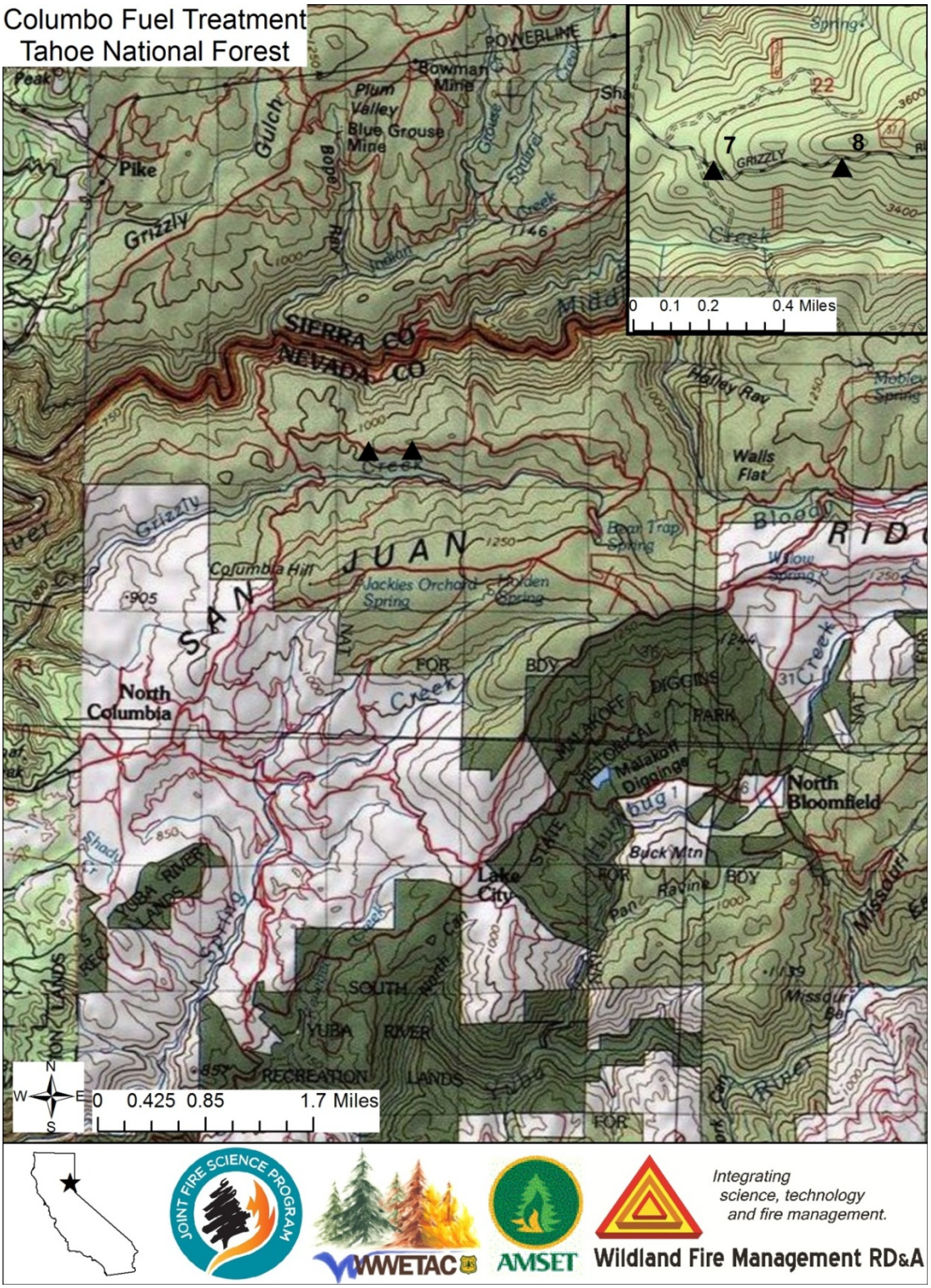

Figure 13. Location map for the Columbo monitoring plots, showing general location of plots, and inset displaying increased detail of plot locations.

Driving directions/GPS/plot layout

Driving directions

Plot 7- From intersection of Tyler Foote road and Hwy 49, proceed east on Tyler Foote for approximately 9 miles. From the CDF Station (on left side of Tyler Foote) travel 0.3 miles to the intersection of Tyler Foote and Cruzon Grade. Turn left onto Tyler Foote Crossing. Travel 2 miles to Grizzly Ridge/37 Rd., stay to right to travel on Grizzly Ridge/37 Rd. At 0.2 miles is the 37 and 8 roads intersection. Continue on 37 Rd. At 1.1 miles from the 37 and 8 roads intersection is the start tree on the right at the fireline (trail) that might still have the number 8 painted on it with orange paint. Follow path (trail or fireline) down the hill; the plot is on left of the path as you are walking down the hill.

Plot 8- From intersection of Tyler Foote road and Hwy 49, proceed east on Tyler Foote for approximately 9 miles. From the CDF Station (on left side of Tyler Foote) travel 0.3 miles to the intersection of Tyler Foote and Cruzon Grade. Turn left onto Tyler Foote crossing. Travel 2 miles to Grizzly Ridge/37 Rd., stay to right to travel on Grizzly Ridge (37) Rd. At 0.2 miles is the 37 and 8 roads intersection. Continue on 37 Rd. At 1.1 miles from 37 and 8 roads intersection is Plot 7, continue 0.7 miles further from Plot 7 to Plot 8. The start tree is on the south side of road (right) at a bend in road. There is a cut fireline path to follow down the hill (not immediately obvious from road) that takes you to the plot (plot will be on right side of fireline).

Table 18. Directions (distance and azimuth) for walking from the" start tree" to each plot. The azimuth takes into account the local declination. Distance and azimuth are approximate as they were recorded by crews walking in from the start tree (usually tagged tree near road edge).

Plot	Start tree (DBH and species)	Azimuth °	Distance
7	74 cm Douglas-fir	159	430 m
8	25 cm Douglas-fir	Approx. south (180)	270 m

Table 19. GPS coordinates for each plot (decimal degrees, datum NAD 1983, projection NAD_1983_California_Teale_Albers).

Plot	Latitude	Longitude
7	39.405703	-120.958976
8	39.405879	-120.952583

Table 20. Plot layout line azimuths (degrees). See Appendix A for plot diagrams. Where AB and CD is the main transect and F1, F2, F3, and F4 are the fuels transects.

Plot	Plot type	AB	CD	F1	F2	F3	F4
7	NPS	26	26	277	19	222	22
8	NPS	114	114	138	320	64	190

Paired pictures

Below is an example of pictures paired or matched over the time steps the plots were visited. All of the Paired pictures are available in the supplied power point file.

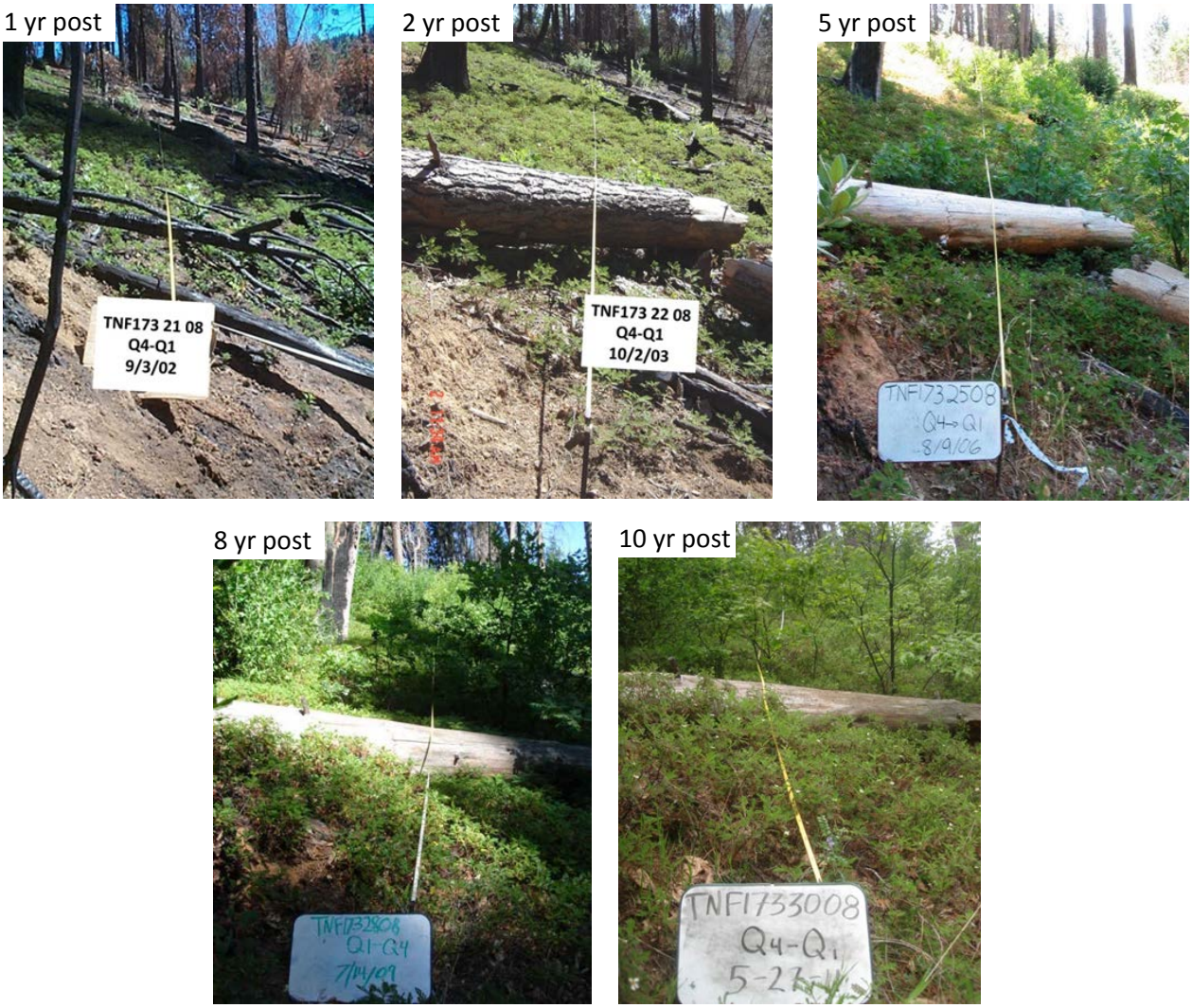

Figure 14. Example paired photos showing changes over the time steps for Plot 8 on the AB (Q4 to Q1) line, which is one of two main transects, from 1 yr post-treatment in 2002 through 10 yr post-treatment in 2011.

Plot findings

Below are graphs and data tables of key metrics from the data gathered in the field for each plot and time period within the project.

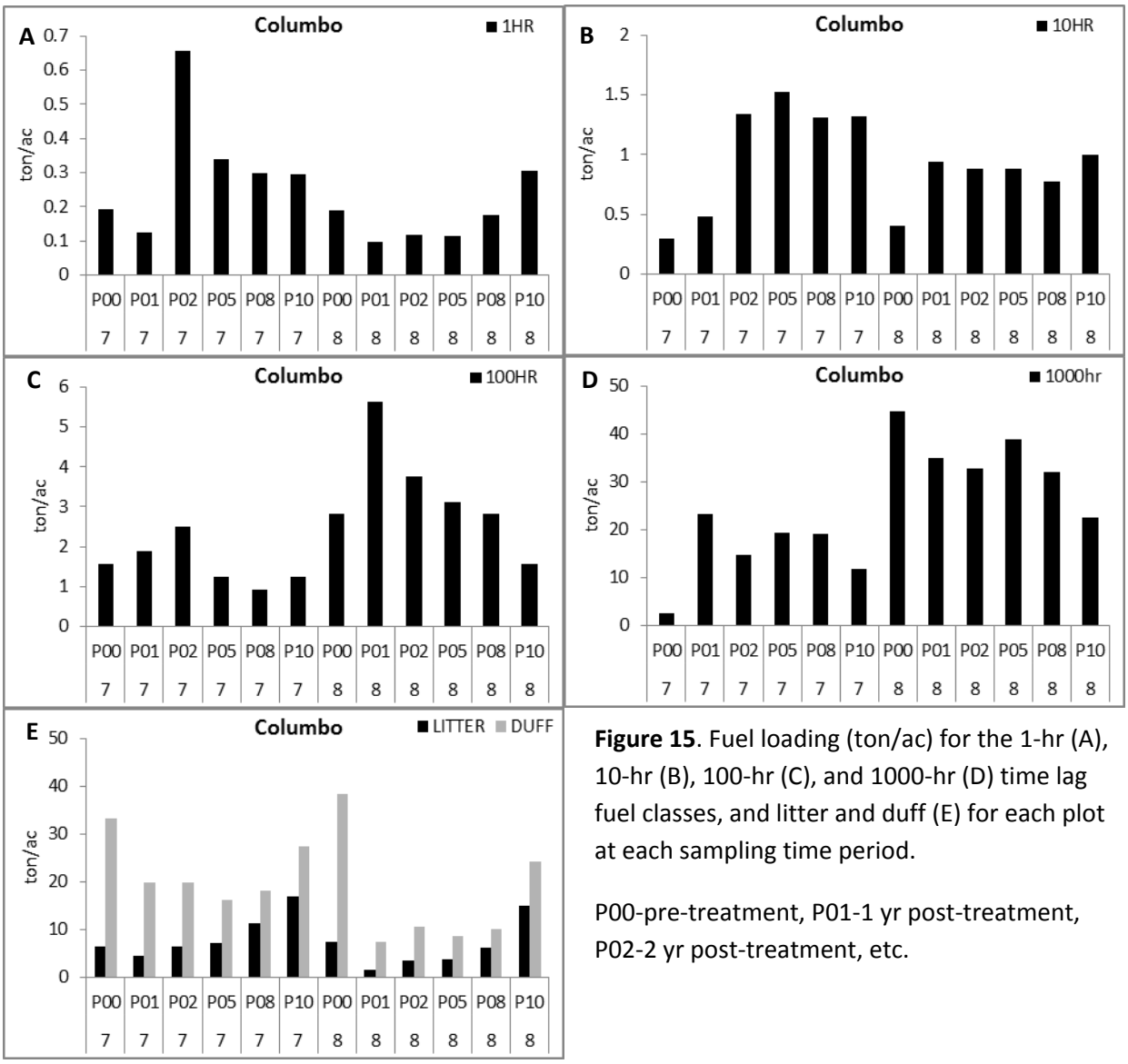

Figure 15. Fuel loading (ton/ac) for the 1-hr (A), 10-hr (B), 100-hr (C), and 1000-hr (D) time lag fuel classes, and litter and duff (E) for each plot at each sampling time period.

P00-pre-treatment, P01-1 yr post-treatment, P02-2 yr post-treatment, etc.

Table 21. Fuel loading (ton/ac) for the 1-hr, 10-hr, 100-hr, and 1000-hr time lag fuel classes, and litter and duff for by time period for all the plots in the Columbo fuel treatment project.

Plot	Time period	1-hr	10-hr	100-hr	1000-hr	Litter	Duff
7	P00	0.19	0.3	1.5	2.6	6.4	33.2
7	P01	0.12	0.5	1.9	23.1	4.4	19.7
7	P02	0.66	1.3	2.5	14.8	6.4	19.8
7	P05	0.34	1.5	1.2	19.4	7.2	16.2
7	P08	0.30	1.3	0.9	19.1	11.2	18.0
7	P10	0.29	1.3	1.3	11.8	17.0	27.3
8	P00	0.19	0.4	2.8	44.6	7.3	38.2
8	P01	0.10	0.9	5.6	35.1	1.7	7.4
8	P02	0.12	0.9	3.8	32.7	3.5	10.7
8	P05	0.11	0.9	3.1	38.8	3.8	8.6
8	P08	0.18	0.8	2.8	32.1	6.3	10.1
8	P10	0.31	1.0	1.6	22.5	15.0	24.1

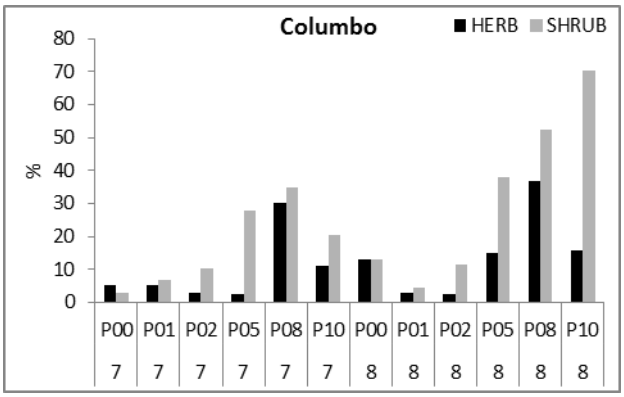

Figure 16. Average herbaceous plant and shrub cover for each plot at each sampling time period.

Table 22. Understory vegetation cover by time period for all the plots in the Columbo fuel treatment project.

Plot	Time period	Herbaceous cover (%)	Shrub cover (%)
7	P00	5	3
7	P01	5	7
7	P02	3	10
7	P05	3	28
7	P08	30	35
7	P10	11	21
8	P00	13	13
8	P01	3	4
8	P02	3	12
8	P05	15	38
8	P08	37	53
8	P10	16	71

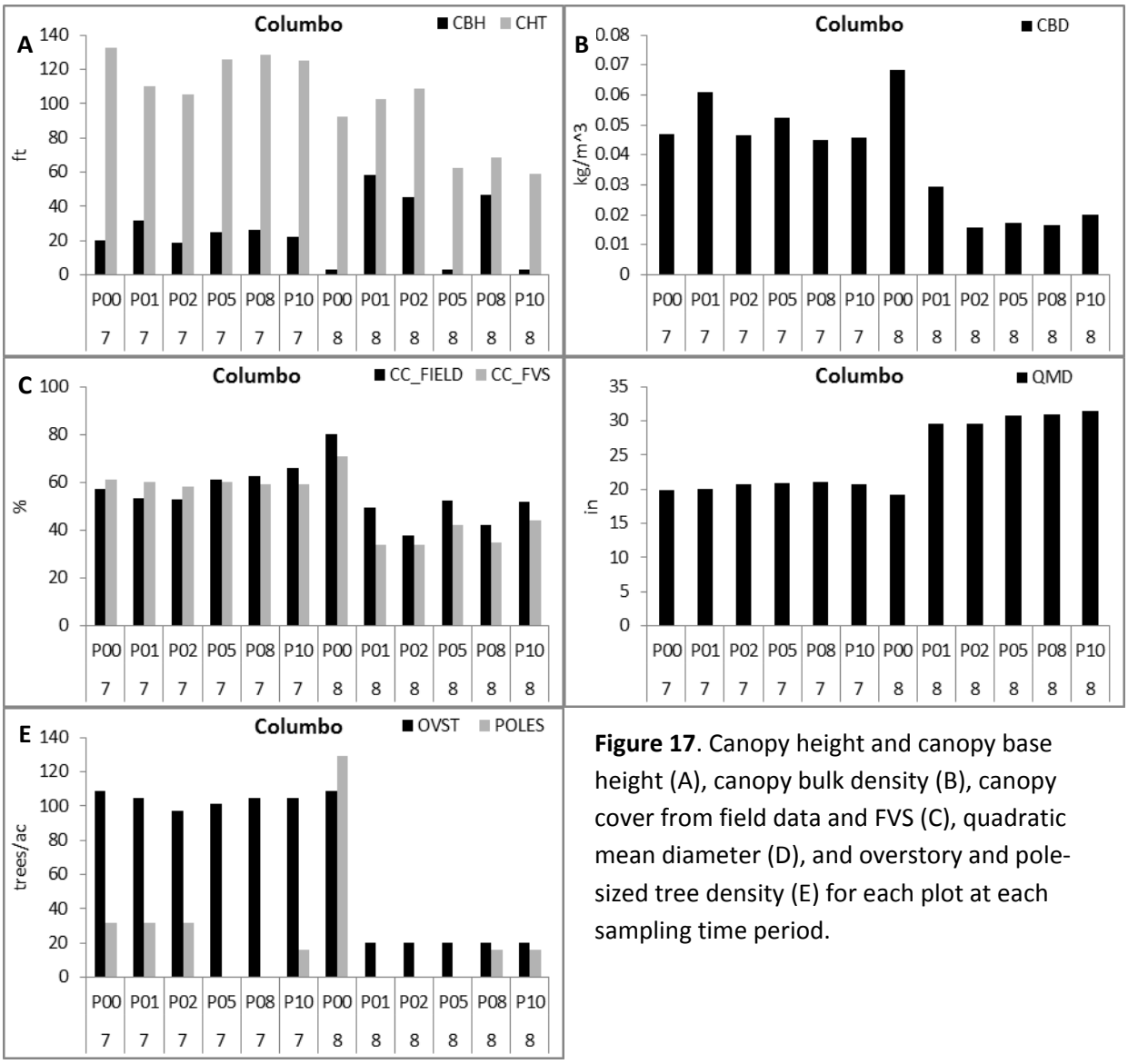

Figure 17. Canopy height and canopy base height (A), canopy bulk density (B), canopy cover from field data and FVS (C), quadratic mean diameter (D), and overstory and pole-sized tree density (E) for each plot at each sampling time period.

Table23. Canopy characteristics by time period for all the plots in the Columbo fuel treatment project.

Plot	Time period	Canopy cover (%) - field	Canopy cover (%) - FVS	Canopy height (ft)	Canopy base height (ft)	Canopy bulk density (kg/m^3)	Quadratic mean diameter (in)	Overstory (trees/ac)	Pole-sized (trees/ac)
7	P00	57	61	132.5	20.0	0.047	19.8	109	32
7	P01	53	60	110.1	32.0	0.061	20.1	105	32
7	P02	53	58	105.4	19.0	0.047	20.7	97	32
7	P05	61	60	125.9	25.0	0.052	21.0	101	0
7	P08	63	59	128.3	26.0	0.045	21.0	105	0
7	P10	66	59	125.0	22.0	0.046	20.7	105	16
8	P00	80	71	92.5	3.0	0.068	19.1	109	129
8	P01	49	34	102.3	58.0	0.029	29.6	20	0
8	P02	38	34	108.4	45.0	0.016	29.6	20	0
8	P05	52	42	62.1	3.0	0.017	30.7	20	0
8	P08	42	35	68.9	47.0	0.017	30.9	20	16
8	P10	52	44	59.2	3.0	0.020	31.4	20	16

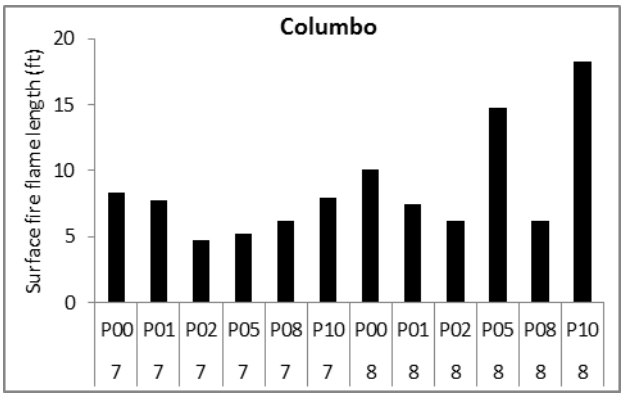

Figure 18. Surface fire flame length from custom fuel models using NEXUS for each plot at each sampling time period under 90th percentile fire weather conditions.

Table 24. Surface fire flame length (modeled in NEXUS with custom fuel models) and type of fire for 90th percentile fire weather conditions for all the plots in the Columbo fuel treatment project.

Plot	Time period	Surface fire flame length (ft)	Type of fire
7	P00	8.28	Surface
7	P01	7.71	Surface
7	P02	4.74	Surface
7	P05	5.22	Surface
7	P08	6.23	Surface
7	P10	7.89	Surface
8	P00	10.11	Passive crown
8	P01	7.44	Surface
8	P02	6.20	Surface
8	P05	14.79	Passive crown
8	P08	6.23	Surface
8	P10	18.31	Passive crown

Jaybird (Project 172, Yuba River Ranger District)

Project history

The Jaybird project had three plots set up pre-treatment using the National Park Service (NPS) plot style. For details about the protocol used, please see "Appendix B: Sampling Protocol" at the end of the report. Only two plots were treated and maintained in the study. Plots were sampled prior to treatment (P00), then 1 yr post (P01), and 2 yr post (P02) (Table 25).

For analysis at the regional level, plots from all projects were grouped into one of two treatment types (mechanical or prescribed fire) and one of three dominant forest types (yellow pine, red fir, or mixed conifer). For this project, all plots were grouped into the prescribed fire type and mixed conifer forest type.

The Pike County Lookout RAWS was used for fire weather and fire behavior simulation modeling.

Table 25. Treatment visits completed by year for each of the plots in the project. ~ Indicates data was not collected for that plot or year.

Plot	2001	2003	2004	2005
4	P00	P01	P02	~
5	P00	~	P01	P02

Treatment information

Prior treatment: None known

During the project treatment: Plot 4 had prescribed fire treatments on 6/12/2003, and Plot 5 had prescribed fire treatment on 3/19/2004. The area was thinned (by contract or hotshot crew) and dozer piled in 2009, then burned over the winter of 2009/2010. Notes show both plots being affected by this second round of treatments and data was no longer maintained after the treatment.

Future treatment: None known.

Project location map

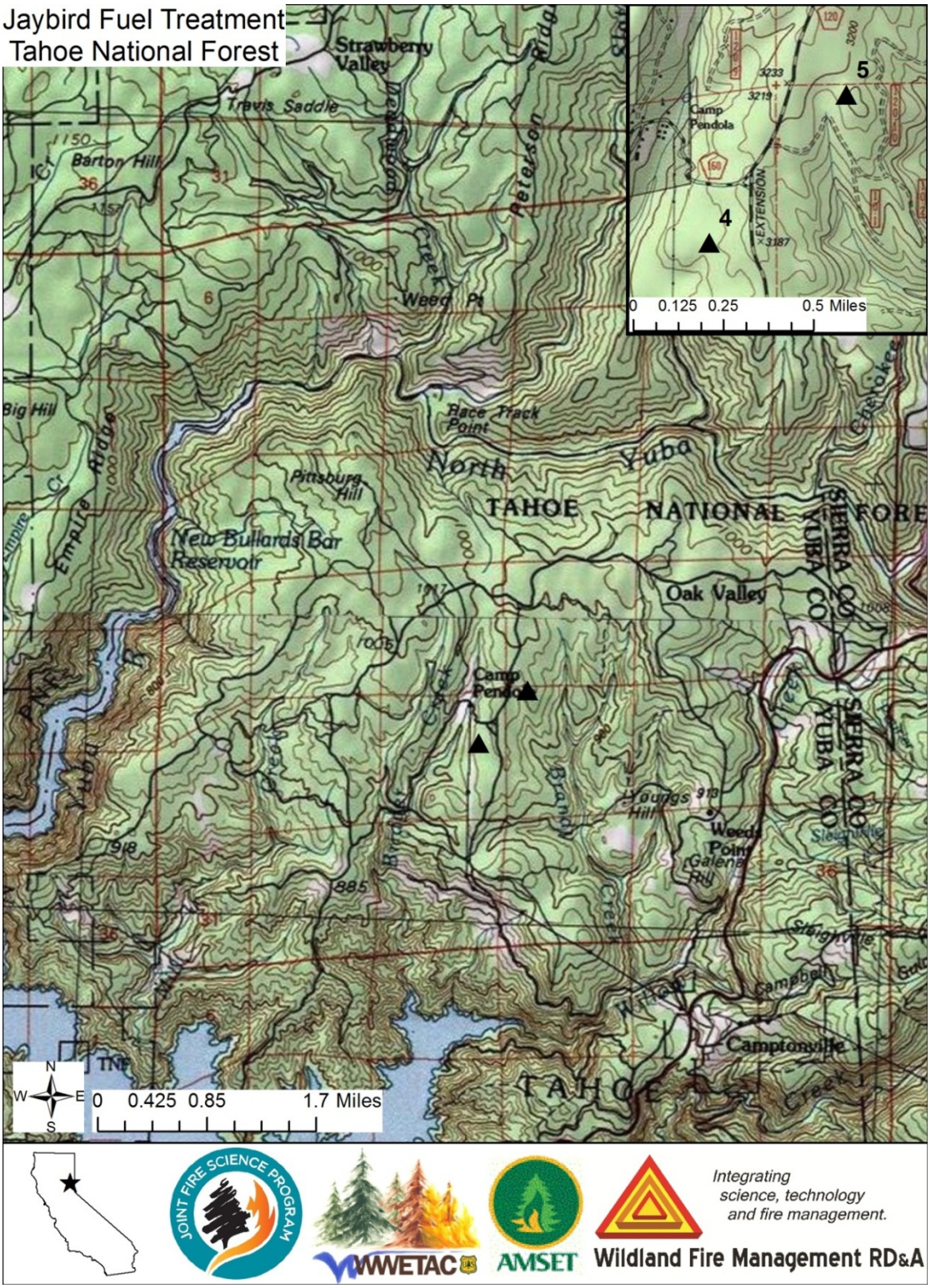

Figure 19. Location map for the Jaybird monitoring plots, showing general location of plots, and inset displaying increased detail of plot locations.

Driving directions/GPS/plot layout

Driving directions

Plot 4- From Nevada City, take Hwy 49 North towards the Forest Service office building in Camptonville, (formerly the North Yuba River Ranger Station). Drive approximately 1 mile past the Camptonville office and make a left onto Pendola Rd. Travel for 3.1 miles to Pendola Ext. At 0.7 miles from intersection turn left into a timber landing. Start tree on north end of landing, that had "UTS" labeled on it with bright paint.

Plot 5- From Nevada City, take 49 North towards the Forest Service office building in Camptonville, (formerly the North Yuba River Ranger Station). Drive approximately 1 mile past the Camptonville office and make a left onto Pendola Rd. You'll wind around drive past the Pendola ranch, and finally come to a Y-intersection at about 3.1 miles. Take the Pendola extension road. At the Mill street intersection start your odometer and keep driving for 0.4 miles; you can barely see the start tree tag from the road.

Table 26. Directions (distance and azimuth) for walking from the" start tree" to each plot. The azimuth takes into account the local declination. Distance and azimuth are approximate as they were recorded by crews walking in from the start tree (usually tagged tree near road edge).

Plot	Start tree (DBH and species)	Azimuth °	Distance
4	110 cm ponderosa pine	333	260 m
5	88 cm Douglas-fir	122	270 m

Table 27. GPS coordinates for each plot (decimal degrees, datum NAD 1983, projection NAD_1983_California_Teale_Albers).

Plot	Latitude	Longitude
4	39.485656	-121.083359
5	39.491646	-121.076317

Table 28. Plot layout line azimuths (degrees). See Appendix A for plot diagrams. Where AB and CD is the main transect and F1, F2, F3, and F4 are the fuels transects.

Plot	Plot type	AB	CD	F1	F2	F3	F4
4	NPS	130	130	348	66	140	56
5	NPS	214	214	6	133	138	63

Paired pictures

Below is an example of pictures paired or matched over the time steps the plots were visited. All of the Paired pictures are available in the supplied power point file.

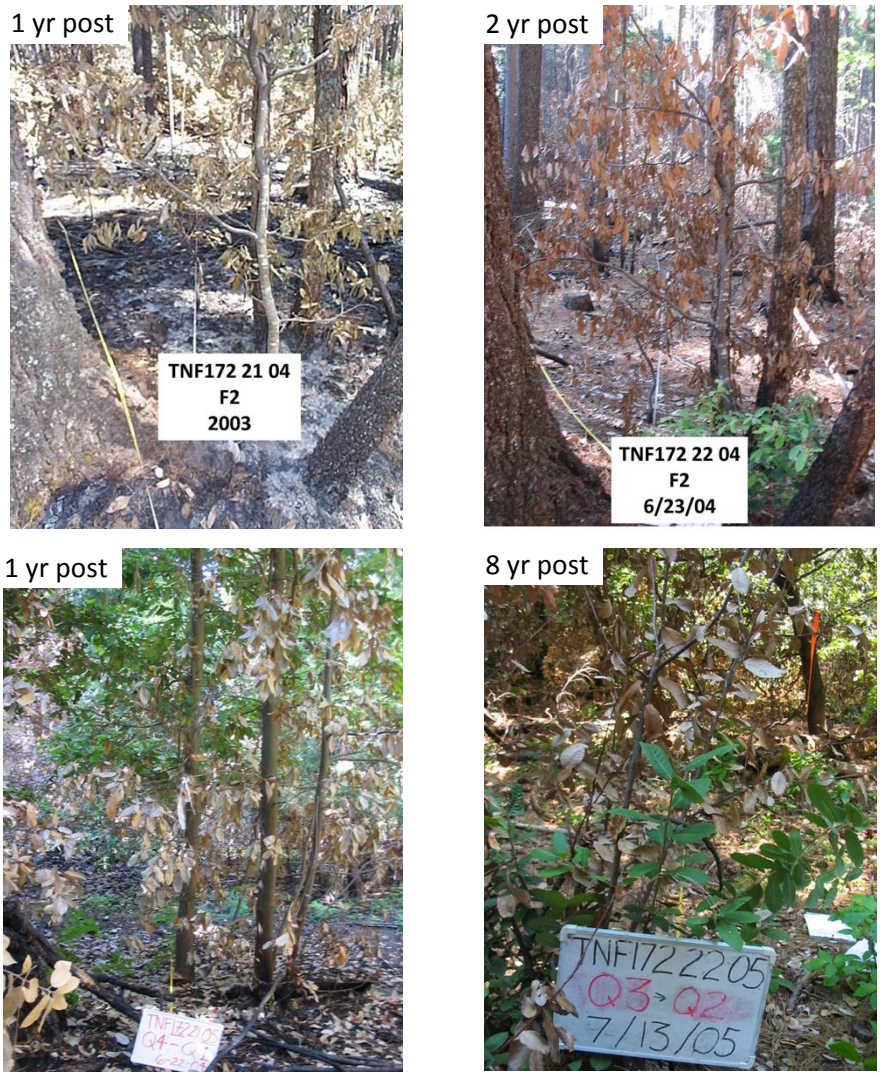

Figure 20. Example paired photos showing changes over the time steps for Plot 4 on the fuels transect 1 (F1, top row) and Plot 5 on the CD (Q3 to Q2, or main transect line, bottom row) from 1 yr post – treatment in 2003/2004) and 2 yr post-treatment in 2004/2005).

Plot findings

Below are graphs and data tables of key metrics from the data gathered in the field for each plot and time period within the project.

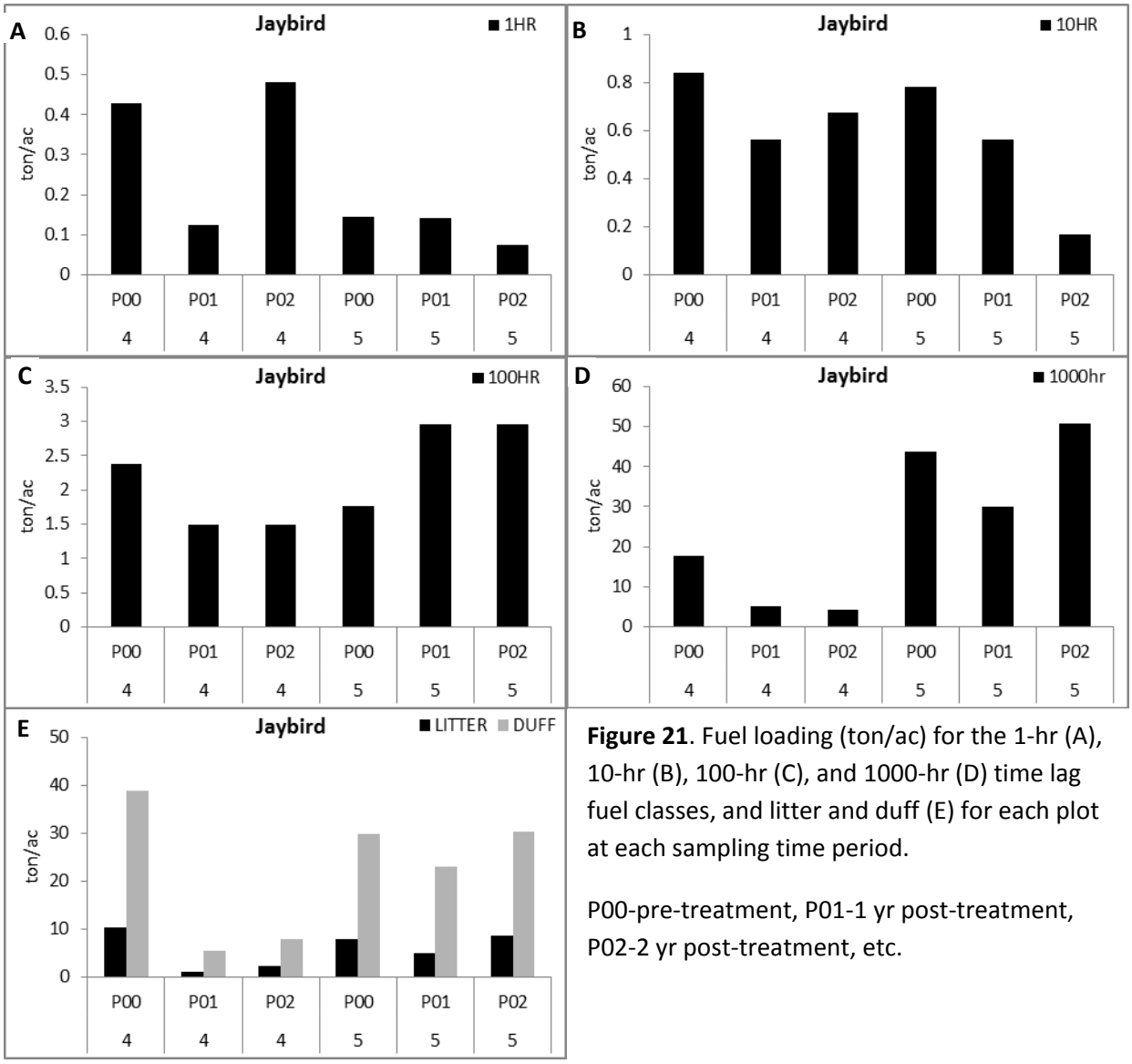

Figure 21. Fuel loading (ton/ac) for the 1-hr (A), 10-hr (B), 100-hr (C), and 1000-hr (D) time lag fuel classes, and litter and duff (E) for each plot at each sampling time period.

P00-pre-treatment, P01-1 yr post-treatment, P02-2 yr post-treatment, etc.

Table 29. Fuel loading (ton/ac) for the 1-hr, 10-hr, 100-hr, and 1000-hr time lag fuel classes, and litter and duff for by time period for all the plots in the Jaybird fuel treatment project.

Plot	Time period	1-hr	10-hr	100-hr	1000-hr	Litter	Duff
4	P00	0.43	0.8	2.4	17.6	10.2	38.8
4	P01	0.12	0.6	1.5	5.0	1.2	5.5
4	P02	0.48	0.7	1.5	4.3	2.3	7.9
5	P00	0.15	0.8	1.8	43.8	7.9	29.8
5	P01	0.14	0.6	3.0	29.8	5.0	22.9
5	P02	0.08	0.2	3.0	50.8	8.7	30.4

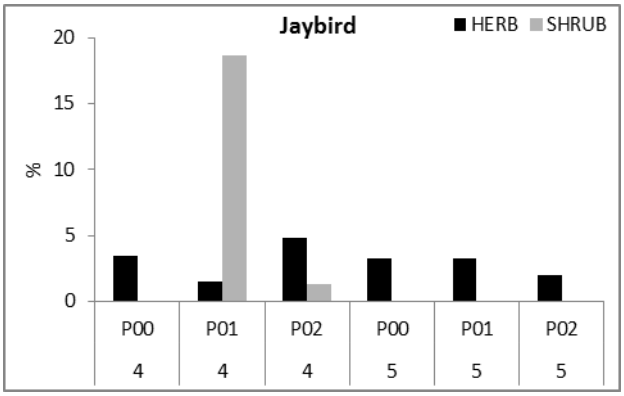

Figure 22. Average herbaceous plant and shrub cover for each plot at each sampling time period.

Note: The high cover P01 for Plot 4 might be due to sampling error in the field.

Table 30. Understory vegetation cover by time period for all the plots in the Jaybird fuel treatment project. Note: The high cover P01 for Plot 4 might be due to sampling error in the field.

Plot	Time period	Herbaceous cover (%)	Shrub cover (%)
4	P00	4	0
4	P01	2	19
4	P02	5	1
5	P00	3	0
5	P01	3	0
5	P02	2	0

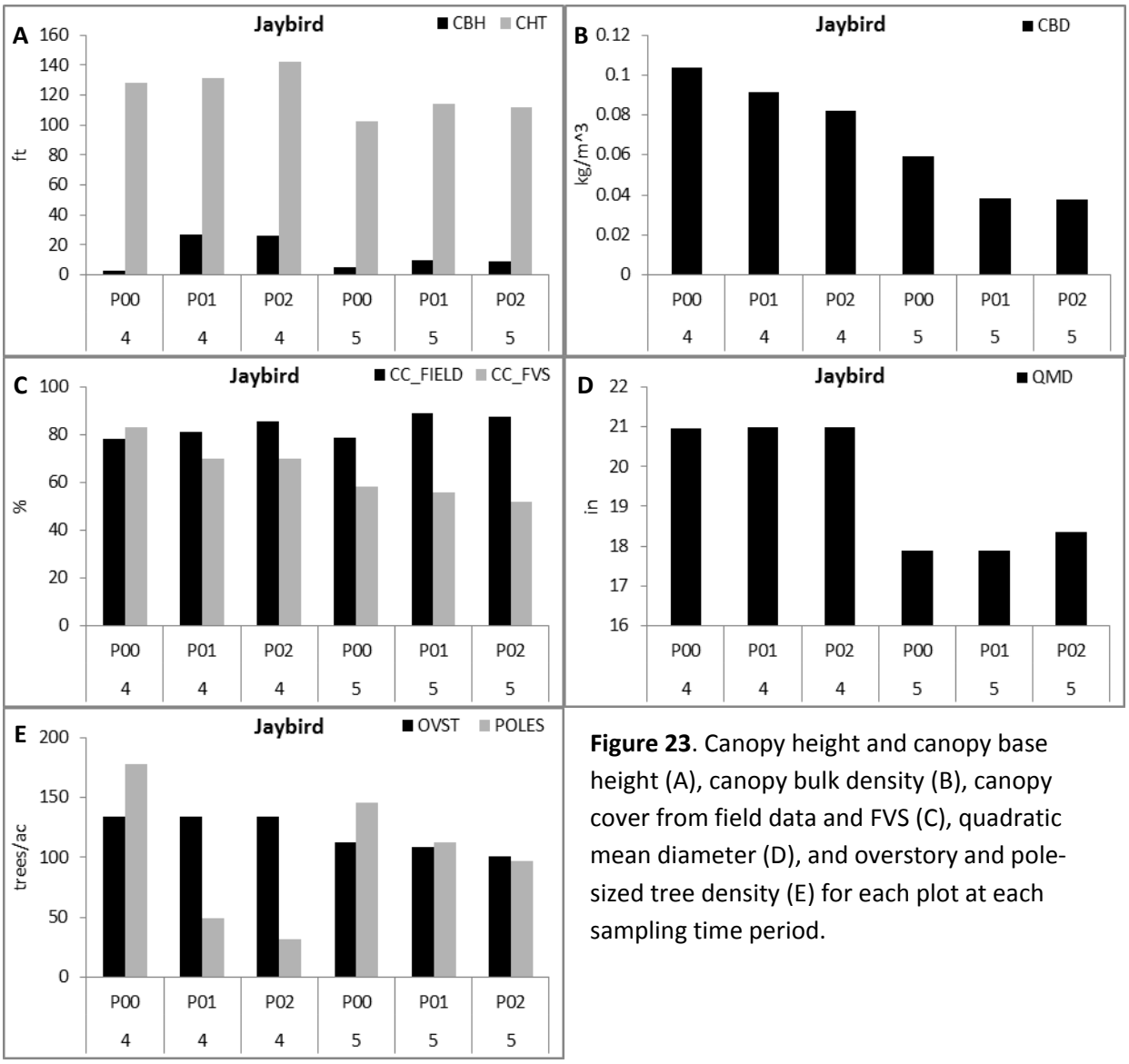

Figure 23. Canopy height and canopy base height (A), canopy bulk density (B), canopy cover from field data and FVS (C), quadratic mean diameter (D), and overstory and pole-sized tree density (E) for each plot at each sampling time period.

Table31. Canopy characteristics by time period for all the plots in the Jaybird fuel treatment project.

Plot	Time period	Canopy cover (%) - field	Canopy cover (%) - FVS	Canopy height (ft)	Canopy base height (ft)	Canopy bulk density (kg/m^3)	Quadratic mean diameter (in)	Overstory (trees/ac)	Pole-sized (trees/ac)
4	P00	78	83	128.6	3.0	0.104	21.0	134	178
4	P01	81	70	131.5	27.0	0.091	21.0	134	49
4	P02	85	70	142.2	26.0	0.082	21.0	134	32
5	P00	79	58	102.5	5.0	0.059	17.9	113	146
5	P01	89	56	114.3	10.0	0.039	17.9	109	113
5	P02	88	52	111.6	9.0	0.038	18.4	101	97

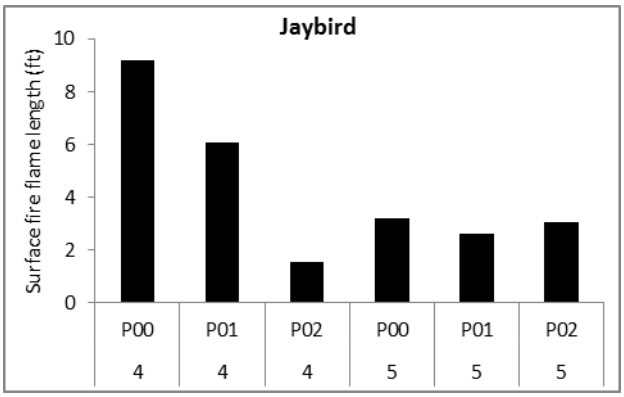

Figure 24. Surface fire flame length from custom fuel models using NEXUS for each plot at each sampling time period under 90th percentile fire weather conditions.

Table 32. Surface fire flame length (modeled in NEXUS with custom fuel models) and type of fire for 90th percentile fire weather conditions for all the plots in the Jaybird fuel treatment project.

Plot	Time period	Surface fire flame length (ft)	Type of fire
4	P00	9.20	Passive crown
4	P01	6.07	Surface
4	P02	1.53	Surface
5	P00	3.20	Passive crown
5	P01	2.60	Surface
5	P02	3.03	Surface

Moon Unit (Project 49, Yuba River Ranger District)

Project history

The Moon Unit project had four plots set up pre-treatment using the detailed 2003 style. For details about the protocol used, please see "Appendix B: Sampling Protocol" at the end of the report. Plots were sampled prior to treatment (P00), then 1 yr post (P01), 2 yr post (P02),and 8 yr post (P08) (Table 33).

For analysis at the regional level, plots from all projects were grouped into one of two treatment types (mechanical or prescribed fire) and one of three dominant forest types (yellow pine, red fir, or mixed conifer). For this project, all plots were grouped into the prescribed fire treatment type. Plots 1 to 3 were grouped into the mixed conifer forest type, and plot 4 was grouped into the yellow pine forest type.

The Pike County Lookout RAWS was used for fire weather and fire behavior simulation modeling.

Table 33. Treatment visits completed by year for each of the plots in the project.

Plot	2004	2005	2011
1	P00/P01	P02	P08
2	P00/P01	P02	P08
3	P00/P01	P02	P08
4	P00/P01	P02	P08

Treatment information

Prior treatment: Both units were masticated 2-3 years before the burn, estimated to have occurred in 2001.

During the project treatment: Plots were treated with prescribed fire on 6/16/2004.

Future treatment: Nothing known.

Project location map

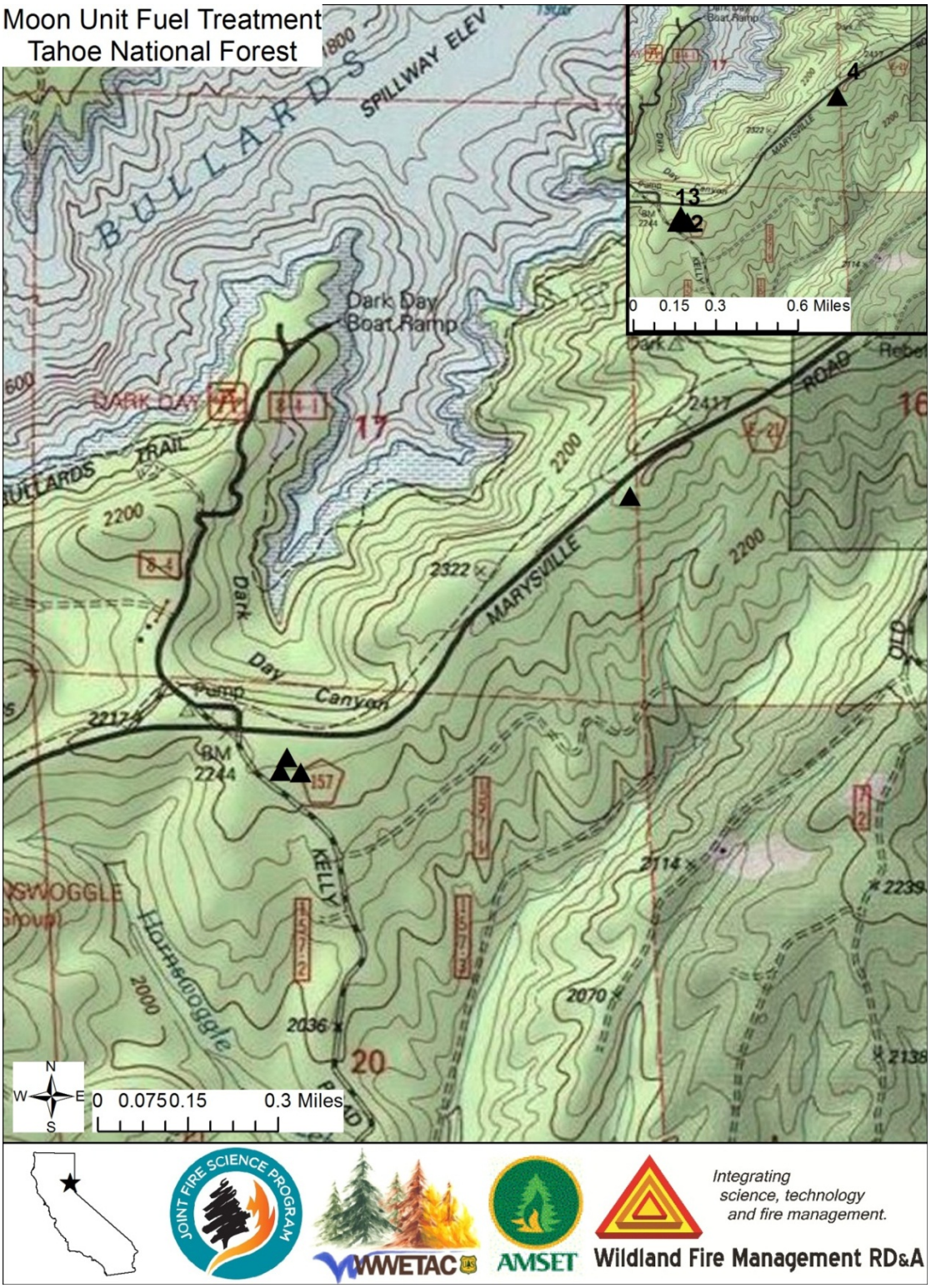

Figure 25. Location map for the Moon Unit monitoring plots, showing general location of plots, and inset displaying increased detail of plot locations.

Driving directions/GPS/plot layout

Driving directions

Plot 1- From Tahoe NF Supervisors Office, take Hwy 49 to the USFS Camptonville office (formerly N. Yuba River Ranger District), go west on Marysville Rd. past old toll Rd., at 2.6 miles from start of Marysville Rd., left turn on Dark Bay Rd. (a.k.a. Kelly Rd.). Plots are SE of intersection about 100 m. Plots 1 to 3 share the same start tree; the placard on the tree faces away from the road.

Plot 2- See Plot 1..

Plot 3- See Plot 1.

Plot 4- From Tahoe Supervisors Office, take Hwy 49 to the Camptonville office, go west on Marysville Rd. Travel 1.8 miles, start tree is across the street from a turnout with the placard facing away from the road.

Table 34. Directions (distance and azimuth) for walking from the" start tree" to each plot. The azimuth takes into account the local declination. Distance and azimuth are approximate as they were recorded by crews walking in from the start tree (usually tagged tree near road edge).

Plot	Start tree (DBH and species)	Azimuth °	Distance
1	126 cm incense cedar	135	82 m
2	Same as Plot 1	90	75 m
3	Same as Plot 1	283	71 m
4	93 cm incense cedar	77	58 m

Table 35. GPS coordinates for each plot (decimal degrees, datum NAD 1983, projection NAD_1983_California_Teale_Albers).

Plot	Latitude	Longitude
1	39.419445	-121.108553
2	39.419807	-121.108998
3	39.419479	-121.109193
4	39.426206	-121.098411

Table 36. Plot layout line azimuths (degrees). See Appendix A for plot diagrams. Where AB and CD is the main transect and F1, F2, F3, and F4 are the fuels transects.

Plot	Plot type	CD	F1	F2
1	Detailed 2003	86	359	27
2	Detailed 2003	102	136	45
3	Fuels 2003	96	4	94
4	Detailed 2003	83	348	78

Paired pictures

Below is an example of pictures paired or matched over the time steps the plots were visited. All of the Paired pictures are available in the supplied power point file.

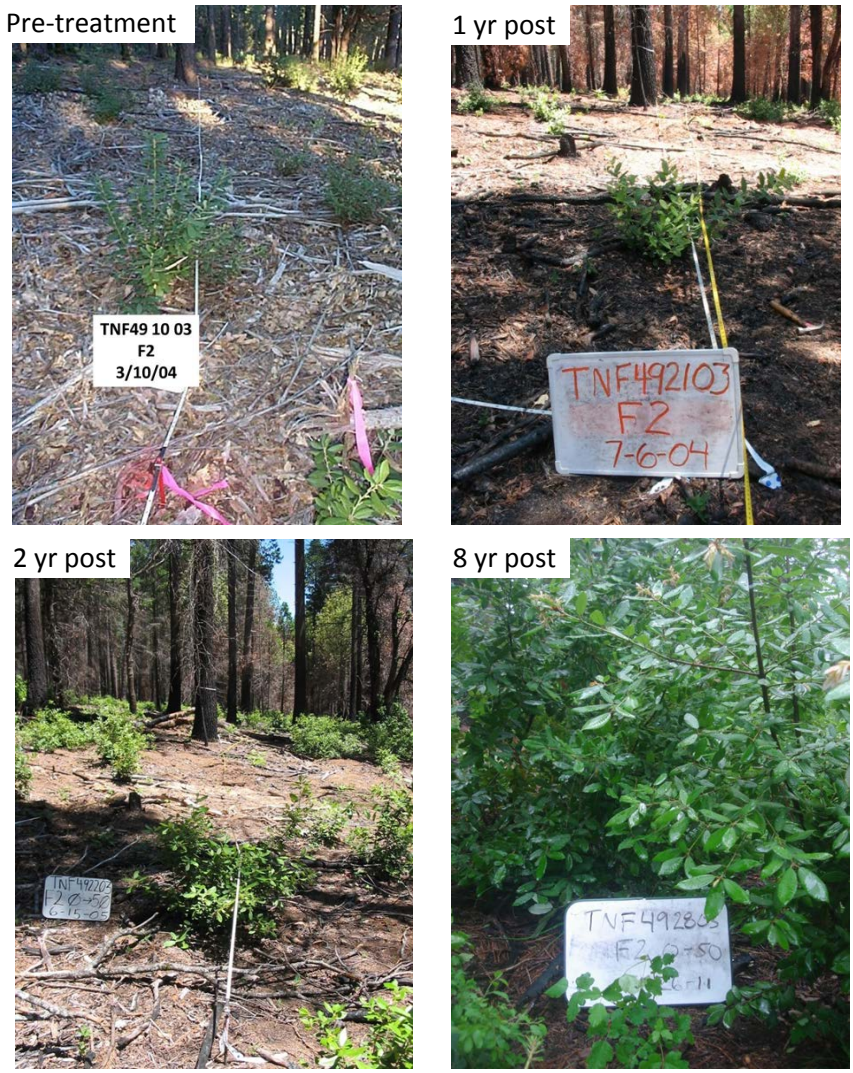

Figure 26. Example paired photos showing changes over the time steps for Plot 3 on fuel transect 2 (F2) from pre-treatment in 2004 through 8 yr post-treatment in 2011.

Plot findings

Below are graphs and data tables of key metrics from the data gathered in the field for each plot and time period within the project.

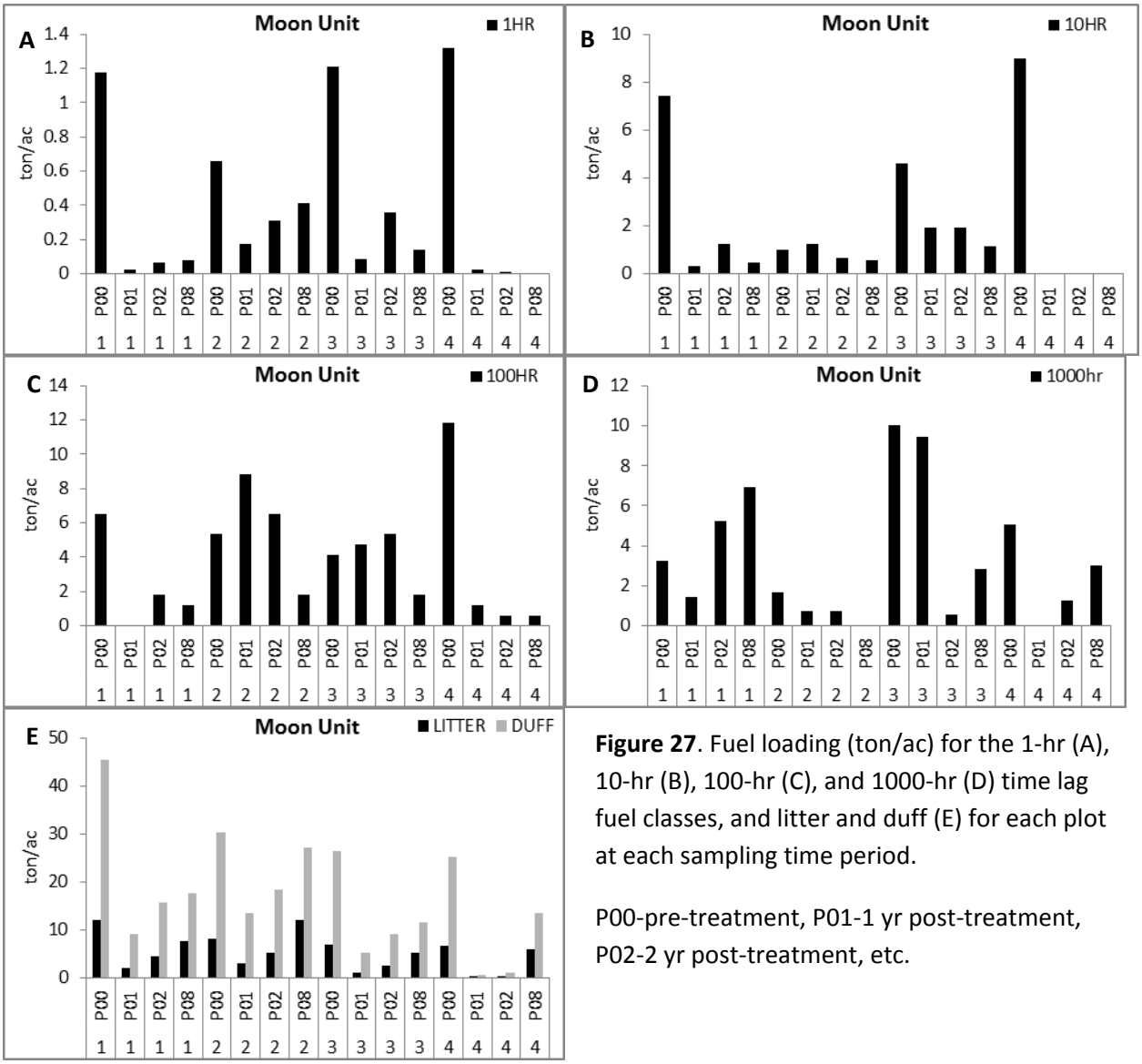

Figure 27. Fuel loading (ton/ac) for the 1-hr (A), 10-hr (B), 100-hr (C), and 1000-hr (D) time lag fuel classes, and litter and duff (E) for each plot at each sampling time period.

P00-pre-treatment, P01-1 yr post-treatment, P02-2 yr post-treatment, etc.

Table 37. Fuel loading (ton/ac) for the 1-hr, 10-hr, 100-hr, and 1000-hr time lag fuel classes, and litter and duff for by time period for all the plots in the Moon Unit fuel treatment project.

Plot	Time period	1-hr	10-hr	100-hr	1000-hr	Litter	Duff
1	P00	1.18	7.4	6.5	3.2	12.0	45.5
1	P01	0.02	0.3	0.0	1.4	2.0	9.2
1	P02	0.06	1.2	1.8	5.3	4.5	15.6
1	P08	0.08	0.4	1.2	7.0	7.8	17.6
2	P00	0.66	1.0	5.3	1.7	8.0	30.4
2	P01	0.17	1.2	8.9	0.7	2.9	13.6
2	P02	0.31	0.7	6.5	0.7	5.3	18.5
2	P08	0.41	0.6	1.8	0.0	11.9	27.1
3	P00	1.21	4.6	4.1	10.0	6.9	26.3
3	P01	0.09	1.9	4.7	9.4	1.1	5.2
3	P02	0.36	1.9	5.3	0.6	2.6	9.2
3	P08	0.14	1.1	1.8	2.8	5.1	11.6
4	P00	1.32	9.0	11.8	5.0	6.7	25.2
4	P01	0.02	0.0	1.2	0.0	0.1	0.5
4	P02	0.01	0.0	0.6	1.3	0.3	1.0
4	P08	0.00	0.0	0.6	3.0	5.9	13.5

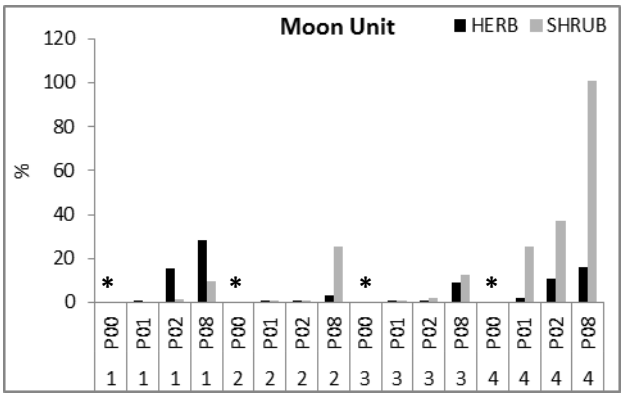

Figure 28. Average herbaceous plant and shrub cover for each plot at each sampling time period.

*Indicates the data was not collected, not a zero value (see Table 38).

Table 38. Understory vegetation cover by time period for all the plots in the Moon Unit fuel treatment project. * Indicates data was not collected for that plot and time period.

Plot	Time period	Herbaceous cover (%)	Shrub cover (%)
1	P00	*	0
1	P01	1	0
1	P02	16	1
1	P08	29	9
2	P00	*	0
2	P01	1	0
2	P02	1	1
2	P08	3	26
3	P00	*	0
3	P01	1	1
3	P02	1	2
3	P08	9	12
4	P00	*	0
4	P01	2	25
4	P02	11	37
4	P08	16	101

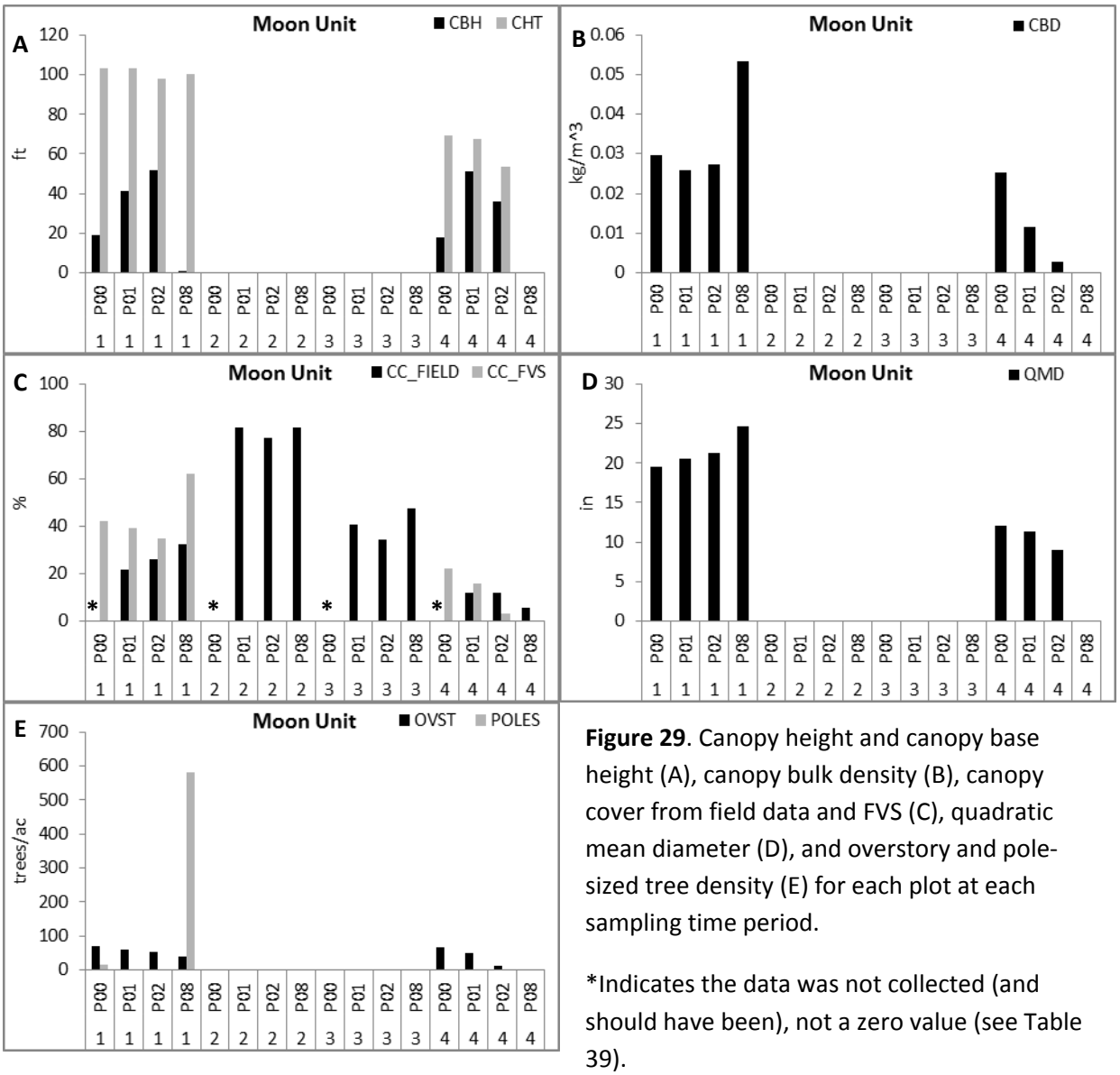

Figure 29. Canopy height and canopy base height (A), canopy bulk density (B), canopy cover from field data and FVS (C), quadratic mean diameter (D), and overstory and pole-sized tree density (E) for each plot at each sampling time period.

*Indicates the data was not collected (and should have been), not a zero value (see Table 39).

Table39. Canopy characteristics by time period for all the plots in the Moon Unit fuel treatment project. * Indicates the data was not collected for that plot and time period.

Plot	Time period	Canopy cover (%) - field	Canopy cover (%) - FVS	Canopy height (ft)	Canopy base height (ft)	Canopy bulk density (kg/m^3)	Quadratic mean diameter (in)	Overstory (trees/ac)	Pole-sized (trees/ac)
1	P00	*	42	103.1	19.0	0.030	19.5	69	16
1	P01	22	39	103.1	41.0	0.026	20.6	61	0
1	P02	26	35	98.0	52.0	0.027	21.2	53	0
1	P08	32	62	100.5	1.0	0.053	24.6	40	583
2	P00	*	*	*	*	*	*	*	*
2	P01	82	*	*	*	*	*	*	*
2	P02	77	*	*	*	*	*	*	*
2	P08	82	*	*	*	*	*	*	*
3	P00	*	*	*	*	*	*	*	*
3	P01	41	*	*	*	*	*	*	*
3	P02	34	*	*	*	*	*	*	*
3	P08	48	*	*	*	*	*	*	*
4	P00	*	22	69.1	18.0	0.025	12.1	65	0
4	P01	12	16	67.2	51.0	0.012	11.4	49	0
4	P02	12	3	53.6	36.0	0.003	9.0	12	0
4	P08	6	0	0.0	0.0	0.000	0.0	0	0

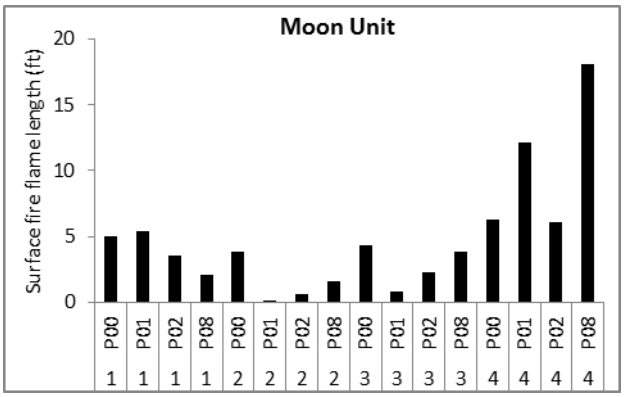

Figure 30. Surface fire flame length from custom fuel models using NEXUS for each plot at each sampling time period under 90th percentile fire weather conditions.

Table 40. Surface fire flame length (modeled in NEXUS with custom fuel models) and type of fire for 90th percentile fire weather conditions for all the plots in the Moon Unit fuel treatment project. * Indicates the tree data was not collected, and type of fire was not modeled.

Plot	Time period	Surface fire flame length (ft)	Type of fire
1	P00	5.06	Surface
1	P01	5.43	Surface
1	P02	3.54	Surface
1	P08	2.12	Passive crown
2	P00	3.89	*
2	P01	0.12	*
2	P02	0.67	*
2	P08	1.59	*
3	P00	4.3	*
3	P01	0.81	*
3	P02	2.24	*
3	P08	3.84	*
4	P00	6.33	Surface
4	P01	12.13	Surface
4	P02	6.04	Surface
4	P08	18.12	Passive crown

Appendix A: Description of Supplied Files

For your use we included a number of supplementary files with the digital version of this report (see the supplied thumb drive).

Final report to the JFSP

We included a digital version of the Final Report we submitted to the Joint Fire Science Program for the entire regional assessment.

FVS input database

For each Forest we included an FVS-ready database with all the plots from all the projects (*.mdb). The database includes two different StandInit and TreeInit tables depending on the plot types within the Forest; separate StandInit and TreeInit tables were created for the “detailed” plots and the “fuels” plots. We did this so one would not assume there was tree data available for all plots when it might not have been sampled. The fuel loading data was collected on all plots and is included by size class in both StandInit tables. For the detailed plots, the tree data collected is within the TreeInit table. For the fuels plots, a “dummy” tree list (a single white fir seedling) was created so the plots can be run through FVS, but caution should be used with these because of the lack of real tree data. If data was missing it is represented as a blank in the data tables.

Photo pairs

Most of the photos taken for each plot is included in the supplied Power Point file (*.pptx). Photos were taken along the main transect line(s) and fuel lines each time the plot was visited.

Plot maps

In addition to the imbedded maps in this report, we have supplied PDF versions of the Project location maps.

GIS shapefile

We supplied a GIS file with all the plots for the Forest.

Appendix B: Sampling Protocol

Data collection protocol (inclusive of all plot layouts)

Plot information naming example

1. Forest name: *"Tahoe NF"*
2. Forest ICS code: *"TNF"*
3. Project name: "Jaybird"
4. Project number: pre-determined for tracking purposes
5. Status: P00=pre-treatment, P01=1st year post, P02=2nd year post, etc.
6. Plot number: *"1"*
7. Surveyors: *"last name, first initial"*
8. Date: *"5/8/09"*
9. Notes: general notes about the area, treatment, anything that stands out

Shrub transect(s) (50 m)

Collect shrub information (for any shrubs that intersect the transect tape) along the length of the transect(s): transect, species, status (live/dead), shrub range in decimeters (dm, distance along transect, i.e. 0.6-0.9 m=3 dm), average height (cm).

Herbs (1x1 m quadrats)

Collect herbaceous species information for all plants rooted in the quadrat. Record the transect, frame, life form (fern, forb, grass, vine, other, unknown), status (live/dead), average height (cm), species (if you know it), and cover class (1=0-5%; 2= 6-25%; 3= 26-50%; 4=51-75%; 5=76-95%; 6=96-100%). Also please take general botany notes for the plot, such as species observed in the plot overall but not captured in the quadrats, and general observations about how much of the plot has weeds or herbaceous plant dominance.

Seedlings (<2.5 cm DBH)

Tally seedlings by species code, status (live/dead), and height class (15=1-15 cm; 30=16-30 cm; 60=31-60 cm; 100=61-100 cm; 200=101-200 cm; 300=201-300 cm, etc.).

Pole-sized trees (>2.5 to <15 cm DBH, and > 4.5 ft (1.37 m) tall)

Live poles: tag #, species, DBH (cm), status (live/dead), partial crown height (m), total tree height (m), canopy class (D=dominant, CD=codominant, I=intermediate, S=suppressed).

Dead poles: tag#, species, DBH (cm), status (live/dead), total tree height (m), decay class (1 newly dead thru 5 long dead).

Overstory trees (>15 cm DBH and > 4.5 ft (1.37 m) tall)

Live trees: tag #, species, DBH (cm), status (live/dead), partial crown height (m), total tree height (m), canopy class (D, CD, I, S).

Dead trees: tag#, species, DBH (cm), status (live/dead), total tree height (m), decay class (1 newly dead thru 5 long dead).

Canopy cover

Collect and record canopy cover, using the moosehorn (canopy sight tube) along the main transects (AB and/or CD) every 1m, starting at 1m and ending at 50m. The moosehorn should be held at the meter mark on the tape, standing on the side of the shrub transect opposite to the side where the herb quadrats are being place. Count the number of hits or intersections, out of 25, where canopy overlaps the grid intersections.

Fuel loading

Each planar fuel transect is 50 ft in length and information is gathered to characterize surface and ground fuels and fuel bed depth.

Surface fuels (1, 10, 100, 1000-hr)

Record the project, plot, transect and tallies for small fuel classes (1, 10, 100-hr), and take notes on the **dominant trees or shrub species** contributing to the fuel load for each transect.

Tally: 1-hr (>0.25”) from 0-6 ft, 10-hr (0.25-<1”) from 0-6 ft, 100-hr (1-<3”) from 0-12 ft.

Record the species, diameter (cm), and status (rotten/sound) for each 1000-hr (> 3’) from 0-50 ft.

Ground fuels (litter/duff/chips)

Measure and record litter and duff depth (thickness) measurements to the nearest 1 cm (measure thickness of each layer, not depth from surface). Starting at 1 foot, take 10 readings, one every 5 ft on each transect: (1 ft, 5 ft, 10 ft… 45 ft). Duff begins where the litter layer organic materials have begun to decompose, and duff ends where the composition is greater than 50% mineral soil. If a sampling spot lands exactly on a log, rock, or other obstruction, take the reading immediately adjacent to the obstruction. If you hit bare soil, your reading will be 0.

If there was mastication/chipping completed, record the depth of the chipped materials as well.

Fuel bed depth

Measure and record the height of the **tallest** downed and dead woody fuel for ten 5 ft collection point intervals (0-5 ft, 5-10 ft, 10-15 ft, up to 45-50 ft) along the planar transect. Measure from the **base of the litter layer to the top of the fuel particle**; measure to the nearest whole cm. If you do not have any dead and downed fuels, your measure will be based on the maximum litter depth in that interval.

Photos

Avoid people and gear in the photos. Line up with the photos supplied from previous plot visits to the best of your ability. Use a photo board to document the photo location within the photos, matching the plot naming protocol example above. **Always take the photos in a portrait orientation (up and down) with the transect tape in the bottom middle of the image**. Photos were only taken from 0 to 50 ft for each fuels transect (labeled F1, F2, etc.), from C to D (and A to B if applicable) for the shrub transect, and one general picture of the plot (this one will not have an old photo to match).

National Park Service (NPS) plot specifics

Shrub transects (50 m)

Collect the shrub data along Q4→Q1 (transect AB) and Q3→Q2 (transect CD) transects according to the current protocol.

Herb quadrats

Looking from 0 m to 50 m on the Q4→Q1 transect, place the herb frame on the right hand side of the line from 9-10 m, 19-20 m, 29-30 m, 39-40 m and 49-50 m. Record this as transect AB. These are frames 1, 2, 3, 4, and 5, respectively.

Looking from 0 m to 50 m on the Q3→Q2 transect, place the herb frame on the left hand side of the line from 9-10 m, 19-20 m, 29-30 m, 39-40 m and 49-50 m. Record this as transect CD. These are frames 1, 2, 3, 4, and 5, respectively.

Seedlings

This should take place in a 50 square meter area between the 25 m and 30 m rebars in quadrant Q1. See the diagram.

Pole-sized trees

Pole-sized trees are measured in the entire area of quadrant Q1. See the diagram.

Overstory trees

Overstory trees are measured in the whole plot area and are numbered in order starting in quadrant Q1 and ending in quadrant Q4. See the diagram.

Canopy cover

Along the Q4→Q1 (transect AB) and Q3→Q2 (transect CD) transects collect the moosehorn intersections every meter starting at 1 m and ending at 50 m.

Fuel loading

The four fuels lines start along the P transect at point 1A, 2A, 3A, and 4A. Each line was given a different random bearing and is 50ft long, the end point rebar are marked as 1B, 2B, 3B, and 4B.

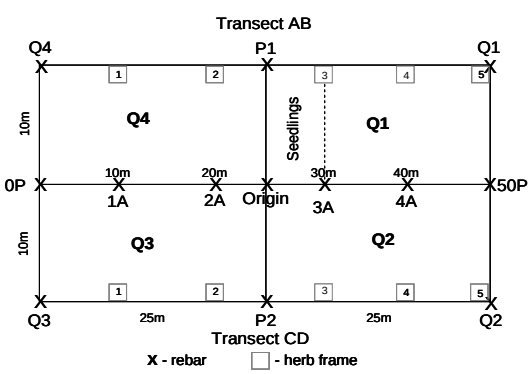

Figure 31. Plot diagram for the NPS plots lay out.

2003 detailed plot specifics

Shrub transects (50 m)

There is one transect (CD) for these plots. It **should** be contour to the slope.

Herb quadrats

There are five quadrats for these plots. They are located from 9-10 m, 19-20 m, 29-30 m, 39-40 m, and 49-50 m along the uphill side of CD transect.

Seedlings

This is a circular plot starting at the pole/seedling origin rebar (at 33.92 m on transect CD) extending out and around 3.99 m in all directions.

Pole-sized trees

This is a circular plot starting at the pole/seedling origin rebar (at 33.92 m on transect CD) extending out and around 8.92 m in all directions.

Overstory trees

This is a circular plot starting from the origin (at 25 m on transect CD) extending out and around 17.85 m in all directions.

Canopy cover

A total of 50 canopy cover readings will be measured. They will start at 1 m and continue every meter until the end of the transect CD (50 m).

Fuel loading

There are two 50 ft fuel transects for this layout. They both start at 7.15 m along the CD transect and have a rebar labeled "F1/F2 0ft". F1 extends uphill at a 45º angle toward the center of the plot, F2 extends downhill at a 45º angle toward the center of the plot.

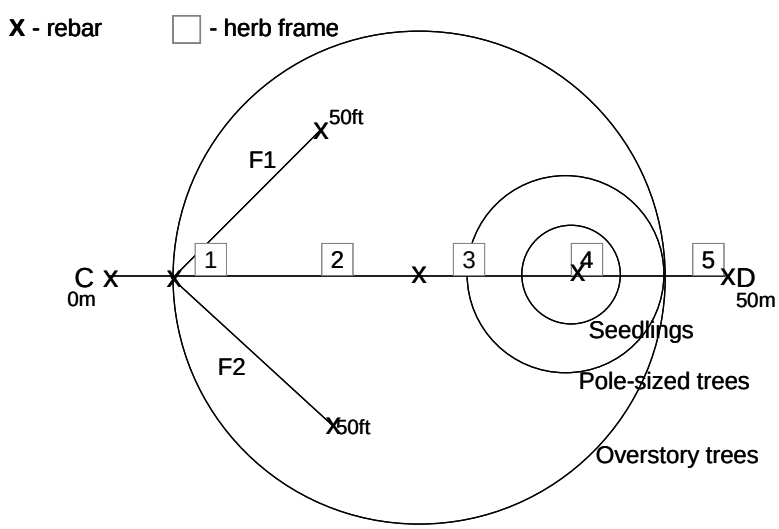

Figure 32. Plot layout diagram for the detailed plots installed from 2003 to 2006.

2003 fuels plot specifics

Starting in 2012 tree data was collected on Fuels '03 plots that were visited. You need to establish the pole/overstory and seedling rebar and tag all pole & overstory trees and gather data on all size classes!

Shrub transect

There is one transect (CD) for these plots. It **should** be contour to the slope.

Herb quadrats

There are 5 quadrats for these plots. They are located from 9-10 m, 19-20 m, 29-30 m, 39-40 m, and 49-50 m along the uphill side of CD transect.

Canopy cover

A total of 50 canopy cover readings will be measured. They will start at 1 m and continue every meter until the end of the transect CD (50 m).

Fuel loading

There are two 50 ft fuel transects for this layout. They both start at 7.15 m along the CD transect and have a rebar labeled "F1/F2 0 ft". F1 extends uphill at a 45º angle toward the center of the plot, F2 extends downhill at a 45º angle toward the center of the plot.

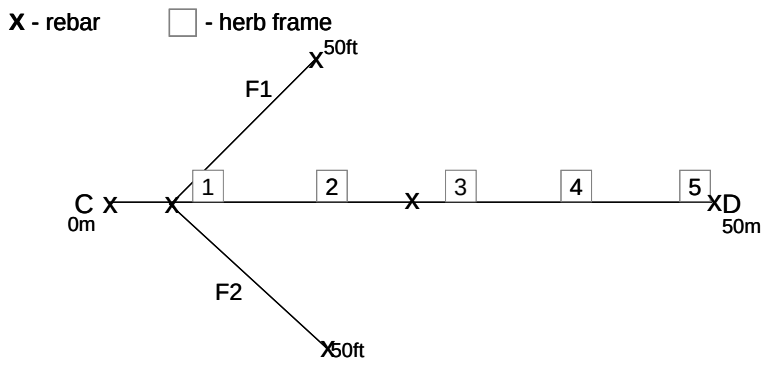

Figure 33. Plot layout diagram for the fuels plots installed from 2003 to 2006.