# EFFECTS OF FUEL LOADING ON POTENTIAL FIRE BEHAIVIOR AND SOIL EROSION IN COAST REDWOOD STANDS

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## INTRODUCTION

Commercial timber harvesting typically reduces aerial fuel loading and continuity, but can actually heighten fire activity through increased surface fuel loading (Agee 1997). Fuel depth and loading, which typically increase after harvest, play a significant role in fire intensity and rate of spread in redwood forests (*Sequoia sempervirens)* (D. Don.) Endl.) (Nives 1989), which are significant predictors of redwood mortality (Finney and Martin 1993). However, residual slash fuels may simultaneously reduce erosion, which may be of greater importance in some areas because they intercept rainfall and soil particles dispersed by overland flow (Fernandez et al. 2004).

The relationship of surface fuel loading on potential fire behavior and soil erosion was explored in coast redwood stands that were selectively harvested 11 years prior to this study by either cable- or tractor-skidding methods (Piirto et al. 1997). The objectives of this study were to (1) assess fuel loading and potential fire behavior in harvested stands and (2) determine if surface soil erosion was influenced by surface fuels.

## METHODS

Data were collected on the Little Creek Timber Management Unit on the Swanton Pacific Ranch near Santa Cruz, California. The site is characterized by a Mediterranean climatic regime with cool, rainy winters and dry summers that are moderated by a coastal fog belt. The land is considered to have good site quality and has nearly 100% tree coverage. Stands originated after the site was cleared for rebuilding efforts following the 1906 San Francisco earthquake. The site is steep with a great deal of instability on lower reaches near the creek. Soils are of the Ben Lomond series, which are designated as an “extreme” erosion hazard type.

Twelve permanent plots were installed in both a cable-logged and tractor-skidded unit for a total of 24 plots. Surface fuel data were obtained utilizing a point-transect method (Brown et al. 1982). Fuel loading was calculated using FMAnalyst (FMAnalyst Version 3.0.2, Fire Program Solutions, Sandy, Oregon, USA).

The effects of downed woody fuels on erosion were examined on all of the 24 plots after each storm events in the winter of 2005-2006. Within each plot, 3 soil erosion troughs were installed away from drainage and stream channels, and positioned transverse to the slope with the apron flush with the soil surface.

Potential fire behavior activity was calculated using BehavePlus (Version 3.0.1). Custom fuel models for the cable-logged and ground-skidded units were tailored from inputs characterizing fuel model TL3, which best describes both sites. The default TL3 1-hour, 10-hour, 100-hour, and fuel depths were replaced with mean values derived from data collected in the field. Winds were set to blow uphill and slope was set to 38%, which was the average slope for the study area.

## RESULTS AND DISCUSSION

Even 11 years after harvest, fuel loading of the 10-hour, 100-hour, 1000-hour timelag fuel types and average fuel depths were all significantly lower in the tractor-skidded unit (Table 1). These results were anticipated given the nature of ground-based operations. Tractor skidding typically crushes and pulverizes some of the residual slash into the ground during log transport to the landing. A slight increase in the ground-skidded 1-hour fuel class also indicates a small shift from mid-size fuels to small fuels within the fuel profile.

The analysis of the soil erosion component in this study produced inconclusive results. At this point, there is no significant difference in sediment production between cable-logged and ground-skidded areas. Both sites produced similar sediment loads, which was somewhat unexpected (Table 1). This could be attributed to a low number of samples collected during the winter, similar site characteristics between units, or the abrupt erosional characteristics associated with the Ben Lomond soil series.

Higher fuel loadings and fuel depths in the cable-logged unit certainly produce intensified fire behavior when compared to the ground-skidded unit (Figure 1). Rate of spread (A) and flame length (B) were both greatest in the cable-logged unit. In addition, both units' exhibit increased fire behavior when compared to Fuel Model TL3, a timber model characterized by moderate load conifer litter and closed canopy.

Although fire is not as common in coastal redwood forest types when compared to drier forest types, it has played a significant ecological role. Typically, fires in redwood forest regions are low intensity surface fires moderated by the higher fuel moistures and cooler temperatures characterizing maritime climates. However, the summer produces extended periods of dry weather which could easily provide fuel conditions that would support a wildfire.

Table 1. Mean fuel loading for standard fuel classes, duff depth, fuel depth, and sediment collections in the Little Creek Management Area at Swanton Pacific Ranch, CA. Data was collected in field plots located in tractor-skidded and cable-yarded units.

| Dead Down Woody Fuel Loading (Tons per Acre) | | | | | | | Avg. Duff Depth (Inches) | Avg. Fuel Depth (Inches) | Soil Collection (ounces) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 1-hr | 10-hr | 100-hr | 0"-3" Total | 1000-hr | Plot Total | | | Treatment | Average Slope (percent) | Average (per plot) | Total Sediment |
| Ground (n=12) | 0.77 | 1.97 | 4.02 | 6.75 | 9.88 | 16.63 | 1.38 | 2.43 | Ground (n=12) | 31.4 | 4.6 | 54.6 |
| Std. Error | 0.08 | 0.49 | 0.84 | 1.21 | 2.68 | 3.02 | 0.14 | 0.20 | Std. Error | 3.42 | 0.96 | |
| Cable (n=12) | 0.56 | 2.89 | 6.09 | 9.53 | 13.91 | 23.43 | 1.55 | 2.53 | Cable (n=12) | 43.6 | 4.5 | 53.6 |
| Std. Error | 0.07 | 0.44 | 1.21 | 1.37 | 3.58 | 4.01 | 0.16 | 0.18 | Std. Error | 3.80 | 0.84 | |

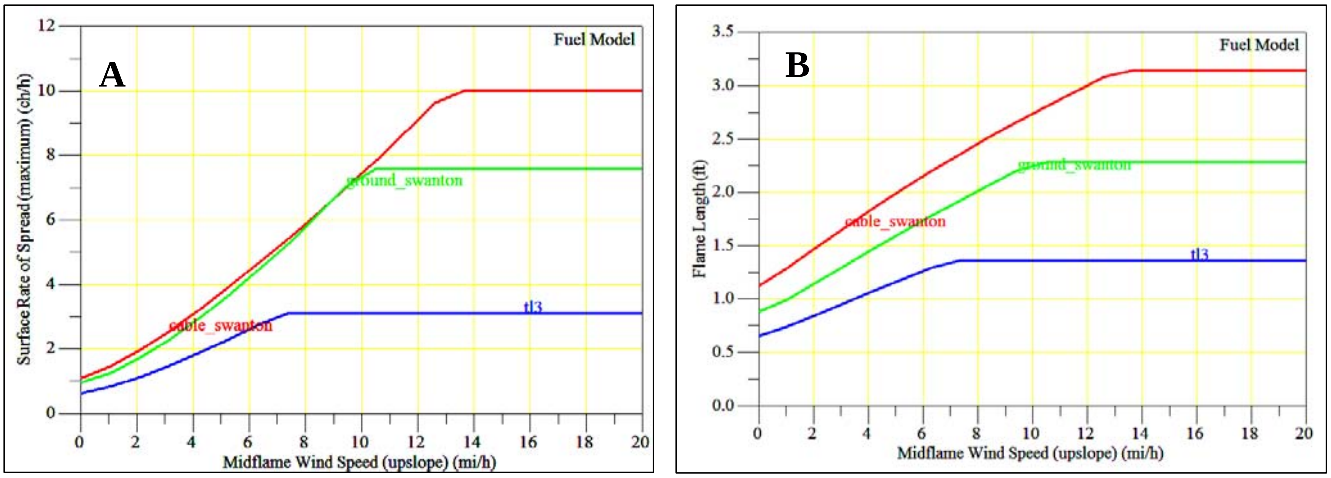


Figure 1. Projected rate of spread (A) and flame length (B) on coast redwood forest type in the Little Creek Management Area at Swanton Pacific Ranch, CA. between cable-logged and ground-skidded harvest units and Fuel Model TL3. Simulation includes a 38% slope, uphill winds, and fuel moistures for 1-hour, 10-hour, and 100-hour fuel moistures as 5%, 6%, and 7%.

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