Final Report, Joint Fire Science Program
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Project Number 03-2-3-20

Project Title:
Effects of Altering Stand Structure on Wildfire Severity and Effects in the Blacks Mountain Experimental Forest, Cascade Range, California.

Project Location:
Blacks Mountain Experimental Forest, northeastern California.

Principal Investigators:
Mary Martin Ritchie, Pacific Southwest Research Station
Bill Oliver, Pacific Southwest Research Station
Carl Skinner, Pacific Southwest Research Station
Kerry Farris, Wildlife Conservation Society
Steve Zack, Wildlife Conservation Society
Gary Nakamura, University of California, Cooperative Extension, Redding

Contact Information:
Mary Martin Ritchie
Pacific Southwest Research Station
3644 Avtech Parkway
Redding CA 96002
Phone: 530-226-2551
email: mritchie@fs.fed.us
EXECUTIVE SUMMARY

Abstract
On September 26th, 2002, the Cone Fire started near the northwest corner of Blacks Mountain Experimental Forest, in northeastern California, just outside of the boundary of the forest. It continued to burn for two days, torching approximately 810 hectares (~2000 acres) of stands dominated by ponderosa pine. The wildfire burned into three BMERP experimental units that had been previously treated with combinations of thinning and prescribed fire.

This JFSP-funded project was initiated to address four areas of research interest: (1) patterns of severity related to pre-fire conditions, (2) effects of varying levels of fire salvage on fuel accumulations and stand establishment, (3) patterns of bark beetle activity in treated and untreated stands, and (4) patterns of soil compaction related to varying levels of fire salvage. The project also funded the establishment of a demonstration site at the experimental forest describing the Cone Fire and the research following the fire.

Findings
- The Cone Fire burned approximately 2000 acres, including three treatment units. In each case the fire dropped from the crown to the surface within a few meters of entering the treatment units. For the half of the Low Diversity units that had been treated with prescribed fire, the fire died out within 50m. On the half of the treatment without prescribed fire, the wildfire continued as a surface fire. A logistic function describes the relationship between tree mortality and distance from treatment boundary.
- We examined the effects of pre-fire treatments and subsequent fire severity on beetle and woodpecker use. Both beetles and woodpeckers were more active outside the treatment areas where fire severity was greater. The general objective of most fuel reduction treatments is to reduce subsequent fire severity and the treatments implemented on BMERP appear to have successfully reached this goal. The Cone Fire burned with much greater severity outside of the BMERP treatment areas. While these treatments acted to drastically reduce fire severity and subsequent tree mortality inside the treated areas, they may not have optimized short-term foraging habitat for beetles and woodpeckers, which concentrated their use in the high severity areas outside the BMERP treatments.
- Salvage harvesting by machine operation at Blacks Mt Experimental Forest increased soil strength on loam textured Alfisols, but decreased soil strength on loam textured Mollisols. Alfisol soils show some evidence of development, which might be an increase in clay content sufficient to increase compactability but not enough to classify the soil as a clay loam. In no instance did the soil strength, pre- or post-treatment, approach or exceed the 3000 kPa thought to impede root elongation.
- Tree condition, tree species, and time since burn were the most influential factors determining the use of post-fire structures by both beetles and woodpeckers. Pre-fire treatment activities (e.g. mechanical thinning and prescribed burning) were of less importance, followed by percent crown scorch volume. Tree diameter was of
minimal influence. Bark beetles, wood-borers, and woodpeckers generally focused their activity on dead pine and fir trees. Pre-fire treatment activities had a negative effect on bark beetle and woodpecker use, with both activities tending to occur in the untreated, and consequently, more intensely burned areas. Percent crown scorch volume had a positive influence on snag attrition, wood-borer use, and woodpecker foraging and nesting activity.

- While the untreated, intensely burned areas were used more frequently by both beetles and woodpeckers, previous research suggests that this activity is short-lived and will decline by the 4\textsuperscript{th} to 5\textsuperscript{th} year following the fire. Further research is needed in order to effectively examine how beetles and woodpeckers may use of the BMERP treatment areas, which may exhibit delayed tree mortality on some of the light to moderately scorched trees.

**Implications**

- Thinning treatments at Blacks Mountain reduced fire severity. Mortality in thinned-only areas of the Cone Fire appeared to be a result of surface fuels.
- The combination of thinning and prescribed fire modified wildfire behavior more than thinning alone, with the crown fire dropping to the forest floor within a few meters of the cutting unit boundary. Mortality was almost nonexistent in thinned and burned stands.
- There is no consistent increase in soil compaction as a result of fire salvage treatments and there is no evidence of sufficient compaction to impact growth of tree seedlings.
- In the short term bark beetle activity is limited, primarily to untreated and severely burned areas of the Cone Fire.
### DELIVERABLES

| Manuscripts Prepared for Cone Fire Research Project | Manuscripts:  
**Farris, Kerry L.** The effects of pre-fire thinning and subsequent wildfire severity on snag use by woodpeckers: a case study from the Cone Fire, northern California. Draft for submission to Forest Ecology and Management.  
**Nakamura, Gary.** Cone Fire Soil Compaction. Draft report on file at PSW Research Station. |
| Demonstration Site | A series of six permanent displays have been developed and placed throughout the Cone Fire describing the fire effects and experiments established through this project. In addition, a main information kiosk was established and materials (graphics) describing the cone fire and research on treatment effects have been installed. |
| Establishment of 15 variable-density salvage treatments | These were completed in the fall of 2003, when salvage work in the Cone Fire was started. There are three replicates of five treatments: salvage with retention of 100, 75, 50, 25, and 0 percent basal area of burned trees. NEPA work for the experiment and salvage, along with 3 DFPZs took one year to complete. Salvage logging was completed in April of 2004. Costs for NEPA and sale administration were covered by the Lassen National Forest.  
A permanent grid of plots for fuels and standing snags was established and first measured in Summer of 2004. We started remeasuring the fuels transects in November of 2005. Remeasurements should be completed by April 2006. |
| Establishment of initial-spacing fire regeneration study. | Installation of a completely randomized study on regeneration growth and survival on 30 one-acre plots. This study has five replications of six spacings ranging from 12 to 22 feet. This study will begin to produce research results in 2006. |
| Establishment of treatment boundary strip plots | Along the boundary of treatment units, strip plots were established to describe the mortality rates and tree damage in the contact zone between treated stands and the untreated areas of the fire. |
Photo of Cone Fire after fire salvage and planting with 5-acre variable retention salvage units and the 10-acre untreated demonstration area in the upper left corner. (Photo date July 12, 2005).

**PRESENTATIONS**


C.N. Skinner. *Forest fires and forest fuels.* Annually from 2003-Present. University of California Cooperative Extension Service and Society of American Foresters, Forestry Institute for Teachers. This workshop provides school teachers with background and teaching aids in forestry related topics. June, various dates, Camp Latiez, Manton, CA. The Cone Fire has been an important part of my presentation since the fire occurred.
DEMONSTRATION
The demonstration site at Blacks Mountain consists of six individual image panels, and one large introductory panel. Image panels 1-6 are installed in the cone fire at a size of 33” x 17”. 

![The Cone Fire at Blacks Mountain Experimental Forest: Overview](image1)

![The Cone Fire: Demonstration Between Treated and Untreated](image2)
The Cone Fire: High Diversity Thinning with Prescribed Fire

At this point the Cone Fire ran into the boundary of Black Mountain Unit 41. Thinned to leave a High Structural Diversity stand, and then burned with prescribed fire in 1997, this treatment reduced a large ground and surface fuel complex, downed log, and logging slash. This reduction in fuels caused the fire to drop out of the forest canopy to the forest floor (surface fire). The change in fire behavior, reduced intensity of burning to a point that trees could survive the fire and suppression crews could directly attack the fire front, halting its spread a short distance from this location.

In photo 5, an unthinned area, all trees were killed by the Cone Fire regardless of age, size, or species. In photo 6, an area thinned then burned under prescription, only some of the snowmass™ trees near the edge of the treatment boundary failed to survive. The aerial photograph above shows the general pattern of fire behavior between untreated and treated areas within the Experimental Forest. Also notice the remnant fire resistant (Snowmass™) strip spanning across from right to left was dropped within Unit 41.

The Cone Fire: Low Diversity Thinning with Prescribed Fire

At this point the Cone Fire encountered Unit 45. An area thinned with a Low Diversity prescription®. As with Unit 41 (High Diversity prescription®), only trees near the edge of the treatment were woodyly dispersed, or killed. This part of Unit 45 was thinned in 1996 and burned with prescribed fire in 1998. Trees in the “snowmass™” survival zone and the spread of the fire was effectively halted regardless of intervention by the suppression crew. The burned split due, in part, to the existing juxtaposition of residual vegetation. The snowmass™, however, acted as a backfire toward the flanks surrounding the fire. This is apparent in photo 9, above.

Many of the trees remained standing and were removed during the salvage operations of 2000.

The change in fire severity associated with Unit 45 is evidence of the impact management can have on minimizing the occurrence of crown fires.
The Cone Fire: Variable Retention Fire Salvage

Often, after severe stand replacing fires, foresters will plant seedlings to reforest the forest. Salvage operations initiated one year after the fire served to reduce fuel loads and ensure healthy regeneration. If removed soon after the fire, burned trees can be milled to produce lumber. This practice of salvage logging can help recover some of the costs of reforesting the forest while removing fuels that may fuel future fires.

Some questions remain about the effects of salvage logging on wildlife, soils, and fuel build-up. After the Cone Fire, an experiment was established to test the effects of varying levels of fire salvage. Five plots of fire-free treatments (C0, 25, 50, 75, and 100%) were applied to 5-acre plots throughout the burned area. The location provides a view of several of these treatments. Across the road and behind you is Plot 11 (a bare burnt area). To the left is Plot 14, where 100% of the basal area was retained. Straight ahead is Plot 15 with 50% retention, and to the right is Plot 12 with 75% retention.

The Cone Fire: Comparison of Thinned Area With and Without Prescribed Fire

This is the Unit 47 boundary between the prescribed half and the prescribed burn half.

The photos on the right were an area thinned then burned by prescribed fire in 1998. Before treatment, 20% of the area was clear cut. The photos on the right were in an area thinned only (before treatment). 16% and after treatment of the area was burned. Both areas were subsequently burned by the Cone Fire in 2000, because of the reduction in fuel load areas that were treated with prescribed fire. The Cone Fire essentially went out without any suppression activity. Almost no trees were damaged or killed in the area with both thinning and prescribed fire. However, in the forest only half of the area, fire passed through part of the underburn, burned surfact fuels, and resulted in some pockets of mortality where surface fuels were abundant near the base of standing trees.
Cone Fire introductory image panel.

The Cone Fire started at 14:07 on September 28th, 2002, burning 870 hectares (2,198 acres). Of this, 402 hectares (1,000 acres) were on the Experimental Forest, including portions of three units previously treated in High-Structural Diversity thinnings with prescribed fire. 20 Low-Structural Diversity thinnings, with prescribed fire, and 20 low-Structural Diversity thinnings without prescribed fire. This information provided an opportunity to quantify the differences in wild fire severity between treated and untreated stands and evaluate new studies looking at the impacts of various levels of fire severity.