Final Report, Joint Fire Science Program

Joint Fire Science RFP 2003-2: TASK 3
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.

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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 4th to 5th 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: **Skinner, C.N.; Ritchie, M.W.; Hamilton, T.; and Symons, J.** 2005**.** Effects of prescribed fire and thinning on wildfire severity: the Cone Fire, Blacks Mountain Experimental Forest. In: S. Cooper, editor. 25th Annual Forest Vegetation Management Conference, January 2004, Univ. of California Coop. Extension, Redding, CA. **Ritchie, M.W., T.A. Hamilton, and C.N. Skinner.** Probability of Wildfire-Induced Tree Mortality in an Interior Pine Forest: Effects of Thinning and Prescribed Fire. Submitted to Fire Ecology. **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.
Web Site	http://www.fs.fed.us/psw/programs/ecology_of_western_forests/projects/cone_fire/
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. *Influence of contrasting stand structures on fire behavior and effects - the Cone Fire of September 2002.* December 2002. To: 2002 Fire Conference: Managing Fire and Fuels in the Remaining Wildlands and Open Spaces of the Southwestern United States. Association for Fire Ecology and the Western Section of the Wildlife Society, December 2-5, 2002, San Diego, CA.

C.N. Skinner; Ritchie, M.W.; Hamilton, T.; Symons, J. (2004**)**. *Effects of prescribed fire and thinning on wildfire severity.* To: 25th Vegetation Management Conference, January 2004, Redding, CA.

C.N. Skinner. *Influence of stand structure on wildfire severity - the case of Cone Fire, September 2002.* April 2004. To: 19th Annual symposium International Association for Landscape Ecology, US Regional Association. Las Vegas, NV.

C.N. Skinner. *Forest fires and forest fuels.* July & Sept. 2003, July & Sept. 2004. In: Biomass Thinning for Fuel Reduction and Forest Restoration, Redding, CA. Northern California Society of American Foresters, University of California Coop. Extension

C.N. Skinner. *Forest fires and forest fuels.* July 2004. To: Cottonwood Creek Watershed Council, Cottonwood, CA

C.N. Skinner. *Managing stand structures to reduce fire severity.* February 2005. To: Fireshed Modeling Public Meeting, Klamath National Forest, Yreka, CA.

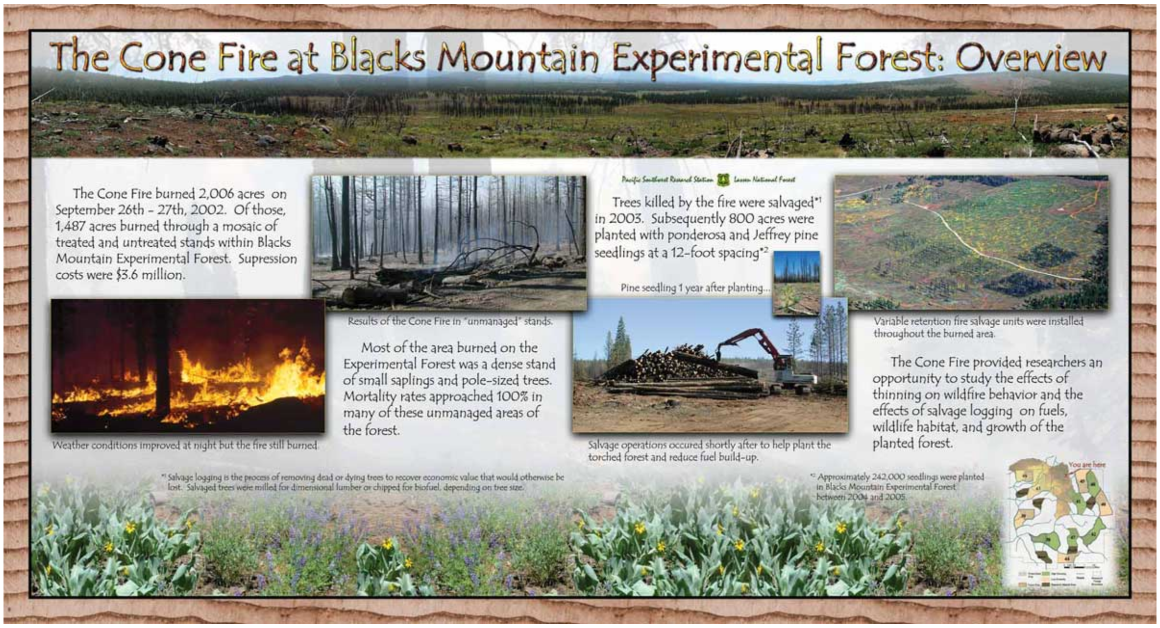
C.N. Skinner. *Effective fuel reduction planning.* April 2005. To: Northwest Regional Fire Safe Councils Conference, Mt. Shasta, CA.

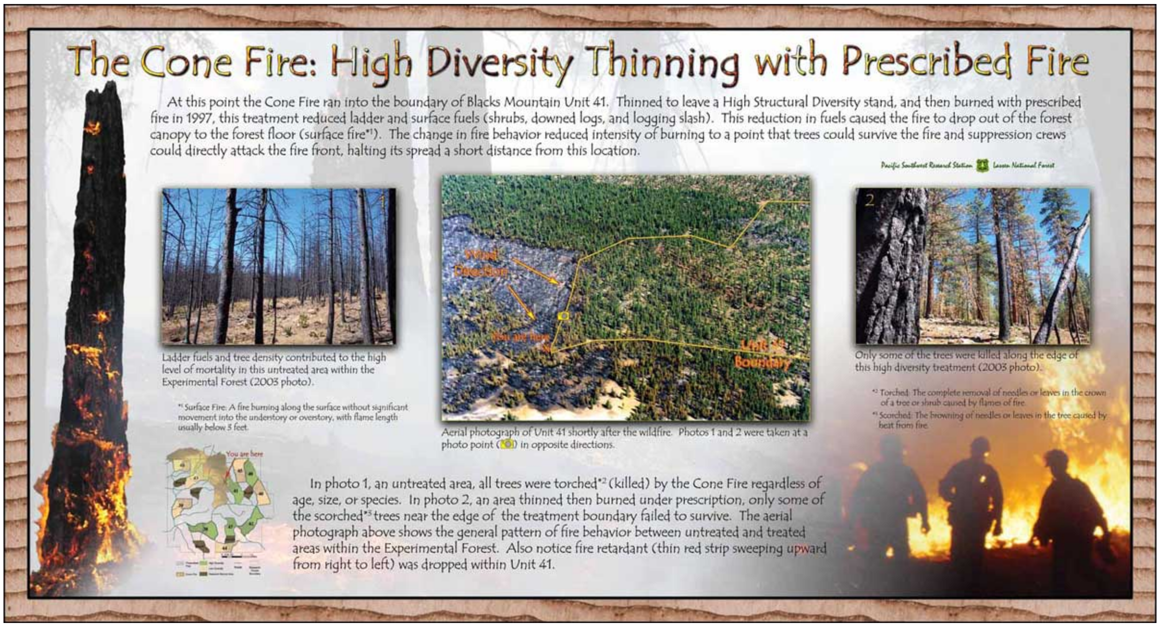
C.N. Skinner. *Forest fires and forest fuels.* Annually from 2003-Present. University of California Cooperative Extension Service and Society of American Foresters, Forestry Institute for Teachers. This workshop provides school teachers with background and teaching aids in forestry related topics. June, 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: High Diversity Thinning with Prescribed Fire
At this point the Cone Fire ran into the boundary of Blacks Mountain Unit 41. Thinned to leave a High Structural Diversity stand, and then burned with prescribed fire in 1997, this treatment reduced ladder and surface fuels (shrubs, downed logs, and logging slash). This reduction in fuels caused the fire to drop out of the forest canopy to the forest floor (surface fire*1). 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.
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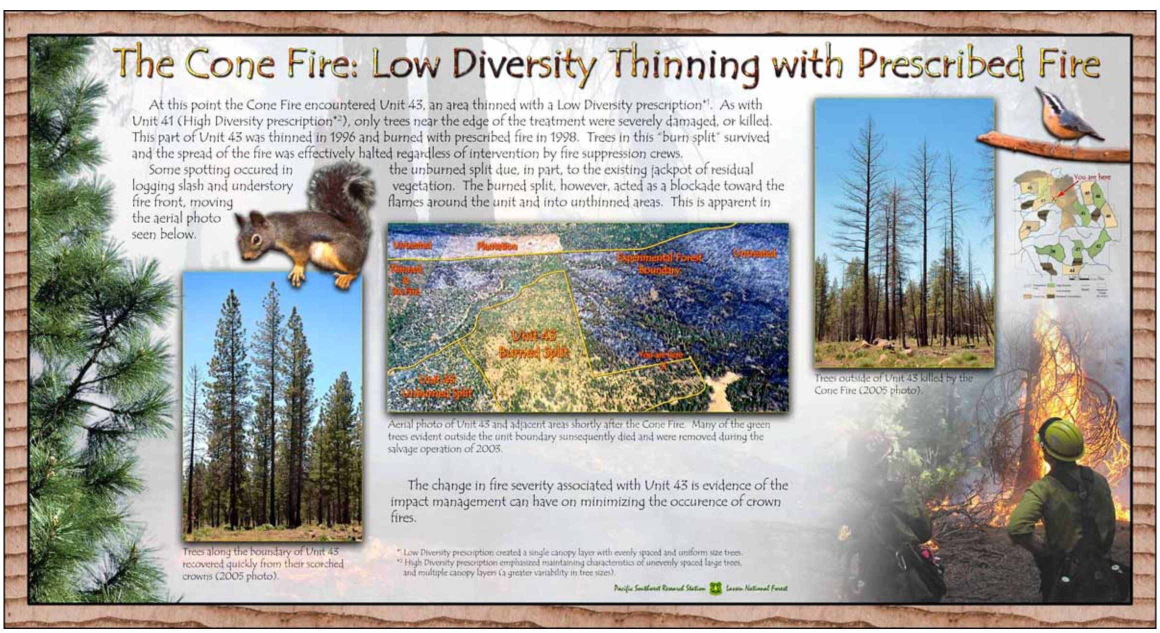
1
Ladder fuels and tree density contributed to the high level of mortality in this untreated area within the Experimental Forest (2003 photo).
*1 Surface Fire: A fire burning along the surface without significant movement into the understory or overstory, with flame length usually below 3 feet.
Aerial photograph of Unit 41 shortly after the wildfire. Photos 1 and 2 were taken at a photo point in opposite directions.
2
Only some of the trees were killed along the edge of this high diversity treatment (2003 photo).
*2 Torched: The complete removal of needles or leaves in the crown of a tree or shrub caused by flames of fire.
*3 Scorched: The browning of needles or leaves in the tree caused by heat from fire.
You are here
In photo 1, an untreated area, all trees were torched*2 (killed) by the Cone Fire regardless of age, size, or species. In photo 2, an area thinned then burned under prescription, only some of the scorched*3 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 fire retardant (thin red strip sweeping upward 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 43, an area thinned with a Low Diversity prescription*1. As with Unit 41 (High Diversity prescription*2), only trees near the edge of the treatment were severely damaged, or killed. This part of Unit 43 was thinned in 1996 and burned with prescribed fire in 1998. Trees in this "burn split" survived and the spread of the fire was effectively halted regardless of intervention by fire suppression crews.
Some spotting occured in logging slash and understory fire front, moving the aerial photo seen below.
the unburned split due, in part, to the existing jackpot of residual vegetation. The burned split, however, acted as a blockade toward the flames around the unit and into unthinned areas. This is apparent in
Plantation
Experimental Forest Boundary
Untreated
Unit 43 Burned Split
Aerial photo of Unit 43 and adjacent areas shortly after the Cone Fire. Many of the green trees evident outside the unit boundary sunsequently died and were removed during the salvage operation of 2003.
You are here
Trees outside of Unit 43 killed by the Cone Fire (2005 photo).
The change in fire severity associated with Unit 43 is evidence of the impact management can have on minimizing the occurence of crown fires.
Trees along the boundary of Unit 43 recovered quickly from their scorched crowns (2005 photo).
*1 Low Diversity prescription created a single canopy layer with evenly spaced and uniform size trees.
*2 High Diversity prescription emphasized maintaining characteristics of unevenly spaced large trees, and multiple canopy layers (a greater variability in tree sizes).
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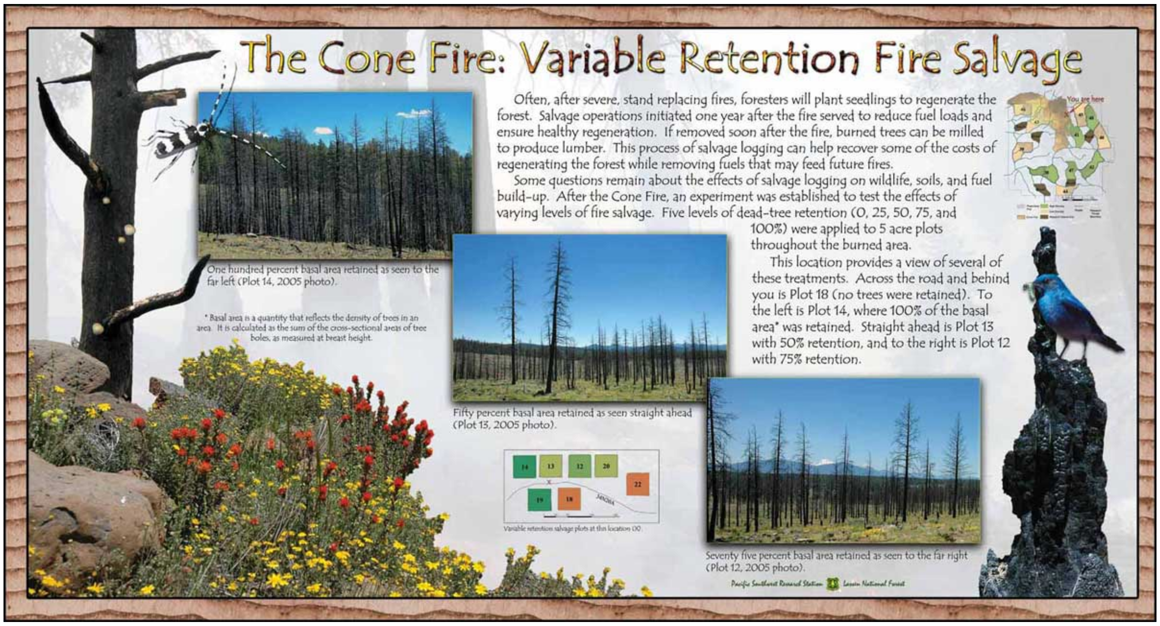
The Cone Fire: Variable Retention Fire Salvage
Often, after severe, stand replacing fires, foresters will plant seedlings to regenerate the forest. Salvage operations initiated one year after the fire served to reduce fuel loads and ensure healthy regeneration. If removed soon after the fire, burned trees can be milled to produce lumber. This process of salvage logging can help recover some of the costs of regenerating the forest while removing fuels that may feed 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 levels of dead-tree retention (0, 25, 50, 75, and 100%) were applied to 5 acre plots throughout the burned area.
This location provides a view of several of these treatments. Across the road and behind you is Plot 18 (no trees were retained). To the left is Plot 14, where 100% of the basal area* was retained. Straight ahead is Plot 13 with 50% retention, and to the right is Plot 12 with 75% retention.
You are here
One hundred percent basal area retained as seen to the far left (Plot 14, 2005 photo).
* Basal area is a quantity that reflects the density of trees in an area. It is calculated as the sum of the cross-sectional areas of tree boles, as measured at breast height.
Fifty percent basal area retained as seen straight ahead (Plot 13, 2005 photo).
14
13
12
20
22
19
18
Variable retention salvage plots at this location (X)
Seventy five percent basal area retained as seen to the far right (Plot 12, 2005 photo).
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The Cone Fire: Comparison of Thinned Area With and Without Prescribed Fire
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This is the Unit 43 boundary between the unburned half and the prescribed burned half. The photos on the right were an area thinned then burned by prescribed fire in 1998 (before treatment, 2a, and after treatment, 2b). The photos on the left were an area thinned only (before treatmnent, 1a, and after treatment, 1b). Both areas were subsequently burned by the Cone Fire in 2005. Because of the reduction in fuel in the area that was 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 thin-only half to the left, the fire carried through parts of the understory, burned surface fuels, and resulted in some pockets of mortality where surface fuels were abundant near the base of standing trees*.
Unit 43 without prescribed fire before thinning (1995 photo).
Unit 43 with prescribed fire before thinning (1995 photo).
You are here
*Trees can be killed by fire even if the crown is not burned. The heat from burning brush, slash and logs can generate enough heat to kill the living tissues at the base of the tree. This may kill the tree outright or weaken it sufficiently that the tree succumbs to attack from insects.
Unit 43 without prescribed fire after thinning (same location as 1a, 1998 photo).
Unit 43 with prescribed fire after thinning (same location as 2a, 1998 photo).

Cone Fire introductory image panel.