EVALUATING FIRE HAZARD GAINS VS. ENVIRONMENTAL LOSSES AFTER FUEL TREATMENTS IN THE WILDLAND-URBAN INTERFACE

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INTRODUCTION

Vegetation is both an asset and a liability within the wildland-urban interface (WUI). The same trees and shrubs that provide tangible and intangible benefits to society are prone to burn with great intensity and destruction. Therefore, emphasis is often placed on fuel reduction treatments to reduce the risk of wildfire losses. However, while fuel treatments can moderate wildfire hazards, they may simultaneously impact societal benefits provided by vegetation, such as air pollution removal, stormwater runoff reduction, home energy savings, and carbon sequestration.

The purpose of this study is to determine if varying fuel treatment types differ in their ability to change fuel properties, subsequent fire behavior, and multiple societal benefits in three separate ecoregions of California. The hope is that the study will help WUI stakeholders understand the potential tradeoffs in fire hazard versus other social values when implementing fire mitigation actions.

STUDY AREAS

The research focuses on three ecoregions in California: the Klamath Mountains, the central Sierra Nevada, and the Peninsular Ranges of southern California (Figure 1). These diverse locations were chosen because they represent some of the most predominant vegetation communities in California. Four to five fuel treatment types were selected in each ecoregion, in order to represent commonly used WUI management practices within each respective area.

Figure 1. Study Areas (north to south): Klamath Mountains, Central Sierra Nevada, Peninsular Ranges.

METHODS

In 2008, surface and canopy fuel data were gathered at treated and untreated WUI sites on U.S. Forest Service and National Park Service lands across the state. Approximately 60 plots were measured per ecoregion. At each plot, three fuel transects were installed to obtain fuel loading by size class and type, and fuelbed depth. In addition, species, diameter, height, and height to live crown were recorded for each living tree greater than 1" DBH (or in southern California, each shrub) to obtain stand composition and structure. Regeneration was measured in a 1-milacre (3.7-ft radius) subplot, and forest canopy cover was estimated using a spherical densiometer. Slope and aspect were recorded, plot centers were documented by GPS, and photographs were taken in all four cardinal directions from plot center.

For treated vs. untreated sites at each of the three ecoregions, the analysis will quantify potential fire behavior (fireline intensity, rate of spread, etc.) as compared to effects on the societal benefits noted above. Fire behavior prediction models will be used to assess post-treatment changes to potential fire behavior at the stand scale (Nexus, FFE/FVS) and landscape scale (FARSITE, FlamMap) in each of the ecoregions.

Treatment effects on air pollution removal, home energy savings, and carbon sequestration will be assessed using UFORE (the Urban Forest Effects Model), developed by the U.S. Forest Service Northeastern Research Station. Effects on stormwater runoff will be evaluated with the NRCS TR-55 hydrologic model.

Klamath Mixed-conifer Forest

The Klamath mountain region is located in Northern California, covering 22,500 km^2 (8,690 mi^2) and accounting for six percent of the overall land mass of the state with elevations ranging from 30 meters (100 ft) to 2,755 meters (9,038 ft). The mixed-conifer forests there contain a wide variety of coniferous and hardwood tree species. The multilayered, multi-aged structure contain a mix of Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) as the most widely distributed conifers with a variety of additional species present in the understory. Four treatment types were examined in this ecoregion (Figure 2).

Figure 2. Treatments examined in Klamath mixed-conifer include (a) broadcast fire, (b) thin + pile and burn, (c) thin only, and (d) thin + broadcast fire.

Sierra Nevada Mixed-conifer Forest

In the central Sierra Nevada, mixed-conifer forest occurs roughly between 3,000 and 6,000 feet elevation. Common tree species include ponderosa and sugar pine, white fir, incense-cedar, Douglas-fir, and California black oak. A century or more of fire exclusion in what had previously been a high-frequency, low- to mixed-severity fire regime has led to dramatic changes in stand structure, composition, and fuel loading (e.g., the growth of extremely dense stands of shade-tolerant species). Research sites for this forest type were located in Yosemite National Park, the Sierra National Forest, and the Stanislaus National Forest. Five treatment types were examined in this ecoregion (Figure 3.)

Figure 3. Treatments examined in Sierra Nevada mixed-conifer include (a) thin + masticate, (b) thin from below, (c) thin +broadcast burn, (d) thin +pile burn, and (e) broadcast burn only.

Southern California Chaparral

This shrub-dominated ecosystem is prevalent in southern California, but also occurs throughout the state in coastal mountain ranges and foothills. The stand-replacing fire regime, along with proximity to a large population and the influence of Santa Ana winds, has created a need for fuel management solutions that not only help minimize the destruction from fires, but do so with the least environmental impact. Four treatment types were examined in this ecoregion (Figure 4).

Figure 4. Treatments examined in southern California chaparral include (a) integrated goat method, (b) mastication, (c) lop and scatter + broadcast fire, and (d) broadcast fire only.

OUTPUTS AND RESULTS

Data collection has been completed for all three ecoregions. Fire behavior analysis is now being conducted with modeling tools including the Fire & Fuels Extension of the Forest Vegetation Simulator (FFE-FVS) (Figure 5) and FARSITE.

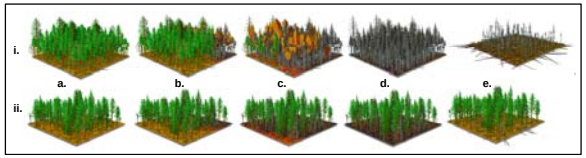

Figure 5. Output obtained using the Stand Visualization Simulator in FFE/FVS. The top row (**i**) is an untreated stand and the bottom row (**ii**) is a stand treated with a thin, pile, and burn prescription. A simulated fire was modeled at Time 0, with **a.** showing the initial stand, **b .– d.** showing the expected fire behavior, and **e.** showing the stand ten years later.

The UFORE (Urban Forest Effects) model allows land managers and researchers to quantify urban forest structure and forest ecosystem functions through the use of standardized field data in combination with air pollution and meteorological data. In this study, UFORE will be used to calculate tons/hectare/year of airborne pollutants removed by treated vs. untreated stands (Figure 6), as well as providing estimates of treatment effects on annual forest/shrubland carbon sequestration and home energy savings.

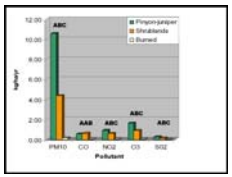

Figure 6. Mean annual air pollution removal capacity (t/ha/yr) in the dominant vegetation types in Kennedy Meadows (Tulare County), CA. Letters represent significance between vegetation types (df=8, α=0.05). From: Dicus, C.A., K. Delfino, and D.R. Weise. In press. Predicted fire behavior and societal benefits in three eastern Sierra Nevada vegetation communities. Fire Ecology.

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