Effects of Landscape-Level Fuel Treatments on Carbon Emissions and Storage Over a 50yr Cycle

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INTRODUCTION
The overriding purpose of the research project is to determine how multiple fuel treatment types, organized in varying spatial arrangements, and at increasing proportions of a mixed-conifer forest in the Klamath Mountains of northern California (~20,000 ha) variably affect fire behavior, as well as carbon and air pollutant sequestration and emissions before, during, and after a wildfire. The portion of the research presented here demonstrates a portion of the carbon and emissions analysis. This phase utilizes 3 fuel treatment scenarios and compares them to an untreated landscape in order to determine which if any of the treatment scenarios works best at reducing carbon emissions from smoke while at the same time increasing the long term carbon storage of the landscape.

STUDY AREA
The study area is located on the Eddy Gulch Late-Successional Reserve (LSR) Assessment Area on the Klamath National Forest in northwest California. Vegetation there consists largely of a multi-layered, multi-aged forest dominated by Douglas-fir (Pseudotsuga menziesii) and ponderosa pine (Pinus ponderosa) in association with Pacific madrone (Arbutus menziesii), white fir (Abies concolor), and others. The study area is proposed to undergo an ambitious fuel treatment project so as to protect adjacent communities and reduce the threat of stand-replacing wildfires.

RESULTS
Each FVS-FFE scenario returned values for carbon storage on a yearly basis and carbon emissions from smoke that resulted from both prescribed fire and wildfire. In the case of wildfire, the simulation provides the potential carbon emissions for the entire landscape, not the potential spread or size of a wildfire as it moves across the study area. This is because FVS is non-spatial and fire behavior in any given stand is not influenced by the fire behavior in adjacent stands.

The figures above illustrate carbon emissions from smoke (figure 1) and long term carbon storage (figure 2). Carbon emissions include those that result from prescribed fire treatments and the simulated wildfire at Year-5. Carbon storage is at Year-50 over the entire landscape. Figures 1 and 2 illustrate the contradiction that the treatment scenario with the largest standing stock of carbon in 50 years when prescribed fire and potential wildfire emissions are accounted for. Figure 3 below compares the net carbon change for each scenario when compared to the no-action scenario and accounts for both carbon emissions and carbon storage. As shown, the increased storage of the complete treatment scenario is enough to offset the increase in emissions because of the large area treated with prescribed fire. The result is a net increase in carbon retained in the complete treatment scenario.

Note: this work represents a worst case scenario in which the entire landscape experiences a wildfire even after fuel treatments. It is expected that in reality the reduction in fire behavior and spread resulting from fuel treatments would provide an even larger increase in carbon storage than was modeled here.

METHODS
Three fuel treatment scenarios were modeled using the ArcFuels workstation within ESRI Croppz’s ArcMap software. One scenario is the complete treatment design proposed by the Forest Service for the Eddy Gulch LSR which includes fuel reduction zones (FR2’s) that include mechanical treatments and prescribed fire, prescribed fire, and mechanical treatments. The second scenario is the portion of the initial design designated for prescription fire (Burn Only) and the third scenario is the portion of the original design designated as FR2 and mechanical treatments. The modeled fuel treatment scenarios were then run in the FVS Fire and Fuels extension (FFE) for 50 years. Included in each FFE scenario is a wildfire simulated using 97th percentile weather conditions, 5 years after the treatment implementation. An untreated landscape was also modeled in FVS for comparison to the treatment scenarios.

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