Model Description

The Forest Vegetation Simulator (FVS) is used by forest managers throughout the United States and Canada to predict stand dynamics and the effects of various management action on future forest conditions. It is an individual tree, distance-independent growth and yield model. The Fire Fuels Extension (FFE) was developed by integrating FVS with elements from existing models of fire behavior and fire effects (The FVS simulates tree growth, tree mortality and regeneration, and the impacts of a wide range of silviculture treatments. The Fire Fuels Extension simulates fuel accumulation from stand dynamics and management activities, and the removal of fuel through decay, mechanical treatments and prescribed or wildfires. (Beukema et al 2002).

FFE-FVS was developed by the Forest Service Research branch. The model is explained in depth in General Technical Report 116 from the Rocky Mountain Research Station (Reinhardt and Crookston 2003). FFE-FVS supports fuel management and postfire treatment decisions in the context of other vegetation management concerns, including wildlife habitat, insect and pathogen hazards, and timber production. It allows forest management decisions to be assessed in a temporal context: not only short-term effects on fuels, stand dynamics, and potential fire behavior are modeled, but also the way in which these interacting ecosystem components may be expected to change over time.

FFE-FVS has a broad geographic scope. FVS variants have been developed for forested regions nation-wide. The fire fuels extension (FFE) has been modified for use with many of the variants used in the western United States, including Northern Idaho, Central Rockies, Utah, Eastern Montana, Western Sierra, Blue Mountains, Eastern Cascades, Central Idaho, Tetons and Southern Oregon/Northern California. Modifications were based on workshops and consultations with scientists and other fire experts familiar with conditions in each region. (Reinhardt and Crookston 2003).

Many of the components of FFE-FVS have long histories in both scientific and management communities. For example, the surface fire component used in the model was first presented by Rothermal in 1972, and the tree mortality and fuels consumption components were developed in the 1980s (Beukema et. al.1999).

A simulation tracks the biomass, growth and mortality of individual trees in a stand; litterfall from living trees and falldown of the snags determine woody fuels loads. Fire, if simulated, impacts surface fuels directly by consuming them, indirectly, over time, as fire-killed trees fall to the ground, and even more indirectly, by impacting future stand structure.

Local Variables

The Klamath Mountains variant was used in the FFE-FVS program. The variant is based on empirical data collected from stands in the Klamath Mountain region. Growth tree data was taken at each plot to calibrate the empirical data in the model. FFE-FVS models

anticipated changes in stand development, including growth and mortality, based on the initial tree condition, stand density and calibrated empirical growth calculations.

Historical weather observations from the Collins Baldy Remote Automated Weather Station (RAWS) were used to determine 90th and 50th percentile days. Adjustments were made to the fine fuel moisture and mid-flame wind speed to account for the site differences between the project area and the Collins Baldy RAWS site. Adjustments were based on NWCG Fireline Handbook, Appendix B – Fire Behavior (1998).

Stand dynamics have been modeled for each of the categories defined in the vegetation report. The initial stand structure, composition and fuel loading is based on field data collected in 2004 and 2005 from a representative sample of stands in each of the following categories:

> Mixed conifer stands with Douglas-fir and Ponderosa pine as the dominant overstory species. Mixed conifer stands were stratified by aspect. Stands on south and west aspects were grouped together. Stands on north and east aspects were similarly grouped.
>
> True fir stands included all stands above 5200 in elevation, with white fir or red fir as the dominant overstory species. True fir stands were not stratified by aspect.
>
> Defensible fuel profile zones (DFPZ) were divided into five groups. Each DFPZ was sampled and modeled independently. The five groups are identified by a geographic feature associated with the DFPZ location. The DFPZs are identified as Siskiyou Peak, Siskiyou Gap; Four Corners; Doe Peak and Cow Creek.

The modeled results from FVS are not intended to be absolute values, but display relative trends in stand development for each of the defined categories. Stand development was modeled over a 40-year period for no action and the proposed treatments associated with each action alternative.

Fuel Treatments

The No Action alternative models stand and fuel dynamics in each stand category without any management intervention. For each of the action alternatives, the FFE-FVS simulations include the proposed silviculture treatment for each stand category. Tree removals were scheduled to occur in 2004. Fuel treatments were modeled to occur in 2009.

<u>Pile Treatments</u> – Simulation results are based on the assumption that 90% of the stand would be treated; 80% of the fuel would be piled and piles would occupy 15% of the area. Standard hand pile specifications include material between 1 and 8” diameter. Hand pile treatments were simulated by retaining all material >12”diameter.

Mastication Treatments – Simulation results are based on the assumption that material in all size classes is masticated. The model reduces fuel bed depth through compaction of the fuel. Assumptions were made that 75% of the >12" diameter material would be redistributed into the 1-3"; 3-6; and 6-12" diameter classes. 25% of the material was retained in the >12" diameter fuel pool. This redistribution is an estimate of what may occur. Actual results would vary depending upon the contract specification and the type of equipment used.

The model assumes a 75% reduction in fuel bed depth to model the effects of mastication, chipping, crushing, etc. The effects of the treatment only last for 5 years in the model. Without further adjustment, fire behavior rapidly increases at the end of the 5-year period. The modeled results are likely to be more severe than what could be expected over time in a masticated fuel bed

Fire Behavior & Effects

Topography – Average slope for plots take in each category were used in the simulations. Slopes range from 20-50%. This affects projected fire behavior. Gentle terrain would result in lower fire line intensity and flame lengths. Steeper terrain would result in an increase in fire line intensity and flame lengths.

Burning Conditions – Fire behavior and fire effects outputs can be evaluated two ways. A potential fire report displays the modeled outcomes of certain parameters under either severe or moderate burning conditions **if** a fire were to occur at any given point in the analysis period. To address fire effects to surface and crown consumption, a fire must be simulated.

Historical weather observations from the Collins Baldy RAWS were used to define severe and moderate burning conditions. Severe conditions were defined by 90th percentile weather observations. Moderate conditions were defined by 50th percentile weather observations. Fine fuel moistures were adjusted up 1% to account for differences between the RAWS site and the project area. The parameters used to define moderate and severe conditions are displayed in the table below.

Table 1. Burning Conditions Defined for Potential Fire Report

Moderate Conditions				Severe Conditions			
1 hr fmc:	7%	Air Temp.	70º F	1 hr fmc:	4%	Air Temp.	85º F
10 hr fmc:	7%	20 ft wind speed	5 mph	10 hr fmc:	4%	20 ft wind speed	10 mph
100 hr fmc:	10%	Duff Moisture:	125%	100 hr fmc:	6%	Duff Moisture:	15%
1000 hr fmc:	25%	Live fuel moisture:	150%	1000 hr fmc:	10%	Live fuel moisture:	70%

The surface flame length; fire type (surface, passive or active crown fire) and percent mortality are outputs of the FFE-FVS Potential Fire Report and were used in the Fire and Fuels assessment

Potential rate of spread as modeled in BEHAVEPlus v3 is used to evaluate relative changes in suppression effectiveness. BehavePlus is a Windows ® application used to predict wildland fire behavior for fire management purposes. It is designed for use by trained, professional wildland fire managers and planners who are familiar with fuels, weather, topography, wildfire situations, and associated concepts and terminology. The Behave program has been used to model fire behavior since 1984. Rothermel's surface fire spread model (1972) is a fundamental component of BehavePlus. The 13 standard fire behavior fuel models as described by Anderson (1982) are used as inputs, along with historic weather parameters defined above

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