Chapter 3—User's Guide

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Abstract

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The Fire and Fuels Extension (FFE) to the Forest Vegetation Simulator (FVS) simulates fuel dynamics and potential fire behavior over time, in the context of stand development and management. This report presents the model's options, provides annotated examples, describes the outputs, and describes how to use model. People who use the FFE-FVS can use this document to learn how to use and apply the model.

Keywords: FVS, FFE, forest fire, stand dynamics, FOFEM, BEHAVE, snags, course woody debris

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1.0 Introduction

The Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS) is introduced in *Chapter 1—Purpose and Applications* and *Chapter 2—Model Description* covers the model's content. Features customized for various geographic regions are described in *Chapter 4—FFE Variants*). Here, the subject is how to use the FFE-FVS. We start with the simplest form of a run, show how to change the initial values, set fires, adjust the snag and fuel parameters, specify management actions, and control the generation of outputs. A detailed explanation of the output tables is presented in *Chapter 2—Model Description*. Lastly, information is presented on using the FFE-FVS with the Event Monitor (Crookston 1990), a feature of FVS that allows for scheduling activities predicated on conditional statements.

This document assumes that you already know how to use the Forest Vegetation Simulator (Wykoff and others 1982), that you have the FFE-FVS software installed on your computer, and that you know how to start the program. Instructions for getting this program and accessing the background information you need are printed on the inside front cover of this volume.

We assume that you will use a text editor to prepare and edit your keyword files and that your tree data files are already prepared. If you are using Suppose (Crookston 1997), you can readily apply what is presented here. Suppose is kept up-to-date with respect to changes in keywords, the model, and default parameter values.

2.0 Simple Run

The example used in the preface paper is used to illustrate how to run the FFE-FVS. We start with the basic keyword fire needed create a *no fire* and *no management* run of FVS (fig. 1). The necessary tree data file is shown in figure 2.

To make FFE run, only two keywords need to be added to those illustrated in figure 1. FMIN signals the start of the FFE keywords and END signals the end. However, unless another keyword is added, the FFE will not provide any output and or simulate any fires or effects. In short, you really need at least one additional keyword.

FMIN Signals the start of the FFE keywords.

END Signals the end of the FFE keywords. All other FFE keywords must appear between the FMIN-END pair. You may code several FMIN-END pairs and you may have one or many FFE keywords between each pair. The sequence may appear anywhere in the keyword file prior to the PROCESS keyword (line 16, figure 1).

Several keywords are used to request output reports, set initial values, simulate fuel and fire management actions and otherwise control the model. Figure 3 shows how the keyword file from figure 1 is modified to request an FFE run and, using POTFIRE keyword, the Potential Fire Report output. This keyword is fully described later in section 8.0 Output. The important feature of figure 3 is the set of keywords inserted between lines 11 and 12. Exactly the same method is used in all of the examples.

3.0 Initializing the Model

The FFE dynamically tracks snags by species, 2-inch diameter class, and hardness. Fuel is tracked by size class. While some default values are present in the model to initialize fuel loads, your projection will be better if you enter values appropriate for your stand.

You can initialize the number of snags using two different methods, separately or in combination. First, trees that are recorded as recent mortality in the FVS tree data file (fig. 2) are made into snags in the FFE. Those snags are always considered hard unless the SNAGPSFT keyword is used to change the proportion of snags that are soft at the time of death (see section 5.3). In addition, you can specify the number of hard and soft snags by species and diameter class using one or more SNAGINIT keywords.

SNAGINIT Add a snag to the snag list. Use as many of these keywords as you need to enter the data that represent your stand.

Field 1: Species number or letter code; entry is required.
Field 2: Dbh at the time of death (inches); entry is required.
Field 3: Height at the time of death (feet); entry is required.
Field 4: Current height (feet); entry is required.
Field 5: Number of years the tree has been dead.
Field 6: Number of snags per acre with these characteristics; entry is required.

Initial dead fuel loads depend on the variant, the cover type of the stand, and the percent cover of the stand. However, you can set the initial amount of dead fuel using the FUELINIT keyword. Live fuel loads include the weights of herbs, shrubs, and grasses, but you cannot adjust or initialize those fuels.

FUELINIT Set the amount of dead fuel in each fuel size class. Values left blank are replaced with variant-dependent defaults shown in the section 4.2 of *Chapter 2—Model Description* and in the documentation for the individual variants.

Field 1: Initial fuel load for fuel 0-1 inch (tons/acre). This loading gets divided equally between the 0-0.25 inch class and the 0.25-1 inch class.
Field 2: Initial fuel load for fuel 1-3 inch (tons/acre).
Field 3: Initial fuel load for fuel 3-6 inch (tons/acre).
Field 4: Initial fuel load for fuel 6-12 inch (tons/acre).
Field 5: Initial fuel load for fuel >12 inch (tons/acre).
Field 6: Initial fuel load for litter (tons/acre).
Field 7: Initial fuel load for duff (tons/acre).

Figure 4 illustrates how to enter initial snag and fuel values. The SNAGINIT keywords are used to create 5 Douglas-fir snags between 30 and 32 inches, 10 grand fir snags between 20 and

25 inches, and 3 lodgepole pine snags of 15 inches. The trees that created these snags died 12 years prior to the inventory year of the stand, and their heights are all lower than they were originally. In the example, each species is grouped using a single keyword that defines the average characteristics. Alternatively, the exact characteristics of each of the 18 snags could have been entered using the SNAGINIT keyword 18 times. Since snags end up grouped into classes with an average diameter and height (see *Chapter 2—Model Description*), it is unlikely that the extra effort would produce substantially different results. Initial fuel loads are set to: 3.5 tons/acre in the 3-6 inch category, 5.2 tons/acre in the 6-12 inch category, 2.1 tons/acre of fuels 12-15 inches, and some downed large logs that were about 6.4 tons/acre. Note that the “8.5” in Field 5 is the sum of all the large material since the FFE does not track these separately. The model uses default values for size classes that are not entered.

4.0 Fires

4.1 Introduction

FFE-FVS can simulate fire and its effects three different ways: simulated fires, pile burns, and potential fires. *Simulated fires* compute fire effects and apply them to the stand, creating snags and changing the state of the fuel and trees for the next time step. These fires simulate forest fires regardless of the method of ignition or policy regarding suppression.

A second way is to simulate *burning piles* of fuel. The model predicts the smoke produced and the reduction of fuel and allows you to specify the percentage of trees killed during the treatment. This method is a simple way to simulate a fuels treatment.

In the third way, the model simulates *potential fires*. All the calculations for simulated fires are done except that the effects are not applied to the fuels and stand; changes in those values are computed as if no fire occurred. When the Potential Fire Report is being generated, as done using the keywords shown in figure 1, information about potential fires is frequently computed, perhaps every year of projected time. In contrast, information about *simulated fires* is only computed when the simulated fires are scheduled to burn.

When you *simulate fires* or use the model to compute *potential fires*, you can set the environmental conditions and several other parameters that control how the model simulates the fires. Keywords used to control the simulated fires are presented next (section 4.2), followed by pile burning (section 4.3), potential fires (section 4.4), and lastly, keywords used to control the fuel model selection that is common to both simulated and potential fires (section 4.5).

4.2 Simulated Fires

A fire is simulated in each year the SIMFIRE keyword is scheduled, since the FFE-FVS model does not predict when a fire will occur. This keyword actually serves two purposes. The main purpose is implied by its name, which is to signal when a fire is simulated. The second purpose is to specify some of the environmental conditions in place at the time of the fire. The environmental conditions at the time of a fire play a big role in the intensity of the fire, and therefore in the mortality of the trees and the consumption of fuel. Some of the environmental conditions can be set using the SIMFIRE keyword. Fuel moisture conditions are set using the MOISTURE keyword. Note that fuel consumption is dependent on fuel moisture, not on the flame length, wind speed, or temperature. Drier fuel burns more completely and more mineral soil may be exposed. Dry duff produces more smoke than wet duff, while the reverse is true for large fuels. Smoke production from all other fuels is not dependent on moisture. The flame length is also dependent on the moisture of small (<3 inch) fuel.

A keyword called DROUGHT also exists (see section 4.5) but it has no impact on the moisture content of fuels or on the fire conditions. In some variants, it affects the choice of fire behavior fuel model, which will affect fire intensity and mortality.

The last keyword in this group is called FLAMEADJ. It can be used to modify the flame lengths predicted by the model directly, in turn affecting the predicted fire effects. It is designed to provide a way to simply tell the FFE what flame lengths to use or how to modify those that the model predicts. Its purpose is to insure that the FFE uses flame lengths that you expect.

SIMFIRE Signal that a fire and its effects should be simulated and specify some of the environmental conditions for the fire. Use one SIMFIRE keyword for each fire you wish to simulate.

Field 1: The FVS cycle number or the calendar year; default is 1.
Field 2: Wind speed in miles per hour 20 feet above ground; default is 20.
Field 3: Nominal moisture levels as shown in table 1. If the MOISTURE keyword is used the value in this field is ignored; the default is 1=very dry.
Field 4: Temperature (^{o}F); default is 70.

MOISTURE Set the moisture content for each fuel size class. These moisture values apply to simulated fires scheduled for the same calendar year. If this keyword is used for any size class, it must be used for all size classes because there are no default moisture conditions.

Field 1: The FVS cycle number or the calendar year; default is 1.
Field 2: Moisture value for 1 hour fuel (0-0.25 inch).
Field 3: Percent moisture for 10 hour fuel (0.25-1 inch).
Field 4: Percent moisture for 100 hour fuel (1-3 inch).
Field 5: Percent moisture for 3 inch+ fuel.
Field 6: Percent moisture for duff.
Field 7: Percent moisture for live fuel.

FLAMEADJ Modify or set the flame length for a fire simulated using the SIMFIRE keyword scheduled for the same year.

Field 1: The FVS cycle number or the calendar year; default is 1.
Field 2: Flame length multiplier. The default is 1.0, which is suggested for free-burning fires. We suggest using a value of 0.3 to simulate a throttle-back fire and 2.0 to simulate a mass-ignition fire.

Field 3: Enter a flame length to be used in place of a computed length. The default is for the model to compute the length and is signified by leaving the field blank or coding -1.
Field 4: Percent of crowns that burn (crowning). If blank or -1, the model computes the percent crowning.

Figure 5 shows the keywords for simulating two fires, a prescribed burn in 2002 and a wildfire in 2003. The prescribed fire is the first instance of the SIMFIRE keyword. Field 1 is used to specify the year and field 5 is used to signal that the default wind speed for prescribed fires be used. The other fields are left blank. The MOISTURE keyword is used to define the moisture values for the prescribed fire, indicated by using the same year in field 1 as is used in field 1 of the first SIMFIRE keyword. The second use of the SIMFIRE keyword simulates a wildfire scheduled for 2003 with winds of 60 miles per hour, temperature of 75 ^{o}F, and “dry” moisture conditions.

Figure 6 illustrates using the SIMFIRE and FLAMEADJ keywords to simulate a low intensity fire. The SIMFIRE keyword is used with its default values and it is followed by the FLAMEADJ keyword where the flame length is set to 2.5 feet and the percent crowning is set to zero to eliminate any possibility of a crown fire.

4.3 Burning Piles

The PILEBURN keyword is used to simulate burning piled fuel in the stand. When used, it reduces fuels, estimates smoke production, and kills the proportion of trees you specify. No other fire effects are simulated.

The keyword has several options as listed below. Default conditions for pile burns and jackpot burns can be used simply by indicating either of these types of fuel burns on the keyword. In place of selecting one of the default types of burns, you can specify exact values for the parameters of the burn, or do both.

PILEBURN Signal that a pile or other concentration of fuel is to be burned.

Field 1: The FVS cycle number or the calendar year; default is 1.
Field 2: The index to the type of fuel burn where 1=pile burn and 2=jackpot burn; the default is 1. These values control the defaults for fields 3-5 on this keyword and otherwise have no special significance.
Field 3: Percent of the stand’s area from which fuel is collected (known as the affected area); the default is 70 when field 2 is 1=pile burn, and 100 for 2=jackpot burn.
Field 4: Percent the affected area were fuel is piled; the default is 10 when field 2 is 1=pile burn, and 30 when it is 2=jackpot burn.
Field 5: Percent of the fuel from the affected area that is placed in the piles; the default is 80 when field 2 is 1=pile burn, and 60 when it is 2=jackpot burn.

Field 6: Percent mortality of trees in the stand caused by this fuel treatment; default is 0.

The default conditions imply a pile burn and can be interpreted as: 80% of the fuels from 70% of the stand are concentrated into piles that cover 10% of the affected area and therefore 7% of the stand's area. When these piles burn, no trees die. Since the FFE-FVS is a non-spatial model, the fuel is assumed to be evenly distributed across the stand both before and after the treatment. Thus, these percentages are simply used to determine how much of the fuel actually burns, and how much mineral soil will be exposed after the burn. For example, if there were 100 tons/acre of fuels in the stand excluding duff, the result of applying the default treatment would be to burn 0.8*0.7*100 = 56 tons/acre. Ten percent of the duff would burn and 10% of the mineral soil would be exposed. Because of differential consumption rates, if the fuels include some that are larger than 1 inch, less than 56 tons/acre of fuel will actually be consumed by fire.

Line FFE 2 of figure 7 illustrates an example with a fuel treatment in year 2007. Fifteen percent of the stand is actually burned, but it holds 75 percent of the fuel from 100% of the stand. One percent of the living trees are killed in this fuel treatment. Note that duff consumption only occurs on the 15% of the stand that contains the burn.

Non-piled fuel treatments may be specified using combinations of the SIMFIRE, FLAMEADJ, and MOISTURE keywords. This approach implies that 100% of the fuels will be treated, but setting the moisture values of the different fuel pools, the flame lengths, or both provides for better control the consumption rates. For example, lines FFE 3-4 of figure 7 show how to use the SIMFIRE and FLAMEADJ keywords to simulate a fuel treatment in year 2037. The SIMFIRE keyword is used to create a fire that burns when there is no wind and with wet moisture conditions (field 3 has the value 4). The FLAMEADJ keyword adjusts the flame length to one-tenth the computed value and sets the percent-crowning zero thereby reducing the mortality rates.

4.4 Potential Fires

As pointed out in section 4.1, the FFE can simulate *potential fires*, those where most of the model predictions are computed and output without actually applying any fire effects. The main output table for this option is the Potential Fire Report, described in section 5.7 of *Chapter 2—Model Description*. You control when calculations for the potential fires start and how often they are output using the POTFIRE keyword. This keyword's use is shown in fig. 3 and its full description is in section 8.0, with the other keywords that control output. The model estimates two sets of values for the potential fires. One set uses moisture, temperature, and wind conditions that are consistent with *severe* fire conditions often associated with wild fires, and the other set corresponds to *moderate* conditions often associated with prescribed fire situations where the suppression policy or required level of action would be considered moderate or light.

You can specify the wind speed, temperature, and fuel moisture conditions for each of the two categories, known to the model as 1=severe and 2=moderate.

POTFWIND Set the wind speeds for the two categories of potential fire severity.

Field 1: The wind speed for the severe category; default is 20 miles per hour.
Field 2: The wind speed for the moderate category; default is 6 miles per hour.

POTFTEMP Set the temperature for the two categories of potential fire severity.

Field 1: The temperature for the severe category; default is 70 ^{o}F.
Field 2: The temperature for the moderate category; default is 70 ^{o}F.

POTFMOIS Set the fuel moisture conditions for the two categories of potential fire severity. The defaults for severe conditions correspond to the values for very dry moistures shown in table 1 and the defaults for moderate conditions correspond to the moist values.

Field 1: An index value that signals which of the two categories of fire the values in fields 2-6 apply where 1=severe and 2=moderate; 1 is the default.
Field 2: Percent moisture for 1-hour fuels (0-0.25 inch).
Field 3: Percent moisture for 10-hour fuels (0.25-1 inch).
Field 4: Percent moisture for 100-hour fuels (1-3 inch).
Field 5: Percent moisture for 3 inch+ fuels.
Field 6: Percent moisture for duff.
Field 7: Percent moisture for live fuels.

4.5 Fire Behavior Fuel Models

Calculations of flame length, for both the *simulated fires* and the *potential fires*, are done using Rothermel’s 1972 fire behavior prediction system as implemented in FIREMOD (Albini 1976). This model requires a number of parameters that are not carried or readily calculated by the FFE. These include fuel characteristics such as surface-to-volume ratio, depth, and moisture of extinction, in addition to some parameters that are computed by the FFE, namely, the fuel loads by fuel size class. Thirteen stylized *fuel models* proposed by Anderson (1982) are used by the FFE in its adaptation of FIREMOD. How these fuel models are used and how they have been extended is covered in section 5.4.2 of *Chapter 2—Model Description*.

Briefly, the FFE picks one or more fuel models, calculates the fire intensity from each one, and then computes a weighted average flame length by interpolating using factors such as fuel loading or canopy cover. This interpolation provides flame lengths that change more gradually as stand conditions change than those that are computed without the interpolation logic.

By default, the model uses the interpolation method for calculating fire intensity, which we call using *dynamic* fuel models. If you prefer, however, you can tell the model to use only the fuel model it considers the best choice, rather then using the interpolation approach. This is done using the STATFUEL keyword.

Furthermore, you can define new fuel models, or change the parameters of existing models using the DEFULMOD (DEFine FUeL MODels) keyword. The purpose of this keyword is to give you the maximum control over the fire intensity calculations. The final keyword that controls the fire intensity calculations is the FUELMODS keyword. With it, you specify which fuel model(s) to use in any given year and specify the weights used in the interpolation logic in cases where more than one model is provided.

In some habitat or cover types, in a few FVS variants, the selection of the appropriate fuel model(s) depends on the weather conditions at the time of the selection. The DROUGHT keyword can identify one or more years as drought years, which may affect the fuel model selection and subsequent fire intensity. Consult the documentation for your variant to see if drought conditions are used. At the time the guide was written, the drought conditions were only used in the Utah and Central Rockies variants.

STATFUEL Signal that the *dynamic* interpolation logic not be used throughout the simulation.

DEFULMOD Modify the parameters of an existing fuel model or define the parameters of a new fuel model. Note that the defaults for fields 3-12 are those defined for the fuel models listed in table 2. Fields 8-12 are coded on a second line; each value in fields that are 10 columns wide starting in column 1. Even if these fields are not used, this additional line must be entered.

Field 1: The FVS cycle number or the calendar year when the definition takes place; default is 1. Once in effect, the changes stay until they are changed again.
Field 2: Fuel model index number from table 2. Values for the standard 13 fuel models of Anderson (1982) are 1-13. Number 14 is a modified version of fuel model 11. You can define new fuel models by giving them values greater than the maximum number listed in table 2, up to a maximum index value of 30.
Field 3: Surface to volume ratio (1/ft) for 0-.25 inch fuel.
Field 4: Surface to volume ratio for .25-1 inch fuel.
Field 5: Surface to volume ratio for 1-3 inch fuel.
Field 6: Surface to volume ratio for live fuel.
Field 7: Loading for 0-.25 inch fuel.
Field 8: Loading for .25-1 inch fuel.
Field 9: Loading for 1-3 inch fuel.
Field 10: Loading for Live fuel.
Field 11: Fuel depth (ft).
Field 12: Moisture of extinction.

FUELMODL Specify the fuel models and the weights used in place of the fuel model selection described in *Chapter 2—Model Description*. This keyword over-rides the dynamic and static fuel model selection during the years it is in effect. Code fields 8 and 9 on a second line, each value in fields that are 10 columns wide starting in column 1. If these fields are not used, there must be a blank line after the keyword. The weights are automatically scaled so that they sum to 1.

Field 1: The FVS cycle number or the calendar year the fuel models specified start being used; default is 1.
Field 2: Index to fuel model 1 (if left blank or zero, then the automatic logic is used from this year onward).
Field 3: Weight given fuel model 1; default is 1.
Field 4: Index to fuel model 2.
Field 5: Weight given fuel model 2; default is 1 when field 4 contains an entry, zero otherwise.
Field 6: Index to fuel model 3.
Field 7: Weight given fuel model 3; default is 1 when field 6 contains an entry, zero otherwise.
Field 8: Index to fuel model 4.
Field 9: Weight given fuel model 4; default is 1 when field 8 contains an entry, zero otherwise.

DROUGHT Set drought years for the fuel model selection process. Drought conditions are used in the automatic fuel model selection in a few variants.

Field 1: The FVS cycle number or the calendar year when the drought starts; default is 1.
Field 2: The duration in years; default is 1.

Figure 8 illustrates the used of FUELMODS and DEFULMOD keywords to simulate 2 fires, one in 2002 (lines FFE 2-4) and the other in 2037 (lines FFE 5-9). A line-by-line explanation follows:

Line FFE 1: The FMIN keyword signals that FFE keywords follow.

Line FFE 2: SIMFIRE is used to signal that a fire is simulated in 2002 using default moisture and weather conditions.

Lines FFE 3-4: The FUELMODS keyword is used to specify that two fuel models will be used, model 8 receives 40% of the weight and model 10 receives 60% of the weight. Note that FFE scales the weights so that they sum to 1. Rather than percentages, .4 and .6 could have been used, or simply the numbers 4 and 6. Note that this keyword has 9 fields and that the last two are coded on a separate line. This additional line must be entered even if the values are left blank.

Line FFE 5: A second SIMFIRE is used to simulate another fire, this one in 2037.

Lines FFE 6-7: In the year 2037 (see field 1) fuel model index 30 (see field 2) is defined with the values coded in the remainder of the fields.

Lines FFE 8-9: This new fuel model, number 30, is given weight .4 and used with the existing fuel model 10. Close inspection of the values used to define fuel model 30 happen to be exactly those tabulated for model 8. The practical consequence of this example is that the fire that burns in the year 2037 will have similar flame lengths as the one that burns in 2007. They will be exactly the same if the stand canopy closure is identical. Canopy closure affects mid-flame wind speed and it, in turn, affects fire intensity.

Line FFE 10: The END keyword is used to signal that the keywords that follow are base FVS keywords.

If POTFIRE keyword were added to the example shown in figure 8, the values in the potential fire report would be affected by the FUELMODS values shown for year 2002 and 2037. Furthermore, if the DEFULMOD keyword were used to change the values of some or all of the default fuel models, the values in the Potential Fire report may also change. Lastly, if the STATFUEL keyword is entered, the static rather than dynamic fuel model logic would be used for simulated fires.

5.0 Adjusting Snag Parameters

5.1 Introduction

You can modify how FFE calculates the creation, decay, breakage, falling, and removal of snags using the keywords shown in table 3. Keywords that control height loss, decay, and falling of snags are presented in this section. Review section 3 of *Chapter 2—Model Description* for an overview of all aspects of how the FFE models snags. Note that the length of time it takes for a snag to lose, say half of its height, or to fall down, depends on whether it is hard or soft. The proportion of snags that are soft, rather than hard, when they are created is controlled using the SNAGPSFT keyword presented in section 5.3 on snag decay.

5.2 Height Loss

Height loss occurs in two stages. The first stage lasts until 50% of the original height is lost. The second stage lasts for the remainder of the life of the snag. Use the SNAGBRK to change the number of years it takes for hard and soft snags of various species to lose 50 percent of the height they had at the time the tree died and to set the number of additional years it takes for the remaining 30 percent of the snag's height to be lost. The FFE converts these values into snag breakage rates and uses them in the snag breakage equations described in section 3 of *Chapter 2—Model Description*. The snag breakage rates for initially soft snags are generally faster than initially hard snags.

SNAGBRK Control the snag height loss rates. The default values depend on the species of the snag. See the individual variant description for details.

Field 1: The tree species letter code or number for the FVS variant you are using. Code a zero ("0") or "All" for all species; the default is 0.
Field 2: The number of years from when a *hard* snag is created until 50% of the original height is lost.
Field 3: The number of years from when a *soft* snag is created until 50% of the original height is lost.

Field 4: The number of years from when a *hard* snag is created until the next 30% of the original height is lost. The height loss rate implied by this number is used until the snag falls down;

Field 5: The number of years from when a *soft* snag is created until the next 30% of the original height is lost. The height loss rate implied by this number is used until the snag falls down.

5.3 Snag Decay

You can control the time it takes for a hard snag to become soft using the SNAGDCAY keyword to set a multiplier that is used to adjust the base rate. The formula used to compute the base rate is covered in section 3.5 of *Chapter 2—Model Description*. It is a linear function of species and size (dbh). Inside the model, the only significant difference between a hard snag and one that has become soft is that fuel from soft snags decays differently than that from hard snags (but see section 5.2 for a difference for soft snags that were never hard).

Table 4 shows a set of multipliers that imply different numbers of years that snags of different sizes will take to make the transition from being hard to being soft. For example, a multiplier of 1 means that a 10 inch tree will take 27 years to become soft, while a 20-inch tree will take 39 years to become soft. You can use the multipliers shown in the body of the table pick adjustment multipliers that meet your needs. Note that a single multiplier is used for all sizes of a given species.

You control the proportion of newly created snags that are classified as soft using the SNAGPSFT keyword.

SNAGDCAY Set a rate multiplier that modifies how fast hard snags become soft.

Field 1: The tree species letter code or number for the FVS variant you are using. Code a zero (“0”) or “All” for all species; the default is 0.

Field 2: The rate of decay adjustment multiplier; must be positive; Higher values increase the amount of time it takes for a hard snag to become soft. default is 1.0.

SNAGPSFT Set the proportion of snags listed *soft* when trees die. This proportion applies to snags created from all sources, which include those specified using the SNAGINIT keyword (section 3), the input sample tree data file, mortality caused by fires and all other causes, and by stand management. The snags that are initially soft can lose height at a different rate than those snags that are initially hard.

Field 1: The tree species letter code or number for the FVS variant you are using. Code a zero (“0”) or “All” for all species; the default is 0.

Field 2: The proportion of snags that are *soft* when they are created; range is 0 to 1; default is zero.

5.4 Snag Fall

The FFE computes that rate at which snags fall depending on whether the snag was present at the time of a fire in addition to the snag's size and species. Furthermore, there is a built in assumption that some of the large snags (a few of those over 18 inches dbh) will stand for a long time. See section 3.6 of *Chapter 2—Model Description* for all the details.

The SNAGFALL keyword is used to specify a species-specific multiplier of the base snag fall rate that is calculated by the FFE (see equation 3.4 of *Chapter 2—Model Description*). Using this keyword, you can also specify how long some of the large snags stand.

The default values, those that are obtained by entering a multiplier of 1, are defined such that 95% of 10-inch snags will fall in 20 years, and they will all be gone in 22 years. For a 20-inch snag, 95% will fall in 31 years, and they will all fall in 100 years. Table 5 shows a set of multipliers that imply different numbers of years that snags of different sizes will take to fall. For example, to have 95% of 15-inch snags fall in 40 years, a multiplier of 0.61 would be entered in Field 2 of the SNAGFALL keyword. Multipliers for snags of other sizes or persistence times can be estimated through interpolation. Note that the multiplier in Field 2 of the keyword is used for all sizes of snags. For example, if a multiplier of 0.5 were to be used, 95% of 10-inch snags would fall in 40 years, while 30-inch snags would take 139 years for 95% of them to fall.

The SNAGPBN (SNAG Post BurN) keyword is used to set the snag fall down rates for snags that exist when a fire burns. The basic assumption is that soft snags and small snags fall faster than hard snags and large snags if they are present when a fire burns. Using the defaults for this keyword implies that all soft snags and 90% of snags less than 12 inches will fall in seven years after any fire. Note that the parameters are not species specific and that the rates implied by the SNAGFALL keyword will take precedence if they are faster than the post fire rates.

SNAGFALL Set a rate multiplier that modifies snag fall rate and set the length of time some of the large snags stand.

Field 1: The tree species letter code or number for the FVS variant you are using. Code a zero ("0") or "All" for all species; the default is 0.
Field 2: The rate of fall adjustment multiplier; must be greater than or equal to 0.001; default is 1.0. This affects all snags less than 18 inches dbh and the first 95% of snags greater than 18 inches. Values greater than 1.0 cause the snag to fall faster.
Field 3: The snag age (number of years the tree is dead) by which the last 5% of snags have fallen. This only affects snags larger than 18 inches dbh.

SNAGPBN Control the fall rates for snags that are present during a fire.

Field 1: Proportion of soft snags which will fall faster after a fire; range is 0-1; default is 1.0.
Field 2: Proportion of small snags which will fall faster after a fire; range is 0-1; default is 0.9.

Field 3: Number of years it will take for these snags to all fall; default is 7.
Field 4: Dbh (inches) which divides small snags from large snags for this calculation; default is 12.
Field 5: Scorch height (feet) that must be exceeded for the increased fall rates implied by this option to be used by the FFE; default is 0.

5.5 Summary

Snag height loss and fall down have a combined impact on the overall amount of volume represented by snags. The definition of one set of parameters may make it less important to define the other. For example, if multipliers are defined so that the snags all fall within 10 years, the impact of the height loss is negligible. And, if the height loss rates are very high, it may be less important to precisely define the fall rate. Direct creation and removal of snags is done using keywords found elsewhere in the guide (table 3).

6.0 Adjusting Fuel Parameters

Fuels accumulate, they decompose, and if there is a fire, they burn. These processes are covered in detail in section 4.0 of *Chapter 2—Model Description*. This section covers those keywords that affect fuel decomposition. Section 3.0 covers how to set the initial amount of fuel using FUELINIT keyword. The breakage of snags is a source of fuel; keywords that control snags are presented in section 5.0. Management actions, like thinning, can add to fuel. Parameters that control how much fuel is added are set using the YARDLOSS keyword presented in section 7.1. Burning piled fuel as a treatment is simulated using the PILEBURN keyword described in section 4.3. Fuel consumption from prescribed or wildfire is simulated using the SIMFIRE keyword, described in section 4.2. The moisture of fuel influences consumption and can be modified using the MOISTURE keyword presented in section 4.2.

6.1 Decay Rates

Fuels are tracked in several pools. A pool is like a table entry where the rows are the six fuel size classes and the columns are four decay rate classes. That makes 24 fuel pools.

You can change the decay rates associated these pools using the FUELDCAY keyword. You can modify the decay rates for each rate class rather than setting them directly using the FUELMULT keyword to specify a multiplier of the model's default rates.

FUELDCAY Set the decay rates for each the fuel pools. The default values depend on the variant.

Field 1: Decay class code, range 1-4. Code a 5 to set the rates for all 4 decay classes at once; an entry is required.
Field 2: Decay rate for the litter fuel size class.
Field 3: Decay rate for the duff fuel size class.
Field 4: Decay rate for the 0 - 0.25-inch fuel size class.
Field 5: Decay rate for the 0.25 – 1-inch fuel size class.
Field 6: Decay rate for the 1 - 3-inch fuel size class.

Field 7: Decay rate for the >3 inch fuel size class.

FUELMULT Specify multipliers for each decay rate class that apply to the decay rates for all fuel size classes.

Field 1: Multiplier for decay rate class 1=very slow; default is 1.
Field 2: Multiplier for decay rate class 2=slow; default is 1.
Field 3: Multiplier for decay rate class 3=fast; default is 1.
Field 4: Multiplier for decay rate class 4=very fast; default is 1.

6.2 Assignment to Pools

The decay rate class of fuel is determined by the tree species from which it originated. By default, in most variants, all of the biomass for all species is added to the first decay rate class (see section 4.5 of *Chapter 2—Model Description*). You can change the assignment of a species to a different decay rate class (or pool) using the FUELPOOL keyword. If different decay rates are set for each decay class, then the assignment of the species to a class is important.

FUELPOOL Specify the assignment of each species to a specific decay rate class.

Field 1: Valid species letter codes or number. Use a “0" or “ALL” to indicate all species; no default.
Field 2: Decay rate class number, 1 to 4; no default.

As the biomass in each pool decays, some portion becomes duff, while the remainder is lost to the air. Since duff usually decays very slowly, the amount of decayed biomass that becomes duff plays an important role in the amount of duff present in the stand over the long term. The decay rate of the duff pool can be changed using the FUELDCAY keyword described above. You can change the proportion of the decayed biomass that goes into the duff pool using the DUFFPROD keyword. This keyword does not affect the decay rate of the original pools, just the amount that moves from the original pools to the duff pool. The portion that does not enter the duff pool is lost to the atmosphere and is not tracked by the FFE.

DUFFPROD Set the proportion of the decayed material that becomes duff, the remainder is lost.

Field 1: Decay class code, range 1-4. Code a 5 to set the proportion for all 4 classes at once; there is no default.
Field 2: Proportion of decayed litter; default is 0.02.
Field 3: Proportion for the 0 - 0.25 inch fuel; default is 0.02.
Field 4: Proportion for the 0.25 - 1 inch fuel; default is 0.02.
Field 5: Proportion for the 1 - 3 inch fuel; default is 0.02.
Field 6: Proportion for the > 3 inch fuel; default is 0.02.
Field 7: Proportion for all fuel size classes. Values coded in this field automatically replace blanks in fields 2-6; default is 0.02.

Figure 9 illustrates some of the keywords presented this section. The example assumes that fuel originating from all species is placed by default in the first decay rate pool. In line FFE 2 of figure 9, the FUELMULT keyword is used to modify the second decay rate class so that the rates are twice as fast as those in the first pool and to modify rates in the third class so that they are half as fast. In line FFE 3, the FUELPOOL keyword is used to assign aspen (using species code AS) to the second class and, in line FFE 4, cedar (using species code WC) is assigned to the third. Line FFE 5 is shown as a reminder that if you don't ask for output, none is provided. In this case, the FUELOUT keyword (described in section 8.3) is used to request that fuel reports start in year 2000.

7.0 Management

Various management options exist in both the FFE and the base FVS model. Most of these options have a direct impact on snags or fuels by creating or destroying them (table 6). These options will also have an indirect impact on fuels or fire intensity. For example, removing snags through salvage logging will directly decrease the number of snags. It will indirectly decrease the amount of fuel because there will be less input coming from the snags. It could also indirectly affect the fire intensity or smoke emissions because these can be dependent on fuel loads. Only one option has an impact on fuel depth, and thus directly on fire intensity.

All the management options with the exception of pile burning (section 4.3) are discussed in the remainder of this chapter. Two base model keywords are discussed in this document because of their direct impact on FFE snags and fuels.

7.1 Base Model Keywords

When management options such as thinning are done in the main FVS model, the FFE assumes that the crowns from the cut trees are left in the stand on the ground and the stems are removed. A base model keyword, YARDLOSS, allows you to change these assumptions and to make some others. The keyword can be used to create snags by "cutting" trees and leaving them dead and standing in the stand. Alternatively, some of the trees can be left in the stand on the ground. These two options are especially useful when simulating a thinning in which some trees are left in the stand. The keyword only applies to the thinning actions that immediately follow it in the keyword file and are scheduled for the same year. You can use the YARDLOSS keyword as often as necessary to achieve your needs. Whole tree yarding can be represented using this keyword.

YARDLOSS Set the proportion of the harvested stems that are not removed and, of those, set the portion that are left standing. Also specify the proportion crown biomass that is removed with removed stems.

Field 1: The FVS cycle number or the calendar year; default is 1.
Field 2: Proportion of harvested stems that are not removed from stand; default is 0. Setting this to 1.0 simulates "cut and leave".
Field 3: Proportion of the trees that are left in the stand that are down; default is 1.0. Biomass from trees that are left in the stand and are down is added to

the fuel pools and trees that are not down become snags. Biomass from snags is added to fuel pools as the snags fall apart and fall down, just as when they are created through mortality.

Field 4: Proportion of crowns remaining in stand from removed stems; default is 1. Set this value to 0.0 to simulate whole tree removal.

Figure 10 illustrates how to use the YARDLOSS keyword. In this example, a stand is being thinned from below to remove a large number of the small trees. At the same time, some large trees are killed but are all left in the stand as snags. Line 12 signals that, for the next thinning option, all of the trees will be left in the stand, and that 100% of those that are left will be left down. As none of the trees will be removed, the value coded in the fourth field is ignored. Line 13 shows the ThinDBH keyword used to cut all of the trees less than 5 inches dbh with 100% efficiency. Line 14 shows that the YARDLOSS keyword is used a second time to specify that all the trees are not removed and are not felled. Therefore, all the trees in the following harvest will become snags. Line 15 illustrates the ThinABA keyword used to "cut" trees larger than 20 inches dbh, down to a residual of 200 ft^2 of basal area, with a 10% efficiency. Lines FFE 1 to 3 illustrate a request for the fuel model output.

The second base model keyword, PRUNE, is used to shorten crowns. Biomass from pruned branches is added to the appropriate fuel pools. The indirect impact within the FFE is that pruning can change the crown base height, weight, and density, thus affecting the chance of a crown fire occurring. The options for this keyword are discussed more fully in other documents.

7.2 Snags Management

Use the SALVAGE keyword to simulate the removal of snags. You can specify a size range, age, and decay status of snags to be removed.

SALVAGE Schedule a snag removal operation.

Field 1: The FVS cycle number or the calendar year; default is 1.
Field 2: Minimum dbh (inches) to be removed; default is 10.
Field 3: Maximum dbh (inches) to be removed; default is 999.
Field 4: Maximum number of years the removed snags have been dead; default is 5.
Field 5: Decay state to remove where: 0=both hard and soft, 1=hard, and 2=soft snags; default is 1.
Field 6: Proportion of eligible snags to fell; default is 0.9.
Field 7: Proportion of felled snags to leave in the stand; default is 0.0.

A chaining operation can be simulated using the SALVAGE keyword in conjunction with base FVS keywords (fig. 11). To achieve the effect of chaining, the YARDLOSS and THINBBA keywords (lines 12 and 13) are used to fell all the trees, leaving them in the stand. Secondly, the SALVAGE keyword (line FFE 2) is used to fell all the snags, leaving them all in the stand. As in previous examples, a fuels output report is requested on line FFE 3.

7.3 Fuel Management

You can manage fuels by changing fuel depth and by changing the amount of fuel in each size class. The PILEBURN keyword, covered in section 4.3, changes the amount of fuel. In this section, keywords used to change the depth or amount of fuel are presented.

The practical methods of changing fuel depth are include direct fuel treatments, like lopping or trampling, or harvest methods that result in different amounts or distributions of fuels. These might include ground-based skidding verses skyline or helicopter logging. You can change the size-class distribution of fuels by chipping or chunking large fuels so that they become small. You can simply haul fuels away.

Use the FUELTRET keyword to modify the fuel depth and use the FUELMOVE keyword to transfer fuels from one size class to another. The FUELTRET keyword allows you to specify the name of a fuel treatment or logging method; for each method the FFE supplies a multiplier (table 7) to the fuel depth that simulates the treatment. If you prefer, you can specify the multiplier yourself and ascribe any meaning you wish to its use.

The FUELMOVE keyword does not image any nominal treatments. You specify an amount of fuel to move from one class to another. You may alternatively specify the proportion to move or the residual to leave. You ascribe the practical meaning to the use of this keyword.

FUELTRET Specify a fuel treatment or harvest method, or specify the multiplier used to modify the fuel depth.

Field 1: The FVS cycle number or the calendar year; default is 1.
Field 2: Fuel treatment type: 0=none, 1=lopping or flailing, 2=trampling, chopping, chipping, or crushing; default is 0.
Field 3: Harvest type: 1=ground-based, cat skidding or line skidding, 2=high lead or skyline, 3=precommercial or helicopter; default is 1.
Field 4: Multiplier used to increase or decrease fuel depth; default depends on the values in field 2 and 3 (table 7) but if both are 0.0, the default for this field is 1.0.

Figure 12 shows how to specify two fuel treatments. Line FFE 2 illustrates that a lopping treatment is applied in 2010, thereby reducing the fuel depth to 83% of its depth prior to the treatment. Line FFE 3 shows another treatment that increases the fuel depth by 10% in 2030.

FUELMOVE Move fuel between size classes to simulate fuel treatments. The amount of fuel to move can be specified in five different ways (see fields 3-7); if values are provided for more than one method, the FFE will use the method that results in the largest transfer. Setting the source pool to 0=none implies that fuel is being imported from outside and setting the destination pool to 0=none implies that fuel is being removed. The order FUELMOVE keywords are entered into the keyword file is important, especially if proportions are used. FFE processes keywords in the scheduled order and removes the fuel from the source pool at that time. The fuel is not added to the destination pool until all keywords for the year have been processed.

Field 1: The FVS cycle number or the calendar year; default is 1.
Field 2: Source fuel pool (0=none, 1=<0.25 inch, 2=0.25-1 inch, 3=1-3 inch, 4=3-6 inch, 5=6-12 inch, 6=>12 inch, 7=litter, 8=duff); default is 6.
Field 3: Destination fuel pool; same codes used in field 2; default is 8.
Field 4: Amount of fuel (tons/acre) to move from the source pool; default is 0.
Field 5: Proportion of source fuel to move; default is 0.
Field 6: Residual fuel (tons/acre) to leave in the source pool; default is 999.
Field 7: Final amount (tons/acre) of fuel in the target; default is 0.

Figure 13 show how to simulate a fuel treatment that chops large fuel into smaller pieces, presumably to increase decay rates and reduce future fire intensity. The treatment goal is to process 80% of the largest fuel (>12 inches) such that 60% of the treated large fuel is added to the 1-3 inches class and the rest are added to the 0.25-1 inch class. The 6-12 inch fuel is similarly treated. Only a small amount of the 3-6 inch fuel is treated, to reduce the amount in that size class to about 12 tons/acre. A line-by-line description of the lines FFE 2-7, figure 12, follows with notes on the reasoning behind their use. Note that the order of the keywords is important.

Line FFE 2: 60% of the fuel in size class 6 is moved to size class 3. The FFE will remove these fuel from the size class before processing the next keyword, leaving the remaining 40% of the fuel in the size class.

Line FFE 3: 50% of the fuel remaining in size class 6 is moved to size class 2. Thus, in total, 80% of the fuel in size class 6 is moved.

Lines FFE 4 and 5: Fuel in size class 5 is moved using the same logic used to move fuel from size class 6 except that an amount of fuel is entered into field 4 of line FFE 5. The FFE calculates whether the 8 tons/acre amount specified in field 4 is more or less than 50% of the remaining fuel in the class. The greater of the two amounts is moved.

Lines FFE 6 and 7: Enough fuel is moved from size class 4 to size class 3 to bring the residual down to 18 tons/acre. Then, enough is moved from class 4 to 2 so that the residual is 12 tons/acre.

Figure 14 shows how to use FUELMOVE to remove fuel from a stand. When removing fuel, the destination tagged as “0” in field 3 and when adding fuel, the source field is tagged as a “0” in field 2. The command is ignored if both the destination and the source fields are “0”. In the example, 85% of the 6-12 inch fuel and 90% of fuel over 12 inches is removed and the rest is left in the stand. Note that the values are entered as proportions, not as percentages.

8.0 Output Keywords

The content of the output reports is presented in *Chapter 2—Model Description* along with the descriptions of the model components to which they apply. The keywords that control output generation are presented below. Seven output tables are available from the FFE. Four provide information about the current state of the stand in terms of levels of snags and fuel, or the potential fire intensity and effects. The remaining three are produced only after a fire, and give summary information about the fire and the impact of the fire. Four of the output files have a second keyword that can be used to affect what is printed in the output file. For example, mortality and snags are printed as size class summaries, and keywords affect the definition of the size classes. Table 8 provides a list of the keywords that control or affect output format, and includes a reference to the location in *Chapter 2—Model Description* where the output is described.

All of the output tables except one are printed to the end of the main FVS output file. Because of its potential size, the detailed snag output table is printed to a separate file.

POTFIRE Request the potential fire report.

Field 1: The FVS cycle number or the calendar year when the output starts; default is 1.
Field 2: Number of years to output; default is 200.
Field 3: Interval to output; default is 1 (every year).

FUELOUT Request the detailed fuels report.

Field 1: The FVS cycle number or the calendar year when the output starts; default is 1.
Field 2: Number of years to output; default is 200.
Field 3: Interval to output; default is 1 (every year).

BURNREPT Request the burn conditions report output.

Field 1: The FVS cycle number or the calendar year when the output starts; default is 1.
Field 2: Number of years to output; default is 200.

FUELREPT Request the fuel consumption report.

Field 1: The FVS cycle number or the calendar year when the output starts; default is 1.
Field 2: Number of years to output; default is 200.

MORTREPT Request the detailed mortality report.

Field 1: The FVS cycle number or the calendar year when the output starts; default is 1.
Field 2: Number of years to output; default is 200.

MORTCLAS Specify the class boundaries used in the detailed mortality report. The classes must be specified in increasing order.

Field 1: Minimum dbh of size class 1; default is 0 inches.
Field 2: Minimum dbh of size class 2; default is 5 inches.
Field 3: Minimum dbh of size class 3; default is 10 inches.
Field 4: Minimum dbh of size class 4; default is 20 inches.
Field 5: Minimum dbh of size class 5; default is 30 inches.
Field 6: Minimum dbh of size class 6; default is 40 inches.
Field 7: Minimum dbh of size class 7; default is 50 inches.

SNAGSUM Request the snag summary report. Unlike the other reports, you can not control when this report output starts and ends.

Field 1: If a negative number is entered, no report is generated (useful only to turn off a previously requested report).

SNAGCLAS Set the snag class boundaries used to assign snags to class in the snag summary report and for the detailed snag report. Values must be specified in increasing order.

Field 1: Lower boundary of size class 1; default is 0 inches.
Field 2: Lower boundary of size class 2; default is 12 inches.
Field 3: Lower boundary of size class 3; default is 18 inches.
Field 4: Lower boundary of size class 4; default is 24 inches.
Field 5: Lower boundary of size class 5; default is 30 inches.
Field 6: Lower boundary of size class 6; default is 36 inches.

SNAGOUT Request the detailed snag report.

Field 1: The FVS cycle number or the calendar year when the output starts; default is 1.
Field 2: Number of years to output; default is 200.
Field 3: Interval to output; default is 5 years.
Field 4: Fortran data set reference number to which the output file is written; default is 3.
Field 5: Enter a 0 if you want headings output for this table, and enter a 1 if you want headings suppressed; default is zero.

SVIMAGES Set the number of frames, or images, showing the fire progression when the base model SVS keyword is used. This keyword is related to the use of the Stand

Visualization System described the *Preface* and illustrated on cover of the volume.

Field 1: The number if frames or images; default is 3.

Figure 15 illustrates asking for every kind of output in addition to changing the default diameter class boundaries for the mortality report so that they exactly match the default boundaries for the snag report. The example starts with the keywords illustrated in Figure 7. In that example, no reports were requested yet the example included a pile burn and a simulated fire. Without those reports, evidence of the fires is limited to how the fire affects base FVS outputs.

Line FFE 5: Request the potential fire report be generated starting in the year 2000. The default interval of 1 year is used and the report is generated for 200 years.

Lines FFE 6-9: Request the detailed fuels, burn conditions, fuel consumption, and detailed mortality reports.

Line FFE 10: Set the class boundaries for the detailed mortality reports to those used in the snag reports. The last field is coded with an 9999 to specify a huge lower bound for the last class, so that there are only really 6 size classes for reporting, which means that all trees over 36 inches are reported in the sixth class.

Line FFE 11: Request the snag summary.

Line FFE 12: Request the detailed snag data be output to the data file reference by the number 3, every 5 years, for 200 years, as the defaults signify. The data file associated with the number 3 is automatically opened by FVS for the tree list output. This example does not use that feature of FVS so this file will contain only the snag data. If the tree list option were also used, the file would contain both the tree list and snag data.

9.0 Using the FVS Event Monitor

The Event Monitor (Crookston 1990) is part of the FVS system. The FFE interacts with the Event Monitor providing the ability to build very powerful keyword command files. Using the capabilities of the Event Monitor you can specify logical expressions that are predicated on the value of state variables that are automatically updated by FVS. Activities, like thinnings, can be set up so they are scheduled only if the logical expressions are true. You can define new state variables as functions of those that are predefined plus new ones that you defined earlier in the keyword set. You can also use variables to define the parameter fields on keywords rather than specifying constant values as shown in all the previous examples.

In this section, we build on the information provided by Crookston (1990) on how to use the Event Monitor with the base FVS system. Therefore, the following text assumes that you understand the information presented in that document.

The FFE capitalizes on the Event Monitor by supporting the use of its features. All FFE keywords that can be scheduled with a fixed year or cycle in field 1 can alternatively be scheduled as part of an IF-THEN sequence. All of these same keywords support the PARMS feature of the Event Monitor. Lastly, automatic variables have been created whose values are defined when the FFE is used. Note that the Event Monitor handles variables listed as having arguments as if they were functions. The variables are as follows.

FIRE has the value 1 (yes) if a fire was simulated in the preceeding FVS cycle and has the value 0 (no) if not.

FIREYEAR is the year that the last fire is simulated; the value will be zero if a fire has not been simulated during the run.

MINSOIL is the percent of mineral soil exposure from the most recent fire.

FUELLOAD(arg1, arg2) is the total tons/acre of fuel in the stand for a range of fuel size classes. The lower limit of the range is defined using arg1 and the upper limit is arg2. The value of arg1 and arg2 can be the same. A coding system is used to specify the classes, where 1 is >=0 to <0.25 inch, 2 is >=0.25 to < 1 inch, 3 is >=1 to <3 inches, 4 is >=3 to <6 inches, 5 is >=6 to <12 inches, 6 is >=12 inches, 7=litter, and 8=duff.

CROWNIDX is the crowning index reported in the potential fire report.

CRBASEHT is the crown base height reported in the potential fire report.

CRBULKDN is the crown bulk density reported in the potential fire report.

POTFLEN(arg1) is the flame length reported in the potential fire report for the severe fire conditions when arg1 is 1 and for the moderate fire conditions when arg1 is 2.

SNAGS(arg1, arg2, …, arg7) is the total number, volume, or basal area of snags meeting the criteria specified using the arguments. Only the first three arguments are required, so only code the others if you need them. Note that the snag data are stored in 2 inch-wide dbh classes. The definitions of the arguments are:

Arg1 defines the type of information returned where 1= snag density, 2 = basal area, and 3 = volume.
Arg2 defines the tree species where 0 = all species and other values are the corresponding species codes for the variant. The numbers or the short alpha codes may be used.
Arg3 defines the decay status where 0 = all, 1 = hard, and 2 = soft.
Arg4 is the lower limit dbh in inches (greater or equal); the default is zero.
Arg5 is the upper limit dbh in inches (less than); the default is a large number.
Arg6 is the lower limit height in feet (greater or equal); the default is zero.
Arg7 is the upper limit height in feet (less than); the default is a large number.

TORCHIDX is the torching index reported in the potential fire report.

Figure 16 illustrates a simple example for scheduling pile burn whenever the small (litter and < 3 inch) fuel loads are greater than 8 tons/acre. The COARSEWD function is used twice, once to sum up the first three fuel classes, and once to return the litter, as described in the following line-by-line account:

Line 12: An FVS IF keyword is used to signal that a logical expression is being entered. The value of 10 in field 1 is a minimum waiting time between events. In this case, the pile burn can not be scheduled any more often than once each 10 years.

Line 13: The FUELLOAD function is used first to sum the first three fuel classes and secondly to get the litter. The sum of these two values is compared to 8.

Line 14: The THEN keyword signals that the expression has ended and that *activity keywords* follow. Activities are keywords that have a cycle number or year in the first field. They are scheduled when the event occurs, which is when the expression is true. When used in an IF-THEN sequence, the value coded in field 1 of activity keywords is added to the year the event occurs and the sum is the year in which the activity is scheduled. Note that logical expressions that define events are only tested on FVS cycle boundaries; see the Event Monitor user's guide for more information (Crookston 1990).

Line FFE 1: The FMIN keyword signals that the FFE keywords follow.

Line FFE 2: All the fields on the PILEBURN are left to their defaults except field 1. The first field is set to 0 so the year the pile burn is scheduled is the same year as the event occurs. Recall that the default value for field 1 is 1. If that number had been used, the PILEBURN would be scheduled for the year following the year the event occurred.

Line FFE 3: End the FFE keywords.

Line 15: End the IF-THEN sequence.

The remainder of the file functions as shown in figure 3.

Figure 17 illustrates how to use the PARMS feature of the Event Monitor with the FFE keywords. In this example, the FLAMEADJ keyword is used to increase the computed flame length by an amount that is a function of the slope and aspect of the stand. No adjustment is made for flat ground, or slopes that face east or west. The flame length is increased by up to 50 percent on south facing slopes and decreased by the same amount on north facing slopes. The amount of the adjustment is computed using a cosine function. The line-by-line description of the keyword file follows:

Line FFE 1: Start the FFE keywords

Line FFE 2: Schedule a fire to burn in the year 2037.

Line FFE 3: Use the PARMS feature of the Event Monitor to compute the flame length multiplier. The Event Monitor's *cos* (cosine) function takes its argument in radians, so the aspect is multiplied by $\pi/180 \approx 0.01745$. The cosine of aspect is multiplied by the slope so that places with little slope will have a small adjustment, regardless of aspect, and further multiplied by 0.5. The product is subtracted from 1 resulting in a multiplier of .5 for north aspects and 1.5 for south aspects that have 100 percent slopes. As the slope decreases to flat, the multiplier becomes close to 1.0; the same happens when aspect is more east or west. The example is used to illustrate how to use the PARMS feature and is not an endorsement of the formula. Note that the other two parameters of this keyword must be supplied. In this case, –1 is used to signal that the default values for those fields are used which means that the model is to compute the flame length and crowning percentages.

10.0 References

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11.0 Keyword Index

Keyword	Note	Page Numbers		
		Ch 3 User's Guide	***Ch 2 Model Description***	***Ch 4 FFE Variants***
BURNREPT				
CRBASEHT	Event Monitor variable			
CRBULKDN	Event Monitor variable			
CROWNIDX	Event Monitor variable			
DEFULMOD				
DROUGHT				
DUFFPROD				
END				
FIRE	Event Monitor variable			
FIREYEAR	Event Monitor variable			
FLAMEADJ				
FMIN				
FUELDCAY				
FUELINIT				
FUELLOAD	Event Monitor function			
FUELMODL				
FUELMOVE				
FUELMULT				
FUELOUT				
FUELPOOL				
FUELREPT				
FUELTRET				
MINSOIL	Event Monitor variable			
MOISTURE				
MORTCLAS				
MORTREPT				
PILEBURN				
POTFIRE				
POTFLEN	Event Monitor function			
POTFMOIS				
POTFTEMP				
POTFWIND				
PRUNE	Base Model keyword			
SALVAGE				
SIMFIRE				
SNAGBRK				
SNAGCLAS				
SNAGDCAY				
SNAGFALL				
SNAGINIT				
SNAGOUT				
SNAGPBN				
SNAGPSFT				
SNAGS	Event Monitor function			
SNAGSUM				
STATFUEL				
SVIMAGES				
TORCHIDX	Event Monitor variable			
YARDLOSS	Base Model keyword			

Table 1—Percent fuel moisture for the four nominal levels defined for field 3 of the SIMFIRE keyword.

Field 3 value	Name of moisture level	Fuel size class					
		0-2.5 inch (1 hour)	0.25-1 inch (10 hour)	1-3 inch (100 hour)	>3 inch	Duff	Live
1	Very dry	4	4	5	10	15	70
2	Dry	8	8	10	15	50	100
3	Moist	12	12	14	25	125	150
4	Wet	16	16	18	50	200	150

Table 2—Fire behavior fuel models used in the FFE-FVS. Values can be changed using the DEFULMOD keyword.

Name	DEFULMOD keyword field numbers										
	2	3	4	5	6	7	8	9	10	11	12
	Index Num ber	Surface to volume ratio (1/ft)				Loading (lb/ft^2)				Depth (ft)	Moisture of Extinction
		0-0.25"	0.25-1"	1-3"	Live	0-0.25"	0.25-1"	1-3"	Live		
Short grass	1	3500	109	30	1500	0.034	0	0	0	1	0.12
Timber (grass & understory)	2	3000				0.092	0.046	0.023	0.023	1	0.15
Tall grass	3	1500				0.138	0	0	0	2.5	0.25
Chaparral	4	2000				0.23	0.184	0.092	0.23	6	0.20
Brush	5	2000		0		0.046	0.023	0	0.092	2	0.20
Dormant brush, hardwood slash	6	1750			1550	0.069	0.115	0.092	0	2.5	0.25
Southern rough	7	1750			1550	0.052	0.086	0.069	0.017	2.5	0.40
Closed timber litter	8	2000	109	30	1500	0.069	0.046	0.115	0	0.2	0.3
Hardwood litter	9	2500				0.134	0.019	0.007	0	0.2	0.25
Timber (litter & understory	10	2000				0.138	0.092	0.23	0.092	1	0.25
Light logging slash	11	1500				0.069	0.207	0.253	0	1	0.15
Medium logging slash	12	1500				0.184	0.644	0.759	0	2.3	0.2
Heavy logging slash	13	1500				0.322	1.058	1.288	0	3	0.25
Light-medium logging slash	14	1500				0.126	0.426	0.506	0	1.8	0.2

Table 3—Summary of the keywords controlling snags.

Keyword	Use	Section
SALVAGE	Remove snags as a management action	7.2
SNAGBRK	Change the rate snag height declines	5.2, 5.3
SNAGDCAY	Change the snag decay rate	5.3
SNAGFALL	Change snag fall down rate	5.4
SNAGPBN	Change snag fall down rate	5.4
SNAGINIT	Set the initial number and size of snags	3.0
YARDLOSS	Creates snags as part of FVS management actions	7.1

Table 4—Multipliers useful in the SNAGDCAY keyword that result in different numbers of years that must pass for a hard snag to become soft. Multipliers near 1.0 are shown in bold as a reference to show the implications of the default decay rates.

Years to Soft	Snag dbh (inches)				
	10	15	20	25	30
10	0.38	0.31	0.26	0.22	0.20
20	0.76	0.62	0.52	0.45	0.39
30	1.14	0.93	0.78	0.67	0.59
40	1.53	1.23	**1.04**	0.89	0.78
50	1.91	1.54	1.29	1.12	**0.98**
60	2.29	1.85	1.55	1.34	1.18
70	2.67	2.16	1.81	1.56	1.37
80	3.05	2.47	2.07	1.78	1.57
90	3.43	2.78	2.33	2.01	1.76
100	3.81	3.08	2.59	2.23	1.96

Table 5—Multipliers useful in the SNAGFALL keyword that result in different numbers of years that must pass before 95% of the snags fall. Multipliers near 1.0 are shown in bold as a reference to show the implications of the default fall rates.

Years to 95% Fall	Snag dbh (inches)				
	10	15	20	25	30
10	2.00	2.43	3.09	4.25	6.81
20	**1.00**	1.21	1.55	2.13	3.41
30	0.67	0.81	**1.03**	1.42	2.27
40	0.50	0.61	0.77	**1.06**	1.70
50	0.40	0.49	0.62	0.85	1.36
60	0.33	0.40	0.52	0.71	1.14
70	0.29	0.35	0.44	0.61	0.97
80	0.25	0.30	0.39	0.53	0.85
90	0.22	0.27	0.34	0.47	0.76
100	0.20	0.24	0.31	0.43	0.68
110	0.18	0.22	0.28	0.39	0.62
120	0.17	0.20	0.26	0.35	0.57
130	0.15	0.19	0.24	0.33	0.52
140	0.14	0.17	0.22	0.30	0.49
150	0.13	0.16	0.21	0.28	0.45

Table 6—Summary of management action keywords that affect snags, fuel, and fuel depth.

Keyword	Use	Model	Section
FUELMOVE	Change the distribution of fuel among fuel size classes	FFE	7.4
PILEBURN	Decrease the amount of fuel	FFE	4.3
FUELTRET	Change the fuel depth and therefore its bulk density	FFE	7.4
PRUNE	Increase the amount of fuel and the base crown height	Base	7.2
SALVAGE	Decrease the number of snags	FFE	7.3
YARDLOSS	Increase the number of snags and increase or decrease the amount of biomass left after a logging operation.	Base	7.2

Table 7—Default fuel depth multipliers used to simulate various nominal fuel treatments and harvest types. Specifying the multiplier on Field 4 of the FUELTRET keyword has the same effect in the FFE as specifying the nominal treatment.

Harvest Method (field 3)	Fuel Treatment (field 2)		
	0=none	1=lopping or flailing	2=trampling, chopping, chipping, or crushing
1=ground-based, cat skidding or line skidding	1.0	0.83	0.75
2=high lead or skyline,	1.3	0.83	0.75
3=precommercial or helicopter	1.6	0.83	0.75

Table 8—List of output tables, the keywords that control them, and references to detailed output descriptions. Details on the keywords are presented in section 8.0 in the order they are presented below.

Report name	Keyword		*Model Description* section were the report is described
	Name	Use	
Potential fire report	POTFIRE	Request report	5.7
Detailed fuel report	FUELOUT	Request report	4.8
Burn conditions report	BURNREPT	Request report	5.7
Fuel consumption report	FUELREPT	Request report	5.7
Detailed mortality report	MORTREPT	Request report	5.7
	MORTCLAS	Modify diameter class boundaries	See this user’s guide
Snag summary table	SNAGSUM	Request table	3.8
	SNAGCLAS	Modify diameter class boundaries; values also apply to the detailed snag report.	See this user’s guide
Detailed snag report	SNAGOUT	Request report	3.8

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----
1	StdIdent
2	300290024601 Stand 300290024601 at Flathead FIA Data
3	Screen
4	InvYear 1993
5	StdInfo 110 692 84 243 20 53
6	Design 0 1 999 1 0 6104
7	Growth 1 10 1 10 10
8	SiteCode 3 54
9	TimeInt 5
10	TimeInt 1 7
11	NumCycle 21
12	Open 2
13	02900246.tre
14	TreeData 2
15	Close 2
16	Process
17	Stop

Figure 1—Keyword file used to make a *no fire* and *no management* run of FVS. The user's guide examples are illustrated by showing how this basic keyword file is modified to include FFE keywords. Note that not all of these keywords are critical to the execution of a basic run; their use ensures that the simulation will produce better results.

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----
1	101 14.851DF 84 0 52 0226 027 0 0 021 0 0
2	102 42.861DF 44 0 38 02556127 0 0 021 0 0
3	103 42.861DF 35 0 31 02556127 0 0 031 0 0
4	104 42.861DF 30 0 23 01556127 0 0 031 0 0
5	201 38.751DF 52 0 32 0527 0 0 0 0 021 0 0
6	301 12.381DF 92 0 62 0426 027 1 0 021 0 0
7	302 2.811DF 193 0 77 0426 82712 0 021 0 0
8	303 23.341DF 67 0 48 0226 027 0 0 021 0 0
9	304 22.746LP 96 96 63 00 2 32635275021 0 0
10	401 36.286LP 76 76 63 00 2 3263527 021 0 0
11	402 5.841DF 134 0 74 04 0 0 0 0 0 021 0 0
12	403 19.661LP 73 0 64 02 0 0 0 0 0 021 0 0
13	404 9.151DF 107 0 70 025572 0 0 0 021 0 0
14	405 58.206LP 60 60 60 00 2 3 0 0 0 021 0 0
15	406 56.316LP 61 61 53 00 2 3 0 0 0 021 0 0
16	501 18.631DF 75 0 69 045577 0 0 0 021 0 0
17	502 11.371DF 96 0 76 04 0 0 0 0 0 021 0 0
18	503 26.401DF 63 0 50 015574 0 0 0 021 0 0
19	504 8.061DF 114 0 73 02 0 0 0 0 0 021 0 0
20	505 36.286LP 76 76 68 00 2 3 0 0 0 021 0 0
21	506 60.196LP 59 59 59 00 2 3 0 0 0 021 0 0
22	507 33.411LP 56 0 68 01 0 0 0 0 0 021 0 0
23	508 42.861DF 14 0 19 015561 0 0 0 021 0 0
24	601 37.301DF 53 0 41 03 0 0 0 0 0 021 0 0
25	602 0.731DF 379 0 97 045574 0 0 0 021 0 0
26	603 2.441DF 207 0 88 04 0 0 0 0 0 021 0 0
27	701 9.501DF 105 0 49 035579 0 0 0 021 0 0
28	702 18.141DF 76 0 46 03 0 0 0 0 0 021 0 0
29	703 19.131DF 74 0 45 015561 0 0 0 021 0 0
30	704 2.181DF 219 0 82 04 0 0 0 0 0 021 0 0
31	705 42.861L 18 0 22 015561 0 0 0 021 0 0

Figure 2—Tree data file, `02900246.tre`, referred to in line 13 of figure 1. This tree data is used with all of the examples.

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8 Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1	StdIdent							
2	300290024601 Stand 300290024601 at Flathead FIA Data							
3	Screen							
4	InvYear	1993						
5	StdInfo	110	692	84	243	20	53	
6	Design	0	1	999	1	0	6104	
7	Growth	1	10	1	10	10		
8	SiteCode	3	54					
9	TimeInt		5					
10	TimeInt	1	7					
11	NumCycle	21						
FFE 1	Fmin							
FFE 2	PotFire							
FFE 3	End							
12	Open	2						
13	02900246.tre							
14	TreeData	2						
15	Close	2						
16	Process							
17	Stop							

Figure 3—The keyword file used to make a *no fire* and *no management* run of FVS (fig. 1) is modified to run the FFE (line FFE 1)and to generate the Potential Fire report (line FFE 3; more information on this keyword is presented in section 4.3).

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8 Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	PotFire							
FFE 3	SnagInit	DF	31	82	52	12	5	
FFE 4	SnagInit	GF	23	72	58	12	10	
FFE 5	SnagInit	LP	15	65	43	12	3	
FFE 6	FuelInit			3.5	5.2	8.5		
FFE 7	End							
12-17	See figure 3							

Figure 4—The keyword file presented in figure 3 further modified to initialize snags (in addition to those that could be in the sample tree data file) and dead fuel loads.

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8 Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	SimFire	2002				1		
FFE 3	Moisture	2002	12	12	14	150	25	150
FFE 4	SimFire	2003	60	2	75	0		
FFE 5	End							
12-17	See figure 3							

Figure 5—The keyword file needed to simulate two fires, a prescribed fire in 2002 with specific moisture conditions and a wildfire in 2003 using more extreme conditions.

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8							
	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	SimFire	2002						
FFE 3	FlameAdj	2002		2.5	0			
FFE 4	End							
12-17	See figure 3							

Figure 6—The keyword file needed to simulate a low intensity fire with a specified flame length.

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8							
	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	PileBurn	2007		100	15	75	1	
FFE 3	SimFire	2037	0	4				
FFE 4	FlameAdj	2037	.1		0			
FFE 5	End							
12-17	See figure 3							

Figure 7—The keyword file needed simulate burning piled fuel in 2007 and a carefully controlled simulated fire in 2037 that is designed to simulate a prescribed burn.

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8							
	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	SimFire	2002						
FFE 3	FuelModl	2002	8	40	10	60		
FFE 4								
FFE 5	SimFire	2037						
FFE 6	DeFulMod	2037	30	2000	109	30	1500	0.069
FFE 7	0.046	0.115	0	0.2	0.3			
FFE 8	Fuelmodl	2037	30	.4	10	.6		
FFE 9								
FFE 10	End							
12-17	See figure 3							

Figure 8—This keyword file shows a fire simulated in 2002 with a specific set of fire behavior fuel models and another fire, set in 2037 that uses specific fuel model parameters.

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8 Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	FuelMult	1	2	.5				
FFE 3	FuelPool	AS	2					
FFE 4	FuelPool	WC	3					
FFE 5	FuelOut	2000						
FFE 6	End							
12-17	See figure 3							

Figure 9—The fuel decay rates for the second decay rate class is modified to be twice as fast and the rate for the third class half as fast as the default rates. Then biomass from aspen (species code AS) trees is assigned to the second class and from cedar (species code WC) is assigned the third.

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8 Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
12	YardLoss	2000	1	1	1			
13	ThinDBH	2000	0	5	1			
14	YardLoss	2000	1	0	0			
15	ThinABA	2000	200	.1	20	999		
FFE 1	Fmin							
FFE 2	FuelOut	2000						
FFE 3	End							
	See lines 12-17 in figure 3							

Figure 10—The use of the FVS keyword YardLoss is shown in conjunction with two thinning options. Had the YardLoss keywords been left out, the FFE would not count the stem wood left in the stand from the precommercial thinning (line 13) as fuel in nor would it account for the standing snags created in the thinning from above (line 15).

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8 Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
12	YardLoss	2010	1	1	1			
13	ThinBBA	2010	0					
FFE 1	Fmin							
FFE 2	Salvage	2010	0	999	999	1	1	
FFE 3	FuelOut	2000						
FFE 4	End							
	See lines 12-17 in figure 3							

Figure 11—Chaining is simulated by cutting all trees (line 13), leaving them in the stand (line 12), and cutting all snags and leaving them in the stand as well (line FFE 2).

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8 Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	FuelTret	2010	1					
FFE 3	FuelTret	2030			1.1			
FFE 4	FuelOut	2000						
FFE 5	End							
	See lines 12-17 in figure 3							

Figure 12—This keyword file illustrates simulating fuel treatments, once with a nominal treatment that implies a fuel depth multiplier (0.83 in this case, see table 7) and a second that shows how to set a specific multiplier.

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8 Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	FuelMove	2023	6	3		.6		
FFE 3	FuelMove	2023	6	2		.5		
FFE 4	FuelMove	2023	5	3		.6		
FFE 5	FuelMove	2023	5	2	8	.5		
FFE 6	FuelMove	2023	4	3			18	
FFE 7	FuelMove	2023	4	2			12	
FFE 8	FuelOut	2000						
FFE 9	End							
	See lines 12-17 in figure 3							

Figure 13—This keyword file illustrates the use of the FUELMOVE keyword to simulate breaking large fuel into smaller pieces (making chunks or chips).

Line Number	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8 Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	FuelMove	2023	5	0		.85		
FFE 3	FuelMove	2023	6	0		.90		
FFE 8	FuelOut	2000						
FFE 9	End							
	See lines 12-17 in figure 3							

Figure 14—This keyword file illustrates the use of the FUELMOVE keyword to simulate the removal of large fuel from the stand.

Line Number	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8							
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	PileBurn	2007		100	15	75	1	
FFE 3	SimFire	2037	0	4				
FFE 4	FlameAdj	2037	0	0				
FFE 5	PotFire	2000						
FFE 6	FuelOut	2000						
FFE 7	BurnRept	2000						
FFE 8	FuelRept	2000						
FFE 9	MortRept	2000						
FFE 10	MortClas	0	12	18	24	30	36	9999
FFE 11	SnagSum							
FFE 12	SnagOut	2000						
FFE 13	End							
12-17	See figure 3							

Figure 15—The keyword file from Figure 7 with keywords added to ensure that all possible output files will be present.

Line Number	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8							
1-11	See figure 3							
12	If	10						
13	FuelLoad(1,3)+FuelLoad(7,7) GT 8							
14	Then							
FFE 1	Fmin							
FFE 2	PileBurn	0						
FFE 3	End							
15	EndIF							
	See figure 3							

Figure 16—This keyword file shows how to use the FVS Event Monitor to schedule a pile burn any time small (litter and < 3 inches) fuel loads are over 8 tons/acre.

Line Number	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
	Column ruler ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8							
1-11	See figure 3							
FFE 1	Fmin							
FFE 2	SimFire	2037						
FFE 3	FlameAdj	2037	Parms(1-(.5*Slope*Cos(Aspect*0.01745)), -1, -1)					
FFE 3	End							
15	EndIF							
	See figure 3							

Figure 17—The FlameAdj keyword is used with the PARMS feature of the Event Monitor to dynamically compute a flame length adjustment. This example is not an endorsement of the formula.