

Westwide Pine Beetle Model Keyword Guide

**Forest Health Technology Enterprise Team
USDA Forest Service**

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Keyword Index by Function

The keywords in **bold** (below) are **required** keywords. Keyword **BMPPIN** must be used before reading in any other WWPB Model keywords and must be accompanied by an **END** keyword at the end of a section of WWPB Model keywords. Asterisked keywords, if used, *must* be placed before keyword **DISPERSE** in the simulation (keyword) file. Stand management keywords, if used, *must* be placed after stand inventories have been read. Stand level keywords must be entered with other individual stand keywords, i.e. between each stand's ADDSTAND and PROCESS keywords. Stand-level keywords must be preceded with BMIN and finished with an END keyword. The FVS user interface Suppose automatically inserts the keywords **BMPPIN**, **BMIN**, and **END** wherever necessary.

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Introduction

This manual provides keyword details for the Westwide Pine Beetle (WWPB) extension of the Forest Service's Forest Vegetation Simulator (FVS) system. It is one of a set of three documents concerning the WWPB Model. The *Westwide Pine Beetle Model Detailed Description* (hereafter, the *Detailed Description*) explains the biological assumptions behind the model and describes the functions and algorithms coded into the model software. The *Westwide Pine Beetle Model User's Guide* (hereafter, the *User's Guide*) provides the information needed to actually construct and run WWPB Model computer simulations within the FVS system, and it discusses details about most WWPB Model keywords. This document, the *Westwide Pine Beetle Model Keyword Guide*, is designed as a concise document which users can reference as they construct, modify, and run WWPB Model simulations.

In FVS and all of its extensions, keywords are the means by which users control model execution and parameterization. The operation of the WWPB Model is coordinated by the Parallel Processing Extension (PPE) of FVS. Within the WWPB Model are three different "types" of keywords: landscape-level keywords, and stand management keywords, and stand-level output-generating keywords. Hence, five different "types" of keywords are typically used to construct WWPB Model simulation (keyword) files: base-model FVS keywords, PPE keywords, and the three types of WWPB Model keywords. Users of the WWPB Model will need, at a minimum, the following three documents (in addition to the WWPB Model documents), to help them build simulation keyword files.

- *Essential FVS: A user's guide to the Forest Vegetation Simulator* (Dixon 2004)
- *Keyword reference for the Forest Vegetation Simulator* (Van Dyck, 1999)
- *User's guide to the Parallel Processing Extension of the Prognosis Model* (Crookston and Stage 1991).

Throughout this keyword guide, there are references to Suppose, FVS' graphical user interface. We recommended that users of PPE/FVS and the WWPB Model become familiar with Suppose, as it is a user-friendly interface that efficiently builds simulation (keyword) files. Suppose software, as well as all FVS software and documentation, is available online at:

<http://www.fs.fed.us/fmsc/fvs/>

Types of Keywords

This section describes the five categories of keywords into which the keywords discussed in this document may be classified: (1) base-FVS keywords; (2) PPE keywords, (3) WWPB Model *landscape-level* keywords (the bulk of the WWPB Model keywords), (4) WWPB Model *stand management* keywords, and (5) WWPB Model *stand-level* output-generating keywords.

Base-FVS Keywords

Keywords **BMPPIN** and **BMIN** are, technically speaking, base-FVS keywords. They inform FVS that subsequent keywords are WWPB Model keywords. Each section of a simulation keyword file containing landscape-level or stand management WWPB Model keywords must begin with keyword BMPPIN and end with an END keyword. Likewise, each section of stand-level WWPB Model keywords must begin with keyword BMIN and end with an END keyword. The graphical user interface Suppose automatically inserts keywords BMPPIN, BMIN, and END where needed.

PPE Keywords

A number of PPE keywords are required to run a WWPB Model simulation. Many of these are “hidden” from the user when using Suppose (e.g. STARTYR, MSTRCYCS, MSTRINT), because Suppose automatically creates and properly inserts them. However, there is one PPE keyword, **AREALOCS**, required by the WWPB Model, which *must* be entered by the user, and it is described in this manual. This keyword and its supplemental records *must* be entered before any other landscape-level WWPB Model keywords.

Other required PPE keywords, not discussed in this document, include ADDSTAND and PROJECT. Keyword YIELDS, while not required, is useful.

WWPB Model Landscape-Level Keywords

Besides the six stand-management keywords and the four stand-level output-generating keywords, all WWPB Model keywords operate at the landscape level. Thus, when these keywords are used, the parameter values associated with that keyword will be used for all stands in the landscape. This is intuitive for keywords that change the parameterization of the model (such as the characterization of the outside world: OWVALUES, or the beetle parameters: REPROD) but may not be so obvious when the driving-variable keywords are used.

Suppose places keywords of a given type in an appropriate order relative to the base-FVS keywords. That is, Suppose automatically places landscape-level WWPB keywords before base-FVS keywords, and places stand-management keywords after FVS keywords (hence, after stand inventories have been read). Suppose, however, does *not* automatically place keywords of a given type in the correct order *amongst themselves*. The user must oversee this. Fortunately, for

most WWPB Model landscape-level keywords, keyword order is not important. However, it is important with regard to keywords **BMPARM** and **DISPERSE**.

Keyword **BMPARM** defines the main beetle type to be simulated, as well as the host tree species. The beetle-type code that the user defines in this keyword *automatically sets the default value for five other keywords* that require a beetle-type code: ATTRACT, BKPKILL, BMDAMAGE, BMHIST, and REPRODN. For the model to correctly assign the default values of these five other keywords to the beetle type defined by BMPARM, the other keywords (if used) must occur *after* BMPARM¹. A good rule of thumb, then, is to ***make sure that BMPARM is the first landscape-level WWPB Model keyword*** entered into the keyword file.

Keyword **DISPERSE** *must* be the last landscape-level WWPB Model keyword entered after all landscape-level keywords that have a ‘year’ field-entry². Suppose users take note: any landscape-level WWPB Model keyword added after DISPERSE has been entered will be placed (in the keyword file) *after* DISPERSE. Therefore, prior to running the simulation, double-check your keyword file (using the *Edit Simulation* feature), and verify that DISPERSE is correctly placed: last. If it is not, move it using the *Cut* and *Paste* features in Suppose, which will automatically append “cut and pasted” keywords to the end of the set of keywords of its given type. (See Section 4.4.2 of the *User’s Guide*)

Landscape-level keywords **BMHIST**, **NONSTOCK**, and **AREALOCS** require the reading-in of supplemental records. This process is described in the next section.

WWPB Model Stand Management Keywords

All the WWPB stand management keywords operate at the stand level³. Unlike base-FVS stand level keywords, their operation is controlled by the PPE. They must be entered after all the stand inventories have been read. They also must contain supplemental records (either after the keyword or in a separate file) that list the stand identification codes (Stand IDs) of the stands that will be treated, (and—in the cases of keywords **AREALOCS**, **BMHIST** and **WETSCORE**—the supplemental record Stand IDs are followed by other parameters on the same line). ***Note that all supplemental record Stand IDs should be left-justified in their field.*** Since Stand IDs are read-in as character strings, if they are not left-justified, then leading blanks will be appended to the Stand ID when it is read-in. Numeric values of other supplemental record fields may reside anywhere within the field’s column definitions.

¹ The keywords ATTRACT, BKPKILL, BMHIST, or REPRODN may be placed before BMPARM, if the user correctly specifies the beetle type code in the keyword’s Field 1. BMDAMAGE, if used, must *always* occur after BMPARM.

² Those keywords that require a year as a field entry are asterisked in the Keyword Index by Function (page 1), and include most of the “Main” and some “Driving Variable” keywords.

³ Although the stand management keywords operate at the stand level, we distinguish them here from “true” stand-level WWPBM keywords because of how they are entered in the keyword file and how they are processed. The stand management keywords, handled by the PPE, are entered once (or merely a few times) in a simulation file and their supplemental records of stand IDs dictate what stands are affected. “True” stand level WWPB Model keywords (the 4 output generating keywords discussed in the next subsection) are typically entered many times in a keyword file, once with each stand for which output is desired.

All stand-management keywords have the same format: Field 1 is the year to occur; Field 2 is the unit (computer memory space) from which to read the Stand IDs; and all remaining fields are for any parameter values that may be necessary⁴. For example:

```
1234567890123456789012345678901234567890123456789012345678901234567890
KEYWORD      year      unit      field3      field4      field5
STANDIDX
STANDIDY
STANDIDZ
-999
```

In this example, the "unit" space would be left blank to indicate that the Stand IDs are in supplemental records following the keyword. (Note: in the example above, as in all of the examples provided in this document, the "header" row consisting of repeating digits 1234567890 is provided merely as a reference depicting the location of keyword field columns

If a value is provided in the "unit" field, the user must ensure that the PPE keyword **OPEN** has been used previously (outside the **BMPPIN/END** set of keywords) to open the file containing the records. (In all cases where supplemental records are being read from an external file, Suppose automatically inserts the appropriate **OPEN** statement, and user-provided filename, before the keyword.) For example:

```
1234567890123456789012345678901234567890123456789012345678901234567890
OPEN          36          ← open computer "unit" #36 (before BMPPIN)
standid.lst   ← filename
BMPPIN        ← start reading WWPB Model keywords
SALVAGE       1990       36 ← Field 2 says "read the list of stands
                        to be salvaged from unit #36, which is
                        (in this case) the file "standid.lst"
END           ← end WWPB Model keywords
CLOSE        36
```

In both cases, whether the list of stands is in a supplemental record or in another file, a "-999" must be used to indicate the end of the list. If the keyword is encountered before the inventories are read, an error message will be printed to the main output file indicating that the keyword was entered in the wrong place.

WWPB Model Stand Level Keywords

⁴ Unit number goes in Field 1 for the keyword **NONSTOCK** (no year is associated with this keyword). Suppose treats **NONSTOCK** like a stand-level keyword—it places it after stand inventories have been read. Technically, **NONSTOCK** may be placed before or after inventories have been read.

Four WWPB Model keywords function unlike all other WWPB Model keywords in that they are entered in a simulation file along with other base-FVS stand level keywords. These output-generating keywords (**BKPOUT**, **MAINOUT**, **TREEOUT**, and **VOLOUT**) operate this way so that users have the option of limiting how much output gets written. Output generated via these keywords will be written only for those stands to which the keywords are “attached”. Unlike all other WWPB Model keywords, which require a preceding **BMPPIN** keyword, the stand-level WWPB Model keywords must be preceded by keyword **BMIN**. Stand level keywords are discussed in a separate section of this document.

Special Considerations for Suppose Users

As mentioned above, Suppose automatically places most keywords in their appropriate places in the simulation (keyword) file. It is the user’s responsibility, however, to ensure that:

- 1) **AREALOCS** is the first keyword entered (after user has selected simulation stands and set the time scale for the simulation).
- 2) **BMPARM** is the first WWPB Model keyword used, or, at a minimum, should occur prior to keywords **ATTRACT**, **BMDAMAGE**, **BMHIST**, **BKPKILL**, or **REPROD** (if used).
- 3) **DISPERSE** occurs after all other landscape-level keywords that require a “year” field-entry.
- 4) Supplemental records being read-in from external files (“addfiles”)—for example, the supplemental records associated with keywords **AREALOCS** and/or **BMHIST**—should contain *only* supplemental records, and should *not* contain any keywords. Note that the default condition in Suppose is that it “expects” supplemental records to be read-in from external files. (Supplemental records may, however, be entered directly into the keyword file via the “*Use Parm*s” feature of Suppose. See the *User’s Guide* for more information.)

This document’s appendices contains two sample keyword files: the first was composed “manually” via a text-editor, and the second was composed by Suppose. Although they appear to be different, they are functionally identical. Notice that Suppose explicitly writes the default values for *most* fields for all keywords. While not computationally necessary (because a default value is a *value that the model uses when a field is left blank*), default values are placed into the keyword file by Suppose so that the user can see which values are being used for the various parameters. However, there are four keywords (the same four influenced by **BMPARM**) where some fields, including Field 1 (default value for beetle-type code), are left blank by Suppose: **ATTRACT**, **BMHIST**, **BKPKILL**, and **REPROD**. They are left blank because the default value(s) will change depending upon the beetle type defined by the user in keyword **BMPARM**. Therefore, although a number of fields associated with these keywords appear blank, there *are* values associated with those fields. For more information about this, refer to the specific keyword in this guide, and to the *Westwide Pine Beetle Model User’s Guide*.

Finally, make sure at least one (numeric) tree-species code in Fields 3-7 of keyword **BMPARM** is entered. No pre-defined defaults have been set. Note that tree-species codes vary from one FVS geographic variant to the next.

Definitions of Size Classes Within the WWPB Model

SIZE CLASS	DBH (INCHES)	MIDPOINT DBH (INCHES)
1	0-3	1.5
2	>3-6	4.5
3	>6-9	7.5
4	>9-12	10.5
5	>12-15	13.5
6	>15-18	16.5
7	>18-21	19.5
8	>21-25	22.5
9	>25-30	27.5
10	>30	35

Keyword Descriptions

APHERO

This keyword controls the simulation of the application of an attracting pheromone. Supplemental records, either following the keyword or in another file, are required. Because this is a stand-level keyword, it must be used after all stand inventories have been read.

Field 1: Year (or cycle) of application (integer).
 Field 2: File number from which to read relevant Stand IDs. If blank, then assume records follow keyword.
 Field 3: Percent efficiency. Range: 0-100
 Fields 4 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1		75				

Note: When using Suppose: Note that Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN/CLOSE** and **BMPPIN/END** keywords (see below). Alternatively, Suppose users may insert supplemental records directly into keyword file via the “Use Parms” feature in Suppose (in which case Suppose will leave Field 1 blank).

Supplemental Record: This record is required. The record consists of one field: a Stand ID. Stand IDs should be left-justified in the field, and may be up to 26 characters in length.

Field 1 (columns 1-26): Stand ID (if “-999”, then end of records).

Example:

```
1234567890123456789012345678901234567890123456789012345678901234567890
OPEN                               60
Filename.ext                       ← The Suppose default file name is apherо.sid.
BMPPIN
APHERO                             60
END
CLOSE                               60
```

References: *User’s Guide*: Section 3.6.3. *Detailed Description*: Section 6.3

AREALOCS

This is a PPE keyword and *must* be entered before any WWPB Model keywords. Since it is a PPE keyword, it does not require the prior use of keyword **BMPPIN**. Keyword **AREALOCS** signals that the stand areas and locations are to be read from the data set referenced by Field 1. If a negative number is entered, any currently stored data are forgotten. Records need not be in sorted order.

Field 1: File number from which to read relevant Stand IDs. If blank, then assume records follow keyword.
 Field 2: A multiplier to scale the location coordinates to meters.
 Field 3: A multiplier used to scale the area data to acres.
 Fields 4-7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants		1	1				

Note: If using Suppose: Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN** keyword (see below). Alternatively, Suppose users may insert supplemental records directly into keyword file via Suppose’s “Use Params” feature (in which case Suppose will leave Field 1 blank).

Supplemental Records: Each line in the supplemental file/lines should contain the Stand ID in columns 1-26, followed by three parameter fields, each 10 characters wide. The Stand ID (Field 1) should be left-justified.

Field 1 (columns 01-28): Stand ID (if “-999”, then end of records.)
 Field 2 (columns 29-38): The east-west coordinate of the stand center.
 Field 3 (columns 39-48): The north-south coordinate of the stand center.
 Field 4 (columns 49-58): The area of the stand.

Example:

```
1234567890123456789012345678901234567890123456789012345678901234567890
OPEN                               51
Filename.ext                       ← The Suppose default file name is Arealocs.alc.
AREALOCS                          51
CLOSE
```

Reference: Crookston and Stage 1991

ATTRACT

This keyword controls several parameters in the between-stand attractiveness equation (see the *User's Guide* for details). If *Ips* is present as a driving variable (i.e., if *Ips* is being modeled as a secondary beetle), this keyword may be entered once for the main beetle type and once for *Ips*.

- Field 1: Beetle-type code (integer: 1 = MPB; 2 = WPB; 3 = *Ips* spp.).
 Field 2: Minimum host DBH (inches) that will attract beetles to a stand †.
 Field 3: Special tree weight ("a" in the attractiveness equation). Range: > 1
 Field 4: Multiplier for weighting the importance of distance between stands ("c" in the attractiveness equation). Smaller numbers decrease the effect of distance and allow BKP to more easily spread further from source stands. Range: >0
 Field 5: Factor controlling attractiveness of stands to themselves ("n" in the attractiveness equation). Values greater than zero decrease attractiveness of self. Range: > 0.
 Field 6: Maximum dispersal distance (R_{MAX}) for BKP (in miles) ††.
 Field 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	*	6**	1	100	1	15	

Notes:

* If **BMPARM** has already been used, the default will be the beetle type specified in Field 1 of **BMPARM**. If **BMPARM** has not already been entered, then beetle type is as yet undefined, therefore the user must explicitly enter a beetle type in Field 1.

** If the main beetle type is *Ips*, then the default for Field 2 is 3 inches (size class 1).

† The model will take into account the basal area all host trees in the *size class* into which the DBH entered in Field 2 falls when determining stand attractiveness. For example, entering a "4" is functionally equivalent to entering a "6", since they both fall into size class 2. The value entered here will not affect what size of trees can or will be beetle-attacked.

†† R_{MAX} also defines the radius of the outside world

References: *User's Guide*: Sections 2.7.2 & 3.4.4. *Detailed Description*: Sections 3.2.2. & 7.6

BKPKILL

This keyword allows users to specify a period of years when the BKP multiplier **BMULT** is fixed, rather than determined by the tree class size. The specified BKP multiplier value will be used for all trees, regardless of size (see figure, below). The BKP level in the outside world will also be reduced by this amount in the specified years. BKP in strip-killed trees have a multiplier of zero in these years. This is a landscape-level keyword and specified parameters are used for all stands in the landscape. This keyword, if used, must be used before keyword **DISPERSE**.

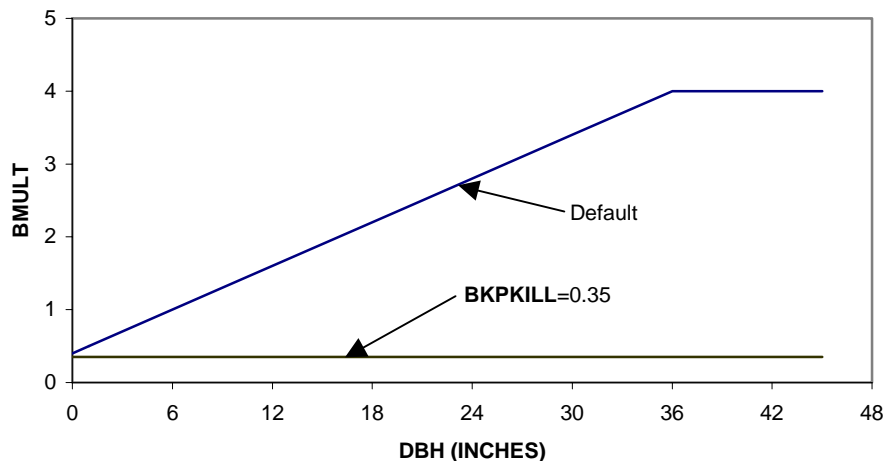
- Field 1: Year (or cycle) for lowered multiplier to start.
- Field 2: Duration of the change in years.
- Field 3: Beetle type (1 = MPB, 2 = WPB, 3 = *Ips*, 4 = both MPB and WPB).
- Field 4: New fixed BKP multiplier value.
- Field 5: New BKP multiplier value for *Ips* (if Field 3 = 4).
- Fields 6 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	25	*	0.35**	0.035		

* Default beetle type is that defined in Field 1 of **BMPARM**, or is undefined if **BMPARM** is not yet entered, and therefore *must* be defined by the user.

** If Field 3 = 3 (*Ips*), then Field 4 default = 0.035.



BMULT multiplier from BKPKILL as compared to a default-year's multiplier.

References: *User's Guide*: Section 3.4.2. *Detailed Description*: Sections 3.4.

BMDAMAGE

If this keyword is present, the BKP levels in the simulated stands will be initialized through damage codes in the inventory. Only damage code 3, with severity codes 0 or 3 will be recognized as trees containing BKP. Damage codes in stands inventoried more than Field 1-years before the master year (i.e. the simulation start year, which by default will be the year of the latest inventory) will be ignored. This keyword, if used, must be used *before* the stand inventories are read and *after* **BMPARM**.

Field 1: Number of years before master starting year for which to consider the damage codes.

Fields 2 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	2						

References: *User's Guide*: Section 3.3.1.

BMFDBK

This keyword allows users to specify the level to which BKP will be reduced if the negative-feedback function—simulating the effects of beetle-density dependent factors—is used.

Field 1: Level of mean stand BKP/acre that will trigger negative feedback (and level to which BKP will be reduced). Range: > 0.

Fields 2 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	50.0						

Notes:

This level is *both* a trigger *and* the level to which BKP will be reduced.

There is a lag of one year before the feedback takes effect.

If this keyword is used, BKP will be reduced to the trigger level one year *after* BKP/acre exceeds the trigger. The feedback function will not, however, be invoked if, in year “t + 1”, BKP is less than the BKP in year “t”, even if the BKP in year “t” exceeds the trigger level.

When the model evaluates a stand’s BKP level for this function, it does so after reproduction and before dispersal. Likewise, if the function determines that reductions are in order, they happen after reproduction but before dispersal.

References: *User’s Guide:* Section 3.4.3. *Detailed Description:* Section 7.8.

BMHIST

This keyword is used to initialize the WWPB Model, and if there are no beetle-damage codes in the inventory, it *must* be present to put BKP in the stand (see also **BMDAMAGE**). Field 1 is for the unit number that contains the supplemental records. Supplemental records consist of Stand IDs, the tree size classes, and the trees per acre (TPA) of recently killed trees (trees that will have beetles emerging in first year of simulation). If Field 1 is blank, the information will be read from supplemental records following the keyword.

Field 1: File number (if blank, then read supplemental records).
 Field 2: Beetle code (1 = MPB, 2 = WPB, 3 = *Ips*).
 Fields 3 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants		*					

Notes:

* Default is the beetle-type code entered in Field 1 of **BMPARM**. If **BMPARM** has not yet been used, then the beetle type is undefined, and the user must define the beetle type.

When using Suppose: Note that Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN/CLOSE** and **BMPPIN/END** keywords. Alternatively, Suppose users may insert supplemental records directly into keyword file via the “Use Parm’s” feature in Suppose (in which case Suppose will leave Field 1 blank).

Supplemental Records: Each line in the supplemental file/lines should contain a Stand ID (up to 26 characters) in columns 1-26, followed by two 10-character wide parameter fields. The Stand ID in Field 1 should be left-justified. (It will be read-in as a character string, and if not left-justified, then leading blanks will be appended to the Stand ID.)

Field 1 (columns 1-26): Stand ID (if “-999”, then end of records).
 Field 2 (columns 31-40): Size class⁵ of successfully-attacked tree(s). Range: integer 1-10.
 Field 3 (columns 41-50): Number of trees/acre of successfully-attacked in Field 2’s size class. Real number, need not be a whole number.

References: *User’s Guide*: Section 3.3.1

⁵ See page 7 of this Guide for a listing of the DBH thresholds defining the WWPB Model size classes.

BMIN

This keyword signals base-FVS that *stand level* WWPB Model keywords follow. (Stand level WWPB Model keywords begin on page 47.) There are no fields associated with this keyword. This keyword must be used in conjunction with the **END** keyword.

Fields 1 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

Example:

See page 47

References: This *Keyword Guide*: page 47. *User's Guide*: xxx

BMOUT

This keyword requests one or both of two output files:

- 1) the “cycle” output file (*.bmc)
- 2) the annual “landscape average” output file (*.bml).

The first file is written at cycle boundaries, and contains various WWPB Model output variables for all WWPB Model-simulated stands. Values represent either cycle-beginning or cycle total values, depending upon the variable. The second writes stand-area-weighted landscape average values of various output variables annually. The default condition (if fields are left blank) is to write the output files. The files are prefixed with the name of the simulation (i.e. the keyword file name) and are suffixed as noted above.

There are two fields associated with this keyword.

- Field 1 Enter a non-zero integer to suppress the writing of the cycle output file
 Field 2 Enter a non-zero integer to suppress the landscape average output file
 Fields 3 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

Note:

Suppose inserts a zero into a field when the user requests that field’s corresponding output file. A zero in a field functions the same as leaving the field blank.

Example:

```
BMPPIN
BMOUT
END
```

References: *User’s Guide* Sections 3.2.1 & 5.1-5.3

BMPARM

This keyword is used to define the main type of pine beetle that is being simulated. The default is a single generation mountain pine beetle on lodgepole pine. The value entered in Field 1 will be used as the default beetle type for all keywords following **BMPARM**, and may change other default values in these keywords: **ATTRACT**, **BKPKILL**, **BMHIST**, and **REPRODN**.

- Field 1: Beetle code (integer): 1 = MPB, 2 = WPB, 3 = *Ips*. Default = none
- Field 2: Number of beetle generations in a year (integer, 1-5).
- Field 3: Main host tree species code (integer). Default = none
- Fields 4 to 7: Other host tree species code (integer). Default = none

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	*	**	*				

Notes:

- * Users *must* enter a beetle-type code and at least one numeric tree-species code.
- ** If the main beetle type is MPB or *Ips*, then the default for Field 2 is 1 (generation per year). If the main beetle type is WPB, then the default generations per year is 3.

Tree-species codes are FVS variant-specific. In the example below, the “10” in Field 3 would represent ponderosa pine for some variants (e.g., BM, CI, SO) but would represent limber pine in the CR variant, and would be undefined for the TT variant. Tree-species codes (for use in fields 3-7), by variant, are listed in Appendix C.

Example:

```

1234567890123456789012345678901234567890123456789012345678901234567890
BMPARM
ATTRACT          2          10
BMPARM          2          -          10          -          -          -          5
REPRODN          -          -          5          20
END
    
```

Notes on above example. Keyword ATTRACT may occur before BMPARM because the beetle type is explicitly entered: (Field 1 =2). User sets WPB as the main beetle type via Field 1 of BMPARM, with ponderosa pine as host (Field 3=10) using the default 3 generations per year (Field 2 is blank). Since field 1 of keyword REPRODN is blank, the parameters set via this keyword are for the main type (WPB) set via BMPARM.

References: *User’s Guide*: Section 3.4.1.

BMPPIN

This keyword signals PPE that WWPB Model keywords follow. There are no fields associated with this keyword. This keyword must be used in conjunction with the **END** keyword.

Fields 1 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

Example:

PPE keywords

```
BMPPIN      <--Begin reading WWPB Model keywords
WWPB
MODEL
KEYWORDS
HERE
END        <--stop reading WWPB Model keywords
```

MORE PPE keywords

```
BMPPIN      <--Begin reading WWPB Model keywords
WWPB
MODEL
KEYWORDS
HERE
END        <--stop reading WWPB Model keywords
```

MORE PPE keywords

References: This *Keyword Guide*: appendix. *User's Guide*: Section 7.0

COMMENT

This keyword is used to enter comments into the sequence of WWPB Model keywords. The comments can be entered on as many supplemental records as desired. Signify the end of the comment with an END keyword. Inclusion of these keywords and comments will not affect simulations. The comments will be printed to the main FVS output file. Keywords contained in a COMMENT block are ignored in the simulation.

No fields are associated with this keyword. At least one supplemental record is required.

Fields 1 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

Notes: An alternative method for creating a single-line comment is to place an asterisk (*) as the first character of a record. With few exceptions, that record is then ignored by FVS regardless of its placement in the keyword sequence. Records beginning with an exclamation point (!) are also ignored by FVS, but are not written to the output file. This convention is used by the Suppose interface program to insert the information it needs.

If using the Suppose interface program, comments may also be added using the “Edit Simulation Notes” feature accessible through the Extras menu.

Supplemental Record(s): Comments are entered in Columns 1-80 on as many lines (supplemental records) as desired. The END keyword must follow the last supplemental record.

Example:

```
BMPPIN
WWPBM
KEYWORDS
HERE
```

COMMENT

```
This is a comment. Nothing placed between the "COMMENT" and
the "END" keywords will affect the simulation.
END
```

```
MORE
WWPBM
KEYWORDS
HERE
```

DEBUG

This keyword turns on the FVS-WWPB Model debugging mode. There are no fields associated with this keyword. This keyword is used primarily for model development. Large amounts of output will be generated and written to the main FVS output file. See also **NODEBUG**.

Fields 1 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

DISPERSE

This keyword specifies the start year and the number of years to simulate the WWPB Model. Note that this keyword *must* be used *after* all other landscape-level WWPB Model keywords that require a year as a field entry (i.e., after all other driving-variable keywords) and *must* be used to “turn on” the WWPB Model.

Field 1: Year (or cycle) to start WWPB Model (integer).
 Field 2: Number of years to simulate WWPB Model (integer).
 Fields 3 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	50					

Note: If Field 2 is less than or equal to the time span specified via PPE keywords MSTRCYCS and MSTRINT⁶, then the WWPB Model will run until the year specified by DISPERSE, and growth projections will continue (without the WWPB Model running) for the remainder of the simulation. If the time span entered here is greater than PPE keyword specifications, then the simulation will run only for the time specified by the PPE keywords. No projection beyond will occur.

Example:

```
BMPPIN
LIGHTN          1992
OTHERBB         1990
QFIRE           1991
DISPERSE      1990      100
END
```

References: *User's Guide* Section 3.2

⁶ Suppose users set these two PPE keywords “blindly”. That is, while not explicitly choosing these two keywords when building a simulation, the user invokes them when s/he sets the time scale for the simulation.

END

This keyword is entered at the end of a set of WWPB Model keywords. It informs FVS that subsequent keywords are PPE keywords. There are no fields associated with this keyword. Every occurrence of **BMPPIN** requires an accompanying **END** keyword.

Fields 1 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

Note: If this keyword follows a COMMENT keyword, then it signals the end of a comment, not the end of a set of WWPBM keywords

Example: See BMPPIN

IPSDV

This keyword turns *Ips* on as a driving variable, as either the primary or secondary beetle type. If *Ips* is to be simulated as a secondary beetle type, this keyword must be used. If *Ips* is to be the primary type simulated, the user may use this keyword in addition to, or in lieu of, keyword **ATTRACT**. In either case, if *Ips* is to be the primary beetle type, then it must be defined via **BMPARM**.

- Field 1: Minimum live-tree DBH (inches) that *Ips* may attack.
 Field 2: Maximum live-tree DBH (inches) that *Ips* can kill the entire tree.
 Field 3: Number of *Ips* generations in a year (integer).
 Field 4: Proportion of the *Ips* dead woody pool that must be filled with *Ips* before *Ips* attacks live trees (positive real-value > 1.0).
 Fields 5 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	3	15	2	0.9			

References: *User's Guide* Section 3.3.1 & 3.4.1

LIGHTN

This keyword allows users to change the density of simulated lightning-struck trees in the landscape. Lightning is a landscape-level event, meaning that it is either active or inactive for all stands. Lightning is always present by default, but it can be turned off by setting Field 2 to zero.

The rate specified remains in effect until explicitly changed by the user via another instance of this keyword. This keyword, if used, must be used before keyword **DISPERSE**.

Field 1: Year (or cycle) to turn on (integer).

Field 2: Density of lightning strikes (number of host trees lightning-struck per acre per year).

Fields 3 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	0.002					

Notes: Lightning struck trees become “special trees”. (See Sections 2.5.2 and 3.5.2 of the *User’s Guide*).

Example

```
1234567890123456789012345678901234567890
BMPPIN
LIGHTN      1990      .005
LIGHTN      2000      -
END
```

Notes on above example. Strike density is increased to 1 strike per 200 acres per year for the first 10 years of the simulation (1990-2000), and then returns to the default (field 2=blank) in 2000.

References: *User’s Guide* Section 3.5.2. *Detailed Description:* Section 5.3

NODEBUG

This keyword turns off the debug mode. There are no fields associated with this keyword. See also **DEBUG**.

Fields 1 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

NONSTOCK

This keyword specifies non-stockable stands. Stands entered as “non-stocked” become ineligible to receive BKP, and will be neglected by the WWPB Model. They continue to be simulated by base-FVS. The WWPB Model assumes that the stand area and location information for stands declared as non-stocked have been included in the area-locations file (see **AREALOCS**). Supplemental records, either following the keyword or in another file, are required.

Field 1: File number from which to read relevant Stand IDs. If blank, then assume records follow keyword.

Fields 2 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

Note: When using Suppose: Note that Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN/CLOSE** and **BMPPIN/END** keywords (see below). Alternatively, Suppose users may insert supplemental records directly into keyword file via the “Use Parm’s” feature in Suppose (in which case Suppose will leave Field 1 blank).

Supplemental Record: This record is required. The record consists of one field: a Stand ID. Stand IDs should be left-justified in the field, and may be up to 26 characters in length.

Field 1 (columns 1-26): Stand ID (if “-999”, then end of records).

Example:

```
123456789012345678901234567890
OPEN          65
Filename.ext   ← The Suppose default file name is nonstock.sid.
BMPPIN
NONSTOCK    65
END
CLOSE        65
```

References: *User’s Guide* Section 3.3.2. *Detailed Description:* Section 3.2.5

OTHERBB

This keyword controls the simulation of “other” bark beetles: i.e., those that are not the main beetle species and that are not *Ips*. Simulated “outbreaks” of other bark beetles occur if a minimum number of eligible stems (Field 4) are reached. Fields 3 and 6 specify the eligibility criteria. Resulting “other” bark beetle activity will only affect the rating value of trees (making them more susceptible to attack by the primary type being simulated) and no mortality from these “other” bark beetles will occur. This is a landscape-level keyword and specified parameters are used for all stands in the landscape. This keyword, if used, must be used before keyword **DISPERSE**.

- Field 1: Year to start outbreak of “other” bark beetles (integer).
 Field 2: Number of years to remain active (integer).
 Field 3: Minimum size class (1-10) eligible to be attacked⁷.
 Field 4: Minimum number of eligible stems that must exist for outbreak to occur (trees per acre of eligible trees).
 Field 5: Attack rate—proportion of eligible trees that will be attacked. (Positive real value ≤ 1.0).
 Field 6: Maximum rating value that is eligible for attack (positive real value ≤ 1.0).
 Field 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	20	4	10	0.75	0.7	

References: *User’s Guide* Section 3.5.4. *Detailed Description:* Section 5.6

⁷ See page 6 of this Guide for a listing of the DBH thresholds defining the 10 size classes within the WWPB Model.

OWIPSDV

If the outside world is assumed “constant” (see **OWTYPE**), and *Ips* is present as a driving variable (i.e., is being simulated as a secondary type), then this keyword allows the user to change the conditions for *Ips* in the outside world in any year of the simulation. Note that the keyword **OWVALUES** should be used to set the conditions for the main beetle type. Levels set by this keyword remain in effect until replaced by new values when the keyword is used again. If *Ips* is the primary type (**BMPARM** Field 1 = 3), the user may use this keyword instead of or in addition to, keyword **OWVALUES**⁸. This keyword, if used, must be used before keyword **DISPERSE**.

Field 1:	Beginning calendar year (or cycle) to change values.
Field 2:	BKP level in the outside (sq. ft./acre).
Field 3:	BA/acre of host trees large enough to be attractive to <i>Ips</i> beetles (e.g. basal area of trees whose DBH is larger than that defined in Field 2 of ATTRACT).
Field 4:	BA/acre of special trees in the outside world.
Field 5:	Trees/acre of special trees in the outside world.
Fields 6 and 7:	Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	*	*	*	*		

Note: * Defaults are the same as the initial average conditions in the “stocked” landscape.

References: *User’s Guide* Section 3.4.5

⁸ Note that keyword OWIPSDV does not let you set total basal area per acre or the RV of the outside world as does keyword OWVALUES. Hence, if *Ips* is the primary type and you opt not to use OWVALUES, then these two attributes will be set to their default values. If *Ips* is the primary beetle type and you want to explicitly set one or both of these attributes of the outside world in any year, then you must use keyword OWVALUES.

OWTYPE

This keyword is used to set the type of outside world that is being simulated. (The outside world is “off” unless explicitly “turned on” by the user via this keyword.) If an outside world is to be used, the user has two options:

1) Conditions in the outside world can remain constant throughout the model, either as defined by the user (see **OWVALUES** and **OWIPSDV**), or by default, in the same condition as the landscape average at the start of the simulation); or

2) The outside world can always be the same as the average of the landscape through time (a "floating" outside world).

Field 3 defines what part of the outside world is not stockable and will not produce beetles (e.g., a lake).

Field 1: Flag to turn the outside world on or off (1 = on, 0 = off).

Field 2: Flag to set the type of conditions in the outside world: -1 = floating with landscape (always the average of the landscape), all other values = constant (unless user changes the values).

Field 3: Percent of the outside world that is non-stockable (Real number, 0-99). If the outside world is 100% non-stockable, then turn off the outside world (set Field 1 to 0).

Fields 4 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	1	0				

References: *User's Guide* Section 3.4.5

OWVALUES

If the outside world is assumed “constant” (see **OWTYPE**), this keyword allows the user to change the conditions in the outside world in any year(s) of the simulation. Note that this keyword is used for setting the conditions for the main beetle type. If *Ips* is present as a driving variable, the keyword **OWIPSDV** should be used to change the outside world conditions for *Ips*. Levels set by this keyword remain in effect until replaced by new values when the keyword is used again. Also, note that if the keyword **BKPKILL** is used, it (**BKPKILL**) will override the outside world BKP (set by **OWTYPE/OWVALUES**) during the years that **BKPKILL** is active. This keyword, if used, must be used before keyword **DISPERSE**.

Field 1:	Beginning calendar year (or cycle) to change values.
Field 2:	BKP level in the outside (sq. ft./acre).
Field 3:	BA/acre of host trees big enough to be attractive to beetles (trees whose dbh is larger than that defined in Field 2 of ATTRACT).
Field 4:	BA/acre of special trees in the outside world.
Field 5:	Trees/acre of special trees in the outside world.
Field 6:	Total BA/acre in the outside (all trees).
Field 7:	Stress level (rating value) of host trees in the outside world, <i>excluding</i> effects from drought (see VARYRAIN) [†] . Range: 0.01 = very stressed & susceptible to beetles, 1 = vigorous, healthy tree.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	*	*	*	*	*	*

Notes: Outside world conditions are used by the model to determine attractiveness scores between the outside world and the stands of the landscape, thereby allowing BKP to be able to move in and out of the landscape (from and to the outside world)

* Default values are the same as the initial conditions in the landscape.

[†] If keyword VARYRAIN is invoked, the RV_D it imposes will be multiplied by the RV set via this keyword during the period both keywords (VARYRAIN, OWVALUES) are in effect.

References: *User's Guide* Section 3.4.5

QDEFOL

This keyword activates the “quick” defoliator model. In the model, defoliators only act on host trees and only reduce the rating value of trees, without actually killing trees. This is a landscape-level keyword, so if requested, defoliators will occur in all stands containing host trees in the specified DBH range. This keyword, if used, must be used before keyword **DISPERSE**.

- Field 1: Calendar year (or cycle) to start outbreak (integer).
 Field 2: Duration of outbreak (integer).
 Field 3: Proportion of host trees more than 70% defoliated. Range: 0-1.0.
 Field 4: Minimum DBH affected.
 Field 5: Maximum DBH affected.
 Fields 6 and 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	20	0.25	8	30		

Notes: Only bark-beetle host trees are eligible to be “attacked” by this model’s defoliators.

As with all other keywords where DBH is entered in a field, the model evaluates the *size class* into which the DBH falls and applies the condition (in this case, defoliation) to all records of the size class. The model will reduce the Rating Value due to defoliators by the proportion given in field 3.

References: *User’s Guide* Section 3.5.4. *Detailed Description:* Section 5.6

QFIRE

This keyword activates the “quick” fire model. Fire can kill all trees (host and non-host) and may affect the rating values of surviving trees. This is a landscape-level keyword, so if requested, fires may occur in any stand. Note that the same fuel-moisture code (Table 1) is used for all stands. This keyword, if used, must be used before keyword **DISPERSE**.

- Field 1: First year (or cycle) for fire to occur (integer).
 Field 2: Period of fire in years (integer). For fire to be appropriately rescheduled, the fire period should be greater than or equal to the cycle length. If the period is less, fire will not reoccur unless explicitly rescheduled via another instance of this keyword.
 Field 3: Landscape-level fuel-moisture code. Range: integer 1-4.
 Fields 4 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	50	3				

Moisture Level	Code
Very Low (wildfire)	1
Low	2
Moderate	3
High	4

Fuel-moisture codes for use in Field 3.

Notes: The WWPB Model’s internal fire model, while very similar to the fire model incorporated into the FFE (Reinhardt and Crookston 2003), is a separate and independent fire model. The fuel pool information kept track of by each of these two models is not synchronized. Model outputs regarding fuel loadings will differ.

References: *User’s Guide* Section 3.5.5. *Detailed Description:* Section 5.7

QMORT

This keyword activates the “quick” extra mortality model. It increases mortality levels on the type of tree specified by the user (host or non-host only) within the DBH limits specified. **QMORT** is a landscape-level keyword and will be active in all stands containing trees within the specified DBH and host-type range. This keyword, if used, must be used before keyword **DISPERSE**.

Field 1:	Year to start extra mortality (integer).
Field 2:	Total number of years of extra mortality (integer).
Field 3:	Type of tree dying (1 = host of main pine beetle, 2 = non-host).
Field 4:	Minimum DBH that will experience extra mortality.
Field 5:	Maximum DBH that will experience extra mortality.
Field 6:	Total mortality of eligible stems (proportion; positive real value ≤ 1.0).
Field 7:	Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	5	2	0	100	0.5	

Notes: Extra mortality imposed via this model will be added to the WWPB Model’s standing dead tree pool, and will be passed to base-FVS’ as recent mortality, hence will be decremented from the FVS live tree list.

Multiple instances of this keyword may be used to specify different mortality rates for different DBH ranges and/or host-types

References: *User’s Guide* Section 3.5.7. *Detailed Description:* Section 5.9

QRROT

This keyword activates the “quick” root disease model, and allows the user to specify the rate of spread of root rot through an infected root system. The WWPB Model recognizes infected root systems by damage codes 61, 62, or 64 in the tree records (no severity codes are needed or used - trees are either infected or not). Infected trees are simulated to have low levels of infection to begin with (1% of roots), and become increasingly stressed over time at a rate determined by Field 1. This model only affects rating values of trees (making them more susceptible to attack by the main beetle), and does not directly cause tree mortality. This is a landscape-level keyword and specified parameters are used for all stands in the landscape. For the user-entered infection rates to take effect, this keyword, if used, must be used *before* the stand inventories are read.

Field 1: Ten-year infection rate—proportion of roots becoming infected per 10 years (positive real value < 1.0).

Fields 2 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	0.1						

References: *User's Guide* Section 3.5.3. *Detailed Description:* Section 5.5

QSRUST

This keyword activates the “quick” stem rust model, and allows the user to specify rate of spread of stem rust on infected trees. The model recognizes infected trees by damage codes 35-39 in the tree records. Infected trees are simulated to have low levels of infection to begin with (0.1% of stems), and become increasingly stressed over time at a rate determined by Field 1. This model only affects rating values of trees (making them more susceptible to attack by the main beetle), and does not directly cause tree mortality. This is a landscape-level keyword and specified parameters are used for all stands in the landscape. For the user-entered infection rates to take effect, this keyword, if used, must be used *before* the stand inventories are read.

Field 1: Ten-year infection rate—proportion of stems becoming infected per 10 years (positive real value < 1.0).

Fields 2 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	0.001						

References: *User's Guide* Section 3.5.3. *Detailed Description:* Section 5.5

QWINDTH

This keyword specifies a simulated windthrow event. Windthrow is a landscape-level model, so if this keyword is used, windthrow can occur in any stand. This keyword, if used, must be used before the keyword **DISPERSE**. Windthrow creates special trees and mortality; it does not affect rating values.

- Field 1: Year (or cycle) of windthrow event (integer).
 Field 2: Number of years to keep model activated (integer).
 Field 3: Minimum height (feet) for trees to be eligible for windthrow.
 Field 4: Minimum number of eligible stems (TPA) that must be present for windthrow to occur.
 Field 5: Proportion of eligible stems to windthrow (positive real value < 1.0).
 Fields 6 and 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	20	8	1	0.4		

References: *User's Guide* Section 3.5.6. *Detailed Description:* Section 5.8

RANNSEED

This keyword specifies random number seed for the WWPB Model's random number generator used by the model in allocating BKP to size classes (see the *WWPB Model Detailed Description* for how BKP size class preferences are defined). It is also used in the "random variation" feature in **VARYRAIN**.

Field 1: Random number seed (integer).

Fields 2 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

REPRODN

This keyword controls the multiplication (**BMULT**) of BKP in successfully attacked or strip-killed trees. The **BMULT** multiplier represents how many units of BKP will “emerge” (the following year) from each unit “going into” successfully-attacked trees. These values are used in all stands in all years (except for specified years when **BKPKILL** is invoked).

- Field 1: Beetle type (1 = MPB, 2 = WBP, 3 = *Ips* spp.).
- Field 2: The DBH at which the BKP produced from the tree size class equals the level that was assigned to the class (*i.e.*, the DBH at which **BMULT** = 1).
- Field 3: The maximum reproductive multiplier value.
- Field 4: The DBH above which the multiplier does not increase.
- Fields 5 to 7: Not used.

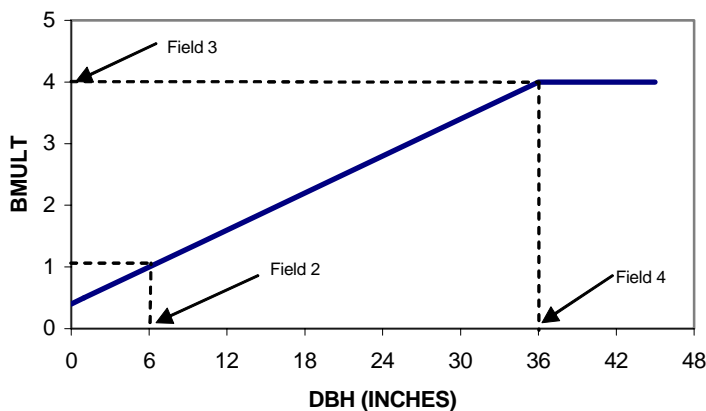
Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	*	6**	4.0**	36**			

Notes: * Default beetle type is that selected in Field 1 of **BMPARM**, or if **BMPARM** not yet entered, then Field 1 is undefined and the user must specify the beetle type.

** If the main beetle type is *Ips*, then **BMULT** for *Ips* in live trees is constant across all size classes and is equal to one tenth of the **BMULT** at DBH=1.5 inches (the midpoint of the smallest size class).⁹

The modeled reproductive dynamics of BKP assume all trees in a size class are identical, hence the model uses only one **BMULT** value per size class (determined by the class-midpoint DBH).



References:

User's Guide: 2.7.5 & 3.4.3.

Detailed Description: Section 3.4

Figure 2: Graph of the BKP multiplier as a function of DBH, showing the points that are controlled by the fields in the REPRODN keyword (default values given).

⁹ This value (the y-value at x=1.5 inches) can vary depending upon the slope of the line, which will change if any values in fields 2, 3, or 4 are changed. If *Ips* is being simulated, and the default **REPRODN** values are used, **BMULT** for *Ips* = 0.055. The user can change the **BMULT** for *Ips* in live trees by altering the function defining **BMULT** via fields 2, 3, or 4 so that the y-value at x=1.5 inches is ten times what the user wants **BMULT** for *Ips* to be. **BMULT** for *Ips* in slash is not user definable; it is “hard-coded” in the model at 5.

RPHERO

This keyword controls the simulation of the application of a repelling pheromone. Repelling pheromones are only assumed successful if used against mountain pine beetle in lodgepole pine, in stands at least 2.5 acres in size and in which less than 10% of the stems have been successfully attacked the previous year. Supplemental records, either following the keyword or in another file, are required. This keyword, if used, must be used after all stand inventories have been read.

Field 1: Year (or cycle) of application (integer).
 Field 2: File number from which to read relevant Stand IDs. If blank, then assume records follow keyword.
 Field 3: Percent efficiency. Range = 0-100.
 Fields 4 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1		75				

Note: When using Suppose: Note that Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN/CLOSE** and **BMPPIN/END** keywords (see below). Alternatively, Suppose users may insert supplemental records directly into keyword file via the “Use ParmS” feature in Suppose (in which case Suppose will leave Field 1 blank).

Supplemental Record: This record is required. The record consists of one field: a Stand ID. Stand IDs should be left-justified in the field, and may be up to 26 characters in length.

Field 1 (columns 1-26): Stand ID (if “-999”, then end of records).

Example:

```
123456789012345678901234567890
OPEN                66
Filename.ext        ← The Suppose default file name is rphero.sid.
BMPPIN
RPHERO              66      -
END
CLOSE               66
```

References: *User’s Guide* Section 3.6.1. *Detailed Description:* Section 6.3

RVDENSE

This keyword deactivates the calculation of a rating value from stand density effects (RV_{DEN}). There are no fields associated with this keyword.

Fields 1 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

References: *User's Guide* Section 3.5.7. *Detailed Description:* Section 5.2

SALVAGE

This keyword is used to simulate removal of standing dead trees (including recently killed trees prior to beetle emergence). Supplemental records, either following the keyword or in another file, are required. This keyword, if used, must be used after all stand inventories have been read.

- Field 1: Year (or cycle) to perform salvage (integer).
 Field 2: File number from which to read relevant Stand IDs. If blank, then assume records follow keyword.
 Field 3: Minimum DBH (inches) to remove.
 Field 4: Maximum DBH (inches) to remove.
 Field 5: Maximum age (years) of dead woody pools to remove (integer).
 Field 6: Minimum eligible volume to be present before salvage will occur (cu. ft./ acre).
 Field 7: Efficiency of harvest. Range 0-1.0.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1		10	60	2	10.0	0.80

Note: When using Suppose: Note that Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN/CLOSE** and **BMPPIN/END** keywords. Alternatively, Suppose users may insert supplemental records directly into keyword file via the “Use Params” feature in Suppose (in which case Suppose will leave Field 1 blank).

As with all other keywords where DBH is entered in a field, the model evaluates the *size class* into which the DBH falls and applies the condition (in this case, SALVAGE) to all records of the size class.

Trees removed via SALVAGE are not reported as removals in base-FVS output files (they manifest in base-FVS as mortality). However, they do show up as salvage harvests in WWPB Model output.

Supplemental Record: This record is required. The record consists of one field: a Stand ID. Stand IDs should be left-justified in the field, and may be up to 26 characters in length.

Field 1 (columns 1-26): Stand ID (if “-999”, then end of records).

Example: See SLASHMGT. (Format is identical; substitute “SALVAGE” for “SLASHMGT”).)

References: *User’s Guide* Section 3.6.3. *Detailed Description:* Section 6.2

SANITIZE

This keyword is used to remove beetle-attacked trees before beetle emergence, or live, un-attacked trees with a low rating value (RV). Supplemental records, either following the keyword or in another file, are required. This keyword, if used, must be used after all stand inventories have been read.

- Field 1: Year (or cycle) of sanitation cut (integer).
- Field 2: File number from which to read relevant Stand IDs. If blank then assume records follow keyword.
- Field 3: Minimum DBH (inches) to remove.
- Field 4: Maximum DBH (inches) to remove.
- Field 5: Maximum rating value of un-attacked trees to remove. Range: 0.01-1.0.
- Field 6: Minimum eligible volume existing before a sanitation cut will occur (cu. ft./acre).
- Field 7: Efficiency of harvest (for un-attacked, low-RV trees)†. Range: 0-1.0.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1		6	999	0.0	10.0	0.95

Notes: † The removal efficiency for recently attacked trees is permanently set at 0.90.

When using Suppose: Note that Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN/CLOSE** and **BMPPIN/END** keywords. Alternatively, Suppose users may insert supplemental records directly into keyword file via the “Use ParmS” feature in Suppose (in which case Suppose will leave Field 1 blank).

As with all other keywords where DBH is entered in a field, the model evaluates the *size class* into which the DBH falls and applies the condition (in this case, SANITIZE) to all records of the size class.

Trees removed via SANITIZE are not reported as removals in base-FVS output files (they manifest in base-FVS as mortality). However, they do show up as sanitation harvests in WWPB Model output.

Supplemental Record: This record is required. The record consists of one field: a Stand ID. Stand IDs should be left-justified in the field, and may be up to 26 characters in length.

Field 1 (columns 1-26): Stand ID (if “-999”, then end of records).

Example: See SLASHMGT. (Format is identical; substitute “SANITIZE” for “SLASHMGT”).

References: *User’s Guide* Section 3.6.2. *Detailed Description:* Section 6.1

SLASHMGT

This keyword is used to simulate removal of fresh (this year's) slash created from harvesting or salvage logging. Supplemental records, either following the keyword or in another file, are required. This keyword, if used, must be used after all stand inventories have been read.

Field 1: Year of slash removal.
 Field 2: File number from which to read relevant Stand IDs. If blank, then assume records follow keyword.
 Field 3: Proportion of slash < 3 inches in diameter to remove. Range: 0-1.0.
 Field 4: Proportion of slash > 3 inches in diameter to remove. Range: 0-1.0.
 Fields 5 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1		0	0.8			

Note: When using Suppose: Note that Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN/CLOSE** and **BMPPIN/END** keywords (see below). Alternatively, Suppose users may insert supplemental records directly into keyword file via the “Use Params” feature in Suppose (in which case Suppose will leave Field 1 blank).

Supplemental Record: This record is required. The record consists of one field: a Stand ID. Stand IDs should be left-justified in the field, and may be up to 26 characters in length..

Field 1 (columns 1-26): Stand ID (if “-999”, then end of records).

Example:

```
123456789012345678901234567890
OPEN          69
Filename.ext   ← The Suppose default file name is slashmgt.sid.
BMPPIN
SLASHMGT     69
END
CLOSE         69
```

References: *User's Guide* Section 3.6.3. *Detailed Description:* Section 6.2

SPRAY

This keyword controls the simulated application of pesticides. Note that pesticides are assumed to be successful at eliminating BKP assigned to the stand if the pesticides are invoked for a stand containing no BKP during the previous year. Supplemental records, either following the keyword or in another file, are required. This keyword, if used, must be used after all stand inventories have been read.

Field 1: Year of application (integer).
 Field 2: File number from which to read relevant Stand IDs. If blank, then assume records follow keyword.
 Field 3: Efficiency of application. Range: 0-1.0.
 Fields 4 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1		0.0				

Note: When using Suppose: Note that Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN/CLOSE** and **BMPPIN/END** keywords (see below). Alternatively, Suppose users may insert supplemental records directly into keyword file via the “Use Parms” feature in Suppose (in which case Suppose will leave Field 1 blank).

Supplemental Record: This record is required. The record consists of one field: a Stand ID. Stand IDs should be left-justified in the field, and may be up to 26 characters in length.

Field 1 (columns 1-26): Stand ID (if “-999”, then end of records).

Example:

```
123456789012345678901234567890
OPEN          69
Filename.ext   ← The Suppose default file name is spray.sid.
BMPPIN
SPRAY         69
END
CLOSE        69
```

References: *User's Guide* Section 3.6.2

VARYRAIN

This keyword invokes the climate conditions (aka drought, stress) submodel, thereby controlling the stand and size-class rating value due to drought (RV_D) for specified years. There are two ways to use this keyword. In the first, “random” stress events are generated. In the second, the user defines a “constant” stress event for specified years. In either case, the effect remains active until the keyword is altered via another instance of the keyword, or is toggled “off”. This is a landscape-level keyword, and specified parameters are used for all stands in the landscape. This keyword, if used, must be used before keyword **DISPERSE**.

- Field 1: Year (or cycle) to start specified change.
- Field 2: Flag to set type of change: -1 = OFF, 0 = random variation, 1 = user-defined constant.
- Field 3: If Field 2 = 0, this is the standard deviation of the distribution of effects, and the input value must be positive. If Field 2 = 1, then Field 3 is the change in effects from their normal value of 1.0, where negative values indicate lower RV (tree stress) conditions and positive values indicate “non-stress” conditions. Range: -10.0 to 10.0.
- Field 4: Coefficient that determines the influence of DBH on tree size-class response to variation. Positive values mean that larger trees will be less susceptible to stress than smaller trees, while negative values mean that larger size classes will be more susceptible to stress events than smaller size classes.
- Field 5: Coefficient for elevation. Positive values mean that stands at higher elevations will be less susceptible (RV is lowered less) than stands at lower elevations; while negative values mean that stands at higher elevations will be more susceptible to stress events lower elevation stands.
- Field 6: Coefficient for stand density index (SDI). A negative value means that low SDI stands are less susceptible (to stress events) than higher SDI stands.
- Field 7: Coefficient for a user-defined site "moisture-score". If this field is non-zero, then the **WETSCORE** keyword must be used to supply the moisture scores for each stand.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	0	3	0	0	-1	0

References: *User's Guide* Section 3.5.1. *Detailed Description:* Section 5.1

WETSCORE

If Field 7 of keyword **VARYRAIN** is non-zero, then this keyword must be used (in conjunction with **VARYRAIN**). It allows the user to input a “site moisture score” or other measure of stand-specific site conditions that will influence how **VARYRAIN** affects each stand. Supplemental records must be used, either within the keyword file or in another file.

Field 1: File number to read supplemental records. If blank, records are assumed to follow the keyword.

Fields 2 to 7: Not used.

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants							

Note: When using Suppose: Note that Suppose will automatically assign a unit number (Field 1), and will, by default, “assume” the supplemental records are in an external file (with its *filename.ext* provided by user). Suppose also will automatically include the needed **OPEN/CLOSE** and **BMPPIN/END** keywords (see below). Alternatively, Suppose users may insert supplemental records directly into keyword file via the “Use Parm’s” feature in Suppose (in which case Suppose will leave Field 1 blank).

Supplemental Records: Each record must contain a Stand ID (up to 26 characters) in columns 1-26, followed by the moisture score in columns 31-40. Stand IDs should be left-justified in their field in the supplemental record list.

Field 1 (columns 1-26): Stand ID. (If “-999”, then end of records.)

Field 2 (columns 31-40): A real-valued “moisture score” or other index.

Example:

```
123456789012345678901234567890
OPEN          70
Filename.ext   ← The Suppose default file name is wetscore.bmm.
BMPPIN
WETSCORE    70
END
CLOSE        70
```

References: *User’s Guide* Section 3.5.1. *Detailed Description:* Section 5.1

Stand Level Keywords

WWPB Model *stand level* keywords are to be placed in a keyword file *along with other base-FVS stand level keywords*. These WWPB Model stand-level keywords must be preceded with keyword BMIN and must be terminated with an END keyword. All four of these output-generating keywords function identically: Field 1 dictates the year to begin writing output, Field 2 establishes the duration of writing, and Field 3 controls the frequency within the interval to write output. Numerous instances per stand may be entered, so that output may be generated at different frequencies for different intervals. Each stand's frequencies and intervals may be different from one another. For those users familiar with the Fire and Fuels Extension (FFE) to FVS, note that these keywords function just like FFE keywords FUELOUT and POTFIRE. Also note that output generated via these keywords may be redirected to a database via Database Extension (Crookston et al 2005) keywords (in which case both the WWPB Model keyword and the DataBase keyword are required).

Example:

```
1234567890123456789012345678901234567890
...
AREALOCS
BMPPIN
BMPARM          1          7          10
DISPERSE        70
END

! Begin stand-level keywords

ADDSTAND
STNDINFO
DESIGN
! Stand-level WWPBM keywords
BMIN
MAINOUT        2000        50          10
MAINOUT        2025        30          1
MAINOUT        2055        20          5
BKPOUT        2000        50          5
BKPOUT        2020        40          1
TREEOUT       2000        60          1
VOLOUT       2000        60          10
END
...
PROCESS
! NEXT STAND
ADDSTAND
...
```

Note about this example. Subsequent instances of a keyword override parameters set via previous instances. Thus, the writing of the "MAINOUT" table every 10 years beginning in 2000 (invoked by the first instance) will change to every one year beginning in 2025. The 50 year duration set by the first instance will be over-riden in 2025 by the second instance. Further, since the DISPERSE keyword instructs the WWPB Model to run until only 2070 (assume the simulation begins in year 2000), the final instance of MAINOUT will result in output being written until only 2070 even though it requests output through 2075.

BKPOUT

This keyword invokes the writing of a WWPB Model output file reporting detailed BKP and rating values data. Output consists of the state of variables as of the beginning of the year of output (before or after dispersal, depending upon the variable). Output variables include: BKP levels before and after dispersal, BKP allocation (amounts to and from other stands in landscape, to and from outside world, and to and from “oneself”); percent survival of BKP; BKP used in pitchouts/strip-kills; BKP removed via sanitation; rating values by driving variable; trees per acre, basal area, and volume mortalities arising from WWPB Model “fast” driving variables.

Field 1: FVS cycle number or the calendar year when output starts.
 Field 2: Years after Field one output writing will end.
 Field 3: Frequency interval defining the years in which output will be written.
 Fields 4-7: Not used

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	100	5				

Note: Multiple instances (per stand) of this keyword are allowed. Parameters set via subsequent instances of the keyword (for a given stand) override parameters set via previous instances (see example). Output may be redirected to a database via DataBase Extension keyword PPBMBKP.

References: *User's Guide* Section xxx *Detailed Description:* Section xxx *Database User Guide:* Section xxx

MAINOUT

This keyword invokes the writing of “main” WWPB Model output variables. Most of the variables are the same as those reported in the cycle output file (see keyword BMOU); however, this keyword allows the user to fetch these variables annually (the Cycle output file reports them on FVS projection cycle boundaries). Output consists of the state of variables as of the beginning or end of the year of output depending upon the variable. Output variables include: BKP levels before and after dispersal; stand rating value; total, host, and beetle-killed basal area, trees per acre and volume; basal area and trees per acre of special trees and sanitation removals; volume removed via sanitation and salvage; amount of Ips slash; and BKP removed via sanitation.

Field 1: FVS cycle number or the calendar year when output starts.
 Field 2: Years after Field one output writing will end.
 Field 3: Frequency interval defining the years in which output will be written.
 Fields 4-7: Not used

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	100	5				

Note: Multiple instances (per stand) of this keyword are allowed. Parameters set via subsequent instances of the keyword (for a given stand) override parameters set via previous instances (see example). Output may be redirected to a database via DataBase Extension keyword PPBMMAIN.

References: *User's Guide* Section xxx *Detailed Description:* Section xxx *Database User Guide:* Section xxx

TREEOUT

This keyword invokes the writing of detailed WWPB Model output variables arrayed by tree size class (see page 7). Output consists of the state of variables as of the beginning or end of the year, depending upon the variable. Output variables include: total, host, and beetle-killed trees per acre (TPA); TPA special trees; and TPA removed via sanitation cutting.

Field 1: FVS cycle number or the calendar year when output starts.
 Field 2: Years after Field one output writing will end.
 Field 3: Frequency interval defining the years in which output will be written.
 Fields 4-7: Not used

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	100	5				

Note: Multiple instances (per stand) of this keyword are allowed. Parameters set via subsequent instances of the keyword (for a given stand) override parameters set via previous instances (see example). Output may be redirected to a database via DataBase Extension keyword PPBM TREE.

References: *User's Guide* Section xxx *Detailed Description:* Section xxx *Database User Guide:* Section xxx

VOLOUT

This keyword invokes the writing of detailed WWPB Model output variables arrayed by tree size class (see page 7). Output consists of the state of variables as of the beginning or end of the year, depending upon the variable. Output variables include: total, host, and beetle-killed cubic foot volume per acre.

- Field 1: FVS cycle number or the calendar year when output starts.
 Field 2: Years after Field one output writing will end.
 Field 3: Frequency interval defining the years in which output will be written.
 Fields 4-7: Not used

Defaults by Fields

Variant	1	2	3	4	5	6	7
All Variants	1	100	5				

Note: Multiple instances (per stand) of this keyword are allowed. Parameters set via subsequent instances of the keyword (for a given stand) override parameters set via previous instances (see example). Output may be redirected to a database via DataBase Extension keyword PPBMVOL.

References: *User's Guide* Section xxx *Detailed Description:* Section xxx *Database User Guide:* Section xxx

Literature Cited

- Crookston, Nicholas L. and Albert R. Stage.** 1991. User's guide to the Parallel Processing Extension of the Prognosis Model. Gen. Tech. Rep. INT-281. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT. 88 p.
- Dixon, Gary E.** comp. 2003. Essential FVS: A user's guide to the Forest Vegetation Simulator. Internal Report Fort Collins, CO: U.S. Dept. of Agriculture, Forest Service, Forest Management Service Center. 193 p.
- Reinhardt, Elizabeth and Nicholas L. Crookston** (technical editors). 2003. The Fire and Fuels Extension to the Forest Vegetation Simulator. Gen. Tech. Rep. RMRS-GTR-116. Ogden, UT: U.S. Dept. of Agriculture, Forest Service, Rocky Mountain Research Station. 209 p.
- Van Dyck, Michael G.** 2004. Keyword reference guide for the Forest Vegetation Simulator. U.S. Department of Agriculture, Forest Service, Forest Management Service Center, Fort Collins, CO 118 p.
- Crookston, Nicholas L., Dennis L. Gammel, Stephanie Rebain.** 2005. Users Guide to the Database Extension of the Forest Vegetation Simulator, Version 2.0. Rocky Mountain Research Station – Moscow

-
- 1 This line is not part of the keyword file. It merely denotes columns. Remove or comment out if reproducing this example verbatim.
- 2 Number of cycles to run.
- 3 Cycle length
- 4 The starting year of simulation.
- 5 Opens unit 17 for the reading-in of the area locations file..
- 6 Specify the file name containing the AREALOCS keyword and records.
- 7 Reads the file *grid.loc*¹⁰
- 8 Closes unit 17.
- 9 Begin reading in WWPB keywords
- 10 Specify beetle type (MPB) and host tree species (ponderosa and lodgepole pines)
- 11 Specifies some reproductive values (change from defaults).
- 12 Specify RMAX (Change from default of 15 miles to 5 miles).
- 13-15 Begin reading in supplemental records containing “beetle history” i.e. beginning-of-simulation BKP levels
- 16 Supplemental records (Field 1: stand ID in columns 1-26; Field 2: size class in columns 31-40; Field 3: trees per acre (in Field 2’s size class) containing BKP.
- 17 Signifies end of supplemental records
- 18 A comment
- 19-20 Defines outside world as “constant” (not floating), 27% non-stocked.
- 21 Changes outside world BKP in 2004 and 2005 values
- 22-23 Re-sets outside world BKP conditions back to default values (= landscape average at beginning-of-simulation)
- 24 Imposes a stress event in 2004 and 2005
- 25-26 Shuts off VARYRAIN (Climate conditions driving variable sub-model is turned off)
- 27 Impose climate conditions favorable to trees (“non-stress” events) for 2 years
- 28 Turns VARYRAIN off again.
- 29 Specifies the year to begin running the WWPB Model.
- 30 Requests 3 output files (“main”, landscape average, and annual stand-level)
- 31 Requests detailed output file.
- 32 Requests driving variable. output file.
- 33 Stop reading WWPB Model keywords.
- 34 Open unit 17 for the reading-in of the file containing stand-level base-FVS keywords and tree records
- 35 Specifies the filename of the file containing tree data and base-FVS keywords
- 36 Read in file *stndfile.ext*.
- 37 Close the computer’s memory unit 17
- 39-42 PPE keywords controlling the writing of output.
- 43 Begin the simulation.

¹⁰ Note: This example supplemental record file differs from that provided in the Suppose-generated keyword file (Appendix B) In this example, the supplemental record file (*grid.loc*) will contain the PPE Keyword AREALOCS along with the supplemental records. In the Suppose-generated keyword file example, the AREALOCS keyword is embedded in the main keyword file, and the supplemental record file being read in (*arealocs.alc*) will contain *only* supplemental records. Both methods are acceptable; be aware that the keyword file syntax requires a specific supplemental file syntax.

*** Example text-editor-written ADDFILE**

* Example entry from the stndfile.ext file (opened above). This file calls for the opening of individual stand tree data files and "assigns" them to individual simulated stands. Note that in this (and previous) example, Stand IDs are 8 characters long. Stand IDs may be up to 26 characters long.

* The following 2 lines depict field locations and column numbers.

```
*
*1234567890123456789012345678901234567890123456789012345678901234567890
*KEYWORD      FIELD1      FIELD2      FIELD3      FIELD4      FIELD5      FIELD6      Field7
```

```
1 1234567890123456789012345678901234567890123456789012345678901234567890
2 ADDSTAND
3 STDIDENT
4 00000005
5 OPEN              18
6 T101008.013
7 ADDFILE           18
8 CLOSE             18
9 INVYEAR           1994
10 MODTYPE           5
11 STDINFO           215          5          99          90          50          87          41
12 DESIGN            0            1          999          5          103.78        1
13 SITECODE          71
14 PROCESS
```

15 *(There would be an entry like this (above) for each stand in the landscape.
16 Example stndfile.ext continues below.)

```
17 BMPPIN
18 SANITIZE      1994          -          3.0          -          0.5          -          0.85
19 00000019
20 . . .
21 00000042
22 -999
23 END
```

Line by line description

<p>1 This line is not part of the keyword file. It merely denotes columns. Remove or comment out if reproducing this example verbatim.</p> <p>2 Begin reading base model FVS keywords</p> <p>3 Specify a stand identification code (StandID)</p> <p>4 The StandID</p> <p>5 Open a unit for reading in tree data</p> <p>6 The name of the file containing the tree data</p> <p>7 Read the file</p> <p>8 Close the computer's memry unit space</p> <p>9 The stand's inventory year</p> <p>10 The model type (CR-variant-specific)</p> <p>11 Stand physiographic information</p>	<p>12 Stand inventory design information</p> <p>13 Stand site index</p> <p>14 Process the stand (end of keywords for this stand)</p> <p>15-16 Comments</p> <p>17 Begin reading WWPB Model keywords</p> <p>18 Specify sanitation cuts in 1994. Do not remove trees in size class 1. Besides recently-attacked trees, remove un-attacked trees if RV_{SC} is < 0.5 at 85% efficiency</p> <p>19-21 StandIDs to sanitize (supplemental records)</p> <p>22 End of supplemental records</p> <p>23 End of WWPB Model keywords</p> <p>Return to the "calling" keyword file</p>
---	--

Appendix B: Example Suppose-generated Keyword File.

 *PPE keywords in italics; WWPB Model keywords in bold. FVS Keywords in normal typeface.

```
!!Suppose 1.0 cr 1 1
!!Top
Comment
Starting year for simulation is 1994
Ending year for simulation is 2024
Min and Max inventory years are 1984 1994
Common cycle length is 5
End
!!End

StartYr          1994
MstrInt          5
MstrCyCs         6

!!CT Parallel Processing Extension: AreaLocs~11 4 -1 cr ppe @
!!SW GPKeyword
!!P # 2 Parallel Processing Extension: AreaLocs~keyword.ppe.AreaLocs~arealocs..
!! alc~51.0 0.0000 Fmax 51.00 NoB~1.0 0.0000 Fmax 1.00 NoB~1.0 0.0000 .
!! Fmax 1.00 NoB~.
!!K
Open          51.0
arealocs.alc
AreaLocs      51.0      1.0      1.0
Close         51.0
!!End
BMPPIN
!!CT West Wide Pine Beetle Model: BMParm~13 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 3 West Wide Pine Beetle Model: BMParm~keyword.wwpb.BMParm~0~1.0 1.0000 .
!! 5.0000 1.00 NoB~7 0.0000 Fmax 0.00 Bok~10 0.0000 Fmax 0.00 Bok~blank.
!! 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax .
!! 0.00 Bok~.
!!K
BMParm          1      1.0      7      10
!!End
!!CT West Wide Pine Beetle Model: Reprodrn~15 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 1 West Wide Pine Beetle Model: Reprodrn~keyword.wwpb.Reprodrn~0~6.0 0.000.
!! 0 Fmax 6.00 NoB~5.0 0.0000 Fmax 4.00 NoB~18.0 0.0000 Fmax 36.00 NoB~.
!!K
Reprodrn       1      6.0      5.0      18.0
!!End
!!CT West Wide Pine Beetle Model: Attract~17 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 2 West Wide Pine Beetle Model: Attract~keyword.wwpb.Attract~0~6.0 0.000.
!! 0 Fmax 6.00 NoB~1.0 0.0000 Fmax 1.00 NoB~100.0 0.0000 Fmax 100.00 No.
!! B~1.0 0.0000 Fmax 1.00 NoB~5.0 0.0000 Fmax 15.00 NoB~.
!!K
ATTRACT        1      6.0      1.0      100.0      1.0      5.0
!!End
!!CT West Wide Pine Beetle Model: BMHist~19 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 1 West Wide Pine Beetle Model: BMHist~keyword.wwpb.BMHist~bmhist.bmh~63..
!! 0 31.0000 Fmax 63.00 NoB~0~.
!!K
END
Open          63.0
bmhist.bmh
BMPPIN
BMHist         63.0      1
END
Close         63.0
BMPPIN
!!End
!!CT West Wide Pine Beetle Model: OWType~21 4 -1 cr wwpb @
```

```

!!SW GPKeyword
!!P # 1 West Wide Pine Beetle Model: OWType~keyword.wwpb.OWType~0~0~27.00 0.0.
!! 000 99.0000 13.50 40.50 0.00~.
!!K
OWType          1          1      27.00
!!End
!!CT West Wide Pine Beetle Model: OWValues~23 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 3 West Wide Pine Beetle Model: OWValues~keyword.wwpb.OWValues~0 2004 0 ~.
!! 1 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax.
!! 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~blan.
!! k 0.0000 Fmax 0.00 Bok~.
!!K
OWValues       2004          1
!!End
!!CT West Wide Pine Beetle Model: OWValues~25 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 3 West Wide Pine Beetle Model: OWValues~keyword.wwpb.OWValues~0 2005 0 ~.
!! 2 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax.
!! 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~blan.
!! k 0.0000 Fmax 0.00 Bok~.
!!K
OWValues       2005          2
!!End
!!CT West Wide Pine Beetle Model: OWValues~27 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 3 West Wide Pine Beetle Model: OWValues~keyword.wwpb.OWValues~0 2006 0 ~.
!! blank 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~blank 0.0000 .
!! Fmax 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~blank 0.0000 Fmax 0.00 Bok~.
!! blank 0.0000 Fmax 0.00 Bok~.
!!K
OWValues       2006
!!End
!!CT West Wide Pine Beetle Model: VaryRain~29 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 2 West Wide Pine Beetle Model: VaryRain~keyword.wwpb.VaryRain~0 2004 0 ~.
!! 2~-3 0.0000 Fmax 0.30 NoB~0.0 0.0000 Fmax 0.00 NoB~0.0 0.0000 Fmax .
!! 0.00 NoB~-1.0 0.0000 Fmax -1.00 NoB~0.0 0.0000 Fmax 0.00 NoB~.
!!K
VaryRain       2004          1          -3          0.0          0.0          -1.0          0.0
!!End
!!CT West Wide Pine Beetle Model: VaryRain~31 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 2 West Wide Pine Beetle Model: VaryRain~keyword.wwpb.VaryRain~0 2005 0 ~.
!! 2~-2 0.0000 Fmax 0.30 NoB~0.0 0.0000 Fmax 0.00 NoB~0.0 0.0000 Fmax .
!! 0.00 NoB~-1.0 0.0000 Fmax -1.00 NoB~0.0 0.0000 Fmax 0.00 NoB~.
!!K
VaryRain       2005          1          -2          0.0          0.0          -1.0          0.0
!!End
!!CT West Wide Pine Beetle Model: VaryRain~33 2 -1 cr wwpb @
!!SW GPKeyword
!!P # 2 West Wide Pine Beetle Model: VaryRain~keyword.wwpb.VaryRain~0 2006 0 ~.
!! 0~0.3 0.0000 Fmax 0.30 NoB~0.0 0.0000 Fmax 0.00 NoB~0.0 0.0000 Fmax.
!! 0.00 NoB~-1.0 0.0000 Fmax -1.00 NoB~0.0 0.0000 Fmax 0.00 NoB~.
!!K
VaryRain       2006          -1          0.3          0.0          0.0          -1.0          0.0
!!End
!!CT West Wide Pine Beetle Model: VaryRain~35 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 2 West Wide Pine Beetle Model: VaryRain~keyword.wwpb.VaryRain~0 2007 0 ~.
!! 2~6 0.0000 Fmax 0.30 NoB~0.0 0.0000 Fmax 0.00 NoB~0.0 0.0000 Fmax 0.
!! .00 NoB~-1.0 0.0000 Fmax -1.00 NoB~0.0 0.0000 Fmax 0.00 NoB~.
!!K
VaryRain       2007          1          6          0.0          0.0          -1.0          0.0
!!End
!!CT West Wide Pine Beetle Model: VaryRain~37 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 2 West Wide Pine Beetle Model: VaryRain~keyword.wwpb.VaryRain~0 2008 0 ~.
!! 2~5 0.0000 Fmax 0.30 NoB~0.0 0.0000 Fmax 0.00 NoB~0.0 0.0000 Fmax 0.
!! .00 NoB~-1.0 0.0000 Fmax -1.00 NoB~0.0 0.0000 Fmax 0.00 NoB~.

```

```

!!K
VaryRain          2008          1          5          0.0          0.0          -1.0          0.0
!!End
!!CT West Wide Pine Beetle Model: VaryRain~39 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 2 West Wide Pine Beetle Model: VaryRain~keyword.wwpb.VaryRain~0 2009 0 ~.
!! 0~0.3  0.0000 Fmax 0.30 NoB~0.0  0.0000 Fmax 0.00 NoB~0.0  0.0000 Fmax.
!!  0.00 NoB~-1.0  0.0000 Fmax -1.00 NoB~0.0  0.0000 Fmax 0.00 NoB~.
!!K
VaryRain          2009          -1          0.3          0.0          0.0          -1.0          0.0
!!End
!!CT West Wide Pine Beetle Model: Disperse~41 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 1 West Wide Pine Beetle Model: Disperse~keyword.wwpb.Disperse~0 1994 0 ~.
!! 50.0  1.0000 Fmax 50.00 NoB~.
!!K
Disperse         1994          50.0
!!End
!!CT West Wide Pine Beetle Model: BMTotals~43 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 2 West Wide Pine Beetle Model: BMTotals~keyword.wwpb.BMTotals~bmtotals.b.
!! mt~64.0  31.0000 Fmax 64.00 NoB~bmtotals.bms~28.0  28.0000 28.0000 28..
!! 00 NoB~bmtotals.bml~29.0  29.0000 29.0000 29.00 NoB~.
!!K
END
Open                64.0
bmtotals.bmt
Open                28.0
bmtotals.bms
Open                29.0
bmtotals.bml
BMPPIN
BMTotals         64.0
!!End
!!CT West Wide Pine Beetle Model: BMDetail~45 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 1 West Wide Pine Beetle Model: BMDetail~keyword.wwpb.BMDetail~bmdetail.b.
!! md~61.0  31.0000 Fmax 61.00 NoB~.
!!K
END
Open                61.0
bmdetail.bmd
BMPPIN
BMDetail         61.0
!!End
!!CT West Wide Pine Beetle Model: BMDVOut~47 4 -1 cr wwpb @
!!SW GPKeyword
!!P # 1 West Wide Pine Beetle Model: BMDVOut~keyword.wwpb.BMDVOut~bmdvout.bmv~.
!! 62.0  31.0000 Fmax 62.00 NoB~.
!!K
END
Open                62.0
bmdvout.bmv
BMPPIN
BMDVOut         62.0
!!End
End

AddStand

!!Stand 00000005 0
StdIdent
00000005 Stand 00000005 at Piney Analysis Area
!!SK cr
Screen
InvYear            1994
ModType            5
StdInfo            215          5          99          90          50          87          41
Design             0          1          999          5          103.78          1
SiteCode           71

```

```

!!End
!!TK
TimeInt                5
NumCycle               6
!!End
!!TR
Open                   2
01008013.fvs
TreeData              2
Close                 2
!!End
SPLabel
  All, &
  Piney_Analysis_Area
Process
!!EndStand
.
... (More stands entered here, just as above [keywords ADDSTAND through PROCESS])
.
AddStand

!!Stand 00000219 160
StdIdent
00000219 Stand 00000219 at Piney Analysis Area
!!SK cr
Screen
InvYear               1994
ModType               5
StdInfo               215      5      89      70      30      98      41
Design                0      1      999      5      103.78      1
SiteCode              63
!!End
!!TK
TimeInt                5
NumCycle               6
!!End
!!TR
Open                   2
07003017.fvs
TreeData              2
Close                 2
!!End
SPLabel
  All, &
  Piney_Analysis_Area
Process
!!EndStand

BMPPIN
!!CB West Wide Pine Beetle Model: Sanitize~49 5 -1 cr wwpb @
!!SW GKkeyword
!!P # 3 West Wide Pine Beetle Model: Sanitize~keyword.wwpb.Sanitize~0 1994 0 ~.
!! sanitize.sid~68.0 0.0000 Fmax 68.00 NoB~3.0 0.0000 Fmax 6.00 NoB~999.
!! .0 0.0000 Fmax 999.00 NoB~0.0000 0.0000 1.0000 0.00 1.00 0.00~10.0 .
!! 0.0000 Fmax 10.00 NoB~0.9500 0.0000 1.0000 0.00 1.00 0.95~.
!!K
END
Open                   68.0
sanitize.sid
BMPPIN
Sanitize             1994      68.0      3.0      999.0      0.0000      10.0      0.9500
END
Close                 68.0
BMPPIN
!!End
End
Project

```

Notes on the above keyword file. The keyword file (above) was created by Suppose. Keywords were entered by the user in the same sequence as in the previous example. Note the following differences:

- 1) Suppose adds numerous lines of extraneous (Suppose-needed) information (lines beginning with “!!”). Ignore these lines.
- 2) Suppose automatically enters (and appropriately places) certain keywords (e.g. when you specify length of simulation and cycle length, Suppose creates keywords MstrCycs, MstrInt)
- 3) One of the more obvious differences between the two files is that Suppose displays all of the default values for a given keyword. While from a computing standpoint this is unnecessary (default values are the values that the model uses *if the fields were left blank*), Suppose puts them in by design, so that the user can see what values are being used for certain parameters.
- 4) There are a few keywords, however, where the default values for certain fields are left blank: Field 1 (beetle type code) of REPRODN, ATTRACT, BMHIST, and BKPKILL. These are blank for a reason. The WWPB Model will automatically set the default beetle type (for each of these keywords) equal to the beetle type code specified in Field 1 of keyword BMPARM. If a user wishes to specify beetle type for these keywords that is different than the main beetle type specified in Field 1 of BMPARM, or if the user places these keywords before BMPARM, then the user must explicitly specify beetle type code parameters in Field 1 of these keywords.
- 5) The user *must* explicitly specify tree type code(s) in Field 3 (and optionally in Fields 4-7). No default is programmed in.
- 6) Unlike the previous example (the “manually-written” keyword file), where the supplemental records for BMHIST were included within the main keyword file, supplemental records for the BMHIST keyword in this example are read in from an external file. See also the footnote at AREALOCS in the previous example for an analogous difference between these two examples.

Appendix C: Pine Tree Species Codes by Variant

HOST TREE SPECIES	FVS TREE SPECIES CODES (SEQUENCE NUMBERS) BY VARIANT														
	VARIANT														
	BM	CA	CI	CR	EC	EM	KT	NC	NI	PN	SO	TT	UT	WC	WS
Lodgepole pine	7	12	7	11	7	7	7	--	7	11	7	7	7	11	--
Ponderosa pine	10	18	10	13	10	10	10	10	10	15	10	--	10	15	10
Bristlecone pine	--	--	--	9	--	--	--	--	--	--	--	--	--	--	--
Coulter pine	--	13	--	--	--	--	--	--	--	--	--	--	--	--	--
Jeffery pine	--	15	--	--	--	--	--	--	--	12	--	--	--	12	--
Limber pine	--	14	--	10	--	--	--	--	--	--	--	2	2	--	--
Pinyon pine	--	--	--	12	--	--	--	--	--	--	--	--	--	--	--
Sugar pine	--	16	--	--	--	--	--	2	--	13	2	--	--	13	2
Western white pine	1	17	1	--	1	--	1	--	1	14	1	--	--	14	--
Whitebark pine	--	10	--	--	--	1	--	--	--	31	16	1	1	31	--

Key to variant abbreviations:

BM: Blue Mountains

CA: Inland California, Southern Cascades (ICASCA)

CI: Central Idaho

CR: Central Rockies (GENGYM)--All Submodels

EC: Eastern Cascades

EM: Eastern Montana

KT: Kootenai / Kaniksu / Tally Lake - Flathead (KOOKANTL)

NC: Northern California (Klamath Mountains)

NI: North Idaho (Inland Empire)

PN: Pacific Northwest Coast

SO: South Central Oregon, Northeast California (SORNEC)

TT: Tetons

UT: Utah

WC: Western Cascades

WS: Westside Sierra Nevada
(WESSIN)