User's Guide to the Event Monitor: Part of Prognosis Model Version 6

Nicholas L. Crookston

If
Riparian EQ
YES and BTPA LT 150
and BADBH GT 12 Then
Perform one-entry shelterwood

THE AUTHOR

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RESEARCH SUMMARY

The Event Monitor dynamically invokes management activities to be simulated by the Prognosis Model. Activities include simulated thinnings, harvesting, plantings, or any other activity that the simulation model can mimic. The Event Monitor accepts statements of conditions to be met and a set of activities to be simulated when the conditions are met. The conditions are logical expressions of stand-state variables. The combination of a condition and a set of activities is considered a rule of stand management. One or more rules may be used to define a stand management policy.

Stand management policies may be evaluated without users foretelling the development of stands in an analysis and manually scheduling activities. If the policy statements are defined by experts so that they apply to the management of many stands, the system will output suggested management schedules that reflect the policies of experts for each stand. The rules that define these policies can be shared between users.

This user's guide replaces General Technical Report INT-196 (Crookston 1985). Most old features of the Event Monitor have been retained; several new features have been added as described herein. Several additional arithmetic functions and stand-state variables are now available. New stand-state variables can be defined as a function of other stand-state variables, and the new variables can be used in expressions. Functions of stand-state variables can be coded in place of constants on some Prognosis Model keywords. Stand management rules can be labeled and related to each other using labels.

ACKNOWLEDGMENTS

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INTRODUCTION

Stand management activities are often contingent upon several factors. Thinning may be called for if the stand is too dense, or spraying may be required if an insect population is causing too much damage. Usually, users of stand-growth simulation models must foretell the occurrence of stand conditions that require management actions and preschedule the program options that represent those actions.

The Event Monitor offers an alternative method of scheduling activities: You specify a set of conditions that must occur, or thresholds that must be reached. The conditions are called an event. You also specify a set of management activities for the model to simulate when and if the event occurs. For example, suppose you wish to schedule a thinning only if the stand crown competition factor (Krajicek and others 1961) exceeds 150, trees per acre exceed 500, and age is greater than 20 and less than 60 years. Using the Event Monitor, the condition is specified via a logical expression followed by the activities (represented by Prognosis Model options) that are to be invoked when that expression is true.

Taken together, an event and the management activities may be viewed as a management rule. One or more rules may be considered a management policy statement. Thus, policy statements may be evaluated using the Prognosis Model without users foretelling the development of each stand in an analysis in order to manually schedule activities.

If the policy statements are defined by management experts in such a way that they apply to the management of a large number of stands, the Event Monitor can be used to provide suggested management schedules that reflect the management policies of those experts. The rules that define these policies can be shared between you and your colleagues. In this way, the Prognosis Model can be used to share management expertise.

The Event Monitor was added to the Prognosis Model when Version 5 was created (Crookston 1985). This guide applies to Version 6 of the model and completely replaces the original version.

Most features of the old version have been retained, and several arithmetic functions and stand-state variables that can be used in expressions have been added. Further, new stand-state variables can be defined as functions of other stand-state variables, and the new variables can be used in expressions. Functions of stand-state variables can be coded in place of constants on some Prognosis Model keywords. Stand management rules can be labeled and related to each other using labels. The only deleted feature concerns some species-specific density measures as described in appendix B.

In this guide, straightforward applications are presented first and advanced features follow. You should already be familiar with the Prognosis Model. Terms, operational rules, and concepts explained in the Prognosis Model user's guides (Ferguson and Crookston 1984; Wykoff 1986; Wykoff and others 1982) are used here without explanation.

EVENT MONITOR USE

IF, THEN, and ENDIF

An event is designated by an IF keyword record, followed by a logical expression. The expression is coded on one or more supplemental data records. It may contain constants, arithmetic operators, parentheses, relational and logical operators (greater than (GT), less than (LT), equal (EQ), AND, OR, etc.), and certain variables. Following the logical expression, a THEN keyword record is entered; it signals the end of the logical expression and the beginning of the activities that will be scheduled only when the expression is true. Any Prognosis Model keyword option (including those found in extensions) that can be scheduled by entering a cycle number or year in the first numeric field can be scheduled by the Event Monitor. An ENDIF keyword is entered to signal that normal activity processing should resume.

Waiting time for Activity Scheduling

The value in field 1 of activity keyword records is added to the year the event occurs. The sum becomes the year the activity is scheduled. Therefore, the value in field 1 is called the waiting time when the activity keyword is used in the context of an Event Monitor rule.

Illustrate IF, THEN, and ENDIF

Assume the following policy: If before-thinning crown competition factor (BCCF) is greater than 150, and before-thinning trees per acre (BTPA) is greater than 500, and age is greater than 20 and less than 60, then thin from below to a residual stand density of 300 trees per acre. This policy can be simulated with the keywords outlined below:

```
                      Example 1:  Illustrate IF, THEN, and ENDIF
                                  Keyword record

Reference
  line      Keyword   Field 1  Field 2  Field 3  Field 4  Field 5  Field 6  Field 7

     1      STDIDENT
     2      EXAMPLE1                     Illustrate IF, THEN, and ENDIF
     3      INVYEAR    1990.
     4      NUMCYCLE      7.
     5      IF
     6      BCCF GT 150 AND BTPA GT 500 AND AGE &
     7      GT 20 AND AGE LT 60
     8      THEN
     9      THINBTA       0.     300.
    10      ENDIF
    11      STDINFO     118.     590.     30.     135.     50.      56.
    12      PROCESS
    13      STOP
```

The tree data and some of the output created by running this example are in appendix A, further explanation of the input file follows:

Lines 1 and 2: Enter the stand identification and a run title.

Line 3: Specify the inventory year.

Line 4: Specify the number of cycles.

Line 5: IF signals that a logical expression follows.

Lines 6 and 7: The logical expression is coded "free form" (that is, characters need not be placed in specific columns) on one or more supplemental data records that follow the IF keyword. An ampersand at the end of a line signals that the expression is continued on the following record.

Line 8: THEN signals that the activities (options specified by date or cycle) that follow will not be scheduled until after the event happens; that is, when the logical expression is true.

Line 9: THINBTA is a thinning option that will be scheduled in the same year that the event happens; thus, a zero is coded in field 1. The residual trees per acre are coded in field 2.

Line 10: ENDIF marks the end of the conditionally specified options.

Line 11: Enter data specific to the stand such as the forest code.

Line 12: All keywords have been entered; begin processing.

Line 13: Stop the Prognosis Model.

DETAILED INSTRUCTIONS

Basic Keywords

As illustrated above, the IF keyword is used to signal that a logical expression follows. The THEN keyword signals that the activities that follow should be scheduled only when the logical expression is true. Note that several activities may follow a THEN keyword. Scheduling activities that follow the ENDIF keyword does not depend on the logical expression.

IF Signals that the logical expression follows on one or more supplemental data records.

field 1: The minimum waiting time before the event may happen again; default is zero years.

Supplemental data record(s):

Contains a logical expression like the one illustrated in example 1. Use an ampersand (&) to indicate that an expression is continued on the next record. You may use a maximum of 200 characters in an expression. See the section "Coding Expressions" for more instructions.

THEN Signals that the activities that follow will be scheduled when the event happens. Field 1 of this keyword is described later.

ENDIF Activities that follow an ENDIF are scheduled normally.

When Expressions Are Calculated

The Event Monitor evaluates expressions at each of two different times during a growth cycle (fig. 1): once at the beginning of the growth cycle prior to thinnings, and once after thinnings. A logical expression that tests on before-thin density can be used to trigger a thinning during the same cycle. If the logical expression uses a variable that depends on an after-thin density, a thinning cannot be scheduled for the same cycle but it can be scheduled for a later cycle by coding a waiting time longer than the current cycle length in field 1 on the thinning keyword.

Figure 1—The Event Monitor is called at the beginning of each time step and after simulated cutting.

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```
                    ┌─────────────────────────┐
          ┌───────► │  For all stands         │
          │         │                         │
          │         │  Input and initialization│
          │    ┌──► │                         │
          │    │    │  For all time steps     │
          │    │    │                         │
          │    │    │  Call Event Monitor     │
          │    │    │  Simulate Cutting       │
          │    │    │  Call Event Monitor     │
          │    │    │  Predict Growth         │
          │    │    │  Update state variables │
          │    └────│  Add Regeneration       │
          │         │                         │
          │         │  Next time step         │
          │         │                         │
          │         │  Write Reports          │
          └─────────│                         │
                    │  Next stand             │
                    └─────────────────────────┘
```
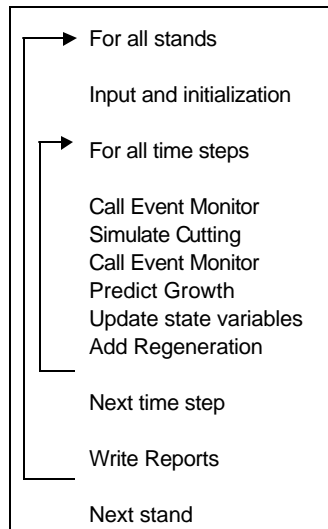
The Regeneration Establishment Model is called near the end of a cycle. Therefore, it is possible to trigger a call to the establishment model as a response to a before-thin or an after-thin density.

You can schedule a thinning in response to detecting that a thinning has occurred. But the conditionally scheduled thinning cannot be simulated during the same cycle the event is detected because the event is, itself, another thinning. You can specify that the conditionally scheduled thinning be scheduled 10 years after the event occurs by coding a waiting time in field 1 of the desired thinning keyword record.   If the cycle length is less than or equal to the waiting time, the conditionally scheduled thinning will be simulated in the following cycle.

When Event Monitor Variables Are Defined

The list of variables that can be used in expressions is in appendix B. The list is divided into four groups based on when the variables are defined. If any variable is undefined when a logical expression is evaluated, the expression is false. Variables listed in group 1 are always known; you can include them in expressions either by themselves or with those listed in the other groups.

Group 2 variables are undefined when the Event Monitor evaluates expressions prior to thinnings. However, they are correctly defined when expressions are evaluated following thinnings, even if no thinnings occur.

Group 3 variables are not defined until after the first Prognosis Model cycle. For example, the stand accretion is computed after the second time the Event Monitor evaluates logical expressions each cycle. Therefore, the stand accretion variable is assigned the accretion from the previous cycle. Variables that measure change, such as DBA (delta basal area, the change in basal area from cycle to cycle), are computed by subtracting the value stored from the previous cycle from the current value. These variables are also undefined until the beginning of the second Prognosis Model cycle. After the second cycle starts, group 3 variables are defined.

Group 4 variables are assigned values by Prognosis Model extensions. The value of these variables remains undefined unless the appropriate extension defines them.

Coding Expressions

Expressions consist of variables (appendix B), constants, parentheses, arithmetic operators, and logical operators in logical expressions. All of the permissible operators are listed in appendix C. When coding expressions, follow these rules:

- A parenthesis or blank must precede and follow logical operators: AGE GT 25 is valid, AGE GT(25) is valid, AGE GT25 is **invalid.**

- A parenthesis, constant, or variable must separate two arithmetic operators: AGE*-2.5 is **invalid,** AGE*(-2.5) and -2.5*AGE are valid.

- Operators are executed in order of precedence given in appendix C, or parentheses may be used to control the precedence of evaluation.

- When equally ranked operations are found, evaluation proceeds from left to right.

- Constants are treated as floating point numbers whether or not a decimal point is coded. For example, 300 is converted to 300.0.

- Arguments to functions found in appendix C are considered expressions. An argument to a function may reference any function including the original function. That is, DECADE(TIME(A,B,C),D/E,ALOG(4*ALOG(F))) is valid if variables A through F are appropriately defined.

- An ampersand (&) signals that expressions are continued on the next line. Any characters that follow the ampersand are output as comments.

- Expressions may contain up to 200 characters. Strings of blanks count as one character; ampersands and characters that follow ampersands do not count.

- The following are **valid** (and equivalent) logical expressions:
  (BTPA*2 GE 1000 OR AGE GT 50.)
  (NOT BTPA LT 500) OR (NOT AGE LE 50.0)
  NOT (BTPA LT 500 AND AGE LE 50)

- The following are **invalid:**
  (ATPA .LT. 500.)—the inclusion of the periods before and after the less-than operator is valid in FORTRAN but **not** in the Event Monitor.
  (NOT (BTPA LT 50)—Unbalanced parentheses.

ADVANCED FEATURES

Since its introduction, the Event Monitor has been enhanced as follows:

1. A COMPUTE option allows you to define variables that can be used in logical expressions, in other COMPUTE options, and as parameters on keyword records.
2. You can code expressions in place of constant parameters on some activity keywords. For example, the residual stand density on thinning keywords can be a function of current stand statistics.
3. You can relate rules to each other by labeling them with the same name. These related rules can be treated like a fully described management policy. Stands are labeled with the name(s) of the management policies that apply to them.
4. You can create decision trees when using the Event Monitor in conjunction with the Parallel Processing Extension (PPE) of the Prognosis Model (Crookston and Stage 1989).

The COMPUTE Keyword

The COMPUTE keyword allows you to define up to 200 variables expressed as functions of Event Monitor variables (appendix B), constants, and variables previously defined using the COMPUTE feature. The COMPUTE option can be scheduled for specific years, and the value of variables may depend on an event.

COMPUTE   Enter one or more expressions that define variables.

field 1:   The date or cycle in which the expression is to be evaluated; default is 1. Enter a 0.0 if you want the expression to be evaluated every cycle.

Supplemental data record(s):

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Contains expressions such as: NORMAL = 25000*(BADBH+1)** (–1.588). Names that appear on the left-hand side of the equal sign may not be longer than eight characters and may not be names found in appendix C. Variable names found on the right-hand side of an equal sign must be previously defined using the COMPUTE option or be variables found in appendixes B or C. Use an ampersand (&) to indicate that an expression is continued on the next record. Code subsequent expressions on subsequent supplemental data records and enter an END keyword after the last expression is entered. Use up to 200 characters for each expression.

The following keyword segment illustrates how to use the COMPUTE option. Note that this keyword segment does not define a complete run.

Example 2: Using the COMPUTE feature to define two variables							
Keyword record							
Reference line	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6 Field 7
1	COMPUTE 0.0						
2	NORMAL = 25000*(BADBH+1)**(-1.588)						
3	PROPCUT = NORMAL/BTPA						
4	END						

Line 1: The COMPUTE keyword has a 0.0 in field 1 indicating that the variables (NORMAL in line 2, and PROPCUT in line 3) should be calculated every cycle.

Line 2: Compute the NORMAL stocking in trees per acre using an equation based on Haigs (1932) yield tables for western white pine type (see Wykoff and others 1982, page 71). The variable BADBH is the average before-thinning diam-eter at breast height (see group 1 in appendix B).

Line 3: Compute PROPCUT, the proportion of the current trees per acre that need to be cut to reach NORMAL stocking.

Line 4: Signal the end of COMPUTE processing.

Coding Expressions on Activity Keywords

You may code expressions in place of constant parameters on many activity key-word records. This is possible for all of the thinning keywords, all of the growth rate multiplier keywords, the top-killing keywords, the FIXMORT keyword, and the defect keywords MCDEFECT and BFDEFECT. If a keyword is not an activity keyword, this feature may not be used (there are two exceptions, THEN and ALSOTRY, discussed in the PPE user's guide, Crookston and Stage 1989).

To code an expression on an activity keyword record, do the following:

1. Code the keyword in the first eight columns and the date/cycle in field 1 of the keyword record as done when this feature is not used.

2.   For the other parameters, code

$$\textbf{PARMS}\ (arg_1, arg_2, ..., arg_n)$$

starting between columns 21 and 30 of the keyword record. Each "arg_n" is an ex-pression using constants, variables found in appendix B, and any of the functions and operators from appendix C except the logical operators. Use an ampersand (&) to continue on to the following record.

3. Ensure that parameter values are within legal limits. For example, say that arg, is the cutting efficiency used on a thinning keyword. You must take care to insure that the value of the expression coded as arg_3 is bounded by 0.0 and 1.0, legal range for the cutting efficiency parameter. When PARMS is not used, the Prognosis Model ensures that the values are within legal limits.

4. Supply all of the parameters used by the activity keyword. When the PARMS feature is **not** used, default values are supplied when a keyword field is left blank.

5. Use variables that are defined when the activity is accomplished by the Prognosis Model.   If the PARMS function references a variable that is not defined when the activity is called for by the model, the activity is CANCELED. For example, if a group 2 variable is used to define the residual density for a thinning activity, the function will be undefined when the thinning is scheduled and the thinning will be canceled.

6. Use variables defined via COMPUTE if you wish.

7. Use the PARMS feature on activities that are conditionally scheduled or

scheduled for a specific date or cycle.

Study the following examples of using the PARMS feature.

Reference line	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
	Example 3: Using the PARMS feature on thinning keywords							
	Keyword record							
1	THINDBH	1990.	PARMS (10.,999.,1.0,0.,0.,0.,0.)					
2	THINDBH	1990.	10.					
3	THINBTA	1990.	PARMS (BTPA-SPMCDBH(1,0,3),1.,0.,999.,0.,999.)					
4	IF							
5	PROPCUT LT 1.0							
6	THEN							
7	THINDBH	0.	PARMS (0.,999.,PROPCUT,0.,0.,0.,0.)					
8	ENDIF							

Lines 1 to 2: These two THINDBH keywords are equivalent; both request that all trees between 10 and 999 inches d.b.h. be cut (fields 2 and 3), that the cutting efficiency be 1.0 (field 4), that all species be cut (field 5), and that the residual trees per acre and basal area per acre within the cut diameter class be zero (fields 6 and 7). Note that only the lower diameter is specified in the second keyword; defaults are supplied by the Prognosis Model for other fields.

Line 3: The residual stand density for a thin from below to a trees-per-acre value (THINBTA) is computed using the Event Monitor variable BTPA, before-thinning trees per acre, and the SPMCDBH function (described in appendix C). The residual trees per acre is the difference between the total number of trees and the number of trees that carry tree-value class code 3 (IMC=3).

The sequence that follows (lines 4 to 8) result in cutting every cycle such that a normal stocking curve is followed.

Lines 4 to 5: If the proportion of trees—PROPCUT as defined using the COMPUTE keywords described in example 2—is less than 1.0, then schedule a thinning option.

Line 7: Use the THINDBH option to actually do the thinning. The PROPCUT is entered as the cutting efficiency. Other arguments specify all of the trees in the diameter range and all species.

Line 8: End the activity group.

These keyword segments do not define complete runs.

Policy Labeling: AGPLABEL

A condition described with a logical expression combined with a set of activities is considered a rule of stand management. One or more rules may be used to define a stand management policy. You can label rules in the Event Monitor. Two or more rules can be related to one stand management policy by labeling them with the same label. For example, say you have a rule for precommercial thinning, another for commercial thinning, and another for final harvest. You may give this management policy a name such as *intensive* and relate the three rules to each other by labeling each of them *intensive.*

Additionally, suppose that the commercial thinning and final harvest rules are appropriate for another stand management policy called *extensive.* By labeling these two rules with both *intensive* and *extensive* labels, two different stand management policies are defined.

A stand can be labeled with the name of the appropriate stand management policy. For example, if a stand is labeled *intensive,* then the only stand management rules that apply to the stand are those labeled *intensive.* By alternately labeling a stand *intensive* for one run of the Prognosis Model and *extensive* for another run, the yields for both management policies may be conveniently simulated. Further-

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more, a stand may be labeled with a list of several stand management policies.

Let's say you have described two regeneration systems and labeled one *clear- cutting* and the other *shelterwood.* For a run of the Prognosis Model, you could predict the yield derived from running a combined stand management policy by labeling the stand with two labels, *intensive* and *shelterwood,* for example.

Rules are labeled using an *A*ctivity *G*roup *P*olicy *L*abel keyword called AGPLABEL. The label is called an activity group label set because more than one name may be associated with the activity group. A *S*tand *P*olicy *L*abel **set** is a list of policies that apply to the stand and it is entered using the SPLABEL keyword. **An activity group will not be scheduled if its label set and the stand's label set do not contain a common member.**

If more than one SPLABEL set is specified for a stand, or if more than one AGPLABEL set is specified for a single activity group, the sets specified last will be used and the others will be ignored. If no SPLABEL set is specified, the default stand policy label set is the union over all of the activity group policy label sets. The SPLABEL set is assigned to activity groups where no AGPLABEL is defined. If no SPLABEL and no AGPLABEL keywords are used in the run, then none of the logic associated with the labeling scheme is used by the model.

The keyword formats are:

AGPLABEL Enter the policy labels applicable to a specific activity group on supplemental data records that follow this keyword. The keyword must follow the THEN keyword to which it applies and be entered before the ENDIF keyword (another case is described below under the ALSOTRY keyword).

Supplemental data record(s)

Each label must be separated by one comma and the total number of characters for all policies may not exceed 100 including commas. Use an ampersand (&) to indicate that the list is continued on the next record. Sequences of more than one blank are converted to one blank and lower-case letters are converted to upper-case letters. Any character may be used as part of the label except commas, periods, and ampersands.

SPLABEL Enter the policy labels applicable to a specific stand on supplemental data records that follow this keyword. See AGPLABEL for a description of how to code the supplemental data record.

Policy labeling is most useful when using the PPE (Crookston and Stage 1989). Documentation of the PPE contains a complete description and examples of how the Event Monitor processes the label sets.

The ALSOTRY Keyword

In the PPE, ALSOTRY signals that an alternative activity group should be scheduled for the stand. When the logical expression is true, the PPE makes a duplicate copy of the stand's state-variables called a replicate. The growth of a stand replicate is simulated as if it were another unique stand in the PPE. For the original stand, the activity group that follows the THEN keyword is scheduled, and for the replicate, the activity group that follows the ALSOTRY keyword is scheduled. If additional ALSOTRY keywords are specified, additional replicates are created.

ALSOTRY can be used to define alternative policies even when not using the PPE. For example, say that both *intensive* and *extensive* management policies call for a commercial thinning when density is too high. But the *intensive* stand management policy also calls for fertilization (Stage and others 1990). In this simple example, one logical expression is used to define high density. The first activity group follows the THEN keyword, contains the thinning and fertilization activi-

ties, and is labeled *intensive.* The second activity group follows the ALSOTRY keyword, contains only the thinning activity, and is labeled *extensive.* The ENDIF keyword follows the second activity group.   If the SPLABEL is extensive and the event occurs, the activities associated with the ***extensive*** policy will be simulated and the ***intensive*** activities will be ignored.

Note that ALSOTRY keywords can be used without using the PPE, and there will be no errors as long as stand duplication is not required to simulate the run. Stand duplication is not necessary if activity group label sets are nonoverlapping and the stand label set contains only one label that is also in an activity group label.

ALSOTRY   Signals that an alternative group of activities should be scheduled when the event occurs. Field 1 is used by the PPE.

Example 4 illustrates an application using APGLABEL, SPLABEL, and ALSOTRY keywords by expanding on example 1.

	Example 4: Illustrate AGPLABEL, SPLABEL, and ALSOTRY Keyword record						
Reference line	Keyword Field 1 Field 2 Field 3 Field 4 Field 5 Field 6 Field 7						
1	STANDID						
2	EXAMPLE4 Illustrate AGPLABEL, SPLABEL, and ALSOTRY						
3	INVYEAR 1190.						
4	NUMCYCLE 10.						
5	IF						
6	BCCF GT 150 AND BTPA GT 500 AND AGE &						
7	GT 20 AND AGE LT 60						
8	THEN						
9	THINBTA 0. 300.						
10	FERTILIZ 1.						
11	AGPLABEL						
12	intensive						
13	ALSOTRY						
14	THINBTA 0. 300.						
15	AGPLABEL						
16	extensive						
17	ENDIF						
18	STDINFO 118. 710. 30. 135. 50. 56.						
19	SPLABEL						
20	intensive						
21	PROCESS						
22	STOP						

Lines 1 and 2: Enter the stand identification and a run title.

Lines 3 and 4: Specify the inventory year and number of cycles.

Line 5 through 7: Specify the event using the same logic used in example 1.

Line 8: THEN signals that the first activity group follows.

Lines 9 and 10: The THINBTA and FERTILIZ (Stage and others 1990) are two activities that form the first activity group.

Lines 11 and 12: AGPLABEL signals that the activity group policy label set follows on the next record. The label set is *intensive.*

Line 13: ALSOTRY signals that the second activity group follows.

Line 14: The THINBTA activity is the only activity in the second group.

Lines 15 and 16: AGPLABEL signals that the activity group policy label set, *extensive* in this case, follows on the next record.

Line 17: ENDIF marks the end of the conditionally specified options.

Line 18: Enter data specific to the stand such as the forest code.

Lines 19 and 20: SPLABEL signals that the stand policy label set follows. In this example, *intensive* is entered. For a different run of the Prognosis Model *extensive* might be desired. If the PPE was being used both *intensive* and *extensive* could
be entered and the PPE would simulate both policies as alternatives.

Line 21: Signals that all of the keywords have been entered and that the stand should be processed.

Line 22: Stop the Prognosis Model.

SUMMARY

Since publication in 1985, the Event Monitor has become popular with Prognosis Model users. The success of the initial system and the need for new features led to the development of this version. The enhanced system is upwardly com-patible with the original system, except for the exclusion of a few variables as described in appendix C. Some of the new components are most useful when
the PPE is being used.

New features include additional arithmetic functions and stand-state variables that can be used in expressions. A new COMPUTE keyword allows you to define additional stand-state variables as a function of other stand-state variables. The additional variables can be used in other expressions. The new PARMS feature allows parameters to be defined as expressions on activity keyword records.
A stand management rule is defined to be a logical expression and the accompanying activity group. Other new keywords, AGPLABEL and SPLABEL, allow stand management rules and stands to be labeled and related to each other. One
or more rules are called a stand management policy.

Using this system, stand management policies may be evaluated without users foretelling the development of stands in an analysis and manually scheduling activities. If the policy statements are defined by experts so that they apply to the management of many stands, the system will output suggested management schedules that reflect the policies of these experts for each stand. The rules that define these policies can be shared between users.

This user's guide replaces General Technical Report INT-196 (Crookston 1985).

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APPENDIX A: OUTPUT FROM EXAMPLE 1

The tree data file used in running example 1 is listed below. The data on each record are arranged according to the default tree data format for Version 6 of the Prognosis Model. Part of the output created by running the example is listed on the following two pages. This output was generated using the Inland Empire version 6.00 with Regeneration Establishment Model version 2.0.

```
                 Column Rule
....+....1....+....2....+....3....+....4....+....


101001    11LP  115 10 73  0    04 0 0 0 0 0 011
101002    11DF   80  0  0  0    06 0 0 0 0 0 022
102003    21DF   65 23 30  0    08 0 0 0 0 0 01
102004    11L    79  6 75  0    03 0 0 0 0 0 011
102005    1EL   346  0  0  0  0010 0 0 0 0 0 032
103006    11L    80  7 63 56  0397 0 0 0 0 0 022
103007    11GF   62 20 38  0    05 0 0 0 0 0 011
103008    11L    84  0  5  0    04 0 0 0 0 0 011
103009    21LP   95 11 60  0    03 0 0 0 0 0 011
104010    11DF  100 10 70  0    00 0 0 0 0 0 011
104011    11L    82 12 65  0  0550 0 0 0 0 0 011
105012    11DF   12  0 11  0  426 0 0 0 0 0 022
105013    11DF   19  0 13  0  475 0 0 0 0 0 022
105014    18LP   72  0  0  0  0011 0 0 0 0 0 032
105015    51GF    1  0  3  0    07 0 0 0 0 0 022
105016    11GF   50  9 30  0    07 0 0 0 0 0 011
106017    11DF  100 10 65  0    04 0 0 0 0 0 011
106018    11DF   61 12 35  0    08 0 0 0 0 0 011
106019    11DF  127 16 67  0    04 0 0 0 0 0 011
107020    00      0  0  0  0    00 0 0 0 0 0 080
108021    21LP   96  5 60  0    03 0 0 0 0 0 022
108022    11DF  104  9 55 49  0596 0 0 0 0 0 022
108023    21LP   85  0  0  0    03 0 0 0 0 0 011
109024    11GF  109 10 65  0    07 0 0 0 0 0 011
109024    11GF  109 10 65  0    07 0 0 0 0 0 011
109025    11DF   94 18 60  0    04 0 0 0 0 0 011
110026    21DF   32  6 17  0  325 0 0 0 0 0 022
110027    41DF    1  0  0  0    07 0 0 0 0 0 022
110028    1Ldf   58 10 28  0    07 0 0 0 0 0 011
110029    21DF   50 10 25  0  373 0 0 0 0 0 011
111030    11GF   66 14 30  0    07 0 0 0 0 0 011
```

OPTIONS SELECTED BY INPUT

KEYWORD   PARAMETERS:
-------   ---

STDIDENT
          STAND ID= EXAMPLE1   Illustrate IF, THEN, and ENDIF

INVYEAR   INVENTORY YEAR= 1990

NUMCYCLE NUMBER OF CYCLES= 7

IF   MINIMUM DELAY TIME BETWEEN RESPONSES TO THE EVENT =   1

          BCCF GT 150 AND BTPA GT 500 AND AGE &
          GT 20 AND AGE LT 60

THEN   ACTIVITIES WHICH FOLLOW WILL NOT BE SCHEDULED UNTIL THE EVENT HAPPENS (WHEN THE LOGICAL EXPRESSION IS TRUE).

THINBTA   DATE/CYCLE=   0; RESIDUAL= 300.00; PROPORTION OF SELECTED TREES REMOVED= 1.000
          DBH OF REMOVED TREES WILL RANGE FROM   .0 TO 999.0 INCHES, AND
          HEIGHT OF REMOVED TREES WILL RANGE FROM   .0 TO 999.0 FEET.

ENDIF   ACTIVITIES WHICH FOLLOW WILL BE SCHEDULED.

STDINFO   FOREST-LOCATION CODE=   118; HABITAT TYPE=590; AGE=   30; ASPECT AZIMUTH IN DEGREES= 135.; SLOPE= 50.%
          ELEVATION(100'S FEET)=56.0; LATITUDE IN DEGREES= 45.
          HABITAT TYPE MAPPED TO 510 FOR THIS PROJECTION.

PROCESS   PROCESS THE STAND.

OPTIONS SELECTED BY DEFAULT

TREEFMT   (I4,T1,I7,F6.0,I1,A3,F4.1,F3.1,2F3.0,F4.1,I1,3(I2,I2),2I1,I2,2I3,2I1)

DESIGN   BASAL AREA FACTOR= 40.0; INVERSE OF FIXED PLOT AREA= 300.0; BREAK DBH=   5.0
          NUMBER OF PLOTS=   11; NON-STOCKABLE PLOTS=   1; STAND SAMPLING WEIGHT= 11.00000
          STAND ATTRIBUTES ARE CALCULATED PER ACRE OF STOCKABLE AREA. STAND STATISTICS
          IN SUMMARY TABLE ARE MULTIPLIED BY .909 TO INCLUDE TOTAL STAND AREA.

ACTIVITY SCHEDULE

STAND ID= EXAMPLE1   MANAGEMENT ID= NONE   Illustrate IF, THEN, and ENDIF

CYCLE DATE EXTENSION KEYWORD   DATE PARAMETERS:
----- ---- --------- -------- ---- --

  1   1990
  2   2000
  3   2010
  4   2020
  5   2030
  6   2040
  7   2050

CALIBRATION STATISTICS:

	LP	DF	L	GF
	----	----	----	----
NUMBER OF RECORDS PER SPECIES	4	14	4	5
NUMBER OF RECORDS WITH MISSING HEIGHTS	1	2	0	0
NUMBER OF RECORDS WITH BROKEN OR DEAD TOPS	0	1	1	0
NUMBER OF RECORDS WITH MISSING CROWN RATIOS	0	1	0	0
NUMBER OF RECORDS AVAILABLE FOR SCALING THE DIAMETER INCREMENT MODEL	3	9	3	4
RATIO OF STANDARD ERRORS (INPUT DBH GROWTH DATA : MODEL)	1.00	.66	1.00	1.00
WEIGHT GIVEN TO THE INPUT GROWTH DATA WHEN DBH GROWTH MODEL SCALE FACTORS WERE COMPUTED	.00	.77	.00	.00
INITIAL SCALE FACTORS FOR THE DBH INCREMENT MODEL	1.00	.85	1.00	1.00
NUMBER OF RECORDS AVAILABLE FOR SCALING THE SMALL TREE HEIGHT INCREMENT MODEL	0	4	0	0
INITIAL SCALE FACTORS FOR THE SMALL TREE HEIGHT INCREMENT MODEL	1.00	1.00	1.00	1.00

STAND ID: EXAMPLE1   MANAGEMENT CODE: NONE   Illustrate IF, THEN, and ENDIF

STAND COMPOSITION (BASED ON STOCKABLE AREA)

		PERCENTILE POINTS IN THE DISTRIBUTION OF STAND ATTRIBUTES BY DBH						TOTAL/ACRE OF STAND		DISTRIBUTION OF STAND ATTRIBUTES BY SPECIES AND 3 USER-DEFINED SUBCLASSES			
YEAR	STAND ATTRIBUTES	10	30	50	70	90	100	ATTRIBUTES				
				(DBH IN INCHES)								
1990	TREES	.1	.1	3.2	6.2	9.4	12.7	745 TREES	35.% DF2,	22.% DF1,	20.% GF2,	10.% GF1
	VOLUME:											
	PULPW	5.8	8.0	9.4	9.6	11.5	12.7	2267. CUFT	31.% DF1,	28.% LP1,	12.% GF1,	11.% LP2
	SAWLG	8.0	9.4	9.6	10.0	11.5	12.7	1621. CUFT	36.% LP1,	23.% DF1,	14.% LP2,	10.% L1
	SAWLG	8.0	9.4	9.6	10.0	11.5	12.7	6403. BDFT	35.% LP1,	22.% DF1,	14.% LP2,	12.% L1
	ACCRETION	5.0	6.5	8.0	9.5	10.9	12.7	115. CUFT/YR	37.% DF1,	27.% GF1,	13.% LP1,	11.% L1
	MORTALITY	5.0	8.2	9.4	9.6	10.9	12.7	24. CUFT/YR	37.% LP1,	23.% DF1,	14.% LP2,	11.% L1
2000	TREES	.4	2.4	5.9	8.7	10.4	15.7	561. TREES	32.% DF2,	26.% DF1,	14.% GF2,	12.% GF1
	VOLUME:											
	PULPW	7.2	9.2	10.0	11.0	13.3	15.7	3177. CUFT	34.% DF1,	22.% LP1,	18.% GF1,	10.% DF2
	SAWLG	8.2	9.4	10.3	11.3	13.3	15.72	2664. CUFT	32.% DF1,	24.% LP1,	17.% GF1,	9.% LP2
	SAWLG	8.5	9.4	10.3	11.2	13.3	15.7	10703. BDFT	29.% DF1,	26.% LP1,	17.% GF1,	10.% LP2
	REMOVAL	.3	.5	.5	2.4	4.9	10.0	261. TREES	65.% DF2,	31.% GF2,	4.% L2,	1.% LP2
	VOLUME:											
	PULPW	4.1	4.9	9.4	9.4	10.0	10.0	203. CUFT	72.% DF2,	16.% L2,	12.% LP2,	0.% GF2
	SAWLG	8.7	9.4	9.4	9.4	10.0	10.0	126. CUFT	60.% DF2,	22.% L2,	18.% LP2,	0.% ---
	SAWLG	8.7	9.4	9.4	9.4	10.0	10.0	471. BDFT	57.% DF2,	23.% L2,	20.% LP2,	0.% ---
	RESIDUAL	5.8	7.2	8.7	9.9	11.2	15.7	300. TREES	49.% DF1,	22.% GF1,	12.% LP1,	10.% L1
	ACCRETION	6.8	8.5	9.4	10.7	13.3	15.7	128. CUFT/YR	39.% DF1,	37.% GF1,	10.% LP1,	6.% L1
	MORTALITY	7.2	9.2	10.0	12.4	12.4	15.7	33. CUFT/YR	36.% LP1,	27.% DF1,	12.% L1,	12.% LP2
2010	TREES	.3	7.0	9.3	10.7	12.8	20.2	341 TREES	47.% DF1,	26.% GF1,	9.% L1,	9.% LP1
	VOLUME:											
	PULPW	8.6	10.6	11.4	12.8	15.3	20.2	3930. CUFT	38.% DF1,	26.% GF1,	18.% LP1,	7.% L1
	SAWLG	9.2	10.6	11.6	13.1	15.3	20.2	3616. CUFT	36.% DF1,	26.% GF1,	18.% LP1,	7.% L1
	SAWLG	9.4	10.7	11.7	13.1	15.5	20.2	15131. BDFT	34.% DF1,	27.% GF1,	19.% LP1,	8.% L1
	ACCRETION	9.0	10.6	11.7	13.1	15.5	20.2	147. CUFT/YR	45.% GF1,	36.% DF1,	7.% LP1,	5.% L1
	MORTALITY	8.5	9.9	10.9	11.9	14.0	20.2	44. CUFT/YR	31.% DF1,	29.% LP1,	16.% GF1,	11.% L1

(The rest of the Stand Composition table and the Stand Attribute table are not listed.)

SUMMARY STATISTICS (PER ACRE OR STAND BASED ON TOTAL STAND AREA)

		START OF SIMULATION PERIOD								REMOVALS				AFTER TREATMENT					GROWTH THIS PERIOD			MAI
		NO OF			TOP		MERCH	SAWLG	SAWLG	NO OF	MERCH	SAWLG	SAWLG				TOP	RES	PERIOD	ACCRE	MORT	MERCH
YEAR	AGE	TREES	BA	SDI	HT	QMD	CU FT	CU FT	BD FT	TREES	CU FT	CU FT	BD FT	BA	SDI	CCF	HT	QMD	YEARS	PER	YEAR	CU FT
1990	30	677	102	241	128	65	5.3	2061	1473	5821	0	0	0	0	102	241	128	65	5.3	10	104	22	49.1
2000	40	510	132	281	161	72	6.9	2888	2422	9730	238	184	115	428	119	227	142	72	8.9	10	117	30	60.5
2010	50	310	144	272	163	74	9.2	3573	3288	11755	0	0	0	0	144	272	163	74	9.2	10	134	40	68.1
2020	60	310	165	303	178	80	9.9	4507	4226	18877	0	0	0	0	165	303	178	80	9.9	10	140	52	72.3
2030	70	233	120	303	186	86	11.9	5387	5162	24291	0	0	0	0	180	308	186	86	11.9	10	164	64	75.4
2040	80	234	194	327	192	92	12.3	6392	6174	30705	0	0	0	0	194	327	192	92	12.3	10	163	71	78.6
2050	90	174	204	321	196	100	14.6	7317	7102	36446	0	0	0	0	204	321	196	100	14.6	10	161	80	80.2
2060	100	167	210	326	196	106	15.2	8126	7914	41508	0	0	0	0	210	326	196	106	15.2	0	0	0	80.3

ACTIVITY SUMMARY

STAND ID= EXAMPLE1   MANAGEMENT ID= NONE   Illustrate IF, THEN, and ENDIF

CYCLE	DATE	EXTENSION	KEYWORD	DATE	ACTIVITY DISPOSITION	PARAMETERS:					
1	1990										
2	2000										
		BASE	THINBTA	2000	DONE IN 2000	300.00	1.00	.00	999.00	.00	999.00
		ESTAB	TALLY	2009	DONE IN 2009	2000.00					
3	2010										
		ESTAB	TALLY	2019	DONE IN 2019	2000.00	2.00				
4	2020										
5	2030										
6	2040										
7	2050										

APPENDIX B: EVENT MONITOR VARIABLES

   Variables that can be used within expressions are divided into four groups depending on when they are defined.

Group 1: Always Defined

AGE	Age at beginning of a cycle
ASPECT	Aspect in degrees from STDINFO keyword
BADBH	Before-thin quadratic mean d.b.h.
BBA	Before-thin basal area per acre
BBDFT	Before-thin Scribner board foot volume
BCANCOV	Before-thin percent canopy cover for the stand defined when the STRCLASS keyword is used
BCCF[1]	Before-thin crown competition factor
BCCFSP	Before-thin crown competition by species. This "variable" is actually a function (appendix C).
BMCUFT	Before-thin merchantable cubic foot volume
BSCLASS	Before-thin structural class code defined when the STRCLASS keyword is used
BSDI	Before-thin stand density index
BSDIMAX	Before-thin maximum stand density index
BSTRDBH	Before-thin weighted average d.b.h. of the uppermost stratum defined when the STRCLASS keyword is used
BTCUFT	Before-thin total cubic foot volume
BTOPHT	Before-thin average top height
BTPA	Before-thin trees per acre
CENDYEAR	Ending year of a cycle (same as the beginning year of the following cycle, minus 1)
CYCLE	Cycle number
DBHDIST	Diameters at each of six nominal percentile points in the distribution of each of 11 different attributes. This "variable" is actually a function (appendix C).
ELEV	Elevation in feet from STDINFO keyword
EVPHASE	1.0 during the first call to the Event Monitor (before cutting, see fig. 1) and 2.0 after cutting
HABTYPE	Habitat type code from STDINFO keyword
INVYEAR	The inventory year of the stand
LAT	Latitude in degrees from STDINFO or LOCATE keyword
LONG	Longitude in degrees from STDINFO keyword

---

[1]   Several Event Monitor variables that measure species contribution to total CCF have been removed. The function BCCFSP (see appendix C) replaces BCCFn (where n is a species number 1,2,. . ., 11), BCCFWP, BCCFL, BCCFDF, BCCFGF, BCCFWH, BCCFC, BCCFLP, BCCFS, BCCFAF, BCCFPP, and BCCFOTH. The function ACCFSP (see appendix C) replaces ACCFn (where n is a species number 1,2, . . .,   11), ACCFWP, ACCFL, ACCFDF, ACCFGF, ACCFWH, ACCFC, ACCFLP, ACCFS, ACCFAF, ACCFPP, and ACCFOTH.

NO	The constant 0
NUMTREES	Number of tree records stored by the model
RANN	A uniform random number between 0 and 1
SAMPWT	Sampling weight entered on the DESIGN keyword
SITE	Stand site index entered on the SITECODE keyword
SLOPE	Slope percent from STDINFO keyword
SMR	Stand mistletoe rating computed when the variant you are using contains a mistletoe model
SPMCDBH	Total trees per acre, basal area, cubic foot volume, board foot volume, mean diameter, average height, percent cover by species, average dwarf mistletoe rating, average diameter growth, or SDI for a specified tree value class, tree status, diameter range, and height range for live, recent mortality or harvested trees. This "variable" is actually a function (appendix C).
SUMSTAT	Elements of the Summary Statistics table are available. This "variable" is actually a function (see appendix C).
UTMEW	UTM easting coordinate from LOCATE keyword
UTMNAD	UTM North American Datum number from LOCATE keyword
UTMNS	UTM northing coordinate from LOCATE keyword
YEAR	Beginning year of a cycle
YES	The constant 1

Group 2: Defined Only After Thinning Each Cycle

AADBH	After-thin quadratic mean d.b.h.
ABA	After-thin basal area per acre
ABDFT	After-thin Scribner board foot volume
ACANCOV	After-thin percent canopy cover for the stand defined when the STRCLASS keyword is used
ACCF[1]	After-thin crown competition factor
ACCFSP	After-thin crown competition by species. This "variable" is actually a function (appendix C).
ATOPHT	After-thin average top height
AMCUFT	After-thin merchantable cubic foot volume
ASCLASS	After-thin structural class code defined when the STRCLASS keyword is used
ASDI	After-thin stand density index
ASDIMAX	After-thin maximum stand density index
ASTRDBH	After-thin weighted average d.b.h. of the uppermost stratum defined when the STRCLASS keyword is used
ATCUFT	After-thin total cubic foot volume
ATPA	After-thin trees per acre
CUT	Set equal to 0.0 if no cutting occurred and equal to 1.0 if cutting did occur
RBDFT	Removed Scribner board foot volume

RMCUFT	Removed merchantable cubic foot volume
RTCUFT	Removed total cubic foot volume
RTPA	Removed trees per acre

Group 3: Defined When Cycle 2 Starts

ACC	Accretion from last cycle, cubic feet/acre/year
DBA	Basal area per acre at the beginning of current cycle minus the basal area at the beginning of previous cycle
DBA%	Basal area per acre at the beginning of current cycle divided by the basal area at the beginning of previous cycle; then multiplied times 100
DCCF	Crown competition factor at the beginning of current cycle minus the factor at the beginning of previous cycle
DCCF%	Crown competition factor at the beginning of current cycle divided by the factor at the beginning of previous cycle; then multiplied times 100
DTPA	Number of trees per acre at the beginning of current cycle minus the number at the beginning of the previous cycle
DTPA%	Trees per acre at the beginning of the current cycle divided by the number at the beginning of the previous cycle; then multiplied times 100
MAI	Mean annual increment last cycle, cubic feet
MORT	Mortality from last cycle, cubic feet/acre/year
PAI	Periodic annual increment last cycle, cubic feet/acre

Group 4: Defined by Extensions to the Prognosis Model

BRCHWT	The branch weighting factor for a given stand (defined by the PPE)
BW%STND	The stand defoliation level caused by the western spruce budworm during the previous cycle
DFTMPROB	Probability of a Douglas-fir tussock moth outbreak in the current stand given that an outbreak is in the region
FIRE	Value is Yes (1.0) when a fire was simulated, and No (0.0) otherwise.
MINSOIL	Percent mineral soil exposed when a fire is simulated.
MPBPROB	Probability of a mountain pine beetle outbreak in the current stand given that an outbreak is in the region
MPBTPAK	The number of trees per acre killed by the mountain pine beetle during the previous cycle
NODES	The number of branch nodes that have been created for the current stand in a PPE run (Crookston and Stage 1989)
PPOTFLEN	Potential flame length that can be expected given nominal prescribed burning conditions.
RDACCESS	Equal to the road access value for this stand. This variable is defined if the RDACCESS data are entered in the PPE (see "Entering Spatial Data", in Crookston and Stage 1989).
STANDWT	The PPE stand weighting factor, see "Stand Weighting Factors"

(in Crookston and Stage 1989).

SELECTED   Takes on the value 1.0 if the stand has been selected for harvest by the PPE's harvest simulation logic (Crookston and Stage 1989). The value is 0.0 if the stand has not been selected.

STARTYR   The master starting year coded using the PPE STARTYR keyword (Crookston and Stage 1989)

TM%DF   The average tree defoliation on Douglas-fir

TM%GF   The average tree defoliation on grand fir

TM%STND   The stand average tree defoliation level caused by the Douglas-fir tussock moth during the previous cycle (Monserud and Crookston 1982)

WPOTFLEN   Potential flame length that can be expected given nominal wildfire conditions.

WSBWPROB   Probability of a western spruce budworm outbreak in the current stand given that an outbreak is in the region

APPENDIX C: FUNCTIONS AND OPERATORS

Table C-I—Functions and operators that can be used in expressions

Operator	Precedence[1]	Description	Example of usage
		Prognosis Model functions	
ACCFSP	1st	See description on page 19	ACCFSP(A)
BCCFSP	1st	See description on page 19	BCCFSP(A)
BOUND	1st	See description on page 19	BOUND(A,B,C)
COARSEWD	1st	See description on page 19	COARSEWD(A,B)
DECADE	1st	See description on page 19	DECADE(A,B,C)
DBHDIST	1st	See description on page 20	DBHDIST(A,B)
LININT	1st	See description on page 20	LININT(X,x_1,x_2,y_1,y_2)
MAXINDEX	1st	See description on page 20	MAXINDEX(A,B,C,...)
MININDEX	1st	See description on page 20	MININDEX(A,B,C,...)
NORMAL	1st	See description on page 20	NORMAL(A,B)
SNAGS	1st	See descpriton on page 21	SNAGS(A,B,C)
SPMCDBH	1st	See description on page 21	SPMCDBH(A,B,C,...,H)
SUMSTAT	1st	See description on page 22	SUMSTAT(A,B)
TIME	1st	See description on page 22	TIME(A,B,C)
		Other functions	
ABS	1st	Absolute value	ABS(A)
ALOG	1st	Natural logarithm (base *e*)	ALOG(A)
ALOG10	1st	Common logarithm (base 10)	ALOG10(A)
EXP	1st	*e* raised to power	EXP(A)
FRAC	1st	Truncate integer part[2]	FRAC(A/B)
INT	1st	Truncate fractional part[3]	INT(A/B)
MAX	1st	Maximum value of arguments	MAX(A,B, . . .)
MIN	1st	Minimum value of arguments	MIN(A,B, . . .)
MOD	1st	Modulus[4]	MOD(A,B)
SQRT	1st	Square root	SQRT(A)
		Trigonometric functions (arguments in radians)	
ARCCOS	1st	Arc cosine	ARCCOS(A)
ARCSIN	1st	Arc sine	ARCSIN(A)
ARCTAN	1st	Arc tangent	ARCTAN(A)
COS	1st	Cosine	COS(A)
SIN	1st	Sine	SIN(A)
TAN	1st	Tangent	TAN(A)
		Arithmetic operators	
**	2nd	Exponentiate	A**B
-	3rd	Change sign	-A
*	4th	Multiply	A*'B
/	4th	Divide	A/B
+	5th	Add	A+B
-	5th	Subtract	A-B
		Logical operators	
EQ	6th	Equal	A EQ B
NE	6th	Not equal	A NE B
LT	6th	Less than	A LE B
GT	6th	Greater than	A GT B
LE	6th	Less than or equal	A LE B
GE	6th	Greater than or equal	A GE B
NOT	7th	Logical not	NOT (A GT B)
AND	8th	Logical and	(A GT B) AND (A LT C)
OR	9th	Logical or [5]	(A GT B) OR (A LT C)

[1]Operators are executed in order of precedence within parenthetical groups. For example consider the following:

ALOG(A)**2.+5/C, the log is taken first, the result is raised to the power of 2, then 5 is divided by C and added to the previ-
ous result.

[2]For example: FRAC(3.4) is equal to 0.4.

[3]For example: INT(3.4) is equal to 3.0.

[4]Returns the remainder after the first argument is divided by the second. For example: MOD(7,2) is equal to 1 .O, MOD(6.2) is equal to zero.

[5]Inclusive OR.

Prognosis Model Function Descriptions

ACCFSP
BCCFSP
Returns the after-thin crown competition factor (**A**CCFSP), or the before-thin crown competition factor (**B**CCFSP) for the species indicated as an argument to the function. Alpha or numeric species codes are used as the argument. If the species is represented by a numeric code, it is specific to the regional variant of the Prognosis Model you are using. For example, in the Inland Empire variant, species 7 is lodgepole pine. BCCFSP(7) is the before-thin crown competition factor for lodgepole in that variant.

BOUND
Return the second argument if it is greater than the first argument and less than the third. If the second argument is less than the first argument, the first argument is returned; and if the sec-ond argument is greater than the third argument the third argument is returned. If the first argument is greater than the third, the function is undefined. Examples:

> the value of BOUND(0.0,0.98,1.0) is 0.98;
> the value of BOUND(0.0,1.9,1.0) is 1.0;
> the value of BOUND(0.0,-28,1.0) is 0.0; and
> the value of BOUND(0.0,0.98,-11) is undefined.

COARSEWD
This function is available only when using the fire extension.

Returns the course woody debris in tons per acre. Only a portion of the total debris is included as indicated by the lower (argument 1) and upper bounds (argument 2). That is, the function includes all the kinds of woody debris within the range of lower to higher bounds.

Argument 1 = The lower bound of the range of kinds of woody debris. The value must be between 1 and the value of argument 2.

Argument 2 = The lower bound of the range of kinds of woody debris. The value must be between argument 1 and 8.

Woody debis types:
1 = Greater than zero, less than or equal to .25 inches.
2 = Greater than .25, less than or equal to 1 inch.
3 = Greater than 1, less than or equal to 3 inches.
4 = Greater than 3, less than or equal to 6 inches.
5 = Greater than 6, less than or equal to 12 inches.
6 = Greater than 12 inches.
7 = Litter (leaf fall and small branches from tree crowns).
8 = Duff = decayed material from the other classes.

DECADE
Returns the argument that corresponds to the decade the run is in. For example, the value of DECADE(15,A/B,C**2.1) will be 15 any time during the first decade of the run, A/B during the second, and C**2.1 during the third and all subsequent decades. Decades are defined as offsets from the inventory year entered on the INVYEAR keyword. If 1988 is the inventory year, the first decade of the run is years 1988 through 1997, the second is years 1998 through 2007, and so on.

DBHDIST   Returns the diameter of the tree corresponding to the nominal percentile in the distribution of a specific attribute.

Argument 1 = attribute

Argument 2 = percentile in the distribution of the attribute

Table C-2 displays the coding scheme used to define arguments for the DHBDIST function. For example, DBHDIST(3,4) returns the d.b.h. of the 70th percentile tree (because the second argument is 4) in the distribution of trees per acre (because the first argument is 3).

Table C-2—Coding scheme used in the DBHDIST function

| | First argument | | Second argument |
| | | | Percentile in distribu- |
Code	Attribute	Code	tion of the attribute
1	Accretion (ft^3/acre/year)	1	10-percentile
2	Mortality (ft^3/acre/year)	2	30-percentile
3	Trees/acre	3	50-percentile
4	Total cubic volume/acre	4	70-percentile
5	Merchantable volume/acre	5	90-percentile
6	Board foot volume/acre	6	100-percentile
7	Removed trees/acre		
8	Removed total cubic volume/acre	7	Total of the attri-
9	Removed merchantable volume/acre		bute is returned
10	Removed board foot volume/acre		rather than the d.b.h.
11	Residual trees/acre		at a percentile

LININT   Returns a linear interpolation between points on a simple Y-over-X graph. The general form is

$$\text{LININT } (\mathbf{X}, x_1, x_{2,...,} x_n, y_1, y_{2,...,} y_n)$$

where $(x_1, y_1),(x_2, y_2),...,(x_n, y_n)$ define points on the graph and $\mathbf{X}$ is some arbitrary value along the X-axis. The function returns the appropriate value along the Y-axis derived from a linear interpolation on the line defined by connecting the points of the graph. Note that x_1 through x_n must be in ascending sequence. If $\mathbf{X}$ is less than or equal to x_1, then LININT returns the value of y_1, and if $\mathbf{X}$ is greater than or equal to x_n, LININT returns the value of y_n.

At least 2 points must be provided, all arguments must be defined, and the total number of arguments must be an odd number. If any of these conditions are violated, the result of LININT is undefined. The maximum number of allowable points depends on the specific use within an expression and may vary by computer installation. In any case, up to 20 points should be permissible.

MAXINDEX   Returns the argument number corresponding to the maximum or
MININDEX   minimum argument value. Examples:

the value of MAXINDEX(0.0,5.2,-1.4) is 2;
the value of MININDEX(0.0,5.2,-1.4) is 3;

NORMAL   Returns a random number from a Normal distribution with a specified mean and standard deviation.

Argument 1 = mean

Argument 2 = standard deviation

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SNAGS   This function is available only when using the fire extension.

Returns the volume or number of snags per acre for a given subset of the snag list. Arguments to the function are:

Argument 1 = Specify a 1 to get the number of snags per acre or a 2 to get the basal area per acre, or 3 to get the total cubic volume per acre.

Argument 2 = Specify the species index to limit the summation to only snags of the specified species. Code a zero for all species.

Argument 3 = Specify a 0 for both hard and soft snags, a 1 for just hard snags, or a 2 for just soft snags.

SPMCDBH   Returns the trees, basal area, total cubic volume,merchantable cubic foot volume, total board foot volume, quadratic mean diameter, average height, percent cover, average mistletoe rating, stand density index, or average diameter growth per acre for a given species, tree-value class, tree status, and range of diameter and height. The first three arguments are required.

Argument 1 = code indicating which measurement is desired, as follows:

                   1 = trees per acre,
                   2 = basal area per acre,
                   3 = total cubic volume/acre, or
                   4 = total board foot volume/acre
                   5 = quadratic mean diameter
                   6 = average height
                   7 = percent cover
                   8 = average dwarf mistletoe rating
                   9 = merchantable cubic foot volume/acre
                   10 = average diameter growth for the cycle
                   11 = stand density index

Argument 2 = alpha or numeric species code where 0 (or All) indicates that the sum over all species is desired. Numeric species codes are variant specific.

Argument 3 = tree-value class (IMC codes 1,2, or 3; see Wykoff and others 1982, p. 16) where 0 indicates that the sum over all tree-value classes is desired.

Arguments 4 and 5 = diameter range for trees included in the sum. The default values are 0.0 and 999.0.

Arguments 6 and 7 = height range for trees included in the sum. The default values are 0.0 and 999.0.

Argument 8 = tree status for trees included in the sum, where 0 indicates live trees, 1 indicates recent mortality trees, and 2 indicates harvested trees. The default value is 0.

Examples: SPMCDBH(1,LP,0) returns the trees per acre that are lodgepole pine; SPMCDBH(2,0,3) returns the basal area/acre that is in IMC class 3; SPMCDBH(3,3,1,10) returns the total cubic volume/ acre that is Douglas-fir, IMC class 1, and in trees greater than 10 inches d.b.h.; SPMCDBH(3,3,1,10,20) is just like the previous example except that the trees must be greater than 10 inches and less than 20 inches d.b.h.; and SPMCDBH(5,0,0,10,999,40,999,1) returns the quadratic

mean diameter of recent mortality trees which are at least 10 inches d.b.h. and at least 40 feet tall.

SUMSTAT   Returns a value from the Summary Statistics Table.

Argument 1 = Summary Statistics Table row (which is the same as the cycle number)

Argument 2 = Summary Statistics Table column. Each column corresponds to a different stand attribute. The following codes are used to retrieve attributes available using SUMSTAT:

1 = year	10 = removed merch bd ft volume
2 = age	11 = basal area/acre after thinnings
3 = trees/acre	12 = ccf after thinnings
4 = total ft³ volume	13 = top height
5 = merch ft³ volume	14 = period length (years)
6 = merch bd ft volume	15 = accretion (ft³/acre/year)
7 = removed trees/acre	16 = mortality (ft³/acre/year)
8 = removed total ft³ volume	17 = stand sampling weight.
9 = removed merch ft³ volume	

If the row number references statistics that have not been computed, the value of SUMSTAT is undefined.

TIME   Returns the first argument if the current year in the simulation is less than the second argument. Returns the third argument if the current year in the simulation is greater or equal to the second argument and less than the fourth, and so on.

For example, consider TIME (3.0,2010,A/B,2030,A*C). For all the years of the simulation prior to 2010, the value of TIME will be 3.0.For the years 2010 to 2029, the value of time will be A/B. For year greater or equal to 2030, the TIME's value will be A*C.

APPENDIX D: KEYWORD SUMMARY

The keywords described in this guide are summarized below. The numbers in parentheses refer to the page number(s) in the text where more information can be found.

AGPLABEL
(8)
 Enter the policy labels for a specific activity group on supplemental data records that follow this keyword. Separate each label with one comma, do not exceed 100 characters, and use an ampersand (&) to continue on the next record.

ALSOTRY
(9)
 Signals that the activities that follow are an alternative group that are scheduled when the event happens.

 field 1: A value that is multiplied by the branch weighting factor when the event occurs; default is 1.0. Applicable when using the PPE.

COMPUTE
(5)
 Enter one or more expressions that define variables.

 field 1: The date or cycle in which the expressions are to be evaluated; default is 1. Enter a 0.0 if you want the expression to be evaluated every cycle.

 Supplemental data record(s) contain expressions such as:
NORMAL = 25000*(BADBH+1)**(-1.588).

ENDIF
(3)
 Activities not included between an IF and an ENDIF are scheduled for the year indicated in field 1.

IF
(3)
 Signals that a logical expression follows on supplemental records.

 field 1: The minimum waiting time before the event may happen again; default is zero years.

 Supplemental data record(s): Enter a logical expression; use an ampersand (&) to indicate that an expression is continued on the next record. Do not exceed 200 characters per expression.

SPLABEL
(8)
 Enter the policy labels applicable to a specific stand on supplemental data records that follow this keyword. See AGPLABEL for a description of how to code the supplemental data record.

THEN
(3)
 Signals that activities will be scheduled following an event.

 field 1: A value that is multiplied by the branch weighting factor when the event occurs; default is 1.0. Applicable only when using the PPE.

   Describes how to use the Event Monitor to dynamically invoke management activities
in the Prognosis Model for Stand Development. The program accepts statements of
conditions--expressed as logical expressions of stand-state variables-to be met and
sets of activities to be simulated when the conditions are met. The combination of a
condition and a set of activities is considered a rule of stand management. Several
rules may be used to define a stand management policies. Replaces General Technical
Report INT-196 (Crookston 1985); retains most features of the Event Monitor, provides
several new features.

INTERMOUNTAIN RESEARCH STATION

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