Root Disease Impact Model Keywords:

Program Execution Control:

ANIN	BBOUT
CARRY	COMMENT
END	OPEN
RRDOUT	RRECHO
RRIN	RRTYPE
SMCOUT	

Inventory Data Entry:

PLREAD	PLOTINF
RRINIT	RRTREIN
SAREA	STREAD
TIMEDEAD	

Management Options:

BORATE	PSTUMP

Other Agent Simulations:

BBCLEAR	BBTYPE1
BBTYPE2	BBTYPE3
BBTYPE4	DNSCALC
WINDTHR	

Modification of Model Assumptions:

INFCOLO	INFKILL
INFSIMS	INFMULT
INOCLIFE	INOCSPAN
RRHOSTS	RRCOMP
RRJUMP	RRMINK
RSEED	SDIRMULT
SPORE	SPREAD
TTDMULT	TDISTN

RDIN

The RDIN keyword is an FVS keyword signifying that the Root Disease Model is to be called. This keyword must appear first in the list of Root Disease Model keywords and all following keywords, up to the associated END keyword, must be Root Disease Model keywords.

There are no fields associated with this keyword.

Example:
RDIN
Root Disease Model Keywords here
.
.
.
COMMENT
any number of comment lines here
.
.
.
END
.
.
.
END

BBCLEAR This keyword is used to deactivate the default bark beetle events. The model will automatically schedule bark beetle events for bark beetle types 1, 3, and 4 using the default values unless BBCLEAR, BBTYPE1, BBTYPE2, BBTYPE3, OR BBTYPE4 are used.

There are no fields associated with this field.

BBOUT This keyword is used to generate a bark beetle output table to be printed to a separate file. An OPEN keyword must be used in conjunction with this keyword to open a file with the same unit number.

Note: The OPEN keyword will be automatically included with the BBOUT keyword if entered using Suppose.

Field 1 File unit number.
Range: [20 to 35]

Fields 2-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	27						

BBTYPE1 This keyword is used to specify a type 1 bark beetle event. A beetle outbreak of type 1 occurs when the density and diameter of trees of a given species exceed user-defined minimums; at this point both root disease infected and uninfected trees in the stand may potentially be killed.

Examples of type 1 bark beetles are mountain pine beetle (*Dendroctonus ponderosae*) on lodgepole pine and western pine beetle (*D. brevicomis*) on ponderosa pine.

Field 1 Earliest date (calendar year or cycle number) than an outbreak can occur.
[Range: 4-digit calendar year or 1 to 40 for cycle number]

Field 2 Tree species number or character code eligible for attack by the bark beetle.
[Range: Number or character code selected from the Variants and Associated Species Table.]

Field 3 Minimum DBH in inches of trees eligible for attack by the bark beetle.
[Range: none]

Field 4 Minimum number of eligible trees/acre necessary for the outbreak to occur; eligible trees must meet the requirements in fields 2 and 3.
[Range: none]

Field 5 Mortality rate applied to all eligible trees if an outbreak occurs.
[Range: 0.0 to 1.0]

Field 6 Number of outbreaks:

0 = multiple outbreaks
1 = 1 outbreak

Field 7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	10	8.0	150.0	0.10	0	

BBTYPE2 This keyword is used to specify a type 2 bark beetle event. A beetle outbreak of type 2 occurs when the number of windfallen trees/acre exceeds a user-defined minimum; at this point both root disease infected and uninfected trees in the stand may potentially be killed.

An example of a type 2 bark beetle is Douglas-fir beetle (*D. pseudotsugae*) on Douglas-fir.

Field 1 Earliest date (calendar year or cycle number) than an outbreak can occur.
[Range: 4-digit calendar year or 1 to 40 for cycle number]

Field 2 Tree species number or character code eligible for attack by the bark beetle.
[Range: Number or character code selected from the Variants and Associated Species Table.]

Field 3 Minimum DBH in inches of trees eligible for attack by the bark beetle.
[Range: none]

Field 4 Minimum number of windthrown trees/acre necessary for the outbreak to occur; eligible trees must meet the requirements in fields 2 and 3.
[Range: none]

Field 5 Mortality rate applied to all eligible trees if an outbreak occurs.
[Range: 0.0 to 1.0]

Field 6 Number of outbreaks:

0 = multiple outbreaks
1 = 1 outbreak

Field 7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	3	0.0	10.0	0.88	0	

BBTYPE3 This keyword is used to specify a type 3 bark beetle event. A beetle outbreak of type 3 occurs when the density of trees of a given species, with a sufficient proportion of their root systems infected, exceeds a user-defined minimum; at this point only trees infected by Annosus root disease may potentially be killed.

An example of a type 3 bark beetle is fir engraver (Scolytus ventralis) on grand fir.

Field 1 Earliest date (calendar year or cycle number) that an outbreak can occur.
[Range: 4-digit calendar year or 1 to 40 for cycle number]

Field 2 Tree species number or character code eligible for attack by the bark beetle.
[Range: Number or character code selected from the Variants and Associated Species Table.]

Field 3 Minimum DBH in inches of trees eligible for attack by the bark beetle.
[Range: none]

Field 4 Minimum number of eligible trees/acre necessary for the outbreak to occur; eligible trees must meet the requirements in fields 2, 3, and 5.
[Range: none]

Field 5 Minimum proportion of roots infected with Annosus root disease needed for a tree to be categorized as an eligible tree.
[Range: 0.0 to 1.0]

Field 6 Number of outbreaks:

0 = multiple outbreaks
1 = 1 outbreak

Field 7 Mortality rate applied to all eligible trees if an outbreak occurs.
[Range: 0.0 to 1.0]

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	4	10.0	10.0	0.30	0	0.88

BBTYPE4	This keyword is used to specify a type 4 bark beetle event. A beetle outbreak of type 4 occurs under the same conditions specified for a type 3 bark beetle event; at this point trees with or without Annosus root disease may potentially be killed (the keyword BBTYPE3 will not cause uninfected trees to be killed). An example of a type 4 bark beetle is mountain pine beetle (*Dendroctonus ponderosae*) on ponderosa pine.
Field 1	Earliest date (calendar year or cycle number) that an outbreak can occur. [Range: 4-digit calendar year or 1 to 40 for cycle number]
Field 2	Tree species number or character code eligible for attack by the bark beetle. [Range: Number or character code selected from the Variants and Associated Species Table.]
	Minimum DBH in inches of trees eligible for attack by the bark beetle. [Range: none]
Field 3	Minimum number of eligible trees/acre necessary for the outbreak to occur; eligible trees must meet the requirements in fields 2, 3, and 5. [Range: none]
Field 4	Minimum proportion of roots infected with Annosus root disease needed for a tree to be categorized as an eligible tree. [Range: 0.0 to 1.0]
Field 5	Number of outbreaks: 0 = multiple outbreaks 1 = 1 outbreak
Field 6	Mortality rate applied to all eligible trees if an outbreak occurs; eligible trees have a proportion of root disease infection larger than that specified in field 5. These are trees of the specified species and size that are inside disease centers and are infected. [Range: 0.0 to 1.0]
Field 7	Col 1-10: Mortality rate applied to all trees that meet the requirements for fields 2 and 3 but are uninfected or have an infection level that is lower than that of field 5. These are trees of the specified species and size that are inside disease centers that have little or no infection [Range: 0.0 to 1.0]
Supplemental Record	This field begins in column 1, and has a width of ten places, including a decimal and 3 decimal places (3F10.3).

Col 11-20: Mortality rate applied to all trees that meet the requirements for fields 2 and 3 but are in the fringe area around the root disease centers. These are uninfected trees in the fringe area.
[Range: 0.0 to 1.0]

This field begins in column 1, and has a width of ten places, including a decimal and 3 decimal places (3F10.3).

Col 21-30: Mortality rate applied to all trees that meet the requirements for fields 2 and 3 but are outside the fringe area around the root disease centers. These are uninfected trees outside the fringe area.
[Range: 0.0 to 1.0]

This field begins in column 1, and has a width of ten places, including a decimal and 3 decimal places (3F10.3).

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	10	4.0	1.0	0.4	0	0.75

Supplemental Record Default Values

Field	Col 1-10	Col 11-20	Col 21-30
All variants	0.3	0.15	0.01

BORATE This keyword is used to simulate the application of borax to stumps (to prevent colonization by spores) after each harvest. This keyword is valid only with Annosus root disease.

Field 1 Date (calendar year or cycle number) to change boraxing parameters.
[Range: 4-digit calendar year or 1 to 40 for cycle number]

Field 2 Proportion of newly cut stumps to receive borax treatment.
[Range: 0.0 to 1.0]

Field 3 Minimum stump diameter for borax treatment.
[Range: none]

Fields 4-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	0.95	12.0				

CARRY This keyword is used to specify the type of carryover model to be simulated.

Field 1 Type of carryover. Valid codes are as follows:

0 = static
1 = dynamic

Field 2 Number of Prognosis growth cycles after harvesting (thinning or clearcutting) that the carryover model will be called.
[Range: none]

Field 3 If field 1 = 0, this is the probability of forming new disease centers. If field 1 = 1, this is the minimum spread rate at root closure.
[Range: 0.0 to 1.0]

Field 4 If field 1 = 0, this is the number of new disease patches which will be formed when the carryover model is invoked.
[Range: 1 to 100]

Fields 5-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	4	1.0/0.0	3			

COMMENT

This keyword is used to enter a comment that will be reproduced in the keyword summary table.

This keyword does not have any associated fields, but does require at least one supplemental record. Comments can be entered in columns 1 to 80 on as many supplemental records as desired. The comment is terminated with an END keyword; anything entered between the COMMENT and END keywords will not affect the operation of the model.

There are no fields associated with this keyword.

DNSCALC

This keyword is used to alter the method by which the outbreak stand density threshold is computed for bark beetle type 1. The default outbreak density threshold is calculated by determining the trees/acre of all trees that exceed a user-defined minimum DBH. A BBTYPE1 keyword must be present in the keyword list if the DNSCALC keyword is used.

Note: If the SDI method is used to calculate the outbreak density threshold, then field 3 of the BBTYPE1 keyword is no longer used for the density calculation, but is still used to determine which trees are subject to beetle attack and subsequent mortality.

Method of calculating the density threshold:

Field 1

0 = trees per acre
1 = Reineke's Stand Density Index (SDI)

Area involved in the density threshold:

Field 2

0 = entire stand
1 = trees outside of root disease patches only

Status of trees involved in the density calculation:

Field 3

0 = living trees only
1 = living trees and standing dead trees that have died in the last two years

Slope of the SDI function (if the SDI method is chosen in field 1).
[Range: -0.5 to –2.5]

Field 4

Not used.

Fields 5-7

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	4	10.0	-1.605			

END This keyword is used to signify the end of a Root Disease Model keyword set or the end of a COMMENT block within a Root Disease Model keyword set as shown in the example below.

Example:
RDIN
Root Disease Model keywords here
.
.
.
COMMENT
any number of comment lines here
.
.
.
END
.
.
.
END

Fields 1-7 Not used.

INFCOLO This keyword is used to change the proportion of the root system which is colonized after death. The spread of root disease is assumed to reach a maximum amount within 5 years of tree death, thus with this keyword the user can alter the proportion of the root system which is colonized at the end of this five year period.

Field 1 Tree species number or character code for which the proportion of the root system colonized is to be changed.
[Range: Number or character code selected from the Variants and Associated Species Table]

If this value is "0" or "ALL", it is assumed that the proportion of root system colonized is to be modified for EACH species in that variant. This requires a supplemental record with the proportion modifications in the following format; eleven values starting in column 1, each with a field width of 5 places including the decimal and 2 decimal places (11F5.2). A value must be entered for each species on the supplemental record; default values are not carried.

Field 2 Maximum proportion of root system colonized after death for that species.
[Range: 0.0 to 1.0]

This value is used only if field 1 contains a number between 1 and 11, inclusive, or a specific species character code.

Field 3 Disease Type:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: The value defaults to 1 or if the RRTYPE keyword comes before INFCOLO in the list of keywords then it will default to what is set by RRTYPE. Suppose will set this field automatically except when Annosus is being run and then it needs to be set to P-Type or S-Type.

Fields 4-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants							

Species Default Values

Code Variant	1	2	3	4	5	6	7	8	9	10	11
BM (Blue Mountains)	0.8	0.95	0.95	0.9	0.9	0.86	0.75	0.95	0.9	0.75	0.86
CI (Central Idaho)											
CR (Central Rockies)											
EC (East Cascades)	0.8	0.95	0.95	0.9	1.0	0.9	0.75	0.95	0.9	0.75	0.86
EM (Eastern Montana)	0.8	0.95	0.95	0.9	0.9	1.0	0.75	0.95	0.9	0.75	0.86
KT (Kookantl)											
NC (Klamath Mtns)											
NI (Northern Idaho)	0.8	0.95	0.95	0.9	0.9	1.0	0.75	0.95	0.9	0.75	0.86
PN (Pacific Northwest Coastal)											
SO (S. Cen. OR/NE CA)	0.8	0.8	0.95	0.9	0.9	0.95	0.75	0.95	0.9	0.75	0.86
TT (Tetons)											
UT (Utah)											
WC (West Cascades)											
WS (Western Sierra Nevada)	0.9	0.8	0.95	0.9	0.95	0.95	0.0	0.50	0.9	0.75	0.0

INFKILL This keyword is used to modify the proportion of the root system that must be infected before tree death occurs.

Field 1 Disease Type:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: The value defaults to 1 or if the RRTYPE keyword comes before INFKILL in the list of keywords then it will default to what is set by RRTYPE. Suppose will set this field automatically except when Annosus is being run and then it needs to be set to P-Type or S-Type.

Field 2 Tree species, number, or character code, for which the proportion of the root system infected at death is to be changed.
[Range: Number or character code selected from the Variants and Associated Species Table on page 2]
(A "0" or "ALL" here indicates all species and requires a supplemental record.)

Note: If this value is "0" or "ALL", it is assumed that the proportion of root system infected at death is to be modified for EACH species in that variant. This requires a supplemental record with the proportion modifications in the following format: eleven values starting in column 1, each with a field width of 5 places including the decimal and 2 decimal places (11F5.2). A value must be entered for each species on the supplemental record; default values are not carried.

Field 3 Proportion of the root system for that species that must be infected before tree death occurs.
[Range: 0.0 to 1.0]

Note: This value is used only if field 2 contains a number between 1 and 11, inclusive, or a specific species character code.

Fields 4-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants							

Species Default Values

Code Variant	1	2	3	4	5	6	7	8	9	10	11
BM (Blue Mountains)	0.6	0.9	0.9	0.8	0.8	1.0	0.5	0.9	0.8	0.5	1.0
CI (Central Idaho)											
CR (Central Rockies)											
EC (East Cascades)	0.6	0.9	0.9	0.8	1.0	0.8	0.5	0.9	0.8	0.5	1.0
EM (Eastern Montana)	0.6	0.9	0.9	0.8	0.8	1.0	0.5	0.9	0.8	0.5	1.0
KT (Kookantl)											
NC (Klamath Mtns)											
NI (Northern Idaho)	0.6	0.9	0.9	0.8	0.8	1.0	0.5	0.9	0.8	0.5	1.0
PN (Pacific Northwest Coastal)											
SO (S. Cen. OR/NE CA)	0.6	0.6	0.9	0.8	0.8	0.9	0.5	0.9	0.8	0.5	1.0
TT (Tetons)											
UT (Utah)											
WC (West Cascades)											
WS (Western Sierra Nevada)	0.75	0.6	0.9	0.8	0.9	0.9	0.0	1.0	0.8	0.5	0.0

INFMULT This keyword is used to change the probabilities of disease transmission given that the vertical projection of the infected and uninfected root systems overlap.

Field 1 Date (calendar year) in which probabilities of infection will be modified.
[Range: must be a 4-digit calendar year, cannot be a cycle number, however, a "0" implies the probabilities will take effect at the beginning of the simulation.

Field 2

Disease Type:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: The value defaults to 1 or if the RRTYPE keyword comes before INFMULT in the list of keywords then it will default to what is set by RRTYPE. Suppose will set this field automatically except when Annosus is being run and then it needs to be set to P-Type or S-Type.

Field 3 Tree species, number, or character code, for which the proportion of the root system infected at death is to be changed.
[Range: Number or character code selected from the Variants and Associated Species Table on page 2]
(A "0" or "ALL" here indicates all species and requires a supplemental record.)

Note: If this value is "0" or "ALL", it is assumed that the proportion of root system infected at death is to be modified for EACH species in that variant. This requires a supplemental record with the proportion modifications in the following format: eleven values starting in column 1, each with a field width of 5 places including the decimal and 2 decimal places (11F5.2). A value must be entered for each species on the supplemental record; default values are not carried.

Field 4 Probability of infection (disease transmission) for that species.
[Range: 0.0 to 1.0]

Note: This value is sued only if field 3 contains a number between 1 and 11, inclusive, or a specific species character code.

Fields 5-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants							

Species Default Values

Code Variant	1	2	3	4	5	6	7	8	9	10	11
BM (Blue Mountains)	0.4	0.4	0.4	0.5	0.5	0.0	0.4	0.4	0.5	0.5	0.0
CI (Central Idaho)											
CR (Central Rockies)											
EC (East Cascades)	0.4	0.4	0.4	0.5	0.0	0.5	0.4	0.4	0.5	0.5	0.0
EM (Eastern Montana)	0.4	0.4	0.4	0.5	0.5	0.0	0.4	0.4	0.5	0.5	0.0
KT (Kookantl)											
NC (Klamath Mtns)											
NI (Northern Idaho)	0.4	0.4	0.4	0.5	0.5	0.0	0.4	0.4	0.5	0.5	0.0
PN (Pacific Northwest Coastal)											
SO (S. Cen. OR/NE CA)	0.4	0.4	0.4	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.0
TT (Tetons)											
UT (Utah)											
WC (West Cascades)											
WS (Western Sierra Nevada)	0.45	0.4	0.4	0.5	0.5	0.5	0.0	0.5	0.5	0.5	0.0

INFSIMS This keyword controls the number of times to simulate the inside-center infection dynamics, and whether to print output table for simulation results. If the output table is requested, an OPEN keyword must be sued in conjunction with this keyword to open a file with the same unit number.

Field 1 Number of times to simulate the inside-center infection dynamics.
[Range: 1 to 50]

Field 2 Output options:

0 = produce no output
1 = produce output

Field 3 File unit number.
[Range: 20 to 35]

Fields 4-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	0	25				

INOCLIFE This keyword is used to change the default rate and patterns of decay of the inoculum in the infected roots of dead stumps and trees. The user can control the rate or root radius decline, the point at which the decline stops, and period of time during which the decline stops.

Note: The rate of decline specified here may be reduced due to the minimum life span of inoculum set by the keyword INOCSPAN.

Field 1 Slope of the relationship between root radius (feet) and rate of decline (feet/year).

Field 2 Intercept of this relationship.

Field 3 Slope of the relationship between dbh (inches) and the root radius at which to stop the decline (feet).

Field 4 Intercept of this relationship.

Field 5 Slope of the relationship between dbh (inches) and the number of years at which to stop the decline at the root radius defined above. The inoculum will disappear after this time has expired.

Field 6 Intercept of this relationship.

Field 7 Disease Type:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: The value defaults to 1 or if the RRTYPE keyword comes before INOCLIFE in the list of keywords then it will default to what is set by RRTYPE. Suppose will set this field automatically except when Annosus is being run and then it needs to be set to P-Type or S-Type.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	.02212	1.2032	.16667	0	2	0	

INOCSPAN This keyword is used to specify the minimum life span of inoculum, in years, for each root disease type.

Note: The minimum life span set here may effect the rate of decline specified by the INOCLIFE keyword.

Field 1 Minimum life span for the P-Type Annosus, in years.
[Range: none]

Field 2 Minimum life span for the S-Type Annosus, in years.
[Range: none]

Field 3 Minimum life span for Armillaria, in years.
[Range: none]

Field 4 Minimum life span for Laminated Root Rot (Phellinus), in years.
[Range: none]

Fields 5-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	0.0	0.0	0.0	0.0			

OPEN This keyword is used to open a file for the RRECHO, SMCOUT, BBOUT, and INFSIMS keywords.

Note: The OPEN keyword will be automatically included with the RRECHO, SMCOUT, BBOUT, and INFSIMS keywords if entered using Suppose.

Field 1 File unit number.
[Range: 20 to 35]

Field 2 Handling of blanks within a record:

0 = spaces are treated as zeroes,
1 = spaces are treated as nulls.

Field 3 File status:

0 = unknown
1 = new,
2 = old,
3 = fresh (if file exists, delete and create new file).

Field 4 File record length.
[Range: 1 to 132]

Fields 5-7 Not used.

Name of the file to be opened, including a pathname if desired, up to 40 characters in length.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	24	0	3	132			

PLOTINF This keyword is used to identify plots that are inside root disease centers, and to specify the proportion of infected trees in each plot.

Field 1 Type of root disease contained in the subplots:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: The value default to 1 or if the RRTYPE keyword comes before PLOTINF in the list of keywords then it will default to what is set by RRTYPE. Suppose will set this field automatically except when Annosus is being run and then it needs to be set to P-Type or S-type.

Fields 2-7 Not used.

Supplemental Record Each supplemental record must contain a diseased subplot number and the proportion of trees in the plot which are infected. The first field contains a 4-digit integer right justified in the first 4 columns of the supplemental record 914).
[Range: 0 to 9999]
The second field contains a real value starting in column 5 with a field width of five places including a decimal and 2 decimal places (F5.2).
[Range: 0.0 to 1.0]
The third field must contain a "-999" in the first 4 columns.

Field Default Values

Field	1	2	3	4	5	6	7
All variants							

PLREAD This keyword is used to specify which subplots within the stand contain root disease when modeling a stand which contains both relatively large, identifiable areas of root disease as well as areas unaffected by root disease. It is only valid when used in conjunction with the RRTREIN keyword; if RRTREIN is present without PLREAD then the stand will be modeled as a single root disease center. This keyword must be entered twice if both S and P types of Annosus root disease are present in the stand.

Field 1 Type or root disease contained in the subplots:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: The value defaults to 1 or if the RRTYPE keyword comes before PLREAD in the list of keywords then it will default to what is set by RRTYPE. Suppose will set this field automatically except when Annosus is being run and then it needs to be set to P-Type or S-Type.

Fields 2-7 Not used.

Each supplemental record must contain a diseased subplot number 9a 4-digit integer right justified in the first 4 columns of each record) ending with a "-999" record.

Field Default Values

Field	1	2	3	4	5	6	7
All variants							

PSTUMP This keyword is used to simulate a stump pushing event in a particular year of the rotation. Stump pushing can only occur once in a scenario.

Field 1 Date (calendar year or cycle number) in which stump pushing is to occur.
[Range: 4-digit calendar year or 0 to 40 for cycle number]

Field 2 Proportion of stumps to be removed.
[Range: 0.0 to 1.0]

Field 3 Minimum stump diameter for stump pushing.
[Range: none]

Fields 4-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	1.0	0.0				

RRCOMP This keyword is used to modify the maximum size of the tree list. Compression will occur whenever the length of the tree list is about to exceed the user-defined maximum or automatically at the default size.

Field 1 Number of records to which the tree list is to be compressed.
[Range: 1 to 500]

Fields 2-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	400						

RRDOUT	This keyword is used to generate the Root Disease Detailed Output Table to be printed after the Root Disease Summary Output Table.
Fields 1-7	Not used.

RRECHO This keyword is used to produce machine-readable output of the Root Disease Summary Table; "machine-readable" output has no table headings. It's used for post processing programs. An OPEN keyword must be used in conjunction with this keyword to open a file with the same unit number.

Note: The OPEN keyword will be automatically included with the RRECHO keyword if entered using the Pest Model Submittal System.

Field 1 File unit number.
[Range: 20 to 35]

Fields 2-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	24						

RRHOSTS This keyword is used to change the disease type for which a tree species can be a host. This keyword is only used for Annosus root disease.

Field 1 Tree species number or character code for which to change disease type.
[Range: Number or character code selected from the Variants and Associated Species Table on page 2]
(A "0" or "ALL" indicates all species and requires a supplemental record.)

Note: If this value is "0" or "ALL", it is assumed that the disease types are to be modified for EACH species in that variant. This requires a supplemental record with the disease types in the following format: eleven values starting in column 1, each with a field width of 5 places, right justified (11I5). A value must be entered for each species on the supplemental record; default values are not carried.

Field 2 Annosus root disease type:

0 = tree species not eligible for colonization by either root disease type.
1 = P-Type Annosus
2 = S-Type Annosus

Fields 3-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	0						

Species Default Values

Code Variant	1	2	3	4	5	6	7	8	9	10	11
BM (Blue Mountains)	1	2	2	2	2	2	1	2	2	1	1
CI (Central Idaho)											
CR (Central Rockies)											
EC (East Cascades)	1	2	2	2	1	2	1	2	2	1	1
EM (Eastern Montana)	1	2	2	2	2	1	1	2	2	1	1
KT (Kookantl)											
NC (Klamath Mtns)											
NI (Northern Idaho)	1	2	2	2	2	1	1	2	2	1	1
PN (Pacific Northwest Coastal)											
SO (S. Cen. OR/NE CA)	1	1	2	2	2	1	1	2	2	1	1
TT (Tetons)											
UT (Utah)											
WC (West Cascades)											
WS (Western Sierra Nevada)	1	1	2	2	2	1	1	1	2	1	1

RRINIT This keyword is used to specify the configuration of root disease centers. The user may specify the total area of root disease including the number of centers in which case the model will randomly distribute these centers (of equal size) throughout the stand, or the user may provide a list of root disease centers with the X and Y coordinates and radius of each. If running Annosus this keyword must be entered once for each Annosus root disease type (P and S) and of one of the disease types is not present in the stand, the user should enter "0" for fields 1, 2, 5, and 6 for that disease type.

Field 1 Method of choosing disease centers:

0 = randomly
1 = disease center attributes read in from supplemental records

Field 2 Number of root disease centers to be located in the stand. If field 1 = 1, this is the number of supplemental records required.
[Range: 1 to 100]

Field 3 Number of infected trees/acre in the root disease centers. If blank, the model will default to 50% of the trees in the root disease centers. If this value is to be obtained from the inventory tree list (indicated by the RRTREIN keyword), the value in this field will be ignored.
[Range: none]

Field 4 Number of uninfected trees/acre in the root disease centers. If blank, the model will default to 505 of the trees in the root disease centers. If this value is to be obtained from the inventory tree list (indicated by the RRTREIN keyword), the value in this field will be ignored.
[Range: none]

Field 5 Average proportion of root infection; all infected trees will be given this infection level.
[Range: 0.0 to 1.0]

Field 6 Total acres of root disease (used only if field 1 = 0). The area of each root disease center is equal to the value in field 6 divided by the value in field 2. If blank, the model will default to 25% of the total stand area.
[Range: none]

Field 7 Disease Type:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: The value defaults to 1 or if the RRTYPE keyword comes before RRINIT in the list of keywords then it will default to what is set by RRTYPE. Suppose will set this field automatically except when Annosus is being run and then it needs to be set to P-Type or S-Type.

Supplemental Record If field 1 = 1 then one supplemental record is required for each disease center to be processed, and the number of records should match the count entered in field 2. Each supplemental record will contain 3 values: the X-coordinate in feet, the Y-coordinate in feet, and the radius of the center in feet, starting in column 1, each with a field width of 7 places including a decimal and one decimal place (3F7.1).

Field Default Values

Field	1	2	3	4	5	6	7
All variants	0	20			0.1		

RRJUMP This keyword is used to specify the extent to which root disease centers will expand through uninfected trees when the stand is thinned or clearcut.

Field 1 Average root-system radius multiplier for P-Type Annosus centers; the model calculates the average root-system radius for all trees in the stand and then multiplies by the value in this field to get the extent to which each root disease center will expand.
[Range: none]

Field 2 Average root-system radius multiplier for S-Type Annosus centers.
[Range: none]

Field 3 Average root-system radius multiplier for Armillaria centers.
[Range: none]

Field 4 Average root-system radius multiplier for Laminated Root Rot (Phellinus) centers.
[Range: none]

Fields 5-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	0.0	0.0	0.0	0.0			

RRMINK This keyword is used to enter a time-to-death value (time from root infection until death of the tree) below which multipliers entered with the TTDMULT keyword will not influence mortality.

Field 1 Time-to-death in years, below which the modifiers specified by the TTDMULT keyword do not influence mortality and infection dynamics for trees infected with type P Annosus root disease.
[Range: none]

Field 2 Time-to-death in years, below which the modifiers specified by the TTDMULT keyword do not influence mortality and infection dynamics for trees infected with type S Annosus root disease.
[Range: none]

Field 3 Time-to-death in years, below which the modifiers specified by the TTDMULT keyword do not influence mortality and infection dynamics for trees infected with Armillaria root disease.
[Range: none]

Field 4 Time-to-death in years, below which the modifiers specified by the TTDMULT keyword do not influence mortality and infection dynamics for trees infected with Laminated Root Rot (Phellinus).
[Range: none]

Fields 5-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	0	0	0	0			

RRTREIN This keyword is used to indicate the root disease conditions will be initialized from the tree inventory list.

Note: If there are no root disease damage codes in the inventory, this keyword will still invoice root disease.

Fields 1-7 Not used.

Note: Disease conditions are read in from the tree list through damage codes and tree history codes.

The damage codes for root disease are as follows:

61 = Armillaria
62 = Laminated Root Rot (Phellinus)
64 = Annosus root disease

The severity codes for root disease are as follows:

01 = tree is within 30 feet of a tree with deteriorating crown or killed by root disease,
02 = pathogen or diagnostic symptoms detected,
03 = crown deterioration.

Stumps are read in through the tree list when a tree record shows a history of 6, 7, 8, or 9 and has one of the root disease damage codes. A tree history of 6 or 7 identifies trees that died in the last 5 years. A tree history of 8 or 9 identifies trees that died more than 5 years ago. Trees that were infected by root disease and then cut in previous rotations are identified by entering a tree height of 1.5 in the tree list; these trees are classified and processed as stumps and then discarded. Stumps can also be added using the STREAD keyword, with or without the RRTREIN keyword.

RRTYPE This keyword is used to specify the root disease type to be simulated.

Field 1 Root disease types. Valid codes are as follows:

1 = P-Type Annosus
2 = S-type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Fields 2-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants							

RSEED This keyword is used to change the random number generator seed value contained in the model.

New random number generator seed value.
[Range: Any large, non-negative, odd integer]

Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	889347						

SAREA This keyword is sued to define the stand area to be simulated in the Root Disease Model.

Field 1 Stand area in acres.
[Range: none]

Fields 2-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	100						

SDIRMULT This keyword is used to modify the calculation of root radius based on SDI. The root radius is multiplied by a value between 0.5 and 1.5 that is calculated from a function of SDI.

Field 1 The "normal" SDI (SDI for which the multiplier should be 1).
[Range: none]

Field 2 Slope of the relationship between SDI and multiplier. A negative slope means multiplier is small when SDI is large or trees in crowded stands have a smaller root system.
[Range: none]

Fields 3-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	369	-0.0033					

SMCOUT This keyword is used to generate a root disease center spread rate table from the Monte Carlo simulation to be printed to a separate file. An OPEN keyword must be used in conjunction with this keyword to open a file with the same unit number.

Field 1 File unit number.
[Range: 20 to 35]

Note: The OPEN keyword will be automatically included with the SMCOUT keyword if entered using Suppose.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	26						

SPORE This keyword is used to change the spore infection parameters for the simulation of spore dynamics with Annosus root disease. Uninfected stumps of all tree species can become colonized by P and S type spores after harvesting. This keyword must be entered once for each Annosus root disease type (P and S).

Field 1 Date (calendar year or cycle number) for parameters to take effect.
[Range: 4-digit calendar year or 0 to 40 for cycle number]

Field 2 Proportion of newly cut stumps to be infected by spores. A "0.0" in this field will turn off the spore model.
[Range: 0.0 to 1.0]

Field 3 Minimum stump diameter for forming new root disease centers by spore infection transmission.
[Range: none]

Field 4 Multiplier for time-to-death (time from spore-initiated infection to tree death) for spore-initiated centers.
[Range: none]

Field 5 Multiplier for the probability of infection transmission, given root overlap, for spore-initiated centers.
[Range: none]

Field 6 Annosus root disease type for this keyword record:

1 = P-Type Annosus
2 = S-Type Annosus

Field 7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	0.1	14.0	3.0	0.5	1	

SPREAD This keyword is used to specify the type of spread model to be simulated, static or dynamic.

Field 1 Date (calendar year or cycle number) for parameters to take effect.
[Range: 4-digit calendar year of 0 to 40 for cycle number]

Field 2 Type of spread model to be used:

0 = static; fixed spread rate for root disease
1 = dynamic; different spread rates for each root disease center
2 = dynamic average; average spread rate applied to each root disease center

Field 3 Fixed annual spread rate, in feet, for root disease centers. This field used only if field 2 = 0.
[Range: none]

Field 4 Fixed annual spread rate, in feet, for S-type Annosus root disease centers if both S-Type and P-Type are being simulated. This field used only if field 2 = 0.
[Range: none]

Field 5 Number of times to simulate the Monte Carlo spread model. This field used only if field 2 = 1 or 2.
[Range: 1.0 to 50.0]

Field 6 Disease Type:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: The value defaults to 1 or if the RRTYPE keyword comes before SPREAD in the list of keywords then it will default to what is set by RRTYPE. Suppose will set this field automatically except when Annosus is being run and then it needs to be set to P-Type or S-Type.

Field 7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	1	0	1.0	1.0	1.0		

STREAD This keyword is used to initialize stumps within the root disease areas of the stand. These stumps will serve as inoculum sources from which infection will spread. A stump, in the context of the Root Disease Model, is a root disease-infected tree that is killed by any means; a stump formed by cutting, a dead standing tree, or a tree snapped off by wind. There can be multiple entries of the STREAD keyword in the keyword set.

Field 1 Tree species number or character code.
[Range: Number or character code selected from the Variants and Associated Species Table, page 2.]
("0" or "ALL" not allowed here.)

Field 2 Stump diameter class code, based on the stump diameter, taken 1 foot above ground:

1 = 0.0 to 12.0 inches
2 = 12.1 to 24.0 inches
3 = 24.1 to 48.0 inches
4 = 48.1 to 100.0 inches
5 = larger than 100.0 inches

Field 3 Number of stumps in the stand (not stumps per acre) of the given species and diameter.
[Range: none]

Field 4 Disease Type:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: Suppose will set the disease type automatically, except when Annosus is being run and then it needs to be set to P-Type or S-Type.

Field 5 Number of years since death (or cutting) of tree.
[Range: none]

Fields 6-7 Not used.

TDISTN This keyword is used to specify the type of spatial distribution in the stand. The distribution can be random or gridded, as in a plantation, and can be changed after some point in the simulation.

Field 1 Date (calendar year) in which distribution will change from that specified in field 2 to the other type distribution.
[Range: must be a 4-digit calendar year, cannot be a cycle number, however, a "0" implies the distribution will be changed to gridded for the entire simulation.]

Field 2 Current tree spatial distribution:

0 = random tree distribution,
1 = gridded tree spacing.

Field 3
Standard deviation about the mean distance between trees in a lattice, or gridded, distribution; useful when a stand is established with planting, but natural regeneration is allowed.
[Range: none]

Fields 4-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants		0	1.0				

TIMEDEAD This keyword is used to change the time since death of infected trees and stumps in the inventory.

Field 1 Number of years since death for size class 0-12" DBH.
[Range: none]

Field 2 Number of years since death for size class 12-24" DBH.
[Range: none]

Field 3 Number of years since death for size class 24-48" DBH.
[Range: none]

Field 4 Number of years since death for size class 48-100" DBH.
[Range: none]

Field 5 Number of years since death for size class >100" DBH.
[Range: none]

Fields 6-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants	5	10	15	15	15		

TTDMULT — This keyword is used to change the time-to-death multipliers (time from root infection to death of the tree) for root disease mortality.

Field 1 — Date (calendar year) in which time-to-death multipliers will take effect.
[Range: must be a 4-digit calendar year, cannot be a cycle number, however, a "0" implies the multipliers will take effect at the beginning of the simulation]

Field 2 — Disease Type:

1 = P-Type Annosus
2 = S-Type Annosus
3 = Armillaria
4 = Laminated Root Rot (Phellinus)

Note: The value defaults to 1 or if the RRTYPE keyword comes before TTDMULT in the list of keywords then it will default to what is set by RRTYPE. Suppose will set this field automatically except when Annosus is being run and then it needs to be set to P-Type or S-Type.

Field 3 — Tree species number or character code for which mortality multipliers will be modified.
[Range: Number or character code selected from the Variants and Associated Species Table on page 2]
(A "0" or "ALL" here indicates all species and requires a supplemental record.0

Note: If this value is "0" or "ALL", it is assumed that the proportion of root system infected at death is to be modified for EACH species in that variant. This requires a supplemental record with the proportion modifications in the following format: eleven values starting in column 1, each with a field width of 5 places including the decimal and 2 decimal places 911F5.2). A value must be entered for each species on the supplemental record; default values are not carried.

Field 4 — Time-to-death multiplier.
[Range: none]

This value is used only if field 3 contains a number between 1 and 11, inclusive, or a specific species character code.

Fields 5-7 — Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants							

Species Default Values

Code Variant	1	2	3	4	5	6	7	8	9	10	11
BM (Blue Mountains)	1.0	1.0	1.0	1.5	1.75	1.0	1.5	1.0	1.5	0.5	1.0
CI (Central Idaho)											
CR (Central Rockies)											
EC (East Cascades)	1.0	1.0	1.0	1.5	1.0	1.5	1.5	1.0	1.5	0.5	1.0
EM (Eastern Montana)	1.0	1.0	1.0	1.5	1.75	1.0	1.5	1.0	1.5	0.5	1.0
KT (Kookantl)											
NC (Klamath Mtns)											
NI (Northern Idaho)	1.0	1.0	1.0	1.5	1.75	1.0	1.5	1.0	1.5	0.5	1.0
PN (Pacific Northwest Coastal)											
SO (S. Cen. OR/NE CA)	1.0	1.0	1.0	1.5	1.75	1.75	1.5	1.0	1.5	0.5	1.0
TT (Tetons)											
UT (Utah)											
WC (West Cascades)											
WS (Western Sierra Nevada)	1.0	1.0	1.0	1.5	1.75	1.75	99.0	0.5	1.5	0.5	99.0

WINDTHR This keyword is used to specify a windthrow event. Both infected and uninfected trees can be windthrown.

Field 1 Earliest date (calendar year or cycle number) a windthrow event can occur.
[Range: must be a 4-digit calendar year or 0 to 40 for cycle number.]

Field 2 Proportion of eligible trees to be windthrown; eligible trees include only the dominant and co-dominant trees of any species (the largest 20% in diameter distribution).
[Range: 0.0 to 1.0]

Field 3 Minimum number of eligible trees/acre necessary for a windthrow event to occur.
[Range: none]

Fields 4-7 Not used.

Field Default Values

Field	1	2	3	4	5	6	7
All variants		0.0	0.0				

Species Default Values

Code Variant	1	2	3	4	5	6	7	8	9	10	11
BM (Blue Mountains)	WP	WL	DF	GF	MH	OTH	LP	PP	AF	PP	OTH
CI (Central Idaho)											
CR (Central Rockies)											
EC (East Cascades)	WP	WL	DF	SF	RC	GF	LP	ES	AF	PP	OTH
EM (Eastern Montana)	WB	L	DF	GF	WH	C	LP	S	AF	P	OTH
KT (Kookantl)											
NC (Klamath Mtns)											
NI (Northern Idaho)	WP	L	DF	GF	WH	C	LP	S	AF	PP	OTH
PN (Pacific Northwest Coastal)											
SO (S. Cen. OR/NE CA)	WP	SP	DF	WF	MH	IC	LP	ES	RF	PP	OTH
TT (Tetons)											
UT (Utah)											
WC (West Cascades)											
WS (Western Sierra Nevada)	OC	SP	DF	WF	GS	IC	BO	JP	RF	PP	TO

Species Abbreviation Table

Species Abbrev.	Species Name	Species Abbrev.	Species Name
AF	Alpine fir	MH	Mountain Hemlock
AS	Aspen	OC	Other conifers
BO	Black Oak	OH	Other hardwood
BS	Blue Spruce	OS	Other softwood
C	Western Redcedar	OTH	Other species
CB	Corkbark Fir	PP	Ponderosa Pine
CW	Cottonwood	RF	Red Fir
DF	Douglas-fir	S	Spruce
ES	Engelmann Spruce	SF	Pacific Silver Fir
GF	Grand Fir	SP	Sugar Pine
GS	Giant Sequoia	TO	Tanoak
IC	Incense-cedar	WB	Whitebark Pine
J	Juniper	WF	White Fir
JP	Jeffrey Pine	WH	Western Hemlock
L	Larch	WL	Western Larch
LM	Limber Pine	WP	White Pine
LP	Lodgepole Pine	WS	White Spruce