

Cruise Compilation Manual

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Includes Amendments

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Amendment No. 4
Amendment No. 3
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Amendment No. 1

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Compilation Sequence

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The compilation program is used to compute *quantitative* estimates for volume, basal area, average diameter and tree count statistics and other related data for a timber cruise. The estimates are reported for both stand total and 'per hectare' values. For example, the total volume and volume per hectare estimates are reported for the timber cruise. In the interior, estimates for lumber recovery and chip yield are also computed.

The estimates for these parameters are reported at the following levels:

1. Timber Type - a stratification of the cutting permit. Trees that belong to a certain type have similar characteristics with respect to species composition, age, size, quality and site index.
2. Cutting Permit - the whole cutting authority area that is compiled..
3. Block - a contiguous area within a cutting authority, made up of 1 or more Timber Types.
4. Harvesting Method - an area within a cutting authority area that is harvested by the same logging system.
5. Treatment Unit - an area of common treatment based on a silvicultural prescription.
6. Plot - an area where tree are sampled. These sampling points provide the estimates for the previous 5 levels.

For each report level, the data may be further broken down into *qualitative* categories such as species, risk group, maturity, damage type, and log grades. The reporting levels are specified in Chapters 8 - 14.

3.1 Compilation Sequence

3.1.1 Step-by-Step Compilation Instructions

- Step 1 Perform Edits and Load Data - Inspect each input card from the input file and compare to the list of edits in Chapter 2. If a fatal error is found, stop the compilation and edit the input file. Remove un-compiled trees and load the data for use by subsequent processing. A sample data model relating the input data elements is given in Section 3.4.
- Output - Edit Error Report (001a)
 - Scattergram of card type 2s and 3s (001b)
- Step 2 If there are any trees with no height, then determine the Height-Diameter curves from the sample trees and apply heights as outlined in Chapter 7.
- Output - Regression coefficients (003a)
 - Scattergram of predicted heights (003b)
- Step 3 Calculate Volume - refer to Section 3.3.1 for step-by-step instructions on calculating volumes.
- Step 4 Produce Reports - for each of the selected reports, refer to the specific Chapters 8 - 14, which defines the report.

3.1.2 Compilation Dataflow Diagram

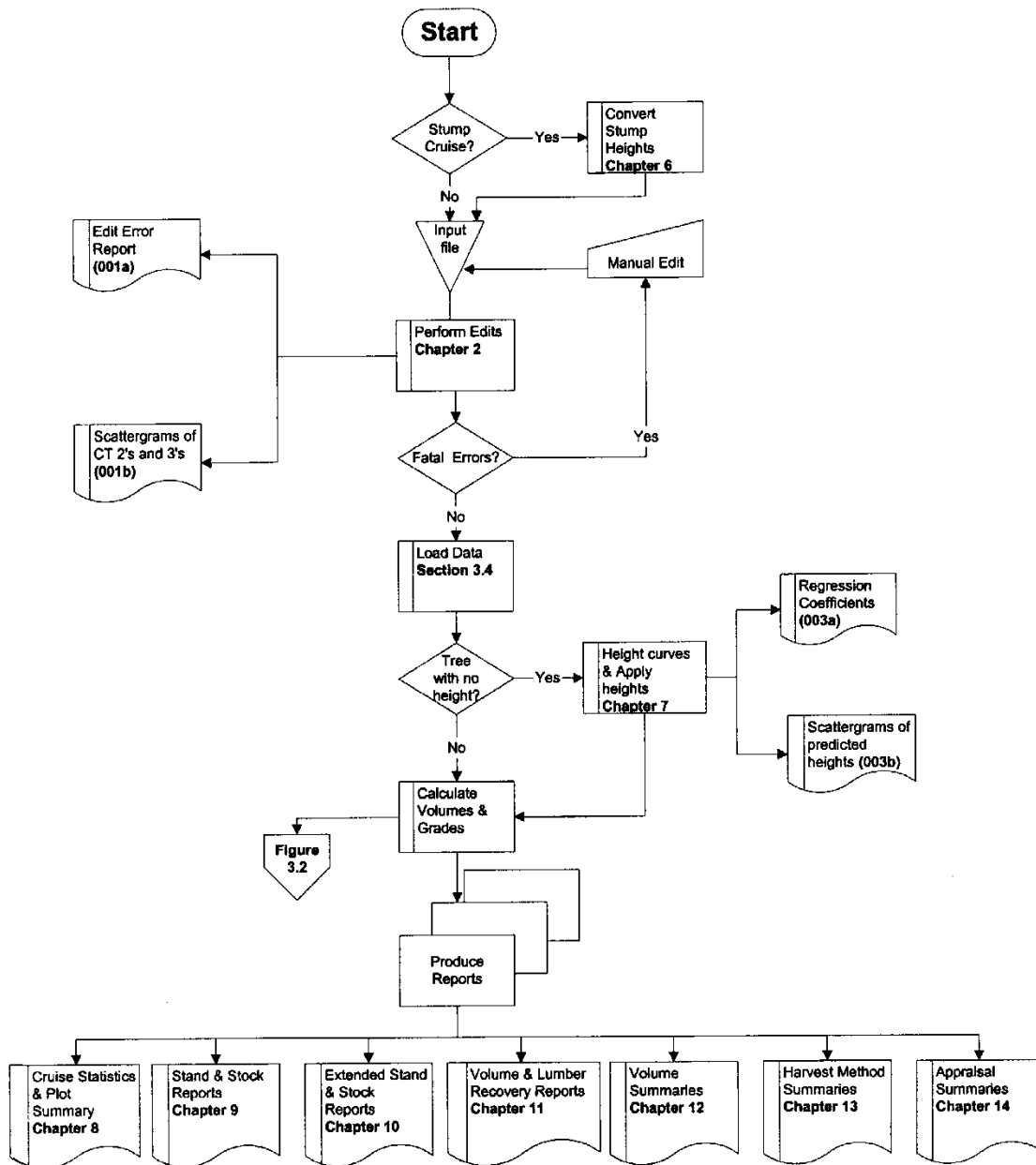


Figure 3.1 Cruise Compilation Sequence.

3.2 Log Volume Calculation - Overview

3.2.1 Step-by-Step Log Volume Calculation Instructions

Only compile the stem count for Western Yew.

Step 1 Set the parameters for calculating the volume of a tree. These are:

1. Forest Inventory Zone.
2. DBH - Diameter at breast height (1.3 m) outside bark in cm to the nearest tenth (e.g., 110.1).
3. Height - Total height in meters to the nearest tenth (e.g., 41.3).
4. Stump ht. - Stump height in meters to the nearest hundredth (e.g., 0.30).
5. Top diam. - Top diameter inside bark in cm to the nearest tenth (e.g., 12.5).
6. Log length - log length in meters to the nearest tenth (e.g., 5.0).

Step 2 Calculate tree volumes - taper equation and volume routine (see Appendix 13).

Use the taper equation and volume routine with the above-defined parameters. This routine will determine:

1. Number of logs in the tree.
2. Volumes for each log.
3. Top diameters for each log.
4. Length of top log.
5. Butt diameter for 1st log.
6. Gross merchantable volume - from stump height to top diameter.
7. Biological volume - from ground to top of tree.

Step 3 Determine loss factor table.

1. Use FIZ tables unless a local loss factor exists for the Unit. All local factors apply only to mature volumes (i.e., 121 years or greater). Refer to Table 17 of the [Cruising Manual](#).
2. Determine maturity based on tree class and age. Refer to the Tree Class Modification of Loss Factors in Table 17 of the *Cruising Manual* at the above URL.
3. Determine Risk Group based on tree class, pathological remarks, and damage.

Tree Class - Tree classes 3, 4, 6, 7 & 9 automatically go to highest Risk Group. The exception being Tree Class 7 Lodgepole Pine in the Interior. These stems will be classed as Risk Group 2. Conk, Blind conk, and blowdown code G will move these stems into Risk Group 3.

Pathological Indicators - Tree class 1, 2, 5 & 8 trees start at the lowest risk group and are then placed into a higher risk group, depending on pathological indicators. Refer to Table 18 in the [Cruising Manual](#).

Damage Codes - trees are further moved into higher risk groups depending on the damage codes associated with them.

Insect Damage

If the Risk Group is **1**, then increase the Risk Group **to 2** for insect damage codes 1, 2, 3, 4, 6 and 8.

Spruce trees in all maturity classes with insect damage code 7 will move to the highest mature risk group. This means that in FIZ A-C, all spruce insect damage code 7 will move to risk group 2. In FIZ D-L, spruce with insect damage 7 will move to mature risk group 3.

Fire Damage

There is no change in Risk Group for fire damage code A, **B or C**.

Blowdown Damage

There is no change in Risk Group for blowdown code E.

For blowdown damage code G, use the highest Risk Group.

For cedar loss factor table 296, the Risk Group is based on the average height from card type 9. If the average height ≤ 40 , then the risk group is 2.

Otherwise, the Risk Group is 1.

4. Determine diameter class, based on DBH. Refer to Appendix 14.

Step 4 Apply loss factors - refer to the "*Cruise Compilation Loss Factor Table Manual*", 1976, for the specific table. Reduce the tree volume by the specified percentages. Apply the loss factors individually and in the order {Decay → Waste → Breakage}.

For mature coast cottonwood, a flat rate of 15 percent is applied in lieu of the loss factors.

For interior Lodgepole Pine addition breakage factors are reduced from gross volume based on insect damage codes and/or tree classes.

The additional breakage factor for all risk group 3 stems is zero (0).

Tree Classes	Damage Code	Breakage Factor Add On
1, 2, 5, 8	No insect code	0
1, 2, 5, 8	1	0
1, 2, 5, 8	2	7.5
3, 7, 9	3	28.0
3, 7, 9	No insect code	28.0

For fire damage, additional breakage factors are reduced from gross volume based on code.

Fire Damage Code	% Breakage Add-On
A	0.0
B	5.0
C	40.0

Maximum DWB reductions for any tree is 100%.

Step 5 If count and measure plots have been tallied, calculate the double sampling ratios (DSR) for each tallied species. The DSR adjusts stem count, basal area, and volume estimates. When using the Average Line method, calculate a DSR for each Timber Type. When using the Block method, calculate a DSR for each Timber Type, each Timber Type within Block and each Timber Type within Harvesting Method.

For tree classes 4 & 6, use 1.0 (i.e., no adjustment in volume).

Use 1.0 for Western Yew (i.e., no adjustment in stem count).

Output - Double Sampling Ratios (004b)

Example: Fir DSR for a Timber Type

$$DSR(fir) = \frac{\# \text{ of meas plots.}}{\text{Total \# of plots}} * \frac{(\# \text{ fir trees}) * (\text{avg. BAF all fir trees})}{(\# \text{ meas. fir trees}) * (\text{avg. BAF meas. fir})}$$

To calculate the average BAF, sum the basal area factors of all the trees in the type and divide by the number of trees in the type. Refer to Section 3.5 for a detailed explanation of the calculation of number of trees and basal area factors.

Example 3.4 - Double Sampling Ratio

Refer to Figure 3.4 for a sample Double Sampling Ratio Report.

In Block 2, Type 2 there are 2 measure plots and 2 count plots. One measure plot is a border plot and has a BAF of 8. The other measure plot is a full plot with a BAF of 10. Both count plots are full plots with BAFs of 8 and 10.

There was 1 cedar tallied in each of the plots. The cedar tallied in the border plot

would count as 2.

The average basal area for all cedars is $(8 + 8 + 8 + 10 + 10) / 5 = 8.8$

The average basal area for all measured cedar is $(8 + 8 + 10) / 3 = 8.66$

$$DSR(\text{cedar}) = \frac{2}{4} * \frac{5 * 8.8}{3 * 8.66} = 0.84615373$$

Step 6 If a percent reduction is being compiled, determine whether there is an eligible reduction for the tree. Refer to Chapter 5 for Percent Reduction handling.

Step 7 Double the volume, basal area and tree count for border plots.

Step 8 Calculate grade percents (Appendices 9 and 10).

Each log is graded and the volume for that log is reported for that grade.

3.2.2 Calculate Volumes and Grades

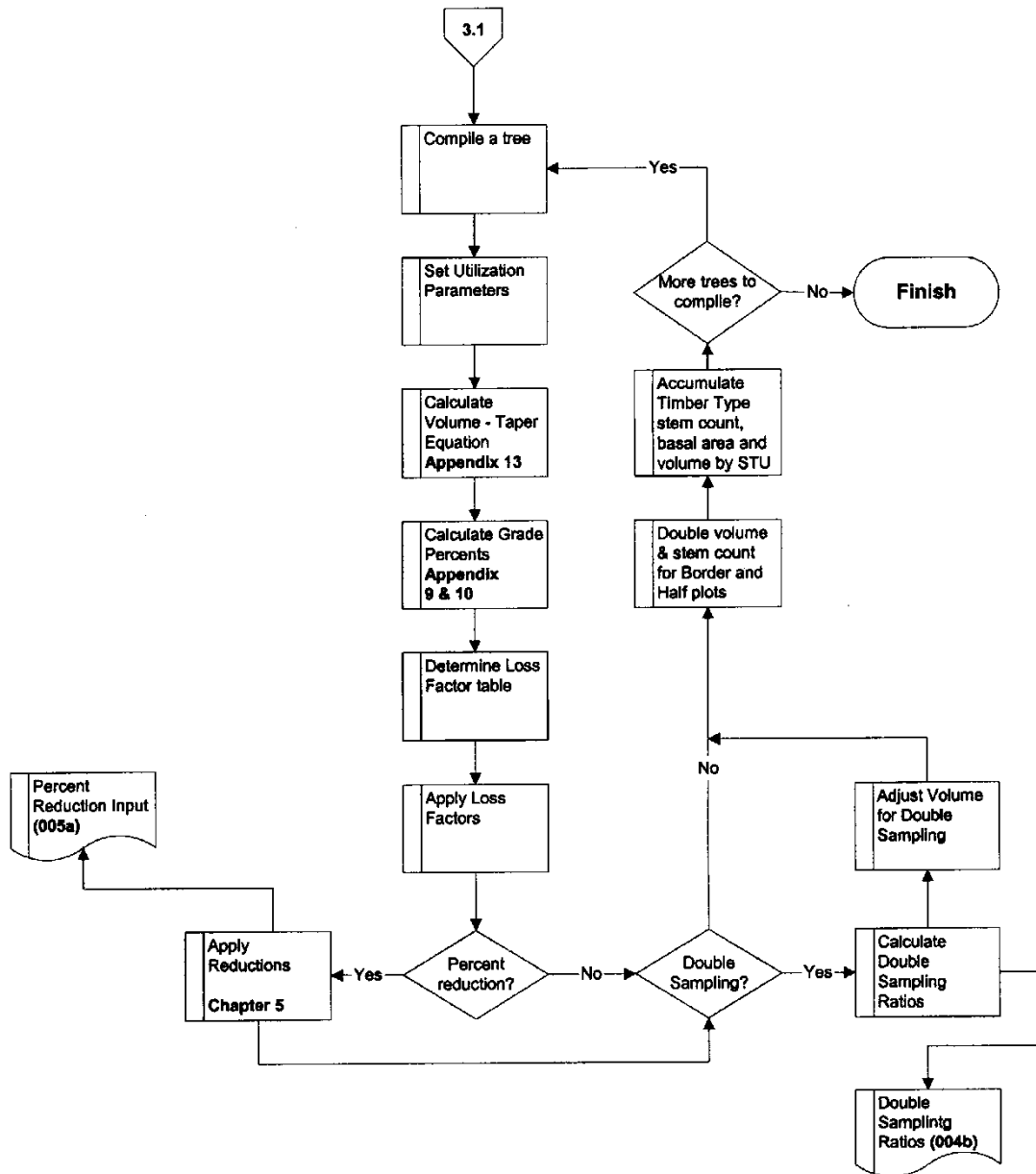


Figure 3.2 Log Volume Calculation.

3.3 Sample Data Model

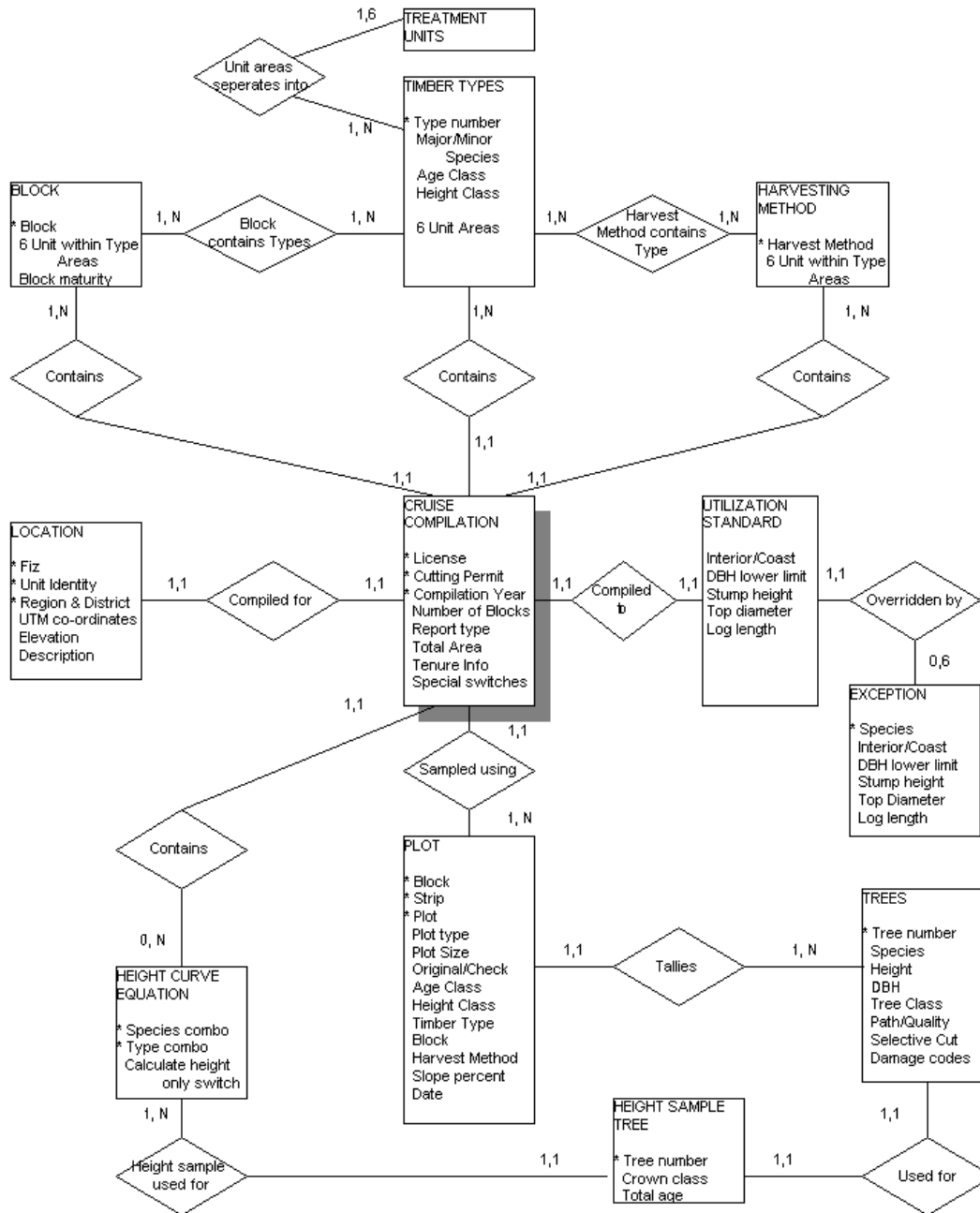


Figure 3.3 Input Data Relationships.

This diagram is only a sample of the input data relationships. Many different views would be required to perform all the reporting calculations.

Read the cardinality rules as: "1 Cruise Compilation CONTAINS 1 or many Harvesting Methods", "1 Tree can be USED FOR 1 Height Sample Tree" etc.

3.3.0.1 Number of Trees per Hectare

Each tree contributes:

$$S_t = \frac{\text{Area one hectare}}{\text{Plot Size}} * R_t$$

Each species contributes:

$$S_p = \sum_{t=1}^{n_p} S_t$$

Example 3.2

Plot 1, Type 1 has two (2) Spruce trees in it. Spruce is reduced by 30 percent in all diameter classes. The area of the plot is 400 m². Tree one has a DBH of 56.0 and tree two has a DBH of 51.1. There is no Double Sampling Ratio because count plots are not used with fixed area sampling.

Tree 1 $S_{t,1} = \frac{10\,000}{400} * (1 - 30 / 100) = 17.5$ stems per hectare

Tree 2 $S_{t,2} = \frac{10\,000}{400} * (1 - 30 / 100) = 17.5$ stems per hectare

$S_p = 17.5 + 17.5 = 35.0$ stems per hectare

Where:

S_p = Stems per hectare estimate for plot p.

n_p = Number of trees in plot p.

R_t = Post-reduction percent for tree t (1 - reduction percent / 100).

S_t = Number of trees per hectare tree t represents.

Area one hectare = 10,000 m²

plotsize = Area of plot from card type 9.

Double this estimate if the plot is a border plot.

3.3.0.2 Basal Area per Hectare

The basal area for each tree is calculated as $\pi (DBH/200)^2$ (i.e., the area of a circle whose diameter is the DBH for the tree).

$$BA_p = \frac{\sum_{t=1}^{n_p} \pi \left(\frac{DBH_t}{200} \right)^2}{plot\ size} * R_t$$

Where:

BA_p = Basal area (m²) per hectare estimate for plot p.

n_p = Number of trees in plot p.

DBH_t = Diameter (cm) at 1.3 m outside bark for tree t.

π = 3.14159

R_t = Post-reduction percent for tree t (1 - reduction percent / 100).

Double this estimate if the plot is a border plot.

3.3.0.3 Volume per Hectare

$$V_p = \sum_{t=1}^{n_p} S_t V_t$$

Where:

V_p = Gross merchantable volume per hectare estimate for plot p.

n_p = Number of trees in plot p.

V_t = Gross merchantable volume for tree t.

S_t = Number of trees per hectare that tree t represents.

Double this estimate if the plot is a border plot.

The procedure for calculating the volume of a tree is described in Section 3.3.

Sub plots are also permitted for fixed area plots and are detected by the presence of a sub-plot size in columns 40-43 of card type 9. There will be a corresponding DBH lower limit in columns 50-52, which will also differ from the main plot DBH lower limit. Use the same logic as is used for prism plots to determine which trees use the sub-plot parameters and which trees use the main plot parameters.

3.4 Double Sampling Ratio - Sample Listing

Report 004b - Sample listing (partial).

Double Sampling Ratios - required.

FOREST REVENUE BRANCH - 2001.0 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION LICENCE: CF7080 - 000 BLOCK NUMBER - 002		RATIOS FOR DOUBLE SAMPLING CRUISE TIMBER TYPES		(004b) PAGE 4 COMPUTED 2001-03-19 17:42:49
SPECIES	1	2		
F	1.00000000	.84615373		
C	1.00000000	.84615373		
H				
HW				
HM				
B	1.00000000	.84615373		
BA				
BB				
BG				
BL				
S				
SS				
SR				
SW				

Figure 3.4 Report 004b.

Damage Reports

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Whenever the codes for Blowdown, Fire and/or Insect damage are detected on card type 2s, damage reports are produced in addition to the normal (non-damage related) output. These reports will segregate the reported volumes into separate damage types and/or codes, as indicated. Root rot damage is reported for block summaries only and is optional.

The damage reports will be the same as the normal output, only there will be a designation of species and damage type and damage codes on the report.

Damage Type	Code	Description	Species
Blowdown	E	Down trees	All Species
	G	Down and shattered trees	All Species
Fire	A	Light fire	All Species
	B	Medium fire	All Species
	C	Heavy fire	All Species
Insect/Disease	1	Green attack	Balsam, Pine
	2	Red attack	Balsam, Pine
	3	Grey attack	Balsam, Pine
	4	Blister rust	White Pine
	5	Green attack - alive	Spruce, Douglas Fir
	6	Green attack - dead	Spruce, Douglas Fir
	7	Grey attack - dead	Spruce, Douglas Fir

Damage Type	Code	Description	Species
	8	Red attack	Douglas Fir
	X	Defoliator G live cambium	All Species
	Y	Defoliator D dead cambium	All Species
Root Rot	J	Light	All Species
	K	Moderate	All Species
	L	Heavy	All Species

4.1 List of Damage Reports

The following damage reports are required for damage types Blowdown, Fire, and Insect:

1. 006 Extended Forest Type Stand and Stock Table, one page with all trees, one page with non-damaged trees, and one page for each Blowdown, Fire, or Insect damage code.
2. 007 Stand and Stock Tables, one page for each species and damage type containing each of the damage codes for that damage type.
 - i 007a Block Stand Table.
 - ii 007b Block Stock Table.
 - iii 007c Block Basal Area.
 - iv 007d Timber Type Stand Table.
 - v 007e Timber Type Stock Table.
 - vi 007f Timber Type Basal Area.
 - vii 007g Cutting Permit Stand Table.
 - viii 007h Cutting Permit Stock Table.
 - ix 007i Cutting Permit Basal Area.
3. 009 Volume Summaries, one page for each species and damage type reporting each of the damage codes for that damage type.
 - i 009a Timber Type Summary.
 - ii 009b Block Summary.
 - iii 009c Cutting Permit Summary.
 - iv 009d Treatment Unit within Block Summary - Coast only.
4. 011 Plot Summary, damage code volumes segregated for each species.
5. 015 Harvesting Method Summary, percent net volumes will be segregated for each Harvesting Method under the headings Fire, Heavy Fire (Damage code C), Down trees, and Insect damage.

The following damage reports are optional:

1. 009b Root Rot Block Summary.

4.2 Damage Report Calculation

Trees with multiple damage codes will report each damage type in the *Damage Summary Reports*. The damage code or codes that will assign the highest risk group will be used in the calculation of the net volume for each of the damage types. If pathological indicator(s) move the risk group higher than the damage code(s) then use the risk group from the pathological indicator(s) to calculate the *Damage Summary Reports*.

Example 1:

Cruise = 1 ha, 1 plot, 1.0 m³ mature Lodgepole Pine tree that represents 100 stems/ha with down tree code G, fire code C and insect 3:

Risk groups (RG) -Down Tree = RG3, Fire = RG2, Insect 3 = RG 2. Use RG 3 since it is the highest risk group.

Volume - Hypothetical loss factor DWB = 30% plus 28% for the grey attack breakage add-on plus 40% Fire C breakage add-on = 98%.

Tree = 1.0 m³ - 0.98 m³. Cruise volume per hectare = 0.02 * 100 stems = 2 m³.

Damage reports -Type, Block and Cutting Permit Damage Report Net Volume = 2 m³ for Lodgepole pine Down Tree (G), Fire (C) and Insect (3).

Example 2:

Cruise = 1 ha, 1 plot, 1.0 m³ mature Lodgepole Pine tree that represents 100 stems/ha with down tree code G, fire code B and insect 3:

Risk groups (RG) -Down Tree = RG3, Fire = RG2, Insect 3 = RG 2. Use RG 3 since it is the highest risk group.

Volume - Hypothetical loss factor DWB = 30% plus 28% for the grey attack breakage add-on plus 5% Fire B breakage add-on = 63%.

Tree = 1.0 m³ - 0.63 m³. Cruise volume per hectare = 0.37 * 100 stems = 37 m³.

Damage reports -Type, Block and Cutting Permit Damage Report Net Volume = 37 m³ for Lodgepole pine Down Tree (G), Fire (B) and Insect (3).

4.3 Sample Damage Report Listings

Some of the DBH classes have been removed from these sample listing.

4.3.1 Extended Forest Type Stand and Stock Damage Report - Sample Listing

(006) PAGE 4
 COMPUTED 2001-03-19 17:42:54
 AVERAGE LINE
 USELESS VOLUMES EXCLUDED
 NO. OF LIVE TREES 1.
 NO. OF DEAD TREES 0.

FOREST REVENUE BRANCH - 2001.0 FOREST TYPE STAND AND STOCK TABLE (STEMS/HA)
 NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION *** DOUBLE SAMPLING CRUISE ***
 NOTE - ALL TREES GREATER THAN 275 CM ARE INCLUDED IN THE 275 CM CLASS

LICENCE NUMBER CF7080 TYPE 1 - PA H C 9 4 1 SPECIES CDAR
 CUTTING PERMIT 000 ROAD/LANDINGS AREA - 5.0 OTHER AREA - 0.0 NO. OF PLOTS (M/C) 3. NO. OF DEAD TREES 0.

DOWN & SHATTERED - UPROOTED DAMAGE

DBH CL CM.	AVERAGE		LIVING TREES					TOTAL	LIVE VETEBANS DEAD U LIVE U
	HT (M)	NET MESH PER TREE (M3)	RISK GROUP 0	RISK GROUP 1	RISK GROUP 2	RISK GROUP 3	POTENTIAL		
40									
45									
50	37.5	2.807	1.348		10.33			10.33	
55									
60									
65									
70									
75									
80									
85									
90									
TOTAL OF AVERAGES		+		10.33				10.33	
PERCENT BY TREE CLASS				100.00				100.00	
TREES 12.5		+		55.50				55.50	
TREES 17.5		+		55.50				55.50	
TREES 22.5		+		55.50				55.50	
TREES 27.5		+		55.50				55.50	
TREES 32.5		+		55.50				55.50	

AVERAGE DBH(CM) AT 5 LEVELS

Figure 4.1 Extended Forest Type Stand and Stock Damage Report - Sample Listing (Partial).

4.3.2 Block Stand Damage Table - Sample Listing

4.3.3 Block Volume Summary Damage Report - Sample Listing

FOREST REVENUE BRANCH - 2001.0		BLOCK SUMMARY	
NOT FOR APPRAISAL PURPOSES DUE TO NON-STANDARD UTILIZATION ***** DOUBLE SAMPLING CRUISE *****		(009B)	PAGE 51
		COMPUTED 2001-03-19	17:42:57
		AVERAGE LINE	
		12.5	
LICENCE NUMBER CF7080	P.S.Y.U. 34-0	NO. OF BLOCKS	2
CUTTING PERMIT 000	F.I.Z. J	USELESS VOLUMES EXCLUDED	6
BLOCK NUMBER 001	5.0 SELECTIVE	NO. OF PLOTS USED (M/C)	6
CLEARCUT		ALBICANDIS PINE - UPROOTED DAMAGE	
		SHATTERED	TOTAL
UTILIZATION	NORMAL		
COMPLETION TYPE	3		
MINIMUM DBH	12.5		
STUMP HEIGHT	30.0		
TOP DIAMETER	10.0		
LOG LENGTH	5.0		
VOLUME AND SIZE DATA			
GROSS MERCH VOLUME M3	1200.	81.	1742.
NET MERCH VOLUME M3	1026.	69.	1484.
NET MERCH./HECTARE M3	205.	14.	297.
% DISTRIBUTION/HECTARE	69.	5.	100.
DECAY	9.	9.	9.
% GROSS	3.	4.	3.
WASTE (BILLING) % NET	4.	4.	4.
BREAKAGE	2.	2.	2.
TOTAL CULL (DWB) % GROSS	15.	15.	15.
STEMS/HA (GREEN & DP)	82.9	6.9	46.6
SNAGS/HA (DU)	12.3	0.0	12.3
AVG. DBH (GREEN&DP) CM	0.4	0.8	0.4
AVG. DBH (SNAGS) CM	0.6	0.0	0.6
GROSS MERCH VOL/TREE M3	2.91	2.50	2.00
NET MERCH VOL/TREE M3	2.49	2.13	1.69
AVG. WEIGHT TOTAL HT M	0.0	0.1	0.0
AVG. WEIGHT MERCH HT M	0.0	0.1	0.0
AVG. 5M LOG NET MER M3	0.48	0.44	0.38
AVG. # OF 5M LOGS/TREE	5.34	5.00	4.53
LUMBER AND CHIPS			
% NET MERCH - STUD LOG	20	20	48
% NET MERCH - SMALL LOG	80	80	52
LRF SMALL LOGS ED FT/M3	10	9	4
LRF LARGE LOGS ED FT/M3	3	3	3
AVG LRF ED FT/M3	2	2	2
CHIP YIELD UNITS/M3	.26	.26	.27
ALGORITHM GRADE %			
#1 SAWLOG	63.	94.	55.
#3 SAWLOG	10.	0.	27.
#4 CHIPPER	27.	6.	19.
#5 CHIPPER	0.	0.	18.

Figure 4.3 Block Volume Summary Damage Report - Sample Listing.