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July 5, 2018

BY EMAIL

To: Regional Executive Directors, Ministry of Forests, Lands & Natural Resource Operations

Re: 2017 Cruising Manual, Amendment No. 2

The purpose of the memo is to inform you that Amendment No. 2 to the 2017 *Cruising Manual* becomes effective July 1, 2018.

The manual will be available on the internet at the following link:

<http://www2.gov.bc.ca/gov/content/industry/forestry/competitive-forest-industry/timber-pricing/timber-cruising/timber-cruising-manual>

Please find a copy of the *Cruising Manua, Amendment No. 2* highlights attached.

Comments or questions about this manual should be referred to Michael Wedel, Cruising Policy Forester, Timber Pricing Branch at (778) 974-2450.

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Attachment

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Highlights

July 2018 Cruising Manual Changes

The *Cruising Manual* is available on the Internet at:

<http://www2.gov.bc.ca/gov/content/industry/forestry/competitive-forest-industry/timber-pricing/timber-cruising/timber-cruising-manual>

Section	Description
2.3, 2.3.6 – Right of Way Cruising	Modification of right of way cruising standards. Sampling error can now be waived on cruise based road permits and amendments in the Great Bear Rainforest North if two plots per ha are established along the right of way. Minimum tree count for the right of way may be waived if the minimum tree count cannot be achieved using a BAF of 12.25 (or less).
A.6.3 – Down Trees	Rounding errors are now corrected so that percentages add to 100%.
Throughout	Spelling errors are now corrected.

Cruising Manual

Effective April 1, 2017

Includes Amendments

Date

Amendment No. 2

July 1, 2018

Amendment No. 1

November 7, 2017

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Definitions

In this manual:

“**100% Cruise**” means a cruise in which every tree is measured. There are no samples or estimates;

“**Absolute Variation**” means the difference between two measurements or a standard and a measurement, disregarding the plus or minus sign (e.g., standard of 7 and measurement of 5 gives absolute variation of 2);

“**Accuracy**” means the nearness of a measurement to the actual value of the variable being measured;

“**BAF (Basal Area Factor)**” means the basal area (m²) per hectare that each "in" tree represents when using a prism or **relaskop**. Prisms are sometimes classified as "diopter" size or inscribed with the BAF number. The size denotes the basal area factor (i.e., an 8 BAF prism which tallies 7 trees in a plot would give a basal area (in timber) of 56 m²/hectare);

“**BC Albers**” means a map projection that is one of the standard map projections used in British Columbia.

“**BCTS**” means BC Timber Sales;

“**Bias**” means a difference between the sampling result and the actual value due to errors in measurement, sampling procedure or calculations;

“**Bole**” means the trunk or main stem of the tree and excludes branches and candelabras. The bole of the tree includes merchantable and non-merchantable portions of the trunk of the tree.

“**Boring Height**” means the distance from the ground (high side) up the tree to where an age is taken with an increment borer. It is usually taken at breast height (1.3 m);

“**Breast Height**” means the location on a tree where its diameter (DBH) is measured. It is located exactly 1.3 m above "high side". If high side is lower than the point of germination (POG), breast height is 1.3 m above the POG;

“**Cardinal directions**” means North, South, East and West. All references to azimuths or bearings mean the “true” value. For a description of True North, please see True North, Magnetic North and Grid North in the Appendices;

“**CEP**” means Circular Error Probability, a measure of precision, defined as the radius of a circle, centered around the mean, which is expected to include 50% of the results.

“**Closure Error**” means the distance between the start and end of the traverse in a closed traverse, divided by the length of the traverse, and is usually expressed in percent;

“**Coast**” means the area subject to the Coast Appraisal Manual;

“**Coefficient of Variation (CV)**” is a relative measure of variation, equal to the sample standard deviation expressed as a percentage of the sample mean ($\frac{SD}{\bar{x}}$);

“**Confidence**” means an expression of precision of sample estimates, usually assessed by confidence intervals such as 95 percent, a specified proportion of which contain the true population parameters;

“**Count Plot**” means a prism plot where only the number of "in" trees by species and plot slope is noted. No individual tree measurements are recorded;

“**Crown Class**” means one of the four crown classes, which are dominant, co-dominant, intermediate and overtopped (see Figure 6.3 Crown Classes);

“**Cruise Based**” means a cutting authority where under section 106 of the Forest Act, the stumpage payable is calculated using information provided by a cruise of the timber conducted before the timber is cut;

“**Cutblock**” means an area that meets the cutblock requirements as specified in the Coast and Interior Appraisal Manuals;

“**Cutting Authority Area**” means the area authorized to harvest Crown timber, as provided by the Forest Act;

“**Cutting Specifications**” mean the timber merchantability specifications as defined in the Coast and Interior Appraisal Manuals;

“**DBH (Diameter Breast Height)**” means the outside bark diameter of a tree measured at breast height;

“**Decay, Waste and Breakage (DWB)**” means factors to reduce the gross merchantable volume to a net merchantable volume and to approximate the volume depletion due to decay, firmwood waste and breakage due to harvesting;

“**DIB (Diameter Inside Bark)**” means the diameter of a tree, excluding bark;

“**Diopter**” means a method of denoting prism "size". A value of one diopter represents a right angled deflection of one unit per one hundred units in distance.

The formula for converting diopter size to BAF size (metric) is:

$$\text{BAF} = 10,000 / \left[1 + \left(\frac{200}{\text{diopters}} \right)^2 \right]$$

“Plot Sampling” means the estimation of volumes and grades by species within a cut block from sample plot measurements, and the determination of the sampling error associated with the plot estimates;

“Precision” means the closeness, to each other, of repeated measures of the same quantity, expressed as Sampling Error or Standard Error of the sample estimate;

“PRP” means plot reference point; a GPS waypoint located a short distance (e.g. 15 to 20 m) from the cruise plot. The bearing and distance to the cruise plot are calculated and measured from this point.

“PSYU (Public Sustained Yield Unit)” means a management area of Crown land, with similar forest attributes based on local samples. PSYU always overrides the tables determined by FIZ;

“Residual tree” means a tree which does not bear any of the following external indications of decay on or immediately adjacent to the bole of the tree: conk, blind conk, scar, fork or pronounced crook, frost crack, mistletoe trunk infection, rotten branches, dead or broken top

“Risk Group” means a grouping by expected "risk" or probability of average decay, waste and breakage. A combination of tree class, pathological indicators, Forest Inventory Zone and PSYU determines the Risk Group of an individual tree for volume deduction.

“RMS” means root mean square and is calculated by taking the square root of the average of the squared errors. It is a measure of precision, meaning that there is a 63 to 68% probability that the results will be within the RMS distance.

“Sampling Error %” means an expression of the accuracy of the sampling of the cruise, calculated as a percent of an estimated mean to a desired probability;

“Scale Based” means the stumpage payable is based on a scale of the timber harvested from the cutting authority in accordance with Part 6 of the Forest Act;

“Single Stem” means the removal of individual trees based on specific tree level criteria, regardless of harvest method. It includes helicopter single standing stem selection as defined in the Coast Appraisal Manual. Single stem removal, for the purposes of this manual, does not include the removal of trees based on spatial distribution or for silvicultural purposes, such as commercial thinning.

“Site Class” means a set of 4 site quality classes (good, medium, poor, low) which characterize the potential growth capacity of the minerals and moisture in the soil, as measured in tree height (metres) attained at the breast height age of 50 years;

“Soundwood” means soundwood as defined in the Scaling Manual.

“Standard Deviation (SD)” means the square root of variance. It characterizes dispersion of individuals about the mean and gives some idea whether most of the individuals in a population are close to the mean or spread out;

“**Standard Error (SE)**” means an expression of how close the sample mean is to the true mean. Two standard errors (2 SE) means there is a 95% chance that the true mean is within the sampling error of the cruise.

“**Stratification**” means the process of delineating strata boundaries within a subpopulation, where each stratum has unique characteristics such as species composition, height, stand volume or age;

“**Stratum**” means a specified portion of a sub-population area for which separate volumes and sampling statistics are calculated. A sub-population may be made up of one or many strata. Strata are commonly known as timber types;

“**Strip Line**” means a ribboned line located through the forest and tied to the boundary at one or both ends. Cruise plots are located at regular intervals along each strip;

“**Stubbed**” means the practice of harvesting or removing a portion of the tree so that part of the bole (stem) above stump height remains.

“**Stumpage Rate**” means a charge levied by the Crown determined in accordance with the policies and procedures approved for the forest region by the minister;

“**Suspect tree**” means a tree which bears one or more of the following external indications of decay on or immediately adjacent to the bole of the tree: conk, blind conk, scar, fork or pronounced crook, frost crack, mistletoe trunk infection, rotten branches, dead or broken top.

“**Tie Point**” means a specific point on the ground whose location is readily identifiable on a digital image, aerial photograph or map. (eg. road intersection, corner of a field or swamp, field located traversed or GPS station);

“**Timber Supply Area**” means large contiguous areas of Crown land on which an annual allowable cut is calculated;

“**Tree Class**” means a series of classes (nine) signifying age/maturity, presence of pathological indicators, and live/dead classification. This classification, in combination with pathological indicators and age in 10's, determines the appropriate risk group for volume deduction;

“**UTC**” means Coordinated Universal Time, the primary global time standard. It is defined more precisely than GMT as it is defined to the sub-second level.

“**UTM**” means Universal Transverse Mercator coordinate system, a two dimensional coordinate system that divides the earth into 60 zones.

“**Variable Plot Sampling**” means a method of plot sampling where the trees to be tallied are based on their size and not the frequency or density of trees in the stand. Each tree has its own plot radius and can be assessed with an angle gauge (e.g. prism or relaskop);

“Variance” is the mean of squared deviations of observations about a sample mean. (These deviations or differences from the mean are called residuals);

“Variation” is the difference, plus or minus, between two measurements or a standard and a measurement (e.g., standard of 7 and measurement of 5 gives variation of -2);

“Waste” is waste as defined in the Provincial Logging Residue and Waste Measurement Procedures Manual.

Terms of Reference

The *Forest Act*, Section 103 to 108 and regulations provide the statutory authority for the determination of stumpage rates for crown timber.

The *Forest Act*, Section 105, requires adherence to the policies and procedures approved for the forest regions by the Minister of Forests, Lands and Natural Resource Operations. The policies and procedures are used in the *Coast Appraisal Manual* and *Interior Appraisal Manual*, for determining stumpage rates charged for Crown timber.

The *Coast Appraisal Manual* and *Interior Appraisal Manual* specify that cruise data must be gathered and compiled according to procedures established in the *Cruising Manual* and the *Cruise Compilation Manual*. The *Cruising Manual* and *Cruise Compilation Manual* are approved by the Director, Timber Pricing Branch.

1.1.1 Calculation Conventions

Each calculation will be calculated to the nearest tenth. This is consistent with the data precision level of the compilation reports.

The rounding rules to be used in this manual are the same as those in the *Cruise Compilation Manual* (see Appendix 16 of the *Cruise Compilation Manual*). (i.e. digits 0-4 are rounded down and 5-9 are rounded up).

For example, meeting a check cruise standard:

- 10.03 = 10.0 and does not exceed 10.0%
- 10.05 = 10.1 and exceeds 10.0%

For example, meeting a minimum threshold:

- 34.99 = 35.0 and meets the 35.0% threshold
- 34.94 = 34.9 and does not meet the 35.0% threshold

2.3 Sampling Error Objectives

Unless otherwise specified, sampling error objectives are based on full measure and count plots and are based on the total stand net merchantable volume prior to any partial harvest reductions.

The following standards apply to both clearcut and partial retention harvest systems.

For cutting authorities ≥ 250 ha (net merchantable area), the largest grid to be used in each type between full measure plots is a 250 metre square or staggered grid (6.25 ha per full measure plot).

For cutting authorities < 250 ha (net merchantable area), the largest grid to be used in each type between full measure plots is a 200 metre square or staggered grid (4.0 ha per full measure plot).

For coastal and interior cruises, a ratio of three (3.0) count plots to one (1.0) full measure plot cannot be exceeded on the cruise plan even if sampling error is achieved.

For cruises where cruise grades will be used in the appraisal, the minimum tree count must be met even if the sampling error requirement has been achieved.

For coastal cruises where cruise grades will not be used in the appraisal and for all interior cruises, there is no required minimum number of trees per plot when the sampling error requirement is achieved.

The minimum tree count requirements include tree classes 1, 2, 3, 5, 7, 8, 9 and not tree classes 4 and 6.

There is no need to change count plots to measure plots in the field if measure plots are dropped due to boundary influence in the field, provided the correct measure/count ratio is identified on the cruise plan and the minimum number of measure plots per type has been achieved (see Section [2.4.2](#)).

The following table serves as a guide to the various cruising standards itemized below:

Situation		Applicable section that details scaling standard	
Rights of Way		2.3.6	
Coastal Cutting Authority	Great Bear Rainforest North (excl. that part of TFL 25 within the Coast Mtn. and North Isl. Central Coast Forest Districts, and Forest Licenses A91438 and A94535)	Cruise Based Cutting Authority	2.3.5
		Cruise Based Road Permit	2.3.6 (1), 2.3.6(2)
		Road Rights of Way appraised with adjacent cutblocks	2.3.6(3)
	Non-Great Bear Rainforest North	Cruise Based Cutting Authority	2.3.4
		Scale Based Cutting Authority	2.3.1
		Road Rights of Way appraised with adjacent cutblocks	2.3.6(3)
Interior Cutting Authority	At least 35% of net merchantable volume of all coniferous species is red and grey attack Lodgepole Pine		2.3.3
	Less than 35% of net merchantable volume of all coniferous species is red and grey attack Lodgepole Pine	General Cruise Based	2.3.2
		Scale Based	2.3.1

For further guidance, refer to *Policy 13.7 Timber Cruising* at the following Internet site:
<https://gwww.nrs.gov.bc.ca/flnr/timber-pricing/timber-measurement-policies>

2.3.1 Scale Based Cutting Authorities

- Unless otherwise stated, the scale-based cutting authority sampling error objective is 15.0% at 2 SE based on the total stand net merchantable volume prior to any partial harvest reductions.
- Single Stem – the options are:
 - i. 100% cruise of the cut trees,

- ii. Achieve at least a 15.0% sampling error on the cut trees at 2 SE using variable radius plots, or
- iii. Sample using at least 2 variable radius measure plots/ha and at least 2.0 cut trees/plot.

The sampling error requirement will be waived if the following three conditions have been met:

1. A systematic grid of equal intervals (square or staggered, but not rectangular) and spacing of 100 metre by 100 metre, or less, has been established in each type,
2. a. For cutting authorities of 20.0 ha net merchantable area or larger in size, a maximum ratio of 1.0 count plot to 1.0 full measure plot has not been exceeded, or
b. For cutting authorities less than 20.0 ha net merchantable area in size, only full measure plots are used, and
3. An average of at least 4.0 trees per plot per block has been met.

If the minimum tree count cannot be achieved with a BAF 2 prism, then the minimum tree count requirement will be waived.

2.3.2 General Cruise Based Cutting Authorities – Interior Only

The following standards apply to all general cruise based cutting authorities within the Interior as described in the *Interior Appraisal Manual*:

1. 8.0% at 2 SE on all plots, and
2. If count plots are used, a 2 SE of 12.0% on full measure plots must be achieved.

All other scale based standards apply, except that the sampling error cannot be waived.

2.3.3 Mountain Pine Beetle Cruise Based Cutting Authorities

The following standards apply to all MPB cruise based cutting authorities:

1. Each block within the cutting authority must contain at least 35% red and grey attack Lodgepole pine net merchantable volume of all coniferous species. The net volume is the post-reduction cruise volume compiled to the interior standard merchantability specifications.
2. Cutting authorities must:
 - achieve a 12.0% sampling error objective at 2 SE using measure and count plots, or
 - the sampling error will be waived as per the scale based standards specified in section 2.3.1(1) or (2).

3. Cutting authorities that do not meet the MPB standards must meet the standards in section 2.3.2 to be a cruise based cutting authority.

2.3.4 General Cruise Based Cutting Authorities – Coast Only

The following standards apply to all general cruise based cutting authorities within the Coast area as described in the Coast Appraisal Manual:

Cutting authorities must:

1. achieve a 10.0% sampling error objective at 2 SE using measure and count plots, and an average of at least 4.0 trees per plot per block, or
2. The sampling error will be waived if the following conditions have been met:
 - a. For cutting authorities of 40.0 ha net merchantable area or larger in size:
 - i. A systematic grid of equal intervals and spacing of not greater than 100 metres by 100 metres has been established, and
 - ii. Only full measure plots are used and an average of at least 4.0 trees per plot per block has been met.
 - b. For cutting authorities less than 40.0 ha net merchantable area in size:
 - i. A systematic grid of equal intervals and spacing of not greater than 70 metres by 70 metres has been established, and
 - ii. A maximum ratio of 1.0 count plot to 1.0 measure plot has not been exceeded and an average of at least 4.0 trees per plot per block has been met.
 - c. In addition, within any stand-alone polygon less than 5 ha net merchantable area in size (regardless of cutting authority size) the following requirements must be met:
 - i. A systematic grid of equal intervals and spacing of not greater than 70 metres by 70 metres has been established, and
 - ii. A maximum ratio of 1.0 count plot to 1.0 measure plot has not been exceeded.

Cruise based cutting authorities under this section, other than BCTS sales, will not require loss factor cruising as Call Grade Net Factor (CGNF) cruising will be used for appraisal purposes. BCTS must continue to collect both loss factor and CGNF cruise data until CGNF is fully implemented across the Coast for appraisal purposes.

Please note that for general cruise based cutting authorities within the Coast area, percent reductions (See Section 5.9) are not permitted and the net merchantable volume will be based upon 100% removal of the net merchantable area.

2.3.5 Cutting Authorities within the Great Bear Rainforest North

The following standards apply to all cruise based cutting authorities, except road permits and road permit amendments, within the Great Bear Rainforest North (GBRN) as defined within the Coast Appraisal Manual:

Cutting authorities must:

1. achieve a 10.0% sampling error objective at 2 SE using measure and count plots, and an average of at least 4.0 trees per plot per block, or
2. The sampling error will be waived if the following conditions have been met:
 - a. For cutting authorities of 40.0 ha net merchantable area or larger in size:
 - i. A systematic grid of equal intervals and spacing of not greater than 100 metres by 100 metres has been established, and
 - ii. Only full measure plots are used and an average of at least 4.0 trees per plot per block has been met.
 - b. For cutting authorities less than 40.0 ha net merchantable area in size:
 - i. A maximum ratio of 1.0 count plot to 1.0 measure plot has not been exceeded,
 - ii. An average of at least 4.0 trees per plot per block has been met, and:
 - a) A systematic grid of equal intervals and spacing of not greater than 70 metres by 70 metres has been established, or
 - b) A systematic grid of full measure plots not greater than 100 metres by 100 metres has been established with count plots offset halfway between the measure plots along either the North-South or East-West grid lines.
For example, where ‘o’ represents measure plots and ‘x’ represents count plots, the following two designs are acceptable:



Cutting authorities in the Northern GBR will not require CGNF cruising as loss factor cruising will be used for appraisal purposes. The exception is BCTS who must continue to collect both loss factor and CGNF cruise data until CGNF is fully implemented across the Coast for appraisal purposes.

2.3.6 Right of Way Cruises

- 1) Cruises of rights of way or cruise based road permits and amendments in the Great Bear Rainforest North (GBRN) must meet the following:
 - a) 10.0% sampling error requirement at 2 SE using variable radius plots, or
 - b) The sampling error will be waived if the following conditions have been met:
 - i) An average of at least 4.0 trees per plot per block has been achieved, and
 - ii) Full measure variable plots have been established along the road centre line using a grid spacing that will achieve a minimum of 2.0 full measure plots per hectare. Type polygons less than 1.0 hectare must contain 2 full measure plots. The first plot is to be located at half the calculated grid spacing along the first tributary road that accesses the cutblock.

In the GBRN, if the minimum tree count cannot be achieved with a BAF of 12.25 (or less), then the minimum tree count requirement will be waived.

When sampling road segments under road permit they must be compiled as blocks that are clearly defined on the cruise plan maps. A block may contain multiple road segments.

- 2) For cruise based road permits or road permit amendments in the Great Bear Rainforest North, where timber on the road right of way within a cutblock is removed under the road permit (RP), instead of the cutting permit, all cruise plots from the timber type within the block containing a road segment may be used in the cruise compilation for the RP. For these segments:
 - a) The area of the RP must be removed from the CP's cruise compilation,
 - b) Road segments internal to a block or type must be typed separately from the external road segments.
- 3) Where BCTS or Coastal Cruise Based (see Sections 2.3.4 and 2.3.5) road rights of way external to a cutblock are to be cruised and appraised with the cutblock harvest area, the following three options are available:
 - a) Extend the cruise grid of the adjacent timber type through the road right of way and establish any plots that fall within the right of way, or
 - b) Identify the road right of way as a separate type at the cruise plan stage, and:
 - i) Establish full measure variable plots along the right of way centre line using a grid spacing that will achieve a minimum of 2.0 full measure plots per hectare. Type polygons less than 1.0 hectare must contain 2 full measure plots. The first plot is to be located at half the calculate grid spacing within that type.
 - c) Submit a rationale from a qualified registered professional stating the cruise data from the cutblock is representative of the road right of way area.
- 4) For scale based authorities, where timber on a road right of way within a cutblock is removed under a road permit (RP) after the block is cruised, the cruise plots that are within the area of the RP shall be included in the cruise compilation for the cutting permit and the area of the RP will be removed from the cruise compilation.
- 5) Right of way areas not removed under the road permit must be included in the net merchantable area and must be sampled.

2.5.4 Schedule "A" (Private) and Schedule "B" (Crown) Lands

Cutblocks containing more than one type of land, as per the following table, are to be cruised and compiled as follows:

Cutblock Configuration	Can Be Cruised As One Type?	Additional Compilation Requirements
Schedule A (Private) and Schedule B (Crown) Land	Yes	Schedule A and Schedule B lands are to be compiled separately. <i>Do not include plots established in Schedule A (private) land in the Schedule B (Crown) compilation if Schedule A lands are typed out separately from Schedule B lands.</i>
Tree Farm Licence (TFL) and Timber Licence (TL)	Yes	A separate summary page for each timber mark is required.
Timber Licence and other Crown land not in a TFL (i.e. Forest Licence)	Yes	Timber Licence and other Crown lands are to be compiled and appraised separately. <i>Do not include plots established in Timber Licence land in the Forest Licence (FL) compilation if TL lands are typed out separately from the FL land.</i>

For the scenarios listed above, if a timber type includes more than one type of land, all plots within that type of land must be included in each of the required compilations.

2.6 Types of Cruises

2.6.1 One Hundred Percent Cruise

A 100% cruise requires that all trees are measured as per the appraisal specifications.

Each tree in a 100% cruise cutting authority must be numbered or marked as a cut tree.

2.6.2 Fixed Area Plot Sampling (See Section 4.3.1.13)

Fixed area plot sampling is a method of using sample plots with a fixed size (area) for selecting the trees to be tallied. The plots are normally circular or square. It is also known as sampling without replacement since trees are not included in more than one sample plot.

The fixed area plot size must be consistent by timber type and count plots are not permitted in fixed area plots. Border plots are permitted in fixed area plots.

For additional information on fixed area plots and calculating sample size, please see the appendix on Additional Sampling Information.

2.6.3 Variable-Plot Sampling (Prism or **Relaskop**)(See Section 4.3.1.15)

Variable plot sampling is a method of selecting trees to be tallied based on their size and not the frequency or density of the trees in the stand. The main advantage with using the variable plot instead of the fixed area method is that the probability of tree selection is proportional to the size (basal area at breast height) of the tree. Variable plots are more efficient to measure than fixed area plots because a plot perimeter is not required since every tree has its own plot radius and can be assessed for in/out status with an angle gauge (e.g., prism or **relaskop**).

For additional information on variable plot sampling, calculating sample size, and calculating coefficient of variation (CV) please see the appendix on Additional Sampling Information.

Table 3-5 DBH Measurement Standards

Diameter at Breast Height (DBH)		
Live and dead potential trees.	a.	At least 90.0 percent of individual stems checked must be within 2.0 percent of true DBH.
	b.	Average absolute variation of all DBHs checked must be within 2.0 percent of the original DBHs.

Dead useless trees should be estimated to the nearest 5cm DBH class.

8 – Quality Remarks (Sections 4.3.2.8)

The following standards apply to the assessment of tree quality remarks used in coast appraisals only:

- 1. Pathological indicators:** At least 90.0 percent of the individual indicators that occur in the middle or lower third must be coded in the correct third of the tree.
- 2. Quality indicators:**

For All Check Plots – At least 90.0 percent of all quality indicators checked must be within plus or minus one code change. The exceptions are:

- Knot codes 5 and 6 are not allowed any variation.
- Spiral Grain – if the check code is greater than 4 and the original is less than 5, or vice versa, it is an error.

3.5 Survey and Area Measurement Standards

This section outlines the distance and area measurement standards used to locate plots and or harvest boundaries. Cruisers or check cruisers may use any appropriate method to measure and or initially verify a distance or area. For audit purposes, the true distance and or area measure may be derived from conventional measurement systems such as a survey chain and compass except when GPS is used to establish cruise plot locations. In these situations, plot location must be audited using a GPS unit that meets the standards specified in this section.

1 – Strip or Tie Lines (Conventional Methods Only - Sections [4.3.1.4](#) and [4.3.1.5](#))

Strip lines are only used with conventional measurement systems (i.e. without GPS technology).

The following standards apply to the strip or tie line measurements used to locate the plot centre. These standards apply from plot to plot or for any combined strip interval distance. The check cruiser will follow the same route (i.e. direction of travel) that the original cruiser traversed. The plot will be re-cruised if the plot location is not within the following standards:

Horizontal distance: plus or minus 2.0 percent (2.0 m per 100m).

Bearing: plus or minus 2.0 degrees (+/- 3.5 m per 100m).

Plus or minus 2° - this translates to 3.5 m in 100 m using the formula:
(100 * (tan 2 degrees)) = 3.49 percent, therefore: 3.49 percent * 100m = 3.49m (rounds to 3.5).

Moving plot centres from the measured/ traversed location presents significant bias and is not permitted in any case.

2 – Plot Measurements (Section [4.3.1.5](#))

Establishing Cruise Plots Using Conventional Methods

The standards applied to the distance measurement used to locate the plot reference tree and the plot are shown in Table [3-6](#):

Table 3-6 Plot Distance Standards

Attribute	Maximum Variation
Plot centre reference tree to plot centre	Plus or minus 1.0 percent of horizontal distance
Radius - fixed and variable radius plots	Plus or minus 1.0 percent of horizontal distance
Length and width: fixed rectangular plots	Plus or minus 1.0 percent of horizontal distance

Establishing Cruise Plots Using GPS Technology

As of November 1, 2014, cruises may be rejected for not meeting the standards in this section when GPS is used to establish cruise plots.

In order to use GPS technology to establish cruise plots, the GPS receiver must meet the following standards:

- Able to achieve submetre accuracy under ideal conditions (i.e. open area, no interference, good satellite coverage)
- Real time correction system with external antenna
- Minimum satellite elevation angle/mask is 15 degrees above the horizon
- RMS (Root Mean Square) minimum rating of 100 cm

If GPS is used to establish cruise plots, the following data must be submitted to the Ministry in a Plot Reference Point (PRP) table (if requested as per Section [3.8](#)):

- Cutblock
- Timber type
- Cruise plot number
- Horizontal Distance (m) from PRP to Cruise plot - *must be a minimum of 5.0 m horizontal distance*
- Calculated bearing (degrees) from PRP to Cruise plot
- Average PDOP – *maximum of 6.0*
- Average HDOP – *maximum of 4.0*
- Number of satellites when establishing PRP – *minimum of 4*
- Number of hits received when establishing PRP – *minimum of 50 hits*
- Mean difference of hits in metres (MDH) – *maximum of 1.0*
- Time of PRP establishment – specify UTC or GMT
- PRP coordinates – specify UTM or BC Albers *
- Cruise plot coordinates - specify UTM or BC Albers *

The required format of the PRP table is shown in Table [3-7](#).

*The map projection system used (i.e. BC Albers, UTM, etc.) must be consistent with the cruise plan.

Table 3-7 Sample of Required Format for PRP Table

CB	T Y P E	P L O T	H D (m)	B R G (°)	P D O P	HD OP	# S A T	# H I T	MDH (m)	Time (UTC)	PRP Easting	PRP Northing	PT Easting	PT Northing
											UTM	UTM	UTM	UTM
7	2	1	16.6	110	3.4	1.9	6	50	0.3	144144.00	683417.473	5657508.768	683433.292	5657503.723
7	2	2	9.7	329	3.9	2.3	8	50	0.1	163211.00	682934.854	5657577.685	682929.529	5657585.834
7	2	3	8.9	157	2.3	2.9	8	50	0.5	181932.00	683125.834	5657600.981	683129.624	5657592.922
7	2	4	11.6	063	2.0	1.7	9	50	0.4	214811.00	683219.529	5657590.781	683229.672	5657596.466
7	2	5	11.7	349	2.0	2.2	9	50	0.2	220113.00	683332.437	5657588.624	683329.720	5657600.010

Cruise plots that are located with GPS must meet the following standards. In order for a cruise to be rejected for cruise plot location data, either both of the first 2 standards (1 and 2) must be exceeded or the last standard (3) must be exceeded:

1. The average absolute variation of all cruise plot locations checked must be within 3.0 m of the check cruise plot locations.
2. The Circular Error Probability standards:
 - a) 50.0% of all cruise plots checked must be within 2.5 m of their respective check cruise plot locations, and
 - b) 90.0% of all cruise plots checked must be within 5.0 m of their respective check cruise plot locations.
3. The distance and bearing between the cruiser's PRP and cruise plot must meet the same standards as those for conventional methods:
 - a) Horizontal distance: plus or minus 2.0 percent
 - b) Bearing: plus or minus 2.0 degrees

In order to require a re-cruise based on these standards, a minimum of 5 cruise plot locations or 10% of the cruise plot locations, whichever is greater, must be checked with a GPS unit that meets the aforementioned standards.

For additional information on precision standards for GPS plot locations, please see Circular Error Probability Method in the appendices.

At each cruise plot that is checked for plot location (GPS or conventional), a count plot will be completed at the check cruise plot location using the same BAF as the original cruise plot. The count plot data will be tracked to enable the Ministry to compare trends and variations between original and check cruise data over time.

4.3 Front Side of Cruise Tally Sheet (FS 205)

The following section identifies the card position and information required following the format of the Cruise Tally Sheet. Where digital data capture software is used, the information collected must follow the format and standards of the Cruise Tally Sheet.

4.3.1 Card Type 9

This card is to be completed for every new plot. The data on this card provides the plot attributes. Optional fields are identified. These fields should be entered if known. Where fields are not identified as optional, they are considered mandatory.

4.3.1.1 Positions 2 to 7 Licence Number (Optional)

Enter the license as provided by the Licensee. This may be Alpha/numeric, and cannot exceed 6 spaces.

4.3.1.2 Positions 8 to 10 Cutting Permit (Optional)

Enter Alpha/Numeric, cannot exceed 3 spaces.

4.3.1.3 Positions 11 to 13 Block (within the Cutting Permit)

Enter: Alpha/Numeric, cannot exceed 3 spaces. Enter only 3 spaces for blocks with more than 3 digits/letters in the block name. (i.e. block ABC123 may be entered as 123, and identified in its entirety in the compilation program for reporting purposes)

4.3.1.4 Positions 14 to 15 Strip Number (Number of Strip on which Plot is Located, if strips are used).

If no strip lines are used, these two spaces may be utilized in cruises with 3 or 4 digit plot numbers.

When using strip lines, they will be run using compass, clinometer and metric surveyor tape or electronic measuring devices. Allowances for slope must be made since all distances must be horizontal. (See Horizontal Distance Correction in Appendices) Strip lines will be marked with survey tape so they can be used to locate plots in the future.

Where used, all of the cruise strip lines must be linked to the boundary. The tie point or reference point of each strip line must be well established on the ground so that it may be found at a future date.

4.3.1.5 Positions 16 to 17 Plot Number or Letter

Will accept alpha/numeric designations.

Plots are to be numbered without duplication on the same strip line (if used).

Three digit plot numbers may be truncated to 2 digits in some compilation software.

Moving plot centres from the measured/ traversed location presents significant bias and is only permitted in accordance with Section 0. If the plot cannot be completed safely, it will be dropped and the reason documented.

Plot Establishment Procedures for Both Conventional Methods and GPS Technology

The following are the steps to be taken when establishing cruise plots:

1. Travel the distance and bearing identified on the cruise plan or map.
2. When the required distance has been measured, a stake, pin or equally effective marker must be established at the plot centre. If this location is within a tree, mark the plot centre with an "X" at the point on the tree. The plot centre is the point at which the marker enters the ground and not the top of the marker.
3. A reference point (RP) must be recorded in the traverse notes or on the cruise tally card. It is acceptable to use a reference tree that is a tallied tree within the plot. The slope or horizontal distance and bearing from plot centre to either a marked point below stump height (preferred) or the nearest point on the tree at breast height must be recorded. The cruiser should record whether they measured slope or horizontal distance and to which part of the tree the measurements were taken (breast height or stump height). The reference point will be used to determine the position of the plot centre if the original plot marker is missing and should be permanent enough to be available at the time of check cruise.

Establishing Cruise Plots using Conventional Methods

For cruises using conventional methods, the cruise must originate from valid tie points such as map locations like road locations, falling corners and GPS positions. The cruise must be tied to at least one (1) and preferably two (2) tie points. Tie points must be linked to the cruise grid with an accurate traverse.

A map feature (falling corner, junction, etc.) or GPS station must be selected to establish the Point of Commencement (POC).

Establishing Cruise Plots using GPS Technology

As of November 1, 2014, cruises may be rejected for not following these procedures when GPS is used to establish cruise plots.

1. Use the GPS to navigate to the cruise plot.

Sampling Procedures

The cruiser holds the prism exactly over plot centre and looks at a tree across the upper edge of the prism, and so views it simultaneously above the prism and also through the prism. The tree image seen through the prism will be laterally displaced. The prism must be over the sample centre as the prism forms the vertex of the angle being projected.

If the displacement is greater than the diameter of the tree, the tree is "out"; if smaller the tree is "in"; if the same, the horizontal distance to the tree must be measured because it is borderline (see [Figure 4.4 "In", "Out" and "Borderline" Trees.](#)). The prism will be "swept" around plot centre and all live and dead trees equal to or larger than the minimum specified size for the "in plot" trees will be recorded.

The cruiser must pay special attention when assessing the trees as "in" or "out". An oddly shaped tree may appear to be "in" or "out" when viewed through a prism from the plot centre, but may have different results if measured using the borderline measurement method.

If a shatter extends through DBH and either the standing or down portion of the tree fall outside of the plot, use the portion of the tree with greater than 50% of the basal area at breast height to determine if the tree is "in" or "out" and assign applicable damage codes (See [Section A.6.3](#))

If a boundary tree is to be harvested or stubbed and it is "in", apply the walkthrough method and record its details once or twice as identified in the walkthrough method procedures.

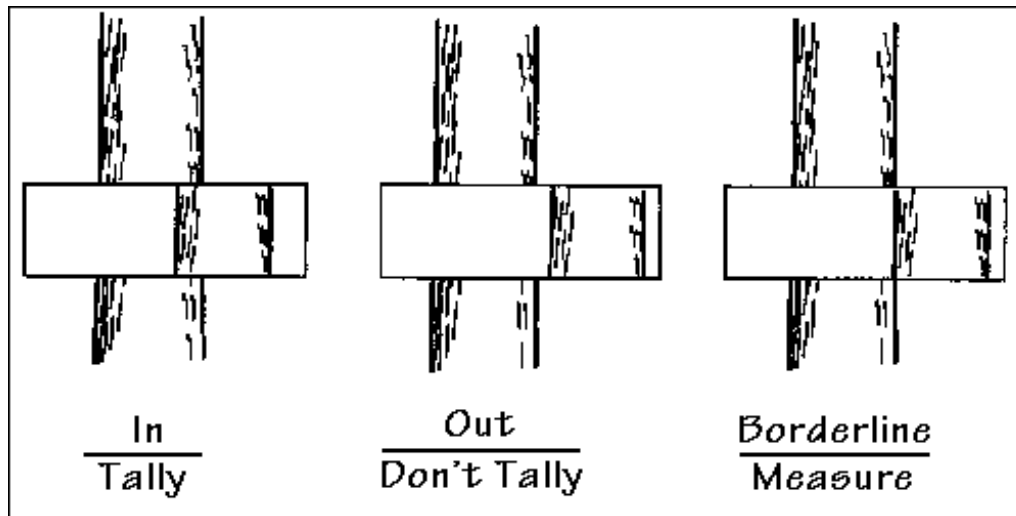


Figure 4.4 "In", "Out" and "Borderline" Trees.

BAF Selection

Changing BAFs within a timber type polygon may introduce a bias in the reporting of summary stand statistics. The BAF may be changed once within each timber type polygon. Once the

change is made, the BAF cannot be changed again regardless of stand composition. More than one BAF change in a timber type polygon may result in the rejection of the cruise. The determination of the BAF must not be made at plot centre. When a BAF change is made, the location of the BAF change must be noted on the cruise field notes or cruise cards.

The BAF may only be changed to a BAF value within 50% of the original BAF value, unless there are extenuating circumstances and a professional rationale is provided. For example, if the original BAF selected is 10 and a new BAF is selected, the new BAF must be between 5 and 15. If the original BAF selected is 14, the new BAF must be between 7 and 21.

Prism Slope Correction

Since each tree on the area may have its own unique slope angle from the centre, each tree must be considered individually in making slope corrections (see [Horizontal Distance Correction](#) in Appendices). In borderline situations, trees are to be measured as described in the following section.

Borderline Trees (Variable Plot Cruises)

When sighting a tree through a prism or *relaskop*, the exact in/out status cannot always be determined. The correct status of borderline trees in measure and count plots must be determined by using the following procedure:

1. Determine the horizontal distance from the plot centre to the face of the tree trunk at breast height. The plot centre is the point at which the plot marker (stake, pin, *etc.*) enters the ground and not the top of the marker.
2. Add one half of DBH to the horizontal distance to determine the horizontal distance from the tree centre to the plot centre.
3. Multiply the plot radius factor times DBH. This represents the plot radius for the tree. In variable cruising every tree has its own plot radius depending on its diameter and the angle of the prism being used (see Variable Plot Sampling in Appendices).
4. If the horizontal distance from the tree to the plot centre is less than or equal to the plot radius, the tree is considered "in". If the horizontal distance from the tree to the plot centre is greater than the plot radius, the tree is considered "out".
5. Record the measured slope distance and slope percent on the cruise tally card and run a single pencil line through the tree details if the tree is "out".

All "borderline" trees must be measured and the measurements recorded for checking purposes.

Measure the bearing and distance from the plot centre to the centre of the “in” tree and then measure an equal distance beyond the centre of the tree on the same bearing from plot centre. Record the tree details twice if the measurement is outside the cruise area. Record separate tree numbers for each tree. Record the tree details once if the measurement is inside the cruise area.

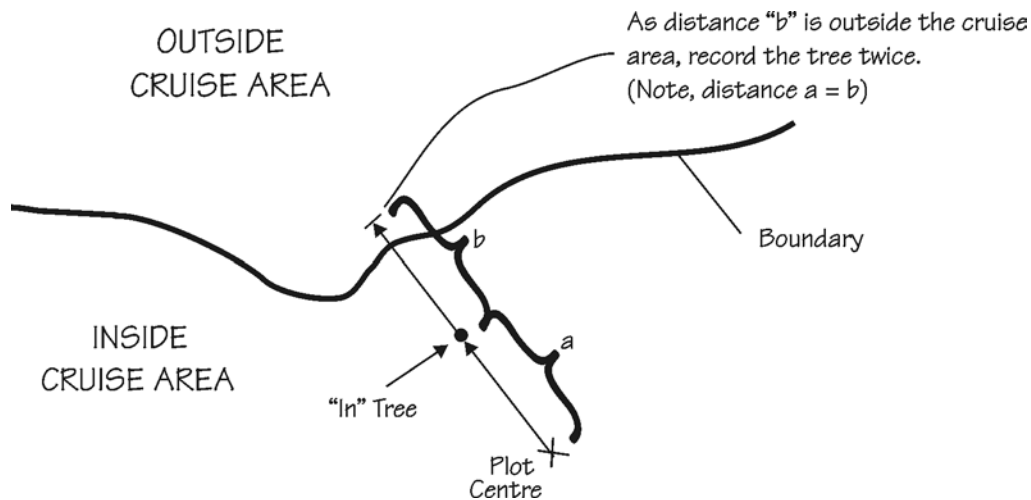


Figure 4.6 Walkthrough Method - Regular Boundary.

Use the walkthrough method at all flagged and traversed harvest boundaries, non-forest type boundaries identified on the cruise plan and road right of way centrelines (as specified later in this section).

Irregular Boundary – see [Figure 4.7 Walkthrough Method - Irregular Boundary](#).

If the point bearing and distance places the point back inside the cruise area then record the tree once.

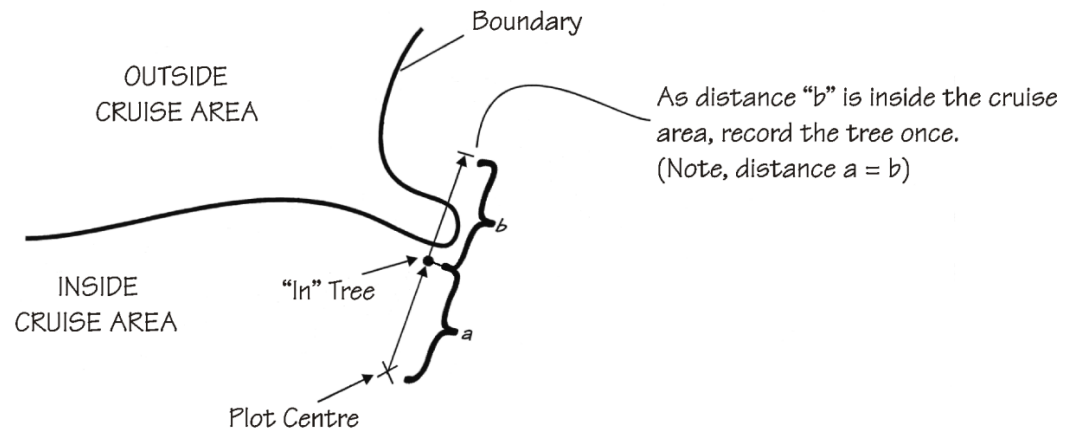


Figure 4.7 Walkthrough Method - Irregular Boundary.

Unmarked Boundary – see [Figure 4.8 Walkthrough Method - Unflagged and Harvested Rights of Way.](#)

When an unmarked opening boundary is encountered (e.g. a cleared road right of way, NP patch identified on cruise plan), the block edge for walkthrough purposes is determined by projecting a line between the outer most face of the merchantable trees on the edge of the opening. If this does not result in a reasonable block edge, then the edge may be determined by projecting a line along the edge that represents a normal stand form in that location.

If a non-harvested road right of way (R/W) forms the block boundary and the road R/W is to be harvested under road permit but is not marked in the field, the road centreline will be used as the block boundary. Removal of road R/W area under the road permit will remove area from the cutting permit, but the sampled cruise plots will be included in the cruise compilation for the cutting permit.

If a road centreline is used as a boundary rather than the correct block boundary, there will be a small bias involved with sampling area between the block boundary and road centreline. This small bias is acceptable to the MFLNRO.

If the road R/W is to be harvested under cutting permit or the licensee is not sure under what tenure the timber will be removed, the block harvest area and cruised area must include the full R/W boundaries (both sides of the centreline).

4.3.2.3.3 Deciduous Tree Heights

In order to obtain a reasonable height for deciduous trees, ensure the height is measured from an adequate distance from the tree when measuring the highest point. It is recommended that the angle of measurement is less than 100 percent. This will assist in distinguishing the highest point on the tree from lower branching or forks.

4.3.2.4 Positions 30 to 31 Species

All living and dead, standing and down trees which are listed in this section (except dead and down tree class 4 that do not meet the minimum CGNF standard on the Coast) and which meet or exceed the timber merchantability specifications must be recorded when present in a plot.

Enter the appropriate commercial species symbol. Genus symbol letters must be "Capitalized" or upper case. Species symbols should be upper case also (entry is left oriented).

Genus Symbols - These symbols must always be entered for the proper implementation of the volume equations and loss factors.

Species Symbols:

1. The specific symbol for broadleaf maple (Mb), the pines (Pl, Pw, Pa, Py), aspen (At) and cottonwood (Ac) must be entered for the proper implementation of the loss factors and volume equations.
2. The species symbols for other species such as the spruces, hemlock and balsams (*Abies* sp.) should only be used when positive identification can be made in the field and the appraisal requires it. Species specific symbols for *Abies amabilis*, *grandis* and *lasiocarpa* must be entered for Interior cruises. Coastal Call Grade Net Factor cruises must use species specific symbols for *Tsuga mertensiana* (Hm), if known. *Tsuga heterophylla* can use H or Hw.

4.3.2.4.1 Commercial Tree Species Names and Symbols

Common Name of Genus/Species	Scientific Name of Genus/Species	Genus Symbol*	Species Symbol*
Alder	<i>Alnus</i>	D	
Red Alder	<i>A. rubra</i>		Dr
Balsam (<i>Abies</i> sp.)	<i>Abies</i>	B	
Alpine fir	<i>A. lasiocarpa</i>		Bl
Amabilis fir	<i>A. amabilis</i>		Ba
Grand fir	<i>A. grandis</i>		Bg
Birch	<i>Betula</i>	E	
Common paper birch	<i>B. papyrifera</i>		Ep
Alaska paper birch	<i>B. neoalaskana</i>		En

Common Name of Genus/Species	Scientific Name of Genus/Species	Genus Symbol*	Species Symbol*
Cedar	<i>Thuja</i>	C	
Western red cedar	<i>T. plicata</i>		Cw
Cypress	<i>Chamaecyparis</i>	Y	
Yellow cedar	<i>C. nootkataensis</i>		Yc
Douglas-fir	<i>Pseudotsuga</i>	F	
Douglas-fir	<i>P. menziesii</i>		Fd
Hemlock	<i>Tsuga</i>	H	
Mountain hemlock	<i>T. mertensiana</i>	CGNF cruises	Hm
Western hemlock	<i>T. heterophylla</i>	CGNF cruises	Hw or H
Larch	<i>Larix</i>	L	
Alpine larch	<i>L. lyallii</i>		Li
Tamarack	<i>L. laricina</i>		Lt
Western larch	<i>L. occidentalis</i>		Lo
Maple	<i>Acer</i>	M	
Broadleaved maple	<i>A. macrophyllum</i>		Mb
Pine	<i>Pinus</i>	P	
Lodgepole pine	<i>P. contorta</i>		Pl
Western white pine	<i>P. monticola</i>		Pw
Whitebark pine	<i>P. albicaulis</i>		Pa
Yellow pine	<i>P. ponderosa</i>		Py
Poplar	<i>Populus</i>	A	
Aspen	<i>P. tremuloides</i>		At
Balsam poplar	<i>P. balsamifera</i>		Ac
	<i>sub. sp. Balsamifera</i>		
Black cottonwood	<i>P. balsamifera</i>		Ac
	<i>sub. sp. trichocarpa</i>		
Spruce	<i>Picea</i>	S	
Black spruce	<i>P. mariana</i>		Sb
Engelmann spruce	<i>P. engelmannii</i>		Se
Sitka spruce	<i>P. sitchensis</i>		Ss
White spruce	<i>P. glauca</i>		Sw
Yew	<i>Taxus</i>	T	Optional
Western Yew	<i>T. brevifolia</i>		

* The bolded symbols are the standard to be used for operational cruises. *Species* symbols which are not bolded may also be used if required. The symbol(s) chosen must be used consistently in all plots. The genus symbols M (maple), P (pine) and A (poplar) cannot be

Dead potential Lodgepole pine will use Risk Group 2 loss factors unless the tree has conk or blind conk. If a dead potential Lodgepole pine has conk or blind conk, it will use the highest risk group.

Tree Class 8 (Younger Immature)

Tree Class 8 trees are younger immature living trees which are:

- a. Coniferous trees, other than Lodgepole pine, equal to or less than 80 years of age.
- b. Lodgepole pine trees equal to or less than 60 years of age.
- c. Deciduous trees equal to or less than 20 years of age.

Two exceptions exist:

- a. Aspen and Cottonwood in FIZ K and L where tree classes 8 will be used for trees less than 81 years of age,
- b. Coastal cruises where the age in 10's is 13 or 14, tree class 8 will be used for trees equal to or less than 120 years of age.

Tree Class 9 (Dead Potential; Younger Immature Dead Potential in Interior)

Tree class 9 dead potential trees are immature and contain at least 50.0% of the tree's original volume. Tree Class 9 shares the characteristics of both the immature dead potential (Tree Class 3) and younger immature tree classes (Tree Class 8). Therefore, the guidelines for Tree Class 3 and Tree Class 8 apply.

Ages

In over mature stands, the establishment of age is not critical except for interior cedar over 141 years as it requires a different top diameter for compilation.

The age correction to breast height is found in the Site Index Tables for British Columbia – All Species in the appendices.

Tree class 3, 7 and 9 trees – record age as counted and corrected. Do not add the number of years that the tree has been dead.

Age of sample trees is determined by a ring count from an increment borer core, taken at diameter breast height (DBH). The pith must be included in the core to properly count the age of the tree. In cases where the pith is not contained in the core, and is missed by an estimated three years or more, the tree must be re-bored.

Sufficient trees must be bored for age to ensure the correct maturity classes, except Lodgepole pine where the inventory age will be used to determine the correct age classes. The number of trees that need to be drilled will be dependent upon the maturity profile in each plot.

Use the following procedure for determining the tree classes for interior Lodgepole pine (PL):

- Overlay the most recent Forest Cover Inventory or Vegetation Resource Inventory (VRI) polygon coverage on the cruise plan map.
- Identify the projected age or the age class code for each overlaying polygon. The projected age can be retrieved from the Vegetation Tab in Mapview or from the licensee forest cover mapping system. The age class codes can be retrieved from the most recent TFL or WL inventory maps.

<https://webmaps.gov.bc.ca/imfs/imf.jsp?site=mapview>

- The age of each interior Lodgepole pine tree tallied in a plot is the projected age or the corresponding age of the inventory polygon in which the plot is located.

Refer to the age class code from the table below to determine the corresponding age range.

Code Age	Age Class Limits	Allowable Tree Classes
1	1 to 20 years	8, 9
2	21 to 40 years	
3	41 to 60 years	
4	61 to 80 years	1, 2, 3
5	81 to 100 years	
6	101 to 120 years	
7	121 to 140 years	5, 7
8	141 to 160 years	
9	250 + years	

Note: Tree Classes 4 and 6 are allowed for all age classes.

Examples of determining PL tree age and tree classes:

1 - Mapview

The polygon projected age is 125 years old. Therefore, the PL trees in the plots in the polygon are classified as mature tree classes 5 or 7.

#2 - Tree Farm Licence

The polygon age class is 4, which corresponds to 61 to 80 years. Therefore, the PL trees are older immature tree classes 1, 2 or 3.

4.3.2.7 Positions 37 to 44 Pathological Remarks

Pathological indicators are recorded when observed on the bole or a merchantable secondary leader (see Section A.4.2) of the tree. The exceptions are:

- *Phaeolus Schweinitzii*, which will occur on the ground near the base of the tree.
- Scars on root collars.

There are qualifications to many of the pathological indicators, such as age of scars, position of fork or crook, size of rotten branches, *etc.* (please refer to Pathological Classification of Trees - Appendix 4, for a detailed description of pathology).

Pathological Indicators located above 10 cm top diameter (inside bark) are not to be recorded.

Refer to the box entitled "Path Code by Tree Third". This indicates the numerical coding to be used in this section. The tree is schematically divided into thirds, with the bottom (BOT) blocks representing the bottom third, the middle (MID) block the middle third, and the top (TOP) block the top third. The shading indicates in which third or thirds the defects occur based on the codes 1 through 7. If the defects occur in the bottom third only, "1" is entered in the defect column. If a defect occurs in both the middle and top thirds, "5" is entered; *etc.*

Path Code by Tree Third							
	1	2	3	4	5	6	7
TOP							
MID							
BOT							

The column heads under "PATH REMARKS" are self-explanatory except for the last two: "Rotten Br." means "Rotten Branch"; "D. or B. Top" means "Dead or Broken Top". All the pathological indicators listed must be recorded in the third(s) where they occur.

Refer to the Risk Group Ratings by Pathological Indicators in Table 18 for pathological occurrence by species and forest inventory zones.

Record the number of clear quarters for the first log (0.3 - 5.3 m from the high side of ground) and for the second log (5.3 - 10.3 m) as follows:

Code	Remarks
0	No quarters with knots (four clear quarters)
1	Knots in one quarter (three clear quarters)
2	Knots in two quarters
3	Knots in three quarters
4	Knots in four quarters
5	One to three knots, branches or stubs estimated to be greater than 10 cm dib, irrespective of the number of clear quarters.
6	Four or more knots, branches or stubs greater than 10 cm dib, irrespective of the number of clear quarters.

Epicormic branches are small sprout-type limbs that originate from dormant or adventitious buds. According to current literature, this type of branching is not generally prevalent on conifers except on the true fir (*Abies*) species. Since these branches do not originate from the pith and if present, live for only a short period (4-6 years), they have no effect on the quality of the wood.

4.3.2.15 Positions 52 to 56

These columns are not in use.

4.3.2.16 Position 59 Selective Cutting

L	leave tree
Blank or C	cut tree

4.3.2.17 Position 60 Miscellaneous

Root Rot	Description
J = light	Tree within a disease centre or within 10 m of a tree or stump that is symptomatic or killed by root disease.
K = moderate	Tree with root disease crown symptoms.
L = heavy	Tree with root disease confirmed by stain, decay, fruiting bodies or basal resinous.

Interior Dead Potential White Pine Log Grade Algorithm

Sap rot and weather checks can be collected in the root rot column, column 60.

The sap rot and weather check codes are as follows:

- a. record by tree third as per pathological indicator location codes 1 to 7,
- b. record codes 1 to 7 for tree thirds that will not be suitable to produce at least 50 percent lumber.

Refer to the Interior Dead Potential White Pine Log Grade Algorithm (Appendix 7) for a more detailed description of the algorithm.

The hemlock and dead white pine grade algorithms are used for interior appraisals. The hemlock algorithm is found in Section A.7.2 (Interior Hemlock Algorithm Flow Chart) and the white pine algorithm is found in Section A.7.1.3 (Dead Potential White Pine Log Grade Algorithm). Sap rot and suncheck codes are required for the dead potential white pine algorithm. The procedure is outlined in A.7.1.2.

4.3.2.18 Positions 61 to 63 Damage Codes

Damage codes are to be recorded as they appear at the time of the cruise with no attempt to predict the future condition of the trees.

The codes are for appraisal reporting purposes and for net volume adjustment purposes in the compilation.

All damage types will be compiled for net volume. Where multiple damage is recorded for a single tree, the most severe damage type will be compiled for that tree.

All damage types will be reported in the cruise as a percentage of the cruise net volume.

See the Damaged Stands appendix (Appendix 6) for further information.

5.2 Compilation Standard (Card Type B)

This card defines the standard of compilation and the output required for the cutting authority.

5.2.1 Position 11 Damage Reporting (required)

Identify whether damage is to be reported in the compilation. Damage must be reported for appraisal purposes, but is optional for non-appraisal compilations. If the value is left as blank, all damage will be compiled and reported.

5.2.2 Position 12 Selective/ Leave Tree Indicator (required)

blank	compile all trees (default)
C	compile only "C" indicated (cut trees) and blank indicated trees.
L	compile only "L" indicated (leave trees) trees.

5.2.3 Position 13 Double Sampling Indicator (required)

Indicates whether the compilation uses measure plots or a combination of measure and count plots. If the value is left as blank, all plots will be compiled. A value of 1 indicates that count plots should not be compiled.

5.2.4 Position 14 Special Compilation (required for interior cruises)

If the cutting permit occupies both Wet and Dry Belt BEC zones, subzones or variants, compile using the zone with the highest Douglas fir total net volume based on the post reduction cruise data. Wet/Dry Belt code is not a compilation check item if the compilation does not include any Douglas fir volume.

WET AND DRY BELT DOUGLAS FIR ZONES		
	Biogeoclimatic Zone	Biogeoclimatic Subzone and Variant
Wet Belt Code = 1	ESSF (Engelmann Spruce - Subalpine Fir)	dc, dk, dm, dv, mc, mk, mm, mv, mw, vc, vv, wc, wk, wm, wv
	ICH (Interior Cedar Hemlock)	dk, dm, dw, mc, mk, mm, mw, vc, vk, w, wk
	IDF (Interior Douglas Fir)	mw, ww
	MS (Montane Spruce)	undifferentiated, mw
	SBPS (Sub-Boreal Pine - Spruce)	dc, mc, mk
	SBS (Sub-Boreal Spruce)	undifferentiated, dh, dk, dw, mc, mh, mk, mm, mw, vk, wk
Dry Belt Code = 2	BG (Bunchgrass)	xh, xw
	ESSF (Engelmann Spruce - Subalpine Fir)	xc, xv
	ICH (Interior Cedar Hemlock)	xw
	IDF (Interior Douglas Fir)	undifferentiated, dc, dk1, dk2, dm1, dm2, dw, xh, xk, xm, xw
	MS (Montane Spruce)	dc, dk, dm, dv, xk, xv
	PP (Ponderosa Pine)	xh, dh
	SBPS (Sub-Boreal Pine - Spruce)	xc

If subzones are missing from the above listing, the general rule to apply is: very dry and dry subzones are Dry Belt; and moist, wet and very wet are Wet Belt.

5.2.5 Positions 15 to 16 Tree Class and Species Compilations (optional)

The default values for appraisal purpose compilations are zero. This will ensure that useless tree class volumes are excluded and all species are compiled in the same manner.

5.3 Type Description (Card Type C)

This section contains the area information for the types, harvest methods and treatment units within the compilation.

5.3.1 Positions 14 to 15 Type Number (required)

The type number corresponds to the type number on the cruise map for the area to be compiled within that type polygon.

5.3.2 Positions 16 to 28 Map Label and Type Identity (optional)

Timber types were traditionally given labels that followed inventory naming conventions, but this is not mandatory. For further information, see the [Timber Type Label Information](#) in the appendices.

5.3.3 Positions 29 to 88 Timber Type Area (required)

Record the merchantable timbered hectares for each timber type (stratum) and treatment unit in the cutting authority to the nearest 0.1 ha.

5.4 Block Description (Card Type D)

This card must have an entry for each type within a block. The number of blocks entered must equal the number of blocks entered on Card Type A (See Section [5.1.3](#))

5.4.1 **Positions 11 to 13 Block Number (required)**

The block number must correspond to the block number on the cruise card. The block number may be Alpha-Numeric, but cannot exceed 3 characters.

5.4.2 **Positions 14 to 15 Type Number (required)**

Enter the type number (see Section [5.3.1](#)).

5.4.3 **Position 16 Coast Block Maturity Indicator (required)**

I	Immature
M	Mature

Each block must be compiled as mature or immature. All types within a block must be cruised and compiled to the same timber merchantability specifications (immature or mature).

The cut block will be compiled using immature timber merchantability specifications if the immature volume is at least 50.1% of the total net volume (post reduction). Immature volume includes all coniferous and deciduous immature stems.

5.4.4 **Positions 17 to 76 Hectares/ Treatment Units (required)**

Enter the total net merchantable hectares to the nearest 0.1 hectare of the block which is part of each treatment unit in the block and type.

Treatment Units are geographic units allowing the user to prescribe different prescriptions within a type, block or harvest method area.

At least one treatment unit must be assigned in the compilation program. Up to ninety nine (99) treatment units are allowed within the current compilation programs.

5.9 FS 221 – Percent Reduction

This form ([Figure 5.3 Percent Reduction Worksheet.](#)) enables the reduction of stems and volumes by percentage points. The percent reduction must be consistent with the cutting specifications in the site plan and/or schedule B. Where dispersed faller selection or retention harvesting is to be used, a percent reduction must be applied. The reduction can be accomplished by a number of methods when the Forest Type Stand and Stock Table output has been **analyzed**.

When a range of stems per hectare is stated in the prescription (ex. site plan, schedule B), the percent reduction input will be based on the average number of stems within that range.

Special consideration must be given to whether dead trees will actually be reserved from harvest when identifying percent reductions. If tree class or live/dead status is not specified in the percent reductions, both live and dead trees will be reserved from harvest and must remain undamaged and on site.

For more information on percent reductions, please refer to Chapter 5 of the [Cruise Compilation Manual](#).

The approved methods of reduction for the dbh classes are:

1. By species, timber type, risk group/tree class and treatment unit.
2. By species, timber type and treatment unit.
3. By species, risk group/tree class, mature/second growth, live/dead and treatment unit.
4. By species and treatment unit:
 - a. Positions 1-2 - Species

These are the letter codes and all species letters must start in column 1. (Section [4.3.2.4](#))

- b. Position 3-4 - Timber Type

These are the numeric codes of the timber type.

- c. Position 5 – Risk Group or Tree Class

These codes are as follows:

CODE	RISK GROUP/ TREE CLASS
A	Risk Group 0 - Living Trees – not used at this time
B	Risk Group 1 - Living Trees
C	Risk Group 2 - Living Trees
D	Risk Group 3 - Living Trees
3	Tree class 3 - Dead Potential (Older Immature D.P. in the Interior)
4	Tree Class 4 - Dead Useless
6	Tree Class 6 - Live Useless
7	Tree Class 7 - Mature Dead Potential
9	Tree Class 9 - Younger Immature Dead Potential

- d. Position 6-7 - Silviculture Treatment Units (99 are available) - This is the unit.
- e. Position 8-10 - Block Number - This is the block number, code blank if for appraisal.
- f. Position 11 - Damage Code - This field corresponds to the damage types:


DAMAGE CODE	DAMAGE TYPE	INCLUDED CODES IN CRUISE DATA
B	Blowdown	E, G
F	Fire	A, B, C
I	Insect	1 to 8, X, Y
R	Root Rot	J, K and L

100 percent of the trees with the appropriate damage type code will be included in the appraisal data.

- g. **Position 13** - Code "L" for live trees and "D" for dead trees. These codes allow for live tree classes 1, 2, 5 and 8 or L (all) or dead tree classes 3, 7 and 9 or D (all) to be included in the appraisal compilation.
- h. Position 14-82 - Percent Reduction for dbh classes (e.g. 10 cm class = 7.5 - 12.4 cm). Use whole numbers only.

100 percent reduction means all trees will be excluded from the appraisal compilation.

A blank entry represents all values in a field.



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Natural Resource Operations

Ministry of
Forests, Lands and
Natural Resource Operations

CRUISE PERCENT REDUCTION WORKSHEET

SPECS		TIMBER TYPE		SPTREE CLASS		TREATMENT UNITS		BLOCK NO.		MATERIALITY		LAND		PERCENT REDUCTION BY D.B.H. CLASS																																	
																1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	35	40
Grid content																																															

FS 221 HVA 2016/04

Figure 5.3 Percent Reduction Worksheet.

5.10 Compilation Output

The cruise compilation shall accurately represent the area and net volume by species, grade, LRF, diameter class, timber type and risk group to be appraised and harvested and shall be compiled with the most recent version of the cruise compilation as of the date of the appraisal data submission to the MFLNRO.

The cruise compilation version must be approved by Timber Pricing Branch.

Modifications to the cruise compilation reports utilizing a calculator are not acceptable for initial compilations used in new appraisals. Manual or hand compilations shall only be used in exceptional cases as approved by the Regional Executive Director or their designate.

5.10.1 Summary of Required/Optional Reports and digital files

The following reports must be submitted electronically as specified in the *Interior* and *Coast Appraisal Manuals*:

Required for all compilations

1. Cruise Statistics
2. CP, Type and Block Volume Summaries
3. Detailed Plot Summary
4. Harvest and all Harvest Method Summaries
5. Appraisal Summary
6. Digital data in ASCII format (.dat, .pr, .red)
7. Digital data in csv file format (CP Summary, Block Summaries and Harvest Method Summaries - full and reduced, where applicable)
8. Percent reduction input values (when used)
9. Double sampling ratios (when count plots are used)

Required if requested by MFLNRO

1. Edit Report (data listing) of cruise data
2. Extended Timber Type Stand and Stock Tables
3. Partial Cut Damage Reports
4. Stand, Stock and Leave Tree Tables
5. Volume and Lumber Recovery Information

Required for Stump Cruises

1. Scattergram of all heights and diameters
2. Scattergram of sample trees/regression coefficients
3. Original scattergram of sample trees/regression coefficients, if suggested curve is overridden. Actual keyed values and explanation is required.
4. Edit Report if height curves used

Optional

1. Plot Summary by Maturity
2. Harvest Method Treatment Unit Summaries

If a percent reduction is being applied, the following reports will also be required:

- (i) the **original** reports before percent reduction was applied,
- (ii) the reports after percent reduction was applied, and
- (iii) percent reduction table showing keyed input values for the percent reductions.

The source documentation for percent reductions must be provided to the MFLNRO upon request.

5.10.2 Valid Compilation Programs

The valid compilation programs can be viewed at the following web link:

[Valid **Compilation** Programs](#)

6 Stump Cruising

6.1 Introduction

The methods described in this chapter are **prioritized** by safety considerations and the most accurate answer obtainable.

- all species, including deciduous, must be tallied,
- all stumps and/or felled trees, including non-merchantable (species and size) must be tallied,
- appropriate timber merchantability specifications will be used. Refer to Sections [4.3.1.16](#) and [5.2.7](#).
- if the volume can be isolated through the official scale, then utilize the scale volume plus a residue and waste volume for the area, and
- if there are situations that arise and the following methods do not apply, contact the Regional Cruising Coordinator in the area.

6.1.1 General Procedures

The standards provide the basis for the sampling system to be used, and the rules for consistent and accurate measurement and compilation of the stumps and tree heights.

The application of a 100 percent stump cruise of an area is currently the most accurate method of volume determination available to the Ministry of Forests, Lands and Natural Resource Operations where unauthorized harvest (UTH) has occurred. The 100 percent stump cruise methodology eliminates the chance of statistical variation that may be attributed to plot sampling.

The regression coefficients and equations used in the conversion of stump diameter to diameter breast height (DBH) are listed in the February, 1989 FRDA publication "Stump and Breast Height Diameter Tables for British Columbia Tree Species", report #062.

www.for.gov.bc.ca/hfd/pubs/Docs/Frr/Frr062.htm

Refer to the following tables in the appendices:

Butt Taper – Mature – FIZ A, B and C – Coast
Constants for Species and Zones

Crown cutting authorities specify a 30 cm stump height.

circumstances local factors apply to a portion of a FIZ. All volumes are reported in cubic metres by species.

6.1.3 Sampling Errors

Potential sources of sampling errors are:

- variation between the decay, waste and breakage for the FIZ and PSYU versus the actual site. The age in 10's and tree classes recorded on the stump cruise tally cards determine the maturity class and risk group,
- variation between the equation to convert from stump diameter to DBH versus the actual DBH. For example, the standard error for spruce noted in [FRDA report 062](#) is as follows:

Spruce: 1.46 cm - coefficients are based on a sample of 3054 trees in FIZ's K and L.

- variation between the calculated tree volume based on the volume equation and the actual volume. The only way to measure this variation is to fall/buck and scale trees from the same timber type that was harvested and perform a taper study, and
- variation between the height DBH curve and the actual tree heights for the harvested trees. The important factors are that the timber type used for the source of the tree height data is similar to the harvested timber type and the full range of diameter classes measured in the stump cruise are represented in the height curves.

6.2 Boundaries

- Locate legal survey posts and confirm the boundary location. Re-establish cut block boundaries from original traverse notes if necessary.
- Closed traverse the UTH area to the tolerances set out in Section 3.5 of the *Cruising Manual* under cruise based allowable errors.
- If the **unauthorized** harvest will result in an administrative penalty under Section 52 of the *Forest and Range Practices Act* and Section 13 of the *Administrative Orders and Remedies Regulation*, then a closed traverse of the area will be required since the penalty levied is in dollars per hectare.

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Additional Sampling Information

Fixed Area Sample Size

The fixed area plot size must be consistent by timber type and count plots are not permitted in fixed area plots. Border plots are permitted in fixed area plots.

The standard method is sampling in a finite population without replacement. Once a plot has been measured on 0.08 ha, this particular 0.08 ha is withdrawn from the population and it is not permitted to be sampled again. If the sampling intensity is greater than 5 percent of the total merchantable area the basic equation for determining the number of plots required is:

$$\frac{t^2 \times CV^2}{E^2} \left(\frac{N-n}{N} \right) \text{where}$$

t = probability factor

CV = coefficient of variation

E = error objective in percent

N = total possible number of plots in the sale

n = actual number of plots in the sale

$\frac{N-n}{N}$ = the finite population multiplier

By algebraic manipulation the above equation for number of plots required can be transformed into the more familiar form of:

$$n = \frac{t^2 \times CV^2 \times N}{N \times E^2 + t^2 \times CV^2} \text{where}$$

n = number of plots required and the other terms are as defined above.

This equation may also be used for plot sampling, but only if the sampling intensity is 5 percent or less.

When stratified sampling is used, an average weighted coefficient of variation must be determined. This value is used in the equation to calculate the total number of plots required. For example:

	Type Area		Area X	Proportional	Weighted CV
--	-----------	--	--------	--------------	-------------

	Type Area		Area X	Proportional	Weighted CV	
Type	Hectares	Av. Volume/ha	Av. Vol.	(Area x Vol)	CV	(P x CV)
F P1	12	272	3 264	0.43	30	12.9
P1	12	134	1 608	0.21	50	10.5
P1 F	16	171	2 736	0.36	40	14.4
	40		7 608	1.00		37.8

If this 40 ha timber sale is to be sampled with 0.1 ha plots and a sampling accuracy of *plus or minus* 15.0% at 2 SE, the required number of samples is:

$$\begin{aligned}
 n &= \frac{t^2 \times CV^2 \times N}{N \times E^2 + t^2 \times CV^2} = \frac{(2)^2 \times (38)^2 \times 400}{400 \times (15)^2 + (2)^2 \times (38)^2} \\
 &= \frac{4 \times 1444 \times 400}{400 \times 225 + 1444} = \frac{5776 \times 400}{90000 + 5776} = \frac{2310400}{95776} \\
 &= 24
 \end{aligned}$$

(Note N= 40 ha/ 0.1 ha = 400)

The probability factor (t=2.069) for n -1 (24-1=23) can be found in the Distribution of 't' table in the appendices.

This new probability factor (t) replaces t=2 and is then used to calculate a new "n", which equals 26. These 26 samples are then distributed among the three types as follows:

$$\begin{aligned}
 n_1 &= \frac{PCV_1}{PCV} \times n \text{ etc.} = F-P1; n = \frac{12.9}{37.8} \times 26 = 9 \\
 P1; n &= \frac{10.5}{37.8} \times 26 = 7 \quad P1-F; = \frac{14.4}{37.8} \times 26 = 10
 \end{aligned}$$

Exact estimates of type size, volume and coefficient of variation are not necessary in advance of cruising to predict sampling requirements. Reasonable approximations are sufficient (e.g. adjacent cruise information) to establish correct relative intensities of sampling for each type.

The sampling error objective (e.g., plus or minus 15 percent, 19 times out of 20) for scale based cruises is for the total net volume per hectare of the cutblocks, and the basis for estimating the number of samples required to meet this objective is the forest types within the area to be cut and their relative volumes.

Variable-Plot Sampling (Prism or Relaskop)

In Variable-Plot (prism) cruising, every tree has its own plot size because the radius of the plot varies directly with the DBH of the tree. The area of the plot is directly proportional to the basal area of the tree DBH it represents. Therefore, the relationship of the basal area of one tree to its plot area is the same as the relationship on a per hectare basis. Basal area per hectare, for a given prism, is the same for every tree in the plot regardless of its DBH or plot size.

Supporting mathematical calculations are as follows.

For a 5.0 diopter prism:

Basal Area Factor (m ² /ha)	=	6.25
Plot Radius Factor	=	0.2
DBH	=	30 cm
DBH	=	90 cm
Basal Area of a 30 cm tree	=	0.07069 m ²
Basal Area of a 90 cm tree	=	0.63617 m ²

The plot radius for a 30 cm tree = $0.2 \times 30 = 6.0$ m. Therefore, a 30 cm tree is counted if it falls within 6.0 m of the sample point.

The area of 6 m radius plot is 113.098 m² or 0.01131 ha, hence there are 88.425 plots per hectare. Therefore, one counted tree represents 88.425 trees per hectare and a basal area per hectare of 88.425×0.07069 or 6.25 m².

Similarly, a 90 cm tree has a plot radius of $0.2 \times 90 = 18.0$ m and an area of 1017.878 m² or 0.10179 ha. Hence there are 9.824 plots per hectare and one counted tree represents 9.824 trees per hectare and a basal area per hectare of 9.824×0.63617 or 6.25 m².

In the foregoing example, it is shown that each tree regardless of DBH, contributed 6.25 m² of basal area per hectare. The Basal Area Factor of the prism used was 6.25 m²/ha. Therefore, total basal area per hectare can be calculated directly by multiplying stem count per point x basal area factor. This value is all that can be calculated directly.

In order to obtain volume per hectare it is necessary to measure DBH on all or some of the samples. There are several possible methods of calculating volume per hectare, depending on the method of sampling used and the type of information required (e.g., total volume per hectare, volume per hectare by species).

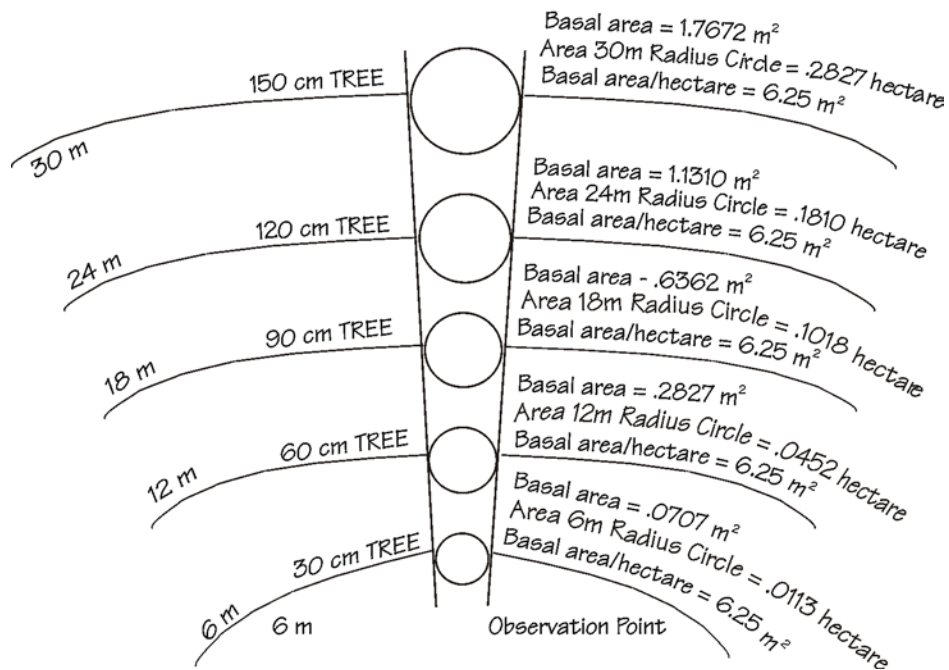


Figure A.1 Illustration of Basal Area/Hectare.

This figure shows why each tree tallied in a plot, regardless of its diameter, has an equal effect on the basal area per hectare. In this example, a 6.25 BAF (5.000 diopter) wedge prism was used, but any BAF or diopter size would still result in equal weighting for each tree.

Variable Plot Sample Size

The factors for selecting the prism basal area factor (BAF) are the size of the trees and the density of the stand.

Samples that include a small number of trees per point generally result in a higher variance than samples with larger numbers of trees. As the number of trees increase, a point is reached where a further decrease in basal area factor and a corresponding increase in tree count results in only a slight gain in precision. If a sample contains more than ten trees it is statistically inefficient because it only repeats the information that is obtained from a smaller sampling unit.

The choice of plot size (BAF) will influence the amount of sampling required to achieve the sampling error because sampling intensity depends on the coefficient of variation.

Prism sampling can be thought of as sampling in an infinite population, since there are an “infinite” number of prism points in the area to be cruised. Prism sampling can also be thought of as sampling in a finite population with replacement, since a given tree may be included in more than one sample. In either case the finite population multiplier is not required and the equation for determining the number of plots required becomes:

$$n = \frac{t^2 \times CV^2}{E^2}$$

t = probability factor

CV = coefficient of variation

E = error objective in percent

n = number of plots

A spreadsheet that can be used to calculate variable plot sample size can be accessed at the following website:

[Cruising Calculations](#)

Coefficient of Variation (CV)

The coefficient of variation is the standard deviation expressed as a percentage of the mean volume.

The coefficient of variation is unique for each timber type and may also vary with the timber merchantability specifications.

The coefficient of variation may be estimated from:

1. Plots previously measured in the same timber types.
2. A pre-cruise of the stand.
3. A general knowledge of the timber types to be harvested.

2. Option to calculate the conventional azimuth bearings from UTM Northing and Easting GPS readings:
 - a. select Survey Utilities,
 - b. select Mapping Plane Computation,
 - c. select Compute Grid Observations using the Inverse Problem,
 - d. input the Northing of the first GPS point under OCCUPIED,
 - e. input the Easting of the first GPS point under OCCUPIED,
 - f. input the Northing of the last GPS point under SIGHTED,
 - g. input the Easting of the last GPS point under SIGHTED, and
 - h. click on “Do Calculation” or hit the Enter key, and the program will calculate the azimuth bearing and the distance between the two GPS points.

There is a free MS-DOS executable file at this site that can be downloaded into your computer for future use.

3. Use the calculated bearing and distance between the first and last GPS points to close the conventional portion of the traverse and determine the closing error.
4. The closing error determined in Step 2 is used to determine if the traverse meets the closure error requirement in Section [3.5](#).

Cruise Compilation Loss Factor Table (Table 17)

The loss factor tables listed in this manual will be used for appraisal cruises. This list is the reference for Cruise Compilation and the auditing of Cruise Compilations. Refer to the following web utility to find the Forest Inventory Zone and Special Cruise Number to cross reference to Table 17.

Map View can be accessed on the Internet at:

<http://webmaps.gov.bc.ca/imfs/imf.jsp?site=mapview>

PSYU Cross Reference Procedure

1. Open MAPVIEW and follow one of the processes below:
 - a) If the block mapping information has been uploaded:
 - i) Find the Feature Search option from the 'Forest Tenures' tab (e.g. Tenure Cut Block, Tenure Harvest Authority, etc.). If you have access to FTA (Forest Tenures Administration) and the permit is in FTA, the cutblock screen has a link to MAPVIEW that will take you right to the block.
 - ii) Enter the search criteria and select search. Letters used in the licence and CP should be capitalized (i.e. A12345, not a12345).
 - b) If the block mapping information has not been uploaded, or if a search is being completed for information purposes:
 - i) Under the 'Navigation' tab, select one of the search functions or zoom to the desired location.
2. Once the cutblock or area of interest has been located, follow these steps:
 - a) Under the 'Navigation' tab, select 'Map Layers'.
 - b) Expand the 'Administrative Boundaries' category.
 - c) Select the boxes beside 'Public Sustained Yield Units - Outlined' and 'Forest Inventory Region Compartment- Outlined'.
 - d) Select the 'Identify' symbol at the top up the page (under navigation tab).
 - e) Click on the map location that you want to define.
 - f) The results are displayed on the left side of the map.
 - g) Among the results highlighted in blue at the left hand side of the map, there should be one or more 5 digit numbers for PSYU (e.g.10706). Select each number until the pop up screen indicates the Special Cruise Number under the 'Attributes' tab.
 - h) Find the SCN in the Tabular Listing of Table Numbers in Table 17. The corresponding administrative unit (e.g., PSYU #) and FIZ are listed on the same row.

TFL 48	All FIZ "L"
TFL 53	Naver locals for Hemlock, Balsam (<i>Abies</i> sp) and Spruce. All others FIZ "H, I"

Southern Interior Forest Region

TFL 15	All FIZ "D".
TFL 18	Raft locals for Cedar and Hemlock. All others FIZ "G".
TFL 33	Eagle locals for Cedar and Hemlock. All others FIZ "G".
TFL 35	All FIZ "D" or "G".
TFL 49	Area #1 (old TFL's 9 and 32) - Okanagan locals for Fir (<i>Pseudotsuga</i>), Cedar and Hemlock. All others FIZ "D". Area #2 (old TFL 16) - Kamloops local for Fir (<i>Pseudotsuga</i>). All others FIZ "D".
TFL 3	Slocan locals for Cedar and Hemlock. All others FIZ "G".
TFL 8	Kettle locals for Spruce and Lodgepole Pine. All others FIZ "E".
TFL 13	All FIZ "F".
TFL 14	Lardeau locals for mature Cedar and Hemlock. All others FIZ "G".
TFL 23 - as located South of Highway 1	Nakusp locals for Cedar and Hemlock. All others FIZ "G".
TFL 55	Arrowhead locals for Cedar and Hemlock. All others FIZ "G".
TFL 56	Arrowhead locals for Cedar and Hemlock. All others FIZ "G".
TFL 5	All FIZ "H".
TFL 52	Cottonwood locals for Cedar, Hemlock, Balsam (<i>Abies</i> sp.) and Spruce. All others FIZ "I".

A.17.2 Other Tenures

For all tenures other than TFL's the appropriate loss factor tables are determined as per: *Metric Diameter Class Decay Waste And Breakage Factors 1976*.

The only authorized exceptions are:

1. The deletion of Stum/Chilko locals for mature Lodgepole Pine. FIZ "H" factors now apply in the Stum and FIZ "B" or "H" in the Chilko PSYU.
2. The use of 10 percent decay, 0 percent waste and 5 percent breakage for all risk groups and diameter classes for cottonwood 41+ years in F.I.Z. A, B and C.
3. Special Cruise Number (SCN) #233 - is for Denman, Hornby, Gabriola, Valdes, Galiano, Thetis, Kuper, Mayne, Prevost, Saltspring, North Pender, South Pender, Saturna, Moresby, Portland, Sidney, James and the Saanich Peninsula. Use FIZ C and the Vancouver PSYU.

SCN #234 - is for the E&N Lands within the Quadra PSYU. Use FIZ B and the Quadra PSYU.

SCN #235 - is for the crown portion of the E&N Lands within the South Island Forest District and the Nootka PSYU with the exception of all the Gulf Islands. Use FIZ C and the Vancouver PSYU.

Note - The southern boundary between SCN#233 and SCN #235 runs from the head of **Finlayson** Arm west for a short distance and then approximately S30W by Empress Mountain and Bluff Mountain to just east of Shirley. The northern boundary between SCN #235 and SCN #234 runs along the boundary between the Nootka and Quadra PSYUs.

4. The Greater Vancouver Water District uses the Vancouver PSYU locals for hemlock and balsam (*Abies* sp.).
5. Those portions of the old TFL 23 block located north of Highway 1 and not included in TFL's 55 and 56 will use the Arrowhead PSYU loss factors.
6. Any cruises that are in the areas that overlap between the Purden and Longworth PSYUs will use the PSYU with the greatest amount of area in the cruise. Contact the Northern Interior Forest Region Cruising Coordinator for the region and compartment numbers that occupy the overlap areas.

All references are to mature factors unless otherwise indicated.

Damaged Stands (Appendix 6)

Trees are assigned damage codes for volume and value adjustments. Each tree is assessed and coded as it appears at the time of the cruise with no attempt to predict the future condition of the trees. Where damage is tallied, it will be compiled and reported.

Damaged tree volumes and LRF's are adjusted using the loss factors. In addition, the cruise compilation reports identify tree volume within the damage code categories to enable cost and value adjustments in appraisal.

Each code has a different effect in the compilation. Damage codes result in the modification of risk group and corresponding adjustments to net volume.

Depending on the patchiness of the damage, consider whether these patches should be treated as unique timber types when designing the sampling plan.

A.6.1 Pest Damage

The following insect damage codes apply to all appraisal cruises and will be entered in column 61 of the cruise tally sheet (Figure 4.1 Cruise Tally Sheet – FS 205C (front side)). Standard cruising methods as outlined in the *Cruising Manual* are to be followed with all beetle attack trees on the cutting authority coded with the appropriate Bark Beetle Code.

A.6.1.1 Bark Beetle Descriptions

The most common and destructive infestation the cruiser will encounter are caused by the following bark beetles:

Mountain pine beetle attacks Lodgepole, Ponderosa and White pine (however, Whitebark, Limber and exotic pines could also be infested).

Douglas fir beetle attacks Douglas fir and sometimes Western larch.

Spruce beetle attacks mainly White and Engelmann spruce in the Interior.

Western pine beetle attacks Ponderosa pine.

Western balsam bark beetle attacks mainly Subalpine fir (*Abies lasiocarpa*).

See the following website for photos and descriptions of common forest pests:

https://www2.qa.gov.bc.ca/assets/gov/environment/air-land-water/land/forest-health-docs/field_guide_to_forest_damage_in_bc_web.pdf

A.6.1.2 Attack Codes for Balsam (*Abies* sp.), White Pine, Yellow Pine and Lodgepole Pine

Code	Description
1	Green Attack
2	Red Attack
3	Grey Attack

These attack codes (based on crown and bole symptoms) are applicable to the following insects:

- The mountain pine beetle (*Dendroctonus ponderosae*) and the lodgepole pine beetle (*Dendroctonus murrayanae*) in lodgepole pine (*Pinus contorta*-PL), yellow pine (*Pinus ponderosa*-PY) and white pine (*Pinus monticola*-PW).
- The western pine beetle (*Dendroctonus brevicomis*) in yellow pine (*Pinus ponderosa*-PY).
- The western balsam bark beetle (*Dryocoetes cofusus*) in alpine fir (*Abies lasiocarpa*-BL).

Green Attack Code 1

Since the mountain pine beetle and the western pine beetle normally complete their life cycles in one year, the Green Attack code will represent trees that have been infested ten to twelve months or less. The crown is green but pitch tubes are evident on the lower bole and the inner bark will contain characteristic gallery patterns and immature stages of the beetles. Successfully attacked trees usually die within a few weeks following initial attack even though their crowns may stay green up to twelve months. How long the crown of an infested tree stays green depends on climate, soil, topography and tree species. White pine and yellow pine infested by mountain pine beetle often start discolouring by fall or mid-spring.

Damage Code E

- Uprooted
- Uprooted with one clean break.
- Standing and one clean break in the bottom or middle third.
- Standing and any shattered breaks in the middle third.

A clean break is shorter in length than the diameter of the stem at the break. The compilation program will assign the risk group by tree class and pathological indicators.

A tree with a break below stump height will be considered uprooted.

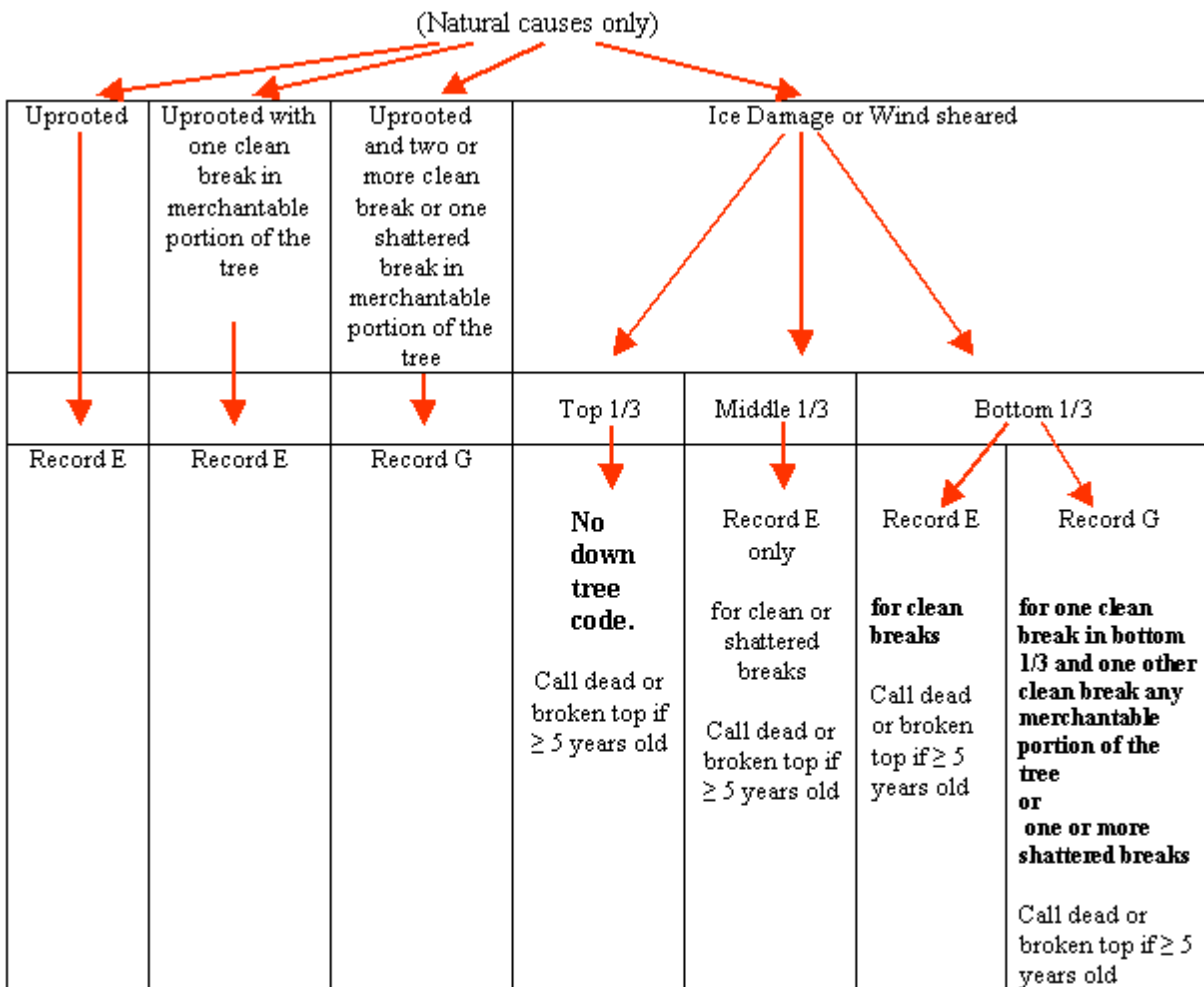
Damage Code G

- Uprooted with more than one clean break .
- Uprooted with any shattered breaks.
- Standing with any shattered break in the bottom third.
- Standing with one clean break in the bottom third and an additional break in the merchantable portion of the tree.

A shattered break is longer in length than the diameter of the stem at the break. The length of shatter is measured from stump height (*i.e.* only the length of the shatter in the merchantable portion of the stem is considered). The compilation program will down grade these trees to the highest risk group.

If the tree is partially uprooted or broken and supported by another standing tree, assign the appropriate down tree code (except Tree Classes 4 and 6). Blowdown codes are not assigned to Tree Class 4 or 6 trees.

If a shatter extends through DBH and either the standing or down portion of the tree fall outside of the plot, use the portion of the tree with greater than 50% of the basal area at breast height to determine if the tree is “in” or “out” and assign applicable damage codes (See Section 4.3.1.15).



Note: Record all trees in plot if DBH is in the plot (natural or man influenced)
 Damage codes can only be recorded for natural occurrences. No codes for hand felled or mechanical influences.
 Do not record uprooted TC 4 or TC 6

Figure A.4 Damage Call Matrix for Uprooted, Ice Damaged and Wind Sheared Trees

Ten Meter Log Table

The purpose of these tables is to assist timber cruisers in calculating the 50% firmwood threshold for dead potential trees. Timber cruisers may choose to either use a general or species/maturity specific table to calculate the 50% firmwood threshold, but should document which tables they use.

The following gross 10m log volume table is a general table for all species and top size based on a weighted average volume for a range of 10cm DBH classes and 5m tree height classes.

Volume % by 10m Log						
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6
15	96	4				
20	84	16				
25	72	27	1			
30	65	30	5			
35	57	31	11	1		
40	52	31	15	2		
45	49	29	17	5		
50	46	28	18	7	1	
55	42	27	19	10	2	
60	40	25	19	11	4	1

The following tables are specific to species, maturity and top size.

Douglas Fir/Larch/White Pine							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	97	3					100
20	81	19					100
25	69	31					100
30	60	34	6				100
35	53	33	14				100
40	47	32	18	3			100
45	43	30	20	7			100
50	40	28	20	10	2		100
55	38	27	20	12	3		100
60	35	25	20	13	6	1	100

Douglas fir used to generate the table.

Western & Mountain Hemlock							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	85	15					100
25	74	26					100
30	65	31	4				100
35	56	34	10				100
40	51	32	15	2			100
45	47	31	17	5			100
50	44	30	18	7	1		100
55	43	28	18	9	2		100
60	39	27	19	11	4		100

Western hemlock used to generate the table.

Spruce							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	85	15					100
25	74	26					100
30	65	30	5				100
35	58	31	11				100
40	52	31	15	2			100
45	47	30	17	6			100
50	43	28	19	9	1		100
55	45	27	17	9	2		100
60	42	25	18	10	4	1	100

Sitka spruce used to generate the table.

Cypress							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	83	17					100
25	72	28					100
30	64	31	5				100
35	59	30	11				100
40	53	30	15	2			100
45	49	28	18	5			100
50	46	27	18	8	1		100
55	43	26	18	10	3		100

50	48	28	16	7	1		100
55	48	27	16	7	2		100
60	45	26	17	9	3		100

Lodgepole pine used to generate the table.

Deciduous							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	87	13					100
25	76	24					100
30	68	29	3				100
35	59	31	10				100
40	54	31	14	1			100
45	48	31	17	4			100
50	44	29	18	8	1		100
55	48	27	17	7	1		100
60	43	27	17	9	3	1	100

Alder/Aspen/Maple/Cottonwood used to generate the table.

Douglas Fir/Larch/White Pine							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	84	16					100
25	70	30					100
30	61	34	5				100
35	53	34	13				100
40	47	32	18	3			100
45	43	30	20	7			100
50	40	28	20	10	2		100
55	38	27	20	12	3		100
60	35	25	20	13	6	1	100

Douglas fir used to generate the table.

Western & Mountain Hemlock							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	85	15					100
25	74	26					100

30	65	31	4				100
35	56	34	10				100
40	51	32	15	2			100
45	47	31	17	5			100
50	44	30	18	7	1		100
55	43	28	18	9	2		100
60	39	27	19	11	4		100

Western hemlock used to generate the table.

Spruce							
10m Log % - 15cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	88	12					100
25	76	24					100
30	66	30	4				100
35	59	31	10				100
40	53	31	15	1			100
45	47	30	18	5			100
50	44	28	19	9			100
55	45	27	17	9	2		100
60	42	26	18	10	4		100

Sitka spruce used to generate the table.

Cypress							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	86	14					100
25	73	27					100
30	65	31	4				100
35	59	31	10				100
40	53	30	15	2			100
45	49	28	18	5			100
50	46	27	18	8	1		100
55	43	25	18	11	3		100
60	40	24	18	12	5	1	100

Cypress used to generate the table.

Western Red Cedar						
10m Log % - 15cm Top (Coast Mature)						

Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	90	10					100
25	77	23					100
30	68	29	3				100
35	61	30	9				100
40	55	29	15	1			100
45	52	28	16	4			100
50	53	26	15	6			100
55	49	25	16	8	2		100
60	46	24	16	10	4		100

Western red cedar used to generate the table.

Balsam							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	86	14					100
25	72	28					100
30	62	33	5				100
35	55	33	12				100
40	49	33	16	2			100
45	45	31	18	6			100
50	42	30	19	8	1		100
55	40	28	19	10	3		100
60	37	27	19	11	5	1	100

Balsam genus used to generate the table.

Lodgepole, Ponderosa and Whitebark Pine							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	89	11					100
25	76	24					100
30	69	28	3				100
35	60	30	10				100
40	53	30	15	2			100
45	50	29	16	5			100
50	43	28	19	9	1		100
55	48	27	16	7	2		100
60	45	26	17	9	3		100

Lodgepole pine used to generate the table.

Deciduous							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	91	9					100
25	77	23					100
30	67	29	4				100
35	59	32	9				100
40	53	32	14	1			100
45	48	31	17	4			100

50	44	29	19	8			100
55	46	26	16	11	1		100
60	44	27	17	9	3		100

Alder/Aspen/Maple/Cottonwood used to generate the table.

Distribution of "t"

Degrees of Freedom	0.05 (95 % Confidence Interval)
1	12.706
2	4.303
3	3.182
4	2.776
5	2.571
6	2.447
7	2.365
8	2.306
9	2.262
10	2.228
11	2.201
12	2.179
13	2.160
14	2.145
15	2.131
16	2.120
17	2.110
18	2.101
19	2.093
20	2.086
21	2.080
22	2.074
23	2.069
24	2.064
25	2.060
26	2.056
27	2.052
28	2.048
29	2.045
30	2.042
31 – 67	2.000
68 – 112	1.980
113 +	1.960

